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A WATER AND SANITATION NEEDS ASSESSMENT FOR MEKELLE CITY, ETHIOPIA

Prepared by

Andrea Castro, Moumié Maoulidi and MCI

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432 Park Avenue South, 13th Floor, New York, NY, 10016, United States
Phone: +1-646-884-7422/7418; Fax: +1-212-548-5720
Website: www.earth.columbia.edu/mci

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Figure 1: Map of Ethiopia Showing the City of Mekelle

Source: Magellan Geographics (1997). http://www.adoptionavenues.org/ethiopia-map.gif.

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ABBREVIATIONS

MCHO	Mekelle City Health Office
MCI	Millennium Cities Initiative
MWSSS	Mekelle Water Supply and Sewerage Service
MDGs	Millennium Development Goals
MGH	Mekelle General Hospital
MoWR	Ministry of Water Resources
NGO	Non-governmental Organization
REST	Relief Society of Tigray, NGO
TRBWMER	Tigray Region Bureau of Water, Minerals, & Energy Resources
TRHB	Tigray Regional Health Bureau
TWWCE	Tigray Water Works Construction Enterprise

EXECUTIVE SUMMARY

The United Nations Millennium Development Goals (MDGs) were established at the advent of the century to reduce poverty, hunger, disease and homelessness, and to promote gender equality, education and environmental sustainability. The seventh Millennium Development Goal (MDG 7) aims to ensure environmental stability. Targets contained within MDG 7 include Target 10, which aims to halve, by 2015, from 1990 levels, the proportion of people without sustainable access to safe drinking water and basic sanitation.

This needs assessment identifies the main water and sanitation challenges in Mekelle and the investment levels required to meet Target 10 of MDG 7. There is a need to improve water supply and sanitation, sewage treatment and hygiene education in Mekelle. Since there are no piped sewage connections in the city (with the exception of Ayder Referral Hospital), and since all toilet facilities are on-site, the city might consider investing in a simple sewage system as recommended by the national sanitation master plan.

Both short-term and long-term plans to increase water production are currently in place in Mekelle. Short-term plans include rehabilitating existing boreholes and constructing additional boreholes/wells, while the long-term interventions include the creation of a surface water dam. [1] If short-term goals of increasing the water supply are achieved, production of water in Mekelle will increase, but may still not meet demand.

Hygiene education, or hygiene promotion, also needs to be encouraged, because it is crucial in preventing such water and sanitation related diseases as cholera, dysentery and typhoid, which result in numerous deaths each year. Emphasizing the importance of washing hands regularly with soap and water to Mekelle residents can significantly reduce the incidence of diarrheal diseases.

The findings of this needs assessment indicate that in order to meet MDG targets related to water and sanitation, spending per capita needs to increase from about $10 in 2010 to $12 in 2015. MCI believes that this modest increase made over five years can dramatically improve Mekelle citizens' access to safe water and sanitation as well as the public health citywide and is well worth the incremental additional investment.

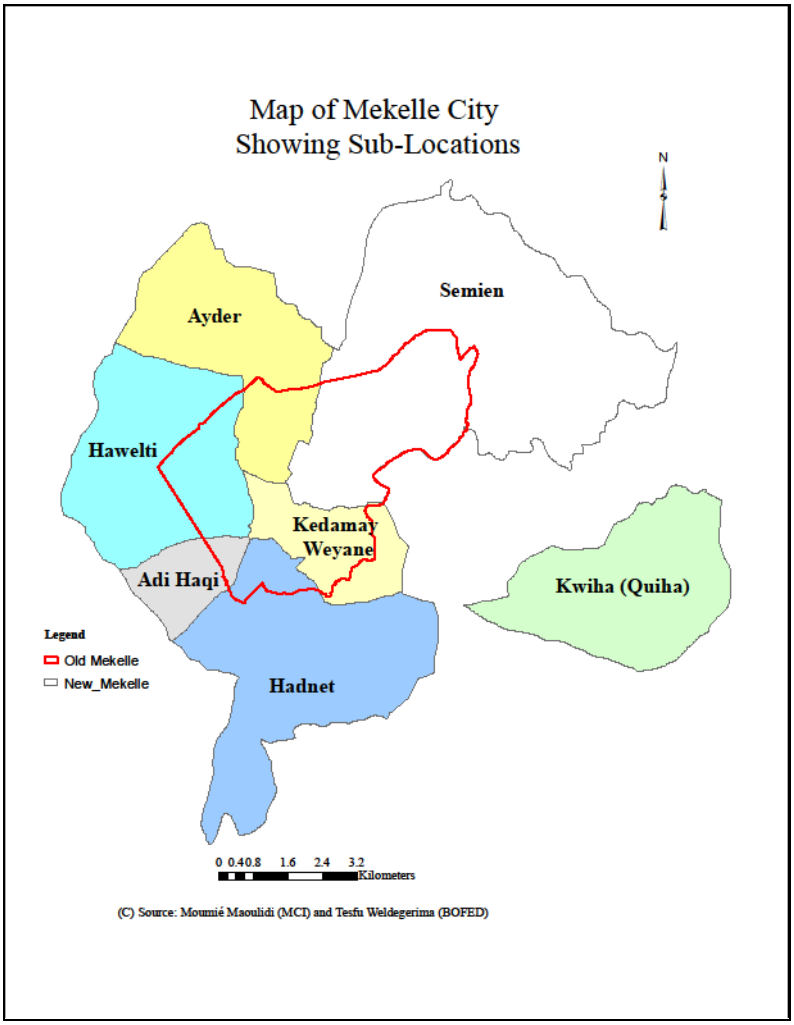
This report is organized into four sections. The introduction presents background information, as well as the objectives, methodology and limitations of the needs assessment. Section Two gives an overview of the situation with regard to water and sanitation in Mekelle; the third section focuses on the financing for water and sanitation in Mekelle and presents the results of the costing model. Section Four concludes the report and offers some recommendations.

[1] Long-term interventions are defined here as those that can be implemented within five years of 2008, when research for this needs assessment began.

I. INTRODUCTION

The city of Mekelle,[2] located in northern Ethiopia, is the capital of Tigray region. It is the sixth largest city in Ethiopia, the largest in Tigray. Water supply in Mekelle does not meet demand, and sanitation coverage needs to improve. Many households, schools and health institutions often lack water and basic sanitation facilities, which has had drastic implications for the public health.

Figure 2: Mekelle Administrative Map



(C) Source: Moumié Maoulidi (MCI) and Tesfu Weldegerima (BOFED).

1.1. Background

Since its establishment in 1872, Mekelle City has expanded tremendously by engulfing many surrounding villages and towns. In 2006 (1998 E.C), the areas known as Quiha (also Qwiha or

[2] Mekelle can also be spelled as Me'kelle, Mekele and Meqelle.

Kuha) and Aynalem were incorporated within Mekelle City limits. Villages recently incorporated include Lachi, Adikenfero, Feleg Daero, Endamariam Dehan, Adi Daero, Adi Kolomey, Serawat, Adi Wolel, Adi Ha and May Alem.[3] As Figure 2 shows, in 2008, the city consisted of seven local administrative areas.

The 2007 (1999/2000 E.C.) Ethiopian Census shows that the city's population was 215,546 and that 51 percent of the residents were women. Applying an exponential population growth function and a growth rate of 5.4 percent, the projected total population of Mekelle was 227,505 in 2008.

In 2001, the Government of Ethiopia adopted a water and sanitation strategy that called for more decentralized decision-making; promoting the involvement of all stakeholders, including the private sector, and integrating activities relating to water supply, sanitation and hygiene promotion.

1.2. Objectives

This needs assessment presents Mekelle's main water and sanitation challenges and identifies the interventions and the investment levels required to meet Target 10 of the Millennium Development Goal 7 (MDG 7), which seeks to halve by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. An additional objective is to identify the necessary infrastructure and human resources required to scale up interventions through that same target date of 2015.

1.3. Methodology

The methodology used in this needs assessment includes the analysis of data collected from municipal and national offices; a review of relevant documents, and a synthesis of informal interviews conducted with stakeholders. Data collection and consultations with stakeholders took place between June 10 and July 24, 2008. A second visit was conducted by the Social Sector Research Manager in August 2009 to validate data and collect additional information.

Members from the following institutions were consulted for information regarding the state of water and sanitation in Mekelle: Mekelle Water Supply and Sewerage Office (MWSSS); Sanitation and Hygiene Department of the Mekelle Municipality; Quiha *Woreda* (district) Office; Tigray Regional Health Bureau; Mekelle City Health Office; Tigray Region Bureau of Water, Minerals and Energy Resources; Tigray Water Works Construction Enterprise; Relief Society of Tigray (Hygiene and Sanitation Program, Water Resources Development Department, Public Health); UNICEF; City of Mekelle Education Office; Central Statistical Authority; Water and Sanitation Program of the World Bank, Addis Ababa, Ethiopia.

