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MINISTRY OF AGRICULTURE, IRRIGATION AND WATER DEVELOPMENT

Malawi Water Sector Investment Plan

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This Report was created through a collaborative process. This included a number of workshops in Lilongwe and a workshop in Liwonde. Participants at these workshops made comments that greatly contributed to the final version of the report. Inputs were received from staff in the Ministry of Agriculture, Irrigation and Water Development, staff from the Water Boards, representatives of the donor community, and NGOs.

Table of Contents

Appendices

Tables

Figures

Boxes

Executive Summary

Key points

Malawi needs to invest more than US$140 million annually in water supply and sanitation, on average, between 2015 and 2030. This is more than four times the amount invested each year in the period 2006 to 2011.

The recommended rate of investment will:

- Secure safe water supplies for the cities
- Provide access to improved water supply to 98 percent of the population by 2025
- Increase access to improved sanitation to close to 90 percent by 2030—more than twenty times the population that has access to improved sanitation currently, and
- Fix the backlog of schools that currently lack adequate sanitation and hygiene facilities.

Funding for urban water investment—including bulk supply—can be provided by Water Boards, provided that (a) they bring performance up to the level of other well-performing African water utilities and (b) on-lending is available through Development Bank Concessional Finance terms to the Ministry who in turn lend to the Water Boards.

Sanitation and rural water investment can be funded by the Government and donors with contributions which—on a per capita per year basis—are comparable to those in 2006-11.

Institution changes will be needed to:

- Bring Urban Water Boards up to the required levels of performance
- Build capacity in District Councils to plan and implement projects, and
- Reconfigure the Ministry responsible for Water Supply and Sanitation into a policy, funding, coordination, and supervision body.

Urban bulk supply projects should go ahead.

Bulk supply projects for Blantyre, Lilongwe, Mzuzu, and Mzimba should go ahead. These schemes all have economic rates of return of well over 10 percent. Without them, Malawi's rapidly growing cities will become infested with water-borne diseases, and the productive potential of city-living will be lost (see Section 3.1).

Blantyre cannot rely on the Shire River—a different source is needed

In Blantyre, options proposed by Sogreah should be reevaluated. Once the real economic value of electricity is considered (US$0.17 per kWh), the Shire River intake options have similar total costs to dam options. Section 3.1 compares Walkers Ferry and Mombezi-Makuwa as an example to prove this point. Mombezi-Makuwa's key advantage is reducing Blantyre's reliance on the Shire River. The

Shire River may well run dry in the future, according to the Water Resources Investment Strategy prepared for the Government by Atkins. The resilience against this risk that Mombezi-Makuwa provides is an important additional benefit from the dam — (This is quantified in Section 3.1).

Water investment should be prioritized

In addition to the bulk supply projects, other urban water investment should total more than US$640 million over the period 2016 to 2030. Rural water investment should total around US$400 million. This level of expenditure is enough to provide full coverage across the nation—though practical difficulties in ramping up funding and institutional capacity suggest this goal can only be achieved by 2025. Prioritizing water makes sense given the very high net benefits per dollar of investment (US$14 in rural water and US$10 in urban water) as well as the fact that urban water can be self-funding through tariffs.

Schools should all be provided with safe water and sanitation

Analysis suggests very high returns to improved water and sanitation in schools, not just in improved health, but also in improved educational outcomes. US$30 million should be spent on providing schools with adequate facilities for sanitation and hygiene that lack it now. Thereafter, the Ministry of Education, Science and Technology should ensure that adequate facilities for sanitation and hygiene are included in all schools as they are built.

Funding constraints mean sanitation needs to improve more slowly

More than US$400 million should be spent on rural and urban sanitation between 2016 and 2030. This is enough to increase access to improved sanitation from 10 percent in 2010, to close to 90 percent by 2030. Progress toward universal sanitation is slower than toward rural water because net benefits per dollar spent on sanitation are lower; rural water has a net benefit of US$14 per dollar invested whereas rural and urban sanitation have a net benefit per dollar invested of US$9 and US$4 respectively. In a situation in which funding is constrained, Malawi will benefit most from concentrating investment in those areas that yield the highest benefit per dollar spent.

If Government and donors to the sector can increase funding above the levels suggested in the plan, obviously greater levels expenditure in sanitation would be both possible and highly desirable.

Water Boards need to become largely self-financing.

Our analysis suggests urban water investment, including the bulk supply projects, can be financed by the Water Boards themselves. To do this, they will have to reduce NRW to 20 percent by 2030, improve collection rates to 95 percent by 2030, and increase tariffs by just one percent per year in real terms. Comparison with other well-performing utilities such as those in Niger, Gabon, Senegal, and Uganda suggests this is eminently doable. These performance improvements will enable Water Boards to service debt advanced

on Development Bank Concessional Finance terms to proceed with urban water investment.

Donors and Government will need to scale up financing too

Investments in rural water and for sanitation would be the responsibility of the Government and donors. Over the period 2016 to 2030, the real per capita annual contributions required from these bodies to the sector will be lower than it was in the period 2006 to 2011. This suggests that this level of funding should be feasible and fiscally responsible.

Institutional reform and capacity building will be needed

More challenging than the sums of money involved are the institutional changes needed to ensure that the money is well spent, and that loans can be repaid. In light of the importance of institutions in the successful implementation of the Investment Plan, US$100 million has been allocated to capacity building from 2016-2030. Three significant changes to institutions are needed:

- Water Boards need to find credible institutional models that allow them to quickly replicate the financial performance of other high-performing African water utilities
- District Councils need to develop the ability to plan and implement rural water and sanitation schemes, and
- The Ministry responsible for Water Development needs to become a unified sector policy, coordination, planning, and financing body that can ensure that implementing agencies—Water Boards and District Councils—select the right projects, and implement them in the right way.

1 Introduction

This report provides an Investment Plan, and associated Funding Plan, for the water and sanitation sector in Malawi, from now until 2030. The aim is to maximize the benefits to the country of expanding access to improved water and sanitation services, while being financeable.

The report is prepared for the Government of Malawi under a consultancy contract managed by the World Bank and funded by the Water Partnership Program. This report is the first volume of a two volume study on a Water Sector Investment Plan for Malawi. The second volume provides a Public Expenditure Review of the sector, an introduction to Monitoring and Evaluation, summarizes work in Water Resources Management and presents a term of reference for the preparation of an irrigation investment and financing plan.

This report starts by illustrating three investment scenarios in aggregate for the sector (Section 2). These scenarios illustrate the investment needed and outcomes from three different investment plans. The report recommends that the sector select an investment plan that will lead to universal access to water by 2025 and 87 percent access to sanitation by 2030. This investment plan will require a substantial increase in funds and investment. This increase will generate huge benefits for Malawi relative to the investment made. However, the increase in funds needed may not be achievable. In this case, a second investment plan is suggested in which universal access to water is reached by 2030 and more than 40 percent of the population achieves access to sanitation by 2030, with 95 percent of the urban population receiving access to improved sanitation by 2030. This report does not recommend continuing to invest at current levels. This would lead to the proportion of the population with access to water and sanitation falling with ruinous effects on the health and productivity of Malawians. An investment plan to reach universal access to water and close to 80 percent access to sanitation in 2020 is rejected as infeasible as it would require a massive ramp up in expenditure, especially on sanitation.

Key urban bulk supply projects that have been proposed are discussed in Section 3, and examples are given of smaller projects for both urban and rural water supply and sanitation that could be considered for inclusion in the investment plan. Clearly with the large spending levels and long timeframes, many of the projects that need financing have not even been identified yet, let alone studied or designed. This section indicates the "project gap"—that is, investments that we know will be needed, but for which projects have yet to be developed—and indicates how this gap can be closed.

Regardless of the cost-benefit analysis, or the merits of potential individual projects, many stakeholders may worry that the sheer sums of money required will not be available for Malawi. In response to this concern, Section 4 offers a Funding Plan. It demonstrates that Water Boards have the capacity to finance the entire urban water investment, if they can increase their performance levels to those of other well-performing African water utilities, and if Development Bank Concessional Finance terms on loans continue to be available. The remaining expenditure in sanitation and rural water can be managed by Government donors and NGOs if they step up their contributions on a per capita basis. To achieve universal access to water by 2025 and 87 percent access to sanitation in 2030 would require Government, donors, and NGOs to increase their per capita contribution by 40 percent. To achieve the scaled back targets of universal access to water by 2030 and more than 40 percent access to sanitation in 2030 would require their contribution to increase by a modest 15 percent over the period.

These bold plans depend on institutions in Malawi for their success. It would be remiss therefore to close without considering the institutional prerequisites for success. Section 5 addresses these. It argues that in rural water, decentralization should take place, with District Councils supported to prepare district investment plans, which Central Government could fund. Water Boards will need to choose the reform path that will let them perform at the level of other well-performing African water utilities. The Ministry's role must also evolve to one that allocates public capital, coordinates between districts, promotes institutional reform, and monitors and evaluates to learn lessons from experience.

2 Investment Levels

Malawi stands to gain substantially if it can increase access to improved water and sanitation. As Section 0 discusses, increased access to improved water and sanitation saves lives, reduces illness, and frees up time to be spent on work, studies, and childcare. Such increases in access are only possible with increased investment.

Investments already made (or committed) for the five-year period from 2011 to 2015, average around US$42 million per annum. This is 45 percent more than was spent in the previous five years. The current level of investment will allow Malawi to reach the MDG target for access to improved water by 2015 (see Box 2.1). The MDG target for sanitation access will, however, be missed.

Looking ahead though, further increases in investment are needed. This section presents three scenarios:

1. **Scenario 1, Business as usual**—continuing current levels of expenditure are shown to lead to stagnating access levels. This scenario cannot be recommended—Malawi needs to continue to increase access
2. **Scenario 2, Full coverage for water by 2025, and 87 percent for sanitation by 2030**—this scenario is highly cost-benefit justified. However, this investment plan entails expenditure of more than US$700 million in the 2016-2020 period, more than US$600 million in the 2021-2025 period, and more than US$700 million in the 2026-2030 period. It is possible that such a scale up in funding and investment is out of reach
3. **Scenario 3, Full coverage for water by 2030, and more than 40 percent for sanitation by 2030**—this is the minimum level Malawi should aim for. In this scenario Malawi achieves universal access to water by 2030 and 95 percent access to improved sanitation in urban areas by 2030. Access to improved sanitation in rural areas falls behind the Governments targets in this scenario. Investment levels are lower than in the previous scenario by US$200 million over the period. Nevertheless, they are still ambitious, running at more than US$700 from 2016-2020, US$400 million from the 2021-2025 period, and more than US$700 from 2026-2030.

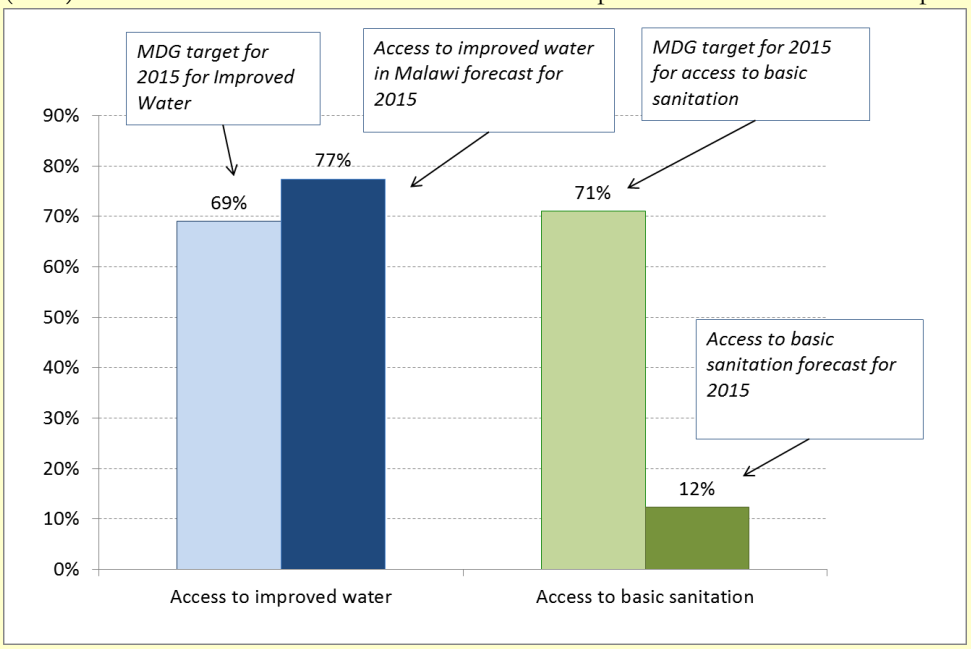
These scenarios are discussed below in sections Section 2.2 to Section 2.4. First though, Section 0 sets out cost benefit analysis under-pinning the case for significantly increasing investment in water and sanitation in Malawi. This analysis also guides government choices on how to prioritize investment when not all targets can be reached with the funding available.

Box 2.1: Malawi's Progress Towards MDGs

The Millennium Development Goal calls for countries to "Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation".[1] Malawi is likely to exceed this goal for access to improved water, reaching close to 80 percent access to improved water by 2015, exceeding the MDG goal of 70 percent.

Malawi is not likely to achieve the MDG for access to basic sanitation, more typically called improved sanitation. Access to basic or improved sanitation is only forecast to reach 12 percent in 2015 (versus 9 percent in 2010). This is far below the MDG objective of 71 percent by 2015. To achieve the MDG goal for 2015 would require raising and spending US$200 million on urban and rural sanitation from 2012 to 2015. This is close to the entire amount spent in the Water and Sanitation sector over the 2011-2015 period and thus does not appear realistic.

While achieving the MDG for improved sanitation does not appear possible, in part this is due to changes in the measurement of access to improved (basic) sanitation which has reduced the rate of access reported for Malawi. For instance, the 2012 JMP reports that more than 50 percent of the population has access to improved sanitation in 2010. A far lower figure of 9 percent was reported in the Demographic and Household Survey (DHS) for 2010. The lower figure reported by the DHS largely arises because the DHS only considered latrines with concrete slabs to be improved. This is likely to under-estimate the number of improved latrines considerably because latrines don't need to have a concrete slab to be improved, they just need an impermeable layer separating excreta from people using and cleaning the latrine. Nevertheless, to be conservative, the figures from the DHS (2010) are used as the baseline for the investment expenditure numbers in this report.



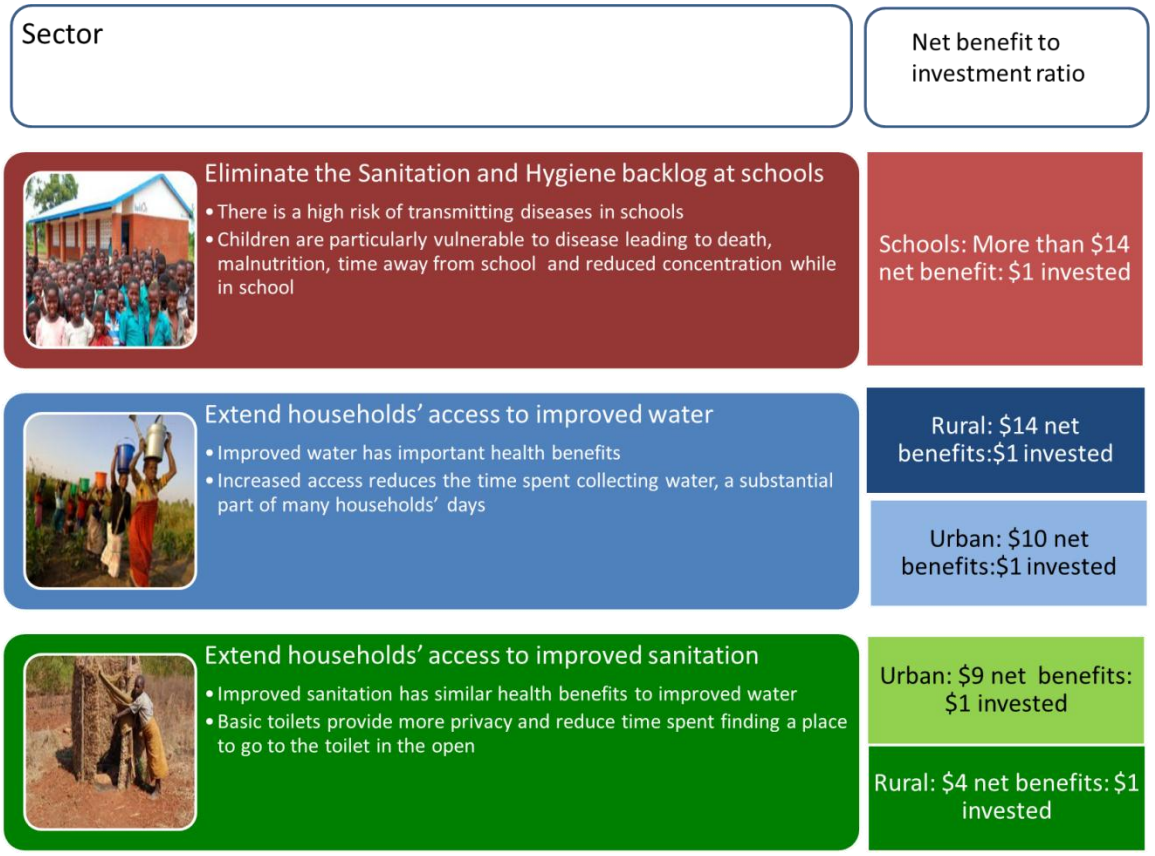
[1] WHO and UNICEF, "WHO / UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation"http://www.wssinfo.org/definitions-methods/introduction.

2.1 Prioritization Based on Benefits and Costs

Investment in water and sanitation generates substantial gains for Malawi. As

Figure 2.1 shows, for every dollar invested in the Malawi water and sanitation sector, benefits of between US$14 and US$4 are generated (depending on the area). This result is in-line with the World Health Organization's finding that investments in "water supply and sanitation … bring economic benefits; US$1 invested would give an economic return of between US$3 and US$34".[2] The high returns from investing in the water and sanitation sector suggest that the Government should aim to provide full access. However, if a lack of investment funds means that full access cannot be achieved, then spending should be cut back, or delayed, in those sectors with the lowest benefit cost ratio. This approach means that the expenditure goes first to the areas with the highest net benefit to investment ratio.

Figure 2.1: Ranking of Spending Priorities



Source: Castalia Calculations, as described in Appendix B.

The 'benefit to investment ratios' in the sector indicate a clear order of priority for scarce investment funds. Closing the sanitation and hygiene deficit at the more than four thousand schools that don't have sufficient facilities for sanitation and hygiene is the top priority. After that, investment should be focused on extending access to water, followed by access to improved sanitation.

[2] WHO, 2004 "Costs and benefits of water and sanitation improvements at the global level" http://www.who.int/water_sanitation_health/wsh0404summary/en.

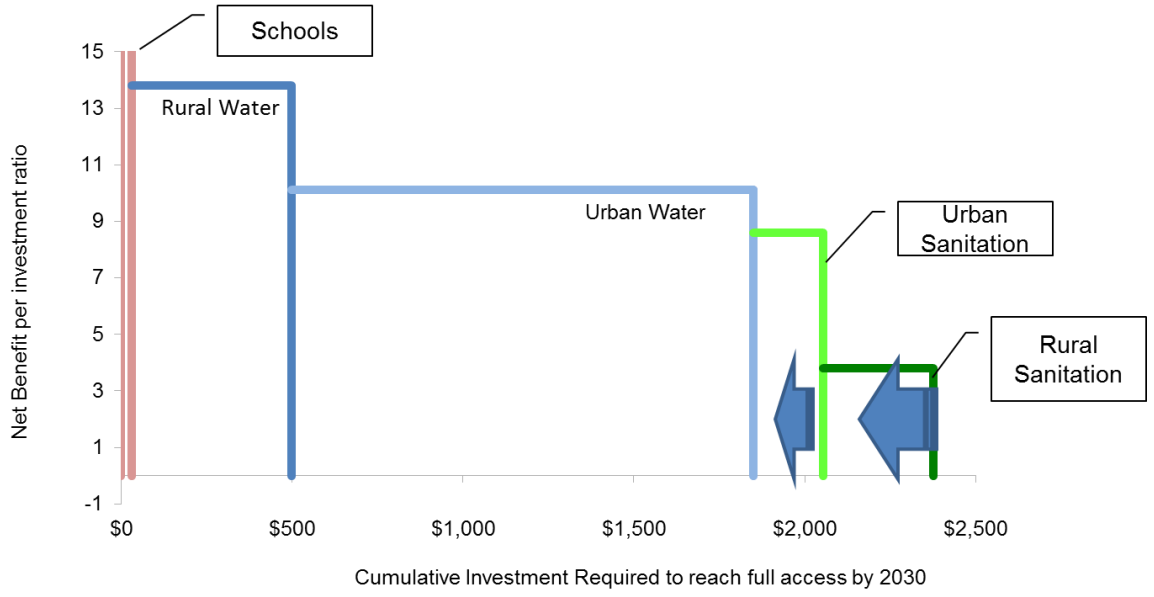
Good sanitation and hygiene in schools is a priority because school children are vulnerable to diseases that can be attributed to poor access to sanitation and hygiene, for example, students infected with intestinal worms transmitted due to poor access to sanitation and hygiene, are 23 percent more likely to drop out of school, and earn 40 percent less as adults.[3] Equally important, girls are more likely to stay in school when they reach puberty if they have appropriate access to improved latrines.

The benefit of investing in improved water supply arises from a combination of the substantial health benefits of increased access to improved water supply as well as the many hours spent by households collecting water.

The benefits of extending sanitation include health benefits and the increase in privacy and dignity that comes from using enclosed toilet facilities. However, just providing access to improved water achieves many of the health benefits sought, which is why, when a choice has to be made, access to improved water is often the higher priority.

Figure 2.2 provides a way to summarize the findings and what they mean for investment in water and sanitation in Malawi. The width of the blocks shows how much investment is needed on cumulative basis to achieve full access by 2030. The heights of the blocks show the average net benefit to investment ratio generated by projects in each sector. Thus, the areas of the blocks show the total net benefit to Malawi generated by investments in each sector. Investments in schools and rural water provide very high net benefits per investment made and so should be given priority. The blue arrows show that, if investment spending needs to be cut or delayed, this should be first done for urban and rural sanitation where the net benefit to investment ratio is the lowest.[4]

Figure 2.2: Cumulative investment and net benefit per investment ratio



Source: Castalia calculations, as described in Appendix A.

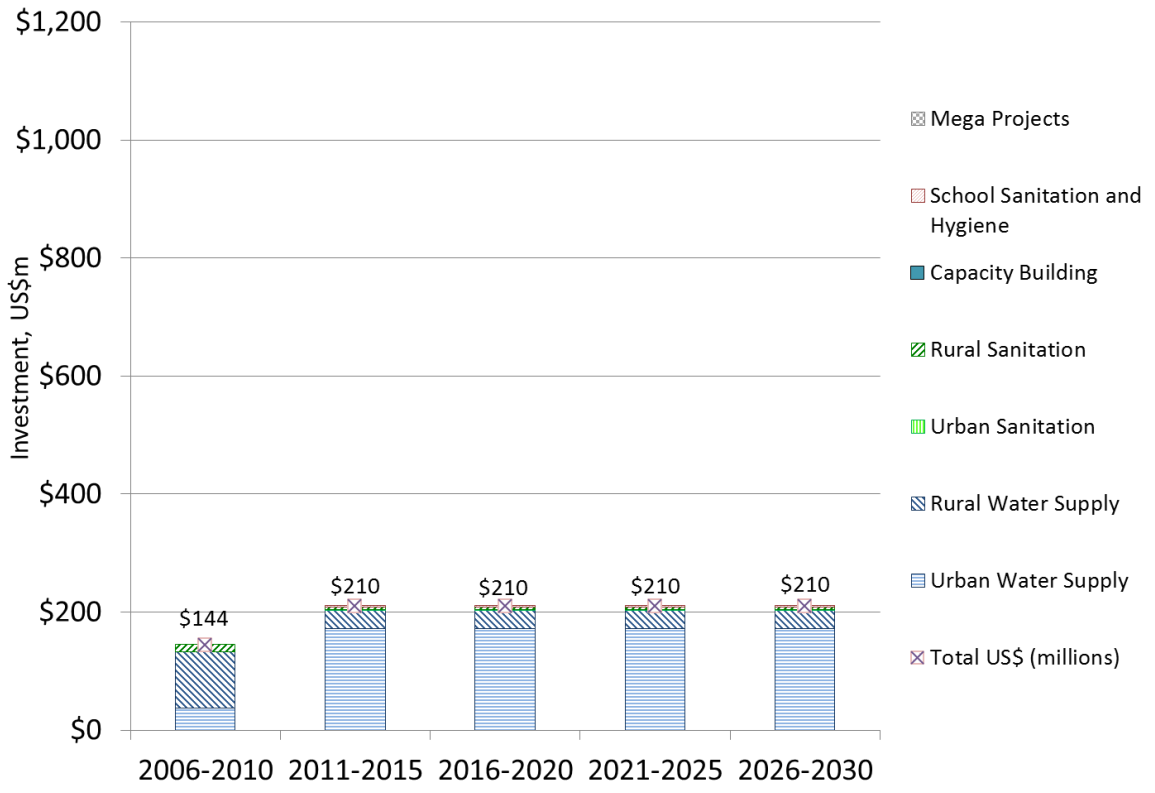
[3] The study was conducted in Tanzania, Sarah Baird, Joan Hamory Hicks, Michael Kremer, and Edward Miguel, 2011 "Worms at Work: Long-run Impacts of Child Health Gains" http://www.povertyactionlab.org/publication/worms-work-long-run-impacts-child-health-gains.

[4] It is plausible that the costs of extending access to communities may increase as the percentage of the population reached

2.2 Scenario 1—Business as Usual

Investment in water and sanitation in Malawi is expected to total around US$210 million over the five year period from 2011 to 2015. As Figure 2.3 illustrates, this is 45 percent higher than the investment in the previous five-year period. Expenditure is overwhelmingly on urban water (81 percent currently). The business as usual scenario looks at what would happen if investment were continued at this level in the future, as shown in Figure 2.4 and Figure 2.5.

Figure 2.3: Investment Expenditure Projected Forward at Current Levels



Data Table 2.3: Current Investment Levels Projected Forward (US$ millions)

	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	2011-2030
School Sanitation and Hygiene	-	3	3	3	3	13
Rural Sanitation	12	4	4	4	4	15
Urban Sanitation	1	1	1	1	1	3
Rural Water Supply	95	32	32	32	32	127
Urban Water Supply	36	171	171	171	171	684
Mega Projects	-	-	-	-	-	-
Total US$ (millions)	144	210	210	210	210	841

Sources:

2006-10: Volume II of the Water Sector Investment Plan

2011-15: Funding committed already from Government of Malawi, donors and International Finance Institutions as described in Appendix F

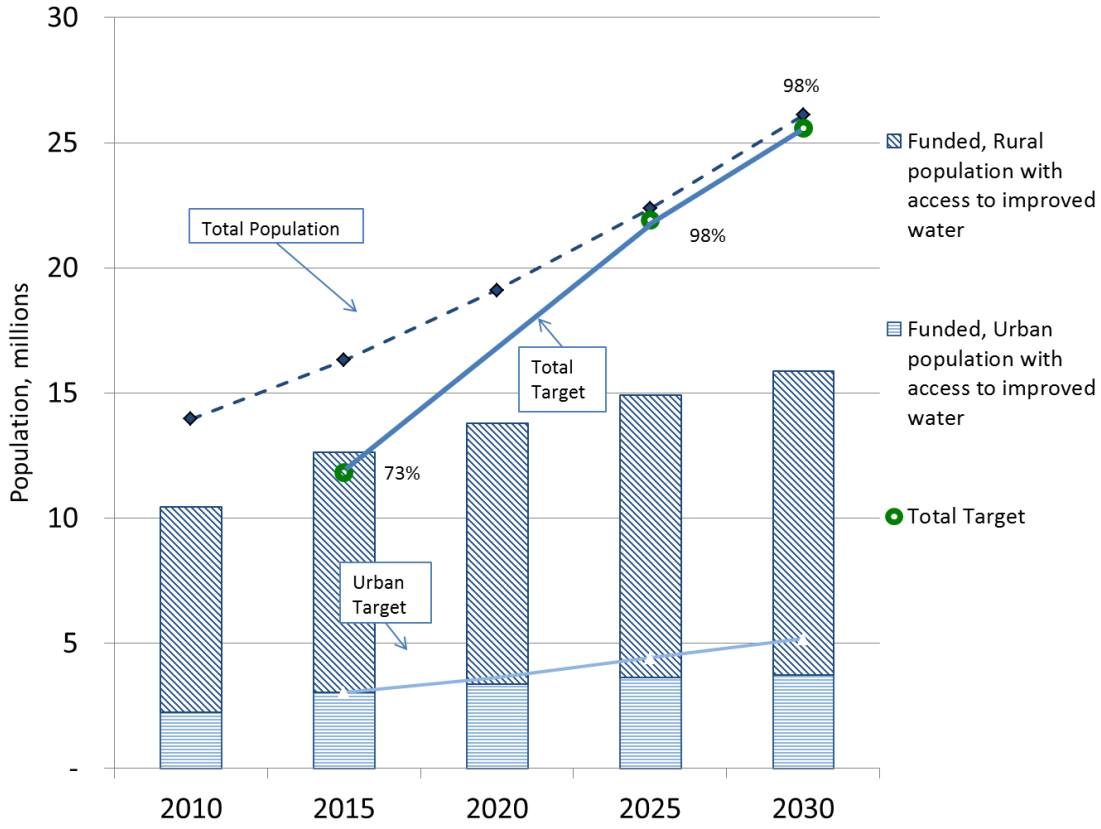
2016 onward: Expenditure projected to remain constant at levels for the current period

Despite the recent 45 percent increase, investment at these levels are still too low to make any real progress toward achieving full access to water and sanitation by 2025.[5] Whatever is spent in the sector will go towards keeping up with population growth.

[5] The World Bank's 2010 "AMCOW Country Status Overview for Malawi" mentions that the Malawi Growth and Development Strategy has a target of full coverage by 2025. This target has been mentioned in meetings and workshops held by Castalia with Ministry officials.

As Figure 2.4 illustrates, if investment continues at current levels until 2030, water access will increase in absolute terms. However, because of population growth, access as a percent of the population in urban areas is likely to decline from close to 90 percent in 2015 to 70 percent by 2030, and across the nation as a whole from about 70 percent to around 60 percent.

Figure 2.4: Water Access Projections for Current Investment Levels



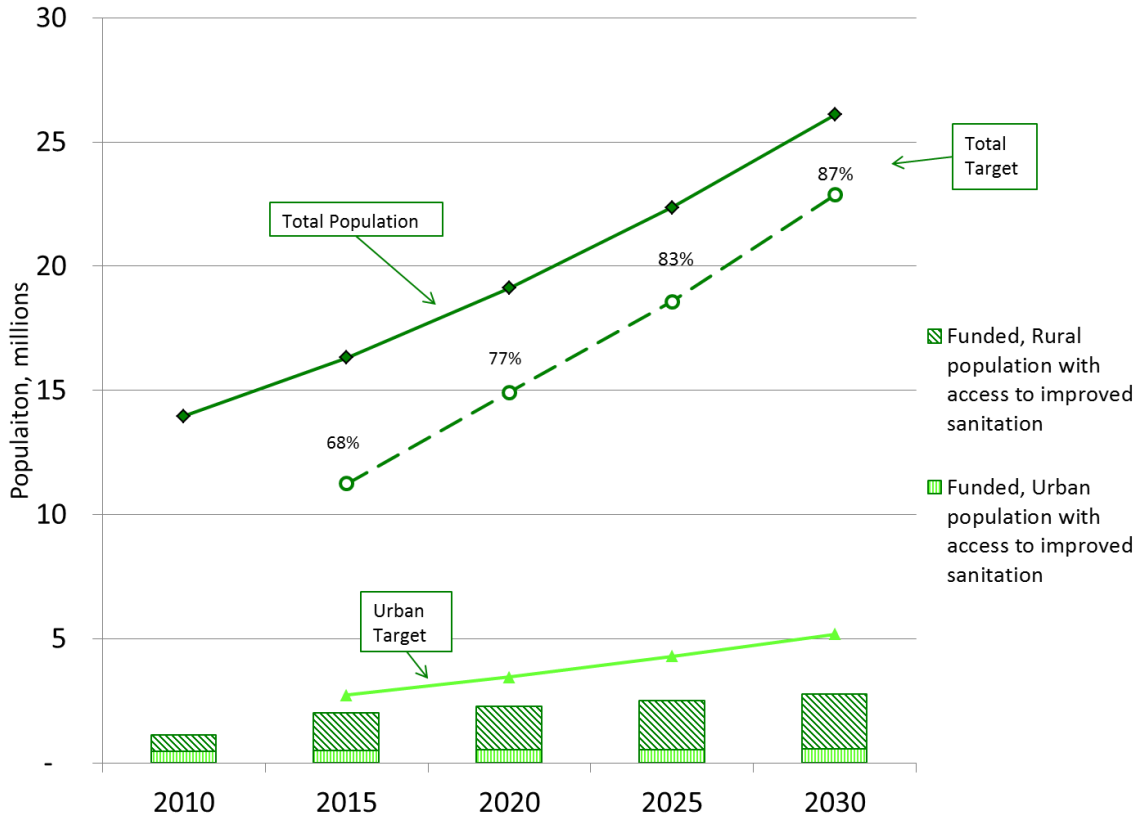
Data Table 2.4: Water Access Projections for Current Investment Levels

	2010	2015	2020	2025	2030
Targets for Access - Water					
Total		70%	n/a	98%	98%
Urban		95%	n/a	98%	98%
Rural		67%	n/a	98%	98%
Achieved Access -Water					
Total	80%	77%	72%	67%	61%
Urban	92%	95%	88%	80%	70%
Rural	77%	73%	68%	63%	58%

Source: Castalia calculations.

Figure 2.5 illustrates how keeping levels of sanitation investment would lead to a small increase the number of people with access to sanitation in absolute terms. But as a percentage of the population, access to improved sanitation remains at less than ten percent.

Figure 2.5: Sanitation Access Projections for Current Investment Levels



Data Table 2.5: Sanitation Access Projects for Current Investment Levels

	2010	2015	2020	2025	2030
Targets for Access - Sanitation					
Total		68%	77%	83%	87%
Urban		85%	90%	95%	98%
Rural		65%	75%	80%	85%
Achieved Access - Sanitation					
Total	8%	12%	12%	11%	11%
Urban	19%	15%	13%	12%	10%
Rural	6%	12%	11%	11%	11%

2.3 Scenario 2—Full Coverage for Water by 2025, 87 Percent for Sanitation by 2030

This section outlines the investment expenditure needed to reach the Government's targets for universal access to water by 2025 and reach its targets for access to sanitation by 2030; where the Government's objective for sanitation is that in:

- **Urban areas** 95 percent of the population will have access to improved sanitation by 2030, and
- **Rural areas** 85 percent of the population will have access to sanitation.

This Scenario includes allocations to fund the bulk water supply schemes needed for Blantyre, Lilongwe, Mzuzu, and Mzimba. This scenario also includes the elimination of the backlog of schools without facilities to adequate facilities for sanitation and hygiene. The net-benefit to Malawi of achieving these targets will be huge.

This plan is achievable if the government is able to dramatically ramp up fund raising and investment expenditure. More than US$700 million would needed in the 2016-2020 period and over US$600 million would be needed in the period in the 2021-2025 period.

While ambitious, this plan does not fully achieve the government's sanitation targets for 2020 and 2025. Hitting the sanitation targets, in addition to the 2025 target of full coverage for water, requires unfeasible levels of investment from 2016 to 2020, as Box 2.2 explains.

Box 2.2: Reaching All Post 2016 Targets is Unaffordable

As shown in the table at the bottom of the box, almost a billion dollars of expenditure will be needed between 2016 and 2020 to reach the Government targets for improved sanitation as well as improved water. The Government's targets for access to water and sanitation are set out below:

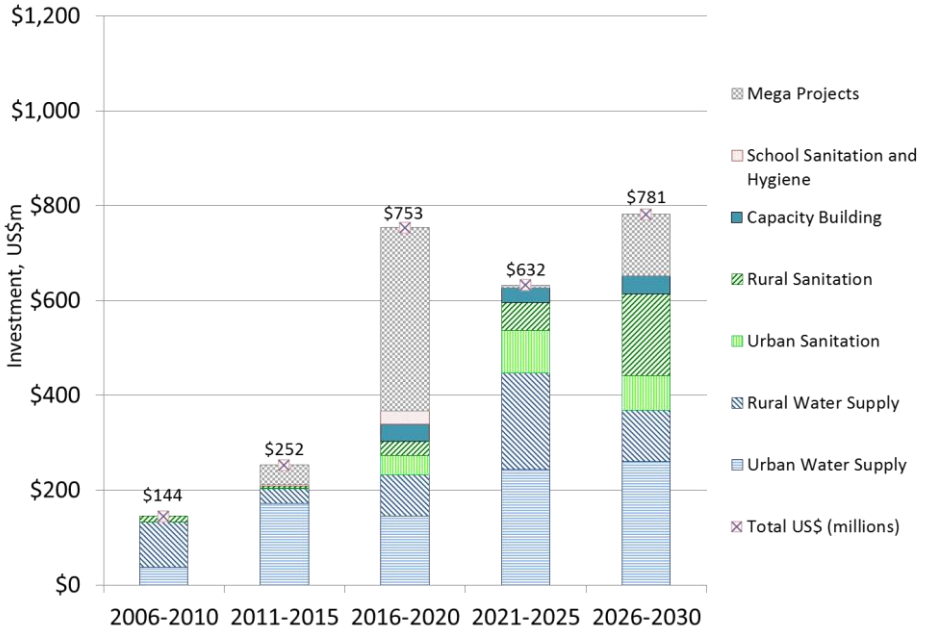
	2010	2015	2020	2025	2030
Targets for Access – Water					
Total		69%	n/a	98%	98%
Urban		95%	n/a	98%	98%
Rural		67%	n/a	98%	98%
Targets for Access - Sanitation					
Total		68%	77%	83%	87%
Urban		85%	90%	95%	98%
Rural		65%	75%	80%	85%

This expenditure is needed to pay for the large bulk supply projects needed over this period to reach the Government's 2020 sanitation targets and to continue spending on improving access to water to reach the target of universal access by 2025. In addition to the nearly one billion dollars in total investment, the table shows that urban sanitation expenditure would have to jump from $1 million now to $127 million in the next five year period, while rural sanitation expenditure would need to jump from $4 million to $161 million. It does not seem feasible to increase both funding and capacity at this rate.

