INTEGRATED DEVELOPMENT PLAN AND FEASIBILITY STUDY FOR URBAN SANITATION, DRAINAGE AND SOLID WASTE MANAGEMENT IN CHIMOIO MUNICIPALITY

ENVIRONMENTAL IMPACT ASSESSMENT

FINAL REPORT

VOLUME I

JUNE 2023

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ENVIRONMENTAL IMPACT STUDY

FINAL REPORT

VOLUME I

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ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
AdM	*Águas de Moçambique*
AfDB	African Development Bank
AIAS	*Administração de Infra-estruturas de Abastecimento de Água e Saneamento* / Water Supply and Sanitation Infrastructures Management
AIDS	Acquired Immune Deficiency Syndrome
ANAC	*Administração Nacional das Áreas de Conservação* / Conservation Areas National Administration
ANE	*Administração Nacional de Estradas* / National Roads Administration
AQUA	*Agência Nacional para o Controlo da Qualidade Ambiental* / National Agency for Environmental Quality Control
ASOS	Automated Surface Observing System
AWF	African Water Facility
BOD	Biochemical Oxygen Demand
CAMS	Copernicus Atmosphere Monitoring Service
CCL4	Carbon tetrachloride
CFC	Chlorofluorocarbons
CIP	Climate Information Platform
CNCS	*Conselho Nacional de Combate ao VIH/SIDA* / National Council for Combating HIV/AIDS
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CR	Critically Endangered
CRA	*Conselho de Regulação de Água* / Water Regulatory Council
Ct	Traffic saturation level
DAI	Direct Area of Influence
dB	Decibel
DEP	*Departamento de Estradas e Pontes* / Roads and Bridges Department
DINAB	*Direcção Nacional do Ambiente* / National Environment Directorate
DNAAS	*Direcção Nacional de Abastecimento de Água e Saneamento* / National Directorate of Water Supply and Sanitation
DNIT	*Departamento Nacional de Infra-estruturas de Transportes* / National Department of Transport Infrastructure
DNTOT	*Direcção Nacional de Terras e Ordenamento Territorial* / National Directorate of Land and Territorial Planning
DPDTA	*Direcção Provincial de Desenvolvimento Territorial e Ambiente* / Provincial Directorate of Territorial Development and Environment
DTAS	*Directiva Técnica para a Implantação e Operação de Aterros Sanitários em Moçambique* / Technical Directive for the Implementation and Operation of Landfills in Mozambique
DUAT	*Direito de Uso e Aproveitamento da Terra* / Land Usage and Exploration Rights
EDM	*Electricidade de Moçambique, S.A.*
EP	Primary Education
EPC	Full Primary Education
EPDA	Environmental Pre-Feasibility Study and Scoping
ESIA	Environmental and Social Impact Assessment

Acronym	Meaning
ESIS	Environmental and Social Impact Study
ESMP	Environmental and Social Management Plan
FAO	Food and Agriculture Organization of the United Nations
FE	*Fundo de Estradas* / Road Fund
FIPAG	*Fundo de Investimento e Património de Abastecimento de Água* / Water Supply Investment and Assets Fund
GdM	*Governo de Moçambique* / Government of Mozambique
GHG	Greenhouse Gas
Ha	Hectare
IAI	Indirect Area of Influence
I&APs	Interested and Affected Parties (Stakeholders)
ICA	Integrated Context Analysis
IFC	International Finance Corporation
INE	*Instituto Nacional de Estatística* / National Institute of Statistics
IPDSA	*Instituto de Planeamento e Desenvolvimento Sustentável* / Institute for Planning and Sustainable Development
ISS	*Instituto de Segurança Social* / Social Security Institute
STI	Sexually Transmitted Infection
ITCZ	Intertropical Convergence Zone
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
MAE	*Ministério da Administração Estatal* / Ministry of State Administration
MDGs	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MICOA	*Ministério para a Coordenação da Acção Ambiental* / Ministry for the Coordination of Environmental Action
MICULTUR	*Ministério da Cultura e Turismo* / Ministry of Culture and Tourism
MITADER	*Ministério da Terra, Ambiente e Desenvolvimento Rural* / Ministry of Land, Environment and Rural Development
MOPHRH	*Ministério das Obras Públicas, Habitação e Recursos Hídricos* / Ministry of Public Works, Housing and Water Resources
MTA	*Ministério da Terra e Ambiente* / Ministry of Land and Environment
NAPA	National Action Program for Adaptation to Climate Change
ND	Nominal Diameter
NO_2	Nitrogen Dioxide
NTS	Non-Technical Summary
O_3	Ozone
OS	AfDB Operational Safeguard
PM10	Particles of equivalent diameter up to 10 µm
PM2.5	Particles of equivalent diameter up to 2,5 µm
PPE	Personal Protective Equipment
PPP	Public Participation Process
PS	Performance Standard

Acronym	Meaning
PS	Pumping Station
SES	*Estudo Ambiental Simplificado* / Simplified Environmental Study
SEP	Stakeholder Engagement PLan
SO_2	Sulphur Dioxide
SPA	*Serviço Provincial do Ambiente* / Provincial Environment Service
ToR	Terms of Reference
TSP	Total Suspended Particulates
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USD	United States Dollars
USEPA	United States Environmental Protection Agency
USP	Urban Structure Plans
USW	Urban Solid Waste
WCS	Wildlife Conservation Society
WHO	World Health Organization
WWTP	Wastewater Treatment Plant

1 Introduction

1.1 General Considerations

The Administration of Water and Sanitation Infrastructures (hereinafter referred to as AIAS) prepared the Integrated Development Plan for Urban Sanitation, Drainage and Waste Management for the cities of Chimoio and Inhambane and their respective Feasibility Study (the Project).

The Project is financed by the African Development Bank (ADB) and other partners, as part of an African Water Facility[1] (AWF) program to combat climate change, and by the Government of Mozambique (GdM), through the Ministry of Public Works, Housing and Water Resources (MOPHRH).

Thus, the main objective of the proposed project is to design and assess the viability of an Integrated Urban Sanitation, Drainage and Waste Management Project in order to improve the resilience, as well as the environmental sanitation conditions in the cities of Chimoio and Inhambane. This will be achieved by improving sanitation, drainage and solid waste management services, which will have an impact on reducing the risk of flooding, as well as improving sanitation and public health conditions.

To obtain the Environmental License for the project, required under provisions of the Environmental Law (Law No. 20/1997, from 01 of October) and the Regulation on the Environmental Impact Assessment Process (Decree No. 54/2015, from 31 of December), the proponent must submit the project to an Environmental Impact Assessment (EIA) Process.

Consultec - Consultores Associados, Lda (Consultec), an EIA consultant duly registered with the Ministry of Land and Environment (MTA) (**Appendix I**), was hired by AIAS (the proponent) to coordinate the EIA process.

Thus, and continuing the EIA process, having been approved the Environmental Pre-Feasibility Study and Scoping (EPDA) report and the Terms of Reference (ToR) of the Environmental and Social Impact Assessment (ESIA) through the letter with Ref No. 165/MTA/183/GM/220/21 - this document corresponds to the Project Preliminary ESIA Report.

1.2 Project Proponent

The Project Proponent is **AIAS**, a public entity under the supervision of MOPHRH responsible for managing secondary public water distribution systems and the systems allocated to them, as well as public wastewater drainage systems, promoting their autonomous management, efficient and operational. The proponents contact details are given in Table 1.1.

[1] An initiative from the African Ministers' Council on Water (AMCOW) to mobilise resources to finance water resources development activities in Africa. This body is based in, and managed by, the African Development Bank (AfDB).

Table 1.1– Proponent's contact details

Project Proponent	Administração de Infraestruturas de Água e Saneamento – AIAS
Address	Eduardo Mondlane Av. 1352, 4th Floor Maputo, Mozambique
Contact Person	Celso Nhantumbo
Contact Number	+258 21321838
Contact e-mail	n.hant@hotmail.com

1.3 Environmental Consultant

The ESIA process is being managed by **Consultec – Consultores Associados, Lda.** Consultec is a Mozambican company based in Maputo and registered as an Environmental Consultant with MITA (see Table below for additional details).

Table 1.2 – Environmental consultant relevant contact details

Environmental Consultant	Consultec		
Address	Tenente General Oswaldo Tazama Str. 169 Maputo, Mozambique		
Contact Person	Décio Camplé		
Contact Number	+ 258-21-491 555	**Fax Number**	+ 258-21-491-578
Contact e-mail	mailto:dcample@consultec.co.mz		

Members of the ESIA team responsible for drafting this report, their relevant experience and roles within the team are listed in Table 1.3.

Table 1.3 – ESIA report team members

Name	Role	Qualifications and Experience
Tiago Dray	Project Director (Consultec)	Honours degree in Biology. Director at Consultec and overall manager of the environmental department.
Décio Camplé	Project Manager and Lead Environmental Specialist, public participation process	Master in Agribusiness Management and Honours degree in Environmental Engineering. 15 years' experience in environmental consultancy.
Miguel Barra	Air Quality, Noise and Climate Change	Honours degree in Environmental Engineering. 22 years' experience.
Susana Paisana	Geology, Soils and Water Resources	Honours degree in Geology. 22 years of experience in environmental consultancy.
Marta Henriques	Biodiversity	Honours degree in Biology and Post-graduate in Environmental Management Policies, 19 years of experience.
Rafael Noronha	Socioeconomy	Masters degree in Social Management and Policy. 13 years of experience in environmental consultancy.
Issufo Adade	Specialist in Geographic Information Systems (GIS)	Degree in Computer Science. 3 years of experience.
Manuel Namurro	Traffic Study	Degree in Civil Engineering (structures). 24 years of experience.

1.4 ESIA Report Objectives and Structure

The purpose of this ESIA is to develop and present relevant information to support the decision-making process regarding the issuance of an environmental license for the proposed activity by the environmental authority. According to Article 11 of the EIA Regulation (Decree No. 54/2015, of December 31), the EIAS Report must include the following information:

- Legal framework for the proposed activity;
- Description of the proposed activity, considering all stages of its life cycle;
- Detailed description and comparison of project alternatives;
- Definition of areas of influence of the activity;
- Description of the reference environmental and social conditions in the areas of influence;
- Identification and assessment of the impacts of the activity;
- Definition of the necessary mitigation measures, in order to avoid, reduce or compensate negative impacts and optimize positive impacts; and
- Elaboration of an Environmental and Social Management Plan (ESMP) for the activity, including monitoring programs, if relevant.

The main functions of an ESIS include: an assessment of the reference environmental conditions in the areas of influence of the project, carried out through specialized studies defined in the ToR of the EPDA, assessment of impacts and definition of mitigation measures, and compilation of an EMP, which includes monitoring actions.

In addition to the functions described above, the ESIS phase also includes a Public Participation Process (PPP) to provide an opportunity for Interested and Affected Parties (I&APs) to review and comment on the Project and the ESIS. This ESIS draft Report has been compiled to support the public consultation activities of the ESIS phase. The results of the ESIS PPP will then be fed into the Final ESIS Report, which will be submitted to the MTA for review and approval.

The structure of this EIAS Report is presented in Table 1.4 below.

Table 1.4 – ESIS report structure

Volume	Content
Volume I	**Introduction** It presents general information regarding the Project under analysis, the scope and objectives, the Proponent and the technical team of the Environmental Consultant responsible for its elaboration, investment value, and describes the objectives and structure of the ESIA.
	Legal and Administrative Framework It summarizes the legal framework under which the ESIA was developed and identifies other relevant environmental and social legislation, standards and guidelines applicable to the Project. **ESIA Approach and Methodology** It describes the assumptions and methodologies for carrying out the ESIA Process. **Project Description** It presents a detailed description of the proposed Project, its components and relevance.
	Project Alternatives Studied It presents the different alternatives to the Project, namely in terms of location and technology.

Volume	Content
	Project Areas of Influence Defines the areas of direct and indirect influence of the Project.
	Environmental and Social Baseline It presents the description of the biophysical and socioeconomic characterization of the Project area.
	References Lists the report cited references.
Volume II	**Impact Assessment and Mitigation Measures** Identification and assessment of the Project's potential environmental and social impacts and proposal of mitigation or potentiation measures for each assessed impact.
	Conclusions and Recommendations It presents the conclusions and recommendations of the ESIS report.
Volume III	**Environmental and Social Management Plan (ESMP)** Presents the ESMP proposed for the Project under analysis.
Volume IV	**Public Participation Process** Describes the PPP carried out in the ESIS phase and presents a proposed methodology for the PPP in the EIAS phase.
Volume V	**Physical and Socioeconomic Survey Report** Describes the results of the Physical and Socioeconomic Survey Report undertaken in the project affected areas.

2 Legal and Administrative Framework

2.1 Introduction

The EIA Process was developed in accordance with the requirements of Mozambican legislation and relevant international standards, namely the African Development Bank (AfDB), World Bank (WB) and International Finance Corporation (IFC). This Chapter presents the national and international legal framework applicable to the proposed Project, including:

- National Development Framework: national development and strategic plans with relevance to the proposed Project (see section 2.2);
- Institutional Framework: relevant governmental institutions and authorities with jurisdiction over the Project or over relevant environmental or social aspects (see section 2.3);
- Legislative Framework: legal requirements which are relevant for the Project's impact assessment (see section 2.4);
- International Best Practice Guidelines and Policies (see section 0).

2.2 National Development Framework

2.2.1 National Development Strategy (2015-2035)

The National Development Strategy (2015-2035), approved in July 2014 (GoM 2014), defines the Government of Mozambique's (GoM) main development strategies to achieve the goal of "*raising its people's quality of life through the structural transformation of the economy and the expansion and diversification of the production base*".

The National Development Strategy believes that industrialisation, grounded in an inclusive and sustainable growth model, is the main way to achieve Mozambique's vision of prosperity and competitiveness. To materialise industrialisation, the strategy defines four main development pillars, namely:

- Human capital development;
- Infrastructure development;
- Research, innovation and technological development; and
- Institutional coordination and articulation.

With regards to infrastructure development, the strategy considers that massive investment in the infrastructure sector is required and is a determinant factor for economic growth. As such, the strategy lists the main infrastructure that should be the focus of investment, including:

- Logistics - transport and storage infrastructure (the latter with a focus on storage of agricultural, fisheries, mineral and hydrocarbon products);
- Maritime cabotage for cargo transport at long distances;
- Power generation, including alternative energy sources;
- Natural gas supply systems;

- Sustainable management of water resources;
- Social infrastructure; and
- Tourism infrastructure.

The Project under assessment proposes an Integrated Development Plan and Feasibility Study for Urban Sanitation, Drainage and Solid Waste Management in Chimoio, which is in full alignment with the infrastructure development strategic goals, as defined in the National Development Strategy for the 2015-2035 period.

2.2.2 National Urban Water and Sanitation Strategy (2011-2025)

The objective of the Urban Water and Sanitation Strategy is to guide the effective implementation of the main objectives of the Water Policy in these areas. As such, in the water supply field, the objective is to reach the medium-term goal (2015) defined by the GoM within the scope of the Millennium Development Goals (MDG), of 70% coverage, serving around 6.6 million people; and in the long term (2025), achieving universal coverage and ensuring sustainability. The objectives of sanitation in urban areas are to increase coverage by 2015, to approximately 67%, representing about 6.3 million people, and in 2025 it will gradually approach universal coverage.

The achievement of these goals depends on the simultaneous achievement of institutional development objectives, with a view to increasing the efficiency of the systems to ensure that, in the medium term, communities served by a safe and reliable water supply system have access to an appropriate sanitation service in each house.

The project under assessment works towards this national strategy's objectives, in the sense that once implemented, it will improve water sanitation conditions in the Chimoio urban area.

2.2.3 Integrated Management Strategy for Urban Solid Waste in Mozambique (2013-2025)

Created in 2012 by the then Ministry for the Coordination of Environmental Action (MICOA), now MTA, this strategy emerges as a contribution to the improvement of waste management and the sanitation of the environment, for the well-being of the citizen through the prevention of its proliferation, improvement of collection, transport and final disposal systems of the said waste.

The strategy aims to provide the basis for an integrated solid waste management in Mozambique, taking into account a systematic approach focused on the components of minimizing the production, conditioning, collection, transport, treatment and final disposal of waste, in order to protect public health and the environment, and therefore contribute to fighting poverty, providing guidelines to create the necessary conditions for the prevention of the proliferation of solid waste in cities and towns, defining the role of each actor in the management of solid urban waste, including the State, the Municipality and Municipal bodies, and including the construction of sanitary landfills and the improvement of waste collection and final disposal services.

The strategy is divided into four parts, the fourth of which presents the action plan for operationalization of the objectives adopted to reverse the situation, providing working tools to respond to GoM priorities for implementation of the strategy in the period 2013 - 2025. Regarding its

scope, the strategy applies only to the integrated management of Urban Solid Waste (USW), excluding hazardous, toxic industrial and biomedical and electronic solid waste, which require special conditions not addressed in the strategy.

2.2.4 National Action Program for Climate Change Adaptation

Created by MITA in 2007, the National Action Program for Climate Change Adaptation (NAPA) aims to coordinate the elaboration and implementation of an action plan for adaptation to climate change for various economic and social development sectors, with an emphasis on disaster risk reduction, early warning systems, agriculture, fisheries, energy, water resources, ecosystems, and coastal zones.

In preparation for the NAPA, the most vulnerable regions, sectors and communities to the adverse effects of climate change (floods, droughts and tropical cyclones) and poverty were consulted and prioritised.

This Plan is in line with the proposed project given that it provides a response solution for the drainage, sanitation and waste management issues identified in Chimoio Municipality, which has been worsen due to the fact that the existing infrastructures are old, obsolete and do not cover the majority of the municipal area.

2.3 Institutional Framework

2.3.1 Infrastructure Sector

The **Ministry of Public Works, Housing and Water Resources** was created by Presidential Decree 18/2015, of 8th April (GoM 2015) and is the entity responsible for ensuring government's activities related to public works, housing, urbanisation, construction industry and water resources and sanitation.

The **National Directorate of Water Supply and Sanitation** (DNAAS) is an administrative and non-autonomous authority responsible for investment programs and implementation of management frameworks in secondary water supply systems.

The **Water Regulation Council** (CRA), created in 1998, regulates the water supply and sanitation sectors, and is responsible for ensuring the quality of water supply and sanitation services to all stakeholders, the interests of users, as well as the economic sustainability of its systems. It is also the CRA's responsibility to approve applicable tariffs to achieve economic sustainability of the sector, mainly in the suburbs.

Administration for Water and Sanitation Infrastructure Management (AIAS), is a public entity under the tutelage of the MOPHRH, tasked with the promotion of autonomous, efficient, and financially sustainable management of public water supply and sanitation systems.

The **Water Supply Investment and Assets Fund** (FIPAG), it is a public entity responsible for water supply investment programs and the implementation of the delegated management framework in

large urban water supply systems (supplying the provincial representative cities and strategic urban areas).

2.3.2 Environmental Authorities

In 1995, the National Environmental Policy was approved by the Council of Ministers, through Resolution No. 5/95, of 3 August (GdM, 1995a), with the main objective of ensuring the sustainable development of the country. This policy reinforced the role of the former Ministry of the Environment as the entity responsible for coordinating, advising, monitoring and evaluating the degree of use of national resources in the country, and ensuring the integration of environmental considerations in the process of planning and managing socio-economic development.

The **Ministry of Land and Environment** (MTA), established by Decree No. 1/2020 of 17 January (GdM 2020a), is the central authority that oversees environmental issues. The main functions and objectives of the MTA were established by Decree No. 4/20, of February 7 (GdM 2020). The MTA is the authority responsible for coordinating, at national level, all activities related to the environment, and promotes the management, preservation and rational use of Mozambican natural resources. The MTA is also responsible for proposing environmental policies and strategies, to be integrated into sectoral plans.

With regard to the EIA Process, the MTA has the following attributions:

- Make decisions regarding the EIA Process and environmental licensing at central level, through the National Directorate for the Environment (DINAB), and at provincial level through the Provincial Environment Services (SPA), including:
    - Project categorization;
    - Analysis and approval of documents and reports within the scope of the EIA process - EPDA, and REIA (Categories A^+ and A), TOR and Simplified Environmental Study (EAS) (Category B), PGAS (Categories A+, A, and B), and Good Environmental Management Practice Procedures (Category C);
    - Issuance of Environmental Licenses.

Issues related to resettlement and compensation are under the responsibility of the **National Directorate for Land and Territorial Development** (DNTDT), at national level, and the **Provincial Directorate for Territorial Development and Environment** (DPDTA) at provincial level. The DPDTA also has competences in the field of climate change.

The **National Agency for the Control of Environmental Quality** (AQUA) was created by Decree 80/2010 of 31st December (GoM 2010a) and amended by Decree 2/2016 (GoM 2016a), and is tasked, among other attributions, with the development and implementation of strategies for the integrated control of water, air and soil pollution.

The **National Administration of Conservation Areas** (ANAC) was created by Decree 9/2013 of 10th April, revised by Decree 8/2016 of 15th April, with the objective of ensuring the implementation of biodiversity conservation policies and managing conservation areas, among others.

The **National Directorate for Cultural Heritage** (formerly the National Council for Cultural Heritage), under the authority of the Ministry of Culture and Tourism (MICULTUR), was created with the aim of promoting the study, preservation, enhancement and management of tangible and intangible cultural heritage, according to national and international standards, through Decree No. 27/94, of 20 July.

2.3.3 Municipal Authorities

Municipal authorities in Mozambique are responsible for a number of service provisions within city limits, including urban infrastructure, social and economic services and regulating private sector activities. In terms of infrastructure, the public drainage system includes both surface and sanitary drains and, according to Decree 33/2006, the municipalities have the competency related to planning and implementation of investments and management of facilities supporting municipal drainage systems and the treatment of urban wastewater and surface water (Helling and SAL e caldeira 2009). Notwithstanding this legal instrument and the implicit policy for decentralisation of drainage functions to *autarquias*, it remains common that state institutions, namely the Ministry of Public Works and Water Resources and its provincial directorates, continue to intervene directly in resolving urban drainage problems.

In terms of services, solid waste removal (collection, transport and disposal on urban solid waste) is the responsibility of **Municipal Councils** and **District Governments**, in their respective areas of jurisdiction. Thus, the municipalities are responsible for the collection and transport of non-dangerous urban solid wastes, employing the proper means, methods, and collection processes, based on what is technically relevant in each situation to guarantee hygienic conditions so as not to endanger public health and the environment (Helling & SAL e Caldeira, 2009).

2.4 Legislative Framework

The Constitution of the Republic of Mozambique (GoM 1990) defines the right of all citizens to a balanced environment and the duty to protect it (Article 90). Additionally, the State is required to ensure: *(i)* the promotion of initiatives to ensure ecological balance and environmental preservation, and *(ii)* the implementation of policies to prevent and control pollution and integrate environmental concerns in all sectorial policies to guarantee the citizen the right to live in a balanced environment supported by sustainable development (Article 117).

The proposed Project must comply with the legal requirements for environmental licensing, taking into consideration not only the specific ESIA regulations but also all the applicable environmental regulation (biophysical and social) that may be relevant to the Project throughout its life cycle (construction, operation and demobilisation).

Environmental instruments and regulations relevant to the proposed Project EIA are discussed in Table 2.1.

Table 2.1 – Key environmental legislation

Legislation	Description	Relevance
ENVIRONMENTAL IMPACT ASSESSMENT		
Resolution 5/95 - National Environmental Policy (GoM 1995a)	Establishes the basis for all environmental legislation. According to clause 2.1, its main goal is to ensure sustainable development to maintain an acceptable balance between socio-economic development and environmental protection. To reach that goal, this Policy requires, among other requirements, the integration of environmental considerations in the socioeconomic planning, the management of the country's natural resources and the protection of ecosystems and of the essential ecological processes.	The Project shall aim to achieve policy objectives by integrating environmental considerations into engineering design to minimize impacts on natural resources and ecosystems. The environmental and social assessment carried out within the scope of this EIA includes contributions with the objective of ensuring the environmental sustainability of the project in all its phases.
Law 20/97 - Environmental Law (GoM 1997a)	Defines the legal basis for the sound use and management of the environment towards the sustainable development of the country. The Environmental Law applies to all public and private activities that may directly or indirectly affect the environment.	The Project should strive to meet the sustainable development principle defined by the Environmental Law, throughout its life cycle. This ESIA is part of that effort.
Decree 54/2015 - Regulation for Environmental Impact Assessment (GoM 2015b)	Establishes the EIA process as one of the fundamental instruments for environmental management, aimed at mitigating the negative impacts of public and private sector projects on the natural and socio-economic environment, by carrying out environmental studies before the start of the project. It defines the EIA process, the necessary environmental studies, the PPP, the study review process and the decision process on environmental feasibility and the issuance of an environmental license. It applies to all public or private activities with a direct or indirect influence on the environment.	The Project must undergo a formal EIA process, in accordance with this regulation. An environmental license must be obtained from the MTA, and the issuance of this license precedes any other license or authorization required for the Project. This EIA process complies with the requirements of the legislation and is essential for environmental licensing.
Decree 25/2011 - Regulation on the Environmental Audit Process (GoM 2011)	Defines an environmental audit as a documented and objective instrument for management and systematic assessment of the management system and relevant documentation implemented to ensure protection of the environment. Its objective is to assess compliance of work and operational processes with the environmental management plan, including the environmental legal requirements in force, as approved for a particular project.	Throughout the Project's lifecycle, the Proponent should conduct independent environmental audits at least once a year, without prejudice to the public environmental audit that may be requested under this decree. The recommendation to develop independent audits will be included in the Environmental and Social Management Plan (ESMP).
Decree 11/2006 - Regulation for Environmental Inspections (GoM 2006)	Regulates the supervision, control and verification of compliance with environmental protection rules at a national level.	During the construction or operational phases of the Project, MITA may undertake inspections to ascertain compliance with environmental legislation and the ESMP. The Proponent must allow for and facilitate such inspections.
Technical Directive for the Implementation and Operation of Sanitary Landfills in Mozambique. (MICOA, 2010)	The Technical Directive for the Implementation and Operation of Sanitary Landfills (DTAS) aims to provide Municipal Councils in the country with a manual of procedures for the Installation and Operation of Sanitary Landfills or controlled landfills, in accordance with the following steps: I. The selection of appropriate locations; II. The feasibility study; III. The Environmental Impact Assessment; IV. The construction and operation of new areas for the final disposal of solid waste; V. The closure and rehabilitation of the deposition area; SAW. Monitoring the area once closed.	Projects relating to controlled landfills are subject to environmental licensing and environmental impact assessment rules. The application for the environmental licensing must be delivered to the competent bodies, under the terms of the Norms on the EIA Process, following the procedure described therein.
Ministerial Decree 129/2006 - General Guidelines for	Provides details on environmental licensing procedures, as well as the format, general structure and contents of the environmental impact assessment report. The objective is to	This EIAS report was prepared in accordance with the specifications described in this Ministerial Diploma.

Legislation	Description	Relevance
Environmental Impact Studies (GoM 2006a)	standardise procedures followed by various role-players in the environmental impact assessment process.	
Ministerial Decree 130/2006 guides the PPP of the ESIA Process (GoM 2006b)	Defines the basic principles, methodologies and procedures for the ESIA's public participation process (PPP). Considers public participation as an iterative process that initiates at the design stage and continues throughout the lifetime of the project.	The PPP for the ESIA Process (including for the present Scoping Report) is being developed in compliance with the guidelines provided in this Ministerial Decree.
ATMOSPHERIC EMISSIONS AND AIR QUALITY		
Law 20/97 - Environmental Law (GoM 1997a)	Article 9 forbids the discharge of any toxic substances to the atmosphere if exceeding the legal standards. The emission standards are defined by Decree No. 18/2004 (see below).	The Project must comply with air quality emissions limits, as defined in this regulation. Given the nature of the project, this will apply to the emission of dust and bioaerosols, odors and vehicle emissions and gas emissions from the wastewater treatment plant (WWTP) and landfill (methane and carbon dioxide).
Decree 18/2004 (as amended by Decree 67/2010) - Regulation for Environmental Standards and Effluent Emissions (GoM 2004; GoM 2010b)	Establishes parameters for the maintenance of air quality (Article 7); patterns of emission of gaseous pollutants for various industries (Article 8); and standards for emission of gaseous pollutants from mobile sources (Article 9) - including light and heavy vehicles.	
Regulation on the Management of Substances that Deplete the Ozone Layer, Resolution No. 78/2009, of December 22	This regulation prohibits the import, export, production, sale and transit of substances that deplete the ozone layer, including: - Chlorofluorocarbons (CFCs); - Halogenated substances (Halon-1211, Halon-1301 and Halon-2402); - Carbon tetrachloride (CCL4); and - Other substances defined by the Montreal Protocol as Ozone Depleting Substances.	The Project must comply with the requirements of the decree, The EIA analyzed and considered the particularities of the project in comparison with the requirements of the Directive, and the ESMP includes measures that the proponent must implement to guarantee compliance in the different phases of the project.
Technical Directive for the Implementation and Operation of Sanitary Landfills in Mozambique (MICOA, 2010)	The Technical Directive for the Implementation and Operation of Sanitary Landfills (DTAS) aims to provide Municipal Councils in the country with a manual of procedures for the Installation and Operation of Sanitary Landfills or controlled landfills, in accordance with the following steps: I. The selection of appropriate locations; II. The feasibility study; III. The Environmental Impact Assessment; IV. The construction and operation of new areas for the final disposal of solid waste; V. The closure and rehabilitation of the deposition area; SAW. Monitoring the area once closed.	The Project must comply with the requirements of the directive. The EIA analyzed considered the particularities of the project in comparison with the requirements of the Directive, and the ESMP includes measures that the proponent must implement to guarantee compliance in the different phases of the project.
WATER RESOURCES AND WATER QUALITY		
Law 16/91 - Water Law (GoM 1991)	This law is based on the principles of public water use, basin scale management, and user-pays and polluter-pays. Intends to safeguard the ecological balance and environment. Water uses require either a water concession (permanent or long-term water uses) or a water license (short term water uses). Licenses are given for a period of 5 renewable years, while concessions are valid for a period of 50 renewable years. Article 54 of this Law stipulates that any activity with the potential of contaminating or degrading public waters, in particular the discharge of effluents, is subject to a special authorisation to be issued by the Regional Water Administration and payment of a fee.	The current ESIA will assess impacts related to water abstraction and potential contamination. In case the Project requires the abstraction of water from natural sources (such as for concrete batching), a water license must be obtained from the competent authority (Regional Water Administration). If the Project requires the discharge of effluents into water bodies (such as in any construction camp), a discharge license must be obtained.
Decree 30/2003, from July 1st –Regulation for Public Water Distribution	Defines the technical conditions that must be complied with the public water distribution systems in order to ensure their	As the proposed project aims to improve urban sanitation and drainage systems, it shall comply with the regulation which

Legislation	Description	Relevance
Systems and Wastewater Drainage	proper functioning, preserving the public health and safety of users and facilities;	defines a set of technical conditions for the public water distribution and wastewater drainage systems.
Decree 18/2004 – Regulations for Environmental Quality Standards and Effluent Emissions (GoM 2004)	Determines that when industrial effluents are discharged into the environment, the final effluents discharged must comply with the standards for discharge as set out in Annex III of the decree. Discharges of domestic effluents must comply with the regulations for discharge as set out in Annex IV. The regulation defines the environmental quality and effluent emission standards for receiving bodies, technologies, systems and treatment methods.	The final effluent must be discharged according to certain emission standards. It requires that the location of the discharge point be determined during the environmental licensing process so that there is no change in the quality of the water in the receiving body. The Project must respect the effluent emission limits established in this regulation. This may apply to any project related effluent release. The EIA analyzed and considered the particularities of the project in comparison with the requirements, and the EMP includes measures that the proponent must implement to guarantee compliance in the different phases of the project.
Technical Directive for the Implementation and Operation of Sanitary Landfills in Mozambique (MICOA, 2010)	The Technical Directive for the Implementation and Operation of Sanitary Landfills (DTAS) aims to provide Municipal Councils in the country with a manual of procedures for the Installation and Operation of Sanitary Landfills or controlled landfills, in accordance with the following steps: I. The selection of appropriate locations; II. The feasibility study; III. The Environmental Impact Assessment; IV. The construction and operation of new areas for the final disposal of solid waste; V. The closure and rehabilitation of the deposition area; SAW. Monitoring the area once closed.	The directive indicates that groundwater must be monitored so as not to be contaminated by leachate from waste disposal. It includes requirements for monitoring and the parameters to monitor. The Project must comply with the requirements of the Directive, and the EIA analyzed and considered the particularities of the project in comparison with the requirements of the same. The ESMP includes monitoring requirements and parameters.
POLLUTION AND WASTE MANAGEMENT		
Law 20/97 – Environmental Law (GoM 1997a)	Limits the production and / or disposal into the soil or subsoil and the disposal into water or the atmosphere of any toxic or polluting substances, as well as the practice of activities that accelerate erosion, desertification, deforestation or any other form of environmental degradation to those limits established by the law (Article 9).	The Project needs to include measures to prevent pollution during and after implementation. Any project must conform to the requirements outlined in this regulation. The ESMP will include such measures.
Penal Code, Decree No. 35/2014 of 31 December	Pollution is considered inadmissible whenever the nature or values of pollutant emissions violate the guidelines or limits imposed by the competent authority in accordance with legal and regulatory provisions, with companies or other similar entities being jointly and severally liable for payment of the fine and remediation. of the damage caused.	The Project must include measures to avoid pollution throughout its life cycle, practicing, as far as possible, the 3 Rs – Reduce, Reuse and Recycle. The ESMP includes mitigation measures, monitoring and recommendations aimed at meeting these requirements.
Decree 94/2014 - Regulation for Urban Solid Waste Management (GoM 2014a)	Establishes the legal framework for urban solid waste management. The key objective is to establish rules for the generation, collection and disposal of urban solid wastes, to minimise their impacts on public health and the environment. Urban solid wastes, according to this decree, are to be classified in accordance with the Mozambican Norm NM339 – Solid Wastes – Classification. Waste management is a responsibility of Municipal Councils and District Governments, in their respective areas of jurisdiction.	The methods or processes for collecting and transporting municipal solid waste, as well as the treatment and recovery systems, must be established and approved by the Municipal Councils or District Governments. The selective collection system is subject to the approval of the Municipal Councils or District Governments, and the waste must be segregated according to the categories provided for in article 14. The final disposal of urban solid waste complies with the operational rules established by the Ministry

Legislation	Description	Relevance
		responsible for the Environment and must be carried out in sanitary landfills. All facilities intended for the treatment and final disposal of urban solid waste are subject to prior environmental licensing in accordance with the EIA Regulations. This ESIS includes an ESMP with provisions for managing and mitigating impacts resulting from waste management and includes a waste management plan.
Decree 83/2014 - Regulation for Hazardous Waste Management (GoM 2014b)	Establishes the legal framework for hazardous waste management. The key objective is to establish rules for the generation, collection and disposal of hazardous wastes, to minimise their impacts on public health and the environment. Annex IX of this decree provides waste classifications.	All facilities and equipment for preliminary storage, transport, disposal, treatment, recovery or disposal of hazardous waste are subject to prior environmental licensing, in accordance with the EIA Regulation. Hazardous waste operators and transporters must be certified by the MTA; the request for a certificate must be made in accordance with Annex I of the regulation. All public and/or private entities carrying out hazardous waste management activities must draw up, before starting the activity, a hazardous waste management plan, including at least the information contained in Annex II of the regulation. This ESIS includes an ESMP with provisions for managing and mitigating impacts resulting from waste management, and includes a waste management plan
Technical Directive for the Implementation and Operation of Sanitary Landfills in Mozambique (MICOA, 2010)	The Technical Directive for the Implementation and Operation of Sanitary Landfills (DTAS) aims to provide Municipal Councils in the country with a manual of procedures for the Installation and Operation of Sanitary Landfills or controlled landfills, in accordance with the following steps: I. The selection of appropriate locations; II. The feasibility study; III. The Environmental Impact Assessment; IV. The construction and operation of new areas for the final disposal of solid waste; V. The closure and rehabilitation of the deposition area; SAW. Monitoring the area once closed.	The directive indicates that, in the operational phase, the registration of waste must be monitored. Includes requirements for monitoring. The Project must comply with the requirements of the Directive, and the EIA analyzed and considered the particularities of the project in comparison with the requirements of the same. The ESMP includes monitoring requirements and parameters.
BIODIVERSITY		
Law No. 19/1997 – GdM Land Law, 1997b)	Regarding biodiversity, the Land Law classifies land in the public domain as Total and Partial Protection Zones. In accordance with Article 7, Total Protection Zones are designated as those reserved for nature conservation, defense and national security activities. Partial protection zones include, among others: For public infrastructure, partial protection zones include, among others: - Secondary and tertiary roads and the 15m strip along these; - Aerial, surface, underground and underwater installations and pipelines / structures for electricity, telecommunications, oil, gas and water and the 50m strip of land along them.	The Project must comply with the requirements of the land law. The use of land in total and partial protection zones requires the issuance of a specific license for the required purpose.
Law for the Protection, Conservation and Sustainable Use of Biological Diversity -	It establishes the basic principles and norms that govern the protection, conservation, restoration and sustainable use of biological diversity throughout the national territory, especially in conservation areas, as well as the framework	The Project must comply with the requirements of the biodiversity law. This EIA includes an approach to biodiversity conservation. Given that the Project is

Legislation	Description	Relevance
Law No. 16/2014 of June 20th (Amended by Law 5/2017 of May 11th)	for the integrated management of the country's sustainable development. This law is applicable to all goods and natural resources existing in the national territory and in the waters under national jurisdiction. In addition to the conservation of biological resources, the law also refers to the preservation of elements of exceptional or unique natural, aesthetic, geological, religious, historical or cultural value, in an area of less than 100 ha, whose integrity must be preserved. Trees of ecological, aesthetic, historical and cultural value are also considered natural monuments.	located in areas already anthropogenically affected, the EIA focused on aspects related to elements of religious, historical or cultural value that can be found in the project areas and proposes the appropriate mitigation measures to manage these impacts.
Regulation for the Control of Invasive Alien Species, Decree No. 25/2008 of 1 July	Article 8 of this decree prohibits activities involving invasive alien species without prior authorization and states that 'after hearing the Inter-institutional Group for the Control of Invasive Alien Species, the National Environmental Authority (MTA) may prohibit any activity which, by its nature, may imply the spread of invasive alien species'. Activities includes the folowing: - Importation of any type of invasive exotic species, whether by sea, land or air; - Possess any type of invasive exotic species; - Develop, breed or otherwise propagate any type of invasive alien species; and - Transport, move or relocate any type of invasive alien species	The Project must guarantee the control of the propagation of invasive alien species. Article 11 of the decree suggests that adequate methods must be implemented to control and eradicate invasive alien species. This EIA includes mitigation measures for potential impacts related to invasive alien species, which must be binding and ensure compliance with the requirements of the Regulation by the proponent.
Technical Directive for the Implementation and Operation of Sanitary Landfills in Mozambique (MICOA, 2010)	The Technical Directive for the Implementation and Operation of Sanitary Landfills (DTAS) aims to provide Municipal Councils in the country with a manual of procedures for the Installation and Operation of Sanitary Landfills or controlled landfills, in accordance with the following steps: I. The selection of appropriate locations; II. The feasibility study; III. The Environmental Impact Assessment; IV. The construction and operation of new areas for the final disposal of solid waste; V. The closure and rehabilitation of the deposition area; SAW. Monitoring the area once closed.	The Project must comply with the requirements of the Directive which indicate that the minimum distance from areas of historical or ecological interest must be 500 m. The areas must be located in a region where land use is outside any conservation unit.
LAND OWNERSHIP AND RESETTLEMENT		
Resolution 10/95 – Land National Policy (GoM 1995b)	Establishes that the State must provide land for each family to build or possess their own habitation, and is responsible for land use and physical planning, although plans can be made by the private sector.	The Project must conform to the principles of this policy, as per the regulations defined in the implementing laws, below.
Law 19/1997 – Land Law (GoM 1997b)	Defines land use rights (DUAT), including details on customary rights and procedures for acquisition and use of land titles by communities and individuals. This law recognises and protects the rights acquired through inheritance and occupation (customary rights and duties of good faith), except for legally defined reserves or areas where land has been legally transferred to another person or institution.	According to Mozambican Land Law, households have land use rights which should be acknowledged during the implementation of this Project.
Decree 31/2012 – Regulation for the Resettlement Process Resulting from Economic Activities (GoM 2012)	Defines rules and basic principles for resettlement processes from the implementation of public or private economic activities. Article 15 states that the Resettlement Plan is part of the ESIA Process and that its approval precedes the issuance of the environmental license.	If physical displacement results from the Project, this regulation is applicable, and a resettlement action plan will be required. Any potential economic displacement (such as the loss of infrastructure, farming plots or other assets) will also need to be assessed in the ESIA and, if present, duly compensated for, in abidance with the Land Law.

Legislation	Description	Relevance
Decree 23/2008 – Regulation for Land Planning (GoM 2008)	Aims to establish regulatory territorial planning measures and procedures to ensure the rational and sustainable use of natural resources, regional potentials, infrastructure and urban centres, and to promote national cohesion and safety of the people. Articles 68 to 71 deal with expropriation procedures for private property for national public interest reasons. Article 70 states that expropriation should be preceded by fair compensation.	If expropriation of land or land rights is required for Project implementation, the requirements of this regulation should be complied with.
Decree 60/2006 of 26 - Urban Land Use	Regulates the Land Law within cities and towns. Among others, it defines protection areas, requirements for land use rights, urban plans and expropriation processes within cities.	If expropriation of land and land rights within the Project area is required, the procedures established in these guidelines should be followed.
Technical Directive for the Implementation and Operation of Sanitary Landfills in Mozambique (MICOA, 2010)	The Technical Directive for the Implementation and Operation of Sanitary Landfills (DTAS) aims to provide Municipal Councils in the country with a manual of procedures for the Installation and Operation of Sanitary Landfills or controlled landfills, in accordance with the following steps: I. The selection of appropriate locations; II. The feasibility study; III. The Environmental Impact Assessment; IV. The construction and operation of new areas for the final disposal of solid waste; V. The closure and rehabilitation of the deposition area; SAW. Monitoring the area once closed.	The directive sets requirements for site selection according to the following: Proximity to urban residential clusters - Houses and other individual facilities: 200 m from the fence. - Residential zones/developments/nuclei: 500 m from the fence. - Houses must not face the prevailing wind direction. Urban planning zones minimum distance of 1 km from the boundaries of the fence. The proponent shall ensure compliance with these requirements.
Ministerial Decree 181/2010 – Guidelines for the Expropriation Process Resulting from Territorial Planning (GoM 2010c)	Establishes procedures for expropriation processes resulting from territorial planning, including procedures for the issuance of a declaration of public interest, compensations for expropriation (including calculation methods) and the expropriation process itself.	If expropriation of land and land rights within the Project area is required, the procedures established in these guidelines should be followed.
CULTURAL HERITAGE		
Law 10/88 - Cultural Heritage Law (GoM 1988)	Aims to legally protect material and non-material assets of the Mozambican cultural heritage. Under this law, cultural heritage is defined as a "group of material and non-material assets created or integrated by the Mozambican people through history, with relevance to the definition of the Mozambican cultural identity". Material cultural assets include: monuments, groups of buildings with historic, artistic or scientific importance, places or locations (with archaeological, historic, aesthetic, ethnologic or anthropologic interest) and natural elements (physical and biological formations with particular interest from an aesthetic or scientific point of view).	The potential presence of cultural heritage on the Project area will be assessed in the ESIS. Archaeological objects may also be found during the construction phase of the Project. In such cases, the Proponent must immediately communicate the finding to the relevant cultural heritage agency. The ESMP will include clear mitigation measures and identify the nearest office to report the finds.
Technical Directive for the Implementation and Operation of Sanitary Landfills in Mozambique (MICOA, 2010)	The Technical Directive for the Implementation and Operation of Sanitary Landfills (DTAS) aims to provide Municipal Councils in the country with a manual of procedures for the Installation and Operation of Sanitary Landfills or controlled landfills, in accordance with the following steps: I. The selection of appropriate locations; II. The feasibility study; III. The Environmental Impact Assessment; IV. The construction and operation of new areas for the final disposal of solid waste; V. The closure and rehabilitation of the deposition area; SAW. Monitoring the area once closed.	The Proponent must comply with the requirements of the Directive regarding the minimum distance from areas of historical or ecological interest. The minimum distance to churches, historical monuments and other places of cultural value must be 500 m.
WORK, HEALTH AND SAFETY		
Law 23/2007 - Labour Law (GoM 2007)	This law applies to legal relations of subordinate work established between employers and domestic and foreign	The Proponent must provide its workers with good hygiene, health and safety

Legislation	Description	Relevance
	workers in all industries, operating in the country. Chapter VI provides the principles of safety, hygiene and health of workers.	conditions, inform them about the risks of their work, implement the mitigation measures and contingency plans associated with the project, and ensure the continuous awareness and education of workers, and availability of personal protective equipment (PPE). The PGAS contains a contingency and emergency response plan that aims to ensure compliance with these requirements and with the standards of hygiene and safety at work.
Law 19/2014 - Law of Protection of People, Workers and Job Applicants Living with HIV/AIDS (revokes Law 5/2002) (GoM 2014c)	This law establishes the general principles that aim to ensure that all employees and job applicants are not discriminated against in the workplace or when applying for jobs, for being suspected of having or having HIV / AIDS. Article 47 states that workers and job applicants should not be discriminated in their rights regarding labour, training, promotions and career advancement, on account of being HIV positive. Article 52 forbids requiring HIV tests for job applications, job maintenance, to access training or to quality for promotion or any other job activity.	Testing job applicants for HIV / AIDS is prohibited. Testing of workers without the employee's consent is also prohibited. The proponent must train and reorient all HIV positive workers who are able to fulfil their duties at work, with activities compatible with their capabilities.
Decree 45/2009 - Regulation on the General Labour Inspectorate (GoM 2009a)	This Regulation lays down the rules on inspections, under the control of the legality of work. Paragraph 2 of Article 4 provides for the employer's responsibility for the prevention of occupational health and safety risks for the employee.	The Proponent shall comply with these requirements. In the case of an inspection, the proponent must help in providing all necessary information to inspectors.
Regulation of the Legal Regime for Accidents at Work and Occupational Diseases, Decree No. 62/2013 of April 4	Establishes norms and principles related to the prevention of accidents at work and occupational diseases and the necessary measures when they occur.	The Bidder must provide its workers with good hygiene, health and safety conditions, inform them about the risks of their work, ensure compliance with this Regulation. The ESMP contains provisions related to potential impacts of accidents at work and occupational diseases.
Law 3/2022 of February 10 – Public Health Law	Establishes mechanisms for the protection and promotion of health, prevention and control of diseases, as well as threats and risks to Public Health. It applies to Public Administration bodies and institutions, citizens and other natural or legal persons, public or private, who contribute to the promotion of health, the prevention and control of diseases and the preservation of Public Health. Identifies risks to Public Health, disease prevention and control measures, water and food protection measures, health measures and waste management.	The Project must identify environmental risks with an impact on Public Health and propose measures for their prevention and minimization, which is carried out in this EIAS. The Project must also safeguard the public health prevention and protection measures referred to in this statute.

2.5 International Best Practice Guidelines and Policies

This EIA process is being carried out in accordance with national norms and regulations and international best practices, particularly the AfDB guidelines for environmental and social assessment and public participation. The most relevant international standards and guidelines are described in Table 2.2.

Table 2.2 – International ESIA Best Practices Guidelines and Policies

International Standard / Guideline	Description	Requirement in terms of National Legislation
Project Categorisation		
African Development Bank's (AfDB) Integrated Environmental and Social Assessment (IESIA) Guidelines (AfDB 2009; 2015)	The AfDB guidelines require Project screening. Projects that are directly funded by AfDB are classified into three categories, depending on the expected severity of the project's potential beneficial and adverse impacts: - Category 1 projects require a full ESIA, including the preparation of an Environmental and Social Management Plan (ESMP). These projects are likely to induce important adverse environmental and/or social impacts that are irreversible, or to significantly affect environmental or social components considered sensitive by the Bank or the borrowing country; - Category 2 projects require the development of an ESMP. These projects are likely to have detrimental and site specific environmental and/or social impacts that are less adverse than those of Category 1 projects and that can be minimised by the application of mitigation measures or the incorporation of internationally recognised design criteria and standards; - Category 3 projects require no impact assessment. These projects shall involve no adverse physical intervention in the environment and induce no adverse environmntal or social impact.	The national ESIA Regulations (Decree 54/2015) requires categorisation of Projects in three broad categories: A, B and C. For Category A projects, a full ESIA and ESMP are required. The national process for ategorisation is generally compliant with international best practices such as AfDB's and IFC's.
IFC's Sustainability Framework 2012	IFC's environmental and social categorisation reflects the relative magnitude of environmental and social risks and impacts of a project as well as disclosure requirements. The applicable categories are as follows: - Category A: Business activities with potential significant adverse environmental or social risks and/or impacts that are diverse, irreversible, or unprecedented - Category B: Business activities with potential limited adverse environmental or social risks and/or impacts that are few in number, generally site-specific, largely reversible, and readily addressed through mitigation measures - Category C: Business activities with minimal or no adverse environmental or social risks and/or impacts - Category FI: Business activities involving investments in financial intermediaries or through delivery mechanisms involving financial intermediation. This category is further divided into FI1, FI-2 and FI3.	
Environmental and Social Assessment and Management		
AfDB Environmental and Social Assessment Procedures (ESAP), 2015	The ESAP require that environmental, climate change and social considerations are assessed early in the Project Cycle and are reflected in project selection, site selection, planning and design. It covers all public and private sector bank lending operations and project activities funded through other financial instruments managed by the bank.	The ESIA Regulations (Decree 54/2015) states that an environmental and social assessment process is required for every Project with the potential to generate environmental and social impacts. From this assessment an ESMP will be drafted, which can be further developed by the Proponent to into an ESMS. The national regulations are thus in line with international best practices.
IFC Performance Standards (IFC, 2012) - PS1 - Assessment and Management of Environmental and Social Risks and Impacts	PS1 underscores the importance of managing environmental and social performance throughout the life of a project. PS1 requires the client to conduct a process of environmental and social assessment, including stakeholder consultation, and to establish and maintain an Environmental and Social Management System (ESMS), appropriate to the nature and scale of the project and commensurate with the level of its environmental and social risks and impacts.	

International Standard / Guideline	Description	Requirement in terms of National Legislation
Public Participation		
AfDB - Stakeholder Consultation and Participation Guidelines	For Category 1 projects, the AfDB guidelines require meaningful consultations during the ESIA. Consultations are required with relevant stakeholders, including potential beneficiaries, affected groups, civil society organisations and local authorities, with the objective of discussing the project's environmental and social aspects as well as taking public views into account. The guidelines indicate that these consultations should be done in compliance with national legal requirements, as long as they meet AfDB minimum requirements for public consultation, which are summarised below: - Consultation should be done as early as possible; - Project and ESIA information should be disclosed in a timely manner and in a form and language accessible to the groups being consulted; - Relevant stakeholders should be consulted during both the scoping phase and the EIS phase; - Contributions from stakeholders should be integrated into the ESIA report and reflected in the proposed mitigation, if applicable; - Stakeholder consultation should be extended from the ESIA into the construction and operational phases.	The EIA Regulation (Decree No. 54/2015) and the General Directive for PPP in the EIA Process (Ministerial Diploma 130/2006) fully comply with the requirements of these international guidelines and policies on stakeholder consultation.
AfDB Civil Society Engagement Framework (2012)	The framework aims to help the Bank achieve greater results and impacts by strengthening its mechanisms for participation and coordination with Civil Society Organisation.	
IFC Stakeholder Engagement Handbook (2007	The handbook focusses on stakeholder groups "external" to the core operation of the business, such as affected communities, local government authorities, non-governmental and other civil society organisations, local institutions and other interested or affected parties. It contains the key concepts and principles of stakeholder engagement, the practices that are known to work, and the tools to support the delivery of effective stakeholder engagement. In addition, it shows how these principles, practices, and tools fit with the different phases of the project cycle, from initial concept, through construction and operations, to divestment and/or decommissioning.	
Resettlement		
AfDB's Involuntary Resettlement Policy	The AfDB's Involuntary Resettlement Policy has been developed to cover involuntary displacement and resettlement of people caused by an AfDB financed project and it applies when a project results in relocation or loss of shelter by the persons residing in the project area, assets being lost or livelihoods being affected. The overall goal of the policy is to ensure that when people must be displaced, they are treated equitably, and that they share in the benefits of the project that involves their resettlement. The policy has the following key objectives: - To avoid involuntary resettlement where feasible, or minimize resettlement impacts where population displacement is unavoidable, exploring all viable project designs. Particular attention must be given to socio-cultural considerations, such as cultural or religious significance of land, the vulnerability of the affected population, or the availability of in-kind replacement for assets, especially when they have	National resettlement requirements are codified in Decree 31/2012. It defines rules and basic principles for resettlement processes from the implementation of public or private economic activities. For Projects with resettlement impacts, the development of a Resettlement Action Plan is required, The Resettlement Plan is part of the ESIA Process and its approval precedes the issuance of the environmental license. The national resettlement regulations are in line with international best practices, having the goals to minimise resettlement when possible and to restore and enhance the standards of

International Standard / Guideline	Description	Requirement in terms of National Legislation
	important intangible implications. When a large number of people or a significant portion of the affected population would be subject to relocation or would suffer from impacts that are difficult to quantify and to compensate, the alternative of not going ahead with the project should be given a serious consideration; - To ensure that displaced people receive resettlement assistance, preferably under the project, so that their standards of living, income earning capacity, and production levels are improved; - To provide explicit guidance to AfDB staff and to the borrowers on the conditions that need to be met regarding involuntary resettlement issues in AfDB operations in order to mitigate the negative impacts of displacement and resettlement and establish sustainable economy and society; and - To set up a mechanism for monitoring the performance of involuntary resettlement programs in AfDB operations and remedying problems as they arise so as to safeguard against ill-prepared and poorly implemented resettlement plans.	living for resettled people, when resettlement is unavoidable.
IFC Performance Standards (IFC, 2012) - PS5 – Land Acquisition and Involuntary Resettlement	PS5 recognises that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons who use this land. PS5 aims to: avoid or at least minimise involuntary resettlement wherever feasible by exploring alternative project designs; mitigate adverse social and economic impacts from land acquisition by (i) providing compensation for loss of assets and (ii) ensuring that resettlement activities are implemented with appropriate consultation and disclosure; and improve or at least restore the livelihoods, standards of living and living conditions of displaced persons.	
Pollution Prevention		
AfDB Operational Safeguard 4: Pollution Prevention and Control, hazardous materials and resource efficiency	The AfDB OS 4 outlines the main pollution, prevention and control requirements for borrowers or clients to achieve high quality environmental performance and efficient and sustainable use of natural resources, over the life of a project. It helps the management and reduction of pollutants resulting from the project and sets a framework for efficiently using all of a project's raw materials and natural resources, especially energy and water	The Environmental Law (Law 20/97) includes provisions for the control of pollution, and Decree 18/2004 defines environmental quality standards (for air and water quality) as well as effluent emissions. Environmental quality issues will be addressed through the ESIA. Where no national standards exist (such as is the case for noise, for example), international
IFC Performance Standards (IFC, 2012) - PS3 – Resource Efficiency and Pollution Prevention	PS3 recognises that economic activity and urbanisation often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. PS3 aims to avoid or minimise adverse impacts on human health and the environment by avoiding or minimising pollution from project activities; promote more sustainable use of resources including energy and water; and reduce project-related emissions that contribute to climate change.	
Biodiversity		
AfDB Operational Safeguard 3 – Biodiversity, renewable resources and	The AfDB OS 3 outlines the requirements for borrowers/clients to identify and implement opportunities to conserve and sustainably use biodiversity and natural habitats, as well as observe, implement, and respond to requirements for the conservation and sustainable management of priority ecosystem services.	Biodiversity protection in Mozambique is codified in Law 16/2014 – Protection, Conservation and Sustainable Use of Biodiversity Law. This law establishes basic principles and norms for the protection, conservation, restoration and

International Standard / Guideline	Description	Requirement in terms of National Legislation
ecosystem services	Its recommendations also align with the International Plant Protection Convention, which covers the movement of invasive alien species, pests and pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms.	sustainable use of biological diversity in national territory.
IFC Performance Standards (IFC, 2012) - PS6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources	PS6 encourages sustainable development while recognising that the protection and conservation of biodiversity and sustainably managing living natural resources are fundamental to sustainable development. PS6 aims to: protect and conserve biodiversity; maintain the benefits from ecosystem services; and promote the sustainable management and use of natural resources through practices that integrate conservation and development.	
Socio-Economic		
Operational Safeguard 5: Labour conditions, health and safety	The AfDB OS 5 aims to protect worker´s rights, stablish, maintain, and improve the employee-employer relationship; promote compliance with national legal requirements and provide supplemental due diligence requirements where national laws are silent or inconsistent with the OS; Protect the workforce from inequality, social exclusion, child labour, and forced labour; and Establish requirements to provide safe and healthy working conditions.	The protection of the fundamental rights of workers is fully encoded in Mozambican law, through the Labour Law (Law 23/2007) and supporting legislation.
IFC Performance Standards (IFC, 2012) -PS2 - Labour and Working Conditions	PS2 recognises that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers. PS2 aims to: establish, maintain and improve the worker-management relationship; promote the equal opportunity of workers, and compliance with national labour and employment laws; protect the workforce by addressing child labour and forced labour; protect vulnerable workers; and, promote safe and healthy working conditions and the health of workers.	
IFC Performance Standards (IFC, 2012) - PS4 – Community Health, Safety and Security	PS4 recognises that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. PS4 aims to: anticipate and avoid adverse impacts on the health and safety of the affected community during the project life cycle; and ensure that the safeguarding of personnel and property avoids or minimises risks to the community's safety and security.	Community health and safety is not specifically defined in national law as a stand-alone concept. However, the requirement to protect community health and ensure community safety and security can be derived from the overall national legal framework. Community health and safety issues will be addressed in the ESIS.
AfDB Gender Policy (2001)	The main goal of the Policy is to promote gender equality and sustainable human and economic development in Africa. For this effect: • Gender analysis shall be an integral part of all Banks' policies, programmes and projects; • Attention shall be paid to the co-operative relations between women and men; • women's economic empowerment will be considered as key to sustainable development; and women will not be considered to be a homogeneous group.	The protection of gender rights are stated in the Constitution of Mozambique, Articles 35 and 36. Several other documents such as the *Plano Quinquenal do Governo (Government Five-Year Plan)* (2015-2019), the Agenda 25, among others, also reiterate the promotion of gender equality as a priority, which is a fundamental factor for development. Gender issues will be addressed in the ESIS in line relevant Mozambican strategies and documents.

International Standard / Guideline	Description	Requirement in terms of National Legislation
AfDB Policy on Poverty Reduction (2004)	The goal of the Bank's poverty policy is to ensure that poverty in Africa is reduced. This involves development of strategies that facilitate national ownership, participation and an orientation towards improvements in the welfare of the poor, especially in the achievement of the Millennium Development Goals (MDGs).	Several national documents such as the *Plano Quinquenal do Governo (Government Five-Year Plan)* (2015-2019), the Agenda *25*, among others, reiterate the need to work towards the eradication of poverty in Mozambique. Poverty will be addressed in the ESIS in line with relevant Mozambican strategies and documents.

3 Approach and Methodology of the Environmental Impact Assessment Process

3.1 General Considerations

The EIA process is a preventive environmental and social management tool, which aims to identify and assess, both quantitatively and qualitatively, the positive and negative environmental and social effects of a proposed project, and to define the necessary avoidance, minimization, mitigation, and compensatory measures to reduce the negative effects and enhance the positive ones.

This Chapter briefly outlines the approach to the EIA and the process that has been followed to date. The approach to this EIA complies with all applicable Mozambican legal requirements and is also in line with international best practice EIA standards and guidelines described in previous chapter.

3.2 General Overview of the EIA Process

The EIA Regulation (Decree No. 54/2015, of December 31) establishes that all public or private activities, which directly or indirectly may influence the environmental components, must be subject to an environmental assessment (Article 3). The level of this assessment depends on the sensitivity of the receiving environment and the nature of the project, being determined by the MTA, through a Pre-Assessment process, based on the Process Instruction Report presented by the Proponent, and by the visit carried out by the environmental authority, within the scope of this process. Article 4 defines the following categories for proposed projects:

- **Category A+**: Projects that, due to their complexity, location and/or irreversibility and magnitude of possible impacts, deserve not only a high level of social and environmental surveillance, but also the involvement of specialists in the EIA process. Annex I of the EIA Regulation lists the activities that are included in this category. Category A^+ projects require a complete process, which includes the EPDA (Scoping) and ESIS (including an ESMP), with oversight by independent expert reviewers with proven experience;
- **Category A**: Projects that significantly affect living beings and environmentally sensitive areas, with potential impacts of greater duration, intensity, magnitude and significance on living beings or sensitive areas. The activities listed in Annex II of the EIA Regulation are part of this category. Category A projects require a complete EIA process, which includes the EPDA and ESIS (including an ESMP);
- **Category B**: Projects with potential impacts on living beings and on sensitive areas that are of lesser duration, intensity, magnitude and significance compared to Category A projects. This category includes the activities referred to in Annex III of the EIA Regulation. Category B projects require preparation and submission to the ToR environmental authority, which must be approved prior to the start of the SES;

- **Category C**: Projects with negligible or insignificant negative impacts, which do not lead to irreversible impacts and which have positive impacts and are greater in number and more

significant than negative ones. The activities referred to in Annex IV of the EIA Regulation are part of this category. These projects require the submission of environmental management best practices procedures for approval by the MTA.

The proposed Project involves the design of an Integrated Development Plan and Feasibility Study for Urban Sanitation, Drainage and Solid Waste Management for the City of Chimoio. According to paragraphs b) and d) of Number 2.7 of Annex II of the EIA Regulation (Decree No. 54/2015), the SPA of the Province of Manica classified the project as Category A (see Annex II). Therefore, the following steps apply to this project:

- **Screening Phase:** it is the first step in the EIA process, which culminates in the submission to the MTA of a Screening Report, which includes a brief description of the project and its context, and a summary description of the receiving environment. It also includes the preliminary environmental assessment form required by the MTA. Based on this information, a preliminary site visit is carried out, which includes a number of MTA technicians determined according to the project category. After the visit, the MTA formally categorizes the project and defines the level of environmental assessment required;
- **Scoping Phase (EPDA Report)**: the main objectives of the scoping phase are to identify scope of the EIA (project scope, definition of project area of influence, applicable regulatory frameworks, assessment methodology, potential environmental and social receptors, potential impacts, and potential fatal flaws and impacts of the project, and to define the ToR for the EIA. The EPDA Phase thus aims to identify key issues and concerns associated with the proposed development. These could include project-related activities which may have the potential to contribute to or cause potentially significant impacts to environmental and socio-economic receptors and resources in the project area of Influence (AOI);
- **Environmental and Social Impact Assessment Study (ESIS)**: the main objectives of the ESIS phase are to assess the potential environmental and social impacts identified in the EPDA, to assess alternative options for impact avoidance, if available, and to define the avoidance, minimization and mitigation measures during construction and operation phase and to develop the ESMP for the implementation of those measures. Where residual impacts remain significant, compensatory measures will be defined. The ESIS Report supports the relevant authorities in the decision-making process, resulting in the environmental licensing or rejection of the activity. The main tasks undertaken in this phase are the following:
  - *Baseline Studies*: these studies are undertaken to review and ascertain existing environmental and social conditions relevant to the project area and its surroundings and to highlight receptors and resources sensitive to potential impacts;
  - *Assessment of Impacts and Mitigation:* the focus is to identify and evaluate the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimize, reduce or compensate for any adverse environmental impacts and to report the significance of residual impacts that occur following mitigation;
  - *Environmental and Social Management Plan:* the identified mitigation measures are integrated into a suite of customized management programs. The EMP is developed to

guide environmental and social management throughout the project's life cycle. This is the mechanism whereby mitigation and monitoring of environmental impacts (as defined in the EIA Report) are integrated with project implementation.