Secondary sources on which this research relied include documents compiled in 2006 by the Urban Institute for the Municipal Infrastructure Investment Plan (MIIP), as well as World Bank and Ministry of Water Resources documents. To determine access to water and sanitation in Mekelle schools, information from the 2007 (1999/2000 E.C.) Tigray Region Education Bureau

[3] This study attempts to include data from these 12 areas in the analysis.

Education Statistics Annual Abstract was used. Information on sanitation was obtained from such sources as MCWSS and the Tigray Regional Health Bureau.

To identify access to water and sanitation in hospitals and health centers, the researcher visited Mekelle General Hospital, Ayder Referral Hospital (which has treatment ponds in place of a septic tank), Mekelle Health Center, Kassech Asfaw Health Center and North (Semen) Health Center.

1.4. Limitations

The main limitation faced when conducting this needs assessment was the availability of required data. For instance, the researcher was not able to obtain reports on the quality of the water. In addition, the cost of providing various water supply technologies and sanitation facilities is site-specific. For example, the cost of providing piped water to a household depends on the proximity of the house to the distribution main, and the cost of building a sanitation facility may depend on soil conditions. To address these limitations, an average cost has been used. When a local unit cost was not available, MCI has substituted a unit cost compiled by the government from national water and sanitation needs assessments.

In July 2008, the Mekelle City Health Office also completed a survey of 38,000 households and included information relevant to this study, such as: the sources of water used by households (river, pond, developed or undeveloped spring, protected or unprotected well, piped supply); the condition of latrines, and whether a household has been exposed to hygiene education. However, while the information itself was collected in a timely manner, only three computers were available at the City Health Office, and with data entry performed by only a few individuals, the survey was not yet complete in time for this study.

II. WATER AND SANITATION IN MEKELLE

2.1. Background

The Ministry of Water Resources (MoWR) in Ethiopia is in charge of setting national policies for the water supply sector. Regional Water Bureaus and *Woreda* Water Desks are responsible for investment planning and providing technical assistance to service providers. Water Boards are responsible for planning and managing town and city water supply systems (World Bank, 2007). The City Administration is responsible for appointing a water board chair and other members and approving investment plans and tariff adjustments.

The Mekelle Water Supply and Sanitation Service (MWSSS), a semi-autonomous entity with its own board of directors, is responsible for the city's water supply. MWSSS is controlled by the local government, but for technical support, it tends to rely on the Tigray Region Bureau of Water, Minerals, and Energy Resources (TRBWMER). TRBWMER also formulates policies and raises funds for the provision of water supply at the regional level. The roles of the MCWSS and TRBWMER have been separate since 2006. Activities such as drilling deep and shallow

wells, reservoir construction, electromechanical installation and spring development are undertaken by the Tigray Water Works Construction Enterprise (TWWCE).

The Ministry of Health is in charge of policies related to sanitation and hygiene promotion. The Hygiene and Sanitation branch of the Mekelle City Health Office and the Sanitation and Hygiene Department of the Municipality are in charge of administering sanitation facilities and promoting hygiene education in Mekelle. One problem is that the Mekelle City Water Supply and Sewerage Service Office does not provide sewerage services, even though its name suggests that it performs this function. The following descriptions of roles and responsibilities were obtained from the Federal Democratic Republic of Ethiopia Ministry of Health:

> The *woreda* (district) health office must ensure that all public latrines are built and managed to a high hygienic standard. The *woreda* health office will ensure that all schools have separate latrines for girls and boys (with urinals) with hand-washing facilities, that emptying will be a key feature of latrine construction, as well as effective/hygienic daily management and timely emptying.

2.2. Mekelle's Water Distribution System

The main source of Mekelle City's water supply is ground water from 17 boreholes that ranged from 32- 250 meters deep (MCA, 2008). The distribution system depends primarily on gravity, but the network also relies on 17 pumps. Water is pumped to surface reservoirs where it is treated with chlorine. The yield of the boreholes varies from 4 to 45 liters per second. As Table 1 shows, 10 of these boreholes are located in Aynalem well field, about five kilometers south of the town.

Table 1: Boreholes, Pumps and Reservoirs in Mekelle

Bore Holes	***(Master Plan Sheet)***			***Year Installed***	***K/W***	***Condition***
Borehole # 1 (depth 117 m)	Aynalem	10 L/S	Functional	2000	22	Good
Borehole # 2 (depth 120 m)	Aynalem	45 L/S	Functional	2000	37	Good
Borehole # 3 (depth 120 m)	Aynalem	7 L/S	Functional	2000	15	Good
Borehole # 4 (depth 152 m)	Aynalem	15 L/S	Functional	2000	22	Good
Borehole # 5 (depth 90 m)	Aynalem	23 L/S	Functional	2000	26	Good
Borehole # 6 (depth 75 m)	Aynalem	20 L/S	Functional	1999	24	Good
Borehole # 7 (depth 176 m)	Aynalem	8 L/S	Functional	2005	15	Good
Borehole # 8 (depth 250 m)	Aynalem	19 L/S	Functional	2005	26	Good
Borehole # 9 (depth 62 m)	Aynalem (Endaba Tariku)	6.7 L/S	Functional	1999	26	Good
Borehole # 10 (depth 73 m)	Aynalem	8 L/S	Functional	2005	13	Good
Borehole # 11 (depth 92 m)	Quiha (Enda Mariam)	NA	NA	1999	5.5	NA
Borehole # 12 (depth 87 m)	Quiha (Gomata)	NA	NA	NA	11	NA
Borehole # 13 (depth 80 m)	Kebelle 07 (Sewhi Negus)	10 L/S	Functional	NA	11	Good
Borehole # 14 (depth 60 m)	Kebelle 07 (Sewhi Negus)	NA	Not functional	NA	NA	NA
Borehole # 15 (depth 32 m)	Lachi	4 L/S	Functional	NA	5.5	Good
Borehole # 16 (depth unknown)	Aynalem	NA	Functional	NA		Good
Borehole # 17 (depth unknown)	Chinfere	NA	Functional	NA		Good
Reservoirs (Storage tanks)	**Location**	**Capacity**	**Condition**			
Reservoir (Storage tank) # 1	Enda Mariam	2000m^3	Functional			
Reservoir (Storage tank) # 2	Enda Gebriel	2000m^3	Good			
Reservoir (Storage tank) # 3	Enda Georgis	500m^3	Good			
Reservoir (Storage tank) # 4	Enda Gebriel	350m^3	Not functional			
Reservoir (Storage tank) # 5	Lachi	32m^3	Functional			
Subtotal Reservoir (Storage tanks)		**4850m^3**				

Source: Urban Institute (2006), Mekelle Infrastructure Annex.

To increase water supply, the city plans to build 20 additional boreholes by 2012. The boreholes will be located within a 20km radius of Mekelle City (North of Mekelle at Chinferes, Southwest of Mekelle at Chelekot, and at the Aynalem well field).[4] As shown in Table 1, the city also has five storage/distribution reservoirs, with capacities ranging from 32 - 2000 m^3. In 2006, it was estimated that the total length of the water supply pipes was 300km (Derbew, Epstein and Schaeffer, 2006).

In 2008, the daily water production was about 13,500 m^3, or 4,927,500 m^3 per year (MCA, 2008). About half the total water produced was used by residential consumers[5]. In 2005, there were 18,772 residential house and yard connections, but since then, several thousand new connections have been added each year (Derbew, Epstein and Schaeffer, 2006). In 2008, the number of household connections (private and yard) was 22,500 (MCA, 2008). Table 3 shows that the number of household and yard connections and the water produced has been increasing since 2004, although, as Banerjee et al (2008) note, the number of standpipes has been decreasing.

Table 2: Number of Connections and Standpipes in Mekelle (2004-2008)

	2004	2005	2006	2007	2008	2012 Target
Number of connections (private+yard)	17391	18772	19999	20500	22500	50000
Number of new customers connected	3712	1381	1227	501	2000	
Number of standpipes		38		37	30	
Capacity of production system (m3/day)	6500	7000	7500	8384	13500	38000

Sources: 2004-2006 data is from a questionnaire completed by MWSSS Manager;
2007 data is from TRBWMER; 2008 data is from Mekelle City Administration.

