



Community Toilets and the Challenge of Urban Sanitation in Nairobi, Kenya

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TOPIC

Sanitation

SUBTOPICS

Urban Planning, Urban Poverty, Informal Settlements

TIMEFRAME

Contemporary 2018

LEARNING GOALS

- Learn how to use incomplete and ambiguous information to make policy decisions regarding basic urban service provision.
- Analyze and evaluate the impacts of different approaches to service provision.

SECONDARY GOALS

- Evaluate non-governmental and community initiatives, and public-private partnerships for service provision.
- Incorporate non-governmental and community initiatives to the urban planning process.

PRIMARY AUDIENCES

- Municipal officials and administrators from developing country cities confronting challenges and opportunities for sanitation service provision in informal urban settlements.
- Central government officials involved in local affairs, utility administrators, and municipal finance experts.
- Staff of NGOs, community organizations, and private sector actors involved in basic service provision.

PREREQUISITE KNOWLEDGE

None, but prior basic knowledge of urban planning desirable.

SUMMARY

The case focuses on the growth of community toilets in Nairobi's sprawling informal settlements. Municipal officials can ignore community toilets and seek the development of centralized sewerage networks, embrace them as part of the city's sanitation strategies, or oppose them as inimical to centralized networks and as aiding the consolidation of the settlements. To act, officials must consider the major challenges of sanitation in informal settlements, the standard approaches implemented in developed countries, and the pros and cons of community toilets—which in turn requires an evaluation of the social, administrative, and physical impacts of these facilities relative to alternative modes of provision, as well as their potential integration into the city's sanitation plans and policies.



These are photographs of open sewers in Kibera, an informal settlement in Nairobi, Kenya. Source: AlexanderXXI/iStock/Getty Images

COMMUNITY TOILETS AND THE CHALLENGE OF URBAN SANITATION

While preparing for an upcoming meeting of the Nairobi City County (NCC) Executive Committee, officials in the NCC's Water, Energy, Forestry, Environment and Natural Resources Sector considered what sanitation infrastructure recommendations to make in the next update of the Nairobi City Sewerage Master Plan. The officials were responsible for providing sanitation for the NCC area, which encompassed Kenya's capital and largest city, and their objective was to collect and treat all wastewater generated by households, businesses, public facilities, and other users such that it could be discharged back into streams and rivers without polluting the natural environment. The expected outcomes from any recommendations formulated by the officials would be increased sanitation coverage (measured as percentage of wastewater collected for treatment) and quality of the treated wastewater (measured in terms of levels of key pollutants, such as coliform bacteria that can cause cholera or typhoid, in the water discharged into rivers and lakes after treatment), leading ultimately to full coverage and quality levels in accordance with international standards.

Since its foundation as a colonial outpost, Nairobi had been plagued by infrastructure limitations. Rapid growth in recent years overwhelmed the city's capacity to fund and execute expansions in its physical networks, forcing many migrants coming to Nairobi to squat on undeveloped areas and build their own houses. As a result, infrastructure services such as piped water, sewerage, and public ways were nearly absent in the city's sprawling settlements like Kibera.

This situation posed difficult questions for County officials. For some, informal settlements were a blight on the city, giving rise to disease and crime, and using public monies to improve their conditions would simply encourage more. Moreover, county engineers and planners had trained under the dominant paradigm of urban service provision, which called for citywide physical networks run as single units; letting settlement residents make their own informal arrangements for infrastructure services would only increase inefficiency and inequality in access to basic services, since the quality of the services that the residents could provide for themselves would very likely be more limited than those provided through centralized networks. Other officials argued that it was unrealistic to expect all services to be provided under the single-network standard: such networks were expensive to build and maintain, and financial resources were perennially insufficient and plagued by corruption and patronage. Something else had to be done to improve conditions in the informal settlements.

Amid this debate, an alternative arose and began expanding rapidly: the community toilet facilities developed by the Umande Trust. County officials considered whether to incorporate Umande's decentralized sanitation model into the Master Plan or to focus on expansion of the sewerage network into the unserved areas of the city. No other major city in the world had incorporated a decentralized approach to sanitation into its development plans since London first created an integrated sewer network around 1860—so their recommendation could make a big difference even beyond Nairobi.

SANITATION AND THE CITY

With the rapid urbanization of developing countries around the world, the challenge of providing basic services to the vast informal settlements housing the urban poor has gained great prominence in recent years. Lack of sanitation has become a particularly urgent issue due to its severe impacts on pollution of water and land resources. Consequences range from higher incidence of infectious disease such as cholera, dysentery, and typhoid to loss of school days among children due to recurring sickness and the insecurity experienced by women and children that lack privacy for their sanitary necessities. In fact, analysts have estimated that investment in sanitation has one of the highest benefits to society in its prevention of these problems. These estimates range from a social benefit of \$3 (e.g., through savings in treatment of infectious disease) for every \$1 spent building and maintaining sanitation infrastructure, according to the United Nations¹ to an extraordinary \$9 per \$1 spent according to the Copenhagen Consensus, an organization seeking to help define economic development priorities.²

The traditional model of utility service provision relies on centralized physical infrastructure networks, but these are expensive to build and maintain, make extensive demands on the use of urban land, and require sophisticated governance and managerial systems to provide

¹ Cited in Umande Trust, *Transformation: The Bio Centre Story*. Nairobi: Umande Trust, 2014.