These three phases are illustrated in Figure 3.1 below and described in detail in the following sections below.

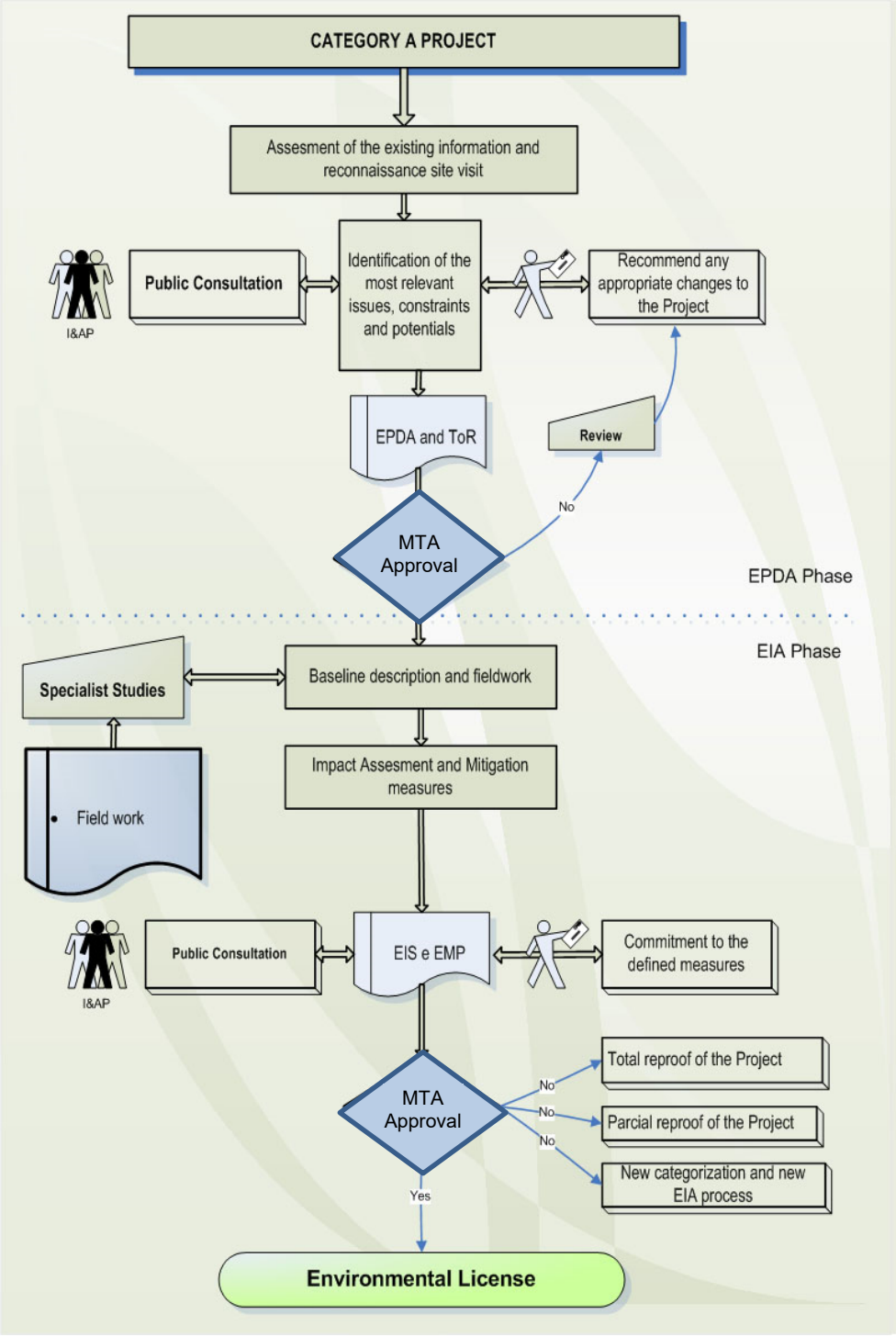


Figure 3.1 – Overview of the EIA Process for Category A Projects

3.3 Phase 1: Screening Phase

The first step of the EIA process was the Screening Phase. During this phase, a Screening Report was compiled and submitted to MTA to assist them determining the level of environmental assessment required. The Screening Report contained information regarding the purpose and objective of the proposed project and a brief description of the biophysical and socio-economic context of the project area of influence. A Preliminary Environmental Information Form was appended to the Screening Report.

After analyzing the Process Instruction, the SPA of Manica, through the letter with Ref nº 218/SPAM/DA/200 (**see Annex II**), classified the proposed Project as Category A.

3.4 Phase 2: EPDA

3.4.1 Objectives of the EPDA

As per Article 10 of the EIA regulation, the EPDA's main goals are to *(i)* determine potential fatal flaws associated with the activity and *(ii)* define the scope of the environmental assessment to be undertaken in the EIA Phase. The objectives of the EPDA Phase were, therefore, to:

- Review existing data about the project area of influence in order to understand the sensitivity of the affected physical, biological and socio-economic environment;
- Present the proposed development to Interested and Affected Parties (I&APs) and identify issues and concerns about the proposed development;
- Identify potential fatal flows, the significant positive and negative environmental and socio-economic impacts;
- Develop the ToR for the specialist studies and for the EIA; and
- Compile project information and results of the public consultation into an EPDA Report and submit to MTA for decision-making.

3.4.2 EPDA Report

To support the goals described above, the EPDA Report provides the following information (as per Article 10 of the EIA Regulation):

- Non-Technical Summary, with the main issues, findings and recommendations of the Report;
- Information regarding the proponent of the project, as well as the consulting team responsible for the EIA process; Definition of the preliminary project areas of influence (AOI);
- Legal framework;
- Description of the project activities throughout its life cycle;
- Brief baseline description of the affected physical, biological and socio-economic environment;
- Identification of potential impacts, negative or positive, that the proposed development might have on the environment and communities;

- Identification and assessment of any potential fatal flaws (environmental and social risks) that may threaten the viability of the project; and
- Identification of the detailed studies to be undertaken in the EIA and development of the respective ToR.

The EPDA Report was compiled based on the collection, compilation and review of secondary data. Secondary data was collected from a variety of sources, including other EIA processes for similar projects, other EIA processes carried out in Chimoio City, information provided by various governmental and non-governmental institutions and organizations, maps and satellite images, among others.

The preliminary EPDA report was disseminated within the scope of the PPP activities in the EPDA phase and all information collected through the PPP activities was integrated into the Final EPDA Report.

After analyzing the EPDA Report, DINAB approved the report, through a letter with the followig reference: 165/MTA/183/GM/220/21 (see Annex III).

3.4.3 Public Participation Process (PPP)

Public consultation is mandatory for all projects in categories A^+, A and B. With regard to categories A^+ and A, Public Consultation meetings must be held during the two phases of the EIA process, the first being to disclose the EPDA draft report and the second to release the ESIA draft report. After the public consultations, a period for receiving comments from the public is defined, which is 15 days for categories A and B and 45 days for category A^+ projects. The project followed the standard public participation process for Category A projects for the EPDA Phase.

The EPDA Phase included a PPP (as per Article 15 of the EIA Regulation) to present the proposed Project to all I&APs and identify issues and concerns about the proposed development. The main objectives of the EPDA PPP were:

- Inform relevant regulatory and administrative authorities regarding the EIA and the project and process;
- Identify key concerns and expectations associated with the EIA process and the project;
- Meet with stakeholders to present the proposed design and EIA process;
- Gather comments on the EPDA Draft Report including, but not limited to, the scope, approach and key issues to be addressed in detail in the ESIS;
- Informing stakeholders about the next steps in the EIA process;
- Present preliminary alternatives for the project under study and identify potential environmental and social issues associated with them;
- Involve authorities, technical services and other interested parties in the process of selection of the best alternative;
- Consult relevant authorities on key elements of the EIA;
- Discuss the best approach for community engagement given future EIA activities, including socio-economic studies.

The PPP started as soon as the draft EPDA report was released for public comment. According to the EIA Regulation, public meetings must be announced 15 days in advance. During this period, the EPDA Preliminary Report was available at key institutions and locations, so that the public could access the document prior to the meeting.

3.4.4 Submission of the EPDA to MTA

Upon completion of the EPDA phase PPP, the EPDA Draft Report was updated to reflect and respond, where relevant and appropriate, to the issues and concerns raised through the PPP.

The EPDA Final Report, including the ToR for the ESIA and the PPP Report, has been submitted to the MTA for review and approval. Following the approval of the MTA issued, by letter with Ref No 165/MTA/183/GM/220/21 (see Annex II), the EIA Process proceeded to the ESIS phase, as described in the next section.

3.5 Phase 4: ESIS

3.5.1 Objectives of the ESIS

The main goals of the EIA phase are to:

- Undertake the specialist studies, in accordance with the EPDA ToR, approved by MTA;
- Stablish and describe, in detail, the environmental characterization;
- Assess the environmental and social impacts associated with the Project;
- Define the mitigation measures for adverse impacts and the enhancement measures for positive impacts; and
- Integrate those measures in an ESMP, as clear, practical measures applicable to the local conditions, based on best practice and relevant legislation.

3.5.2 ESIS Report

To support the above-described goals, the EIA Report provides the following information (as per Art 12 of EIA Regulation):

- Non-technical summary, with the main issues, findings and recommendations of the Report;
- Information regarding the proponent of the project, as well as the consulting team responsible for the EIA process;
- Legal framework of the activity and its context within the existing planning instruments;
- Description of the activities to be carried out under the proposed project, for all phases (planning, construction, operational and where relevant decommissioning), as well as alternatives considered;
- Definition of the project areas of influence;
- Baseline assessment of the receiving physical, biological and socio-economic environment;
- Identification and assessment of the project social and environmental impacts;

- Definition of mitigation measures;
- Integration of the mitigation measures in an EMP for the activity, also including monitoring programs and other management tools, where relevant; and
- Public consultation report.

Some of the key aspects of the EIA phase, such as the specialist studies, the development of the ESMP and the public participation process, are further described.

3.5.3 Specialty Studies

During the ESIA four specialty studies were carried out in accordance with the ToR, developed in the EPDA Phase and approved by the MTA, namely:

- Air Quality;
- Water Resources;
- Traffic;
- Socioeconomics.

In the course of these studies, the different experts carried out the following tasks:

- Determination of the environmental baseline conditions;
- Identification, evaluation and classification of potential impacts associated with the Project, with emphasis on establishing their pre and post-mitigation significance;
- Qualitative evaluation of potential cumulative impacts, if any, to which the Project may contribute;
- Recommendation of mitigation and/or enhancement measures aimed at lowering the significance of potential negative impacts and optimizing the benefits of potential positive impacts;
- Proposal of environmental management and monitoring programs, where appropriate.

3.5.4 Environmental and Social Management Plan (ESMP)

The EMP is a fundamental part of the EIA process. External decision-makers would refer to the EIA assessment results (e.g., significance of residual impact ratings) in the decision-making process. As an ESIS is based on forecasts made before activity starts, it effectively assumes that the Project will implement the proposed controls and mitigation measures.

If controls and measures are not implemented, the usefulness of the ESIS as a tool for I&APs and external decision makers is compromised. Therefore, it is important that these assumptions, i.e., mitigation measures, constitute commitments that will be effectively implemented.

Therefore, after the potential impacts have been identified and the mitigation measures developed, agreed with the Proponent and described in the ESIS, it is necessary to integrate them into the Project to ensure their future implementation. The ESMP is the instrument that ensures the integration of mitigation in the Project. As such, the ESMP prepared in the ESIS phase, integrates the measures for mitigating and monitoring environmental impacts, identified in the ESIS Report, in a set of actions and management and monitoring plans.

Additionally, if the ESIA identifies the need for additional studies or plans, to be developed by the Proponent and/or its contractors, the ESMP provides guidelines for their development and implementation.

The implementation of such plans should ensure that any unforeseen impacts or issues that arise are addressed effectively, in accordance with relevant Mozambican laws and regulations and international best practice. In this way, I&APs and external decision makers should rely on the ESIS as a tool to help the decision-making process regarding the Project.

3.5.5 Public Participation Process (PPP)

The ESIS phase also includes a PPP (according to Art.º 15 of the EIA Regulation), with the following objectives:

- Update the I&AP database compiled for the EDPA Phase;
- Present the results of the specialist studies, impacts assessment, mitigation measures defined and the corresponding ESMP;
- Refer to the issues raised by I&APs during the EPDA public consultation process, and how they were considered during the ESIS process;
- Provide I&APs with opportunity to participate effectively in the process and identify any additional issues and concerns associated with the proposed activity, considering the more detailed studies undertaken during the EIA; and
- Explicit comments from I&APs with regards to the ESIS report and the ESMP.

The ESIS PPP should follow the same global methodology used for the EPDA phase.

For more information on the PPP for the ESIS phase please consult Volume IV – Public Participation Process.

3.5.6 ESIS Submission to MTA

After the PPP has been carried out, the conditions will be met to prepare the Final Report of the ESIS, reflecting the comments and contributions of the I&APs, which will be submitted to the MTA for analysis and decision on the Project.

If the project is approved and the environmental license issued, all the activities that follow, associated with the different phases of the project, will be governed by the ESMP, as well as any additional conditions that may be stipulated in the environmental license.

The Proponent shall adopt the ESMP and subsequently develop it into an Environmental and Social Management System (ESMS) for the Project, to ensure that the Project is properly conducted and managed. The Proponent must ensure that its contractors comply with the ESMP, making it part of their contractual obligations, whenever applicable and relevant.

4 Project Description

4.1 Context

During the past decade or so, urban areas in Mozambique have substantially increased in terms of population numbers due to the return of many refugees to the country who have settled in urban areas, as well as a general migration from rural to urban areas (AWF, 2016). While some cities have grown 100 – 200 % over the past 20 years, drainage and sanitation systems have not been upgraded or maintained to accommodate this new, much larger population. Today, it is clear that these systems are inadequate to deal effectively with the basic sanitation, drainage and solid waste management needs of most cities in Mozambique (AWF, 2016).

In addition to the above, Mozambique is one of the country's most strongly affected by climate change, with poverty and limited institutional capacity increasing the country's vulnerability (AWF, 2016). Over the past 25 years, Mozambique has suffered from an uninterrupted succession of droughts and floods, with damaging consequences for social and economic development.

Obsolete and/or undersized rainwater drainage systems and the increasingly growing presence of disordered human settlements in areas susceptible to flooding are the main factors that contribute to flooding in urban areas. Inadequate drainage systems and poor sanitation contribute to an increased risk of disease, which is exacerbated in areas densely populated by unplanned urban settlements.

According to AWF (2016), development in urban sanitation has stagnated in Mozambique, and updated approaches to service delivery are urgently needed. In 2015, sanitation coverage in urban areas is 60%, according to government estimates (AWF, 2016). Overall, it is estimated that the urban part of the millennium development goals (MDGs) sanitation targets are unlikely to be met due to the shortfall of adequate sanitation facilities in peri-urban areas, given the shrinking government support to on-site sanitation over the last decade.

The present Integrated Project, thus arises with the aim of improving climate resilience and drainage and sanitation conditions in the cities of Chimoio (the present study) and Inhambane, through the rehabilitation and/or improvement of drainage, sanitation, and solid waste management services.

4.2 Project Location

The proposed project is intended to be undertaken in Chimoio Municipality [2], in Manica Province (Figure 4.1).

[2] It should be noted that the Municipality of Chimoio shares the same boundaries with the District of Chimoio.

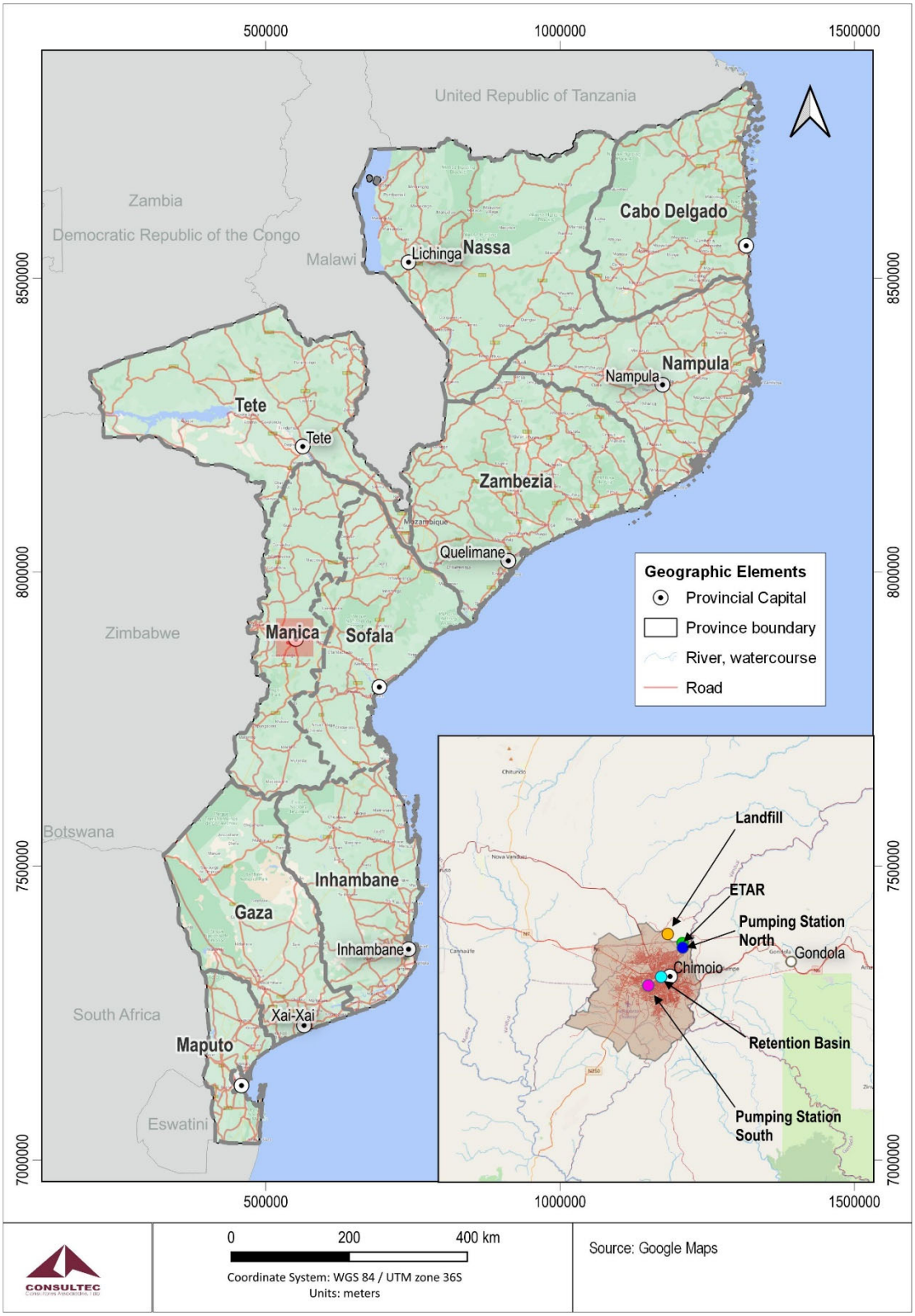


Figure 4.1 – Project Location

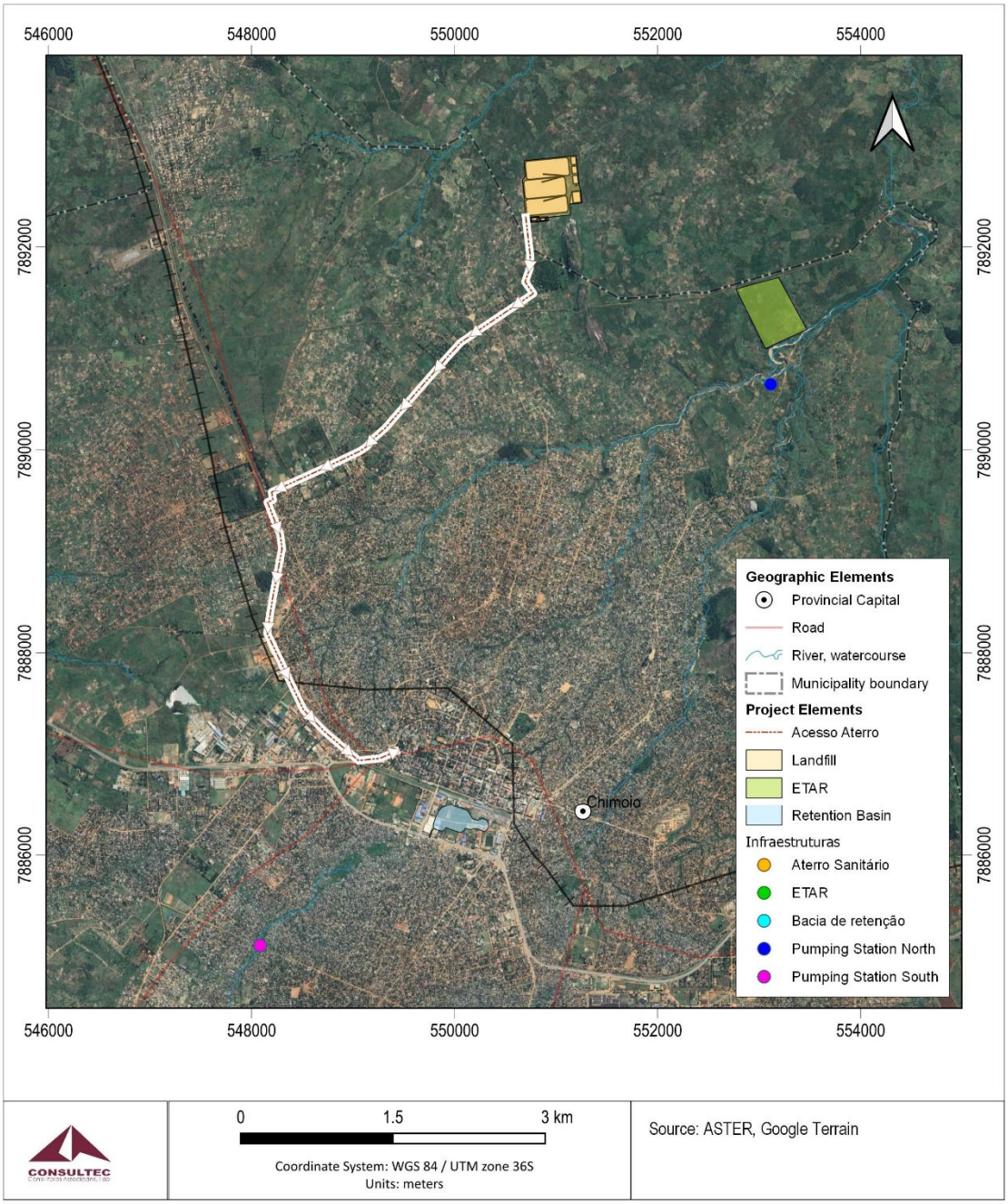


Figure 4.2 – Project Infrastrutures Location in Chimoio

4.3 Project Justification

The City of Chimoio is the capital of Manica Province, and is located on a plateau with an altitude of between 500 and 1,000 m. The storm water collection system, located in the central area of the city, dates back to 1950 and has not been subject to rehabilitation actions in recent years, with the exception of the recent extension on Av. do Trabalho, being now obsolete given the development and expansion of the city in recent years.

It is mixed network, that is, it is used for both storm water and domestic wastewater (TPF & Salomon, 2020).

There are several discharge points that discharge to peri-urban areas, giving rise to accumulations of contaminated and stagnant waters.

Storm water and blackwater from Bairro 3 de Fevereiro, Bairro 3 and the remaining neighbourhoods in the consolidated urban area is discharged into a collector that crosses the N6 road and discharges into the Mwenesi River in the Bairro do Centro Hípico (TPF & Salomon, 2020).

In the central part of the city, houses have septic tanks that are emptied at irregular intervals by private operators. In the peri-urban area, people rely on septic tanks and latrines.

Thus, the main problems related to drainage include:

- The flooding of several areas without storm water drainage (need for extension of the storm water drainage network);
- Erosion and degradation of roads and gullies; and
- Flooding of the densely occupied Mwenesi River valley (mainly in Bairro 5) with the natural flow being increased by the discharge from the city's drainage system.

The Municipal Council, through the Department of Urban Sanitation and Cemeteries, which is part of the Council of Sanitation and Environment, is the entity responsible for the management of urban solid waste (USW) in the Municipality of Chimoio. A municipal company is in the process of being set up to take over this role.

USW collection is carried out by the municipal services in an undifferentiated manner, even though there is a project for the transformation of USW into animal food. Despite the work carried out by the municipality for cleaning the city, there are many difficulties in collecting and treating the solid waste produced.

USW collection covers the central area of the city, most of the main markets and some neighbourhoods. However, the human resources and equipment allocated to this service are clearly insufficient, given the amount of waste currently produced. This aspect is visible through the accumulation of USW in various parts of the city (TPF & Salomon, 2020).

Most of the USW collection fleet is degraded due to breakdowns, poor maintenance, old age of the vehicles, and accidents, which greatly limits the USW collection capacity, aggravated by the large increase in USW production associated with population growth.

There are not enough waste depositing containers, they have low capacity and in some cases they are non-existent, and in some neighbourhoods families deposit waste on the streets, in openings made by erosion or in a nearby stream (as is the case in *Bairro 7 de Setembro*). On their turn, there are no containers for disposal of solid waste in the peri-urban neighbourhoods and the population burns or buries the waste.

There are no updated comprehensive sanitation, drainage and solid waste management plans for Chimoio City. Simultaneously, infant mortality reached 114 per 1,000 live births in Manica Province in 2012, far above the national average of 89.7 per 1,000 live births.

Taking into consideration the above, as well as the relation between the lack of sanitation and the infant mortality data in Mozambique, the Municipality of Chimoio was selected for the project of the Integrated Development Plan and Feasibility Study for Urban Sanitation, Drainage and Solid Waste Management.

4.4 Project Phases

This project contemplates two distinct phases:

- **Construction phase**, in which the civil works will take place, here called structural solutions, that includes the definition of some non-structural solutions or measures related to the local improvement of the sanitation system value chain, such as training actions, environmental awareness campaigns, financing and credit, among others, that will support the project development and operation.
- **Operation phase**, with the operation of the built infrastructures and related activities.

The estimated period for the development of the project, considered for the installation and construction of the infrastructure, is 25 years, from 2023 to 2048. According to the project, a decommissioning phase is not foreseen, as the project components aim to improve the current urban drainage, sanitation and solid waste management facilities of the Chimoio Municipality, therefore the project operation may be extended through maintenance and/or additional improvements.

4.5 Main Project Components

The project includes structural and non-structural solutions divided into three main components (see location of Project elements in **Figure 4**.3):

- Storm water drainage System;
- Wastewater drainage and treatment (including a wastewater treatment plant - WWTP); and
- USW collection and treatment, which includes a Municipal Solid Waste Landfill.

The subchapters below describe in detail and for each phase of the project indicated above, the three components of the project.

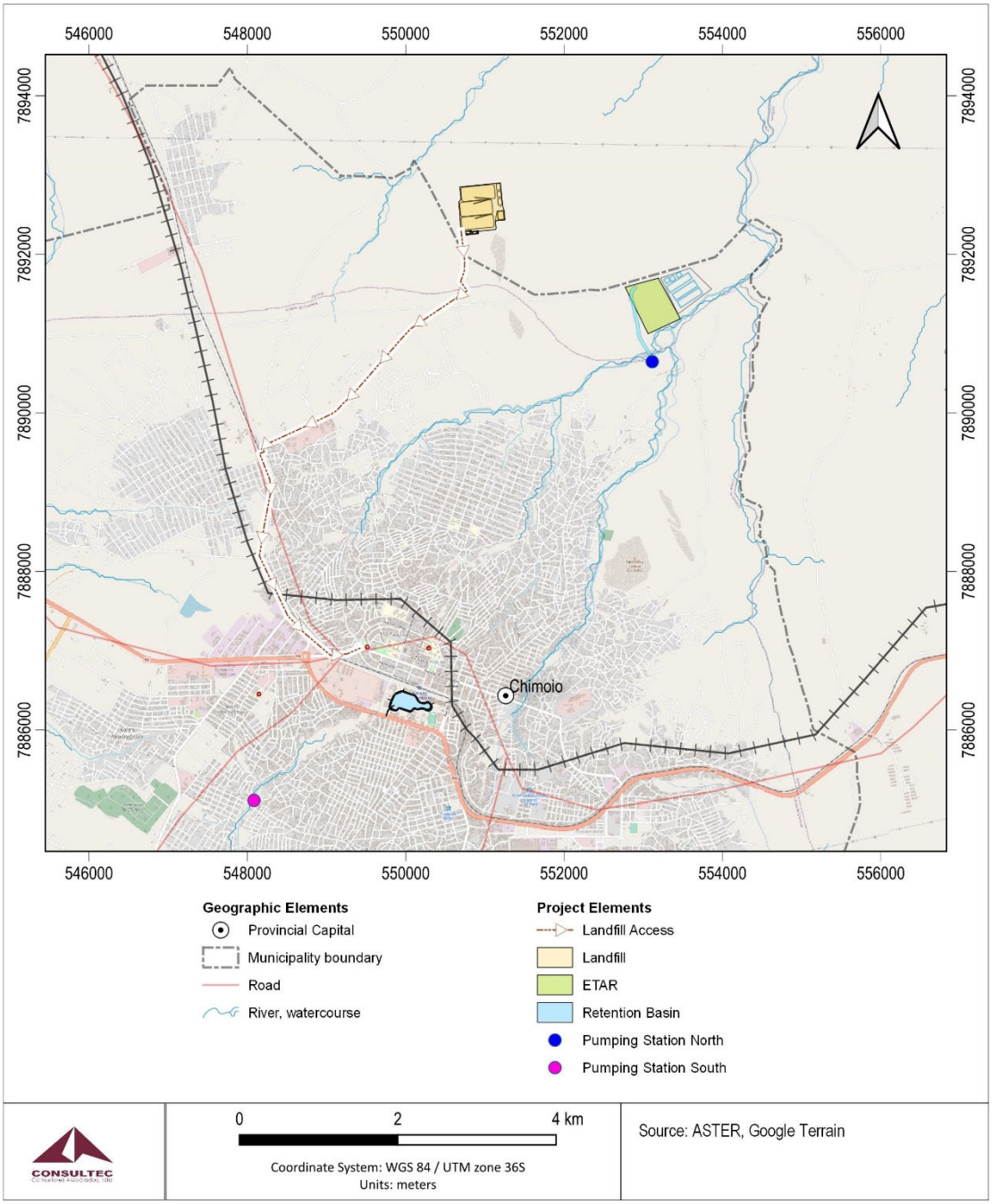


Figure 4.3 – Project Components framework

4.5.1 Construction phase

4.5.1.1 Storm water Drainage Component

Structural measures correspond to the engineering works to control urban surface ouflow, minimising the problem of urban flooding. Under the proposed project, Sustainable Urban Drainage Systems (SuDS) will be used to mitigate or solve existing drainage problems.

These are building systems that, due to technological development with high environmental concern, offer answers to common problems of storm water management in cities.

They are designed to maintain hydrological characteristics as close as possible to the conditions prior to occupation, and to minimize downstream discharge.

The systems cover a range of measures designed to minimize the environmental impacts of urbanization and the threat of pollution to natural watercourses. They use innovative techniques with the aim of attenuating flood peaks, diminishing the risk of flooding and reducing the concentration of pollutants from storm water in urban areas.

Overall, the solutions to be implemented involve the following infrastructure:

- Expansion and remodelling of the existing unitary network in the city of Chimoio, which is now dedicated exclusively to stormwater drainage;
- Construction of drainage networks in the area defined as urbanised in the Urban Structure Plan (PEU) for the city of Chimoio, with priority given to areas that are already structured, namely the urbanised areas of the 16 de Junho, 25 de Junho, 3 de Fevereiro, Bairro 2, Bairro 4, Bairro 5, Bloco 9, Eduardo Mondlane, Josina Machel and Nhamaonha neighbourhoods, to be followed by the construction of drainage networks in other areas as and when they are structured;
- Construction of a retention basin with the aim of retaining the runoff for a period of a few hours to reduce the peak discharge and therefore the design flow of the downstream channels.

The project thus includes different types of infrastructure to be built in response to rainfall events, namely:

- Underground collectors, in reinforced concrete, circular in cross-section, with diameters varying between DN400 and DN1500, with a total length of 8233.3 m;
- Underground galleries, in reinforced concrete, without steps, of variable rectangular cross-section, with widths between 1500 and 2000 mm and heights of 1500, for a total length of 760.6 m;
- Stepped spillway, in reinforced concrete, with variable rectangular sections, with widths between 800 and 1750 mm and heights between 1200 and 2000, totalling an extension of 1362.2 m;
- Construction of drainage channels, in reinforced concrete, with trapezoidal cross-section, to be executed in case of incapacity of drainage channel runoff foreseen in the scope of the "Detailed Design for asphalting of the access road to Avenida da Liberdade, city of Chimoio";
- A retention basin (Figure 4.4), executed by excavation and backfill on natural ground, with slopes covered with cement mortar reno mattress bedding, with a total storage volume of 189 000 m^3

Figure 4.4 – Retention Basin location.

Some of the key applications include the following infrastructure:

- Artificial ditch - relatively wide and not very deep channels covered by vegetation. They are designed to convey and store outflows and, depending on the type of soil present, may allow water to infiltrate into the ground;
- Retention basins - storm water storage structures. They retain outflows for a period with the aim of reducing peak discharge;
- Permeable surfaces - there are areas where it may be favourable to retrofit the surface by changing it to permeable, such as certain car parks or pavements where the soils are favourable for water infiltration; and
- Rain collectors.

The main problems related to urban storm water drainage experienced in Chimoio City comprise the lack of capacity of the existing storm water drainage network, and even its non-existence in several areas, aggravated by the flooding in the Mwenesi River Valley. Thus, it was considered that over the duration of the Project, the following infrastructure will be implemented in three different areas of the city (Zones 1, 2 and 3 - see Figure 4.5):

- Remodelling of the existing network in the City of Chimoio, which will become a separate network (another network is proposed for wastewater drainage);
- Construction of drainage networks in the area defined as urbanized in the Urban Structure Plan (USP) of Chimoio City, having as priority the areas that are already structured, namely the urbanized areas of the following 8 neighbourhoods: 16 de Junho, 25 de Junho, 3 de Fevereiro, Bairro 2, Bairro 4, Bairro 5, Bloco 9, Eduardo Mondlane, Josina Machel and Nhamaonha Textáfrica;
- Construction/implementation of a drainage system that allows the control of the flows that drain into the Mwenesi River so as not to worsen the situations that are occurring today and that will tend to worsen with the increase in the waterproofed area of the contributing basin.

After a thorough study of the drainage systems proposed for the consolidated areas of the Municipality of Chimoio, the following priority projects were considered, and the investment will be made in the period between 2023 and 2028 (first 5 years):

- Drainage system CHI.01 - This project includes the construction of a drainage network in the cement area of the city of Chimoio (also covering the replacement of pipes in a large extension where the existing network is undersized), the construction of a retention basin, underground galleries and possibly trapezoidal drainage channels that will channel the water to the Mwenesi River. This solution will ensure not only the drainage of the basin area corresponding to the CHI.01 drainage system, but also the reduction of the inflows into the Mwenesi River, thus contributing to the reduction of floods that occur in the valley of this river. This system has an extension of approximately 5.09 km of buried collectors and 0.76 km of buried galleries.

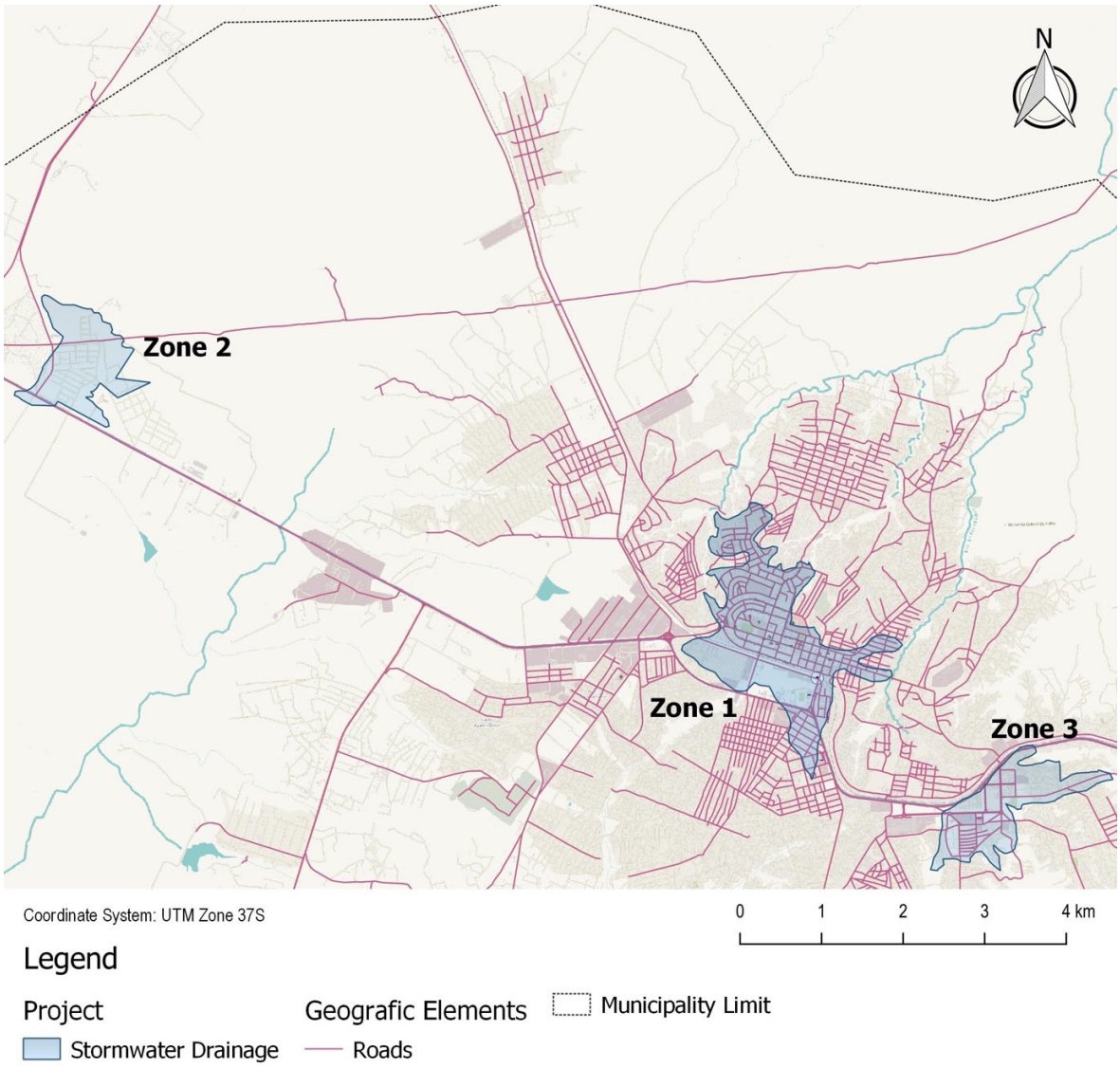


Figure 4.5 – Stormwater drainage: areas of intervention

- Drainage system CHI.02 and CHI.03 - In addition to the extension of the drainage network, these projects also include the replacement of pipe areas where the existing network is undersized. The CHI.02 system has about 0.43 km of underground storm water collectors and 0.35 km of canals. System CHI.03 has about 0.21 km of underground storm water collectors and 0.09 km of rectangular section channels with steps;
- Drainage system CHI.10 - Construction of a new drainage network of about 1.46km of underground storm water collectors and 0.42 km of rectangular section channels with steps;
- Drainage system CHI.11 - Construction of a new drainage network of about 1.05 km of underground storm water collectors and 0.51 km of rectangular section channels with steps;

The parameters used for the design of the drainage systems were as follows:

- Drainage contribution areas used;
- Rainfall projection, which was made based on IDF (intensity, duration and frequency) curves. These curves, established for the entire national territory, were calculated for the Maputo

City area and then extrapolated for the remaining territory through the application of a proportionality coefficient. In the present case of Chimoio City, this coefficient is 1.2.

This way, and in accordance with international good practice, it was considered that the following returning periods will be adjusted according to the type of work to be carried out, namely:

- For ditches/collectors
  - 1:10 years for sizing of system components;
  - 1:20 year verification without overflow;
  - 1:5 years for sizing of the system components with rainfall data influenced by climate change.
- Retention basins
  - 1:10 years for the sizing of the system components;
  - 1:5 years for the sizing of the system components with rainfall influenced by climate change
  - The material of the storm water drainage network was considered to be concrete (reinforced or simple);
  - The surface outflow coefficient was considered to be in the range of 0.80 to 0.82 for basins in structured or densely occupied areas;
  - It was also considered that the minimum diameter of the headwater collectors should be DN400 mm except for the existing networks to be kept.

4.5.1.2 Wastewater Drainage and Treatment Component

For the area considered urban, which covers the 8 neighbourhoods above mentioned, the studies carried out (TPF & Solomon, 2020) identified that some dwellings and commercial or public establishments in the city drain their wastewater to an existing network of collectors that was designed for storm water drainage.

The said network (buried collectors and, in some sections, drainage ditches), only has a small part (Eduardo Mondlane neighbourhood) connected to a WWTP, which is currently inoperative, so that several sections of the network and part of the network connected to the WWTP discharge wastewater directly into the environment without any type of treatment.

Thus, the structural interventions include the construction of a public wastewater drainage network that should be connected to an operational treatment plant, which could be either the existing WWTP (after rehabilitation and capacity expansion) or a new WWTP built from the ground up.

The structural interventions must also incorporate connection works (connection branches) of the dwellings/establishments to the new drainage network, and also the deactivation and reconnection to the new network of the branches that currently serve the dwellings and establishments connected to the storm water drainage network.

After the studies carried out, a concertation took place between the project designer (TPF), the environmental consultant and AIAS, in which it was concluded that the best option for the project would be the construction of a new WWTP (see Chapter 5, Study of Alternatives).

Collectors Network

In view of the location of the neighbourhoods proposed to be covered by the network and the existing topographic and infrastructural conditions, the definition of the layout of the main collectors demanded the study area to be divided into three sub-basins whose contributions must be conveyed through dedicated interceptor sewers to the WWTP, regardless of their location.

In general terms, 3 interceptors are required to ensure the conveyance of the sewage collected in the 3 sub-basins.

- The first interceptor is intended for conveyance of the sewage collected in the eastern part of the city, particularly in the neighbourhoods of 25 de Junho, Bloco 9, Nhamatsane and parts of the Vila Nova neighbourhood, and extends for about 4.32 km to the WWTP;
- The second interceptor is intended for conveyance of the sewage collected in the central neighbourhoods of the city, namely neighbourhoods 1 and 2, and parts of Eduardo Mondlane, Chinfura, 7 de Setembro, Vila Nova, and 16 de Junho neighbourhoods. This interceptor is entirely gravity-fed and stretches for about 4.3 km;
- The third interceptor is intended to for conveyance of the sewage collected in the southern and south-eastern neighbourhoods of the city, namely neighbourhood 3 and parts of the neighbourhoods Centro Hípico, Eduardo Mondlane, neighbourhoods 4 and 5, Textáfrica, 3 de Fevereiro and Josina Machel. This interceptor starts with a pressure section of about 2.23 km, followed by a gravity-fed section of about 7.07 km to the WWTP, thus having a total length of 9.3 km.

Upstream of the interceptors, the network of collectors is made up as follows:

- Head collectors; and
- Discharge collector

The first ones carry out the discharge into the second ones, which in their turn are connected at various points with the general interceptors.

For the layout of both the network of collectors and the general interceptors, following up the existing consolidated streets was perused as much as possible, both at urban and peri-urban neighbourhoods levels, and the local topography, favouring gravity drainage as much as possible.

In the case of the general interceptors, it was not always possible to observe gravity drainage, so two pumping stations were included. There is a need for the construction of two pumping stations as part of the sewage collected in the neighbourhoods. South Pumping Station is intended for the transfer of the flow collected in Basin 1 to the collection chamber CR-01, located next to the head manhole of the Interceptor collector CI-03 and North Pumping Station for the transfer of the flow collected in the four basins to the WWTP.

Still with regards to the general interceptors, the need to maintain, as much as possible, the gravitational drainage throughout the entire route dictated the crossing of areas of uncontrolled and non-urbanised occupation, which means that for its execution there will be the need to demolish some infrastructures to make way for the laying of collectors.

It is being considered that the entire network will be designed as a conventional network (i.e. in strict compliance with the regulatory provisions on minimum diameter) but consideration will also be given to the possibility of using simplified networks for the head collectors, which can be installed either as decanted sewers or as small-diameter collectors.

- The first case (decanted sewage) implies the on load maintenance of the existing septic tanks (eliminating, however, the infiltration drain) and the discharge of an effluent with lower solid content into the network of headwater collectors, which allows the adoption of smaller sized collectors. This variant also makes it possible to reduce the need for conventional manholes, which can be replaced by inspection eyes.
- The second case corresponds to a scenario in which the headwater collectors receive direct discharges without, however, observing the regulatory provisions for minimum diameter. In this case, the tanks must necessarily be decommissioned (as stipulated in the regulation), which implies inflows into the network containing a substantial load of biodegradable solids and, therefore, with special needs to ensure their hydraulic and sanitary performance even without complying with the regulatory minimum diameter. The requirements regarding the need for manholes are similar to those of the conventional network.

The collection collectors and the 3 general interceptors described above will be designed as conventional collectors.

Pumping Stations

As described above, the project also foresees the construction of two pumping stations (PS).

South Pumping Station will be implemented in the southern part of Chimoio, next to a water line to the west of Bairro 5 (Figure 4.6) connected to interceptor 3, which will be located in Bairro 5. The corresponding section of the pressure pipeline will have an approximate length of 2.23 km and must overcome a topographical gradient of 42.2 m.

Figure 4.6 – South Pumping Station Location

The system now planned is intended to convey the wastewater from the affluent basins to a high point, from which it will be conveyed gravitationally to the North Pumping Station and from there to the WWTP.

North Pumping Station will be implemented in the northern part of Chimoio (Figure 4.7). This pumping station will lift the wastewater produced in the city of Chimoio to the wastewater treatment plant to be built.

Figure 4.7 – North Pumping Station Location

Both Pumping Station share the same characteristics (Figure 4.8), as described below.

The maximum flow expected to flow into the PS (project horizon) is 5,350 m^3/day.

The underground elements of the installation include an entrance chamber where a screen basket will be installed, a wet well where the electric pump groups will be installed, and an attached manoeuvring chamber where the control valves for the hydraulic circuits will be installed. On the ground floor will be the electrical switchboard room and outside a hydraulic shock protection system.

Access to the pumping well and entry chamber will be through the building, by means of covers and access ladders, respectively.

In order to ventilate the operating areas a forced ventilation system will be installed at the pumping station. Ventilation pipes and a HEB profile with monorail and manual differential will be installed to lift the electric pump groups and the HDPE graded container with a capacity of 200l.

The installation of access stairs to the valve chamber to support the descent is planned.

A drinking water network from the public mains will feed the service water network. This water intake will be controlled by a meter. Inside the station the network will be HDPE in the underground sections and AISI 304 stainless steel in the exposed sections.

The pumping station will be equipped with an emergency discharge from the closure of the wall valve at the entrance to the manhole, or from a rise in the level of waste water in the pumping station.

In these situations the effluent will accumulate upstream and will be led from the tank immediately upstream of the manhole to an emergency discharge collector that will discharge this flow into the water line.

The discharge will be protected and will be fitted with a PN10 cast iron tide valve type check valve, suitable for wastewater.

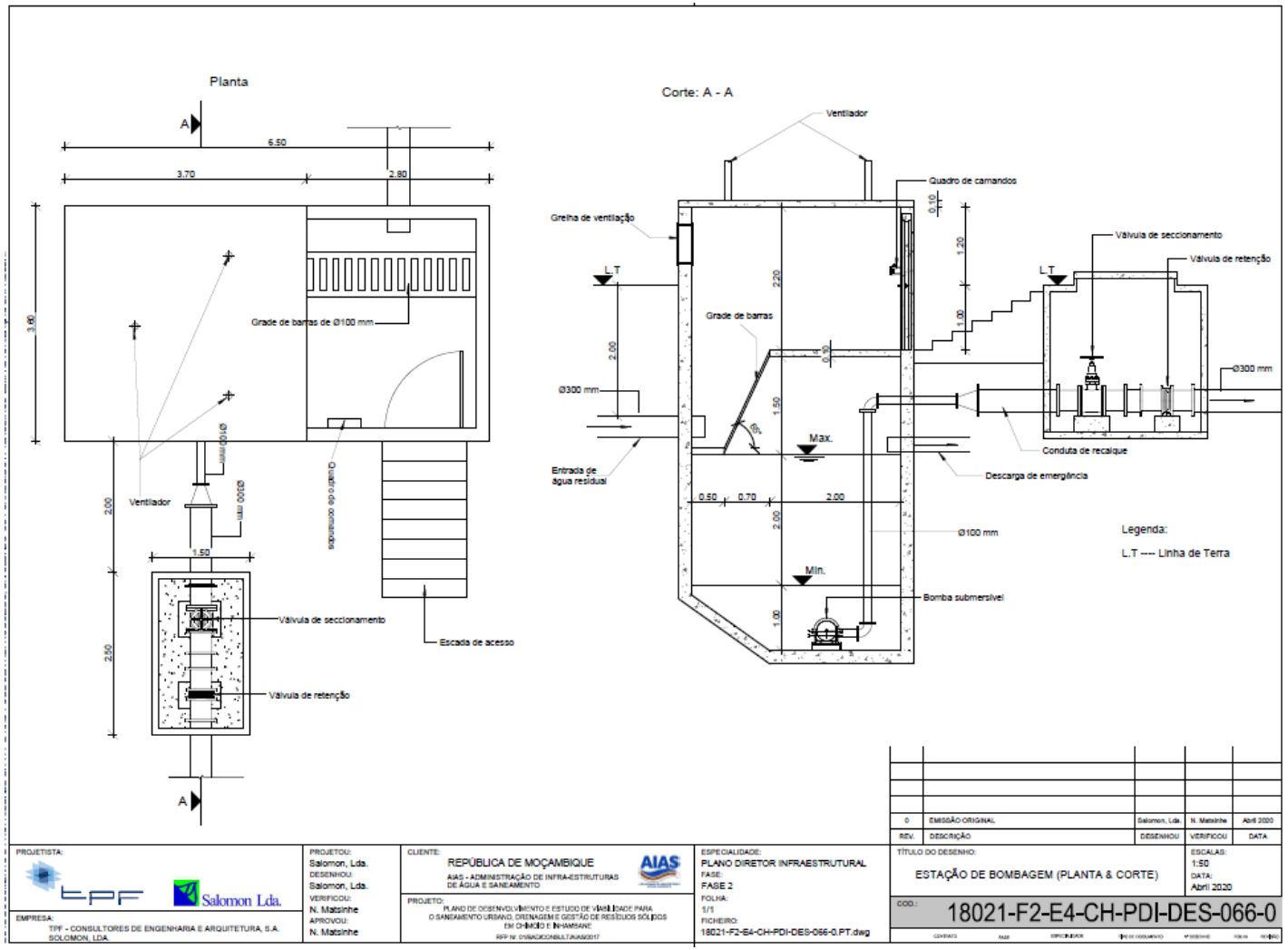


Figure 4.8 – Pump station components

Wastewater Treatment Plant (WWTP)

The WWTP, which will occupy a total area of 25.2 ha, is located in the Chaurrumba Administrative Post in the Bengo neighbourhood. Near the north limit of WWTP area runs the Beira-Zimbabwe oil pipeline owned by the CPMZ (Companhia do Pipeline Moçambique Zimbabwe), a buried pipeline that transports oil from Beira (Mozambique) to Harare (Zimbabwe) (Figure 4.9). The WWTP does not interferes with CPMZ Pipeline.

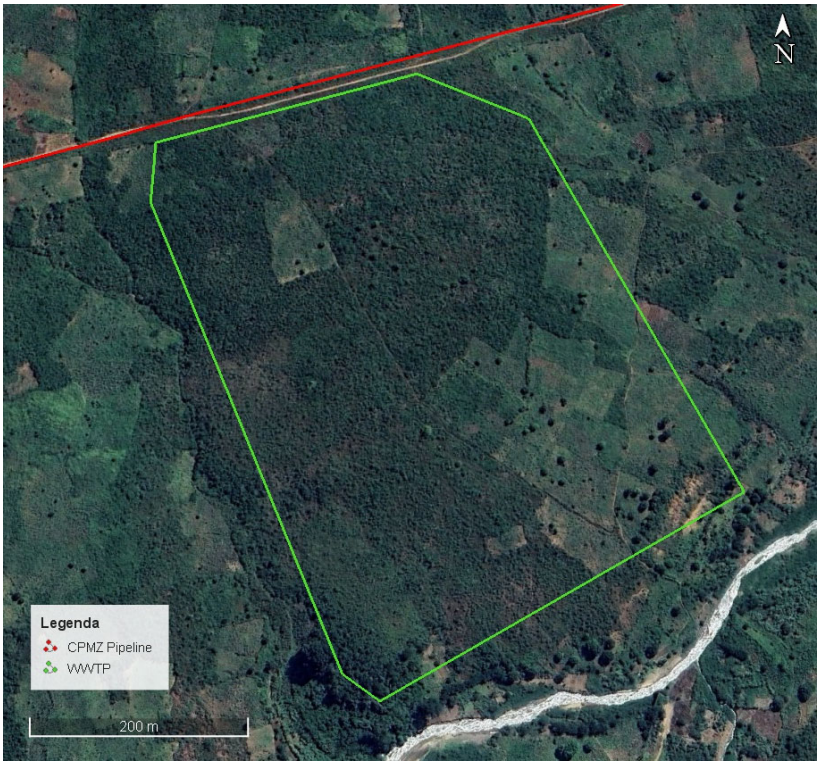


Figure 4.9 – WWTP limit and CPMZ pipeline.

The WWTP will treat wastewater by non-conventional methods using stabilisation lagoons and will follow the following sequence of operations and complementary installations:

- Access channel with bar grid;
- Anaerobic lagoons
- Facultative lagoons;
- Maturation lagoons (optional);
- Drying beds for sludge treatment.

The considered complementary works and installations include:

- Venturi meter / Parshal flume (Flow measurement);
- Flow partition boxes;
- Wells for collecting the sludge drained from the anaerobic lagoons;
- Open drainage channels for storm water and the
- WWTP effluents to the receiving environment.

The complementary WWTP facilities for operational support will include the operator/security house and warehouse, adequate roads (access) to allow heavy vehicles to circulate (discharge of faecal sludge and collection of stabilised sludge) and a fence around the WWTP, which will have at least two gates (one entrance and one exit).

The constructive details of the WWTP components are presented below.

Bar Grid Access Channel

The entrance at the WWTP will be done through an access channel (in reinforced concrete) equipped with a bars grid (Figure 4.10). The access channel was sized for an approach speed to the bar grids sufficient to avoid the deposition of sand and organic matter upstream of the bars (V approach = 0.5 m/s). The access channel will be of rectangular shape and will consist of two parallel circuits, each one 0.6 m wide, along which two sets of bar gratings (thin and thick) will be installed. For the WWTP flow rate (0.13 m^3/circuit), approach speed (0.5 m/s) and channel width (0.6 m), the water height in the channel will be around 0.5 m. Manual cleaning bar grids placed at an angle of 70^o are proposed. The first bar grating will consist of 5 circular bars of ø 20 mm made from reinforced steel duly protected against corrosion, equally spaced by 60-70 mm. The grids will be placed approximately 2 m downstream of the point where the entry channel divides into two parallel circuits. The second bar grating (thin bars) will consist of 12 ø 10 mm circular bars placed 2.0 m downstream of the first bar grating. Thin bars will be equally spaced by 30-40 mm.

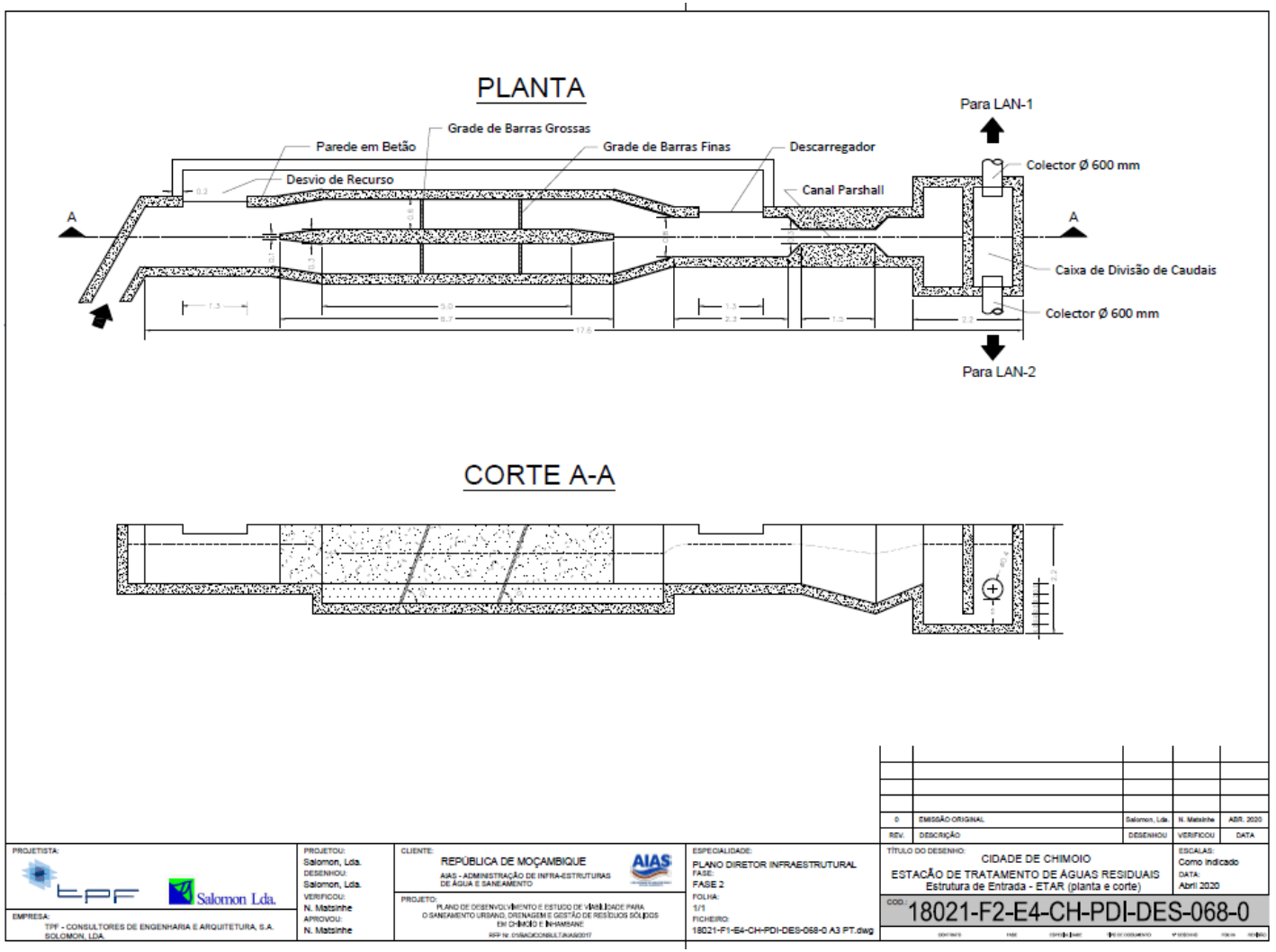


Figure 4.10 – WWTP entrance structure

From the construction point of view, this unit should also include pedestrian accesses to allow cleaning and maintenance operations of the gratings. Under the above conditions (flow rate, diameter and bar spacing), the flow velocity through the bars will be about 0.56 m/s in the first bar section (thick bars) and 0.68 m/s in the second section. The corresponding load losses (rise in water level upstream of the bars) will be 0.3-0.4 cm in the first bar section and 0.5-0.6 cm in the second.

A Parshall flume must also be constructed immediately downstream of the bar grid channel, which should be suitable for measuring the range of flows expected to flow into the WWTP.

Anaerobic Lagoons

Two parallel anaerobic lagoons will be installed in the WWTP, each with an estimated surface area of about 0.44 ha, a volume of 11,940 m^3 and an estimated depth of 2.7 m (Figure 4.11). The first 25 m of the pond, immediately after the entry, will be constructed a 1.0 m depth in relation to the rest of the lagoon to allow for greater sludge accumulation. For the average inflow at the end of the project period, the retention time, within the anaerobic lagoons, will be of about 1.7 days, a value slightly lower than recommended in the project´s criteria (Rt = 3-6 days), but long enough for the establishment of anaerobic conditions within the lagoons (based on expected flow rates and organic loads). Biochemical oxygen demand (BOD) removal efficiencies under these conditions will be around 40% to 50%.

