Coast region. By multiplying with the proportion of average area of the village in the two regions, the average settlement area of the villages in Dar es Salaam is presumed as 26.8%.

For the formulation of the groundwater development plan, the exploitable number of wells is estimated in accordance with area of the settlement of each village.

9.7 WATER QUALITY ANALYSES

9.7.1 OUTLINE OF WATER QUALITY ANALYSES

The water quality analyses was carried out at following periods.

- Surface water (river, charco-dam, shallow well) in dry season (sampling period: 21 to 29 October 2004) in rainy season (sampling period: 17 to 20 January 2005) at 36 number of locations
- Groundwater (existing wells) (sampling period: 21 to 29 October 2004) at 35 number of locations
- Groundwater (test wells drilled in the Study) (sampling period: 18 December 2004 to 7 January 2005) at 9 number of locations

A total of 110 samples were collected and analysed. Demarcation of the sampling number from each water source and detailed sampling points are tabulated in *Table 9.8* and *9.9*, respectively. Their locations are shown in *Figure 9.20*. *Table 9.10* summarised analyses methods applied for each parameter.

Table 9.8 Number of Samples Collected for the Water Quality Analysis

Water Source		Number of samples collected		Total number of samples
		Dry season	Rainy season	
Groundwater	Test well	9		9
	Existing well	35		35
Surface Water	Dug well	4	5	9
	Shallow well	10	10	20
	River	13	12	25
	Dam	3	3	6
	Charco Dam	1	1	2
	Spring	2	2	4
Total				110

9.7.2 WATER QUALITY STANDARDS

For the evaluation of the water quality, following Guidelines and Standards are applied based on the agreement with MoWLD.

(1) Microbial Aspects: The Guidelines for Drinking-water Quality Third Edition (WHO, 2004) (hereinafter called “WHO Guideline”)

(2) Chemicals that are of Health Significance: WHO Guideline

(3) Acceptability Aspects: Temporary Standards of Quality of Domestic Water in Tanzania (Ministry of Water Development and Power, 1973) (hereinafter called “Tanzanian Standard”)

Comparative table of Guidelines and Standards for water quality is shown in *Table 9.11*.

Table 9.9 List of Sampling Points

(Groundwater-Test Wells)

Point No.	Date	District Municipality	Location	Source	Latitude	Longitude	Well No.
J-1	20/12/2004	Kinondoni	Msumi	Test well	6°42'40.8"	39°06'27.0"	DSM 664/2004
J-2	22/12/2004	Ilala	Buyuni	Test well	6°57'27.0"	39°06'06.6"	DSM 771/2004
J-3	23/12/2004	Temeke	Potea	Test well	7°03'16.8"	39°29'12.0"	DSM 699/2004
J-4	3/1/2005	Bagamoyo	Kwanduma	Test well	6°00'36.0"	38°04'40.8"	CO 775/2004
J-5	7/1/2005	Bagamoyo	Matipwili	Test well	6°13'55.8"	38°42'57.0"	CO 772/2004
J-6	6/1/2005	Bagamoyo	Magindu	Test well	6°49'15.6"	38°18'55.8"	CO 773/2004
J-7	5/1/2005	Kibaha	Kipangege	Test well	6°51'56.4"	38°50'17.4"	CO 774/2004
J-8	18/12/2004	Mkuranga	Dundani	Test well	7°04'16.8"	39°13'27.0"	CO 770/2004
J-9	23/12/2004	Kisarawe	Kise	Test well	7°09'36.6"	39°07'00.0"	CO 768/2004

(Groundwater-Existing Wells)

Point No.	Date	District Municipality	Location	Source	Latitude	Longitude	Well No.
B-01	25/10/2004	Bagamoyo	Kibindu	Borehole well	5°59'45.3"	37°55'23.8"	130/91: Bagamoyo-36
B-02	25/10/2004	Bagamoyo	Bagamoyo Secondary	Borehole well	6°27'18.6"	38°55'35.8"	247/99: Bagamoyo-5
B-03	25/10/2004	Bagamoyo	Mbegani Fisheries	Borehole well	6°28'18.6"	38°57'37.8"	231/2001: Bagamoyo-10
B-04	25/10/2004	Bagamoyo	Ziko Village	Borehole well	6°33'31.8"	39°00'20.8"	146/99: Bagamoyo-4
B-05	29/10/2004	Kinondoni	Bunju 'A'	Borehole well	6°38'06.0"	39°06'30.5"	174/2001: Kinondoni-172
B-06	29/10/2004	Kinondoni	Wazo Hill	Borehole well	6°40'35.3"	39°10'28.7"	39/2003: Kinondoni-230
B-07	29/10/2004	Kinondoni	J.K.Nyerere School(Kawe)	Borehole well	6°43'27.8"	39°13'21.3"	382/2001: Kinondoni-189
B-08	30/10/2004	Kibaha	Kitomondo P/School	Borehole well	6°52'12.5"	38°36'33.3"	410/99: Kibaha-12
B-09	29/10/2004	Kinondoni	Mwenge	Borehole well	6°46'13.7"	39°14'10.9"	34/2003: Kinondoni-229
B-10	29/10/2004	Kinondoni	Kagera Maluwi	Borehole well	6°47'57.1"	39°14'52.1"	181/99: Kinondoni-72
B-11	26/10/2004	Kibaha	Maili Moja	Borehole well	6°47'22.2"	39°00'29.8"	115/99: Kibaha-2
B-12	26/10/2004	Kibaha	Disunyala	Borehole well	6°45'25.1"	38°43'36.9"	247/2001: Kibaha-40
B-13	29/10/2004	Kinondoni	Ubungo Kisiwani	Borehole well	6°48'07.6"	39°12'24.5"	570/99: Kinondoni-103
B-14	21/10/2004	Ilala	Tabata Lawiti	Borehole well	6°49'49.9"	39°13'35.5"	47/2003: Ilala-424
B-15	26/10/2004	Kibaha	Zogowale	Borehole well	6°46'19.1"	38°49'08.3"	370/2000: Kibaha-39
B-16	28/10/2004	Temeke	Chang"Ombe Ttc	Borehole well	6°50'50.7"	39°16'21.1"	205/2001: Temeke-213
B-17	28/10/2004	Temeke	Mwembe Yanga	Borehole well	6°51'36.5"	39°15'29.8"	86/99: Temeke-81
B-18	28/10/2004	Temeke	Yombo Kilakala(Mwinyi Road)	Borehole well	6°52'29.9"	39°14'28.8"	293/2002: Temeke-346
B-19	28/10/2004	Temeke	Kibugumo P/School	Borehole well	6°52'12.3"	39°22'36.8"	196/99: Temeke-91
B-20	21/10/2004	Ilala	Kipunguni-Kitunda	Borehole well	6°52'41.9"	39°11'17.4"	74/2003: Ilala-429
B-21	21/10/2004	Ilala	Pugu Mnadani	Borehole well	6°52'41.9"	39°07'35.2"	72/2003: Ilala-427
B-22	26/10/2004	Kibaha	Kabunduguru	Borehole well	6°45'44.1"	39°00'09.0"	351/2002: Kibaha-49
B-23	28/10/2004	Temeke	Mbagala Kibangulile	Borehole well	6°55'31.2"	39°16'55.4"	163/2001B: Temeke-207
B-24	27/10/2004	Mkuranga	Vikindu	Borehole well	7°00'14.1"	39°18'30.9"	390/2004: Mkuranga-32
B-25	28/10/2004	Ilala	Msongola Kitonga	Borehole well	7°00'08.5"	39°09'27.8"	410/2002: Ilala-404
B-26	27/10/2004	Kisarawe	Homboza Near P/School	Borehole well	7°04'04.2"	39°02'48.8"	38/2001: Kisarawe-41
B-27	27/10/2004	Mkuranga	Mama Siti Sec.School	Borehole well	7°06'48.3"	39°12'03.6"	59/2004: Mkuranga-25
B-28	27/10/2004	Kisarawe	Msimbu	Borehole well	7°06'32.1"	39°01'32.4"	83/2001: Kisarawe-45
B-29	27/10/2004	Mkuranga	Mbezi- Gongoni	Borehole well	7°11'09.8"	39°14'31.9"	28/2002: Mkuranga-18
B-30	27/10/2004	Kisarawe	Masanganya	Borehole well	7°09'58.0"	38°54'04.5"	122/2002: Kisarawe-49
B-31	27/10/2004	Kisarawe	Kikwete P/School	Borehole well	7°11'53.3"	38°50'00.5"	500/99: Kisarawe-12
B-32	28/10/2004	Kisarawe	Boga	Borehole well	7°12'56.6"	38°47'44.0"	495/99: Kisarawe-9
B-33	28/10/2004	Kisarawe	Msanga Dibidulize	Borehole well	7°15'56.9"	38°48'44.4"	90/2000: Kisarawe-16
B-34	28/10/2004	Kisarawe	Chole Samvula	Borehole well	7°20'38.8"	38°39'51.9"	503/2004: Kisarawe-92
B-35	28/10/2004	Kisarawe	Chole Vikumburu	Borehole well	7°26'13.4"	38°36'00.8"	502/2004: Kisarawe-91

(Surface Water/Shallow Well)

Point No.	Sampling (dry season)	Sampling (rainy season)	District Municipality	Location	Source	Latitude	Longitude
W-01	25/10/2004	17/1/2005	Bagamoyo	Pongwe Kiona	S/W	6°10'58.4"	38°14'04.6"
W-02	25/10/2004	17/1/2005	Bagamoyo	Miono Mandera	Wami River	6°14'47.5"	38°23'10.0"
W-03	25/10/2004	17/1/2005	Bagamoyo	Kiwangwa	Dug Well	6°22'43.9"	38°35'07.9"
W-04	25/10/2004	17/1/2005	Bagamoyo	Fukayosi Wws Intake	Dam	6°23'41.9"	38°40'43.6"
W-05	29/10/2004	17/1/2005	Kinondoni	Mabwepande(Bunju)	S/W	6°39'13.6"	39°05'08.8"
W-06	25/10/2004	18/1/2005	Kibaha	idogozero Vigwaza Intake	Ruvu River	6°39'04.8"	38°43'11.3"
W-07	26/10/2004	19/1/2005	Kibaha	landizi Dawasa Wss Intake	Ruvu River	6°41'25.9"	38°41'40.7"
W-08	29/10/2004	18/1/2005	Kinondoni	Kimara King"Ong"O	Dug Well	6°46'37.8"	39°09'38.1"
W-09	26/10/2004	19/1/2005	Kibaha	Ruvu Stat.Intake	Ruvu River	6°48'17.4"	38°39'30.3"
W-10	26/10/2004	19/1/2005	Kibaha	Kikongo	Dug Well	6°47'58.7"	38°42'56.9"
W-11	26/10/2004	18/1/2005	Kibaha	Bokotimiza	S/W	6°47'43.0"	38°56'00.0"
W-12	26/10/2004	18/1/2005	Kibaha	Soga Secondary	Ring Well	6°49'28.4"	38°52'00.3"
W-13	28/10/2004	19/1/2005	Temeke	Kisiwani P/School	S/W	6°51'59.0"	39°20'08.0"
W-14	26/10/2004	18/1/2005	Kibaha	Kwala WSS, Kwala	River	6°49'29.3"	38°37'23.9"
W-15	28/10/2004	19/1/2005	Temeke	Ukoeni Somangira	River	6°53'22.2"	39°25'34.9"
W-16	27/10/2004	17/1/2005	Kisarawe	Kisarawe Intake	Reservoir	6°54'33.1"	39°05'54.2"
W-17	27/10/2004	17/1/2005	Kisarawe	Sanze Intake	Stream	6°55'16.7"	39°03'55.4"
W-18	28/10/2004	19/1/2005	Temeke	ngulila, (at Bridge Charambe)	River	6°56'13.0"	39°16'30.2"
W-19	28/10/2004	19/1/2005	Temeke	Toa Ngoma	River	6°57'06.1"	39°17'09.0"
W-20	21/10/2004	17/1/2005	Ilala	Mbuyuni	S/W	6°58'03.6"	39°05'51.0"
W-21	21/10/2004	17/1/2005	Ilala	Msongola	S/W (Ring)	6°58'28.5"	39°10'32.0"
W-22	28/10/2004	19/1/2005	Temeke	Mbungoni Kimbiji	River	7°01'02.8"	39°32'02.4"
W-23	21/10/2004	17/1/2005	Ilala	Msongola Mvuti	Spring	7°01'56.1"	39°07'33.9"
W-24	26/10/2004	19/1/2005	Kisarawe	Mafizi	Ruvu River	7°00'03.5"	38°30'20.9"
W-25	27/10/2004	20/1/2005	Kisarawe	Masaki	Dug Well	7°14'44.1"	38°57'58.3"
W-26	27/10/2004	18/1/2005	Mkuranga	Mbezi- Gongoni	S/W	7°10'52.3"	39°14'38.7"
W-27	26/10/2004	-	Kisarawe	Gwata Wss Intake	Ruvu River	7°06'53.1"	38°28'54.3"
W-28	27/10/2004	20/1/2005	Kisarawe	Maneromango Wss	Kanga Dam	7°10'47.1"	38°48'46.1"
W-29	27/10/2004	18/1/2005	Mkuranga	Kimanzichana	S/W	7°21'58.0"	39°04'06.9"
W-30	27/10/2004	18/1/2005	Mkuranga	Mkiu-Mbwingo	S/W	7°26'51.2"	39°07'48.6"
W-31	28/10/2004	20/1/2005	Kisarawe	Marui Kihare	Charco Dam	7°27'55.8"	38°40'48.6"
W-32	27/10/2004	18/1/2005	Mkuranga	Lukanga	River	7°28'20.2"	39°08'43.7"
W-33	27/10/2004	18/1/2005	Mkuranga	Njopeka Spring Wss	Spring	7°30'02.8"	39°07'02.9"
W-34	-	20/1/2005	Kisarawe	Mtakayo	Dug well	7°01'52.2"	38°44'46.7"

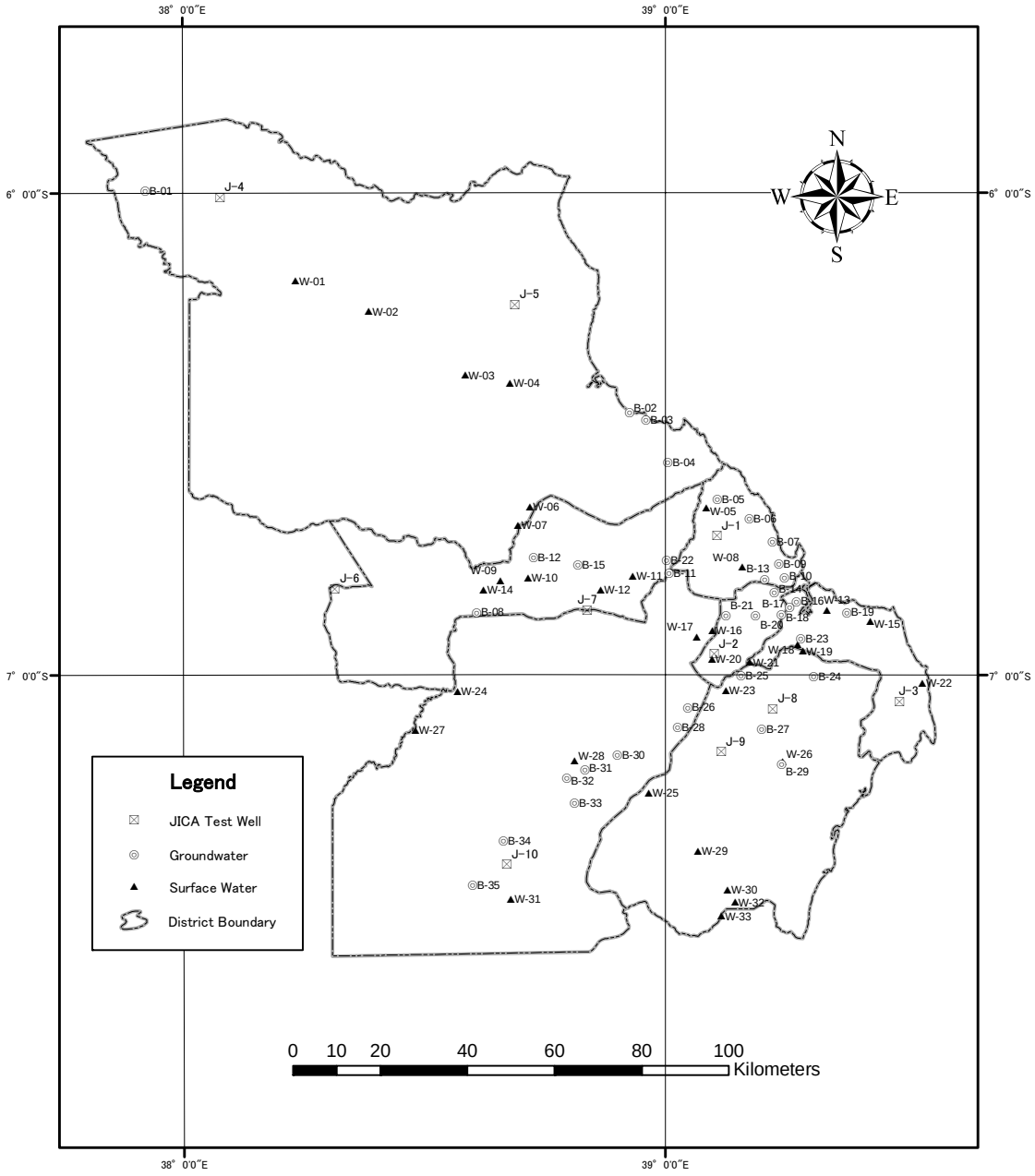

FIGURE 9.20 LOCATION OF SAMPLING POINT FOR WATER QUALITY ANALYSIS

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Table 9.10 Methods of Water Quality Analyses

Aspects and Items			Method of Analysis	Detection Limit
Microbial aspects	1	Total coliform bacteria	Membrane filtration	-
	2	Escherichia Coli		-
Chemicals that are of health significance	3	Cadmium (Cd)	Atomic Absorption Spectrometer	<0.001 mg/liter
	4	Cyanide (CN)	Atomic Absorption Spectrometer	<0.001 mg/liter
	5	Lead (Pb)	Atomic Absorption Spectrometer	<0.01 mg/liter
	6	Arsenic (As)	Atomic Absorption Spectrometer	<0.001 mg/liter
	7	Mercury (Hg)	Atomic Absorption Spectrometer	<0.00001 mg/liter
	8	Selenium (Se)	Atomic Absorption Spectrometer	<0.001 mg/liter
	9	Barium (Ba)	Atomic Absorption Spectrometer	<0.01 mg/liter
	10	Fluoride (F)	Potentiometric	<0.01 mg/liter
	11	Hexavalent-chromium (Cr^{6+})	Atomic Absorption Spectrometer	<0.001 mg/liter
	12	Total chromium (T-Cr)	Atomic Absorption Spectrometer	<0.001 mg/liter
	13	Nitrate (NO_3-N)	Cadmium reduction Spectrophotometric	<0.01 mg/liter
	14	Nitrite (NO_2-N)		<0.001 mg/liter
	15	Boron (B)	Carmine	<0.1 mg/liter
	16	Nickel (Ni)	Atomic Absorption Spectrometer	<0.001 mg/liter
	17	Antimony (Sb)	Atomic Absorption Spectrometer	<0.001 mg/liter
	18	Molybdenum (Mo)	Atomic Absorption Spectrometer	<0.0005 mg/liter
	19	Manganese (Mn)	Periodate Method	<0.01 mg/liter
	20	Organic Carbon (as carbon in Chloroform)	Dichromate	<0.001 mg/liter
Acceptability aspects	21	Hardness	EDTA Titrimetric	<0.1 mg/liter
	22	Calcium (Ca)	EDAT Titrimetric	<0.1 mg/liter
	23	Magnesium (Mg)		<0.1 mg/liter
	24	Iron (Fe)	Spectrophotometric	<0.01 mg/liter
	25	Zinc (Zn)	Atomic Absorption Spectrometer	<0.01 mg/liter
	26	Copper (Cu)	Atomic Absorption Spectrometer	<0.01 mg/liter
	27	Chloride (Cl^-)	Argentometric (titration)	<0.1 mg/liter
	28	Residue	Filtration (using GFC) and Drying at 105ºC	<0.1 mg/liter
	29	Total filterable residue	Gravimetric	<0.1 mg/liter
	30	Anionic surface active agents (as ABS)	MBAS Method	<0.001 mg/liter
	31	Phenols	4-Amino antipyrine	<0.001 mg/liter
	32	Hydrogen sulfide (H_2S)	Iodometric	<0.01 mg/liter
	33	Ammonium (NH_3+NH_4)	Nesler reagent	<0.01 mg/liter
	34	Total nitrogen (Excluding NO_3)	Titration	<0.01 mg/liter
	35	BOD	5-day BOD test	<0.1 mg/liter
	36	Potassium permanganate consumption	Oxidation reduction	<0.1 mg/liter
	37	pH	Potentiometric	<0.1
	38	Taste	-	-
	39	Odour	Threshold	-
	40	Colour	Platinum cobolt	1 mg Pt/liter
	41	Turbidity (Tr)	Nephelometric	<0.1 NTU
	42	Temperature	Thermometer	< 1 ^oC
	43	Conductivity (EC)	Conductivity meter	< 1 micro S/cm
	44	Residual chlorine (Cl)	DPD (No analysis)	<0.1 mg/liter
	45	Sulfate (Mg+Na Salts)	Spectrophotometric	<0.1 mg/liter
Water quality items related to the characteristics of groundwater	46	Sodium (Na)	Atomic Absorption Spectrometer	<0.1 mg/liter
	47	Potassium (K)	Atomic Absorption Spectrometer	<0.1 mg/liter
	48	Bicarbonate (HCO^{3-})	Titrimetric	<0.1 mg/liter
	49	Total alkalinity	Titration	<0.1 mg/liter
	50	Sulfate (SO_4^{2-})	Tubdimetric	<0.1 mg/liter

Table 9.11 Comparative Table of Water Quality Standard for Drinking Water

Aspects and Items			Unit	Tanzanian Standard (1974) *1	WHO Guideline (2004) *2
Microbial aspects	1	Total coliform bacteria	count/100ml	0	-
	2	Escherichia Coli	count/100ml	0	0
Chemicals that are of health significance	3	Cadmium (Cd)	mg/l	0.05	0.003
	4	Cyanide (CN)	mg/l	0.20	0.07
	5	Lead (Pb)	mg/l	0.10	0.01
	6	Arsenic (As)	mg/l	0.05	0.01
	7	Mercury (Hg)	mg/l	-	0.001
	8	Selenium (Se)	mg/l	0.05	0.01
	9	Barium (Ba)	mg/l	1.00	0.7
	10	Fluoride (F)	mg/l	8.0	1.5
	11	Hexavalent-chromium (Cr^{6+})	mg/l	0.05	-
	12	Total chromium (T-Cr)	mg/l	-	0.05
	13	Nitrate (NO_3-N)	mg NO_3/l	100	50
	14	Nitrite (NO_2-N)	mg NO_2/l	-	3 / 0.2 *3
	15	Boron (B)	mg/l	-	0.5
	16	Nickel (Ni)	mg/l	-	0.02
	17	Antimony (Sb)	mg/l	-	0.020
	18	Molybdenum (Mo)	mg/l	-	0.07
	19	Manganese (Mn)	mg/l	0.5	0.4
	20	Organic Carbon (as carbon in Chloroform)	mg/l	0.5	-
Acceptability aspects	21	Hardness	mg/l	600	-
	22	Calcium (Ca)	mg/l	-	-
	23	Magnesium (Mg)	mg/l	-	-
	24	Iron (Fe)	mg/l	1.0	-
	25	Zinc (Zn)	mg/l	15.0	-
	26	Copper (Cu)	mg/l	3.0	2.0
	27	Chloride (Cl^-)	mg/l	800	-
	28	Residue*4	mg/l	-	-
	29	Total filterable residue*5	mg/l	2,000	-
	30	Anionic surface active agents (as ABS)	mg ABS/l	2.0	-
	31	Phenols	mg/l	0.002	-
	32	Hydrogen sulfide (H_2S)	mg/l	-	-
	33	Ammonium (NH_3+NH_4)	mg/l	-	1.5
	34	Total nitrogen (Excluding NO_3)	mg/l	1.0	-
	35	BOD	mg/l	6.0	-
	36	Potassium permanganate consumption	mg/l	20	-
	37	pH	-	6.5 - 9.2	
	38	Taste	dilution	not objectionable	-
	39	Odour	dilution	not objectionable	-
	40	Colour	mg Pt/l	50	15
	41	Turbidity (Tr)	NTU	30	5
	42	Temperature	℃	-	-
	43	Conductivity (EC)	mS/m	-	-
	44	Residual chlorine (Cl)	mg/l	-	-
	45	Sulfate (Mg+Na Salts)	mg/l	-	-
Water quality items related to the characteristics of groundwater	46	Sodium (Na)	mg/l	-	-
	47	Potassium (K)	mg/l	-	-
	48	Bicarbonate (HCO_3^-)	mg/l	-	-
	49	Total alkalinity	mg/l	-	-
	50	Sulfate (SO_4^{2-})	mg/l	600	-

*1: "Maji Review" Ministry of Water Development and Power vol. 1, No. 1, MoWDP, Dar es Salaam, 1974

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova, 2004

*3: Short term / long term

*4: Residue is equal to [Total solids - Total dissolved solids]

*5: Total filterable residue is equal to Total dissolved solids (TDS).

☐ Items adopted for water quality evaluation.

9.7.3 RESULTS OF WATER QUALITY ANALYSES

The results of the water quality analysis are summarised as *Table 9.12* for groundwater (test wells), *Table 9.13* for groundwater (existing wells) and *Table 9.14* for surface water (dry season and rainy season).

Table 9.12 Result of Water Quality Analysis, Test Wells

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*2	J-1 Kinondoni Msumi	J-2 Ilala Buyuni	J-3 Temeke Potea	J-4 Bagamoyo Kwamduma	J-5 Bagamoyo Matipwili	J-6 Bagamoyo Magindu	J-7 Kibaha Kipangege	J-8 Mkuranga Dundani	J-9 Mkuranga Kise
1	Total coliform bacteria (count/100ml)	0	**0**	0	8.0 x10	0	4.7×10^2	8.0×10^2	2.6×10^2	4.7×10^2	0	3.0×10^2
2	Escherichia coli (count/100ml)	0	**0**	0	5	0	3.6×10^2	1.5×10^2	1.8×10^2	3.6×10^2	0	2.2×10^2
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.052	0.059	0.050	0.053	0.057	0.060	0.062	0.066	0.058
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	1.00	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	0.008	0.010	0.006	0.005	0.010	0.005	0.009	0.007	0.007
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	<0.00001	<0.00001	<0.00001	0.00100	<0.00001	<0.001	<0.00001	<0.00001
8	Selenium: Se (mg/l)	0.05	**0.01**	<0.001	<0.001	0.005	0.010	<0.001	<0.001	<0.001	0.010	0.003
9	Barium: Ba (mg/l)	1.00	**0.7**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
10	Fluoride: F (mg/l)	8.00	**1.5**	0.30	0.50	<0.01	0.68	<0.01	0.16	0.17	0.50	0.90
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010
12	Total chromium : T-Cr (mg/l)	-	**0.05**	<0.001	<0.001	<0.001	0.020	<0.001	<0.001	<0.001	0.030	0.030
13	Nitrate: (as NO_3 mg/l)	100	**50**	7.50	26.1	4.90	0.10	9.70	13.7	9.30	10.6	<0.01
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.066	0.023	0.020	<0.001	0.003	0.010	0.062	0.030	0.007
15	Boron: B (mg/l)	-	**0.5**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	0.010	<0.001	<0.001	<0.001	0.030	0.020	<0.001	0.010	0.020
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	0.04	<0.01	0.10	0.10	2.10	0.50	0.10	<0.01	0.02
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.002	0.022	0.012	0.027	0.023	0.012	0.012	0.008	0.002
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	504	139	72.0	164	1,010	970	750	142	1,160
22	Hardness (as $CaCO_3$ mg/l)	-	-	154	36.4	15.2	14.4	136	148	132	22.4	122
23	Magnesium: Mg (mg/l)	-	-	28.9	11.7	8.3	31.1	163	146	102	20.9	178
24	Iron: Fe (mg/l)	**1.0**	-	0.12	0.02	<0.01	0.50	6.40	5.60	0.60	0.02	0.04
25	Zinc: Zn (mg/l)	**15**	-	0.40	0.80	<0.01	<0.01	0.10	0.30	0.50	0.10	5.00
26	Copper: Cu (mg/l)	**3.0**	**2.00**	5.00	2.00	<0.01	<0.01	1.00	3.00	<0.01	1.00	<0.01
27	Chlorides: Cl (mg/l)	**800**	-	450	109	41.2	63.1	1,970	1,050	1,000	213	1,320
28	Residue (mg/l)	-	-	2,030	493	338	729	7,400	3,200	2,510	640	3,060
29	Total filterable residue (mg/l)	**2,000**	-	1,230	350	330	643	6,170	2,990	2,400	630	2,940
30	Surfactants: ABS (mg/l)	**2.0**	-	0.006	0.004	0.006	0.002	0.002	0.003	<0.001	0.002	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.33	0.62	0.03	0.08	0.09	0.23	0.13	0.36	0.65
33	Ammonium: NH_3 (mg/l)	-	**1.5**	0.68	1.11	<0.01	0.03	0.40	0.43	0.58	0.04	0.17
34	Ammonium: NH_3 (mg/l)	**1.0**	-	0.55	0.87	0.02	0.02	0.31	0.33	0.47	<0.01	0.13
35	BOD_5 (mg/l)	**6**	-	4.3	1.9	1.3	0.8	5.4	5.9	4.6	1.6	5.9
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	7.6	3.4	2.4	1.6	9.2	10.0	8.0	3.0	10.6
37	pH	**6.5 - 9.2**	-	8.3	6.7	7.6	8.1	7.8	7.4	7.7	7.2	6.6
38	Taste	not objectionable	-	Salty	Sweet	Sweet	Sweet	Salty	Salty	Salty	Sweet	Salty
39	Odour	not objectionable	-	UN	UN	UN	UN	UN	UN	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	6	8	6	2	14	<1	<1	8	<1
41	Turbidity: Tr (NTU)	**30**	**5**	7.4	19.0	2.0	4.0	564	146	27.0	1.0	500
42	Temperature (°C)	-	-	25	25	25	25	25	25	25	25	25
43	Conductivity: EC (microS/cm)	-	-	1,890	640	610	990	9,490	4,600	3,690	1,150	4,520
44	Conductivity: EC (microS/cm)	-	-	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	321	134	124	199	3,460	963	715	283	868
46	Sodium: Na (mg/l)	-	-	200	85.0	100	150	1,700	600	500	200	500
47	Potassium: K (mg/l)	-	-	8.0	6.6	16.9	5.2	10.7	10.4	6.6	4.8	13.5
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	326	126	72.0	164	300	588	292	142	194
49	Total alkalinity (mg/l)	-	-	326	126	236	380	300	588	292	208	194
50	Sulphate: SO_4 (mg/l)	**600**	-	92.5	37.0	16.0	18.0	1,600	217	113	62.5	190