	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	**2011-2030**
School Sanitation and Hygiene	-	13	18	0	-	**31**
Capacity Building	-	-	47	26	30	**103**
Rural Sanitation	12	4	161	46	55	**266**
Urban Sanitation	1	1	127	36	39	**203**
Rural Water Supply	95	32	98	195	107	**432**
Urban Water Supply	36	174	144	242	260	**821**
Mega Projects	-	42	387	6	131	**567**
Total US$ (millions)	144	265	983	552	621	**2,422**

For these reasons, the most aggressive scenario presented in the report aims to meet the water target for 2025, but aims to meet the sanitation target only by 2030.

Figure 2.6: Investment Required to Meet Water Access Target for 2025 and Sanitation Targets for 2030



Data Table 2.6: Investment Required to Meet Water Access Target for 2025 and Sanitation Targets for 2030 (US$ millions)

	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	2011-2030
School Sanitation and Hygiene	-	3	28	0	-	31
Capacity Building	-	-	36	30	37	103
Rural Sanitation	12	4	30	60	173	267
Urban Sanitation	1	1	40	90	72	203
Rural Water Supply	95	32	88	203	108	431
Urban Water Supply	36	171	144	242	260	817
Mega Projects	-	42	387	6	131	567
Total US$ (millions)	144	252	753	632	781	2,419

Note: The assumptions used for creating these expenditure estimates—and all the other expenditure and access levels in this report—are summarized in **Error! Reference source not found.**

The spending in Figure 2.6 is allocated to a number of components. These are:

- School Sanitation and Hygiene—investment is allocated to expenditures to eliminate the backlog of schools that don't have adequate facilities for sanitation and hygiene
- Capacity Building—these funds are invested in improving the capacity of institutions so that investments can be made more effectively and sustainably (the key institutions in which these funds will be invested are described in Section 5 on page 60)
- Urban and rural sanitation—these funds are allocated to increasing access to sanitation. The funds would be allocated to marketing campaigns, subsidies for households building latrines and public latrines located in public spaces such as markets
- Mega-projects—these funds are allocated to the major bulk water supply projects needed for Lilongwe, Blantyre, Mzuzu and Mzimba (these projects are described in detail in Section 3.1)
- Urban and rural water supply—these funds are allocated to extending access to water. In urban areas the investments are in distribution and smaller transmission and bulk supply projects.

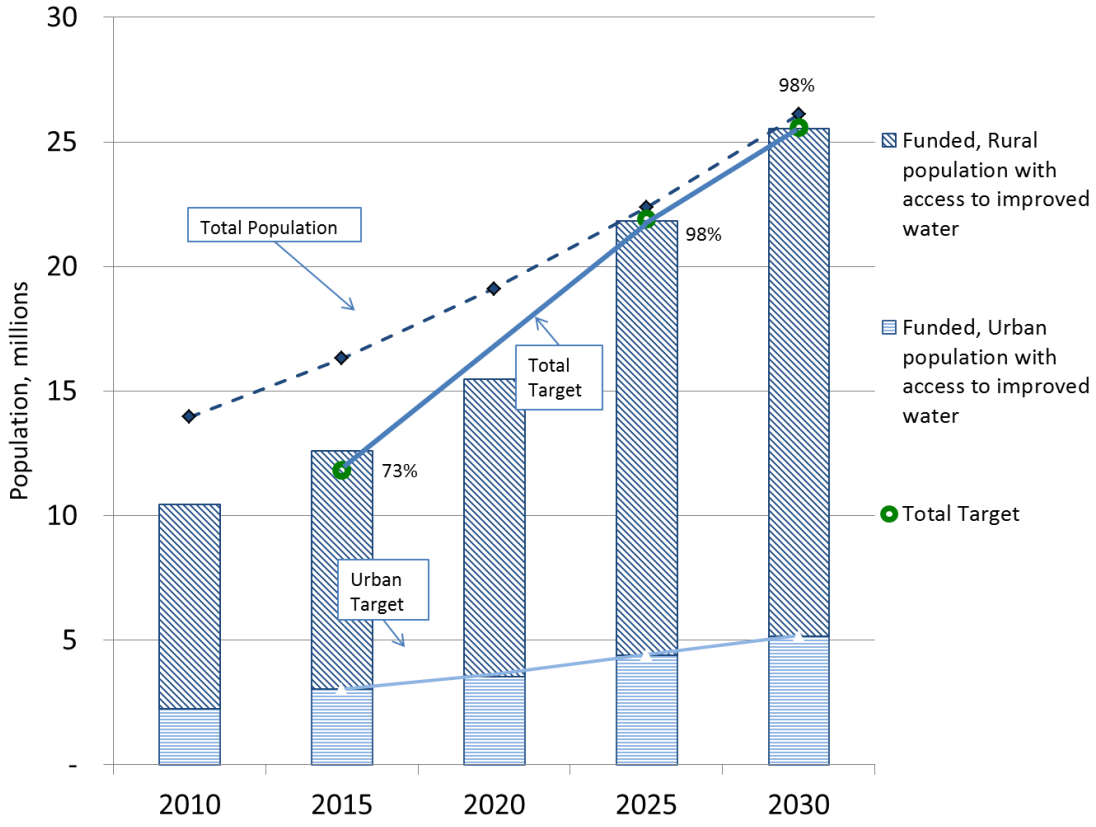
The calculations for the numbers in the Investment Plans are described in Box 2.3.

Figure 2.7 shows the increase in access to improved water in terms of the investment plan. Universal access to improved water is reached by 2025 and is sustained till 2030 (the end of the plan period).

As can be seen in Figure 2.7, most of the increase in investment needed is in response to the large increase in population over the period. The population in the Water Board supply areas will grow to 5 million people by 2030. We expect that on the very fringes of cities (in peri-urban areas) 3 percent of the urban population will receive water access from boreholes and protected wells. This reflects a fall from the 10 to 20 percent of the urban population that received access from these sources in 2008.[6] The unpredictable growth of peri-urban areas means that we expect that 2 percent of the population will continue to be un-served. Outside the Water Board Areas the population grows to 20 million from less than 10 million in 2010.

[6] According to the 2008 Census.

Figure 2.7: Water Access Projections to Reach Access to Improved Water by 2025



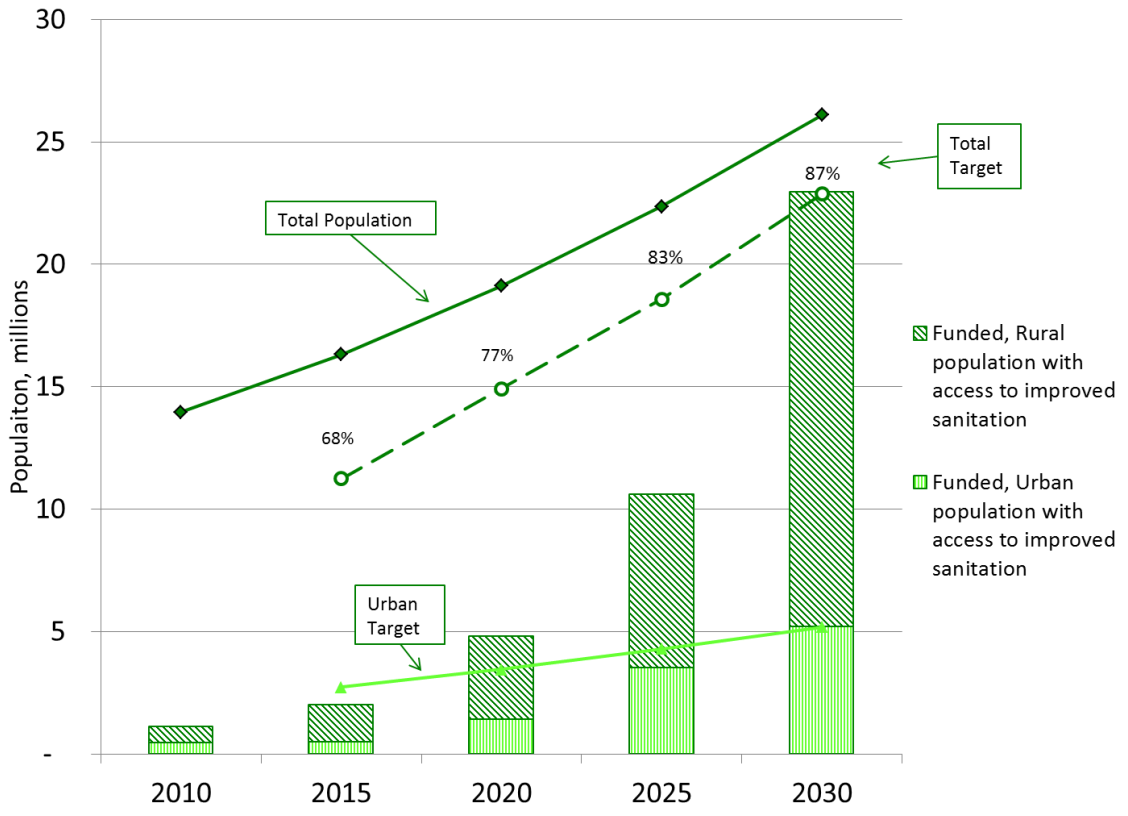
Data Table 2.7: Water Access Projections to Reach Access to Improved Water by 2025

	2010	2015	2020	2025	2030
Targets for Access - Water					
Total		69%	n/a	98%	98%
Urban		95%	n/a	98%	98%
Rural		67%	n/a	98%	98%
Achieved Access -Water					
Total	80%	77%	81%	98%	98%
Urban	92%	95%	93%	98%	98%
Rural	77%	73%	78%	98%	98%

Figure 2.8 shows the increase in access to sanitation over time, reaching the government target of 87 percent access by 2030. As shown in Figure 2.6 there is higher expenditure on increasing access to improved water than on extending access to sanitation during the 2016-2025 periods. This is in line with the prioritization described in Section 0. Delaying spending on sanitation initially is also warranted by the need to build up capacity in the sanitation sector, in light of historically low levels of expenditure. Nevertheless, as can be seen in Figure 2.6, expenditure on access to improved sanitation in rural and urban areas is increased

rapidly compared to historical levels, till relatively high levels of expenditure are made in 2026-2030.

Figure 2.8: Sanitation Access Projections to Reach Access Targets by 2030



Data Table 2.8: Sanitation Access Projections to reach Access Targets by 2030

	2010	2015	2020	2025	2030
Targets for Access - Sanitation					
Total		68%	77%	83%	87%
Urban		85%	90%	95%	98%
Rural		65%	75%	80%	85%
Achieved Access - Sanitation					
Total	8%	12%	25%	47%	87%
Urban	19%	15%	37%	78%	98%
Rural	6%	12%	22%	40%	85%

Source: Castalia calculations

Box 2.3: Assumption for Investment and Access Scenarios

The cost of meeting targets is calculated by estimating the population (or schools) that need to be served to meet the targets and multiplying that by the average cost of providing access per person and per school to calculate the total cost of reaching the target.

Population

Population figures are the same as in Appendix D and come from the Census, Water Board Strategy Documents, and the Sogreah Feasibility Reports for Lilongwe and Blantyre. The number of primary schools comes from the 2008 School WASH Report.

Base levels

The access to improved water and sanitation in urban and rural areas for 2010 was taken from the Demographic and Health Survey for 2010.

Targets

Access targets for 2015 are from the Sector Performance Review[7] and refer to the access needed to reach the MDGs. The target for full access to improved water by 2025 is the Government Target. There are no targets for 2020 for access to improved water. The targets for access to sanitation are the Ministry responsible for Water and Sanitation targets for the sector.

Costs

The costs per person provided with access for:

- **Rural Water** is US$37 and comes from the AMCOW Country Status Overview for Malawi (this figure is similar to estimates for the cost of providing access using gravity fed schemes). In addition to spending on extending access, a proportion of investment is allocated to the rehabilitation of existing water supply assets. Every year 6 percent of boreholes are assumed to need rehabilitation with each borehole costing US$13 per capita to rehabilitate[8]
- **Urban Water** is US$209 per person for extending the distribution network (this figure comes from the Sogreah Lilongwe feasibility report). In addition, the costs of the bulk water projects are from the Sogreah feasibility reports for bulk water supply for Blantyre, Lilongwe, Mzuzu, and Mzimba. The cost of these bulk water supply projects is taken from the time when construction commences onwards.[9] The cost of bulk supply in towns is US$122 and is the average cost of bulk supply per person from the Salima Lakeshore and Nkhotakota projects (as described in the World Bank Project Appraisal Document for NWDP II AF). The percentage of infrastructure that needs to be rehabilitated is estimated to be 2 percent of the capital base
- **Rural Sanitation** the cost is US$16 per person and comes from the cost of the marketing sanitation component of the WASH program and figures from UNICEF on the extension in access achieved from this spending. These cost estimates are conservative and should be able to also cover the provision of subsidies to households and the building of public latrines. The cost of building the latrine for both urban and rural sanitation programs is borne by the household, and so is not included in the estimated cost to the Government of extending access in urban or rural areas. As described in the Appendix the cost benefit analysis incorporates the costs of toilets as well as the cost of marketing
- **Urban Sanitation**, the cost is US$43 per person for an urban sanitation marketing campaign

[7] 2010 Malawi Irrigation, Water, and Sanitation Sector Performance Report (SPR), Ministry responsible for Water Supply and Sanitation, May 2011, page 11.

[8] This is the figure used in the Uganda Strategic Sector Investment Plan for the Water and Sanitation Sector in Uganda.

[9] It is assumed that the cost of pre-construction engineering studies is covered by NWDP II AF.

and comes from the NWDP II AF Project Appraisal Document. The cost is based on the expenditure on sanitation marketing required to extend access in Lilongwe and Blantyre.[10] These per capita costs numbers are conservative and so should be sufficient to also fund the provision of subsidies to households and public latrines. The focus of this spending will be on access to improved latrines. The rationale for this focus on onsite solutions is that they are more cost effective. In time piped sewer systems for densely populated areas will need to be introduced. The main risk with this approach is polluting the ground water, but we are prioritizing 100% access to piped water services in the densely populated parts of the cities. These should give constantly pressurized pipes which means that polluted ground water will not enter the water supply system. It is worth noting that cities as large as Jakarta[11] and Manila[12] (both with more than 9 million citizens) largely rely on onsite solutions with less than 10 percent of the population relying on piped sewage.

Figure 2.9 shows a plan to eliminate the sanitation and hygiene backlog in schools. By 2020, all schools that currently have more than sixty students per latrine will be provided with additional latrines, so that this ratio is respected. Schools that lack the infrastructure needed for adequate hygiene will have that provided.

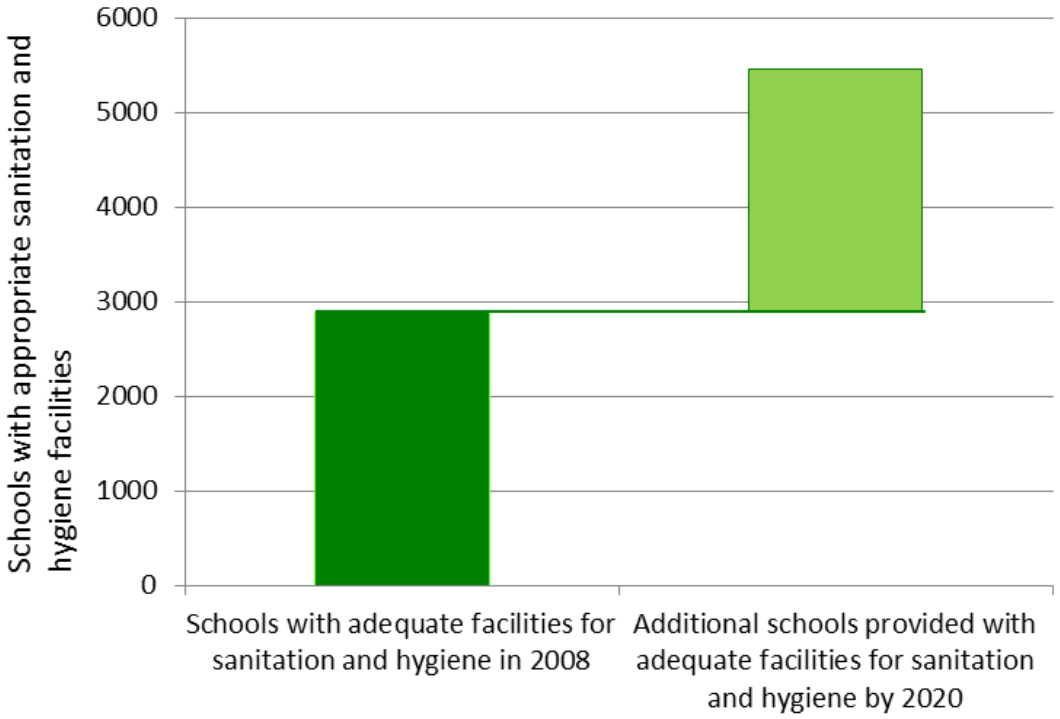
The plan does not allocate further funding to extending access to adequate facilities for sanitation and hygiene in schools—after the backlog is cleared—because it is assumed that new school buildings will be provided with appropriate facilitates out of the construction budget of the Ministry of Education, Science, and Technology.

[10] NWDP II AF, Sanitation Marketing Campaign in Lilongwe and Blantyre.

[11] World Bank, "Jakarta Case Study Overview Climate Change, Disaster Risk and the Urban Poor: Cities building resilience for a changing world" http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1306291319853/CS_Jakarta.pdf.

[12] Junio M Ragragio, "The case of Metro Manila, Philippines" http://www.ucl.ac.uk/dpu-projects/Global_Report/pdfs/Manila.pdf.

Figure 2.9: Improvements with Recommended Investment Levels



Data table 2.9: Schools without Adequate Facilities with Recommended Investment Levels

Primary Schools	2008	2020
Backlog of schools without sufficient facilitates for adequate sanitation and hygiene	4,142	0

Source: Malawi School WASH 2008: A Status Report on Water, Sanitation and Hygiene in Primary Schools, Ministry of Education, Science & Technology, 2009.

The expenditure levels described in Figure 2.6 will be challenging to raise and spend over the time frames needed. A less ambitious approach would be to improve access in a more gradual fashion that does not stretch fund raising and implementation capacity to quite the same extent. These considerations are the basis of the Investment Plan presented in the next section.

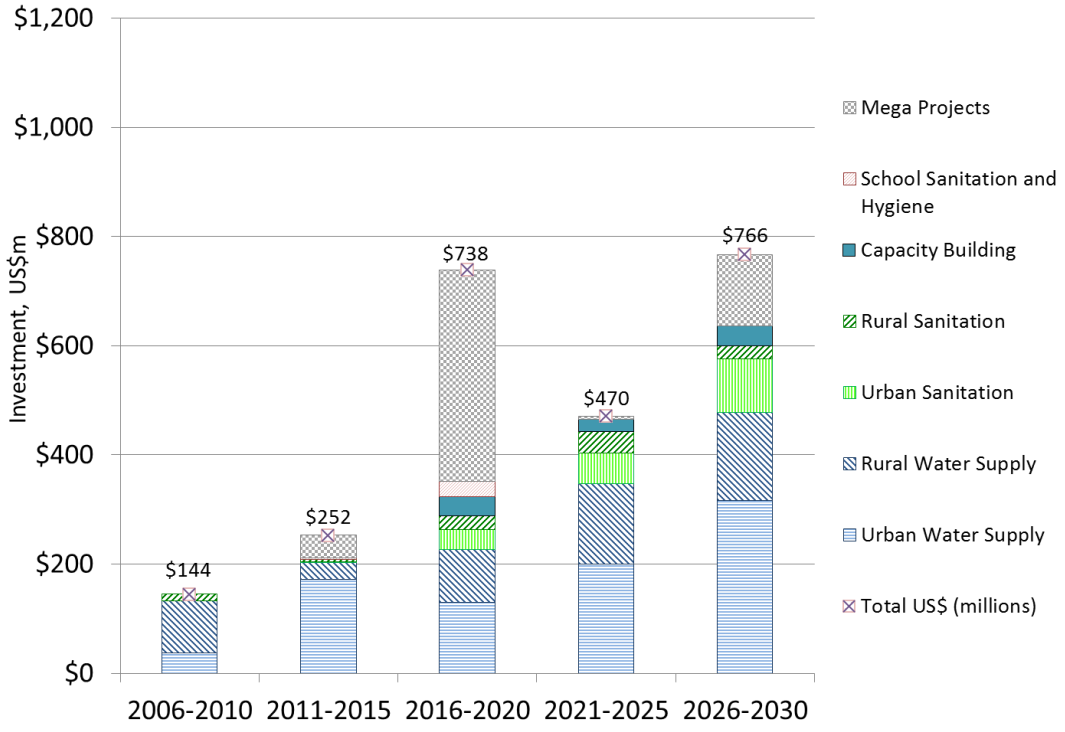
2.4 Scenario 3—Full coverage for water by 2030, and more than Forty Percent for Sanitation by 2030

In light of the high levels of investment needed in Scenario 2, this scenario scales back investments in line with the prioritization described in Section 0. The targets reached in this third scenario are:

- **Schools**: the backlog of schools without adequate sanitation and hygiene facilities is eliminated by 2020 (in line with Scenario 2)
- **Water**: universal access to water is achieved in 2030 rather than 2025. Expenditures are allocated to build the urban bulk supply schemes on the same timeline as in Scenario 2
- **Sanitation**: the Government targets for sanitation in urban areas are achieved by 2030. Funds are allocated to achieve access to improved sanitation in rural areas of 33 percent in 2030, a fivefold increase over access levels in 2010 of 6 percent.

Figure 2.9 shows the investments in Scenario 3 (that is full coverage for water by 2030, and more than forty percent for sanitation by 2030). Expenditure of more than US$700 million is needed in the 2016-2020 period, largely due to the expenditure on the mega projects during this period. During the 2021-2025 period, under US$500 million is needed. Expenditure then increases to more than US$700 million in the 2026-2030 period as large spending again occurs on the mega projects.

Figure 2.10: Investment Levels for Scenario 3—Full Coverage for Water by 2030, and more than 40 percent for Sanitation by 2030



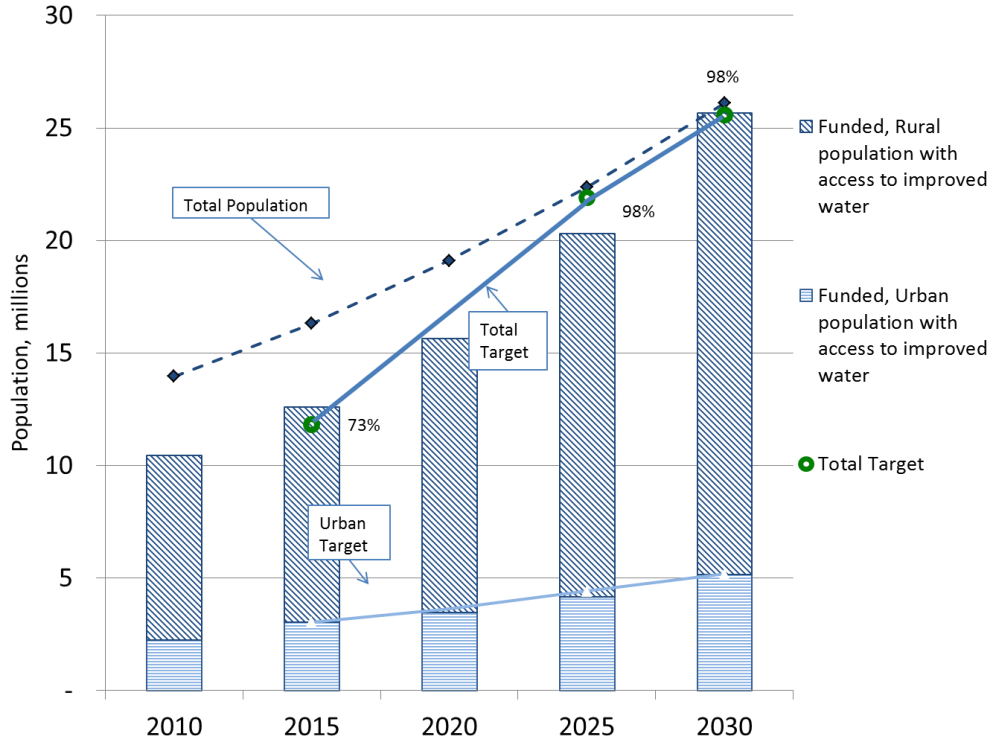
Data table 2.10: Expenditure required for Scenario 3—Full Coverage for Water by 2030, and more than 40 percent for Sanitation by 2030

	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	2011-2030
School Sanitation and Hygiene	-	3	28	0	-	31
Capacity Building	-	-	35	22	36	94
Rural Sanitation	12	4	25	38	23	90
Urban Sanitation	1	1	37	57	99	195
Rural Water Supply	95	32	96	147	161	435
Urban Water Supply	36	171	130	199	316	815
Mega Projects	-	42	387	6	131	567
Total US$ (millions)	144	252	738	470	766	2,227

The figures for 2006-2010 are based on actual expenditure. For the period 2011-2015 the figures are based on expected expenditure based on planned projects **and** expenditure that is expected to be needed on the bulk water supply projects. The figures for 2016-2030 are for planned expenditure.

As shown in Figure 2.11 universal access to improved water is achieved by 2030.

Figure 2.11: Water Access Projections in Scenario 3—Full Coverage for Water by 2030, and More Than 40 Percent for Sanitation by 2030



Data table 2.11: Water Access Projections for Scenario 3—Full Coverage for Water by 2030, and more than **40 percent for sanitation by 2030**

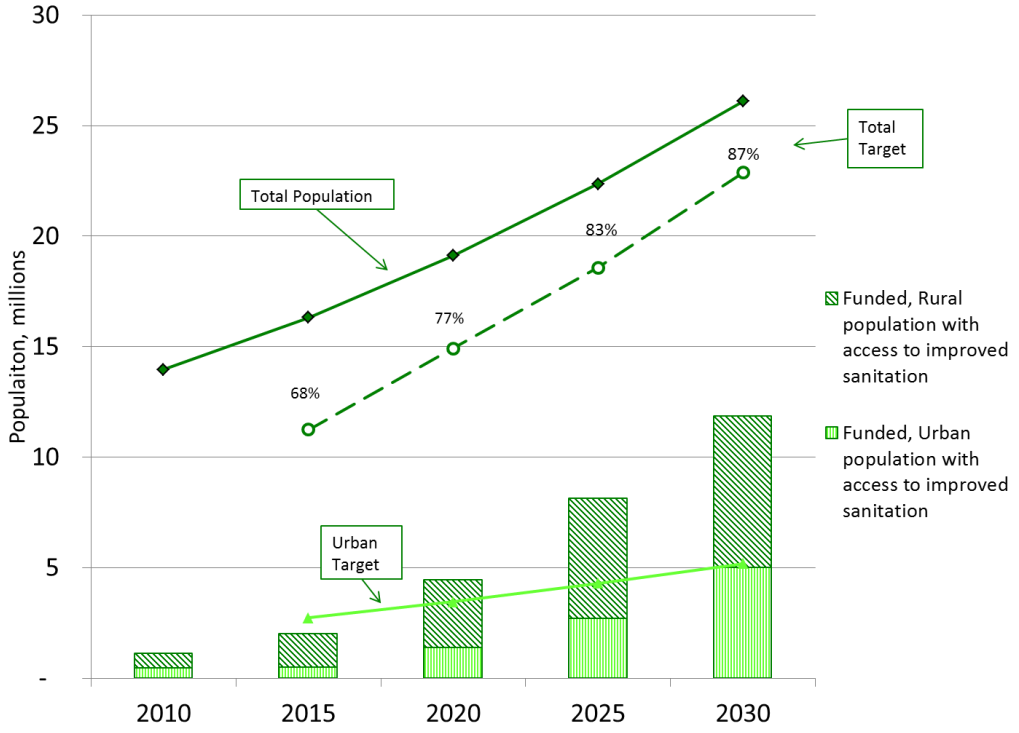
	2010	2015	2020	2025	2030
Targets for Access - Water					
Total		69%	n/a	98%	98%
Urban		95%	n/a	98%	98%
Rural		67%	n/a	98%	98%
Achieved Access -Water					
Total	80%	77%	82%	91%	98%
Urban	92%	95%	91%	92%	98%
Rural	77%	73%	80%	90%	98%

Source: Castalia calculations.

Figure 2.12 illustrates the increase in access to sanitation in urban and rural areas. A further 10 million people will get access to improved sanitation over the period, amounting to access to improved sanitation increasing more than five times. However, given the low level of access currently—less than 10 percent nationally according to DHS (2010)—and rapid population growth, this equates to growth in access levels that don't achieve the targets for 2025. This aspiration is not achieved because funding has rather been allocated to reaching the targets for improved water, and increasing access to sanitation and hygiene at schools.

This follows from the recommendation that where investment dollars are severely limited, expenditure with the highest benefits per dollar must be prioritized, as described in Section 0.

Figure 2.12: Sanitation Access Projections for Scenario 3—Full Coverage for Water by 2030, and more than 40 percent for Sanitation by 2030



Data table 2.12: Sanitation Access Projections for Scenario 3—Full Coverage for Water by 2030, and more than 40 percent for S**anitation by 2030**

	2010	2015	2020	2025	2030
Targets for Access - Sanitation					
Total		68%	77%	83%	87%
Urban		85%	90%	95%	98%
Rural		65%	75%	80%	85%
Achieved Access - Sanitation					
Total	8%	12%	23%	36%	45%
Urban	19%	15%	36%	60%	95%
Rural	6%	12%	20%	30%	33%

Source: Castalia calculations.

2.5 Summary of the Investment Plans

This section has outlined a number of scenarios for investment in the Malawi Water and Sanitation Sector. This report suggests that the Ministry responsible for Water and Sanitation should implement Scenario 2 if possible, and fall back to Scenario 3 if the funds and capacity required for Scenario 2 are not forthcoming:

- **Scenario 2—Achieve full coverage for water by 2025 and 87 percent access to sanitation by 2030**. The benefits to Malawi from reaching these targets would be huge. To achieve these targets would require large amounts of funding rising and investment expenditure over the period. If these amounts of funding and investment cannot be achieved a scaled back version of this investment plan should be considered
- **Scenario 3—Achieve full coverage for water by 2030 and more than 40 percent access to sanitation by 2030**. This scenario delays reaching universal access to water till 2030 and 95 percent access to sanitation in urban areas is reached by 2030 but access to sanitation in rural areas significantly lags the Government's targets.

This section rejected two alternative investment plans, the first because it is not desirable the second because it is not feasible:

- **Scenario 1—Business as Usual** is to keep investing at current levels. These levels of investment in water supply are too low to keep up with the country's rapidly growing population and so access to water as a percentage of the population falls to 60 percent in 2030 from 80 percent in 2010. Continuing to spend at current levels on extending access to sanitation will leave the country with access to sanitation at just over 10 percent in 2030. Given the large net benefit from making these investments to Malawi described in Section 0 allowing access to fall or stagnate in this way is clearly not desirable and should not be seriously considered
- **Hitting all the Targets**: is not feasible from funding or capacity standpoint. While the access to water targets could be reached, combing these with the access to sanitation targets for 2020 and 2025 is not feasible. The ramp up in expenditure is too aggressive. In particular, to hit the access to sanitation targets by 2020 requires expenditure on sanitation to increase from a few million dollars in the 2011-2015 period, to hundreds of millions of dollars in the 2016-2020 period.

3 Projects and Programs

The previous section sets out expenditure levels and access targets for each sub-sector in water and sanitation. This section mentions projects and programs that could be financed. Urban water is considered first, then urban sanitation, rural water, rural sanitation, and finally schools. Capacity building is also a component of the investment plan, and was estimated at five percent of total investment spend in each plan period. The areas where these funds are intended to be spent are discussed in Section 5.

Throughout this section, the scenarios, and associated investment plans, will be referred to as Scenario 2 (achieve full access to water by 2025, and 87 percent access to sanitation by 2030), and Scenario 3 (achieve full access to water by 2030 and 40 percent access to sanitation by 2030).

3.1 Urban Water

Urban water investments refer to all those investments needed to provide access to safe and reliable water within the service area of a Water Board. This section first recommends the way forward on bulk supply projects, which are considered under the mega project category in the investment plan. Options are analyzed for Blantyre, Lilongwe, Mzuzu, and Mzimba. The recommendation is to proceed with major bulk supply projects for each of these cities and town. Then, smaller urban water supply projects, considered under the "urban water supply" category in the investment plan, are described.

3.1.1 Bulk supply project for Blantyre

Blantyre has already run out of water to serve its growing population. Analysis shows that a significant new bulk supply scheme for Blantyre is economically justified.

Blantyre needs a new bulk water supply

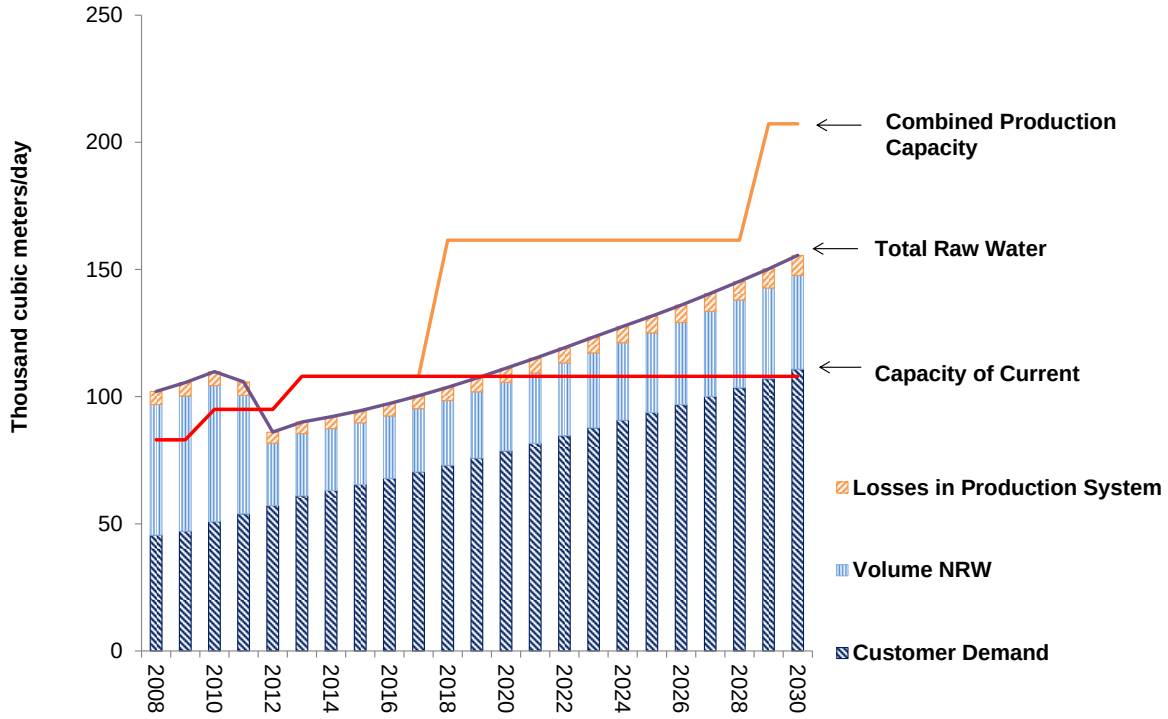
As shown in the projected supply-demand balance below (Figure 3.1), if Blantyre does not invest in a new water source, water shortages will re-emerge by 2019.

The current water shortages are being alleviated by the success that the Blantyre Water Board is having in reducing non-revenue water, assisted by Vitens, the advisors contracted to the Board. This situation will further be improved by the rehabilitation of the current Walkers Ferry supply. These developments are shown in Figure 3.1 as the shrinking of the light-blue 'Volume NRW' component of total raw water demand, and the upward movement in the red line that represents the maximum raw water that the current systems are capable of supplying.

Continuing population growth will push up demand for water in the Blantrye Water Board area. Even assuming continued success in in getting non-revenue water down to just 25 percent by 2020, demand for water will outstrip supply by 2019. This is can be seen in the figure as the point where the bars representing bulk water demand start to rise above the red line showing total supply available from existing sources.

Given the lead times on a building a dam, uncertainty about rates of demand growth and non-revenue water reduction, and the high costs of failure to supply reliable water, it is worth proceeding with development of new bulk supply now.

Figure 3.1: Blantyre's Water Needs and Current Capacity



Source: All figures from Sogreah "Blantyre New Water Source: Feasibility Study Report" July 2010, except progress on NRW reduction from Vitens (personal communication).

Sogreah Feasibility Study reviewed a number of options for supplying water to Blantyre. It recommended the construction of a dam at Mombezi with an intake at Makuwa. However, this option has an Economic Internal Rate of Return (EIRR) of only 4.8 percent[13]. The option with the lowest costs of supply—and the highest EIRR—is augmenting supply from the Shire River at Walkers Ferry. This option however is reported to have an EIRR of 6.4 percent[14]. Traditionally, development agencies such as the World Bank only fund projects with an EIRR over 10 percent.[15] Given the many demands for capital in a developing country, this cut-off makes sense. But it seems hard to believe that it would be right to leave Blantyre without new water sources.