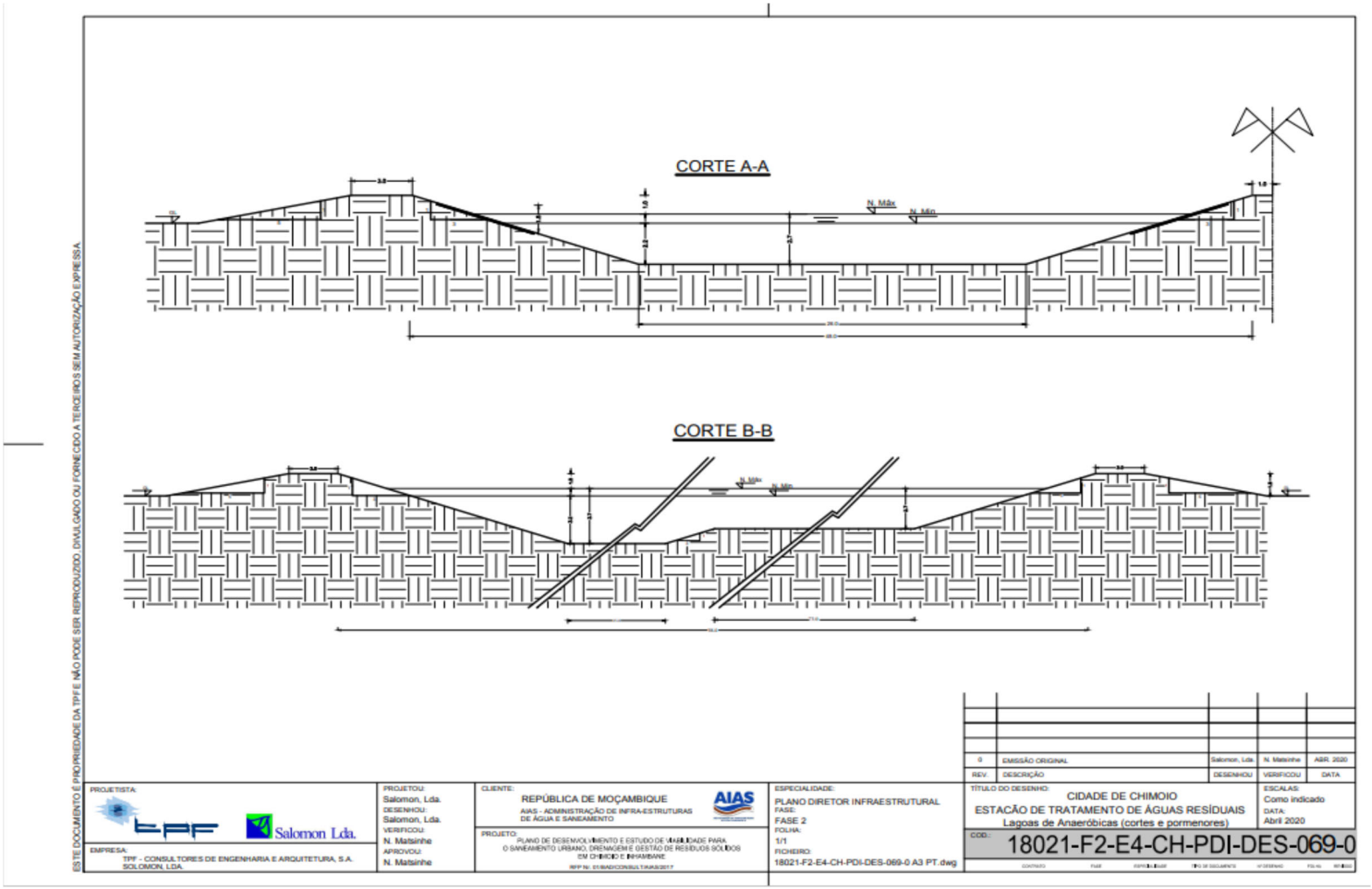


Figure 4.11 – anaerobic lagoons

The construction of anaerobic lagoons will be done by excavation to a depth of 2.2 m (3.2 m at the deepest part) below ground surface and embankment construction (using excavation or suitably compacted imported soils) to a height of 1.5 m above ground surface. A freeboard of 1.0 m above the maximum water level in the lagoons is proposed, which is intended to accommodate foaming at the surface of the lagoons (essential to establish anaerobic conditions within lagoons to anaerobic) and also the effect of waves caused by wind during high wind days.

The top of the earth side slopes will be 3m wide to allow for vehicle circulation during maintenance periods, which must be covered with a well compacted layer of loose gravel placed on top. For reasons of stability and protection against erosion caused by rainfall outflow, the slope gradient will be 1:3 (inner slope) and 1:4, or even 1:5 of the outer slope. The middle slope, separating the two tanks, will be built with an gradient of 1:3 on both sides. The top of the slope will be 2.0 m wide.

The inner embankment walls must also be coated for protection against erosion caused by water level variations (e.g. due to the wind) using concrete slabs manufactured *in situ* and placed manually on a 300 g/m^2 geomembrane. The geomembrane will be placed on a well compacted clay bed, extending over the bottom of the lagoon and the inner side of the embankments. The lining of the external slope should make use of natural materials. To cope with the outlow caused by rainfall on the embankments, the open ditches lined with concrete must be built on the underside of the outer slopes.

To feed the lagoons, and as a way of reducing the risk of hydraulic short-circuiting, a multiple inlet system is proposed with two inlets separated by approximately 25 m. The proposed inlet structure comprises two-cell variable level spillways, with the first intended to serve as a skimmer (Figure 4.12). Control of the water level (and therefore flow) into the lagoon will be achieved by concrete slabs (stop logs) with 600x200x100 mm. The flow will be divided between the two inlet structures by means of distribution boxes built into the body of the dike, which must also have two cells separated by a dividing wall where variable level spillways will also be installed. The collectors connecting the distribution boxes to the intake structures must have a nominal diameter (ND) = 400mm.

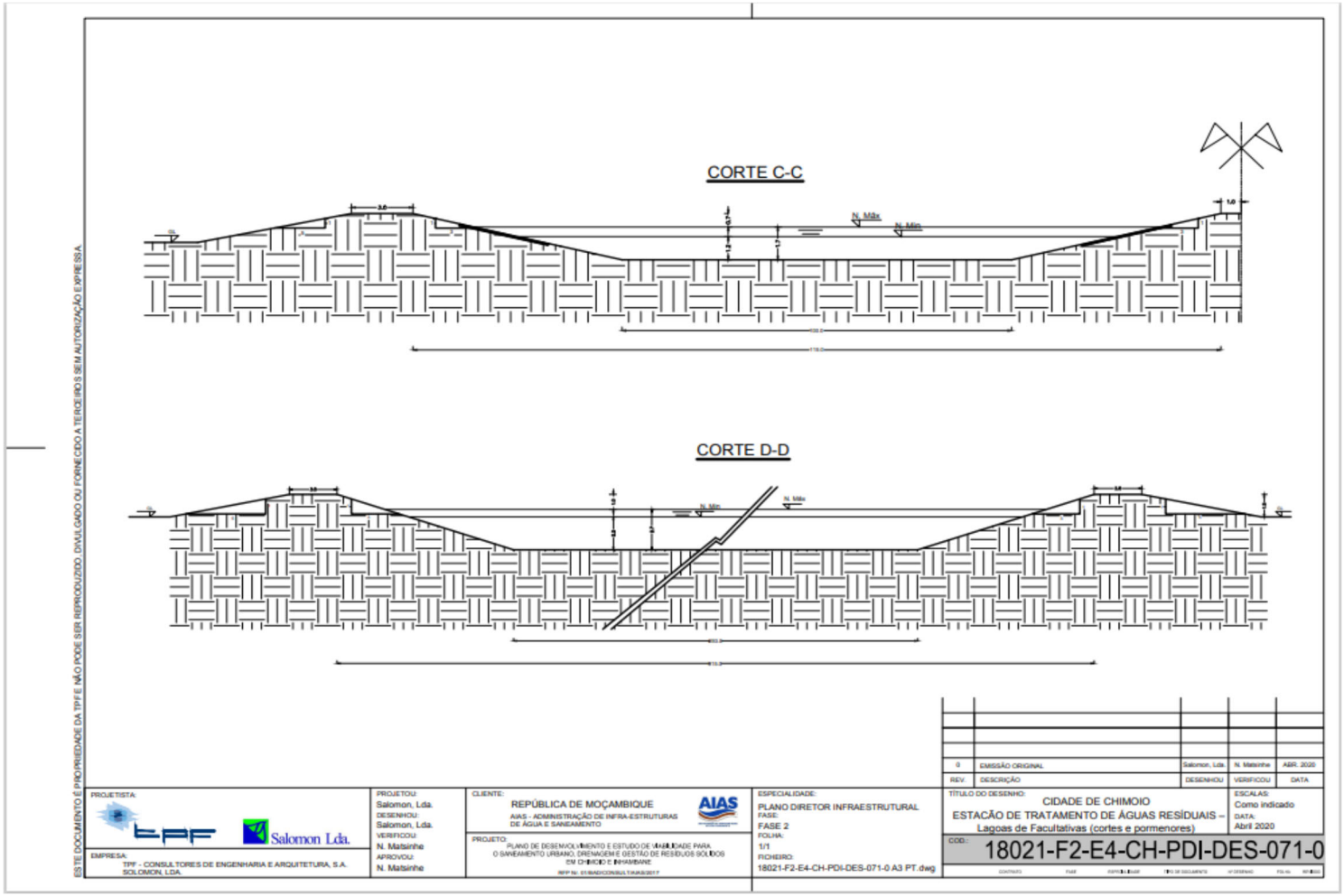


Figure 4.12 – Inlet and outlet structures of the lagoons

The effluent from the anaerobic lagoons will also be discharged at two points (not more than 20 m apart) and will also be achieved by variable-level spillways built into the body of the downstream slope. The collected flow will be launched into a common distribution box that will communicate with the two facultative lagoons planned for each production line of the WWTP.

Similar to the inlet structures, the discharge level control in the anaerobic lagoons will be achieved by adjustable concrete slabs. Communication between the outlet structures and the distribution box by the facultative lagoons will also be by means of ND 600 mm concrete pipes.

Facultative Lagoons

According to the project, 2 parallel facultative lagoons are required per production line, each with a surface area of approximately 3.94 ha and average depth of 1.7 m (Figure 4.13). For the average affluent flow rate in the horizon year the retention time will be in the order of 20 days. The expected efficiency (BOD removal) under these conditions will be around 70%-75%.

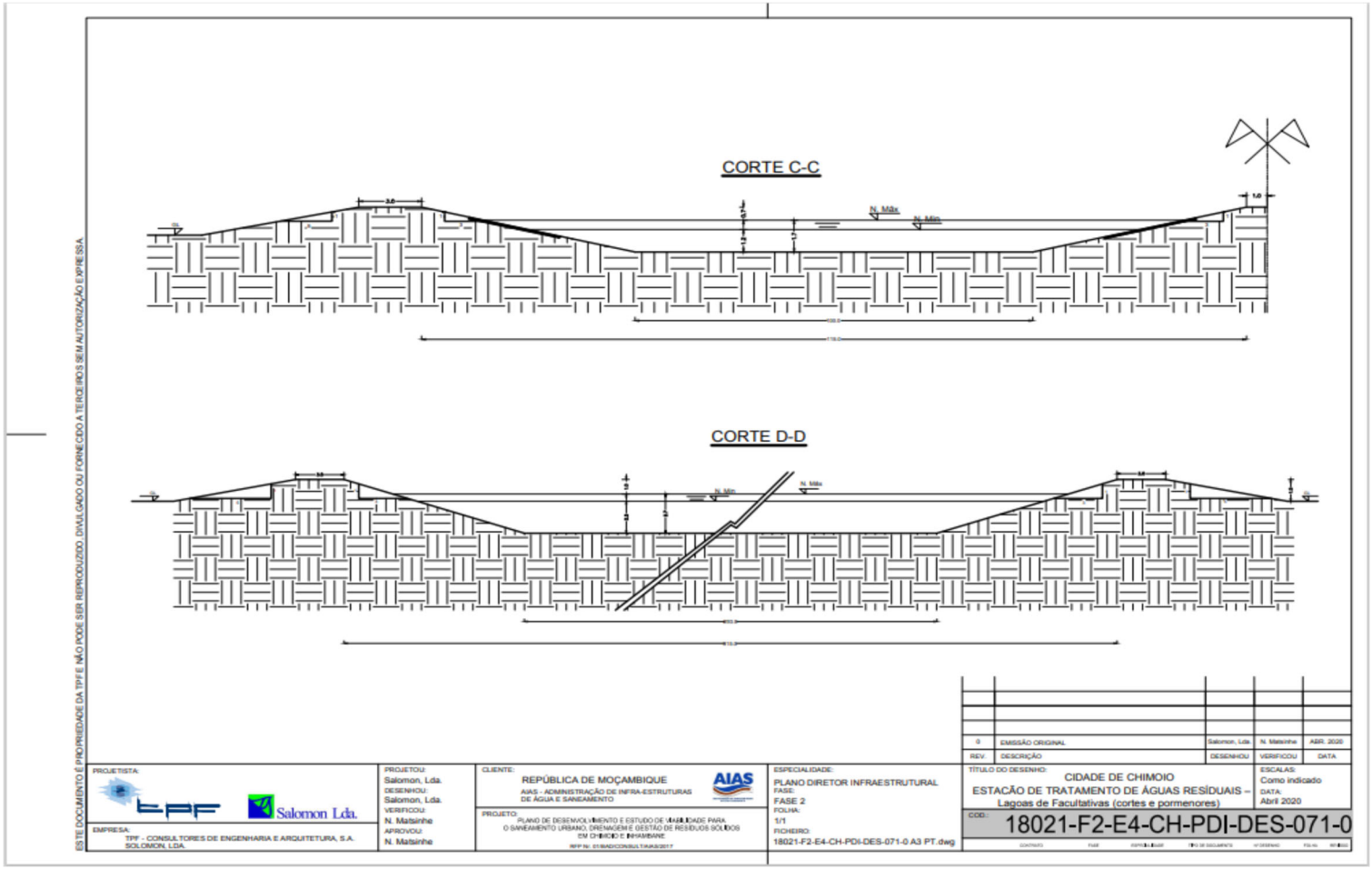


Figure 4.13 –Facultative Lagoons

The proposed dimensions of each lagoon (based on a ratio L/B =3) are 115x345 m, resulting in a useful surface area of the pond (maximum level) of 3.97 ha. The lagoons will have an average useful depth of 1.5 m. As with the anaerobic lagoons, the construction of the facultative lagoons will be through excavation (to a depth of around 1.2 m below the natural ground level) and the construction of side dykes (an embankment using compacted soil from the excavation) up to 1.2 m in high above the natural ground level.

A freeboard of 0.7 m is proposed between the elevation of the maximum water level in the lagoons and the elevation of the dikes crowning, aimed at accommodating the effect of swell during periods of high winds.

Dykes crowning should also be built with a minimum of 3 m wide and a layer of compacted loose gravel should be spread over it.

Also for stability and protection against erosion reasons, the dike slopes gradient should be 1:3 (internal slope) and 1:4 or even 1:5 (external slope). The lining of the dikes and the drainage system (slope foot ditches) should be the same as that proposed for the anaerobic lagoons. The dyke separating the two lagoons will, however, be built with a crowning width of 2.0 m and a slope gradient of 1:3.

The water intake for the facultative lagoons will also be done by means of multiple inlets and based on a two-cell variable-level spillway inlets structure. However, for the facultative lagoons three inlets are proposed separated by about 35 m.

The division of flow between the inlet structures will also be achieved by distribution boxes built into the body of the dyke. The distribution and inlet collectors will have the same dimensions as the collectors proposed for the anaerobic lagoons.

The effluent will be discharged via multiple outlets (two points no more than 40 m apart) consisting of variable-level spillways which will discharge into a common distribution collector connected to the maturation lagoons. Like the inlet box, the spillway structure will be achieved through 800x120x100 mm adjustable concrete slabs.

A concrete skimmer will be built upstream of the discharge section to retain oils, fats and other floating material present on the surface of the facultative lagoons. The connection between the facultative lagoons discharge collectors and the distribution box for the maturation lagoons will also be made through buried concrete pipes of ND= 600 mm.

Maturation Lagoons

The maturation lagoons are essentially designed for the removal of micro-organisms, hence their configuration/arrangement being slightly different from anaerobic and facultative lagoons. As a general rule, a serial configuration is used (several lagoons associated in series, functioning as complete mixing reactors) and a piston-flow configuration (chicane) in which the same lagoon is divided into several channels by means of partition walls intended to maintain the piston flow.

The project therefore considers a piston-flow configuration with partition walls spaced every 25 m towards the smallest extent of the lagoon.

Two parallel lagoons will be constructed with a surface area of 2.63 ha each. For the average inflow in the horizon year, the retention time will be around 4 days. The proposed dimensions of each lagoon are 115x230 m, resulting in a useful surface area of the lagoon (maximum level) of 2.63 ha. The lagoons will have an average useful depth of 1.0 m.

As with the anaerobic and facultative lagoons, the maturation lagoons will be constructed by excavation (to a depth of approximately 0.5 m below the site natural ground level) and the construction of side dykes (embankment with duly compacted soils from the excavation) with a height of up to 1.0 m above the site natural ground level (Figure 4.14). For the present case, a 0.5 m freeborder is proposed between the maximum water level ground elevation in the lagoons and the elevarion of the dikes crowning, in order to accommodate the effect of swell during periods of strong winds.

The crowning of the dikes must be built with a minimum of 2.0 m wide and a layer of properly compacted loose gravel should be spread over it. Also for stability and protection against erosion reasons, the slopes gradient should be 1:3 (internal slope) and 1:4, or even 1:5 (external slope).

The lining of the dikes and the drainage system (slope foot ditches) should be the same as that proposed for the facultative lagoons. The dividing walls will be made of solid block laid on a reinforced flat concrete foundation and supporting bollards, with a useful height of 1.4 m measured from the bottom of the lagoon. The water entry will be through a single two-cell inlet box equipped with variable level surface spillways achieved by concrete slabs (stop logs) 800x200x100 mm.

The effluent discharged will make use of the variable level spillways that will discharge into a free surface channel that will communicate with the receiving environment. Like the inlet structure, the outlet structure will also comprise two cells separated by a dividing wall in one of which the adjustable concrete slabs will be installed.

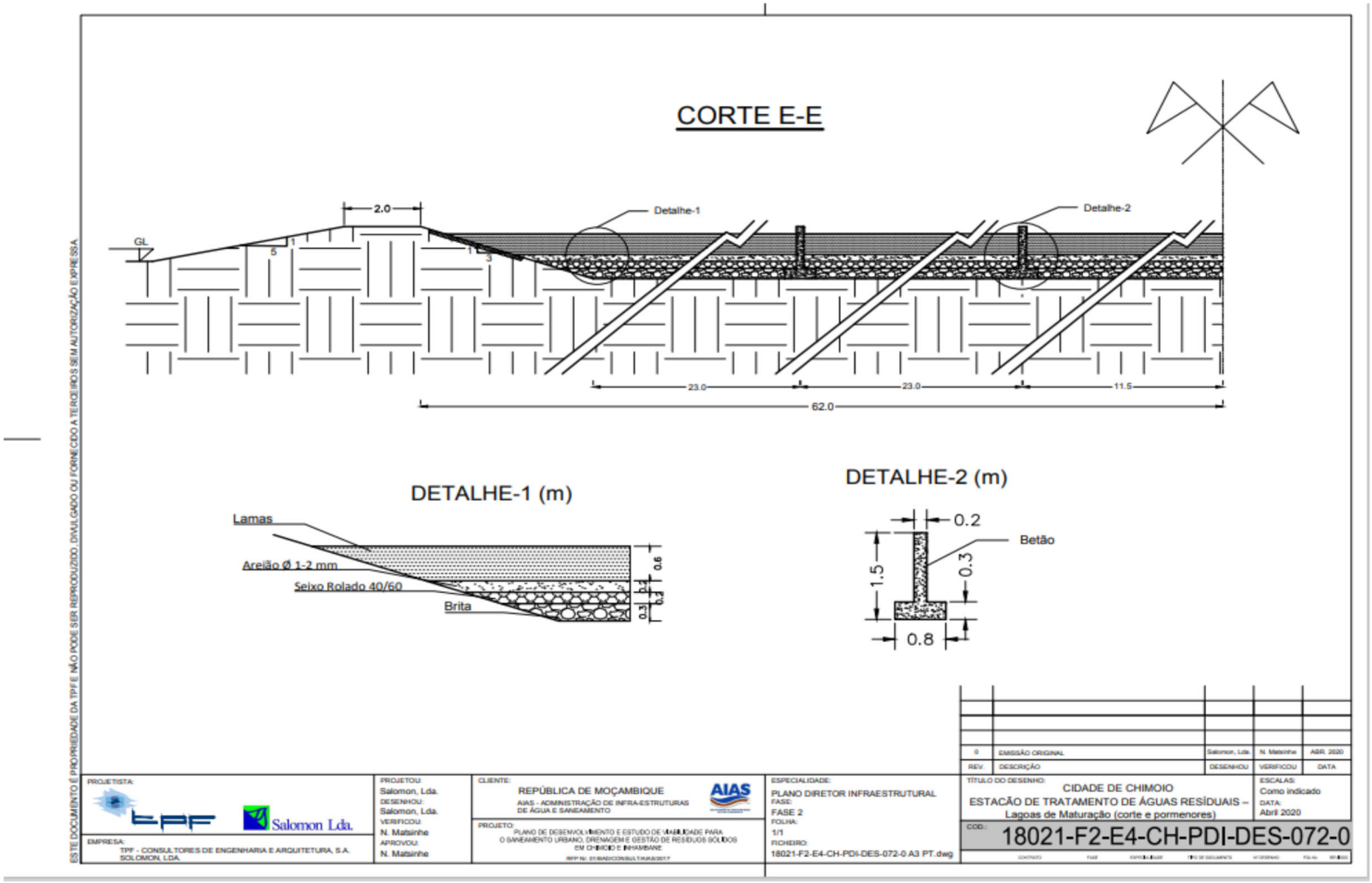


Figure 4.14 – Maturation Lagoons

Drying Beds

The drying beds will be sized to accommodate sludge discharges from the anaerobic lagoons at a rate of two discharges per year, corresponding to a volume of sludge of some 4,100 m3.

The treatment of the sludge (already stabilised) will involve spreading it on drying beds with a supernatant height (height of the sludge layer) not exceeding 0.6 m, corresponding to a spreading area of around 0.67 ha. It is proposed to divide it into 8 cells with a useful area of 25x35 m each.

Similarly to the lagoons, the construction of the drying beds will be by excavation (to a depth of about 0.6 m below the site natural elevation) and construction of side dikes (embankments with properly compacted soils from the excavation) with a height of up to 1.1 m above the site natural elevation, resulting in a total height of the drying beds of 1.7 m (Figure 4.15). For the present case, a freeborder of 0.2 m is proposed between the elevation of the maximum level of the sludge and the crowning elevation of the dikes.

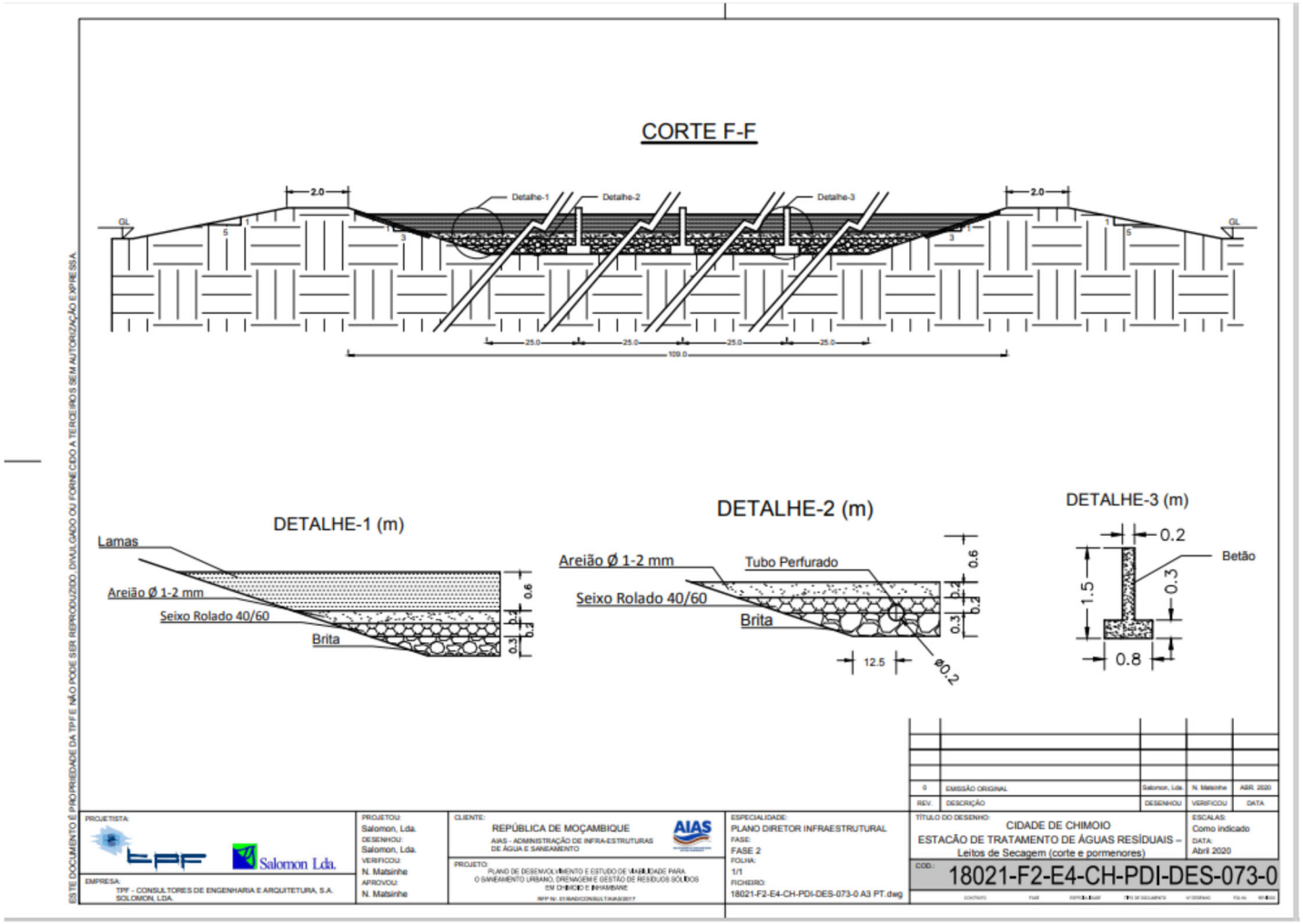


Figure 4.15 – Drying Beds

The crowning of the dykes should be built at least 1.5m wide and a layer of properly compacted loose gravel should be spread over it. For stability and protection against erosion reasons, the slopes gradient should be 1:3 (internal slope) and 1:4 or even 1:5 (external slope). The lining of the dikes as well as the drainage system (slope foot ditches) should be the same as that proposed for the anaerobic lagoons. The separation dikes between cells will, however, be built with a crowning width of 1.0 m and a slope gradient of 1:3.

In addition to the construction and protection of the dykes, the construction of the drying beds will comprise its filling with filtering and waterproofing material, which should include:

- A base layer composed of compacted clay 300 mm thick (bottom and slopes waterproofing);
- A 300 g/m^2 geotextile blanket over the compacted clay layer;
- A 30 cm thick layer of gravel placed manually on top of the geotextile blanket;
- A layer of 200 mm thick rolled pebble (class 40/60) placed on top of the gravel layer; and
- A layer of coarse sand 300 mm thick placed manually on top of the rolled pebble layer, over which the sludge will be spread to dry.

The infiltration flow collection will be independent for each cell and will comprise a system of perforated side drains (ND 110mm, HDPE) connected to a main collector also in HDPE with ND 200mm that will discharge into a collection box before final discharge into the receiving environment, with the spacing between the perforated drains not exceeding 4 m.

Final Effluent Discharge Channel

To collect the effluent from the WWTP (maturation lagoons and drying beds) and discharge it into the receiving environment, the construction of concrete-lined trenches with a triangular or trapezoidal section and a slope gradient dictated by the natural site gradient, but never less than 0.3%, is proposed.

Complementary Works

At various points in the WWTP there will be constructed interconnections works between units and effluent conveying collectors will be laid to diversion/transition manholes or to the receiving environment.

Thus, between the two facultative lagoons planned for each production line, lateral spillways will be installed to create an overflow spillway between the two lagoons and also for discharge into the receiving environment. The overflow spillway between lagoons will be built on the separation dike between the two lagoons, while the remaining ones will be built close to the inlet structures of each lagoon and will the respective discharges into dedicated collection boxes, which will then discharge directly into the receiving environment.

These interconnections will be important for the initial period of operation of the WWTP, period during which wastewater contributions are expected, that may not be sufficient to justify the inclusion of maturation lagoons, at which time one of the facultative lagoons will be operated as a maturation lagoon, receiving the effluent from the other facultative.

An interconnecting collector is to be installed between the flow-sharing boxes of the facultative lagoons on each production line.

This connection will ensure that if one of the anaerobic lagoons is decommissioned, the effluent from the anaerobic lagoon under load will be shared equally between the four facultative lagoons. The collector in question will have a nominal diameter of ND = 300 mm.

To protect the outside walls of the lagoon dikes, slope foot ditches should be built to intercept rainwater runoff and channel it to the discharge points. The refered to ditches should be triangular in shape with B = 0.4 m and H = 0.5 m, built with a minimum gradient of 0.3% and lined with concrete. Drainage ditches must also be built to channel the discharges resulting from the emptying of the lagoons to the receiving environment.

4.5.1.3 Collection and Treatment of Solid Urban Waste

The solutions foreseen for solid waste management were developed considering the priority investments corresponding to the first five years of the project's investment plan and focus on two main aspects, which are:

- In the operation phase, the undifferentiated collection, and transport of urban solid waste (USW); and
- Construction and operation of a sanitary landfill for the treatment of collected USW.

The collection and transport of USW will not therefore involve the construction of specific infrastructures, but the acquisition of materials and equipment that are described in detail in the description of the operation phase.

Thus, the proposed solid waste conditioning and treatment infrastructure is described below.

Sanitary Landfill

The sanitary landfill, which will occupy a total area of 28.8 ha was designed considering the two fundamental principles underlying the construction of a sanitary landfill, which are, namely:

- The isolation of solid waste from the environment, to protect neighbouring settlements, soil, groundwater, surface water and the atmosphere; and
- The control of physical, chemical and biological processes taking place inside the landfill.

The sanitary landfill will be built in a phased manner, in three disposal cells, over a period of 25 years. However, the priority investment refers to the construction of the 1st cell, with capacity to accommodate the USW produced in the first 10 years (Figure 4.16).

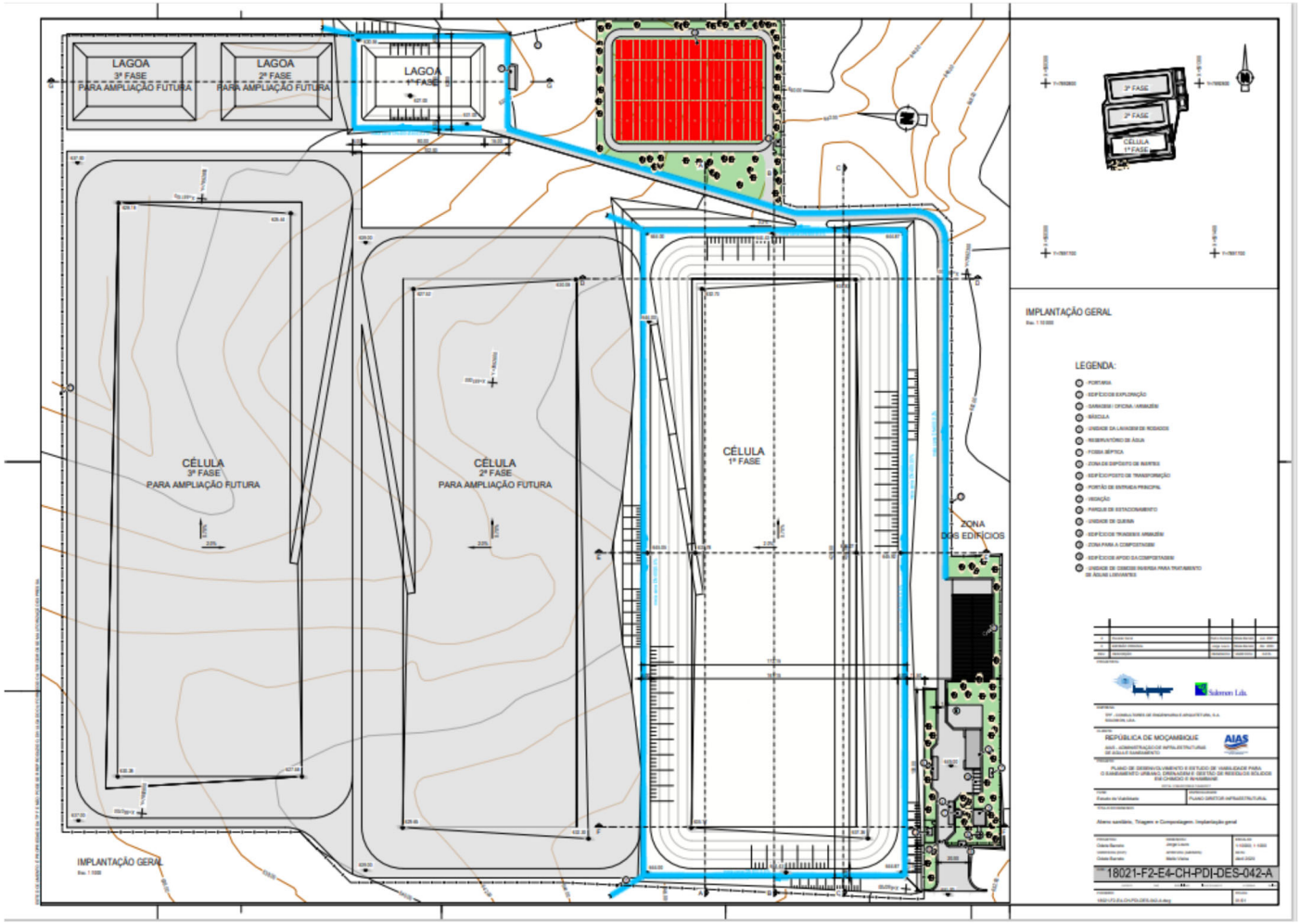


Figure 4.16 – General structure of the USW landfill

Table4.1 presents the sizeing of the sanitary landfill corresponding to the first phase (horizon year 2033), considering that the specific mass of the waste in the landfill is 800 kg/m³.

Table4.1 –Sanitary landfill Sizing

Year	Waste to be discharged in landfill (ton/year)			Covering Lands (m³)	Accomodation volume (m³)
	Quantity (ton/year)	Volume (m³/year)	Accumulated volume		
2023	44.971	56.214	56.214	6.246	62.460
2024	48.512	60.640	116.854	6.738	123.592
2025	52.202	65.252	182.106	7.250	189.356
2026	56.043	70.054	252.160	7.784	259.943
2027	60.039	75.049	327.209	8.339	335.547
2028	64.191	80.238	407.447	8.915	416.362
2029	69.314	86.643	494.089	9.627	503.716
2030	74.635	93.293	587.383	10.366	597.749
2031	80.156	100.195	687.578	11.133	698.711
2032	85.883	107.354	794.932	11.928	806.860
2033	91.813	114.766	909.698	12.752	922.450
-	727.758	909.698	-	101.078	-

Support Infrastructure

In the first phase of construction, in addition to the USW disposal cell, the infrastructures to support the exploration of the sanitary landfill will be executed. The main works and equipment in this phase are as follows (**Figure 4.17**):

- Rehabilitation of the 1.7 km long access road;
- Cell of the 1st phase of USW deposit;
- Gatehouse;
- Support building;
- Workshop;
- ite for the disposal of aggregates;
- Internal access roads;
- Lagoon for the regularization of leachates;
- Water supply;
- Drainage of waste water and storm water;
- Electrical installations;
- Backhoe loader;
- loader; and
- Weighbridge.

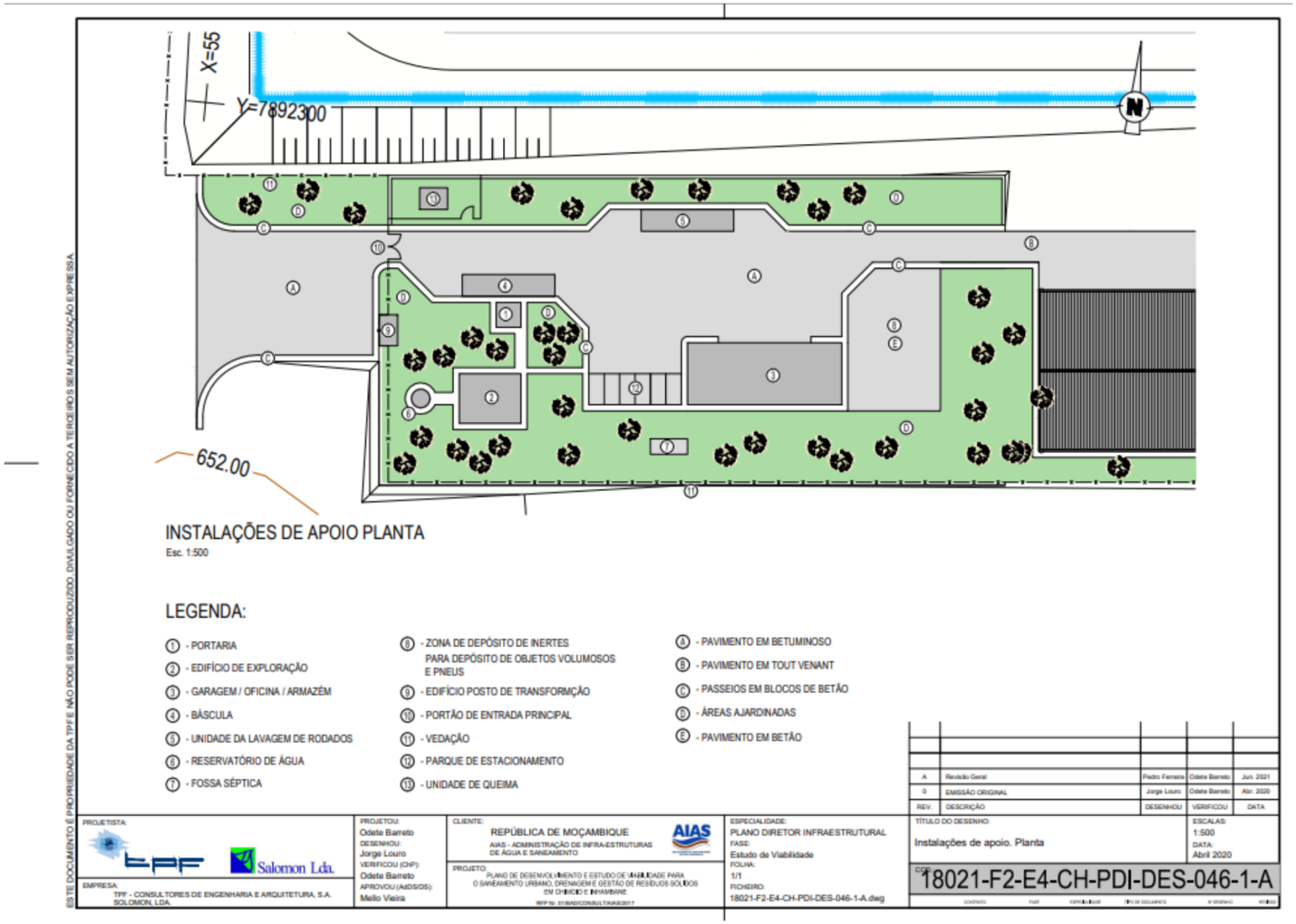


Figure 4.17 – Overview of landfill support facilities

The sanitary landfill will have a total height of 18 m and an excavation of approximately 9 m. The carried out implementation took into account the areas necessary for the future extension of the landfill and the respective leaching water lagoons. Table4.2 shows the implementation areas occupied by the sanitary landfill infrastructures:

Table4.2 – Areas occupied by the sanitary landfill infrastructures

Name	Area (ha)
Total fenced area	28,84
Area occupied by the cell 1st Phase	7,29
Occupied area reserved for the construction of the 1st and 2nd Phase cells	16,14
Area occupied by 1st Phase leachate lagoon	0,52
Area occupied 2nd and 3rd Phases leachate lagoons	1,15
rea occupied by the support installation	0,51

The sanitary landfill waterproofing and leachate water drainage system will consist of:

- - Bottom / base of the embankment
  - Passive barrier: 0.5 meter layer of clay soils;
  - Active barrier: 2mm thick HDPE geomembrane protected at the bottom and the top by a 300 g/m^2 non-woven geotextile. If clay is available on site, the possibility of replacing the geomembrane with clay will be studied;
  - Drainage layer for leachates: mineral drainage layer with a minimum thickness of 0.5 m.
- Slopes:
  - Passive barrier: 0.5 meter layer of clay soils;
  - Active barrier: 2mm thick HDPE geomembrane protected at the bottom by a 300 g/m^2 non-woven geotextile. Other means of protecting the geomembrane, such as the use of tyres, will be used during exploration of the landfill;
- Screens biding area
  - Passive barrier: 0.5 meter layer of clay soils;
  - Active barrier: 2mm thick HDPE geomembrane protected from below and above by a 300 g/m^2 non-woven geotextile.

Leachates treatment

Leachate waters produced at the landfill will be drained by a network of HDPE drains installed in the drainage layer. The bottom of the landfill will be inclined to facilitate leachate waters drainage into the lower area.

Leachate waters will drain through perforated HDPE drains ND 125 mm into a leachate waters pit to be built in the lowest corner of the landfill. The ground elevation allows gravity drainage from this pit to the leachate waters regulation lagoon located downstream.

The leachate waters settled in the lagoons will have to be treated by reverse osmosis. This system will not dismiss the construction of lagoons since they are essential for the regularisation of the

produced leachates. Indeed, due to the great variation in quantity and quality of the produced leachates throughout the year, they need to be regularised in properly impermeable lagoons in order to reduce the impact on the downstream treatment system. The planned lagoons will also have the advantage of allowing for the evaporation of part of the produced flows. The volume of the lagoon required to settle the flow of leaching water in the 1st Phase 1 is 7,883 m^3. For the 2nd and 3rd Phases the lagoons will have 11,180 m^3 and 13,642 m^3 respectively. Therefore, it will be possible to reduce the capacity of the reverse osmosis unit to a minimum, being the planned capacity for the 1st, 2nd and 3rd Phases 53 m^3/day, 74 m^3/day\ and 91 m^3/day respectively.

Given that this is a small reverse osmosis unit it would not be justifiable to install it in stages, so a single compact unit of 100 m^3/day is foreseen.

The unit will be complete, requiring the planning of only two small pump and pipeline units to feed it from the lagoon in operation.

Waste Sorting

A building will be constructed for the sorting and subsequent composting of waste in the sanitary landfill. This building will be equipped with equipment such as a conveyor belt for sorting. The planned system will include, in addition to the sorting belt, silos for receiving the sorted materials, a baling press for paper/cardboard and plastics as well as a press for metals. The feeding of the presses will be done manually (without a feeding belt) with a wheeled loader.

Inside the sorting building a warehouse is planned for the paper/cardboard, plastics and metal bales. The planned system will be able to accommodate 10 to 20 sorters simultaneously.

4.5.1.4 Complementary and Support Activities

As described above, the main activities during the construction phase will include the rehabilitation of the drainage and sewerage systems, the construction of a sanitary landfill and a WWTP as well as all supporting components.

This will include the mobilisation of the contractor to the site, the establishment of premises, offices, warehouses, accommodation, access roads and all other measures necessary for the execution of the works. Demobilisation after completion of the work will include cleaning of all sites, removal of sign boards, removal of all temporary equipment and facilities, restoration of all sites used, adopting all necessary and appropriate measures.

In addition, this phase will include construction works which will include the site bush clearance and excavations, levelling, concrete works, paving, fencing, collection (transport, loading, unloading, spreading) and disposal of excess material at suitable disposal sites. The application and supply of materials, such as geomembrane and clay bedding for the landfill, pipes, valves, sand, gravel, among others, will also be done in this phase. Some materials will be sourced from borrow areas, to be selected by the construction contractor(s).

In addition, it is anticipated that normal chemicals used in any construction work (such as lubricants, oils, cleaning products, varnishes and paints, etc.) will be required.

In addition to the main project components described above, from the consultant's experience, it is expected that the implementation of the project will require a number of complementary components and activities, which are required to support the construction of the infrastructure or to enable its operation and maintenance. These include:

- Construction/rehabilitation of access roads, such as for construction and maintenance purposes of the WWTP, as well as for access to the sanitary landfill;
- Exploration of borrow pits to provide aggregates and inert materials; and
- Establishment of construction support camp(s).

These activities are briefly described below.

Access Road Rehabilitation

During the construction phase, access will be required to access the proposed locations for the WWTP and for the sanitary landfill, which will imply the improvement of roads, still to be defined at this stage.

Opening and/or exploration of borrow pits

Inert materials and aggregates required for civil works associated with the project will be sourced from borrow pits. These materials will be sourced as close to the work site as possible. The location of these borrow pits is not yet defined and will be selected by the construction contractor with approval from AIAS and Municipal Authorities.

Establishment of construction support camp(s)

Support infrastructure to the construction phase may require construction camps, machinery parks, material and equipment storage areas and other construction support facilities. The location of these construction camps is also not yet defined at this stage and will be the construction contractor responsibility, with approval from AIAS and Municipal Authorities, considering such aspects as access to the camp and water availability, among other issues.

Manpower Needs

No estimates are yet available for the manpower for the construction phase. However, based on experience from previous and similar projects, the total labour required for the construction phase is likely to be around 200 workers, including both skilled and unskilled workers.

The labour force required for the operational phase is estimated to be mostly used at the landfill and WWTP, however, it should be on a small scale and to be defined later. It is important to note that some activities will continue to be carried out by the sanitation service workers of the Municipality of Chimoio.

4.5.2 Operation Phase

4.5.2.1 Storm water Drainage

Taking into account the proposed systems for the consolidated areas of the Municipality of Chimoio with the respective investment to be carried out in the period between 2023 and 2028 (first 5 years),

namely the drainage systems CHI.01, CHI.02, CHI.03, CHI.10 and CHI.11 (described in the construction phase), the operation phase assumes the effective use and management of the built infrastructures, with storm water being efficiently conveyed to the considered receiving environment.

The project design also considers, for this phase, the development of non-structural measures (i.e., those that do not imply the construction of any protection structure, such as a dam or flood protection dike), which will improve the performance of the drainage systems. Non-structural measures are those capable of altering susceptibility to flood risk, through, for example, land use planning, the removal of people and structures in areas exposed to risk, the reduction of taxes on properties that are not in an area at risk, among others.

Non-structural measures present two very important advantages over protective structures:

- if adopted at the right time, i.e. before people settle in flood areas, are much less costly than flooding, and
- do not create the false sense of security associated with protection dykes, which even though may reduce the frequency of flooding, never eliminate it.

4.5.2.2 Storm water Drainage and Treatment Component

Network of Collectors

It is foreseen that in this phase, the network of collectors, including the pumping station, will be fully operational, draining the wastewater to the WWTP, which should perform its due treatment.

Wastewater Treatment Plant (WWTP)

Design Flows

The WWTP design flows are summarized in Table4.3 and correspond to the maximum daily flows (daily peak factor of 1.2) expected to flow into the WWTP in the horizon year (2048). Although the WWTP is designed to receive only wastewater, the residual flow was increased by 10% to accommodate possible inflow of storm water into the network. The WWTP design flow totals therefore 17,901 m^3/day (0.21 m^3/s).

Table4.3 – WWTP Flows

Type of contribution	Year	
	2033	2048
Average domestic wastewater (m^3/day)	6.895	11.792
Industrial contribution (m^3/day)	1.034	1.769
Public and institutional contribution (m^3/day)	207	354
Daily Peak Factor	1,2	1,2
Safety margin	1,1	1,1
WWTP flow (m^3/day)	10.467	17.901

Organic Load and Effluent Standards

In the absence of historical data characterizing the wastewater quality in Chimoio, which was not considered relevant since its evolution in time until the project horizon (2048) can be expected as a result of changing consumption patterns, the reference values in Table 4.4 (obtained from the literature) were used to infer the average concentration of impurities relevant for the WWTP sizing.

Table 4.4 – Typical concentration values (gr/m³) of mineral substances in domestic wastewater in tropical areas

Constituent/variable	Per capita contribution (gr/inhab.day)	Average concentration in wastewater (gr/m³)
Chlorides	10-15	100-150
BOD	35-45	350-450
Sedimentable suspended solids	10-20	100-200
Nitrogen	5-8	50-80
Phosphorus	1-3	10-30
Sodium	2-4	20-40
Total hardness	10-20	100-200
STD (non-volatile)	3-5	30-50
Total concentration	50-150	500-1.500

Source: Okun & Ponghis (1975).

Thus, for the present project and particularly with respect to the inflowing BOD and SS (settleable fraction) load, the following average concentrations were used for sizing: BOD = 400 mg/l = 0.4kg/m^3; SS = 150 mg/l = 0.15 kg/m^3.

As for the effluent standards and, consequently, the efficiency expected from the treatment, the values for BOD (25 mg/L) and SS (15 mg/L) are used as reference.

Access Channel with Bar Grid

From an operational point of view, it is admitted that the bar gratings are cleaned whenever 60-65% of the space between the bars is clogged due to waste accumulation. Under these conditions, the flow speed between the clogged bars will be about 1.8 m/s in the first and second bar section, and the corresponding load losses about 2-3 cm in the first section and 3-4 cm in the second. The maximum water level rise upstream of the first bar screen is therefore estimated to be 0.10m. With this water level rise, the access channel should have a minimum working height of 0.65 m. By adding a free plate of 0.25-0.3 m, the total height of the entrance channel should be 0.9 - 1.0 m.

During operation, and as a result of clogging of the bar grates, an alternative circuit (diversion channel) is required to maintain flow downstream of the unit even when the bar grate sections are clogged beyond their capacity. A side discharger is proposed, constructed upstream of the separation zone. The crest of the side discharger will be positioned approximately 5 cm above the maximum water level in the inlet channel when the bar sections are clogged (0.65 m).

Since this is a side spillway installed in a channel with a low gradient and a spillway crest positioned above the critical channel height, the expected water profile over the side weir will be upstream. The length of the spillway was obtained by applying the expression developed by De Marchi for

rectangular section channels, assuming that 65% -70% of the inflow will be diverted through the side spillway.

The estimated discharge flow rate under these conditions will be 0.17-0.18 m^3/s, and the length of the side dam 1.2 m. The diversion channel for the units downstream of the WWTP should have the same dimensions as the inlet channel.

Sludge Accumulation and Discharge in the Anaerobic Lagoons

With the operation of the WWTP, there will be deposition and accumulation of sludge in the anaerobic lagoons, which will result from both the deposition of sedimentable suspended material and the formation of biomass resulting from the removal of organic matter (BOD) in these lagoons. Sludge accumulation in anaerobic lagoons is estimated at 0.03-0.1 m^3/hab per year. Its removal is periodic and should be carried out whenever the sludge layer reaches 1/3 of the depth of the lagoon. In the present case a sludge accumulation rate of 0.05 m^3/inhab per year was adopted, corresponding to an annual accumulated sludge volume of 5,500 m^3/year (the calculation basis is the population served in 2033) which implies a cleaning every two years.

For the discharge of sludge a cleaning system is proposed with maintenance of the lagoons in operation and through a hydraulic discharge system with direct discharge (gravity) to a common collection pit from where the sludge will be pumped to the drying beds.

At least two sludge discharge points will be installed in each lagoon (one for the deeper and one for the shallower area) all connected by gravity to the same collection pit. The estimated discharge flow rate for the lagoons project conditions (useful depth of 2.7 m in the sludge accumulation area) will be of the order of 0.26m^3/s, corresponding to a flow speed in the collectors of the order of 3.7 m/s and discharge times of the order of 5 hours.

Deactivation and Drainage of the Anaerobic Lagoons

If it is necessary to deactivate one of the anaerobic lagoons (operational issues), the entire liquid volume of the lagoons will have to be drained. For this operation, a hydraulic discharge system is also proposed with discharge of the effluent into a collection pit from which the effluent will be pumped to the facultative lagoons. For this operation, concrete collectors of nominal diameter ND = 200mm are proposed. The maximum discharge flow rate for the design conditions of the lagoons (useful height of 2.0 m) will be of the order of 0.27 m^3/s, corresponding to a maximum flow speed in the collectors of the order of 3.8 m/s.

Faecal Sludge

As it is anticipated that a large part of the town will continue to rely on individual wastewater management solutions (septic tanks and latrines) there is a need to predict a point of discharge for faecal sludge (suction lorries).

For this operation it is proposed that a sludge discharge structure is to be built which will communicate to the lagoons by means of an overhead discharge with downward jetting. The sludge discharge pipe (ND 200 mm) will be adequately supported by support bollards.

Drainage of storm water runoff

For the collection of rainwater runoffs, a system of triangular-shaped, concrete-covered foot-slope trenches are proposed, with a base width B= 0.4 m and height h = 0.5 m built with a minimum gradient of 0.3%.

Accumulation and Discharge in Facultative Lagoons

Similarly to anaerobic lagoons, with the operation of the WWTP there will be deposition and accumulation of sludge in the facultative lagoons that will result both from the deposition of sedimentable suspended material and from the formation of biomass resulting from the removal of organic matter (BOD). The accumulation of sludge in anaerobic lagoons is estimated at 0.03-0.04 m^3/inhab per year, and its removal should take place when the sludge layer reaches 1/3 of the depth of the lagoon or simply through periodic annual cleaning. In this case a sludge accumulation rate of 0.03 m^3/inhab per year was adopted, corresponding to an annual accumulated sludge volume of 3,300 m^3/year (the calculation base is the population served in 2033), which implies cleaning every 10-15 years.

Although this is an infrequent operation, a drainage system is proposed for the discharge of sludge, with the lagoons kept in operation by means of a piping system with hydraulic discharge and gravity discharge into a collection pit with subsequent pumping to the drying beds. The discharge will be achieved by concrete collectors of nominal diameter ND = 200mm.

The estimated discharge flow rate for the design conditions of the optional lagoons (useful depth of 1.7 m) will be of the order of 0.1 m3^{3}s, corresponding to a flow speed in the collectors of the order of 2.9 m/s and discharge times of the order of 17 hours.

Deactivation and Drainage of the Facultative Lagoons

A system similar to the one proposed for anaerobic lagoons is proposed for the drainage of the lagoons, should it prove to be necessary.

Maturation Lagoons

The inlet to the maturation tanks will be made by a single inlet structure containing two cells and variable level overflow spillways. Effluent discharge will also be made by variable level overflow weirs, which will discharge into an open drainage channel that will convey the effluent to the receiving stream.

4.5.2.3 Collection and Treatment of Urban Solid Waste

USW Collection and Transport

As previously mentioned, priority investment solutions were defined, corresponding to the first five years of the investment plan. Regarding USW collection, it is considered that the equipment should be acquired according to the annual needs.

The estimated number of containers to be purchased in the first five years of investment was based on the daily volume of USW to be collected and on the envisaged collection frequency. The accepted assumptions were:

- Specific weight of the mass of USW in container: 300 kg/m^3, in accordance with the value used in the Waste Master Plan;
- Collection frequency: 6 times a week, from Monday to Saturday.

Currently, the USW collection and transport equipment is insufficient and many are in a poor state of repair. However, the new ones should be kept, namely thirty-two 6 m^3 containers and two container trucks. Table 4.5 shows the volume of USW collected and the number of containers necessary for the first five years of investment. The 1,100 L containers will have to be acquired and the 6 m^3 containers correspond to the existing ones, to be maintained.

Table 4.5 – USW daily volume to be collected and containers needed

Year	USW (m^3/day)	1100 L containers	6m^3 containers
2023	479	262	32
2024	517	294	
2025	556	333	
2026	597	369	
2027	640	410	
2028	684	450	

The 1,100 L containers foreseen have the following main features:

- Material: mild steel plate, galvanized, with metal lid and lifting system;
  - Does not absorb liquids;
  - Resistant to corrosion
  - Fire resistant;
- Lifting system: compatible with the foreseen vehicles.

For the areas with better access it is proposed to use 15 m^3 compactor vehicles. The 7 m^3 mini-compactor vehicles and the 6 m^3 container trucks will be used in areas with more difficult access. In the latter case, these vehicles will be used to collect the existing large capacity containers.

In the first five years, three 7 m^3 mini compactor vehicles and three 15 m^3 compactor vehicles will be needed. However, due to the existence of two new container vehicles (from the Chimoio Municipal Council), only one 7 m³ and three 15 m³ vehicles will be purchased.

The proposed mini compactor is composed of a 7 m³ cargo box made of steel plate, and the trapezoidal structure of this box allows a simple and waterproof unloading operation. The compaction system works on sliding guides located on the top of the cargo box and is composed of a trolley with a compacting plate that allows a fast loading and a considerable compaction capacity.

The 15 m³ vehicle will guarantee a higher USW compaction than the 7 m³ vehicles. The waste collection equipment includes a compacting mechanism to collect the waste placed in the reception hopper and compact it inside the box.

Sanitary Landfill

As mentioned before, the sanitary landfill will be built in phases over a period of 25 years. Table4.1 (see page 76) presents the sizing of the sanitary landfill corresponding to the first phase, horizon year 2033.

Gas Production in the Sanitary Landfill

The gases produced within the waste mass are mainly carbon dioxide and methane, in varying concentrations throughout the lifetime of the landfill and depending on its age and the nature of the waste deposited. Carbon dioxide has a density greater than air and is highly soluble in water, therefore its natural drainage is associated with the circulation of leachates. Methane is lighter than air, so it tends to escape upwards by diffusion through the waste mass.

USW Sorting and Composting

As far as sorting stations is concerned, these facilities receive the flows from selective collection which, after further sorting, are packed and sent to the recyclable materials market. Automatic and manual systems are envisaged. In this case, a system with a conveyor belt (feeding belt) and manual sorting is planned. The quantities expected to be recycled are the ones presented in Table4.6, It should be noted that glass separation was not foreseen, since its quantity in the USW does not justify it.

Table4.6 – Sorting system sizing

Ano	Papel/cartão (ton/ano)	Metais (ton/ano)	Plástico (ton/ano)	Total (ton/ano)
	20%	20%	20%	
2023	1 304	1 349	1 079	3 733
2024	1 407	1 455	1 164	4 027
2025	1 514	1 566	1 253	4 333
2026	1 625	1 681	1 345	4 652
2027	1 741	1 801	1 441	4 983
2028	1 862	1 926	1 541	5 328
2029	2 010	2 079	1 664	5 753
2030	2 164	2 239	1 791	6 195
2031	2 325	2 405	1 924	6 653
2032	2 491	2 576	2 061	7 128
2033	2 663	2 754	2 204	7 620
2034	2 750	2 844	2 275	7 869
2035	2 838	2 936	2 349	8 123
2036	2 928	3 029	2 423	8 380
2037	3 019	3 123	2 499	8 642
2038	3 112	3 219	2 575	8 907
2038	3 206	3 316	2 653	9 175
2040	3 300	3 414	2 731	9 446
2041	3 431	3 549	2 840	9 820
2042	3 493	3 613	2 891	9 997
2043	3 590	3 714	2 971	10 275
2044	3 711	3 839	3 071	10 621
2045	3 836	3 968	3 174	10 978
2046	3 965	4 101	3 281	11 347
2047	4 098	4 239	3 391	11 728
2048	4 235	4 381	3 505	12 121
Total	72 616	75 120	60 096	207 832

The planned system includes, in addition to the sorting belt, silos for receiving the sorted materials, a baling press for paper/cardboard and plastics and a metal press.

The feeding of the presses will be done manually (without a feeding belt) with a wheeled loader. Inside the sorting building a warehouse is planned for the paper/cardboard, plastics and metal bales. The planned system will be able to accommodate 10 to 20 sorters simultaneously.

The project also contemplates the use of simple composting systems, without technological or equipment requirements. It should be noted that the composting process will not be successful should there be no use of the compost by the farmers and it will have to be disposed of in the landfill, the same having to be done with the recyclable bales if there is no one interested in them.

The materials to be composted will mainly consist of organics from markets and restaurants and green waste. The managing entity will provide containers placed in the markets where fruit and vegetable remains produced in the markets will be deposited, as well as grass, tree and shrub trimmings carried by the population close to the market. The green waste can also be collected door-to-door by the management entity, at the request of the population located further away from the markets.

This waste will be transported to the sanitary landfill where there will be a composting centre made up of bins (cells) prepared for this process. The quantities foreseen to be composted are the ones presented in Table4.7.

Table4.7 – Sizing of the composting system

Year	Percentage of recycled organic matter (%)	Recycled organic matter (ton/year)
2023	20%	5.217
2024	19%	5.217
2025	17%	5.217
2026	16&	5.217
2027	15%	5.217
2028	14%	5.217
2029	13%	5.217
2030	12%	5.217
2031	11%	5.217
2032	10%	5.217
2033	10%	5.217

According to the illustrated data, the system foreseen for the 1st Phase will have a capacity to treat 5,217 tons/year. This system will be expanded in the 2nd Phase and will have double the capacity. It should be noted that, with the implementation of the proposed sorting and composting solutions, there will be an increase in the useful lifetime of the sanitary landfill in about 4 years.

4.5.3 Project Investment

The total investment budget for the project is currently estimated at around US$54 million. This value is divided according to each proposed infrastructure, namely:

- Stormwater drainage – USD 10.842.965,24;
- Sanitation:
  - Phase I – USD 18.490.531,62;
  - Phase II – USD 11.188.983,53.
- Solid waste – USD 13.386.713,19.

5 Analysed Project Alternatives

The proposed project will be carried out in the Municipality of Chimoio, which is administratively divided into three administrative posts and 33 neighborhoods. According to Mozambican municipal legislation, the Municipal Council is responsible for the drainage, sanitation and waste management of the city.

5.1 Alternative Zero

This alternative would imply that the project would not be carried out. The following factors were considered in its analysis:

- Current conditions of the storm water drainage system;
- Current conditions of the wastewater drainage and treatment system;
- Current conditions of the urban solid waste management system;
- Public health risks arising from the current conditions of the different systems;
- Contribution of the project to the solution of the identified problems.

In summary, drainage and sanitation conditions present the following deficiencies:

- The storm water collection system, located in the central area of the city, dates back to 1950 and has not been subject to rehabilitation actions in recent years, with the exception of the recent extension that was carried out in Av. do Trabalho, being obsolete given the development and expansion of the city in recent years;
- The network is mixed, that is, it is used for both storm water and domestic wastewater (TPF & Salomon, 2020);
- There are several discharge points that discharge to peri-urban areas, giving rise to accumulations of contaminated and stagnant water;
- Storm water and black water from Bairro 3 de Fevereiro, Bairro 3 and the remaining neighbourhoods in the consolidated urban area are discharged into a collector that crosses the N6 road and discharges into the Mwenesi River in the Bairro do Centro Hípico (TPF & Salomon, 2020);
- The collection of USW is carried out by the municipal services, in an undifferentiated manner. Despite the work developed by the municipality for the cleaning of the city, there are many difficulties in the collection and treatment of the produced solid waste;
- The human resources and equipment allocated to USW collection are clearly insufficient, given the amount of waste currently produced;
- Most of the USW collection fleet is degraded due to breakdowns, poor maintenance, old age vehicles and accidents;
- The containers for waste disposal are in insufficient number, they have low capacity and in some cases they are non-existent, and in some neighbourhoods families deposit waste on the streets, in openings made by erosion or in a nearby stream (as is the case in 7 de

Setembro neighbourhood). In the peri-urban neighbourhoods there are no containers for solid waste disposal and the population burns or buries the waste.

These deficiencies result in various problems ranging from flooding of various areas without storm water drainage, erosion and degradation of roads and ravines, flooding of the Mwenesi River valley, to the high risks to public health associated with poor drainage and poor sanitation of the environment.

The present project appears as an alternative for the resolution of the problems presented above, therefore the Alternative Zero was discarded.

5.2 Project Components and Studied Alternatives

The project main components and respective studied alternatives are illustrated in Figure 5.1, comprising:

- Storm water drainage;
- Wastewater drainage and treatment (WWTP); and
- USW collection and treatment (Municipal Landfill).