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.13 Result of Water Quality Analysis, Existing Wells (1/5)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	B-01 Bagamoyo Kibindu	B-02 Bagamoyo Bagamoyo Secondary	B-03 Bagamoyo Mbegani Fisheries	B-04 Bagamoyo Ziko Village	B-05 Kinondoni Bunju 'A'	B-06 Kinondoni Wazo Hill	B-07 Kinondoni J.K.Nyerere School(Kawe)
1	Total coliform bacteria (count/100ml)	0	**0**	1.3×10^3	2.6×10	0	0	0	8	1.1×10^2
2	Escherichia coli (count/100ml)	0	**0**	1.0×10^3	2.0×10	0	0	0	1	6
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	0.100	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.004	0.032	0.028	0.008	0.067	0.054	0.042
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	<0.001	<0.001	<0.01	<0.001	<0.01	<0.001	0.006
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	<0.001	<0.00001	0.00006	0.00088	<0.00001	<0.001
8	Selenium: Se (mg/l)	0.05	**0.01**	<0.01	<0.001	<0.01	<0.001	<0.01	<0.001	<0.01
9	Barium: Ba (mg/l)	1.00	**0.7**	<0.7	<0.01	<0.7	<0.7	<0.7	<0.7	<0.7
10	Fluoride: F (mg/l)	8.00	**1.5**	0.50	0.31	0.36	0.21	0.75	0.20	0.31
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.100
12	Total chromium : T-Cr (mg/l)	-	**0.05**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.05
13	Nitrate: (as NO_3 mg/l)	100	**50**	6.20	2.66	6.20	10.2	5.32	8.90	3.50
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.062	<0.2	0.026	0.039	0.030	0.007	0.039
15	Boron: B (mg/l)	-	**0.5**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	0.228	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	0.04	<0.01	0.10	<0.01	<0.01	0.20	<0.01
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.200	0.158	0.194	0.188	0.195	0.093	0.137
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	540	728	295	255	496	260	1,990
22	Hardness (as $CaCO_3$ mg/l)	**-**	-	108	184	46.0	70.0	146	62.4	544
23	Magnesium: Mg (mg/l)	**-**	-	65.7	65.1	43.8	19.5	32.0	25.3	153
24	Iron: Fe (mg/l)	**1.0**	-	0.10	0.10	0.18	0.46	0.02	0.54	<0.01
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
27	Chlorides: Cl (mg/l)	**800**	-	514	915	970	568	750	270	3,340
28	Residue (mg/l)	-	-	1,420	2,190	2,150	1,210	1,600	772	6,370
29	Total filterable residue (mg/l)	**2,000**	-	1,290	1,790	2,140	1,200	1,460	565	5,990
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.035
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.74	0.55	0.55	0.28	0.49	0.55	0.87
33	Ammonium: NH_3 (mg/l)	-	**1.5**	<0.01	<0.01	0.09	<0.01	0.04	0.19	1.13
34	Ammonium: NH_3 (mg/l)	**1.0**	-	0.03	0.07	0.02	<0.01	0.44	0.04	0.15
35	BOD_5 (mg/l)	**6**	-	1.5	1.6	4.5	0.9	3.4	1.5	2.0
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	2.8	3.0	8.0	1.8	5.6	2.2	3.2
37	pH	**6.5 - 9.2**	-	6.5	6.8	6.8	7.3	6.9	6.8	6.0
38	Taste	not objectionable	-	Sweet	Salty	Salty	Sweet	Salty	Sweet	Salty
39	Odour	not objectionable	-	UN	OB	OB	OB	OB	UN	OB
40	Colour (TCU mg Pt/l)	**50**	**15**	16	5	14	22	11	34	7
41	Turbidity: Tr (NTU)	**30**	**5**	2.1	0.2	9.5	7.4	2.0	24.0	2.0
42	Temperature (^oC)	-	-	25	30	31	30	30	30	30
43	Conductivity: EC (microS/cm)	-	-	1,990	3,200	3,290	1,850	2,430	1,048	9,220
44	Conductivity: EC (microS/cm)	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	350	630	874	400	355	315	1,450
46	Sodium: Na (mg/l)	-	-	200	400	600	300	250	150	1,200
47	Potassium: K (mg/l)	-	-	15.0	16.0	34.0	3.5	5.0	10.0	10.0
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	182	60.0	32.0	48.0	80.0	60.0	118
49	Total alkalinity (mg/l)	-	-	182	60.0	32.0	48.0	80.0	60.0	118
50	Sulphate: SO_4 (mg/l)	**600**	-	85.0	165	230	80.0	70.0	140	97.5

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.13 Result of Water Quality Analysis, Existing Wells (2/5)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	B-08 Kibaha Kitomondo P/School	B-09 Kinondoni Mwenge	B-10 Kinondoni Kagera Maluwi	B-11 Kibaha Maili Moja	B-12 Kibaha Disunyala	B-13 Kinondoni Ubungo Kisiwani	B-14 Ilala Tabata Lawiti
1	Total coliform bacteria (count/100ml)	0	**0**	1	0	1.4×10^4	9	0	0	0
2	Escherichia coli (count/100ml)	0	**0**	0	0	8.0×10^2	4	0	0	0
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.059	0.047	0.057	0.020	0.010	0.051	0.051
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	<0.00001	<0.001	<0.00001	<0.001	<0.001	<0.00001
8	Selenium: Se (mg/l)	0.05	**0.01**	<0.01	<0.01	<0.001	<0.001	<0.01	<0.001	<0.01
9	Barium: Ba (mg/l)	1.00	**0.7**	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
10	Fluoride: F (mg/l)	8.00	**1.5**	<0.01	0.17	0.53	<1.5	<1.5	0.41	0.36
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	<0.001	<0.001	<0.001	0.030	<0.001	<0.001
12	Total chromium : T-Cr (mg/l)	-	**0.05**	<0.001	<0.001	<0.001	<0.001	0.041	<0.001	<0.001
13	Nitrate: (as NO_3 mg/l)	100	**50**	4.00	19.0	316	4.90	12.8	27.9	9.70
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.016	<0.2	0.049	0.043	0.043	0.082	0.030
15	Boron: B (mg/l)	-	**0.5**	<0.5	0.4	0.3	0.3	<0.1	<0.5	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	0.20	<0.01	<0.01	0.20	<0.01	0.03	<0.01
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.003	0.154	0.163	0.002	0.201	0.194	0.194
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	129	260	535	252	605	625	413
22	Hardness (as $CaCO_3$ mg/l)	-	-	22.0	46.0	130	40.8	118	114	95.2
23	Magnesium: Mg (mg/l)	-	-	18.0	35.3	51.1	36.5	75.4	82.7	42.7
24	Iron: Fe (mg/l)	**1.0**	-	0.80	<0.01	0.03	0.35	0.04	0.05	0.20
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	<0.01	0.10	<0.01	<0.01	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
27	Chlorides: Cl (mg/l)	**800**	-	56.7	687	620	131	689	959	543
28	Residue (mg/l)	-	-	197	1,060	1,200	500	1,620	2,240	1,350
29	Total filterable residue (mg/l)	**2,000**	-	150	1,030	1,020	475	1,520	1,920	1,060
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.034	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.72	0.33	0.70	0.51	0.23	0.88	0.86
33	Ammonium: NH_3 (mg/l)	-	**1.5**	0.18	0.10	0.95	<0.01	0.08	0.06	0.03
34	Ammonium: NH_3 (mg/l)	**1.0**	-	<0.01	0.89	0.15	0.02	0.07	0.76	0.03
35	BOD_5 (mg/l)	**6**	-	1.4	1.7	3.6	1.7	1.1	2.2	1.9
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	2.0	2.4	5.8	2.8	2.0	3.4	2.8
37	pH	**6.5 - 9.2**	-	6.5	7.2	6.5	6.9	7.5	6.0	6.1
38	Taste	not objectionable	-	Sweet	Sweet	Sweet	Sweet	Salty	Salty	Sweet
39	Odour	not objectionable	-	UN	UN	UN	UN	OB	OB	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	17	7	11	<1	8	11	5
41	Turbidity: Tr (NTU)	**30**	**5**	44.7	0.3	1.7	3.4	0.6	1.4	1.9
42	Temperature (^oC)	-	-	28	29	29	29	27	29	29
43	Conductivity: EC (microS/cm)	-	-	283	1,880	1,860	730	2,330	3,210	1,912
44	Conductivity: EC (microS/cm)	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	66.0	582	391	105	505	688	408
46	Sodium: Na (mg/l)	-	-	25.0	400	250	50.6	250	450	225
47	Potassium: K (mg/l)	-	-	7.5	10.0	50.0	3.5	14.0	5.0	7.5
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	88.0	18.0	170	160	122	94.0	68.0
49	Total alkalinity (mg/l)	-	-	88.0	18.0	170	160	162	94.0	68.0
50	Sulphate: SO_4 (mg/l)	**600**	-	23.0	148	90.0	18.0	180	155	140

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.13 Result of Water Quality Analysis, Existing Wells (3/5)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	B-15 Kibaha Zogowale	B-16 Temeke Chang'Ombe Ttc	B-17 Temeke Mwembe Yanga	B-18 Temeke Yombo Kilakala (Mwinyi Road)	B-19 Temeke Kibugumo P/School	B-20 Ilala Kipunguni-Kitunda	B-21 Ilala Pugu Mnadani
1	Total coliform bacteria (count/100ml)	0	**0**	0	0	6.5 x10	9.2 x10	4	0	0
2	Escherichia coli (count/100ml)	0	**0**	0	0	5.6 x10	5.3 x10	2	0	0
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.021	0.070	0.065	0.053	0.036	0.012	0.043
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	<0.00001	<0.00001	<0.001	<0.001	<0.001	0.00037
8	Selenium: Se (mg/l)	0.05	**0.01**	<0.01	<0.001	<0.01	<0.001	<0.01	<0.01	<0.01
9	Barium: Ba (mg/l)	1.00	**0.7**	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
10	Fluoride: F (mg/l)	8.00	**1.5**	<1.5	0.34	0.16	0.08	<0.01	0.42	0.30
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
12	Total chromium : T-Cr (mg/l)	-	**0.05**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
13	Nitrate: (as NO_3 mg/l)	100	**50**	5.80	38.5	70.0	17.3	2.20	9.70	11.1
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.030	0.059	0.102	0.033	0.020	0.033	0.036
15	Boron: B (mg/l)	-	**0.5**	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.02
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	<0.01	0.02	<0.01	<0.01	<0.01	0.10	0.03
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.153	0.009	0.007	0.009	0.096	0.096	0.076
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	78.0	138	165	25.0	138	103	96.0
22	Hardness (as $CaCO_3$ mg/l)	-	-	8.8	40.0	33.6	4.8	40.8	9.6	21.6
23	Magnesium: Mg (mg/l)	-	-	13.6	9.2	19.7	3.2	8.8	19.2	10.2
24	Iron: Fe (mg/l)	**1.0**	-	0.12	0.03	0.02	0.03	0.02	0.19	0.12
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	0.10	<0.01	<0.01	<0.01	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
27	Chlorides: Cl (mg/l)	**800**	-	273	50.4	160	78.0	250	316	170
28	Residue (mg/l)	-	-	890	368	565	200	560	821	498
29	Total filterable residue (mg/l)	**2,000**	-	839	320	325	182	560	644	465
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.001	<0.001	<0.002	<0.001	<0.002	<0.002	<0.001
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.11	0.39	0.91	0.94	0.50	0.56	0.83
33	Ammonium: NH_3 (mg/l)	-	**1.5**	0.33	0.04	0.06	0.03	<0.01	<0.01	<0.01
34	Ammonium: NH_3 (mg/l)	**1.0**	-	0.27	0.05	0.81	0.03	0.02	<0.01	0.03
35	BOD_5 (mg/l)	**6**	-	0.9	1.8	2.3	1.6	2.8	2.2	2.2
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	1.4	2.8	3.6	2.4	4.0	4.0	3.4
37	pH	**6.5 - 9.2**	-	7.8	7.1	5.8	5.5	6.9	6.0	6.2
38	Taste	not objectionable	-	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet
39	Odour	not objectionable	-	UN	UN	UN	UN	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	13	12	55	11	15	11	11
41	Turbidity: Tr (NTU)	**30**	**5**	1.9	<0.1	0.3	0.2	0.4	10.2	1.6
42	Temperature (^oC)	-	-	28	30	32	29	30	28	28
43	Conductivity: EC (microS/cm)	-	-	1,290	580	590	330	940	990	864
44	Conductivity: EC (microS/cm)	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	341	107	117	95.7	202	242	268
46	Sodium: Na (mg/l)	-	-	260	62.5	50.0	62.5	150	175	125
47	Potassium: K (mg/l)	-	-	5.0	12.5	16.0	4.5	7.0	7.5	7.5
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	144	192	22.0	26.0	62.0	32.0	32.0
49	Total alkalinity (mg/l)	-	-	188	192	22.0	26.0	62.0	32.0	32.0
50	Sulphate: SO_4 (mg/l)	**600**	-	67.5	35.0	47.5	30.0	43.0	47.5	133

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.13 Result of Water Quality Analysis, Existing Wells (4/5)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	B-22 Kibaha Kabunduguru	B-23 Temeke Mbagala Kibangulile	B-24 Mkuranga Vikindu	B-25 Ilala Msongola Kitonga	B-26 Kisarawe Homboza Near P/School	B-27 Mkuranga Mama Siti Sec.School	B-28 Kisarawe Msimbu
1	Total coliform bacteria (count/100ml)	0	**0**	0	0	0	0	0	1.5×10^{2}	0
2	Escherichia coli (count/100ml)	0	**0**	0	0	0	0	0	9.8 x10	0
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.028	<0.07	0.057	<0.07	0.014	0.063	0.021
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	0.007
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	0.00040	0.00023	<0.00001	<0.00001	0.00078	<0.00001
8	Selenium: Se (mg/l)	0.05	**0.01**	<0.01	<0.01	<0.01	<0.001	<0.001	<0.001	<0.01
9	Barium: Ba (mg/l)	1.00	**0.7**	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
10	Fluoride: F (mg/l)	8.00	**1.5**	<1.5	<0.01	0.29	<0.01	<0.01	0.53	0.55
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	0.010	<0.001	<0.001	<0.001	<0.001	<0.001
12	Total chromium : T-Cr (mg/l)	-	**0.05**	<0.001	0.020	<0.001	<0.001	<0.001	<0.001	<0.001
13	Nitrate: (as NO_3 mg/l)	100	**50**	9.30	5.30	11.1	15.9	1.30	7.10	1.30
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	<0.2	0.026	0.033	0.033	0.033	0.039	0.026
15	Boron: B (mg/l)	-	**0.5**	0.3	<0.1	<0.1	0.4	<0.1	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	0.10	<0.01	<0.01	0.02	0.05	0.02	0.03
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.152	0.160	0.006	0.010	0.005	0.162	0.008
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	362	620	33.0	144	94.0	100	54.2
22	Hardness (as $CaCO_3$ mg/l)	-	-	21.6	76.0	0.4	23.2	7.2	16.0	7.2
23	Magnesium: Mg (mg/l)	-	-	74.9	105	7.8	20.9	18.5	14.6	8.8
24	Iron: Fe (mg/l)	**1.0**	-	0.45	0.02	0.02	0.07	0.08	0.09	0.10
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	<0.01	0.10	<0.01	0.10	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
27	Chlorides: Cl (mg/l)	**800**	-	102	834	12.0	245	179	460	103
28	Residue (mg/l)	-	-	905	1,960	194	527	464	1,070	318
29	Total filterable residue (mg/l)	**2,000**	-	871	1,820	144	393	398	873	260
30	Surfactants: ABS (mg/l)	**2.0**	-	0.074	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.002	<0.001	<0.002	<0.001	<0.002	<0.002	<0.002
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.99	0.65	0.88	0.72	0.98	0.71	0.95
33	Ammonium: NH_3 (mg/l)	-	**1.5**	<0.01	0.04	<0.01	<0.01	<0.01	0.08	<0.01
34	Ammonium: NH_3 (mg/l)	**1.0**	-	0.34	0.04	<0.01	0.02	0.20	0.07	0.02
35	BOD_5 (mg/l)	**6**	-	1.6	3.0	1.1	1.2	1.6	1.3	1.5
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	2.8	4.8	1.8	1.8	2.6	2.0	2.4
37	pH	**6.5 - 9.2**	-	6.7	6.6	6.0	6.5	5.0	6.5	5.5
38	Taste	not objectionable	-	Sweet	Salty	Sweet	Sweet	Sweet	Sweet	Sweet
39	Odour	not objectionable	-	UN	OB	UN	UN	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	<1	10	15	14	17	4	16
41	Turbidity: Tr (NTU)	**30**	**5**	13.2	<0.1	<0.1	1.6	2.8	0.2	2.1
42	Temperature (^{o}C)	-	-	28	29	29	29	28	30	27
43	Conductivity: EC (microS/cm)	-	-	1,340	2,800	240	736	744	1,530	400
44	Conductivity: EC (microS/cm)	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	256	607	54.8	231	216	325	109
46	Sodium: Na (mg/l)	-	-	150	350	40.0	150	115	250	65.0
47	Potassium: K (mg/l)	-	-	1.5	12.0	2.5	5.5	6.0	13.0	4.0
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	524	110	22	12.0	14.0	40.0	22.0
49	Total alkalinity (mg/l)	-	-	524	110	22	12.0	14.0	40.0	22.0
50	Sulphate: SO_4 (mg/l)	**600**	-	1.0	153	7.0	60.0	82.5	60.0	35.0

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.13 Result of Water Quality Analysis, Existing Wells (5/5)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	B-29 Mkuranga Mbezi- Gongoni	B-30 Kisarawe Masanganya	B-31 Kisarawe Kikwete P/School	B-32 Kisarawe Boga	B-33 Kisarawe Msanga Dibidulize	B-34 Kisarawe Chole Samvula	B-35 Kisarawe Chole Vikumburu
1	Total coliform bacteria (count/100ml)	0	**0**	0	0	0	0	0	0	7.0 x10
2	Escherichia coli (count/100ml)	0	**0**	0	0	0	0	0	0	0
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.051	0.033	0.008	<0.07	<0.07	0.066	0.057
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	<0.001	<0.01	<0.001	<0.001	<0.01	<0.001	<0.001
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	<0.00001	<0.00001	<0.001	<0.00001	<0.00001	0.00066
8	Selenium: Se (mg/l)	0.05	**0.01**	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01
9	Barium: Ba (mg/l)	1.00	**0.7**	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
10	Fluoride: F (mg/l)	8.00	**1.5**	0.19	0.40	0.40	0.29	0.56	<0.01	<0.01
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	0.010	<0.001	<0.001	<0.001	<0.001	<0.001
12	Total chromium : T-Cr (mg/l)	-	**0.05**	<0.001	0.020	<0.001	<0.001	<0.001	<0.001	<0.001
13	Nitrate: (as NO_3 mg/l)	100	**50**	3.10	2.70	23.0	8.00	12.4	12.8	210
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.016	0.026	0.016	0.039	0.013	0.026	<0.2
15	Boron: B (mg/l)	-	**0.5**	0.5	<0.5	<0.1	<0.1	0.5	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	<0.01	0.05	0.10	0.04	<0.01	<0.01	0.10
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.002	0.008	0.005	<0.001	0.195	0.006	<0.001
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	55.0	46.0	28.0	61.0	350	31.0	14.0
22	Hardness (as $CaCO_3$ mg/l)	-	-	3.2	6.0	4.8	8.8	56.0	1.2	<0.1
23	Magnesium: Mg (mg/l)	-	-	11.4	7.5	389	9.5	51.1	6.8	3.4
24	Iron: Fe (mg/l)	**1.0**	-	0.13	0.10	0.49	0.06	0.02	0.04	0.40
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	0.10	<0.01	<0.01	<0.01	0.20
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	<0.01	0.30	<0.01	<0.01	<0.01	<0.01
27	Chlorides: Cl (mg/l)	**800**	-	67.5	145	42.5	53.0	504	50.0	19.0
28	Residue (mg/l)	-	-	205	490	191	155	1,420	243	90.0
29	Total filterable residue (mg/l)	**2,000**	-	180	321	154	127	1,100	160	70.0
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.001	<0.001	<0.001	<0.001	<0.002	<0.002	0.002
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.95	0.96	0.81	0.57	0.88	0.99	0.94
33	Ammonium: NH_3 (mg/l)	-	**1.5**	0.13	0.04	0.14	0.06	0.05	0.09	<0.01
34	Ammonium: NH_3 (mg/l)	**1.0**	-	0.11	<0.01	0.12	0.06	0.08	0.08	0.19
35	BOD_5 (mg/l)	**6**	-	3.1	1.6	1.1	1.0	3.8	1.3	5.1
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	5.0	2.6	1.8	1.6	6.2	2.0	8.4
37	pH	**6.5 - 9.2**	-	5.5	5.2	6.3	5.7	6.0	5.0	5.5
38	Taste	not objectionable	-	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet
39	Odour	not objectionable	-	UN	UN	UN	UN	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	37	12	40	45	10	37	>500
41	Turbidity: Tr (NTU)	**30**	**5**	7.3	0.4	13.4	9.3	2.9	8.4	255
42	Temperature (^oC)	-	-	28	28	28	27	27	27	29
43	Conductivity: EC (microS/cm)	-	-	290	600	280	230	2,000	290	140
44	Conductivity: EC (microS/cm)	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	62.4	168	181	63.5	636	96.8	57.0
46	Sodium: Na (mg/l)	-	-	40.0	85.1	50.0	23.0	350	50.0	20.0
47	Potassium: K (mg/l)	-	-	3.0	5.5	4.0	3.0	22.0	1.0	7.0
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	46.0	14.0	48.0	46.0	22.0	34.0	8.0
49	Total alkalinity (mg/l)	-	-	46.0	14.0	48.0	46.0	22.0	34.0	8.0
50	Sulphate: SO_4 (mg/l)	**600**	-	11.0	75.0	27.3	31.0	235	40.0	33.6

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.14 Result of Water Quality Analysis, Surface Water (1/8)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	W-01 Bagamoyo Pongwe Kiona (Ring Well)		W-02 Bagamoyo Miono Mandera (Wami River)		W-03 Bagamoyo Kiwangwa (Ring Well)		W-04 Bagamoyo Fukayosi Wws Intake (Dam)	
				Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
1	Total coliform bacteria (count/100ml)	0	**0**	4.0×10	9.0×10	8.0×10^2	1.0×10^3	1.2×10^1	3.5×10^3	5.2×10^3	5.0×10^3
2	Escherichia coli (count/100ml)	0	**0**	1.0×10	3.0×10	6.4×10^2	8.5×10^2	2.0×10	2.0×10^3	2.1×10^3	3.8×10^3
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.025	<0.001	0.022	<0.001	<0.001	0.002	0.014	0.010
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	0.047	0.080	<0.001	<0.01	<0.001	0.010	<0.001	0.070
7	Mercury: Hg (mg/l)	-	**0.001**	0.00019	<0.00001	<0.00001	<0.00001	0.00031	<0.00001	<0.00001	<0.00001
8	Selenium: Se (mg/l)	0.05	**0.01**	0.106	0.005	<0.01	0.010	0.086	<0.001	0.017	<0.001
9	Barium: Ba (mg/l)	1.00	**0.7**	6.00	<0.01	<0.7	<0.01	5.00	0.70	<0.01	<0.01
10	Fluoride: F (mg/l)	8.00	**1.5**	1.19	<1.5	0.41	0.65	0.34	<0.01	<0.01	0.64
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	<0.001	0.010	<0.001	<0.001	<0.001	0.010	<0.001
12	Total chromium: T-Cr (mg/l)	-	**0.05**	0.050	<0.001	0.020	<0.001	<0.001	<0.001	0.020	<0.001
13	Nitrate: (as NO_3 mg/l)	100	**50**	11.5	<0.01	5.80	20.8	8.40	72.7	30.6	<0.01
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.030	0.030	0.020	0.049	0.020	<0.2	<0.001	0.023
15	Boron: B (mg/l)	-	**0.5**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	0.020	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	0.03	0.10	0.40	<0.01	1.10	<0.01	<0.01	<0.01
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.152	0.005	0.006	<0.001	0.010	<0.001	0.005	0.035
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	535	500	33.0	102	121	33.0	33.2	40.5
22	Calcium: Ca (mg/l)	-	-	64.0	50.0	7.2	22.0	21.2	7.2	5.2	7.0
23	Magnesium: Mg (mg/l)	-	-	91.2	91.2	3.7	11.4	16.5	3.6	4.9	5.6
24	Iron: Fe (mg/l)	**1.0**	-	0.06	0.10	0.77	<0.01	0.41	<0.01	1.75	<0.01
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	<0.01	<0.01	0.10	<0.01	<0.01	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	0.30	<0.01	0.10	<0.01	0.30	<0.01	0.90
27	Chlorides: Cl (mg/l)	**800**	-	900	650	8.5	56.7	36.2	92.2	7.1	35.5
28	Residue (mg/l)	-	-	1,750	1,840	128	205	507	338	250	551
29	Total filterable residue (mg/l)	**2,000**	-	1,710	1,830	71.5	186	325	185	63.0	162
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.001	<0.001	<0.002	<0.002	<0.002	<0.002	<0.001	<0.001
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.47	0.01	0.58	<0.01	>1.0	<0.01	0.52	0.89
33	Ammonium: NH_3 (mg/l)	-	**1.5**	<0.01	<0.01	0.19	0.27	<0.01	1.76	0.22	2.45
34	Total Nitrogen, exclusive Nitrate (mg/l)	**1.0**	-	0.02	<0.01	0.16	0.23	<0.01	1.47	0.17	1.91
35	BOD_5 (mg/l)	**6**	-	0.8	11.0	5.0	4.0	3.6	6.1	50.0	40.0
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	1.6	2.0	8.6	6.8	6.2	10.2	84.0	68.0
37	pH	**6.5 - 9.2**	-	7.0	7.1	6.8	8.3	4.3	5.4	6.2	6.0
38	Taste	not objectionable	-	Salty	Salty	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet
39	Odour	not objectionable	-	OB	UN	UN	UN	UN	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	22	<1	120	62	21	47	350	390
41	Turbidity: Tr (NTU)	**30**	**5**	0.2	<0.1	22.5	53.0	41.0	178	52.0	520
42	Temperature (^oC)	-	-	26	29	28	30	32	30	28	29
43	Conductivity: EC (microS/cm)	-	-	3,000	3,550	110	330	500	300	120	220
44	Residual chlorine (mg/l)	-	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	785	765	26.6	100	232	69.6	<0.1	30.6
46	Sodium: Na (mg/l)	-	-	500	550	6.0	25.0	40.0	50.0	15.0	25.0
47	Potassium: K (mg/l)	-	-	2.0	5.0	4.0	7.5	22.0	2.5	8.0	10.0
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	32.0	756	26.0	57.0	20.0	4.0	50.0	58.0
49	Total alkalinity (mg/l)	-	-	32.0	756	26.0	93.0	20.0	4.0	50.0	580
50	Sulphate: SO_4 (mg/l)	**600**	-	194	74.0	17.0	27.0	175	16.0	<0.1	<0.1

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.14 Result of Water Quality Analysis, Surface Water (2/8)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	W-05 Kinondoni Mabwepande(Bunju) (Ring Well)		W-06 Kibaha Kidogozero Vigwaza Intake Ruvu River)		W-07 Kibaha Mlandizi Dawasa Wss Intake (Ruvu River)		W-08 Kinondoni Kimara King'Ong'O (Dug Well)	
				Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
1	Total coliform bacteria (count/100ml)	0	**0**	1.6×10^3	1.4×10^4	9.4×10^2	9.2×10	8.8×10^2	3.2×10^3	8.3×10^3	9.0×10^3
2	Escherichia coli (count/100ml)	0	**0**	9.0×10^2	8.0×10^3	6.9×10^2	7.2×10	3.0×10^2	1.0×10^3	5.8×10^3	6.0×10^3
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.054	<0.001	0.012	<0.001	0.004	<0.001	<0.07	<0.001
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	0.119	0.180	<0.001	<0.001	<0.001	<0.001	<0.001	0.090
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00060	<0.00001
8	Selenium: Se (mg/l)	0.05	**0.01**	0.044	0.010	0.446	0.039	0.162	<0.001	<0.01	<0.01
9	Barium: Ba (mg/l)	1.00	**0.7**	<0.01	<0.01	2.00	<0.01	<0.7	<0.01	10.0	1.00
10	Fluoride: F (mg/l)	8.00	**1.5**	<0.01	0.54	<0.01	0.40	<1.5	0.55	<0.01	0.17
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	0.050	<0.001	0.050	<0.001	<0.001	0.020	<0.001	0.010
12	Total chromium: T-Cr (mg/l)	-	**0.05**	<0.05	<0.001	<0.05	0.031	<0.001	0.027	<0.001	0.040
13	Nitrate: (as NO_3 mg/l)	100	**50**	64.7	636	<0.01	3.54	5.80	14.6	82.8	<0.01
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.141	0.082	0.016	0.013	0.020	0.010	0.079	0.026
15	Boron: B (mg/l)	-	**0.5**	4.0	<0.1	<0.1	<0.1	<0.1	<0.1	0.6	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	0.50	<0.01	<0.01	0.03	<0.01	0.50	0.10	0.60
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.008	0.012	0.003	0.026	0.001	<0.001	0.009	0.023
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	200	248	29.0	110	35.0	42.0	62.0	108
22	Calcium: Ca (mg/l)	-	-	56.8	44.0	6.4	12.8	7.2	7.2	15.2	21.6
23	Magnesium: Mg (mg/l)	-	-	14.0	33.6	3.2	19.0	4.1	5.8	5.8	13.1
24	Iron: Fe (mg/l)	**1.0**	-	3.03	<0.01	0.98	0.06	0.66	1.61	1.55	0.70
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	<0.01	0.20	<0.01	0.30	<0.01	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	0.50	<0.01	0.20	<0.01	0.20	<0.01	3.00
27	Chlorides: Cl (mg/l)	**800**	-	184	100	11.0	78.0	7.8	21.3	113	171
28	Residue (mg/l)	-	-	6,650	499	86.0	192	169	191	300	419
29	Total filterable residue (mg/l)	**2,000**	-	418	448	38.8	165	60.5	77.0	265	338
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.002	<0.001	<0.002	<0.001	<0.001	<0.001	<0.001	<0.001
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.22	<0.01	0.58	<0.01	0.30	<0.01	0.89	0.02
33	Ammonium: NH_3 (mg/l)	-	**1.5**	0.52	2.94	0.35	0.22	0.23	0.40	1.03	2.20
34	Total Nitrogen, exclusive Nitrate (mg/l)	**1.0**	-	0.15	2.30	0.28	0.17	0.19	0.31	0.07	1.72
35	BOD_5 (mg/l)	**6**	-	41.6	12.0	3.4	31.0	1.0	4.3	10.9	34.0
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	68.0	20.0	6.0	52.0	1.8	7.2	18.0	58.0
37	pH	**6.5 - 9.2**	-	7.5	6.4	6.8	6.9	7.3	7.2	6.0	8.6
38	Taste	not objectionable	-	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet
39	Odour	not objectionable	-	Earthy	UN	UN	UN	UN	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	110	37	150	62	140	62	300	260
41	Turbidity: Tr (NTU)	**30**	**5**	3,080	193	61.8	46.0	47.5	40.0	8.7	126
42	Temperature (^oC)	-	-	30	28	30	31	30	29	30	28
43	Conductivity: EC (microS/cm)	-	-	760	830	76	320	110	140	480	570
44	Residual chlorine (mg/l)	-	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	138	139	10.2	34.0	18.1	18.3	101	112
46	Sodium: Na (mg/l)	-	-	75.0	75.0	5.0	15.0	7.0	7.5	75.0	75.0
47	Potassium: K (mg/l)	-	-	12.5	2.5	1.9	12.5	2.5	7.5	7.5	10.0
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	72.0	250	24.0	34.0	44.0	<0.1	58.0	156
49	Total alkalinity (mg/l)	-	-	72.0	355	24.0	34.0	44.0	36.0	58.0	18.0
50	Sulphate: SO_4 (mg/l)	**600**	-	49.0	18.0	2.0	<0.1	7.0	5.0	20.0	24.0