² <http://www.copenhagenconsensus.com/post-2015-consensus/water-and-sanitation>. Accessed April 18, 2018.

effective services—all of which pose major challenges to developing countries. Financial resources are limited due to low per capita incomes and shallow capital markets, space is already scarce in tightly packed informal settlements, and governance mechanisms are plagued by corruption and clientelism. To make matters worse, retrospective installation of physical infrastructure networks is extremely expensive in many informal settlements, which are often dense and irregular and situated on challenging terrain, such as steep hillsides or floodplains.

Decentralized approaches for the provision of these basic services offer a radically different paradigm. In the case of sanitation, one of the most promising technologies in terms of cost, simplicity, scalability, and waste minimization, is the biodigester, a sealed container where microorganisms accelerate natural decomposition processes, turning organic waste into biogas, largely methane and thus usable as a clean fuel, and fertilizer (see exhibit 1). Already extensively used in rural communities to treat and recover value from agricultural waste, it has begun to emerge as a solution for urban areas as well.

Planners and engineers, however, often view such an approach with suspicion for urban areas. In addition to the bias imparted by their training in the design of integrated physical networks, they worry decentralized solutions will fragment the city into different areas with different standards, and, in the case of informal settlements, they are concerned that servicing informal areas that should not have been built in the first place will encourage new ones to arise.

SANITATION IN NAIROBI

Built on hilly terrain at an elevation of 4,500 to 6,000 feet, Nairobi traces its roots to the recent colonial past: In order to connect the prized colony of Uganda with the sea, in the late 19th century the British built the Mombasa–Uganda Railway, creating an inland workers’ camp and construction depot that became the modern city. With moderate temperatures (ranging from 54°F to 82°F) typical of tropical highlands, Nairobi was an attractive spot for European settlers, and the 1927 city plan even envisioned a “Settler Capital”; in 1948, with 119,000 inhabitants, this vision was confirmed in a new plan.

Nairobi’s status as the colonial capital led to its becoming Kenya’s national capital upon the country’s independence in 1963, with a population of 342,000.³ Since independence, the concentration of population and economic activity in Nairobi has only grown: it provides 50 percent of Kenya’s formal jobs and generates over half of the country’s gross domestic product (GDP). Its population—mostly young adults and children—is about five million in the metropolitan area, with more than three million people in the city limits. About 60 percent of Nairobi’s population lives in informal settlements, where population densities can reach 1,200 persons per hectare, such as in the Mathare settlement.

³ The Project on Integrated Urban Development Master Plan for the City of Nairobi in the Republic of Kenya Plan 2014. Nairobi City Council, with technical support from Japan International Cooperation Agency (JICA), Nippon Koei Co., Ltd., IDCJ, Ltd., and EJEC, Inc., December 2014 (henceforth Plan 2014).

Kenya was strongly centralized for much of its post-independence period, but the new constitution in 2010 enshrined a significant degree of decentralization, with the creation of county governments with broad powers—including water and sanitation—as the main political and administrative units below the national government. Like U.S. states, Kenya’s county governments reproduce the national government structure: an elected governor and deputy governor hold executive power, assisted by a County Executive Committee made up of departmental heads and a County Assembly of elected and appointed members. Property tax revenues and transfers from the national government fund counties.⁴ In the case of Nairobi City County, the government is organized into 10 departments (plus a County Public Service Board that oversees the civil service), of which the Water, Energy, Forestry, Environment and Natural Resources Sector oversees water and sewerage policy.⁵

The provision of water and sewerage services by County governments is regulated by the Water Act of 2002, which requires the establishment of water services boards responsible for improving the water supply and sewerage services, contracting with water-service providers, and holding any related assets owned by the national government. Accordingly, the Ministry of Environment, Water and Natural Resources transferred its former functions to eight regional water boards under County control, including the Athi Water Services Board (AWSB), which serves a population of over 4.5 million in Nairobi City and its surrounding environs.⁶ In turn, water-service boards license water-service providers; in Nairobi, the service provider is the Nairobi City Water and Sewerage Company (NCWSC), wholly owned by Nairobi City County.⁷ Under this arrangement, the sewerage master plan is developed by the City Engineering Department of Nairobi City County; the AWSB is responsible for the planning, design, and implementation of specific projects in the Athi Catchment area, where Nairobi City is located, and the NCWSC is in charge of the operation, maintenance, and management of the area’s water and sewerage systems. In 2009, the AWSB and NCWSC jointly prepared the Strategic Guidelines for Improving Water and Sanitation Services in Nairobi City’s Informal Settlements, which showed that these entities were aware of the challenges they faced in providing services to informal settlements (see exhibit 2) and their willingness to accommodate decentralized sanitation efforts in informal settlements⁸ (see exhibit 3).

Nairobi’s water supply situation has severe deficiencies. Of the more than three million residents of Nairobi City, only 50 percent have direct access to piped water; the rest obtain it from kiosks, vendors, and illegal connections. Much if not all alternatively sourced water

⁴ Plan 2014.

⁵ Nairobi City County government website, <http://www.nairobi.go.ke/> Accessed April 11, 2018.

⁶ Athi Water Services Board website, <http://awsboard.go.ke> Accessed April 11, 2018.

⁷ Nairobi City Water and Sewerage Company website, www.nairobewater.co.ke Accessed April 11, 2018.