Costs of not supplying Blantyre with Water

It goes against common sense to suggest that water supply to Blantyre should not be increased. Considering the rate of migration to Blantyre, and the population currently without improved water services, it is likely that if supply is not increased, by 2035 almost a million people will be living in the city without access to safe water. How could this be the economically justified result?

[13]" Blantyre New Water Source: Feasibility Study Report", Sogreah, Table 88.

[14] Blantyre New Water Source: Feasibility Study Report", Sogreah, Table 88.

[15] Pedro Belli et al., Handbook on Economic Analysis of Investment Operations, ed. Operational Core Services Network Learning and Leadership Center, page 195, accessed March 5, 2012, http://siteresources.worldbank.org/ INTCDD/Resources/HandbookEA.pdf.

The answer of course is that it is not economically justified to leave Blantyre without water. Sogreah's analysis made the basic error of valuing water at the tariff. Where the tariff is set by Government without reference to either the costs of supply or consumer willingness to pay, it is a far from reliable guide to the real economic value of water.

The costs of **not** supplying Blantyre with water were calculated based on three scenarios. In the first scenario, the health and inconvenience cost to each person not supplied with water is assumed to be US$147 per person per year (See Appendix A for the calculations). This is probably an underestimate, given the disease levels that would develop in a city of 2 million people where half the population lacks access to a reliable, improved water source. The health and time costs of not supplying water have a present value to US$500 million[16].

Of course, it could also be argued that lack of water in Blantyre—and the disease-ridden conditions that would ensue—would lead to a slowing in migration to the city. This is likely to be true. The cost of a reduction in urbanization is great, so this result would also be bad for the country. City-dwellers are more productive than people in the countryside. So for each person who decides not to move to Blantyre—or to move away—because of poor water supplies, national income would be expected to reduce by US$216 per annum. If the population in Blantyre stagnated because of lack of water, the present value of cost to the country would be around US$473 million.

Finally, people might decide to move to Blantyre and find private solutions to the water supply problem. One market solution to the needs of the growing city would be trucking water, probably from the Shire River. The present cost of supplying the entire growth in population through tanker trucks is around US$961 million. Not surprisingly, this is about six times higher than the cost of supplying the city with Walkers Ferry or Mombezi-Makuwa schemes. Table 3.1 below present the costs of not providing water to Blantyre, under the three possible scenarios described above.

Table 3.1: Costs of Not Supply Blantyre Compare to Cost of Supplying

	Scenario	NPV US$ million
1	Not Providing Water	500
2	No Population Growth	473
3	Tanker Trucks from the Shire River	961

Note: Calculations are done over the period to 2060 (to be consistent with Sogreah's economic analysis) and using a 10 percent discount rate. Calculations and sources are explained in the text

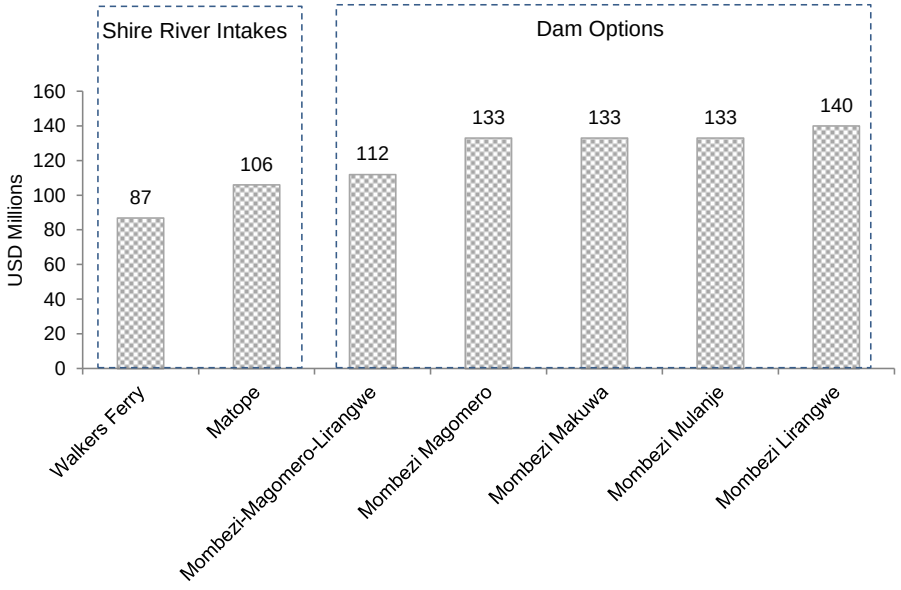
In short, the benefit of a bulk supply project for Blantyre can be thought of as the avoided cost of **not** supplying the city. The real cost of not building a scheme would be some mix of disease and suffering as people move to the city and try to live without a piped water supply, some loss of productivity from people not moving to the city, and the costs of private supply for some who move to the city and find a way to make private arrangements for water supply. The cost of not supplying the city will certainly exceed US$500 million.

[16] Calculations are done over the period to 2060 (to be consistent with Sogreah's economic analysis) and using a 10 percent discount rate, for all the present values in this section.

Bulk Supply Options for Blantyre

Sogreah analyzed a total of 16 options in the Feasibility Study for a new raw water source for Blantyre. It rejected nine of these on environmental grounds, leaving seven for further analysis. These seven were then evaluated and ranked on the basis of their EIRR, as well as other factors: environmental, security of supply, and their usefulness for multiple purposes. These options are presented in Table 3.2 below, in line with costs and rankings presented in Sogreah's Feasibility Study.

Table 3.2: Sogreah Evaluation of Options



	Walkers Ferry	Matope	Mombezi-Magomero-Lirangwe	Mombezi Magomero	Mombezi Makuwa	Mombezi Mulanje	Mombezi Lirangwe
Capital Cost (USD Millions)	87	106	112	133	133	133	140
Operating Cost	High	High	Low	Low	Low	Low	Low
Security of Supply	X	X	✓	✓	✓	✓	✓
Sogreah Ranking Scored	3	6	3	3	1	2	7

Source: Feasibility Study for Blantyre's New Raw Water Source. Pg 247 and 249. Cost numbers and ranking by Sogreah Consultants.

The options that Sogreah reviewed include two intakes on the Shire, and five Dam options:

- **Shire River Intakes**: two projects would create intakes on the Shire at Matope or Walkers Ferry. Matope, like Walkers Ferry, has a lower capital cost but higher operating costs, than dams because of energy costs of pumping water from the Shire. Further, pumping water from Matope, or Walkers Ferry, will still leave Blantyre dependent on the Shire River, and so does not improve security of supply
- **Dams**: The five dam options all have a similar capital cost to Mombezi Makuwa. All of these options propose to build a dam at Mombezi. These dams would have lower operating costs than the intake options, and probably have a higher security of supply because they store water and so can supply water during periods when the Shire runs dry.

Mombezi Makuwa is Sogreah's Recommended Option

Sogreah recommended the Mombezi-Makuwa option. This project would cost around US$214 million, to be incurred in two phases[17]. Capital costs for this bulk supply scheme include construction works for a dam, a water intake, water treatment plant, pipelines, reservoirs, electric lines, and pumping stations. Additional capital costs have been allocated towards resettlement, engineering, and possible physical contingencies.

The recommendation to proceed with Mombezi-Makuwa has been controversial because the Sogreah Report states that the economic internal rate of return is higher for Walkers Ferry than Mombezi-Makuwa. This is largely because the higher electricity costs of Walkers Ferry are more than offset by its lower capital costs. On this basis the Walkers Ferry is the better option because it is cheaper. Using Sogreah's costs, and a discount rate of 10 percent, the present value of costs of Walker Ferry is US$23 million less than the present value of the costs of Mombezi-Makuwa.

In fact, Mombezi-Makuwa may be cheaper and have a higher, EIRR than Walkers' Ferry. The reason is that Sogreah's feasibility study fails to take into account the true cost of electricity. Sogreah use the tariff rate of US$0.03 per kWh. This figure would be fine for a financial evaluation, but is not correct, and also too low, for an economic analysis. Calculations appropriate to an economic analysis described in Appendix B suggest that the real cost of power in the country is around US$0.17 per kWh[18]. At this cost, Walkers Ferry is the same cost as Mombezi Makuwa. This estimate of US$0.17 per kWh is relatively conservative as the economic costs of electricity in Malawi have been estimated as high as US$0.25 per kWh in the Shire River Basin Management Program. With electricity at a cost of US$0.25 per kWh Walkers Ferry is substantially **more** expensive than Mombezi Makuwa.

[17] It is hard to be as precise as we would like about the cost of the project as there are some discrepancies between the capital costs reports in Table 73 of Sogreah's "Blantyre New Water Source: Feasibility Study Report", and those given in Appendix H3 for the Economic Analysis. Because we needed the costs broken down by year, we used the numbers in Appendix H3.

[18] The economic cost of power supply in Malawi was recalculated, assuming that a 300MW coal fired plant is built as the next capacity increment according to Malawi Power System Project Studies: Final Feasibility Study Report, August 19, 2010 prepared for Millennium Challenge Corporation. The all-in cost of power from such a plant would be around US$0.08 per kWh. Systems losses at the target rate of 17.5 percent add another US$0.01 to this. International benchmarks suggest that cost-reflective transmission and distribution charges would also be around US$0.08 per kWh. The final figure is US$0.17 per kWh.

Table 3.3: Cost of Mombezi-Makuwa Compared to the Cost of Walkers Ferry[19]

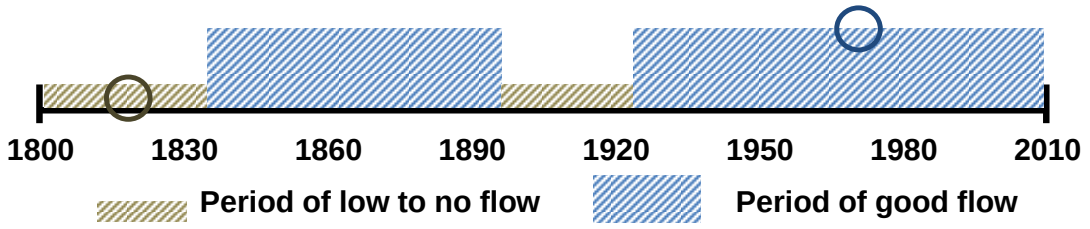
NPV 2012-2060 US$m at 10%	Mombezi – Makuwa	Walkers Ferry
Capex	97	70
Operating and maintenance expenses (excluding electricity)	8	7
Electricity (at tariff)	5	10
Subtotal	***110***	***87***
Electricity at US$0.17 per kWh (increment to economic cost)	24	47
Total	**134**	**134**

In addition to being similar or even lower cost, Mombezi-Makuwa has an additional benefit over Walkers Ferry in that it may well provide more security of supply.

Security of Supply Considerations for Blantyre

In the Water Resources Investment Strategy prepared for the Government of Malawi, Atkins analyzed the historical record for the Shire River. Although the river has been reliable for the last 50 years, looking further back in time reveals periods where the flow from Lake Malawi has been completely dry for ten years or more at a time. This record is summarized graphically in Figure 3.2**Error! Reference source not found.**.

Figure 3.2: Shire River Flow—Historical Record



Source: Water Resources Investment Strategy, Component 2, Final Report, Atkins, August 2011 Table 4-2.

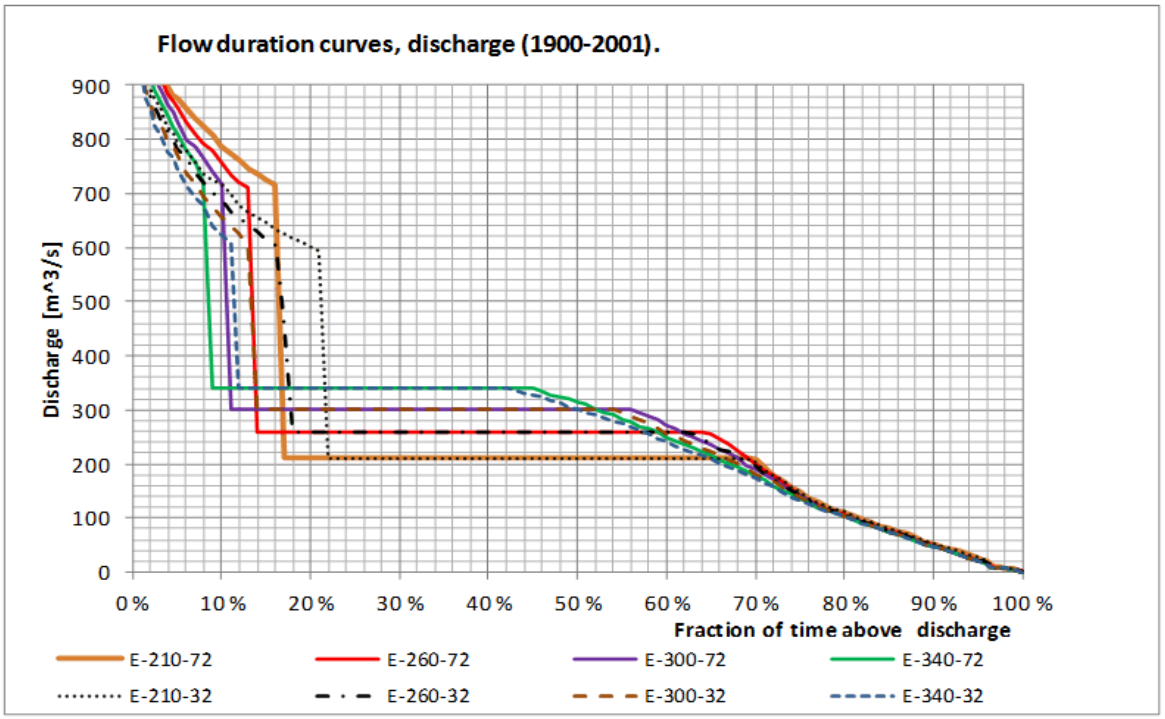
Atkins put the available historical data into a rating curve to produce the flow probability diagram. The Atkins diagram indicates that, when data from only 1955 onward is considered, there seems to be no chance of the Shire River running dry. However, when the complete historical record is considered, the model implies the probability of zero or near zero outflow from Lake Malawi into the Shire River approaches 20 percent. If that was right, it would mean that over a 100-year period, we would expect the Shire River to be dry for 20 years.

More thorough analysis carried out by Norplan indicates that the risk of the Shire River running dry is much less than this. In part, the Water Resource Strategy over-estimated the risk because it did not take into account the planned upgrades to the Kamuzu Barrage that will further increase the amount of water stored in Lake Malawi and thus mitigate the risk

[19] Refer to Appendices C and D for detailed calculations of electricity costs and Shire River risk.

that no water will flow out of the Lake into the Shire. Figure 3.3 illustrates the probability of low to zero flow in the Shire River, as presented by Norplan.[20] The risk level is somewhere between zero and four percent. A two percent risk was used for the purposes of quantifying the cost to Blantyre if the Shire River ran dry[21].

Figure 3.3: Shire River Hydrological Risk



Further analysis is needed before finalizing the choice of bulk water supply for Blantyre

On currently available analysis, Mombezi Makuwa seems to the best available option. However, there are social and environmental concerns regarding the construction of a dam at Mombezi. If the dam was to be built it would flood established communities, submerging a school, a graveyard and a mosque amongst others. In addition, concerns have been raised that the dam would be relatively shallow and vulnerable to siltation.

In light of these concerns it is worthwhile investigating the water sources in the general vicinity of Blantyre that are reliable, and where the water available from dams on these rivers would not be strongly correlated Shire River flows. Foremost among these are the various streams on the Mulanje Massif[22]. It is worth spending a bit more time exploring whether

[20] This figure is the result of initial modeling by Norplan as their study has not yet been finalized.

[21] Refer to Appendix C.1.4 for detailed cost of the Shire River risk.

[22] Sogreah Feasibility Study discusses options for direct supply from Mulanje Massif and/or Zomba Plateau without a dam in Section 5.1.8, pg. 157. This option was not considered feasible without a storage component. Therefore, Sogreah also looked dam options around Mulanje Massif in Section 5.1.14 pg. 161 of the Study. A Mulanje Massif dam option, like a dam at Mombezi, raises social and environmental concerns and also has higher constructions costs, which makes it a less attractive investment and does not avoid any social environmental concerns.

there is a source that could be used to build a dam cost effectively compared to Shire River intake options that provides sufficient security of supply.

3.2 Bulk Supply Project for Lilongwe

Lilongwe needs to move ahead with adding new bulk water supply capacity. With current capacity, the supply shortfall is predicted to be 20,000 cubic meters per day by 2015. Sogreah's recommendation to proceed with the Diamphwe Lower Dam (with an 18m depth and an irrigation component—Option 3) appears sound.

The recommended scheme will entail total capital expenditure of US$250 million between now and 2030. The first phase of construction—which we estimate would start in 2015 and take four years—will cost around US$190 million. Most of the remaining expenditure would go on a second construction phase sometime between 2026 and 2030. Capital costs for this option include civil works and equipment[23], as well as the supply, laying, and installation of transmission pipelines. Like capital costs for Blantyre, other costs were allocated for resettlement, physical contingencies, and engineering costs. Because this bulk supply scheme will also provide water for fisheries and irrigation (not just drinking water), some of the capital costs are for acquiring land for compensation irrigation, development of fisheries, and irrigation schemes. Sogreah also provides capital cost estimates for network expansion and connections, in the distribution system[24]. However, these costs are not reflected in the required investment for **bulk** water supply. They have been accounted for in the proposed investment plan under urban water supply, but were excluded here to make all bulk water investment requirements comparable.

Sogreah estimates the EIRR of the scheme at 12 percent—several errors appear to have been made in the economic evaluation, but correcting these would mostly increase, rather than decrease the estimate of the EIRR.

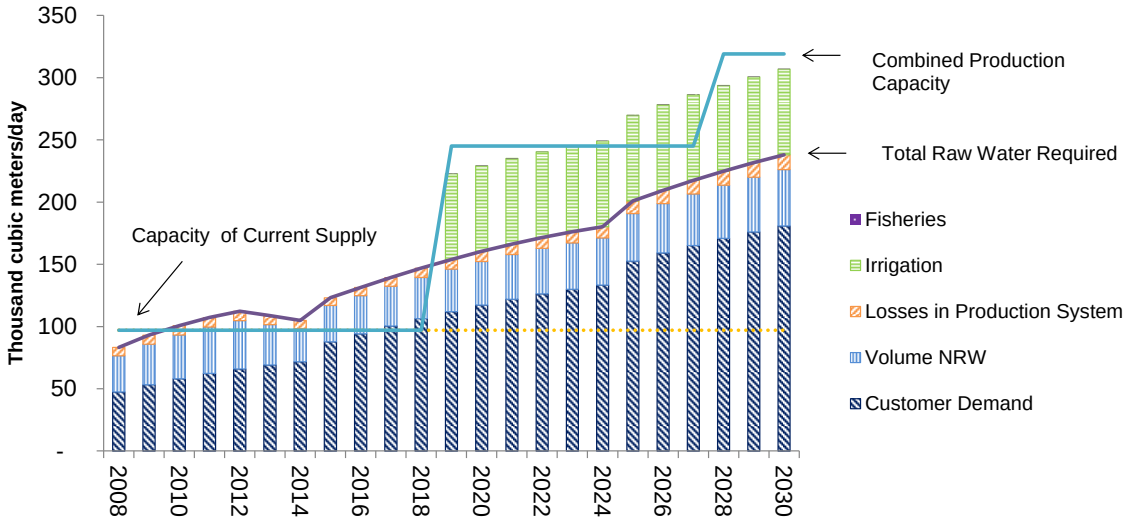
Demand will quickly exceed supply in Lilongwe

Demand for water in the Lilongwe supply area is forecast to reach 88,000 cubic meters per day by 2015. Even with projected reductions in NRW, bulk water supply of 123,000 cubic meters per day will be needed to meet demand as Figure 3.4 below illustrates. By 2025, the bulk water deficit is predicted to grow to 94,000 cubic meters per day if nothing is done.

[23] These include construction of dam, water treatment plant, tanks, pumping stations, road and earthworks, SCADA systems, power plant, and electric lines.

[24] The estimated present value cost (at 10 percent discount rate) of a complementary distribution system is about $59 million.

Figure 3.4: Lilongwe Bulk Water Demand vs. Current Capacity



Source: Sogreah Lilongwe Feasibility report numbers were used for all components of this graph, except for NRW reduction. Demand projections are based on the medium growth scenario. Expected decreases in NRW reflect expected outcomes of Private Service Contract with Vitens; this was gathered from a personal communication with the Project Manager for the Contract in Lilongwe.

The Diamphwe Lower Dam is the right option

Sogreah recommends the Diamphwe Lower Dam (with an 18m depth and irrigation and fisheries component—Option 3).[25] Sogreah recommended this option after a review of three site options, and thee design variants for the recommended site. Of the feasible options, the recommended option has the highest EIRR, at 12 percent.[26]

The analysis seems to have been generally sound. Unlike the Blantyre analysis, the levels of NRW assumed seem to be reasonable. The EIRR of the recommended option is 12 percent, which is above the normal hurdle rates for investment approval.

There are some flaws in the economic analysis related to the value of water, and electricity costs and values. These are unlikely to affect the conclusions, but are described below for completeness.

The Sogreah analysis seems to understate the economic value of the water supplied by the scheme. The analysis estimates the value of water supplied to customers with individual connections at the tariff paid, plus the additional cost of getting water under a counterfactual "without project" scenario in which only kiosk supply is available to new users.[27] By making continued supply from kiosks at current prices the non-project counterfactual, the analysis seems to assume that water to supply an additional 800,000 inhabitants[28] through kiosks would be available even if bulk supply is not augmented. Since current supply is not enough

[25] Feasibility Studies and Preliminary Design for Lilongwe New Water Source, Updated Feasibility Study Report, July 2010, N° 1.32.0145 R10, Sogreah [Sogreah Lilongwe Feasibility Study].

26 Sogreah Lilongwe Feasibility Study, Table 148, p.253.

27 Sogreah Feasibility Study pg. 250.

28 Population projections from Sogreah Report section 2.3.2.

to meet projected 2015 demand, this assumption does not seem reasonable. It seems more likely that the true counterfactual would be that many people would not get water at all. If that is the case, then Sogreah's analysis seriously understates the true economic benefits of the scheme.

As with the Blantyre economic analysis, Sogreah seems to underestimate the economic value of electricity consumed in supplying water. In considering the economic cost of power consumed, the report assumes a figure of less than US$0.06 per kWh. Castalia analysis suggests that the true economic value of electricity in Malawi is closer to US$0.17 per kWh (See Appendix B). However, this understatement costs is probably trivial in comparison to the understatement of benefits, so the conclusion that the scheme is economically justified would still stand.

In choosing between options, Sogreah recommended against adding a hydropower component to the recommended option. The report considered the current shortage of power in Malawi, and the reliance on diesel generators, and assigned a value per kWh of power produced in excess of US$0.39[29]. This is probably too high. Our analysis suggests that that value of power generated will, over the medium-term, be around US$0.08 per kWh. It certainly is inconsistent to assume, as Sogreah has done, that power consumed is worth less than US$0.06 per kWh but power generated is worth more than US$0.39 per kWh. However, using a lower-value for power generated would reinforce Sogreah's conclusion that adding a hydropower component is not economically justified, so correcting the error would not change the recommendation.

Government and Lilongwe Water Board should proceed with the Diamphwe Lower Dam

In conclusion, there can be little doubt that Lilongwe needs a significant boost to its bulk water supply, to keep pace with growing demand, and close the existing supply deficit. The Diamphwe Lower Dam is the economically justified way to do this. This project should proceed. Its estimated cost is US$250 million between now and 2030.

3.2.1 Bulk Supply Projects for Mzuzu

Like Lilongwe and Blantyre, Mzuzu is running out of water. The town's population exceeds 150,000 already, and is projected to grow rapidly. Supply is already not adequate to meet demand. By 2015 a shortfall of 8,000 cubic meters per day is projected, even assuming that non-revenue water can be reduced to 25 percent (from the current level of around 30 percent). Construction of a dam on the Lambilambi River is the best option to serve this growing demand, and is cost-benefit justified.

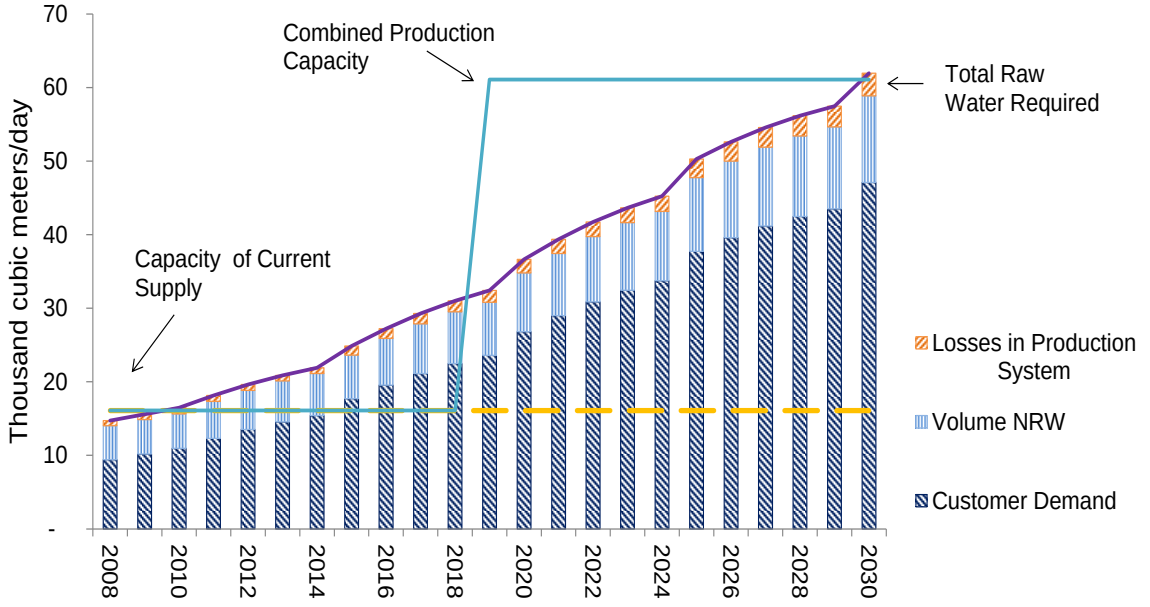
Total capital cost of the Lambilambi Dam project would be US$70 million, which should be incurred between 2014 and 2017. Cost provisions are for construction of dam, transmission pipelines, water treatment plant and tank, and electric lines. Further, capital cost estimates include construction of service road and earthworks, land compensations, engineering, and physical contingencies. Once built, the scheme should be adequate to meet demand in Mzuzu until about 2030. At that point, an additional dam could be built. Sogreah has identified a number of possible second phases, but it is not necessary at this point to make a decision on which would be best.

[29] Sogreah Report pg. 251.

Mzuzu is running out of water

According to Sogreah's analysis, demand for water in Mzuzu is already 14,000 cubic meters per day, even though only around 70 percent of the people in the area are served with piped water. The current water supply capacity of 16,000 cubic meters per day has already been exceeded, as Figure 3.5 shows. Reductions in non-revenue water levels are feasible, but will not be adequate to restore supply and demand for water to balance.

Figure 3.5: Mzuzu Bulk Water Demand vs. Current Capacity



Source: Sogreah Mzuzu & Mzimba Feasibility report numbers were used for this graph.

The Lambilambi Dam is cost benefit justified

Sogreah recommends that the Lambilambi Dam be developed to meet this growing demand, followed by development of the Luzangazi Dam to meet additional demand after 2029. However, the Sogreah Mzuzu-Mzimba Feasibility Study indicates that the EIRR for this project is 4.3 percent. All the other schemes considered have an EIRR of this level or less according to Sogreah's calculations[30]—except for the option of dam on the Lichelemu River which, if hydro-generation is incorporated, is estimated to have an EIRR of 10.9 percent.

As was the case with Blantyre, it seems implausible that it would be cost-benefit justified to leave so many people without a safe reliable water supply. Castalia redid the calculations, using the Sogreah population and demand forecasts, and the costs of the Lambilambi Dam (excluding phase 2 capital costs)[31]. As with the other projects, electricity costs were set at US$0.17 per kWh in line with estimates of the economic costs of supply (see Section 3.1.1). The benefits of the project were assumed to be US$147 per person supplied with improved water (see Appendix A).

[30] Sogreah Mzuzu-Mzimba Feasibility Study, Table 89, page 190.

[31] Refer to Appendix A for the cost-benefit analysis.

The results of this improved economic analysis show an EIRR of around 20 percent for the Lambilambi Dam. This confirms the rational view that a growing town needs a water supply adequate to the needs of its population.

The Lambilambi Dam is better than other options

The next question is whether the Lambilambi Dam is better than the other options. At first sight, one might think that the dam and hydropower generation Lichelemu River might be better, given that Sogreah estimated it to have twice the EIRR of the Lambilambi Dam. However, once a more realistic estimate of the value of power generation is used (US$0.08 per kWh), the EIRR turns out to be 17 percent—viable but less than that of the recommended Lambilambi Dam.

The other close contender is building a dam on the Lusangazi. This has a slightly higher water yield, and slightly lower capital cost, than the Lambilambi scheme. However, Sogreah reports that

> *"The potential site on Lusangazi River would have major and serious negative impacts on nearby settlements and human activities, including loss of farm land, separation of communities and disruption of footpaths." Sogreah Mzuzu Mzimba Feasability Study p.IX.*

On the assumption that these disadvantages outweigh any slight cost advantage, it seems safe to proceed with the Lambilambi Dam in order to provide increased water supply to Mzuzu. This is recommended for inclusion in the investment plan.

An additional water supply will be needed around 2029, but it does not make sense to decide on that now. Planning for that should start around 2020. By that time, better information on population growth, as well as any changes in hydrology patterns, will allow better decisions to be made.

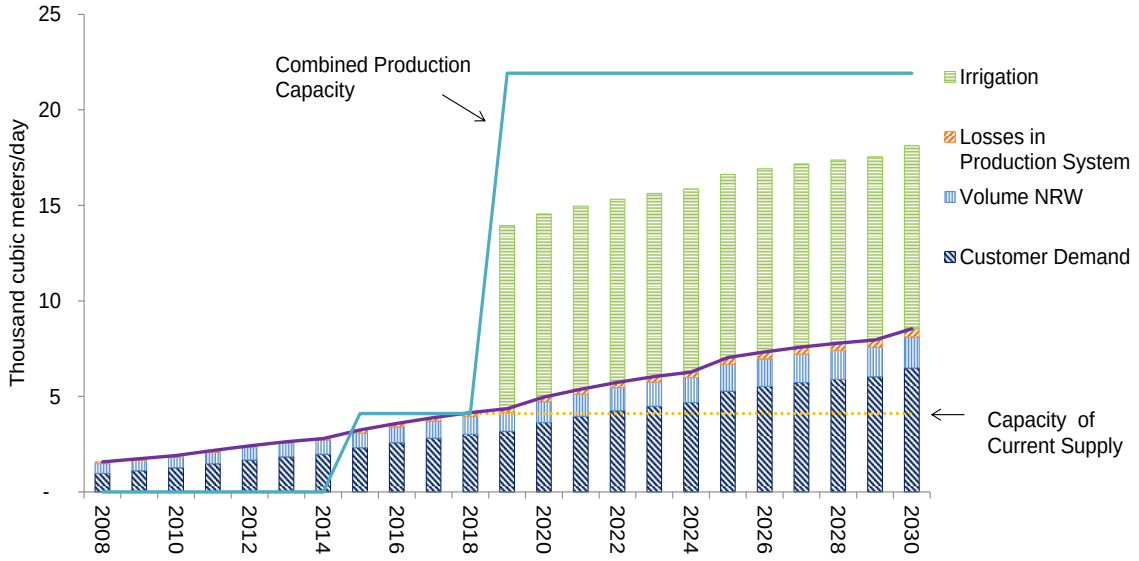
3.2.2 Bulk Supply Project for Mzimba

Mzimba is a town of around 20,000 people, with rapid population growth and inadequate water supply. Sogreah reports that the only option for supply of water to meet Mzimba's needs is a dam on Mzimba River.[32] A dam sized only for water supply is estimated to have an EIRR of just 1.8 percent. However, a larger dam irrigating 240 hectares of land is estimated to have an EIRR of 16.6 percent.[33] Assuming the irrigation values have been calculated correctly, it would make sense to proceed with this scheme, and it is recommended for inclusion in the Investment Plan. The recommended option has a cost of about US$39 million. Just as the bulk supply options for Blantyre, Lilongwe, and Mzuzu, capital costs for Mzimba include dam construction, transmission pipelines, service road and earthworks, water treatment plant and tank, electric lines, land compensation, physical contingencies, and engineering. As is the case for Lilongwe, Mzimba bulk supply scheme will also provide water for irrigation; so a part of capital costs is for irrigation systems.

[32] Sogreah Mzuzu-Mzimba Feasibility Study p.201.

[33] Sogreah Mzuzu-Mzimba Feasibility Study p.188.

Figure 3.6: Mzimba Bulk Water Demand



Source: Sogreah Mzuzu & Mzimba Feasibility report numbers were used for this graph.

3.2.3 Urban Water Supply

As discussed above, we recommend that the major bulk water supply projects for Blantyre, Lilongwe, Mzuzu, and Mzimba are funded. From 2011-2020 these projects require around $550 million in funding.

In addition to the mega projects more than forty urban water projects, with a combined capital cost of around US$120 million, have already been selected for funding and should—like all projects that are already funded—stay in the Investment Plan.

Scenario 2 and 3 suggests that around $815 million is needed which suggests that substantial funding still needs to be allocated to urban water projects.[34] A number of other urban water projects have been identified by Water Boards, but have not yet secured funding. Examples of the types of urban water projects that could be funded are provided below.

The Northern Regional Water Board has proposed water supply systems for Usisya, Mpamba, and Kande. The estimated cost is $12 million. The project is expected to have around 18,000 beneficiaries.

A project proposed by Central Regional Water Board is for rehabilitation and expansion of Kasungu water supply. It involves the construction of distribution pipelines and installation of a storage tank, and 19 community water points. An estimated 12,700 people in low income areas around the town would benefit; the project would cost $400,000.

A Southern Regional Water Board project that has a funding gap is the construction of Zomba water supply scheme. The total estimated cost of the project is $8.3 million, but it

[34] The expenditure on urban water is $817 million in Scenario 2 because infrastructure is built earlier and so there is expenditure on rehabilitation. Expenditure for Scenario 3 is $815 million because investments occur later and so less rehabilitation is planned for.

has only received $7.8 million. The project aims to expand supply to low income areas. Funds provided are to be used for rehabilitating and replacing asbestos cement and galvanized iron pipes, as well as construction of a reservoir to improve capacity. If the funding gap results in the inability to properly and successfully complete the project, remaining funds could be provided to finish the project.

Projects that have yet to receive funding are worth an aggregate amount of about $8 million. The complete list of unfunded rural water supply projects can be found in Table F.6 in Appendix F.2.

3.3 Urban Sanitation

The Investment Plan allocates around US$200 million under Scenario 2 and Scenario 3, for projects that increase access to improved sanitation in urban areas. Currently, there is only one funded urban sanitation project. Its total cost is less than $1 million (refer to Appendix F). This is a sanitation project is for continuing sanitation marketing campaigns in peri-urban areas of Lilongwe and Blantyre. The campaigns aim to increase adoption of latrine options, hand washing, use of safe drinking water, and clean latrines. About 4,650 households (or 21,400 people) will benefit from this project. Two unfunded projects, worth a total of $23 million, are to develop sewerage systems for two towns in the service area of Northern Regional Water Board. In addition, to these Box 3.2 discusses an array of options for sanitation technologies that could be considered for inclusion in the investment plan.

3.4 Rural Water

Scenario 2 and Scenario 3 of the Investment Plan recommends that more than $430 million be spent on rural water supply projects from 2011 to 2030. There are 14 rural water projects that have been funded in rural areas with a total cost of more than US$25 million (refer to Appendix for funded rural water projects). This means around $400 million worth of projects have yet to be identified under scenario 2, or Scenario 3.

A number of projects, worth a total of about $8 million, have been prepared by the Ministry responsible for Water Supply and Sanitation but not yet funded. Examples of projects that have not yet received funding but could be included in the Investment Plan, are rehabilitations for piped water supply schemes in three rural districts[35], as well as Mwasambo-Nhotakota and Ntchisi, Champila South-Mzimba, and Chitekwa in Chitipa. As discussed in more detail in Section 5, further spending on rural water should be allocated to District Councils which would develop projects in line with their District Sector Investment Plans. Box 3.1, below discusses some options for rural water supply technologies that District Councils could consider in developing investment projects in rural water supply.

[35] Specific districts are note specified in source of information.

Box 3.1: Rural Water Supply Technologies

In rural areas the Government provides communities with access to improved water from a range of technologies which include boreholes, gravity fed piped water schemes, rain water harvesting, and other piped schemes using water from aquifers. Historically, large scale investments in boreholes have dramatically increased access to improved water in rural areas of Malawi. However, the scope for increasing access to water through boreholes is limited. For this reason the Government has shifted focus from boreholes, to piped water systems.

Rural technology options

An important reason for the shift away from boreholes is that in many areas there is not enough ground water for additional boreholes. Another consideration is that accessing water from boreholes requires that community members go fetch water from the borehole itself, while piped water schemes supply water closer to people's homes. As a result, boreholes require community members to spend more time hauling water. The need to haul the water reduces the amount of water they can carry home and use.

While piped water systems have significant advantages, they are more difficult for the community to operate and maintain. Piped water systems are larger and more sophisticated than boreholes. Additionally, it is harder to organize the community to maintain and operate the systems because they serve more people across a wider area. In light of these concerns the Government is helping to establish Water User Associations that take on the operations and maintenance of these schemes. The intention is that larger WUAs will outsource operations and maintenance and even the collection of fees to a contractor. This contractor could be an independent contractor or a Water Board.

Rainwater harvesting is used by less than 0.01%[36] of the population. One advantage is that it can be a relatively low cost technology. However it is less useful in many areas in Malawi because of the country's long dry season.