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.14 Result of Water Quality Analysis, Surface Water (3/8)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	W-09 Kibaha Ruvu Stat.Intake (Ruvu)		W-10 Kibaha Kikongo (Dug Well)		W-11 Kibaha Bokotimiza (Ring Well)		W-12 Kibaha Soga Secondary (Ring Well)	
				Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
1	Total coliform bacteria (count/100ml)	0	**0**	2.8×10^2	7.0×10^2	3.6×10^3	1.0×10	1.0×10^1	4.1×10^3	1.1×10^2	1.2×10^3
2	Escherichia coli (count/100ml)	0	**0**	2.6×10^2	5.6×10^2	5.0×10^2	3.5×10^2	4.8×10^2	2.8×10^3	8.0×10^2	9.5×10^2
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.039	<0.001	0.030	<0.001	0.026	<0.001	<0.001	<0.001
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	0.004	<0.001	0.033	<0.001	<0.01	<0.01	<0.001	0.050
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	0.00300	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
8	Selenium: Se (mg/l)	0.05	**0.01**	0.029	<0.001	<0.001	0.050	<0.001	<0.001	<0.001	0.030
9	Barium: Ba (mg/l)	1.00	**0.7**	<0.7	<0.7	<0.7	<0.01	<0.01	<0.01	6.00	<0.01
10	Fluoride: F (mg/l)	8.00	**1.5**	<1.5	0.73	1.50	<0.01	1.33	0.02	<1.5	0.61
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	0.010	0.020	0.010	<0.001	0.020	<0.001	0.010
12	Total chromium: T-Cr (mg/l)	-	**0.05**	<0.001	0.024	0.034	0.028	<0.001	0.040	<0.001	<0.05
13	Nitrate: (as NO_3 mg/l)	100	**50**	14.6	<0.01	34.6	11.52	<50	1.33	4.90	<0.01
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.020	0.023	<0.001	0.023	<0.2	0.007	0.030	0.020
15	Boron: B (mg/l)	-	**0.5**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.02	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	<0.01	<0.01	0.10	<0.01	<0.01	<0.01	<0.01	<0.01
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.001	0.014	0.002	0.021	0.006	0.005	0.190	<0.001
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	31.0	33.0	12.0	95.0	66.0	75.0	59.0	73.0
22	Calcium: Ca (mg/l)	-	-	0.8	8.0	2.8	6.0	9.2	10.0	12.8	19.2
23	Magnesium: Mg (mg/l)	-	-	2.8	3.2	1.2	19.5	105	12.2	6.6	6.1
24	Iron: Fe (mg/l)	**1.0**	-	0.55	0.80	0.55	0.39	1.86	0.89	0.05	<0.01
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	0.50	<0.01	0.20	<0.01	0.30	<0.01	3.00
27	Chlorides: Cl (mg/l)	**800**	-	5.0	10.6	11.4	70.0	58.2	95.7	44.7	103
28	Residue (mg/l)	-	-	100	150	40.0	116	438	303	195	261
29	Total filterable residue (mg/l)	**2,000**	-	37.3	74.0	39.0	110	163	294	170	260
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	0.042	<0.001	<0.001	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.002	<0.002	<0.002	<0.001	<0.001	<0.001	<0.002	<0.001
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.40	0.46	0.35	<0.01	0.56	<0.01	0.71	0.76
33	Ammonium: NH_3 (mg/l)	-	**1.5**	0.31	0.27	0.41	0.43	<0.01	0.91	<0.01	<0.01
34	Total Nitrogen, exclusive Nitrate (mg/l)	**1.0**	-	0.25	0.22	0.32	0.34	0.11	0.71	<0.01	0.02
35	BOD_5 (mg/l)	**6**	-	2.4	4.1	3.3	2.7	2.8	32.0	2.7	21.2
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	4.2	6.8	5.6	4.6	4.6	54.0	4.4	36.0
37	pH	**6.5 - 9.2**	-	7.1	7.0	7.3	5.6	6.9	6.4	6.6	6.4
38	Taste	not objectionable	-	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet
39	Odour	not objectionable	-	UN	UN	Earthy	UN	UN	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	97	32	430	220	>500	250	57	<1
41	Turbidity: Tr (NTU)	**30**	**5**	34.3	60.0	35.9	54.0	14.3	92.0	5.7	2.0
42	Temperature ($^{\circ}C$)	-	-	30	29	27	29	26	28	26	28
43	Conductivity: EC (microS/cm)	-	-	64	110	60	220	250	380	330	510
44	Residual chlorine (mg/l)	-	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	13.7	11.7	10.2	27.5	49.5	78.2	74.6	101.1
46	Sodium: Na (mg/l)	-	-	6.0	7.5	6.0	5.0	25.0	50.0	50.0	80.0
47	Potassium: K (mg/l)	-	-	2.0	2.5	1.5	2.5	1.0	2.5	1.5	5.0
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	22.0	42.0	8.0	6.0	20.0	42.0	76.0	94.0
49	Total alkalinity (mg/l)	-	-	22.0	42.0	8.0	6.0	20.0	42.0	76.0	94.0
50	Sulphate: SO_4 (mg/l)	**600**	-	5.0	1.0	3.0	3.0	14.0	16.0	18.0	15.0

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.14 Result of Water Quality Analysis, Surface Water (4/8)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	W-13 Temeke Kisiwani P/School (Dug Well)		W-14 Kibaha Kwala Wss (River)		W-15 Temeke Ukoeni Somangira (River)		W-16 Kisarawe Kisarawe Intake (Reservoir)	
				Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
1	Total coliform bacteria (count/100ml)	0	**0**	0	1.5×10^{2}	1.4×10^{2}	2.0×10^{2}	1.8×10^{4}	1.6×10^{4}	5.1×10^{2}	8.1×10^{2}
2	Escherichia coli (count/100ml)	0	**0**	0	1.1×10^{2}	4.0×10	5.0×10	9.2×10^{3}	7.8×10^{3}	2.5×10^{2}	7.0×10^{2}
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.034	<0.001	0.019	<0.001	0.061	<0.001	0.023	<0.001
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	<0.001	0.020	<0.001	<0.001	0.016	0.050	<0.001	0.030
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	0.00700	<0.00001	<0.00001	0.00121	0.00200	<0.00001	<0.00001
8	Selenium: Se (mg/l)	0.05	**0.01**	0.065	0.050	0.852	0.040	<0.001	0.020	0.172	0.020
9	Barium: Ba (mg/l)	1.00	**0.7**	4.00	2.00	6.00	1.00	11.0	1.00	4.00	2.00
10	Fluoride: F (mg/l)	8.00	**1.5**	<0.01	<0.01	<1.5	0.46	<0.01	<0.01	0.61	0.42
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	0.010	<0.001	0.020	<0.001	0.010	<0.001	<0.001
12	Total chromium: T-Cr (mg/l)	-	**0.05**	<0.001	0.042	<0.001	0.030	<0.001	0.031	<0.001	0.018
13	Nitrate: (as NO_3 mg/l)	100	**50**	5.30	61.1	16.8	<0.01	2.70	24.8	3.10	12.0
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.033	0.026	0.033	0.026	0.033	0.026	0.013	0.023
15	Boron: B (mg/l)	-	**0.5**	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	0.013	<0.001	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	<0.01	<0.01	<0.01	<0.01	0.10	<0.01	0.10	<0.01
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.001	0.006	0.001	0.005	0.007	0.015	0.163	0.005
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	29.0	155	85.0	62.0	65.0	70.0	218	250
22	Calcium: Ca (mg/l)	-	-	6.0	18.0	17.2	10.0	19.6	17.6	29.6	30.0
23	Magnesium: Mg (mg/l)	-	-	3.4	26.8	10.2	9.0	3.9	6.3	35.0	42.6
24	Iron: Fe (mg/l)	**1.0**	-	0.02	0.02	0.22	<0.01	0.40	0.17	0.16	<0.01
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	0.20	<0.01	<0.01	<0.01	0.10	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.60
27	Chlorides: Cl (mg/l)	**800**	-	99.4	121	15.6	35.5	48.3	67.0	494	409
28	Residue (mg/l)	-	-	142	249	170	130	190	171	950	758
29	Total filterable residue (mg/l)	**2,000**	-	83.6	245	138	130	161	161	836	743
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.001	<0.001	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.72	<0.01	0.57	0.68	0.40	<0.01	0.55	<0.01
33	Ammonium: NH_3 (mg/l)	-	**1.5**	<0.01	<0.01	0.06	0.27	0.52	0.14	0.39	0.17
34	Total Nitrogen, exclusive Nitrate (mg/l)	**1.0**	-	0.02	<0.01	0.06	0.22	0.41	0.12	0.30	0.14
35	BOD_5 (mg/l)	**6**	-	1.4	2.1	2.6	6.8	2.7	5.4	4.9	4.6
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	2.0	3.8	4.2	11.4	4.2	9.0	8.0	7.8
37	pH	**6.5 - 9.2**	-	6.5	6.1	6.8	6.6	7.1	8.3	6.0	6.3
38	Taste	not objectionable	-	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet
39	Odour	not objectionable	-	UN	UN	UN	UN	UN	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	13	<1	20	19	31	<1	26	<1
41	Turbidity: Tr (NTU)	**30**	**5**	0.3	0.5	3.4	13.0	5.7	12.7	20.2	6.0
42	Temperature (^{o}C)	-	-	39	29	38	32	40	27	28	29
43	Conductivity: EC (microS/cm)	-	-	160	480	250	240	304	185	1,530	1,530
44	Residual chlorine (mg/l)	-	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	34.4	72.3	26.2	34.0	64.9	87.3	385	355
46	Sodium: Na (mg/l)	-	-	25.0	37.5	15.0	25.0	45.0	40.0	240	230
47	Potassium: K (mg/l)	-	-	6.0	5.0	5.0	5.0	4.0	5.0	18.0	7.5
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	52.0	60.0	105	70.0	74.0	18.0	8.0	22.0
49	Total alkalinity (mg/l)	-	-	52.0	60.0	105	70.0	74.0	66.0	8.0	22.0
50	Sulphate: SO_4 (mg/l)	**600**	-	6.0	8.0	1.0	<0.1	16.0	41.0	110	82.5

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.14 Result of Water Quality Analysis, Surface Water (5/8)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	W-17 Kisarawe Sanze Intake (Stream)		W-18 Temeke Mzinga (At Bridge Charambe) (River)		W-19 Temeke Mkongoe (River)		W-20 Ilala Mbuyuni (Ring Well)	
				Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
1	Total coliform bacteria (count/100ml)	0	**0**	5.0×10	1.0×10	8.3×10^3	1.5×10^4	1.5×10^4	2.9×10^4	7.0×10	2.5×10^2
2	Escherichia coli (count/100ml)	0	**0**	2.0×10	5	6.0×10^3	9.0×10^3	6.2×10^3	9.0×10^3	1.1×10^2	2.0×10^2
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.021	0.026	0.052	0.002	0.061	<0.001	0.046	<0.001
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	<0.001	<0.001	0.011	0.020	<0.001	0.050	<0.01	<0.01
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	<0.00001	<0.00001	0.00300	0.00026	<0.00001	0.00149	0.00300
8	Selenium: Se (mg/l)	0.05	**0.01**	<0.001	0.070	0.035	0.090	0.195	0.030	<0.001	0.010
9	Barium: Ba (mg/l)	1.00	**0.7**	3.00	1.00	6.00	1.00	9.00	1.00	6.00	0.90
10	Fluoride: F (mg/l)	8.00	**1.5**	0.64	0.47	<0.01	<0.01	0.15	<0.01	0.24	<0.01
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	<0.001	<0.001	0.020	<0.001	0.020	<0.001	<0.001
12	Total chromium: T-Cr (mg/l)	-	**0.05**	<0.001	<0.001	<0.001	0.044	<0.001	0.049	<0.001	0.011
13	Nitrate: (as NO_3 mg/l)	100	**50**	7.10	11.5	10.2	20.8	5.30	11.5	10.6	<0.01
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.069	0.039	0.089	<0.2	0.026	0.066	0.039	<0.001
15	Boron: B (mg/l)	-	**0.5**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	0.044	<0.001	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.02	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	0.03	<0.01	<0.01	<0.01	0.03	<0.01	0.02	0.15
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.200	0.023	0.121	0.014	0.052	0.020	0.061	0.017
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	610	672	234	224	75.0	118	136	110
22	Calcium: Ca (mg/l)	-	-	82.0	68.0	4.9	40.0	13.2	17.6	44.0	29.6
23	Magnesium: Mg (mg/l)	-	-	98.5	122	33.1	30.2	10.2	18.0	6.3	8.8
24	Iron: Fe (mg/l)	**1.0**	-	0.12	<0.01	0.68	<0.01	0.06	0.03	0.07	0.36
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.10
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	0.30	<0.01	0.20	<0.01	0.10	<0.01	0.30
27	Chlorides: Cl (mg/l)	**800**	-	1,050	145	302	241	124	206	141	262
28	Residue (mg/l)	-	-	2,350	2,260	872	569	359	401	548	780
29	Total filterable residue (mg/l)	**2,000**	-	2,280	2,250	663	530	297	398	365	706
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.78	<0.01	0.60	<0.01	0.39	<0.01	0.72	0.67
33	Ammonium: NH_3 (mg/l)	-	**1.5**	0.03	0.14	0.32	0.26	0.12	<0.01	<0.01	2.56
34	Total Nitrogen, exclusive Nitrate (mg/l)	**1.0**	-	0.04	0.12	0.28	0.31	0.10	0.02	<0.01	1.99
35	BOD_5 (mg/l)	**6**	-	2.7	4.8	8.0	6.6	4.7	5.1	2.7	12.0
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	4.4	8.0	12.8	11.0	7.5	8.6	4.2	18.8
37	pH	**6.5 - 9.2**	-	6.3	8.3	6.8	8.4	7.2	8.3	6.8	6.6
38	Taste	not objectionable	-	Salty	Salty	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet
39	Odour	not objectionable	-	OB	UN	UN	UN	UN	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	18	<1	36	<1	30	<1	10	330
41	Turbidity: Tr (NTU)	**30**	**5**	23.0	7.0	8.5	21.1	4.8	1.5	2.2	321
42	Temperature (^{0}C)	-	-	30	29	27	28	26	31	27	29
43	Conductivity: EC (microS/cm)	-	-	3,510	4,420	1,220	1,060	540	780	660	900
44	Residual chlorine (mg/l)	-	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	914	977	376	218	121	158	141	167
46	Sodium: Na (mg/l)	-	-	600	700	200	140	87.5	125	87.5	150
47	Potassium: K (mg/l)	-	-	34.0	15.0	7.5	2.5	4.5	5.0	5.0	10.0
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	45.0	<0.1	72.0	104	70.0	88.0	82.0	68.0
49	Total alkalinity (mg/l)	-	-	48.0	30.0	72.0	140	70.0	116	82.0	68.0
50	Sulphate: SO_4 (mg/l)	**600**	-	215	155	143	48.0	23.0	15.0	47.5	8.0

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.14 Result of Water Quality Analysis, Surface Water (6/8)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	W-21 Ilala Msongola (Ring Well)		W-22 Temeke Mbungoni Kimbiji (River)		W-23 Ilala Msongola Mvuti (Spring)		W-24 Kisarawe Mafizi (Ruvu River)	
				Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
1	Total coliform bacteria (count/100ml)	0	**0**	1.0×10^2	2.0×10^1	6.4×10^1	6.4×10^2	1	3.4×10^3	2.9×10^2	3.5×10^2
2	Escherichia coli (count/100ml)	0	**0**	5.5×10^2	1.4×10^1	6.0×10^2	4.0×10^2	0	2.6×10^3	1.6×10^2	2.2×10^3
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.022	<0.001	0.034	0.025	0.051	<0.001	0.049	<0.001
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	<0.001	0.020	<0.001	0.020	<0.001	0.020	0.015	0.060
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	<0.00001	0.00080	0.00300	<0.00001	<0.00001	<0.00001	0.00200
8	Selenium: Se (mg/l)	0.05	**0.01**	<0.001	0.020	0.102	<0.001	0.070	<0.001	<0.001	<0.001
9	Barium: Ba (mg/l)	1.00	**0.7**	7.00	1.00	3.00	<0.01	<0.01	0.59	13.0	0.90
10	Fluoride: F (mg/l)	8.00	**1.5**	0.47	0.43	0.38	<0.01	0.28	0.35	<1.5	<0.01
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	-	<0.001	<0.001	<0.001	0.020	<0.001	<0.001	0.010	<0.001
12	Total chromium: T-Cr (mg/l)	-	**0.05**	<0.001	0.013	<0.001	0.040	<0.001	<0.001	0.015	0.031
13	Nitrate: (as NO_3 mg/l)	100	**50**	12.8	32.8	7.10	7.09	26.1	16.8	12.4	8.86
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	0.062	0.020	0.033	0.052	0.049	0.036	0.033	<0.001
15	Boron: B (mg/l)	-	**0.5**	<0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	0.013	<0.001	0.050	<0.001	<0.001	<0.001	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	0.20	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.10
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	<0.001	0.005	0.072	0.015	0.004	0.005	<0.001	0.014
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	68.0	24.0	218	260	56.0	84.9	37.0	105
22	Calcium: Ca (mg/l)	-	-	18.4	4.0	64.8	82.0	7.2	20.8	6.4	8.0
23	Magnesium: Mg (mg/l)	-	-	5.4	3.4	13.6	13.4	9.2	8.0	5.1	20.7
24	Iron: Fe (mg/l)	**1.0**	-	0.24	<0.01	0.02	<0.01	0.04	0.07	0.36	0.14
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	0.90	<0.01	4.00	<0.01	<0.01	<0.01	0.20
27	Chlorides: Cl (mg/l)	**800**	-	21.3	42.5	166	1,600	70.3	81.5	10.6	60.3
28	Residue (mg/l)	-	-	180	156	396	445	200	304	130	175
29	Total filterable residue (mg/l)	**2,000**	-	122	148	358	440	160	291	59	135
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.002	<0.001	<0.002	<0.001	<0.001	<0.001	<0.002	<0.002
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.46	<0.01	0.38	<0.01	0.18	<0.01	0.40	<0.01
33	Ammonium: NH_3 (mg/l)	-	**1.5**	0.05	0.22	0.04	<0.01	<0.01	0.50	0.19	<0.01
34	Total Nitrogen, exclusive Nitrate (mg/l)	**1.0**	-	0.06	0.76	0.04	0.03	0.02	0.40	0.16	<0.01
35	BOD_5 (mg/l)	**6**	-	1.9	2.5	2.8	2.1	1.0	3.2	2.6	6.1
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	3.2	4.2	4.4	3.6	1.6	5.4	4.6	10.0
37	pH	**6.5 - 9.2**	-	6.0	5.4	7.2	8.3	7.6	7.9	7.1	6.4
38	Taste	not objectionable	-	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet
39	Odour	not objectionable	-	UN	UN	UN	UN	UN	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	22	<1	23	<1	9	150	52	9
41	Turbidity: Tr (NTU)	**30**	**5**	3.7	3.0	0.6	0.5	3.1	48.0	25.0	51.0
42	Temperature ($^{\circ}C$)	-	-	27	29	27	27	29	29	30	29
43	Conductivity: EC (microS/cm)	-	-	232	2,300	650	860	290	400	90	270
44	Residual chlorine (mg/l)	-	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	70.8	83.4	82.6	111	76.2	90.5	10.1	36.2
46	Sodium: Na (mg/l)	-	-	30.0	40.0	50.0	75.0	35.0	50.0	3.0	7.5
47	Potassium: K (mg/l)	-	-	5.0	2.5	4.5	2.5	7.5	5.0	2.0	10.0
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	48.0	14.0	68.0	185	18.0	51.0	32.0	40.0
49	Total alkalinity (mg/l)	-	-	48.0	14.0	68.0	217	18.0	51.0	32.0	40.0
50	Sulphate: SO_4 (mg/l)	**600**	-	35.4	40.0	19.0	23.0	32.0	32.5	2.0	8.0

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.14 Result of Water Quality Analysis, Surface Water (7/8)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	W-25 Kisarawe Masaki (Dug Well)		W-26 Mkuranga Mbezi- Gongoni (Ring Well)		W-27 Kisarawe Gwata Wss Intake (Ruvu River)	W-28 Kisarawe Maneromango Wss (Kanga Dam)		W-29 Mkuranga Kimanzichana (Ring Well)	
				Dry	Rain	Dry	Rain	Dry	Dry	Rain	Dry	Rain
1	Total coliform bacteria (count/100ml)	0	**0**	2.4×10^2	1.0×10^4	2.1×10	2.4×10^3	9.0×10	1.2×10^2	2.3×10^2	3.0×10	7.8×10^2
2	Escherichia coli (count/100ml)	0	**0**	2.1×10^2	6.9×10^3	9	8.0×10	5.0×10	2.8×10	1.2×10^3	8	4.2×10^2
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.043	0.002	0.057	<0.001	0.030	0.057	0.005	0.063	<0.001
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	0.002	0.030	0.175	0.101	<0.001	<0.001	<0.001	<0.001	<0.001
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	0.00400	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00018	<0.00001
8	Selenium: Se (mg/l)	0.05	**0.01**	0.048	0.005	0.019	<0.001	<0.001	0.091	0.004	0.225	0.050
9	Barium: Ba (mg/l)	1.00	**0.7**	12.0	<0.01	5.00	<0.01	16.0	4.00	2.00	9.00	<0.01
10	Fluoride: F (mg/l)	8.00	**1.5**	<0.01	<0.01	0.34	<0.01	<1.5	0.48	0.44	0.29	0.30
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	**-**	<0.001	0.030	<0.001	0.010	<0.001	<0.001	<0.001	0.010	0.020
12	Total chromium: T-Cr (mg/l)	-	**0.05**	<0.001	<0.05	<0.001	0.024	<0.001	<0.001	0.046	0.020	0.045
13	Nitrate: (as NO_3 mg/l)	100	**50**	142	36.3	2.20	5.76	11.5	4.90	12.4	47.8	14.6
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	<0.2	<0.2	0.033	0.026	0.026	0.010	0.085	0.049	0.003
15	Boron: B (mg/l)	-	**0.5**	<0.1	<0.1	<0.1	<0.1	<0.1	1.0	<0.1	0.7	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	0.057	<0.001	<0.001	<0.001	<0.001	0.046	<0.001	0.016
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	0.60	0.70	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.004	<0.001	0.003	0.009	<0.001	0.004	0.006	0.005	0.041
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	66.0	210	49.0	106	33.0	37.0	80.0	53.0	80.0
22	Calcium: Ca (mg/l)	-	-	9.0	14.0	11.6	30.8	8.8	4.8	6.0	9.6	14.8
23	Magnesium: Mg (mg/l)	-	-	10.2	42.6	4.9	7.0	2.7	6.1	15.8	7.1	10.5
24	Iron: Fe (mg/l)	**1.0**	-	0.91	3.02	0.02	0.09	0.37	0.31	0.14	0.23	0.33
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	0.20	<0.01	3.00	<0.01	<0.01	0.10	<0.01	0.10
27	Chlorides: Cl (mg/l)	**800**	-	135	180	79.5	199	14.1	128	160	74.4	42.5
28	Residue (mg/l)	-	-	380	659	294	391	180	374	365	369	194
29	Total filterable residue (mg/l)	**2,000**	-	220	418	202	389	65.0	338	365	154	177
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.001	<0.002	<0.001	<0.001	<0.002	<0.001	<0.001	<0.001	<0.002
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.80	<0.01	0.92	<0.01	0.52	0.57	<0.01	0.54	<0.01
33	Ammonium: NH_3 (mg/l)	-	**1.5**	0.04	2.76	0.12	0.12	0.13	0.27	0.82	0.52	0.27
34	Total Nitrogen, exclusive Nitrate (mg/l)	**1.0**	-	0.18	2.30	0.10	0.10	0.11	0.21	0.67	0.42	0.21
35	BOD_5 (mg/l)	**6**	-	1.7	10.5	1.2	2.2	2.8	1.4	21.0	2.3	3.1
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	2.8	17.6	2.0	3.8	4.6	2.2	35.0	3.8	5.2
37	pH	**6.5 - 9.2**	-	6.3	6.1	5.9	8.5	6.9	6.8	7.8	6.3	6.0
38	Taste	not objectionable	-	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Sweet	Salty
39	Odour	not objectionable	-	Muy	UN	UN	UN	UN	Earthy	UN	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	>500	>550	27	<1	45	74	46	310	70
41	Turbidity: Tr (NTU)	**30**	**5**	194	265	4.6	2.0	18.5	6.8	87.0	82.0	28.0
42	Temperature (°C)	-	-	33	29	27	29	30	30	29	27	29
43	Conductivity: EC (microS/cm)	-	-	400	600	310	600	100	520	720	280	320
44	Residual chlorine (mg/l)	-	-	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	<0.1	108	71.8	113	10.7	139	179	59.1	64.5
46	Sodium: Na (mg/l)	-	-	60.0	40.0	50.0	87.5	6.0	100	125	30.0	30.0
47	Potassium: K (mg/l)	-	-	2.0	2.5	3.0	5.0	2.5	7.5	7.5	14.0	10.0
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	10.0	18.0	40.0	<0.1	30.0	46.0	94.0	10.0	76.0
49	Total alkalinity (mg/l)	-	-	10.0	18.0	40.0	68.0	30.0	46.0	94.0	10.0	76.0
50	Sulphate: SO_4 (mg/l)	**600**	-	<0.1	25.0	17.0	18.0	2.0	32.5	38.0	22.0	24.0

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Table 9.14 Result of Water Quality Analysis, Surface Water (8/8)

	Water Quality Analysis Items	Tanzania Standard for Rural Water Supplies (1974)	WHO Guideline (2004)*1	W-30 Mkuranga Mkiu-Mbwingo (Ring Well)		W-31 Kisarawe Marui Kihare (Charco Dam)		W-32 Mkuranga Lukanga (River)		W-33 Mkuranga Njopeka Spring Wss (Spring)		W-34 Kisarawe Mtakayo (Dug Well)
				Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain	Rain
1	Total coliform bacteria (count/100ml)	0	**0**	7	9.6×10^2	3.5×10^2	1.2×10^3	3.2×10^2	1.4×10^2	3.5×10^2	1.3×10^2	2.4×10^2
2	Escherichia coli (count/100ml)	0	**0**	4	8.4×10^1	1.4×10^2	1.0×10^3	2.0×10^1	1.0×10^2	2.3×10^2	5.2×10^2	1.5×10^3
3	Cadmium: Cd (mg/l)	0.05	**0.003**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4	Cyanide: CN (mg/l)	0.20	**0.07**	0.036	0.002	0.052	0.019	0.058	0.006	0.066	<0.001	0.004
5	Lead: Pb (mg/l)	0.1	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6	Arsenic: As (mg/l)	0.05	**0.01**	<0.001	0.020	0.178	0.052	<0.001	0.040	<0.01	<0.001	0.020
7	Mercury: Hg (mg/l)	-	**0.001**	<0.00001	<0.00001	0.01880	0.0400	0.00085	<0.00001	0.00102	<0.00001	0.00800
8	Selenium: Se (mg/l)	0.05	**0.01**	0.086	0.040	<0.001	0.090	0.175	0.010	<0.01	<0.001	0.080
9	Barium: Ba (mg/l)	1.00	**0.7**	6.00	3.34	<0.01	3.61	3.00	1.00	<0.7	<0.7	<0.01
10	Fluoride: F (mg/l)	8.00	**1.5**	<0.01	0.24	<0.01	<0.01	0.37	0.33	0.76	0.52	<0.01
11	Hexavalent-chromium : Cr^{6+} (mg/l)	0.05	**-**	<0.001	0.020	<0.001	<0.001	<0.001	0.020	<0.001	0.010	<0.001
12	Total chromium: T-Cr (mg/l)	-	**0.05**	<0.001	0.031	<0.001	<0.05	<0.001	0.044	<0.001	<0.05	<0.001
13	Nitrate: (as NO_3 mg/l)	100	**50**	<50	<0.01	483	93.0	7.10	<0.01	2.70	<0.01	<0.01
14	Nitrite: (as NO_2 mg/l)	-	**3/0.2**	<0.2	0.082	<0.2	0.082	0.030	0.043	0.036	0.037	0.036
15	Boron: B (mg/l)	-	**0.5**	0.9	<0.1	0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16	Nickel: Ni (mg/l)	-	**0.02**	<0.001	<0.001	0.128	0.056	<0.001	0.020	<0.001	<0.02	<0.001
17	Antimony: Sb (mg/l)	-	**0.02**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
18	Molybdenum: Mo (mg/l)	-	**0.07**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
19	Manganese: Mn (mg/l)	**0.5**	**0.40**	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.20	<0.01
20	Organic carbon as carbon in chloroform (mg/l)	**0.5**	-	0.078	0.014	0.130	0.026	0.196	0.012	0.196	0.026	<0.001
21	Hardness (as $CaCO_3$ mg/l)	**600**	-	38.2	42.0	38.0	110	420	355	505	325	240
22	Calcium: Ca (mg/l)	-	-	4.1	5.2	3.2	6.0	84.0	48.0	110	46.0	28.0
23	Magnesium: Mg (mg/l)	-	-	6.8	7.1	7.3	23.1	51.1	57.0	56.0	51.1	41.3
24	Iron: Fe (mg/l)	**1.0**	-	0.65	<0.01	14.0	2.00	<0.01	<0.01	<0.01	0.09	0.45
25	Zinc: Zn (mg/l)	**15**	-	<0.01	<0.01	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Copper: Cu (mg/l)	**3.0**	**2.0**	<0.01	0.10	<0.01	0.20	<0.01	0.20	<0.01	0.30	0.10
27	Chlorides: Cl (mg/l)	**800**	-	55.4	113	18.5	42.5	717	589	646	582	160
28	Residue (mg/l)	-	-	934	221	1,880	203	1,620	1,330	1,490	1,350	300
29	Total filterable residue (mg/l)	**2,000**	-	132	190	88	158	1,320	1,320	1,440	1350	288
30	Surfactants: ABS (mg/l)	**2.0**	-	<0.001	<0.001	<0.001	0.010	<0.001	<0.001	0.039	0.010	<0.001
31	Phenolic substance as phenol (mg/l)	**0.002**	-	<0.002	<0.001	<0.002	<0.002	<0.001	<0.002	<0.001	<0.001	<0.002
32	Hydrogen sulfide: H_2S (mg/l)	-	-	0.92	0.92	0.47	0.72	0.74	0.60	0.68	0.55	0.04
33	Ammonium: NH_3 (mg/l)	-	**1.5**	94.02	1.57	0.45	2.91	0.17	0.02	0.12	<0.01	0.59
34	Total Nitrogen, exclusive Nitrate (mg/l)	**1.0**	-	0.93	1.25	0.67	2.29	0.14	0.03	0.10	0.02	0.15
35	BOD_5 (mg/l)	**6**	-	19.0	14.0	24.0	19.0	6.8	6.1	5.0	5.2	3.9
36	PV: Oxygen abs. $KMnO_4$ (mg/l)	**20**	-	31.0	23.6	39.0	30.0	11.2	10.2	8.2	8.8	6.6
37	pH	**6.5 - 9.2**	-	5.7	5.9	7.0	6.5	6.5	6.7	6.6	6.8	8.3
38	Taste	not objectionable	-	Sweet	Sweet	Sweet	Sweet	Salty	Sweet	Salty	Sweet	Sweet
39	Odour	not objectionable	-	UN	UN	UN	UN	OB	UN	OB	UN	UN
40	Colour (TCU mg Pt/l)	**50**	**15**	>500	>550	>500	>550	95	20	40	9	140
41	Turbidity: Tr (NTU)	**30**	**5**	223	186	327	500	9.7	3.0	0.2	8.0	56.0
42	Temperature (^oC)	-	-	29	29	35	29	26	29	26	29	29
43	Conductivity: EC (microS/cm)	-	-	240	370	160	310	2,370	2,020	2,260	2,000	570
44	Residual chlorine (mg/l)	-	-	-	-	-	-	-	-	-	-	-
45	Sulphate as Mg+Na Salts (mg/l)	-	-	72.8	67.1	62.3	39.1	491	465	601	516	62.8
46	Sodium: Na (mg/l)	-	-	35.0	60.0	15.0	15.0	300	300	400	350	17.5
47	Potassium: K (mg/l)	-	-	4.0	7.5	5.0	1.5	18.0	5.0	18.0	5.0	2.5
48	Bicarbonate: HCO_3 (as $CaCO_3$ mg/l)	-	-	10.0	24.0	15.0	94.0	44.0	66.0	72.0	60.0	16.0
49	Total alkalinity (mg/l)	-	-	10.0	24.0	15.0	94.0	44.0	66.0	72.0	60.0	136
50	Sulphate: SO_4 (mg/l)	**600**	-	31.0	<0.1	40.0	1.0	140	108	145	115	4.0

*1: "MAJI REVIEW" Ministry of Water Development and Power, vol 1, No. 1, July 1974, Dar es Salaam

*2: "WHO Guideline for Drinking Water Quality Third Edition", World Health Organization, Genova 2004

UN : unobjectionable

OB: objectionable

Number of samples of which item did not satisfy the WHO Guidelines or the Tanzanian Standards is summarized in *Table 9.15* below.

Table 9.15 Number of Samples with Items exceeding the Guidelines and Standards

Aspects and Items		Test well	Existing well	Surface water (Dry season)		Surface water (Rainy season)	
				River and Dam	Shallow well and Spring	River and Dam	Shallow well and Spring
Total Number of Sample		9	35	17	16	16	17
Microbial aspects	Escherichia coli	6	10	17	14	16	17
Chemicals that are of health significance	Cadmium (Cd)	0	1	0	0	0	0
	Cadmium (Cd)	0	0	0	0	0	0
	Cyanide (CN)	0	0	0	0	0	0
	Lead (Pb)	1	0	0	0	0	0
	Arsenic (As)	0	0	4	4	9	11
	Mercury (Hg)	0	0	2	1	6	4
	Selenium (Se)	0	0	11	9	8	7
	Barium (Ba)	0	0	12	11	10	5
	Fluoride (F)	0	0	0	0	0	0
	Hexavalent-chromium (Cr^{6+})	0	0	0	0	0	0
	Total chromium (T-Cr)	-	-	-	-	-	-
	Nitrate (NO_3-N)	0	3	1	3	1	3
	Nitrite (NO_2-N)	0	0	0	0	0	0
	Boron (B)	0	0	1	4	0	0
	Nickel (Ni)	1	1	1	0	4	1
	Antimony (Sb)	0	0	0	0	0	0
	Molybdenum (Mo)	0	0	0	0	0	0
	Manganese (Mn)	2	0	0	3	1	2
	Organic Carbon (as carbon in Chloroform)	0	0	0	0	0	0
Acceptability aspects	Total Hardness	4	5	0	0	1	0
	Hardness	0	1	2	3	4	5
	Calcium (Ca)	-	-	-	-	-	-
	Magnesium (Mg)	-	-	-	-	-	-
	Iron (Fe)	2	0	2	3	2	1
	Zinc (Zn)	0	0	0	0	0	0
	Copper (Cu)	1	0	0	0	1	0
	Chloride (Cl)	4	5	1	1	1	0
	Residue	-	-	-	-	-	-
	Total filterable residue	4	2	1	0	1	0
	Anionic surface active agents (as ABS)	0	0	0	0	0	0
	Phenols	0	0	0	0	0	0
	Hydrogen sulfide (H_2S)	-	-	-	-	-	-
	Ammonium (NH_3+NH_4)	0	0	0	1	2	6
	Total nitrogen (Excluding NO_3)	0	0	0	0	2	6
	BOD	0	0	4	3	8	9
	Potassium permanganate consumption	0	0	2	2	4	4
	pH	0	17	3	7	3	10
	Taste	5	7	2	2	1	2
	Odour	0	8	3	5	0	0
	Colour	0	2	9	8	5	9
	Turbidity	3	2	5	6	8	10
	Temperature	-	-	-	-	-	-
	Conductivity (EC)	-	-	-	-	-	-
	Residual chlorine (Cl)	-	-	-	-	-	-
	Sulfate (Mg+Na Salts)	-	-	-	-	-	-
Water quality items related to the characteristics of groundwater	Sodium (Na)	-	-	-	-	-	-
	Potassium (K)	-	-	-	-	-	-
	Bicarbonate (HCO^{3-})	-	-	-	-	-	-
	Total alkalinity	-	-	-	-	-	-
	Sulphate (SO_4)	1	0	0	0	0	0

(1) Groundwater (Test well)

Among the nine test wells, only two wells satisfy all the analyzed items: Potea in Temeke and Dundani in Mkuranga. Other seven wells do not satisfy either the Guidelines (WHO, 2004) or the Standards.