⁸ Available at http://www.wsp.org/sites/wsp.org/files/publications/Af_Nairobi_Strategic_Guidelines.pdf.

provides no revenue to the NCWSC, so it only collects revenue on 60 percent of the water it provides.⁹ Due to insufficient investment in water-supply infrastructure, the city's daily demand in excess of 24 million cubic feet amply exceeds the available supply of slightly less than 20 million cubic feet, so rationing is common; among all residents with piped water connections, only about 40 percent receive water on a 24-hour basis. Informal water supply to residents without piped water connections is allegedly run by "mafias" involving corrupt NCWSC utility employees that use violence to keep out competitors and the NCWSC.¹⁰ The price charged by these vendors exceeds NCWSC's price by 10 to 25 times.¹¹ This means water is often the biggest expense for inhabitants of informal settlements like Kibera, absorbing up to a third of their income despite the poor quality. Water sourcing also requires a disproportionate effort on the part of women and girls, who are typically in charge of fetching water.¹²

The situation regarding access to sewerage is significantly worse. In 2003, an estimated 10 percent of the population was served by sewers, with another 20 percent using septic tanks, and the remainder relying on latrines and open defecation.¹³ More specifically, among the population living in informal settlements, 24 percent were estimated to have a latrine or a flush toilet in 2009, while 68 percent used public toilets (mostly overcrowded, low-quality latrines), and six percent resorted to open defecation, particularly in the form of the infamous "flying toilets"—plastic bags that are then disposed of in any available open space.¹⁴

Another study published in 2014¹⁵ compared total water consumption in the city with the amount of sewage treated by the city's system. The total water distributed daily by NCWSC was estimated at 141 million cubic feet, while the total daily sewage inflow received by the existing sewerage treatment works (STWs) was estimated at 35 million cubic feet; under the assumption that sewage generation would be approximately equivalent to the actual water consumption, the difference between these quantities is discharged to the rivers untreated—and even the treated water does not meet national standards for effluent treatment (see exhibits 4 and 5).

Lastly, the sewerage network is estimated to cover only 40 percent of the city area already covered by piped water supply—perhaps 20 percent of the total area of the city. Sewage treatment takes place at any one of the city's 24 mostly small plants, which have a daily capacity of less than 2,000 m³ and which often do not work well. The largest plants are Dandora (120,000 m³) and Kariobangi (32,000 m³), but the latter suffers from deterioration and mechanical trouble and is thus nonoperational (exhibit 6). In informal settlements, the removal of sludge from latrines is handled by small-scale operators working under unsanitary conditions. They dispose of the sludge into sewer inlets, rivers, and drainage ditches.¹⁶

⁹ Reuters, "Kenyan women pay the price for slum water 'mafias'," World News, November 26, 2014.

¹⁰ Ibid.

¹¹ Ibid.

¹² Plan 2014; www.nairobiwater.co.ke.

¹³ Plan 2014; www.nairobiwater.co.ke.

¹⁴ Plan 2014; www.nairobiwater.co.ke.

¹⁵ Plan 2014.

¹⁶ Plan 2014.

PLANNING FOR THE FUTURE

Planning decisions require consideration of a variety of factors, beginning with the availability of financial resources to execute the action items under consideration, which requires planners to prioritize among competing items. The most common way to do so is to compare the benefits and costs of each item, and rank them by the level of benefit relative to cost. This is easier said than done; however, estimating the costs of a project involves significant uncertainty, especially about construction and material costs, which are heavily dependent on the design of the planned infrastructure. Even harder is the estimation of benefits, since in public projects these often bear little if any relationship to project-related revenue generation and are instead indirect (e.g., realized through job creation, economic growth, improved living and public health conditions, or reduced inequality).

In developing countries, these considerations encounter the additional complication of a paucity of data about geographic and social conditions. Residents of informal settlements are often excluded from censuses, and official maps fail to show the settlements because they lack official status and are thus considered temporary. As a result, any plans related to informal settlements face even greater uncertainty regarding topography, public ways, population, and social conditions. A particularly vexing issue for any infrastructure-related action in an informal settlement is the displacement of local residents to build the infrastructure at all. With typically high densities of occupation and narrow, winding public ways, building and placing infrastructure necessarily involve displacing many families. Absent legal title to the land and socioeconomic data, however, compensating the displaced families requires trust on both sides to negotiate in good faith—and trust is scarce, too.

From a planning perspective, a decentralized approach poses additional challenges. Planning presupposes some degree of control, through the allocation of financial resources and control over project design and execution, and control assumes that plans can be fulfilled and accountability to citizens reasonably ensured. But a decentralized approach necessarily relies on other parties to obtain at least some financial resources, as well as the expertise and labor to design and implement local projects. This introduces another layer of uncertainty and complicates the chain of accountability: if third party actors fail to do enough, voters will hold public officials responsible for the failure. Unsurprisingly, then, decentralization often involves public-private partnership contracts binding private and nongovernmental parties to specific targets in exchange for financial support or regulatory permissions.

