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COUNTRY : REPUBLIC OF MALI

Bamako Sanitation Project

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

SUMMARY

Project Name	:	**Bamako Sanitation Project**			
Country	:	**MALI**			
Project Number:		**P ML B00 004**			
Department	:	**OWAS**	Division	:	**OWAS.1**

1. INTRODUCTION

In efforts to update the Bamako Sanitation Master Plan (SDAB), a priority project to construct two faecal sludge disposal and treatment plants in Bamako has been identified. The project is designed to improve the living environment of the population by addressing the town's acute sanitation problems. SOMAPEP SA initiated the project with the financial support of the African Development Bank.

In accordance with Mali's Environmental and Social Impact Assessment (ESIA) procedure and AfDB operational safeguard on environmental and social impact assessment, the project has been classified under Environmental Category 1 (projects subject to environmental and social impact assessment).

This document summarizes the environmental and social impact assessment report. It seeks to incorporate environmental concerns into the project planning. The assessment is conducted in accordance with the current procedure in the Republic of Mali and AfDB guidelines.

2. PROJECT DESCRIPTION AND RATIONALE

2.1 Context and Rationale

Bamako is facing development challenges (staggering population growth and annual urbanization rate of about 4.77%), and lacks appropriate sanitation infrastructure to address its expansion problems.

Sanitation is one of the major difficulties faced by the town. In addition to insufficient sanitation facilities and equipment, Bamako does not have a faecal sludge treatment plant. It should be noted that the town has about one hundred vacuum trucks distributed among the district's six municipalities, with each truck estimated to cover 1 375 households. This situation illustrates the pressure on the facilities and equipment used. There is also the proliferation of disorderly disposal sites, and the attendant pollution and noise nuisances for the people living around these sites (nauseating odours and fly breeding on disposal sites and their surroundings, increase in cases of diseases due to unhygienic living conditions, and population's hostility to the sites).

In Bamako, the Niger River is both an outlet for the various storm water collectors and a source of drinking water supply for the capital, which is currently polluted by the discharge of untreated household and industrial wastewater. This increases water treatment costs and causes environmental degradation (scarce fish species that are sensitive to the various water quality variations, proliferation of aquatic plants, etc.).

2.2. Presentation of the Project

2.2.1 Project Objectives and Components

The Project to Construct Two Faecal Sludge Treatment Plants and procure 30 "spiro" trucks for the operator was initiated by SOMAPEP SA. The various project components are:

- Sanitation Infrastructure Development: Construction and equipping of two faecal sludge disposal and treatment plants of a capacity of 300 m3/d each, and procurement of 30 “spiro” trucks for the operator;
- Capacity Building and Support for the Project Implementation Entities;
- Project Management and Coordination: Concerns all activities to facilitate coordination, monitoring and supervision of the delivery and execution of services and works for building all project facilities.

The project will cost over CFAF 20 billion for the 2017-2025 period.

2.2.2 Description of the Treatment Process and Selection of Sites

The activated sludge process has been adopted for the operation of faecal sludge treatment plants (FSTPs). It is a biological treatment process with a higher performance compared with the physico-chemical and mixed treatment processes. The activated sludge biological treatment process is the most cost-effective treatment process, and has a lesser chemical load for the receptor environment compared with the physico-chemical and mixed treatment processes.

Below is the diagram of the activated sludge treatment process.

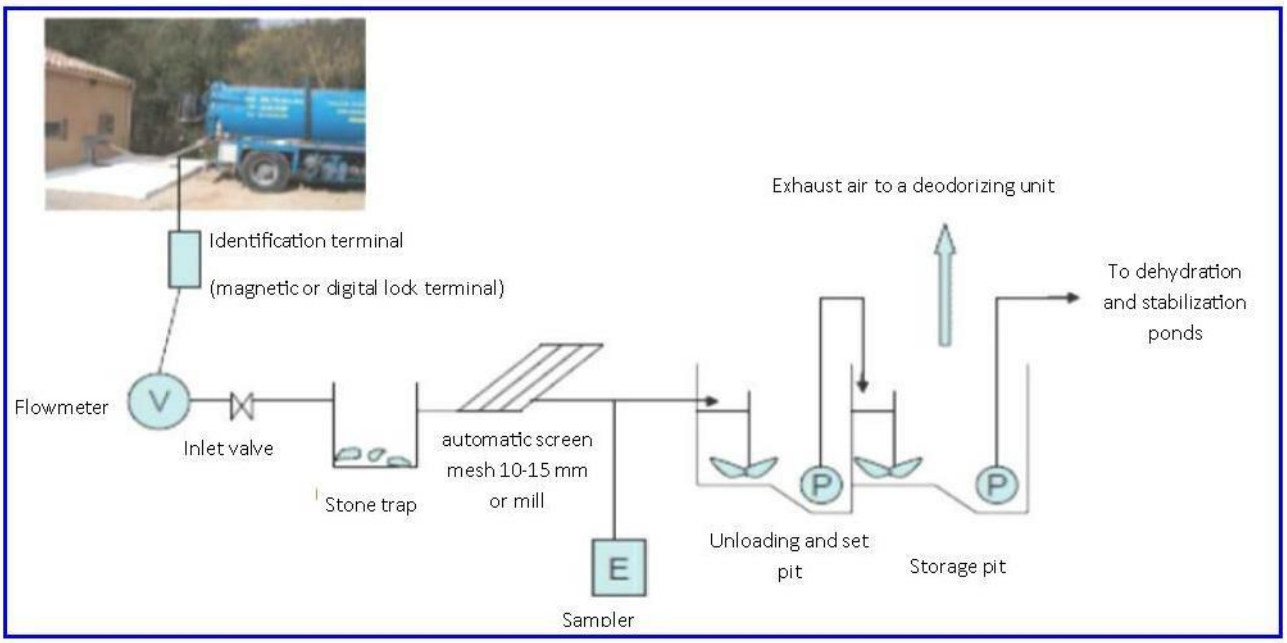

Figure 1: Operation Diagram of the Faecal Sludge Treatment Plant (FSTP)

The sites identified to host the various plants cover a total surface area of 45 hectares, distributed between Dianéguéla (20 hectares) and Sotuba (25 hectares) sites. Due to the scarcity of appropriate sites in Bamako, Dianéguéla and Sotuba sites were selected based on the following environmental criteria: availability of adapted spaces, closeness to the outlet, few obstacles on the sites, development costs, and possibility of extension without acquiring new land.

Figure 1: Map of the Planned Faecal Sludge Treatment Plants

REF	INTITULÉ
1	Poste de garde + Maison du gardien
2	Pont à bascule
3	Boues de vidange : Dépotage
4	Boues de vidange : Dégrillage, lavage, compactage et ensachage des refus.
5	Boues de vidange : Stockage / Homogénéisation
6	Bâtiment de deshydratation des boues de vidange
7	Relevage / Comptage / Chambre de contrôle des effluents urbains
8	Traitement préliminaire : Tamisage, lavage, compactage et ensachage des refus
10	Bâtiment Administratif
11	Atelier
12	Bâtiment électrique
14	Lagunage naturel ("centrats" boues de vidange)
15	Filtre planté de roseaux
21	Comptage sortie lagune
22	Comptage avant rejet

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2.2.3 Major Required Inputs

The major works execution inputs are:

Water

The contractor will collect water for site works (manufacture of blocks and concrete, watering, lagoon compacting, etc.). The collection of water to meet site needs should take river flow and water quality into consideration. These parameters are required to ensure water availability.

Fuel

Construction machines and vehicles need fuel and lubricants (oil and grease) to operate. Accidental spills from the handling of these products pollute various environments. The same is true for wastes from their use (drain oil).

Gravel

Gravel is available in quarries in Mountougoula. It can be acquired through purchase, and is believed to be of better quality than gravel from the river bed. Hence, the contractor will not need to dredge gravel from the bottom of the river. Such practice degrades the environment and destroys existing ecosystems.

Sand deposits

Sand extraction is not common in the area in spite of the considerable sand potential. Such practice degrades the environment and destroys existing ecosystems.

Labour force

The needs of the construction site in terms of number of people to be mobilized are still to be assessed. However, it should be pointed out that the area has a considerable labour force potential. The required labour force will comprise builders, labourers, a works supervisor, an architect, a civil engineer, etc.

Cement

Cement is sold on the market and can be procured from various sources (Mali, Côte d'Ivoire, Senegal, Togo, etc.). It affects the skin and burns the cornea.

3. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1 Policy Framework

The Project to Construct Two Faecal Sludge Disposal and Treatment Plants is fully consistent with the objectives and policies defined by the Government of the Republic of Mali, the achievement and implementation of which will contribute to improving the population's living environment. The policies include the Growth and Poverty Reduction Strategy Paper, the National Sanitation Policy, the General Policy Statement by the Prime Minister, the National Land Use Planning Policy, the National Environmental Action Plan, and the National Climate Change Policy.