1) Microbial Aspects (Escherishia Coli)

Microbial Aspects are detected in six test wells. Generally, contamination by Microbial Aspects is not detected in deep groundwater. Accordingly, using those groundwater for drinking use need disinfection with chlorination.

2) Chemicals that are of Health Significance

Chemicals that are of health significance are detected in two wells: Matipwili and Magindu in Bagamoyo. Contents of Lead (Pb), Nickel (Ni) and Manganese (Mn) are more than the WHO Guidelines in Matipwili. Contents of Manganese (Mn) is more than the WHO Guidelines in Magindu.

3) Acceptability Aspects

Acceptability aspects were good in four wells. Total hardness and chloride (Cl) were more than the Standard in four wells. The wells of which taste is evaluated "salty" are of high content of chloride (Cl). Iron (Fe) is high in two wells: Matipwili and Magindu in Bagamoyo. In Matipwili, sulphate (SO_4) is also high. High content of copper (Cu) was detected only in one well, Msumi in Ilala.

(2) Groundwater (Existing well)

Concentration of analyzed items exceeding the Guidelines or the Standards are observed on 13 items; Microbial aspects (Escherichia Coli), Cadmium (Cd), Nitrate Nitrogen (NO_3-N), Nickel (Ni), Total Hardness, Chloride (Cl^-), Total Dissolved Solid (TDS), pH, Taste, Odor, Colour and Turbidity. Among them, items related to the Chemicals that are of health significance are Cadmium (Cd), Nitrate Nitrogen (NO_3-N) and Nickel (Ni). Although contamination of groundwater is observed on some items in overall, the results will not affect the Water Supply Plan formulated in the Study, because the sampling sites are generally not located in the target village and remarkable zonal variation in contamination is confirmed.

1) Microbial Aspects (Escherishia Coli)

Escherishia Coli was detected. No regional characteristics of bacterial contamination was observed from the results. All samples were collected from tube wells. Generally, groundwater in tube well is free bacterial contamination. It is suggested that it might be caused by breakage of casing pipes or inappropriate sealing in the borehole.

2) Chemicals that are of Health Significance

i) Cadmium (Cd)

High concentration of Cadmium is observed at Bunju 'A', Kinondoni. However, the contamination source is not clear.

ii) Nickel (Ni)

High concentration of Nickel is observed at Zeko Village, the eastern area of Bagamoyo. However, the contamination source is not clear.

iii) Nitrate (NO_3)

Concentration of Nitrate Nitrogen (NO_3-N) exceeds the Guidelines at three sites in Dar es Salaam. These samples were collected from the two tube wells located in the urban area of Dar es Salaam and one in Kisarawe. Contaminations by Nitrate Nitrogen are always accompanied by Microbial aspects in the Study area. This fact suggests that the contamination is caused by wastewater.

3) Acceptability Aspects

i) Chloride (Cl^-)

High concentration of Chloride is observed at five villages in Bagamoyo, Kinondoni and Temeke. These villages are located near the coast. Therefore, this contamination is likely caused by sea water intrusion.

ii) pH

The pH values lower than 6.5 are observed at 17 villages. Among them, pH value of nine villages are lower than 6.0. Distribution of low pH value has no particular characteristics and it is widespread in the Study area. Low pH value will cause corrosion of steel materials such as casing screen pipes. Therefore, these characteristics were taking into consideration in the design of deep tube wells in the Study area.

iii) Electric Conductivity (EC)

Distribution of Electric Conductivity is shown in *Figure 9.21*. Relatively high Electric Conductivities (more than 1,000 micro-S/cm) are observed in the areas, Kinondoni, Kibaha and the southeastern area of Bagamoyo. On the one hand, relatively low Electric Conductivities (less than 1,000 micro-S/cm) are measured in the areas, Ilala, western half of Temeke, northern part of Mkuranga and on the hill in Kisarawe.

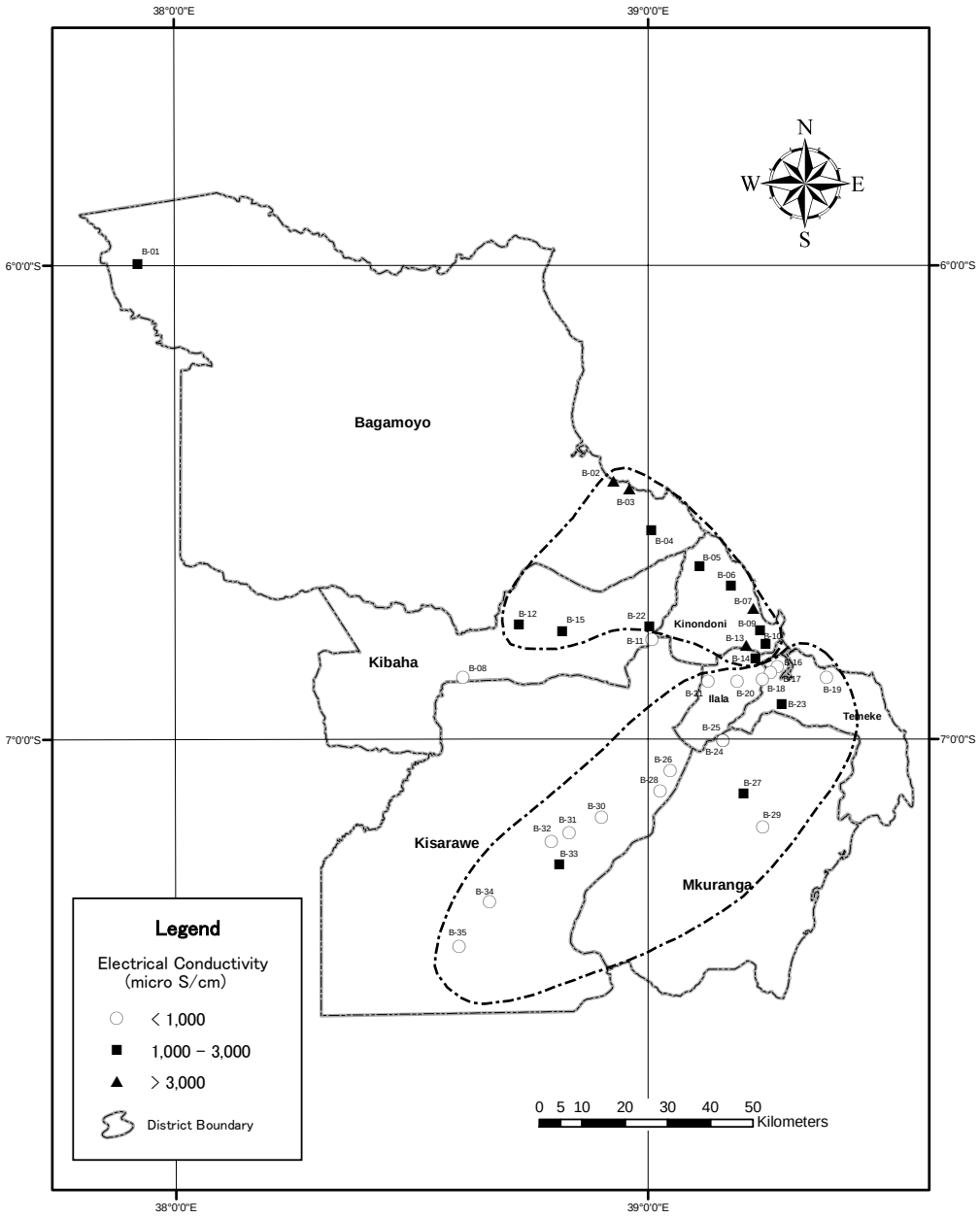

FIGURE 9.21 DISTRIBUTION OF ELECTRIC CONDUCTIVITY (EC)

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iv) Chemical Properties

High concentration of Total Dissolved Solid (TDS) is confirmed at five villages same as Chlorides. At the same time, Electric Conductivity (EC) is also high in the same villages. High concentration of Total Dissolved Solid has a close relation with concentration of Chloride and Electric Conductivity.

Color of water sometimes shows milky white, particularly in Chole in Kisarawe. This color is likely derived from the fine soil material of aquifer.

(3) Surface Water

Water quality analyses results show that surface water including the water in shallow wells (unprotected wells) are generally contaminated with respect to many water quality items. However, it will cause no affect to the Water Supply Plan prepared in the Study because the surface water is not used as the water sources of the water supply scheme proposed in the Study except the Wami water for Matipwili, Bagamoyo and spring water in Njopeka, Temeke.

As shown in *Table 9.15*, contamination was observed on eight chemical items that are of health significance. In addition, contamination was also observed on 14 items related to acceptability aspects. Such contamination should be basically related with potential contamination sources. However, in most cases, potential contamination sources are unclear and such sources are likely not present in the areas where such contamination was observed.

1) Microbial Aspects (Escherishia Coli)

Contamination by Microbial aspects and organic pollutions were confirmed. Microbial aspects more than Guidelines is observed in 97 % of samples. This means that almost all the surface water is polluted due to insufficient protection.

2) Chemicals that are of Health Significance

Many chemicals that are of Health Significance exceed the Guidelines: Arsenic, Mercury, Selenium, Barium, Nitrate, Boron, Nickel and Manganese. Such contamination sources are generally thought to be of geological origin, chemical factories or agrichemicals. Among them, contamination by arsenic is sometimes caused naturally by arsenic in geological formations. Such examples are reported in many areas in the world such as Bangladesh (Asia Arsenic Network et al, 1999), China (Gao, 1999), Chile (Yamasaki and Hata, 2000). However, it is not clear whether contamination of As is caused naturally by geological situation in the Study area. Contamination by other chemicals is rare. There are no chemical factories near the sampling points and agrichemicals are not likely used in the Study area. Therefore, no possible contamination source was confirmed in the Study area.

i) Arsenic (As)

The number of sites in which As content is more than Guideline is, eight sites in dry season and 20 in rainy season. The number increases in rainy season. Among them, it is more than Guidelines at seven sites in both dry and rainy seasons.

ii) Mercury (Hg)

High content of Hg more than Guidelines was detected at three sites in dry season and 10 sites in rainy season. At three sites, contamination was confirmed in both dry and rainy seasons.

iii) Selenium (Se)

A total of 20 sites in dry season show the content of Se more than Guidelines, while it is 15 sites in rainy season. Among them, it is more than Guidelines at eight sites in both dry and rainy seasons.

iv) Barium (Ba)

Ba content is more than Guidelines at 22 sites in dry season and 16 sites in rainy season. At 14

sites, high content of Ba was confirmed in both dry and rainy seasons.

v) Nitrate (NO_3)

The number of sites where NO_3 content is more than Guidelines, is four in dry and rainy seasons. At two sites, contamination was confirmed in both seasons.

vi) Boron (B)

High concentration of B was detected at five sites only in dry season. No contamination was confirmed in rainy season.

vii) Nickel (Ni)

In dry season one site shows Ni content higher than Guidelines while at five sites in rainy season.

viii) Manganese (Mn)

Content of Mn more than Guidelines was detected at three sites in dry and rainy seasons. At one site, contamination was confirmed in rainy season.

3) Acceptability aspects

Many items of acceptability aspects show high concentration more than Standards: Ammonium, Total Nitrogen, Copper, BOD, Potassium permanganate consumption, Taste, Color and turbidity. Only sulphate content is lower than Standards.

i) Iron (Fe)

High content of Fe more than standard is detected at five sites in dry season and three sites in rainy season.

ii) Copper (Cu)

Concentration of Copper exceeds the Standards at one site, Mbungoni Kimbiji in Temeke.

iii) Chloride (Cl) and TDS

Contamination by Cl and TDS is rare in the Study area. The number of contaminated sample is two in dry season and one in rainy season.

iv) Ammonium (NH4), Total Nitrogen (T-N), Potassium permanganate consumption and BOD

Ratio of contamination by Ammonium, Total Nitrogen, Potassium permanganate consumption, Taste and Odor are from 11 % to 18 %. As for BOD, around 20% of samples show values more than Standards in dry season and it is about 50% in rainy season. These contaminations are likely caused by wastewater from human activities.

v) Color and Turbidity

More than 40% of samples do not satisfy the Standards in both dry and rainy seasons.

vi) pH

Low pH values less than 6.5 are observed at 10 sites in dry season and 13 sites in rainy season. Water of low pH less than 6.5 will affect the materials made of iron and steel, therefore, countermeasure for low pH is necessary in the construction of water supply scheme if such water is used as source.

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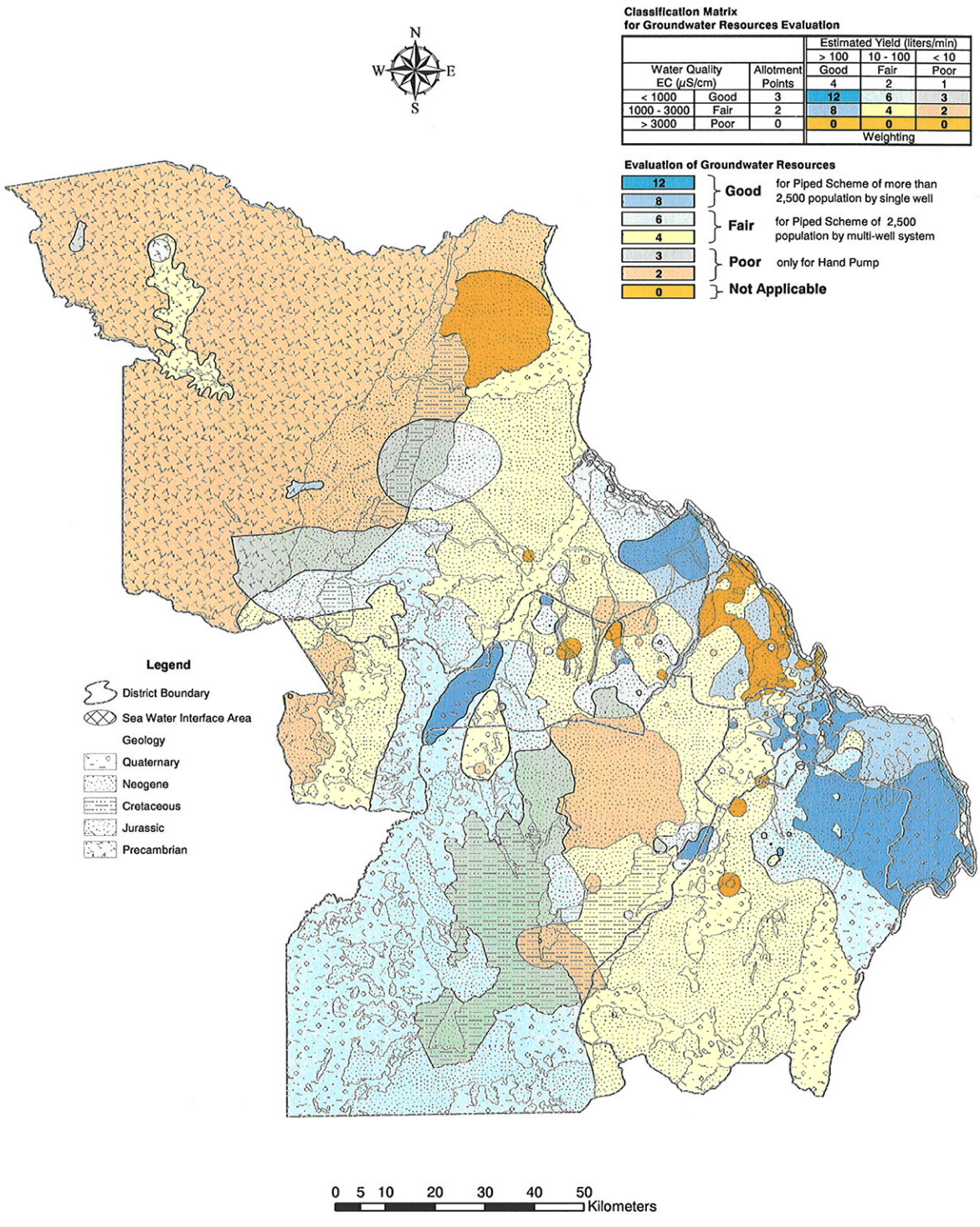

FIGURE 9.17 GROUNDWATER RESOURCES EVALUATION MAP

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9.5.2 POTENTIAL EVALUATION

(1) Yield

In the evaluation of groundwater, the criteria are provided from the planning point of view. As for the yield, groundwater potential is classified into three categories, namely less than 10 letter/min, between 10 to 100 liter/min and more than 100 liter/min.

To provide the water demand for 2,500 populations under 10 to 12 hours of operation, the yield of 100 liter/min is required. Therefore, the rank of "Highly Productive Aquifer" is given to the yield of more than 100 liter/min.

The yield of 10 liter/min is a marginal yield, since a minimum yield of 6 liter/min is required for hand pump operation. Therefore, the rank of "Low Yielding Aquifer" is given to the yield of less than 10 liter/min.

Consequently, the range of groundwater yield from 10 to 100 liter/min is ranked as "Moderately Productive Aquifer".

(2) Water Quality

Electric Conductivity (EC) is an important representative factor of water quality. According to the water quality standards for drinking water in Tanzania, quality of drinking water is divided into three classes based on the value of EC:

- EC under 1,000 μS/cm, which is the maximum desirable level, is good water for drinking.
- EC between 1,000 and 3,000 μS/cm, which is the maximum permissible level, is fair water for drinking.
- EC of 3,000 μS/cm and over is poor or not satisfactory for drinking water use.

The hydrogeological map shows these boundary lines for EC. The value of EC is useful as the practical indicator of water quality; therefore the above classification is used to make the evaluation map. As a matter of cause, there are other considerable elements such as fluoride and heavy metals; therefore a detailed chemical analysis is necessary during the implementation stage of water supply development plan.

(3) Depth to Groundwater

Depth to groundwater usually relates to pumping cost, or operation cost, of a production well. The isobaths of groundwater depth are shown in the hydrogeological map. As shown in the hydrogeological map, however, the depth to groundwater is not more than 40 mbgl. Practically, this means that the depth to groundwater is a less important factor for groundwater development for the study area. Therefore this factor was not used to make the evaluation map.

(4) Geological Structure

As described in Chapter 4 on Topography and Geology, some geological structures such as a lineament and fault zone affect the productivity of groundwater in basement rock region. The classification of the area on groundwater yield was modified from the viewpoint of geological structure.

9.5.3 PROMISING AREA FOR GROUNDWATER DEVELOPMENT

(1) Area Evaluation

After the preparation of the hydrogeological map, the groundwater resources evaluation map was prepared based on it. The evaluation map was drawn in accordance with the distribution of groundwater yield and quality (EC). *Figure 9.18* shows the combination of factors used in the evaluation map.

			Estimated Yield (liters/min)		
			100 <	10 - 100	< 10
Water Quality EC (μS/m)		Allotment Points	Good	Fair	Poor
			4	2	1
< 1000	Good	3	**12**	**6**	**3**
1000 - 3000	Fair	2	**8**	**4**	**2**
3000 <	Poor	0	**0**	**0**	**0**
			Weighting		

Evaluation of Groundwater Resources

12	Promising water source for the Piped Scheme of more than 2,500 population by single well
8	
6	Fairer water source for the Piped Scheme of 2,500 population by multi-well system
4	
3	Can be utilized for Hand Pump
2	
0	Not suitable for drinking water

Figure 9.18 Matrix of the Classification for Groundwater Evaluation

The evaluation is described as follows.

Weighting: 12 and 8 Good

- Promising water source for the Piped Scheme of more than 2,500 populations with single well. EC is good for drinking for weighting point 12, and fair for weighting point 8, and besides the yield expected is 100 liter/min and more.

Weighting: 6 and 4 Fair

- Promising water source for the Piped Scheme of more than 2,500 population with multi-well system. EC is good for drinking for weighting point 6, and fair for weighting point 4, and the yield expected is from 10 to 100 liter/min. This volume is exploitable using a small submersible pump.

Weighting: 3 and 2 Poor

- The yield is fair to exploit for hand pump water supply scheme. EC is good for drinking for weighting point 3, or EC is fair for drinking for weighting point 2.

Weighting: 0 Not Applicable

- EC is poor for drinking. As shown in *Figure 4.20*, an area classified to this class may have a groundwater potential yielding 100 liter/min or more. It may be possible to use as a source for small scale industrial water or livestock water, otherwise elaborate water treatment facility is necessary for drinking water use.

(2) Promising Area for Groundwater evaluation

The area evaluated as Good on the evaluation map is the promising area for the development of Piped Scheme (Level-2). It is the dark blue and blue coloured area on the map.

In Dar es Salaam, especially in Temeke, northern part of Mkuranga and coastal area of Bagamoyo, the promising area for Level-2 is fairly large. The Quaternary aquifer distributed along the Ruve River in Kibaha area is also expected as promising area. In general, the area where Quaternary formation is distributed is expected to be promising area.

The area evaluated as Fair on the evaluation map is the potential area for the development of Piped Scheme (Level-2) by multiple well systems. It is the light blue and yellow coloured area on the map. In Mkuranga, Kisarawe, Kibaha and eastern part of Bagamoyo, this potential area for development is extensively distributed.

The area evaluated as Poor on the evaluation map is the possible area for the hand pump water supply. It is the green and orange colored area on the map. In general, the areas where geological unit of Precambrian, Jurassic and Cretaceous are distributed belong to this category. These are the areas of Jurassic formation and Precambrian formation of Bagamoyo Plateau, and Cretaceous formation Msanga-Pugu Hills.

The area evaluated as Not Applicable is the red colored area on the map. In Kinondoni district,

this area is fairly distributed. This is mainly due to the poor water quality.

It should be noted that, however, geological investigation, especially geophysical survey, even in the promising area is very important. The Neogene aquifer is unevenly distributed even in the promising area.

9.6 GROUNDWATER DEVELOPMENT PLAN

9.6.1 EVALUATION OF THE EXPLOITABLE AMOUNT OF THE GROUNDWATER

The potential groundwater recharge from rainfall by basin was estimated in Chapter 2 of this Supporting Report. Using the estimated potential groundwater recharge, exploitable amount of the groundwater is examined. *Table 9.4* shows the annual potential recharge amount and estimated current extraction by existing wells. The result suggests that the current extraction ratio against potential recharge amount is generally low, it is mostly less than 1%. In the three basins of Coast R3, R4, R5 where Dar es Salaam is situated, the extractions are relatively high, it is a range of 2 to 7%.

Table 9.4 Estimated Groundwater Recharge Amount and Extraction Amount by the Basin

Basin Name	River Name	Potential Recahrge to Groundwater		Estimated Current Extraction by Existing Wells	
		(mm)	Annual Amount (m^3)	Amount (m^3)	Ratio (%)
Wami	Wami	185.7	**696,189,300**	**47,817**	**0.007%**
Ruvu	Ruvu	55.0	**451,110,000**	**183,125**	**0.041%**
Coast R1	Mkuza, Kerege	211.7	**109,660,600**	**14,349**	**0.013%**
Coast R2	Mpiji	272.2	**133,105,800**	**140,693**	**0.106%**
Coast R3	Mbezi	247.7	**77,282,400**	**1,657,296**	**2.144%**
Coast R4	Msimbo	375.7	**119,848,300**	**6,945,910**	**5.796%**
Coast R5	Kizinga	355.4	**88,494,600**	**6,675,540**	**7.543%**
Coast R6	Mzinga	299.1	**183,946,500**	**1,102,413**	**0.599%**
Coast R7	Mbezi, Mbele, Ukooni	219.3	**466,670,400**	**840,661**	**0.180%**
Coast R8	Luhute, Luhule	176.0	**273,328,000**	**10,035**	**0.004%**

Therefore, from the macro water balance point of view, it is concluded that the area has considerable margin for the groundwater exploitation. However, in the urban area of Dar es Salaam Region, where most of existing wells are concentrated, it is recommended to start systematic monitoring of the groundwater level as soon as possible.

Table 9.5 shows the current estimated current extraction by existing wells. The table shows Ilala municipality has the highest extracting ratio of 3.81%. Therefore, from the water balance point of view, it is evaluated that the groundwater development amount by this plan is still at safe level.

Table 9.5 Estimated Groundwater Extracting Ratio by District

District Name	Area (km2)	Potential Recahrge to Groundwater		Estimated Current Extraction	
		(mm)	Amount (m^3)	Amount (m^3)	Ratio (%)
Bagamoyo	8590.74	129.8	1,115,078,052	449,803	**0.04%**
Kibaha	197.29	81.8	16,138,322	116,466	**0.72%**
Kisarawse	4988.03	114.1	569,134,223	233,071	**0.04%**
Mkuranga	2746.11	210.7	578,605,377	279,862	**0.05%**
Ilala	292.03	349.7	102,122,891	3,893,026	**3.81%**
Kinondoni	527.89	281.4	148,548,246	3,318,197	**2.23%**
Temeke	784.19	241.9	189,695,561	6,995,736	**3.69%**

9.6.2 AREA OF INFLUENCE

Area of influence of the wells is estimated in order to examine the site planning at the design stage. For the estimation, the results of the pumping test of 79 existing wells and 9 tests well were utilized. The area of influence is estimated, under the condition that the influenced drawdown is 1 mm within the pumping time from one hour to 10 hours.

The results are shown in *Table 9.6.*

The distribution of estimated area of influence by the aquifer type is shown in *Figure 9.19.* The quaternary aquifer shows highest area of influence. However, in general, it is revealed that most of the aquifers show the area of influence within 50m radius. It is concluded that, in most of case, area of influence is negligible, as long as there is 100m spacing between wells.

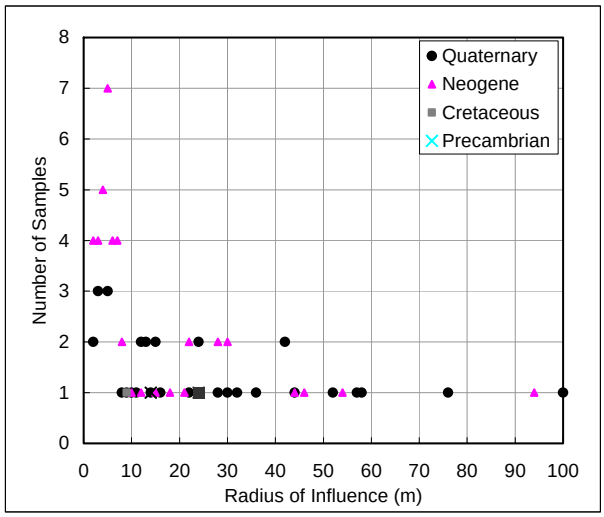


Figure 9.19 Distribution of Area of Influence by Aquifer Type

9.6.3 CRITERIA OF THE GROUNDWATER DEVELOPMENT PLAN FOR THE WATER SUPPLY

In order to formulate the groundwater development plan, the exploitable number of wells is examined for both Level 1 and 2 plans.

(1) Level 2 Plan (Submersible Pumped Well)

As the measure to estimate the exploitable number of wells, required area to recharge the planned pumping rate is examined. The pumping rate of the Level-2 plan is 100 liter/min in general. Therefore, as shown in *Table 9.7*, the area required to recharge the extracted amount of 100 liter/min is estimated by Districts.

The exploitable number of wells for the groundwater development plan is estimated, based on the estimated area by districts and the number of existing wells.