Water consumption in 2008 was 30 liters per capita per day (MCA, 2008). According to the World Bank (2007), residents in mid-sized African cities (fewer than 500,000 people) typically require 75 liters par capita per day. According to these guidelines, water consumption in 2008 would have been less than half what Mekelle residents required. The city plans to increase production so that residents are able to consume 80 liters per capita per day by 2012 (MCA, 2008).

Key water supply problems in Mekelle include water loss and non-revenue water. In 2008, water losses in the distribution system amounted to 4,456 m^3/day.[6] There are two types of water losses: real and apparent. "Real" losses include leakages from reservoir walls, reservoir overflows, pipes, joints and fittings. They can be severe and may go undetected for months or years. In 2005, the Mekelle water utility attributed 20 percent of unaccounted water losses to leakages, but illegal connections and the lack of gauges on some reservoirs were also cited as contributing factors (Derbew, Epstein and Schaeffer, 2006). This indicates that it is also

[4] Mekelle Water Supply and Sewerage Service (MWSSS).
[5] In 2006, Derbew, Epstein, Scheffer found that 56 percent of water produced was for residential use. The 2008/09 (2001 E.C.) MWSSS Annual Report shows that private customers consumed 1,671,560 m^3 out of 3,300,952 m^3, or 51 percent.
[6] Total water loss = amount of water produced - amount of water billed or consumed.

important to focus on "apparent" losses, which typically result from unauthorized consumption and inaccuracies from reading meters. According to Farley (2003), in developing countries it is important to focus on identifying "apparent" losses, because illegal connections, meter error or accounting errors are often more significant than leakages. Reducing "apparent" and "real" losses is hence critical because it could restore an enormous supply of valuable treated water.

There is also a need to reduce non-revenue water and improve financial management. Non-revenue water is a key problem: according to the World Bank (2007), approximately 30 percent of the volume produced in cities like Mekelle is not billed, and 25 percent of what is billed is not paid; hence the water utility is collecting tariffs on only half the volume of water produced.[7] To improve operational efficiency, the World Bank urban water supply and sanitation project (WSSP) in Ethiopia, which includes Mekelle as one of the beneficiary secondary cities, has set specific targets. These include the reduction of non-revenue water by 10 percent and the recovery of 80 percent of costs through tariffs (World Bank, 2007),

2.3. Access to Water in Mekelle

Access to safe drinking water is defined as access to water taps inside a house or in a yard; public standpipes, and boreholes/protected wells. Unprotected wells/springs or water from rivers/lakes/ponds are not included because they are not considered "improved" sources.

In 1994 (1987 E.C.), the most commonly used source of piped water in Mekelle, Aynalem and Quiha was a tap outside of the compound. Total access to an improved water source in 1994 was 31 percent.

Table 3: Sources of Drinking Water for Households (1994)[8]

Location	Tap in House	Tap in Compound Private	Tap in Compound Shared	Tap Outside Compound	Protected Well/ Spring	Unprotected Well/ Spring	River/ Lake/ Pond	Not Stated
Mekelle	4%	11%	17%	50%	6%	7%	4%	1%
Aynalem	18%	2%	4%	35%	10%	1%	29%	2%
Quiha	4%	7%	9%	75%	1%	2%	2%	1%
					Total access to a safe water source			31%

Source: Census Commission (1994).

Most of the improved sources are house and yard connections. Mekelle residents also rely on public fountains (also known as standpipes, or "Bono"). Public fountains are most commonly used in high-density, low-income areas. Since 2007, communal standpipes have been operated by an individual selected by the local administration, which is also in charge of submitting payments for the water bill and for paying the agent.

[7] This is an average estimate, based on Mekelle City and the cities of Awassa in the Southern Region, Jimma in Oromia Region and Gondor in Amhara Region.
[8] Note: No indication of the distance from the tap to the home was given.

It is essential to know the distance from standpipe (public fountain) to home in order to determine whether a particular use of standpipes can be defined as "improved access." Ideally, an improved water source should be located within a 1.5km radius. A survey similar to the Urban Institute's 2005 household survey, inquiring how many households use a house connection, yard connection or standpipe, along with the distance of the standpipe to the home, needs to be conducted, in order to accurately estimate coverage of the population by source.[9]

2.4. Mekelle's Sanitation System

Sanitation facilities in Mekelle consist mainly of pit latrines and pour-flush latrines with septic tanks. A 2005 household survey conducted by the Urban Institute indicates that more than half the population used dry-pit latrines, and a third of the population used flush toilets connected to septic tanks. As of 2007, Mekelle still did not have a sewerage system. The Federal government's sanitation master plan has recommended that a partial sewerage system be installed in Mekelle; indeed, the city needs a simplified piped sewerage system.

In addition, given the high percentage of those using flush toilets connected to septic tanks, the city needs to ensure that the tanks are emptied regularly and that sludge is not emptied directly into storm drains, ditches, canals or rivers. To confirm that the septic tanks operate effectively and do not contaminate the environment, the MWSSS will also have to ensure that anaerobic digestion takes place in the tanks and that sludge is collected by vacuum trucks and taken to dry beds or disposed of in sanitary landfills.

Solid Waste

Solid waste collection and disposal in Mekelle City is inadequate. In 2006, only 68 percent of solid waste produced was collected and brought to dump sites (Urban Institute and Adam Smith International, 2006). Since then, the amount of solid waste generated in Mekelle has only increased: in 2008, it was estimated that each person generated between 0.30-0.33 kg/day (Tadesse, Ruijs and Hagos, 2008).

There are two major methods to collect solid waste: door-to-door collection and communal containers. Door-to-door solid waste collection is carried out by tractor trailers. Households can also deposit their solid waste into $8m^3$ containers which are picked up by skip loaders and transported to dump sites when they are full. According to Tadesse, Ruijs and Hagos (2008), in 2006, the city had 58 containers, 3 skip loaders and 4 tractor trailers.[10] Table 4 shows the refuse collection equipment available in 2006. To effectively collect solid waste, the city needs additional tractor trailers and skip loaders in good condition.

The city has two dump sites, one in Messobo and one in Quiha. Nevertheless, some residents dump waste on any available unoccupied ground. The Messobo site, located 13.5km away from the city center, is an open dump that has accumulated deposits; however, but it is being upgraded, and the city is also proceeding with plans for a modern landfill in Quiha.

[9] The Urban Institute's 2005 household survey is useful, despite the small sample size (N = 420).

[10] None of the 58 containers were located in Quiha or Aynalem.

Table 4: Inventory of Sanitation Equipment in Mekelle (2006)

Type of Equipment	Number	Year Bought	Condition	No. Loads/Wk.
Refuse Trucks (vol/load)	3			
Skip Loader #1 Per load (7- 8m^3)		2001	2	21
Skip Loader #2Per load (7- 8m^3)		2002	2	21
Skip Loader #3 Per load (7- 8m^3)		2005	1	21
Tractors	4			
Tractor #1 Per load (1-1.5m^3)		2000	2	21
Tractor # 2 Per load (1-1.5 m^3)		2000	2	21
Tractor #3 Per load (11.5 m^3)		2000	2	21
Tractor #4 Per load (1-1.5m^3)		2000	2	21
Key: Condition: 1 = Good, 2 = Satisfactory, 3 = Unsatisfactory				

Source: Urban Institute (2006).

Liquid Waste

Mekelle City lacks the proper infrastructure for the collection and treatment of liquid waste. Some residents reportedly dump liquid waste on neighborhood roads and vacant locations around the city (Derbew, Epstein, Schaeffer, 2006); untreated liquid waste is also disposed of on fields and farmlands. Such practices have the potential to contaminate ground water reserves and can cause health and environmental problems for the citizens of Mekelle.

The City Administration has approved the construction of a liquid waste treatment site with an oxidation pond or lagoons on a 14-hectare site near the city's industrial zone. Requirements for such a wastewater treatment plant include settling ponds, anaerobic tanks, a biolagoons and engineers, lab assistants, operators and general staff to operate the site.

2.5. Access to Sanitation in Mekelle

As shown in Table 3, in 1994 few residents in Mekelle, Quiha and Aynalem had a toilet. In Mekelle and Quiha, the most used toilet facility was the shared pit latrine, while in Aynalem residents used shared pit latrines and private pit latrine facilities. Coverage in Mekelle was highest (53 percent), followed by Quiha (36 percent), and lastly, Aynalem, with only nine percent sanitation coverage. When coverage is calculated as an average of all three towns, access in 1994 was 32 percent.