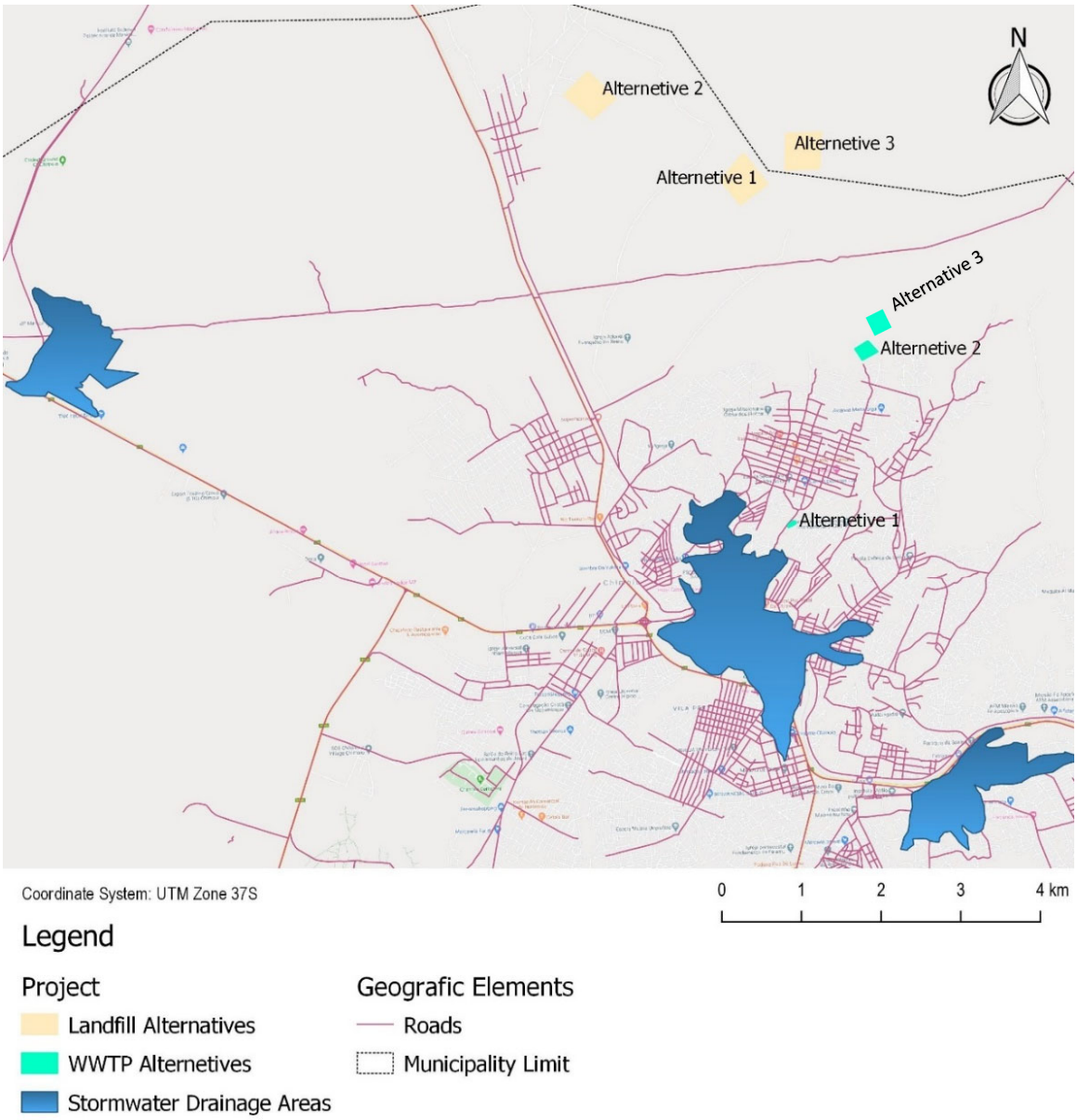


Figure 5.1 – Overview of alternatives for the different components of the Project

5.2.1 Location Alternatives

After the technical study of the location and technological alternatives made by the designer (TPF), these were taken for analyses and discussion with AIAS and the environmental consultant. A comparative analysis of the options was undertaken, considering environmental and social criteria, and also the Technical Directive for the Implementation and Operation of Sanitary Landfills in Mozambique (DTAS; MICOA, 2010). The sections below describe the different alternatives studied and the alternative selected as the most suitable.

5.2.1.1 Wastewater Drainage Network and WWTP

WWTP

Regarding the WWTP the following three alternatives were studied (see Figure 5.2).

Alternative 1

Alternative 1 corresponds to the area where the existing WWTP is located.

Due to its location, this alternative has the merit of allowing the use of part of the existing infrastructure to develop a more robust and higher capacity WWTP.

However, it has the following disadvantages:

- Location close to an already consolidated residential area;
- The existing space is limited, affecting future expansions;
- Because of its location in high topographical elevations in relation to the different residential areas with the potential to be connected to the network of collectors, the proposed drainage network must necessarily include three pumping stations;
- A part of the city located downstream of the WWTP and at lower elevations (Bairro Vila-Nova) cannot be connected to the WWTP without an additional pumping station.

Alternative 2A

It comprises a drainage system which has the WWTP located in an alternative site, further away from residential areas (in Bairro Nhamatsane) and with greater availability of space to accommodate the WWTP and its future expansions.

Due to its location in lower topographic elevations, this alternative has the merit of allowing most of the wastewater collected by gravity to be conveyed to the WWTP (reducing the number of pumping stations to 1), however, it has the demerit of requiring greater extension of the interceptor collector connecting to the WWTP.

Alternative 2B

Alternative 2B also comprises a drainage system that has the WWTP located in an alternative location, further away from residential areas (in the Nhamatsane Neighborhood) and with greater space availability to accommodate the WWTP and its future expansions.

The advantage mentioned for Alternative 2A regarding the conveying of wastewater to the WWTP also applies to this alternative. The difference between them consists of the technological options, described below.

The initial location of Alternative 2B was slightly adjusted (with a distancing of about 1km having been made to the west) due to the existence of a slightly growing informal housing area and to avoid potential social conflicts between the project and the community.

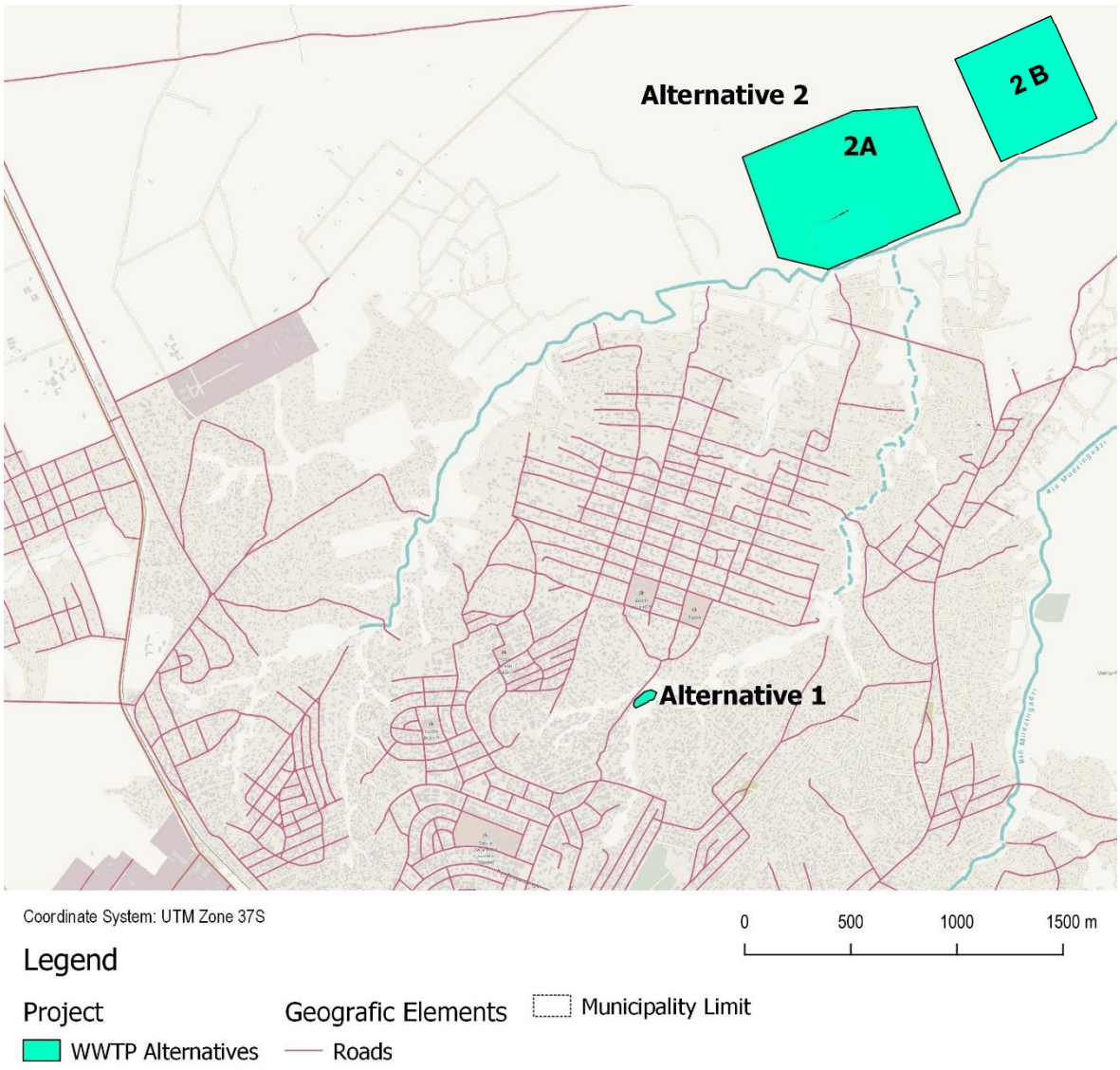


Figure 5.2 – WWTP location alternatives

The comparative analysis of the options, considering environmental and social criteria, and in accordance with the requirements of the DTAS is presented in Table 5.1.

The comparative evaluation of the sites in question was carried out considering a buffer area (500 meters for the landfill, 200 meters for the WWTP with conventional treatment, and 500 meters for the WWTP with the lagoons system), and based on predefined indicators, grouped according to the characteristics of the biophysical and social environment, namely:

- Number of residential structures within the landfill site;
- Number of access roads within the landfill site;
- Areas of agricultural occupation within the landfill site;
- Existence of concentrated population nuclei;
- Number of residential structures
- Areas of agricultural occupation;
- Social facilities (schools, health centres, cemeteries);

- Economic enterprises (agro-industrial properties) denoting an installed agro-industrial use.

The indicators were assessed using a scale of zero (0) to two (2), with the lowest value (=0) equivalent to no sensitivity; the middle value (=1) equivalent to some sensitivity and the highest value (=2) being equivalent to high sensitivity.

Sensitivity was defined in relation to the following factors:

- Need for physical displacement;
- Annoying smell;
- Dragging of materials by the wind;
- Contamination;
- Disturbance to the community;
- Visual disturbance.

For each indicator, the Consultant developed the following criteria to assign the respective score, within the selected area and outside it, considering the established buffer areas:

- Has no importance - 0;
- Can be compensated - 1;
- Its compensation entails serious problems - 2.

The assignment of the values was carried out based on the Consultant's knowledge of the area and the mapping of the site using Google Earth. Table 5.1 presents the analysis of the alternatives for the location of the WWTP according to the established criteria.

Table 5.1 – Analysis of the alternatives for the WWTP location in accordance with social and environmental aspects

Indicators	Comparative analysis			Classification of the alternatives		
	Alternative 1- Existing WWTP	Alternative 2 - New WWTP		Alternative 1- Existing WWTP	Alternative 2 - New WWTP	
		2A (Option 1) Conventional	2B (Option 2) Lagoons		2A (Option 1) Conventional Treatement	2B (Option 2) Lagoons
Buffer zone (according to the Directive's guidelines)	200 m	200 m	500 m	200 m	200 m	500 m
Comprehensiveness of the sewerage network coverage	More extensive area	Less extensive area	Less extensive area	0	2	2
Capacity of the body receiving treated waste	Less extensive basin	More extensive basin	More extensive basin	2	0	0
Existence of odour-sensitive receptors in the prevailing wind direction	Affects more sensitive receptors	Affects Less sensitive receptors	Affects Less sensitive receptors	2	0	0
Existence of concentrated population clusters in the treatment plant	-	-	-	0	0	0
Number of residential structures in the treatment plant	-	0	0	0	0	0
Number of access roads in the treatment plant	-	0	0	0	0	0
Areas of agricultural occupation within the treatment plant	-	≤30%	≤30%	0	0	0
Existence of concentrated population clusters in the buffer zone	95%	-	-	2	0	0
Number of residential structures within buffer zone	-	-	-	2	0	0
Areas of agricultural occupation within the buffer zone	5%	≤30%	≤30%	0	1	1
Social facilities (schools, health centres, cemeteries, airports) in the buffer zone	Not indicated	Not indicated	Not indicated	0	0	0
Economic enterprises (agro-industrial properties) in the buffer zone	Not indicated	Not indicated	Not indicated	0	0	0
Total	**-**	**-**	**-**	**8**	**3**	**3**

According to the scoring, Alternative 1 (existing WWTP) would be the most socially recommended alternative, since it has fewer impacts. However, it is important to consider the technical and environmental reasons for considering the alternative of building a new WWTP.

In this context, a comparative cost analysis was carried out, and it was concluded that Alternative 2A is the one with the best score if the decision criterion is the lowest investment cost, while if the decision criterion is to have the lowest operating costs, Alternative 2B is the one that should move on to the implementation phase. Alternative 1 is clearly an alternative not to be considered.

Considering all criteria used and after consultation between the AIAS, the designer and the environmental consultant, Alternative 2B was selected as the best for implementation of the WWTP.

Wastewater Drainage Network

For the wastewater collection component, two alternatives were considered that differ in the proposed location of the wastewater treatment plant.

From the point of view of the network of collectors, the first alternative would require the construction of a network of collectors of lesser length (108.94 km of network of collectors and interceptors) but, on the other hand, the inclusion of three pumping stations to ensure the conveyance of all the sewage collected to the WWTP. This alternative would also require that a part of the city located downstream from the WWTP and at lower topographical elevations (Bairro Vila-Nova) not be integrated into the system without necessarily including a fourth pumping station. Also with regard to this alternative, despite the advantage associated with the location of the WWTP in an area where there is already some infrastructure that could be reused, this space is confined (besides being located near residential areas) and does not offer possibilities for future expansions of the treatment system.

The second alternative involves a longer collector network (136.99 km) but with greater comprehensiveness to what regards its coverage (Vila-Nova could now be integrated) and a smaller number of pumping stations (just 1).

5.2.1.2 USW Collection and Municipal Landfill

Landfill

The following three alternatives have been studied:

- Alternative 1 - Area located in Bairro Nhamatsane;
- Alternative 2 - Area located in Bairro Agostinho Neto, near the current waste dump;
- Alternative 3 - Area also located in Bairro Nhamatsane.

The main criteria that differentiate the three alternatives are the topography, the proximity of population clusters and the existence of water lines and roads.

The comparative analysis carried out and presented in

Table5.2 considered the technical, environmental, social and gender aspects inherent to the construction of the sanitary landfill in each of the alternative locations. Figure 5.3 presents the studied alternatives.

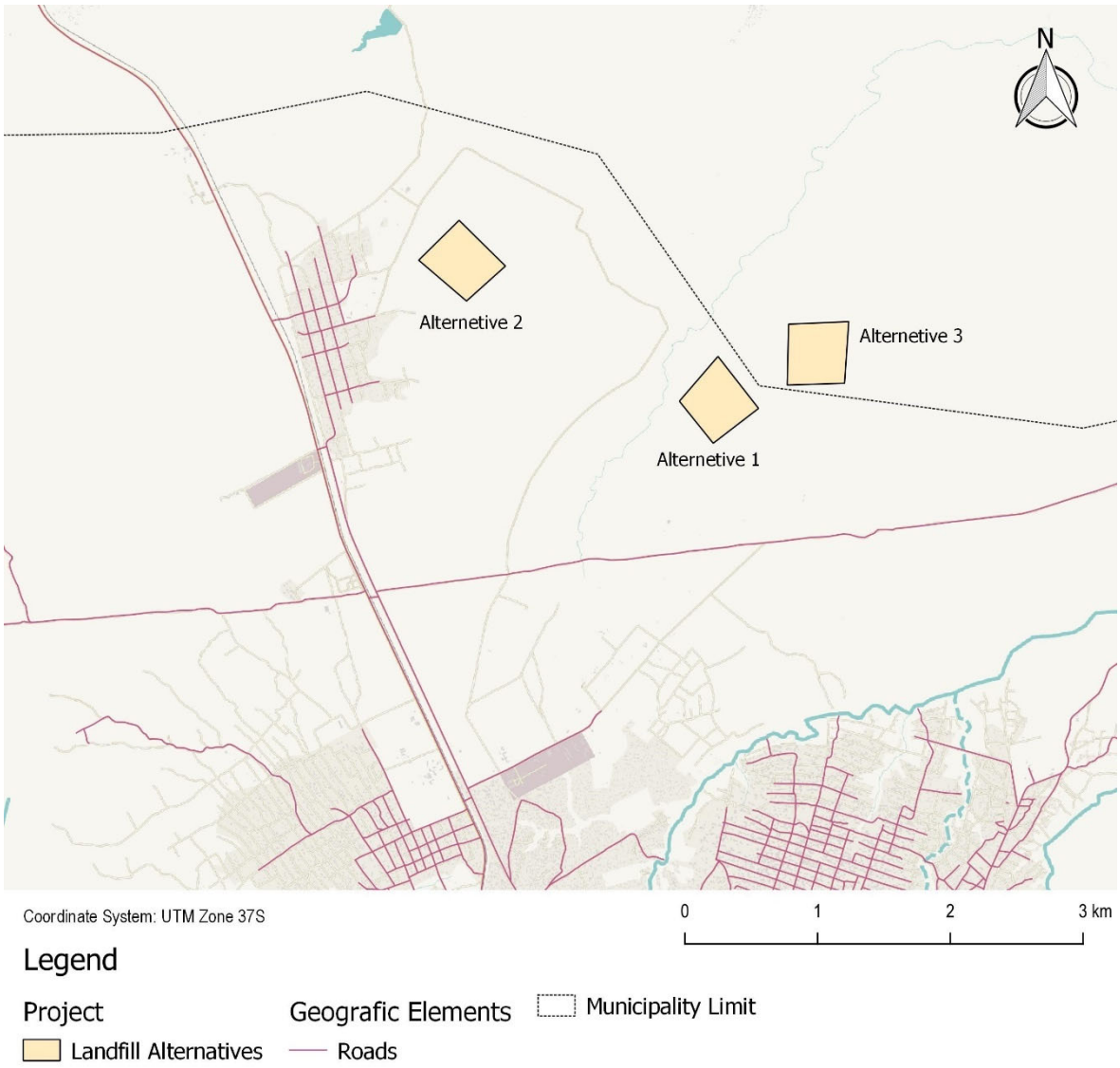


Figure 5.3 – Alternative locations for the landfill

Table5.2 – Comparison of sanitary landfill site location alternatives according to environmental and social aspects

Indicators	Comparative analysis			Classification of the alternatives		
	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3
Location	Nhamatsane	Agostinho Neto	Fora do Município	Nhamatsane	Agostinho Neto	Outside the Municipality
Flood risk area	0	0	0	0	0	0
Ecologically sensitive area	0	0	0	0	0	0
Interference to natural drainage	Crossed by a natural drainage line	Crossed by a natural drainage line	With no drainage lines	2	2	0
Existence of odour-sensitive receptors in the prevailing wind direction	0	Near the expansion area of Bairro	0	0	2	0

Indicators	Comparative analysis			Classification of the alternatives		
	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3
		Agostinho Neto				
Number of residential structures on the landfill´s premises	0	0	0	0	0	0
Number of access routes within the sanitary landfill´s premises	1 (less important)	2 (important)	1 (less important)	1	2	1
Agricultural areas within the sanitary landfill´s premises	50%	10%	0	1	1	0
Existence of population centres concentrated in a 500 m buffer zone	2 (small clusters)	10 (7 big clusters)	4 (small clusters)	1	2	1
Residential structures within a 500 m buffer zone	9	3	5	2	1	1
Agricultural area within a 500 m buffer zone	Around 50% of the buffer zone	Around 50% of the buffer zone	Around 10% of the buffer zone	2	2	1
Social facilities (schools, health centres, cemeteries) inside a 500 m buffer zone	0	0	0	0	0	0
Economic enterprises (agro-industrial properties) inside a 500 m buffer zone, denoting an established agro-industrial use	0	0	0	0	0	0
Total classification	**-**	**-**	**-**	**9**	**12**	**4**

From the technical and socio-environmental analysis the following can be concluded:

- In environmental terms none of the alternatives is located in areas with flood risk or sensitive areas in ecological terms;
- Alternatives 1 and 2 are crossed by natural drainage line, which correspond to affluent spring areas of the Mezingazi River (belonging to the Púnguè River basin);
- Alternative 2 is, definitely an alternative to be discarded, not only because the area contains two important access roads used by the local population, but also because, within a buffer zone of 500 m from the chosen area, there are several large population groups, resulting in potentially more significant impacts. Additionally, Alternative 2 (current dump) is also relatively close to the urban expansion area of Bairro Agostinho Neto, which could be exposed to bad odors coming from the landfill, since the prevailing winds are from the southeast and this urban area is located west of Alternative 2;
- **Alternative 3** is located in a flatter area of the plateau, where no drainage lines are identified, showing itself, therefore, preferential under this criterion, since in addition to avoiding

changes in natural drainage, the downstream area is less susceptible to the risk of spillage or accidental leachate leakage.

In view of the above, **Alternative 3** was considered the most advantageous. There is already a landfill project for the Municipality of Chimoio developed for this site, so it is recommended that the sanitary landfill be maintained at this location.

5.2.2 Technological Alternatives

5.2.2.1 Storm Water Drainage Component

Since the current system is unitary, that is combining storm water and wastewater drainage in a single system, and given the problems such a system would have, separative solutions were studied and recommended for storm water drainage and wastewater drainage (sewage). For the storm water component, the proposed systems cover some urban areas of the city considered priority and were designed taking into account the direction of outflow and the contribution of the respective drainage basins.

Since the most appropriate solution for storm water drainage follows the outflow path delimited by the drainage basins no alternatives in terms of networks were studied.

Drainage networks were studied according to the delimitation of basins and storm water networks were laid along the existing streets to function by gravity. The solutions to be adopted were those traditionally applied in the storm water drainage network, namely gutters with adequate spacing, cement sewers and, sometimes, open drainage ditches and retention basins.

5.2.2.2 Wastewater Collection and Treatment Component

WWTP

For the WWTP component, two intervention alternatives were studied, namely:

- Rehabilitation with expansion (capacity increase) of the existing treatment plant;
- Construction of a new WWTP.

The first alternative considers that the current location and basic technological option of the existing WWTP will be maintained as the city's wastewater treatment solution. It should, however, benefit from rehabilitation and expansion works (capacity increase to adapt it to the demands of the horizon year, and should also benefit from the inclusion of new unit processes to increase the efficiency of the biological treatment stage.

For the second alternative, in a new area located in the Nhamatsane neighbourhood, the following alternatives have been considered: (i) conventional treatment and (ii) treatment by stabilisation lagoons (non-conventional).

The conventional option considers the implementation of a WWTP with a similar configuration to the one described for alternative 1, but with all unit processes built from the ground up.

Treatment using stabilisation lagoons (anaerobic, facultative and maturation lagoons) has been chosen as intervention alternative in this study because of its operational simplicity and relatively low operating and maintenance costs.

Regarding the technological alternatives considered, it should be noted that both alternatives constitute relatively simple technologies, without major operational and maintenance requirements, which minimizes the risks of operational difficulties and, consequently, the risk of discharges without adequate treatment, which have negative environmental consequences. However, the surface catchment alternative, being the technology closest to the natural purification system, requires slightly less intervention and is more advantageous in this respect.

After the technical and socio-environmental analysis of the alternatives, the alternative of building a WWTP from the ground up was chosen - **Alternative 2**, of non-conventional treatment by stabilization lagoons (anaerobic, facultative and maturation lagoons), for its operational simplicity and relatively low operating and maintenance costs.

Wastewater Drainage Network

For the wastewater collection component, two alternatives were considered that differ by the proposed location of the wastewater treatment plant described above.

After analysing the technical particularities of each alternative and also the respective advantages and disadvantages (including comparison of capital investment costs and operation and maintenance costs) intervention **Alternative 2** was selected; that is, a network of collectors connected to a WWTP located in the Nhamatsane neighbourhood.

The entire domestic and industrial wastewater drainage network will be built from the ground up, abandoning the existing one, which will be dedicated exclusively to storm water drainage.

5.2.2.3 Urban Solid Waste Collection and Treatment Component

Collection

As far as USW collection solutions are concerned, two possible alternatives have been considered, namely selective collection and undifferentiated collection.

The selective collection implies the separation of the USW by type to allow its recycling. The many types of USW separated (glass, paper and cardboard, plastics and metals) are placed in the ecopoints and ecocentres.

This process requires the participation of the citizens, who must carry out the domestic separation of the different types of waste, each citizen being responsible for promoting the correct selective disposal of their waste in the ecopoints.

The waste deposited in the ecopoints and ecocentres is forwarded to a sorting station, where a more rigorous selection by type is carried out, through mechanical and manual processes, to allow it to be forwarded to recycling companies. The materials deposited that cannot be valorised are forwarded to disposal in the landfill.

The selective collection implies a large investment in ecopoints, ecocentres and sorting stations.

Given the above, and since there are no economic agents locally interested in recyclable waste, it was selected the alternative of **undifferentiated collection.**

USW Landfill

Regarding the treatment of USW, no alternatives in terms of technologies were studied, since the most appropriate solution for the treatment of USW in the Municipality of Chimoio is a sanitary landfill. The choice of more advanced technologies would imply much higher investment, operation and maintenance costs, compared to the proposed solution. The operation of more complex USW treatment technologies would also require highly specialised staff.

6 Project Areas of Influence

6.1 General Considerations

The ESIA Regulations define the Area of Influence (AoI) as the geographical space directly or indirectly affected by an activity's environmental impacts. Despite this seemingly straightforward definition, in practice the definition of a project's AoI is not an easy task, given that the AoI is a function of many factors which have changing and varying degrees of influence on the areas surrounding the project throughout the course of the project's lifecycle.

The AoI can, therefore, be thought of as the sum of a number of fluctuating factors. The geographical extent of some of these can be partially quantified (e.g., the drainage system extension), while the extent of others is very difficult to measure (e.g., direct and indirect economic effects). Project impacts also change over time, e.g., a project employing hundreds of workers during construction, but only a small number once operational, has a very different social AoI in those two phases.

A further consideration is the presence of other organisations or developments - each with their own AoI - within the AoI of the proposed project, making it very challenging to assign an AoI to each individual development. To this end, it is often useful to consider and/or adopt existing units, such as catchments, cadastral boundaries (e.g., municipal, district, provincial, etc.), linear infrastructure and/or natural features (notably railway lines, roads, rivers, canals, etc.) when defining the AoI.

Considering the above, determining the AoI therefore requires informed but subjective judgment, based on available information and the knowledge of previous and similar project impacts, combined with practical findings.

The ESIA Regulations require the definition of an Area of Direct Influence (ADI) and an Area of Indirect Influence (AII). The following sections outline the AoI for the proposed Project in line with the considerations described above. Note that the delineation of the Project's AoI will be a continuous process along the ESIA Process, as information on environmental and social baseline conditions and potential project impacts increases.

6.2 Area of Direct Influence

The Project's ADI is made up of two components:

- The project's footprint area, i.e., the area occupied by the Project's infrastructure; and
- The area where direct impacts from the construction and operational activities will be felt.

The ADI includes the municipal area occupied by the proposed drainage and sewage systems, as well as the WWTP and landfill area, including the access road. In the construction phase, the ADI also includes any ancillary infrastructure that may be required, such as temporary accesses, borrow pits or shipyards. It is expected that this ancillary infrastructure will be located in the immediate vicinity of the Project site, but their exact location is not known at this stage.

Various activities such as vegetation and soil removal, earthworks, etc. will be carry out in the ADI, which may result in direct impacts, such as soil loss or compaction, noise and dust emissions, among others. In addition, direct impacts on the socio-economic environment within the project occupation area are also likely to occur, such as the loss of infrastructure, agricultural plots and other.

Considering the footprint area described above, direct impacts during the construction phase are likely to be felt in those *bairros* or areas crossed by project infrastructure, as listed in Table 6.1.

These direct impacts during construction are particularly likely to be felt along a corridor of 200 m for linear project infrastructure (e.g., drainage component) and around a 500 m buffer for individual structures such as the WWTP and landfills (Figure 6.1 and Figure 6.2).

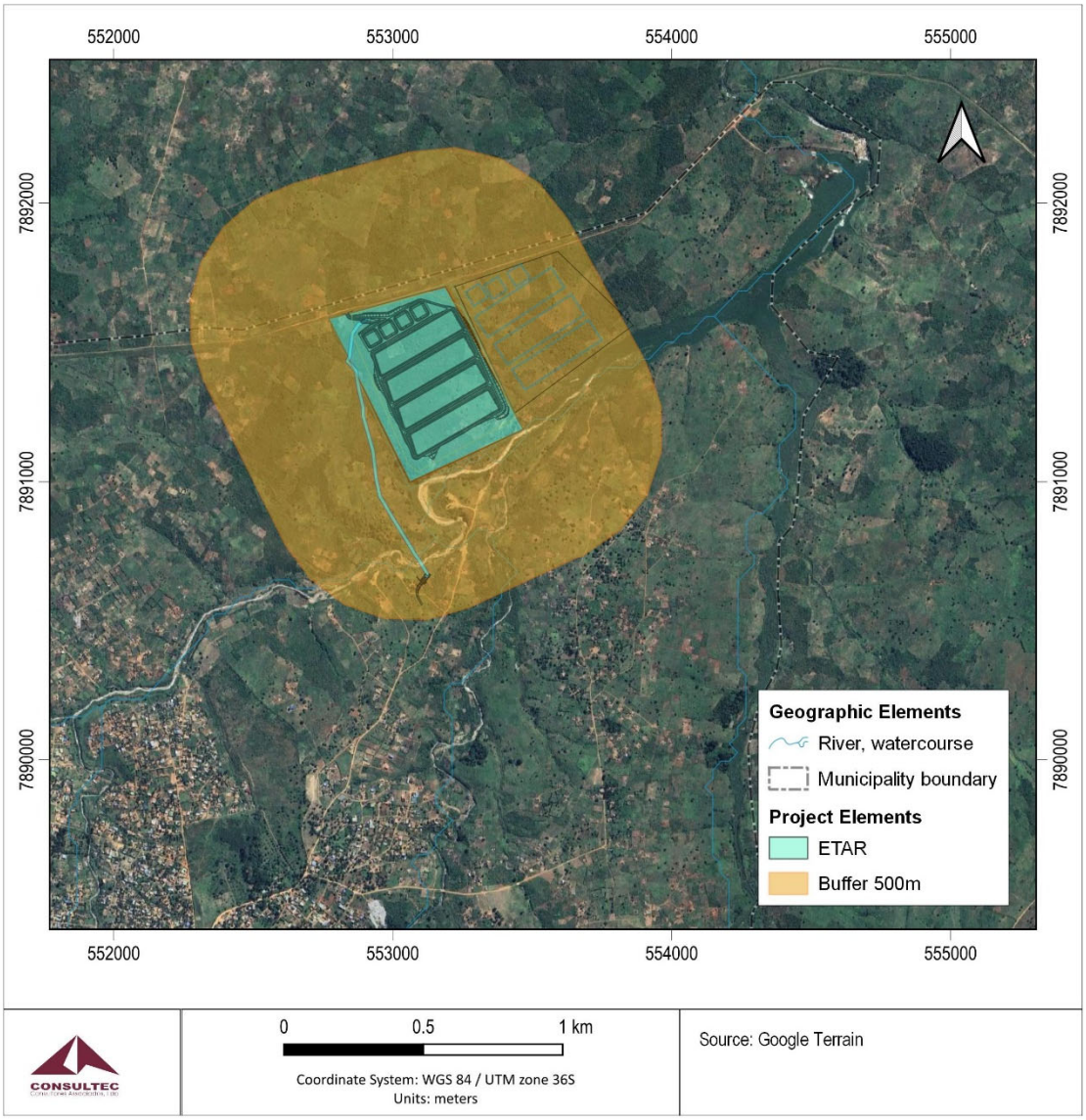


Figure 6.1 – WWTP buffer zone.

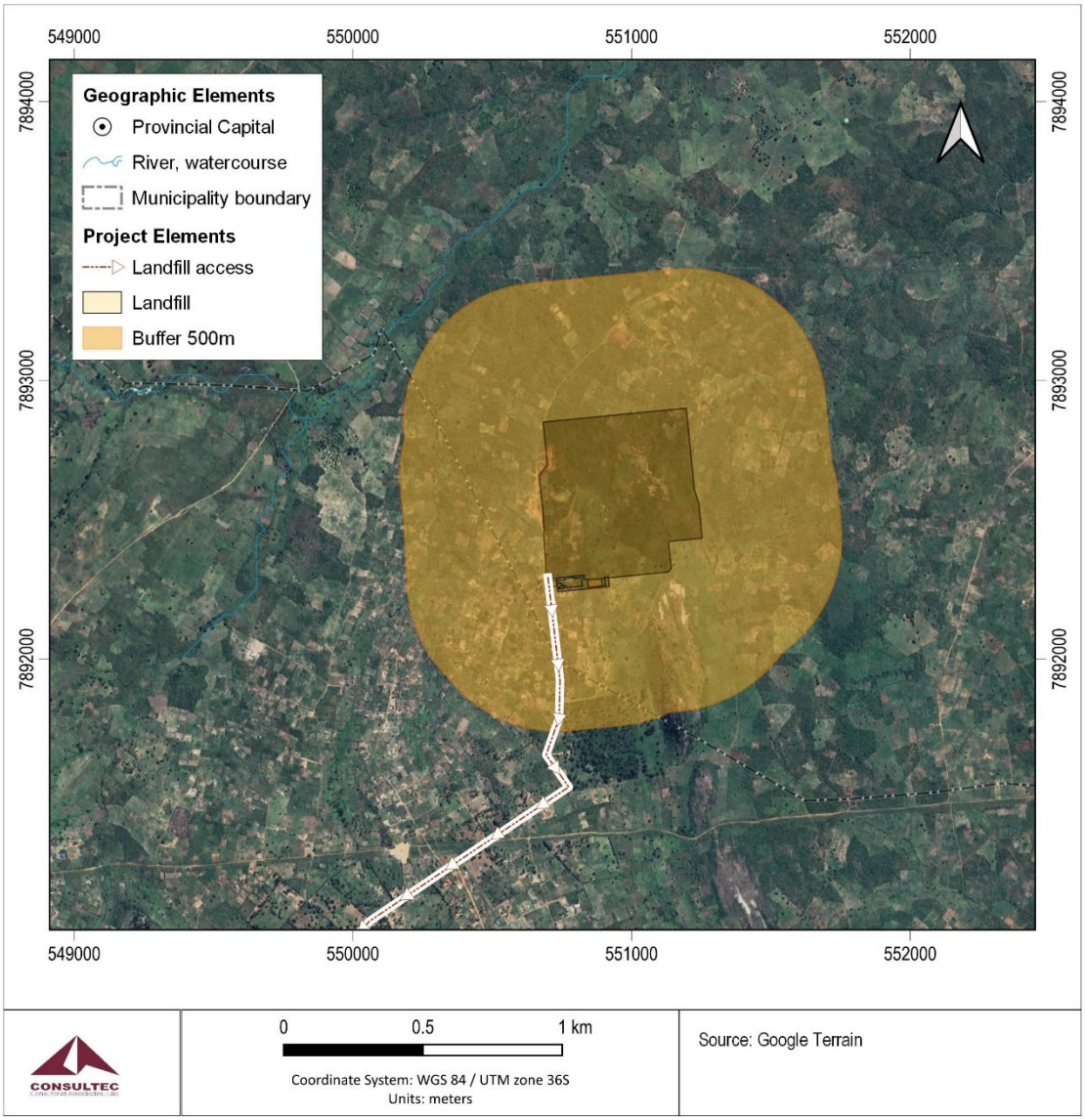


Figure 6.2 – Sanitary Lanfill buffer zone.

Table 6.1 – Neighbourhoods / areas crossed by the Project's infrastructure

Project component	Affected neighbourhood (*bairro)*
Storm water drainage component	Area 1 - Bairros 1, 2 and 3; Bloco 9; Eduardo Mondlane, 25 de Junho, 7 de Setembro, Josina Machel, Chifura, Vila Nova Area 2 - Heróis Moçambicanos Area 3 - Textáfrica, Francisco Manyanga, Nhauir and 1 de Maio
Wastewater drainage and treatment component	Network of collectors: Bairros 25 de Junho, Bloco 9, Nhamatsane and parts of Vila Nova, Bairros 1 and 2, and parts of the Bairros Eduardo Mondlane, Chinfura, Bairros 7 de Setembro, Vila Nova, and 16 de Junho; Bairro 3, and parts of the Bairros Centro Hípico, Eduardo Mondlane, Bairros 4 and 5, Bairro Textáfrica, Bairro 3 de Fevereiro and Bairro Josina Machel WWTP: Nhamatsane
Waste collection and treatment component	Collection: Neighbourhoods included in the collection circuit, including the PPZ of the road to be built. Treatment: Alternative 3 in Bairro de Nhamatsane

Direct impacts are also expected in areas where construction camps will be located, as well as any areas affected by access construction and borrow pit exploration. However, the locations of these areas are currently unknown, and thus will not be considered in the definition of the preliminary Project ADI.

During operation, the ADI is likely to cover the entire Municipality of Chimoio, considering that the waste management services would serve the entire city and that in the medium to long terms, sanitation and drainage would also serve the whole city. If adequately managed, these new structures are liekly to improve the well-being and living conditions of Chimoio's residents.

The Project ADI for the construction phase is thus defined as a 200 m corridor along linear infrastructure and 500 m of buffer zone around point structures, covering municipal neighborhoods and the area listed in Table 6.1**.** During the operation, the ADI will correspond to the entire Municipality of Chimoio.

6.3 Area of Indirect Influence (AII)

The Project's AII is the geographical area where indirect impacts are likely to be felt, or in other words, where secondary impacts resulting from direct ones are felt.

Regarding the construction of project infrastructure such as drainage and sanitation channels, WWTP and landfill, few or no indirect impacts are expected outside of the ADI, in terms of the biophysical environment. However, indirect impacts are likely to be felt throughout the Municipality of Chimoio, such as the potential contamination of surface and/or groundwater resources downstream from the Municipality; and indirect health impacts linked to improved sanitation, drainage and solid waste management once the system is fully operational.

Therefore, the Project's AII is defined as corresponding to the limits of the City of Chimoio, as well as the areas downstream of the project's infrastructure.

7 Environmental and Social Baseline Assessment

This Chapter provides a brief baseline assessment of the potentially affected environment within the preliminary Project's AoI, as defined in Chapter 6 The baseline assessment is based on primary and available secondary information for the study area, and is focused on relevant environmental and social components according to the type of Project and expected potential impacts. Table 7.1 shows the structure of the baseline assessment.

Table 7.1 – structure of the baseline assessment

Environment	Component
Physical Environment	- Climate - Air Quality - Noise - Geology and Geomorphology - Soils - Water resources
Biological Environment	- Flora and Vegetation - Fauna
Socioeconomic environment	- Governance and political administrative division - Demographics and socio-economic conditions - Housing and wellbeing - Basic services and infrastructure - Economic activities - Road traffic

7.1 Physical Environment

7.1.1 Climate

7.1.1.1 Regional Climate

Mozambique is located on the East Coast of Southern Africa at 11-26˚ South of the Equator and has a tropical to subtropical climate that is moderated by the influence of the mountainous topography in the west-central part of the country. In the southwest of cthe country there are some semi-arid regions. According to Köppen's classification, most of the coastal territory of Mozambique has a tropical savannah rainy climate (Aw), which is influenced by the movement of the Intertropical Convergence Zone by the Southern Atmospheric Oscillation and expressed through a reduction or increase in temperature of the Indian and Atlantic Oceans - a phenomenon known as El Niño (increased temperature) and La Niña (reduced temperature).

According to Köppen's climate classification, Chimoio is located in the Cwa climate region (Figure 7.1). Cwa is a Humid Subtropical climate, characterised by a pronounced and seasonal pattern in precipitation and temperature levels. This is a typical climate of continental zones located away from the coast in middle latitudes. It presents a high range of temperature variation precisely due to the effect of continentality. It is also influenced by air masses of tropical maritime origin, but mostly by

air masses of desert continental origin Dry weather is expected in the winter months, with temperatures above 10ºC. In the warmer summer months, temperatures are above 22ºC.

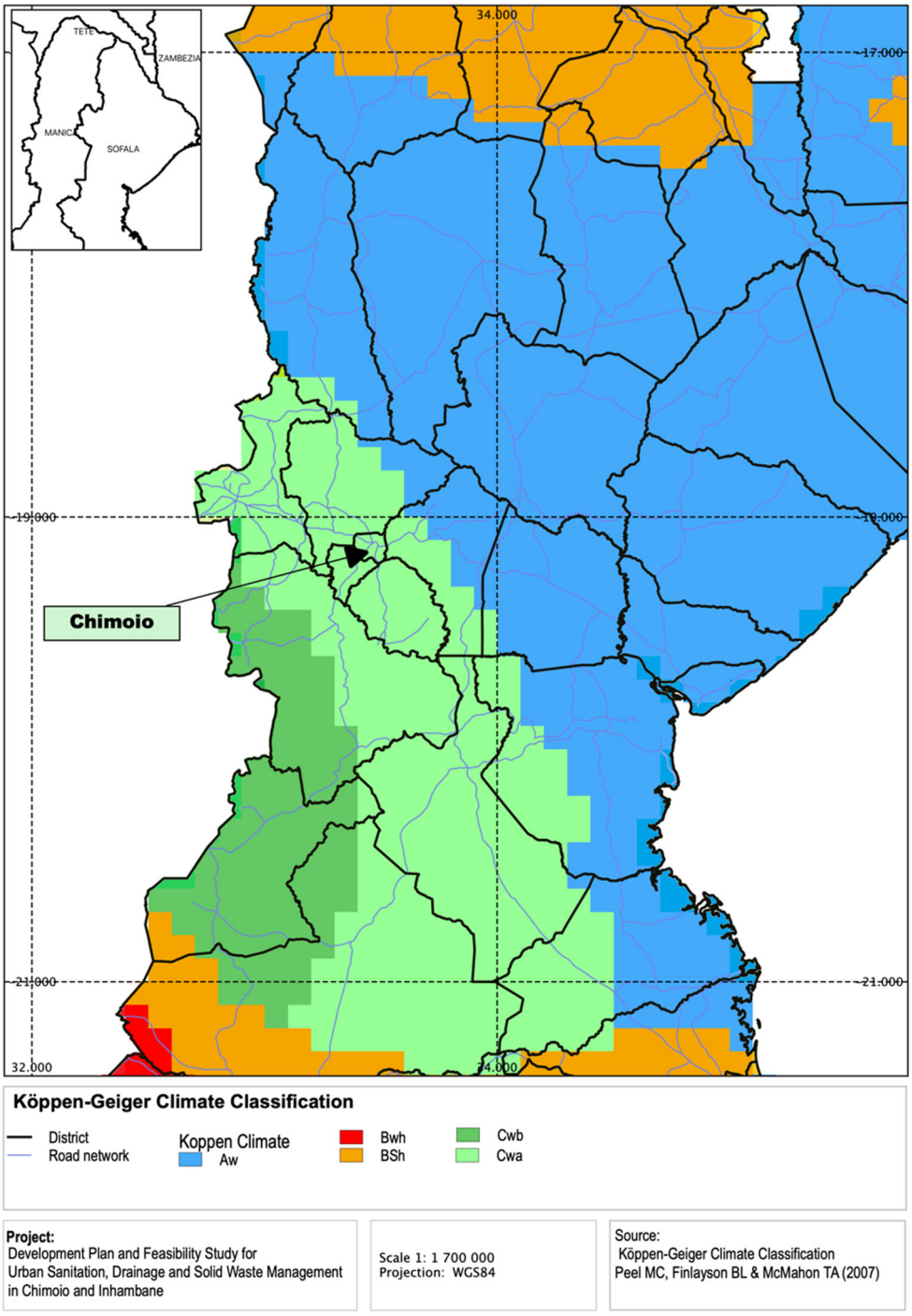


Figure 7.1 – Climatic classification of Chimoio region, as per Köppen's classification

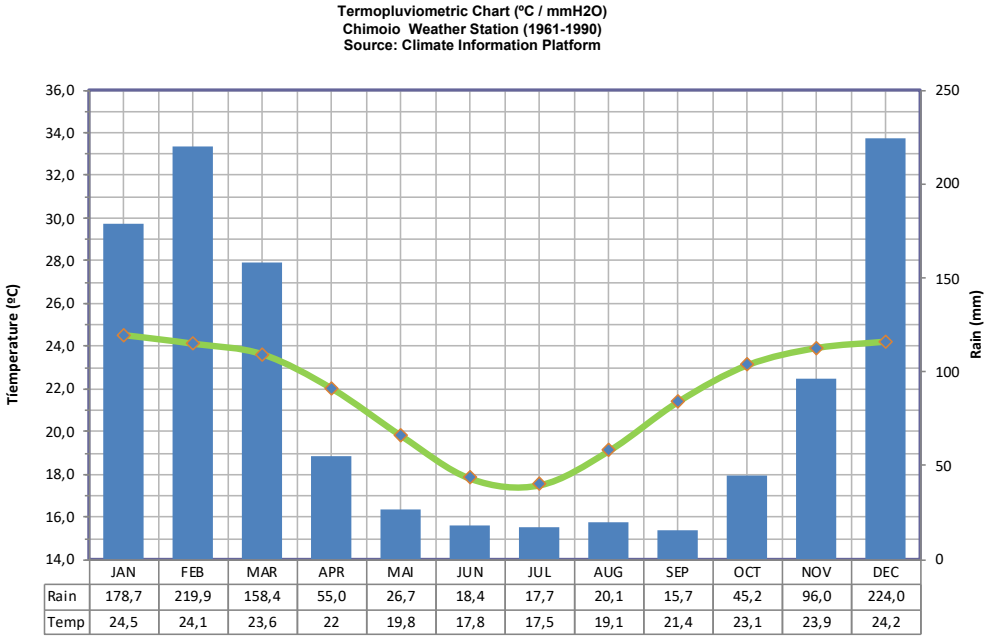
7.1.1.2 Local Climatic Parameters

The meteorological parameters presented below were retrieved from the Climate Information Platform (CIP) managed by the University of Cape Town. CIP is a web interface that integrates a

climate database that stores and queries a large set of observational climate data, as well as projections of future climate. Historical data period totals at least 30 years of observations as recommended by the World Meteorological Organization to characterize the climate of a region.

Temperature and rainfall

The Chimoio region has an average annual temperature of 21.7°C. January is the hottest month, with an average temperature of 24.5°C, while the lowest average temperature for the whole year corresponds to the month of July, with 17.5°C. Average temperatures vary by at least 7.0°C throughout the year. According to CIP data, the average annual precipitation is around 1,100 mm. September is the driest month with 15.7 mm and December is the month with the highest rainfall with an average of 219.9 mm. The difference between the driest and wettest months is 202.2 mm. Figure 7.2 represents the thermopluviometric graphic for Chimoio.



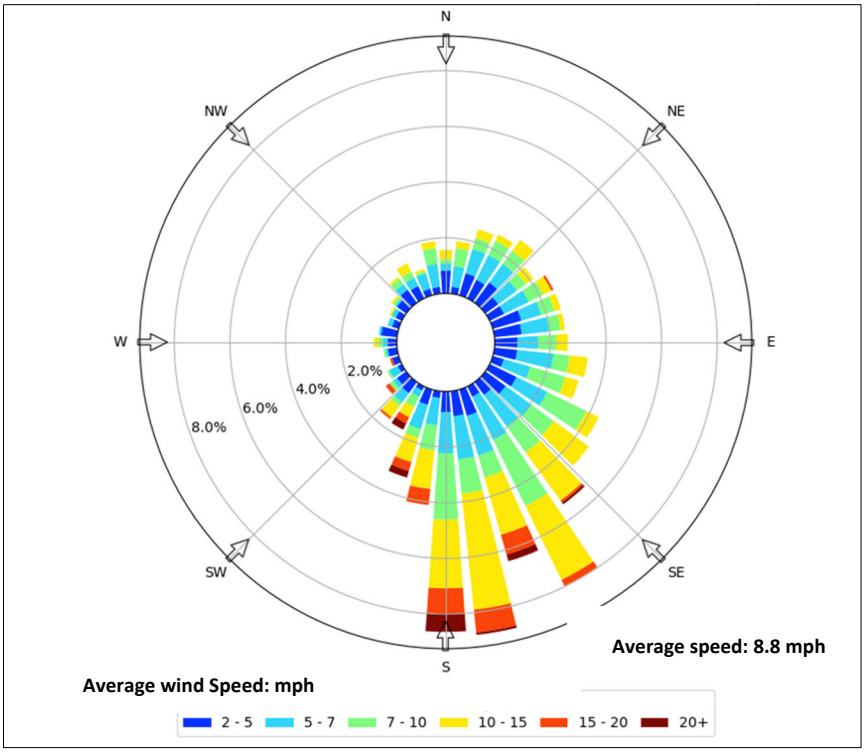
	JAN	FEB	MAR	APR	MAI	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rain	178,7	219,9	158,4	55,0	26,7	18,4	17,7	20,1	15,7	45,2	96,0	224,0
Temp	24,5	24,1	23,6	22	19,8	17,8	17,5	19,1	21,4	23,1	23,9	24,2

Source: CIP, 2019 adapted.

Figure 7.2 – Thermo-pluviometric graph, Chimoio

Wind regime

In the Chimoio region, and according to data from the Automated Surface Observing System (ASOS) database, accessed from the Iowa Environmental Mesonet, IEM/ASOS (Data Acquisition Network managed by the University of Iowa, United States of America), relatively low wind speeds with an average annual speed of 8.8 km/h (14.2 mph) are predicted in the project region (Figure7.3). Statistical data regarding the predominant wind direction per annum for the period 1991 to 2020 indicate winds predominantly from the south, south-east and east-south-east quadrants.



Source: IEM (2021).

Figure7.3 – Annual wind speed and direction

Vulnerability to natural disasters

Mozambique is a country vulnerable to natural disasters from a meteorological origin, including droughts, floods and tropical cyclones, mainly due to its geographic location, its 2,700 km of coastline, several international rivers emptying into the Indian Ocean and areas below sea level

Other factors such as the lack of capacity to predict extreme events, inadequate timely warning notices, extreme poverty and dependence on natural resources which in turn depends on climate variability, contribute to the country's vulnerability to extreme meteorological events.

Cyclones occur cyclically, accompanied by strong winds and torrential rain. In general terms, the cyclone season occurs between November and April, with a peak in December and January. Between 1993 and 2012, 40 cyclones were recorded in the country (INAM, 2012), of which nine were classified as very intense (maximum speed above 212 km/h). On average, three to five cyclones form in the Mozambique Channel every year (Tinley, 1971). However, of these only an average of just over two cyclones per year reach the Mozambican coast.

In general, the highest hurricane wind speeds range from 63 km/h to speeds exceeding 212 km/h. However, the most frequent hurricanes in the country are characterised by category 1 to 4 winds, with speeds ranging from 63 to 212 km/h, respectively. Category 5 hurricanes with wind speeds above 212 km/h are rare.

The Integrated Context Analysis (ICA) is a collaborative tool, managed by the United Nations World Food Program (WFP), used to identify the most appropriate programmatic strategies in specific geographic areas, based on areas of convergence of historical food security trends and natural impact risk. This tool was used in Mozambique in 2017 and, among other issues, assessed the cyclonic risks existing in this country. The Chimoio region presents a low exposure to cyclones as it is located far from the coast, inland, as illustrated in the figure below.

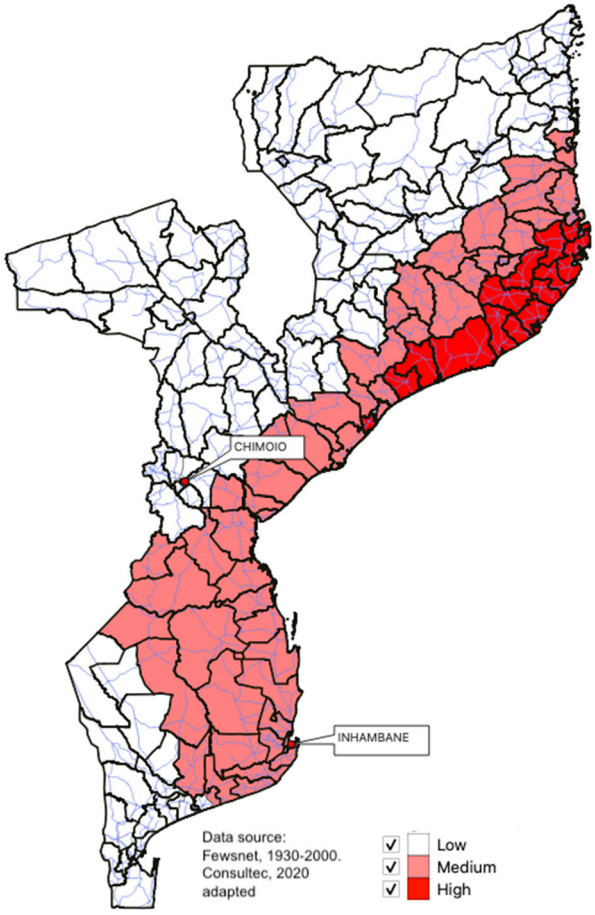


Figure 7.4 – Chimoio ciclones vulnerability Risk

7.1.2 Climate Change

7.1.2.1 General considerations

Climate change refers to any change in the current climate, attributed directly or indirectly to human activity, to which is added the natural climate variability observed over comparable periods of time (MICOA[3], 2007).

It is widely accepted by the scientific community that climate patterns worldwide are changing and that the trend will be towards an overall increase in average air temperature, greater variability in

[3] *Ministério para a Coordenação da Acção Ambiental* / former Ministry for the Coordination of Environmental Affairs, now called *Ministério da Terra e Ambiente* / Ministry of Land and Environment – MTA.

rainfall regime, rise in the average level of the sea and the increased occurrence of extreme situations such as flooding phenomena, cyclones and extended periods of drought.

The observed warming since the mid-twentieth century is largely due to increased concentration of greenhouse gas (GHG) emissions resulting from human activities. The excessive increase in GHG results in an increase in the amount of heat trapped, and in global warming, which is currently affecting the climate on a global scale.

Some of the most common gases that create the greenhouse effect include carbon dioxide, water vapour, methane, nitrogen oxides and chlorofluorocarbons (CFC's). The most relevant elements are water vapour and carbon dioxide. Carbon dioxide, for example, remains in the atmosphere for centuries after being emitted, and is stored on earth in different forms.

Mozambique has signed and ratified the Kyoto Protocol in 2005 being classified as a party non included in Annex I to the Convention, which means that it has no fixed emission reduction targets that it is obliged to meet. As a signatory to the Kyoto Protocol and being among the first states to sign the Paris Agreement, Mozambique is an active country in the effort to reduce the negative effects of climate change.

According to the National Climate Change Strategy report (2013-2025), published by the MTA, Mozambique is especially vulnerable to climate change due to its geographical location, in the intertropical convergence zone and downstream of shared hydrographical basins, the extensive coastline, and large areas with altitude below current sea level.

Also contributing to its vulnerability and low adaptive capacity are poverty, limited investments in advanced technology and the weakness of the social infrastructure and services, particularly health and sanitation, amongs other factors.

In Mozambique, climate change is observed through changes in temperature patterns. According to a report published by INGC (2009) for a period of 45 years, between 1960 and 2005, a clear trend of temperature increase in most parts of the country was verified.

However, the warming trend has not been uniform: increases of up to 1.6°C are evident in the central region of Mozambique during winter, while in the north temperatures increased by about 1.1°C during the months of March-April-May and September-October-November.

Temperatures in Mozambique may increase between 1.2 and 1.7ºC by 2050, and between 3.2 and 4.0ºC by 2095 (USGC). Rainfall variability will increase, potentially affecting the onset of the rainy season and the distribution of rainfall, resulting in wetter wet seasons and drier dry seasons. The central provinces are more prone to floods, tropical cyclones and epidemics, followed by the southern and northern provinces. The South, with its dry tropical savanna climate, is more prone to droughts than the Central and Northern regions, which are respectively dominated by a rainy tropical climate and a moderately humid climate modified by altitude (INGC, 2009).

7.1.2.2 National Greenhouse Gas Emissions

Total GHG emissions in Mozambique, when expressed in global warming potential (CO2eq.), reached in 2018 a value equivalent to 110.07 MtCO2e/year (WRI, 2021) (Figure 7.5). These quantified data were obtained from the World Resources Institute database (CAIT, data referring to GHG Emissions by country (1850-2018)). These include accounting for emissions resulting from land-use change and deforestation (LUCF), according to the calculations published by the Food and Agriculture Organization of the United Nations (FAO) included here.

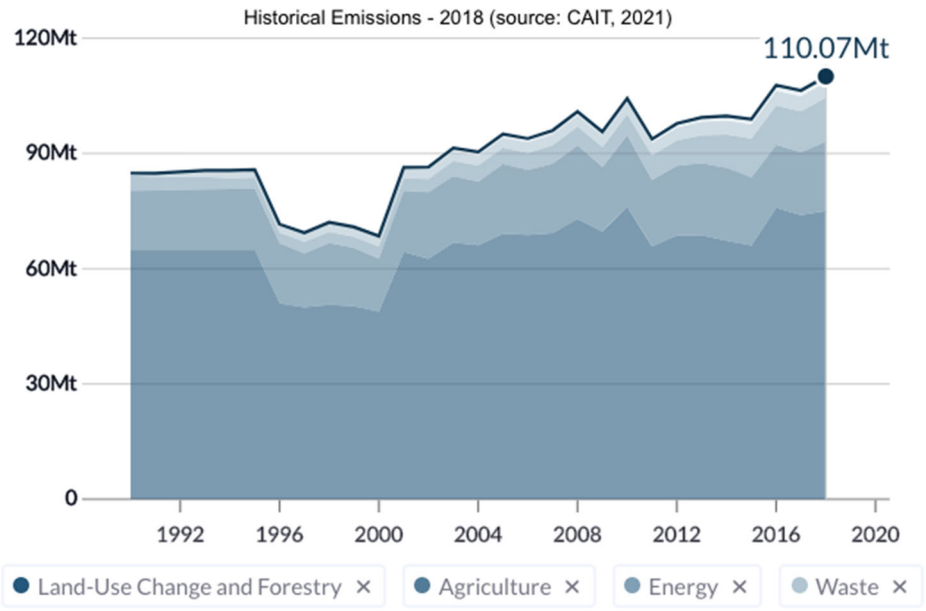


Figure 7.5 – Total GHG emissions in Mozambique, by sector, for 2018

Out of this total MtonCO_2eq., 75 million tonnes of CO_2eq. are due to LUCF, 18.1 MtonCO_2eq. are emissions from agricultural activity, being the remaining emissions associated with the energy sector (11.36 Mton), transport and industrial processes.

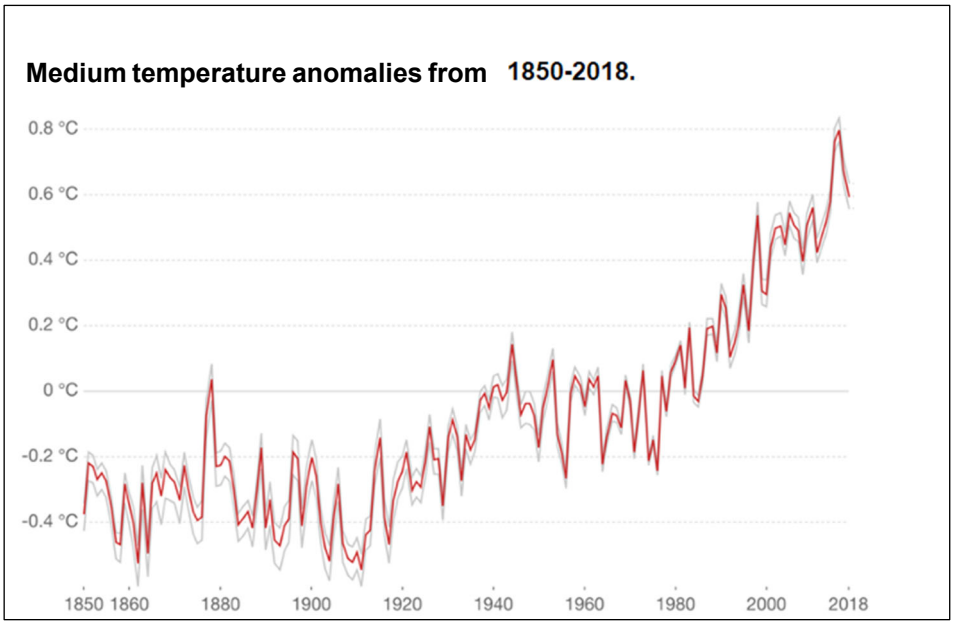
The most significant GHG is carbon dioxide (CO_2). Other gases, such as CH_4 and N_2O, are emitted on a smaller scale, but still in quantities considered relevant. It should be noted that CO_2 is emitted mainly by industries associated with the energy sector, manufacturing and construction industries, transport and other sectors, namely residential, commercial/institutional, and fishing/farming/forestry.

On a global scale and in relative terms, Mozambique's contribution to global GHG emissions is insignificant. An analysis of per capita emission rates shows that in 2018, Mozambique accounted for less than 2 tons of CO_2eq/capita.

7.1.2.3 Climatic Anomalies

In 2018, the average global temperature increased by 0.6°C compared to average values for the period 1961-1990. Along with 1998, 2018 was the year with the highest temperature on the planet (Hadley Centre, 2018). The World Meteorological Organization has confirmed that the last ten years

have been the warmest since 1984. The figure below illustrates this upward trend in global average temperature from 1880 to 2018.



Source: Hadley Centre (2018).

Figure 7.6 – Temperature anomalies relative to the 1961-1990 global average

In the southern African region, meteorological observations over the last 50 years suggest that temperatures have been increasing considerably over the second half of the 20th century and that the rate of warming has also increased, especially in the last two decades of the 21st century. From 1961 to 2014, the temperature increased at a rate of 0.4°C per decade.

Temperature patterns across seasons indicate slightly higher warming in the austral summer (December-January-February) and during the March to May period compared to the rest of the year.

The report of the National Strategy on Climate Change (2013-2025), published by MITADER[4], shows that Mozambique is a country particularly vulnerable to climate change due to a number of factors, which include its geographic location, since it is located in the Intertropical Convergence Zone (ITCZ), and, downstream of internationally shared river basins, due to present an extensive coastline and topographic features of extensive areas with altitude below the current sea level.

In the country, climate change will likely manifest itself through changes in temperature and precipitation patterns, through a rise in sea level, and also through an increase in extreme weather events (both in terms of frequency and intensity) such as droughts, floods and tropical cyclones that already affect different regions of the country every year.

4 Now called MTA – *Ministério da Terra e Ambiente* / Ministry of Land and Environment

7.1.3 Air Quality

7.1.3.1 Air quality standards and guidelines

Air quality standards are set aimed at the safeguarding public health and protecting ecosystems, considering the different ways in which gaseous compounds or particulate materials present in the atmosphere are absorbed.

The environmental quality standards in Mozambique are defined through Decree no. 18/2004 of 2 June (Regulation on Environmental and Emission of Effluents Quality Standards), amended by Decree No. 67 / 2010 of 31 December Decree No. 18/2004 defines pollutant emission limits for fixed and mobile sources, as well as ambient air quality standards. Mozambique currently has ambient air quality standards for sulfur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), ozone (O3), and Total Suspended Particles (TSP) (see Table 7.2).