Table 9.6 Estimated Area of Influence of Test and Existing Wells

BH. No.	Village	Transmissivity T (m^2/day)	Discharge Rate Q (l/min)	Effective Porosity S	Duration t (min)	Drawdown s (m)	Well Function W(u)	u	b	**Radius of Influence** R (m)	Geology
J-1 664/2004	Msumi	2.5	20.89	0.15	600	0.001	0.001043827	5.1	2.26	**12**	Neogene
J-2 771/2004	Buyuni	0.75	16.50	0.15	600	0.001	0.000396465	5.93	2.44	**7**	Neogene
J-3 699/2004	Potea	32	264.00	0.15	600	0.001	0.001057239	5.05	2.25	**42**	Neogene/Quatermary
J-4 775/2004	Kwamduma	5.5	58.90	0.15	600	0.001	0.000814469	5.29	2.30	**18**	Precambrian
J-5 772/2004	Matipwili	0.04	1.84	0.15	600	0.001	0.000189614	6.55	2.56	**2**	Neogene
J-6 773/2004	Magindu	0.04	1.47	0.15	600	0.001	0.000237339	6.35	2.52	**2**	Jurassic
J-7 774/2004	Kipangege	0.07	1.40	0.15	600	0.001	0.000436111	5.83	2.41	**2**	Neogene
J-8 770/2004	Dundani	3.6	38.40	0.15	600	0.001	0.000817708	5.29	2.30	**15**	Neogene
J-9 768/2004	Kise	0.36	6.00	0.15	600	0.001	0.000523333	5.67	2.38	**5**	Quaternary/Neogene
169/2001	Kiwangwa	8.5	88.00	0.15	600	0.001	0.000842487	5.25	2.29	**22**	Neogene
360/2003-1	Vikindu	0.144	9.70	0.15	600	0.001	0.000129485	6.9	2.63	**3**	Neogene
360/2003-2	Vikindu	0.18	11.00	0.15	600	0.001	0.000142727	6.81	2.61	**4**	Neogene
324/2003	Mbanambaya	0.12	4.70	0.15	600	0.001	0.000222695	6.4	2.53	**3**	Neogene
247/2001	Disunyala	2.59	88.00	0.2	600	0.001	0.000256711	6.29	2.51	**12**	Quaternary
185/2001	Chamgoi II	1.5	34.73	0.15	600	0.001	0.000376716	5.97	2.44	**10**	Neogene
28/2002-1	Mbezi Gongoni	0.05	3.33	0.15	600	0.001	0.000130964	6.9	2.63	**2**	Neogene
28/2002-2	Mbezi Gongoni	0.027	3.33	0.15	600	0.001	0.00007072	7.7	2.77	**2**	Neogene
37/2003	Vikindu	60.83	146.67	0.15	600	0.001	0.00361746	4.3	2.07	**54**	Neogene
137/2002	Mkuranga town	0.13	8.80	0.15	600	0.001	0.00012885	6.9	2.63	**3**	Neogene
176/2001	Vikindu	6.18	188.57	0.15	600	0.001	0.00028585	6.2	2.49	**21**	Neogene
1/2002	Vikindu	0.72	88.00	0.15	600	0.001	0.00007136	7.43	2.73	**8**	Neogene
12/2002	Vikindu	4.8	165.00	0.15	600	0.001	0.00025374	6.3	2.51	**18**	Neogene
15/2002	Mbezi Msufini	0.35	12.67	0.15	600	0.001	0.00024095	6.34	2.52	**5**	Neogene
264/2001	Vianzi- Vikindu	14.66	176.00	0.15	600	1.001	0.00072652	5.39	2.32	**30**	Neogene
195/2001	Mkuranga town	0.66	69.47	0.15	600	2.001	0.00008287	7.3	2.70	**7**	Neogene
194/2001	Kimanzichana	0.3	18.90	0.15	600	3.001	0.00013845	6.85	2.62	**5**	Neogene
441/99	Msanga	11.1	47.30	0.15	600	4.001	0.00204686	4.5	2.12	**24**	Cretaceous/Neogene
115/99	Mzizi Maja/Kilungu	47.06	342.85	0.15	600	5.001	0.00119722	4.95	2.22	**51**	Neogene
412/99	Gumba	0.91	12.00	0.15	600	6.001	0.00066144	5.47	2.34	**7**	Neogene
414/99	Lupunga No1	0.18	2.63	0.2	600	7.001	0.00059696	5.58	2.36	**3**	Quaternary
354/99	Nyumbu J.W.T.Z	0.51	7.77	0.15	600	8.001	0.00057250	5.6	2.37	**6**	Neogene
413/99	Kikongo	0.71	8.80	0.15	600	9.001	0.00070372	5.43	2.33	**7**	Neogene
352/99	Miswe Village	0.57	13.20	0.15	600	10.001	0.00037664	5.98	2.45	**6**	Neogene
473/99	Visiga	0.18	9.10	0.15	600	11.001	0.00017253	6.65	2.58	**4**	Neogene
357/99	Visiga Madafu	0.36	13.20	0.15	600	12.001	0.00023788	6.38	2.53	**5**	Neogene
357/99	Visiga Madafu	0.29	13.20	0.15	600	13.001	0.00019162	6.55	2.56	**5**	Neogene
357/99	Visiga Madafu	0.29	13.20	0.15	600	14.001	0.00019162	6.55	2.56	**5**	Neogene
411/99	Lupunga No 2	0.17	4.60	0.2	600	15.001	0.00032234	6.1	2.47	**3**	Quaternary
27/2000	Tumbi	0.15	11.00	0.15	600	16.001	0.00011894	7	2.65	**3**	Neogene
32/2000	Boko Timiza	0.32	6.00	0.15	600	17.001	0.00046519	7.78	2.79	**5**	Neogene
118/2000	Zogowale Visiga	0.58	5.50	0.15	600	18.001	0.00091980	5.18	2.28	**6**	Neogene
28/98	Hoyoyo	0.89	66.00	0.15	600	19.001	0.00011762	7	2.65	**8**	Neogene
166/98	Kizuda	12.4	188.57	0.15	600	20.001	0.00057356	5.6	2.37	**28**	Neogene
454/2000	Kisarawe magoiwa	28.76	660.00	0.15	600	21.001	0.00038008	5.95	2.44	**44**	Neogene
476/99	Kisarawe	0.63	4.25	0.15	600	22.001	0.00129294	4.9	2.21	**6**	Neogene
235/2003	Masanganya	1.14	45.00	0.15	600	23.001	0.00022096	6.4	2.53	**9**	Cretaceous
370/2000	Msongola Village	0.18	10.15	0.15	600	24.001	0.00015468	6.75	2.60	**4**	Neogene
247/99	Bagamoyo sec school	16.03	132.00	0.15	600	25.001	0.00105922	5.08	2.25	**30**	Neogene
146/99	Zinga Farm	266.33	188.57	0.15	600	26.001	0.01231898	3.05	1.75	**95**	Neogene
130/91	Kibindu	3.57	24.00	0.15	600	27.001	0.00129743	4.9	2.21	**14**	Precambrian
356/99	Chasimba	66.16	40.00	0.15	600	28.001	0.01442656	2.9	1.70	**46**	Neogene
152/99	Lower Ruvu	13.73	150.00	0.15	600	29.001	0.00079837	5.3	2.30	**28**	Neogene
353/99	Ruvu Sec School	1.96	36.67	0.2	600	30.001	0.00046620	5.78	2.40	**10**	Quaternary
209/98	Boko Munemela	0.18	14.67	0.15	600	31.001	0.00010702	7.05	2.66	**4**	Neogene
74/2004	Buza	2.7	20.30	0.2	600	33.001	0.00116010	5	2.24	**11**	Quaternary
579/99	Mabwepande	0.51	7.13	0.2	600	34.001	0.00062389	5.53	2.35	**5**	Quaternary
31/2003	National Std	24	193.30	0.2	600	35.001	0.00108295	5.05	2.25	**32**	Quaternary
162/2000	Kinondoni	57	132.00	0.2	600	36.001	0.00376641	4	2.00	**44**	Quaternary
16/99	Kinduchi Mtongani	31.13	264.00	0.2	600	37.001	0.00102850	5.1	2.26	**36**	Quaternary
258/2000	Mburahati	2.43	120.00	0.2	600	38.001	0.00017663	6.65	2.58	**12**	Quaternary
125/98	Masjid Ladwa	13.72	120.00	0.2	600	39.001	0.00099724	5.1	2.26	**24**	Quaternary
75/99	Kinondoni	45.1	220.00	0.2	600	40.001	0.00178806	4.6	2.14	**42**	Quaternary
431/2000	Sinza	0.08	11.00	0.2	600	41.001	0.00006343	7.53	2.74	**2**	Quaternary
363/2003	Yombo Vituka	0.1	9.10	0.2	600	42.001	0.00009585	7.15	2.67	**2**	Quaternary
363/2003	Yombo Vituka	3.97	264.00	0.2	600	43.001	0.00013116	6.9	2.63	**15**	Quaternary
85/2002	Kigamboni	468.3	377.13	0.2	600	44.001	0.01083079	3.15	1.77	**111**	Quaternary
212/2000	Mbande	117.33	120.00	0.2	600	45.001	0.00852815	3.35	1.83	**57**	Quaternary
328/2001	Tandale Police Post	0.5	26.40	0.2	600	46.001	0.00016519	6.67	2.58	**5**	Quaternary
202/2003	Mbagala Kibonde Maji	4.31	55.00	0.2	600	47.001	0.00068351	5.43	2.33	**14**	Quaternary
216/2000	Mtoni Sabasaba	253.66	120.00	0.2	600	48.001	0.01843732	2.75	1.66	**76**	Quaternary
55/2002	Mtoni Kijichi	10.62	132.00	0.2	600	49.001	0.00070174	5.42	2.33	**22**	Quaternary
30/2004	Mikoroshoni	3.16	165.00	0.2	600	50.001	0.00016704	6.68	2.58	**13**	Quaternary
217/98	Air Port Ukonga	1.44	37.67	0.2	600	51.001	0.00033342	6.07	2.46	**9**	Quaternary
98/97	Keko Prison	13.1	155.28	0.2	600	52.001	0.00073584	5.38	2.32	**24**	Quaternary
309/2003	Buza	4.48	77.63	0.2	600	53.001	0.00050336	5.7	2.39	**15**	Quaternary
209/2001	Mjimwema	23.86	94.28	0.2	600	54.001	0.00220738	4.45	2.11	**30**	Quaternary
198/97	Kibada Hospital	21.53	86.67	0.2	600	55.001	0.00216672	4.47	2.11	**28**	Quaternary
553/99	Kisarawe II	4.32	33.00	0.2	600	56.001	0.00114182	5	2.24	**13**	Quaternary
341/2001	Nzasa	7083.33	26.37	0.2	600	57.001	2.34290399	0.057	0.24	**58**	Quaternary
33/2001	Gongo la mboto	0.17	5.50	0.2	600	58.001	0.00026960	6.25	2.50	**3**	Quaternary
199/2002	Ilala Bomani	4.81	188.57	0.2	600	59.001	0.00022248	6.4	2.53	**16**	Quaternary
11/2002	Kipunduni 'A'	1.07	52.80	0.2	600	60.001	0.00017676	6.62	2.57	**8**	Quaternary
23/2001	Gongo la mboto	0.43	18.85	0.2	600	61.001	0.00019897	6.5	2.55	**5**	Quaternary
251/2002	Manzese TipTop	56.03	816.67	0.2	600	62.001	0.00059841	5.77	2.40	**52**	Quaternary

Table 9.7 Required Areas for the Groundwater Development

District Name	Area (km2)	Potential Recahrge to Groundwater			Required Area for the Recharge of 100 l/min. by the district (km2)
		(mm)	Amount ($m^{3/}$annual)	Amount (liter/min.)	
Bagamoyo	8590.74	129.8	1,115,078,052	2,121,533.58	0.40
Kibaha	197.29	81.8	16,138,322	30,704.57	0.64
Kisarawe	4988.03	114.1	569,134,223	1,082,827.67	0.46
Mkuranga	2746.11	210.7	578,605,377	1,100,847.37	0.25
Ilala	292.03	349.7	102,122,891	194,297.74	0.15
Kinondoni	527.89	281.4	148,548,246	282,626.04	0.19
Temeke	784.19	241.9	189,695,561	360,912.41	0.22

(2) Level 1 Plan (Hand Pump Well)

In case of hand pump, pumping rate is marginal compared with powered pump, and the pumping operation is not constant. Therefore, the development plan of the hand pump well is often made by considering the area of influence. In the study area, since the maximum radius of area of influence is 50 m, site planning can be done with 100 m spacing between wells. However, in heavily populated areas such as Ilala of Dar es Salaam, groundwater development plan should be examined by considering environment impacts. On the other hand, it is impractical to execute micro water balance simulation for each village.

It is difficult to identify the exact pumping rate of the hand pump; the following assumption can be made for the estimation of rate.

In general, capacity of the hand pump is 0.7 liter/stoke, and number of stroke by manpower is 25/min. Therefore, the pumping rate can be estimated as 17.5 liter/min. The average pump operation hour is assumed as 6 hours/day. With this assumption, daily pumping amount is calculated as 6,300 liter/day. This amount is consistent with the amount of 6,250 liter/day, which is calculated by Tanzanian Water Policy by multiplying the unit consumption (25 liter/person) with the suggested number of users (250 persons/hand pump).

Accordingly, it is considered that the exploitable number of hand pump wells shall be determined based on the 400 m of suggested maximum distance to the water point by the Tanzanian Water Policy. In this study, therefore, required area for the development of a hand pump well is determined as 0.5 km^2 , which is the area of 400m radius.

The wells will be allocated for settlement areas only, not the whole area of the target villages. According to the Coast Region Socio-Economic Profile (1997, The Planning Commission Dar es Salaam and Regional Commissioner's Office), land use pattern of settlement area is 18%. However, settlement area is often identified as only densely populated area. Considering the existence of scattered dwelling type areas, therefore, it is assumed that 3.6% which is 2 times of settlement area of 18% is practical percentage.

Using this condition, average settlement area of the villages by region is calculated in the following manner.

1) Coast Region

In case total area of the village is less than 100 km^2 : 3.6% of the total area

In case total area of the village is more than 100 km^2 : 1.6% of the total area

2) Dar se Salaam

Considering the difference of the average area of the village in the two regions, which is 63km^2 for Coast region and 8.45km^2 for Dar es Salaam, and high population density of the Dar es Salaam, the percentage of the settlement area of Dar es Salaam should be higher than that of

Chapter 10

Preliminary Design of Priority Project

CHAPTER 10 PRELIMINARY DESIGN OF PRIORITY PROJECT

10.1 GENERAL CONCEPT OF PRELIMINARY DESIGN

The priority project consists of 22 piped water supply schemes (Level-2). Out of these, water source for 20 schemes is groundwater. Water sources of other two schemes are surface water of the Wami River and spring water. In order to minimize the construction cost and operation cost, the water treatment facilities are not included in the schemes except for the case of surface water and the water is supplied by gravity to the service area through public water points. Considering these concepts, the preliminary design was prepared for priority project. Water supply facilities are designed to meet the water demand in the year 2015, the target year of the Study. Institutional water demand is also taken into consideration.

10.2 TARGET VILLAGES OF PRIORITY PROJECT

The water supply plan prepared initially proposed 49 Level-2 schemes using the two criteria, population in 2015 and availability of water sources. All the target villages for Level-2 schemes were clarified whether they were suitable or not from both technical and socio-economical points of view in the second field survey in June and July 2005. Finally, 22 Level-2 schemes in 22 villages were selected as the priority project. The water supply plan for the priority project is summarized in *Table 10.1*. Location of priority project is shown in *Figure 10.1*.

10.3 WATER DEMAND

Water demand is estimated considering the domestic water use and institutional use as discussed in Chapter 5 of this report. Unit water demand for domestic use is 25 litre/capita/day. Detailed unit water demands are shown in *Table 5.14* in Chapter 5. Water demand of each scheme is cited in *Table 10.1*.

10.4 MANUAL AND GUIDELINE APPLIED IN THE PRELIMINARY DESIGN

MoWLD established Design Manual in 1997. This manual was basically adopted in designing of relevant water supply facilities. Guideline for Design of Water Supply Facilities in Japan (2000) was also applied to the design of laying depth of transmission and distribution pipes.

10.5 DESIGN CONDITIONS

Water facilities for priority project are composed of intake, transmission line, storage tank, distribution line and public water point. Treatment facility is planned for only one scheme in Matipwili Village, Bagamoyo District where the Wami River is the water source. Design conditions considered in the designing of the water supply facilities are summarized in *Table 10.2*.

Table 10.1 Water Supply Plan for Priority Project

District/Municipality Village/Mitaa	Name of Village	Serial No. of Scheme	Service Population (2002)	Service Population (2010)	Service Population (2015)	Number of Wells	Water Production (m^3/day)
BAGAMOYO							
KIBINDU	KIBINDU	BGM-1	4,904	5,746	6,344	2	173
KWAMDUMA	KWAMDUMA	BGM-2	2,545	2,982	3,292	2	86
MKANGE	MATIPWILI	BGM-3	1,948	2,283	2,518	Wami	72
KIBAHA							
RUVU	MINAZI MIKINDA (1/2)	KBH-1A	1,624	2,083	2,508	1	72
RUVU	MINAZI MIKINDA (2/2) /KITOMONDO	KBH-1B	1,627	2,102	2,513	1	72
KISARAWE							
CHOLE	CHOLE	KSW-1	2,685	3,001	3,217	2	106
MSIMBU	MSIMBU	KSW-2	2,199	2,458	2,635	2	76
MKURANGA							
LUKANGA	NJOPEKA	MKR-1	3,371	4,439	5,272	Spring	132
VIKINDU	MWANDEGE/KIPALA	MKR-2	2,100	2,370	2,815	1	79
VIKINDU	KISEMVULE	MKR-3	2,260	2,731	3,244	2	86
VIKINDU	MOROGORO MFURU MWAMBAO	MKR-4	1,945	2,036	2,635	1	72
VIKINDU	VIANZI	MKR-5	1,871	2,463	2,926	1	79
ILALA							
KITUNDA	KITUNDA-Kivuke (1/2)	ILL-4A	2,614	3,746	4,690	2	126
	KITUNDA-Kivuke (1/3)	ILL-4B	1,744	2,499	3,129	1	90
	KITUNDA-Mzinga	ILL-4C	4,114	5,895	7,382	2	198
MSONGOLA	MSONGOLA	ILL-5	1,410	2,021	2,530	1	72
PUGU	PUGU STATION	ILL-6	6,481	9,287	11,629	1	72
KINONDONI							
GOBA	MATOSA	KND-1	2,580	3,558	4,350	1	72
TEMEKE							
MJIMWEMA	KIBUGUMO	TMK-1	1,883	2,698	3,379	1	84
MJIMWEMA	MJIMWEMA	TMK-2	2,000	2,866	3,589	1	90
PEMBA MNAJI	YALEYALE PUNA	TMK-3	3,113	4,461	5,586	1	150
PEMBA MNAJI	TUNDWI SONGANI	TMK-4	1,475	2,114	2,647	1	72

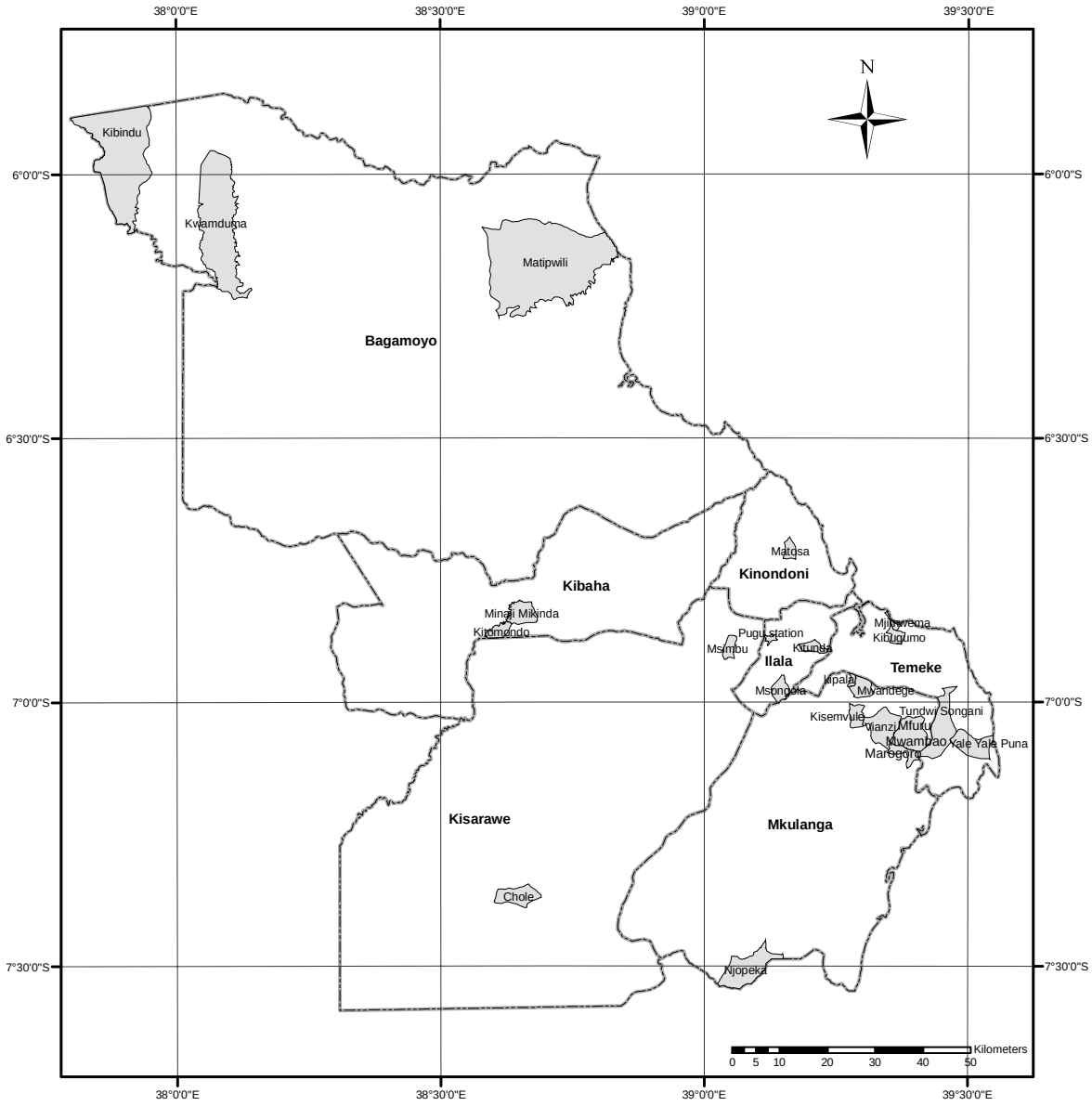


FIGURE 10.1 LOCATION OF TARGET VILLAGES OF PRIORITY PROJECT

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

Table 10.2 Design Conditions of Water Supply Scheme

1. Time period of water consumption: 6 hours (from 6:00 to 9:00a.m. and from 3:00 to 6:00 p.m.)		
2. Design Flow		
Daily average flow	Daily average flow = Daily water demand + Distribution losses	
Daily maximum flow	Daily maximum flow = Daily average flow	
Hourly maximum flow	Hourly maximum flow = Daily maximum flow / 6 hours[1)]	
3. Distribution Losses	20 % of Daily average flow	
4. Facilities	Specification	
Intake facilities	Daily operation hour	Average: 10 hours (=600 min.) Maximum: 12 hours (=720 min.)
	Capacity (m^3/min.)	Daily maximum flow (m^3/day) / 600 (min/day)
	Type of pump	Submersible pump (Centrifugal pump)
	Power source	Generator (diesel engine with generator)
Disinfection facility*	Chlorine feeder	Dropping type, Sodium hypochlorite
Transmission Line	Design Flow	Daily maximum flow (m^3/day) / 600 (min/day)
	Method of water supply	Pressure flow
	Material of pipes	P.V.C. pipe
	Earth covering depth	0.75 m (minimum)
Storage tank (Distribution tank)	Capacity (m^3)	Daily maximum flow (m^3/day) x 50% (40-120 m3)
	Type of tank	Ground tank or Elevated tank (12 m in maximum)
	Low Water Level	Ground tank (G.L+0.2 m) Elevated Tank (G.L+8.95 m in maximum)
	No. of tank	1 tank /scheme
	Material of tank	Reinforced concrete
Distribution Line	Design Flow	Hourly maximum flow
	Material of pipes	P.V.C. pipe (Galvanized pipe)
	Earth covering depth	0.75 m (minimum)
	Method of water supply	Gravity flow
Public water point (PWP)	Number of tap /PWP	One or two taps/PWP according to the population
	Number of PWP	One tap/250 persons against the population in 2010
	Maximum number of user	250 persons / tap
	Maximum distance of access	400 m from household

* : Disinfection facility is installed in Matipwili only.

10.6 FACILITY PLAN

10.6.1 WATER SOURCE AND INTAKE FACILITY

(1) Groundwater

Groundwater is extracted from deep tube wells and transmitted to the storage tank. Standard designs of well are shown in *Figure 10.2*. The pH value of groundwater is lower than 6.5 in most of the Study area. This chemical characteristic will cause corrosion of steel pipes, therefore, casing and screen piped made of steel shall be avoided. In addition, opening ratio of screen pipes shall be approximately 20 % considering the effective pumping of groundwater. From these points of view, pipes made of FRP was selected. In order to enable smooth installation of FRP pipes, diameter of well is planned as 12-1/4 inches. Standard design of tube wells are summarized in *Table 10.3* and *Figure 10.2*. Wells will be drilled by mud rotary method. In Bagamoyo and Kisarawe District, DTH method will be applied instead of mud rotary method, because the groundwater is fissure water in the hard rocks. Maximum diameter for drilling by the DTH method is 10-5/8 inches. Since FRP pipes is not suitable to install in 10-5/8 inches of wells, pipes made of stainless steel are selected for the wells in Bagamoyo and Kisarawe. Annular space between well and pipes are filled with gravel.

(2) Spring Water

Spring water is the source in Njopeka Village in Mkuranga District. The water has no contamination by Microbial aspects and no treatment facility is required. The water is collected at the intake facility and pumped up by submersible pump as shown in *Figure 10.3*.

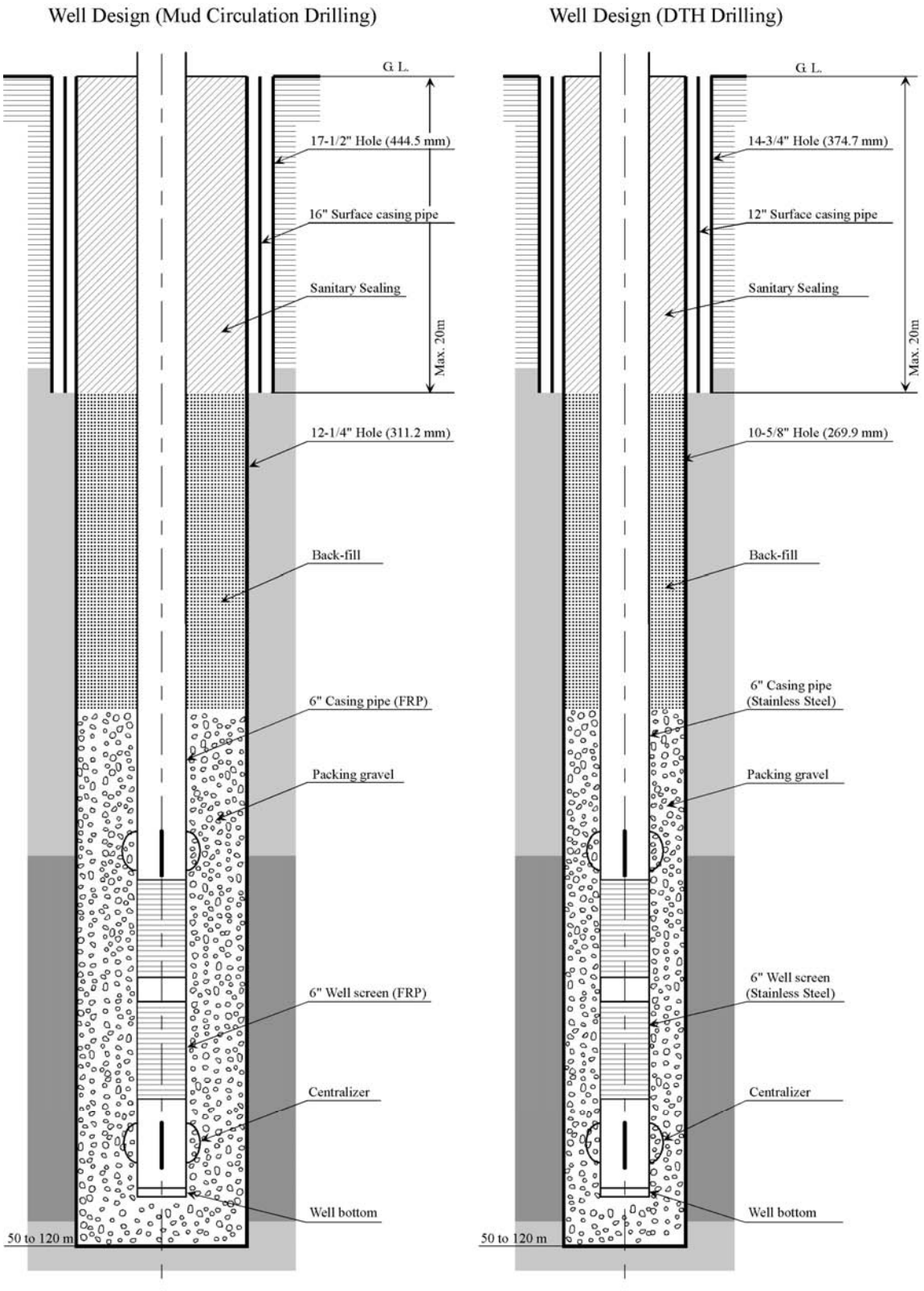
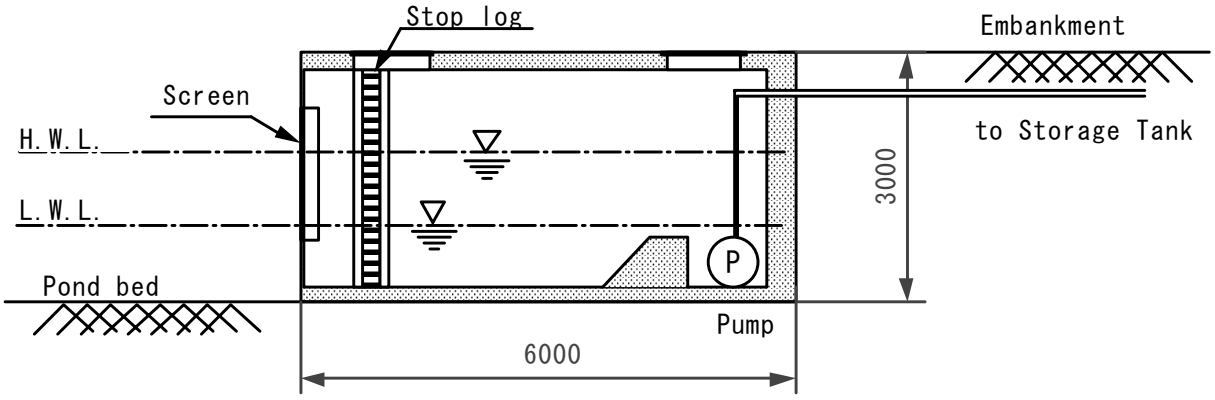


FIGURE 10.2 STANDARD DESIGN OF DEEP TUBE WELL



(Cross Section View)

FIGURE 10.3 DESIGN OF INTAKE FACILITY FOR SPRING WATER (NJOPEKA, MKURANGA)

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Table 10.3 Design of Deep Tube Wells

Items	Specification
Depth	50-120m
Drilling Diameter	10-5/8 inches in Bagamoyo and Kisarawe 12-1/4 inches in other area
Casing and Screen Diameter	Diameter: 6 inches
	Material: FRP (Bagamoyo and Kisarawe) Stainless Steel (Other District)
Installation depth of submersible pump	50 m
Gravel packing in the section of screen	necessary
Cementing of upper annular space	necessary

(3) Surface Water

At Matipwili Village in Bagamoyo District, the water source is river water of the Wami River. The river water is once led to the intake facility and then pumped up from the intake facility to the sedimentation tank as shown in *Figure 10.4*.

(4) Electric Power Source

Diesel engine generator is proposed as the stable power source to the water supply facilities. Although the electric power supplied by TANESCO is available in some villages, it is not planned as the power source due to following reason. Electric power supply in Tanzania is not stable there is often power failures. Those easily lead the breakdown of generators. In order to avoid such situation, electric power by TANESCO is not considered as the power source in the Study. Solar power is one of the alternatives of power supply. It can save the operation cost of water supply. However, the power will not meet the demand of intake facilities. Accordingly, solar power is also not applied as the power source in the Study.

10.6.2 TREATMENT FACILITY

The scheme in Matipwili uses river water as the source. The river water of the Wami is has no contamination by Microbial aspects, therefore, disinfection facility is indispensable. Drop type of chlorination system is proposed at the inlet of the storage tank. In addition, turbidity of the river water is rather high in rainy season, therefore, sedimentation tank is proposed to reduce the turbidity. *Figure 10.5* shows the design of the treatment plant (Sedimentation Tank) in Matipwili, Bagamoyo District.

10.6.3 TRANSMISSION LINE

Groundwater is extracted by submersible pump from the well and sent to the storage tank by the head of the submersible pump. The pipes are planned to be laid down in a minimum depth of 1 m below the ground surface. No booster pump is planned in the line. Standard design is shown in *Figure 10.6*.

10.6.4 STORAGE TANK

The capacity of storage tank is determined to meet 50 % of the daily maximum (Qdmax) flow which is considered same as hourly maximum flow (Qhmax). As type of tanks, one type of ground tank and two types of elevated tank are planned considering the topographic condition of the service area (*Figure 10.7 to 10.9)*. Structure of the tank is planned to be reinforced concrete. Water level gauge and flow meter will be equipped in each tank considering operation and maintenance.

