11.3 Annex 3: Calculations for Average Incremental Cost (AIC)

Determination of projected costs and tariffs require project definition and cost estimates. The following calculations are based on research findings in Mombasa.

Project definition and cost estimate

Recent engineering studies concluded that there was need to improve bulk water supply and to strengthen the distribution network in Mombasa and the coastal area. Among other outputs, the studies defined two main project components:

- Bulk water supply development for Mombasa and
- Improvements to water distribution network in Mombasa.

The total construction cost of the bulk supply component is estimated at US$223 million. The operation and maintenance costs for this component is estimated at US$1.82 million per year. It is assumed that these costs will remain constant for the life of the project since flow of water is by gravity.

The construction cost for the component to improve the distribution network is estimated at US$62 million. Assuming commercial management, the optimal operation and maintenance costs for the distribution system is estimated at about Ksh27/= (US$0.37) per m3.

The total capital costs to implement both the bulk supply component and improvements in distribution network is estimated at US$285 million.

Project Scenarios

Two different scenarios for determination of the average incremental cost (AIC) for Mombasa are considered. The scenarios are based on implementing the two project components recommended by the recent engineering studies. It is assumed that NWCPC succeeds in obtaining low interest, long term investment capital to undertake bulk supply development, transmission and distribution works. The following assumptions have been made to facilitate determination of AIC costs:

- Capital costs are only incurred at the end of construction period, after which the project starts to produce benefits.
- The only benefits delivered by the project are in form of revenue from sale of water. In practice, infrastructure projects, and more so water projects, deliver social and economic benefits, most of which cannot be easily quantified.
- Annual operation and maintenance (O & M) costs are constant. In many infrastructure projects, O & M costs increase over time as the infrastructure gets old. O & M costs could also reduce over time if management efficiency increases in the operations and maintenance phase of a project.
- The life of the project is assumed to be only 25 years for purposes of calculating the AIC. It is known that such projects have a much longer life span. In particular, most gravity based water projects deliver benefits for longer periods, sometimes as long as fifty to a hundred years. The existing Mzima pipeline water project is over 45 years old and still producing the same quantity of water it was producing 45 years ago at minimal operation and maintenance cost.

- The quantity of water produced by the infrastructure and sold to customers is constant throughout the life of the project. In practice, some water projects operate at a low capacity on commissioning and achieve full production capacity a few years later as population and water demand increases. Since Mombasa is a capacity constrained city with suppressed demand, high willingness to pay but with problems of obtaining investment capital, it is assumed that the project now under consideration will be operated at full capacity soon after commissioning. Other projects will come on line after a few years to help meet the water demand of the growing population.

The total capital cost for both project components is US$285 million. Provision for rehabilitation of the system is made at US$10 million. It is assumed that this amount will be spent in the 10th year after commissioning. Both scenarios 1 and 2 assume that financing will be available to finance bulk supply and improvements to the distribution network. It is assumed that the full costs of improving the water supply system will be met from water sales from the entire region.

The following further assumptions are made:

- Financing is secured at 8% per annum with a grace period equal to the construction period, so that repayments commence after commissioning when water is sold to customers.
- Management of the distribution system will be on commercial basis.

The operation and maintenance cost for Sabaki (Baricho) water source has been estimated at US$0.59 per m^3. It is assumed that Marere and Tiwi maintain production at capacities of 12,000m^3/day and 6,000m^3/day respectively and that Baricho source maintains its present contribution of 72,000m^3/day. The total amount of water distributed by the strengthened network is assumed to be 176,400m^3

Scenario 1 assumes a high level of management efficiency estimated at 15% unaccounted for water (UFW) and 90% bill collection efficiency. For this scenario, the average incremental cost of water works out as US$1.08 per m^3. With the present exchange rate of KSh73/= to the US$, the Average Incremental Cost is about Ksh78.85/= per m^3

Scenario 2 assumes a moderate level of management efficiency at 20% unaccounted for water (UFW) and 85% bill collection efficiency. For this scenario, the average incremental cost of water works out as US$1.21 per m^3. With the present exchange rate of KSh73/= to the US$, the Average Incremental Cost is about Ksh88.30/= per m^3.