3.2 National Legal Framework

The project's legal framework comprises laws, decrees and orders governing the environment in Mali. These include Law No. 01-020/AN/RM of 30 May 2001 on pollution and nuisances (basic principles of pollution and nuisance control), Decree No. 08-346/P-RM of 26 June 2008, as amended by Decree No. 09-318/P-RM of 26 June 2009, on environmental and social impact assessment (ESIA rules and procedures), Decree No. 01-397/P-RM of 6 September 2001 (conditions for managing air pollutants), Decree No. 01-396/P-RM of 6 September 2001 (conditions for managing sound pollutants), Inter-Ministerial Order No. 2013/0256/MEAEE-MATDAT-SG of 29 January 2013 (conditions for organizing public consultations on environmental and social impact assessment) and Inter-Ministerial Order No. 10-1509/MEAEE-MIIC-MEF of 11 May 2010 (conditions for paying and managing environmental and social impact assessment costs).

Specifically, the sanitation sector is governed by the following regulatory instruments: Decree No. 01-395/P-RM of 6 September 2001(conditions for managing wastewater and human waste), Decree No. 01-394/P-RM of 6 September 2001 (conditions for managing solid wastes); Inter-Ministerial Order No. 0-0767/MEA/MEIC/MEME/SG of 6 April 2009 (application of Malian wastewater disposal standards), and Decree No. 2014-0572/P-RM of 22 July 2014 (details on powers devolved by the State to Local Authorities in sanitation and pollution and nuisance control).

Involuntary displacement of the population on the works rights-of-way is governed by Law No. 02-008 of 12 February 2002 on the amendment and ratification of Ordinance No. 00-27/P-RM of 22 March 2000 on the State Property and Land Tenure Code, Decree No. 2015-0538/P-RM of 6 August 2015 (fixing the transfer prices and royalties on urban and rural land located in the private landed property of the State that is used for commercial, industrial, artisanal, school, office, housing and related purposes), and Order No. 2014-1979/MDR-SG fixing the rates of compensation for plants, plant products, growing crops and farmlands throughout the country.

3.3 International Conventions

In compliance with its commitment to work for environmental conservation, the Republic of Mali has signed and/or ratified many conventions in the environment sector. The conventions include the African Convention on the Conservation of Nature and Natural Resources signed in Maputo in 2003 to ensure sustainable development of African economies, the Kyoto Protocol to the United Nations Framework Convention on Climate Change adopted on 11 December 1997 in Kyoto (Japan), the Montreal Protocol on Substances that Deplete the Ozone Layer adopted on 16 September 1987 in Montreal (Quebec), the United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa, adopted on 14 May 1994 in Paris (France), the Convention on Wetlands of International Importance, Especially as Waterfowl Habitat adopted on 2 February 2000 in Ramsar (Iran), the Convention on International Trade in Endangered Species of Wild Fauna and Flora adopted on 3 March 1973 in Washington (USA), the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal adopted on 22 March 1989 (Basel–Switzerland), and the Convention for the Safeguarding of the Intangible Cultural Heritage.

3.4 Administrative Framework

The Ministry of Environment, Sanitation and Sustainable Development oversees environmental management in Mali. The National Sanitation and Pollution and Nuisance Control Department (DNACPN), which is under the authority of this Ministry, supervises and

controls ESIA procedures. In addition, it prepares and ensures compliance with sanitation, pollution and nuisance standards. Under this project, many technical services will work, alongside DNACPN, with the local authorities concerned by the project in validating the Terms of Reference of the ESIA report and in monitoring the works.

The services belonging to various Ministries are: ANGENSEM, DNUH, SOMAPEP, DNEF, DNPC, DGPC, DNS, DNDS, the Bamako District Municipality, and Municipalities VI and I.

3.5 Bank Safeguard Policies

Classified under Environmental Category 1, the Project to Construct Two Faecal Sludge Disposal and Treatment Plants falls within the five (5) AfDB Operational Safeguards:

- Operational Safeguard 1: Environmental and Social Assessment;
- Operational Safeguard 2: Involuntary Resettlement: Land Acquisition, Population Displacement and Compensation;
- Operational Safeguard 3 : Biodiversity and Ecosystem Services;
- Operational Safeguard 4 : Pollution Prevention and Control, Greenhouse Gases, Hazardous Materials and Resource Efficiency;
- Operational Safeguard 5: Labour Conditions, Health and Safety.

The other relevant policies and guidelines are applicable as soon as they are triggered under the Integrated Safeguards System (ISS). They mainly include (without being exhaustive):

- Bank Gender Policy (2001);
- Framework for Enhanced Engagement with Civil Society Organizations (2012);
- Disclosure and Access to Information Policy (2012);
- Handbook on Stakeholder Consultation and Participation in Bank Operations (2001);
- Bank Policy on Population and Strategies for Implementation (2002);
- Environmental and Social Assessment Procedures for Bank Operations (2015).

4 DESCRIPTION OF PROJECT ENVIRONMENT

4.1 Description of Biophysical Environment

4.1.1 Climate Data

The project impact area is located in Bamako District, mainly in Municipalities I (Sotuba neighbourhood) and VI (Dianéguéla neighbourhood). It has a Sudanese-type climate with two distinct seasons, a dry season (November to May) and a rainy season (June to October). It has an average rainfall (1960-2014) of about 1000 mm. The mean annual maximum temperature recorded from 1960 to 2009 stood at 34.5°C, while the minimum temperature over the same period stood at 21.42°C.

Furthermore, average wind speed between 2006 and 2014 was 9.44 km/h, with wind directions generally parallel to the flow of the Niger River in the study area.

- *Climatic warming*

0.8°C variation in maximum temperatures has been recorded throughout the country over the past three decades. However, all the envisaged scenarios show that the country is a carbon sink.

- *Air quality*

Air in Bamako is highly polluted. The current daily average threshold value for PM 10 (fine particulates dangerous for the respiratory system) in the town is 72 ɥg/m^3, as against a limit value of 40 ɥg/m^3 considered in the 2008/50/CE European guideline. Mali does not have national air quality standards. The WHO standards are the references considered. The last study conducted by Aria Technologies (January 2015) on air pollution in Bamako showed that Bamako District is polluted by particulates, specifically nitrate (NO_2), benzene (CH_4), sulphur dioxide (SO_2) and carbon dioxide (CO_2).

Insufficient temporary sites, irregular waste collection, and insufficient appropriate facilities for waste storage and disposal compel some people to throw waste into streams. In addition, the river bed is used for market gardening in the dry season.

4.1.2 Relief and Pedology

The landform in the Sotuba project site area is relatively flat. Dianéguéla site comprises a lateritic hill near the river, and its outlet is found in a flat area on the banks of the river. The soils are clayey to sandy-clay in Sotuba and lateritic to sandy-clay in Dianéguéla. The river banks are suitable for the cultivation of various urban crops (not only market gardening, but also cereal farming). Owing to their geomorphological nature (alluvial terrace), the lands are sedimentary formations that transport various alluvial solid wastes, depending on the force of urban watershed runoffs.

4.1.3 Vegetation

The vegetation of the project area is uneven, comprising a few scattered patches of trees and shrubs. There are also roadside trees and grooves. Many plant species have been identified in the project area. They are local species (nere, baobab, borassus palm, doum palms, desert date palms, *Spondias mombin, acacia spp*, etc.) and planted trees in the marketing gardening sites on the river banks (mango trees, banana trees, orange trees, lemon trees and pawpaw trees).

There are also various species on the banks of the Niger River, along the Dianéguéla site. In addition to *Guiera senegalensis*, there are many local protected species along the river banks on Sotuba site. The site harbours *Bombax costatum, Parkia biglobosa, Borassus aethiopium, Acacia spp*, etc.

The above-mentioned local species are partially or wholly protected by Malian forestry regulations. Grass species include: *Cenchrus biflorus, Amorphophallus aphyllus, Cynodon dactylon, Andropogon spp, Crotalaria spp*, etc. There are aquatic plants along the river banks, especially hyacinth and fresh water lettuce (characteristic of water pollution).

4.1.4 Wildlife

Land and aquatic fauna mainly comprises reptiles, birds and fresh water fish. Common bird species are pigeons and turtledoves. A large number of them take refuge during the dry season in the many islets located on the Niger River. Fish is becoming increasingly rare due to pressure from fishermen and river water pollution. The fish species are *Barbus spp, Alex dentex, Tilapias spp, Synodontis spp, Mormyrus spp, Clarias anguilaris, Citharinus spp, Distichodus brevipinnis and Barillus senegalensis.*

4.1.5 Hydrography

The Niger River is the major river flowing along the sites selected. It skirts Bamako town over a distance of about 30 km. The Niger River is the outlet for faecal sludge treatment plants (Sotuba and Dianéguéla). It is the catchment area for water supply to Bamako from Kabala, Baco Djicoroni, Magnambougou and Missabougou package plants. The Niger River is also a fishing and recreation area for the population during very hot periods.