Table 5: Access to Sanitation (1994)

Location	Has No Toilet	Flush Toilet Private	Flush Toilet Shared	Pit Private	Pit Shared	Not Stated
Mekelle	47%	5%	7%	13%	26%	2%
Aynalem	91%	0%	0%	3%	3%	3%
Quiha	64%	1%	1%	11%	21%	2%
Total Access to Basic Sanitation in 1994 (Mekelle, Aynalem, Quiha)						32%
Target Access 2015 (Mekelle, Aynalem, Quiha)						66%

Source: Federal Democratic Republic of Ethiopia Office of Population and Housing Census Commission, 1994.

Toilet facilities used in Mekelle include private as well as communal (public) flush toilets and pit latrines. The type of flush toilet most commonly used is a simple ceramic Turkish/squat type or a ceramic seat type. Communal latrines differ from public latrines in that they are typically located within the compound of a house, shared and maintained by a cluster of households. This usually results in the facilities being better maintained than public latrines, which are open to the public and cared for by an attendant.

The following observations were culled from informal interviews with sanitation personnel or local residents.

1. Squat type toilets are generally preferred because they require less maintenance. They also have fewer parts that may require replacement, require less water than a toilet with a seat and tank, and are easier to clean.

2. Open defecation is widely practiced, even in places where there are well-kept public toilet facilities, partly because of a stigma attached to public toilets as being unclean. Locations near rivers seemed to have the highest occurrence of open defecation, as rivers are commonly treated as public dumping grounds.

There are approximately 21 public and three communal toilets in Mekelle, as well as two public toilet facilities in Quiha. All public toilets are the squat-type; some also have septic tanks and/or public showers.

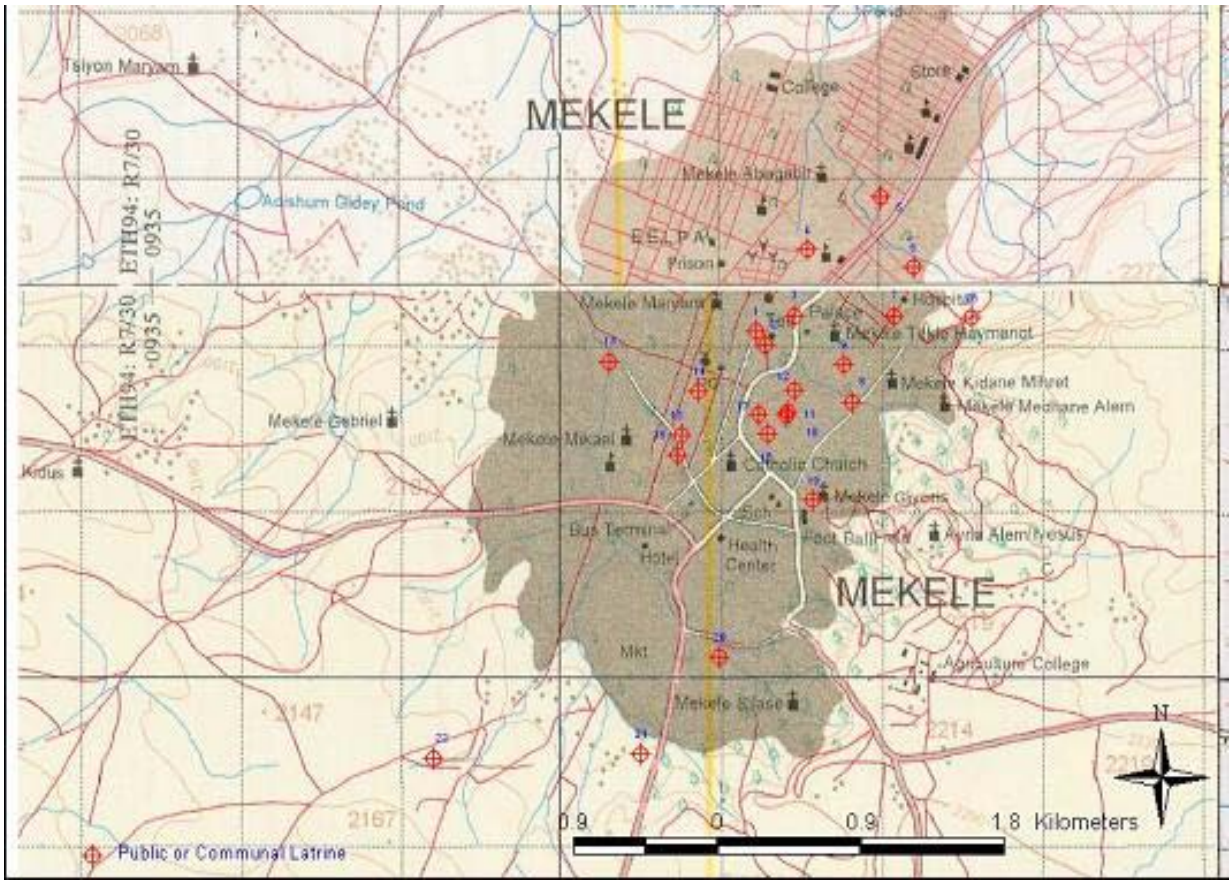
Table 6: Inventory of Public and Communal Toilets in Mekelle (2006)

Name by Location	Location	No. of Rooms	Communal Latrine	No. of Beneficiary households
1. Edaga Kedamay Woyane	Kebelle 12	11	Near St. Michaels Church, Tabia Kedamay Weyane	11
2. Edaga hawelti	Kebelle 11	10		
3. YMCA	Kebelle 04	5	Kebelle 14, Tabia Adisalem	5
4. Behind TDA Office	Kebelle 07	14		
5. Upper Gate of Municipality	Kebelle 08	6	Kebelle 15, Tabia Adisalem	6
6. Endasheka Mill	Kebelle 15	8		
7. Inderta Hotel	Kebelle 14	4	Kebele 4, near Mekelle Hospital, Tabia Sewhinigus	7
8. Merkeb Hotel	Kebelle 09	14		
9. Kebelle 19 Office	Kebelle 19	10	Kebelle 7, near youth center, Tabia Sewhinigus	0
10. Behind Hawelti Hotel	Kebelle 07	6		
11. Behind Betekihnet	Kebelle 01	4		
12. Kebelle 17 Goods Market	Kebelle 17	10		
13. Endalincheiti	Quiha	3		
14. Near Edaga Kedam	Quiha	6		
15. Kongo Sefer	Quiha	7		
16. Behind Abraha Castel	Kebelle 18	10		
17. Near Kindergarten	Quiha	8		
18. Medebir Hatsin (Metals)	Kebelle 06	6		
19. Kebelle 06 Goods Market	Kebelle 06	6		
20. Near Kebelle Adihawsi	Kebelle 18	6		
21. Near Green Hotel	Kebelle 09	6		
22. Edaga Ayder	Kebelle 03	6		
23. Edaga Bieray (Cattle Market)	Kebelle 17	6		

Source: Derbew, Epstein and Schaeffer (2006).

Figure 3 below gives approximate locations for all public sanitation facilities in Mekelle.

Figure 3: Map of Public and Communal Toilets in Mekelle, July 2008



Source: Data for map collected by Andrea Castro; map created by Andrea Castro, with the help of Gebrewut, of the Tigray Region Bureau of Water, Minerals, and Energy Resources.

Mekelle City has done more than many other local governments in building public toilets. However, a problem with public sanitation facilities is that some people defecate around public facilities rather than inside, especially, but not only, at night. This leaves feces out in the open, which increases the fly population. Also, the local service providers' water supply has been demonstrated to be almost universally insufficient, rendering non-functional those toilets requiring a lot of water, including even simple hand-washing basins or urinals. Facilities generally keep barrels of water equipped with cups to use for manual flushing, to accommodate the lack of a reliable water supply.

The location of public toilets adjacent to rivers, as is currently the trend, may be suitable culturally, as rivers are commonly viewed as public dumping grounds, but the practice has severe impacts on water quality. Better cooperation is needed between the Mekelle City Health Office and the Municipality in placing hygiene posters in public toilets, rather than locking these facilities and preventing their use, as is done now. During MCI's visits to some public toilets, one guard complained of the lack of cleaning materials, while another lamented the costs of

emptying the latrines. A few of the facilities were locked, while others appeared to be abandoned and in terrible hygienic condition. Lastly, some of the facilities are leaking, due to their being either undersized or cracked, thereby releasing sewage and sewage odor into the environment.

To address the sanitation problem, communal rather than public latrines need to be promoted, as they are better cared for than public toilets. A fund for the proper management of public latrines (specifically, for cleaning supplies) should be created, so the public will be encouraged to continue to use them. In addition, the city should conduct workshops to demonstrate proper latrine construction from local materials and should undertake mass media campaigns that emphasize the proper maintenance of latrines. Finally, the public latrines should have guards and lighting at night, to increase the facilities' nighttime use and to decrease the occurrence of open defecation.