10.6.5 DISTRIBUTION LINE

The pipe routes are planned based on the results of the field survey. Length of pipes is determined adding 15 % of the distance calculated using the coordinates measured by GPS in

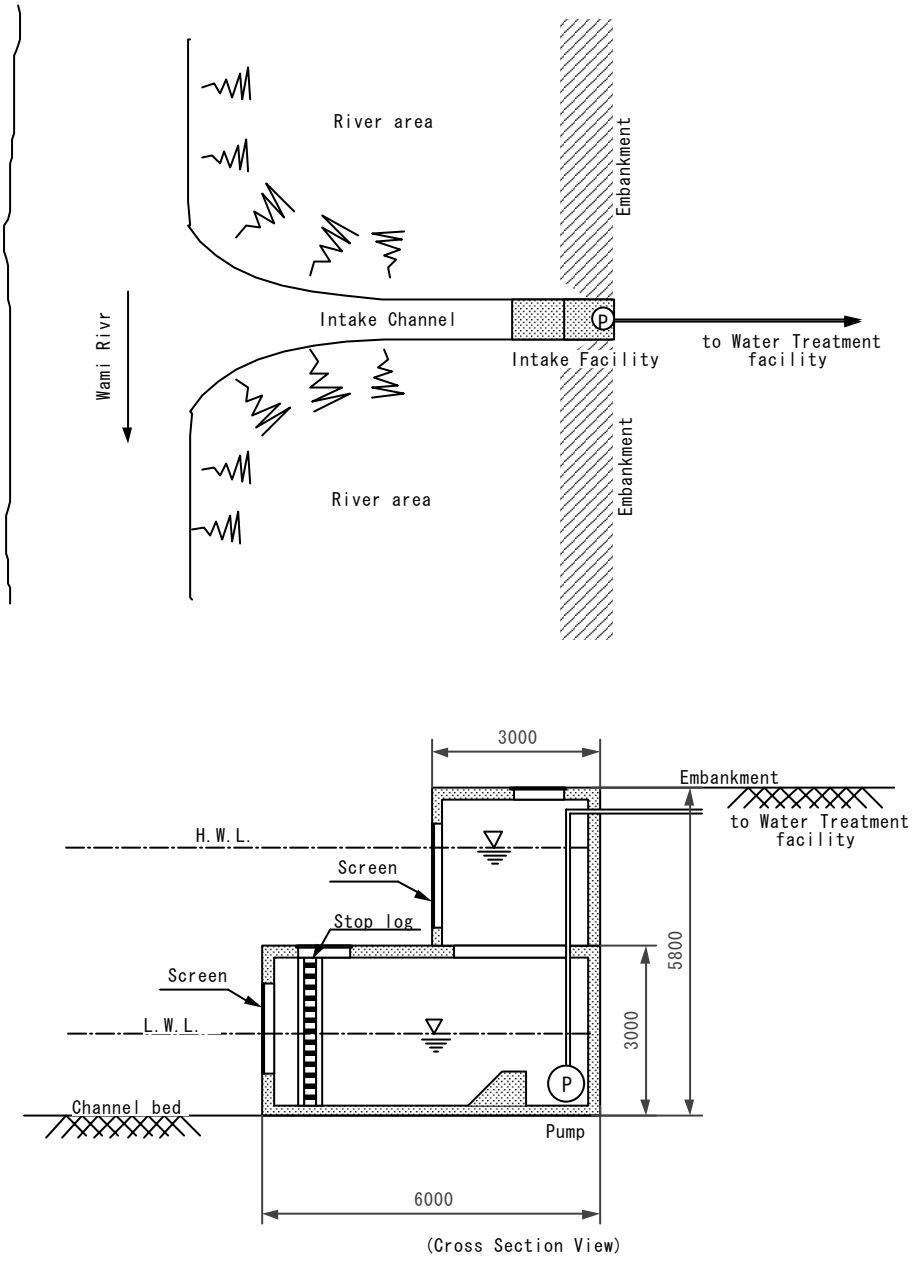
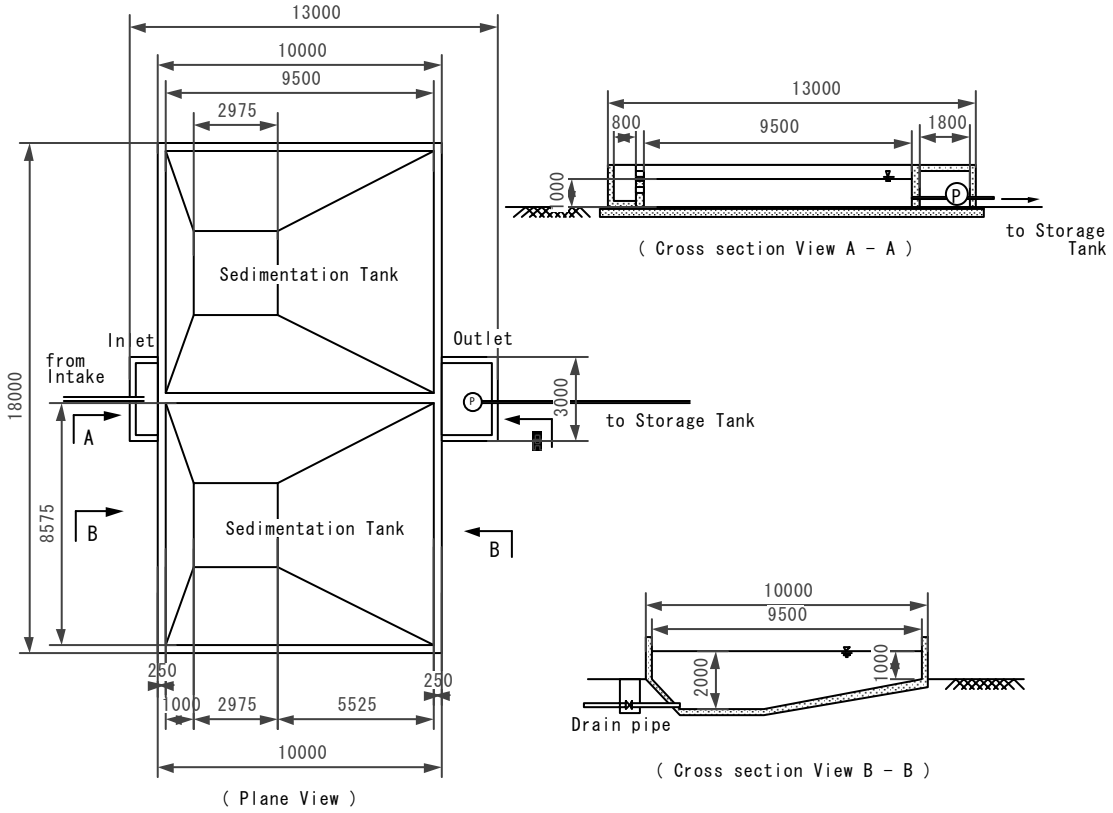


FIGURE 10.4 LAYOUT AND DESIGN OF INTAKE FACILITY FOR RIVER WATER (MATIPWILI, BAGAMOYO)



(Sedimentation Tank)

FIGURE 10.5 DESIGN OF WATER TREATMENT FACILITY (MATIPWILI, BAGAMOYO)

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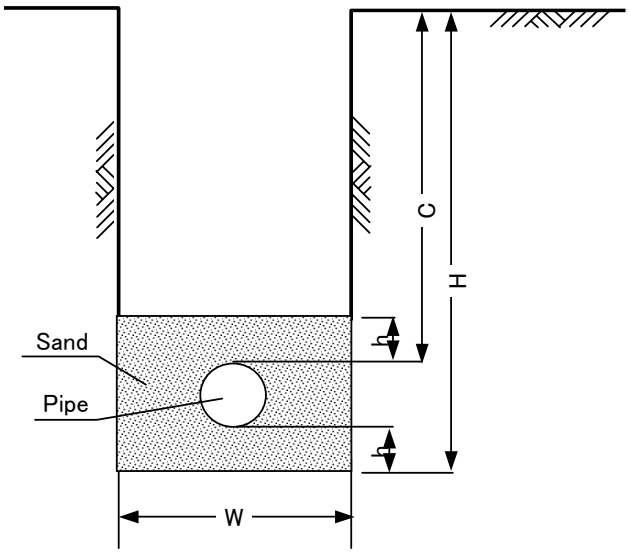
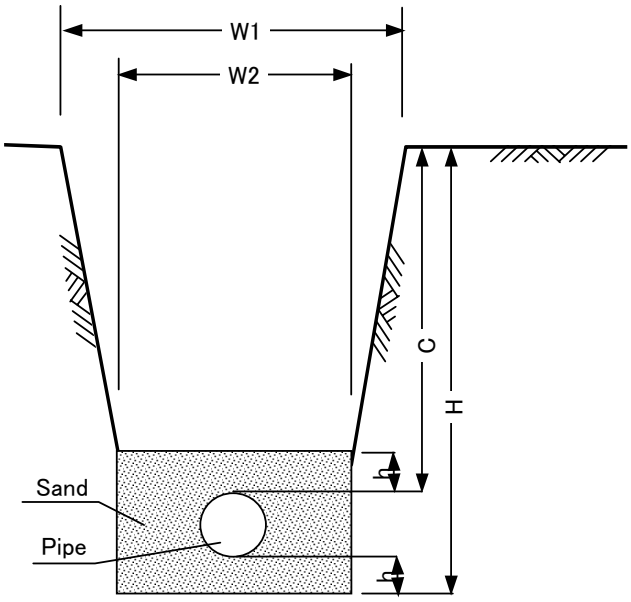
Excavator digging



Pipe Diameter (mm)	C (m)	h (m)	H (m)	W (m)
32	0.75	0.10	1.17	0.50
40			0.40	0.55
50			0.50	0.55
63			0.63	0.60
75			0.75	0.60
90			0.90	0.65
110			1.10	0.65
125			1.25	0.70
140			1.40	0.70
160			1.60	0.75
200			2.00	0.75

Hand digging



Pipe Diameter (mm)	C (m)	h (m)	H (m)	W1 (m)	W2 (m)
32	0.75	0.10	1.17	0.60	0.5
40			0.40		
50			0.50		
63			0.63		
75			0.75		
90			0.90		
110			1.10		
125			1.25		
140			1.40		
160			1.60		
200			2.00		

FIGURE 10.6 DESIGN OF TRANSMISSION AND DISTRIBUTION LINES

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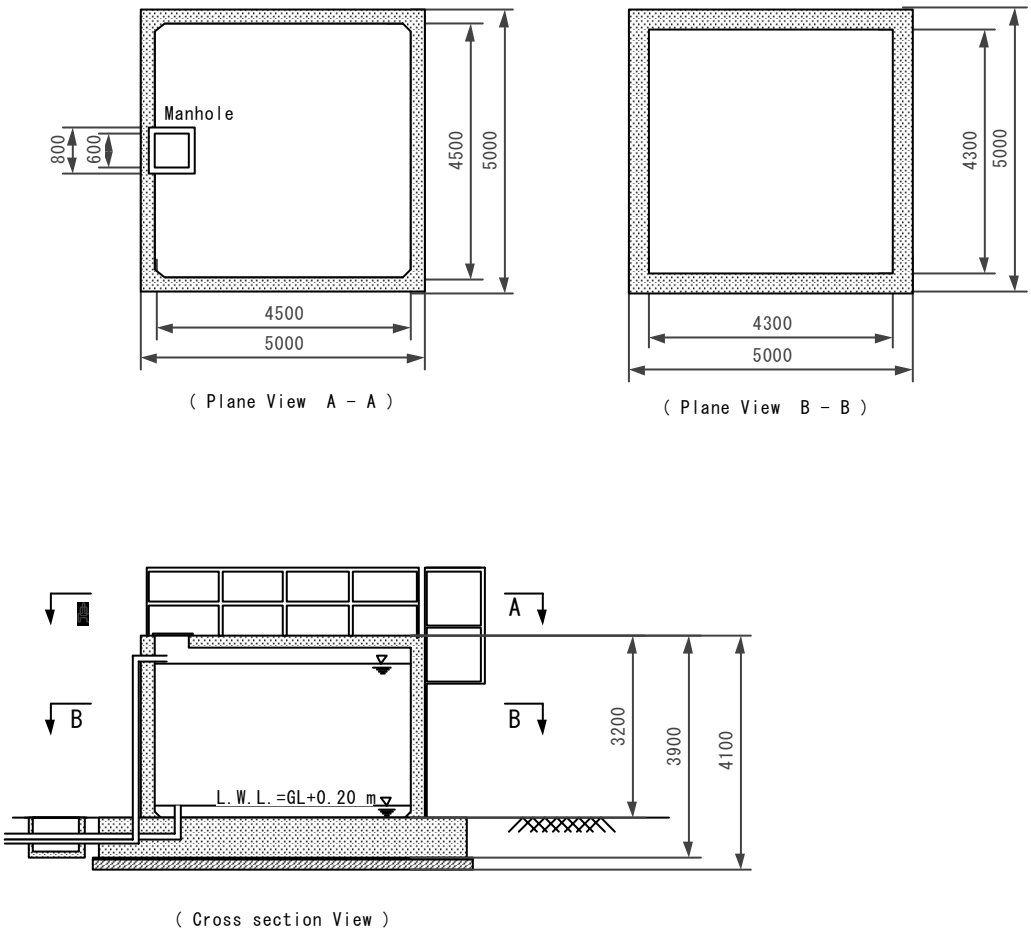

FIGURE 10.7 DESIGN OF STORAGE TANK-GROUND TANK

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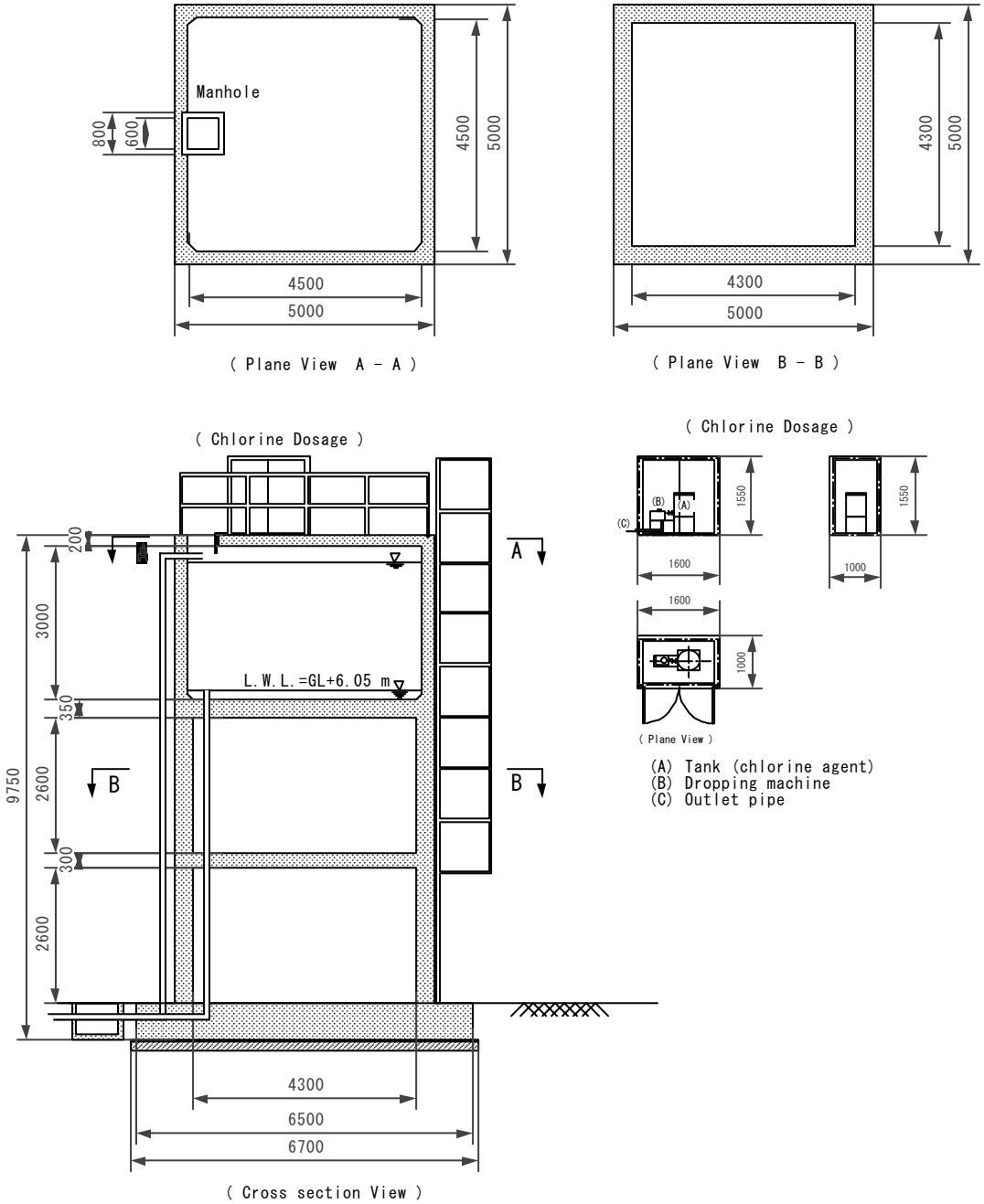

Note: Chlorine dosage is only for Matipwili.

FIGURE 10.8 DESIGN OF STORAGE TANK -ELEVATED TANK (1)

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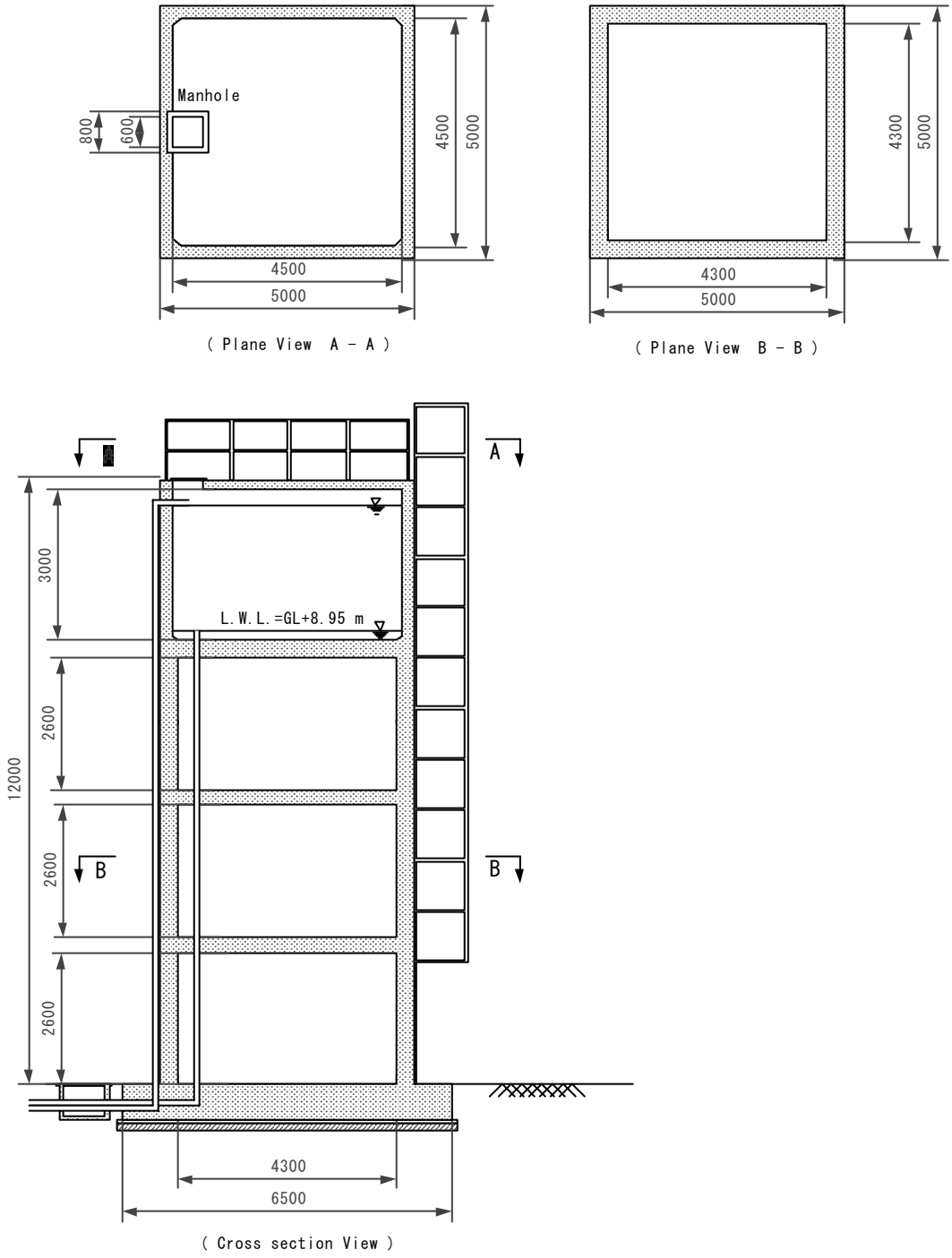

FIGURE 10.9 DESIGN OF STORAGE TANK -ELEVATED TANK (2)

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the field reconnaissance. Therefore, precise length of pipe shall be reviewed based on the topographic survey in the implementation of projects. PVC pipes are principally proposed for the material of pipes because they are widely used in Tanzania. Diameters of pipes are determined based on supply by gravity flow. Standard design is same as that of Transmission lines (*Figure 10.6*).

10.6.6 PUBLIC WATER POINT

Locations of public water points (PWP) are proposed considering the results of the field survey. Public water point is allocated for every 150 persons (single tap). Maximum access distance to a tap from households is 400 m in principal. Number of tap at Public Water Point (PWP) is one or two. It is decided considering the service population. Design of public water point is shown in *Figure 10.10*.

10.7 FACILITY PLAN AND LAYOUT OF WATER SUPPLY SCHEME

Facility plans and layout of each water supply schemes are shown in *Table 10.4* and figures from *Figure 10.11* to *Figure 10.32*, respectively.

Table 10.4 Facility Plan for Priority Project

Village /Mitaa	Water Sources (Well)		Transmission Pipe Line		Storage Tank		Total Length of Distribution Line (m)	No. of Public Water Point		
	No. of Well	Well Depth (m)	Diameter (mm)	Length (m)	Capacity (m^3)	Type of Tank 1)		PWP with Single Tap	PWP with Double Taps	Total
Kibindu	2	100	75	2,060	100	Ground tank	6,820	13	5	18
Kwanduma	2	100	50	1,500	50	Ground tank	2,590	2	5	7
Matipwili	Wami River	-	63	510	40	Elevated tank (A)	1,330	10	0	10
Minazi Mikinda	1	50	50	100	40	Elevated tank (A)	1,280	0	5	5
Kitomondo/Minazi Mikinda	1	50	50	100	40	Elevated tank (A)	6,900	9	0	9
Msimbu	2	120	90	4,700	50	Ground tank	18,400	11	0	11
Chole	2	80	110	3,960	60	Ground tank	10,550	18	0	18
Mwandege /Kipala	1	80	63	100	50	Elevated tank (A)	10,660	22	0	22
Kisemvule	2	80	63	940	60	Ground tank	9,560	12	0	12
Marogoro /Mfuru Mwambao	1	50	50	100	40	Elevated tank (B)	11,370	14	0	14
Vianzi	1	100	75	100	50	Elevated tank (A)	7,420	13	0	13
Njopeka	Spring	-	110	2,480	80	Ground tank	13,830	12	3	15
Kitunda-1	2	80	50	400	80	Elevated tank (A)	7,930	0	8	8
Kitunda-2	1	80	63	100	50	Elevated tank (A)	8,900	0	5	5
Mzinga	2	80	63	400	120	Elevated tank (A)	8,440	0	12	12
Msongala	1	80	75	100	40	Elevated tank (A)	6,620	9	0	9
Pugu Station	1	90	75	1,420	50	Ground tank	2,230	0	5	5
Matosa	1	120	75	2,180	50	Elevated tank (A)	5,070	4	3	7
Yaleyale Puna	1	80	125	4,430	90	Elevated tank (A)	9,990	6	6	12
Tundwi Songani	2	80	63	3,920	40	Elevated tank (A)	8,550	16	0	16
Mjimwema	1	50	50	100	60	Elevated tank (B)	4,980	6	3	9
Kibugumo	1	50	75	100	50	Elevated tank (B)	3,590	7	2	9
Total	28	-	-	29,800	1,290	-	167,010	184	62	246

1) Ground tank : Low water level = GL + 0.20 m
Elevated tank (A): Low water level = GL + 6.05 m
Elevated tank (B): Low water level = GL + 8.95 m

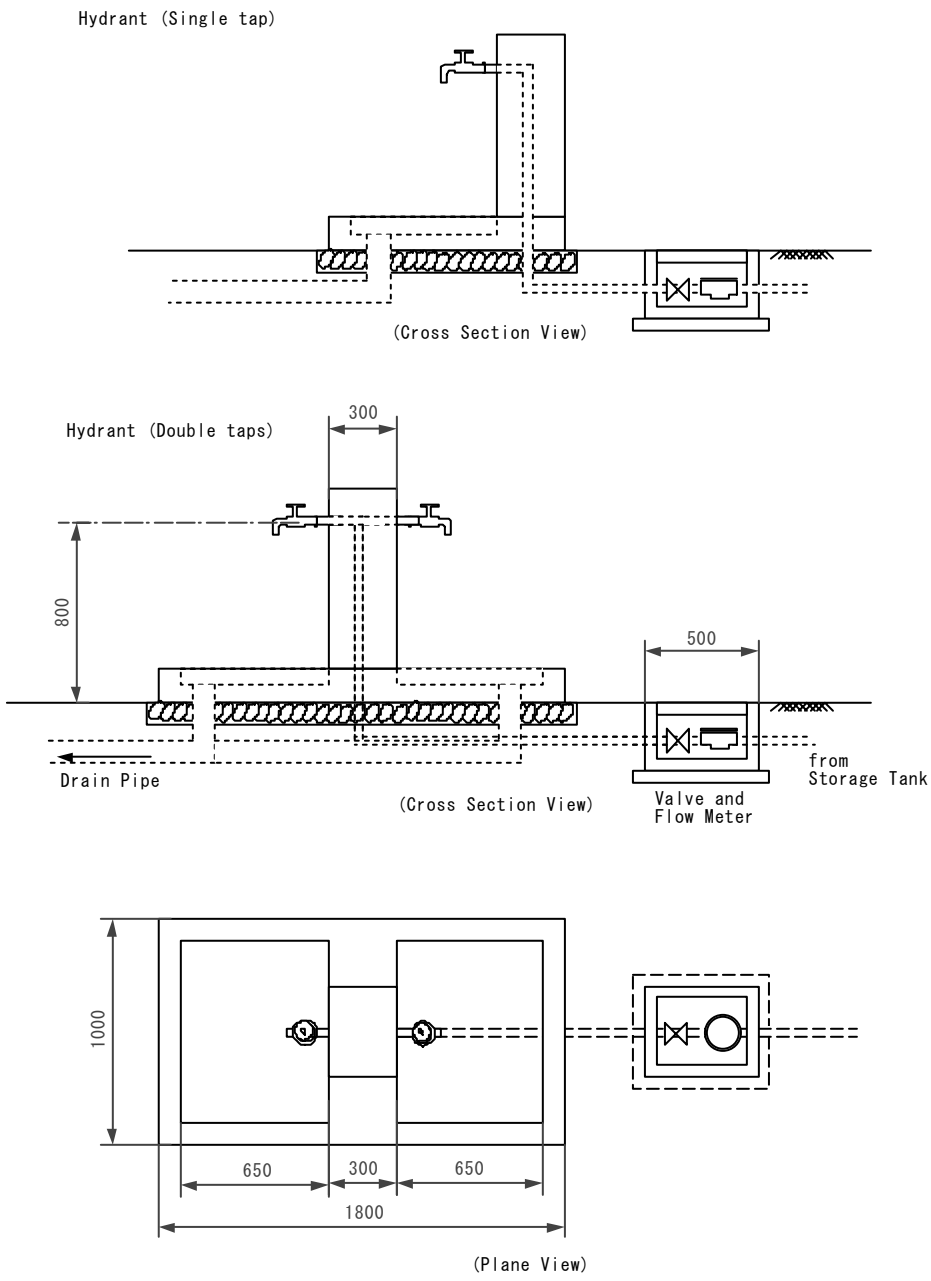
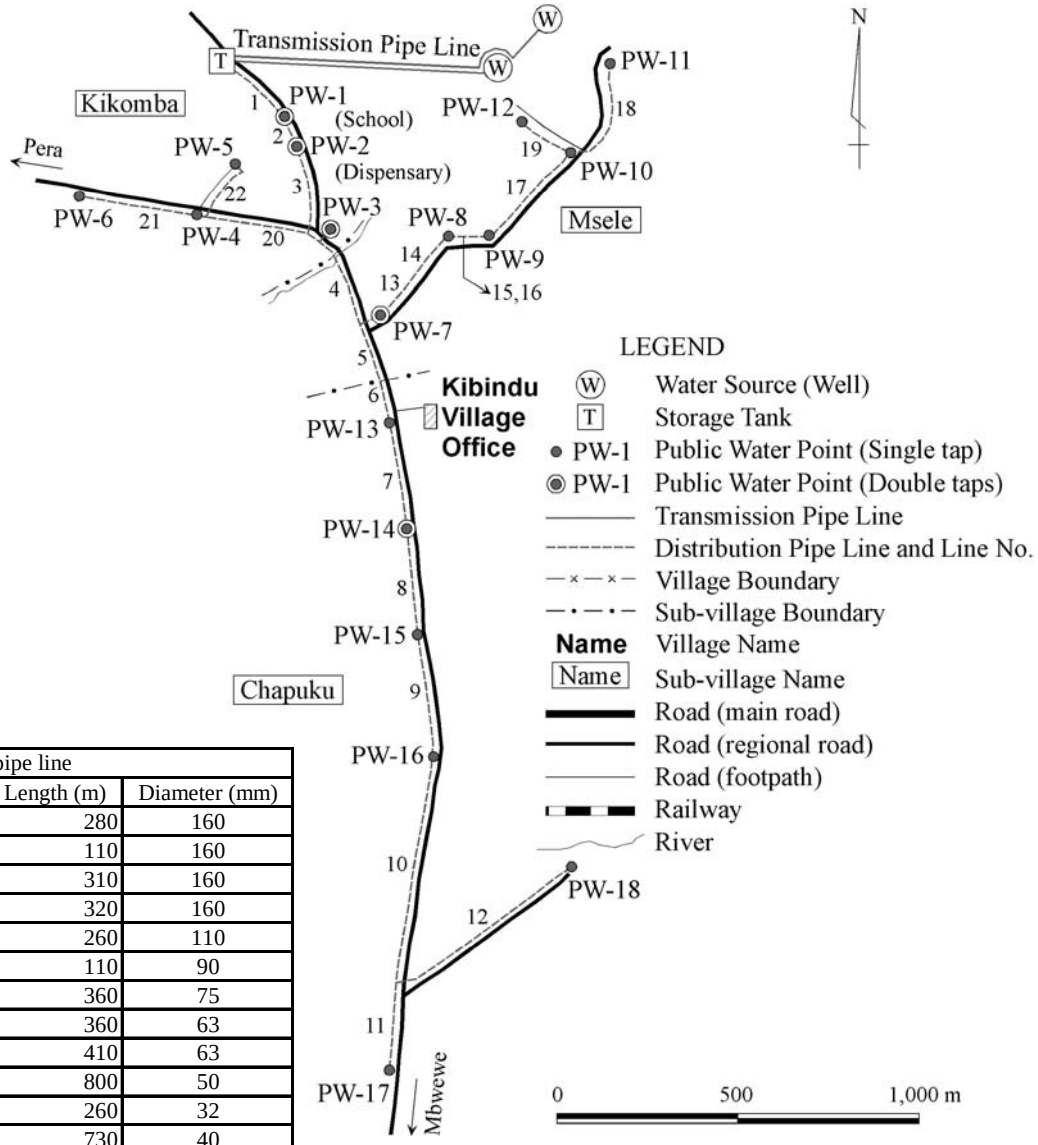
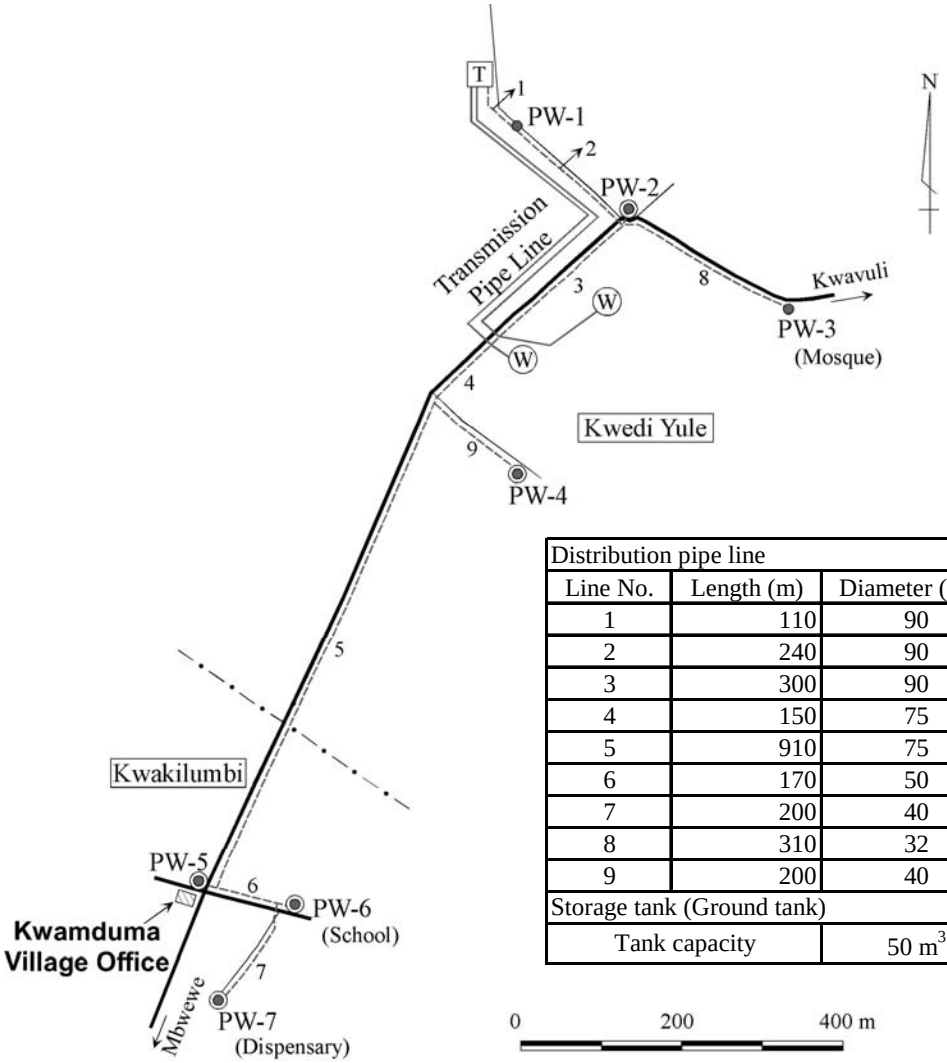


FIGURE 10.10 DESIGN OF PUBLIC WATER POINTS (PWP)