District councils should decide on suitable technologies

As mentioned in section 5, District Councils will be expected to generate projects for rural investment in the future. Considering this sample of technologies to choose from, District Councils will want to develop District Plans that fund the types of water systems that would be most appropriate for rural areas in their districts.

Factors such as the availability of groundwater versus surface water, and the costs of each technology compared to the additional benefits could help guide investment decisions. For example, a gravity scheme may be more costly but it also provides the benefit of delivering water closer to homes and so reducing time spent collecting water. Could small dams be an option to improve surface water reliability? Does the potential for rainwater harvesting exist in areas with scarce water resources, and how much storage would be needed to get households through the long dry season?

Lastly, institutions should be designed to provide sustainable operations and maintenance. This may include strengthening of Water User Associations, or contracting out the scheme to an individual, firm or Water Board. Such institutions could help collect fees from users, and ensure system is maintained.

3.5 Rural Sanitation

Under Scenario 2, the investment plan dedicates $267 million for rural sanitation to achieve 87 percent access to sanitation in rural areas by 2030, while Scenario 3 sets aside $90 million to achieve 40 percent access by 2030.

[36] Census reports approximately only 1,000 people use the technology.

The WASH program is the only rural sanitation program that has been funded so far, WASH is worth more than US$3 million (refer to Appendix F) , and has a large sanitation marketing component that educates citizens about the benefits of sanitation facilities, as well as proper hygiene methods.

Another US$9 million worth of projects have been identified but not yet funded. In line with the recommended spend for rural sanitation; under Scenario 2 at least $255 million worth of projects need to be developed in order to meet the target of 87 percent coverage by 2030. To fill the project gap under Scenario 3, projects worth a minimum of $78 million need to be developed to achieve 40 percent coverage. As discussed previously, money for rural sanitation projects should be allocated to District Councils who would implement projects in line with their Investment Plans.

3.6 Schools

The recommended spend for a school is $31 million. There are two funded schools programs, the school sanitation program in Dedza and the schools component of the WASH. Together, they have funding of under US$2 million. These are listed in Appendix F.

The schools sanitation program in Dedza involves construction of improved latrines, urinal blocks, and hand washing, facilities. Funds will also cover construction supervision as well as an effort to promote of proper hygiene practices.

There remains a need for the Malawi Government to develop additional projects to eliminate the remaining number of schools that don't have adequate facilities for sanitation and hygiene.

Box 3.2: Sanitation Infrastructure

The government aims to increase sanitation access through a number of sanitation technologies. These include improved traditional pit latrines, ventilated improved pit (VIP) latrines, ecological sanitation facilities, and pour flush toilets.

Latrines options

Improved pit latrines, as defined by the Joint Monitoring Programme (JMP), are latrines that successfully separate human waste from human contact. A basic latrine is the most basic form of an improved latrine. It has an impermeable layer, often a concrete slab and the excreta is blocked from entering the ground water. In Malawi it is quite common for two or more households to share a single "private" latrine. JMP currently does not consider this as an improved sanitation option because of concerns that shared latrines would not be hygienic. However, this conclusion is tentative. For instance, it may well that a latrine shared by two households is, on average, as hygienic as a latrine used by a single household.

Communal latrine blocks are used for reducing open defecation in public places such as markets. Increased access to communal latrines is an important objective of the Government.

Achieving Sanitation Targets

As is the case in for rural water supply, District Councils should consider which improved sanitation options are best suited to help achieve sanitation targets. Again, the costs of each option could be compared to the benefit it provides rural areas. It is important to take into account the ability of households to afford materials for on-site solutions, and maintain the facility. One way to reduce cash costs for households is by using local materials and techniques for building the latrine.

The experience in Malawi is that different institutions have installed very different quality latrines leading to overly costly latrines being built, many of which are not appropriate to Malawian conditions. To increase standardization in the sector the Government has developed a "Low Cost Latrine Technologies Catalogue" which provides the guidelines for household sanitation. The Catalogue includes information on standard dimensions and Bills Of Quantities to facilitate costing.

An important approach to increasing access to improved sanitation is marketing and education campaigns. In addition, some countries have provided households with subsidies to install latrines; an example is Burkina Faso.

Source: Joint Monitoring Programme website and Ministry of Agriculture, Irrigation, and Water Development.

4 Funding Plan

The financing needs for both recommended Scenarios, with associated Investment Plans, are over US$2 billion between now and 2030. For both Scenarios the average annual investment required is more than a hundred million dollars **each year**. This is over four times the average annual investment in the sector between 2006 and 2010. How can this money be found?

The good news is that both recommended Scenarios can be financed provided two conditions are met:

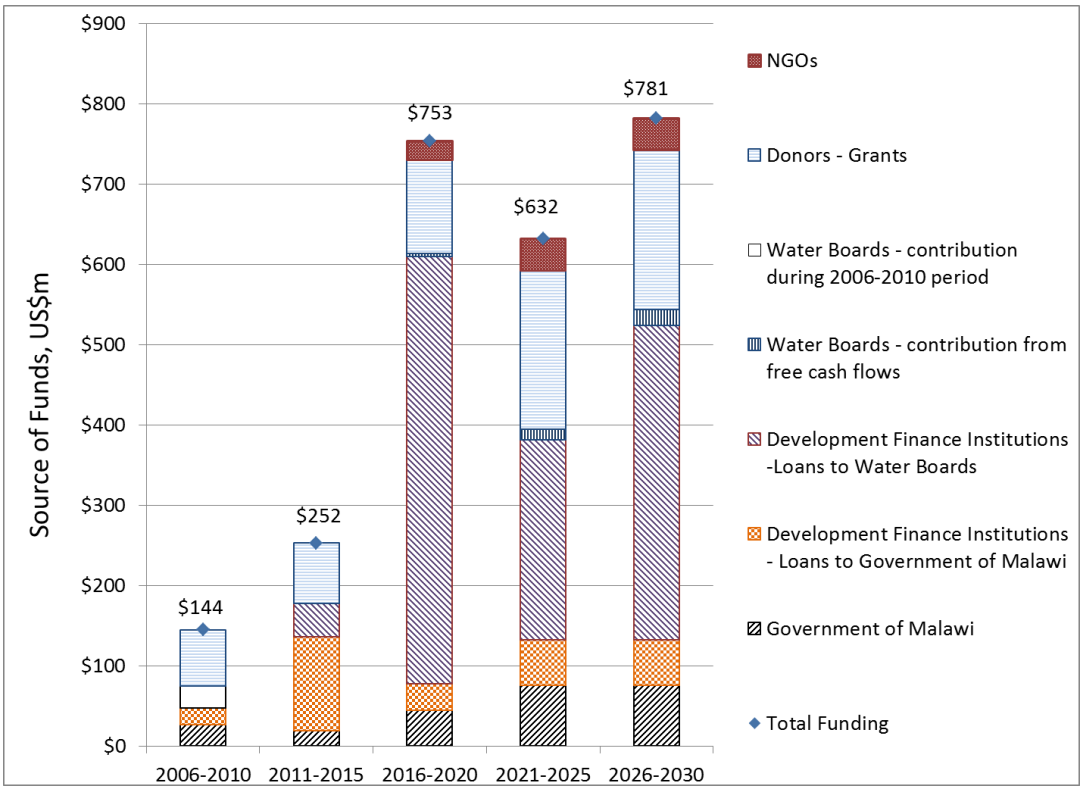
The first condition is that the Water Boards improve their operating, commercial, and financial performance to levels of other well-performing utilities in Africa, and are able to borrow on Development Bank Concessional Finance terms.[37] If these conditions hold, Water Boards will be able to able to finance the entire urban infrastructure investment planned—including the bulk supply projects—on their own balance sheets.

The second condition is that other funders of the sector—in particular the government, donors providing grants, NGOs and development financing institutions lending to Government— step up the levels of funding, on a **per capita basis**. To reach full coverage for water by 2025, and 87 percent for sanitation by 2030 (Scenario 2) these funders will need to provide 40 percent more on a per capita basis than they did over the 2006-2010 period. The alternative Scenario of reaching full coverage for water by 2030 and over 40 percent access to sanitation by 2030 (Scenario 3) requires that funders increase their funding by 15 percent (on a per capita basis) over what they provide over the 2006-2010 period.

If these conditions can be met, the Funding Plan for the Scenario 2 Investment Plan is shown in Figure 4.1. The Funding Plan Scenario 3 is shown in Figure 4.2 on page 55.

[37] The terms of this loan are based on the terms of the NWDP II loan provided by IDA. The loan required payments of 1 percent every six months five years after the closing date and then payments of 2 percent every six months fifteen years after the closing date. Interest is assumed to be paid on the withdrawn amount immediately upon withdrawal of the money.

Figure 4.1: Recommended Funding Plan for Scenario 2 which Reaches Full Coverage for Water by 2025, and 87% Coverage for Sanitation by 2030

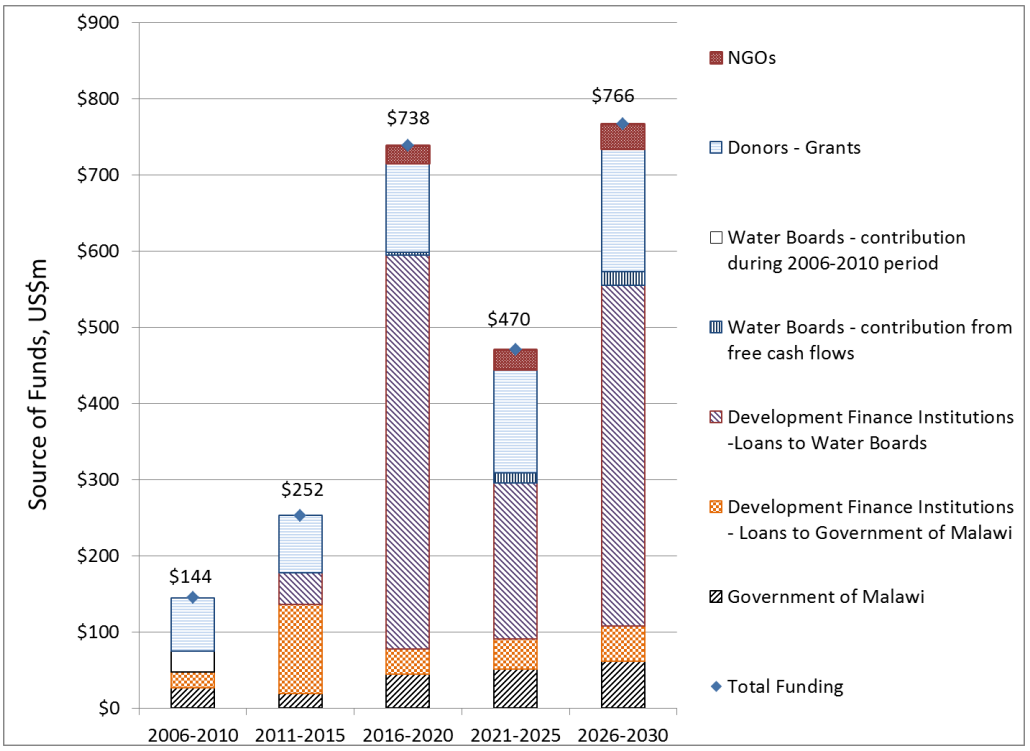


Data Table 4.1: Recommended Funding Plan for Scenario 2 which Reaches Full Coverage for Water by 2025, and 87 percent Coverage for Sanitation by 2030 (US$ millions)

	2006 - 2010	2011-2015	2016-2020	2021-2025	2026-2030	Total (2011-2030)
Total Funding	144	252	753	632	781	2,419
Government of Malawi	*27*	*19*	*44*	*75*	*75*	*214*
NGOs	*n/a*	*n/a*	*23*	*40*	*40*	*103*
Development Finance Institutions - Loans to Government of Malawi	*20*	*116*	*34*	*57*	*57*	*264*
Development Finance Institutions -Loans to Water Boards	*-*	*42*	*532*	*249*	*391*	*1,213*
Water Boards - contribution from free cash flows	*-*	*-*	*4*	*14*	*20*	*37*
Water Boards - contribution during 2006-2010 period	*28*					*-*
Donors - Grants	*70*	*75*	*116*	*198*	*198*	*587*

Source: Castalia calculations.

Figure 4.2: Recommended Funding Plan for Scenario 3 which Reaches Reach Full Coverage for Water by 2030, and over 40 percent Coverage for Sanitation by 2030



Data Table 4.2: Recommended Funding Plan for Scenario 3 which Reaches Full Coverage for Water by 2030, and over 40 percent Coverge for Sanitation by 2030 (US$ millions)

	2006 - 2010	2011-2015	2016-2020	2021-2025	2026-2030	Total (2011-2030)
Total Funding	144	252	738	470	766	2,227
Government of Malawi	*27*	*19*	*44*	*51*	*61*	*176*
NGOs	*n/a*	*n/a*	*23*	*27*	*32*	*82*
Development Finance Institutions - Loans to Government of Malawi	*20*	*116*	*34*	*39*	*46*	*235*
Development Finance Institutions -Loans to Water Boards	*-*	*42*	*517*	*205*	*447*	*1,211*
Water Boards - contribution from free cash flows	*-*	*-*	*4*	*13*	*19*	*36*
Water Boards - contribution during 2006-2010 period	*28*					*-*
Donors - Grants	*70*	*75*	*116*	*135*	*161*	*487*

Source: Castalia Calculations.

4.1 Urban Infrastructure can be Financed by Water Boards

If the Water Boards could progressively improve their performance on non-revenue water and collection rates to the levels achieved by other well-performing Africa utilities, while increasing tariffs by just 1 percent per year in real terms, they would be able to fund the entire urban water infrastructure requirements for reaching full coverage by 2025 or 2030, assuming Development Bank Concessional Finance lending terms continue to be available.

Malawi's Water Boards are currently not financially viable. Collectively, the free cash from operations they generate is negative. Put simply, they are losing money. Key reasons for this poor financial performance are that collection rates are low, and non-revenue water levels are relatively high.

If these two things could be fixed, Water Boards would start to make an operating cash surplus on every liter of water they sell. At that point, growth starts to become self-financing. Investments in new bulk supply and new connections start to generate increased operating cash as a result of increased sales. Castalia analysis shows that if tariffs were to increase in real terms by just 1 percent per annum, and if Development Bank Concessional Finance terms continue to be available, the free cash generated will be enough to finance the entire urban water investment plan, including the bulk supply projects. The biggest requirement is simply to match the performance of other African water utilities on non-revenue water and collections rates.

Table 4.1 shows how Water Boards in Malawi compare to other well-performing African water utilities on the key indicators of non-revenue water, collections rates, and tariffs. To provide context, GDP per capita for each country is also reported.

Table 4.1: Targets for Water Boards Compared to Regional Peers

	Niger (SEEN)	Gabon (SEEG)	Senegal (SDE)	Uganda (NWSC)	Target for Malawi's Water Boards for 2030
Targets and peer group indicators					
NRW	18%	20%	17%	33%	20%
Collection rate	92%	N/A	99%	100%	95%
Tariff	$0.47	$0.35	N/A	$0.90	$0.86
Incomes for peer group countries and Malawi					
GDP per capita (PPP), 2010	$728	$15,183	$1,933	$1,272	$872

Source: National Water and Sewage Corporation, Annual Report 2009-2010 for figures on NWSC, figures for SEEN, SEEG and SDE from the Water Operators Partnerships-Africa Utility Performance Assessment Final Report June 2009, and GDP per capita figures from the World Development Indicators 2010.

There is no fundamental reason why Water Boards in Malawi should not be able to achieve the operational, commercial, and financial performance reached by utilities in Uganda, Gabon, Niger, and Senegal. If Malawi's water utilities could achieve 20 percent non-revenue water on average by 2030, they would still have worse NRW levels than in Niger, a poorer country.

Reducing NRW to 20 percent at Malawi's Water Boards will largely result from organizational changes in the Water Boards. Skills and knowledge of the staff needs to be improved and the whole organization (from management down) needs to focus on activities related to reducing NRW. These organizational changes will not be simple and will take strong local leadership and time to make it sustainable. Upfront investments are also required and these can be substantial. It is estimated that at minimum, a few million dollars will be needed for the sector as a whole to reduce NRW to 20 percent. However, in the context of a need to invest more than a billion dollars over the next seventeen years the investment required to reduce NRW is relatively insignificant.

If the Water Boards could increase collections to 95 percent, they would be below the levels achieved in Senegal and Uganda already. Box 4.1 describes the potential for prepaid meters to improve the Water Boards' performance. A 1 percent real tariff increase per annum would push the tariff up to US$0.86 per cubic meters in 2030—lower than the average tariff in Uganda now.

Box 4.1: Would Prepaid Meters Work in Urban Areas in Malawi?

As discussed in greater detail in Appendix E, prepaid water meters can dramatically increase collections, improve water demand management, and decrease the costs of manual meter readings and billing. Prepaid meters have been implemented in water utilities in Uganda, South Africa, and Kenya. The experience from these countries suggests that prepaid water meters are most successful for (a) connections with greater water demand, (b) systems with improved quality of service, and (c) areas with poor payments and community operated connections.

Higher return on investment for connections with greater water demand

A prepaid meter for a kiosk costs at least US$300 and for a household it costs upwards of US$150. This investment is largely paid for by improved collections from customers paying upfront for the water they consume. The return from prepaid water meters is greater for customers such as kiosks and households with higher levels of water consumption (more than 100 liters per capita per day). The return on investment from installing a prepaid meter at a kiosk is 258 percent and may be in the order of 20 percent for households consuming around 100 liters per day. For households that consume closer to the estimated average in urban Malawi (about 66 liters per capita per day), the increase in collections is lower, and has a lower return on investment. For instance, for a Malawi household that consumes the average 66 liters per capita per day, the return on investment is 12 percent. It follows that, returns increase in relation to decreasing price of prepaid meters, the amount of water demanded and the proportion of uncollected bills. As discussed in the Appendix, the cost of prepaid meters varies greatly, and the financial viability of the investment should be determined on a case by case basis.

Improved quality service

To successfully implement prepaid water meters Water Boards should ensure that customers using this technology actually receive service they paid for. Water Boards need to check that the meters are working properly. At times, particularly in systems with intermittent supply, air enters the system and the meter registers the air as water being consumed (this happens with conventional meters too). Water Boards may consider investing first in improving continuity of service.

African water utilities use them in areas with poor payments and community operated connections

This technology was used in Uganda and Kenya for informal settlements where access to water, and quality of service, was poor. In these communities one person would charge—rates even higher than the tariff—for using the kiosk connection, and collections were rarely handed over to the utility. So, customers with a lower ability to pay were charged higher costs for low quality water service, and the utility would not even receive collections from providing service. When prepaid meters were introduced, access to water increased at more affordable prices, and the water utilities received close to 100 percent of collections because users had to pay upfront.

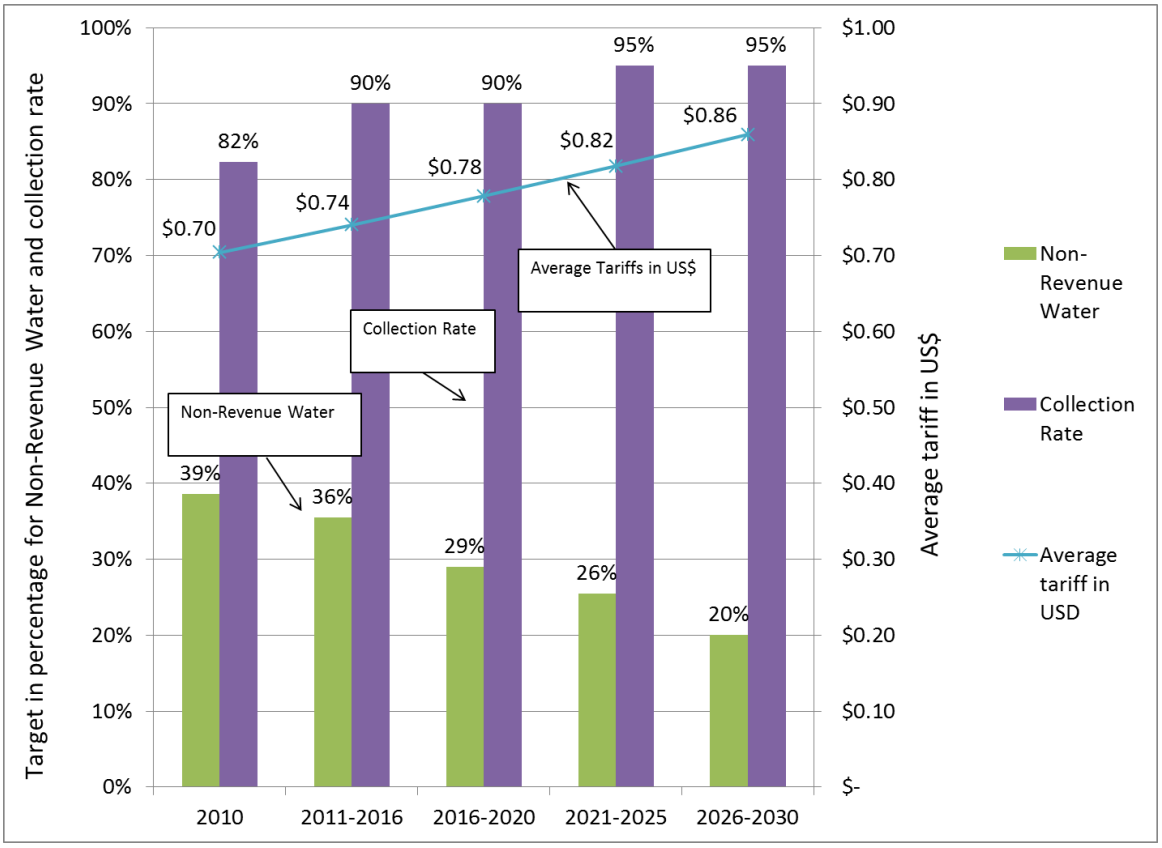
Should Water Boards invest in prepaid meters?

Additional costs from implementing new management systems, and replacing infrastructure, may apply when installing these meters. Water Boards should take into account the conditions needed for the technology to succeed in reducing costs and increasing financial returns. Investments in improving water supply system may be needed before investing in prepaid meters, to maximize their chances of success. A suitable system is needed for selling prepaid cards or selling credits through mobile phones. Lastly, prepaid meters have resulted in radically improved collections where installed; but it is important to consider the price consumers pay for their water. For example, customers with lower ability to pay could be offered a water allowance, or a subsidized cost of water, to prevent them from turning to unimproved sources or illegally connecting to the system. Even where it makes financial sense to invest in prepaid meters, external conditions should be factored in to ensure the success of this technology.

Source: Refer to Appendix E for sources, technology background, case studies, explanation of costs, and a financial analysis.

Of course, such improvements take time and institutional change. Figure 4.3 indicates the rate of improvement we project to be feasible in Malawi.

Figure 4.3: Projected Improvements in Water Board Performance



Data Table 4.3: Projected Improvements in Water Board Performance

	2010	2011-2016	2016-2020	2021-2025	2026-2030
Non-Revenue Water	39%	36%	29%	26%	20%
Collection Rate	82%	90%	90%	95%	95%
Average tariff in US$	$0.70	$0.74	$0.78	$0.82	$0.86

…which would generate significant free cash from operations.

If Water Boards were able to improve as suggested in Figure 4.3, they would quickly start to generate substantial amounts of cash. Figure 4.4 shows the total free cash from operations that Water Boards could generate if they hit the performance targets, and increased sales of water at the rate that would be made possible by the Investment Plan that achieves full coverage for water by 2025. The operating cash flow is shown as the dashed blue line.

Figure 4.4: Water Board's Operating Cash Flow Potential vs. Debt Service for Scenario 2 which reaches full Coverage to Water by 2025

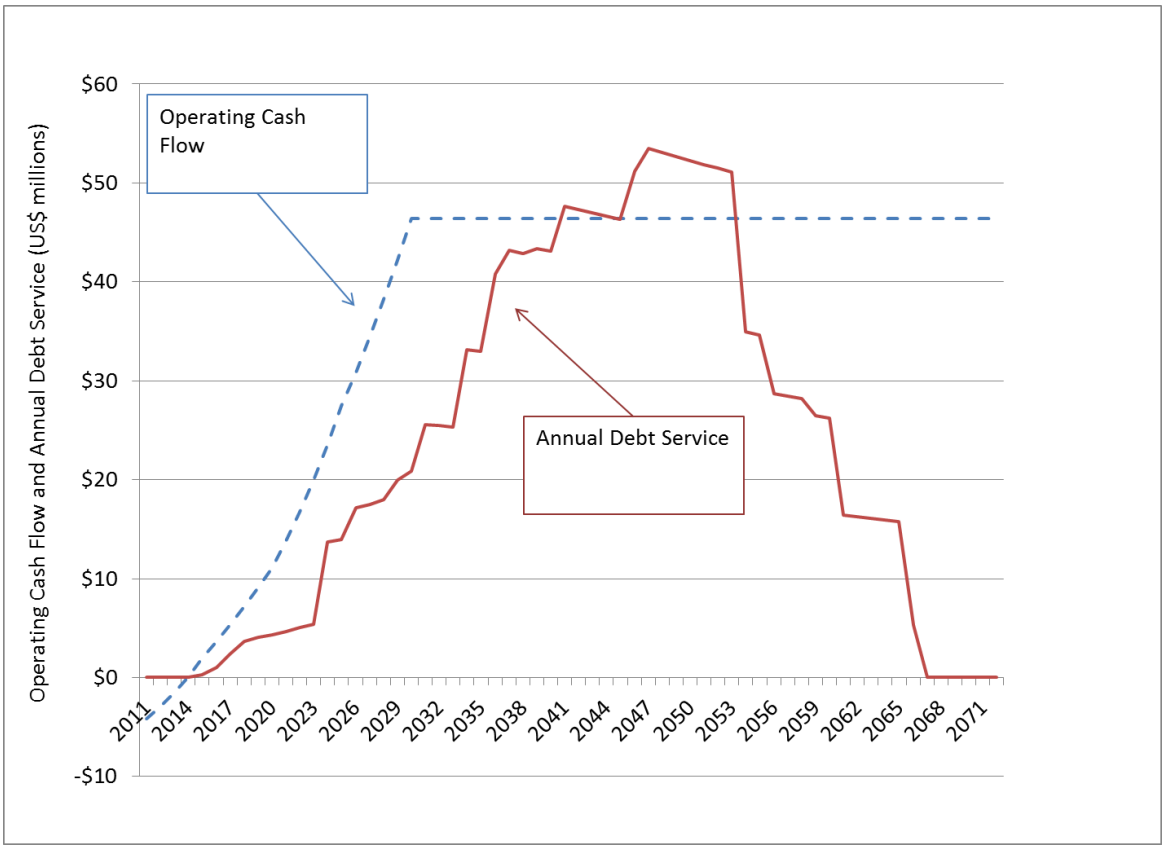


Figure 4.4 also shows the total debt service payments that would be required if all the urban water infrastructure in the Investment Plan were to be financed on Development Bank Concessional Finance terms. Annual debt service payments are shown as the red line. They were calculated on the assumptions that the Water Boards are able to borrow at an interest rate of 0.75 percent, and are able to pay off the loan over 35 years after the closing date with a five-year grace period after the closing date.[38]

As the graphic makes clear, cash from operations exceeds the debt service in every year of the plan up to 2041 for the Investment Plan to achieve full coverage for water by 2025. The same result holds for the Investment Plan to achieve full coverage for water by 2030.

The difference between reaching full coverage by 2025 and 2030 is that when full coverage is reached in 2030 the Water Boards' operating cash flow covers the debt burden slightly more comfortably because investments on distribution in urban areas are delayed.

Although the graphic suggests that starting in 2041 Water Boards might be unable to service the loans, this is simply because modeling of Water Board performance stopped from 2030 onward. In reality, the free cash generated between 2030 and 2041 would be ample to allow

[38] The terms of this loan are based on the terms of the NWDP II loan provided by IDA. The loan required payments of 1 percent every six months five years after the closing date and then payments of 2 percent every six months fifteen years after the closing date. Interest is assumed to be paid on the withdrawn amount immediately upon withdrawal of the money.

the Water Boards to service their debts throughout the period, so long as it was invested in revenue-producing assets (such as additional urban water infrastructure), and tariffs and operating performance were sustained.

4.2 Rural Infrastructure and Sanitation can be Funded by Government with Support from Donors

Government and donors should concentrate on the non-revenue generating parts of the Investment Plan—rural water, and both urban and rural sanitation—once urban water investment can be financed using Water Board cash flows. The Funding Plan shown in Figure 4.1 and Figure 4.2 showed the funding in total dollar-terms needed by the Investment Plan in these areas.

Total funding from Government, donors, and development finance institutions lending to Government, needs to increase. By 2026-2030, these entities need to be contributing at a level more than two times higher in real terms than they were in 2006-2010. The Funding Plan for both Investment Plans assumes that their shares remain in the same proportion to each other as they were in 2006-2010, so that all increase in real terms by the same amount over the period.

While this increase seems large, the reality is that the per capita funding from these agencies to the sector will be comparable to the funding levels over the 2006-2010 period:

- The funding needed on per capita basis for the Scenario 2 Investment Plan (to reach full coverage for water by 2025 and 87 percent access to sanitation by 2030 is shown in Figure 4.1. Funding for this investment plan needs to increase by more than 40 percent on a per capita basis
- The funding needed for the Scenario 3 Investment Plan to reach full coverage for water by 2030 and more than 40 percent access to sanitation by 2030 is shown in Figure 4.2. This scaled back investment plan needs funding on a per capita basis to increase by around 15 percent.

Looking at funding on a per capita basis makes sense, since government tax revenues should rise in-line with population growth, so it is per capita numbers that matter for considerations of fiscal sustainability. Donors providing grants are, we assume, willing to match either population increases or government funding increases also. In light of this, the 40 percent increase in funding on a per capita basis needed for the investment plan to reach full coverage for water by 2025 does appears possible, but would require an assertive push to raise funds at a faster rate than they would tend to increase otherwise.

The Scenario 3 Investment Plan to achieve full coverage by 2030 and more than 40 percent access to sanitation by 2030 would also require an increase but a more modest increase of 15 percent which would be easier to achieve.

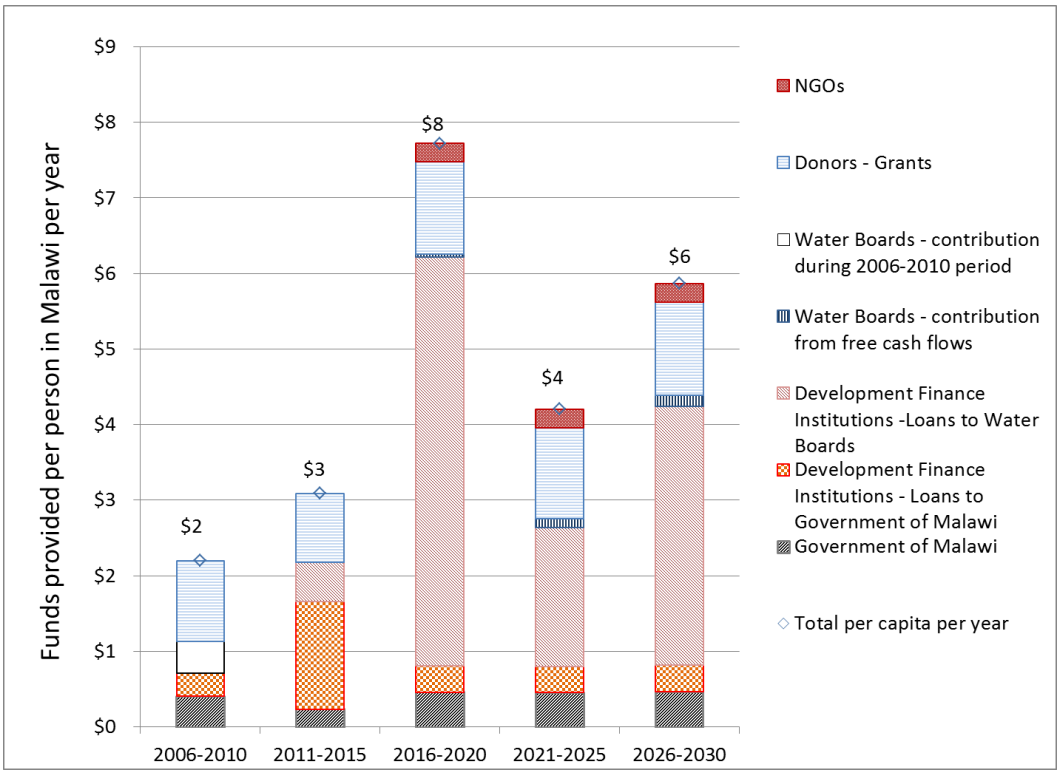
Thus, with Water Boards shouldering the burden of urban water infrastructure, Government and donors should be able to increase their funding to sanitation and rural water providing funds that on a per capita basis are comparable to those provided over the 2006-2010 period .

Figure 4.5: Funding Required on a Per Capita Basis for Scenario 2 which Reaches Full Coverage by 2025 and 87 percent Access to Sanitation by 2030

Data table 4.5: Funding Required on a Per Capita Basis for Scenario 2 which Reaches Full Coverage by 2025 and 87 percent Access to Sanitation by 2030

	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	Average (2016-2030)
Funding per capita per year						
Total per capita per year	$2.20	$3.10	$7.88	$5.65	$5.99	$4.88
Government of Malawi	$0.41	$0.24	$0.46	$0.67	$0.58	$0.43
NGOs			$0.24	$0.35	$0.30	$0.23
Development Finance Institutions - Loans to Government of Malawi	$0.31	$1.43	$0.35	$0.51	$0.44	$0.32
Development Finance Institutions -Loans to Water Boards	$0.00	$0.52	$5.56	$2.22	$3.00	$2.70
Water Boards - contribution from free cash flows	$0.00	$0.00	$0.04	$0.12	$0.15	$0.08
Water Boards - contribution during 2006-2010 period	$0.42					
Donors - Grants	$1.07	$0.92	$1.22	$1.77	$1.52	$1.13
Population						
Total Population in Malawi (millions)	13	16	19	22	26	21

Figure 4.6: Funding Required on a Per Capita Basis for Scenario 3 which Reaches Full Coverage by 2030 and more than 40 percent Access to Sanitation by 2030



Data table 4.6: Funding Required on a Per Capita Basis for Scenario 3 which Reaches Full Coverage by 2030 and more than 40 percent Access to Sanitation by 2030

	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	Average (2016-2030)
Funding per capita per year						
Total per capita per year	$2.20	$3.10	$7.72	$4.21	$5.87	$4.45
Government of Malawi	$0.41	$0.24	$0.46	$0.46	$0.47	$0.35
NGOs			$ 0.24	$ 0.24	$0.25	$ 0.18
Development Finance Institutions - Loans to Government of Malawi	$0.31	$1.43	$0.35	$0.35	$0.35	$0.26
Development Finance Institutions -Loans to Water Boards	$0.00	$0.52	$5.41	$1.83	$3.42	$2.67
Water Boards - contribution from free cash flows	$0.00	$0.00	$0.04	$0.12	$0.14	$0.08
Water Boards - contribution during 2006-2010 period	$0.42					
Donors - Grants	$1.07	$0.92	$1.22	$1.21	$1.23	$0.91
Population						
Total Population in Malawi (millions)	13	16	19	22	26	21

5 Institutional Changes Needed to Deliver the Investment Plan

The previous sections have shown that an ambitious water and sanitation Investment Plan is feasible and financeable; delivering it will nevertheless be challenging. Institutional changes will be needed to convince donors and development finance agencies to back Malawi with bigger grants and loans. The ability to plan, prioritize, and execute significant capital projects and programs will need to be upgraded. Sustainability of service delivery—both technical and financial—will need to increase if the vast expenditures are to be translated into real benefits to people for years to come. In light of the importance of these institutional changes the recommended Investment Plans allocate 5 percent of expenditure to capacity building to support and sustain the institutional changes needed.

Government policy is that water supply and sanitation responsibilities should be devolved to autonomous agencies below the level of national Government. In Water Board Service Areas, Water Boards are intended to be capable, autonomous suppliers of water and sanitation services. They are intended to manage the operation and expansion of the urban infrastructure, and to be financially self-sufficient.[39] In the areas not served by Water Boards, water supply and sanitation is the responsibility of District Councils. While many District Councils have not in practice shouldered this responsibility in the past, the Government fully intends that they should do so in the future.[40]

Implementing the decentralization policy, while rising to the challenges of financing and executing the Investment Plan, will require institutional change in three key areas:

- **Water Boards** will need to reach the operational, commercial, and performance levels of other well performing African utilities. Their abilities to plan and execute very large capital works will also need to be further developed
- **District Councils** will need to develop the skills needed to identify necessary projects and apply for funding. Procurement, financial management, and operation and maintenance of the resulting infrastructure will also need to be improved, in ways which are consistent with the policy of decentralization
- **Water User Associations (WUAs)** will need to operate effectively, which requires extensive capacity building
- **The Ministry responsible for Water Supply and Sanitation** (the Ministry) will need to develop a unified capacity in appraising funding applications, and overseeing financial management and delivery by Water Boards and District Councils. It will also need to strengthen its monitoring and evaluation capacities.

Each of these three key areas of reform is elaborated on below.

[39] The Water Policy provides that Water Utilities should: "9.3.1 Operate and manage waterworks for the delivery, distribution and management of potable water supply"; and "9.3.5 Implement investment programmes, tariffs and compensations related to the development and management of water supply and water borne sanitation facilities and services;" among other things.

[40] The Water Policy provides that Local Governments should "9.4.1 Plan and co-ordinate the implementation of water and sanitation programmes at local assembly level", among other things.