Table 7.2 – National ambient air quality standards

Pollutant	Unit	Concentration	Averaging period
Total Suspended Particles (TSP)	µg/m^3	150	Average daily maximum
		60	Annual average
Nitrogen Dioxide (NO_2)	µg/m^3	190	Average hourly maximum
		10	Annual average
Sulphur Dioxide (SO_2)	µg/m^3	500	Instantaneous value – 10 min average
		800	Average hourly maximum
		100	Average daily maximum
		40	Annual average
Carbon Monoxide (CO)	µg/m^3	30 000	Average hourly maximum
		10 000	8 hour maximum
		60 000	30 min maximum
		100.000	15 min maximum
Ozone (O_3)	µg/m^3	160	Hourly maximum value
		120	8 hours maximum
		50	24 hours maximum
		70	Annual average

In the absence of national standards, the World Health Organization (WHO) standards for particulate matter (PM10) were considered: concentrations expressed in 99th percentile (P99) of 45 µg/m3 (average period of 24 hours) and 15 µg /m3 (annual average period) (Table 7.3)

Table 7.3 – International ambient air quality guidelines

Pollutant	Averaging Period	Mozambique (µg/m^3)	WHO (µg/m^3)	European Union (µg/m^3)	South Africa (µg/m^3)
PM10	24 hours	--	45	50	--
	1 year	--	15	40	--
PM2.5	24 hours	--	25	--	--

Pollutant	Averaging Period	Mozambique (µg/m³)	WHO (µg/m³)	European Union (µg/m³)	South Africa (µg/m³)
	1 year	--	10	20 (2015)	--
SO_2	Instantaneous	--	500	--	500
	1 hour	800	--	350	--
	24 hours	100	20	125	125
	1 year	40	50	20	50
CO	1 hour	30.000	--	--	--
	8 hours	10.000	10.000	10.000	--
NO_2	1 hour	190	200	200	376
	24 hours	--	--	--	188
	1 year	10	40	40	94
Benzene	1 year	--	1,7 (risk 1: 10 000) [5]*	5,0	5,0

7.1.3.2 Air pollution sources

Chimoio, where the Integrated Development Plan for Urban Sanitation, Drainage and Solid Waste Management is to be implemented, has a markedly urban/residential land use with commercial and industrial land use characteristics as well.

The main sources of air pollutants in the Chimoio region are of anthropogenic origin and can be grouped into three main types, as summarized below.

- **Road and Rail traffic** – In-line sources responsible for gaseous emissions and particulate matter, generated by the exhaust of internal combustion vehicles and the mobilization of dust on the unpaved road network;
- **Domestic Fuel burning –** gaseous and particulate emissions from the burning of domestic fuels;
- **miscellaneous fugitive dust sources** – Generated by wind erosion in bare areas (with low vegetation cover).

7.1.3.3 Local air quality characterisation

The air quality assessment provided below was based on data retrieved from the Copernicus Atmosphere Monitoring Service (CAMS). The time period considered in the observations was the Mozambican dry season with data retrieved in October 2019.

Figure 7.7 below illustrates concentrations of SO_2 and NO_2 in central and southern Mozambique during the dry season. As seen, surface levels of SO_2 in the Chimoio region can range between a minimum of 0.5 ppbv (1.31 ug/m³)[6] up to a maximum of 1 ppbv (2.62 ug/m³).

[5] (*) As no health-safe level of exposure can be recommended, WHO does not provide any guidance values for carcinogenic substances. For guidance purposes, the WHO issues concentration values resulting from occupational medicine studies for the additional lifetime risk of developing cancer. Accordingly, the table shows the concentrations, the risk of 1: 100,000 (one additional case of cancer based on an exposed population of 100,000 people).

[6] The unit conversion from ppbv to ug/m³assumes an ambient pressure of 1 atmosphere and a temperature of 25 degrees Celsius.

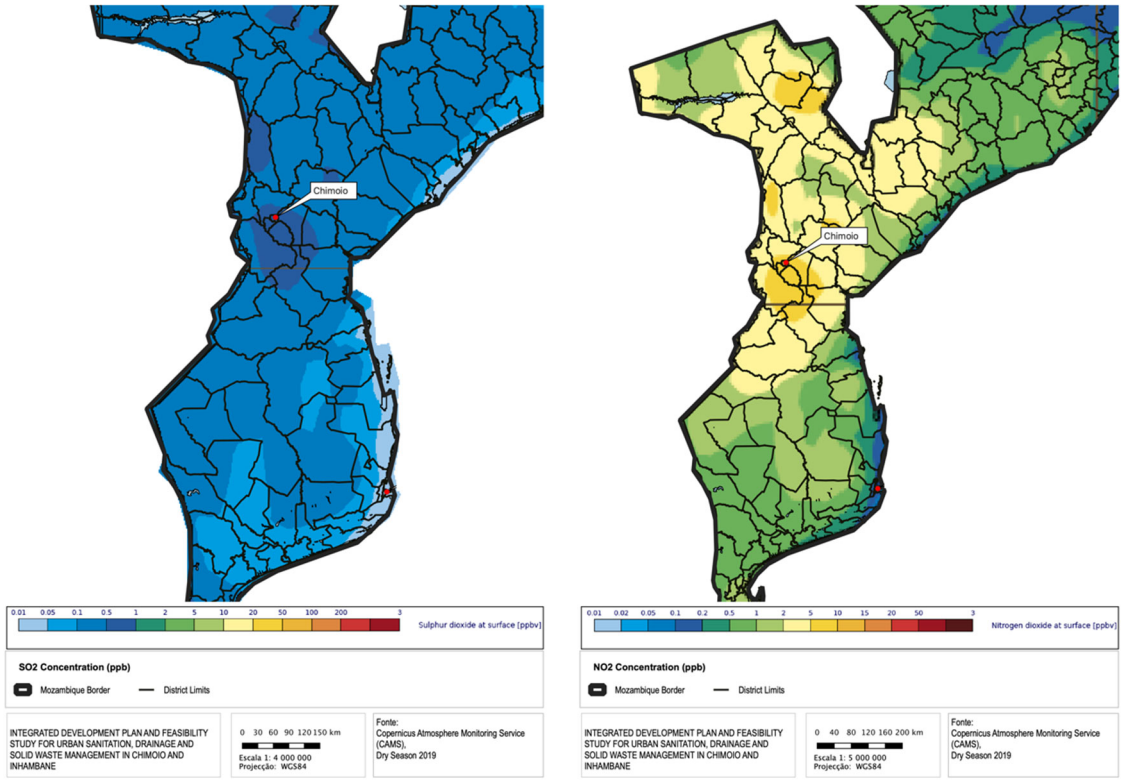


Figure 7.7 – SO_2 and NO_2 concentration during the dry season

NO_2 concentrations at the surface level are also consistently low, ranging between 5 ppbv (9.4 ug/m^3) up to 10 ppbv (18.8 ug/m^3) expressing the relatively low level of industrialisation in the area.

According to Brauner et al., (2017), the particulate matter respiratory fraction's (PM2.5) mean annual exposure in Mozambique ranges between a minimum of 21.3 µg/m^3 up to 23.6 µg/m^3, thus exceeding both UE and WHO guidelines. Less common air contaminants such as ozone (O_3) are unlikely to be of concern as there are currently no significant anthropogenic sources near the proposed Project.

Considering the low significance of air pollutant emission sources in the project area and the expected low background concentrations represented in the figures above, Particulate Matter (TSP and PM10) and pollutant gases such as the SO_2 an NO_2 in the study area are expected to comply with the limit values established by national Decree 18/2004, as amended by Decree 67/2010, as well as with WHO and WB/IFC guideline values. As such, the regional airshed is classified as good or non-degraded.

7.1.3.4 Sensitive Receptors

The definition of an air quality sensitive receptor in this study applies to human receptors, as the air quality guidelines against which the project impacts are to be assessed will be based on the potential adverse effects of air pollution linked to the construction and operational phases of the project on human well-being and public health.

As such, potential air quality sensitive receptors include residential areas in the vicinity of the project's direct area of influence, as well as associated social infra-structure such as schools and hospitals that may be potentially affected, mainly during the construction phase of the project, but also during its operation. Given that sensitive receptors are the same for both air quality and noise, these are presented in Figure 7.9 through to Figure 7.12 (see page 124).

7.1.4 Noise

7.1.4.1 Noise Standards and Guidelines

Mozambique has not yet established national guidelines for environmental noise. The national environmental quality standards are established by Decree no. 18/2004 of 2 June (Environmental and Effluent Emission Quality Standards), amended by Decree no. 67/2010 of 31 December, which determines the environmental standards and effluent emission limits, aiming to control and maintain acceptable concentrations of pollutants in the environment. This Regulation (Decree no. 18/2004), in its Chapter 4, Article 20 (Limits in terms of Noise Emissions) states that:

- The level of noise permitted for the safeguarding of public health and peace shall be established in terms of the source of noise emission.
- Without prejudice to the provisions of special legislation, the Minister for the Coordination of Environmental Action shall establish, for each sector of activity, by ministerial diploma, the standards for noise emissions.

However, up until this date, specific guidelines on noise monitoring have not yet been published. In their absence, the WHO and WB noise guidelines are referenced and will be adopted as Project standards.

WHO-recommended noise guidelines were defined considering the potential negative effects of noise on health and specific environments. Under WHO guidelines, residential areas, schools and hospitals are considered sensitive receptors. Table 7.4 lists WHO's ambient noise guidelines for such sensitive receptors.

Table 7.4 – WHO ambient noise level guidelines

Land use / Specific Environment	Guideline (L_{Aeq} in dB (A))	Reference Period	Effect on Health
Outdoor of residential areas (day-time)	55 dB(A)	16 hours (06h00 – 22h00)	Serious annoyance
Outdoor of residential areas (night-time)	45 dB(A)	8 hours (22h00 – 06h00)	Sleep disturbance

Source: Berglund et al. (1999).

In 1998, the WB developed a pollution management program to ensure that WB financed projects in developing countries were environmentally sustainable (WBG 1999), the scope of which included noise. The results were then incorporated into WB and IFC guidelines, which state that noise impacts from a particular project should not exceed the levels presented in Table7.5, or result in an increase in ambient noise levels of more than 3 dB at the location of the nearest sensitive receiver.

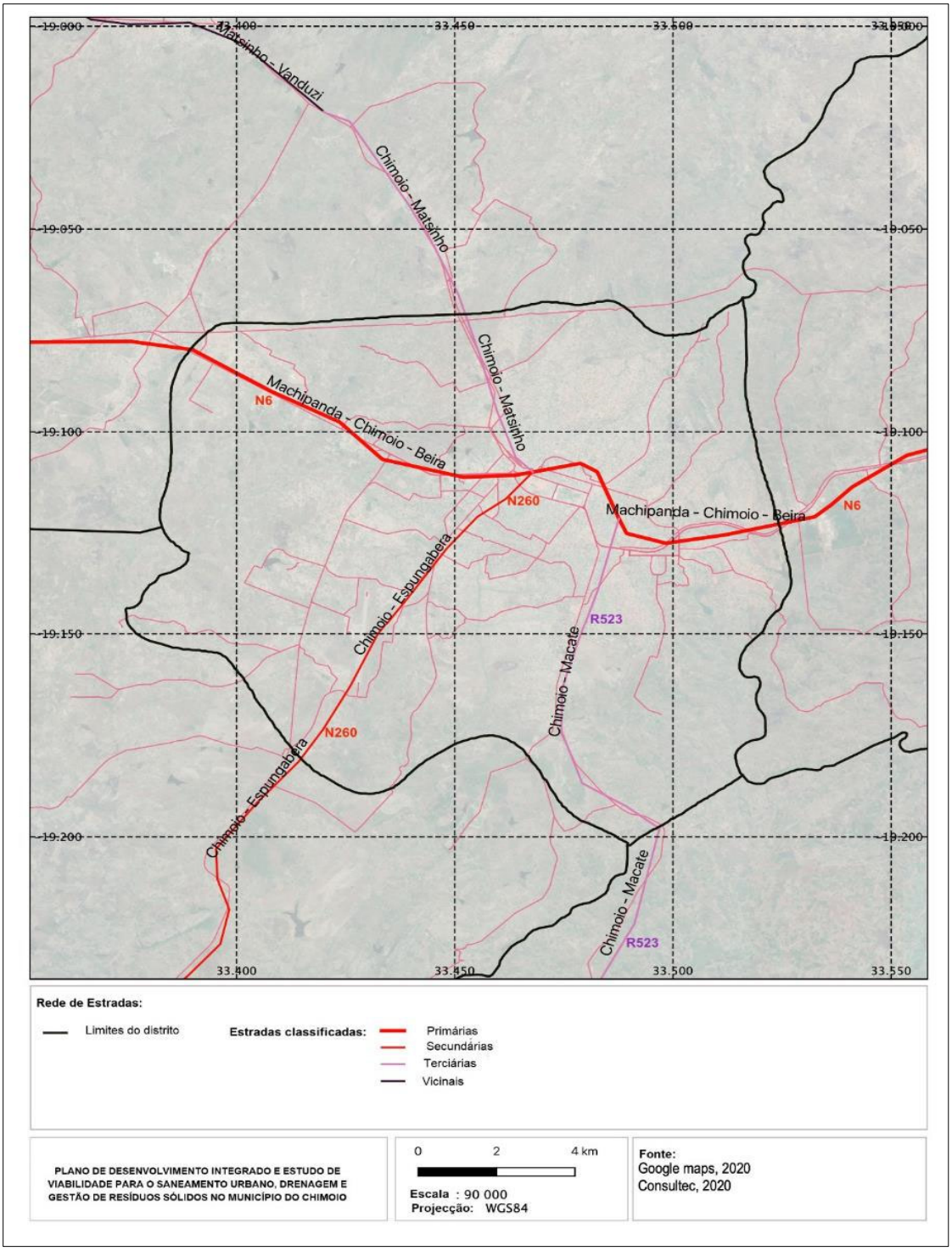
Table7.5 – WB/IFC Environmental Noise Guidelines

Receptor	LAeq (dB(A)) – 1 hour	
	Daytime period (07:00-22:00)	Night period (22:00–07:00)
Residential, institutional, educational	55	45
Industrial, comercial	70	70

As noted in the tables above, the WHO guidelines for residential areas are the same as the IFC guidelines for residential, institutional or educational receptors, for both reference periods (daytime and nighttime).

7.1.4.2 Local noise emission source

The project will be implemented in the Chimoio municipal area, a small town characterised by urban, semi-urban and more rural areas, as well as a few industrial, commercial and service areas. The City of Chimoio is served by a well-established road network (see Figure7.8), an airport and a railway.



Source: Consultec (2020).

Figure7.8 – Chimoio main road network

Thus, the main noise sources within the project's area of influence are:

- **Natural noises** - noise caused by waves, wind, rain and wildlife (birds, insects, etc.);
- **Human settlements** - noise generated by human activities such as people talking, children playing, music, etc;

- **Airport traffic** - noise generated by sporadic noise from air traffic at Chimoio airport, namely at landing and take-off.
- **Railway traffic** - noise generated by the periodic passage of trains
- **Vehicle traffic** - noise caused by heavy and light motor vehicles throughout the road network, mainly through the N6 and N260 traffic lanes, as indicated in the figure below.

The movement of light and heavy road traffic along the N6 road promotes an increase in ambient noise, contributing directly to local noise disturbance. The N6 road has a considerable traffic density due to the movement of heavy and light vehicles along this road, which connects Machipanda to Beira.

7.1.4.3 Reference Noise Levels

No recent noise data is available for the Project area. Therefore, a qualitative noise assessment is presented based on the identification of local noise emission sources in the study area, on literature review and the main local land uses.

Environmental noise is defined as noise emitted from all sources, except industrial workplaces (WHO, 2011). The European Union (EU) Directive defines ambient noise as "unwanted or harmful external sound created by human activities, including noise from roads, railways, airports and industrial areas".

In urban or industrial environments many different sources of environmental noise to which people are exposed can be found, including: transport noise (road traffic and air traffic); industrial and construction noise; community noise (noise emissions from neighbours, radio, television, bars and restaurants); and social and leisure noise.

The existing acoustic environment in the project areas can then be described as having medium to high noise levels, which are affected by road traffic travelling on local roads.

Measurements carried out in urban areas of Mozambique, with characteristics similar to those of the area under study, namely noise measurements at points located in the interior of Mozambique in populated cities and towns, allowed for the verification that noise levels during the daytime period can vary between 46 dB(A) and 65 dB(A).

The areas adjacent to the project implementation site present a high degree of human activities and transformation (anthropomorphization), predominantly the areas occupied by residences, commerce and other services inherent to human habitation. It is also possible to verify that the current acoustic environment in the different areas of intervention of the project and its surroundings is already disturbed to some extent, as a result of the different human activities carried out at this site.

Based on the inventory of noise sources referred to above and from the acoustic data, it can be concluded that the acoustic environment of the project implementation area is typical of an area of urban use.

7.1.4.4 Sensitive receptors

Potential noise sensitive receptors include residential areas as well as social infra-structure such as schools, health units and places of worship. Figure 7.9 to Figure 7.12 illustrate the populated areas and health units (health centres and hospitals) existing in the vicinity of the project areas.

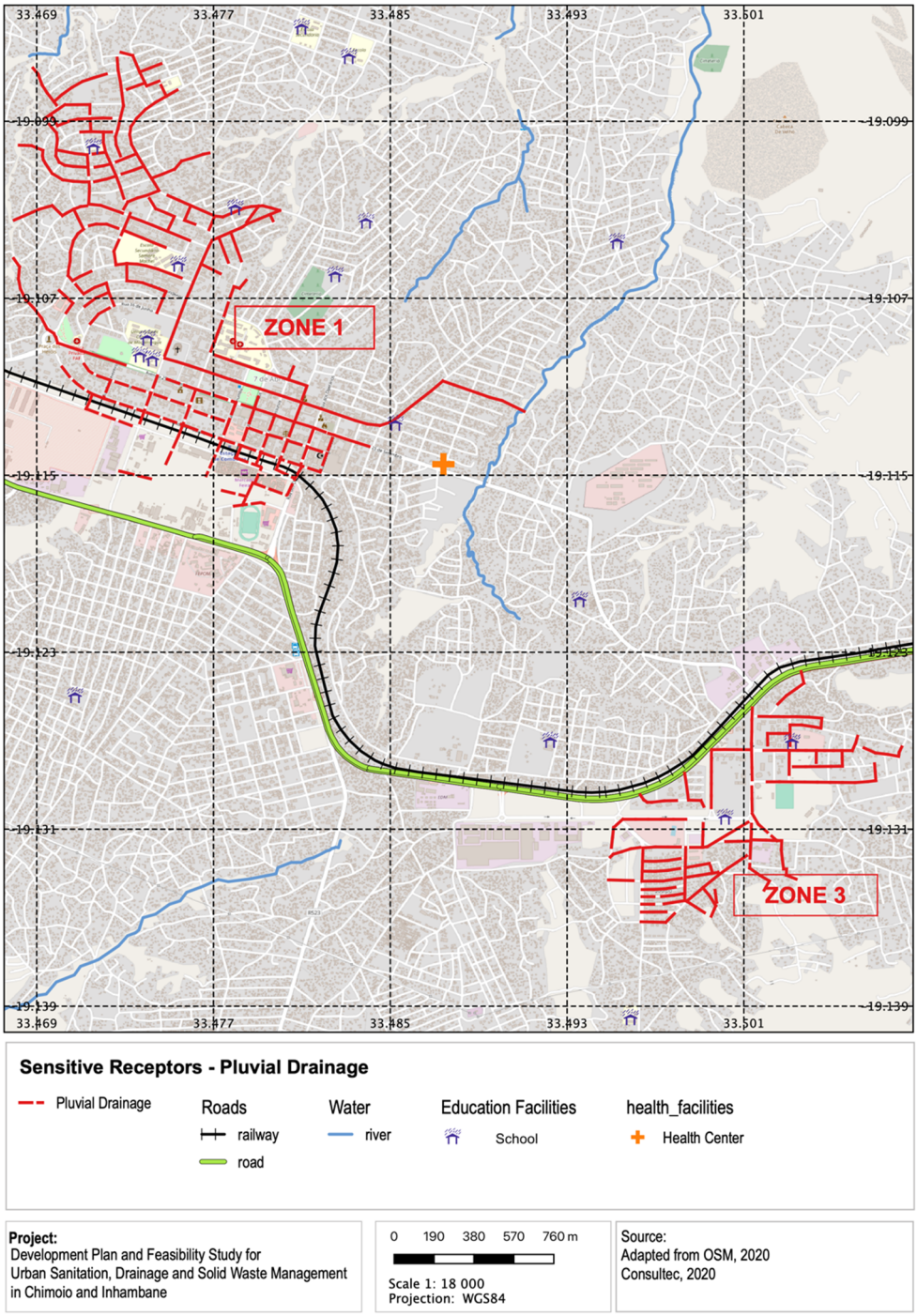


Figure 7.9 – Sensitive receptors and the drainage project component (1/2)

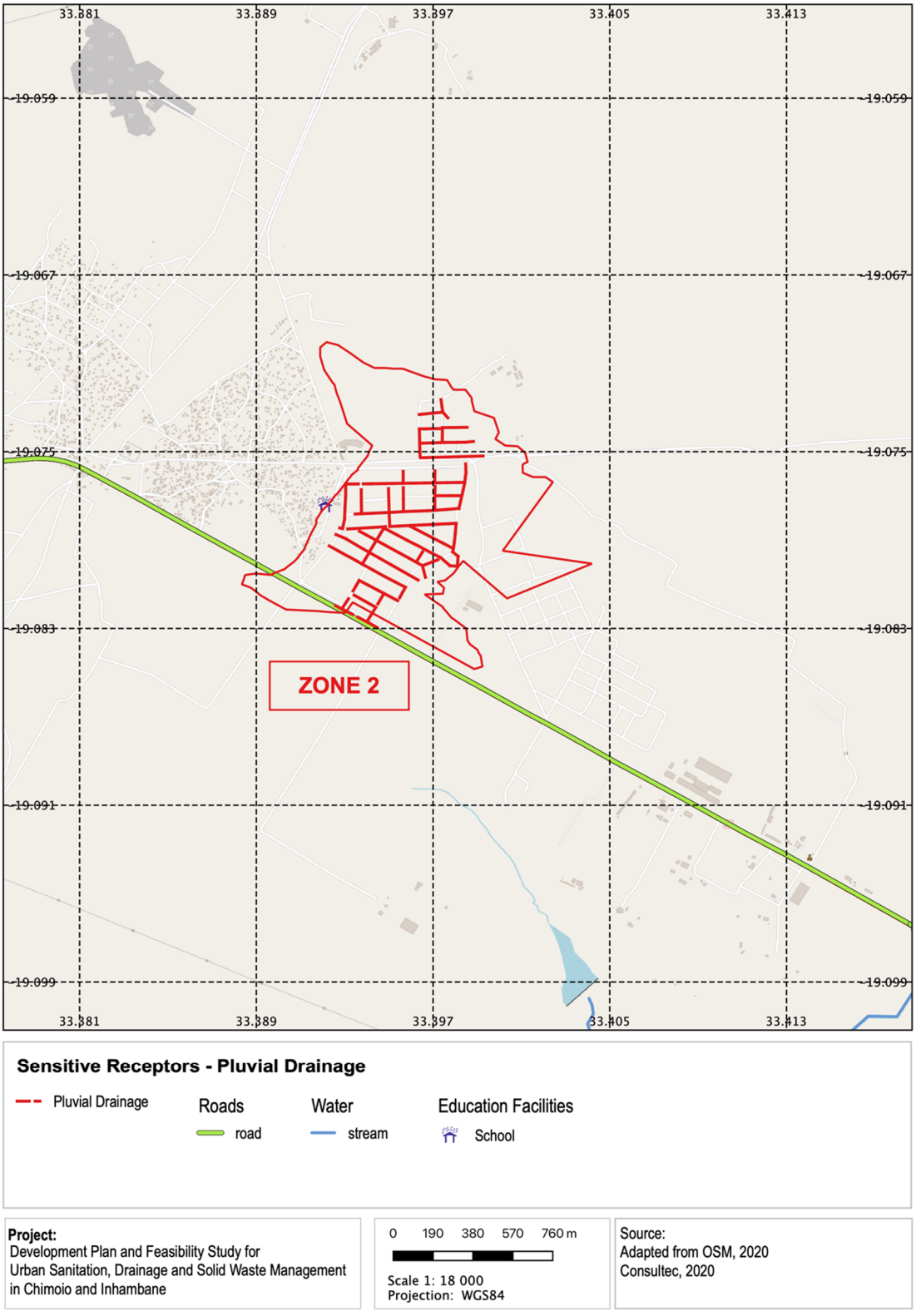


Figure 7.10 – Sensitive receptors and the drainage project component (2/2)

Figure 7.11 illustrates the location of the densest residential areas in relation to the future WWTP of Chimoio.

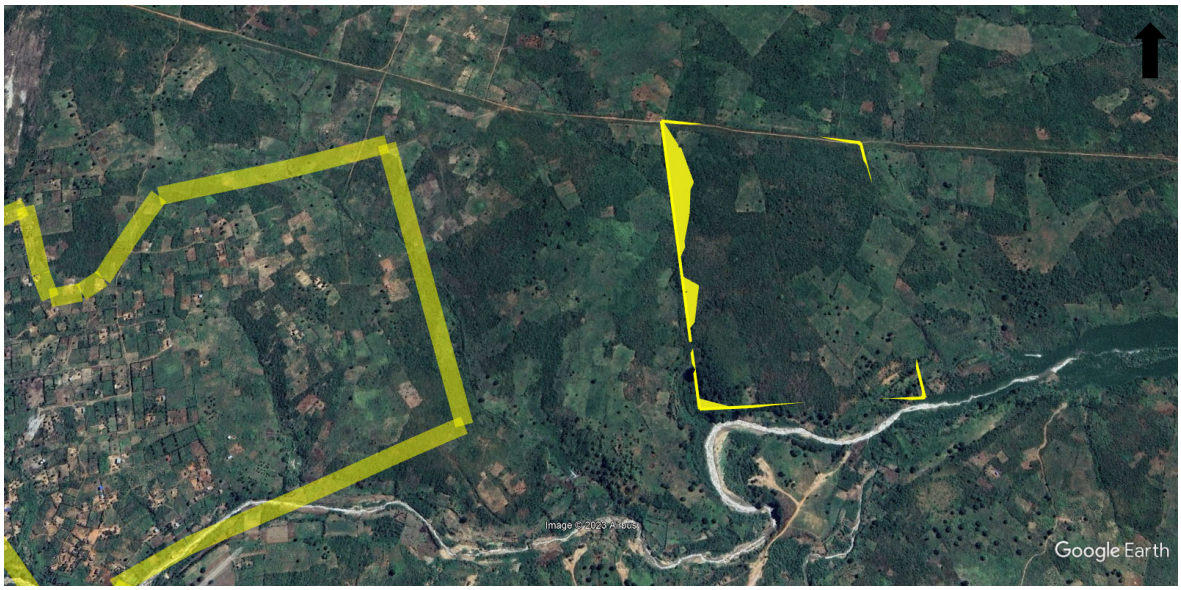


Figure 7.11 – Sensitive receptors near the WWTP

Figure 7.12 illustrates the location of the densest residential areas in relation to the future landfill.

Figure 7.12 – Sensitive receptors and the landfill project component

7.1.5 Geology

7.1.5.1 General Considerations

The geological assessment of the study area was based on literature review and required a broader area of analysis than the AoI, to allow for an understanding of the regional geological environment and production of a local ground model. Data sources used in this assessment include the geological maps from the National Directorate of Geology (1:250 000), specifically sheets 1932/1933 that cover the study region.

7.1.5.2 Geomorfology

Geomorphologically, the Mozambican territory is divided into four physiographic zones (Afonso *et al*., 1998): **Mountainous Zones**, with elevations of more than 1000 m; **Great Plateau Zone**, with elevations from 1000 to 500; **Middle Plateau Zone**, with elevations from 500 to 200 m and **Great Coastal Plains Zone**, with elevations of less than 200 m. These units are delimited by more or less accentuated escarpments and, as a general rule, the altitude progressively increases from the coast towards the interior.

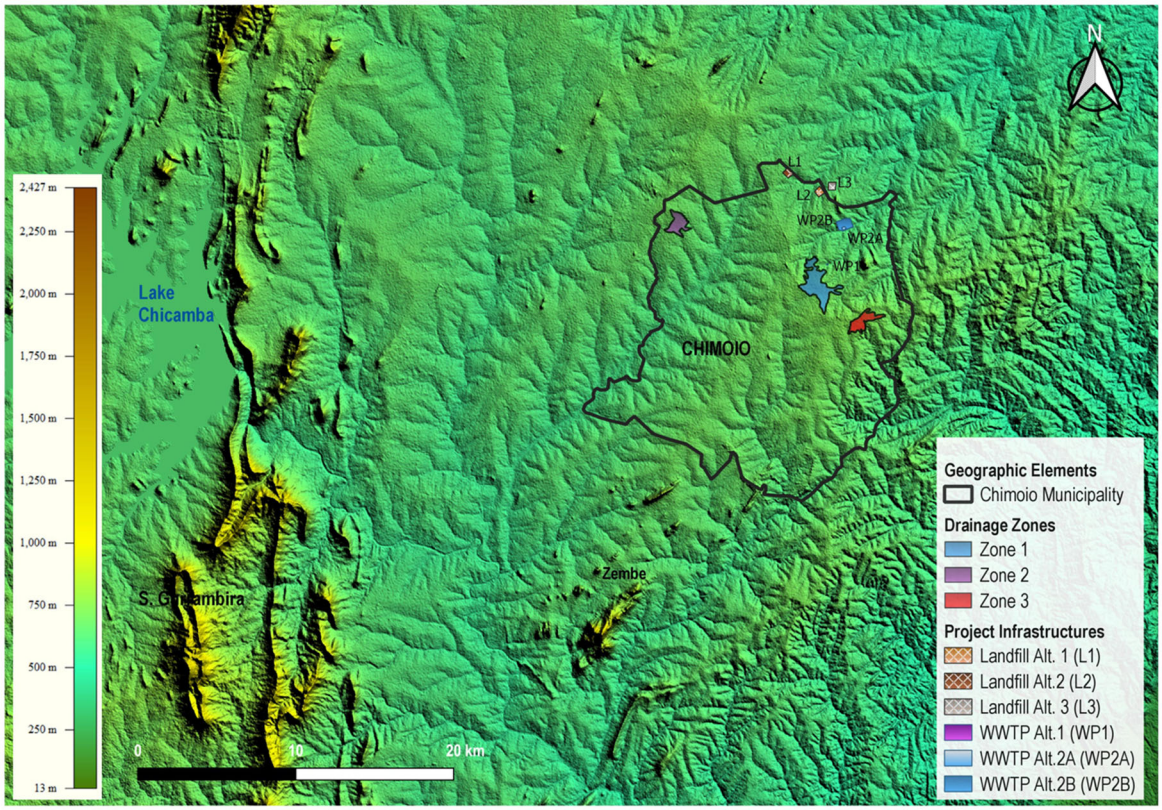
Landscape features in Manica Province include the Chimanimani Mountains and Lake Chicamba on the border with Zimbabwe (Figure 7.13). The mountains are located in the southern portion of the eastern highlands or Manica Highlands, a belt of highlands that extend north and south along the international border between the Zambezi and Save Rivers. The Chimanimani Mountains include Monte Binga (2,436 m), the highest peak in Mozambique and the second-highest in Zimbabwe.

The municipality is located on the so–called Chimoio Plateau, with altitudes ranging from 500 to 1,000 m, marked by an undulating relief punctuated by *inselbergs*, such as the so-called *Cabeça do Velho* (Old Man's Head), which marks the landscape of the city of Chimoio (Figure 7.13).

7.1.5.3 Geological Framework

Mozambique has a rich and complex geology, including formations as old as Mesoarchaic age (3.200 million years), occupying one third of the country, mainly in the centre and southern regions and in the NE coastal strip, to formations of Quaternary age.

The Chimoio region is largely composed by various Mesoproterozoic rocks included in the **Báruè Complex**. The Báruè Complex has been subdivided into the Macossa and Chimoio Groups (Figure 7.14), both intruded by plutonic rock of various composition. Lithologically and structurally, these Groups have much in common.



Source: USGS, SRTM-1Arc-Second Global

Figure 7.13 – Regional hypsometry of the project area

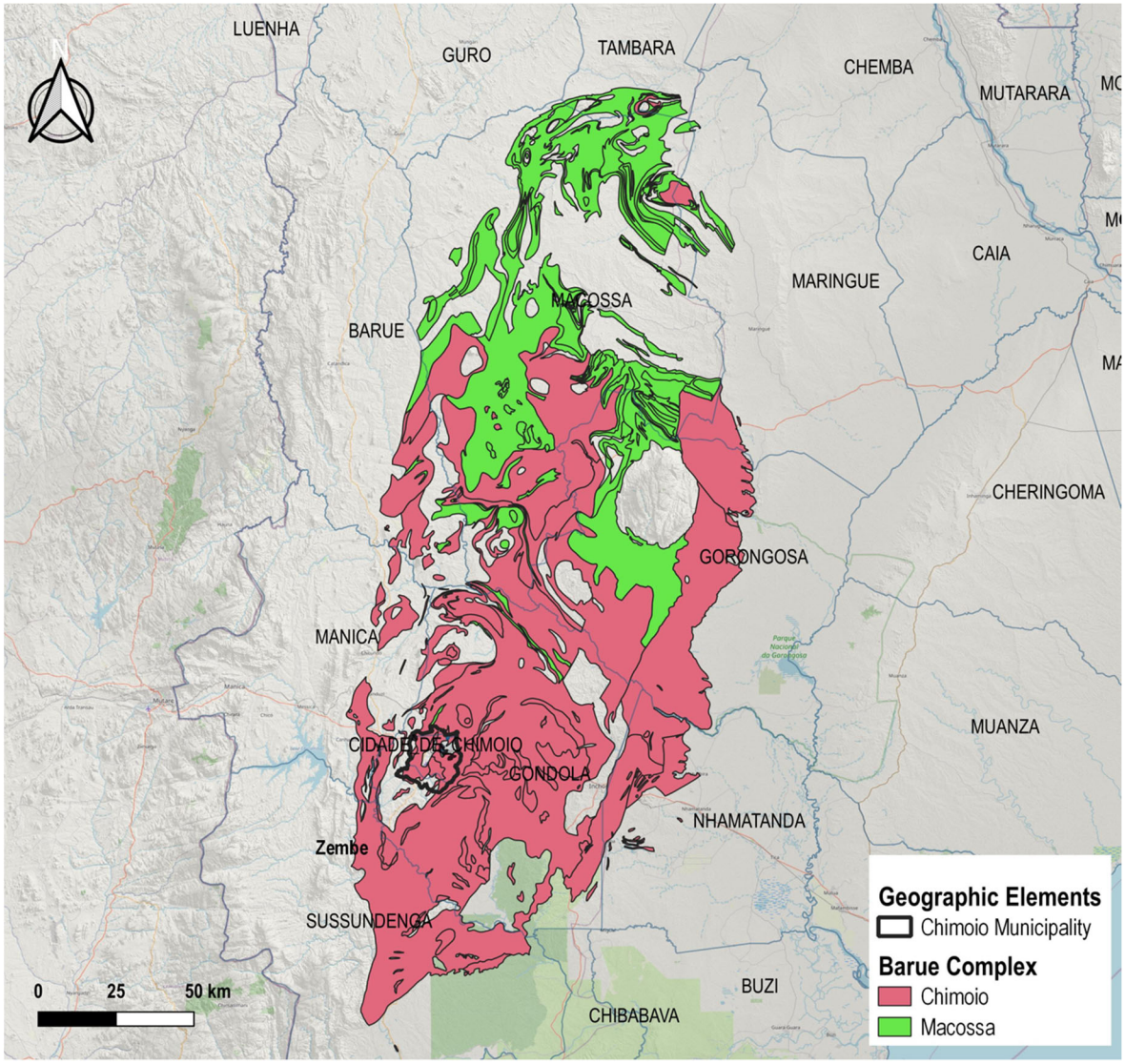


Figure 7.14 – Báruè Complex

The Báruè Complex is not distinguished by any intrinsic characteristic properties but rather by the lack of them. The rocks of the Complex form a series of plateaus rising from the coastal lowlands towards the Báruè highlands and the Chimanimani Mountains. It is typically a weakly dissected undulating country with inselbergs formed mostly from intrusive rocks.

The Báruè Complex has a variety of medium- to high-grade gneisses, migmatites and granitoids, with subordinate intercalations of mafic rocks, quartzites, marbles and associated calc-silicate rocks. The sedimentary protoliths of these lithologies correspond most likely to monotonous turbiditic sequences deposited on the passive continental margin of the Zimbabwe Craton.

As mentioned, the Báruè Complex has been sub-divided into two supracrustal groups each with several lithologic informal units into which some seven different varieties of igneous rocks have been emplaced.

Macossa Group

The supracrustal rocks assigned to the Macossa Group comprise a succession of lithologies with most likely sedimentary precursors, originally deposited in a shallow marine environment. Although the definitive character and position of all units observed within the rock succession are not fully solved, the overall lithostratigraphy of the palaeobasin has been reduced from several geological sections made in the area.

The lowermost rock units of the inferred palaeobasin include garnetiferous leucocratic gneisses, quartz-feldspar gneisses, meta-arkoses and arkosic quartzites. These psammitic metasediments are overlain by more pelitic rocks (metagreywackes, garnet and sillimanite bearing mica schist and mica gneisses) with thin calc-silicate gneiss and marble interbeds.

Chimoio Group

The supracrustal rock units of the Chimoio Group comprise predominantly of variously migmatized, psammitic paragneisses and pelitic metasediments, pure siliciclastic rocks and amphibolites constituting only a minor portion in the supracrustal sequence. Rare intrusive rocks observed in the southern part of the Báruè Complex are granitoids, commonly deformed into garnetiferous orthogneisses.

7.1.5.4 Local Geology

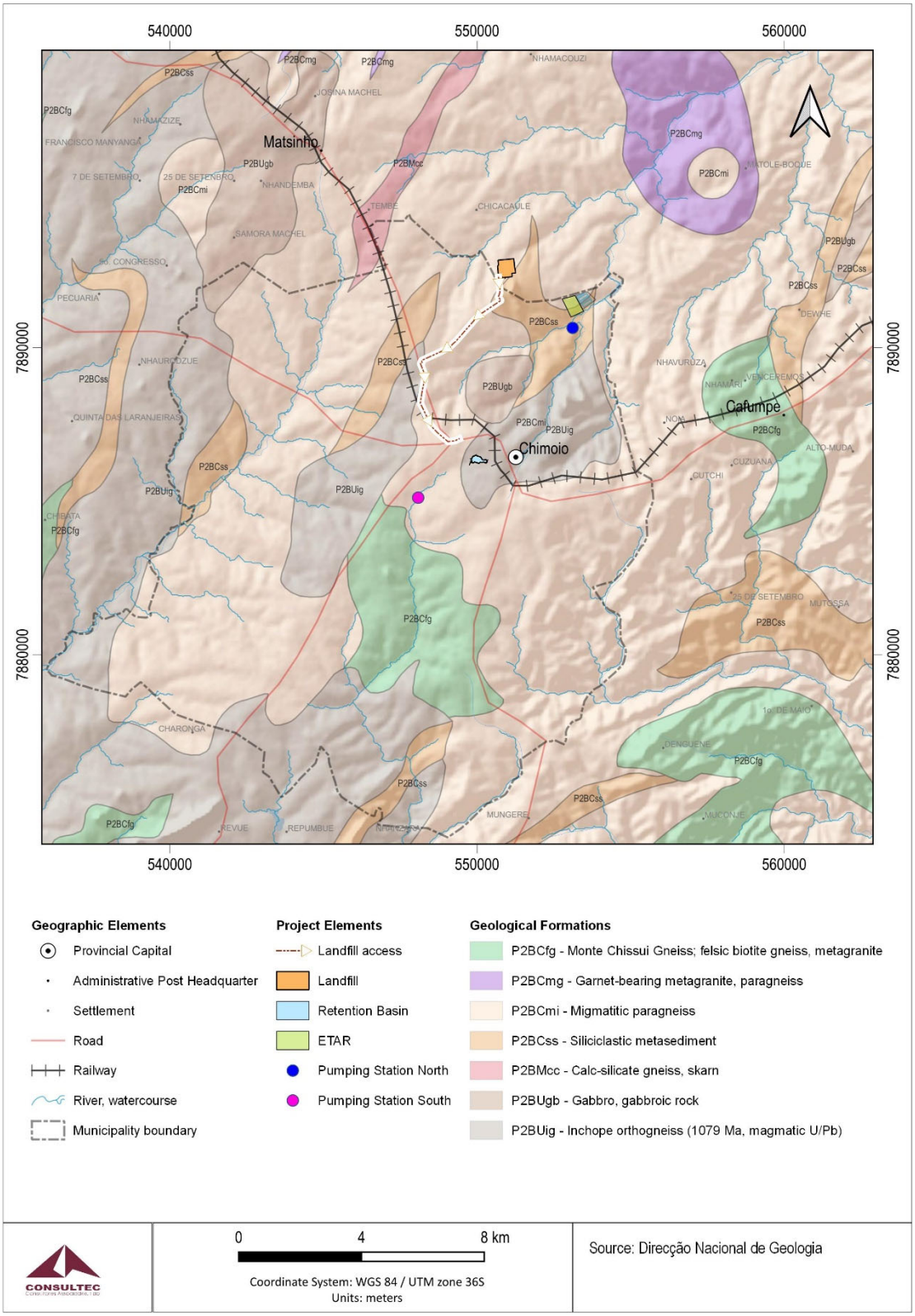
The study area is largely composed by various Mesoproterozoic gneiss, orthogneiss, migmatized paragneisses, quartzitic rocks (siliciclastic metasediments) and gabros. The geological formations present in the proposed project area are shown in Table 7.6 and belong to the Báruè Complex, with some lithological units belonging to the Chimoio Group.

Table 7.6 identifies the geologic units intercepted by the project's infrastructure and the respective symbology that can be found on the map above.

Table 7.6 – Geologic Formations Intercepted by the Project

Code	Complex | Group	Litology	Project's infrastructures
P_2BCss	Báruè Complex | Chimoio Group	Siliciclastic metasediments	Landfill & WWTP
P_2BCmi	Báruè Complex | Chimoio Group	Migmatitic paragneiss	Landfill, access road & WWTP

Source: Consórcio GTK (2006a, b).



Source: National Directorate of Geology, 2006

Figure 7.15 – Geological formations in the study area (detailed legend on Table 7.6)

The geological units interested to the study are described below, from the oldest to the most recent.

The **Migmatitic Paragneisses (P2BCmi**) constitute the lithology with the greatest expression in the Chimoio Group, namely in the southern and central sections of the Báruè Complex. To the west of Chimoio City, the gneisses are generally mesocositic, with rolled shaped garnets, strongly migmatised and with strong foliation defined by the preferential orientation of the biotite sheets.

Due to intense metamorphism, the primary sedimentary characteristics are often completely obliterated, and the intermediate varieties of rocks are homogeneous, from tonalite to granodiorite orthogneiss appearance. There are outcrops, where the slightly altered (brownish) plagioclase can be confused with the potassic feldspar. Occasionally, some granite fragments occur.

The main minerals occurring in these paragneisses are plagioclase, quartz, clinopyroxene and biotite, with potassic feldspar occurring as an accessory mineral, as does the amphibole, which is dehydrated to form pyroxene.

The **Siliciclastic Metasediments (P2BCss)** are represented by a heterogeneous sequence in the central section of the Báruè Complex, where these rocks, mostly quartzite, form low hills and elongated ridges in the migmatised paragneisses of the Chimoio Group. Random quartzite interlayers of metapelites have also been detected east of the Inchope settlement.

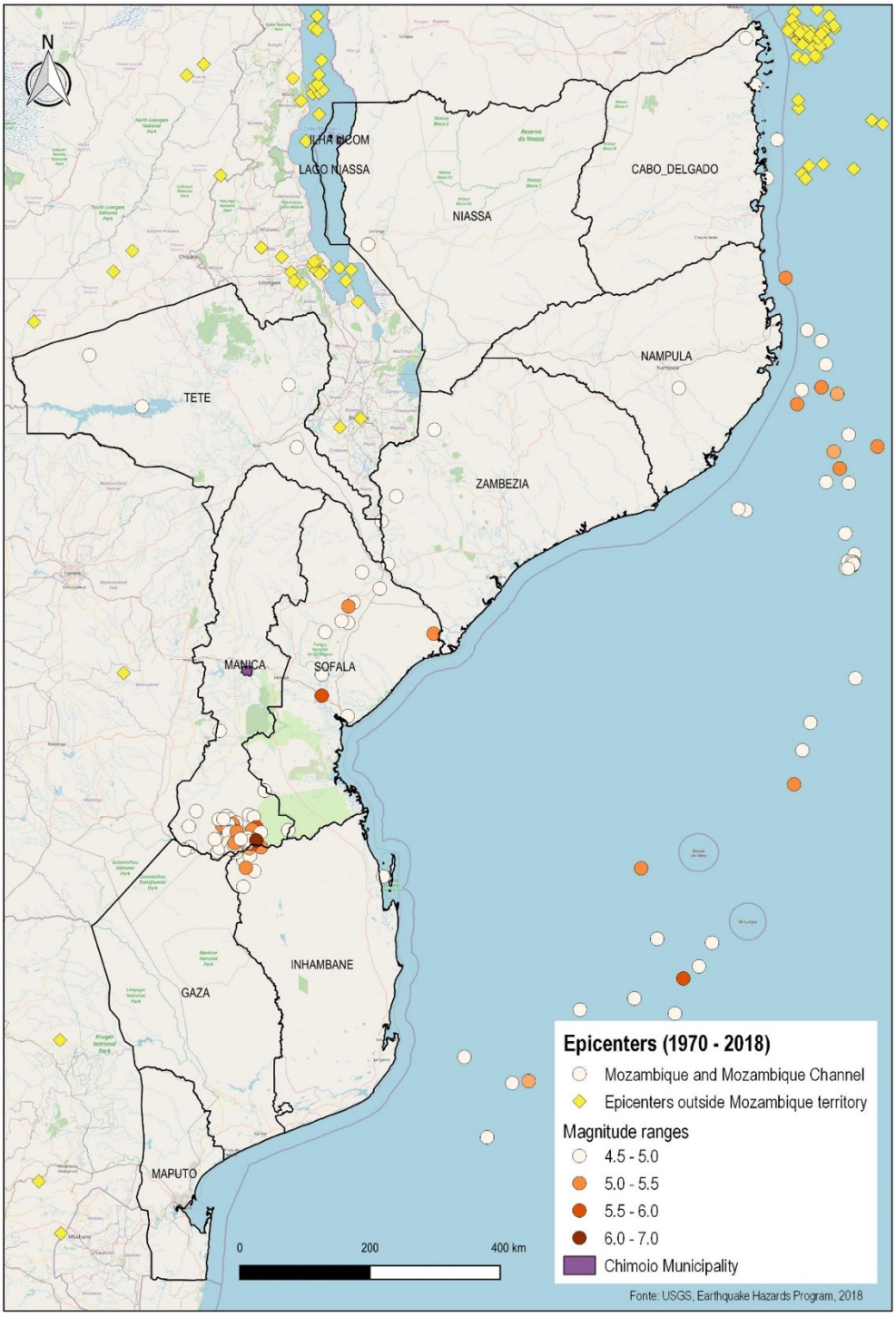
In general, most siliciclastic metasediments are fairly pure quartzites, however, they may contain thin interlayers of micaceous or feldspathic material. The accessory minerals are amphibole, garnet, sillimanite and iron oxides. Texturally, these rocks present themselves markedly foliated, elongated or milonitized.

7.1.5.5 Sismicity

Central Mozambique, where Manica is situated, is under the influence of the Great Rift Valley, which separates the Arabian, African and Indian plates, extending in a north-south direction from northern Syria to central Mozambique.

In Africa, the Rift begins in the Red Sea, in the separation of the African and Arabian plates, extending along the NW-SE direction to the Gulf of Aden. Then, it is directed south to the Urema region, within the African plate. Prolongations of this Rift to the south can also be observed in the area of Machaze (Manica) in the Graben region of Funhalouro, apart from others in the same region. The southern section is part of Niassa Lake, following the Shire River until it flows into the Zambezi River.

According to USGS (2018), 133 earthquakes of magnitude higher than 4.5 were registered in Mozambique (38 of which in the Mozambique Channel) - Figure 7.16. More than 75% of these had a magnitude of less than 5.0 (liquid oscillates in containers, sleeping people wake up), and 24% had a magnitude lower than 6.0 (difficult to stand up, cracks in saturated soils, small structural damages).



Source: USGS (2018).

Figure 7.16 – Epicenters of earthquakes with a magnitude greater than 4.5 in 1970 – 2018

February 2006 in the Machaze district in the south of Manica Province. Most of the epicenters of recent continental seismic activity were located in the Machaze region.

From the information presented, it can be concluded that the seismic activity in Mozambique is recurrent but generally of reduced magnitude. However, the recent tectonic evolution of the Miocene Rift system throughout East Africa, represented in Mozambique by the Lake Niassa - Chire - Urema - Sofala branch, may be responsible for an increase in the frequency of recorded earthquakes.

7.1.6 Soils

7.1.6.1 Soil Units

Soil is a living system that represents a finite resource vital to life on earth, and forms the layer of unconsolidated organic and mineral matter on its surface. It develops slowly from various minerals and is modified by time, climate, macro- and micro-organisms, vegetation and topography. It is as important as plants, animals, rocks, landforms, lakes and rivers. Soil influences the distribution of plant species and provides a habitat for a wide range of organisms. It also controls the flow of water and chemicals between the atmosphere and the land and acts as a storage source for storing gases in the atmosphere.

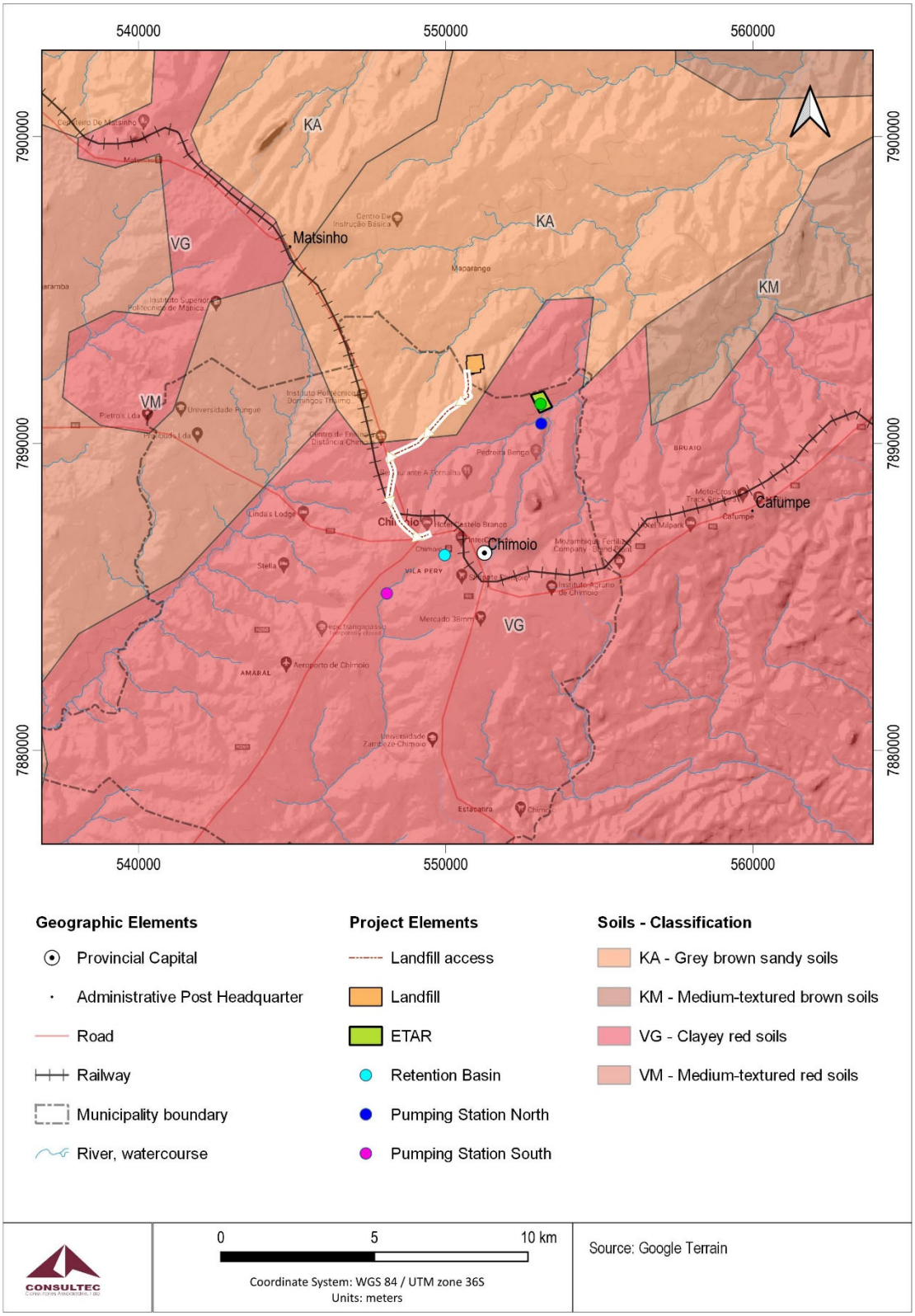
Soils are complex mixtures of minerals, organic compounds and living organisms that continuously interact in response to natural and imposed biological, chemical and physical forces. The world's soil resources are finite, essentially non-renewable, unevenly distributed across several ecoregions and fragile to drastic disturbance because they have a very low formation rate: on average about 1 cm every 80 to 400 years.

Despite their inherent resilience, inappropriate management can lead to soil degradation or reduced soil quality. Sustainable use of soil requires a full knowledge of its properties and quality management processes to ensure the preservation of its function and value for humans. To enable such knowledge, with respect to the project under assessment, this chapter provides an assessment of the baseline soil situation of the study area at local level.

The description of the soil units in the study area was based on the National Soil Map (INIA, 1994). Figure 7.17 shows an overview of the soil units present in the study area.

According to the classification criteria used by INIA, the identified soils can be grouped into four major physiographic units: Alluvial Zones, Sedimentary Basin, Volcanic Rocky Areas and Precambrian Shield.

The geological structure (base materials) strongly influences pedogenetic processes, although other factors also contribute to soil formation, such as climate, living organisms, relief and time. The main soil units in the study area are therefore associated with sedimentary areas and the Precambrian shield that formed the source materials.



Source: INIA (1995).

Figure 7.17 – Soil units found in the study area (for a detailed legend, see Table 7.7)

Table 7.7 shows the geological environmental conditions of soil formation. The source material and soil differentiation criteria (if any), and the respective symbology are presented in the Figure 7.17.

Table 7.7 – Soil classification key in the study area

Symbol	Parent Material	INIA Designation	FAO Designation	Project Zone
Precambrian shield				
VGo	Precambrian shield, acid rocks: granite, gneiss	Clayey red soils | Oxic clayey red soils	Rhodic Ferralsols	WWTP; Pumping Stations; Retention Basin and access road
VMp	Precambrian shield, acid rocks: granite, gneiss	Dystric medium- textured red soils | Sandy clay loam, reddish brown, deep	Haplic Acrisols	Drainage networks
KA	Precambrian shield, acid rocks: granite, gneiss	Grey brown sandy soils | Sandy, greyish brown, deep	Cambic Arenosols	Landfill & access road

7.1.6.2 Description of Local Soils

Although the sites for the WWTP and sanitary landfill are on the edge of the settlement, the Project implementation will take place in a fundamentally urban area, with densely populated zones, even if in some neighbourhoods with a disorderly occupation typology.

The soils in presence, originating in acid rocks such as granite and gneiss (Pre-Cambrian), are mostly sandy-clay, with low water and nutrient retention capacity, and prone to wind and water erosion. Their constitution is closely related to geomorphological evolution, formation and precipitation, and there is also being a strong relationship with vegetation.

For the storm water drainage system and the WWTP, VGo is the main soil type, but some VMp may also occur in smaller percentages. In the location indicated for the installation of the sanitary landfill, the dominant soils are KA and KAm types.

The soils of unit V of the Precambrian Shield are considered to be Rhodic Ferralsolos, clayey, reddish brown and with a highly variable organic matter content (low to very high). The sandy component variations are Acrissolos Haplicos, with greater acidity and a greater quantity of organic matter. These types of soils (VGo and VMp) are found in the three areas with interest for the implementation of drainage systems, as well as in the WWTP area.

The soils of the K Unit of the Pre-Cambrian Shield are Cambrian Arenosols, sandy, greyish brown, with low to moderate amounts of organic matter and slightly acid to alkaline. These soils (KA and KAm) are found in the sanitary landfill implementation area.

Table7.8 presents the main characteristics of the most frequent soils existing in the study region.

Table7.8 – General characteristics of the soils existing in the Project area

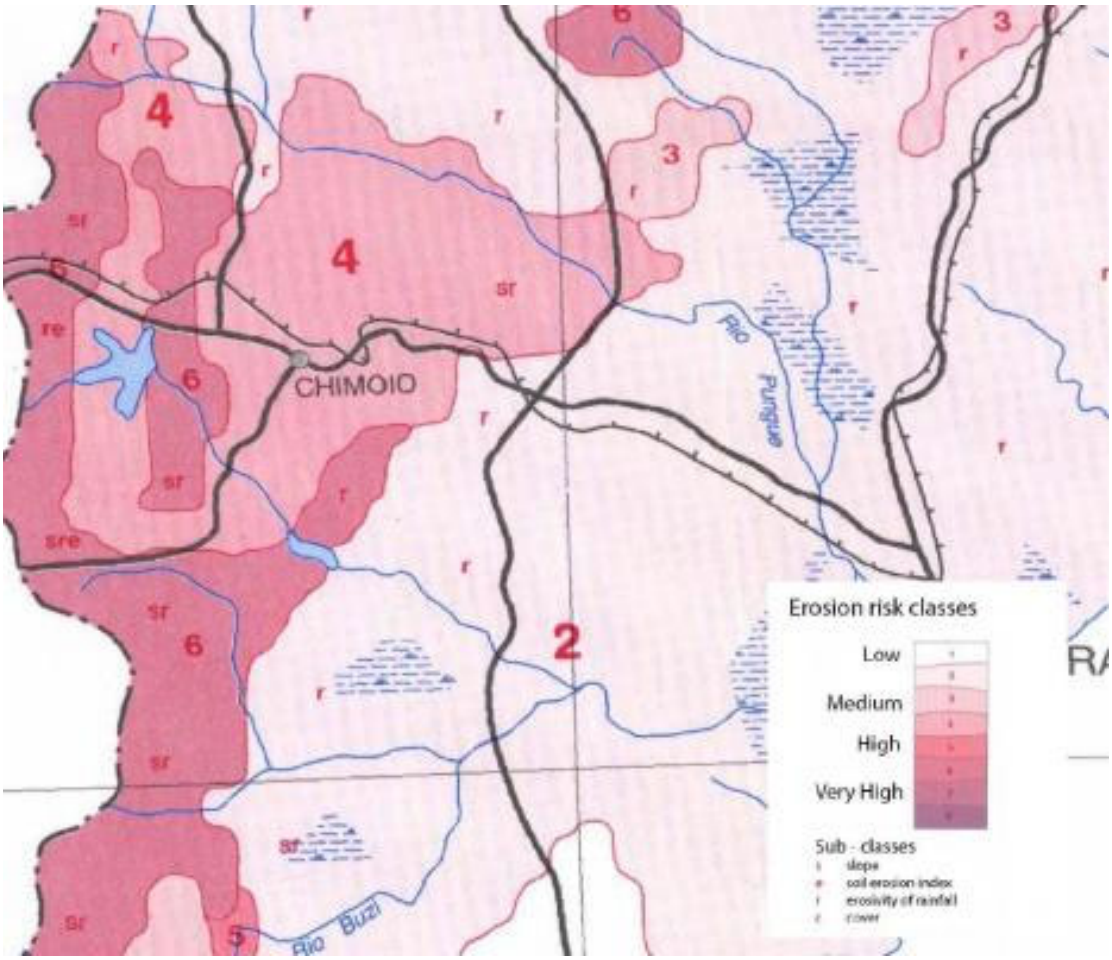
Symbol	VGo		
Soil Grouping	Oxic red clay soils	**Acidity and Alkalinity (pH)**	Moderately acidic (5 - 6.5)

Symbol	VGo		
Dominant characteristics	Clay, reddish brown	**Main Constraints for Agriculture**	Fertility, phosphorus fixation
Geology	Clays of the Precambrian Shield	**Organic Matter**	Low - very high (0.5 - 6)
Soil depth (cm)	Deep > 100	**FAO classification (1988)**	Rhodic Ferralsolos
Drainage	Good	**Adaptability of land for irrigation (USBR)**	Moderately adequate
Symbol	**VMp**		
Soil Grouping	Medium textured red, dystric soils	**Acidity and Alkalinity (pH)**	Strongly to slightly acidic (4.5 - 6.5)
Dominant characteristics	Reddish-brown sandy clay	**Main Constraints for Agriculture**	Fertility, erosion risk
Geology	Precambrian Shield clays	**Organic Matter**	Moderate - High (1 - 10)
Soil depth (cm)	Deep > 150	**FAO classification (1988)**	Acrisols Haplicos
Drainage	Good	**Adaptability of land for irrigation (USBR)**	Moderately to marginally suitable
Symbol	**KA**		
Soil Grouping	Greyish-brown sandy soils	**Acidity and Alkalinity (pH)**	Slightly acid to alkaline (5.5 - 7.5)
Dominant characteristics	Greyish brown sands	**Main Constraints for Agriculture**	Fertility, water holding capacity
Geology	Sands of the Precambrian Shield	**Organic Matter**	Low - moderate (0.5 - 2.5)
Soil depth (cm)	Deep > 100	**FAO classification (1988)**	Cambic sandstones
Drainage	Somewhat excessive	**Adaptability of land for irrigation (USBR)**	Moderate to marginally suitable

7.1.6.3 Risk of Erosion

Soil formation and erosion are two natural and opposing processes. Many natural, undisturbed soils have a rate of formation balanced with a rate of erosion. Under these conditions, soil appears to remain in a steady state as the landscape evolves. In general terms, soil erosion rates are low unless the soil surface is directly exposed to wind and rain. Erosion problems arise when natural vegetation cover is removed, causing soil erosion rates to accelerate sharply. In these cases, the rate of soil erosion far exceeds the rate of soil formation, making it necessary to apply erosion control practices to reduce erosion rates and maintain soil productivity.

The only available erosion risk information for the study area is the Mozambique Erosion Risk Map, produced at a national scale (1:2 000 000). Erosion risk for the study area is shown in Figure 7.18**.** As can be seen, the project area is located in a medium to high erosion risk area associated with rainfall erosivity (and relief).



Source: SADCC (1985).

Figure 7.18 – Erosion Risk

7.1.7 Recursos Hídricos

7.1.7.1 Hidrologia Superficial

Enquadramento Hidrológico

From a regional perspective, the municipality of Chimoio is located on the ridge that separates the hydrographic basins of two major international rivers, the Pungwe River in the northeast and the Buzi River in the southwest (Figure 7.19).

The Púnguè River is born on the eastern highlands of Zimbabwe, flowing eastwards through the Mozambican provinces of Manica and Sofala on its way to the Indian Ocean in Beira. The river is 400 kilometres long and drains a total catchment area of some 31,151 km^2 of which 1,461 km^2 (4.7%) is within Zimbabwean territory and 29,690 km^2 (95.3%) within Mozambique. The main tributaries of the Púnguè River from the source to the mouth are the Honde, Nhazonia, Txatora, Vunduzi, Nhandungue, Urema and Muda rivers.