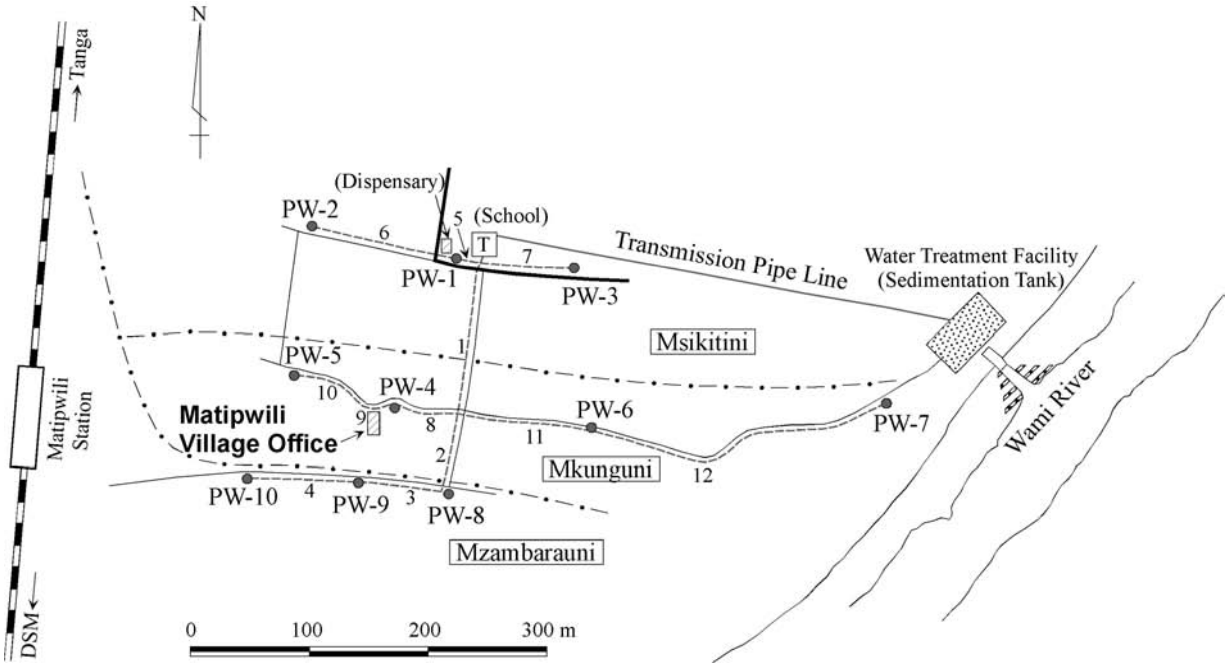
Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	280	160
2	110	160
3	310	160
4	320	160
5	260	110
6	110	90
7	360	75
8	360	63
9	410	63
10	800	50
11	260	32
12	730	40
13	310	110
14	40	90
15	140	75
16	60	75
17	340	75
18	380	32
19	190	32
20	440	63
21	400	40
22	210	32
Storage tank (Ground tank)		
Tank capacity	100 m^3	

FIGURE 10.11 Layout of Water Supply Scheme (Kibindu: BGM-1)



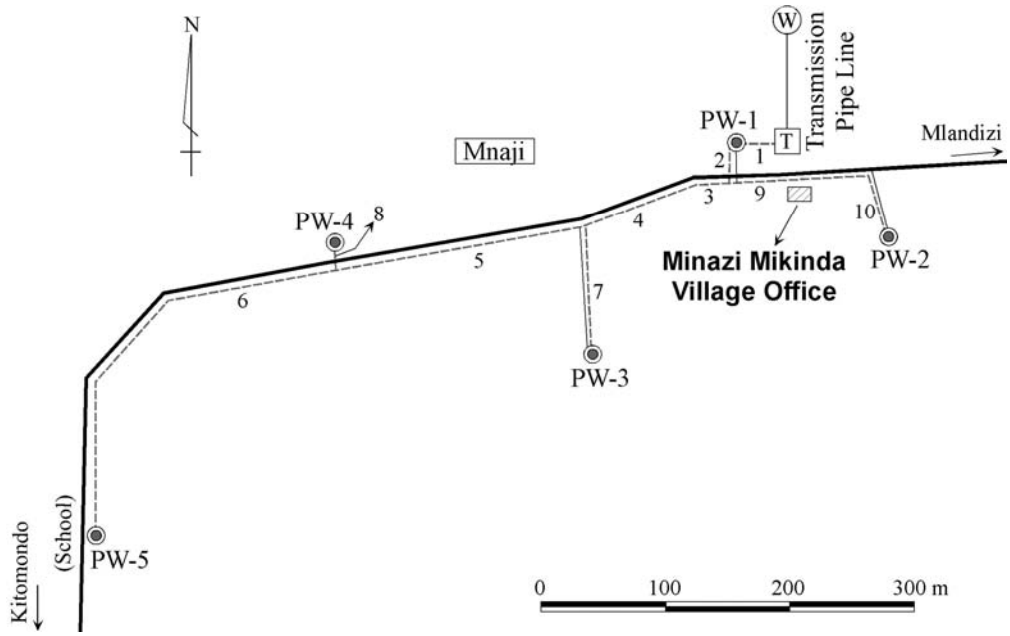
Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	110	90
2	240	90
3	300	90
4	150	75
5	910	75
6	170	50
7	200	40
8	310	32
9	200	40
Storage tank (Ground tank)		
Tank capacity		50 m^3

FIGURE 10.12 Layout of Water Supply Scheme (Kwamduma: BGM-2)



Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	160	90
2	80	50
3	100	40
4	110	32
5	20	40
6	150	32
7	100	32
8	70	50
9	60	50
10	50	40
11	130	50
12	300	40
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity	$40m^3$	

FIGURE 10.13 Layout of Water Supply Scheme (Matipwili: BGM-3)



Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	90
2	30	75
3	30	75
4	120	63
5	240	63
6	410	50
7	120	32
8	20	32
9	140	40
10	70	40
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity		40 m^3

FIGURE 10.14 Layout of Water Supply Scheme (Minazi Mikinda (1): KBH-1)

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	110
2	1,750	110
3	30	40
4	270	110
5	1,520	110
6	500	90
7	230	75
8	300	50
9	30	32
10	320	40
11	50	40
12	750	63
13	60	32
14	480	63
15	510	40
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity	40 m^3	

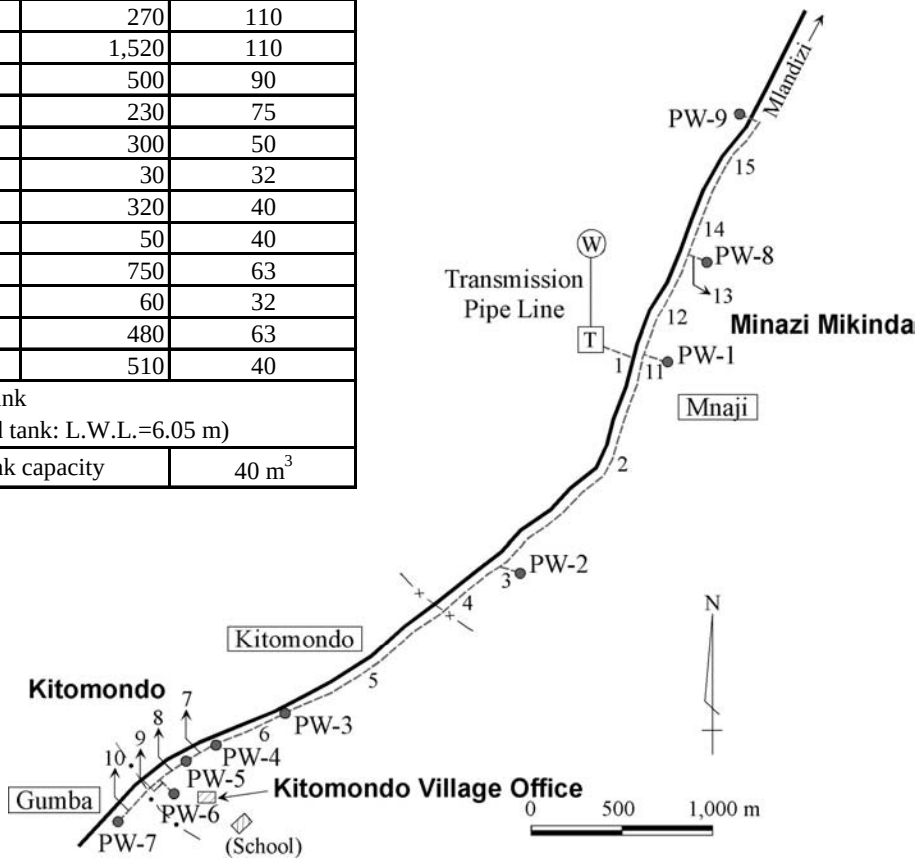


FIGURE 10.15 Layout of Water Supply Scheme (Minazi Mikinda (2)/Kitomondo: KBH-2)

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	110
2	560	110
3	80	110
4	530	110
5	420	110
6	1,000	110
7	380	32
8	760	40
9	590	90
10	150	63
11	480	50
12	340	32
13	270	63
14	160	32
15	560	63
16	470	50
17	1,040	40
18	510	40
19	1,350	40
20	400	50
21	250	40
22	150	32
Storage tank (Ground tank)		
Tank capacity		60 m^3

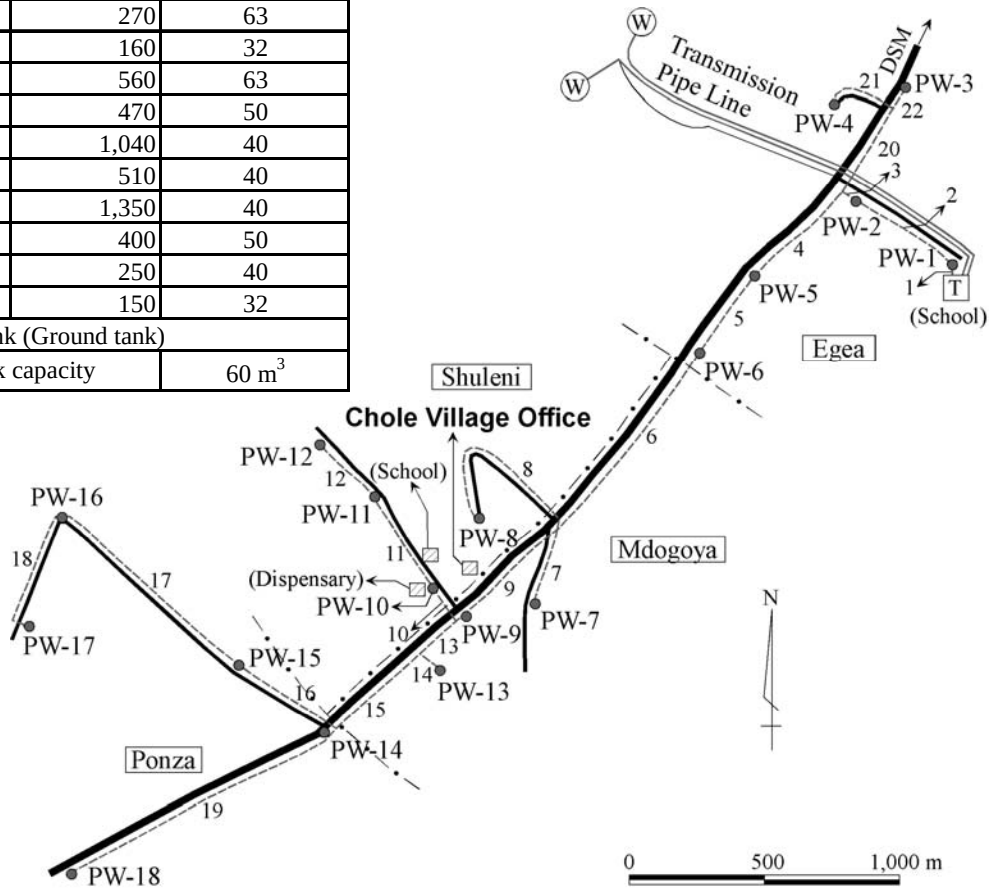


FIGURE 10.16 Layout of Water Supply Scheme (Chole: KSW-1)

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Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	110
2	1,110	110
3	1,860	63
4	1,000	32
5	70	50
6	1,800	50
7	1,000	40
8	1,020	40
9	230	63
10	1,700	50
11	910	50
12	1,390	32
13	2,860	32
14	1,830	40
15	1,350	40
16	170	50
Storage tank (Ground tank)		
Tank capacity		50 m^3

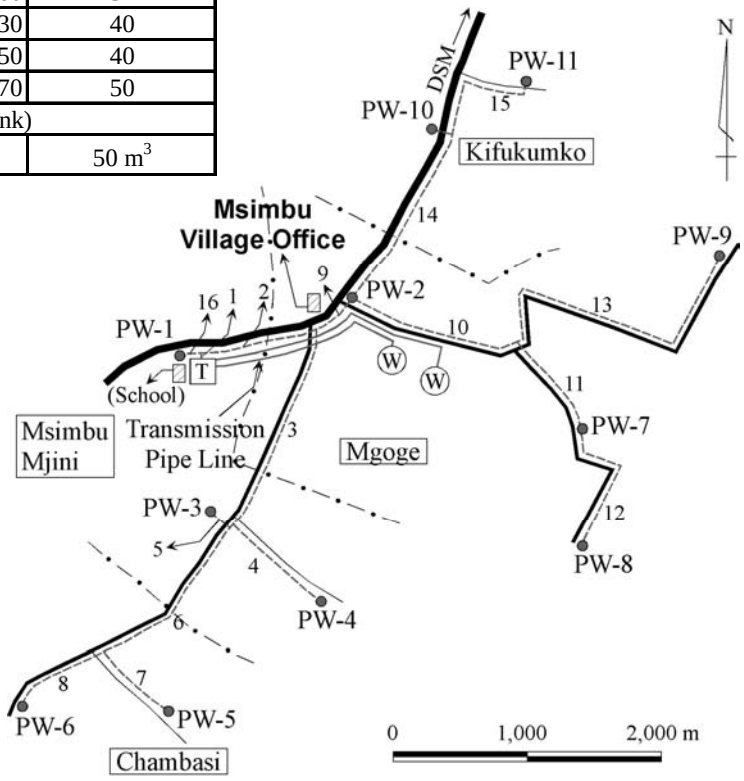
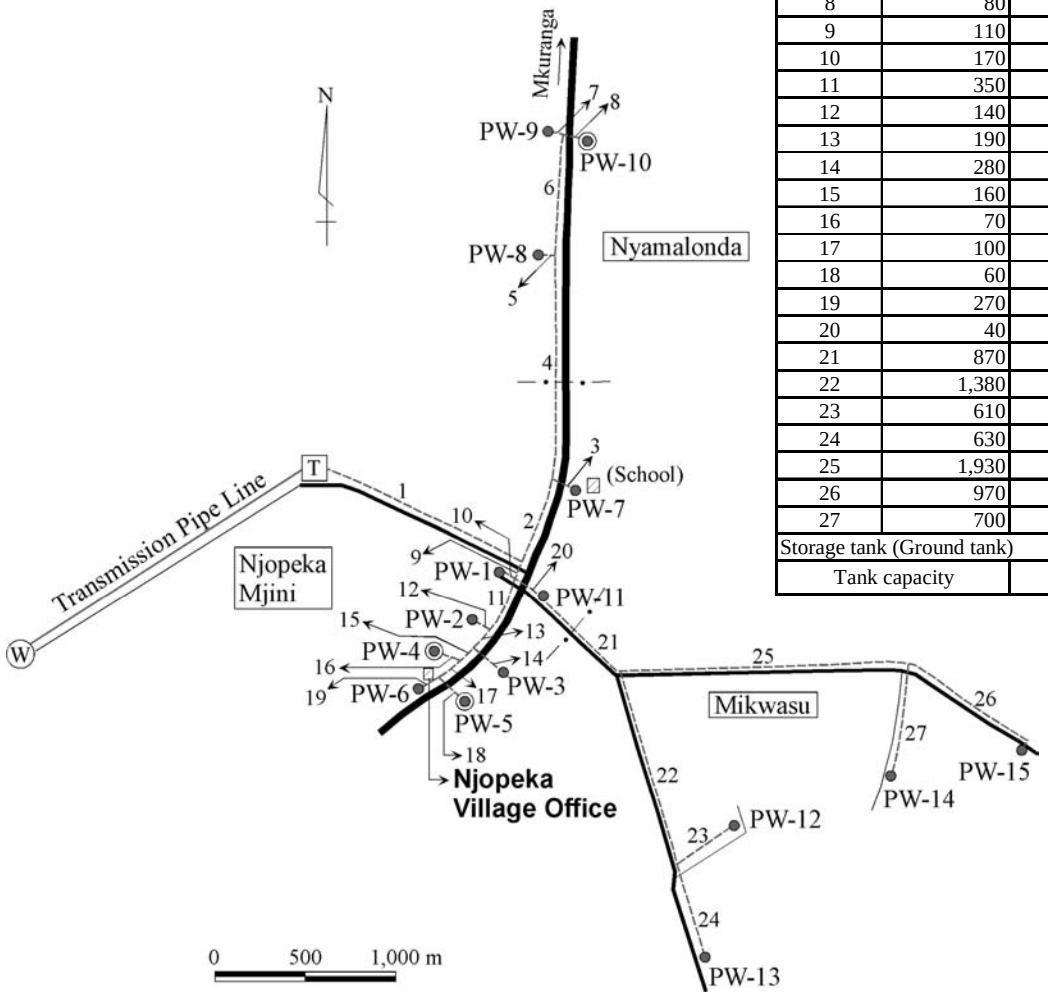
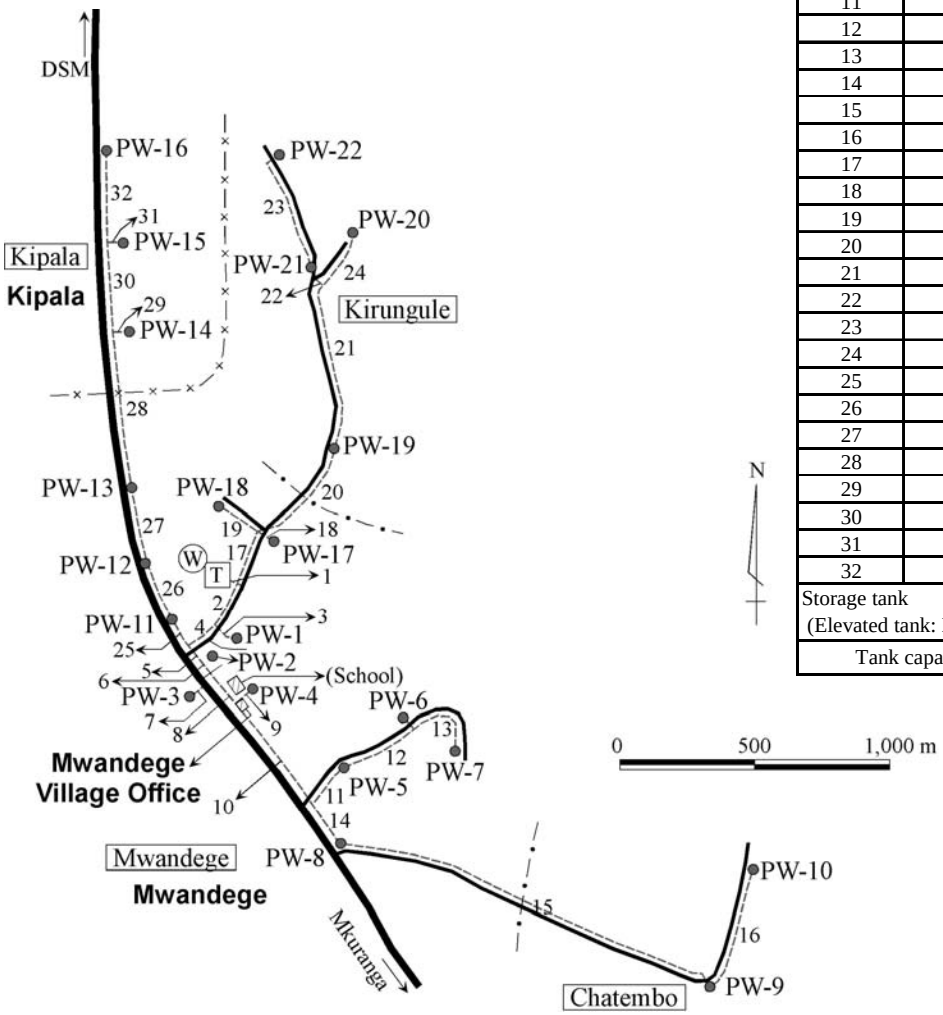


FIGURE 10.17 Layout of Water Supply Scheme (Msimbu: KSW-2)



Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	1,610	160
2	600	75
3	80	32
4	1,600	63
5	40	32
6	730	50
7	60	32
8	80	32
9	110	140
10	170	110
11	350	125
12	140	32
13	190	125
14	280	32
15	160	125
16	70	32
17	100	110
18	60	32
19	270	110
20	40	75
21	870	75
22	1,380	75
23	610	40
24	630	40
25	1,930	50
26	970	40
27	700	50
Storage tank (Ground tank)		
Tank capacity		80 m^3

FIGURE 10.18 Layout of Water Supply Scheme (Njopeka: MKR-1)



Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	110
2	260	110
3	80	32
4	140	90
5	40	32
6	110	75
7	90	32
8	140	75
9	40	32
10	710	75
11	260	40
12	370	40
13	450	40
14	290	50
15	1,770	40
16	560	32
17	330	50
18	20	32
19	270	32
20	480	40
21	860	40
22	80	32
23	530	32
24	200	32
25	210	75
26	280	50
27	340	50
28	500	40
29	50	32
30	500	40
31	50	32
32	550	32
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity	50 m^3	

FIGURE 10.19 Layout of Water Supply Scheme (Mwandege/Kipala: MKR-2)

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	110
2	1,490	110
3	280	90
4	160	90
5	290	32
6	100	90
7	140	75
8	520	63
9	710	63
10	190	50
11	340	32
12	1,520	75
13	1,530	63
14	950	40
15	560	63
16	680	63
Storage tank (Ground tank)		
Tank capacity		60 m^3

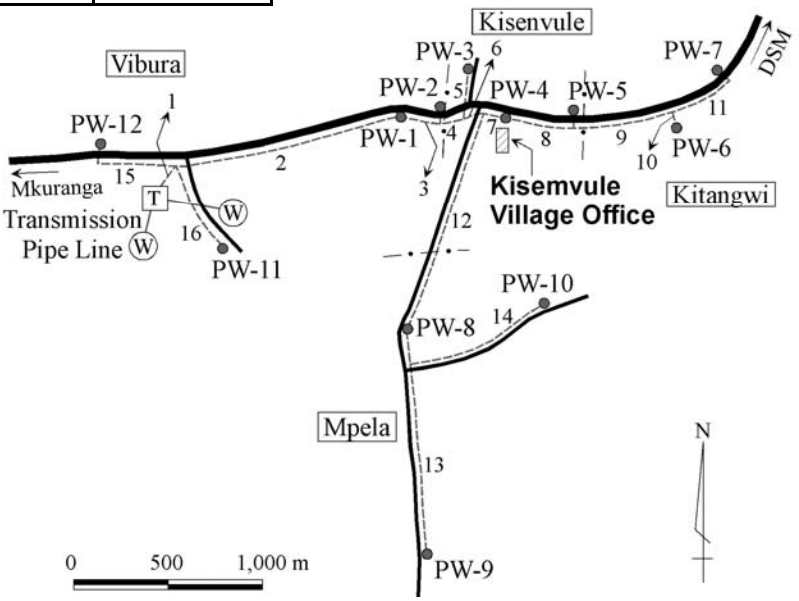


FIGURE 10.20 Layout of Water Supply Scheme (Kisemvule: MKR-3)

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	110
2	400	110
3	130	32
4	200	90
5	30	32
6	330	90
7	150	50
8	380	75
9	40	32
10	2,360	75
11	820	40
12	540	32
13	420	40
14	840	40
15	40	32
16	350	32
17	160	90
18	140	32
19	490	75
20	550	32
21	330	63
22	500	40
23	380	63
24	20	40
25	1,640	40
26	30	32
Storage tank (Elevated tank: L.W.L.=8.95 m)		
Tank capacity		40 m^3

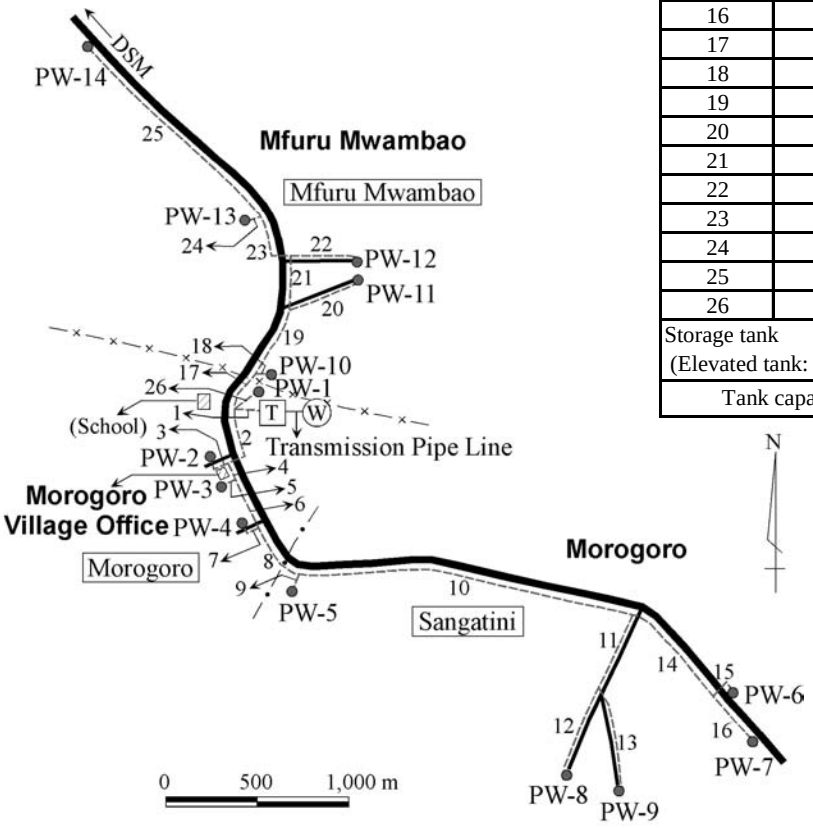


FIGURE 10.21 Layout of Water Supply Scheme (Morogoro/Mfuru Mwambao: MKR-4)

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	90
2	510	75
3	600	63
4	100	50
5	350	50
6	150	32
7	280	32
8	880	32
9	80	32
10	950	32
11	40	32
12	210	32
13	610	40
14	710	32
15	310	40
16	950	32
17	590	32
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity		50 m^3

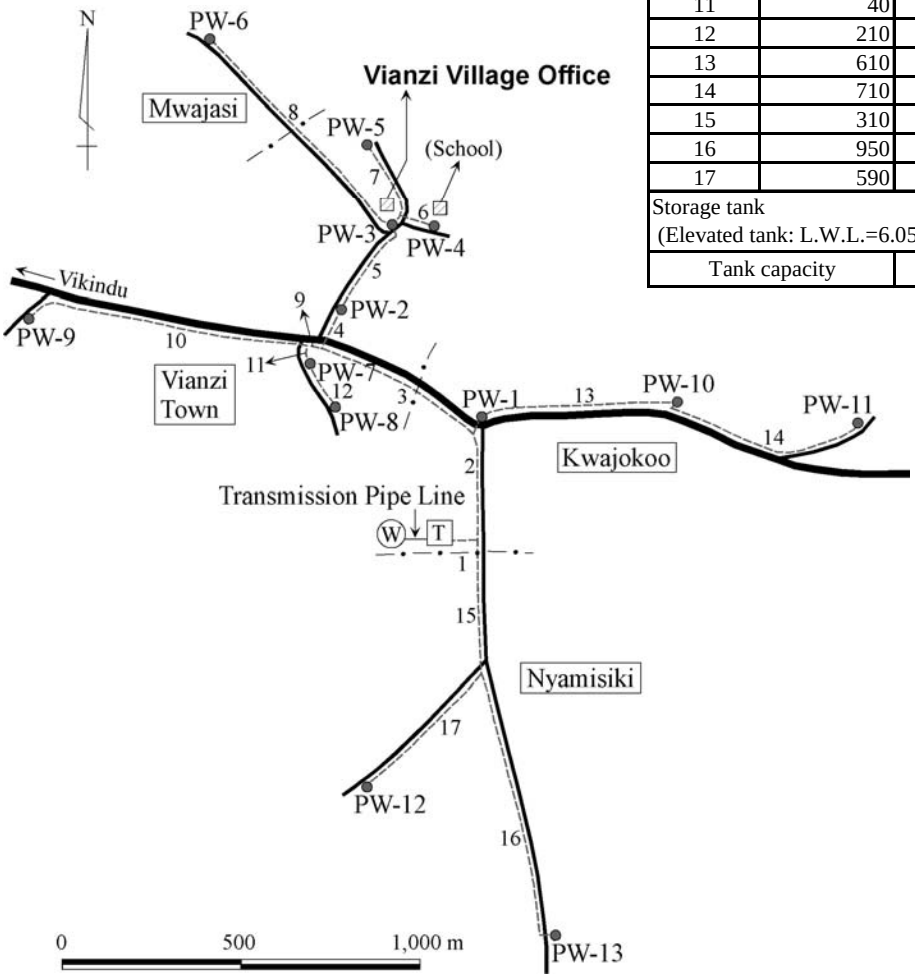


FIGURE 10.22 Layout of Water Supply Scheme (Vianzi: MKR-5)

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	140
2	220	125
3	400	110
4	440	110
5	790	40
6	280	50
7	390	40
8	360	40
9	340	63
10	570	63
11	680	50
12	900	75
13	2,460	75
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity		80 m^3

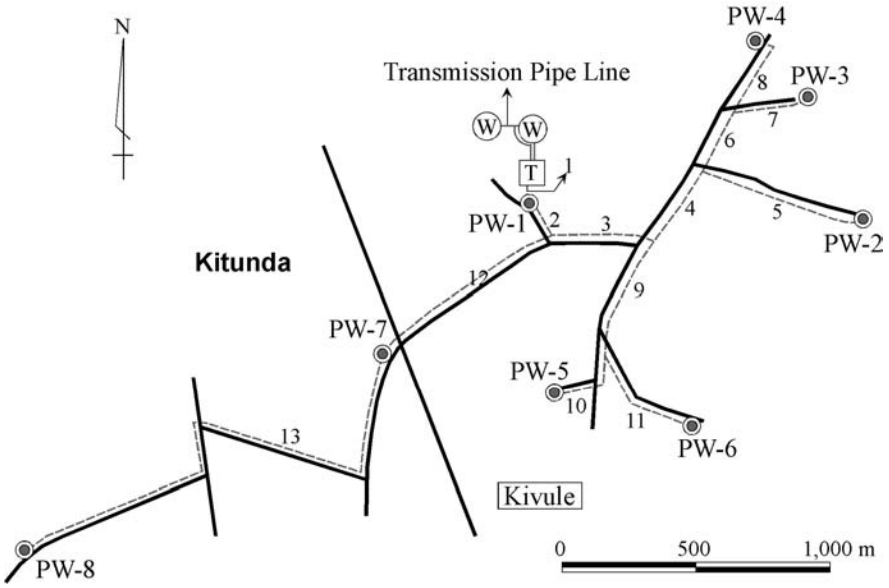


FIGURE 10.23 Layout of Water Supply Scheme (Kitunda-Kivule (1/2): ILL-1A)