However, the quality of its water is degraded by liquid (domestic and industrial wastewater) and solid (river bank backfilling and solid waste storage) waste discharges. The characteristics of river water at ENSUP and in Moribabougou are presented in the table below.

Table 1
Characteristics of River Water at ENSUP and in Moribabougou

Description	ENSUP	Moribabougou
pH	7.76	7.76
Conductivity	58.5	49.3
Temperature (°C)	24.3	24.6
NO_3	0.01	0.03
NH^{4+}	0.44	0.57
PO^{3-}_4	0.17	0.8
SS	7	6
O_2	7.86	7.33
Colour	2060	0
Turbidity	2	2

Source: National Water Laboratory, Bulletin No. 2-2015: Monitoring of Niger River Water Quality

4.2 Human Environment

4.2.1 Administrative and Demographic Data

The project impact area is located in Bamako District, mainly in Municipalities I (Sotuba) and VI (Dianéguéla). The surface area of Dianéguéla site (rural homestead of Magnambougou) is 20 hectares and Sotuba Institute of Rural Economy (IER) site covers 25 hectares. According

to the 2009 General Population and Housing Census (RGPH), 13 801 people (6 827 of them women) live in Sotuba and 20 982 (10 259 of them women) in Dianéguéla. There are 2 342 households in Sotuba (5.9 persons per household) and 3 327 in Dianéguéla (6.3 persons per household). The population comprises people of various denominations (Muslims, Christians and animists) who earn a livelihood through various urban activities (trade, mechanics, market gardening, etc.). The extended project impact area covers the entire Bamako District.

4.2.2 Education

Pupils and students are in the various levels of education in Bamako District, namely preschool, primary, secondary, university and vocational education.

Municipality I under which Sotuba neighbourhood falls has 73 Government schools, 129 private schools, 16 community schools and 50 madrasas. First cycle enrolment stands at 59 555 pupils, 30 214 of them boys (50.7%) and 29 341 girls (49.3%) for 1 282 classrooms. The pupil/classroom ratio is 46.45. Furthermore, at CAP in Sogoniko which covers Dianéguéla neighbourhood, there are 7 080 pupils in the first cycle for 860 elementary school teachers. CAP has 21 685 students, 10 857 of them girls, in the second cycle.

The educational institutions in the project impact area are the Dianéguéla Institute of Finance and the Sotuba Institute of Rural Economy. The former is located on the right-of-way of the Dianéguéla plant site and part of IER site will be used for the project.

4.2.3 Health

Health is one of the important factors in ensuring the population’s well-being. There are various health services at all levels in Municipalities I and VI. The existing health services are: the Mali University Teaching Hospital (CHU), the Referral Health Centres of Municipalities I and VI, and the Community Health Centres of Sotuba and Dianéguéla neighbourhoods. There are clinics and physician’s offices in the project area. The technical facilities depend on the level of the health service.

Malaria is the most common disease and the primary cause for consultations in health services. Measles and cholera epidemics have been recorded nationwide. The national HIV/AIDS prevalence rate is 1.1%.

4.2.4 Agriculture

Intensive farming is practised in the project area for lack of space due to pressure on land. Market garden crops, dry crops, shrubs and trees are cultivated, depending on the season.

The main crops grown on Dianéguéla site are sweet potato, celery, lettuce, maize, okra, rice, common sorrel, parsley, pepper, mint, carrot, eggplant, beet, sorghum, etc. Sotuba site is used for agricultural experimentation by the Institute of Rural Economy (IER) for the cultivation of groundnut, millet, sorghum, maize, etc.

Market gardening equipment is quite rudimentary, comprising hoes, sumps and sprayers. The various fertilizers used are urea and cotton complex. Lack of equipment and working capital for inputs replacement are the major constraints noted.

4.2.5 Livestock Production

Many animals are bred in Bamako District, namely cattle, sheep, goats and poultry. It involves pastureland animal production, using the loose-housing system. The banks of the Niger River are used for watering animals, mostly cattle. Furthermore, cage fish farming is developing. There are very few stock breeding activities on the sites due to constraints (presence of buildings, fences, etc.).

4.2.6 Trade

Trade is one of the most important activities carried out in Bamako District and municipalities covered by the project. It is carried out in the various markets and developed areas (motor parks, etc.). Markets are open daily. All municipalities have at least one market. The main markets in Bamako are the Main Market (Grand Marché), the Medine Market, the Halles de Mamako Market and the Crafts Centre commonly called "Artisanat". Agricultural products are the main products sold on the various markets. Dianéguéla neighbourhood has a market.

4.2.7 Tourism

The discrete attractions of Bamako are the monuments and squares built to promote the country's cultural and historical heritage for the intellectual development of its citizens. The brickworks sites, the Niger River, and the IER site are its tourist attractions.

4.2.8 Employment and Poverty

Job creation is the permanent concern of decision-makers. According to EMOP (2016), there are 66 297 (3.2%) unemployed people (working population without a remunerated activity) in Bamako District, 26 230 of them men (39.6%) and 40 067 women (60.4%). The bulk of unemployed people are youths aged between 20 years and 30 years. Farming is the main activity carried out by job-seeking youths.

5 PRESENTATION AND SELECTION OF PROJECT OPTION

5.1 Analysis of the "With Project" and "Without Project" Alternatives

5.1.1 "Without Project" Alternative

The "without project" alternative is untenable for Bamako, and will result in:

5.1.1.1 Maintenance of existing ecosystems

The current situation will allow the existing ecosystems to be conserved and land use to be maintained. Many partially or wholly protected plant species identified on the sites could be preserved.

However, current wildlife habitats will increasingly be degraded by the cumulative effect of domestic and industrial waste discharges (tanneries, dye-works, etc.) and land pressure on the river banks. Water contamination by heavy metals (arsenic, lead, colorants, etc.) will increase the scarcity of fish species sensitive to environmental degradation (mainly scaleless fish). There will be the proliferation of aquatic plant species (*Typha Australis, Salvigna Molesta,* etc.).

5.1.1.2 Damage to the living environment

The living environment is an essential element in the harmonious development of people. Sanitation-related difficulties are among the major challenges to be addressed in Bamako. Sanitation infrastructure is insufficient and dilapidated. The town does not have faecal sludge disposal and treatment plants. Such a situation promotes proliferation of illegal disposal sites and will cause conflicts with the people living around the current sites. Many conflicts have erupted in Mandé municipalities and with the population of Gouana (near the airport sites) because of inconveniences caused by odours and trickling of wastewater toward houses. Many households in the various neighbourhoods do not have sceptic tanks, leading to connections to gutters or discharges into the streets during rainy periods, with the resulting unpleasant odours, fly breeding and disfigurement of the environment.

5.1.1.3 Increase in cases of diseases due to unhygienic living conditions

The presence of liquid and solid wastes near dwellings is one of the major sources of diseases in Bamako. Malaria accounts for more than 50% of consultations. The anopheles mosquito is the main vector of the disease, and breeds in wastewater bodies surrounding dwellings and in unhygienic environments. In addition, the sludge disposal staff are exposed to skin and respiratory infections, as well as olfactory problems. These same health problems are faced by the population living around disposal sites. They are expected to worsen with the proliferation of disorderly sites.

5.1.1.4 Pollution of the Niger River

The Niger River is the main source of water supply to Bamako. Lack of a faecal sludge treatment and disposal plant compounds the pollution of water in the river because it is the main outlet for domestic and industrial liquid wastes. Such a situation leads to growth of aquatic plants. Many fish species sensitive to environmental degradation are extinct, and the cost of water treatment by SOMAGEP is increasing.

5.1.1. 5 Insufficient and dilapidated sanitation equipment and facilities

Bamako has about one hundred vacuum trucks for a population of 1 810 366 inhabitants, divided into 137 355 households, according to the 2009 General Population and Housing Census. Some of these trucks, which are generally used trucks, are defective. As a result, each truck serves 1 373 households, which means a lot of pressure on the truck. With population growth, the situation is likely to worsen. In addition, the town does not have any faecal sludge treatment plant. The current situation, if maintained, will be compounded by the lack of management infrastructure, as well as insufficient number of vacuum trucks and unskilled cesspit emptiers.

5.1.1.6 Increased sludge drainage cost and acts of civil irresponsibility

High pressure on equipment and facilities, taxing of disposal sites, and distance from disposal areas will increase the cost of sludge drainage. The current cost varies from CFAF 12 000 to CFAF 40 000 per drainage trip.

5.1.1.7 Deterioration in the population's living standard

The lack of hygiene and sanitation will lead to a fall in the standard of living of people in Bamako, especially those living near disposal sites. The affected persons, mainly those living in the suburbs of the town, are the vulnerable population segments, given their low income.