Planning for infrastructure in Kenya is well supported by existing laws. The Water Act of 2002 gives county water boards clear authority over the management, conservation, use, and control of water resources; over the acquisition and regulation of rights to use water; and the regulation and management of water-supply and sewerage services. Rights-of-way for water

and sewer systems development are governed for privately held lands under the Wayleaves Act and for public lands under the Government Lands Act, with fairly simple processes for utilities to obtain rights-of-way and for the government to use public property at will, take private property for development, and compensate private owners at market value, if necessary, much like eminent domain legislation in the U.S. Moreover, about 80 percent of the lands in Nairobi City are owned by the government, even if about 41 percent of those (i.e., one third of total land) were alienated to private and other parties. For example, the entirety of the Kibera informal settlement is built on national government land, allowing the government to demolish any existing structure in Kibera in order to build infrastructure without compensation.¹⁷

The Nairobi Integrated Urban Development Master Plan, prepared by Nairobi City County in 2014, includes the sewerage system within the area of infrastructure development. As part of this effort, AWSB's work was supported through the multi-year Kenya Water and Sanitation Service Improvement Project that the World Bank had created in 2007. These efforts, however, followed the traditional standard of centralized sanitation, whereby most of the sewage generated within Nairobi City would be conveyed to and treated in the Dandora treatment plant (see Exhibits 7, 8, 9, and 10).

MEANWHILE, IN KIBERA

In recent years, innovation around decentralized sanitation has rapidly proceeded, especially in sub-Saharan Africa, where the challenges of providing sanitation services to informal settlement dwellers are most daunting. Several companies have developed decentralized business models, with varying degrees of consolidation and success. In Kenya, Sanivation uses container-based toilets in urban communities that charge a small service fee and treat the waste material to produce odorless fuel briquettes. Also in Kenya, Sanergy, with about 50,000 users, builds low-cost sanitation centers for residents of informal settlements consisting of modular toilets, which are franchised to local entrepreneurs who provide services for a fee; the waste is collected and treated at a central facility to produce fuel and fertilizer. Lastly, Pivot Works in Rwanda relies on turning waste into "Pivot Fuel," which is then sold to industrial customers.¹⁸

In Kenya, perhaps the most successful initiative is the Bio Centre model developed by the Umande Trust, established by Dr. Saad Yahya in 2004. Umande means "dew" in Kiswahili, conveying the cleanliness and value built into Umande's "Bio Centre," a community toilet facility offering sanitary services (bathrooms and showers) for a small fee, with additional revenue generated by renting out rooms for events to community groups or other parties, and providing additional services such as water vending, office space rental, or a cyber café. Some Bio Centres also include community facilities, such as libraries, or are built in local schools (see exhibit 11). Payment to use a Bio Centre for sanitary purposes can be made electronically,

¹⁷ Plan 2014.

¹⁸ NextBillion.org, 2017.

such as through Kenya's highly successful mobile payments system, M-Pesa. Bio Centres process waste into biogas and fertilizer using biodigester technology, the simplicity of which allows the Centres to be built and maintained at a low cost, using local labor and materials, and scaled easily to serve anywhere from 150 to 1,000 persons daily, amounting to 10,000–40,000 bathroom visits and 3,000–12,000 shower visits each month (exhibit 12). Umande vets and supports the community self-help groups that build and run Bio Centres, which are then operated by a caretaker. Water supply is obtained through a partnership with the NWSC and the AWSB. Typical Bio Centre prices are two to five shillings (\$0.04–0.05) to use the bathrooms and 10 shillings to use the showers. Operating from 6:00 a.m. to 9:00 p.m., they serve an area of about 60 meters around the Bio Centre, which in a densely settled place like Mathare means servicing the bathroom and shower needs of upwards of 1,200 residents.¹⁹

This business model allowed Umande to quickly expand the number of Bio Centres from the first one in Nairobi's largest informal settlement, Kibera, to many other locations in Nairobi and other Kenyan cities (exhibit 13). This success also encouraged Umande to shift from a grant-funded approach to partnering with local financial institutions to finance new center development and to create a revolving Sanitation Development Fund (SANDEF) that made loans to community groups to build new facilities. These changes require that new Bio Centres earn a margin of revenue over operating and maintenance costs sufficient to service the loans from the banks or the SANDEF (i.e., paying interest and principal).

Other projects are in the offing; the World Bank, for instance, is pursuing the Kenya Informal Settlements Improvement Project. However, decentralized approaches still suffer from limitations: First, a decentralized solution raises the question of coordination and careful planning to ensure that various initiatives result in a balanced and comprehensive access to sanitation and include adequate construction, operation, and maintenance. Second, the economic viability of Bio Centres and other decentralized initiatives is not clear; although Umande provides some estimates of revenues per Bio Centre, it does not offer information about costs. Bio Centres have so far been built with donor funding and volunteer work from community members—that is, with a high level of subsidy. It is possible that if Bio Centres had been built using wage labor and capital at going market rates, they would not be able to survive at the prices Umande currently charges, but charging higher prices could reduce overall revenue and limit economic access for potential users. Third, the possibility of corruption or collusion between services providers and public officials cannot be dismissed in situations where the former depends on the latter, such as obtaining permits or subsidies, and making decentralized services part of official plans and policies might introduce such a risk.

¹⁹ Umande Trust, *Transformation: The Bio Centre Story*. Nairobi: Umande Trust, 2014. A circle with a 60-meter radius has an area slightly exceeding a hectare; a Bio Centre thus serves in excess of 1,200 persons.

GO WITH THE FLOW?