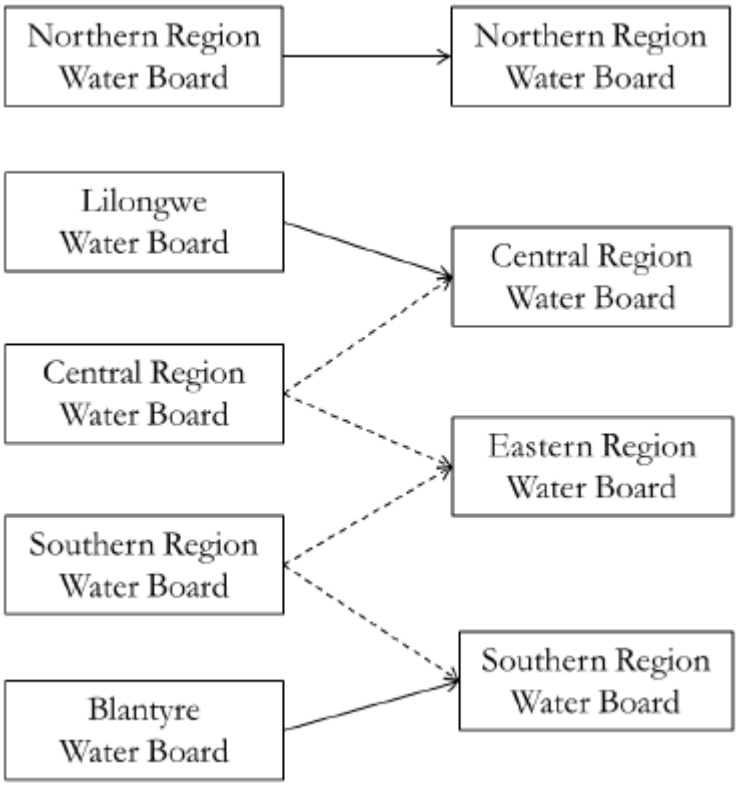
5.1 Water Boards

For the Investment Plan to work, Water Boards need to be able to do three main things:

- Reduce non-revenue water supply to target levels, so that the new bulk water supply serves the projected population growth, and does not leak away
- Improve operating financial performance. This will follow in part from reduced non-revenue water supply, but more importantly from more complete collection of bills, and gradual real tariff increases
- Manage the execution of large and complex capital projects.

At the same time, Government policy is to turn the current five Water Boards into four, as illustrated in Figure 5.1. This amalgamation will increase institutional demands on the system, but may also provide a window to make other changes which can achieve the three objectives above.

Figure 5.1: Proposed Amalgamation of Water Boards



A comprehensive plan of institutional change in the Water Boards is needed to achieve the desired objectives.[41] Many options are possible, and Malawi will have to design one which suits its particular needs and circumstances. Inspiration can be drawn, however, from success elsewhere. Options which may be considered include:

[41] This would be consistent with the Water Policy, which stipulates "6.1.2.8 Strengthening and supporting Water Utilities through establishment of effective institutional and governance arrangements, and major infrastructure developments".

- Building on the successes of the advisory contracts with Vitens, which have already helped Blantrye and Lilongwe Water Boards to reduce non-revenue water rapidly and at low cost
- Provide managers with strong performance incentives, Box 5.1describes Uganda's experience
- Introduce benchmarking between the Water Boards, for instance by upgrading the Water Supply Services Association of Malawi (WASAM), including the establishment of a secretariat to facilitate the collection of data. Benchmarking has been successfully implemented in a number of countries including the Netherlands, Colombia and Uganda (as described in Box 5.1 for Uganda)
- Outsourcing NRW reduction, and billing and collection, to specialist firms under performance-based contracts
- Contracting a specialist private firm for utility operations, and building a strong public sector asset holding and financing company to manage the Investment Plan, as Senegal has done
- Contracting a specialist water company to take on responsibility for the provision of services and the delivery of new infrastructure, as has been done in Gabon and Niger.

It is too early to say which option is right for Malawi. But it is not too early to ask the questions. A useful approach for coming up with the right way forward for Malawi's water sector is for representatives of Malawi's Water and Sanitation Sector to engage with experiences elsewhere. This can be done by going on study tours, hiring advisors, or a combination of these. The engagement with the experiences elsewhere and applying the lessons to Malawi should lead to a credible plan to strengthen Water Board performance that will raise the finance for the urban component of the Investment Plan.

Box 5.1: Reform of Water Utilities——the Ugandan experience

From 1998 to 2008 Uganda's water utility, the National Water and Sewage Corporation (NWSC), was successfully turned around. The NWSC went from being a poorly performing publicly owned utility into one of the best performing water utilities in Africa. The NWSC was able to reduce NRW from 51 percent to 36 percent and increase the number of water connections from 50 thousand to 200 thousand. It did this while reducing the number of employees from 1,850 to 1,423[42] and going from losing money to positive net income. A number of reforms where integral to this success. These include performance payments, effective Monitoring and Evaluation systems and Benchmarking.

Performance payments: the NWSC provided the managers in charge of its regional branches strong incentives to improve performance. At first, this was done through Area Performance Contracts (APCs) with managers of its regional branches. "APCs were basically one-year performance agreements with local management teams, with bonuses and penalties (of up to 25 percent of basic salary) based on targets. Local managers were given more authority to make operational decisions and also made accountable for outcomes."[43] The second generation of the scheme where called Internally Delegated Area Management Contracts (IDAMC). In these schemes the regional branches were transformed into quasi-private, ring-fenced, business units. The NWSC entered into private law contracts with them. The remuneration received by the partnerships running the regional branches was based on the divisions' operating cash flows. In turn the operating cash flows depended on the performance of five key indicators: cash operating margin, nonrevenue water, working ratio, bill collection, and the percentage of inactive connections.

Effective Monitoring and Evaluation: for payments to be linked to performance the NWSC had to implement an effective Monitoring and Evaluation (M&E) to measure the performance of the regional branches. They also implemented a system of random audits to ensure that the regional branches were not inaccurately reporting results.

Benchmarking: the NWSC implemented a system of benchmarking to measure the performance of the regional divisions against each other. The lessons that could be learnt from the high performers were shared through quarterly workshops attended by representatives from the regional branches.

Source: William Muhairwe, 2009 "Making public enterprises work, from despair to promise: a turnaround account" IWA Publishing, London United Kingdom

5.2 District Councils

Government policy is to devolve responsibility for local service provision—including water and sanitation—to District Councils[44]. This creates a difficult challenge, as many District Councils currently lack capacity in this area. Capacity to plan, implement and maintain projects will need to be built at District level. The Ministry will need to continue to fund the infrastructure, and to supervise performance of the Councils. The way forward probably contains three parts, as suggested below.

[42] Page 227, William Muhairwe, 2009 "Making public enterprises work, from despair to promise: a turnaround account" IWA Publishing, London United Kingdom.

[43] Philippe Marin, William Muhairwe, Silver Mugisha, and Josses Mugabi, 2002 "Internal delegation contracts for water in Uganda, An innovative approach to establishing a successful public utility" GridLines, Note Number 55 – June 2010.

[44] National Decentralization Policy, in particular clauses 6(a) concerning development of infrastructure and district plans, clause 2(d) concerning environmental sanitation, 3(c) concerning sewage removal and disposal, and 15, which deals with water services. The Water Policy states at clause 9.4.1 that local governments should plan and co-ordinate the implementation of water and sanitation programmes at local assembly level; and clause 6.2.1.7 which aims "To ensure smooth transfer of all devolved functions of the rural water supply and sanitation services;".

Strengthening District Councils

The Ministry should build on its success so far in helping Councils to prepare District Plans. The capacity to plan needs to be deepened, so that in time plans can be more comprehensive, identify particular projects, and demonstrate the technical and economic feasibility of the proposed projects. It also needs to be widened, so that all Districts gain an adequate level of capacity.

To this ability to plan will need to be added the capacity to procure the execution of projects, to manage the funds that will pay for those projects, and to supervise the contractors. Thought will need to be given to whether it is best for these responsibilities to be fully developed at the District Level, or whether some of these responsibilities should be "delegated upward" by Councils to the Ministry, or to a regional entity that could perform these functions for a number of Districts.

District Councils will need to boost the skills in discovering what services communities most want, and how communities can best be involved in making those services sustainable, either by operating them, or by paying for a third party to operate them.

Allocating funding and supervising performance

District Councils do not have a revenue base sufficient to allow them to fund the rural components of the Investment Plan. This includes the cost of investment and the funds they need to contribute to the Operations and Maintenance of these facilities. For the foreseeable future, the Government and donors will provide the bulk of the funding.

The Government will therefore need criteria on which to allocate the funding. In doing this it should consider the factors enumerated in clause 10(4) of the Decentralization Policy, which include population size, level of development (using agreed poverty indicators), responsiveness and equalization. Guiding principles for funding allocation, consistent with these concepts, could be:

- The number of people lacking access to improved water and sanitation in the district
- The need for Districts to have sensible plans for how to spend the money allocated
- The past performance of the District in following good practices in procurement, financial managements, maintenance and operations, so as to ensure value for money in project delivery, and sustainable provision of the service.

Strengthening coordination between key stakeholders

Increased investment through the District Councils will require improved coordination between the Ministry, District Councils, donors, and NGOs. The absence of coordination between these actors has lead investments to be made in Districts without the Districts knowledge. Similarly, investments levels by donors in Districts are set without consultation with the District Councils. This leads to investments that are not aligned with the District Councils' own priorities and in some cases, lead to investments in areas that don't need additional water supply infrastructure.

5.3 Water User Associations

It is important for the success of the Investment Plan that investments in rural water supply are sustainable. Otherwise, the rural water supply schemes built with the investments will fail as the scheme is not effectively operated and maintained. To ensure that investments are sustainable Malawi has adopted a community-managed approach to maintaining and operating rural water supply systems. This approach has been successful at operating and maintaining rural water supply systems in a number of developing countries.[45] This approach has had success in Malawi with the Ministry responsible for Water and Sanitation successfully facilitating the successful implementation of community management in a number of districts in Malawi.

Community management is implemented in Malawi through the appointment of Water User Associations (WUA). The WUAs collect payment from users, organize routine operation and maintenance of the water system and appoint a contractor for the more substantial maintenance of the system. In order for WUAs to do this effectively, they need capacity building. The type of assistance they need includes training on how to set up and register the WUA structure, training on the management of the WUA's finances, and assistance with the appointment of contractors. Ensuring that WUAs receive support in these areas will be crucial to ensuring the sustainability of rural water supply systems. An important use of the funds allocated to capacity building, will be ensuring that WUAs receive the capacity building they need.

5.4 Ministry Responsible for Water Supply and Sanitation

In the water supply and sanitation sector, the MoAIWD needs to evolve away from project execution, toward a focus on:

- Policy development
- Sector and cross-jurisdictional planning and coordination
- Efficient allocation of capital between Districts and Water Boards
- Supervision of District Councils and Water Boards.

The need to move in this direction comes from government policies in several areas. The policy on decentralization requires that rural water projects and services be the responsibility of District Councils. Water Boards should be responsible for services and project delivery in urban areas. At the same time, the decision to end the use of special Project Implementation Units will require the mainstreaming of the project and funding management. The Water Policy at Clause 9.1 sets out the Ministry's role as focused on policy, regulation, and multi-purpose infrastructure.

The MoAIWD has developed a strong Project Management Unit (PMU) that has managed the NWDP. An unintended side-effect of the strength and importance of the PMU may have been to defer the building of capacity in other areas. Donors have worked with the relatively strong Ministry PMU, rather than build capacity in the relatively weak District

[45] Dale Whittington, Jennifer Davis, Linda Prokopy, Kristin Komives, Richard Thorsten, Heather Lukacs, Alexander Bakalian, Wendy Wakeman, 2008 "How well is the demand-driven, community management model for rural water supply systems doing? Evidence from Bolivia, Peru, and Ghana" January 2008 BWPI Working Paper.

Councils. The importance of the PMU in delivering funding, and the completion of vital projects, has made it a key point of contact for Water Boards, District Councils, donors, and development finance institutions. The challenge now is to preserve the competence, relationships and knowledge the PMU has built up, while mainstreaming it into operation of the Ministry proper.

A way forward may lie in re-engineering the PMU and the Planning Unit into a unified 'Financing and Supervision' group. This group's functions could include:

- Owning and refreshing the Investment Plan for the sector (of which this report provides the first version)
- Managing relationships with donors and development finance institutions to maximize the international funding available to the sector, and the concessionality of the financing terms
- Developing criteria for the allocation of public capital among Water Boards and District Councils
- Receiving and approving funding applications from Water Boards and District Councils
- Setting standard and monitoring the performance of Water Boards and District Councils[46]
- Intervening to strengthen performance where necessary
- Promoting inter-jurisdictional planning, especially in bulk supply and in rolling out programs and best practice in rural water and sanitation across District boundaries
- Reviewing the boundaries of Water Boards, to ensure that areas that are best served commercially-oriented utilities using piped supply are put under Water Board jurisdiction.

At the same time, in-line with the Water Policy[47] the Ministry responsible for water needs to set policies for the sector, and also to regulate tariffs. In the context of funding the Investment Plan this will include leading the development of policies to bring Water Boards up to the levels of other well performing African water utilities, and also creating a regime in which the recommended one percent per annum real tariff increases are sanctioned.

[46] Consistent with the Water Policy, which mandates as a specific strategy "6.2.2.12 Developing and disseminating standards and guidelines for rural water supply and sanitation in liaison with Local Government".

[47] National Water Policy (2005).

6 Conclusion

This report has presented an Investment Program for the Water Supply and Sanitation sector in Malawi. In doing this the report has discussed four main issues: (a) planned investment expenditure in the sector (the Investment Plan); (b) it has proposed projects for funding (the Project Plan); (c) it has described where the funding should come for the envisaged investment expenditures (the Funding Plan), and; (d) the report has described a number of institutional aspects that should be considered:

- **Investment Plan**—It is proposed that more than US$2 billion is spent in the sector. These proposed investment expenditures would eliminate the backlog in schools with access to improved sanitation and water, it would achieve full access to improved water by 2030 and generate large scale increases in access to improved sanitation in urban and rural areas
- **Project Plan**—A number of projects in the sector require funding to go ahead. This includes the mega projects and a number of projects to increase the supply of water and sanitation to households and ensure that schools have adequate facilities for sanitation and hygiene
- **Funding Plan**—The Funding Plan describes how the Investment Plan would be funded. The plan would be funded from donors, lending by International Finance Institutions and the Government of Malawi. It is shown that with improvements in the efficiency of their operations the Water Boards would be able to finance the envisaged investment expenditures in urban areas, including the investments needed in the mega projects in bulk water
- **Institutional considerations**—A number of institutional changes that are needed for the Investment Plan are described. They are to bring Urban Water Boards up to the required levels of performance, build capacity in District Councils to plan and implement projects and reconfigure the Ministry responsible for Water Supply and Sanitation into a funding, coordination and supervision body.

Appendix A. Benefit Cost Analysis of the Water Sector

This section describes the tremendous social value that is created by investing in improved sanitation and water supply in Malawi. Public expenditure extending access to water and sanitation in schools and households generates benefits that are three to twenty times the cost. These findings for Malawi reinforce findings on regional level from the World Health Organization (WHO) and WSP. The WHO states that "US$1 invested would give an economic return of between US$3 and US$34." This section begins by describing the health benefits from access to improved Water, Sanitation, and Hygiene (WSH). The discussion then reviews the benefits and costs of extending access to improved water supply to households, improved sanitation to households and facilities needed for adequate sanitation and hygiene in schools.

A.1 Benefits of Improved Health from Access to Water, Sanitation, and Hygiene

Poor access to improved Water, Sanitation and Hygiene (WSH) leads to a range of waterborne diseases. These WSH related illnesses are a serious problem in Malawi. The WHO attributes more than 20,000 deaths per year to poor access to WSH and 25 million episodes of illness.[48] The effects of WSH related illness are felt throughout the population, harming the growth of children, keeping students from school and adults from work:

- **Children are particularly vulnerable.** Deaths from WSH related illnesses are concentrated in the very young, 90 percent of those who die from diarrheal diseases are below the age of 5.[49] In addition, diarrheal disease leads to malnutrition which harms children's growth. In 2010, more than 30 percent of children in Malawi from the age of 6 to 23 months had suffered from diarrhea in the two weeks preceding the survey, with more than 3 percent having blood in their stool.[50] This diarrhea leads to malnutrition which leads to growth retardation, including stunting and wasting. This is a serious problem in Malawi, where 48 to 53 percent of children under the age of 5 are stunted.[51]
- **Students' learning is harmed**. In total, across Malawi, children of school age experience more than a million episodes of illness from diarrhea per year, many of which lead to time away from school. It has been shown that students infected with intestinal worms, transmitted due to poor access to WSH, are 23 percent more likely to drop out of school, and once they are of working age, children who

[48] WHO, 2010 "Estimated deaths attributable to water, sanitation and hygiene ('000), by disease and WHO Member State, 2004" http://www.who.int/quantifying_ehimpacts/publications/wshdeaths2004_annex.pdf.

[49] These figures are from a model developed by the WHO and calibrated to Malawi for this project. The model is similar to the work by Prüss, A., Kay, D., Fewtrell, L., and Bartram, J. Estimating the global burden of disease from water, sanitation, and hygiene at the global level. Environmental Health Perspectives, 2002. 110(5): p. 537-542.

[50] NSO, 2010 "Malawi Demographic and Health Survey 2010" September 2011, http://www.nso.malawi.net/images/stories/data_on_line/demography/MDHS2010/MDHS2010%20report.pdf.

[51] Ariana Weisz, Gus Meuli, Chrissie Thakwalakwa, Indi Trehan1, Kenneth Maleta and Mark Manary, 2011 "The duration of diarrhea and fever is associated with growth faltering in rural Malawian children aged 6-18 months" *Nutrition Journal* 2011.

have experienced intestinal worms have earnings 40 percent lower than those who did not[52]

- **Adults are taken away from work and childcare** by illnesses caused by WSH related illnesses. In Malawi adults experience more than three million episodes of illness. Many of these are relatively mild, lasting less than a day, but more than 10 percent of episodes are serious enough to last more than five days. A substantial percentage of these serious episodes require admittance to hospital. The days of work lost in Malawi to these illnesses, are equivalent to the work done annually by more than 10,000 people.

The cost of treating those with WSH related illnesses is relatively high, for those who receive treatment. According to WHO estimates it costs the public sector more than a dollar for reach outpatient treated and for serious cases, that require inpatient treatment, the cost is more than five dollars.[53] Treating those with WSH related illnesses is estimated to cost the government healthcare system just less than US$3 million per year.[54] This does not include the likely substantial out of pocket expenditures by those suffering from these illnesses and the time spent by those looking after the ill.

A.2 Household Access to Improved Water

The benefits from extending access to improved water supplies include the health benefits described above as well as less time spent fetching, collecting, and carrying water. A quarter of households in urban areas, and close to a half of households in rural areas, spent more than 30 minutes a day collecting water. This is a task that largely falls on women and girls who are responsible for collecting water in 80 percent of households.[55] This has important implications for women's ability to work and girls' ability to attend school.[56] In light of the significant time spent collecting water in Malawi, the Water Resource Investment Strategy suggests that households save two hours a day collecting water when they gain access to an improved water source[57]. In effect, this means that each household that receives access to an improved water source frees up three months of every year for one member of the household to spend looking after children or working.

Figure A.1: shows the benefits per person of receiving access to improved water in urban and rural areas. The benefits of access to improved water arise from saving lives, reducing time off work from illness; time saved collecting water and savings to the public health

52 The study was conducted in Tanzania, Sarah Baird, Joan Hamory Hicks, Michael Kremer, and Edward Miguel, 2011 "Worms at Work: Long-run Impacts of Child Health Gains" http://www.povertyactionlab.org/publication/worms-work-long-run-impacts-child-health-gains.

53 These results are from results of a economic model disseminated by WHO which has been calibrated for Malawi for this project, the model is called "WHO-CHOICE unit cost estimates of the costs of healthcare delivery."

54 The number of patients visiting clinics and hospitals for diarrhea comes from the Malawi Governemnt, 1998, "Malawi National Health Accounts (NHA), A Broader Perspective of the Malawian Health Sector, Sources of Finance in the Health Sector, 1998/9 Financial Year" http://www.who.int/nha/country/Malawi_NHA_1998_99.pdf.

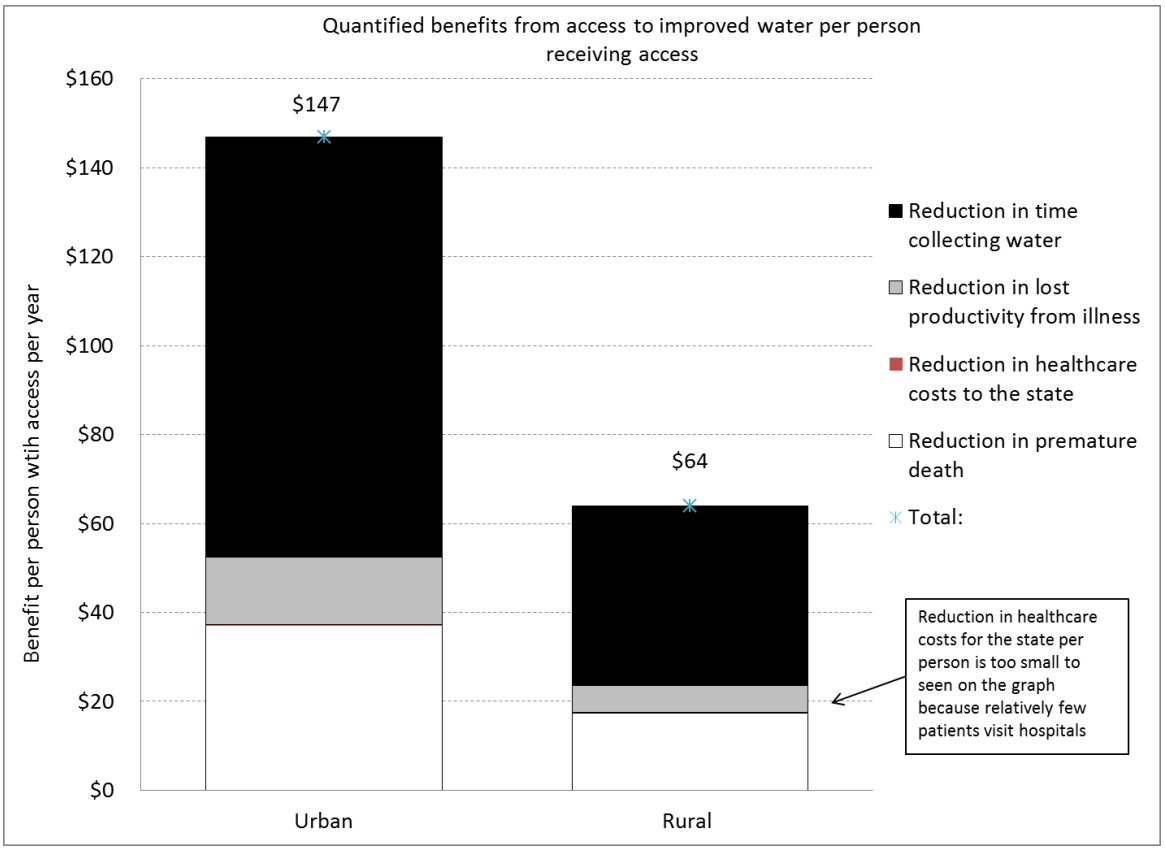
55 NSO, 2010 "Malawi Demographic and Health Survey 2010" September 2011, http://www.nso.malawi.net/images/stories/data_on_line/demography/MDHS2010/MDHS2010%20report.pdf.

56 Celine Nauges and Jon Strand, 2011 "Water hauling and girls' school attendance: some new evidence from Ghana" May 26, 2011.

57 Page 47 Government of Malawi, 2011 "Water Resource Investment Strategy, Component 2".

system from less need for healthcare services. The benefits of access to water shown in Figure A.1: are substantially higher in urban areas. The reason for this is that workers in urban areas are more productive, and so a higher value is assigned to when they can't work due to illness, time spent collecting water, or from a shorter working life.

Figure A.1: Benefits of Extending Access to Improved Water in Urban and Rural areas



Source: Castalia calculations

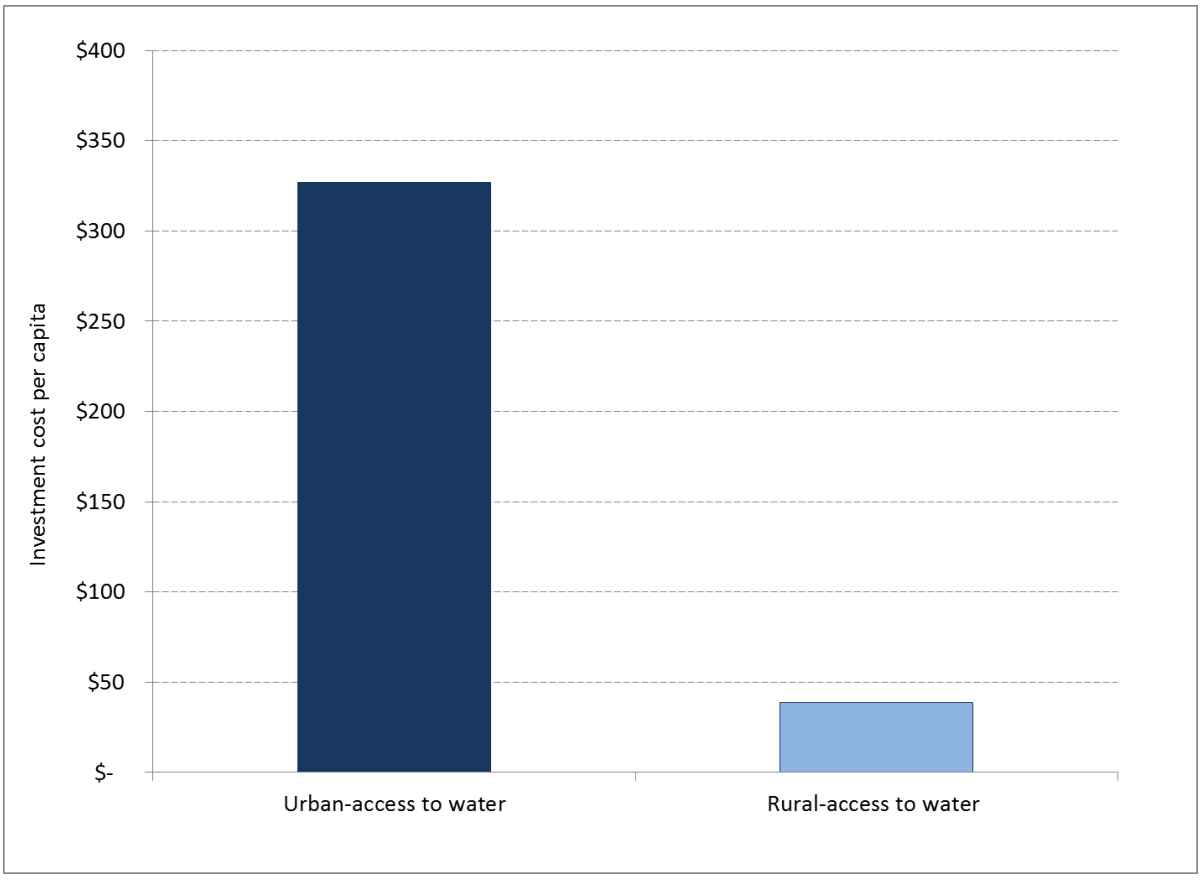
The investment required to extend access to water for urban and rural areas is shown in Figure A.2: These show the cost of extending access to water using a standpipe in urban areas[58] and a borehole in rural areas.[59] Figure A.2: demonstrates that the investment required for providing access to water in urban areas is far higher than in rural areas. The investment shown for urban areas includes substantial investments (on a per person served basis) required to provide bulk water. As a result, the cost of investment in Figure A.2: adds more than US$200 to the costs described in the AMCOW report on Malawi. In addition to the investment costs, there are also ongoing O&M costs of providing water. These are

[58] Urban areas are supplied from standpipes. The cost of bulk supply is added to the original figure (from the AMCOW Country Status Overview for Malawi) by allocating a portion of the cost of the proposed dam for Blantyre to kiosks. Consumers using kiosks use far less water per day than other customers and so, in line with this, they are assigned a relatively small proportion of the bulk water costs.

[59] Rural customers are assumed to be supplied with water from a borehole. A cost of 5 percent of the investment is added to take into account the capacity building that is needed for urban water projects. This is in line with assumptions underlying the Ugandan Water Sector Investment Program.

incorporated in the calculations described in Section **Error! Reference source not found.** but are relatively small in comparison to the benefits and investments required.[60]

Figure A.2: Cost of Extending Access to Water in Urban and Rural Areas



Source: World Bank and Sogreah.[61]

A.3 Household Access to Improved Sanitation

Improved access to sanitation has similar health benefits to improved access to water. The Global Water Supply and Sanitation Assessment states that "*improved sanitation facilities interrupt the transmission of faecal [matter] ….Epidemiological evidence suggests that sanitation is at least as effective*

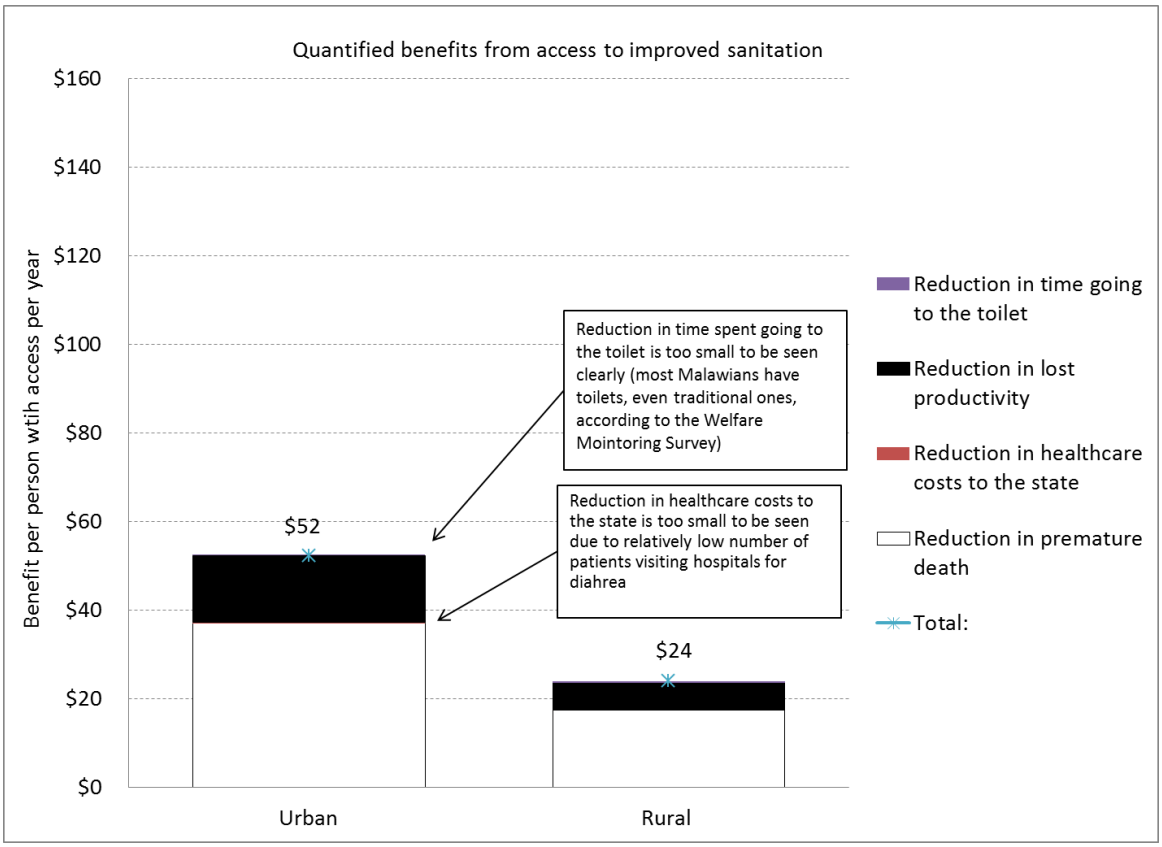
[60] The O&M costs for rural projects are estimated to be 3percent of the investment cost per year. O&M costs for urban water were based on the Water Boards average operating cost per meter cubed of water supplied. The total demand was based on the demand for consumer per day used in the Sogreah reports for low income consumers (those who use kiosks).

[61] The figures for the investment cost for a standpipe per capita is US$120 and comes from World Bank, "Water supply and sanitation in Malawi: turning finance into services for 2015 and beyond, An AMCOW Country Status Overview". It is reported that these figures ultimately came from the Ministry responsible for Water Supply and Sanitation. The cost of bulk supply is calculated from Sogreah, 2010 "Consultancy Services for Feasibility Studies and Preliminary Design for Blantyre's New Raw Water Source and other purposes, Feasibility Study Report" and similar studies for Lilongwe, Mzuzu, and Mzimba (all by Sogreah). In line with the AMCOW study infrastructure in urban areas is assumed to last forty years and infrastructure in rural areas lasts 10 years.

in preventing disease as improved water supply."[62] Access to a toilet facility (be it traditional, basic or improved) means that people don't have to go into the bush to find a suitable location to defecate. This saves time and is more private and dignified than using the bush. In some countries there are substantial savings from extending access to sanitation because many people defecate in the open. However, in Malawi these benefits are relatively small because relatively few Malawians (less than 10 percent) defecate in the open.

A number of benefits of access to improved sanitation are shown in Figure A.3: . The benefits of improved access to sanitation overwhelmingly arise from the health benefits (which are identical to the health benefits for water). The benefits from reduced time spent looking for a toilet is relatively small because almost all Malawians already have access to a latrine.[63] There are other benefits from improved access to sanitation which are more difficult to quantify. These include the improvement in dignity from not defecating in the open.

Figure A.3: Benefits from Access to Improved Sanitation



Source: Castalia calculations

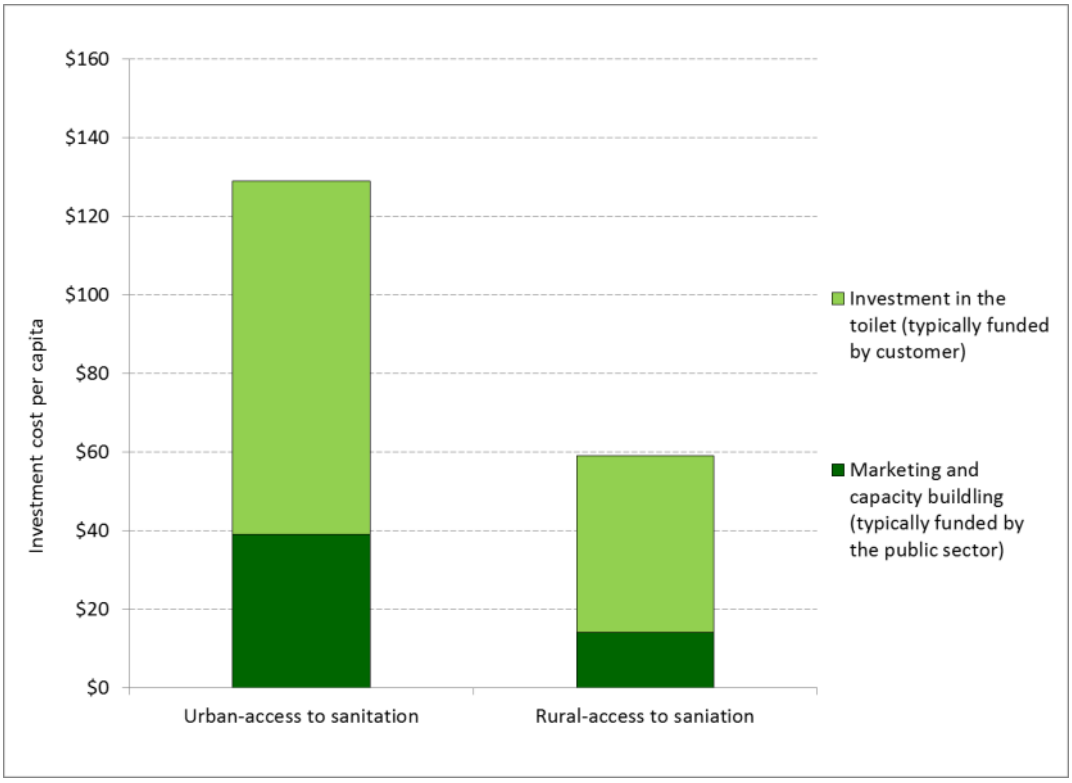
Figure A.4 shows the cost of extending access to sanitation. These costs include the cost of sanitation marketing (typically borne by the public sector) and the cost to the household

62 WHO/UNICEF, 2000 "Global Water Supply and Sanitation Assessment 2000 Report:" http://www.who.int/water_sanitation_health/monitoring/jmp2000.pdf.

63 According to the 2010 Welfare Monitoring Survey.

(typically borne by the household). Extending access to sanitation requires major behavioral changes which requires difficult to implement sanitation marketing programs. While difficult, such a program has been effectively implemented in a very large scale in Malawi. The WASH program—which used various social marketing interventions to motivate villages in rural areas to build improved toilets and achieve Open Defecation Free (ODF) status—has persuaded more than 200,000 households to build latrines, thereby benefiting around one million people. This has required less than US$8 million in funding. UNICEF's experience demonstrates that increasing access to improved sanitation can be done cost effectively and at scale in Malawi.[64] In addition to the marketing costs, extending access to sanitation also requires households to spend time, and sometimes money, to build their latrines. The combination of the cost of the sanitation program and the costs borne by the household mean that the cost of extending access to sanitation is comparable to the cost of extending access to water. The O&M costs of extending access to improved sanitation are relatively small compared to the cost of the initial investment and the benefits amounting to around 6 percent of the initial investment cost per year.[65]

Figure A.4: Investments Required to Extend Access to Improved Sanitation



Source: World Bank and UNICEF.[66]

[64] Based on interviews and data provided by UNICEF.

[65] This is the figure used in the Uganda Strategic Sector Investment Plan for the Water and Sanitation Sector in Uganda.