5.1.2 "With Project" Alternative

5.1.2.1 Technical solutions adopted and alternatives explored

The project engineering design is mainly based on a benchmark of standalone (private) technical sewage disposal solutions, which represent more than 99% of Bamako's system. There is currently no infrastructure for treating effluents from these standalone systems. The construction of faecal sludge treatment plants will address the requirements of the current context thanks to the development of technologies that are more adapted to private disposal systems. Consequently, the decision was taken to establish domestic faecal sludge disposal and treatment plants. However, the system will improve progressively in the long term towards the construction of wastewater collection networks and affiliated treatment plants. This trend will continue as the system matures to collective sanitation (requiring more advanced technologies), at the expense of the current private systems.

Consequently, in Bamako's current context, which is largely dominated by private systems, this project's benchmark or "technical package" of possible sanitation solutions comprises: (i) the construction of two (2) household faecal sludge disposal and treatment plants (1 FSDTP on each bank of the Niger River); and (ii) the delivery to FSDTPs of about thirty vacuum trucks to improve the collection and transportation of sludge for treatment. This will help not only to increase the operating output of FSDTPs, but also to prevent clandestine effluent discharges which create unsafe hygiene conditions conducive to a high prevalence of water-borne diseases, especially among the most vulnerable population segments.

This will reduce discomfort-related conflicts between the population and cesspit emptiers caused by the presence of the sites (unpleasant odours, fly breeding, disfigurement of the environment, etc.). The construction of faecal sludge treatment and disposal plants will also contribute to reducing illegal disposal sites.

5.1.2.2 Closeness of disposal sites

The environmental criteria for the selection of Sotuba and Dianéguéla sites are: availability of sites, distance from water catchment areas, low energy requirement, accessibility, low site occupation level, and position in relation to dwellings (wind direction).

Municipalities VI and I, which are close to Kati area, have land potential. They are also home to 49% of households in Bamako and 804 748 people (that is 44.5% of the population of Bamako District). As a result, the selection of Sotuba and Dianéguéla sites will help to bring the cesspit emptiers of the said municipalities closer to the developed disposal sites, as well as reduce the current sludge drainage cost per household estimated at between CFAF 12 000 and CFAF 40 000. It should be noted that the poverty line in Mali is estimated at CFAF 175 000 (EMOP 2014).

5.1.2.3 Environmental conservation and health of the local population

Activated sludge biological treatment with solar sludge drying is the treatment method adopted for the Sotuba and Dianéguéla faecal sludge treatment plants. This method will help to considerably mitigate the inconveniences caused by nauseating odours and fly breeding on the sites to the local population. Furthermore, with securement of the land on which the sites are located (acquisition and fencing off), the transition from FSTP to UWTP will not require new land expansion.

5.1.2.4 Improvement of the Niger River water quality

The construction of FSTPs will reduce waste discharges into the Niger River. This will also lead to proliferation of aquatic plants, improved water quality, and reduced cost of water treatment by SOMAGEP.

5.1.2.5 Improvement of the living environment

Bamako, like other major capitals, will improve its liquid and solid waste management by constructing faecal sludge treatment and disposal plants. This will contribute to creating a living environment suitable for harmonious development of the population and to controlling the waste stream resulting from population growth.

5.1.2.6 Improvement of access to organic fertilizers

The banks of the Niger River are areas for intensive market gardening activities. Hence, dry materials from the plants will be developed for agricultural purposes. Such is one of the wishes expressed by market gardeners, most of them women.

5.2 Comparative Analysis of the Various Alternatives

A comparative analysis of the advantages and disadvantages of the various alternatives is presented in the table below.

Table 2
Comparative Analysis of the Various Alternatives

Criteria	Alternative		Remarks
	Without Project	With Project	
Sanitation of the living environment	---	+++	
Conservation of water quality	---	+++	
Biodiversity conservation	---	+++	
Service accessibility	--	+++	Closeness to households
Treatment costs	N/A	+++	
Health impacts	---	+++	
Job creation	--	+++	Linked to the development of products
Climatic warming	---	+++	
Land use	---	+++	Less demand for plots
Quality of effluents		+++	Improved quality of effluents discharged
Air pollution and sound nuisances	--	++	Far from dwellings and reduced contact areas

The findings contained in the matrix show that the “with project” option is a more desirable option.

6 POTENTIAL IMPACTS AND MITIGATION AND ENHANCEMENT MEASURES

6.1 Positive Project Impacts

6.1.1 During the Construction Phase

6.1.1.1 Job creation

Hundreds of direct and indirect jobs will be created by construction site works and the operation of construction site offices and workers' camps. The labour force in great demand will be builders, labourers and drivers. This situation will reduce youth unemployment in the target areas and improve the income of vulnerable population segments.

6.1.1.2 Creation of income-generating activities

The presence of construction site workers and their food needs will encourage the development of income-generating activities near the sites. Specifically, these activities will comprise petty trade (cigarettes, telephone airtime refill, drinks, etc.) and eating places.

6.1.1.3 Improved turnover of local suppliers and service providers

The procurement of office equipment and supplies, fuels, cement, sand, etc. for contractors will improve the turnover of local suppliers.

The same will be true for local service providers in civil engineering, soil analysis and working design.

6.1.1.4 Improvement of the skills and practical experience of trainees

Faecal sludge treatment plant construction works will provide an opportunity for student trainees to improve their skills in the construction of this type of infrastructure. Further or apprenticeship training could focus on equipment assembly and maintenance, civil engineering, laying of membranes, etc.

6.1.2 During Faecal Sludge Treatment Plant Operation Phase

6.1.2.1 Improvement of the population's living environment

The construction and operation of FSTPs will positively impact the population's living environment. The project will lead to the closure of disorderly disposal sites and elimination of the attendant discomforts (unpleasant odours, flow of faecal sludge near dwellings, sound nuisances generated by disposal equipment and facilities, etc.). The population's living environment will be sanitized.

6.1.2.2 Reduction in cases of diseases due to unhygienic living conditions

Many common diseases in Bamako are caused by lack of sanitation. The project implementation will reduce the prevalence of many of them. The risks related to the discharge of sludge from health infrastructure will also be reduced. Wastewater bodies and insect and microbe-infested human waste will be eliminated by dewatering.

6.1.2.3 Job creation and improved financial resource mobilization by the communities

Sustainable jobs will be created by the operation of FSTPs and the development of sludge treatment by-products for agricultural purposes (watchmen, drivers, machine operators, mechanics, vendors, truck rental intermediaries, operator's suppliers, etc.).

Furthermore, the various commercial activities will lead to improved municipal tax collection (parking fees, business licence, discharge fee, etc.) in the municipalities concerned.

6.1.2.4 Improved access to FSTP-related sanitation services by the population

The location of the faecal sludge treatment plants will facilitate access to the sites by the cesspit emptiers of the various municipalities in Bamako District.

6.1.2.5 Improved river water quality and reduced water treatment costs

The good quality of effluents from the activated sludge biological treatment process will reduce water pollution after discharge. This will lead to reduced costs of treating water collected by the package plants.

6.1.2.6 Improved Niger River biodiversity

Water quality is an essential element for the survival of Niger River biodiversity. The good quality of discharges from FSTPs will contribute to preventing the extinction of water pollution-sensitive fish species. It will also help to control plants that pollute water.

6.1.2.7 Improved wastewater and human waste management and treatment framework

The construction of FSTPs will foster the establishment of a platform for meetings and discussions between cesspit emptiers operating on these sites. This platform could facilitate the formation of associations within the group.

6.1.2.8 Improved farmer access to low-cost organic fertilizers

The banks of the Niger River in Bamako are dotted with market gardening plots. Most farmers use inorganic fertilizers to provide nutrients for their crops. The construction of FSTPs will facilitate access to low-cost organic fertilizers. The current price of a bag of urea is CFAF 10 500, compared with a bag of sludge which could be sold for less than CFAF 3,000. In addition to the low price, treated faecal sludge will improve the soil.

6.2 Negative Project Impacts

6.2.1 During the Worksite Installation Phase

6.2.1.1 Destruction of vegetation cover

The felling of trees along the site rights-of-way will lead to the destruction of vegetation cover on the sites. Some local species (African locust, shea tree, palmyra tree, African mahogany,

etc.) are partially or wholly protected by national regulations. Three hundred (300) eucalyptus trees, 80 mango trees, and 10 shea trees have been identified on Dianéguéla site.

6.2.1.2 Destruction of property and various networks located on the site rights-of-way

The freeing and cleaning of the faecal sludge treatment plant rights-of-way will lead to involuntary displacement of the population and the loss of land. The property likely to be affected in Dianéguéla comprise 9 villas, 18 unregistered plots of land, 15 buildings under construction, 1 artisanal soap factory, 6 businesses, 1 filling station and 1 Finance Institute. Concerning Sotuba site, the faecal sludge treatment plant will be constructed on part of the land title.