2.6. Wastewater Treatment

Currently there is no wastewater treatment network in Mekelle, nor is there any facility available to treat raw sewage removed from on-site systems. This deficit has resulted in the common practice of raw sewage being applied to farmers' crops as fertilizer.[11] Ayder Hospital is the only health facility with a fully functioning sewage system; in Ayder's case, the sewage is piped into seven lined treatment ponds, located about 1.5km from the hospital.

A fecal sludge drying bed, used to treat raw sewage removed from latrines or septic tank systems, is currently under construction, and will be funded by the World Bank and the municipal government. The budget and timeline for this project were not available at the time of this report.

Recommendations to improve wastewater management include:

- Completing the construction of a simple drying bed – a place where sewage can dry, in a location convenient for emptying by vacuum trucks;
- Designating a location for emptying sullage, to prohibit the emptying of vacuum trucks containing raw human excreta on farmland;
- Establishing and enforcing regulations prohibiting open defecation;
- Providing staff scholarships to pursue education in wastewater treatment/sewage-related fields.

2.7. Hygiene Education

Hygiene education is important because the MDGs cannot be achieved simply by increasing the number of sanitation facilities, but will also require changing behaviors. Many people in Mekelle are unaware of the close linkages between sanitation and health. Hygiene education campaigns aimed at behavioral change can be carried out by health extension workers. These campaigns should primarily target women, who play the lead role in families, both in transferring health knowledge and in managing water and sanitation at the household level.

[11] Mekelle City Health Office.

Adequate funds need to be allocated to hygiene education. In general, when funds are available for sanitation and water supply, priority tends to be given to installing and improving infrastructure. However, installing infrastructure will not lead to health benefits, if not accompanied by interventions to improve such behaviors as promoting correct usage of latrines, hand-washing with soap and the proper handling of drinking water.

Hygiene education should also be incorporated into the school curriculum. Currently no separate hygiene education is given in schools; it is assumed that hygiene education is covered by environmental health education, and any established hygiene clubs are voluntary. It will be cost-effective for health workers to train teachers in hygiene education. The cost of a three-day teacher training program is estimated to be $31,000, for the current number of primary and secondary teachers in Mekelle.

2.8. Access to Water and Sanitation in Schools and Hospitals

Water and Sanitation in Schools

Data on the number of latrines per school and the availability of water were available from the Tigray Region Education Bureau, Education Statistics Annual Abstracts for 1999 E.C. (2006/2007) and 2000 E.C. (2007/2008). No data were accessible concerning the number or availability of simple hand-washing facilities supplied daily with water and soap,

Lack of toilet facilities in schools can negatively affect attendance (especially in the likely case of a parasitic illness). It is common for female students not to attend class during menstruation if no facility is available for the disposal and/or changing of sanitary napkins during school hours. According to the Federal Democratic Republic of Ethiopia, Ministry of Health, National Hygiene and "On-Site" Sanitation Protocol (June 2006), institutional facilities should be equipped with separate latrines for girls and boys, as well as with urinals for boys.

Yet in 2007, only 62 percent of schools in Mekelle had toilets; that is, 21 out of 56 schools had no toilet facility).[12] Of the schools outfitted with pit latrines, five did not have separate latrines for boys and girls. Students prefer separate facilities for boys and girls for privacy purposes; otherwise “noises and peeking through the cracks” by the opposite sex become a concern for students.

Only 73 percent of schools had water taps in 2007, meaning that 15 of 56 schools lacked any connection to a water tap.[13] Of the 41 schools with a tap connection, two also have wells. But many schools have only one tap available to students; installing more taps in schools should be a priority.

It is crucial that sanitation in schools and the proper maintenance of sanitation facilities be made a top priority. The latrines should abide by the institutional minimum standards of usage, to ensure that the facilities are not being overused. Each school should create and prioritize a water and sanitation budget for operation and maintenance planning purposes. Schools that rely on the water service providers for drinking water should arrange for a back-up water source for those

[12] Tigray Region Education Bureau, Education Statistics Annual Abstracts for 1999 E.C. (2006/2007).
[13] Two of these schools were private.

all-too-common occasions when the service providers are short. Schools should also be equipped with hand-sanitizing solution that children can apply before eating when water is scarce.

Water and Sanitation in Hospitals

All hospitals and health centers in Mekelle have water connections, sanitation facilities and septic tanks. Ayder is the only hospital with a piped sewage connection to lined treatment ponds. However, almost all health facilities have problems with their current water and sanitation facilities. All facilities except Ayder reported an insufficient supply of water from the piped water connection with the utility. This in turn makes certain sanitation systems inadequate.

At Kassech Asfaw Health Center, the storage tanks do not currently store water – water bypasses the tank directly. In addition, the water tanks are rusting. At North (Semen) Health Center, water storage tanks, sinks and flush toilets are in place but unusable, due to the inadequacy of the water supply from the piped connection provided by the utility. At Mekelle Health Center, the sanitation facility has no doors for privacy, no water available for flushing or hand-washing, no lighting and a strong odor.

The worst water and sanitation facilities were found at Mekelle General Hospital (MGH). This hospital would benefit greatly from a compact on-site wastewater treatment method, as septic waste is currently leaking into a nearby stream, exposing the community to hospital waste and resulting in numerous community complaints. In addition, the gradient of the sewage network at Mekelle Hospital needs careful repair, as sewage odors and backflow are common. A well is currently being developed at Mekelle Hospital to supplement the inadequate supply.

Cost estimates required to rehabilitate each facility were not obtained. However, the utilities' failure to provide sufficient water to nearly all facilities highlights the need to increase production by the water service provider.

To address some of the problems mentioned above, local officials might consider the following suggestions:

- Creating signs informing patients of proper use of facilities (e.g., "Do not throw stones in toilets as it will damage septic system");
- Using more durable faucets, as opposed to less hardy types;
- Looking into other on-site wastewater treatment options for Mekelle General Hospital, which currently poses a public hazard; rehabilitate non-functional facilities at MGH;
- Connecting North (Semen) Health Center to water main, or investigating other on-site water sources (such as a shallow well);
- Replacing storage tanks at Kassech Asfaw Health Center;
- Seeking funds for an operation and maintenance budget of sanitation in health facilities, specifically, for the rehabilitation of non-functional or damaged equipment.

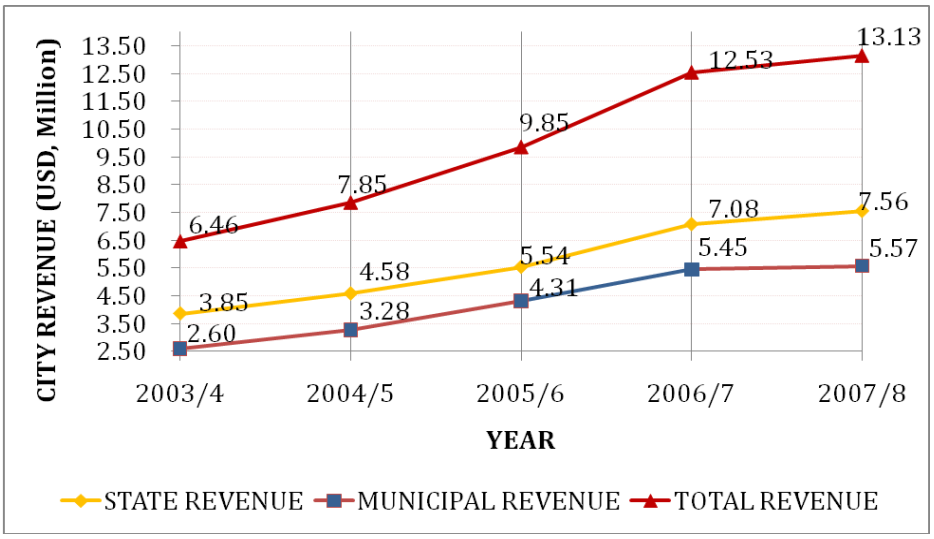
The following section focuses on financing mechanisms for water and sanitation activities and discusses unit costs to provide water and sanitation services. It also presents the results of the Millennium Project water and sanitation costing model.

III. FINANCING WATER AND SANITATION IN MEKELLE

3.1. Financing Water and Sanitation

A major challenge facing local authorities in Mekelle is finding ways to finance water and sanitation activities. The primary municipal revenue sources for the city include land use rent, trade services, penalties and interests and lease holdings. As it can be seen in Figure 4, the city's total revenue has been steadily increasing since 2003.