Detailed calculations for each of the two scenarios are presented below.

Scenario 1: AIC calculation based on high level of management efficiency
Scenario 1 assumes a high level of management efficiency.

Further assumptions are:

- Unaccounted for water (UFW) is 15% so that 85% of water produced is sold (billed for).
- Revenue (bill) collection efficiency of the water utility is 90% (with commercial management). This means that 90% of the water sold is actually paid for.

Total Capital Cost of the second Mzima pipeline, storage, & distribution
US$285,000,000

Annual O&M cost (Mzima bulk supply, 86400m3/day)	US$2,000,000/yr
Annual O&M cost (Baricho & Tiwi bulk sources, 78,000@US$0.59)	US$16,797,000/yr
Annual O&M costs (distribution system with commercial management)	US$8,000,000yr
Total operation and maintenance costs	US$26,797,000/yr
Annual water produced 176,400m3/day	64,386,000m^3/yr
Annual water sold (@15%UFW)	54,730,000m^3/yr
Annual water sold and paid for (@90% bill collection efficiency)	49,260,000m^3/yr
Discount Rate	8%

With these assumptions, the average incremental cost for the project is calculated as shown below.

Table 11.1. Scenario 1: AIC calculation based on high level of management efficiency (15% UFW and 90% bill collection efficiency)[1]

Year	Capital Costs in '000 US$	Operation and MaintenanceCosts in '000 US$	Total Costs in '000 US$	Discount Factor at 8% Discount Rate	Present Value of Total Costs in '000 US$	Water sold and paid for in '000m^3/yr	Present Value of Water sold and paid for in '000m^3/yr
1	285,000	16,797	301,797	0.926	279,464	25,000	23,150
2		26,797	26,797	0.857	22,965	49,260	42,216
3		26,797	26,797	0.794	21,277	49,260	39,112
4		26,797	26,797	0.735	19,696	49,260	36,206
5		26,797	26,797	0.681	18,249	49,260	33,546
6		26,797	26,797	0.630	16,882	49,260	31,034
7		26,797	26,797	0.583	15,623	49,260	28,719
8		26,797	26,797	0.540	14,470	49,260	26,600
9		26,797	26,797	0.500	13,399	49,260	24,630
10	10,000	26,797	36,797	0.463	17,037	49,260	22,807
11		26,797	26,797	0.429	11,496	49,260	21,133
12		26,797	26,797	0.397	10,638	49,260	19,556
13		26,797	26,797	0.368	9,861	49,260	18,128
14		26,797	26,797	0.340	9,111	49,260	16,748
15		26,797	26,797	0.315	8,441	49,260	15,517
16		26,797	26,797	0.292	7,825	49,260	14,384
17		26,797	26,797	0.270	7,235	49,260	13,300
18		26,797	26,797	0.250	6,699	49,260	12,315
19		26,797	26,797	0.232	6,217	49,260	11,428
20		26,797	26,797	0.215	5,761	49,260	10,591
21		26,797	26,797	0.199	5,333	49,260	9,803
22		26,797	26,797	0.184	4,931	49,260	9,064
23		26,797	26,797	0.170	4,556	49,260	8,374
24		26,797	26,797	0.158	4,234	49,260	7,783
25		26,797	26,797	0.146	3,912	49,260	7,192
				TOTAL PRESENT COSTS	545,312	TOTAL PRESENT VALUE OF WATER SOLD AND PAID FOR	503,336

1. Average Incremental Cost = (Present Value of Total Costs)/(Present Value of water sold and paid for
=US$545,312,000 503,336,000$m^3$ = US$1.08per m^3

In this scenario, the average incremental cost of water is US$1.08 per m^3. With the present exchange rate of KSh73/= to the US$, the Average Incremental Cost is about Ksh78.85/ = per m^3

In order to break even, the average tariff would be set at US$1.08 per m^3.