[66] The cost of a toilet in urban areas was US$90 based on the cost of a VIP toilet. The cost of a toilet in rural areas was US$48 based on the cost of a simple pit latrine. Although a simple pit latrine is not improved, our understanding, based on interviews with UNICEF, is that the cost in rural areas of an improved toilet is comparable to that of a simple pit latrine. Both sets of figures come from World Bank, "Water supply and sanitation in Malawi: turning finance into services for 2015 and beyond, An AMCOW Country Status Overview." The cost of sanitation marketing in rural areas is based on figures provided by UNICEF on expenditure on sanitation and resulting increased number of latrines. It is

A.4 WASH in Schools

School age children are particularly susceptible to diseases that can be attributed to poor access to improved water and sanitation and school children are vulnerable to ill effects from contracting these diseases. Transmission of these diseases is facilitated in the school environment, with many children in close contact for extended periods. Illness means that children cannot attend school, or can't concentrate when at school, which harms their studies. Student who fell ill with WSH related illness (intestinal worms) were 23 percent more likely to drop out of school. Access to toilets is particularly important for teenage girls. In Malawi it has been suggested that the provision of improved sanitation facilities for girls improves the gender balance in education. As discussed in the 2008 School WASH, appropriate facilities for menstrual hygiene lead girls to attend school on days that they have their period instead of staying home, or even dropping out altogether when they reach puberty. It should also be noted that providing separate and adequate improved sanitary facilities for male and female staff in schools that are separate from those of pupils helps to attract and retain teachers in schools. Teaching children good sanitation and hygiene behaviors at school can make them "agents of change" in their families and wider community, and serve them well into their adult lives.[67]

The nature of the benefits from improved access to water and sanitation on a school level makes it difficult to quantify them. Nevertheless, they are likely to be substantially higher than for households' access to water and sanitation. The close concentration of children who are prone to transfer disease, combined with the need for a healthy environment for children to learn, all suggest that improving access to water and sanitation in schools has a very high benefit that is higher than the benefits calculated for households.

While the benefits of extending access to water, sanitation, and hygiene in schools is likely to be substantial, the costs of doing so is likely to be relatively small. School WASH estimated that it would cost US$30 million to extend access to WASH to Malawi's primary schools that don't have access.

assumed that 50 percent of the resulting latrines were improved based on interviews with UNICEF. The cost of sanitation marketing programs in urban areas is based on the Sanitation Marketing programs in the NWDP II AF. In line with World Bank AMCOW study infrastructure in urban areas is assumed to last forty years and infrastructure in rural areas is assumed to last ten years.

[67] Malawi School WASH 2008: A Status Report on Water, Sanitation and Hygiene in Primary Schools, Ministry of Education, Science & Technology, 2009.

Appendix B Electricity Costs

The actual cost of supplying electricity is not always reflected in the price consumers pay. For example, ESCOM charges medium voltage customers, like Blantyre Water Board, $0.03 per kWh, however, the economic cost of supplying customers is actually $0.17 per kWh. Table B.1 below, shows how we calculated economic cost of retail supply.

Table B.1: Economic Cost of Retail Supply of Electricity

	Item	Units	Calculation	Value	Source
A	Unit Capital Cost	$/kW		2,080	PAD on ESKOM Investment Project March 2010 paragraph 195, page 57
B	Interest during construction (IDC)	Index		1.1	
C	Unit Capital Cost Including IDC	$/kW	A x B	2,340	
D	Capital Cost Recovery	% p.a.		17.8	Castalia calculated using an assumed pre- tax Real WACC of 12%, pre-tax Nominal WACC of 20.62%, Corporate Tax rate in Malawi of 30%, and a project life period of 20 years
E	Availability	%		95	Benchmark from international power developers Castalia works with
F	Capital Costs	$ cents/kWh	C x D x E	4.99	
G	Fixed O&M Costs	$ cents/kWh		0.42	Benchmark from international power developers Castalia works with
H	Variable O&M Costs	$ cents/kWh		0.50	Benchmark from international power developers Castalia works with
I	Fuel costs	$ cents/kWh		1.85	Benchmark from international power developers Castalia works with
J	Value of Power Generation	$/kWh	(F+G+H+ I)/100	0.08	
K	Transmission	$ cents/kWh		2.39	Benchmarks from systems Castalia works with that have cost recovery tariffs

	Item	Units	Calculation	Value	Source
L	Distribution	$ cents/kWh		5.37	Benchmarks from systems Castalia works with that have cost recovery tariffs
M	T & D Costs	$ /kWh	K + L	0.08	
N	System Loss Percentage	%		17.5	http://www.mcc.gov/documents/reports/qsr-2010002031405-malawi.pdf
O	System Loss Costs	$/kWh	J x N	0.01	
P	Economic Cost of Retail Supply	$/kWh	J + M +O	0.17	

A **cost of power generation of $0.08 per kWh** was calculated under the assumption that the next capacity increment ESCOM is considering is a 300 MW coal fired power plant which could be expected to have an "all in" generation cost of $0.08.[68] Value of power generation is calculated by adding capital costs, fixed operation and maintenances costs, variable operation and maintenance costs, and fuel costs.

For transmission and distribution costs, we referred to the Manila Electric Company (Meralco) Rate Schedule, where the cost of transmission is about $0.02 per kWh, and the cost of distribution of about $0.05 per kWh.[69] This adds up to a **transmission and distribution cost of $0.08 per kWh.** We use Meralco because it is one of the few electricity utilities in a developing country that has a fully disaggregated, cost-reflecting tariff schedule. Note that given the higher power density in Malawi, per kWh transmission and distribution costs are likely to be higher in Malawi than in Manila.

Lastly, we calculated the cost of system loss per kWh by multiplying the cost of power generation at $0.08 per kWh and the percent of system loss target at 17.5 percent[70]. As a result, the **system loss cost is $0.01 per kWh.**

The **economic cost of retail supply of power is $0.17 per kWh** and is calculated by adding the value of power generation ($0.08), transmission and distribution costs ($0.08), and system loss costs ($0.01).

The economic cost of power supply at retail is more than five times higher than the tariff. So, we increased the annual energy costs Sogreah presented by multiplying it by this factor.

68 ICF International and CORE International, Inc, Malawi Power System Project Studies-Final Feasibility Study Report, ed. Millenium Challenge Corporation, page #s, accessed February 29, 2012, http://www.mca-m.gov.mw/documents/MCC_Malawi_FINAL_Feasibility_Study_Report.pdf.

69 Meralco, "Schedule of Rates," Manila Electric Company, accessed March 1, 2012, last modified February 2012, http://www.meralco.com.ph/pdf/rates/2012/ February/summary_schedule_rates_February2012.pdf.

70 MCC. "Malawi Compact," Millenium Challenge Corporation, accessed March 15, 2012. http://www.mcc.gov/documents/reports/qsr-2010002031405-malawi.pdf.
Note, system losses are currently above this target.

Appendix C. Blantyre Costs of Not Building New Water Source, and Hydrology Risk of Shire River

This section outlines the costs of not building a new water source and the data sheets used in these calculations.

C.1 Costs of Not Building New Water Source for Blantyre

To capture the true economic opportunity cost of not building a new water source, we assumed that one of three scenarios could occur:

- Not providing the additional population in Blantyre with water, period
- Use tanker trucks to bring water from Shire River to Blantyre, as people make private arrangements to serve a growing population in an environment of water scarcity
- Fewer people move to Blantyre, and so Malawi does not benefit from the additional productivity that urban living provides.

Each scenario assumes a 10 percent discount rate over the period 2012-2060.

C.1.1 Costs of Not Providing Access to Water

The benefit of providing urban access to improved water supply is $146.87 per capita per year. Appendix A of the Water Sector Investment Plan explains how we calculated the benefit of access to urban water supply.

The per capita, per year, benefit of $146.87 was then multiplied by the population served by the new water source in each year. Our NPV calculations are from 2012 to 2060. However, because the assumption is that Mombezi-Makuwa would begin operating in 2019, we considered that benefits would also begin in 2019. So, the population served by the new source in any given year, is calculated:

- Additional Population Served by New Source = (Population in Service Area x Urban Access Target) – Population Served by Current System.

As a result, the benefit for each year is calculated:

- Benefit of Providing Access to Water = $146.87 x Additional population Served by New Source.

Lastly, NPV costs were calculated for years 2012 through 2060, at a 10 percent discount rate. As a result, in the case that population continues to grow, costs due to disease and time wasted amount to $500 million.

C.1.2 Costs of Supplying Water with Tanker Trucks

The main costs that determine the cost of supplying water to Blantyre by using tanker trucks are the pump price of diesel ($1.54 per liter)[71] and the rental cost of a 15 cubic meter tanker

71 Alan Whitworth ZIPAR, "Is Indeni the best option for Zambia's Fuel Supply?" How to Cut Zambian Fuel Costs, accessed February 29, 2012, last modified July 2010. http://www.google.com/ url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCMQFjAA&url=http%3A%2F%2Fwww.eaz.o rg.zm%2Fdownloads%2Ffile%2F201102250836170.EAZ%2520Fuel%2520Presentation-

truck ($239 per day).[72] Table C.1 below shows the assumptions used to calculate the full cost of a tanker working bring water to Blantyre for a day, and the amount of water it could supply in a day.

Table C.1: Tanker Truck Costs

	Item	Units	Calculations	Value	Source
A	Pump Price of Diesel	$/l		1.54	ZIPAR Presentation
B	Rental Cost of 15 cu. m Truck	$/day		239	Blowfish Wetting Services
C	Truck Diesel Consumption	l/km		3	Blowfish Wetting Services
D	Distance from Blantyre to Shire River	km		40	Sogreah Blantyre Feasibility Study
E	Estimated roundtrip load and unload time	Hours		2	
F	Number of trips made to Shire River	Number of trips/day	24 hours/ E	12	
G	Fuel Cost per Roundtrip to Shire River	$/ trip	A x C x D x 2	370	
H	Cost per Tanker per	$/truck	B + (F x G)	4,674	
I	Quantity of Water one tanker can deliver in one day	cu. m/truck	F x (15 cu. m/truck)	180	

The water shortage per year that would result from not building a new supply project is calculated, and then the number of truck-days that would be required to fill this gap in each year is calculated. The number of truck-days required is then multiplied by the cost per truck-day to give the cost per year. These annual costs are then discounted back to find the present value of meeting the water shortage with trucks. Of course, this is not a realistic scenario, but it does show the high cost to citizens of making alternative arrangements if a bulk water supply scheme is not provided.

C.1.3 Costs of Productivity Losses Due to No Population Growth

If Blantyre does not get a new bulk supply scheme, it will suffer from extreme water shortages. Lower inward migration to the city will reduce population growth. This will have a cost to Malawi of lost productivity, as city-dwellers tend to be more productive than those in the countryside.

1.ppt&ei =w3xnT4_aDOuamQWpqYS6CA&usg=AFQjCNGTkMVpw4oEWDuLwzL9BW6N2aC6Q&sig2=4fhxZEN8T4RoG OOxEYV5oA.

72 Personal communication with Blowfish Wetting Services in South Africa on February 29, 2012. They indicated the cost of a 15 cubic meter truck was about ZAR 1,800 per day, with a driver. This converts to approximately $239 per day.

Ideally, an income per capita figure would be used to calculate the productivity differential between city and country. However, the best estimate found was per capita expenditure. So, this figure was used as a proxy to capture productivity of a person living in urban area versus productivity of a person living in a rural part of the country. The table below shows the calculation of the per person productivity gap between city and countryside--$216 per person per year.

Table C.2: Productivity Differential between City and Country

	Item	Units	Calculation	Value	Source
A	Expenditure per capita in Blantyre City	$/capita/year		514	Integrated Household Survey 2005
B	Expenditure per capita in Rural Blantyre	$/capita/year		298	Integrated Household Survey 2005
C	Expenditure per capita difference between urban and rural	$/capita/year	A -B	216	

Source: Values in lines A and B come from the Integrated Household Survey 2005, published by the National Statistics Office of Malawi.

In the scenario, it is assumed that if a new water supply is not built, the population in Blantyre would remain capped at current levels. In each year, the gap between projected and "capped" population is calculated. The number of people not present in Blantyre as a result of not having water is then multiplied by the annual per capita productivity differential to give the annual economic loss. This is then discounted to give a present value of the economic loss.

The numbers presented above were converted to USD and adjusted for inflation. So, these numbers are in 2011 prices. Based on the productivity foregone ($216 per capita per year), the net present value cost of this scenario is $473 million.

C.1.4 Hydrology Risk

The main purpose of this scenario was to show that though Walkers Ferry may seem like a more attractive option to Mombezi - Makuwa because of lower investment costs, but security of supply is also important. Walkers Ferry is dependent on the Shire River and highly dependent on pumping rather than storage like Mombezi-Makuwa. So, based on the probability that the Shire will run dry (around 2 percent per day), the costly hydrology risk shows that it is not worth investing in Walkers Ferry if the risk is any higher than 0.47percent per day.[73]

[73] Value derived by using excel goal seeker option.

If a drought happens, tanker trucks would be used as the alternative supply source—except this time trucks would travel to the Kamazu Barrage in Lake Malawi (118 km from Blantyre) rather than the Shire River (40 km from Blantyre). Because of the longer distance, cost of fuel per trip is higher, and the number of trips in one day decreases, relative to Scenario 2. This means the cost per day is overall more expensive because you need more trucks to provide the same amount of water as in scenario 2. Table C.3 shows the assumptions used to calculate the cost to Blantyre if the Shire River went dry.

Table C.3: Hydrology Risk

	Item	Units	Calculations	Value	Source
A	Pump Price of Diesel	$/l		1.54	ZIPAR Presentation
B	Rental Cost of 15 cu. m Truck	$/day		239	Blowfish Wetting Services
C	Truck Diesel Consumption	l/km		3	Blowfish Wetting Services
D	Distance from Blantyre to Kamazu Barrage	km		118	Sogreah Blantyre Feasibility Study
E	Estimated roundtrip load and unload time	Hours		4	
F	Number of trips made to Kamazu Barrage	Number of trips/day	24 hours/ E	6	
G	Fuel Cost per Roundtrip to Kamazu Barrage	$/ trip	A x C x D x 2	1,090	
H	Cost per Tanker per	$/truck	B + (F x G)	6,780	
I	Quantity of Water one tanker can deliver in one day	cu. m/truck	F x (15 cu. m/truck)	90	

Source: ZIPAR presentation, Blowfish Wettings Services Tanker Truck Company, and Sogreah Blantyre Feasibility Study were used for values in lines A through D. Castalia calculated values in line E through H.

The number of trucks required to fill the gap is calculated by dividing the assumed the daily water demand in each given year by the amount of water each truck can deliver in one day.

The daily cost of using tanker trucks to provide Blantyre with water is calculated by multiplying the cost per tanker per day by the amount of trucks needed per drought day.

Lastly, the cost of supplying water during a drought was calculated by multiplying the cost per drought day by the probability that the Shire River will go dry. As mentioned before, this probability was calculated by Atkins to be around is as high as 20 percent on any given day. However, recent research has estimated the risk to be considerably lower, about 1 to 2 percent. So, the annual cost of supplying Blantyre with water during a drought is:

- Cost of using tanker trucks x 365 days x 2%

Again, these annual costs are then discounted back to find the present value of using trucks during a drought.

C.2 Cost-Benefit Analysis for Blantyre's New Water Source

Cost-Benefit Analysis for Blantyre New Water Source (Medium Growth Scenario)

A	New Water Source Operating?	0 = No, 1 = Yes			0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
		Unit	Calculation	NPV 2012- 2060	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
B	Population in Service Area	No. of People			825,045	847,465	873,486	901,106	929,958	959,995	991,149	1,023,335	1,056,444	1,089,771	1,122,981	1,155,711	1,187,591	1,218,246	1,249,335	1,282,335
C	People Served	No. of People			641,859	699,756	723,811	749,329	776,015	803,840	832,755	862,696	893,574	924,808	956,116	987,191	1,017,718	1,047,372	1,077,945	1,109,498
D	% Coverage	% of People	B/C		78%	83%	83%	83%	83%	84%	84%	84%	85%	85%	85%	85%	86%	86%	86%	87%
E	Targets for Urban Access to Improved Water	% of People			95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
F	Population Served by New Water Source	No. of People	(B x E) - C		241,565	262,864	287,584	313,823	341,232	369,767	399,364	429,940	461,394	493,054	524,604	555,697	585,983	615,106	644,640	675,990
G	Customer Demand (total average net demand)	cu. m/day			57,221	60,965	63,166	65,473	67,872	70,390	73,047	75,814	78,697	81,644	84,648	87,687	90,744	93,785	96,900	100,145
H	NRW	cu. m/day			24,523	24,561	24,279	24,285	24,507	24,908	25,459	26,126	26,890	27,721	28,606	29,529	30,479	31,262	32,300	33,382
I	Total Clear Water Required	cu. m/day	G + H		81,744	85,526	87,445	89,758	92,379	95,298	98,506	101,940	105,587	109,365	113,254	117,216	121,223	125,047	129,200	133,527
J	Capacity of Current Supply - Average Production	cu. m/day			95,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000
K	Reserve margin - Average Production	cu. m/day	I -J		(13,256)	(22,474)	(20,555)	(18,242)	(15,621)	(12,702)	(9,494)	(6,060)	(2,413)	1,365	5,254	9,216	13,223	17,047	21,200	25,527
L	NRW Deficit	cu. m/day	K x %NRW		(3,977)	(6,454)	(5,707)	(4,936)	(4,144)	(3,320)	(2,454)	(1,553)	(614)	346	1,327	2,322	3,325	4,262	5,300	6,382
M	Customer Demand Deficit	cu. m/day	K - L		(9,279)	(16,020)	(14,848)	(13,307)	(11,477)	(9,382)	(7,040)	(4,507)	(1,798)	1,019	3,927	6,895	9,898	12,785	15,900	19,145
	Scenario 1 - Cost of NOT Providing water																			
N	Benefits per person from providing access to water	$/c/yr (2010 prices)			147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147
O	Cost of not providing water	$/annum	A x F x N	$499,935,320	-	-	-	-	-	-	-	63,147,115	67,766,829	72,416,960	77,050,767	81,617,599	86,065,830	90,343,136	94,680,998	99,285,503
	Scenario 2 - Increased cost of supplying water																			
P	Cost per tanker truck per day	$/day			4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674
Q	Quantitiy of water one tanker truck can deliver per day	cu. m/truck/day			180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
R	Customer Demand Deficit (total	cu. m/day			(9,279.00)	(16,020)	(14,848)	(13,307)	(11,477)	(9,382)	(7,040)	(4,507)	(1,798)	1,019	3,927	6,895	9,898	12,785	15,900	19,145
S	Number of trucks needed to meet	No. of	R / Q		(52)	(89)	(82)	(74)	(64)	(52)	(39)	(25)	(10)	6	22	38	55	71	88	106
T	Cost of Supplying water to all of	$/ year	A x P x S x 365	$960,848,492	-	-	-	-	-	-	-	(42,718,703)	(17,043,684)	9,660,884	37,220,203	65,345,116	93,814,534	121,174,099	150,697,550	181,453,119
	Scenario 3 - No population growth																			
U	Expenditure per capita in Blantyre	$/annum			514	514	514	514	514	514	514	514	514	514	514	514	514	514	514	514
V	Expenditure per capita in Rural Areas	$/annum			298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
W	Expenditure per capita difference between urban and rural	$/annum			216	216	216	216	216	216	216	216	216	216	216	216	216	216	216	216
X	Value of productivity foregone from no population growth	$/annum	A x (F_{2012} - F_n) x W	$472,799,301	-	-	-	-	-	-	-	40,726,783	47,527,041	54,372,073	61,193,075	67,915,490	74,463,323	80,759,553	87,144,923	93,922,793
	Scenario 4 - Cost of a Drought																			
Y	Cost per tanker truck per day during drought	$/day			6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780
Z	Quantitiy of water one tanker truck can deliver per day	cu. m/truck/day			90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
AA	Number of trucks needed to meet customer demand deficit	No. of trucks	R / Z		(103)	(178)	(165)	(148)	(128)	(104)	(78)	(50)	(20)	11	44	77	110	142	177	213
AB	Cost of Supplying Water to Blantyre per drought day	$/day	Y x AA		(699,061)	(1,206,886)	(1,118,634)	(1,002,507)	(864,660)	(706,850)	(530,392)	(339,565)	(135,478)	76,793	295,858	519,419	745,719	963,196	1,197,874	1,442,346
AC	No. of Day without water when a drought occurs	No. of days			365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
AD	Daily probabilty of drought	%			2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
AE	Cost of Supplying Water During a Drought	$/drought period	A x AB x AC x AD	$55,754,868	-	-	-	-	-	-	-	(2,478,825)	(988,989)	560,589	2,159,766	3,791,762	5,443,748	7,031,333	8,744,482	10,529,126

Note: In this scenario, the water source begins to operate in 2019.

Cost-Benefit Analysis for Blantyre New Water Source (Medium Growth Scenario)

A	New Water Source Operating?	0 = No, 1 = Yes			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Unit	Calculation	NPV 2012- 2060	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
B	Population in Service Area	No. of People			1,315,887	1,350,498	1,386,210	1,422,759	1,460,138	1,498,338	1,537,357	1,577,207	1,618,214	1,660,288	1,703,455	1,747,745	1,793,187	1,839,810	1,887,645	1,936,723	1,987,078	2,038,742
C	People Served	No. of People			1,142,077	1,175,719	1,206,522	1,238,038	1,270,256	1,303,170	1,336,774	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082
D	% Coverage	% of People	B/C		87%	87%	87%	87%	87%	87%	87%	87%										
E	Targets for Urban Access to Improved Water	% of People			95%	95%	95%	95%	95%	95%	95%	95%										
F	Population Served by New Water Source	No. of People	(B x E) - C		707,865	740,745	774,672	809,393	844,903	881,193	918,261	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119
G	Customer Demand (total average net demand)	cu. m/day			103,524	107,046	110,826	114,717	118,682	122,793	127,077	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504
H	NRW	cu. m/day			34,508	35,682	36,942	38,239	39,561	40,931	42,359	43,835										
I	Total Clear Water Required	cu. m/day	G + H		138,032	142,728	147,768	152,956	158,243	163,724	169,436	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339
J	Capacity of Current Supply - Average Production	cu. m/day			108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000										
K	Reserve margin - Average Production	cu. m/day	I -J		30,032	34,728	39,768	44,956	50,243	55,724	61,436	67,339										
L	NRW Deficit	cu. m/day	K x %NRW		7,508	8,682	9,942	11,239	12,561	13,931	15,359	16,835										
M	Customer Demand Deficit	cu. m/day	K - L		22,524	26,046	29,826	33,717	37,682	41,793	46,077	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504
	Scenario 1 - Cost of NOT Providing water																					
N	Benefits per person from providing access to water	$/c/yr (2010 prices)			147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	147
O	Cost of not providing water	$/annum	A x F x N	$499,935,320	103,967,029	108,796,318	113,779,229	118,878,928	124,094,437	129,424,500	134,868,839	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128
	Scenario 2 - Increased cost of supplying water																					
P	Cost per tanker truck per day	$/day			4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674
Q	Quantitiy of water one tanker truck can deliver per day	cu. m/truck/day			180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
R	Customer Demand Deficit (total	cu. m/day			22,524	26,046	29,826	33,717	37,682	41,793	46,077	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504
S	Number of trucks needed to meet	No. of	R / Q		125	145	166	187	209	232	256	281	281	281	281	281	281	281	281	281	281	281
T	Cost of Supplying water to all of	$/ year	A x P x S x 365	$960,848,492	213,478,718	246,859,647	282,685,857	319,564,107	357,143,716	396,107,089	436,710,127	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495
	Scenario 3 - No population growth																					
U	Expenditure per capita in Blantyre	$/annum			514	514	514	514	514	514	514	514	514	514	514	514	514	514	514	514	514	514
V	Expenditure per capita in Rural Areas	$/annum			298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	298
W	Expenditure per capita difference between urban and rural	$/annum			216	216	216	216	216	216	216	216	216	216	216	216	216	216	216	216	216	216
X	Value of productivity foregone from no population growth	$/annum	A x (F_{2012} - F_n) x W	$472,799,301	100,814,038	107,922,792	115,257,679	122,764,478	130,441,751	138,287,649	146,301,762	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553
	Scenario 4 - Cost of a Drought																					
Y	Cost per tanker truck per day during drought	$/day			6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780
Z	Quantitiy of water one tanker truck can deliver per day	cu. m/truck/day			90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
AA	Number of trucks needed to meet customer demand deficit	No. of trucks	R / Z		250	289	331	375	419	464	512	561	561	561	561	561	561	561	561	561	561	561
AB	Cost of Supplying Water to Blantyre per drought day	$/day	Y x AA		1,696,913	1,962,254	2,247,031	2,540,171	2,838,887	3,148,601	3,471,349	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870
AC	No. of Day without water when a drought occurs	No. of days			365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
AD	Daily probabilty of drought	%			2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
AE	Cost of Supplying Water During a Drought	$/drought period	A x AB x AC x AD	$55,754,868	12,387,466	14,324,451	16,403,328	18,543,251	20,723,872	22,984,788	25,340,848	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554

Note: In this scenario, the water source begins to operate in 2019.

Cost-Benefit Analysis for Blantyre New Water Source (Medium Growth Scenario)

A	New Water Source Operating?	0 = No, 1 = Yes			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Unit	Calculation	NPV 2012- 2060	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	
B	Population in Service Area	No. of People			2,091,749	2,146,135	2,201,934	2,259,185	2,317,924	2,378,190	2,440,022	2,503,463	2,568,553	2,635,335	2,703,854	2,774,154	2,846,282	2,920,286	2,996,213	
C	People Served	No. of People			1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	1,371,082	
D	% Coverage	% of People	B/C																	
E	Targets for Urban Access to Improved Water	% of People																		
F	Population Served by New Water Source	No. of People	(B x E) - C		956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	956,119	
G	Customer Demand (total average net demand)	cu. m/day			131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	131,504	
H	NRW	cu. m/day																		
I	Total Clear Water Required	cu. m/day	G + H		175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	175,339	
J	Capacity of Current Supply - Average Production	cu. m/day																		
K	Reserve margin - Average Production	cu. m/day	I -J																	
L	NRW Deficit	cu. m/day	K x %NRW																	
M	Customer Demand Deficit	cu. m/day	K - L		50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	
	Scenario 1 - Cost of NOT Providing water																			
N	Benefits per person from providing access to water	$/c/yr (2010 prices)			147	147	147	147	147	147	147	147	147	147	147	147	147	147	147	
O	Cost of not providing water	$/annum	A x F x N	$499,935,320	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	
	Scenario 2 - Increased cost of supplying water																			
P	Cost per tanker truck per day	$/day			4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	4,674	
Q	Quantitiy of water one tanker truck can deliver per day	cu. m/truck/day			180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	
R	Customer Demand Deficit (total	cu. m/day			50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	50,504	
S	Number of trucks needed to meet	No. of	R / Q		281	281	281	281	281	281	281	281	281	281	281	281	281	281	281	
T	Cost of Supplying water	$/ year	A x P x S x 365	$960,848,492	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	478,668,495	
	Scenario 3 - No population growth																			
U	Expenditure per capita in Blantyre	$/annum			514	514	514	514	514	514	514	514	514	514	514	514	514	514	514	
V	Expenditure per capita in Rural Areas	$/annum			298	298	298	298	298	298	298	298	298	298	298	298	298	298	298	
W	Expenditure per capita difference between urban and rural	$/annum			216	216	216	216	216	216	216	216	216	216	216	216	216	216	216	
X	Value of productivity foregone from no population growth	$/annum	A x (F_{2012} - F_n) x W	$472,799,301	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	154,486,553	
	Scenario 4 - Cost of a Drought																			
Y	Cost per tanker truck per day during drought	$/day			6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	6,780	
Z	Quantitiy of water one tanker truck can deliver per day	cu. m/truck/day			90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	
AA	Number of trucks needed to meet customer demand deficit	No. of trucks	R / Z		561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	
AB	Cost of Supplying Water to Blantyre per drought day	$/day	Y x AA		3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	3,804,870	
AC	No. of Day without water when a drought occurs	No. of days			365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	
AD	Daily probabilty of drought	%			2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
AE	Cost of Supplying Water During a Drought	$/drought period	A x AB x AC x AD	$55,754,868	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	27,775,554	

Note: In this scenario, the water source begins to operate in 2019.

Annual Capital and Operating Costs for Mombezi Makuwa and Walkers Ferry

	Blantyre New Water Source Costs Medium Growth Scenario	Units	Calculation	NPV 2012- 2060	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
	Cost of New Water Source - Mombezi +Makuwa																			
	Capex (DWS Component)																			
A	Dams	$			-	-	-	19,320,000	19,320,000	19,320,000	-	-	-	-	-	-	-	-	-	-
B	Resettlement	$			-	-	-	-	1,400,000	1,400,000	-	-	-	-	-	-	-	-	-	-
C	WTP	$			-	-	-	-	-	5,170,000	5,170,000	-	-	-	-	-	-	-	-	-
D	Pipelines +reservoirs+electric lines	$			-	-	-	-	-	16,640,000	16,640,000	-	-	-	-	-	-	-	-	-
E	Pumping Stations	$			-	-	-	-	-	3,070,000	3,070,000	-	-	-	-	-	-	-	-	-
F	Physical Contingencies	$			-	-	-	2,320,000	2,320,000	5,300,000	2,990,000	-	-	-	-	-	-	-	-	-
G	Engineering	$			-	-	1,930,000	1,930,000	1,930,000	1,930,000	1,930,000	-	-	-	-	-	-	-	-	1,950,000
H	**Sum of Total Capex**		A+B+C+D+E+F+G	$97,120,271	-	-	1,930,000	23,570,000	24,970,000	52,830,000	29,800,000	-	-	-	-	-	-	-	-	1,950,000
	OpEx (DWS Component) - excluding energy costs																			
I	Chemicals	$			-	-	-	-	-	-	-	46,000	53,000	59,000	66,000	73,000	80,000	87,000	93,000	100,000
J	Annual Maintenance	$			-	-	-	-	-	-	-	1,067,000	1,067,000	1,067,000	1,067,000	1,067,000	1,067,000	1,067,000	1,067,000	1,067,000
K	Personnel	$			-	-	-	-	-	-	-	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000	98,000
L	**Sum of Total Opex- excluding energy cost**		I+J+K	$7,753,587	-	-	-	-	-	-	-	1,211,000	1,218,000	1,224,000	1,231,000	1,238,000	1,245,000	1,252,000	1,258,000	1,265,000
	Energy																			
M	Energy cost at tariff ($0.03/kWh)	$		$5,238,422	-	-	-	-	-	-	-	436,000	496,000	557,000	622,000	686,000	751,000	815,000	878,000	939,000
N	Energy Cost at economic cost ($0.17/kWh)	$	M x (0.17/.0.03)	$29,468,708	-	-	-	-	-	-	-	2,452,715	2,790,245	3,133,400	3,499,057	3,859,088	4,224,745	4,584,777	4,939,183	5,282,338
	NPV (at 10% discount rate)																			
N	Capex + Opex (excluding energy cost)	$	H + L	$104,873,858	-	-	1,930,000	23,570,000	24,970,000	52,830,000	29,800,000	1,211,000	1,218,000	1,224,000	1,231,000	1,238,000	1,245,000	1,252,000	1,258,000	3,215,000
O	Capex + Opex (including energy cost at tariff)	$	H + L + M	$110,112,281	-	-	1,930,000	23,570,000	24,970,000	52,830,000	29,800,000	1,647,000	1,714,000	1,781,000	1,853,000	1,924,000	1,996,000	2,067,000	2,136,000	4,154,000
P	Capex + Opex (including energy cost at economic cost)	$	H + L + N	$134,342,566	-	-	1,930,000	23,570,000	24,970,000	52,830,000	29,800,000	3,663,715	4,008,245	4,357,400	4,730,057	5,097,088	5,469,745	5,836,777	6,197,183	8,497,338
	Economic Internal Rate of Return																			
Q	Benefit of Supplying Water	$		$499,935,320	-	-	-	-	-	-	-	63,147,115	67,766,829	72,416,960	77,050,767	81,617,599	86,065,830	90,343,136	94,680,998	99,285,503
R	EIRR (with energy cost at tariff)	%	Q - O	35%	-	-	($1,930,000)	($23,570,000)	($24,970,000)	($52,830,000)	($29,800,000)	61,500,115	66,052,829	70,635,960	75,197,767	79,693,599	84,069,830	88,276,136	92,544,998	95,131,503
S	EIRR (with energy cost at economic cost)	%	Q - P	34%	-	-	($1,930,000)	($23,570,000)	($24,970,000)	($52,830,000)	($29,800,000)	59,483,400	63,758,584	68,059,561	72,320,710	76,520,510	80,596,084	84,506,359	88,483,815	90,788,165
	Cost of New Water Source - Walkers Ferry																			
	Capex (DWS Component)																			
T	Dams	$			-	-	-	-	2,220,000	-	-	-	-	50,000	-	-	-	-	50,000	-
U	Resettlement	$			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
V	WTP	$			-	-	-	-	6,320,000	6,320,000	-	-	-	-	-	-	-	-	-	1,010,000
W	Pipelines +reservoirs+electric lines	$			-	-	-	15,560,000	15,560,000	15,560,000	-	-	-	-	-	-	-	-	-	11,340,000
X	Pumping Stations	$			-	-	-	-	5,110,000	5,110,000	-	-	-	-	-	-	-	-	-	2,150,000
Y	Physical Contingencies	$			-	-	-	1,870,000	3,510,000	3,240,000	-	-	-	-	-	-	-	-	-	1,360,000
Z	Engineering	$			-	-	1,610,000	1,610,000	1,610,000	1,610,000	-	-	-	-	-	-	-	-	1,240,000	1,240,000
AA	**Sum of Total Capex**	$	T+U+V+W+X+Y+Z	$70,423,661	-	-	1,610,000	19,040,000	34,330,000	31,840,000	-	-	-	50,000	-	-	-	-	1,290,000	17,100,000
	OpEx (DWS Component) - excluding energy costs																			
AB	Chemicals	$			-	-	-	-	-	-	72,000	82,000	94,000	105,000	118,000	130,000	142,000	154,000	166,000	178,000
AC	Annual Maintenance	$			-	-	-	-	-	-	693,000	693,000	693,000	693,000	693,000	693,000	693,000	693,000	693,000	693,000
AD	Personnel	$			-	-	-	-	-	-	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000
AE	**Sum of Total Opex - exluding energy costs**	$	AB+AC+AD	$6,853,027	-	-	-	-	-	-	923,000	933,000	945,000	956,000	969,000	981,000	993,000	1,005,000	1,017,000	1,029,000
	Energy																			
AF	Energy cost at tariff ($0.03/kWh)	$		$10,217,178	-	-	-	-	-	-	826,000	939,000	1,056,000	1,177,000	1,300,000	1,423,000	1,544,000	1,664,000	1,779,000	1,868,000
AG	Energy Cost at economic cost ($0.17/kWh)	$	AF x (0.17/.0.03)	$57,476,665	-	-	-	-	-	-	4,646,657	5,282,338	5,940,521	6,621,205	7,313,141	8,005,077	8,685,761	9,360,820	10,007,752	10,508,421
	NPV (at 10% discount rate)																			
AH	Capex +Opex excluding energy cost)	$	AA+ AD	$77,276,689	-	-	1,610,000	19,040,000	34,330,000	31,840,000	923,000	933,000	945,000	1,006,000	969,000	981,000	993,000	1,005,000	2,307,000	18,129,000
AI	Capex +Opex (including energy cost at tariff)	$	AA + AD + AE	$87,493,867	-	-	1,610,000	19,040,000	34,330,000	31,840,000	1,749,000	1,872,000	2,001,000	2,183,000	2,269,000	2,404,000	2,537,000	2,669,000	4,086,000	19,997,000
AJ	Capex +Opex (including energy cost at economic cost)	$	AA + AD + AF	$134,753,354	-	-	1,610,000	19,040,000	34,330,000	31,840,000	5,569,657	6,215,337.97	6,885,521	7,627,205	8,282,141	8,986,077	9,678,761	10,365,820	12,314,752	28,637,421
	Economic Internal Rate of Return																			
AK	Benefit of Supplying Water	$		$530,035,218	-	-	-	-	-	-	58,656,188	63,147,115	67,766,829	72,416,960	77,050,767	81,617,599	86,065,830	90,343,136	94,680,998	99,285,503
AL	EIRR (with energy cost at tariff)	%	AK - AI	50%	-	-	($1,610,000)	($19,040,000)	($34,330,000)	($31,840,000)	56,907,188	61,275,115	65,765,829	70,233,960	74,781,767	79,213,599	83,528,830	87,674,136	90,594,998	79,288,503
AM	EIRR (with energy cost at economic cost)	%	AK- AJ	47%	-	-	($1,610,000)	($19,040,000)	($34,330,000)	($31,840,000)	53,086,530	56,931,777	60,881,308	64,789,755	68,768,626	72,631,522	76,387,068	79,977,315	82,366,246	70,648,082

Note: Mombezi - Makuwa begins operating in 2019. Walkers Ferry in 2018. Benefit of water supply begins the first year of operation. Walkers Ferry benefits begin a year before Mombezi-Makuwa