6.2.1.3 Risks of conflicts due to occupation of the project rights-of-way

Sotuba site is part and parcel of the land title on which the Institute of Rural Economy, which is a research institution affiliated to the Ministry of Agriculture, is built. The occupation of Dianéguéla site (rural homestead of Magnambougou) is likely to create conflicts due to involuntary displacement (refusal to quit, late compensation, dissatisfaction with compensation and resettlement, etc.).

6.2.1.4 Risk of accidents resulting from the handling of site equipment and materials

Accidents involving site equipment and materials are likely to occur during installation works. They will mainly be road accidents during the conveyance of materials and equipment, and accidents due to the handling of equipment (saws, hammers, shovels, etc.).

6.2.1.5 Loss of landscape harmony

Freeing of rights-of-way will entail the removal of trees, buildings and landforms that make up the landscape in the works rights-of-way. This will result in loss of harmony and bearing for persons who frequent these places.

The storage of scrap material and site waste will also contribute to rendering the sites unhealthy.

6.2.1.6 Sound nuisances

The movement of site vehicles and machines, as well as generators will cause sound nuisances likely to disrupt the calm of the local population during the works. Wildlife that frequent the sites may also be scared away.

6.2.2 During the Construction Phase

6.2.2.1 Soil pollution resulting from hydrocarbon and used oil spills

The repair and maintenance of vehicles and machines on the sites will cause soiling by hydrocarbon and used oil spills. This could lead to soil contamination or pollution.

6.2.2.2 Soil remolding and compaction

The development of watersheds and excavation works will change the soil profile. Pool floor excavation and compaction works will also affect soil structure.

6.2.2.3 Risk of accidents resulting from the handling of equipment and materials

Accidents involving site materials and equipment are likely to occur during works. They will mainly be road accidents during the conveyance of materials and equipment, falls and accidents due to the handling of equipment.

6.2.2.4 Increased GHG emissions resulting from fuel combustion in site vehicle, machine and equipment engines

During the works, CO_2 emitted from the combustion of fuel used to operate the engines of vehicles, machines and generators will contribute to increasing greenhouse effect. However, Mali's absorption capacity will considerably mitigate this risk. In fact, the country is considered as a carbon sink in all scenarios.

6.2.2.5 Scaring away of wildlife

Noises produced by human presence and construction site machines will scare away wildlife living in the project sites. The wildlife comprises birds, fish, reptiles, etc.

6.2.2.6 Health risks

The intermingling of worksite staff with each other and with street vendors is likely to expose staff to health risks. The common diseases are acute respiratory infections, skin infections, conjunctivitis and digestive disorders. There is also the risk of sexually transmitted diseases and exposure to epidemics.

6.2.3 Negative Impacts during the Operation Phase

6.2.3.1 Risk of water table pollution by infiltration or runoff

Groundwater may be polluted by the accidental infiltration of leachate from lagoons and drying areas. This could result from the dilapidated state of geotextile membranes or accidental degradation (perforation).

6.2.3.2 Emission of offensive odours

Gas emissions from the spread of sludge on drying areas and sludge treatment dysfunctions will pollute the air in the project right-of-way. This could create discomfort and conflict with the local population of the sites under construction.

6.2.3.3 Sound nuisances from sludge disposal and the operation of generators

Noises produced by the operation of generators, as well as disposal equipment and plant vehicles and trucks will cause sound nuisances in the immediate environment of the activities concerned. However, the 100 m safety area will mitigate these nuisances.

6.2.3.4 Health risk related to closeness to faecal sludge

Gas emissions from sludge disposal and lagooning will cause skin infections, respiratory infections, and lesions of the cornea of operators involved in the activities.

6.2.4 Cumulative Impacts

There are several projects in Bamako aimed at improving the sanitation of the living environment; they include:

- Freeing of the rights-of-way of roads across the town;
- Construction of a dye-work water treatment plant in Sotuba;
- Sanitation works in Bamako ahead of the Africa-France Summit.

Several projects likely to impact the Project to Construct Two Faecal Sludge Disposal and Treatment Plants have also been launched, namely:

- Silt Control in the Niger River;
- Extension of the corniche road between the Martyrs Bridge and the 3rd bridge.

The cumulative impacts resulting from the synergy between the various potential impacts are presented in the table below.

Table 3
Potential Cumulative Impacts

Description	Construction Phase	Operation Phase
Positive Impacts	Increased temporary job creation; Increased staff income; Creation of income-generating activities (petty trade, beaneries); Improved turnover of suppliers and service providers; Reduced insecurity of vulnerable populations.	Reduced Niger River water pollution; Improved sanitation in Bamako; Improved living environment; Improved public health; Improved urban mobility; Creation of sustainable jobs in maintenance of the infrastructure and facilities constructed.
Negative Impacts	Increased involuntary population displacement along the river banks; Sharp increase in site waste production; Increased risk of site-related accidents; Destruction of vegetation cover; Increased air pollution; Land use-related conflicts; Increased water needs.	NTR

6.3 Mitigation and Enhancement Measures

The main project implementation-related impact mitigation and enhancement measures are presented in the table below.

Table 4
Potential Project Impact Mitigation and Enhancement Measures

Receptor	Phase	Impacts	Mitigation and Enhancement Measures
Air	Construction	Ambient air pollution by dust generated by construction works	Water construction sites with very high dust emissions; Humidify lateritic materials in the borrow pit prior to their use during road development works; Oblige truck drivers to protect the materials transported using tarpaulin to fully cover them in order to avoid their dispersal or spreading; Limit the speed of construction machines to 30 km/h when moving through urban centres and on the construction site; Pave roads leading to faecal sludge treatment plants.
		Discomfort and inconvenience caused to local residents by dust emissions	Inform and sensitize the local population on dust-generating works.
		Deterioration of air quality by pollutant gases and particulates	Ensure regular maintenance of construction equipment and facilities.
	Operation	Emission of foul gases due to sludge treatment and disposal	Apply activated carbon; Reduce exchange space between air and decanted sludge; Create a vegetation screen around faecal sludge treatment plants in order to reduce odours; Maintain a minimum distance of 100 metres from houses (NF EN 12 255-5 Standard); Cover waste disposal sites equipped with air ventilation and filtration systems.
Climate	Construction	Emission of CO_2 (GHG) by vehicles	Ensure regular maintenance of construction site equipment and facilities; Take CO_2 emission rate into account when selecting construction machines and vehicles.
		Felling of trees and shrubs serving as carbon sinks	Reduce tree felling to the bare minimum.
	Operation	CO_2 and CH_4 (GHG) emission	Establish a gas recovery system; Train the staff of sanitation facilities in greenhouse effect issues.

Table 4
Potential Project Impact Mitigation and Enhancement Measures (continued)

Receptor	Phase	Impacts	Mitigation and Enhancement Measures
Soil	Construction	Modification of land use	Inform and sensitize the local population on the operation of faecal sludge treatment plants (FSTPs).
		Land use modification-related conflicts	Obtain the necessary titles of ownership; Inform and sensitize the local population on the operation of FSTPs
		Restructuring of the soil profile; Soil compaction; Destruction of topsoil in the project site rights-of-way; Water erosion; Soiling.	Prohibit discharge of off-specification liquid waste on the ground; Limit, as much as possible, construction site cleaning to the works right-of-way; Build facilities on impermeable soil; Construct toilets with watertight cesspools for workers.
	Operation	Soil pollution by leachate from sludge and leakages from spiro trucks	Construct a watertight platform for drying sludge; Lay geomembranes to protect the soil from infiltration through ponds; Provide FSTP operators with soil decontamination equipment; Prevent access to the construction site by tank trucks that are not watertight.
		Limitation of spaces due to the volume of sludge to be dried.	Store sludge in sealed containers.
		Reduction of soil pollution due to the disposal of faecal sludge on illegal sites.	Regularly monitor soil pollution indicators; Prohibit and impose sanctions against sludge disposal on illegal sites; Make disposal of sludge in the plants constructed affordable.
		Improvement of the quality of treated sludge.	Regularly collect and analyze the chemical load of sludge before its recycling as compost for agricultural purposes.
Surface water	Construction	Risk of silting due to non-reusable construction site scrap and waste	Prohibit dumping of liquid waste and non-reusable scrap from the construction site on river beds.
		Water contamination/ pollution through the discharge of liquid and solid waste from construction sites	Prohibit the maintenance and cleaning of equipment and materials less than 100 metres from rivers; Identify and construct a waste storage area on the construction site.
	Operation	Reduction of pollution of the waters of River Niger	Inform and sensitize the population on risks related to the pollution of the river through the discharge of liquid and solid waste; Encourage the construction of sceptic tanks in health facilities (community health centres, reference health centres and the University Teaching Hospital);

			Ensure regular monitoring of surface water pollution indicators; Include the construction of liquid waste pre-treatment plants in the specifications of industrial units.