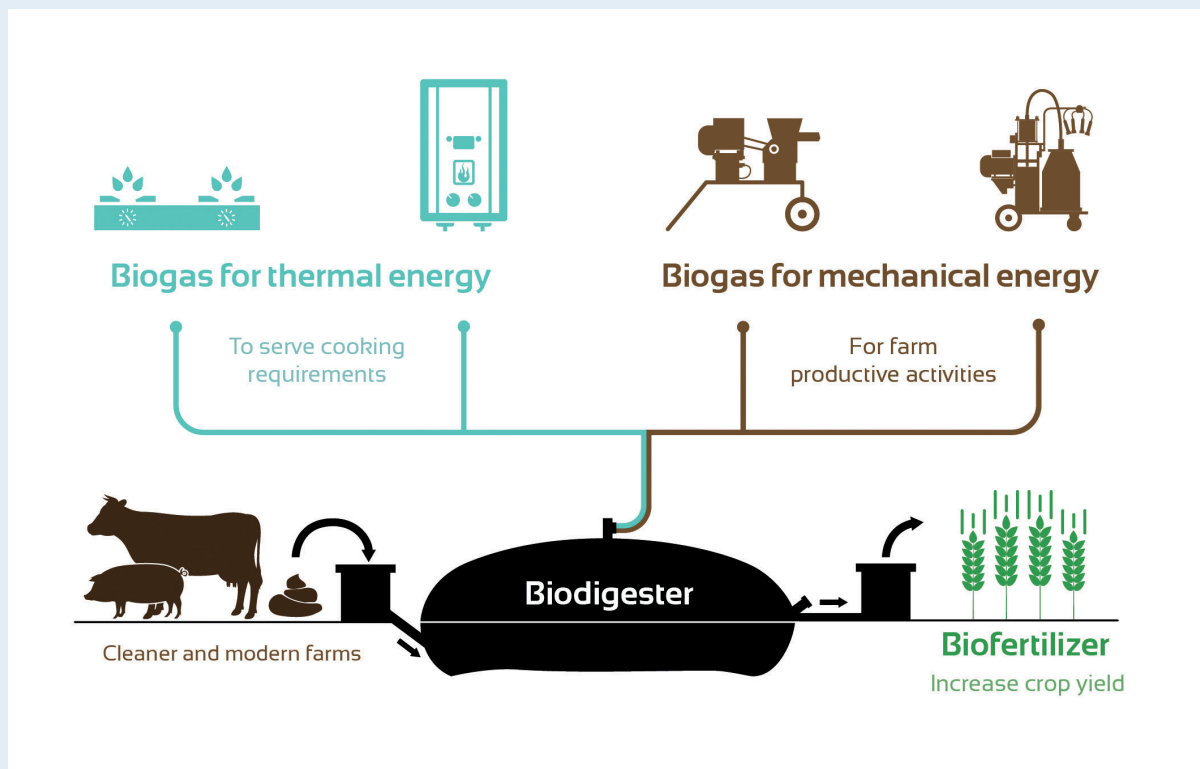
Government officials were in a difficult position. Should they accept the “facts on the ground” and Umande’s decentralized model? Could the decentralized model work with the existing sanitation planning processes? What would be the role of city planning in implementing such an approach? Should they consider the fact that Umande was a customer of Nairobi City Water and Sewerage Company (NCWSC) and was capturing revenues that would otherwise be lost?

Or, should officials discourage or limit the decentralized model because it undermines the eventual building of a reliable centralized system and encourages the continued growth of informal settlements—which then further compounds the problem of building out a centralized infrastructure?

Is there a way to meet short-term needs while working towards a long-term solution that benefits all the stakeholders?

Exhibit 1

How a Biodigester Works



Source: Sistema Biobolsa <http://sistema.bio>. Accessed April 11, 2018.

Exhibit 2

NCWSC and The Informal Settlements

A large population of Nairobi's residents live in informal settlements, that is about 60% in sub-standard living conditions, where congestion has proved to be a challenge for NCWSC to provide access to water and sewerage services to the residents.

This is mainly due to the unplanned nature of the settlements coupled by land tenure issues. In 2008 the Company formed a department solely responsible of improving access to water and sanitation services in the informal settlements of Nairobi. The 2002 Water Act brought about reforms in the Water Sector that were aimed at facilitating access to clean water and sewerage services to all Kenyans. The reforms saw the creation of regional Water Boards which were tasked with the responsibility of overseeing the operations of water and sewerage/sanitation utilities in their respective areas of jurisdiction, besides major asset development.

NCWSC through the informal settlements department have initiated several projects in partnership with various NGOs and other development partners to cushion these vulnerable groups to access clean water and sanitation.

In pursuit of achieving the MDGs of access to clean water and sanitation by the year 2015 and in ensuring the realization of the constitutional requirement to 'the right to water' we have recently constructed 24 water kiosks and extended 18 km water pipeline in Mathare valley in partnership with WSTF and Pamoja Trust to serve a population of 200,000.



There are other interventions in other informal settlements like Kibera- kambi muru in partnership with WSUP constructed sanitation Blocks and 2.5 km sewer line. Through the social connection policy we are implementing the Kayole Soweto water project and with Global Partnership on Output Based Aid (OBA) funds channeled through K-Rep bank to cater for the connections fees. The world bank has given a grant of \$3,000,000 under the water and sanitation improvement program (Wassip) to improve water services.

This involves construction of 18.5 km of water pipeline extension to serve the residents of this low income settlement. After completion 2200 plots with over ten households will be connected with clean water and a total of 85,000 populations served.

Source: NCWSC 2018.