Figure 4: Mekelle City Revenue (2003-2008)



Source: MCA (2008)

To finance water and sanitation activities, the city charges residents connection costs, meter rents, deposits and water usage fees. Table 7 shows the tariff structure in Mekelle.

Table 7: Tariff Structure of Mekelle Town Water Supply and Sewerage Office

Category	Water Usage Rate (m^3)	Fee in Ethiopian birr (per m^3)	Fee in US$ (per m^3)
Domestic	0 - 5	2.3	0.24
	6 - 10	3.5	0.37
	11 - 20	5.5	0.58
	> 20	6.1	0.64
Non-domestic (commercial, industrial)	Flat Fee	6.1	0.64

Source: Mekelle Water Supply and Sewerage Office, June, 2008

Fees vary for domestic connections on the basis of water usage rate and the assumed ability of households to pay. For example, it is assumed that low-income households will consume less water and will hence be less able to pay the full cost of production, estimated at approximately \$0.56- 0.58 /m^3 (MWSSS). The remaining deficit (that is, the ratio of revenue to expenses) is cross-subsidized by users' paying a higher fee than production costs. However, this is not sufficient to cover the residual costs, which are therefore also subsidized by the municipality.

Tariffs, connection fees and deposits simply do not generate enough revenue to address all Mekelle's water and sanitation needs. As a result, local authorities depend on funds from the central authority and from bilateral and multilateral donors to finance investments in the water and sanitation sector. The city obtains funding from the following channels:

1. As a result of decentralization, block grants from the Federal government come to *woredas* such as Mekelle, via the regional Bureaus of Finance and Economic Development (BoFEDs) (Water Aid, 2008). The *woredas* then autonomously decide how allocate the grants. These 'on-budget' grant amounts are determined by a formula determined by the Federal Ministry of Finance and Economic Development (MoFED), BoFEDs and *woreda* finance offices.

Subsidies for building household latrines are not provided at the *woreda* level, except in specific situations where village/*kebele* leaders identify abject poverty, extreme physical disability or adverse local ground conditions confirmed by health extension workers. For such cases, the *woreda* council establishes a "discretionary" Improved Hygiene and Sanitation (IHS) fund, with eligibility criteria for receiving subsidies.

2. Another crucial funding source are the non-governmental organizations (international or national) and other donors, whose monies are generally transferred directly to service providers and are, hence, 'off-budget'. Key donors funding water projects in Ethiopia include the World Bank, the European Union (EU), the African Development Bank and the Department for International Development (DFID). The World Bank has approved a $65 million loan and $35 million grant to finance an urban water supply and sanitation (WSSP) sectoral project in Ethiopia, with Mekelle as one of the beneficiary secondary cities.[14] Projects like WSSP require a 10-15 percent matching fund from the regions. This is problematic, as *woredas* find it difficult to raise enough resources to allocate matching funds to sector projects (Water Aid, 2008).

Funds from donors are typically given to the Ministry of Water Resources (MoWR) and are then allocated to Bureaus of Water Resources (BoWRs) before being channeled down to *woreda* water offices. GOE has also established the Water Resources Development Fund (WRDF), to finance urban water supply and sanitation projects. BOFEDs and municipalities would support water boards and *woredas* with proposal preparation, so that they can qualify for loans from WRDF.

3. A third source is the Local Investment Grant (LIG), a conditional grant designed jointly by the World Bank and the Government of Ethiopia. LIG is to be used only for capital investment and is available to any *woredas* and/or municipal administrations (Thomson, 2007). In order to make LIG effective, the Government of Ethiopia and the World Bank have agreed that the allocations should be formula-based and have proposed using the current block grant formula.

4. The Urban Development Fund (UDF), based on an agreement between the Governments of Ethiopia and Germany, is another funding mechanism. The overall goal of the UDF is to contribute to improved service delivery and infrastructure provision. The UDF co-finances

[14] The other secondary cities are Awassa in Southern region; Jimma in Oromia region, and Gondor in Amhare region.

improved municipal service delivery (e.g. investment in solid waste management), as well as investment in sanitation, drainage and public water standpipes.[15]

It was not possible to obtain accurate data on what proportions of the Mekelle City water and sanitation budget are financed by block grants, donors and local investment grants. However, Water Aid (2008) estimates that the regional block grant accounts for 80-90 percent of the *woreda*/local government budget, largely for recurrent expenditures. As a result, capital investments rely on such funding mechanisms as the LIG and the UDF.

Recognizing the urgency of this problem and the need for a consolidated approach to achieving these targets, in 2003, the National Water Resources Management Policy called for promoting involvement of all stakeholders, including the private sector, in the development and management of water supply and sanitation systems (World Bank, 2003). Currently the World Bank is financing the Urban Water Supply and Sanitation Project (UWSSP); bilateral donors and NGOs are also financing various water and sanitation projects in Mekelle. However, to meet the MDG targets, the city needs additional investment in this vitally important sector.

Proposed Projects

In 2005, the Urban Institute recommended a number of water and sanitation projects (Table 7), collectively known as the Municipal Infrastructure Investment Project (MIIP), including:

- The construction of new boreholes and the rehabilitation of existing boreholes;[16]
- The construction of additional reservoirs and new pumping stations;
- The expansion of meter lines to new residential areas;
- The development of a dam with a capacity of 48 million m^3 on the Giba river; dam construction is expected to be completed in 2012 (2000 E.C.), at an anticipated cost of 900 million birr ($94.7 million).

The total estimated costs for these projects are shown in the left column of Table 8, below. However, given that implementation of some of these projects started as early as 2006-07, this needs assessment only considers project costs intended to be covered during the 2009-2011 period.

Table 8: Municipal Investment Infrastructure Projects Proposed by the Urban Institute

Project	Description	Cost (2009-2011)
Water Supply System Upgrading and Expansion (300m birr)	Increase water supply capacity by constructing four boreholes, rehabilitating existing boreholes, replacing pipes, valves, and gauges and expanding supply lines to new residential settlement areas.	120,000,000 birr
Liquid Waste Treatment Plant (10m birr)	Build a liquid waste treatment site on land (14 ha) near the industrial zone area. This project was scheduled to be completed in 2008.	0

[15] Source: http://www.ces.de/05/01/71-0402e-c.pdf

[16] In 2008, the Mekelle City Administration indicated that 20 boreholes were to be built, of which only four had been completed as of November 2009.

Solid Waste Treatment (19.1m birr)	This project aims to build a sanitary landfill in Quiha-Aynalem, upgrade the open dumpsite in Messobo, and build a treatment plant for solid waste. In addition, skid loaders, a dozer and a compactor will be purchased. The project is identified as one of first priority projects in the municipal strategic plan and city master plan.	1,000,000 birr (purchase of 1 skip loader) 500,000 birr (upgrade of Messebo dump in 2009-2010)
Public Toilet and Shower Construction; Vacuum Truck Purchase (22m birr)	The aim of the project was to improve the condition of basic hygiene by developing public toilet facilities in five *kebeles* and two public showers in each *kebele.* The project also aimed to increase efficiency of liquid waste collection by purchasing five more vacuum trucks. This project was scheduled to be completed in 2008.	0

Source: Urban Institute (2006)

The Government of Ethiopia's 2005 national sanitation needs assessment provided the following financing requirements for the provision of a sewerage system and septage collection, treatment and disposal in urban Tigray[17] (see Table 9, below).

Table 9: Costs of Sewerage System and Septage Collection, Treatment, Disposal

Annual Costs in Birr							
	2009	2010	2011	2012	2013	2014	2015
Sewerage System	7,498,288	1,771,773	2,313,414	2,737,015	3,326,776	3,915,581	3,304,823
Septage Collection, Treatment & Disposal	502,198	606,455	744,200	903,304	1,108,418	1,324,702	1,713,522
Annual Costs in USD							
Sewerage System	789,293	186,502	243,517	288,107	350,187	412,166	347,876
Septage Collection, Treatment & Disposal	52,863	63,837	78,337	95,085	116,676	139,442	180,371

FDRE (2005), Tables 12 and 13.

3.2. Simulation model

Interventions

The interventions proposed in this needs assessment are based on a review of the Water Sector Development Program[18] (WSDP) and the Water Supply and Sanitation Master Plan for Mekelle.

Improved water sources or technologies identified by MCI as appropriate for Mekelle include:[19]

1. Household connection
2. Yard connection
3. Public standpipes
4. Boreholes/Protected wells

Public standpipes are an alternative water source option for residents in low-income areas who cannot afford a household or yard connection.[20] For one thing, they can be readily converted to

[17] These costsare not included in MCI's needs assessment, as they are included in World Bank's Urban Water Supply and Sanitation project.
[18] WSDP aims to provide clean adequate and reliable water supply and sewerage services.
[19] This list of interventions is presented as a reference and should not be viewed as an exhaustive set of options.

household connections when residents can afford it. Water sources such as rainwater harvesting, river water, as well as hand-dug and untreated wells, are not considered as safe sources of water for human consumption and are therefore not included as "improved water sources."