Table 4
Potential Project Impact Mitigation and Enhancement Measures (continued)

Receptor	Phase	Impacts	Mitigation and Enhancement Measures
Surface water	Operation	Reduction of drinking water treatment cost in package plants	Encourage river water depollution initiatives; Inform and sensitize women dyers on risks associated with the disposal of dyeing wastewater into the river; Design a project to control aquatic weeds (hyacinthus, freshwater lettuce, etc.).
Groundwater	Construction	Groundwater contamination/ pollution through discharge of liquid waste from construction sites	Design tanks such as to leave sufficient depth to protect groundwater; Prohibit waste disposal that does not comply with disposal standards; Build sealed sludge traps to manage wastewater in the workers' camp.
	Operation	Risk of groundwater contamination by leachate through the disposal of faecal sludge	Build concrete parterres for sludge drying; Store sludge in tanks; Build boreholes to monitor groundwater quality.
		Reduction of risk of water-table pollution on temporary and illegal disposal sites	Sensitize and train operating staff and cesspit emptiers responsible for the collection, transfer and treatment of faecal sludge; Prohibit and impose sanctions against the discharge of waste on disorderly disposal sites.
		Accidental pollution of water table by leachate emanating from dumped faecal sludge	Ensure day-to-day monitoring of water quality; Lay geomembranes in all ponds; Establish a pollution warning mechanism.
Plants	Construction	Destruction of vegetation cover	Restrict tree felling in the works right-of-way; Replace felled trees; Inform and sensitize workers on the preservation of natural resources; Carry out landscape management in construction sites; Plant trees along main roads and around construction site fences.
		Reduction of local biodiversity	Integrate protected species into landscape management; Prevent, as much as possible, tree felling in the works right-of-way.
Wildlife	Construction	Destruction of wildlife habitats (borrows, shelters and trees)	Prohibit workers from fishing and hunting during the execution of construction works; Restrict logging to the barest minimum.
		Disruption of wildlife tranquility	Avoid unnecessary noise emission;

		Scaring away of wildlife	Encourage the use of low-noise making equipment; Soundproof the machine rooms of faecal sludge treatment plants.
	Operation	Disruption of wildlife tranquility	Ensure regular maintenance of soundproofed buildings; Prohibit unnecessary noise emissions; Sensitize the staff of FSTPs on wildlife preservation.
		Scaring away of wildlife	

Table 4
Potential Project Impact Mitigation and Enhancement Measures (continued)

Receptor	Phase	Impacts	Mitigation and Enhancement Measures
Noise environment	Construction	Modification of the noise environment in the works right-of-way	Use low-noise equipment (compressors, generators, power saws, etc.)
		Disruption of the tranquility of residents	Inform and sensitize local residents on noisy works; Avoid, as much as possible, noisy works during hours of rest,; Inform and sensitize workers on risks associated with work in a high-noise environment.
		Risk of noise-related conflicts	Establish a framework for the detection and exchange of views on complaints with local residents; Comply with working hours.
		Lack of concentration due to construction site noises	Reduce the period of worker exposure by modifying the distribution of time spent in noisy work stations; Equip workers exposed to high noise levels (+60 DBA) with personal protective equipment against noise (ear plugs, headbands and helmets).
	Operation	Modification of the noise environment	Make provision for soundproofing when designing machine rooms; Ensure regular maintenance of equipment and facilities; Create a vegetation screen around faecal sludge treatment plants; Take into account sound level during the procurement of equipment.
Health and safety	Construction	Risk of exposure to diseases	Establish a construction site health care unit; Organize a pre-recruitment medical check-up for new recruits by the Contractor; Organize medical check-ups for construction workers twice a year; Conduct tetanus immunization for all workers; Inform workers about construction site-related health hazards.
		Risk of accidents related to the	Equip workers with personal and collective

		handling of materials and equipment	protective equipment (helmets, boots or safety shoes, gloves, goggles and shoulder belts); Train workers in the use of materials and equipment; Ensure strict compliance with the wearing of PPE on construction sites; Set up a staff rescue team; Formally prohibit the use of drugs and the consumption of alcohol beverages on construction sites; Establish and monitor work execution and equipment handling procedures
		Fire hazards	Equip sensitive work stations with fire extinguishers; Train workers in the use of fire extinguishers.

Table 4

Potential Project Impact Mitigation and Enhancement Measures (continued)

Receptor	Phase	Impacts	Mitigation and Enhancement Measures
Health and safety	Construction	Risk of electrification and electrocution	Ensure regular verification of electric installations; Protect electric cables with sheaths.
	Operation	Health hazards associated with the handling of faecal sludge	Organize medical check-up of workers twice a year; Dry sludge to reduce health hazards (sterilization); Equip FSTPs with first-aid kits.
		Electrical hazards	Ensure regular verification of electric installations.
		Risk of accidents due to the dysfunction of equipment	Equip workers with PPE (overalls, shoulder belts, boots, goggles, gloves and helmets; Provide a first-aid kit; Prepare laboratory protocols; Signal danger zones (machine room and ponds); Post the traffic plan in FSTPs; Prepare work execution and equipment handling procedures; Organize an immersion session for persons who are unfamiliar with the sites; Ensure strict compliance with safety procedures. Put the list of contact persons and their access numbers on the construction site; Protect all electrical cables with sheaths.
		Fire hazards	Make provision for a fire hydrant in each plant site; Equip sensitive work stations with fire extinguishers; Train workers in the use of fire extinguishers; Identify an assembly point on the construction site.

		Reduction of cases of diseases due to unhygienic living conditions	Sensitize the population on risks due to unhygienic living conditions; Analyze sludge before developing it for use in agriculture.
		Health hazards associated with the handling of faecal sludge	Organize medical check-up of workers twice a year; Dry sludge to reduce health hazards (sterilization); Equip FSTPs with first-aid kits.
		Electrical hazards	Ensure regular verification of electric installations.

Table 4

Potential Project Impact Mitigation and Enhancement Measures (continued)

Receptor	Phase	Impacts	Mitigation and Enhancement Measures
Agriculture and livestock production	Construction	Destruction of experimental farms in the construction site in Sotuba	Pay compensation to persons whose crops are destroyed.
		Obstruction of the movement of animals.	Prevent access to construction sites by animals and unauthorized persons; Establish a security service; Fence the construction sites.
	Operation	Improvement of access to treated sludge-based organic fertilizer	Ensure extensive communication on the use of faecal sludge for agricultural purposes; Support the establishment of faecal sludge fertilizer business enterprises.
		Improvement of animal health	Regularly monitor the compliance of liquid discharges.
Trade	Construction	Destruction of buildings housing six shops	Pay compensation to the owners of the affected shops
		Development of income-generating activities (small shops)	Make provision for a shed for catering services and small shops
		Increase in the turnover of local suppliers of contractors	Give preference to local contractors for the supply of consumables.
	Operation	Creation of business opportunities for the development of treated sludge for use in agriculture	Provide support for the establishment of faecal sludge fertilizer business enterprises; Make provision for a place for traders at the entrance to the construction site.
		Reduction of cesspit emptying cost	Inform and sensitize sector players on the operation of FSTPs; Ensure regular maintenance of facilities; Establish a management framework involving all sector players.

Living environment	Construction	Modification of the living environment	Blend the project with the living environment; Inform and sensitize workers on the cleanliness of the working environment; Equip the construction site with changing rooms and catering sheds which are regularly maintained; Provide drinking water to construction workers under hygienic conditions.
	Operation	Improvement of the cleanliness of the living environment	Train cesspit emptiers in the collection and disposal of wastewater and human waste under secure conditions; Support the construction of septic tanks and cesspits in houses;
			Inform and sensitize the population on the sanitation of the living environment.