Exhibit 3

Selections from the 2009 Strategic Guidelines for Improving Water and Sanitation Services in Nairobi's Informal Settlements

Nairobi and other cities in Kenya have been unable to keep up the pace of planning and developing its infrastructure to meet the demands of a growing population with the population (4 to 5 percent average growth per year since the 1990s). Rural migration and the natural growth of the urban population have been largely absorbed in the fast growing urban informal and unplanned settlements.

The asset holder, AWSB, and the operator (NCWSC), which is formally responsible for water services in Nairobi, currently have limited capacity to extend or improve services to informal settlements. Residents rely largely on kiosks and vendors providing services of lesser quality at higher costs. NCWSC and AWSB have recently increased their efforts to improve services in the informal settlements and both the Board and the Company recognize the importance of partnerships with other players in the informal settlements.

Increased awareness on the need for water and sanitation services improvements in the informal settlements has led to positive developments, including the development of community-run water kiosks, ablution blocks and solid waste management as well as ecological sanitation approaches....Although these initiatives provide valuable models and practices and have led to local improvements, their overall impact has remained limited. They have not been scaled up and sustainability remains a challenge....In response to their public mandates for poverty reduction and environmental health, NCWSC and AWSB have recently taken up the challenge of supporting such community efforts, including the promotion of improved on-site sanitation and improved hygiene.

Sanitation, an increasingly difficult problem, needs tackling in a socially, financially, and environmentally sustainable way. AWSB and NCWSC commit to this by promoting, facilitating, and supporting the increase of basic sanitation facilities to informal settlements. This commitment includes developing and promoting innovative solutions, including improved individual or communal on-site sanitation, which will remain the prevalent mode for some time. It will also include pilot efforts to introduce condominal (low-cost) sewerage systems. To achieve this, NCWSC prioritizes certain solutions: a) Promotion of community managed pay ablution blocks including bio-latrines. NCWSC will seek ways to develop such latrines in partnership with CBO and/or private operators. Pilot bio-ablution blocks of different designs have been built and operated by CBOs in Kibera since 2004 and, although in need of improvements, will provide useful models. NCSWC will play a facilitating role focusing on land allocation/acquisition, mobilization of funds, providing a water connection and ensuring a sewer connection to dispose of wastewater.

While preferring public ownership, AWSB welcomes different ownership arrangements....Privately funded interventions (individual, CBO, NGO, community, private sector) are owned by the community partner, unless agreed otherwise....AWSB and NCWSC commit to collaborating with civil society and communities to identify local priorities, plan, and support service delivery and implementation within informal settlements.

Exhibit 4
Waste Disposal Methods by Nairobi City District in 2009

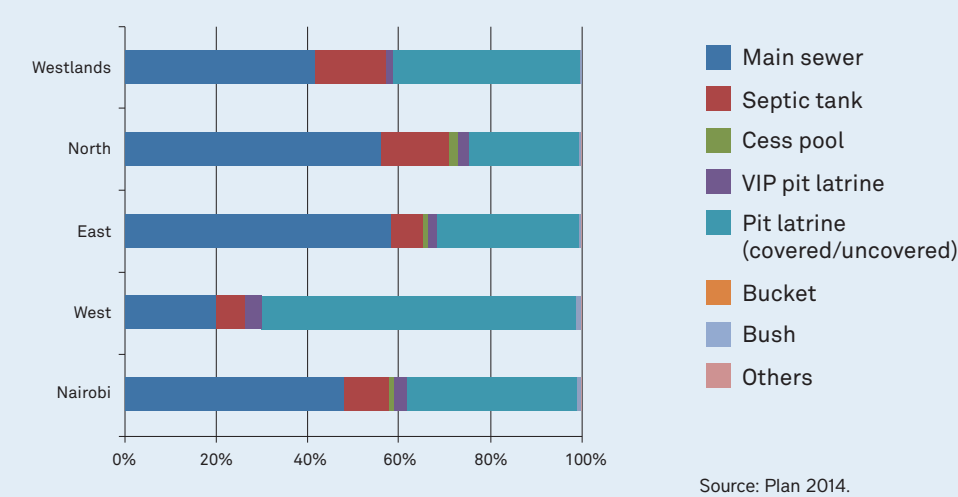


Exhibit 5
Estimation of Sewage Generation, Treatment and Conveyance in Nairobi in 2016

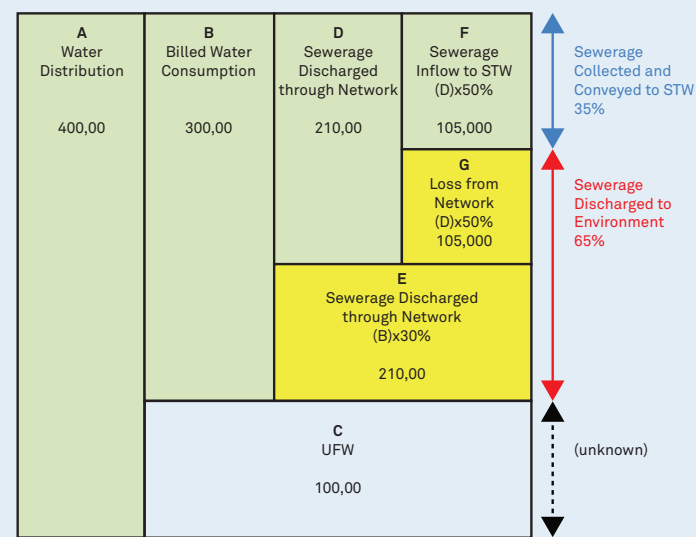


Exhibit 6

Operating Conditions of Existing Major Sewage Treatment Plans (STPs) in Nairobi City, 2011