According to the definition proposed by Millennium Project Water and Sanitation Task Force, individuals living in urban areas are considered to have "access to an improved water source" if they live within half a kilometer of a safe water sources and can access 40 liters per person per day. Fulfilling this last requirement is difficult, because data on distance to a water source is not always available, and the amount of total water used per day by individuals depends on the type of water source. For instance, on average, households with in-house connections use much more water than households with public standpipes, because of the convenience afforded by in-house connections. Derbew, Epstein and Schaeffer (2006) estimate that those using public taps consume 18 liters per day, while those with yard taps consume 30 liters, and those with connections inside their homes use 40 liters per day. Individuals using public taps consume less water, in part because they have to walk to a standpipe, wait in line and then carry the water home. This inconvenience limits the amount of water that individuals relying on water taps can consume per day.

Technologies included in this needs assessment as representing "improved" sanitation include:

1. Improved pit latrine (with a slab)
2. Pour-flush latrines
3. Communal toilets connected to septic tanks
4. Connections to simplified sewage ("condominial")

It is assumed that the Mekelle City administration will cover the investment costs of communal toilets and septic tanks. Moreover, as recommended by the master plan, it is envisaged that a small sewer system will be in place and will serve three percent of the city's population. Simplified sewage, otherwise known as condominial sewage, can be put in place in the new residential areas.

Some of the sanitation technologies listed above require a lot of water, while others do not. Table 10 compares the amounts of water required by various sanitation technologies.

Table 10: Water Requirements for Different Sanitation Technologies

Sanitation Technology	Minimum Water Requirement
Pit latrine	1 to 2 liters
Pour/Flush toilet	6 to 10 liters per person per day
Sewered PF toilets/septic tanks	7.5 liters per person per day
Ventilated improved pits (VIP)	None

Source: Gleick (1996).

[20] However, some people believe public water sources are less desirable than a private or yard connection, because the high number of users at a public access point increases the chances that such a system will become susceptible to contamination.

Coverage

Improved water and sanitation coverage data for 1994 and 2007 are used to estimate the population to be covered to attain the MDG target, taking into account population growth until 2015 and assuming that coverage increases linearly each year between 2007 and 2015.[21] The 1994 coverage level is obtained from the 1994 (1987 E.C.) census data on access to improved water sources and sanitation. According to Teka and Mulugeta (2003), reliable data on sanitation coverage in Ethiopia is scarce because few systematic assessments have been conducted regarding access to appropriate sanitary facilities.

In this needs assessment, coverage data for 2007 were derived from MWSsS[22]. The coverage target for 2015 is obtained from the Water Sector Development Plan (WSDP) and the national sanitation MDGs needs assessment report. The MWSSS and municipal planning documents were also consulted for data on coverage targets.

It should be noted that there are noticeable differences in water supply and sanitation coverage data reported in different publications. According to JPM (2000), coverage figures for some countries have sometimes varied because the definitions of "improved" water supply and sanitation technologies have differed over time. In addition, differences are partly explained by the fact that some publications express coverage percentages in terms of population, while others express coverage in terms of households. For instance, Derbew, Epstein and Scheffer (2006) estimate that 40 percent of households had access to potable water via a private house or yard connection in 2006, and that eight percent of households relied on 39 public standpipes.[23] The 2004 Ethiopia Welfare Monitoring Survey also shows the distribution of sources of drinking water according to households while documents from the Ministry of Water Resources and the Tigray Region show the distribution of water sources in terms of population.

Table 11: Water Coverage Data and WSDP Targets for Urban Tigray (1994-2015)

	1994 (1987 E.C)	2001 (1993 E.C)	2006 (1998 E.C)	2007 (1999 E.C)	2011 (2003 E.C)	2015 (2000 E.C)
Mekelle	31%			55.7%	82%	89%
Urban Tigray (WSDP Targets)		59%	87%		100%	100%

Sources: CSA (1995); MWSSS provided 2007 and 2011 data; WSDP (2002) for urban Tigray data.

It is difficult to gather accurate sanitation coverage data for Mekelle because a) varying definitions of sanitation coverage have been used, and b) most data are for "urban Tigray," as shown in Table 11. The coverage targets for urban Tigray are WSDP targets, which, in this needs assessment, are used as proxies for MDG targets. (See Table 12, below.)

[21] In other words, the targeted population is assumed to receive improved water and sanitation in equal annual increments from the beginning of 2007 until 2015.

[22] The 2007 coverage level allows MCI to estimate the population yet to be covered in order to meet the MDG target in 2015. This needs assessment assumes that coverage in 2007 was similar to that in 2005-2006.

[23] According to the Tigray Region Bureau of Water, Minerals, & Energy Resources (TRBWMER), 25 percent of these connections were private household connections, and 75 percent were yard connections.

Table 12: Baseline and Calculated Sanitation Coverage - Urban Tigray (1994-2015)

	1994 (1987 E.C)	2000 1993 E.C)	2006 (1998 E.C)	2007 (1999 E.C)	2011 (2003 E.C)	2015 (2000 E.C)
Mekelle	32%					
Urban Tigray (WSDP Targets)		60%	62%	63%	71%	80%

Source: CSA (1995); FDRE (2005) for urban Tigray data.

Unit Costs

In assessing the financing requirements to meet the MDG water and sanitation targets, the Millennium Project framework involves using data on construction costs as well as estimates of operation and maintenance (O&M) costs. O&M costs, as well as costs associated with rehabilitation of infrastructure, are entered as a percentage of capital costs. Following the approach used by the Ethiopia government in its national water and sanitation MDG needs assessments, operation and maintenance (O&M) costs are calculated as 10 percent of the capital cost (FDRE, 2005). The O&M costs for latrines are much lower (two percent). It is assumed that rehabilitation costs amount to 20 percent of the capital cost.

Unit costs for water interventions are shown in Table 13 and are derived from municipal sources, MOFED, UNDP (2004) and AICD (2008).

Table 13: Unit Costs of Urban Water Interventions (excluding program costs)

Urban Water Supply Construction	Unit cost of construction		Unit cost of Rehabilitation		Unit Cost of Operation	
	(birr)	(US$)	(birr)	(US$)	(birr)	(US$)
Household Connection (treated)	1050	111	420	44	105	11
Standpipe	2679	282	1072	113	268	28
Borehole/Drilled Well and Pump	79000	8,316	31600	3,326	7900	832
Spring Development	3,000,000	315,789	1,200,000	126,316	300,000	31,579
Reservoir (300 m3)	545,000	57,368				

Source: MOFED and UNDP (2004); AICD (2008) for data on standpipes.

The unit costs for household piped water and standpipes are assumed to include average treatment costs. The unit cost for a household connection represents the cost of materials and labor, and a deposit of approximately $5. However, it does not include the cost of building a water supply network.

Unit costs for sanitation facilities, shown in Table 14, are derived from municipal sources as well as from the national sanitation needs assessment.

Table 14: Unit Costs of Urban Sanitation Interventions[24]

Latrine Type	Unit cost of construction		Unit cost of Rehabilitation		Unit Cost of Operation	
	(birr)	(US$)	(birr)	(US$)	(birr)	(US$)
Traditional Pit	400	42	160	17	40	4
Pour flush toilet and Septic Tank	15000	1579	6000	632	1500	158
Latrine and Communal Septic Tank (HH)	10000	1053	4000	421	1000	105
Communal VIP latrine	14400	1516	5760	606	1440	152
Sewered Connection	12000	1263	4800	505	1200	126
Collection of Waste and Treatment						
Septage Collection (5-8 m3)	120	13	48	5	12	1
Sludge treatment	900	95	360	38	90	9
Cost of treatment plant	62000	6526	24800	2611	6200	653
Sewer network (per hectare)	27000000	2842105	10800000	1136842	2700000	284211

Source: FDRE (2005) Sanitation MDG Needs Assessment, Table 10.

3.3. Scenarios

Given the uncertainty regarding some of the assumptions in the analysis, three different scenarios were run: a baseline scenario; a recent coverage scenario, and an optimal scenario. The infrastructure costs are as follows: $111 capital cost for household piped water (the same cost is assumed for a yard connection); $282 for a standpipe, $8,316 for a borehole. For sanitation, the infrastructure costs are: $42 for a pit latrine; $789 for a pour-flush toilet with a septic tank; $1,053 for a communal toilet with a septic tank, and $1,263 for connecting to a simplified sewer system.