Table 4

Potential Project Impact Mitigation and Enhancement Measures (continued)

Receptor	Phase	Impacts	Mitigation and Enhancement Measures
Employment and mobilization of the financial resources by communities	Construction	Creation of temporary jobs	Give preference to the employment of the local labour force mainly in Municipalities VI (Sotuba) and I (Dianéguéla) concerned by the project; Encourage female applicants during recruitment; Monitor staff recruitment and management procedures stipulated by the Labour Code; Prepare and ensure compliance with construction site by-laws; Encourage the recruitment of local contractors for work subcontracted and the supply of goods and equipment; Organize apprenticeship and skills training for first-job seekers in the project area; Ensure compliance with regulations governing extra work.
		Substantial improvement of incomes	Take the minimum wage into account in wage determination.
	Operation	Creation of permanent jobs in the sector	Give preference to the recruitment of workers from the municipalities concerned for unskilled jobs in FSTPs; Provide entrepreneurship training to spiro truck owners; Encourage the development of waste recycling and reuse businesses; Establish a line of credit for the replacement of waste collection equipment (spiro trucks); Support the establishment of faecal sludge fertilizer business enterprises.
		Improvement in the financial resources collected by local authorities	Adapt the tax base to FSTPs and related activities
		Creation of temporary jobs	Give preference to the employment of the labour work force mainly in Municipalities VI

			(Sotuba) and I (Dianéguéla) concerned by the project; Encourage female applicants during recruitment; Monitor staff recruitment and management procedures stipulated by the Labour Code; Prepare and ensure compliance with construction site by-laws; Encourage the recruitment of local contractors for work subcontracted and the supply of goods and equipment; Organize apprenticeship and skills training for first-job seekers in the project area; Ensure compliance with regulations governing extra work.
Education	Construction	Destruction of the buildings of the Finance Institute; Loss of experimental farms in IER.	Pay compensation to persons whose property was destroyed; Provide support to persons whose property was destroyed for their resettlement.
		Improvement and enhancement of trainee occupational skills	Organize apprenticeship and skills training during construction works; Pay starting allowances to trainees.

Table 4

Potential Project Impact Mitigation and Enhancement Measures (continued)

Receptor	Phase	Impacts	Mitigation and Enhancement Measures
Education	Operation	Creation of a healthy learning and teaching environment	Ensure routine and regular maintenance of facilities
Sanitation	Construction	Production of different kinds of waste	Prepare a waste management and disposal plan; Develop a selective temporary waste disposal site on the parterre constructed; Monitor waste disposal; Form a cleaning team; Construct a sealed pit for the storage of construction site wastewater; Sign agreements with specialized enterprises for hazardous and special waste management and disposal; Recycle, as much as possible, waste collected.
		Unhygienic work environment	Inform and sensitize workers on the need to keep the working environment clean.
	Operation	Development of the town's faecal sludge treatment facility and equipment potential	Ensure routine and periodic maintenance of the facilities constructed; Monitor the performance of facilities built; Widely publicize the existence of FSTPs among the general public and sector players. Encourage the replacement of faecal sludge collection equipment;

			Train cesspit emptiers in the collection and secured transfer of faecal sludge.
		Reduction in disorderly waste disposal sites	Close all identified temporary and illegal sites; Inform and sensitize cesspit emptiers on the need to frequent FSTPs; Punish cases of non-compliance identified; Train media organizations on the promotion of FSTPs.
		Improvement of the faecal sludge management framework	Involve all sector stakeholders in the management of FSTPs; Ensure extensive communication on the operation of FSTPs; Train cesspit emptiers in the handling of collection and disposal equipment; Support the establishment of a coordination unit for cesspit emptiers in Bamako District; Support efforts to equip public premises with septic tanks and cesspits; Ensure the construction of pre-treatment plants in industrial units; Prohibit the use of vacuum trucks without watertight tanks.

Table 4

Potential Project Impact Mitigation and Enhancement Measures (continued)

Receptor	Phase	Impacts	Mitigation and Enhancement Measures
Infrastructure and cultural heritage	Construction	Destruction of underground networks (DWS, optical fibre, etc.) and houses	Identify and mark out underground network routes (water, telephone, etc.) before works start-up; Displace constraining networks; Pay compensation to persons whose houses were destroyed or weakened by construction works.
		Moral depravity due to behavioural change	Prevent access to construction sites by non-construction workers; Inform and sensitize staff on the need to comply with moral standards.
		Risk of destruction of buried historical vestiges	Suspend work upon discovery of historical vestiges; Inform specialized services for the adoption of appropriate measures.
	Operation	Enhancement of waste management infrastructure potential	Ensure regular routine maintenance

Conditions of women and other vulnerable groups	Construction	Creation of jobs accessible to vulnerable groups (women, youths, etc.)	Encourage female applicants during recruitment; Adopt positive discrimination in favour of women and other vulnerable persons during recruitment.
		Risk of accidents involving vulnerable groups on construction sites	Inform and sensitize staff on construction site-related risks; Provide crossing points to excavation areas; Signal drain networks. Limit the speed of vehicles and trucks to 30 km/h in areas with a high population density; Choose routes with a low population density; Inform and sensitize drivers on the highway code.
		Development of income-generating activities	Construct a sales shed at the entrance of construction sites.
	Operation	Reduction of health risks related to the unhygienic living environment of vulnerable groups	Inform and sensitize the population on the construction of sceptic tanks in compounds that have none; Promote healthy living environments; Provide for access by people with disabilities.
		Creation of jobs in the faecal sludge treatment sector	Encourage female applicants during recruitment; Adopt positive discrimination in favour of women and other vulnerable persons during recruitment; Establish three points for the sale of dried sludge products.

Table 4
Potential Project Impact Mitigation and Enhancement Measures (continued)

Receptor	Phase	Impacts	Mitigation and Enhancement Measures
Conditions of women and other vulnerable groups	Operation	Improvement of access to FSTP- related services by vulnerable groups	Inform and sensitize vulnerable groups on the opportunities offered by FSTPs; Support women's associations in raising awareness on the sanitization of the living environment.
		Creation of jobs accessible to vulnerable groups (women, youths, etc.)	Encourage female applicants during recruitment; Adopt positive discrimination in favour of women and other vulnerable persons during recruitment.
		Risk of accidents involving vulnerable groups in construction sites	Inform and sensitize staff on construction site-related risks; Provide crossing points to excavation areas; Signal drain networks. Limit the speed of vehicles and trucks to 30 km/h in areas with a high population density; Select routes with a low population density; Inform and sensitize drivers on the highway code.

6.4 Cost of Project Impact Mitigation and Enhancement Measures

The cost of the project impact mitigation and enhancement measures identified were evaluated on the basis of the cost of similar projects and current market prices. They are summarized in the table below.

Table 5
Cost Summary Table

Description	Cost (CFAF)	Coverage
Cost of sensitization activities	22 000 000	Works contract
Cost of measures for the conservation and restoration of vegetation cover	42 720 000	
Cost of health and safety measures	64 700 000	
Cost of training measures	12 800 000	
Cost of measures for enhancement of impacts on education	7 200 000	
Cost of measures for enhancement of impacts on the living conditions of women and other vulnerable groups	33 000 000	
Cost of measures for mitigation of impacts on agriculture and livestock production	6 000 000	
Cost of measures for enhancement of impacts on sanitation	115 000 000	

Description	Cost (CFAF)	Coverage
Cost of measures for mitigation of project impacts on water	55 000 000	
Additional initiatives	655 000 000	
Building capacity in environmental monitoring	3 9200 000	
Total	**1 052 620 000**	

7 ENVIRONMENTAL RISKS AND CLIMATE CHANGE

7.1 Project Environmental Risks

Environmental risk management helps to identify accidents that can occur during the execution of sanitation infrastructure development works, assess their consequences and propose measures to prevent or control them.

The proposed approach is based on the analysis of operators' tasks and work situations. This will involve examining the list of tasks to be performed in building facilities and the list of operations of each task, analyzing the risks inherent in the operations, and determining effective risk preventive measures. The criteria taken into account relate to the frequency and severity of risks.

The risks identified by phase include:

Construction phase:

- Risk of accidents associated with the movement of construction vehicles and machines;
- Risk of accidents associated with the handling of equipment (saws, shovels, hammers, etc.);
- Risk of falling;
- Health hazards associated with epidemics, exposure to bad weather (long periods of exposure to the sun or rain) and hearing disorders (related to noise);
- Electrical hazards (electrocution and electrification).

Operation phase:

- Risk of pollution of river water by infiltration of leachate emanating from sludge left to dry;
- Pollution of the water table by accidental leakages from lagoons;
- Electrical hazards associated with electric installations;
- Risk of falling;
- Risk of accidents associated with the movement of "spiro" trucks on the construction site;
- Risks associated with the handling of equipment.

The following preventive measures were identified:

Construction phase:

- Recruit a full-time health, safety and environment officer for the two construction sites;
- Inform and sensitize workers on occupational hazards;
- Equip workers with personal protective equipment;
- Ensure compliance with the wearing of PPE on construction sites;
- Mark out hazardous areas (ditches, voltage sources, etc.);
- Protect electric saws with sheaths;
- Equip construction sites with a first-aid kit;
- Protect all electric cables with sheaths;
- Prohibit access to high risk areas;
- Provide medical care to workers (regular medical check-ups).

Operation phase:

- Develop a Crisis Response Plan for both construction sites;
- Appoint an officer in charge of monitoring health, safety and environmental issues;
- Ensure day-to-day monitoring of ground and surface water quality;
- Verify the imperviousness of membranes during maintenance works;
- Equip the staff of treatment plants with PPE adapted to their activities;
- Prevent access to construction sites by persons who are not involved with ongoing activities;
- Zone treatment plants by level of risk;
- Construct watertight sludge storage tanks;
- Store dried sludge in appropriate containers and cover them with tarpaulin;
- Equip construction sites with fire extinguishers;
- Make provision for a fire hydrant in each plant;
- Determine the chemical load of sludge before developing it for use in agriculture.