	Blantyre New Water Source Costs Medium Growth Scenario	Units	Calculation	NPV 2012- 2060	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
	Cost of New Water Source - Mombezi +Makuwa																					
	Capex (DWS Component)																					
A	Dams	$			-	100,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	Resettlement	$			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	WTP	$			6,000,000	5,170,000	-	-	-	3,310,000	-	-	-	-	-	-	-	-	-	-	-	-
D	Pipelines +reservoirs+electric lines	$			21,650,000	21,650,000	-	-	-	-	-	-	-	-	6,000,000	830,000	-	-	-	-	3,310,000	-
E	Pumping Stations	$			7,040,000	5,750,000	-	-	-	2,390,000	-	-	-	-	-	-	-	-	-	-	-	-
F	Physical Contingencies	$			3,910,000	3,920,000	-	-	-	-	-	-	-	-	7,040,000	2,410,000	-	-	-	-	4,480,000	-
G	Engineering	$			1,950,000	1,950,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	**Sum of Total Capex**		A+B+C+D+E+F+G	$97,120,271	40,550,000	38,540,000	-	-	-	5,700,000	-	-	-	-	13,040,000	3,240,000	-	-	-	-	7,790,000	-
	OpEx (DWS Component) - excluding energy costs																					
I	Chemicals	$			107,000	113,000	121,000	128,000	141,000	155,000	168,000	183,000	198,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000
J	Annual Maintenance	$			1,067,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000
K	Personnel	$			98,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000
L	**Sum of Total Opex- excluding energy cost**		I+J+K	$7,753,587	1,272,000	1,984,000	1,992,000	1,999,000	2,012,000	2,026,000	2,039,000	2,054,000	2,069,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000
	Energy																					
M	Energy cost at tariff ($0.03/kWh)	$		$5,238,422	1,002,000	1,068,000	1,137,000	1,209,000	1,336,000	1,466,000	1,599,000	1,736,000	1,880,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000
N	Energy Cost at economic cost ($0.17/kWh)	$	M x (0.17/.0.03)	$29,468,708	5,636,744	6,008,027	6,396,186	6,801,221	7,515,659	8,246,973	8,995,163	9,765,856	10,575,927	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500
	NPV (at 10% discount rate)																					
N	Capex + Opex (excluding energy cost)	$	H + L	$104,873,858	41,822,000	40,524,000	1,992,000	1,999,000	2,012,000	7,726,000	2,039,000	2,054,000	2,069,000	2,084,000	15,124,000	5,324,000	2,084,000	2,084,000	2,084,000	2,084,000	9,874,000	2,084,000
O	Capex + Opex (including energy cost at tariff)	$	H + L + M	$110,112,281	42,824,000	41,592,000	3,129,000	3,208,000	3,348,000	9,192,000	3,638,000	3,790,000	3,949,000	4,112,000	17,152,000	7,352,000	4,112,000	4,112,000	4,112,000	4,112,000	11,902,000	4,112,000
P	Capex + Opex (including energy cost at economic cost)	$	H + L + N	$134,342,566	47,458,744	46,532,027	8,388,186	8,800,221	9,527,659	15,972,973	11,034,163	11,819,856	12,644,927	13,492,500	26,532,500	16,732,500	13,492,500	13,492,500	13,492,500	13,492,500	21,282,500	13,492,500
	Economic Internal Rate of Return																					
Q	Benefit of Supplying Water	$		$499,935,320	103,967,029	108,796,318	113,779,229	118,878,928	124,094,437	129,424,500	134,868,839	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128
R	EIRR (with energy cost at tariff)	%	Q - O	35%	61,143,029	67,204,318	110,650,229	115,670,928	120,746,437	120,232,500	131,230,839	136,639,128	136,480,128	136,317,128	123,277,128	133,077,128	136,317,128	136,317,128	136,317,128	136,317,128	128,527,128	136,317,128
S	EIRR (with energy cost at economic cost)	%	Q - P	34%	56,508,285	62,264,291	105,391,044	110,078,707	114,566,778	113,451,527	123,834,676	128,609,272	127,784,201	126,936,628	113,896,628	123,696,628	126,936,628	126,936,628	126,936,628	126,936,628	119,146,628	126,936,628
	Cost of New Water Source - Walkers Ferry																					
	Capex (DWS Component)																					
T	Dams	$			-	-	-	50,000	-	-	-	-	50,000	-	-	-	-	50,000	-	-	-	-	-
U	Resettlement	$			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
V	WTP	$			6,320,000	6,320,000	-	-	4,050,000	-	-	-	-	1,010,000	-	1,010,000	-	-	-	-	4,050,000	-
W	Pipelines +reservoirs+electric lines	$			11,340,000	11,340,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X	Pumping Stations	$			4,240,000	4,240,000	-	-	3,990,000	-	-	-	-	2,150,000	-	1,780,000	-	-	-	-	3,310,000	-
Y	Physical Contingencies	$			2,630,000	2,630,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Z	Engineering	$			1,240,000	1,240,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AA	**Sum of Total Capex**	$	T+U+V+W+X+Y+Z	$70,423,661	25,770,000	25,770,000	-	50,000	8,040,000	-	-	-	50,000	3,160,000	-	2,790,000	-	50,000	-	-	7,360,000	-
	OpEx (DWS Component) - excluding energy costs																					
AB	Chemicals	$			189,000	202,000	214,000	228,000	251,000	275,000	299,000	325,000	351,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000
AC	Annual Maintenance	$			693,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000
AD	Personnel	$			158,000	158,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000
AE	**Sum of Total Opex - exluding energy costs**	$	AB+AC+AD	$6,853,027	1,040,000	1,607,000	1,656,000	1,670,000	1,693,000	1,717,000	1,741,000	1,767,000	1,793,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000
	Energy																					
AF	Energy cost at tariff ($0.03/kWh)	$		$10,217,178	1,961,000	2,058,000	2,159,000	2,338,000	2,522,000	2,709,000	2,903,000	3,106,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000
AG	Energy Cost at economic cost ($0.17/kWh)	$	AF x (0.17/.0.03)	$57,476,665	11,031,592	11,577,265	12,145,439	13,152,403	14,187,493	15,239,461	16,330,806	17,472,781	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509
	NPV (at 10% discount rate)																					
AH	Capex +Opex excluding energy cost)	$	AA+ AD	$77,276,689	26,810,000	27,377,000	1,656,000	1,720,000	9,733,000	1,717,000	1,741,000	1,767,000	1,843,000	4,981,000	1,821,000	4,611,000	1,821,000	1,871,000	1,821,000	1,821,000	9,181,000	1,821,000
AI	Capex +Opex (including energy cost at tariff)	$	AA + AD + AE	$87,493,867	28,771,000	29,435,000	3,815,000	4,058,000	12,255,000	4,426,000	4,644,000	4,873,000	5,158,000	8,296,000	5,136,000	7,926,000	5,136,000	5,186,000	5,136,000	5,136,000	12,496,000	5,136,000
AJ	Capex +Opex (including energy cost at economic cost)	$	AA + AD + AF	$134,753,354	37,841,592	38,954,265	13,801,439	14,872,403	23,920,493	16,956,461	18,071,806	19,239,781	20,491,509	23,629,509	20,469,509	23,259,509	20,469,509	20,519,509	20,469,509	20,469,509	27,829,509	20,469,509
	Economic Internal Rate of Return																					
AK	Benefit of Supplying Water	$		$530,035,218	103,967,029	108,796,318	113,779,229	118,878,928	124,094,437	129,424,500	134,868,839	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128
AL	EIRR (with energy cost at tariff)	%	AK - AI	50%	75,196,029	79,361,318	109,964,229	114,820,928	111,839,437	124,998,500	130,224,839	135,556,128	135,271,128	132,133,128	135,293,128	132,503,128	135,293,128	135,243,128	135,293,128	135,293,128	127,933,128	135,293,128
AM	EIRR (with energy cost at economic cost)	%	AK- AJ	47%	66,125,437	69,842,053	99,977,790	104,006,525	100,173,943	112,468,040	116,797,033	121,189,346	119,937,618	116,799,618	119,959,618	117,169,618	119,959,618	119,909,618	119,959,618	119,959,618	112,599,618	119,959,618

Note: Mombezi - Makuwa begins operating in 2019. Walkers Ferry in 2018. Benefit of water supply begins the first year of operation. Walkers Ferry benefits begin a year before Mombezi-Makuwa

	Blantyre New Water Source Costs Medium Growth Scenario	Units	Calculation	NPV 2012- 2060	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
	Cost of New Water Source - Mombezi +Makuwa																		
	Capex (DWS Component)																		
A	Dams	$			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	Resettlement	$			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	WTP	$			-	-	-	-	-	-	-	-	-	-	-	-	6,000,000	4,140,000	-
D	Pipelines +reservoirs+electric lines	$			-	-	6,000,000	4,140,000	-	-	-	-	-	-	16,640,000	16,640,000	-	-	-
E	Pumping Stations	$			-	-	-	-	-	-	-	-	-	-	-	-	7,040,000	6,900,000	-
F	Physical Contingencies	$			-	-	7,040,000	4,810,000	-	-	-	-	-	-	-	-	-	-	-
G	Engineering	$			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	**Sum of Total Capex**		A+B+C+D+E+F+G	$97,120,271	-	-	13,040,000	8,950,000	-	-	-	-	-	-	16,640,000	16,640,000	13,040,000	11,040,000	-
	OpEx (DWS Component) - excluding energy costs																		
I	Chemicals	$			213,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000	213,000
J	Annual Maintenance	$			1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000	1,697,000
K	Personnel	$			174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000	174,000
L	**Sum of Total Opex- excluding energy cost**		I+J+K	$7,753,587	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000
	Energy																		
M	Energy cost at tariff ($0.03/kWh)	$		$5,238,422	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000
N	Energy Cost at economic cost ($0.17/kWh)	$	M x (0.17/.0.03)	$29,468,708	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500	11,408,500
	NPV (at 10% discount rate)																		
N	Capex + Opex (excluding energy cost)	$	H + L	$104,873,858	2,084,000	2,084,000	15,124,000	11,034,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	2,084,000	18,724,000	18,724,000	15,124,000	13,124,000	2,084,000
O	Capex + Opex (including energy cost at tariff)	$	H + L + M	$110,112,281	4,112,000	4,112,000	17,152,000	13,062,000	4,112,000	4,112,000	4,112,000	4,112,000	4,112,000	4,112,000	20,752,000	20,752,000	17,152,000	15,152,000	4,112,000
P	Capex + Opex (including energy cost at economic cost)	$	H + L + N	$134,342,566	13,492,500	13,492,500	26,532,500	22,442,500	13,492,500	13,492,500	13,492,500	13,492,500	13,492,500	13,492,500	30,132,500	30,132,500	26,532,500	24,532,500	13,492,500
	Economic Internal Rate of Return																		
Q	Benefit of Supplying Water	$		$499,935,320	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128
R	EIRR (with energy cost at tariff)	%	Q - O	35%	136,317,128	136,317,128	123,277,128	127,367,128	136,317,128	136,317,128	136,317,128	136,317,128	136,317,128	136,317,128	119,677,128	119,677,128	123,277,128	125,277,128	136,317,128
S	EIRR (with energy cost at economic cost)	%	Q - P	34%	126,936,628	126,936,628	113,896,628	117,986,628	126,936,628	126,936,628	126,936,628	126,936,628	126,936,628	126,936,628	110,296,628	110,296,628	113,896,628	115,896,628	126,936,628
	Cost of New Water Source - Walkers Ferry																		
	Capex (DWS Component)																		
T	Dams	$			50,000	-	-	-	-	50,000	-	-	-	-	50,000	-	-	-	-
U	Resettlement	$			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
V	WTP	$			-	1,010,000	4,050,000	1,010,000	-	-	-	-	-	-	-	1,010,000	-	1,010,000	4,050,000
W	Pipelines +reservoirs+electric lines	$			-	-	-	-	-	-	-	-	15,560,000	15,560,000	15,560,000	-	-	-	-
X	Pumping Stations	$			-	2,150,000	3,990,000	1,780,000	-	-	-	-	-	-	-	2,150,000	-	1,780,000	3,310,000
Y	Physical Contingencies	$			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Z	Engineering	$			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AA	**Sum of Total Capex**	$	T+U+V+W+X+Y+Z	$70,423,661	50,000	3,160,000	8,040,000	2,790,000	-	50,000	-	-	15,560,000	15,560,000	15,610,000	3,160,000	-	2,790,000	7,360,000
	OpEx (DWS Component) - excluding energy costs																		
AB	Chemicals	$			379,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000	379,000
AC	Annual Maintenance	$			1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000	1,247,000
AD	Personnel	$			195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000	195,000
AE	**Sum of Total Opex - exluding energy costs**	$	AB+AC+AD	$6,853,027	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000	1,821,000
	Energy																		
AF	Energy cost at tariff ($0.03/kWh)	$		$10,217,178	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000	3,315,000
AG	Energy Cost at economic cost ($0.17/kWh)	$	AF x (0.17/.0.03)	$57,476,665	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509	18,648,509
	NPV (at 10% discount rate)																		
AH	Capex +Opex excluding energy cost)	$	AA+ AD	$77,276,689	1,871,000	4,981,000	9,861,000	4,611,000	1,821,000	1,871,000	1,821,000	1,821,000	17,381,000	17,381,000	17,431,000	4,981,000	1,821,000	4,611,000	9,181,000
AI	Capex +Opex (including energy cost at tariff)	$	AA + AD + AE	$87,493,867	5,186,000	8,296,000	13,176,000	7,926,000	5,136,000	5,186,000	5,136,000	5,136,000	20,696,000	20,696,000	20,746,000	8,296,000	5,136,000	7,926,000	12,496,000
AJ	Capex +Opex (including energy cost at economic cost)	$	AA + AD + AF	$134,753,354	20,519,509	23,629,509	28,509,509	23,259,509	20,469,509	20,519,509	20,469,509	20,469,509	36,029,509	36,029,509	36,079,509	23,629,509	20,469,509	23,259,509	27,829,509
	Economic Internal Rate of Return																		
AK	Benefit of Supplying Water	$		$530,035,218	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128	140,429,128
AL	EIRR (with energy cost at tariff)	%	AK - AI	50%	135,243,128	132,133,128	127,253,128	132,503,128	135,293,128	135,243,128	135,293,128	135,293,128	119,733,128	119,733,128	119,683,128	132,133,128	135,293,128	132,503,128	127,933,128
AM	EIRR (with energy cost at economic cost)	%	AK- AJ	47%	119,909,618	116,799,618	111,919,618	117,169,618	119,959,618	119,909,618	119,959,618	119,959,618	104,399,618	104,399,618	104,349,618	116,799,618	119,959,618	117,169,618	112,599,618

Note: Mombezi - Makuwa begins operating in 2019. Walkers Ferry in 2018. Benefit of water supply begins the first year of operation. Walkers Ferry benefits begin a year before Mombezi-Makuwa

Appendix D WSS Sub-sector Definitions and Data

	Definition	Population estimate	Coverage estimates
Urban Water	Urban areas are those within the Water Boards' Service Areas. Access to water includes piped water provided by the Water Boards as well as estimates of access provided by boreholes and protected wells.	In urban areas—areas in the Water Boards Service Areas—the population is estimated to be 2.4 million in 2008.[74] This figure comes from Sogreah's Feasibility Report for Lilongwe[75] and Blantyre[76] and by the Water Boards for SRWB, CRWB and NRWB. The population projections comes from the Sogreah Feasibility studies for Lilongwe and Blantyre. For the Mzuzu and Zomba the population projections were derived from the Census.[77] Estimates for the growth-rate in towns was estimated from the historical growth rates of towns served by CRWB and SRWB.	The population served with improved water in urban areas from Water Boards is estimated to be 1.6 million. A further 12 percent of the population are estimated to receive water from boreholes and protected wells, a percentage that falls to 3 percent by 2030 as Water Boards networks are predicted to expand. The Water Boards' coverage is estimated from figures in the Sogreah Feasibility studies for Lilongwe and Blantyre, figures from the NRWB and SRWB for coverage in their areas and the Census is used for CRWB.
Urban Sanitation	Urban areas are those within the Water Boards' Service Areas. The definition of improved sanitation is that used in the Malawi Demographic and Health Survey 2010. At its most basic this is access to improved latrine with an impermeable floor that is not shared with other households. It also includes flush toilets and others.		The population with access to improved sanitation in urban areas—the population in Water Board Service Areas—is taken from the 2010 Demographic and Household Survey.
Rural Water	Rural areas are those outside the Water Boards Service Areas. Access to water is from improved water sources.[78]	The population in rural areas—areas outside of the Water Board Service Areas—is estimated to be 10.5 million. This estimate is calculated by deducting the population in urban areas from the total population. The population growth is projected in line with projections for rural districts from the 2008 Census.[79]	The population with access to improved water in rural areas is taken from the 2008 Census.
Rural Sanitation	Rural areas are those outside the Water Boards Service Areas. The definition of the improved sanitation is that used in the Malawi Demographic and Health Survey 2010[80] that is access to improved latrine with an impermeable floor that is not shared with other households.		The population with access to improved sanitation in rural areasthe population outside of Water Board Service Areas—is taken from the 2010 Demographic and Household Survey.
Schools (backlog)	The Schools backlog is for primary schools and uses figures from the 2008 School WASH Report.	The backlog of schools figure comes from the 2008 School WASH Report.[81]	Number of schools with access to improved water and sufficient number of latrines comes from the 2008 School WASH Report.

[74] 2008 is the date of the most recent census and so the latest date for which figures on population are known.

[75] Feasibility Studies and Preliminary Design for Lilongwe New Water Source, Updated Feasibility Study Report, July 2010, N° 1.32.0145 R10.

[76] Blantyre New Water Source: Feasibility Study Report", Sogreah.

[77] 2008 Population and Housing Census Results, National Statistical Office of Malawi, Government of Malawi.

[78] An improved water source is defined as one that comes from a range of water sources including boreholes, protected wells and the Water Boards. The definition comes from WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation in Malawi (updated March 2010).

[79] 2008 Population and Housing Census Results, National Statistical Office of Malawi, Government of Malawi.

[80] 2010 Malawi Demographic and Health Survey.

[81] "Malawi School WASH 2008, A Status Report on Water, Sanitation and Hygiene in Primary Schools" Ministry of Education, Science & Technology, May 2009.

Appendix E Will Prepaid Water Meters Work in Urban Areas in Malawi?

Prepaid water meters manage the volume of water supplied to connections by only providing the amount that customers pay for. This technology, along with an accompanying management system, can help improve data gathering, increase collections where installed, reduce operating costs, and incorporate water demand management. Utilities in countries such as Uganda, South Africa, and Kenya, have introduced these meters with mixed success. Despite the advantages, relevant institutions like Water Boards, the Ministry responsible for Water Supply and Sanitation, and Development Partners, should carefully consider conditions that will affect the success of this technology before they invest in it. Lastly, based on some of the costs presented in this report it seems to make sense to use prepaid meters for communal water points, but a more thorough financial analysis should be conducted to determine if investment for individual residential connections should proceed.

E.1 How do Prepaid Water Meters Work?

A prepaid water meter controls the volume of water supplied by a connection, according to the amount the customer pays upfront. Meter users can generally purchase credit through a bank, ATM, cell phone banking, or credit card, but this varies depending on the system. After introducing the credit, the meter supplies the customer with water until credit is consumed, which triggers the valve to automatically close.

The meter can have features like automatic meter reading (AMR) that measures the amount of water consumed by each connection. Other features can indicate where the system is leaking, signal when the meter has been tampered with which automatically shuts off water supply, and even be programmed to allow for block tariffs and free water allowances. Table E.1: Prepaid Meters offered by Manufacturers below presents a sample of pre-paid meters offered by manufacturers, along with features and unit costs.

Table E.1: Prepaid Meters offered by Manufacturers

Manufacturer	AMR	Tamper Detection	Leak detection	Block Tariff/Water Allowance	Billing Savings	Unit Cost (USD)	Comments
TagMeter – Intelligent Meter (Namibia)	✓	✓		✓	✓	N/A[82]	Microprocessor measures flow and controls sensors, transponder Tags read the meter, and data results are written on Tag and fed into Management Software. Meter is powered with battery (5 year lifespan), or hydropower optional feature. Very accurate (0.05 liter) system for Water Board to create effective water and cash flow management.
Prepaid Meters – Prepaid Sub-Meter(South Africa)	✓	✓				$295-308[83]	Sub-meters do not necessarily replace primary meter systems owned by the utility/municipality; but can be privately owned, or publicly owned and privately managed. Utility still sends property monthly bills, but allows the owner/manager to receive payment from tenants for the utilities used. Can request to replace primary meter with pre-paid meter as well. Battery life lasts 7 to 10 years. Consumer can see credit limit, meter status, battery statues, and input tokens, on display.
Efteq – Intelligent Meter (South Africa)	✓	✓	✓	✓	✓	$133-143[84]	Efteq offers the intelligent water metering system: consists of integrated meter and control valve, vending network, meter management system, wireless communication between meters and management system, and ensures 100% collection where used. Also offers paperless post-pay system that lets customers accumulate debt and pay through vending network. Meter configurations include a water management device that controls daily consumption, standard prepayment meter, and post pay mode with settable credit limit (no billing it required). Also has air flow detection and correction. Battery powered (5 year life).

Source: TagMeter, accessed April 5, 2012, http://www.tagmeternamibia.com/. Prepaid Meters, accessed April 5, 2012, http://www.prepaidmeters.co.za/. Efteq effective technologies, accessed April 5, 2012 http://efteq.com/.

[82] According to website, meters and spare parts are offered at a low cost, but not costs were provided on website and manufacturer did not respond.

[83] Company offers two models. Cost of meter does not include tax (14percent in South Africa).

[84] Basic meter costs (includes features mentioned in the table) is $156 but discount of about 15% is available for orders of 10,000 meters or more; discount brings cost down to $133.

Even the most basic prepaid meters in the table above have automatic meter reading and tamper detection components. Additional features are optional, and are likely customized upon ordering meters. Though optional features may add to the unit cost of the meter, the additional benefits of the features may be well worthwhile. We offer a financial analysis in Section E.5, but a more in depth financial analysis could provide each Water Board with an idea of what make sense for them if they decide to implement prepaid meters.

E.2 Potential Benefits

Potential benefits of prepaid meters include increased collections, avoided costs of disconnecting consumers that do not pay their bills, and avoided fees on behalf of consumers for reconnecting to the system. This technology also helps improve water demand management[85], and decrease operating costs of manual meter readings and billing.

Prepaid meters help increase collections where it is used, because consumers only receive the water they pay for. So, if the system is working properly, it should promise a high collections rate where used. Prepayment also allows avoids the need to disconnect customers for defaulting on payments because they will not receive more water until they pay for it; this in turn will avoid the reconnection cost. Improvement in water demand management is advertised as a benefit of the technology; because consumers pay for water upfront, and realize the cost of water, they are more likely to consider how much water they use. AMR technology that is built into prepaid meters allow utilities to save on costs associated with manual readings, such as personnel for reading meters, transportation costs, and losses from misreading meters. Lastly, a utility can save on the cost of billing customers with prepaid meters—the technology collects revenue upfront so there is no need to incur the cost of billing the customer.

The main takeaway of this technology is that people consume what they pay. Water Utilities in Uganda, South Africa, and Kenya have installed prepaid meters in recent years; these cases are further discussed below.

E.3 Where have prepaid meters been used in Africa?

E.3.1 Uganda – Kampala Urban Poor Project

The National Water and Sewerage Corporation (NWSC) in Uganda implemented prepaid water meters at public stand posts (PSPs) in efforts to improve water supply and sanitation services in poor, informal settlements in Kampala. The first project was completed in 2008, and a second followed shortly after. Funds were provided by the German Development Agency KfW, the African Water Facility (AFW), and the African Development Bank (AfDB).[86]

NWSC was strongly motivated to implement this technology because it discovered that vendors at PSPs would charge rates up to five times higher than the tariff. Additionally, vendors would fail to turn in collections to the utility.[87] Failure to turn in arrears led the

[85] "Meters were introduced [in Johannesburg] as an innovative water demand management tool to control consumption" http://www.globalwaterintel.com/archive/5/11/market-insight/ready-for-advanced-solutions.html (Warrington, 6).

[86] National Water and Sewerage Company. Accessed April 6, 2012. http://www.nwsc.co.ug/affairs01.php.

[87] 7M Construction Magazine. "Kampala Urban Poor Water Supply and Sanitation Project by NWSC." (September 2010). Accessed April 6, 2012. http://www.7m-magazine.com/development/108-development/201-kampala-urban-poor-water-supply-and-sanitation-project-by-nwsc.

utility to disconnect PSPs that had in fact paid for their water. This resulted in poor access in these communities—customers could not afford the water and had limited access to supply. In this case, prepaid meters helped bypass not the higher cost of water that the poor were paying, and also ensure that the Utility gained the collections from water actually consumed.

In the long run, NWSC expects to reduce operating expenses where prepaid meters have been installed—60 percent of the service charge comes from meter reading, producing and delivering bills, and collection of payments. With prepaid systems, NWSC can reduce these costs by 90 percent.[88] Another positive result is that the poor now pay at tariff, and supposedly there is an increased availability of water because PSPs can be accessed at all times not just when the vendor decides to operate it.

E.3.2 South Africa

Prepaid electricity meters had been working well in South Africa, and it seemed like a good idea to introduce the same technology for water. However, "people don't really tamper with [electric meters] because they are afraid of getting an electric shock"[89] whereas water meters do not pose the same threat and so were being tampered with. Given the technological features that prepaid meters can have, as presented in Table E.1: Prepaid Meters offered by Manufacturers, the problems encountered in South Africa can be avoided in the future. Tamper detection features not only notify the utility that a meter has been manipulated, but also automatically shuts off the water valve so that the connection will not supply water until the Utility reactivates it. Furthermore, the meters can be programmed to allow for block tariffs, free water allowances, change back between pre and post pay, and even have a lifeline flow (which continues to provide a small quantity of water after the credit is exhausted).

E.3.3 Kenya

The Kisumu Water and Sewerage Company (KIWASCO) in Kenya introduced prepaid water metering in 2010. A pilot project was launched in the Nyalenda slum, which has 50,000 people.[90] Because of limited access to water, illegal and unmetered connections were a major problem in this slum. Low quality water coming from these connections was resold to the community at an expensive rate. The overall objectives of the project were to provide water supply service to Nyalenda, and improve quality of service at a more affordable price while reducing water losses that had resulted from un-metered and illegal connections.

If the project works, the intention is to expand the project to other slums as well, contributing to NRW reduction, which according to KIWASCO is around 45 percent.[91] Clearly, other Water Utilities have been using prepaid meters in attempts to control the water supplied, and also to allow consumers to pay for water at the price the utility charges and not some arbitrary third party supplier. Prepaid meters will likely help reduce NRW by

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[88] Ibid. [89] Global Water Intelligence. Accessed April 5, 2012. http://www.globalwaterintel.com/archive/4/4/general/emerging-markets-pleased-to-meter.html.

[89] Global Water Intelligence. Accessed April 5, 2012. http://www.globalwaterintel.com/archive/4/4/general/emerging-markets-pleased-to-meter.html.

[90] http://www.ambafrance-ke.org/IMG/pdf/27_-_Water_and_Sanitation_-_Kisumu-Nyalenda.pdf. Used TagMeter company in Namibia.

[91] http://www.kiwasco.co.ke/news&events11.html. KIWASCO reports a large part of NRW is due to illegal and unmetered connections, but the entire NRW amount should not be contributed only to this.

decreasing the cost of supplying water, but will also help increase collections where these meters exist, because people will pay for the water upfront.

E.4 Risks and Conditions for Success

Prepaid meters have been used by various water utilities with the hope of increasing collections, reducing NRW, and essentially gaining better control of operations in areas of with poor management. Though installation of prepaid meters have had mixed results in the past, with careful consideration this technology could be successful in urban areas in Malawi. Some of the failures illustrated in the cases above, could be easily resolved by choosing to features like tamper proof detection, which could detect any attempts to manipulate or vandalize meters. Another potentially beneficial feature is the programmed block tariff, free water allowance or lifeline flow; this option would make it possible to segment the market and install prepaid meters across communities with varying disposable income.

Though some aspects of this technology increase the chances of success, the Water Boards and communities may have to contribute to make the technology work. For example, though prepaid meters can have a tamper proof feature, this should be complemented with laws that enforce punishment to criminals that attempt to establish illegal connections, or vandalize the property of the water utility. Another task the Water Boards should take responsibility for is ensuring that customers that use prepaid meters will actually receive the service they paid for by checking that meters are functioning well, and that the system does not have air in it. An intermittent water supply system can easily cause air, and even dirt and other foreign particles, to enter the water supply system, and the meter detects the activity as if water is being supplied to that connection when it is not.[92] By closely monitoring that meters are functioning properly, and if possible investing in improving continuity of service, Water Boards could ensure that customers are receiving the quality of service they pay for.

It is important that logistics related to prepaid meters, but not necessarily inherent in the technology are considered. The obvious complementary service for prepaid meters is the system that sells credit to customers, which they need to use for their prepaid meters. So, it is important to provide or make sure that locations that sell credit are readily accessible to customers. Credit can normally be purchased via a bank, ATMs, cell phone banking, credit cards, and cards bought at local stores. Customers should also have easy access to things needed to use credit service; for example, a bank account is needed for using an ATM, and a cell phone is needed for cell phone banking. Another investment that may be worthwhile is an education campaign to show users how the technology works, and becomes socially accepted. Lastly, investments in this technology should occur where it makes economic sense—such as where demand exists at the scale needed to recover investment—but also where institutions to manage the technology exist, like Utilities for a piped systems. The following section includes a brief financial analysis that tests if it makes sense to use this technology in Water Board Service Areas in Malawi.

E.5 Indicative Financial Analysis

This technology is used for cost-recovery; however, investment costs vary greatly depending on the type of prepaid meter—our research has shown that prepaid meters can cost as little as $10 or more than $300 for individual connections, and from $300 to $500 for kiosk

[92] http://www.wsp.org/wsp/sites/wsp.org/files/publications/Continuous_Water_Supply.pdf.

connections.[93] The best cost estimate to use would be one provided directly by the manufacturer, for meters tailored with the features the Water Board prefers.

Investment costs can be passed onto the consumer in the form of registration fees and service costs. When coupled with increased collections and decreased operating costs, investment costs can be quickly recovered. Table 6.2 below, shows an example of the investment required to install this technology, as well as the payback period for individual connections and kiosks.

Table E.2: Investing in Prepaid Meters for Residential Connections

	Item	Units	Calculations	Value	Source
A	Price of Prepaid Meter	$		133[94]	Efteq South African Manufacturer. Referenced in Table 2.1
B	Household consumption	cu. m/day		0.30	Sogreah for per capita consumption per individual connection for Blantyre and NSO for people per household[95]
C	Water tariff	$/cu. m		0.88	Sogreah Blantyre Feasibility Study
D	Water Expenditure per Household	$/year	B x C x 365	95	
E	Collection Rate	%		82	Northern Regional Water Board, 2010[96]
F	Losses per individual connection	$/year/connection	(1-E) x D	17	
G	Payback period	years	A/F	8	
H	NPV of Savings for individual connections	$	NPV of Meter Costs(A) – NPV of Losses per	10[98]	

[93] Some manufacturers found on alibaba.com/showroom/prepaid-water-meter.html, advertise $10-30 per piece, but a minimum of 1,000 pieces must be ordered. A manufacturer in South Africa offers prepaid meters for individual connections at about $308 before tax. Efteq provided a cost of $300 per kiosk meter while a study for NWSC showed $488 per kiosk meter.

[94] Personal communication with the manufacturer indicated that the unit cost is $156, but that about a 15% discount can be applied to orders of 10,000 or greater. The discounted value is $133.

[95] 66 liters per capita per day.

[96] The only Water Board that provided collection rates.

	Item	Units	Calculations	Value	Source
			connections (F)[97]		
I	EIRR of investment for individual connections	%		12	
J	Cost of Prepaid Meter for Kiosk	$		488[99]	NWSC Pro-poor water strategies paper[100]
K	Kiosk Consumption	cu. m/day		6.25	Sogreah assumption for capita consumption for Blantyre and District Investment Plan for people per kiosk[101]
L	Annual Expenditure per Kiosk	$/year	E x F x 365	2,008	
M	Losses per kiosk connection	$/year/connection	(1-E) x J	361	
N	Payback period	years	H/K	1	
O	NPV of Savings for kiosk connections	$	NPV of Meter Costs(J) – NPV of Losses per connections (M)[102]	2,305	
P	EIRR of investment for kiosk connections	%		285	

[98] NPV was calculated using a 10% discount rate.

[97] Cash flow created by assuming investment of meter in year 1($133), and constant losses per connection ($17) for 15 years (useful life of meter). These were discounted at 10%.

[99] Cost is for a public water point that assumes will supply 150 people. It is not clear if this cost came from a per capita cost, in the case of Uganda would be $3.25, or if it is a fixed cost and so would mean a lower cost per capita in Malawi—250 people per kiosk would mean $1.95 per capita.

[100] Pro-poor water service strategies in developing countries: Promoting justice in Uganda's urban project. University of Florida for NWSC. Table 1: Breakdown of unit capital costs. pg.16. http://warrington.ufl.edu/purc/purcdocs/papers/0807_Berg_Propoor_Water_Service.pdf.

[101] Assumes 25 liters per capita per day and 250 people per kiosk connection.

[102] Cash flow created by assuming investment of meter in year 1($488), and constant losses per connection ($361) for 15 years (useful life of meter). These were discounted at 10%.

Based the unit cost of only prepaid meters it seems to make sense to install them at individual and kiosk connections—the rate of return is 12 percent for individual connections and 258 percent for kiosks. The payback period at the household level is relatively long for an average sized household (9 years) with a correspondingly low IRR of only 12 percent. This result is sensitive to the price of the meter (in our analysis the return drops below 10 percent when meter price is above $144). Further, it could make sense to install them in households with high consumption and poor payment history. For example, some estimates expect individual connection consumption to increase to an average of 135 liters per capita per day, in which case the payback period decreases to 4 years and the IRR increases to 36 percent (assuming all other assumptions stay the same).[103] Meter costs will vary depending on the specifications of the meter ordered, but manufacturers provide costing to clients and so Water Utilities could look into this further for more tailored cost estimates.

E.6 The Way Forward

Apart from the meter costs presented in the financial analysis, additional costs for the management system and infrastructure replacements may apply, and so we recommend that a thorough financial analysis is conducted before investing in this technology. Relevant institutions should also take into account the conditions needed for the technology to succeed in reducing costs and increasing financial returns to the Water Boards, while providing access and improved service to consumers. Even where it makes financial sense to invest in prepaid meters, external conditions should be factored in to ensure that this technology is effective.

[103] Feasibility Study for Lilongwe New Water Source pg. 27, Sogreah Consultants.

Appendix F Projects in the Sector

Funded and unfunded projects for urban and rural, water supply and sanitation are presented in this Appendix.

F.1 Funded Projects for Urban and Rural, Water Supply and Sanitation

This section shows projects that received funding, and that will most likely be implemented in the current plan period (2012-2015). These have been incorporated into the investment plan presented. Table F.1 below, lists funded urban water supply projects according to each Water Boards.