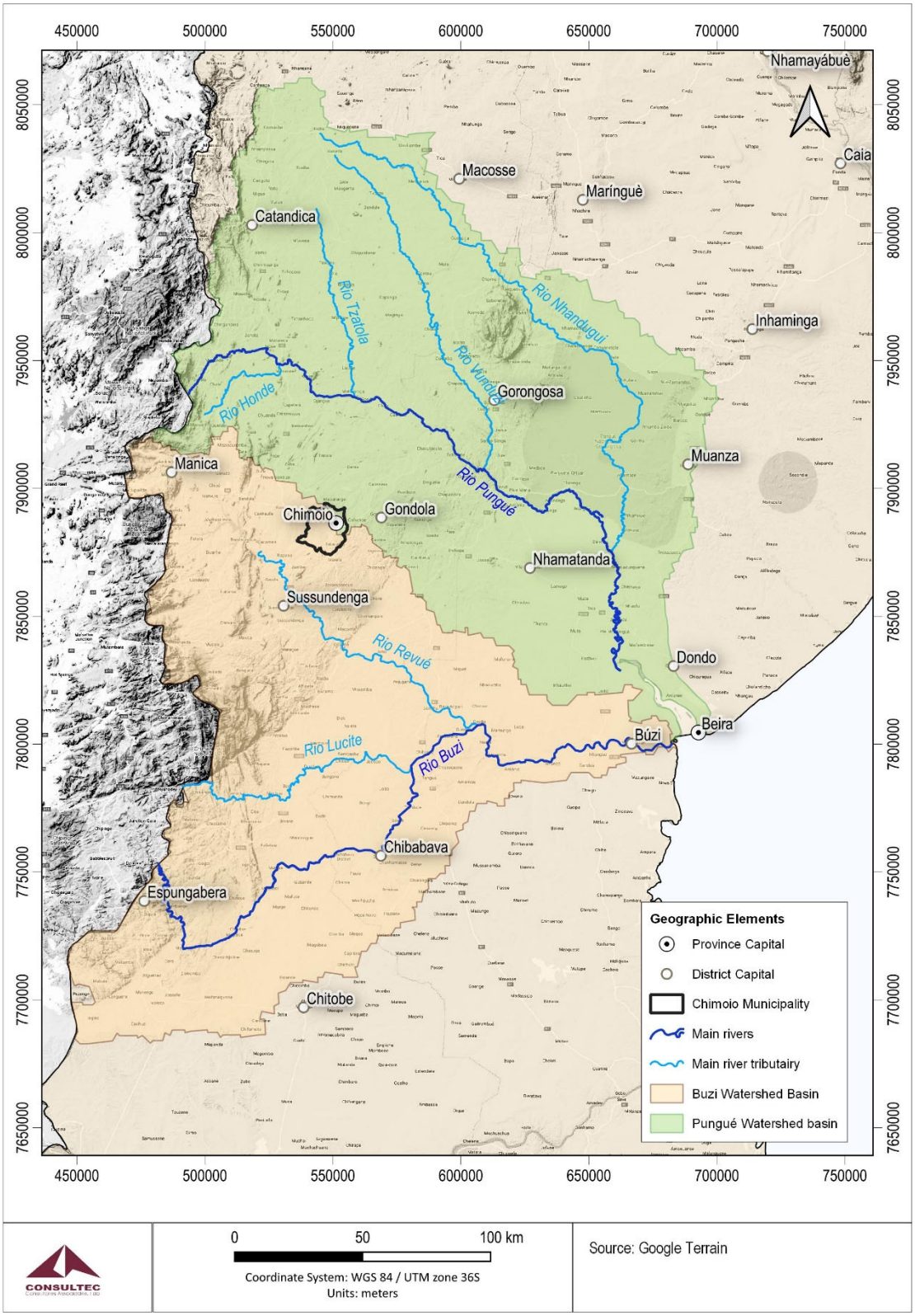


Figure 7.19 – Chimoio Municipality Hydrographic framework

The Púnguè is a perennial river with a low degree of development with regards to abstractions, diversions and regulation. The large temporal variation in precipitation within the region leads to great inter-annual variations in the Púnguè flows. Both flood and drought periods are experienced. The cyclic pattern of many wet years, followed by consecutive dry years is typical of southern Africa. Preliminary results from a study on the impact of climate change indicate that rainfall will decrease slightly in the Púnguè River region and that drought periods will be more persistent in the future.

The Búzi River has a catchment area of approximately 28,980 km^2 of which a significant part, of approximately 26,000 km^2 (90%), is located in Mozambique, and approximately 3,000 km^2 (10%) in Zimbabwe. It borders the Púnguè River basin to the north and the Save River basin to the south.

The eastern highlands in Zimbabwe are located along the border of Mozambique. Southwest of Chimoio City are the Chimanimani Mountains, with Mt. Binga (2,436m), Mozambique's highest peak, located in the Búzi River basin. Búzi River flows eastwards, towards the Indian Ocean, and covers parts of two provinces in central Mozambique, Sofala and Manica.

The river system consists of three major rivers: the Búzi River, the Lucite River and the Revué River. Two hydropower schemes, Chicamba and Mavuzi, are considered the most important water activities, located at the Revué River

As mentioned, Chimoio is located at a drainage divide position, namely between the Mezingazi river sub–basin (which forms part of the Púnguè river basin) and the Tembe and Toa rivers sub-basins, tributaries of the Revué river which is a major sub-basin of the Búzi river basin (Figure 7.20). The municipality is crisscrossed by several tributaries of these sub-basins which are all temporary, with flow strictly dependent on precipitation and, during the rainy season, it may assume a torrential flow in periods of intense rainfall, with risk of damage to structures built in adjacent areas.

Mezingazi River is 66 km long and has a catchment area of approximately 935 km^2. The river has a flow direction from SW to NW, being a direct tributary to the Púnguè river. The watershed has an arborescent shape, with a dendritic drainage pattern. Mombeze River is its main tributary that flows NW from the Mezingazi river and joins it at the downstream sector of the basin. Almost all the tributaries are first-order streams (single source tributaries). This river covers the neighborhoods of Mudzingadzi and establishes the limit between the Nhamaonha and Josina Machel neighborhoods.

Tembe River is 33 km long and has a catchment area of approximately 276 km^2. The river has a flow direction from NNE to SSW, being a direct tributary of the Revuè river. Upstream, the shape of the basin is relatively narrow and elongated, with symmetry related to the number of tributaries on each of the banks of the Tembe River. In the downstream sector, the Tembe River receives its main tributary, expanding the basin in this sector and losing symmetry. Almost all the tributaries are first-order streams. This river stablishes the boundary with Tembwe neighborhood.

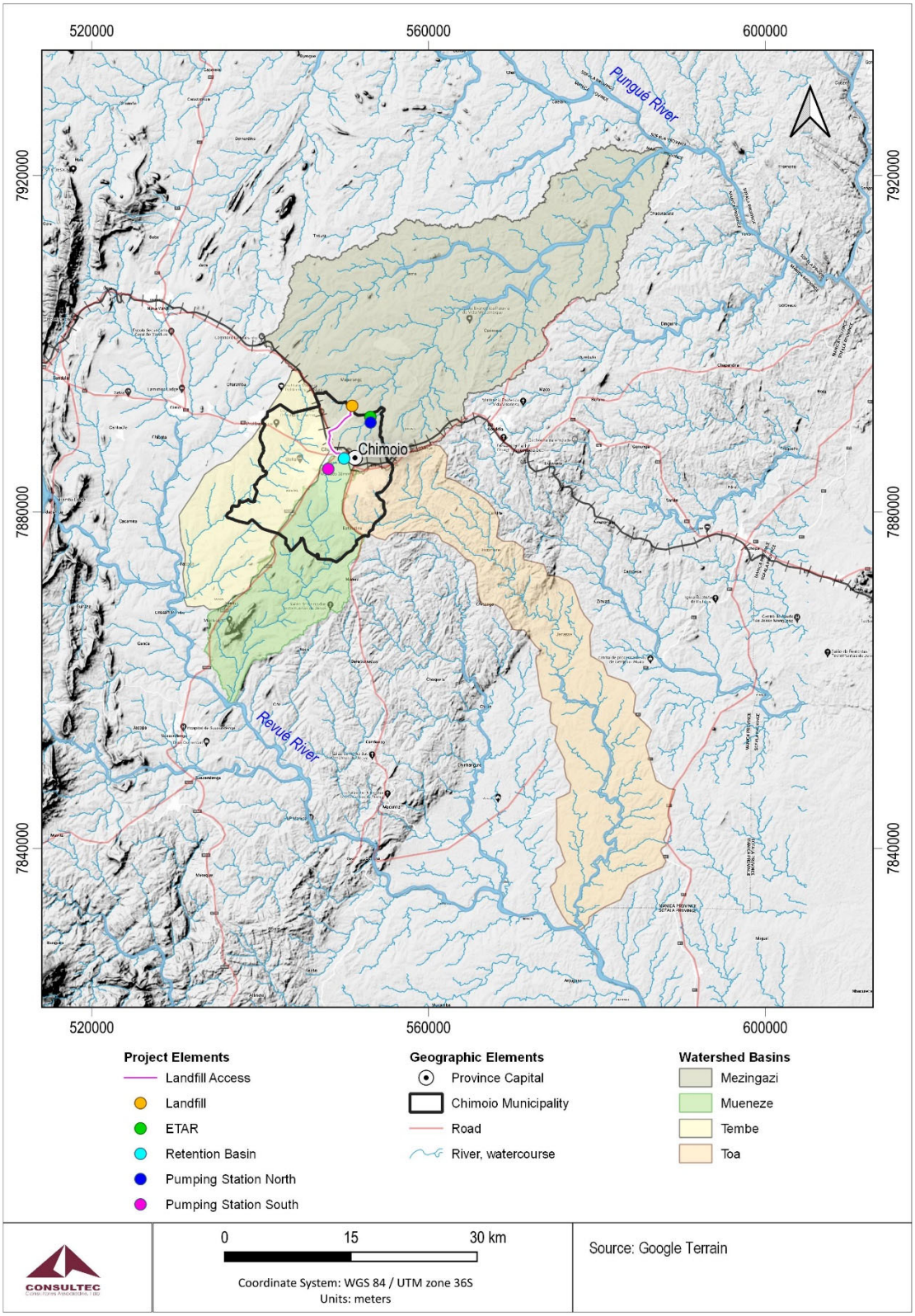
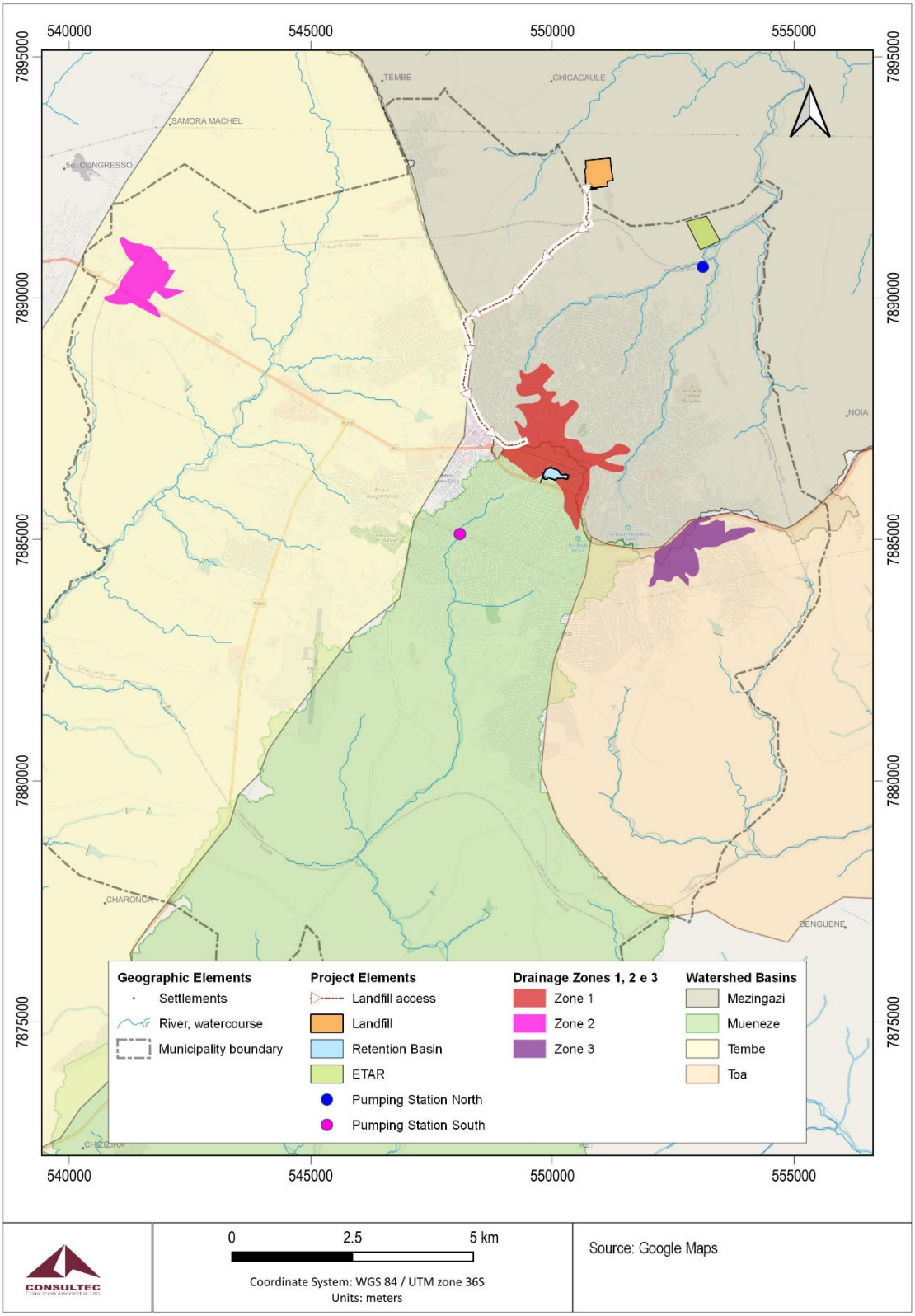


Figure 7.20 – Location of the Municipality of Chimoio in a ridge area between several river basins

Toa River is 102 km long and has a catchment area of approximately 633 km^2. The shape of the basin is elongated, arched and narrow, widening slightly in the downstream section, close to the confluence with the Revué river. Almost all the tributaries are first-order streams. Toa River has no significant tributaries and is located in the extreme southeast of the municipality.

Local Hydrography

Figure 7.21 shows the location of the proposed infrastructure in relation to the local river system, while Table 7.9 summarizes the placement of the infrastructure in the local hydrological context.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Settlements
River, watercourse
Municipality boundary
Project Elements
Landfill access
Landfill
Retention Basin
ETAR
Pumping Station North
Pumping Station South
Drainage Zones 1, 2 e 3
Zone 1
Zone 2
Zone 3
Watershed Basins
Mezingazi
Mueneze
Tembe
Toa
0
2.5
5 km
Coordinate System: WGS 84 / UTM zone 36S
Units: meters
Source: Google Maps
CONSULTEC

Table 7.9 – Project infrastructure location in the hydrological context

Elements of the Project	BASIN	SUB-BASIN	SECTOR
Zone 1	Púnguè	Mezingazi	Headwaters of the watershed. Near the river to the West
	Revuè (Búzi)	Mueneze	Headwaters of the watershed. 6km North from the river. Near first order tributaries
Zone 2	Revuè (Búzi)	Tembe	Headwaters of the watershed. 3km West from the river. Near first order tributaries
Zone 3	Revuè (Búzi)	Toa	Headwaters of the watershed. Near the river to the West
Sanitary Landfill	Púnguè	Mezingazi	Headwaters of the watershed. 5 km from the river. Near first order tributaries
Retention Basin	Revuè (Búzi)	Mueneze	Headwaters of the watershed near the limit with Mezingazi basin
Pumping Station South	Revuè (Búzi)	Mueneze	Headwaters of the watershed
Pumping Station North	Púnguè	Mezingazi	At the headwaters of the watershed in a 2nd order water line
WWTP	Púnguè	Mezingazi	Headwaters of the watershed. 2km from the river. Near first order tributaries

In the territory of the Municipality of Chimoio none of these water lines assume a permanent character, although in some areas, stagnant water remains as a result of the reduced inclination, creating serious risks of proliferation of diseases associated with the water environment. The flow rate is strictly dependent on rainfall, and in the rainy season it may become torrential during periods of heavy rainfall, with the risk of damage to structures built in adjacent areas. In this sense, the flooding of the Mezingazi river valley, densely occupied (mainly in Neighbourhood 5), is of particular concern, with the natural flow being increased by the discharge from the city drainage system.

In the rural areas of the municipality, there are small dams intended for irrigation, which provide water reserves for the dry season, relevant for adaptation to possible reduction in precipitation due to climate change.

Water supply and water quality

Urban water supply systems are currently managed by Fund for Investment Ownership and Water Supply Assets (*Fundo de Investimento e Património do Abastecimento de Água*; FIPAG). In 2009, the water supply systems of Chimoio, Manica, and Gondola were physically connected and aggregated under FIPAG's management. This integration was done using a single water source (the Chicamba Dam) and setting up a transfer scheme of the treated water between cities.

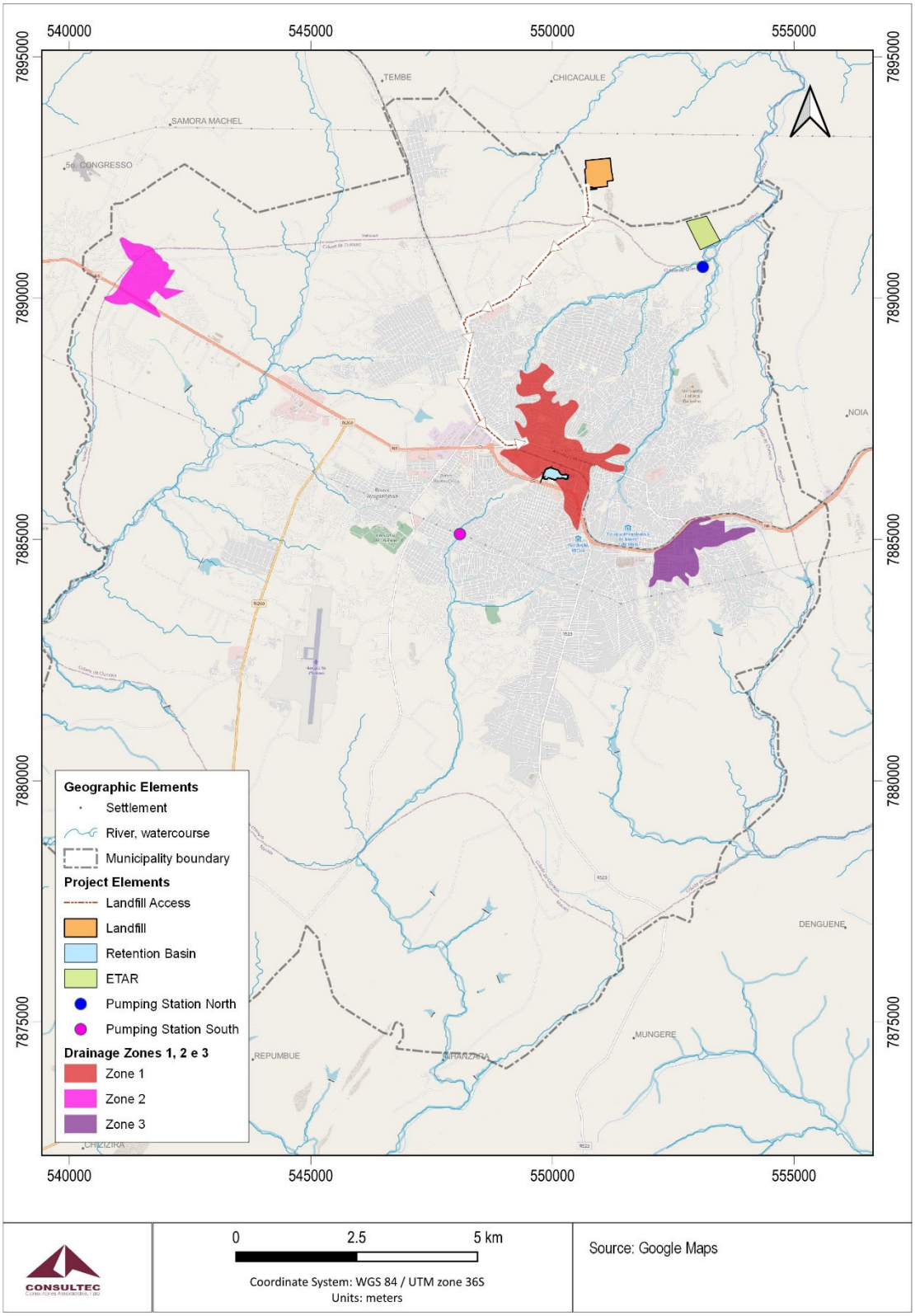


Figure 7.21 – Proposed infrastructure in relation to the local river system

In peri-urban areas the piped water supply system, when it exists, consists of a limited number of household connections (at home and in the yard) that follow the existing road network, penetrating slightly into the neighbourhood´s interior. Fountains are the source of drinking water that supplies the largest number of households. Domestic sanitation is based on isolated household facilities such as external toilets, septic tanks and latrines, with some households even having no sanitation facilities at all. Sanitation in the neighbourhood is very poor, as there is no storm water drainage system covering the whole neighbourhood and the same is true for domestic waste collection.

In peri-urban and rural areas where urbanization is incipient and public services are almost totally absent, piped water and electricity supply and social facilities are scarce or non-existent, as are sanitation services.

At the same time, many independent water sources exist within municipal boundaries, including point sources (dug wells and boreholes) and small piped systems which are often privately developed and managed to provide water to households and enterprises in peri-urban areas where municipal and/or public enterprise supported distribution networks do not provide coverage.

The Púnguè and Búzi Rivers have saline intrusion at their mouths, which may be an indication of changing on water fluxes regime. Water quality in the two basins is not a major environmental problem, but the Púnguè River basin shows deterioration of water quality at places where artisanal gold mining is prominent.

7.1.7.2 Groundwater Resources

The biggest source for hydrological information in Mozambique is the Explanatory Notes to the hydrogeological map of Mozambique (scale 1: 1,000,000) (Ferro and Bouman / DNA, 1987).

Chimoio Municipality is characterised by areas with local aquifers (intergranular or fissured), with limited productivity or in areas without significant groundwater (Figure 7.22). These areas have:

- **Areas with local continuous aquifers** (designated by C1 on the hydrogeological map) with limited productivity (generally Q < 5m^3/h), located in areas with crystalline rocks have the water occurrence limited to the areas with alterations or fractures of subjacent heavy rocks (alteration thickness usually between 20m and 50m).
  Areas with limited groundwater (designated by C2 on the hydrogeological map), generally with low productivity Q < 3m^3/h). In the areas with crystalline rocks, the existence of outcrops or little thickness of alteration limits the occurrence of groundwater (alteration usually lower than 20m). However, fault zones and alluviums can correspond to exception zones, generally more productive. It is important to point out that fissured, fractured systems coexist laterally and in depth, much fractured zones with other little fractures, where the change acts as a buffer to the drainage. The existence of heterogeneous areas necessarily induces rapid changes in terms of hydrodynamics. These changes, even within the same mapped system, are the result of the changes and transitions between possible different systems, which are, in some way, spatially interconnected which justifies the range of expected productivity values in this type of formation / aquifer.

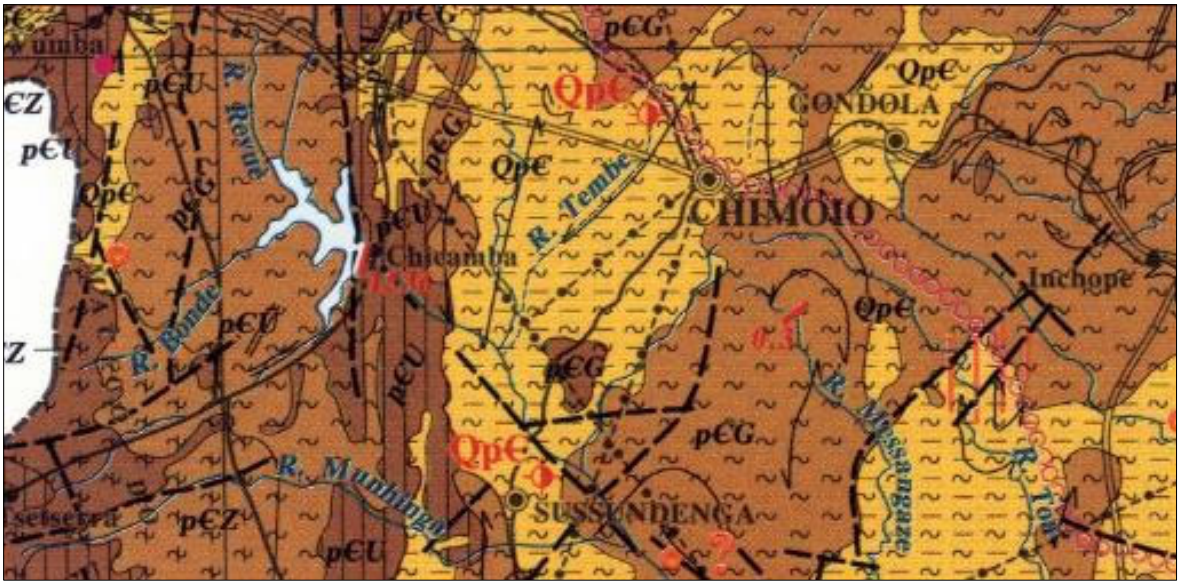


Figure 7.22 – Excerpt of the Hydrogeological Map of Mozambique (Original Scale of 1:1000000) – Aquifer Systems

Groundwater is used as a complementary source to supply water to the municipality's population, mainly in rural and even in peri-urban areas.

It should be noted that along the valleys of the water lines that cross the municipality, the populations collect water through wells dug at shallow depths.

7.2 Biotic Environment

7.2.1 Introduction

Mozambique is rich in biodiversity, with 14 ecoregions composed of a variety of terrestrial, marine, coastal and aquatic ecosystems. The habitats in these ecosystems support a wide diversity of species, including over 5,500 plant species, 220 mammal species, 690 bird species, 167 reptiles and 79 amphibians, some of which are endemic (CEAGRN, 2015).

The following sections provide a brief, regional and local assessment of the flora and fauna in the project area, based on the review of secondary data by work area.

The description of the baseline situation of the biological environment of the Project area of influence was based on literature review and secondary data analysis at provincial and district level.

To complement this literature review a site visit was carried out in October 2021. The visit aimed to confirm the vegetation units mapped in the desktop study and collect qualitative data on the conservation status of the habitats and main species of terrestrial flora and fauna present.

7.2.2 Flora and Habitats

7.2.2.1 Regional Framework

The vegetation in the study area falls within the phytogeographic unit referred to as the Zanzibar Coastal Mosaic and Miombo Dry Forest (White, 1983; RESOLVE, 2017) (Figure 7.23). In Manica Province, the main existing vegetation types consist of undifferentiated miombo woodlands, including dense deciduous forests, open deciduous forests and open scrubland. Due to the expansion of urbanization, degraded forms of different vegetation types may also emerge, as well as agricultural areas and disturbed vegetation associated with human settlements and urban expansion.

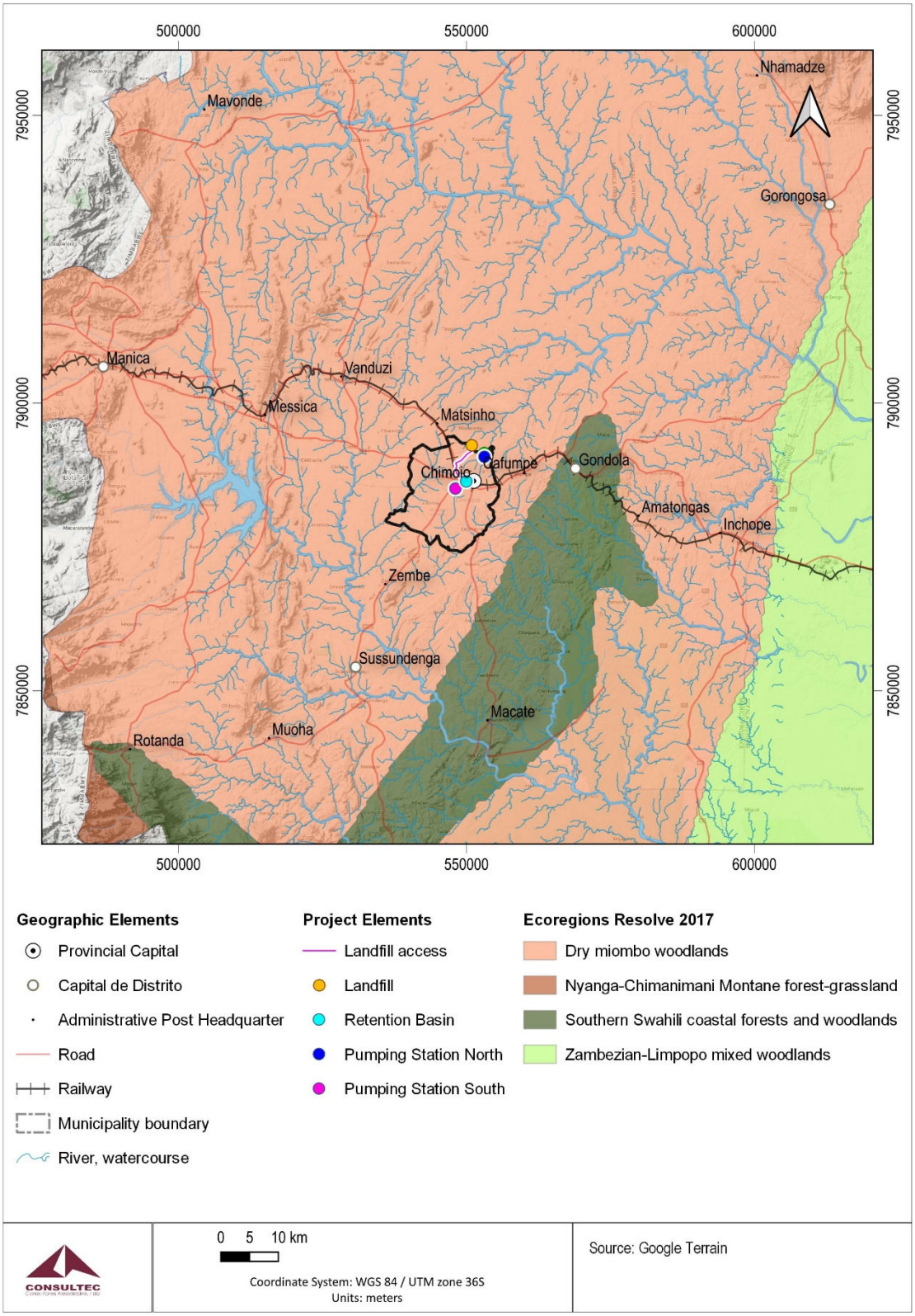


Figure 7.23 – Map of ecoregions in Manica Province

The Miombo Dry Forests represent ecoregions that occur in variable topography, part on flat or undulating plains, but most of it occurs in rugged regions, hills and inselbergs (RESOLVE, 2017). These forests are typical of seasonal tropical climate whose rainy season occurs in the hottest months, which can last up to 6 months.

The Mosaic Forests ecoregion occurs in regions that present gently undulating topography with the presence of some higher and isolated plateaus and inselbergs with important sand dunes supporting the vegetation, this ecoregion contains important sub-centres of endemism (RESOLVE, 2017). The ecoregion has a tropical climate further north and subtropical climate to the south.

The Miombo Forest is mainly dominated by the subfamily Caesalpinioideae and characterised by species of the genera Brachystegia and Julbernardia, especially Brachystegia spiciformis and Julbernardia globiflora. Other common species include Uapaca kirkiana, Brachystegia boehmii, Monotes glaber, Faurea saligna and Combretum molle. Endemism in this ecoregion is low and mammal species diversity high (RESOLVE, 2017).

Fire is a natural ecological factor in the Miombo Forests, however, the increased frequency of burning by human activities in the opening of cultivation areas and scaring away wild animals for hunting, makes fire a threat to this ecoregion.

Vegetation in Manica Province is mainly miombo woodland with different strata (upper, middle and lower) covering almost 25.2% of the total forest cover, with predominance of species such as Brachystegia spp., Julbernardia spp. and Isoberlinia spp.; savannah (tree and shrub) covering 13.5%; mopane forest (open and closed) covering 10.1%; and forest areas with shifting agricultural mosaic occupying 13.2% (Roque, 2015).

7.2.2.2 Local Framework

Considering the ecological framework of the project implementation area, the flora and vegetation present are subject to a high degree of disturbance, with the presence of some lightly disturbed forest areas (Figure 7.24).

In Chimoio City, the natural vegetation has been greatly affected by intensive human activities. As previously mentioned, the study area is located in an urban environment, where housing, developments and activities have profoundly altered the original vegetation cover. In the bordering areas of the Chimoio Municipality, which have not been fully developed, there are some forest areas, although not very dense, with a predominance of species with an average height between 10 m and 15 m, such as *Brachystegia* spp., *Julbernardia* spp. and *Isoberlina* spp., *Diplorhynchus condylocarpon*, *Dalbergia* sp., *Millettia stuhlmannii* (Jambirre/Panga-panga) and *Pterocarpus angolensis*. Given the urban environment, the occurrence of species of special interest in the study area is unlikely.

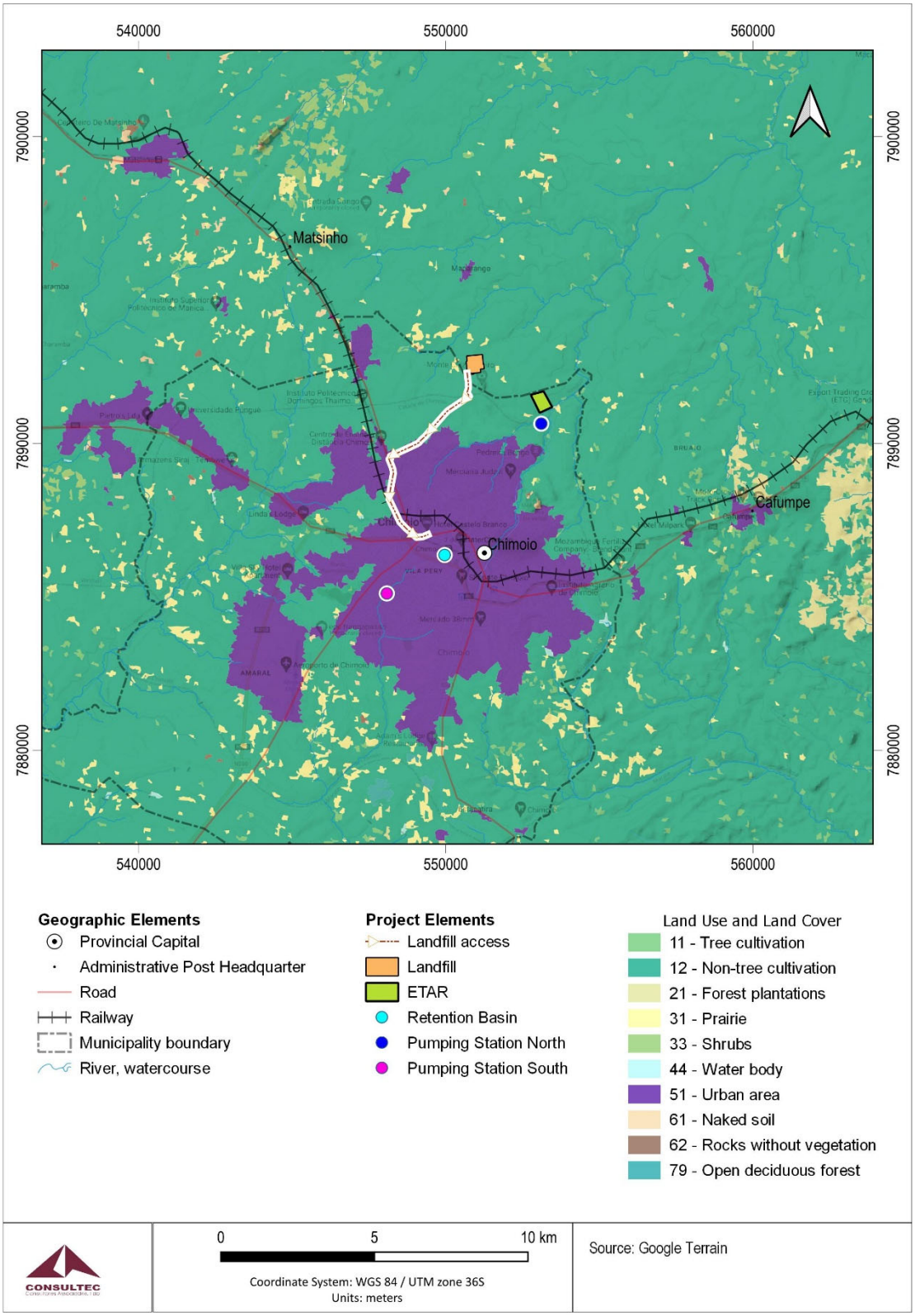


Figure 7.24 – Vegetation of Chimoio City

7.2.2.3 Uses of Floristic Species

Native plants are used by local communities for various purposes, including:

- **Food and drinks**: fruit trees, in particular, provide a source of food, and are also used for the production of alcoholic drinks for their own consumption and/or sale. Fruit trees include native and naturalised species such as Ziziphus mucronata (*maçaniqueira*), Carica papaya (papaya) and Mangifera indica (mango). The Phoenix reclinata palm has multiple uses: the fruit is edible and the sap is used to produce drinks (Van Wijk & Van Wijk, 1997);
- **Wood**: several local species are commonly used for the construction of canoes and dwellings, as well as for charcoal production. The most commonly used species include Diospyros spp. and Miombo species such as Brachystegia spp. and Julbernardia spp. (Consultec, 2013). Species of the genus Commiphora are used for charcoal production;
- **Building materials**: several herbaceous plants are used for the construction of ceilings; the leaves of silver spike grass (Imperata cylindrica) are commonly used for the ceilings of houses, and local communities often burn the margins of marshes to encourage their growth, as this species is fire resistant;
- **Traditional medicine**: many local trees, shrubs and herbs are used for traditional medicine, e.g. as remedies for malaria, diarrhoea and infectious diseases. The tsutou tree (Trichilia emetica) is used in traditional medicine to treat abdominal pain and dermatoses, among other uses (Baatile et al., 2011). Some palm trees, such as Raphia sp. are used to produce rope.
- **Other uses**: the stems, bark and branches of several species, such as raffia (Raphia sp.), Sterculia sp. and sisal (Agave sisalana), among others, are used to produce rope.

7.2.2.4 Flora Species of Conservation Interest

The floristic species likely to occur in the Project region with interest for conservation include some species on the Red List of Plants of Mozambique, with conservation status attributed by the IUCN (Izidine & Bandeira, 2002) - Table7.10.

Table7.10 – Red List Flora species potentially occurring in the Project region

Scientific name	Vernacular name (Koning, 1993)	Conservation Status (IUCN, 2021)	Endemism	Habitat
Celosia pandurata	-	VU	Endemic	Central Mozambique Forests
Centella obtriangularis	-	VU	Endemic	Endemic to the Chimanimani mountains
Croton leuconeurus	muntaru	VU	Endemic	-
Danthoniopsis chimanimaniensis	-	VU	Near Endemic	Endemic to the Chimanimani Mountains and Zimbabwe
Digitaria fuscopilosa	-	VU	-	-
Erica pleiotricha	-	VU	-	High-altitude rocky areas
Encephalartos chimanimaniensis	-	VU	Near Endemic	Endemic to the Chimanimani Mountains and Zimbabwe

Scientific name	Vernacular name (Koning, 1993)	Conservation Status (IUCN, 2021)	Endemism	Habitat
Impatiens salpinx	-	VU	Near Endemic	Altitudes of 1 550 m. Also in Zimbabwe.
Lannea stuhlmannii	-	VU	-	Widely distributed in the Zambezian Flora
Lobelia cobaltica	-	VU	Near Endemic	From the Chimanimani mountains
Rhynchosia chimanimaniensis	-	VU	Near Endemic	From the Chimanimani mountains
Sterculia appendiculata	-	VU	-	-
Sterculia quinqueloba	mtonha	VU	-	-
Streptocarpus grandis *S. michelmorei*	-	VU	Near Endemic	From the Chimanimani mountains and also in Zimbabwe
Tricliceras lanceolatum	-	VU	-	Open Forests
Vernonia muelleri	-	VU	Near Endemic	From the Chimanimani mountains

7.2.3 Fauna

7.2.3.1 Regional Framework

The fauna of Manica Province mostly occurs within conservation areas. The most common species of wildlife in the region are bushbuck (*Tragelaphus scriptus*), eland (*Taurotragus oryx*), antelope (*Hippotragus niger*), Klipspringer (*Oreotragus oreotragus*), common duiker (*Sylvicarpa grimmia*) and blue duiker (*Philantomba monticola*). The southern reedbuck (*Redunca arundinum*) occurs in riverside areas and buffalo (*Syncerus caffer*) inhabit forests on mountain slopes (Ecoplan, 2009).

The diversity of herpetofauna in the Province of Manica is little known and many of the species of reptiles and amphibians that occur in the highlands of Chimanimani are endemic, such as the lizard *Platysaurus ocellatus*; snakes of the genus *Dromophis* and amphibians such as *Bufo vertebralis* and *Anthrolrptis troglodytes*. Many species of birds are migratory and shared with neighbouring countries like Zimbabwe. Some of them are endemic, such as the case of Chirinda *(Apalis chirindensis)* and Swynnerton (*Swynnertonia swynnertoni)* (Roque, 2015).

7.2.3.2 Local Framework

The City of Chimoio, given its urban characteristics, is subject to intense human activity, thereby resulting in low terrestrial fauna diversity. As such, the terrestrial fauna in this area is mainly represented by species which are either anthropophilic (i.e., that are actively associated with human settlements) or highly tolerant to ecological disturbance and human presence.

Among amphibians, only common and ecologically tolerant species may occur, including species such as the guttural toad (*Amietophrynus gutturallis*), Mozambique rain frog (*Breviceps mossambicus*), Anchieta's ridged frog (*Ptychadena anchietae*) or the water lily reed frog (*Hyperolius pusillus*).

Reptiles present in the study area likely include species commonly present in human settlements, such as the blue-throated agama (*Acanthocercus atricollis*), tropical house gecko (*Hemidactylus mabouia*) and skink (*Trachylepis margaritifera*), and tolerant species that may occur in the few areas where ruderal grasslands or secondary shrubs still exist, such as the common puff adder (*Bitis arietans*), the Mozambican shield snake (*Aspidelaps scutatus*) or the spotted flat lizard (*Platysaurus maculatus*).

With regards to mammals, only a few species of rodents, shrews and bats are expected to occur in the study area given its heavily degraded nature. Rodents and shrews may include anthropophilic species such as the brown rat (*Rattus norvegicus*) and the pygmy mouse (*Mus minotoides*) or small rodents that use the grasslands for foraging. Common bat species, typically found in urban settings, may also occur, including *Nyctalus* spp*., Myotis* spp. and *Rhinolophus spp.*

7.2.4 Conservation Areas

The Conservation Law (Law No. 16/2014, as amended by Law No. 5/2017) classifies protected areas into two broad groups: 'full conservation areas' and 'conservation areas of sustainable use'. These broad groups are further divided into seven categories: integral (contiguous) nature reserves, national parks and cultural and natural monuments, special reserves, environmental protection areas, official coutadas, community conservation areas, sanctuaries, wilderness farms and municipal ecological parks.

The proposed Project does not interfere with any protected areas. The nearest protected area is the Régulo Zumbo Forest Reserve, located about 20 km south of the project area (CEAGRN, 2015). Also of note are the Gorongosa National Park, 70 km northeast of the project area, Official Coutada No. 13, 70 km north of the project area and the Chimanimani National Reserve 60 km southwest of the project area (CEAGRN, 2015).

7.2.5 Ecosystem Services

An ecosystem is defined as a dynamic complex of plants, animals, micro-organisms and abiotic components that interact amongst them as a functional unit. Human communities are an integral part of ecosystems and are beneficiaries of the various goods and services provided by them.

These benefits are called Ecosystem Services (ES). The benefits that local communities derive from local natural and modified habitats are crucial to their well-being. The ES provided by, or ecologically associated with, habitats potentially affected by the Project were assessed at a macro-scale.

The Millennium Ecosystem Assessment (MEA, 2005) programe highlighted the importance of ecosystem services for human well-being and economic development. Its findings constitute the first advanced methodical assessment of the status and trends of the world's ecosystems and the services they provide, and the basis for measures of conservation and sustainable use. The MEA defined four categories of services:

- **Provisioning services**: which refer to the products that people obtain directly from ecosystems (e.g., agricultural products, edible plants, game, medicinal plants, drinking

water, biomass fuels, timber, etc.). Within the Project area, miombo woodlands and aquatic habitats provide natural resources that are utilised by local communities. The main provisioning services are agiculture production, livestock resources, wild foods, traditional medicine, biomass fuels and fisheries catches;

- **Regulating services**: which refer to the benefits that local communities derive from ecosystem regulating services (e.g. climate regulation, waste decomposition, water and air purification, etc.);
- **Cultural services**: which refer to the intangible benefits that people obtain from ecosystems (e.g., sacred and spiritual sites, ecotourism, education, etc.). These services can be materialised by the presence of sacred sites or species protected by communities. The baseline situation of the socio-economic environment provides further information on the presence of these elements in the Project areas;
- **Supporting services**: which are the natural processes that maintain the other services (e.g., nutrient cycling, gene production and genetic exchange channels, etc.).

Table7.11 lists the main ecosystem services provided by the main habitats surrounding the Project area.

Table7.11 – Typical ecosystem services by habitat

Ecosystem services	Urbanized Areas	Anthropised Grassland	Agricultural Areas
Provisioning			
Agricultural Cultures	■	□	■
Livestock	■	■	■
Fishing	□	□	□
Wood and Other Ligneous Materials	□	■	□
Fibers and resins	■	■	■
Animal skins	■	■	■
Sand, gravel, clay, etc.	□	□	□
Biomass fuel	□	■	□
Drinking water	□	□	□
Genetic resources	□	□	□
Biochemicals, natural medicine	□	□	□
Regulation			
Air quality regulation	□	□	□
Global climate regulation	□	□	□
Local/regional climate regulation	□	□	□
Hydrological cycle regulation	□	□	□
Waste assimilation	□	□	□
Cultural			
Recreation and ecotourism	□	□	□
Spiritual and religious values	□	□	□

Ecosystem services	Urbanized Areas	Anthropised Grassland	Agricultural Areas
Ethical values / non-use	□	□	□

Legend: ■ represents a high importance and □ represents a reduced importance of the ecosystem service. The table does not include ecosystem services considered not relevant or residual.

7.2.6 Habitat Assessment

7.2.6.1 Habitat Status

According to IFC Performance Standard 6 (PS6 - Biodiversity Conservation and Sustainable Management of Natural Living Resources) (IFC, 2012), habitats can be classified into the following categories:

- **Natural Habitats** - areas composed of viable communities of floristic and/or faunal species of mostly native origin, and/or where human activity has not substantially modified their primary ecological functions and specific composition;
- **Modified Habitats** - areas containing a large proportion of floristic and/or faunistic species of exotic origin, and/or where human activity has substantially modified their primary ecological functions and specific composition.

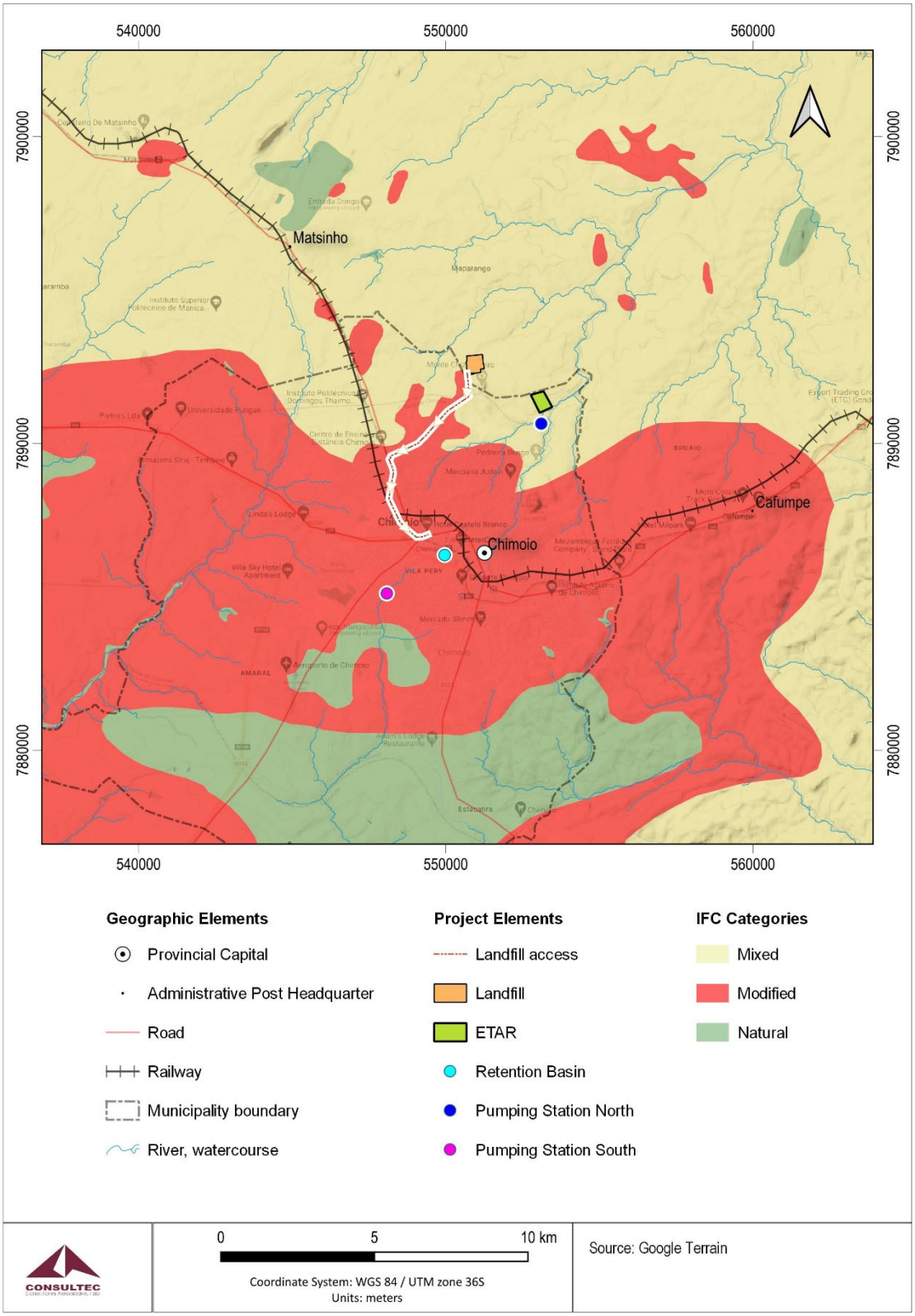
CEAGRE (2015) has produced a habitat classification for Mozambique that includes an additional category of Mixed Habitat, which falls between Natural and Modified habitats:

- **Mixed Habitat** - mosaic made up of natural areas, small cultivated areas and isolated villages / houses.

In general terms, Modified Habitats are considered to be less sensitive to further degradation, given that habitats have already lost their natural structure and integrity, thus containing less biodiversity and lower conservation value.

Natural Habitats are highly sensitive to habitat loss and degradation as their natural structure and biodiversity present themselves largely intact, in terms of the representation of natural species (albeit with reduced abundance of large mammals) and are thus vulnerable to habitat degradation and increased human disturbance.

The habitat classification produced by CEAGRE (2015) is illustrated in Figure 7.25. As can be seen from this figure, the project is mostly developed in modified and mixed habitats (assuming CEAGRE, 2015 classification).



Source: CEAGRE (2015).

Figure 7.25 – Habitat Categories in project area

7.2.6.2 Determination of Critical Habitat

IFC's PS6 (IFC, 2012) requires that a Critical Habitat Determination analysis be developed to identify key areas for biodiversity that require specific levels of mitigation to ensure their conservation: critical habitats are areas with high biodiversity value. PS6 establishes five criteria for the definition of Critical Habitats:

- **Criterion 1:** Critically Endangered (CR) and/or Endangered (EN) species**;**
- **Criterion 2:** endemic species and/or species with restricted distribution;
- **Criterion 3:** migratory and/or gregarious species;
- **Criterion 4:** highly threatened and/or unique ecosystems; and
- **Criterion 5:** key evolutionary processes.

However, the determination of Critical Habitat is not necessarily limited to these criteria. The designation of Critical Habitat can be supported by other recognised values of high biodiversity, and their suitability should be analysed on a case-by-case basis.

In the project region under study, in accordance with the previous analysis and the mapping of the habitats of Mozambique undertaken by CEAGRN (2015), the areas of critical habitat were identified, as identified in Figure 7.26, associated with the Chimanimani Mountains and Mount Gorongosa.

It should be highlighted that the project does not interfere with any critical habitat.

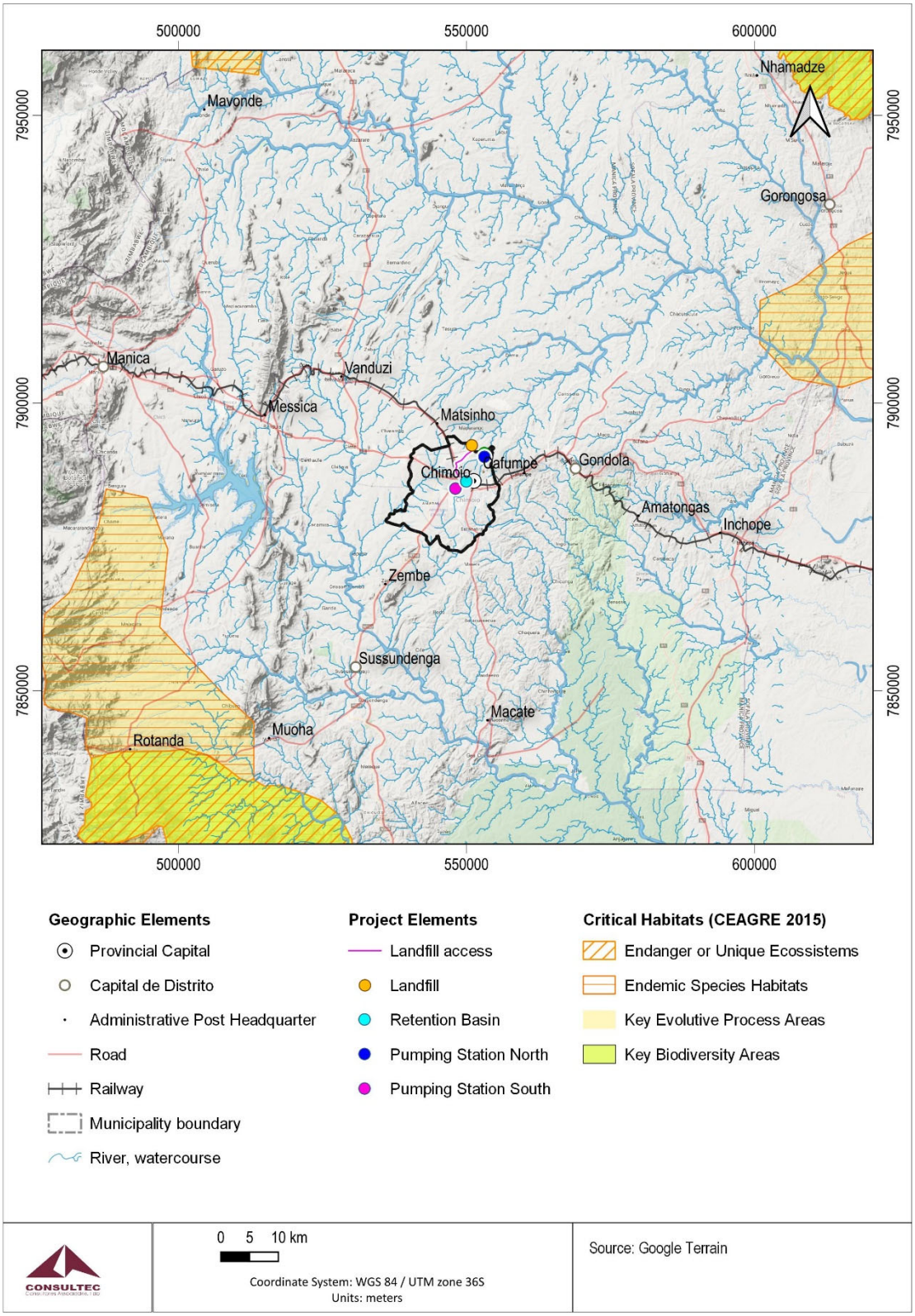


Figure 7.26 – Critical Habitats in the Project region

7.2.6.3 Key Biodiversity Areas

Key Biodiversity Areas are sites that make a significant contribution to the overall existence of biodiversity, in terrestrial, freshwater and marine ecosystems. These areas are identified based on internationally accepted scientific criteria.

In 2021, MTA, through DINAB, in partnership with the Wildlife Conservation Society (WCS) and with funding from USAID through the SPEED+ Program, presented the project "Red List of Threatened Species, Ecosystems, Identification and Mapping of Key Biodiversity Areas (KBAs) in Mozambique", where the Key Areas in Mozambique were identified (WCS, 2021).

Figure 7.27 identifies the KBAs in the project region, and as can be seen, the closest KBAs are Machipanda, Gorongosa/Marromeu Complex and Chimanimani located over 60km from the Project area.

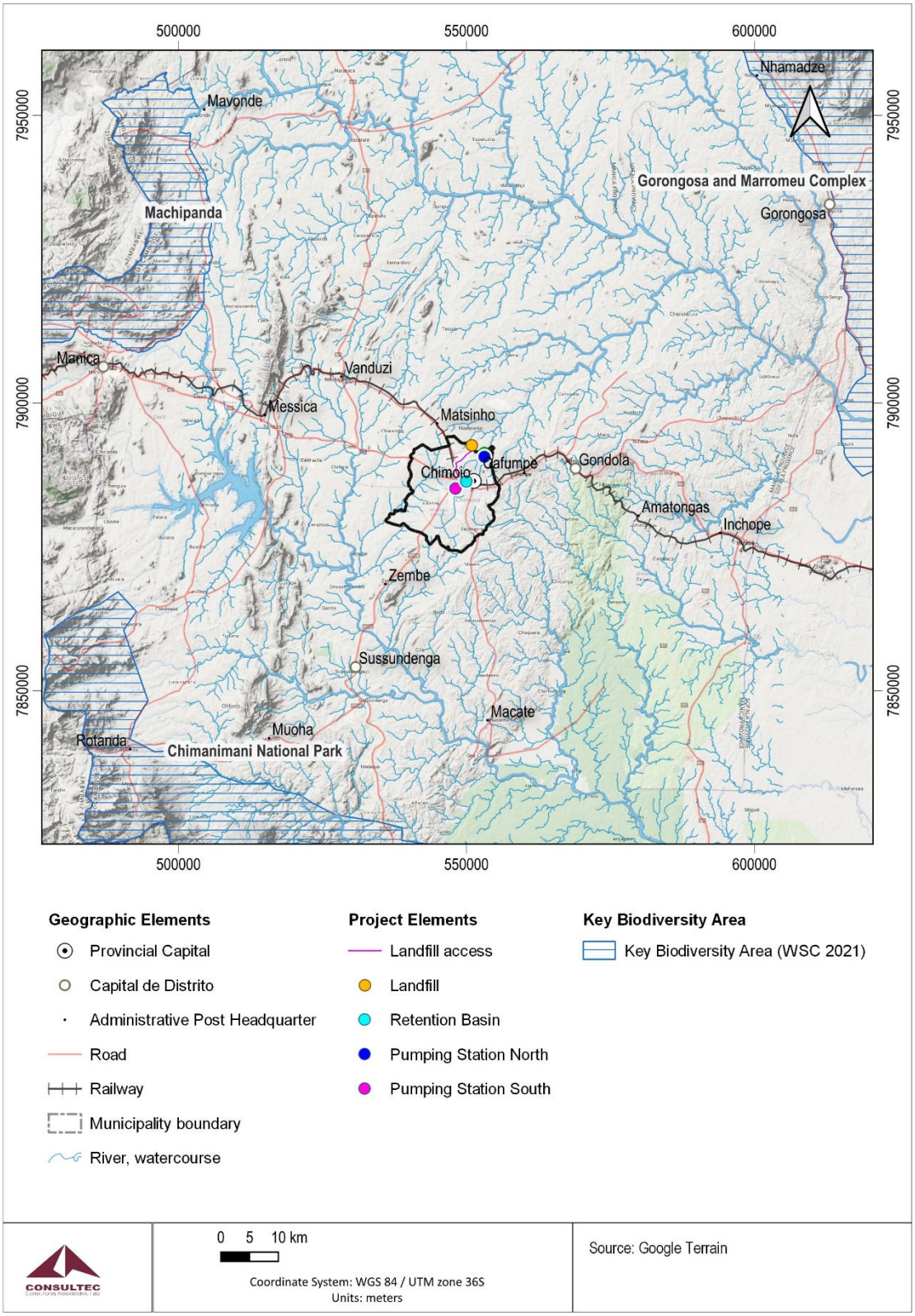


Figure 7.27 – Biodiversity Key areas in the Project region

7.3 Socio-economic environment

7.3.1 Approach and Methodology

The methodology used to characterise the reference situation in the project areas, both at a regional level (Provincial and District) and at the specific level of the area where the project is located, was based on two distinct components:

- Survey of secondary data through the bibliographic review of existing documents on the District of Chimoio, where the project is inserted;
- Two field visits, the first with the objective of surveying all infrastructures and agricultural areas potentially affected by the project within its boundaries, and the second to survey the social infrastructures of the neighbourhoods affected by the project and to conduct semi-structured interviews with the leaders of the communities involved. Field surveys were carried out by the team in the periods from 12 to 31 August 2021 (Landfill and South Pumping Station), 12 to 21 June 2022 (WWWTP) and 13th – 15th of June 2023 (North Pumping Station and Water retention basin).

The description and socio-economic characterization followed the following structure: regional framework that includes the description at provincial and district level, local framework that includes the communities **covered by the project**, and the specific framework that encompasses the buffer area, that is, the directly affected people living **within the project area**.

7.3.2 Administrative Framework

7.3.2.1 Administrative Division

The proposed Project is located in Manica Province, in the City of Chimoio. Manica Province is located in the central region of Mozambique, along the railway line connecting the cities of Beira in Sofala Province in Mozambique and Harare in Zimbabwe.

The Ministry of State Administration (MAE) classifies urban cities in Mozambique into four types, according to land use and population density, namely A, B, C and D (Muzima, 2009). Type A includes the country's capital Maputo, type B the provincial capitals of Nampula, Beira and Matola, and type C all other provincial capitals, including Chimoio, which is the fifth largest in the country in terms of population size.

Chimoio is both a Municipality and a District which is divided into three urban districts and 33 *bairros* or neighborhoods (Table 7.12 e Figure 7.28) (Ferrão *et al.*, 2016)) in a city that has urban, semi- or peri-urban and more rural or agricultural areas.

As per the Chimoio Municipality Urban Structure Plan, an analysis of the *bairros'* population showed that 71% of the population occupies 15% of the city's area, and that the more densely populated area has the most severe drainage and sanitation issues (AWF, 2016).