Scenario 2: AIC calculation based on moderate level of management efficiency
Scenario 2 is similar to scenario 1 above but at a lower level of management efficiency. In this scenario, the AIC is calculated assuming that UFW is 20% and bill collection efficiency is 85%.

Total Capital Cost of the second Mzima pipeline, storage, & distribution	US$285,000,000
Annual O&M cost (Mzima bulk supply, 86400m^3/day)	US$2,000,000/yr
Annual O&M cost (Baricho & Tiwi bulk sources, 78,000@US$0.59)	US$16,797,000/yr
Annual O&M costs (commercial management assumed)	US$8,000,000/yr
Total operation and maintenance costs	US$26,797,000/yr
Annual water produced 176,400m^3/day	64,386,000m3/yr
Annual water sold (@ 20%UFW)	51,510,000m3/yr
Annual water sold and paid for (@ 85% bill collection efficiency)	43,800,000m3/yr
Discount Rate	8%

With these assumptions, the average incremental cost for the project is calculated as shown below.

In this scenario, the average incremental cost of water is US$1.21 per m^3. With the present exchange rate of KSh73/= to the US$, the Average Incremental Cost is about Ksh88.30/ = per m^3

In order to break even, the average tariff would be set at US$1.21 per m^3.

The above calculations show that efficient management of a water utility has the potential to lower water tariffs.

Table 11.2. Scenario 2: AIC calculation based on high level of management efficiency (15% UFW and 90% bill collection efficiency)[1]

Year	Capital Costs in '000 US$	Operation and Maintenance Costs in '000 US$	Total Costs in '000 US$	Discount Factor at 8% Discount Rate	Present Value of Total Costs in '000 US$	Water sold and paid for in '000m^3/yr	Present Value of Water sold and paid for in '000m^3/yr
1	285,000	16,797	301,797	0.926	279,464	24,000	22,224
2		26,797	26,797	0.857	22,965	43,800	37,537
3		26,797	26,797	0.794	21,277	43,800	34,777
4		26,797	26,797	0.735	19,696	43,800	32,193
5		26,797	26,797	0.681	18,249	43,800	29,828
6		26,797	26,797	0.630	16,882	43,800	27,594
7		26,797	26,797	0.583	15,623	43,800	25,535
8		26,797	26,797	0.540	14,470	43,800	23,652
9		26,797	26,797	0.500	13,399	43,800	21,900
10	10,000	26,797	36,797	0.463	17,037	43,800	20,279
11		26,797	26,797	0.429	11,496	43,800	18,790
12		26,797	26,797	0.397	10,638	43,800	17,389
13		26,797	26,797	0.368	9,861	43,800	16,118
14		26,797	26,797	0.340	9,111	43,800	14,892
15		26,797	26,797	0.315	8,441	43,800	13,797
16		26,797	26,797	0.292	7,825	43,800	12,790
17		26,797	26,797	0.270	7,235	43,800	11,826
18		26,797	26,797	0.250	6,699	43,800	10,950
19		26,797	26,797	0.232	6,217	43,800	10,162
20		26,797	26,797	0.215	5,761	43,800	9,417
21		26,797	26,797	0.199	5,333	43,800	8,716
22		26,797	26,797	0.184	4,931	43,800	8,059
23		26,797	26,797	0.170	4,556	43,800	7,446
24		26,797	26,797	0.158	4,234	43,800	6,920
25		26,797	26,797	0.146	3,912	43,800	6,395
				TOTAL PRESENT COSTS	545,312	TOTAL PRESENT VALUE OF WATER SOLD AND PAID FOR	449,186

1. Average Incremental Cost = (Present Value of Total Costs)/(Present Value of water sold and paid for)
= US$545,312,000/449,186,000$m^3$ = **US$1.21 per m3**