Table F.1: Complete List of Funded Urban Water Supply Projects

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
BLANTYRE WATER BOARD					
A020	Rehabilitation of Walker's Ferry Treatment Plant	4,000,000	150,000	27	Improvement of Walker's Ferry treatment works by increasing capacity of treatment plant from 78,000 m3 to 96,000 m3. NWDP Progress Report: Indicates that 105,000 m3 will not be achieved. Currently work being done under EIB.
A142	Chapima Heights	565,088	5,000	113	Supply water to 1,000 plots that are beige developed. Project co-funded with Press Properties Ltd. Extend water supply service to new areas being developed.
A018	Construction and supervision of three storage reservoirs	9,200,000			Improve pressures in high upland areas by construction of-pipeline construction for reservoir. Some resources for construction supervision and other for consulting service. Reservoirs at Kameza, Chilobwe, and Chigumula.
A019	Rehabilitation and renewal of Chileka pumping station	7,820,000			Replacement of pumps at Chileka pumping station. BWB water supply investments and projects report say it involved repairing electrical transformers, pumps, and motor at two main pumpingg stations. Allowed for increased water production and transmission due to shortened breakdown time. This will enable transfer for additional quantity of water to Blantyre city through walker's ferry. There will be need to increase pumping capacity to match treatment works expansion.
A140	BWB-Prepaid metering	30,060			Immediate phase is a pilot (my 5M).Aims to improve collection efficiency and enable board to manage projects through increased

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
					funds that they will put towards service delivery and increased coverage.
A141	BCA Mavuto Branch MHC.	173,401			Lay reticulation for newly developed plots so future residents have access to water supply services. Extend water supply service to new areas being developed.
A145	Mudi Rehabilitation Works.	2,000,000			Works would be undertaken with funding from current IDA. Improve water supply and have impact on people living in Blantyre as more than 35% of served population rarely gets water services 24 hours. NWDP Progress Report says that the design report and draft bidding documents were submitted to the Bank in May 2011 for review. Bank granted a conditional no objection for works. Board responded to Bank comments, and bidding process is expected to commence by mid October 2011. Will improve water supply (continuity of service).
A148	Kanjedza Lands.	787,572			The project is co-financed by Ministry of Lands to supply water to over 1,000 plots that would be developed in Kanjedza. Extend water supply service to new areas being developed.
A155	CCODE Projects in Machinjiri.	180,360			BWB is planning to supply water to project where number of plots are going to be formed. Jointly funded by BWB and CCODE. Extend water supply service to new areas being developed.
A156	Mpemba DC.	159,879			Extend service to several plots that would be developed in area. Jointly financed with Blantyre District Council. Extend water supply service to new areas being developed.
LILONGWE WATER BOARD					
A027	Supply and installation of penstock for (TW2), Cone Valves for Kamuzu Dam 2 and Bunda Plant, and Piezometers for KD 1 to reduce NRW.	850,000	600,000	1	Renewal of convey valves for Kamazu Dam 2 and Bunda Plant and piezometers at KD 1. Supply and installation of penstock for TW2, Cone Valves for Kamuzu Dam 2 and Bunda Plant, and Piezometers for Kamuzu Dam 1 to reduce NRW. Lilongwe Corporate Plan 2008-2013 :TW2 high lift station pumps water simultaneously both to Mtunthama and Chayamba. Comprises of 4 no. high lift pump sets each with design capacity of 1,147 m3/hour. Three pumps can be run simultaneously with one pump serving as standby. Maximum achievable flow of three pumps is

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
					2,937 m3/hour. EIB Project shortfall to accomplish objective. Otherwise scope will be reduced.
A023	Chikungu-Construction of 2000m3 area 9 tower and 5000 m3 storage tank; Supply of pipes and fitting for Chikungu and area 9 water supplies.	8,150,000	150,000	54	Construction of Area 9 tower and pumping mains: This sub component involves the construction of 2000m3 RC tower at area 9; construction of 5,000m3 RC GL tank; construction of operators building, fencing, and landscaping. Supervision will be carried out by consultants. Bidding documents will be finalized soon and the works will be tendered out.
A012	Construction of 100 kiosks for Chikungu development project.	300,000			Design and bid documents are ready. Supervision will be carried out in-house, by LWB staff. Tendering could commence as soon as funds are approved.
A026	Procurement of materials for TW1 rehabilitation.	1,682,833			Procurement of materials for TW1 rehabilitation, for Mwenda. Lilongwe Corporate Plan 2008-2013: TW1 high lift station pumps water to Mwenda (southern part of Lilongwe City). The station comprises of pump sets in three sections A, B, C with difference capacities.
A032	Supply 2 pump sets each for Mtunhama and Chikungu (4 total).	700,000			Supply of 2 No. Pump Sets at booster station to pump water to 2000m3. Installation by supplier. Lilongwe Corporate Plan 2008-2012: Mtunthama booster station comprises of 3 pump sets. One big pump design flow of 396m3/hr and a pumping head of 54m and two identical smaller pumps with a design flow of 248m3/hr and a head of 54m. The mode of operation is such that 2 pumps are on duty at one particular time, and the other on standby.
NORTHERN REGIONAL WATER BOARD					
A091	Supply of water meters, and pipes for Mzuzu, Chitipa, Karonga, Chilumba, Rumphi, Ekwendi, Mzimba, Nkhata Bay, and Chintheche Water Supply.	889,000	20,000	44	Supply of water meters for Mzuzu, Chitipa, Karonga, Chilumba, Rumphi, Ekwendi, Mzimba, Nkhata Bay and Chintheche Water Supply.
A008	Construction supervision and construction of new	2,500,000	40,000	63	Part of New Water Source for Mzimba—New water intake, 10 km of main pipe, water supply improved from 15 to 22 hrs; current

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
	water intake weir and transmission pipe for Mzimba; and uprading and expansion of Mzimba water supply system.				intake not reliable in dry season. Construct concrete intake weir across river and a 12km long 315mm diameter pipeline will be installed to convey water from river to treatment plant. Design for works available. Construction of project will provide potable water for additional 40,000 people. EIA will also be conducted. According to NWDP Progress Report, environmental and social Impact Assessment contract and associated water transmission pipeline was signed in July 2011. Assignment was supposed to be completed in October 2011. World Bank has provided "no objection" for construction of project and associated water transmission pipeline for Mzimba water supply system. Advertisement for works awaits completion of ESIA report.
A016	Water Supply Consultancy/Supervision, and Distribution pipelines for Mzuzu Town.	18,550,072	160,000	116	Consultancy service for design of project "distribution pipelines for Mzuzu town". Construction supervision of upgrading and expansion works for Mzuzu distribution system. NWDP Progress Report says bids received by September 2011 deadline. Bids were evaluated and evaluation report is currently being finalized. Then report will be submitted to World Bank's "No Objection".
A007	Construction, and construction supervision of Songwe Water Supply Scheme and capacity building of communities at Songwe.	2,590,000	4,000	648	Construction supervision of upgrading and expansion works for Songwe water supply scheme. Market center with government institutions and small businesses. Involves drilling and development of boreholes, construction of storage tanks, installation of water treatment equipment and pipelines. 4,000 beneficiaries of potable water. Water supply engineer submitted revised SEIA report in July 2010 and was accepted. Consultant also submitted a detailed design report which was accepted. NRWB PIU is still carrying out financial analysis of project and preparing business plans. Upgrading and expansion works for Songwe water supply scheme. NWDP Progress report says that bids received to undertake the drilling of 3 boreholes were received, evaluated, and submitted to Office of Director for Public Procurement for approval. Response has yet to be given. World Bank provided "no objection" on bidding documents for the rest of the works for constructing Songwe water supply system. Advertisement for works will begin after drilling and development of boreholes has been completed.

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
A099	Capacity building of NRWB staff to manage upgraded and expanded water supply systems.	350,000	131	2,672	Capacity building of NRWB staff to manage upgraded and expanded water supply systems. NRWB says that training of member of WUA and CWP is in progress in Chizumulu island. Presentation of messages to communities about importance of potable water, sanitation facilities, and HIV&AIDS issues is ongoing. Preparation of radio and video documentaries on construction works for Chizumulu water supply system is also underway.
A169	Supply and Installation of 2 diesel generators for Chitipa Boma.	0			NRWB is in the process of engaging a supplier for the generators. The process has taken long because contract negotiation failed with the supplier who was identified initially. NWDP Progress report says that negotiation of contract is dependent on assurance from lowest bidder, that NRWB will pay bidder's supplier directly (in U$), for the generators. NRWB has sent a request for "no objection" to World Bank. Fresh quotations will be sources in Oct-Dec 2011 quarter.
CENTRAL REGIONAL WATER BOARD					
A006	Construction/expansion of Nkhotakota Water Supply.	2,900,000	70,000	41	7 boreholes, pumps, pump stations, 8km transmission pipeline, 18 km distribution pipeline. NWDP Progress report: designs are under final internal review before submission to Bank to start recruitment process for contractor. Designs have been completed. Construction of Nkhotakota Water Supply Rehabilitation, Upgrading and Expansion Works. Detailed designs and bid documents and scope will be submitted to Bank for approval. No objection to commence tendering process given in this period. Tendering will commence.
A002	Rehabilitation and expansion of Mponela Water Supply.	2,830,000	40,000	71	Construction of Mponela Water Supply Rehabilitation, Upgrading and expansion works. NWDP AF: Investment for laying 20 km dist. Pipeline, and installation of one water tank of 350 m3. Benefits 20,987 people. NWDP Progress report indicates that works contract was signed in May 2011 for U$ 1,899,000 (Contractor is Aquabor International). Works started in May 2011 and is at 52% completion rate. Designs and bid documents for IDA additional financing requirement were submitted to Bank in September 2011. Designs have already been completed according to NWDP excel file.

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
A022	Expansion Salima Lakeshore Water Supply Scheme.	7,570,000	50,000	151	Construction and Expansion of Salima Lakeshore Water Supply Schemes: New intake structure + 3 structures, treatment plant 1.2 km pumping main, 14 transmission pipelines, storage tanks, 30 km distribution network, 14 new communal water points, 12 rehab communal water points, etc. NWDP Progress Report: Design and financial analysis, together with bid documents 1st phase (U$ 2 million), were submitted to the Bank in May 2011. Comments from Bank have since been incorporated in designs and submitted. ToRs for recruitment of Consultant for Construction Supervision will be reviewed together with submitted designs.
A034	Rehabilitation and expansion of Kasungu Water Supply Project.	3,770,000	12,700	297	Construction of Kasungu Water Supply Rehabilitation, Upgrading and Expansion Works: Construction of 11 km distribution pipeline supply and install of 350 m3 storage tank and 19 community water points. Estimated 12,700 beneficiaries of low income areas around casing town. NWDP Progress Report says works commenced in April 2011 by contractor (Proprietary Manufacturing and Engineering-Western Construction JV). Contract for construction supervision was signed in January. Consultant is Metaferia Consulting Engineers of Ethiopia, in association with Hydroconsult of Malawi. Additional Financing is on hold to observe progress and performance of contractor. Designs have been completed.
A149	Kochilira-Kamwendo.	737,000			Draft designs completed August 2010; final approved July 2011. Bid submitted in October 2011. NWDP Progress Report: final designs and tender documents preparation were submitted to Bank in July 2011. Bank approved float tender in September. Bid submission are in October 2011.
A153	Mitundu & Linthipe (MCs).	390,613			100m3 tanks were installed in each market center in December 2009. Contracts for boreholes awarded in July 2010. 2 boreholes drilled in each center and wait to be equipped. Contract for installing reticulation was signed in April 2011. Works started in May 2011 and was expected to be completed in October 2011, but is delayed. Contract for completing installation of system for both centers was signed in April 2011. Work began in May 2011, work should have been completed by October 2011. Progress in Mitundi

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
					and Linthipe is approximate 75% and 60% respectively. Contractor is Grimo Contractors (local). Installation of pipes and fittings for both centers to be done between Oct-Dec 2011.
SOUTHERN REGIONAL WATER BOARD					
A176	Feasibility Studies and preliminary designs for raw surface water sources.	400,000	26,733	15	The raw water surface will be for multi-purpose use. The population presented is for towns under SRWB jurisdiction.
A013	Construction Supervision and Construction of Nsanje Water Supply Scheme.	4,200,000	220,000	19	Construction Nsanje Water Supply Project: drill and equip boreholes, 7km transmission lines, 2 concrete reservoirs, 32.5 km distribution pipelines, 20 new communal water points (CWPs), rehab and upgrade 21 CWPs. USD 4M for works and USD.2M for construction supervision. According to info provided by SRWB, Final detailed design report is awaited from consultant after SRWB commented. All detailed designs have been completed.
A154	Construction of Lirangwe Market Center.	270,000	7,620	35	Supervising consultant is Eng. Owen Kankhulungo at MK 6,240,000. Mr. Ephrone Mwenitete, is an individual consultant for Miseu Folo at a price of MK 5,610,000. The contractor for Lirangwe is Hema Construction Civils & Building Contractors at a price of MK 40,735,500. Contractor mobilized in February 2011 for a period of 4 months. Works completed and waiting for ESCOM connection. Local Utility operators were recruited. .
A080	Construction supervision of Neno water supply.	100,000	2,000	50	Construction supervision of Neno water supply : Designs, tender documents, and technical specifications for Neno Market Centre were completed in July 2011. No obligation to tender from MAIWD received in April 2011. Revised design report resubmitted to PMU after incorporating comments from WB. Contract is in post review; comments were addressed and resubmitted to PMU to forward to Bank. Approval from IPC to notify shortlisted consultant was received in August 2011. Reviewing technical and financial proposal from Mr. Tutule Msukwa under progress to be completed October 2011. Proposals are under review though contract signing will pend waiting for works contract.
A150	Construction of Miseu Folo Market Center.	450,000	8,000	56	Contract for Miseu Folo awarded to Munshi & Nephew JV, contract price MK 67,981,180. Works completed in September

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
					2011 and awaiting for ESCOM connection. Local Utility operators were recruited .According to NWDP Progress Report (July-Sept 2001), construction of buildings and pipe networks have been completed, and boreholes and service reservoirs are at 80%.
A005	Upgrading of Zomba Water Supply.	5,613,800	92,507	61	Zomba and Mangochi Water Supply Project will be executed as one contract although there are different financiers. Recruitment of contractor is almost finalized. Works to commence in September 2011.
A146	Construction of Chididi, Ntowe and Tengani Market Centres.	1,400,000	22,458	62	Contractor Saifro Ltd & Unipumps Nigeria Ltd JV mobilized in May 2011 at price MK 157,293,485. Supervising Engineer is DDMA at contract price: MK 25,619, 305. Contract is for period of 10 months.
A143	Construction of Jali, Mayaka, and Chambe Market Centers.	2,700,000	26,675	101	Malbro International (CIVILS) engaged in April 2011 to construct water supply and sanitation facilities for listed MC. Contract amount MK 400,233,858. The same consult hydroconsult will also supervise these centers.
A147	Construction of Maldeco Market Center.	1,300,000	12,819	101	Proprietary Manufacturing Engineering were engaged in June 2011 for construction works for water supply and sanitation facilities for Maldeco Market Centre. Contract amount is MK 187, 400,000. Supervising engineer is hydroconsult.
A015	Upgrading of Mangochi Water Supply Scheme.	3,000,000	17,634	170	Zomba and Mangochi Water supply project will be executed as one contract although there are different financiers. Recruitment of the contractor is almost finalized. Works will commence in early September.
A081	Construction supervision and Construction of Balaka Water Supply Scheme.	4,500,000	22,110	204	Construction of Balaka Water Supply will help with water supply shortage by constructing boreholes, rehabilitating and extending, transmission and distribution network, reservoirs, administrative block, operational and supervision consultancy. New water sources are being proposed to supplement to Mpira Balaka Dam. Will also help water supply shortage and enhance system performance. Includes drilling and equipping boreholes and associated structures, Laying of 150mm diameter pumping main, supply and, installation of 2no. Tanks, Laying of extension pipelines at Balaka, Carry out new water connection.

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
A014	Construction Supervision and Construction of Mangochi Water Supply Scheme, and new connections.	7,138,674	24,460	292	To cover construction supervision costs of Mangochi Water supply scheme. Supervising Consultant is SSI in association with Chapita Consultants at a contract price of U$480,233.

The following table lists funded rural water supply projects. These have also been included in the investment plan.

Table F.2: Funded Rural Water Supply Projects

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita	Description of Project
A177	WASH - Develop and Rehabilitate drinking water sources, and Sanitation Marketing Campaign.	5,454,021	940,000	6	Nationwide program that aims to increase access to safe drinking water sources, as well as sanitation facilities (with emphasis on women and children). Works in primary schools and teaches proper hygiene methods.
A046	Chikwawa East Bank GFS.	165,058	11,040	15	Construction of Chikwawa water supply. Rehabilitation and expansion of GFS—covers work contract expenses, materials, fittings, and accessories for rehabilitation and construction of system components. According to AM Oct/Nov 2011, the scheme has 4 water systems. The 4 schemes had intakes rehabbed, mainlines upgraded; 1 set of treatment works was rehabbed. The project had 350 taps, of which 6% were repaired. Works related to this project, pending, are construction of chambers for gate and air valves, pipe connections between treatment works, construction of river crossings on some main lines (i.e. under-bed and suspended and completion of tap unit rehabilitation). An estimate of $90,000 is required to complete rehabilitation of remaining treatment works (4 roughing and 2 slow sand filters). NWDP Progress report: contract is 98% complete. 269 water point committees have been formed. 35 committees trained.
A047	Usisya GFS.	274,999	18,360	15	Rehabilitation of treatment works at Usisya-Nkhatabay. Rehabilitation of GFS—covers works contract expenses, materials, fitting, and accessories for rehabilitation and construction of system components. Schemes to be rehabilitated and extended in the second phase of the project.
A043	Nkhamanga-Katizi GFS.	538,999	34,200	16	Rehabilitation of treatment works at Nkhamanga-Rumphi (Katizi new line). 90m3 tank has been built for Nkamanga scheme. Rehabilitation and expansion of GFS—covers works contract expenses, materials, fitting, and accessories for rehabilitation and construction of system components. 85% complete.
A114	Strengthening of	12,160,559	625,000	19	Goal is to improve access to water supply in rural areas:

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita	Description of Project
	Decentralized Water Management Structures.				Karonga(45,537), Rumphi(45,228), Nkhota- kota (93,752), Ntcheu(108,350), Ntchisi(69,721), Balaka(50,502), Chikwawa(104,807), Mangochi (179,496), Nsanje(42,488), Phalombe(42,184), Thyolo(192,492). Components: Awareness creating in local councils, community mobilization campaigns, rehab/maintain non-functional water points; construct new water facilities; assess capacity gaps ;conduct training for water point committees in local council; monitor and supervise facilities repair/maintenance/training sessions; monitor/evaluate local mgmt. structure in communities. Progress to date according to PSIP profile: 2,500 boreholes were assessed for rehabilitation or maintenance; all of them will be rehabilitated or maintained between November 2011- October 2012; water point committees will be established between December 2012- August 2013; Committees will be trained between October 2013- May 2015; All water points will be commissioned between July 2015- June 2016.
A044	Ntonda GFS.	159,999	7,680	21	Rehabilitation and expansion of GFS—covers works contract expenses, materials, fitting, and accessories for rehabilitation and construction of system components.
A059	Chapananga GFS.	1,144,999	49,320	23	Rehabilitation and expansion of GFS—covers works contract expenses, materials, fitting, and accessories for rehabilitation and construction of system components. Tender documents for goods for schemes developed and ready for advertising. According to NWDP Progress Report (July-Sept 2011), preliminary designs for scheme have been completed, and final design is in final stage.
A117	Ground Water Development & Mgmt. Programme.	2,404,800	100,000	24	Build 119 boreholes and rehabilitate 281 (400 boreholes total with corresponding water point committees); benefitting 100,000 people total providing them with water supply and capacity to operate and maintain facilities; also includes procurement of equipment. Chitipa, Karonga, Mzimba, Nkata-Bay, Rumphi, Dedza, Dowa, Kasungu, Lilongwe, Mchinji, Nkhota-Nhkota, Ntcheu, Ntchisi, Salima, Balaka, Blantyre, Chikwawa, Chiradzulu, Machinga, Mangochi, Mulanje, Mwanza, Neno, Nsanje, Phalombe, Thyolo, Zomba—increase access to water supply in rural areas mainly through constructing boreholes and rehabilitation of 300-700 non-

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita	Description of Project
					productive boreholes. Project will contribute to reducing water-borne diseases through improved water supply facilities. Also will produce groundwater map (3 years) and will have a capacity building component (5 years).
A041	Mpira-Balaka GFS.	1,239,999	49,800	25	Rehabilitation and expansion of GFS—covers works contract expenses, materials, fitting, and accessories for rehabilitation and construction of system components. AM Oct/Nov 2011: Works at main treatment plant are in progress. MoIWD staff and community upgraded lines, construct one under bed crossing, rehabilitated over 200 taps and constructed 50 additional taps. MoIWD established Trust in Balaka to oversee management. The tariff in place is not enough to sustain scheme operations. Need to hire Local Utility Operator, but will be difficult do due to limited financial resources. NWDP Progress Report: Contract offer withdrawn and works were re-advertised, bids have been evaluated and another contractor is yet to start works.
A040	Mvula GFS.	1,107,999	27,600	40	Rehabilitation and expansion of GFS—covers works contract expenses, materials, fitting, and accessories for rehabilitation and construction of system components. AM Oct/Nov 2011: Works at main treatment plant are in progress. MoIWD staff and community upgraded lines, construct one under bed crossing, rehabilitated over 200 taps and constructed 50 additional taps. MoIWD established Trust in Balaka to oversee management. The tariff in place is not enough to sustain scheme operations. Need to hire Local Utility Operator, but will be difficult do due to limited financial resources. NWDP Progress Report: Contract offer withdrawn and works were re-advertised, bids have been evaluated and another contractor is yet to start works.
A053	Ifumbo GFS.	409,999	7,800	53	Rehabilitation of Ifumbo piped water supply system in Chitipa: Rehabilitation and expansion of GFS - covers work contract expenses, materials, fitting, and accessories for rehabilitation and construction of system components. NWDP Progress Report mentions that survey was done for this scheme, and that designs are being completed by an engineer.
A048	Chinukha GFS.	339,999	4,800	71	Rehabilitation of Chinukha piped water supply system in Chitipa:

Project ID	Project Name	Estimated Cost (USD Equivalent)	Beneficiaries (Individuals)	Cost per Capita	Description of Project
					Rehabilitation and expansion of GFS—covers work contract expenses, materials, fitting, and accessories for rehabilitation and construction of system components. NWDP Progress Report mentions that survey was done for this scheme, and that designs are been are being completed by an engineer
A042	Misuku GFS.	1,192,999	13,920	86	Rehabilitation and expansion of GFS—covers work contract expenses, materials, fitting, and accessories for rehabilitation and construction of system components. Tender documents for goods have been developed and ready for advertising.
A045	Lizulu GFS.	229,999	2,400	96	Lizulu Scheme-Ntcheu-Construction of treatment works. Rehabilitation and expansion of GFS—covers work contract expenses, materials, fitting, and accessories for rehabilitation and construction of system components. NWDP Progress Report says that detailed designs for treatment works have been completed and have been submitted for further checking and approval.

Table F.3 below, lists funded sanitation projects that will be developed in urban and rural areas. An additional category is included in this table to indicate whether the project is urban or rural. If one of the Water Boards is listed under the "Implementing Agency" column that indicates it is an urban sanitation project. If the MoAIWD (the Ministry Responsible for Water Supply and Sanitation) is listed, than this is a rural sanitation project.

Table F.3: Funded Urban and Rural Sanitation Projects

Project ID	Project Name	Estimated Cost (USD Equivalent)	Implementing Agency	Beneficiaries (Individuals)	Cost per Capita	Description
A180	WASH - Hygiene and Sanitation Practices.	3,385,255	MoAIWD	1,000,000	3	Nationwide program that aims to increase access to safe drinking water sources, as well as sanitation facilities (with emphasis on women and children). Works in primary schools and teaches proper hygiene methods.
A001	Investments under BWB and LWB - Sanitation Planning and Marketing.	800,000	BWB	21,390	37	Continue implementation of sanitation marketing under NWDP II: aim to increase adoption of latrine options, hand washing, use of safe drinking water, and clean latrines. -Same campaign carried out by BWB and LWB—estimated 4,650 beneficiaries. Combined. NWDP Progress Report says that a Bids Reevaluation Report (BER) was submitted to Bank after IPC approval. Bank rejected this BER, and asked to re-issue bidding documents. The new deadline is Oct 12, 2011. Contract would be for 6 months.

The table below shows school projects that have been funded.

Table F.4: Funded Projects for Schools

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Schools)	Cost per School	Description of Project
A003	School Sanitation in Dedza.	1,000,000	Funded	63	15,873	Construction of improved latrines urinal blocks, and hand washing facilities, construction supervision of promotion of hygiene.
A179	WASH- Safe sanitation facilities in schools.	188,070	Funded	300	627	Nationwide program that aims to increase access to safe drinking water sources, as well as sanitation facilities (with emphasis on women and children). Works in primary schools and teaches proper hygiene methods.

F.2 Unfunded Projects for Urban and Rural Water Supply and Sanitation

This section lists projects for urban and rural water supply and sanitation that have not yet received funding. Projects are listed from lowest cost per capita (most cost effective), to highest cost per capita (least cost effective). Cost per capita could provide a realistic indication of how much the project will achieve in terms of contributing to increases in access to water supply and sanitation. However, investment decisions should take into account other considerations as well, such as the particular benefits the project will have, the capacity of institution to implement the project, and equity.

Table F.5: Unfunded Urban Water Supply Projects

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
LILONGWE WATER BOARD						
A024	Procurement of meters and connection fittings in new areas of 25, 49 and Chikungu.	300,000	Not Funded	3,000	100	Procurement of meters and connection fittings in new areas of 25, 49, and Chikungu.
NORTHERN REGIONAL WATER BOARD						
A123	Repair & replacement of malfunctioning meters.	240,000	Not Funded	30,000	8	
A119	Rehabilitate water closet systems in public schools.	1,000,000	Not Funded	40,000	25	
B016	Water Supply Consultancy/Supervision and Distribution pipelines for Mzuzu Town.	4,600,000	Component Not Funded	160,000	29	Upgrading and expansion works for Mzuzu water supply distribution system. NWDP progress report indicates Submitted bids are under review. Supply and installation of app. 95 km of pipeline. Expected additional beneficiaries of 28,000 with continuity of 20-23 hrs. of supply. 28,000 beneficiaries. Follow up to earlier works in Mzuzu in order to extend supply to low income areas.
A097	Karonga Intake structure and Suction Pipe Construction.	1,100,000	Not Funded	30,000	37	
A121	NRWB Prepaid metering system for prioritized institutions.	44,370	Not Funded	1,000	44	

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
B091	Supply of water meters, and pipes for Mzuzu, Chitipa, Karonga, Chilumba, Rumphi, Ekwendi, Mzimba, Nkhata Bay and Chintheche Water Supply.	900,000	Component Not Funded	20,000	45	Supply of water meters for Mzuzu, Chitipa, Karonga, Chilumba, Rumphi, Ekwendi, Mzimba, Nkhata Bay, and Chintheche Water Supply.
A122	Individual metering for security forces.	285,000	Not Funded	5,000	57	
A120	Develop laboratory in Mzimba and Karonga.	35,000,000	Not Funded	359,000	97	
A093	Design, construction supervision, and construction of sewerage system for Mzuzu.	9,200,000	Not Funded	90,000	102	Design and construction supervision of sewerage system for Mzuzu.
A105	Design, construction supervision, construction, and capacity building for communities at of Wovwe, Nyungwe, and Ngala water supply systems.	7,153,750	Not Funded	47,350	151	Design and construction supervision for Wovwe, Nyungwe and Ngala water supply systems.
A118	Develop investment appraisals for at least 4 potential market centers, and develop potential market centers.	3,520,000	Not Funded	20,000	176	
A103	Design, construction supervision, construction, and capacity building for	7,656,750	Not Funded	32,554	235	Design and construction supervision for Hewe and Livingstonia water supply systems.

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
	communities at Hewe and Livingstonia water supply systems.					
A094	Design, construction supervision, and construction of Karonga and Mzimba.	13,800,000	Not Funded	50,000	276	Detailed design and supervision of Karonga and Mzimba.
A101	Construction supervision, construction, and capacity building for communities at Mpherembe and Embangweni water supply systems.	4,263,750	Not Funded	12,100	352	Construction supervision for Mpherembe and Embangweni water supply systems.
A096	Design, construction supervision, and construction of upgrading and expansion works for Karonga.	11,500,000	Not Funded	30,000	383	Design and construction supervision of upgrading and expansion works for Karonga.
A104	Design, construction supervision, construction, and capacity building for communities at of Wenya, Chisenga, and Misuku water supply systems.	11,692,500	Not Funded	26,700	438	Design and construction supervision for Wenya, Chisenga, and Misuku water supply systems.
A102	Construction supervision, construction, and capacity building for communities at Mwazisi	3,375,000	Not Funded	7,000	482	Construction supervision for Mwazisi water supply system.

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
	water supply system.					
A092	Construction and construction supervision, of new water intake, treatment plant, transmission mains, and upgrading and expansion of distribution system for Chitipa water supply scheme.	13,570,000	Not Funded	25,590	530	Construction supervision of upgrading and expansion works for Chitipa water supply system.
A106	Design, construction supervision, construction, and capacity building for communities at Usisya, Mpamba and Kande water supply systems.	12,000,000	Not Funded	18,000	667	Design and construction supervision for Usisya, Mpamba and Kande water supply systems. Surveys have been completed for this scheme, and designs are being completed by Engineer. Preliminary design for this scheme has been completed and submitted for checking.
A095	Construction supervision, and construction of upgrading and expansion works for Chilumba, Rumphi, and Nkata Bay.	18,440,000	Not Funded	25,910	712	Construction supervision of upgrading and expansion works for Chilumba, Rumphi, and Nkata Bay.
A009	Detailed design and supervision, and construction of Mzimba Dam.	41,130,000	Not Funded	50,000	823	Detailed design and supervision of Mzimba Dam. Feasibility designs and preliminary designs completed.
A100	Design, construction supervision, construction, and capacity building for communities at Jenda water supply system.	5,400,000	Not Funded	5,000	1,080	Design and Construction supervision for Jenda water supply system.

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
A098	Design, construction supervision, construction of upgrading and expansion works for Ekwendi & Chintheche.	13,800,000	Not Funded	10,000	1,380	Design and construction supervision of upgrading and expansion works for Ekwendi & Chintheche.
B099	Capacity building of NRWB staff to manage upgraded and expanded water supply systems.	350,000	Component Not Funded	131	2,672	Capacity building of NRWB staff to manage upgraded and expanded water supply systems. NRWB says that training of member of WUA and CWP is in progress in Chizumulu island. Presentation of messages to communities about importance of potable water, sanitation facilities, and HIV&AIDS issues is ongoing. Preparation of radio and video documentaries on construction works for Chizumulu water supply system is also underway.
A107	Design, construction supervision, construction, and capacity building for communities at Chikangawa, Euthini, Edingeni, Kafukule, and Manyamula water supply systems.	21,000,000	Not Funded	5,000	4,200	Design and construction supervision for Chikangawa, Euthini, Edingeni, Kafukule, and Manyamula water supply systems.
CENTRAL REGIONAL WATER BOARD						
B034	Rehabilitation and expansion of Kasungu Water Supply Project.	400,000	Component Not Funded	12,700	31	Construction of Kasungu Water Supply Rehabilitation, Upgrading and Expansion Works: Construction of 11 km distribution pipeline supply and installation of 350 m3 storage tank and 19 community water points. Estimated 12,700 beneficiaries of low income areas around casing town. NWDP Progress Report says works commenced in April 2011 by contractor (Proprietary Manufacturing and Engineering-Western Construction JV). Consultant is Metaferia Consulting Engineers of Ethiopia, in association with Hydroconsult of Malawi. Additional Financing is on hold to observe progress and performance of contractor.

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
						Designs have been completed.
A037	Construction of Extension of Dwanga Water Supply Scheme to new zone including surface water treatment package plant.	1,500,000	Not Funded	25,000	60	Continuation of ACGF intervention to reach more low income areas. Drilling of boreholes started in October 2010; 3 were unsuccessful, 1 more will be drilled and tested. NWDP Progress Report: 88% of planned pipeline extension has been installed. Remaining pipelines are for transmission and part of new distribution of new supply zone on southern side works wait for drilling of boreholes from internal resources.
SOUTHERN REGIONAL WATER BOARD						
B081	Construction supervision and Construction of Balaka Water Supply Scheme.	275,000	Component Not Funded	22,110	12	Detailed design and construction supervision for Mwanza, Balaka, Chikwawa, and Mulanje water supplies.
A175	Muloza Water Supply Scheme.	707,617	Not Funded	6,257	113	
B004	Construction Supervision and Construction of Zomba Water Supply Scheme, and new water connections.	2,242,278	Component Not Funded	19,200	117	Construct water supply scheme for Zomba and expand supply to low income areas. AF is for rehab and replacement of 35 km asbestos cement and galvanized iron pipes and construction of reservoir to improve capacity. 2 components: works -USD 2.35 m and supervision—USD $1.5 M. Contract awarded to SSI in association with Chapita Consultants at contract price $480,233; signed March 2011. Supervision to start in November 2011.
A086	Construction of Ngabu Water Supply.	3,316,666	Not Funded	7,510	442	Construction of Ngabu Water Supply.
A083	Mulanje Water Supply Scheme.	7,681,693	Not Funded	15,790	486	Construction of Mulanje Water Supply.
A085	Construction of Luchenza Water Supply.	5,316,666	Not Funded	10,750	495	Construction of Lucheza Water Supply.
A084	Construction of	3,775,000	Not	7,000	539	Construction of Chikwawa Water Supply.

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
	Chikwawa Water Supply.		Funded			
A082	Mwanza Water Supply Scheme.	8,322,981	Not Funded	14,560	572	Construction of Mwanza Water Supply.
A087	Construction of Namwera Water Supply.	2,916,666	Not Funded	4,500	648	Construction of Namwera Water Supply.

The table below lists rural water supply projects that have not been funded.

Table F.6: Unfunded Rural Water Supply Projects with Complete Information

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
B041	Mpira-Balaka GFS.	11,364	Component Not Funded	49,800	0	Supply and delivery of 1800 water meters (800 for 7 schemes and 1000 for 11 schemes).
B059	Chapananga GFS.	11,364	Component Not Funded	49,320	0	Supply and delivery of 1800 water meters (800 for 7 schemes and 1000 for 11 schemes).
B043	Nkhamanga-Katizi GFS.	11,364	Component Not Funded	34,200	0	Supply and delivery of 1800 water meters (800 for 7 schemes & 1000 for 11 schemes).
B040	Mvula GFS.	11,364	Component Not Funded	27,600	0	Supply and delivery of 1800 water meters (800 for 7 schemes and 1000 for 11 schemes).
B047	Usisya GFS.	11,364	Component Not Funded	18,360	1	Supply and delivery of 1800 water meters (800 for 7 schemes and 1000 for 11 schemes).
B042	Misuku GFS.	11,364	Component Not Funded	13,920	1	Supply and delivery of 1800 water meters (800 for 7 schemes and 1000 for 11 schemes).
B046	Chikwawa East Bank GFS.	11,364	Component Not Funded	11,040	1	Supply and delivery of 1800 water meters (800 for 7 schemes and 1000 for 11 schemes).
A060	Three focus districts—Procurement of materials and tools and equipment for rehabilitation of piped water supply systems, and rehabilitation of piped water supply systems.	200,000	Not Funded	175,000	1	Procurement of materials, tools, and equipment for rehabilitation of piped water supply systems in 3 focus districts. AM Oct/Nov 2011: the 3 districts have distributed sanitation plans and are mobilizing communities to build improved latrines. Designs completed months ago, but procurement is not up to date. Additional resources required especially for Chapananga scheme.
B053	Ifumbo GFS.	11,364	Component Not Funded	7,800	1	Supply and delivery of 1800 water meters (800 for 7 schemes and 1000 for 11 schemes).
B044	Ntonda GFS.	11,364	Component Not Funded	7,680	1	Supply and delivery of 1800 water meters (800 for 7 schemes and 1000 for 11 schemes).

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
B048	Chinukha GFS.	11,364	Component Not Funded	4,800	2	Supply and delivery of 1800 water meters (800 for 7 schemes and 1000 for 11 schemes).
A050	Dombole-Ntcheu. Procurement of materials and tools and equipment for rehabilitation of pipelines, and Rehabilitation of treatment works.	174,286	Not Funded	60,000	3	Procurement of material,s tools, and equipment for rehabilitation of pipelines at Dombole-Ntcheu.
A049	Lingamasa-Mangoch.- Procurement of materials and tools and equipment for rehabilitation of pipelines, and rehabilitation of treatment works.	314,286	Not Funded	100,000	3	Procurement of materials, tools, and equipment for rehabilitation of pipelines at Lingamasa-Mangochi.
A058	Kavomolo in Chitipa. Procurement of materials and tools and equipment for rehabilitation of piped water supply system, and rehabilitation of piped water supply system.	237,286	Not Funded	70,000	3	Procurement of materials, tools, and equipment for rehabilitation of Kavomolo piped water supply system in Chitipa.
A054	Champila South-Mzimba. Procurement of materials and tools and equipment for rehabilitation of pipelines, and rehabilitation of	264,286	Not Funded	75,000	4	Procurement of materials, tools, and equipment for rehabilitation of pipelines at Champila South-Mzimba. Schemes to be rehabilitated and extended in the second phase of the project.

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
	treatment works.					
A052	Mwasambo-Nhotakota &Ntchisi. Procurement of materials and tools and equipment for rehabilitation of pipelines, and rehabilitation of treatment works	214,286	Not Funded	60,000	4	Procurement of materials, tools, and equipment for rehabilitation of pipelines at Mwasambo-Nhota kota &Ntchisi. Schemes to be extended in the second phase of the project.
A056	Chisenga in Chitipa.Procurement of materials and tools and equipment for rehabilitation of piped water supply system, and Rehabilitation piped water supply system.	429,286	Not Funded	100,000	4	Procurement of materials, tools, and equipment for rehabilitation of Chisenga piped water supply system in Chitipa.
A051	Chipoka-Salima-Procurement of materials and tools and equipment for rehabilitation of pipelines, and rehabilitation of treatment works	219,286	Not Funded	50,000	4	Procurement of materials tools and equipment for rehabilitation of pipelines at Chipoka-Salima.
B045	Lizulu GFS.	11,364	Component Not Funded	2,400	5	Supply and delivery of 1800 water meters (800 for 7 schemes and 1000 for 11 schemes).
A055	Dwambazi-Nkhota kota and Nkhata Bay. Procurement of materials and tools and equipment for	371,886	Not Funded	70,000	5	Procurement of materials, tools, and equipment for rehabilitation of pipelines at Dwambazi-Nkhota kota and Nkhata Bay. Schemes to be rehabilitated and extended in the second phase of the project.

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
	rehabilitation of pipelines, and rehabilitation of treatment works.					
B117	Ground Water Development & Mgmt. Programme.	601,200	Component Not Funded	100,000	6	Build 119 boreholes and rehabilitate 281 (400 boreholes total with corresponding water point committees); benefitting 100,000 people total providing them with water supply and capacity to operate and maintain facilities; also includes procurement of equipment. Chitipa, Karonga, Mzimba, Nkata-Bay, Rumphi, Dedza, Dowa, Kasungu, Lilongwe, Mchinji, Nkhota-Nhkota, Ntcheu, Ntchisi, Salima, Balaka, Blantyre, Chikwawa, Chiradzulu, Machinga, Mangochi, Mulanje, Mwanza, Neno, Nsanje, Phalombe, Thyolo, Zomba—increase access to water supply in rural areas mainly through constructing boreholes and rehabilitation of 300 -700 non-productive boreholes. Project will contribute to reducing water-borne diseases through improved water supply facilities. Also will produce groundwater map (3 years) and will have a capacity building component (5 years).
A057	Chitekwa in Chitipa. Procurement of materials and tools and equipment for rehabilitation of piped water supply system, and rehabilitation of piped water supply system.	198,000	Not Funded	30,000	7	Procurement of materials, tools, and equipment for rehabilitation of Chitekwa piped water supply system in Chitipa.
A111	Dispersed Boreholes Construction and Rehabilitation Programmes.	4,779,540	Not Funded	225,000	21	Drilling and rehabilitation of boreholes in 27 districts. Increase access to potable water supply to meet MDG by 2015.

Table F.7 below, lists projects for urban and rural sanitation, that have complete information (estimated cost and number of beneficiaries), but have not received funding.

Table F.7: Unfunded Projects with Complete Information for Urban and Rural Sanitation

Project ID	Project Name	Estimated Cost (USD Equivalent)	Status of Funding	Implementing Agency	Beneficiaries (Individuals)	Cost per Capita (USD/capita)	Description of Project
B180	WASH - Hygiene and Sanitation Practices.	16,402,424	Component Not Funded	MoAIWD	1,000,001	16	Nationwide program that aims to increase access to safe drinking water sources, as well as sanitation facilities (with emphasis on women and children). Works in primary schools and teaches proper hygiene methods.
A093	Design, construction supervision, and construction of sewerage system for Mzuzu.	9,200,000	Not Funded	NRWB	90,000	102	Design and construction supervision of sewerage system for Mzuzu.
A094	Design, construction supervision, and construction of Karonga and Mzimba	13,800,000	Not Funded	NRWB	50,000	276	Detailed design and supervision of Karonga and Mzimba.