Table 7.12 – Neighbourhoods of the Chimoio Municipality

	Neighbourhoods
Chimoio Municipality	Bloco 9; Eduardo Mondlane; Bairro 1; Bairro 2; Bairro 3; 3 de Fevereiro; Textáfrica; Bairro 4; Centro Hípico; Nhamadjessa; 25 de Junho; Chinfura; Josina Machel; Vila Nova; 7 de Setembro; 16 de Junho; Mudzingadzi; Nhamaonha; Bairro 5; 7 de Abril; Francisco Manyanga; 1º de Maio; Nhamatsane; Agostinho Neto; Hombwa; Tembwe; Círculo de Mudzingadzi; Chianga; Nhaurir; Stanha; Chissui; Heróis Moçambicanos; Trangapasso.

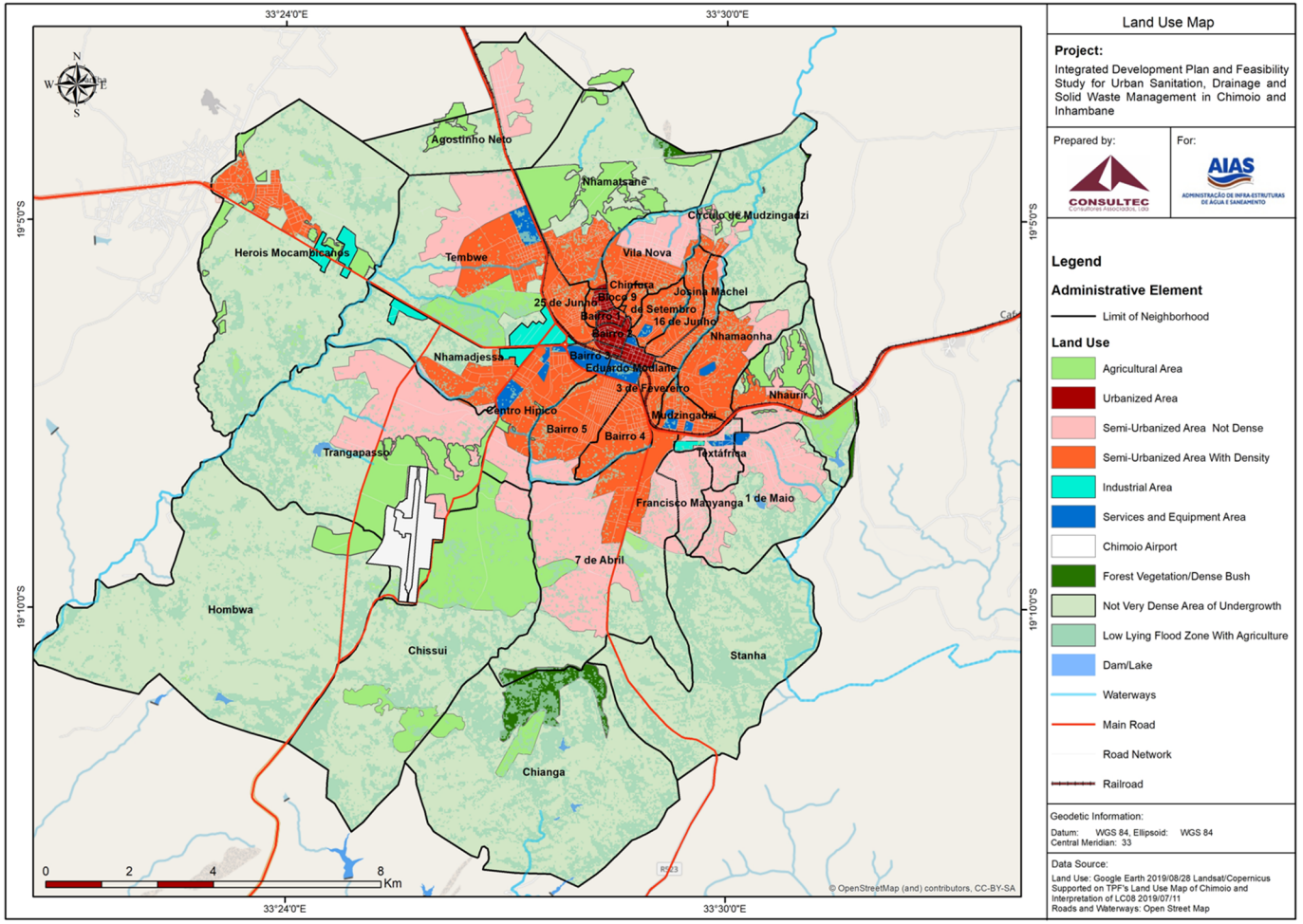


Figure 7.28 – Administrative division and land use in Chimoio

The project under study is directly inserted in three (3) administrative posts, namely Ngomaio, Chaurrumba and Nhaucaranga, distributed in four (4) neighbourhoods/communities (Table7.13).

Table7.13 – Administrative division of neighbourhoods/communities covered by the project

Infrastructure	Administrative Post	Neighbourhoods/Communities
South Pumping Station	Ngomaio	Bairro 5
North Pumping Sattion	Chaurrumba	Bengo
Sanitary Landfill	Nhaucaranga	Nhamatsane
Wastewater Treatment Plant (WWTP)	Chaurrumba	Bengo
Storm water Drainage Network	Ngomaio and Chaurrumba	16 de Junho, 25 de Junho, 3 de Fevereiro, Bairro 2, Bairro 4, Bairro 5, Bloco 9, Eduardo Mondlane, Josina Machel and Nhamaonha Textáfrica

Figure 7.29 illustrates the distribution of administrative posts and communities covered by the project.

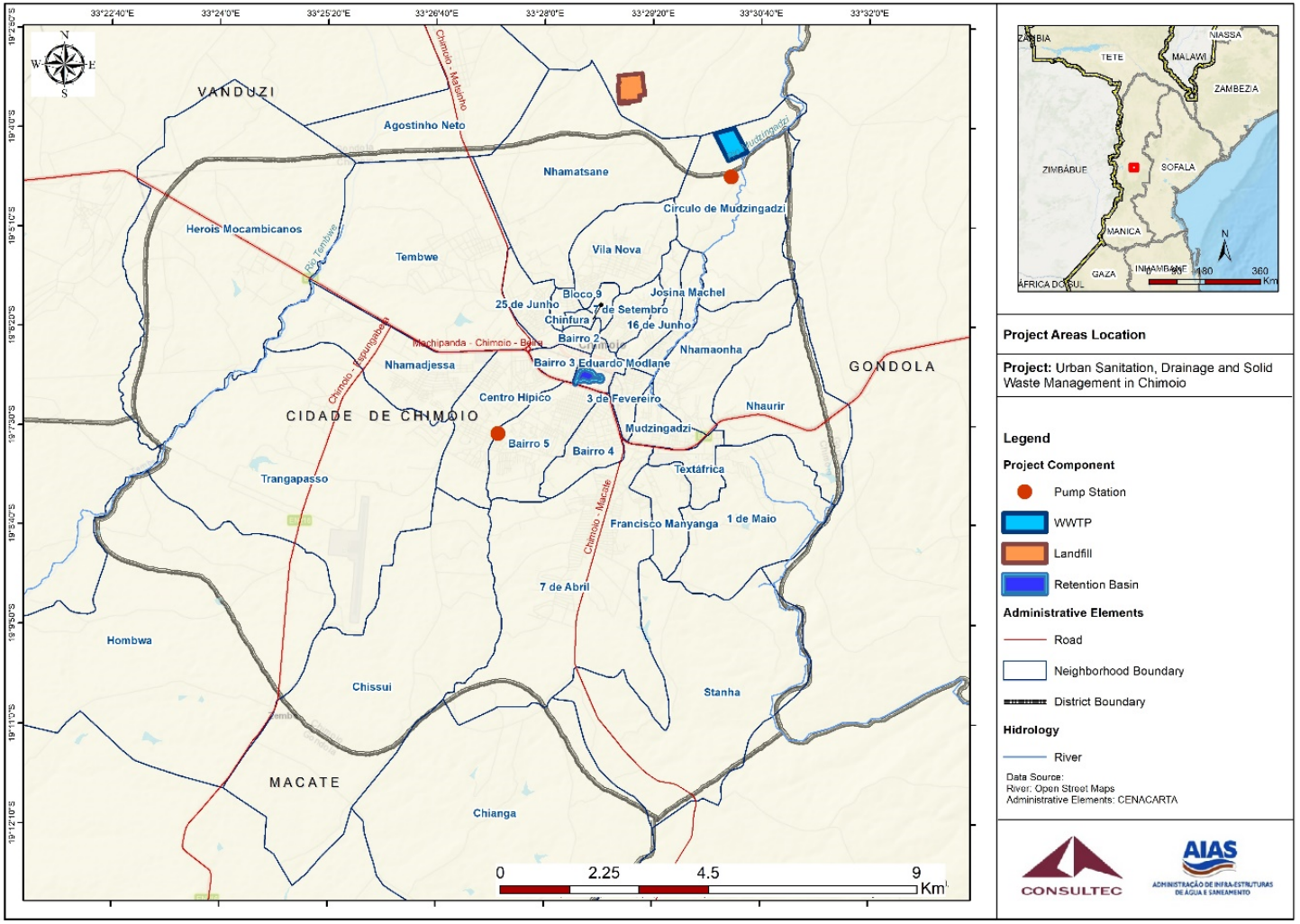


Figure 7.29 – Administrative posts and communities covered by the project

7.3.3 Government Organization

7.3.3.1 Provincial Government

Decree No. 63/2020 of 7 August, which regulates Law No. 7/2019 of 31 May, establishes the current legal framework for the organization and functioning of the State representative entities in the province, revoking previous Decrees No. 5/2020 and 16/2020. Manica Province, like the other provinces in the country, has a Provincial Government which is headed by a Governor, who acts as the head of the hierarchical structure of government and as a political figure.

Provincial Governors are now appointed by the political parties based on the results of provincial elections. As part of the Governor's Office, there is now the figure of the Secretary of State, appointed by the President of the Republic, who plays a crucial role in coordinating provincial governance.

At the provincial level, Decree No. 64/2020 of 7 August, which regulates Law No. 4/2019 of 31 May, establishes the current legal framework for the principles, organizational rules, powers and operation of the decentralised representatives of provincial governance, and revokes the previous Decrees No. 2/2020 and 15/2020. At the provincial level, there are also various sectoral institutions (provincial directorates and services), such as those for the environment, agriculture, fisheries, tourism, health, education, mineral resources, energy, etc., which represent the line ministries as described in Table7.14. In addition to the provincial directorates, the Province also has a Provincial Public Prosecutor and a Provincial Police Commander.

In addition, there are other relevant public institutions at the provincial level such as the Social Security Institute (ISS) and the provincial delegation of the National Council for Combating HIV/AIDS (CNCS). As mentioned above, the Province is administratively subdivided mainly into districts and municipalities. Municipal Councils are managed by the Mayor and the Municipal Assembly, which is an elected body.

Table7.14 – Structure of the Authorities of the Province, District and Municipality

Level	Authority
Province	Province Governor
	Secretary of State in the Province
	Provincial Directorates and Services
District	District Administrator
	District Directorates
	Head of Administrative Post
	Locality Chief
	Traditional leadership
	1st Level (Régulo)
	2nd Level (Village Secretary); and
	3rd Level (Block Secretary)
Municípality	Mayor of the Municipality
	Councilmen

Level	Authority
	Régulos (Traditional chiefs)
	Neighbourhood Secretary
	Unit Secretaries
	Head of Block

7.3.3.2 District Government

The districts are governed by District Administrators appointed by the Ministry of State Administration and Public Service. These administrators are supported by their Secretariat and a number of district services including: economic activities, planning and infrastructure; education, youth and technology; health, women and social welfare as well as a district directorate of INAS, the civil registry and notary services and a District Division of the Police of the Republic of Mozambique (PRM). Figure7.30 illustrates the basic structure of the district administration.

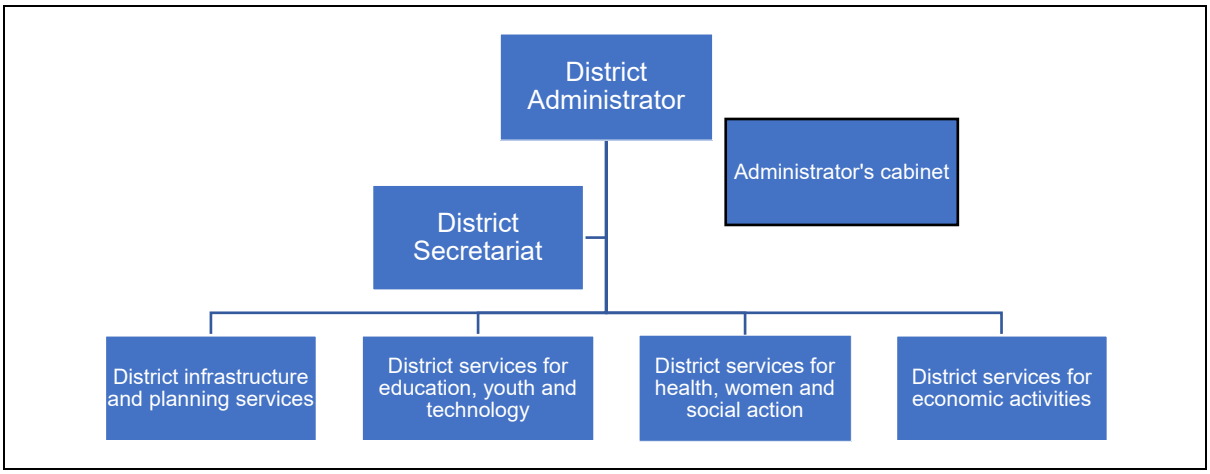


Figure7.30 – Basic Structure of the District Administration

This apparently simple governance structure is much more complex due to several different power foundations that cross and often overlap with each other. Firstly, the district directorates are formally linked and accountable to the various ministries in the respective sector at provincial and central government level, while at the same time they are administratively accountable to the district administrator. There is a public sector reform process aiming at decentralization, but the actual dependency between the central, provincial and district levels of government varies considerably between the different directorates and their departments. Figure7.31 below represents the hierarchy of district governance.

Figure7.31 – District Governance Hierarchy

At district and local level there is also another line of governance that plays an important role with regard to community participation.

In most districts there is a parallel alignment consisting of local leaders / community leaders and traditional authorities, and which falls under the administration of the districts at local level.

These entities are recognised on the basis of Decree no. 15/2000 of 20 June and Decree no. 11/2005 of 10 June.

These decrees recognise the role of local leaders within communities as a form of legitimate authority. In terms of legitimacy, these parallel systems are based on the principle that traditional leaders are an intrinsic component at local level with authority and therefore allow for more and better participation and communication between citizens and the administrative divisions of the governments.

District planning follows a hierarchical process in which economic and social development plans and activities are developed on the basis of policies and guidelines provided from the central (ESP - Economic and Social Plan) and provincial (Provincial ESP) levels.

From these policies, the districts produce their own economic and social plan (district ESP), which is then reported back to the provincial economic and social plan, which in turn is reported to the annual national plan. This process, and the community participation that is integral to it, is facilitated by the current governance structure that includes community and traditional leadership. In addition, consultative councils have been established at administrative post and locality level to improve and strengthen participation within these planning processes.

Localities (the lowest level of the state administrative system) generally consist of several communities/villages or settlements. These terms are ambiguous, with different meanings in different contexts and scenarios.

However, in their most frequent meaning, they refer to a cluster of households, a village, or a group of villages (here these terms are used interchangeably).

At the community level, authority is generally exercised by community leaders, who may be either neighbourhood secretaries or block secretaries, depending on whether the administrative section is urban, peri-urban or rural. In peri-urban and rural areas, these authorities are often supported by community leaders and possibly traditional leaders. Traditional leadership often plays a more important role in more rural areas.

While local authorities play an important role in mobilising people in relation to district planning sessions and communication with the state etc., their primary role is to maintain a form of social order and to resolve individual or social conflicts at community level, prior to any potential escalation to the formal judicial system. Community leaders play an additional and extremely important role in the allocation and management of land used by community members, as well as new individuals and families seeking land for subsistence.

7.3.3.3 Chimoio Municipal Council

The organizational structure of the Chimoio Municipal Council, as in other municipalities, is based on a nuclear structure consisting of municipal bodies and their respective directorates, in a flexible structure consisting of divisions. The Chimoio Municipality Council consists of 1 (one) Cabinet of the President and 7 (seven) Bodies. Table7.15 presents the hierarchical structure of the Municipal Government.

Table7.15 – Hierarchy of Municipal Governance

Institution	Composition
Cabinet of the President	Municipal Police Command
	Municipal Administration and Internal Logistics Service
	Municipal Operations Service
	Municipal Inspection and Civic Education Service
	Assessors' Cabinet
	Public Relations Cabinet
Council of Administration and Finance	Municipal Secretariat
	Municipal Human Resources Management Service
	Municipal Accounting and Treasury Service
	Municipal Property and Facilities Service
	Municipal Taxation Service
	Municipal Information System Technology Service
	Municipal Planning and Monitoring Service
Council for Water, Urban Sanitation, Environment and Energy	Municipal Water and Energy Management Service
	Municipal Environmental Management Service
	Municipal Cleaning, Gardening and Sanitation Service

Institution	Composition
	Municipal Cemeteries and Funeral Service
Council for Municipal Territorial Administration	Technical Assistance Service to Municipal Administrative Posts Service
	Municipal Service of Administrative Division and Toponymy
Council for Transport and Road Network	Municipal Service of Traffic Regulation and Road Signalling
	Municipal Service of Transport Licensing and Supervision
	Municipal Services of Car Workshop and Equipment
Council for Economic Activities	Municipal Services for Economic Activities and Licensing
	Municipal Slaughterhouse Management Service
	Municipal Services for Industry, Hotels and Tourism
	Municipal Service for the Management of the Economic Activities Register
	Municipal Markets, Exhibitions and Fairs Management Service
Council of Urban Planning and Infrastructures	Municipal Urban Planning Service
	Municipal Service for Cadastre and Urban Land
	Municipal Infrastructures and Inspections Service
	Municipal Road and Bridge Maintenance Service
Council of Social Affairs	Municipal Health Service
	Municipal Services for Gender, Children and Social Action
	Municipal Services for Education and Culture
	Municipal Youth and Sports Service

Source: http://cmchimoio.ac.mz/organograma/

7.3.4 Demographics and Socio-economic Conditions

7.3.4.1 Demography

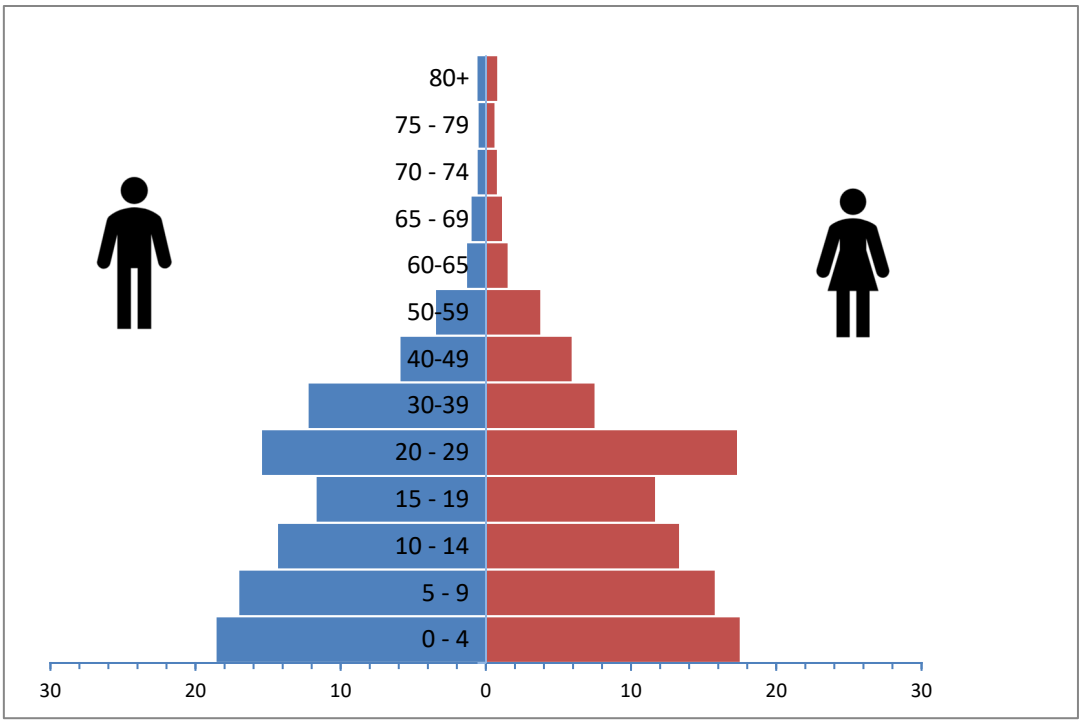
According to the National Institute of Statistics (INE), the population of Manica Province was, in 2017, de 1.851.931 while the Municipality of Chimoio's population was 363.336, in a 241 km^2 area. Table 7.16 population density and gender distribution provided (INE, 2017).

Table 7.16 – Population 2017 Manica Province and Chimoio Municipality

Location	Total surface area (km^2)	Total Population	Population Density (inhab./km^2)	Female (%)
Manica Province	61.661	1.851.931	31	48
Municipality of Chimoio	241	363.336	1.367	50.7

Source: INE (2017).

In terms of population's age structure, the Chimoio Municipality follows a traditional age pyramid structure with a large young population (Figure 7.32).



Source: INE (2017).

Figure 7.32 – Age pyramid for the Chimoio Municipality

7.3.4.2 Communities Covered by the Project

As already mentioned in the previous section, the Project covers three (3) neighbourhoods/communities covered by the Pumping Stations, Sanitary Landfill and Wastewater Treatment Plant, and the Drainage Network component is covered by twelve (12) neighbourhoods. Table 7.17 presents the population numbers of the neighbourhoods covered by the project. The data presented was acquired through semi-structured interviews with local leaders and information made available at the headquarters of the Administrative Post and the Municipality.

Table 7.17 – Population of the neighbourhoods covered by the project

Project Infrastructure	Neighbourhoods	Population
Pumping Station	Bairro 5	40.000
Sanitary Landfill	Nhamatsane	22.116
Wastewater Treatment Plant and North Pumping Sattion	Bengo	3.705
Storm water Drainage Network	16 de Junho, 25 de Junho, 3 de Fevereiro, Bairro 2, Bairro 4, Bairro 5, Bloco 9, Eduardo Mondlane, Josina Machel and Nhamaonha Textáfrica Ngomaio and Chaurrumba,	*

* The network works will be along the existing access roads.

Bairro 5, where the South Pumping Station will be implanted, had the highest number of inhabitants, representing 60.42% of all neighbourhoods/communities covered. Bairro Bengo had the lowest population figure (representing 0.17%) which we believe is because it is a new and expanding neighbourhood.

Bairro Bengo headquarters (where the WWTP will be inserted) does not have any infrastructure to hold meetings with community members or other interested groups, unlike Bairro Nhamatsane (sanitary landfill area) and Bairro 5 (pumping station area). The photographs in Figure 7.33 illustrate some of the headquarters of the neighborhood covered by the project.

Bairro 5 headquarter

Bairro Bengo headquarters

Sede do Bairro Nhamatsane

Figure 7.33 – Administrative headquarters of the neighborhoods covered by the project

7.3.4.3 Project Servitude Area

The servitude area comprises the area of the Pumping Stations, Sanitary Landfill, WWTP, storm water drainage network and improvement of the access road. The socio-economic survey did not cover the last two components as these are rehabilitation works for existing infrastructure and the activities will be carried out between the roads in the neighbourhoods mentioned above.

Within the entire project area, 920 families, that will be economically affected by the Project, have been identified. In the Sanitary Landfill and WWWTP area, 54 households that will be impacted by the project were identified (with machambas/crop fields), 35 impacted households were identified; in the Retention Basin and 5 households in the pump stations areas.. Table7.18 illustrates the number of households interviewed by project area and community.

Table7.18 – Number of households interviewed within the project area, by community

Infrastructure	Administrative Post	Neighbourhoods/Communities	No. of households	Total number of household members
South Pumping Station	Ngomaio	Bairro 5	2	16
Sanitary Landfill	Nhaucaranga	Nhamatsane	28	172
Wastewater Treatment Plant and North Pumping Station	Chaurrumba	Bengo	20	132
Total	**3**	**3**	**50**	**320**

The fieldwork has shown that 320 people have some use of land within the Project area, which corresponds to an average of 6.2 people per household (household size varies from 1 to 14 members per family). The uses and occupation of the land within the project area are namely: agricultural areas, spaces for construction of dwellings and inhabited houses. In the Nhamatsane and Bengo neighbourhoods, where the sanitary landfill and the WWTP will be inserted, only agricultural fields (machambas) were identified.

The field survey has shown that 4.93% of the heads of households are married, the remainder are widowed (6.58%), in civil unions (12.71%) or single (75.66%) and only 0.66% are separated.

Of the 55 households surveyed, approximately 59% are headed by women.

Of the 51 households surveyed, approximately 45% are headed by women. The household headed by a single female parent should be considered vulnerable due to local circumstances in which women are generally more economically disadvantaged. The photographs in Figure 7.34 illustrate the heads of some of the households interviewed within the project area.

Figure 7.34 – Some of the household's heads interviewed

Figure 7.35 presents photographs of the main houses of some of the households interviewed in the project area.

Figure 7.35 – Main houses of some of the households interviewed in the project area

The following figure shows photographs of machambas of some of the households interviewed in the project area (WWTP and Sanitary landfill).

Figure 7.36 – Machambas of some of the households interviewed in the project area

The survey has shown that the age distribution of people living in the project area is similar to that of the Municipality of Chimoio, with a dominance of younger age classes. This would be expected, given the low life expectancy of the population of Mozambique, which is below 56 years of age (INE, 2017).

According to the survey, 35.85% of the affected people are under 15 years old and 8.88% are over 65 years old, meaning that 55.26% of the affected population is composed of economically active people and 44.73% of the population is composed of young and elderly people, corresponding to the part of the population not economically active and dependent on other family members.

Figure 7.37 illustrates the age structure of the households living in the project area.

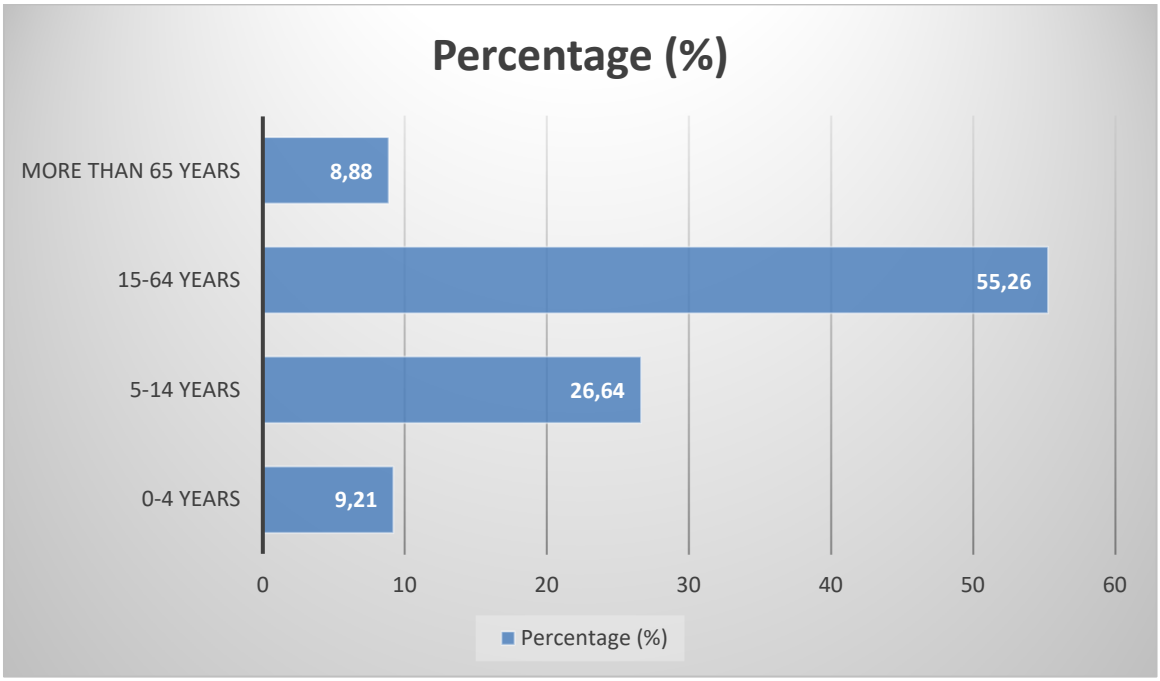


Figure 7.37 – Age structure of the households living in the project area

Regarding household heads, the survey revealed that the vast majority (66.67%) are in the age group of 24 to 65 years (economically active age), there is no minor among the household heads, and 33.33% of the household heads are above 65 years of age.

A household head over 65 years of age is considered vulnerable as he/she is in principle no longer economically active and thus dependent on other family members.

7.3.5 Cultural Heritage

7.3.5.1 Province e District

Mozambique, like most other sub-Saharan countries, is culturally and ethnolinguistically diverse, comprising several ethnic groups, determined mainly by geographical region. The Makhuwa and Maconde are the dominant groups in the Northern region, the Sena and Ndau in the Central region, and the Tsonga and Changanas in the Southern region.

The source Ethnologue[7] reports 43 languages in Mozambique. However, the study centre NELIMO (Centre for Studies of Mozambican Languages, Eduardo Mondlane University, Maputo) reports the existence of only 20 languages spoken in the whole country.

The higher number referred to by Ethnologue is explained by this source independently listing several different dialects of the same language (Monjane Henriksen, 2014). The most influential languages in Chimoio are Portuguese, Chitewé, Chimanica and Chibarué.

Manica Province is part of the Shona culture, which encompasses a set of peoples who have similar languages and customs and an identical socio-political organization (ARPAC, 2017). Culture in Manica is manifested through various symbols namely: rites, traditional dance, handicrafts, among other practices.

According to ARPAC (2017) Manica Province has a varied socio-tourism potential namely: (i) natural cultural heritage, consisting of plant communities or areas containing a variety of landscape types and ecosystem elements, places inhabited by plants or animals or even endangered species, undisturbed environments or environments influenced by natural processes; ii) Historical and cultural heritage, such as places of spiritual importance for communities (sacred woods, trees, lakes and rivers), ceremonial sites or places where ancestors were buried, evidence of tools used by ancestors, massacre sites, caves, paintings, forts, archaeological sites and others.

The country is equally diversified in terms of religion. According to the last census conducted by INE in 2017, Catholics represent 27.2% of Mozambique's population, Muslims 18.9%, Zionists 15.6%, Evangelists/Pentecostals 15.3% and Anglicans 1.7% of the population.

Seven percent (7.3%) of Mozambicans hold other beliefs, such as Animism, Judaism and Hinduism. Additionally, about 14% of the population does not adhere to any religion.

According to INE (2017), Manica Province is predominantly Christian (69.1%), as shown in Table7.19.

Table7.19 – Main religions professed in Manica Province

Religion	% of the population
Christianity (Catholic)	8,2
Christianity (Anglican)	1
Islamic	1,2
Christianity (Zionist)	36,6
Christianity (Evangelical/Pentecostal)	23,3
No Religion	25
Other Religion	3
Unknown	1,8
Total	**100**

Source: INE (2017).

[7] www.ethnologue.com/country/MZ/languages

7.3.5.2 Communities Covered by the Project

In the communities covered by the project, the predominant ethnic group is Matewé. Apart from Portuguese, the population speaks Ciutee, Sena, Ndau and Cinyungwe.

In the communities crossed by the project, Christian religions (Catholics, Zionics, Anglicans, Apostolics and Evangelicals) predominate. The religious infrastructures are mostly made of conventional material (cement block walls and sheet metal roofing).

In all, 108 churches were identified in the communities covered by the project, with the majority located in Bairro 5 (72 churches, representing 66.67% of the total number of churches identified).

Bairro Bengo presented the lowest number of churches, equivalent to approximately 10.18% of the churches sampled. Table 7.20 represents the number of churches in the communities covered.

Table 7.20 – Churches in the communities crossed by the project

Neighbourhoods/Communities	Nº of churches
Bairro 5	72
Nhamatsane	25
Bengo	11
Total	**108**

During the field visit it was found that none of the identified churches are impacted by the project. Figure 7.38 below illustrates some of the churches in the communities covered by the project.

Apostolic Faith Mission Church in Mozambique, Bairro 5

Jesus the Light of the World Pentecostal Church, Bairro 5

Figure 7.38 – Infra-estruturas religiosas nas comunidades abrangidas pelo projecto

Regarding sacred sites, in all communities there is the custom of holding the funeral ceremonies of their loved ones in community cemeteries which, however, do not exist in all communities, resulting in the existence of family cemeteries in backyards.

In the communities covered by the project, two community cemeteries were identified. One in Nhamatsane, not impacted by the Project and the other in Bengo, impacted by the WWTP area.

Figure 7.39 represents the sacred site of the Nhamatsane cemetery and Figure 7.40 indicates the location of the Bengo cemetery.

Figure 7.39 – Nhamatsane Cemetery

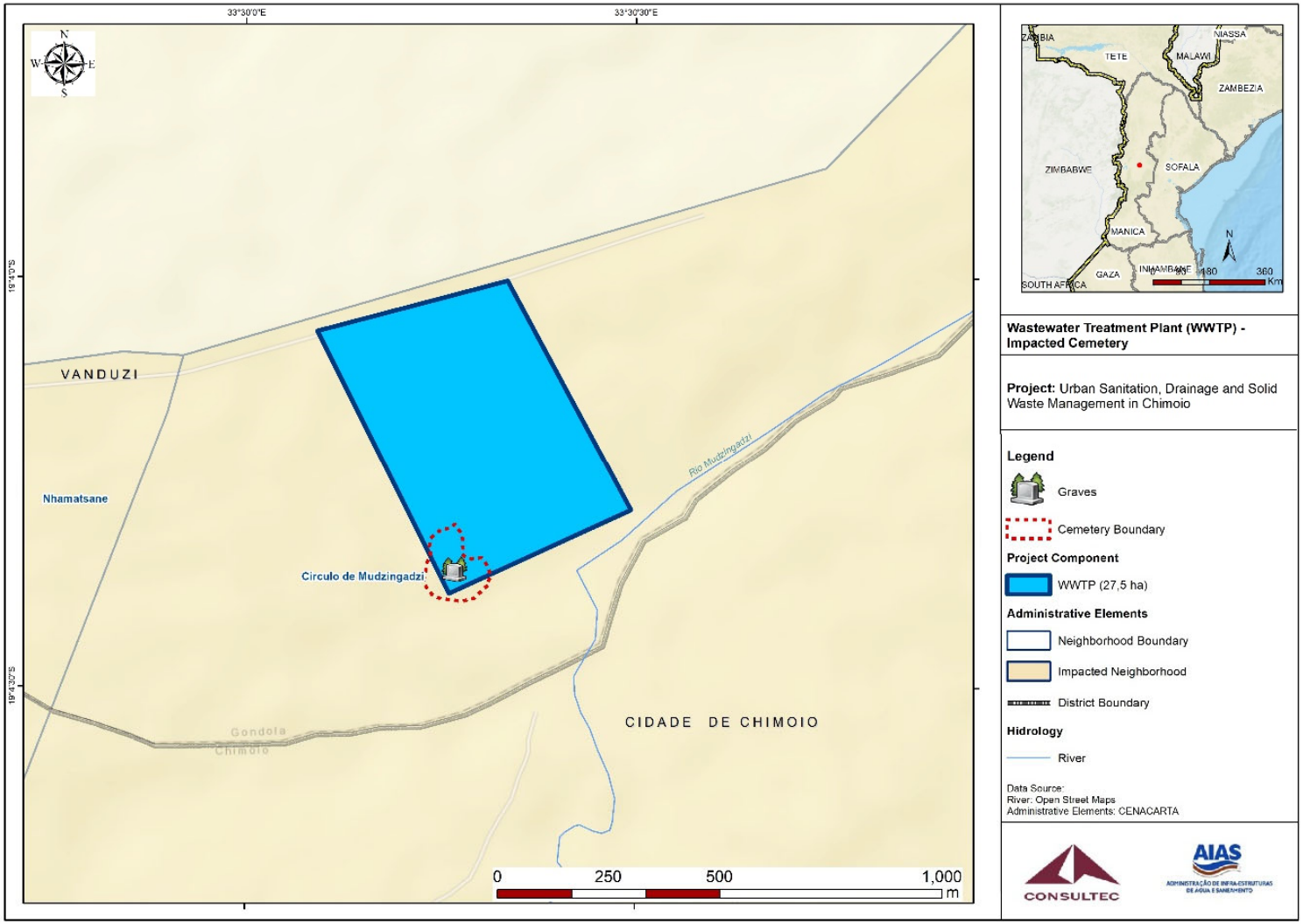


Figure 7.40 –Cemetery impacted by the project in Bengo

7.3.5.3 Project Servitude Area

The majority of the households within the project area belong to the Sena and Ciutee ethnolinguistic groups (40.66%). Only 25% of the interviewees mentioned Portuguese as the main language spoken among the households. Other languages spoken are Chibarué, Chona, Chuabo, Lómwé, Cinyungwe, Chimanica and Ciutee.

In terms of daily activities, the management of household property and assets is generally the responsibility of the man, although they also participate in agriculture, firewood collection, cattle rearing, house building and other activities such as the sale of traditional drinks.

Women are generally responsible for household chores (cooking, water collection, washing and childcare) and most agricultural activities (land clearing, sowing, weeding, harvesting and processing agricultural goods). Women are also responsible for the organization of the household.

The elderly are, in general, responsible for teaching the new generations about cultural habits, social practices, traditions, stories and for conducting the initiation rites, in which men deal with boys and women with girls.

Regarding traditional practices, the ceremonies for the petition for rain and the protection of the family are good examples of current traditional practices. These rites are performed by community leaders, neighbourhood secretaries, religious leaders, elders and traditional healers.

Through the semi-structured interviews, it was verified that all the localities crossed by the project have a traditional sacred place, but none of these sacred places is located within the project area.

Regarding cemeteries, during the fieldwork it was reported that it is common for families to bury their relatives within their plot or in community cemeteries. The existing cemeteries are not within the project area.

7.3.6 Education

7.3.6.1 Province e District

The education system in Mozambique is structured into 6 levels of education, according to Law 18/2018 of 28 December:

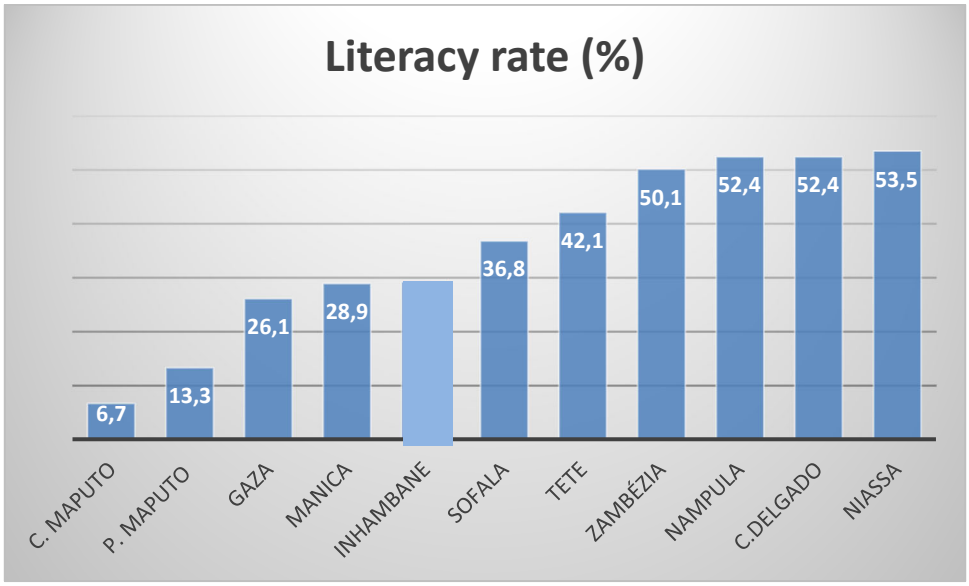
- Pre-School Education Subsystem
- General Education Subsystem
    - Primary Education
        - 1st Cycle: 1st to 3rd Grade
        - 2nd Cycle: 4th to 6th Grade
    - Secondary Education
        - 1st Cycle: 7th to 9th Grade
        - 2nd Cycle: 10th to 12th Grade

- Vocational Education Subsystem
- Teacher Education and Training Subsystem;
- Higher Education subsystem.

Primary education in Mozambique is free and compulsory from 1st to 9th grade for people between the ages of 6 and 12. Despite this, the majority of people in the country and in Manica Province does not complete primary education. In fact, the latest statistical data shows that girls outperform boys at all levels, the pedagogical achievement rate of primary school completion in the country has been increasing, rising from 74.2% in 2016 to about 78.9% in 2017 (PEE, 2019).

Illiteracy rates are high throughout the country, but substantially higher in the northern provinces of the country and in rural areas.

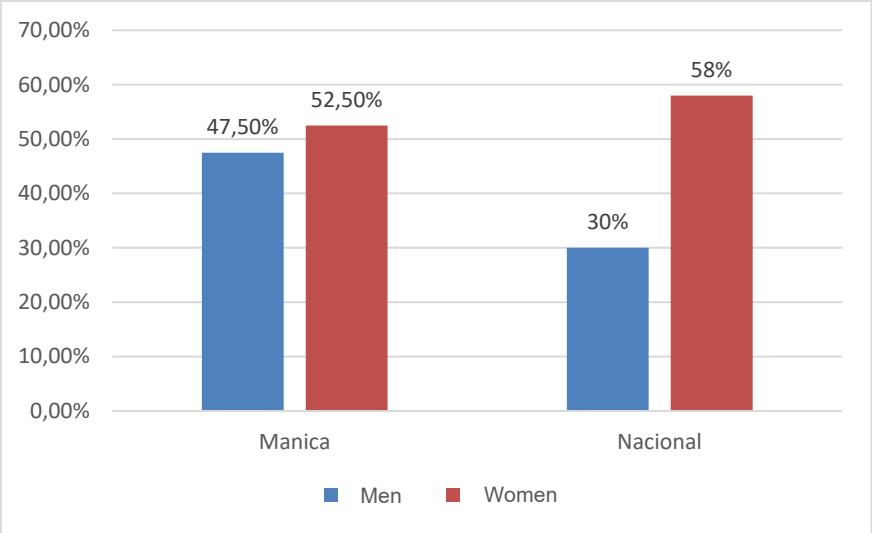
In Manica Province, illiteracy rates remain high, although they are declining (UNESCO, 2016). Figure 7.41 presents the illiteracy rates in all provinces, illustrating the disparity between the three geographical regions (South, Centre and North).



Source: INE (2021).

Figure 7.41 – Illiteracy rates by province in Mozambique

As in most other provinces, and particularly among the more rural population, there is a gender disparity in relation to levels of schooling and illiteracy. Figure 7.42 shows that, however, this disparity in Manica Province is smaller than for the rest of the country.



Source: INE (2017).

Figure 7.42 – Illiteracy rates by gender

The education system in the Municipality of Chimoio follows the same trend as the rest of the country, with a focus on primary education, as shown by the significantly higher number of primary education facilities when compared to the secondary or higher education establishments in the city (see Table7.21).

Table7.21 – Educational facilities in the Chimoio Municipality

Level of Education	Chimoio Municipality
EP 1 e EP 2	30
ESG 1 2 2	7
Higher Education	2

Source: CAC (2020).

Figure 7.43 shows the distribution of school facilities in Chimoio Municipality.

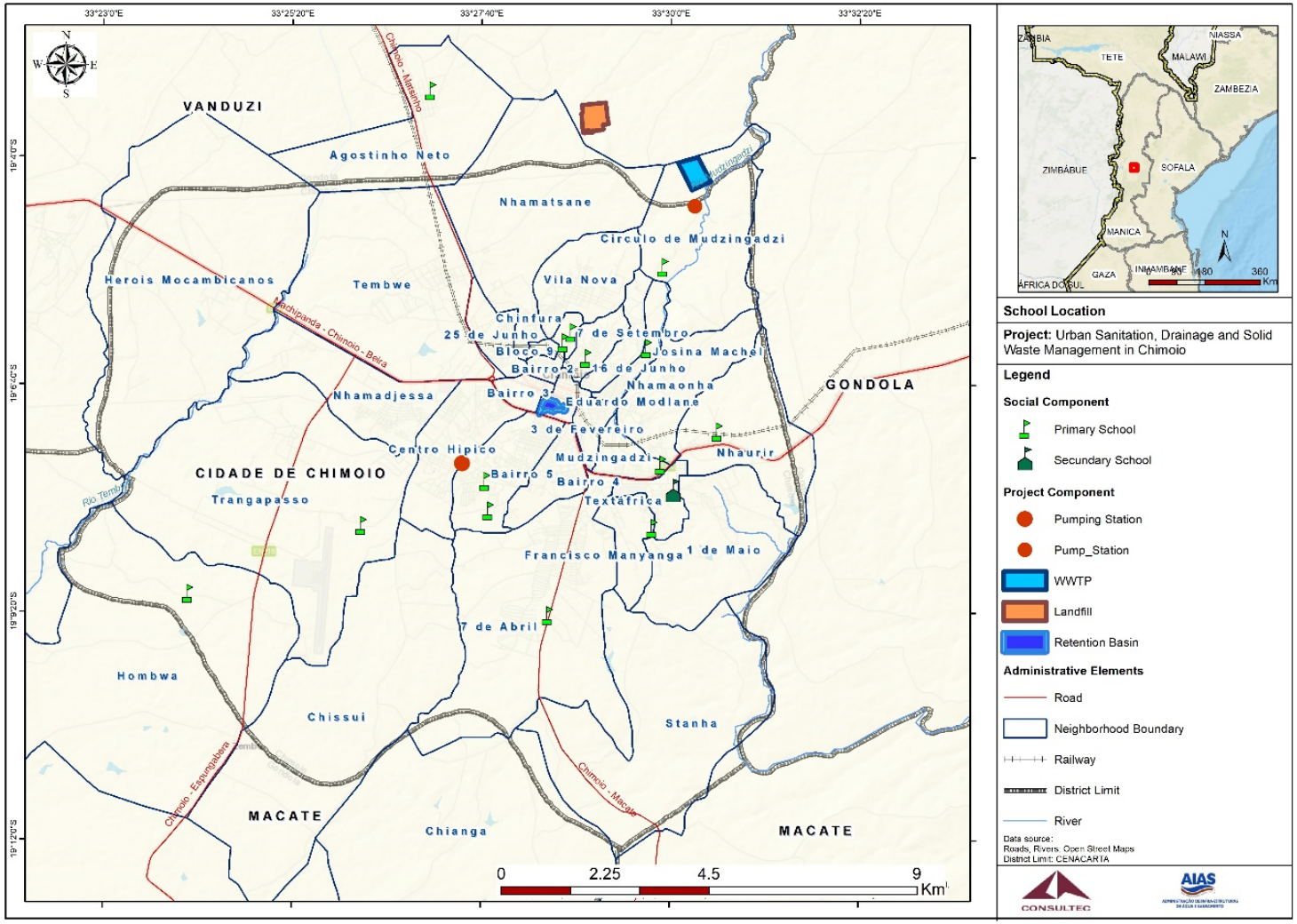


Figure 7.43 – Distribution of educational establishments in Chimoio

7.3.6.2 Communities Covered by the Project

In the communities covered by the Project, 9 (nine) schools were identified. Bairro 5 had the highest number of schools (6 schools), and Bairro Nhamatsane was the only one with a technical school and a children's centre. In Bairro Bengo only one school exists, of the EPC type. Table7.22 illustrates the educational establishments identified in the communities covered by the project.

Table7.22 – Educational facilities in the communities covered by the project

Neighbourhoods/Communities	No. of Schools	Nanes of the Schools
Bairro 5	4 EPC	25 de Setembro Primary School
		Mwana Unerufaro Primary School
		Primary School AKA Power
		Complete FOPOM Primary School
	2 ESG II	Missionária American Board Secondary School
		Fepom de Chimoio Secondary School
Nhamatsane	1 Technical School	ADPP Future Teacher Training School Chimoio
	EPC	Formigas do Futuro Language and Culture School
		4 de Outubro Primary School
	1 Children's centre	Nhamatsane Children's Centre
Bengo	1 EPC	Bengo Primary School

All the identified educational facilities are of conventional material. In Bairro 5, Fepom Complete Primary School and 25 de Setembro Primary School have suffered damages due to the latest climatic events (cyclones Idai and Keneth), so they are being rehabilitated. The level of education of the teachers in these schools varies from medium to technical and higher levels, with medium level being the predominant one. None of the schools identified in the communities covered by the Project are directly impacted.

Figure 7.44 illustrates the different types of educational facilities identified along the Project route.

25 de Setembro Primary School, Bairro 5

Sanitary block 25 de Setembro Primary School, Bairro 5

AKA Power Primary School, Bairro 5

American Bord Secondary Missionary School, Bairro 5

Fepom Complete Primary School, Bairro 5

Temporary rooms at Fepom Complete Primary School,, Bairro 5

ADPP Training School for Teachers of the Future Chimoio, Nhamatsane

EPC Formigas do Futuro Escola de Língua e Cultura, Nhamatsane

4th of October Primary School Sanitaries, Nhamatsane

4th of October Primary School classroom block, Nhamatsane

Figure 7.44 – Educational infrastructures in the communities covered by the project

7.3.6.3 Project Servitude Area

Regarding educational institutions, except for Bairro Vila Nova, all the neighbourhoods have at least one primary school. The table below presents the list of schools attended by the people living in the project area. Some schools are outside the neighbourhoods covered by the project. Generally, to attend to secondary education, pupils move to other neighbourhoods and to the centre of Chimoio City.

Table7.23 – Educational facilities attended by pupils in the project area

Type	Name of the Facility
University	Púnguè University
	Zambeze University
Technical School	Njerenje Education Centre
Secondary School	Eduardo Mondlane ESG
	Samora Moisés Machel ESG
	Vila Nova ESG
	Mussarufo ESG
	Tembwé ESG
	Heróis Moçambicanos
	Seminário Santo António ESG
	Filipe Samuel Cancomba ESG
	Tambara 2 ESG
	Secundaria FEPOM ESG
	7 de Abril ESG
	Paulo Samuel Kamkomba ESG
Primary School	Amílcar Cabral EPC
	Matequenha EPC
	4 de Outubro EPC
	Bengo EPC
	Textafrica EPC
	7 de Setembro EPC
	Unilufaro EPC
	Bloco Nove EPC
	Sussundenga EPC
	Agostinho Neto EPC
	Chinfura EP
	Cabeça do Velho EP
	Vila Nova EPC

According to the survey carried out, the majority of the population has completed primary (43.9%) or secondary (29.93%) level education. Only a small percentage of the population living in the project area has completed university level or technical level (respectively 3.61% and 0.99%).

In relation to the academic level of the head of the household, it was observed that men have a higher level of education than women. Figure7.45 shows the distribution of the educational level of the household heads. Most of the household heads have primary level, representing 43.09% of the male heads. Only 3.62% of the household heads have higher level of education.

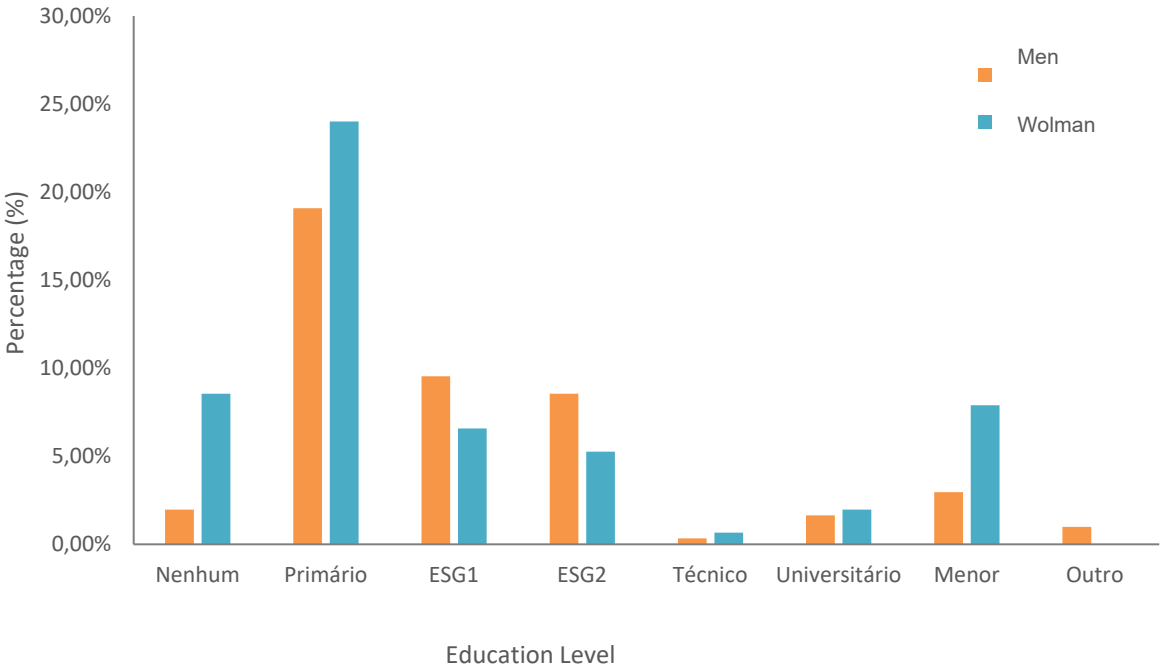


Figure7.45 – Level of education of household heads by gender

7.3.7 Health

7.3.7.1 Province and District

The health sector in Mozambique focuses on primary healthcare services and is characterised by various types of health facilities including community health facilities, health posts, health centres (urban and rural) and hospitals (district, rural, provincial and central), each offering different types of services. Some facilities are better equipped than others, depending on location and the number of people served.

Table7.24 illustrates the number of Health Units in Manica Province in 2019.

Table7.24 – Health Units in Manica Province, 2019

Health Units	Quantity
Urban Health Centre	9
Rural Health Centre	106
Health Post	1
District Hospital	4
Provincial Hospital	1
Total	**121**

Source: Health Statistical Yearbook, 2019

According to INE (2017), Chimoio Municipality had eight health care facilities in 2017, of which seven are health centres and one is a Provincial Hospital. Two of the health centres are private clinics (Ferrão *et al.*, 2016).

Based on the interviews conducted in the neighbourhoods covered by the project, the main diseases affecting the neighbourhoods are common to adults and children, namely malaria and diarrhoea, while tuberculosis, malaria and hypertension are predominant only among adults, with malaria being more prevalent.

This may be related to the inadequate drainage, sewerage and waste management systems in the city, which can help to spread vectors such as insects and rodents, which transmit diseases and constitute a potentially serious public health risk in the city (TPF and Salomon Ltd., 2020).

Figure 7.46 illustrates the location of health facilities in Chimoio District.

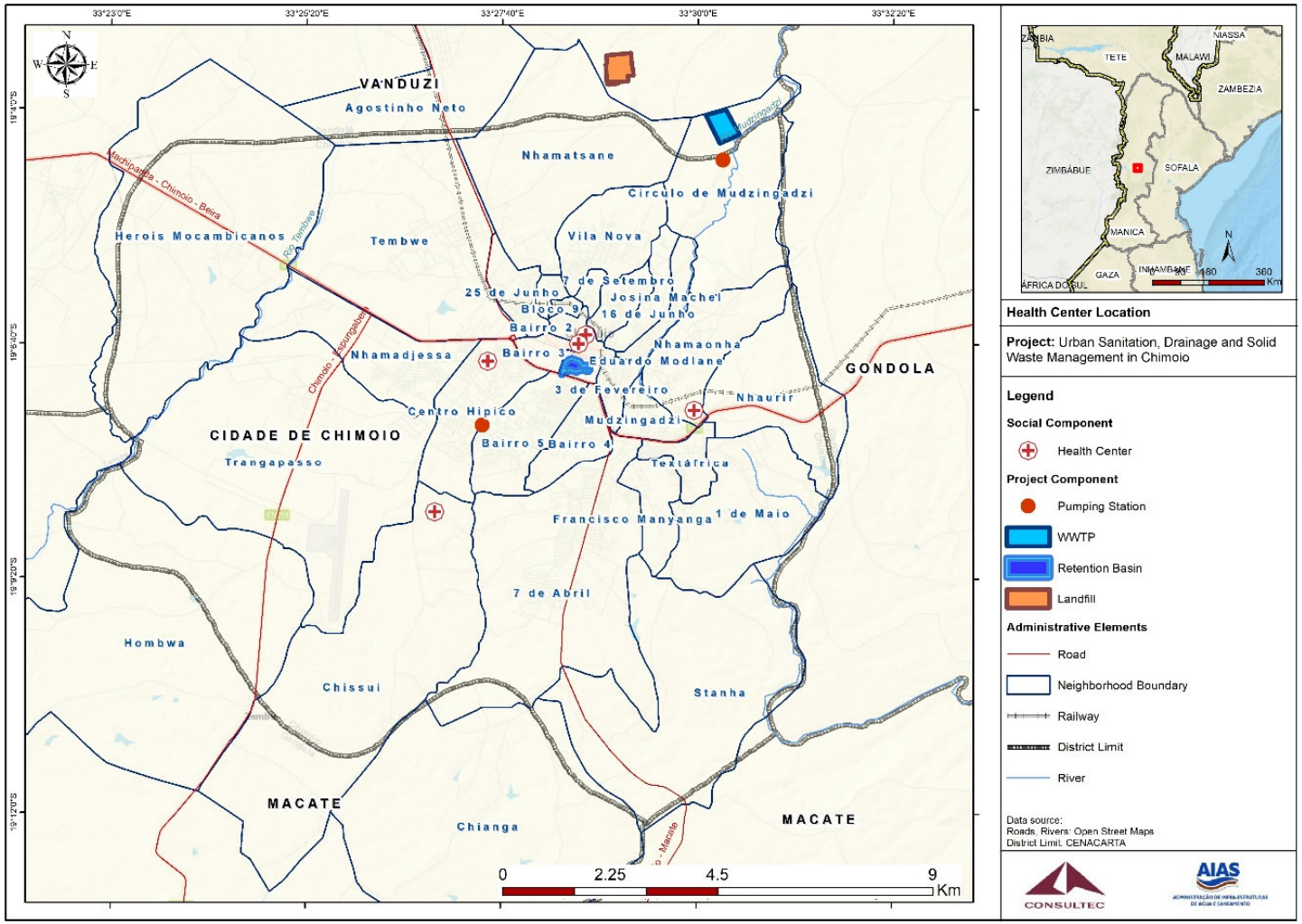


Figure 7.46 – Health units distribution in Chimoio District

7.3.7.2 Communities Covered by the Project

No health unit has been identified in the communities covered by the project. To have access to health services, residents in the communities covered by the project must travel to other neighbourhoods.

For example, the residents of Bairro 5 go to health units in Bairro 1o de Maio and Bairro 7 de Abril, while the residents of the Nhamatsane community go to health units in Bairros Tambara 2, Vila Nova and 1o de Maio. Finally, the community of Bairro Bengo uses the health services in Tambara 2 (Vila Nova).

The time taken by communities to access health services varies between 1 to 2 hours. Table7.25 presents the time travelled by each community to access health services.

Table7.25 – Time travelled to access a health facility in the communities covered by the project

Neighbourhood/Community	Health Unit attended	Time travelled on foot
Bairro 5	1º de Maio Health Centre	45 minutes
	7 de Abril Health Centre	
Nhamatsane	Vila Nova Health Centre	120minutes
	1º de Maio Health Centre	
Bengo	Vila Nova Health Centre	60 minutes:

Most of the time, to reach the health centre, the community members have to walk, since the lack of transport has been one of the biggest difficulties, especially in cases of seriously ill patients. The main diseases affecting the communities are common to adults and children, namely malaria and diarrhoea, while tuberculosis and hypertension are predominant among adults.

7.3.7.3 Project Servitude Area

During the field survey, household heads responded that household members have sought state health services when they are ill (as opposed to resorting to traditional medicine). About 20.83% of the household heads responded that at least one person in the household suffers from a chronic illness, with cardiovascular diseases (hypertension), HIV and mental illness being among the most common.

Among the most common diseases affecting the residents covered by the project, malaria stands out, and to a lesser extent asthma, STIs and tuberculosis. Table7.26 illustrates the health facilities attended by the residents within the project area.

Table7.26 – Health units attended by residents in the project area

Health units
1º de Maio Health Centre
Chissui Health Centre
Tambara 2 Health Centre
vila nova Health Centre
Eduardo Mondlane Health Centre

Health units
Chimoio Provincial Hospital

7.3.8 Housing and Well-being

7.3.8.1 Province and District

The province is diversified in terms of housing types, classified according to INE (2017) by location (urban and rural) and by the type of construction material. Manica Province registers a high number of hut type dwellings, which are generally made out of local material (sticks and straw). Table7.27 illustrates the types of dwellings in rural and urban environments in Manica Province (INE, 2017).

Table7.27 – Types of dwellings in Manica Province, in the rural and urban environments in 2017

Type of dwelling	Total
Urban	**124.828**
Conventional house complete[1]	9.807
Conventional house incomplete[2]	5.61
Flat/Apartment	1.546
Hut	170.377
Improvised house	2.410
Mixed house	72.157
Basic house	122.257
Part of a commercial building	774
Other	434
Conventional house complete	8.853
Conventional house incomplete	3.457
Flat/apartment	413
Hut	20.752
Improvised house	691
Mixed house	24.080
Basic house	65.998
Part of a commercial building	327
Other	257
Rural	**260.095**
Conventional house complete	954
Conventional house incomplete	1.704
Flat/apartment	1.133
Hut	149.625
Improvised house	1.719
Mixed house	48.077
Basic house	56.259
Part of a commercial building	447
Other	177
Total	**384.923**

Source: INE (2017).

Within the Municipality of Chimoio, the majority of dwellings are formal units, typical of the peri-urban and urban character of the area.

In the central part of the city, most structures consist of colonial buildings, one to four storey houses with large streets and large areas of private space. On the contrary, most of the suburbs are crowded, with housing units made of bamboo and wooden poles, and others with bricks and concrete with very or non-existing roads (Ferrão et al 2016). Rural areas on the city outskirts are characterised by scattered houses made with locally available materials.

According to Ferrão et al 2016, residents from the city centre have medium to high-income levels, while residents from the suburbs have low to medium income levels and residents from the outskirts of town have low-income levels.

In terms of household goods such as radio, TV, telephone, computers, etc. which constitute criteria to determine the wellbeing of a community (as well as providing an indication of purchasing power), the table below compares the Province of Manica with the Municipality of Chimoio. It is clear that, in general, Chimoio's inhabitants have better access to goods when compared to the rest of the Province, which is largely characterised by rural settlements.

Table 7.28 – List of household goods in Manica Province and Chimoio Municipality

Household Goods	2017	
	Manica (%)	Chimoio (%)
Radio	40	36
Television	22	53
Telephone (not mobile)	2	4
Computer	4	13
Internet	2	5
Iron	25	41
Coal and wood stove	40	80
Electric and gas stove	5	16
cooler/freezer	11	30
Car	4	9
Motorbike	8	10
Bicycle	29	21
No good / asset	29	11

Source: INE (2017).

7.3.8.2 Communities Covered by the Project

In the communities covered by the project, houses are made of both conventional and non-conventional materials. There are a significant number of houses made of cement blocks, locally produced adobe blocks, which are made from clay. These can either be burnt for strength or dried in the sun.