(a) Type, Capacity, Inflow and Outflow				
STP	Type	Capacity (m ³ /day)	Sewerage Inflow (m ³ /day)	Treated Outflow (m ³ /day)
Dandora	Lagoon	120,000	90,870	69,941
Kariobangi	Conventional biological aerated filter	32,000	11,933	(N/A)
(b) Treatment				
STP	Item	Water Quality (mg/L)		
		Sewerage Inflow	Treated Outflow	Effluent Standard
Dandora	BOD	375	66	30
	COD	924	245	50
	TSS	500	113	30
Kariobangi	BOD	340	194.8	30
	COD	774.7	373.1	50
	TSS	306.5	77.3	30

Exhibit 7

2014 Nairobi Integrated Urban Development Master Plan for Sewerage

Phase 1: Preparation of Improvement Plan

1. Monitoring and analysis of the sewerage treatment performance of the Dandora Estate STW (Sewage Treatment Works) to identify the needs for improvement;
2. Investigation and analysis of trunk sewers, reticulation lines, and sewerage connections to identify the needs for improvement;
3. Plan and design the improvements for the Dandora Estate STW;
4. Plan and design the improvements for trunk sewers, reticulation lines, and sewerage connections; and,
5. Preparation of the implementation plan, including cost estimates and budgetary arrangement.

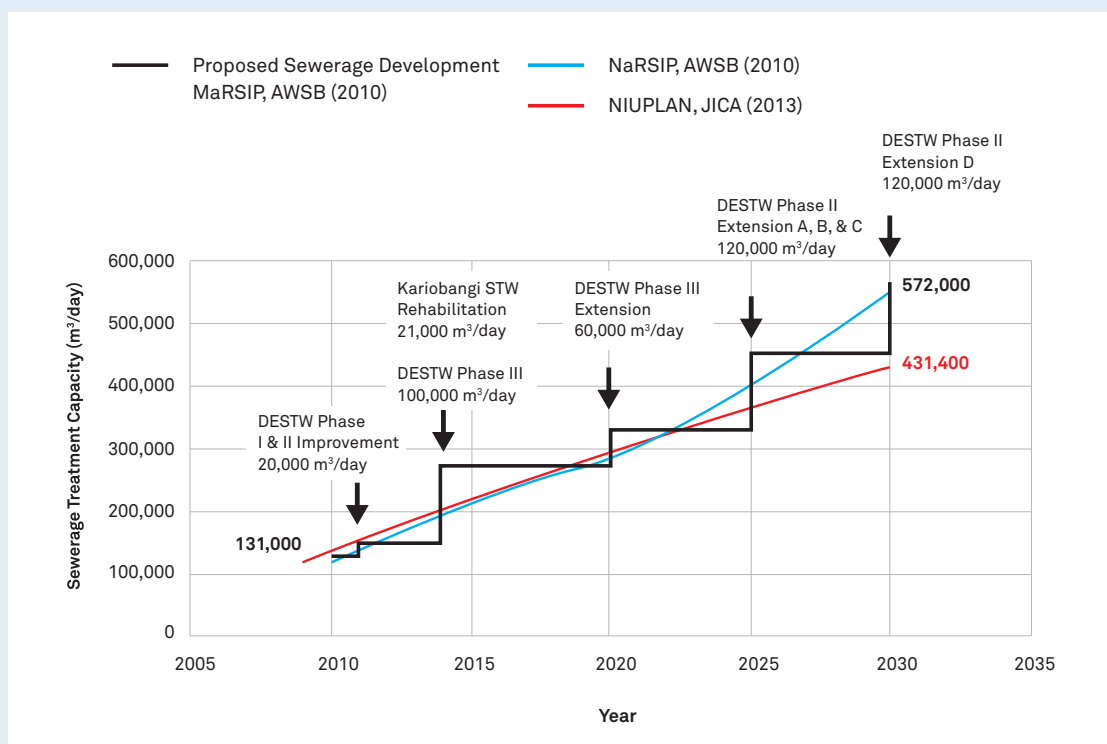
Phase 2: Implementation

1. Implementation of the improvement for the Dandora Estate STW;
2. Implementation of the improvement for trunk sewers, reticulation lines, and sewerage connections;
3. Monitoring, review, and analysis of the sewerage treatment performance of the Dandora Estate STW;
4. Monitoring, review, and analysis of sewerage collection and conveyance by the sewerage network, comprising trunk sewers, reticulation lines, and sewerage connections; and
5. Preparation of feedbacks for O&M (Operation and Maintenance) and further sewerage development.

Source: Plan II, pp. 8–22 [160]. Prepared for Nairobi City County by Nippon Koei Co. Ltd., IDCJ Inc., and EJEI Inc.