7.2 Climate Change

Flooding from the rising waters of the Niger River may occur on the Sotuba site. To address the situation, it was recommended that the TN should be raised to protect it from floods.

8 ENVIRONMENTAL AND SOCIAL MONITORING PROGRAMME

8.1 Environmental Monitoring Mechanism

Environmental surveillance are inspections, controls and operations carried out to ensure that all environmental protection requirements and conditions are met. The main environmental surveillance actors are presented below.

8.1.1 Project Owner

The Project Owner will ensure implementation of the mitigation measures presented in this report by reflecting them in the service contract. It will also ensure implementation of the Environmental and Social Management Plan (ESMP), as well as monitor and control the implementation by the Contractor of the Environmental Protection Plan. This plan will be based on the provisions set out in the ESMP.

8.1.2 Contractor

The Contractor will ensure the efficient and effective application of environmental requirements. To be fully operational, it is recommended that it recruits an environmental expert to ensure compliance with environmental technical specifications after identifying the most delicate environmental constraints on the construction site, include environmental surveillance in the worksite logbook, and act as point of contact with the Technical Control Firm on environmental issues.

8.1.3 Technical Control Firm

Besides the traditional control of works, the Technical Control Firm recruited by the Client will ensure compliance with environmental measures on the construction site. It will, in conjunction with the Contractor, control the quality of the environment in project impact areas. The Project Owner and the Technical Control Firm will be liable for any environmental damage caused. To successfully carry out environmental surveillance activities, the Technical Control Firm will recruit an environmental expert. The latter will, under the responsibility of the Control Mission Head, ensure effective ESMP implementation, in consultation with local technical services.

The monthly report prepared by the Control Mission will include an environmental component to provide an assessment of the hygiene, safety, health and environmental situation of the construction site. Similarly, a monthly report will be prepared on construction site incidents and accidents.

8.2 Environmental Monitoring Mechanism

Environmental monitoring is a short, medium and long-term observation and assessment activity. It seeks to determine the real project impacts of greatest concern compared with the impact predictions made during the impact assessment in order to make the necessary amendments to the recommended mitigation measures, where necessary.

According to Article 30 of Decree No. 8-346/P-RM of 26 June 2008 on environmental impact assessments, as amended by Decree No. 9-318/P-RM of 26 June 2009, the implementation of the Environmental Monitoring and Surveillance Programme will be under the control of the Ministry in charge of the project and the Ministry in charge of Environment. This domain falls within the competence of the National Directorate of Sanitation and Pollution and Nuisance Control (DNACPN).

To ensure proper monitoring of environmental issues, the DNACPN will draw on the expertise of technical services depending on the areas of investigation and local communities.

Indicators such as the quality of effluents discharged, air quality, sound level in FSTPs, groundwater quality, and river water quality will be monitored.

Table 6
Environmental Monitoring Programme

Impact Receptor	Monitoring Element	Monitoring Indicators (indicative)	Monitoring Method	Monitoring Entity	Monitoring Period	Monitoring Frequency
Air	Pollution	Ambient air quality	Air analysis kit	DNACPN	During and after construction	Monthly during the construction phase, and quarterly during the operation phase.
Soil	Erosion	Erosional unconformity	Visual	DNACPN	During and after construction	Monthly
	Pollution	Soil pollution, Soil purity	Soil analysis		During and after construction	Monthly
	Land use	Land-use map	GIS		After construction	Five-yearly
Water	Pollution	Heavy metal content, conductivity, pH, organic matter	Water analysis	DNACPN DNH LNE ANGESEM	During and after construction	Quarterly
	Quantity	Water availability	Measures		During and after construction	Half-yearly
Vegetation and wildlife	Regeneration of vegetation cover	Reforestation success rate	Visual	DNEF	During and after construction	Periodically
	Wildlife disturbance, Destruction of wildlife habitats	Wildlife behaviour change	Inventory	DNEF	During and after construction	Yearly
Health and safety	ARDS, STDs, HIV/AIDS	Number of cases	Census	DNS	During and after construction	Half-yearly during the construction phase and yearly during the operation phase
	Accident	Number of accidents during the construction phase	Census	DGPC	During construction	Monthly
		Number of accidents during the operation phase	Census	DGPC	After construction	Monthly
Compensation for property lost	Destruction of public and private buildings	Status of compensation of persons affected by construction works	Verification	SOMAPEP, Governorate of Bamako District	During and after construction	Monthly during the construction phase, and yearly during the operation phase

Impact Receptor	Monitoring Element	Monitoring Indicators (indicative)	Monitoring Method	Monitoring Entity	Monitoring Period	Monitoring Frequency
Employment	Job creation Improvement of incomes	Number of jobs created Average income in the Central Sub-division	Census	SOMAPEP	During and after construction	Monthly for employment Yearly for average income

8.3 Institutional Arrangements and Capacity Building Needs

The project implementation will involve various stakeholders, namely SOMAPEP SA, DNACPN, ANGESEM, local authorities and the association of cesspit emptiers.

The capacity building needs identified during discussions are:

- capacity building in environmental and sanitation legislation;
- procurement of equipment (water and air quality analysis kits, sound level meter, and computer hardware) for SOMAPEP, ANGESEM, and DNACPN; and
- procurement of a four-wheel-drive pick-up vehicle for DNACPN.

9 PUBLIC CONSULTATIONS AND DISSEMINATION OF INFORMATION

In accordance with Malian regulations governing public consultations on environmental and social impact assessments, the beneficiary population as well as the technical services operating in the project area were informed and consulted during the conduct of this study.

To that end, individual meetings were held with the technical services in April and July 2015. During data collection, many technical services were contacted to express their concerns and expectations regarding the project.

In addition, regarding the dissemination of information, a workshop for presentation of the study, as well as the environmental and social component, was held on 8 July 2016 in the conference room of Azalaï Hotel in Bamako. The remarks and concerns of the stakeholders invited were noted and used to improve the report.

To take into account the concerns of the population living in the project right-of-way, two (2) public consultations were held on 18 June 2016 in Dianéguéla and on 30 July 2016 in Sotuba.

The table below summarizes the fears and expectations expressed by project beneficiaries.

Table 7
Summary of the Fears and Expectations Expressed by Stakeholders

Item	Fears	Expectations
Technical services	Availability of land	Monitoring equipment support.
Beneficiaries	Failure to implement the project	The road network in Dianéguéla has been improved to enable access to sanitation facilities; Enable the Women Market Gardeners' Association to benefit from the products grown as a result of the recycling of faecal sludge for agricultural purposes; The populations in the construction sites are informed and sensitized through meetings held to exchange views; Facilities are built to manage wastewater from dye-works in Dianéguéla.
Affected persons	Mismatch between research activities and the faecal sludge treatment plant	Compensation is paid to affected persons; Outreach meetings are held to inform the affected persons.

N.B.: During the public consultation held in Dianéguéla, the adviser of the head of the neighbourhood proposed that the 63-hectare land reserve of Municipality VI situated between the canal and the river to the right of the Mali Hospital should be used as resettlement site for the affected persons.

10 COMPLEMENTARY INITIATIVES

10.1 Resettlement Plan

(See the Compensation and Resettlement Plan report).

10.2 Support Measures

The population identified a number of support measures to enhance project impacts, namely:

- the construction of facilities for the pre-treatment of wastewater from public places such as the Bamako Grand Mosque, the Gabriel Touré Hospital, and the Main Market;
- the construction of cesspits for wastewater from dye-works in Municipality VI (Dianéguéla);
- the implementation of activities to sensitize women on the need to improve the living environment.

Specific studies (technical, ESIA, etc.) were not conducted on the different activities identified.

11 CONCLUSION

The Environmental and Social Impact Assessment shows that the project implementation will have irreversible or unavoidable negative and positive environmental impacts. However, the project's positive impacts on the physical, biological and human environments will surely lead to sustainable and sustained improvement of the living conditions of the population in

Bamako District.

The project is in line with national laws and regulations on environmental management. It is also fully consistent with National Economic and Social Development Planning objectives, and seeks to achieve the objectives of the Growth and Poverty Reduction Strategy Paper (GPRSP).

In light of the foregoing findings and analyses, the Environmental and Social Impact Assessment Mission concluded that the project, as designed, is environmentally sustainable and socially justified, and is in keeping with the Malian Government's socio-economic development policy and priorities.

12 REFERENCES AND CONTACTS

- Environmental and Social Impact Assessment;
- Resettlement Action Plan;
- Works-related Engineering Studies.

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