The roof of the houses is generally made of precarious material (sticks and straw) acquired locally, in some houses there is a combination of sticks, straw and plastic, and in others the roof is made of sheets. The floor inside the houses is generally made of rammed earth, but there are also some with

cement floors. Figure 7.47 illustrates some types of houses in the communities covered by the project.

Block production furnace, Vila Nova

House built with unburned blocks; Vila Nova

House under construction made of burnt clay blocks, Vila Nova

Example of burnt brick and cement plaster house

Figure 7.47 – Types of housing in the project area communities

7.3.8.3 Project Servitude Area

When looking at the housing typology of the households within the project area, the field survey revealed that on average there are four structures per household, usually including, generally, a main house and three outside structures which may be the kitchen, outside bedroom, bathroom or latrine. The field survey revealed that the main house of most households is constructed out of conventional material.

The construction material of the houses followed the same trend as the Chimoio Municipality. Despite being within the boundaries of the municipality, houses made of non-conventional material were also observed. It should be noted that the infrastructure identified in the Project area is from the South Pumping Station area, where only two land plots will be affected, of which the main houses will not be impacted. Table7.29 lists the materials used in the construction of houses located within the Project area.

Table7.29 – Materials used in the project area for the construction of the main house

Material used in the walls
Untreated reeds or sticks
Unplastered cement blocks

Material used on roofs
Grass
Zinc sheets
Material used in the floors
Cement

Fourteen Project-affected households have partially impacted residential plots.

None of the interviewees had the main house impacted, The households whose ancillary structures is the only one affected, will be compensated in cash for the full replacement cost or will be compensated in kind. Table 7.30 below specifies the types and number of auxiliary structures that will be affected by the Project.

Table 7.30 – Types and number of auxiliary structures that will be affected by the Project – Physical HH

Type of auxiliary structures	Total
Bathroom, improved latrines and/or individual latrines, walls	14
Total	14

The possession of durable goods is an indicator of household well-being and wealth in rural areas, as the habit of saving is not common. These goods are symbols of social status/wealth and are easily traded for other goods, food or money, to solve problems during times of crisis. The same applies to animals, which can also be used as an indication of wealth. In the Project area, the number of goods with high economic value, such as cars, motorbikes, televisions and even computers is very small.

7.3.9 Basic Services and Infrastructure

7.3.9.1 Energy, Water and Sanitation

Province and District

In urban and peri-urban areas of Mozambique, electricity is the main source of energy and is provided by *Electricidade de Moçambique* (EDM), while water is provided by *Águas de Moçambique* (AdM). Table7.31 illustrates basic services at province level.

Table7.31 – Basic services in Manica Province, 2017

Basic services	Manica Province No. of inhabitants with access to the services
Energy	
Electricity	82.285
Generator/solar plate	9.199
Gas	241
Oil/paraffin/kerosene	11.142
Candles	13.665
Batteries	26.085

Basic services	Manica Province No. of inhabitants with access to the services
Firewood	44.717
Battery	184.035
Other	11.912
Unknown	1.642
Water	
Piped water	79.275
Non piped water	305.648
Others	1.026
Unknown	1.642
Rubbish collection	
Municipal authorities	16.950
Private authorities/association	326
Bury	97.509
Burn	161.376
Dump on field / swamp / lake / river	86.837
Others	20.283
Unknown	1.642
Sanitation	
Toilet connected with flush cistern	15.934
Toilet connected without flushing	5.814
Improved latrine	77.186
Traditional improved latrine	75.339
Non-improved latrine	109.003
No toilet / latrine	100.005
Unknown	1.642

Source: INE (2017).

The inhabitants of Chimoio Municipality, particularly within its central urban areas, are mainly served by the *Fundo de Investimento e Património de Abastecimento de Água* (FIPAG), the majority of which with a single tap in the yard (TPF and Salomon Lda. 2020). However, the majority of the population residing in the peri-urban and rural areas of the city still rely on unprotected wells as water sources.

Drinking water provided by FIPAG is sourced from the Chicamba reservoir, located approximately 36 km southeast of Manica City, and with an installed capacity of 40.920 m^3/d. Besides Chimoio, this system also supplies Gondola District, as well as the Villages of Messica and Bandula (FIPAG, 2016).

With regards to sanitation, the central part of town is serviced by sewage and sanitation facilities built in the 1960s, while sanitation is poor in the suburbs and mainly serviced by septic tanks (Ferrão et

al, 2013; TPF and Salomon Lda., 2020). The formal sanitation and drainage infrastructure in the central part of the city is in need of urgent repair, and the inadequate drainage infrastructure, coupled with the lack of maintenance and un-regulated constructions, contribute to regular floods in some parts of the city (AWF, 2016).

No formal piped sewerage system exists. Some houses have connected their sewerage to the old drainage system. In the central part of the city, some households have septic tanks that are emptied by private operators while households in the peri-urban areas rely on latrines (AWF, 2016).

At least part of the Chimoio city is connected to the electricity grid and the water supply line. The city's water drainage system is the same as the sewerage system, resulting in water contamination along the water lines.

Table 7.32 summarises basic water, sanitation and energy services in Chimoio Municipality and Manica Province.

Table 7.32 – Basic services in the Chimoio Municipality and Manica Province

Serviços Básicos	2017	
	Chimoio Municipality (%)	Manica Province (%)
Water		
Tap water inside the house	3,6	0,8
Tap water outside the house	9,4	3,2
Public taps	9,8	5,5
Protected wells	17,9	19,4
Unprotected wells	58,2	41,1
Sanitation		
Septic tank	7,8	2,0
Improved Latrine	24,3	6,1
Traditional improved latrine	17,7	7,2
Traditional latrine	39,4	25,4
None	10,9	59,4
Energy		
Electricity	31,4	7,9
Petroleum/Paraffin	64,6	56,2
Candles	2,8	2,7
Wood	0,8	31,2

Source: INE (2017).

Solid waste is currently collected in the central part of the city without separation and deposited in the City's main rubbish dump located in *bairro* Agostinho Neto, about 17 km from the city's centre in an unfenced area. Waste is mainly organic and collection is done via garbage trucks in 40 collection points throughout the city and 22 garbage bins (TPF & Salomon Lda. 2020).

Communities Covered by the Project

All communities covered by the project (Bairro 5, Nhamatsane and Bengo) are connected to the electricity grid, but not all the house are connected. The houses that are not connected to the

electricity grid use other sources of energy such as firewood, candles, oil and solar panels (which they use to charge their cell phones).

A part of Bairro 5 is crossed by the high-voltage line and this area has been invaded by the population, some houses are not benefiting from electrification because they are in inappropriate areas.

Regarding the availability of drinking water for the communities covered by the project, they mainly resort to boreholes (extraction of underground water). The boreholes are generally managed by the Chimoio Municipal Council, but there are also committees for the management of the boreholes and symbolic charges are made which are channelled towards the maintenance of the equipment. With the exception of Nhamatsane community, borehole fees vary between 20.00-25.00 MZN/month/family.

In the community of Nhamatsane, besides the water from boreholes there is also piped water supplied by FIPAG, whose monthly payment is variable depending on the consumer, and can range from 150.00 - 3,000.00 MZN/month/family.

Other sources of water are the rivers Nhamatsane, Mwenesi and Nhamando. The water from the rivers is generally not used for consumption, but for other activities such as construction, washing clothes and irrigation of the machambas.

There are also individual wells in the dwellings, which are shared by the neighbourhood and there is usually no charge for extracting water from the wells.

Apart from drinking water from boreholes and FIPAG, there is no treatment of drinking water in all the communities covered by the project. Table7.33 summarises the basic water, sanitation and energy services in the communities covered by the project.

A total of 21 (twenty one) boreholes were identified of which only 2 (two) are out of order. Regarding the wells, these are made of non-conventional material, and there are also concrete washers.

Most communities use unimproved latrines.

Solid waste is also managed by the individual household, and the rubbish is usually burnt in the backyards of the houses. Nhamatsane benefits from collection by the Chimoio Municipal Council.

Table7.33 – Basic services in the communities covered by the project

Neighbourhood/Community	Boreholes		It has a well?	It is connected to FIPAG?	It is connected to the electricity grid?
	Operational	Out of order			
Bairro 5	6	0	Yes	No	Yes
Nhamatsane	5	1	Yes	Yes	Yes
Bengo	6	1	Yes	No	Yes
Total	**19**	**2**	**-**	**-**	**-**

Figure 7.48 illustrates the types of water supply identified in the communities covered by the project.

Rainwater drainage channel in Bairro 5

Women carrying water from the borehole in Bairro 5

Childrens carrying water from the borehole in Bairro 5

Example of a well in Bairro 5

Figure 7.48 – Water sources in the communities covered by the project

Project Servitude Area

The fieldwork revealed that households living within the project area acquire water from public standpipes, while the remaining ones obtain water from rivers and backyard wells. The water sources are close to the residences, so there is no need to travel long distances to collect water.

Regarding water quality, the survey showed that about 95.83% of the respondents do not do any water treatment, and only 4.17% of the respondents use chlorine to treat water for consumption. It should be noted that the public standpipes have untreated drinking water, so the lack of water treatment can contribute to the occurrence of some diseases such as diarrhea and cholera.

All the other neighbourhoods covered by the project are partially connected to the electricity grid. Part of the interviewees uses other alternative sources of lighting in their homes, the most predominant being the use of solar lanterns, which also help to charge mobile phone batteries, and finally candles, which are used by a minority of the interviewees as it is a resource that requires more attention in its use.

In relation to the costs for lighting in the houses, some of the interviewed families do not spend any amount for lighting, others spend between 50.00 and 200.00 MZN/month. The main sources of energy for cooking used by the members of the households living in the Project area are firewood and charcoal. They spend between 50.00 - 300.00 MZN/month on cooking.

Waste management is mostly done individually in the houses themselves, sometimes the habit is to burn the rubbish in the yard or bury it in the yard and sometimes the rubbish is deposited in the containers distributed by the Chimoio Municipal Council.

The sanitation facilities in the houses of the people living within the project area are mostly individual latrine facilities Figure 7.49 shows an Example of a latrine within the project area in the project area (in the area of the South Pumping Station).

Figure 7.49 – Example of a latrine in a householdnear the project area

7.3.9.2 Transport, Access Roads and Communication

Province and District

According to the Provincial Directorate of Public Works, Housing and Water Resources, the Province had about 3,000 km of road network in 2017, including: 513 km of primary roads, 336 km of secondary roads and 950 km of tertiary roads. Only 750 km of classified roads are paved (INE, 2017).

About 0.2% of the City's surface area is covered by roads, including the N6 and the N260, that correspond to the main access road into the City, as well as the Chimoio – Espungabera connecting road, respectively (TPF and Salomon Lda. 2020). Over the past few years, the local government has invested in the rehabilitation of some of its urban access roads.

Public transport in the Chimoio Municipality is mainly guaranteed by private operators, using minibuses (*Chapa 100*) and covering mainly primary roads.

The City also has a small airport (*Aeroporto de Chimoio*) in the outskirts of the City, with flights that connect it with other provincial capitals.

Communication in the Municipality is provided by cell phone companies Vodacom and Movitel, as well as by TMCEL providing cell phone and land line phone services.

Communities Covered by the Project

Within the communities covered by the project the access roads are dirt roads, and the streets are slightly eroded. In Bairro Bengo, for example, the road is open, but the community is crossed by the

Nhamatsane River, which in the rainy season makes it difficult to cross to other points, especially for students to go to school.

In Bairro 5 the streets are very bumpy and some do not even allow cars to enter. This neighbourhood is crossed by the Mwenesi River and it does not have a bridge to allow a better traffic flow, especially during the rainy season, being the circulation inside the neighbourhood made on foot. Transportation in the communities covered by the project has been done by motorbike, bicycle, on foot and by private public transport called chapas, which circulate to the city centre and other points.

Figure 7.50 illustrates the access routes and means of transport within the covered communities.

Access road to Bengo community

Nhmatsane roads

Example of erosion in Bairro 5

Nhmatsane roads

Figure 7.50 – Access roads and routes in the project areas

Project Servitude Area

Regarding transportation, according to the field survey, it was found among residents in the Project area, that each household has at least one bicycle. Others use the existing public transport in the neighbourhood.

It was also observed that most of the communities covered are connected by the signal of the three mobile networks. When the households were asked about the best way to receive and give information most of them replied to be the local leader, family members and mobile phones. The

survey also revealed that everyone living within the project area has at least one mobile phone per household.

7.3.10 Economic Activities

7.3.10.1 Province and District

Even though Chimoio is located inland, it has always played an important role in the region's economy, as it is crossed by the Beira corridor, which links the Port of Beira to the Republic of Zimbabwe.

The Municipality is crossed by the N6, linking Manica Province to Beira and the Republic of Zimbabwe. Another important logistic infrastructure that crosses Chimoio is the Beira – Bulauaio Railway, with significant importance to the transportation of goods form the Port of Beira to the interior.

Agriculture also constitutes an important economic activity in the Municipality, with more than 49,152 km² of cultivated area. Most agriculture activities are carried out at a small and medium scale, with more than 99% of cultivated areas just for small and medium explorations (INE, 2013).

Small industry, as well as formal and informal trade, represented a significant part of the municipality's economy, with special attention to catering and retail trade. In terms of agricultural production the province has excelled in all aspects. The following table illustrates the agricultural products that were produced in the year 2018.

Table7.34 – Agricultural production at Manica province and Chimoio municipality level in the year 2018.

Production in 2018 (%)		
Product/indicator	**Manica Province**	**Chimoio Municipality**
Maize	54,6	13,4
Mapira	3,4	0,0
Sorghum	0,6	0,0
Wheat	0,0	0,0
Groundnut	0,5	4,7
Beans (varieties)	1,6	4,0
Soybeans	0,3	0,0
Pea	0,1	0,0
Irish potatoes	2,3	1,4
Sweet potato	8,6	24,0
Cassava	3,1	8,1
Yam	1,4	0,0
Onion	2,1	20,4
Tomato	4,4	5,2
Cabbage	2,4	3,1
Kale	1,8	2,6
Carrot	0,6	0,1
Cucumber	0,0	0,1
Lettuce	0,0	0,6
Garlic	0,0	0,0

Production in 2018 (%)		
Product/indicator	**Manica Province**	**Chimoio Municipality**
Citrus	1,0	1,6
Mangoes Trees	1,1	5,8
Banana Trees	8,0	0,3
Avocado	0,7	2,2
Litchis	0,8	2,3
Pineapple	0,8	0,0

Source: POCA, 2019

7.3.10.2 Communities Covered by the Project

The main economic activity in the communities covered is subsistence farming and there are few employment opportunities in these communities. Agriculture is practiced in specific zones with machambas areas that tend to vary from 0.5 to 5 hectares per farmer. People also have the habit of cultivating in the yards around their homes.

The main rain-fed crops produced in the communities are maize (Zea mays), cassava (Manihot esculenta), cowpea (Vigna unguiculata), sweet potato (Ipomoea batatas) and groundnut (Arachis hypogaea).

The main horticral pruducts produced are: tomato (Solanum lycopersicum), cucumber (Cucumis sativus), cabbage (Brassica oleracea var. capitata), kale and lettuce (Lactuca sativa).

Fruit trees are also present in these communities, the most dominant being citrus trees such as orange (Citrus sinensis) and lemon (Citrus sp.), and there are also avocado (Persea americana) and mango (Mangifera indica) trees. The production of the fruit trees is for own consumption and sometimes can be sold if there is surplus production.

In Bairro Nhamatsane there is an agricultural association that is located in a low and marshy area, thus allowing the production of several agricultural crops, from horticral pruducts to rain-fed crops. This association comprises an area of 104.9 hectares and has a DUAT.

Besides the practice of agriculture, cattle, goats, pigs (in a very small scale) raising and poultry such as chickens and ducks are dominant in these communities.

In Bairro 5, there is a large-scale production of chickens and layers, carried out by a singular entrepreneur, with its well defined market, supplying locally and to the large markets in the City of Chimoio.

In addition, there are also small grain processors, and the mills that have registered high adherence by the population because they make the work much easier, since before they could use the mills women had to manually process the grain harvested in the field.

Bairro 5 has two markets; in Nhamatsane the area for the installation of the market has already been defined and is waiting for financing. In the backyards of the houses there are also small shops selling, for example, firewood and charcoal. There is also the culture of selling the surplus of the production among the neighbourhood.

At Chizombera Mountain in Nhamatsane, gravel exploitation is practiced by women and men, who spend the day breaking the rock and filling buckets to sell, being cars sometimes used for the transportation.

The photographs in Figure 7.51 show some images of economic activities in the communities covered by the project.

Vegetable fields at Nhamatsane Farmers Association

Aviary for laying hens in Bairro 5

Grinding in Bairro 5

Firewood and charcoal stand in Bairro 5

Grocery and bread stand, Bairro 5

Vegetable stand in Bairro 5

Men working on Chizombera Mountain, Nhamatsane

Men working on Chizombera Mountain, Nhamatsane

Figure 7.51 – Economic activities of the communities covered by the project

7.3.10.3 Project Servitude Area

Regarding the economic activities practiced by the population residing in the project area, the field survey revealed that a large number of household heads are farmers (33.3%). Other occupations mentioned include civil construction (37.5%), traditional medicine (16.67%), and brick production (8.33%).

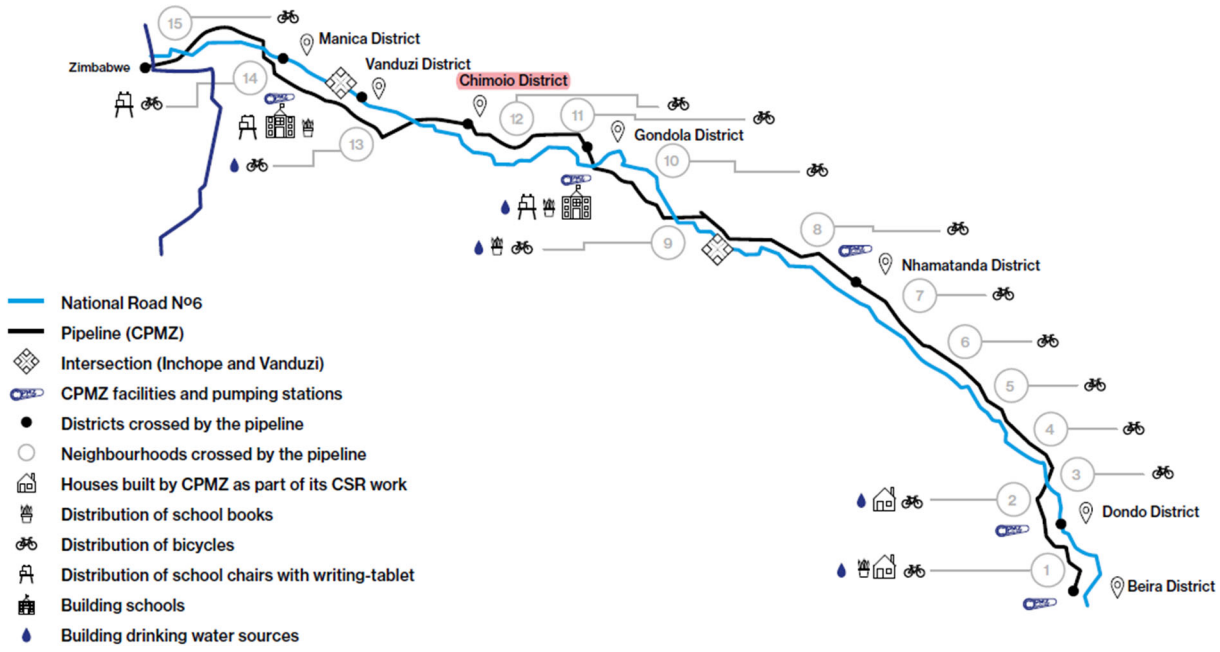
Only 12.5% obtain their income through the sales of products from the machambas, and some heads of households have other activities, namely carpentry, hydraulic and shop assistants, corresponding to 20.83% of the interviewees.

When analysing the income level of the sampled households, it was found that many of them have an income lower than 5,000.00 meticais per month (about 83 USD/month). Considering that each household has an average of 6 members, which means that most households have an income of approximately 39.00 meticais (0.65 USD) per household member per day. This is below the poverty level of 120.00 meticais per day (~2 USD/day) stipulated by the United Nations. However, a monthly income of 5,000.00 Meticais is in line with the minimum wages stipulated by the government for the agricultural sector at the time of the physical and socioeconomic survey.

Among the households living in the project area, 86.36% have an income of less than 1,000.00 MZN/month, 9.09% have income between 5,000.00 and 10,000.00 MZN/month and only 4.55% of the population has an income of over 10,000.00 MZN/month.

Infrastructures

As mentioned in Project Description the Mozambique Zimbabwe Oil Pipeline runs near the WWTP north limit, this pipeline is owned by CPMZ and transports oil products from Beira (Mozambique) to Harare (Zimbabwe) along 294 kms, uninterruptedly for 40 years. The WWTP does not interferes with CPMZ Pipeline.



Source: CPMZ Institutional Brochure (2022)

Figure 7.52 - CPMZ pipeline route & sphere of influence/2022

Agriculture

The cultivation methods used by the households are in general rudimentary and manual. Thus, the cultivated area is directly associated with the available labour force. Most of the machambas in the project area are located in the area of the sanitary landfill, the water retention basin, the Pumping Stations and the WWTP.

Agriculture in the analysed area is predominantly rainfed and there is also horticultural products production.

During the fieldwork, a total of fifty-nine (59) machambas were identified, belonging to 56 PAPs, representing a total of 58.6 hectares, around 26.7 hectares for the WWTP area and around 26 hectares in the Sanitary Landfill zone and the remining in the pump station and water retention basin. The crops grown by the population follow the same trend as the rest of Chimoio District. Table7.35 lists the crops and fruit trees grown by the households.

Table7.35 – Agricultural crops grown by the households living in the project area

Agricultural crops	%	Tree	%
Maize	42,9	Banana	86,33%
Sorghum	2	Mango	8,89%
Meixoeira	4,1	Guava	1,30%
Nhemba Beans	18,3	Sugar cane	1,05%
Sweet potato	44,9	Avocado	0,69%
Groundnut	12,2	Lemon	0,51%
Pumpkin	28,6	Orange	0,26%
Cabbage	14,3	Pawpaw	0,23%
Cucumber	24,5	Custard apple	0,20%

Agricultural crops	%	Tree	%
Tomato	10,2	Apple tree	0,15%
Cassava	40,8	Sugar apple	0,13%
Potato	14,3	Tangerine	0,08%
Lettuce	12,2	Indian Jujube	0,08%
Buer Beans	8,2	Baobab	0,05%
Pineapple	2	Black Plum (*Jambaloeiro*)	0,05%
Rice	8,2		
Ash	2		
Sugar Cane	30,6		

Figure 7.53 illustrates the distribution of the machambas within the project area.

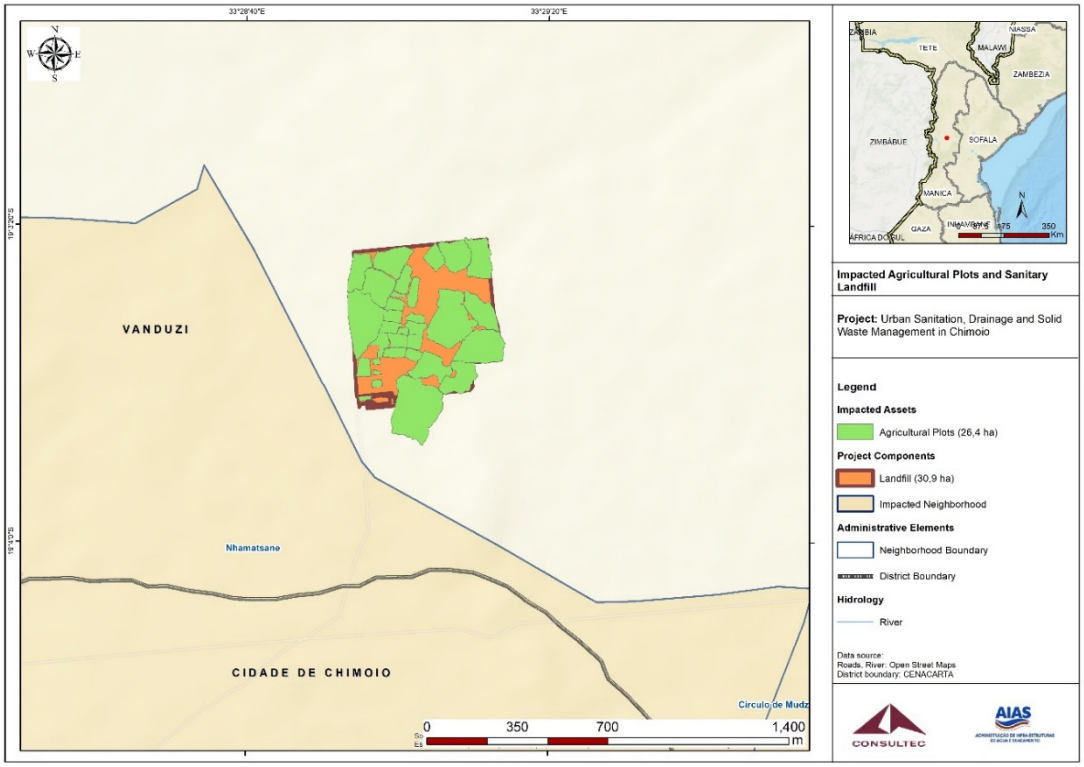


Figure 7.53 – Affected machambas in the Sanitary Landfill area

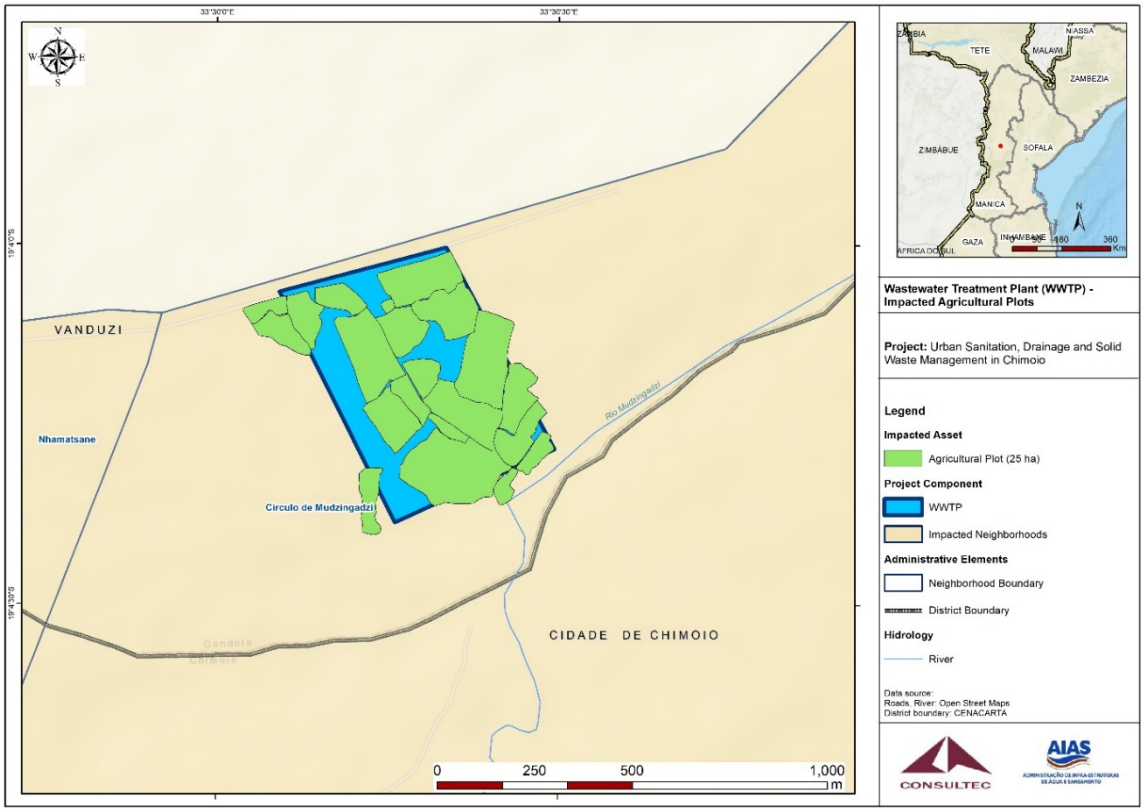


Figure 7.54 – Affected machambas in the WWTP area

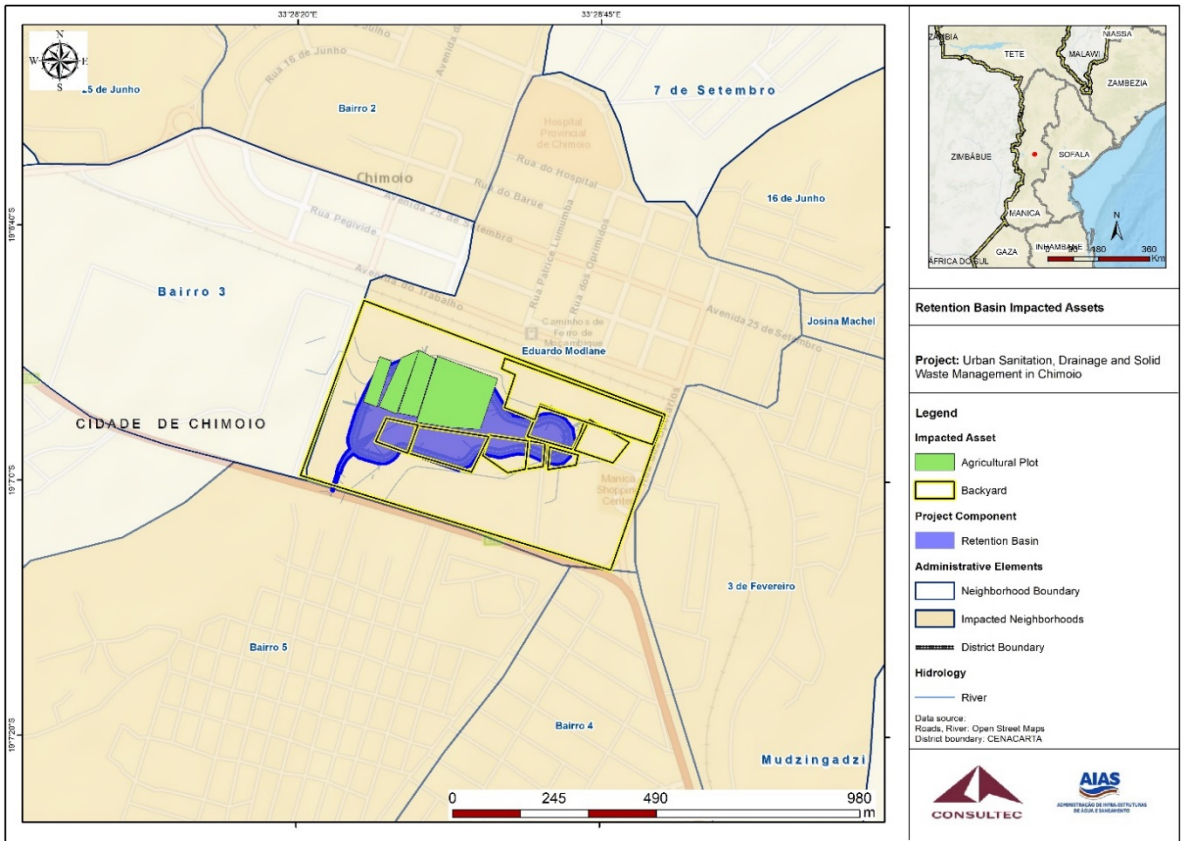


Figure 7.55 – Affected machambas in the water retention basin area.

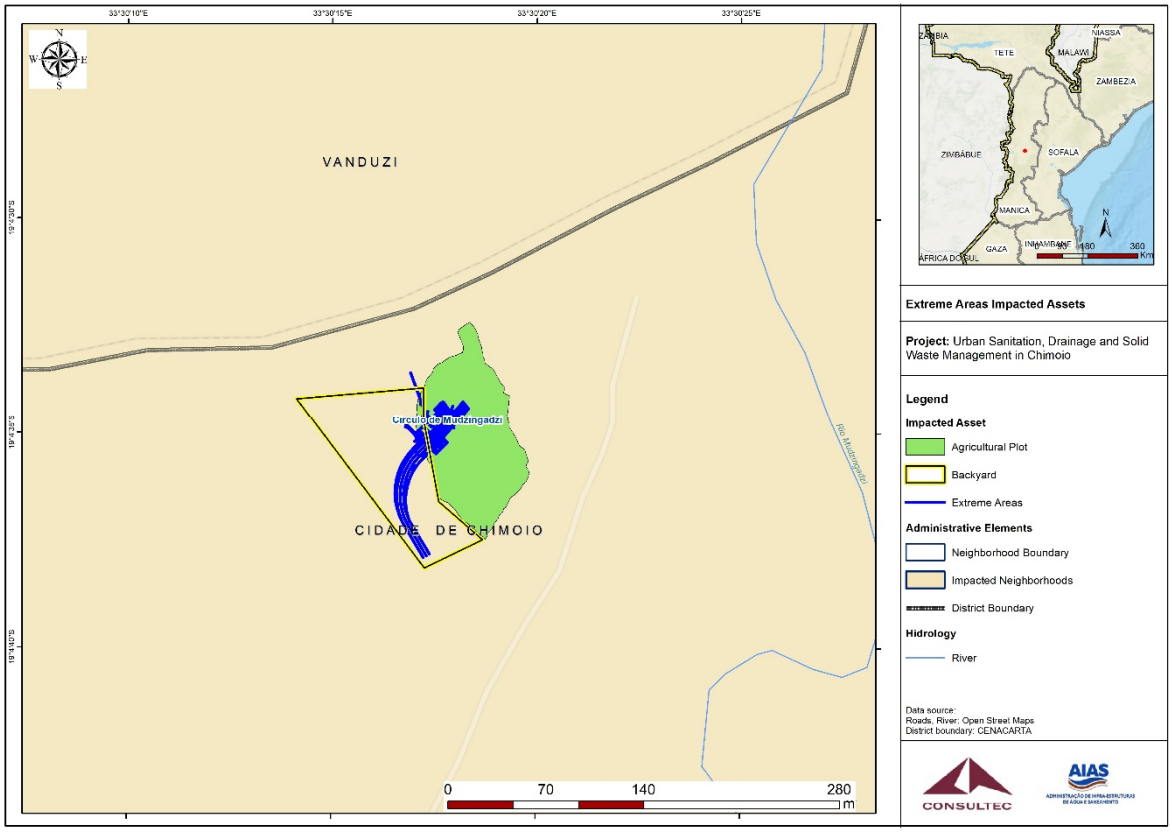


Figure 7.56 - Affected machambas in the North Pumping Station area.

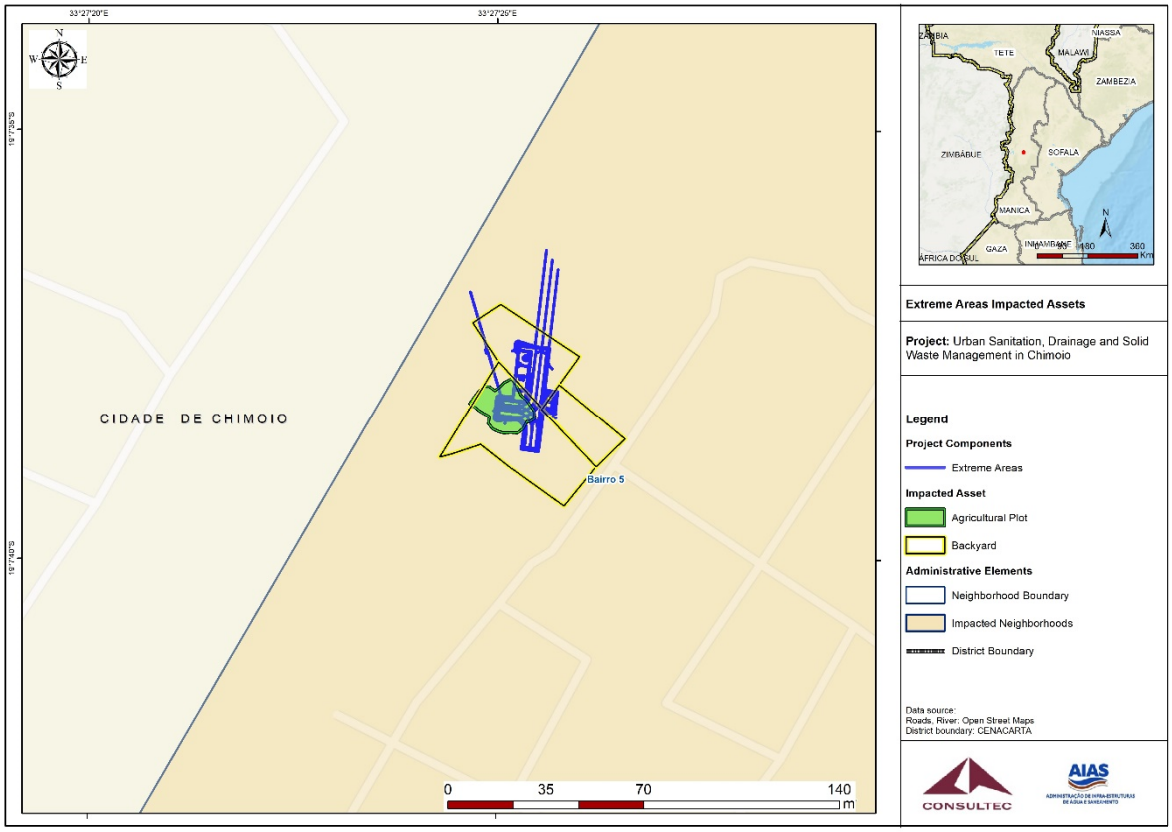


Figure 7.57- Affected machambas in the South Pumping Station area.

Commerce Infrastructures

A total of 24 commercial establishments located in the Project implementation area were identified all located in the water retention basin area.

The figure below sows the impacted infrastructures in the water retention basin.

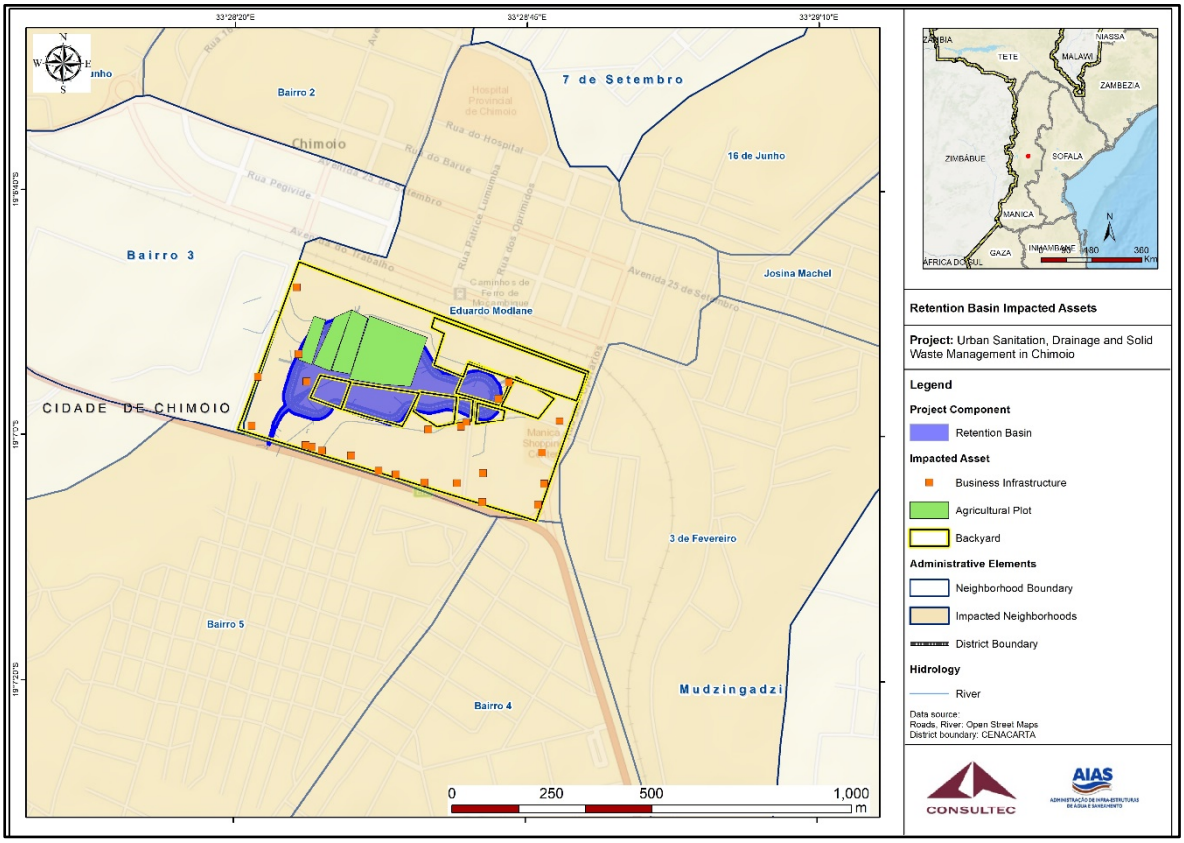


Figure 7.58 – Impacted infrastrcture in the water retentation basin

Informal Market

One informal market will be impacted by the project, which is located in the water retention basin area.

Land Use Rights (DUAT)

According to the fieldwork, none of the interviewees has formal land use rights – Right to Use and Benefit from the Land (DUAT).

7.3.11 Road Traffic

7.3.11.1 Road Classification

In terms of classification, roads in Mozambique are divided into National Roads and Regional Roads. National roads are in turn divided into Primary and Secondary roads. Primary roads are the main roads in the country connecting ports to borders and provincial capitals. The secondary roads

establish the connection between the primary network and the district capitals, allowing the economic development of the country with the localities, according to the division presented in Table7.36.

Table7.36 – Categorisation of Mozambique's road network

Categorisation	Designation	Functional definition	Numeration
National Roads	Primary Roads	They form the network of national roads and allow the connection of: - Provincial capitals; - Provincial capitals and other cities - Provincial capitals and main seaports - Provincial capitals and main border posts.	N1 to N199
	Secondary Roads	They form the secondary network complementing the road network and link: - Primary roads - Provincial capitals and (other) maritime or fluvial ports - Primary roads and major economic hubs - Primary roads and (other) border posts	N200 to N399
Regional Roads	Tertiary Roads	They allow tertiary roads to connect with: - Secondary roads with primary roads or with other secondary roads - District centres - District centres and administrative posts - District centres and economic hubs of high importance	R400 to R799
	Vicinal Roads	They allow for the connection of Vicinal roads with: - Tertiary roads - Administrative posts - Administrative posts and other population centres	Starting from R800

Source: Final Report on The Reclassification of the Mozambique Road Network, 2003.

The network of classified roads, national and regional roads, is managed by the National Roads Administration (ANE) which, among other competencies, regulates and plans the development of the network of classified public roads according to the provisions issued by Decree No. 65/2019 of 30 July.

The roads not managed by ANE (unclassified, municipal and/or urban roads), are managed by the infrastructure departments of each municipality and district, with the main objective of guaranteeing the necessary road circulation conditions including their maintenance.

It is also important to refer to Decree-Law No. 01/2011, of 23 March establishing the Road Code, as well as Decree No. 109/2014, of 31 December, referring to the Regulation of Use of Roads and Their Protection Zones.

7.3.11.2 Road Maintenance

Day-to-day maintenance actions of the road network is implemented at provincial level through the ANE provincial delegations from April 2006, which previously was done by the Departments of Roads and Bridges (DEPs) of the Provincial Directorates of Public Works and Housing.

The Road Sector Strategy (ANE), prepared by ANE in collaboration with the Road Fund (FE) and MOPHRH, contains the key attributes, strategies and objectives of the Government of Mozambique for the development and management of classified roads at country level.

ESE adopts a medium to long term perspective in the development and management of the road network with main focuses on preservation of goods transported on the roads and improvement of road possibility throughout the different seasons of the year. Such focuses are complemented by the principles of sustainability, connection and accessibility, objectives that will be achieved through careful planning in the sector and sound management and implementation.

Unclassified, municipal and/or urban roads are the responsibility of the infrastructure departments of the country's districts and municipalities.

7.3.11.3 Chimoio Municipality Road Network

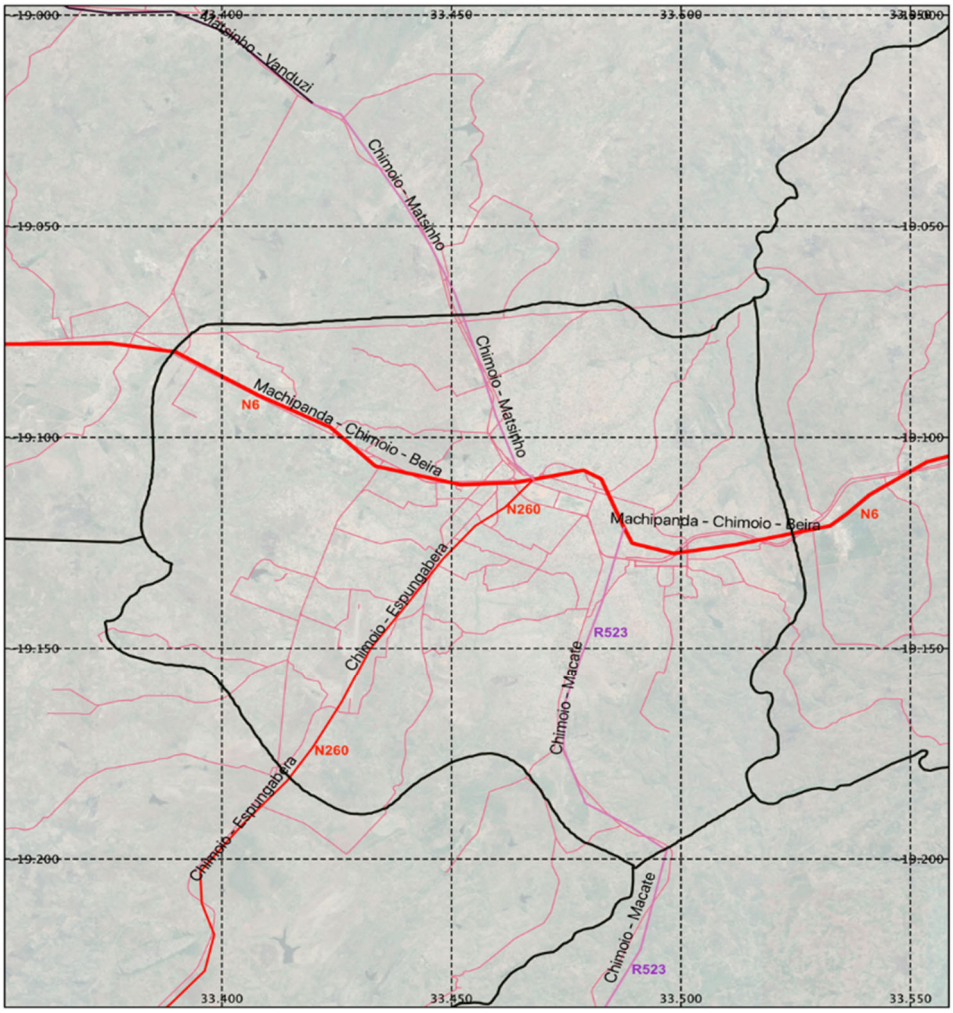
The Municipality of Chimoio has a good road network, of which the N6 primary road stands out and is in a good general state of repair.

The urban sanitation project component covers the central zone of the City of Chimoio, but also other neighbouring areas. The central zone of Chimoio is the first urbanized zone in which the housing areas are equipped with most of the administrative, commercial, service and industrial activities which are mainly developed along the 25 de Setembro Avenue and the N6 road. This part of the city is an area with dense housing occupation with single-family characteristics, mostly with conventional constructions, although there are also some informal settlements around it. In the city centre, the urbanized area covers the areas along the road leading to the Provincial Hospital, and also extends along the N6 to the East and along the 25 de Setembro Avenue.

In terms of road circulation flows, the Municipality of Chimoio is endowed with a traffic regulation system through the use of traffic lights, with particular emphasis on those existing on 25 September Avenue, at the junction between Avenida da Liberdade and Sussundenga Street, but also at other points in the city.

It is also important to highlight the existence of a railway line that crosses the city of Chimoio. Situated in the centre of the country, the Central railway corridor is made up of the railway complex that establishes the connection between the Port of Beira and the city of Machipanda located near the Zimbabwe border, with a length of 280 kilometers.

Figure 7.59 below illustrates Chimoio District's road network, showing the main connections between the City of Chimoio and other points in the province.



Source: Adapted from National Road Administration (2020).

Figure 7.59 – Road network in the District of Chimoio

From the fieldwork carried out it can be seen that on the main arteries of Chimoio City there is already a significant level of road traffic which becomes more evident during peak traffic periods (early morning and late afternoon). It can also be verified that traffic conditions in the city are globally adequate as they allow the maintenance of a constant and fluid flow of road traffic. On secondary and tertiary roads traffic congestion is less relevant.

7.3.11.4 Assessment of Current Traffic Conditions

Methodological Approach

To assess the current traffic conditions in and around the streets in the centre of Chimoio City covered by the project, a characterisation of the existing traffic was carried out based on the methodologies proposed by ANE in the "Manual of Procedures for Carrying out Traffic Counts". Other reference documents consulted were the "Manual for Analysis of Traffic Studies" published in 2018 by the *Empresa Municipal de Desenvolvimento de Campinas* (EMDEC); the "Manual for Traffic Studies" published in 2006 by the *Departamento Nacional de Infra-estruturas de Transportes* (DNIT)

and the "Manual For the Preparation of the Urban Traffic Impact Report (RITU)" published in 2016 by the *Instituto de Planeamento e Desenvolvimento Sustentável* (IPDSA). Currently, the manual counting method is used by ANE, this being the simplest counting technique, not requiring the installation of any equipment and relying on human capacity for observation. This method has the advantage of being easy to operate, low cost and high flexibility in changing locations to cover an area in a short period, but it is also susceptible to human error.

The methodology used focused on the analysis of the current road capacity of some streets in the city centre of Chimoio where the project will be implemented, having the following points of the city been assessed: Avenida do Trabalho, Avenida da Liberdade, Rua de Barué, Rua dos Operários, Rua do Hospital, Praça dos Heróis/Praça da Mulher and Rua Sussundenga.

The traffic counts aimed to determine the quantity, direction and composition of the flow of vehicles passing through the selected points of the road system in a given unit of time. The counts were carried out directly on site by observers with the aid of counting sheets, on which each passing vehicle was recorded by means of a dash, thus filling in the sheet for each direction of the road under observation.

All counts were divided into periods of 15 minutes and were carried out on 27 September, 01 and 06 October 2021.

Vehicle Classification

In the analysis of the existing traffic, 8 different vehicle typologies (classes) were considered, as illustrated in Figure 7.60.

Classe		Descrição
A		Light and 4-wheel drive vehicles
B		Light goods vehicles (2-wheel axle)
C		Light passenger vehicles (capacity up to 20 people)
D		Heavy passenger vehicles
E		Heavy goods vehicles with 2 axles (twin wheels on rear axle)
F		Heavy goods vehicles with 3 or 4 axles
G		Heavy goods vehicles with more than 4 axles
H		Agriculture tractors with or without trailer

Figure 7.60 – Types of vehicles considered for the analysis

Traffic Data Processing and Analysis

The period chosen for the counts was 12 hours, between 6:00 am and 6:00 pm, this being considered the most critical period with regard to the potential impact that the construction works could generate on existing road traffic.

The degree of road saturation (or level of service) was calculated by the relation between the vehicular volume and the road's traffic flow capacity, assuming as vehicular volume the following equivalences, as proposed in the adopted analysis methodology:

- Light (passenger) cars = 1;
- Motorbikes = 0,33
- Two-axle bus = 2;
- Two Axle Lorry = 2;
- Three axle lorry = 3

On the basis of the data collected during the counts we determined which hourly interval, and the interval of (fifteen) 15 minutes, presented the highest peak of vehicles (highest total equivalent values) for each of the observation points. Based on these data, the Peak Hour Factor (PHF) was calculated by applying the following equation:

PHF = Peak Hour Volume / 4 x (Volume greater than 15 min)

As an example and based on the acquired data, the peak hour on Avenida da Liberdade corresponds to the period from 12h15m to 13h15m, in which a traffic volume equal to 911 equivalent vehicles was registered, with the largest 15 minutes peak volume of 254 vehicles. This gives an PHF of 0.90. Note that an PHF is considered satisfactory when it is higher than the nominal value of 0.75.

7.3.11.5 Analysis of Road Capacity and Service Levels

After analyzing the traffic conditions on the different roads that were counted and based on the calculations made for the traffic situation at peak hours, it can be concluded that the values found allow the conclusion that all the arterials evaluated present satisfactory PHF, which, in all cases analyzed, are higher than 0.83.

The levels of traffic saturation, except for Rua dos Operários, are globally reduced, varying between 15% and 57% (Table7.37). It can thus be concluded that even during peak hours, traffic conditions on these roads are generally satisfactory and allow for a full flow of traffic in Chimoio city centre.

Table7.37 – Characterisation of traffic flow capacity

Traffic Counting Point	Peak Hour Factor	Traffic Saturation Level
Avenida do Trabalho	0,96	0,57
Avenida da Liberdade	0,90	0,28
Rua de Barue	0,90	0,54
Rua dos Operários	0,95	0,96
Avenida 25 de Setembro	0,91	0,54
Rua do Hospital	0,89	0,32

Traffic Counting Point	Peak Hour Factor	Traffic Saturation Level
Pr. dos Heróis/ Pr. da Mulher	0,87	0,44
Rua Sussundenga	0,83	0,15

Taking the Avenida da Liberdade as an example and considering a maximum traffic flow capacity of 1.700 vehicles/hour on each carriageway, where a maximum of 3.200 vehicles/hour is allowed when both carriageways are considered (except in short stretches, such as tunnels and bridges, where it can reach 3,400 vehicles/hour), it was found that at peak hour on this artery, a traffic saturation level (Ct) corresponds to 28%, which presupposes a low traffic saturation level and which enables adequate traffic conditions to be maintained.

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Annex I - Consultec's Registration with the MTA

República de Moçambique

MINISTÉRIO DA TERRA E AMBIENTE

CERTIFICADO DE CONSULTOR AMBIENTAL

Nº. 47 / 2022

O Ministério da Terra e Ambiente, ao abrigo do Regulamento sobre o Processo de Avaliação do Impacto Ambiental, aprovado pelo Decreto nº 54/2015, de 31 de Dezembro, certifica que o (a) sr (a) ----------

Consultec – Consultores Associados, Limitada ----------

está devidamente credenciado (a) a exercer funções de Consultor Ambiental em Moçambique.

CERTIFICADO DE CONSULTOR

Maputo, aos 31 / 08 /2022 Validade até 31 / 08 /2025

Ivete Joaquim Maibasi

A Ministra

Annex II - Correspondence with the MTA

REPÚBLICA DE MOÇAMBIQUE
MINISTÉRIO DA TERRA E AMBIENTE
GABINETE DO MINISTRO

À:
Administração de Infra-estruturas de Água e Saneamento (AIAS

Maputo

N/Refª N º165/MTA/183/GM/220/21 Maputo: 28/05/2021

Assunto: Estudo de Pré-viabilidade Ambiental e Definição do Âmbito (EPDA) e Termos de Referência (TdR) do Plano de Desenvolvimento Integrado para o Saneamento Urbano, Drenagem e Gestão de Resíduos Sólidos no Município de Chimoio

Exmos Senhores,

O Ministério da Terra e Ambiente (MTA) recebeu o documento de V.Excias referente ao Projecto em epígrafe, tendo merecido a devida análise técnica.

Após a revisão feita nos termos do Artigo 16, do Regulamento sobre o Processo de Avaliação do Impacto Ambiental, aprovado pelo Decreto nº 54/2015, de 31 de Dezembro, o MTA comunica à V.Excias que o presente documento está aprovado mas, recomenda para o Relatório de Estudo de Impacto Ambiental (REIA), o cumprimento integral do EPDA e TdR e das questões apresentadas no relatório de revisão em anexo.

Informa-se ainda que o REIA deverá ser submetido ao MTA em doze (12) exemplares em formato de papel A4, sendo quatro (4) para o Serviço Provincial do Ambiente de Manica e oito (8) par a DINAB e o respectivo formato electrónico.

Com os melhores cumprimentos.

A Ministra

Ivete Joaquim Maibaze

CC: Suas Excelências:
O Ministro das Obras Públicas, Habitação e Recursos Hídricos
O Ministro da Saúde
O Secretário de Estado da Província de Manica

Relatório de Revisão do Estudo de Pré-viabilidade Ambiental e Definição do Âmbito (EPDA) e Termos de Referência (TdR) do Plano de Desenvolvimento Integrado para o Saneamento Urbano, Drenagem e Gestão de Resíduos Sólidos no Município de Chimoio

1. Introdução

O Projecto acima mencionado, submetido à Direcção Nacional do Ambiente (DINAB) para apreciação e tomada de decisão, localizar-se-á no Município de Chimoio, na Província de Manica. O proponente do Projecto é a Administração de Infra-estruturas de Água e Saneamento (AIAS) e pretende implementar o Projecto Integrado de Saneamento Urbano, Drenagem e Gestão de Resíduos Sólidos.

Para a efectivação do projecto serão investidos cerca de 48.492.541.00 USD (quarenta e oito milhões, quatrocentos e noventa e dois mil e quinhentos e quarenta e um dólares americanos).

O Projecto apresenta as seguintes componentes:

- Sistemas de Drenagem de Águas Pluviais;
- Estação de Tratamento de Águas Residuais (ETAR); e
- Aterro Municipal de Resíduos Sólidos (Aterro Sanitário).

Sistemas de Drenagem de Águas Pluviais

Para a drenagem de águas pluviais, as infra-estruturas serão implantadas em três áreas da cidade e consistirá na remodelação da Cidade de Chimoio, construção de redes de drenagem na zona definida como urbanizada no Plano de Estrutura Urbana (PEU) da Cidade de Chimoio e a construção de um sistema de drenagem que permita o controlo de caudais que drenam para o Rio Mwenessi.

Estação de Tratamento de Águas Residuais (ETAR)

Para o tratamento de águas residuais são apresentadas duas alternativas de intervenção, nomeadamente:

- Reabilitação com expansão (aumento da capacidade) da estação de tratamento existente; e

- Construção de uma nova ETAR.

Aterro Municipal de Resíduos Sólidos (Aterro Sanitário)

A gestão de resíduos sólidos será por recolha indiferenciada, onde os resíduos serão colocados no mesmo contentor, sem diferenciação por tipo de resíduo que depois serão encaminhados para aterro sanitário por construir.

A concepção do aterro sanitário terá em conta o isolamento dos resíduos sólidos do ambiente, a fim de proteger as povoações vizinhas, o solo, as águas superficiais e a atmosfera e o controlo dos processos físicos, químicos e biológicos que ocorrem no interior do aterro, tendo em conta os seguintes aspectos:

- Impermeabilização das células de deposição de resíduos;
- Drenagem, recolha e tratamento de águas lixiviantes;
- Drenagem, captação e tratamento de biogás;
- Drenagem de águas pluviais;
- Plano de monitorização durante a operação e pós encerramento; e
- Plano de recuperação pós selagem.

2. Formação da equipa de revisão do EPDA e TdR

Para a revisão do projecto constituiu-se a respectiva Comissão Técnica de Avaliação composta pelas seguintes instituições: (i) Ministério da Terra e Ambiente (Direcção Nacional do Ambiente, Direcção Nacional de Terras e Desenvolvimento Territorial e Serviço Provincial do Ambiente de Manica); (ii) Ministério da Saúde (Direcção Nacional de Saúde Pública) e (iii) Conselho Municipal da Cidade de Maputo (Direcção Municipal de Ambiente e Salubridade).

3. Contexto de realização do EPDA e TdR

O presente estudo foi realizado na fase preliminar da actividade.

4. Participação Pública

Consta do EPDA, que foi realizado o processo de consulta pública no dia 08 de Fevereiro de 2021, na Cidade de Chimoio, Província de Manica, onde estiveram presentes 20 participantes.

5. Equipa de consultores responsável pelo EPDA e TdR

O EPDA e TdR foram elaborados pela CONSULTEC, Lda, empresa de consultoria ambiental, registada pelo MTA nos termos do Regulamento sobre o Processo de Avaliação do Impacto Ambiental, aprovado pelo Decreto nº 54/2015, de 31 de Dezembro.

8. Conclusões e Recomendações

Face aos aspectos acima mencionados e que não inviabilizam a aprovação do EPDA e os TdR e o prosseguimento dos passos subsequentes, conclui-se que o mesmo reúne requisitos mínimos para sua aprovação. Contudo, para o Estudo de Impacto Ambiental, recomenda-se:

a) A observância do Regulamento sobre o processo de Avaliação do Impacto Ambiental, aprovado pelo Decreto n° 54/2015, de 31 de Dezembro e das Directivas Gerais para a Elaboração de Estudos de Impacto Ambiental e para o Processo de Participação Publica;

b) A observância para além dos vários instrumentos legais previstos no EPDA, do seguinte:

- Regulamento Sobre a Gestão de Resíduos Sólidos Urbanos, aprovado pelo Decreto nº 94/2014, de 31 de Dezembro;
- Regulamento sobre Padrões de Qualidade Ambiental e de Emissão de Efluentes, aprovado pelo Decreto nº 18/2004, de 2 Junho;
- Estratégia de Gestão Integrada de Resíduos Sólidos Urbanos em Moçambique (2012);
- Directiva Técnica sobre a Implantação, Operação e Encerramento de Aterros Sanitários em Moçambique.

c) A apresentação do Resumo Não Técnico com as principais questões abordadas, conclusões e propostas;

d) A selecção das alternativas de localização da ETAR, do aterro sanitário e das infra-estruturas de apoio para a fase de construção, até ao momento de realização do Estudo do Impacto Ambiental, de modo a se avaliar melhor os reais impactos do projecto sobre os componentes ambientais (água, ar, solo, flora e fauna) e a definição das respectivas medidas de mitigação, de acordo com as alternativas escolhidas;

e) A descrição sobre a paisagem e os padrões de uso de solo nas áreas de influência, os potenciais impactos das actividades e respectivas medidas de mitigação;

f) A inclusão no capítulo sobre o meio socioeconómico, da análise do valor fundiário das áreas de influência directa da ETAR, do aterro sanitário e do sistema de drenagem de águas pluviais;

g) A apresentação de figuras, fotos satélites e mapas em tamanho maior, contendo escala, legenda e fonte, de modo a facilitar a sua leitura e compreensão;

q) A realização da consulta pública na fase do Estudo de Impacto Ambiental (EIA), de acordo com a Directiva Geral para o Processo de Participação Pública, aprovada pelo Diploma Ministerial n°130/20016, de 19 de Julho, envolvendo tecnicos de niveis central e local;

r) A elaboração do Plano de Gestão Ambiental contendo acções concretas de gestão ambiental com respectiva periodicidade e responsabilidade, objecto e parâmetros de monitorização. Deve-se indicar ainda, os pontos de monitorização (locais de colheita de amostras para analises dos parâmetros da qualidade ambiental);

s) A elaboração do Plano de Emergência para casos de acidentes;

t) A elaboração do Plano de encerramento e reabilitação;

u) O cumprimento integral das questões constantes neste relatório de revisão, bem como o atendimento ao EPDA e os respectivos Termos de Referências.

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