Exhibit 8

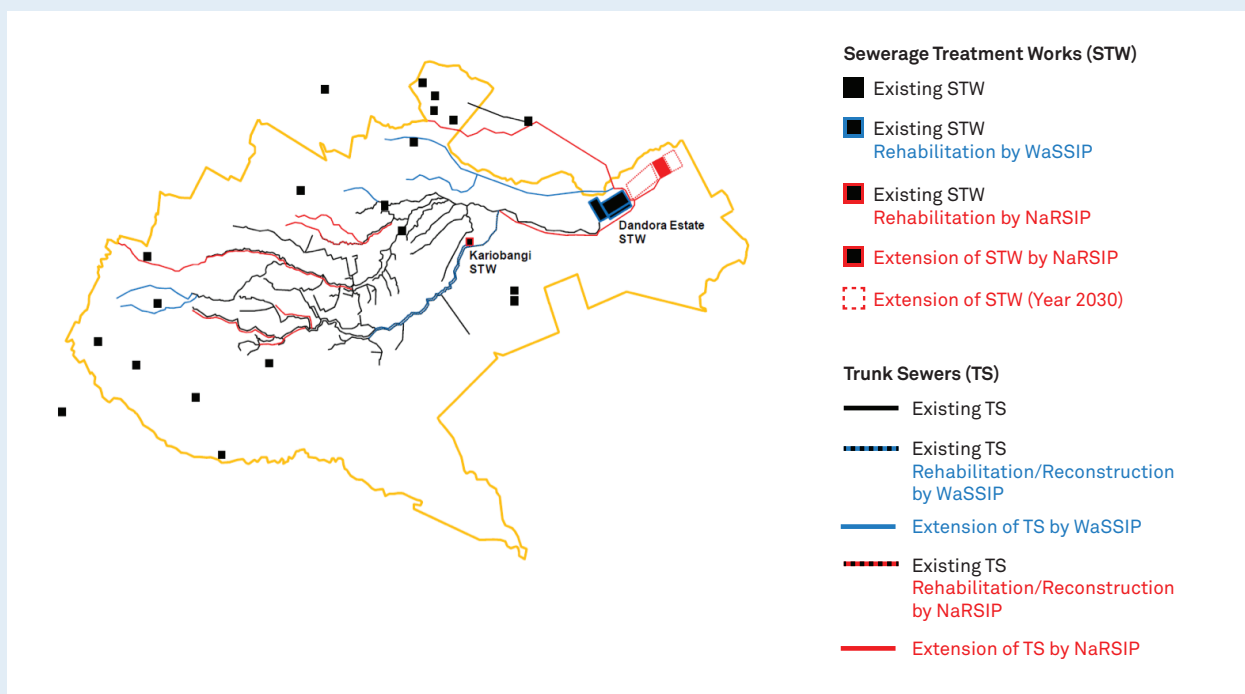
2014 Plan for Development of Nairobi's Sewerage Network



Source: Plan 2014.

Exhibit 9

Existing and Planned Development of Trunk Sewers in Nairobi City in 2014



Note: "NaRSIP" is the Nairobi Rivers Rehabilitation and Restoration Program: Sewerage Improvement Project

Source: Plan 2014.

Exhibit 10

Sample Sanitation Plan

The Gatharaini trunk sewer project is located in Ruai, Gatharaini South, Gatharaini North, Clay works, and Ruaraka areas of the City of Nairobi. The lower reaches of the Gatharaini sewers are accessible from Kagundo Road while the upper reaches of the trunk sewer are accessible through the Nairobi-Thika road and the Kamiti road.

The works being undertaken under in this Project comprise of various trunk sewers, covering about 50 km², as follows:

- 1. Ruai Outfall Trunk Sewer:** This sewer stretches from the outfall manhole MH 127 on the Dandora Estate Trunk Sewers to manhole GMH-01 of Gatharaini North Trunk Sewer near the railway bridge situated between Mwiki and Githurai 45.
- 2. Gatharaini North Trunk Sewer:** The Gatharaini North Trunk Sewer stretches Ruai Outfall Trunk Sewer at manhole GMH-01, near the railway bridge situated between Mwiki and Githurai 45 to Mururui Estate, to Mururui Estate, for a distance of about 9,332 m. The trunk sewer therefore drains into the Ruai Outfall Trunk Sewer.
- 3. Gatharaini South Trunk Sewer:** The trunk sewer stretches from Manhole GMH-13 of the Gatharaini North Trunk Sewer and traverses Mwiki Estate, Kasarani Stadium, ICIPE, across Thika Highway and Safari Park hotel to Thome estate. The total length of this trunk sewer is 8,212 m.
- 4. Clay Works Trunk Sewer:** The Clay works trunk sewer drains into Manhole GMH43 of the Gatharaini North Trunk Sewer and it passes through Clay works estate, Thika Highway before terminating at Zimmerman next to Kamiti road. The total length of this trunk sewer is 3,000 m.
- 5. Ruaraka Trunk Sewer:** Ruaraka trunk sewer runs from Allsopps area, next to Kenya Breweries, through Garden Estate to Ridgeways. The total length of this trunk sewer is 3,299 m.
- 6. Secondary Sewers:** The works on the secondary sewers will involve construction of approximately 23 km of concrete pipes of diameter ranging from 300 mm to 450 mm and 347 manholes.

Source: Athi Water Board (accessed April 13, 2018).

Exhibit 11

Lunga Lunga BioCentre in the Mukuru Settlement of Nairobi



Source: Umande Trust, 2014.

Exhibit 12

Construction of Bio Centre at Nyabondo Girls Boarding Primary School in Nyakach, Kisumu County, Kenya



Source: Umande Trust, 2014.

Exhibit 13

Map of Bio Centres Located in Kibera



Key

● School Bio-centres

● Community Bio-centres

Source: Umande Trust, 2014.

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