In the second scenario, the baseline year is 2007 instead of 1994, because the water and sanitation coverage in Mekelle City has improved since 1994. The 2007 baseline coverage is 55.7 percent for water and 63 percent for sanitation; the 2015 targets are 89 percent for water and 100 percent for sanitation.

The third or "optimal" scenario assumes that the entire population now relying on public taps and boreholes receives a household water connection and a low-cost sanitation technology (pit latrine and pour-flush toilet). Sixty percent of the population will have access to pit latrines, and 20 percent will have access to pour-flush toilets. A simplified sewerage system is not adopted.

3.4. Results

Under the baseline scenario, the estimated annual per capita spending required between 2010 and 2015 to increase coverage is $1.98 to meet the water component of the MDG target; $7.84 for sanitation, $0.39 for wastewater treatment and $0.42 for hygiene education.

[24] Note that the $42 unit cost to build a latrine with a cover slab (slab and vent pipe) has been described as close to the unit cost, in a paper by Lakeou1, Latigo, Muchow and Getachew (2006), which proposed building 30,000 latrines, at a total cost of $1,106,946. The unit cost is therefore $37.

The results for the "recent coverage scenario were similar to the results for the baseline scenario. Under the optimal scenario, the estimated annual per capita spending required between 2010 and 2015 is $2.51 to meet the water component of the MDG target, $7.84 for sanitation and $0.37for hygiene education. This indicates that the comprehensive distribution of pit latrines is a low-cost means to increase sanitation coverage.

Costs for School Water and Sanitation Interventions

Assuming that 28 schools need latrines, 56 hand-washing facilities are built, and 15 water connections are added, the total initial costs of providing water and sanitation facilities to schools are approximately $280,000. If, instead of water taps, shallow wells are built,[25] the total initial costs would be approximately $397,000[26] (Table 15). The total cost of providing back-up water storage tanks is $74,000.[27]

Table 15: Initial Costs of Supplying Sanitation Facilities and Water in Schools (in USD)

Item	Cost
Dry Latrine Construction, 4 male seats, 4 female seats	228,421
8 Faucets Construction, not including water line connection	50,105
Subtotal	*278,526*
Water Tap	1,895
Total with water tap	**280,421**
Shallow Well	118,421
Total with shallow well	**396,947**

Total operation and maintenance costs are approximately $16,800 per year, excluding cleaning materials for school latrines.[28]

Table 16: Operation and Maintenance of Latrines in Schools

Janitorial Salary	Latrine Emptying Fee	Total
15,916	884	16,800

These investments can yield significant returns, encouraging not only school attendance, but also the reduction of diarrhea and other medical conditions and diseases that tend to afflict children.

[25] Hand-dug wells are less expensive than shallow wells but are not advisable within the city limits, due to their inevitable proximity to on-site sanitation systems.

[26] Source of costing information for latrine, hand-washing facility and water tap (assuming the water line is 20m from the school): Mekelle branch office of UNICEF. The actual distance from the water line varies depending on the location of the school. The cost of a shallow well (approximately 60m in depth) was obtained from the Tigray Region Bureau of Water, Minerals & Energy Resources; the availability of water at this depth would also be site-specific.

[27] These costs are based on the costs of a storage tank able to store enough water to satisfy the enrollment from each school, at such times as water is not available from the service provider, multiplied by a water usage rate of 10 liters/day/student.

[28] These costs are based on a janitor's salary of $32 (Source: Kassech Asfaw Health Center) for nine months, and an emptying frequency of once per year, at a cost of $16 per school (Mekelle Health Office).

CONCLUSION AND RECOMMENDATIONS

While access to water and sanitation is improving in Mekelle, much remains to be done to halve the number of people without access to safe drinking water and sanitation by 2015. Rapid population growth and expansion of the city to include formerly rural areas has rendered the existing water supply inadequate. Mekelle's spatial and population growth are challenging its ability to furnish an adequate and reliable supply of clean water: even in 2007, the duration of the water supply was only about 12 hours per day (World Bank, 2007), a situation likely to be exacerbated in the years to come, particularly if the water table decreases. Additional problems identified include the need to enhance cost recovery by reducing non-revenue water and improving billing and collection.

In order to meet the 2015 targets regarding water and sanitation, wastewater treatment and hygiene education, Mekelle City has to increase investments from $10 per capita in 2010 to approximately $12 per capita in 2015. In other words, the city has to increase per capita spending on water and sanitation by $0.40 each year between 2010 and 2015. Several concrete recommendations follow, predicated on the research and findings of this needs assessment.

1) Increase the number of boreholes/wells, and explore alternative water supply systems.
There is a need to drill more boreholes/wells or to find new locations for wells, to ensure the distribution of a sufficient water supply. A second aquifer, possibly of better water quality and with a higher quantity of water, is believed to be located beneath the aquifer from which water is now collected; at the time of this study, however, the city's water distribution facility lacked the capacity to drill deeply enough to penetrate the lower aquifer.

Supplying adequate and reliable water from ground sources has become a challenge. As a result, the city is exploring alternative water supply systems. The regional government has contacted an Israeli firm to study alternative water supply sources, including surface water. According to a 2004 Tigray Regional State Water Supply and Sanitation Capacity Assessment, many urban centers relying on drilled wells are suffering from water shortages, in part because previous hydro-geological studies were either inaccurate or not exhaustive. For this reason, the regional government and WSDP are recommending combining ground water with surface water sources. In the interim, the city might consider increasing the use of reservoirs, given the frequent interruptions of the water supply. By gathering and storing water during the rainy season, reservoirs can mitigate the effects of water shortages, particularly during the dry season.

2) Strengthen operational efficiency.
Mekelle City needs to manage the demand by controlling waste or loss from pipe leakage and consumption through the increased of use of meters.

3) Assess tariffs and improve cost recovery.
In 2005 the Urban Institute recommended that Mekelle assess the option of converting the current flat rate water tariff to a progressive rate that would increase with level of consumption (Derbew, Epstein, Schaeffer, 2006). By 2007, though, the Mekelle Water Supply Service Office was still charging all customers 1.5 birr per m^3 consumed, regardless of the volume of water

used.[29] To improve its cost recovery, the city might again consider various mechanisms for increasing water prices with the quantity of water consumed.

4) Improve the management of public toilet facilities and build more communal toilets.
Open defecation is a major concern. Some residents defecate in public even when a public toilet is available nearby, because public toilets are not well maintained. The administration of public toilets might be leased to private service providers, as recommended by Teka and Mulugeta (2003). Penalties (e.g., fines) for public defecation could be imposed.

The construction of communal toilets needs to be made a priority. The city can build a number of communal latrines and assign a specific number of households to each, giving them keys to the facility.[30]

A key problem with the use of water-flushed toilets is that they cannot be properly used when the water supply is irregular. There is therefore a need to look at alternative pit latrine technologies, such as VIPs or urine diversion dry toilets (UDDTs).

5) The City administration should manage septage collection.
Services such as sludge collection are not well developed. As recommended by the national water and sanitation master plan, septage collection should be under the control of the city administration, and penalties for dumping raw sewage on farmlands should be imposed.

6) Improve hygiene education.
There is limited awareness about the impact of hygiene among the general public, or on the causal relationship between poor hygiene and disease. The importance of hand-washing with soap must be publicized, as it is currently commonly practiced *after* eating, rather than before, to remove the aroma of food, rather than to remove germs before contact with the mouth.

7) Mobilize additional resources.
In order to bridge any financial gaps that may arise as a result of increasing water and sanitation coverage, the City of Mekelle needs to improve its capacity for resource mobilization, including by organizing donor conferences and meetings with prospective individual donors.

In sum, with only a modest increase in investment in the water and sanitation sectors in Mekelle City, the MDG target of halving those without access to clean water and sanitation, together with the consequent reduction in incidence of waterborne disease among the urban population of Tigray, can be readily achieved.

[29] Questionnaire administered to MWSSS Gidena questionnaire, 2007.
[30] With communal toilets, four to five households share one toilet or shower facility built on the property of one of the households.

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Annex 1

1994 was used as the base year. The number of housing units using each intervention and the total number of housing units was available from the 1994 Population and Housing Census; the researcher then used this information to calculate percentages for each intervention to determine what percentage of households use each intervention.

Costs of Basic Sanitation - Calculations

The unit cost of a latrine is approximately $42, which includes 25kg of cement, a vent pipe, and cover slab (Source: Relief Society of Tigray). To determine ongoing costs, it was estimated that the latrine would be emptied every three years at a cost of $16 (Mekelle City Health Office).