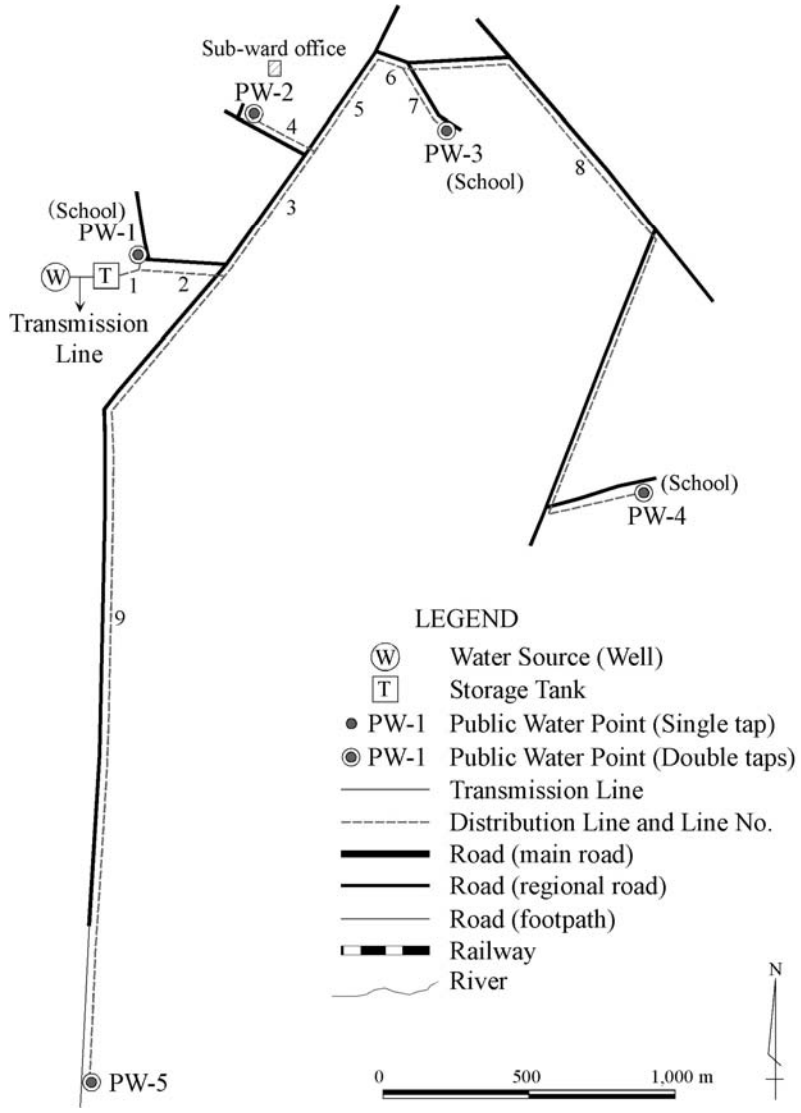
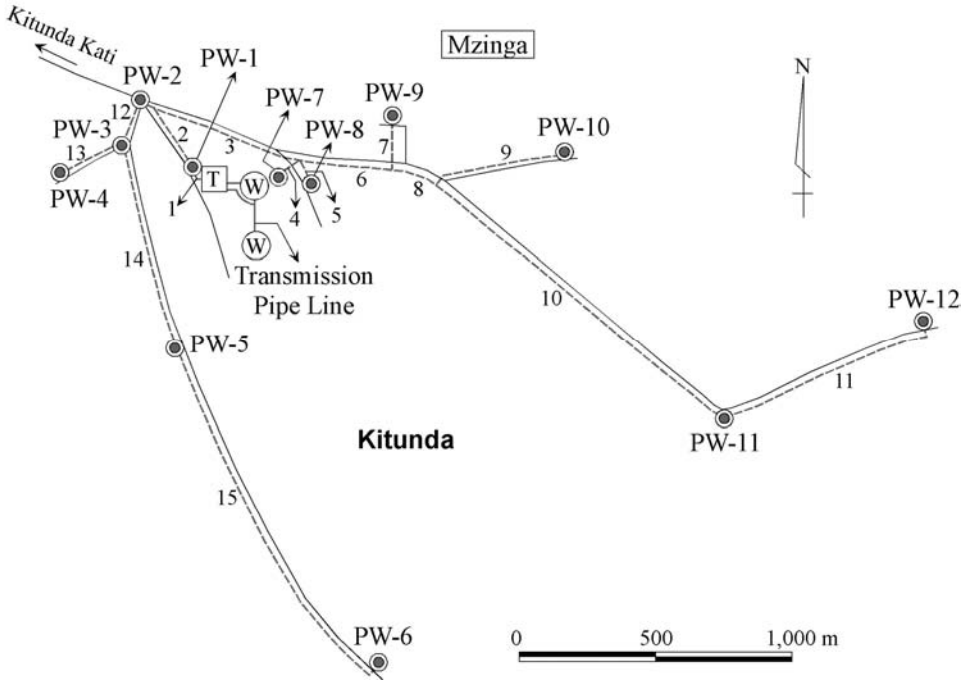


FIGURE 10.24 Layout of Water Supply Scheme (Kitunda-Kivule (2/2): ILL-1B)



Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	200
2	340	200
3	650	160
4	120	75
5	210	75
6	590	140
7	290	40
8	190	110
9	560	40
10	1,650	63
11	980	50
12	220	110
13	330	75
14	950	110
15	1,260	110
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity	120 m^3	

FIGURE 10.25 Layout of Water Supply Scheme (Kitunda-Mzinga: ILL-1C)

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	200
2	1,220	125
3	240	40
4	220	90
5	690	63
6	130	75
7	120	75
8	340	50
9	940	50
10	870	40
11	20	110
12	850	110
13	880	125
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity		40 m^3

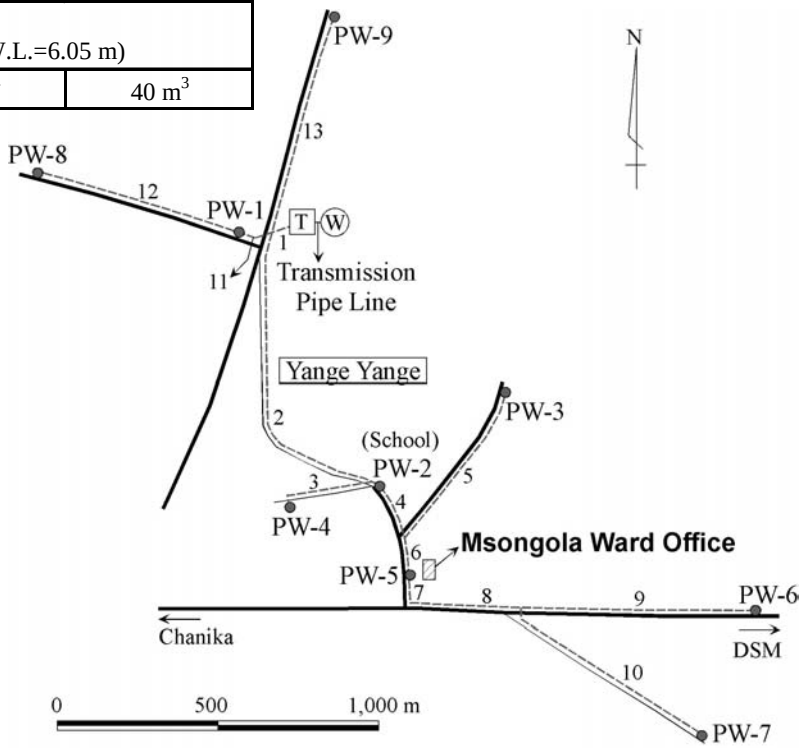
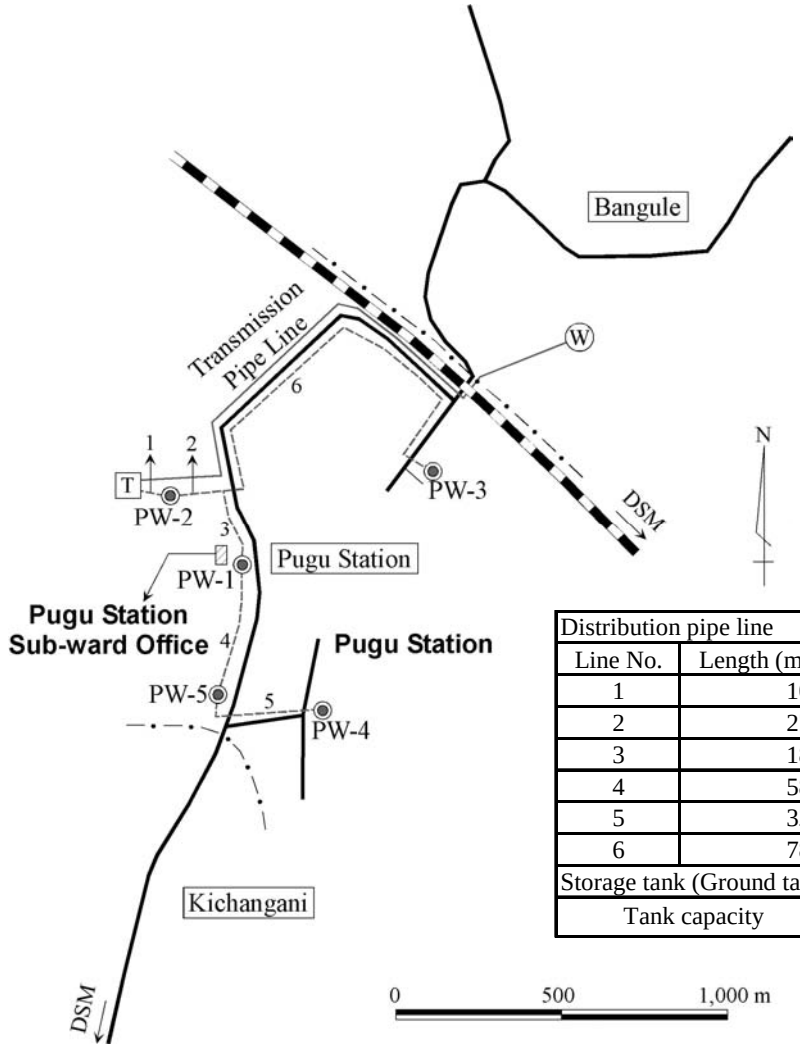
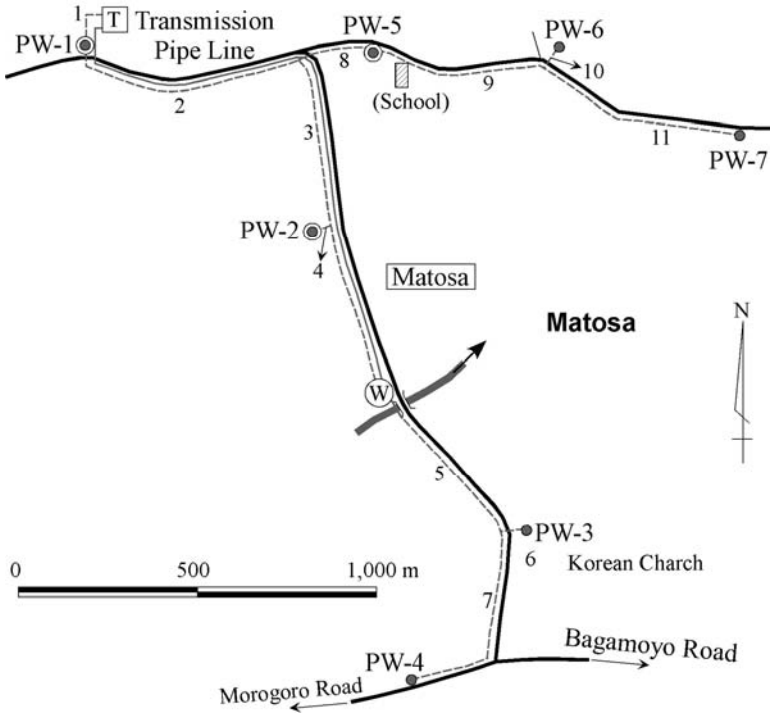


FIGURE 10.26 Layout of Water Supply Scheme (Msongora: ILL-2)



Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	110
2	270	90
3	180	75
4	580	75
5	320	50
6	780	40
Storage tank (Ground tank)		
Tank capacity		50 m^3

FIGURE 10.27 Layout of Water Supply Scheme (Pugu Station: ILL-3)



Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	75
2	800	75
3	610	63
4	10	32
5	1,210	50
6	20	32
7	740	32
8	190	63
9	620	50
10	40	40
11	730	32
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity	50 m^3	

FIGURE 10.28 Layout of Water Supply Scheme (Matosa: KND-1)

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	220	160
2	60	140
3	450	50
4	430	140
5	170	32
6	20	32
7	490	140
8	220	125
9	190	50
10	300	110
11	390	50
12	270	110
13	380	110
Storage tank (Elevated tank: L.W.L.=8.95 m)		
Tank capacity	50 m^3	

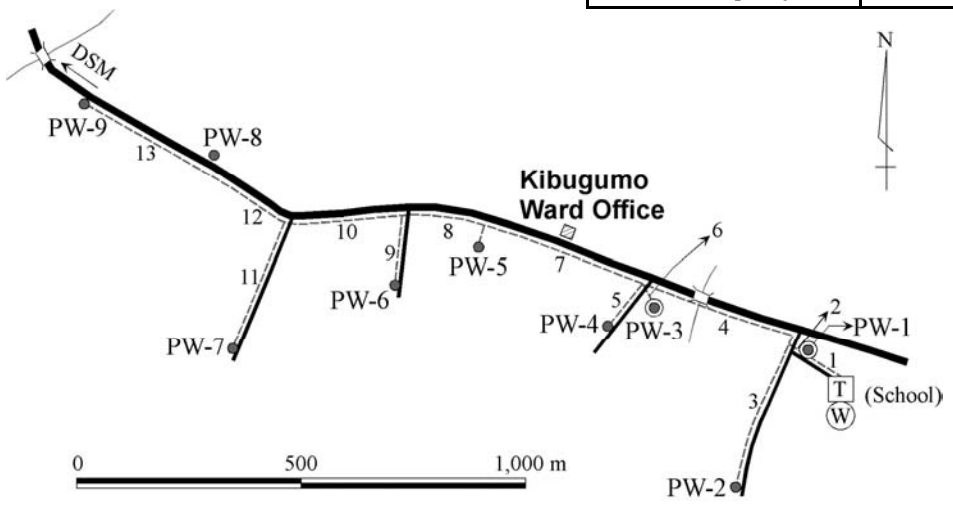


FIGURE 10.29 Layout of Water Supply Scheme (Kibugumo: TMK-1)

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	160
2	230	160
3	100	32
4	200	140
5	740	140
6	490	125
7	570	110
8	140	75
9	280	75
10	100	40
11	510	50
12	740	75
13	180	50
14	230	32
15	370	32
Storage tank (Elevated tank: L.W.L.=8.95 m)		
Tank capacity		60 m^3

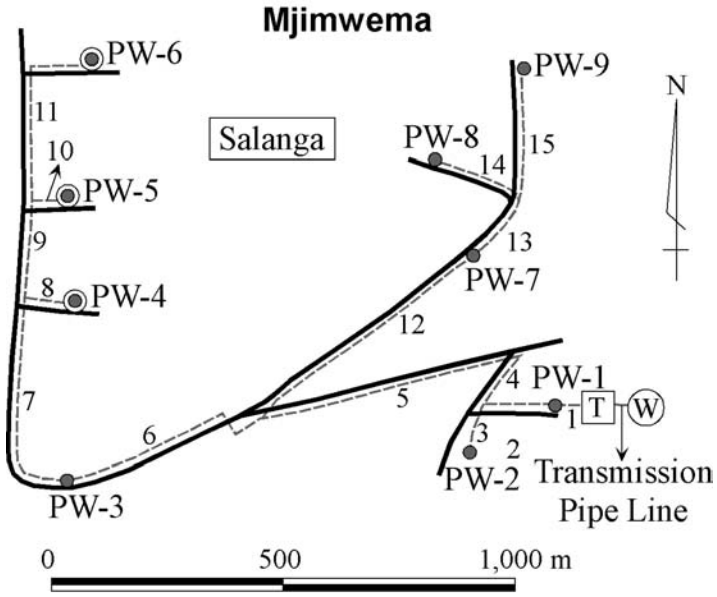


FIGURE 10.30 Layout of Water Supply Scheme (Mjimwema: TMK-2)

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	140
2	620	140
3	510	110
4	600	32
5	260	90
6	680	75
7	550	63
8	20	63
9	600	63
10	370	40
11	790	40
12	1,030	40
13	160	32
14	1,110	90
15	540	32
16	1,520	75
17	530	50
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity	90 m^3	

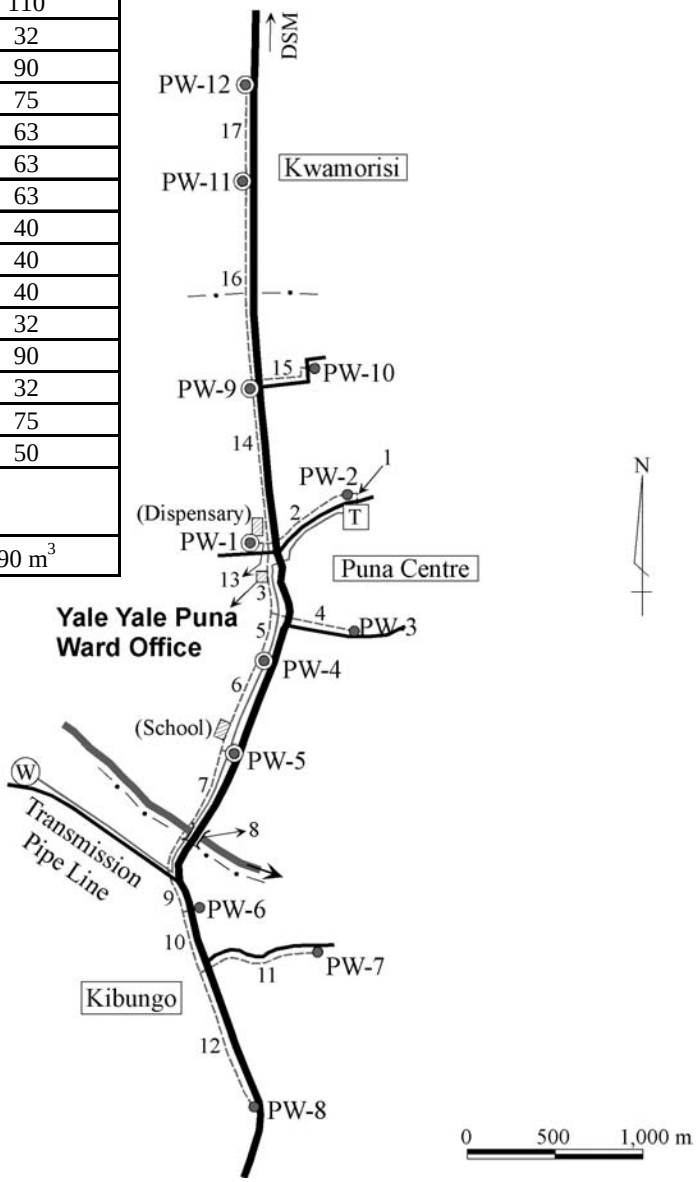


FIGURE 10.31 Layout of Water Supply Scheme (Yale Yale Puna: TMK-3)

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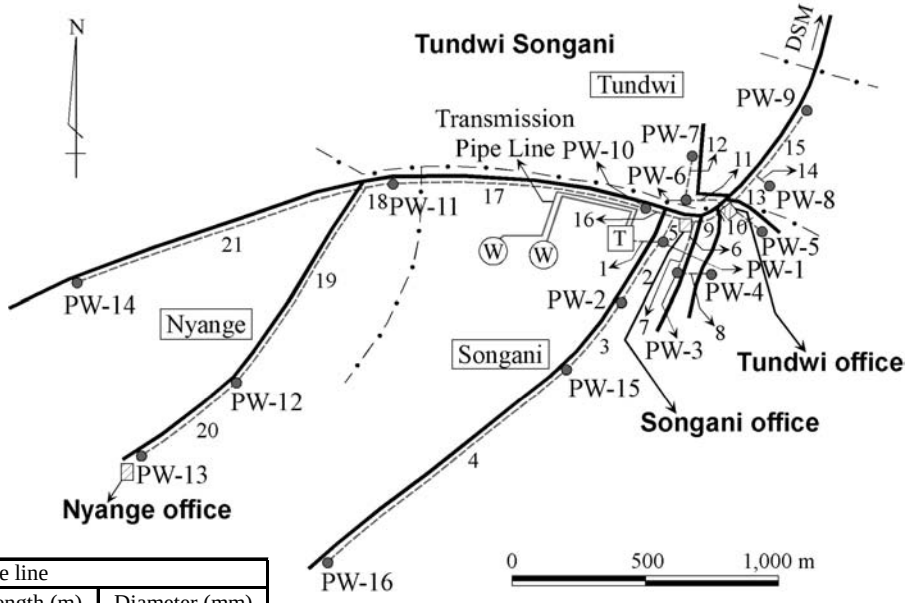

Distribution pipe line		
Line No.	Length (m)	Diameter (mm)
1	100	90
2	330	50
3	390	40
4	1,380	32
5	170	90
6	70	50
7	270	32
8	100	32
9	90	40
10	250	32
11	120	40
12	210	32
13	160	40
14	50	32
15	420	40
16	140	63
17	1,250	63
18	100	40
19	1,060	40
20	530	32
21	1,360	32
Storage tank (Elevated tank: L.W.L.=6.05 m)		
Tank capacity	40 m^3	

FIGURE 10.32 Layout of Water Supply Scheme (Tundi Songani: TMK-4)

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Ministry of Water (1997) Design Manual for Water Supply and Waste Disposal-Second Draft Volume, Ministry of Water, Tanzania

Chapter 11

Water Supply Development Plan

CHAPTER 11 WATER SUPPLY DEVELOPMENT PLAN

11.1 GENERAL

The water supply plans formulated in the first field survey was finalized in the second field survey after the supplementary survey on the candidate villages for the priority project. Alternatives proposed to the villages in the Study area are (1) Piped water supply scheme (Level-2), Hand pump water supply scheme (Level-1), (3) Extension of existing water supply scheme such as DAWASA and Chalinze Water Supply Scheme, and (4) Rehabilitation of existing water supply scheme. Approximate cost was estimated for the total water supply plan.

In this Chapter, the implementation plan of the proposed projects was discussed including financial plans considering the National plans, strategies and policies. Then, the projects proposed in the Study were evaluated from the view points of the economic and financial aspects, the institutional aspects, environmental and social consideration and appropriate technique.

11.2 APPROXIMATE COST ESTIMATION

11.2.1 CONDITIONS OF THE ESTIMATION

The international base of cost was estimated considering the following conditions.

- The project cost consists of construction cost, engineering service cost, administration cost and physical contingencies.
- The cost for the land acquisition is not included.
- Engineering service cost is assumed to be 15 % of the total construction cost.
- The success rate of well drilling is assumed to be 70 %.
- All the costs are estimated under the economic conditions prevailing in July 2005.
- Exchange rate of currencies to be used is US$ 1.00= 1,137 Tsh.
- Construction cost for Chalinze Water Supply Project (Phase II) and schemes to be constructed by DAWASA are excluded.

11.2.2 BASIS OF THE ESTIMATION

(1) Piped Water Supply Scheme (Level-2)

A total of 22 Level-2 schemes were finally proposed in the water supply plan (Chapter 5 of Main Report). These schemes were selected as the priority project.

The international base of costs for 22 Level-2 schemes were estimated based on the information collected in the field survey and other similar projects carried out in Tanzania.

(2) Hand Pump Water Supply Scheme (Level-1)

Originally, 538 Level-1 schemes were proposed tentatively. However, finally number of the scheme was increased to 607 (Chapter 5 of Main Report) consequent to the supplemental field survey carried out in June to July 2005.

- Some of Level-2 schemes were changed to Level-1.
- Sub villages excluded from the service area of Level-2 scheme were planned to supply by Level-1 schemes.

(3) Rehabilitation of Existing Water Supply Scheme

The criteria for the provision of Level-2 scheme is not satisfied in most of villages where schemes exist. Accordingly, no rehabilitation plan was provided for these villages. Rehabilitation in Matipwili is only exceptional case since there is no alternative water source for water supply other than existing protected well.

(4) Chalinze Water Supply Project Phase II

In the initial stage of this Study in 2004, the implementation of this project was not decided. However, MoWLD carried out the feasibility study and requested the necessary fund to BAEDA recently in 2005. Therefore, the project cost for the project was quoted from the feasibility study report (MOWLD, 2005).

(5) Projects related to DAWASA

The cost for the projects to be carried out by DAWASA were not estimated in this Study.

11.2.3 APPROXIMATE COST ESTIMATION

Based on the conditions and estimation bases described above, the approximate cost for Level-2 scheme was estimated at approximately 16.5 million USD including the engineering cost and soft component cost as shown in *Table 11.1*.

Table 11.1 Estimated Projects Cost for Level-2

Unit: Thousand USD

District/ Municipality	Village/Mitaa	Intake	Transmission Line	Storage Tank	Distribution Line	Total
Bagamoyo	Kibindu	262.2	33.0	51.8	152.6	499.6
	Kwanduma	252.8	20.0	36.0	62.6	371.4
	Matipwili	427.1	7.0	77.5	45.6	557.2
Kibaha	Minaji Mikinda	80.7	1.0	77.5	38.2	197.4
	Kitomondo/Minaji Mikinda	80.7	1.0	77.5	146.8	306.0
Kisarawe	Msimbu	213.4	84.0	36.0	284.1	617.5
	Chole	234.6	80.0	38.4	237.8	590.8
Mkuranga	Mwandege /Kipala	88.3	1.0	86.1	194.8	370.2
	Kisemvule	176.6	14.0	38.4	218.2	447.2
	Marogoro /Mfuru Mwambao	80.7	1.0	77.1	218.9	377.7
	Vianzi	93.9	2.0	86.1	142.5	324.5
	Njopeka	102.2	50.0	43.4	302.4	498.0
Ilala	Kitunda-1	192.3	5.0	112.0	148.1	457.4
	Kitunda-2	100.8	1.0	86.1	162.7	350.6
	Mzinga	214.2	6.0	131.5	199.2	550.9
	Msongala	96.2	2.0	77.5	146.2	321.9
	Pugu Station	104.0	22.0	36.0	61.2	223.2
Kinondoni	Matosa	111.4	34.0	86.1	97.0	328.5
Temeke	Yaleyale Puna	107.1	101.0	116.8	244.7	569.6
	Tundwi Songani	176.6	57.0	77.5	170.2	481.3
	Mjimwema	88.6	1.0	90.7	119.6	299.9
	Kibugumo	80.7	2.0	83.9	113.4	280.0
Sub Total		3,365.1	525.0	1,623.9	3,506.8	9,020.8
Transportation Cost						186.1
Skilled Worker						238.5
Total (Direct Cost)						9,445.4
Indirect Cost						4,533.9
Construction Total (Direct Cost+Indirect Cost)						**13,979.3**
Engineering Cost						2,096.9
Soft Component						419.4
Grand Total						**16,495.6**

In case of Level-1 scheme, the cost is composed of the drilling cost, installation of casing/screen pipes, pumping test and accessories (such as apron, sawkway pit, etc). The unit cost for one scheme is estimated at 17,400 USD. Therefore, the total construction cost for the whole Level-1 scheme is 17,400 (USD/well) x 607 (well) = 10,561,800 USD (approximately 10.6 million USD). The total implementation cost for Level-1 is approximately 12.2 million USD including engineering cost (15 % of construction cost).

There are piped schemes (Level-2), which no longer in operation due to various reasons. Rehabilitation cost for these existing scheme was once estimated in the Study, however, the criteria for the provision of Level-2 scheme is not satisfied in most of villages where these schemes exist. Accordingly, the schemes for such villages were changed to Level-1 schemes. The scheme in Saadani, Bagamoyo District is exceptinally proposed to be rehabilitated because there is no alternative water sources. Therefore, rehabilitation cost is required only this scheme.

The implementation of extension of Chalinze Water Supply Scheme (Phase II) was not decided during the initial stage of this Study. During the cource of the Study, MoWLD has decided to implement the project and its cost is estimated at aproximately 9.3 million USD only recently (MoWLD, 2005).

As for the extension of DAWASA water supply and schemes to be imlemented under CWWSP by DAWASA, the implementation costs were not estimated in this Study.

The total cost for implementation of projects proposed in this Study is summarized in *Table 11.2*.

Table 11.2 Summary of Projects Cost

Unit: million USD

Type of Scheme	Construction Cost	Engineering Service (15%)	Administration Cost (3%)	Physical Contingency (10%)	Total	Note
Level-2 (Priority Project)	13,979.3	2,516.3	-	-	16,495.6	22 schemes (Priority Project)
Level-1	10,561.8	1,584.3	316.9	1,056.2	13,519.2	607 schemes
Rehabilitation	181.2	27.2	5.4	18.1	231.9	1 scheme
Chalinze (Phase II)	7,546.9	754.7	226.4	754.7	9,282.7	42 villages
Total	32,269.2	4,882.5	548.7	1,829.0	39,529.4	

Note: (1) Administration cost and physical contingency are not included in Level-2 project because its implementation is expected as Japanese Grant Aid Project.
(2) Engineering Service cost for Level-2 wad added about 3% of construction cost for soft conponent.
(3) Engineering Service cost for Chalinze Water Supply Project Phase II is 10 % of the construction cost.

11.3 IMPLEMENTATION PLAN

The implementation plan for the proposed projects in this Study shall be in concordance with Tanzania's national plans and strategies. The government of Tanzania prepared "The Tanzania Development Vision 2005" (Planning Commission, 1998). This is the stem of the framework for water sector policy, strategy and financial planning and the target of it is "Universal access to safe water" by the year 2025. This target was developed in "National Water Poliicy" (MoWLD, 2002). One of the target of the policy was to establish a protected, year-round potable water supply of 25 liter/capita/day through water points located within 400 m from the furthest homestead in rural areas. The Revised Poverty Reduction Strategy set out to raise the water supply level from 53 % in the year 2003 to 65% by the year 2009 (MoWLD, 2004).

Following external support will be expected in the Study area (*Table 11.3*).

Table 11.3 Expected Projects in the Study Area

(As of August 2005)

No.	Project	Implementation Agency	Donor	Status
1	Priority Project (Level-2)	MoWLD	Japan	Request
2	Chalinze Water Supply Project (Phase II)	MoWLD	BAEDA	Appraisal was concluded
3	Mkuranga Water, Hygiene and Sanitation Project	AMREF	EU	Request
4	Community Water Supply and Sanitation Project (CWSSP)	DAWASA	WB	Ongoing
5	Extension of Distribution System	DAWASA	WB	Ongoing

MoWLD has submitted the request on the implementation of the priority project to the government of Japan. It is expected to be commenced in 2006, provided it is accepted. Chalinze Water Supply Project Phase II will be carried out by MoWLD using the fund from BAEDA in 2006 and 2007. The first phase of Mkuranga Water, Hygiene and Sanitation Project was started in 2001 and will be completed in 2005 by AMREF, providing 138 tube wells and protected wells. AMREF is going to start the second phase of the project in 2006. The request for the fund was submitted to EU in June 2005. If this project and the priority project are implemented , water supply service will cover all the villages in Mkuranga District. DAWASA has an intension to provide water supply serivice in all the Mitaas in Dar es Salaam Region. It depends on the availability of water sources. DAWASA will start the study on deep groundwater in Dar es Salaam and Coast Regions in 2005. DAWASA is currently carrying out CWSSP in Dar es Salaam Region. The project targets to provide water supply schemes to approximately 30 communities.

In the Study area, the target of 53 % of water suply in 2003 (Poverty Reduction Storategy Paper, 2000) was not attained. As mentioned above, the Revised Poverty Reduction Strategy (2004) set a new target to attain the water supply service level to 65% till 2009. In order to correspond to this target, following preconditions were considered in formulating the implementation of the proposed projects in this Study.

(1) The priority project (Level-2) will be completed by the year 2008.

(2) Expansion of Chalinze Water Supply Scheme will be completed in 2007 (MoWLD, 2005)

(3) Expansion of DAWASA water supply scheme and CWWSP in Dar es Salaam Region will be completed in 2008.

(4) Mkuranga Water, Hyegine and Sanitation Project (2^{nd} Phase) will be commenced in 2006 and completed in 2010, which was requested to EU for funding by AMREF in June 2005. This project is carried out independently from MoWLD and basically will provide Level-1 schemes. If this project is implemented, additional need for the total number of Level-1 in the Study area other than Mkuranga District will be reduced to 370 schemes. The project cost for Level-1 will be reduced from USD 12.1 Million to USD 7.1 milllion.

(5) The Level-1 project will be started just after the completion of the priority project and will be completed by the year 2015, the target year of the Study.

If the projects are implemented as planned in *Table 11.4*, the service population will rise to 158.8 thousand persons (66.9%) in 2009 and 945.2 thousand persons (68.1 %)in 2015. These projection will satisfy the target of the revised Poverty Reduction Strateg as shown in *Table 11.5*. In *Table 11.3*, service population by Level-1 scheme is separated into two projects, Mkuranga Water, Hygiene and Sanitation Project and other.

Considering these situations mentioned above, the implemetationt schedule is planned as shown in *Table 11.4.*

Table 11.4 Implementation Schedule for Priority Project

District/Municipality	2006	2007	2008	2009	2010
Bagamoyo	←	→			
Kibaha	←	→			
Kisarawe	←	→			
Mkuranga		←	→		
Ilala			←	→	
Kinondoni		←	→		
Temeke			←	→	

Increase in service population by implementation of projects proposed in the water supply plan is summarized in *Table 11.5*. The service populations are estimated based on the following conditions.

- The priority project is implemented in three years from 2006 to 2008 and the water supply service starts in each year of construction.

- The construction of Level-1 scheme starts just after the completion of the priority project in 2009 except Mkuranga District. The number of schemes to be constructed is evenly allocated to every Districts and Municipalities in every year.
- Level-1 schemes in Mkuranga are constructed by AMREF within five years from 2006 in the same manner as other Level-1 schemes above.
- Chalinze Water Supply Project Phase II starts its service in 2007.
- Rehabilitation of existing water supply scheme is carried out in 2009*.
- The service population of DAWASA is allocated evenly in each year.

Table 11.5 Increase in Water Supply Population up to 2015

Unit: population

Year / Project	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Priority Project (Level-2)	19,048	34,930	61,930	64,017	66,184	68,436	70,777	73,211	75,739	78,352
Chalinze (Phase II)		108,814	111,160	113,558	116,010	118,517	121,081	123,703	126,383	129,125
Level-1				77,231	78,885	80,586	82,335	84,133	85,983	87,886
Rehabilitation				1,544	1,575	1,607	1,639	1,671	1,705	1,739
Mkuranga	8,506	17,608	27,336	37,724	48,805	50,513	52,281	54,111	56,005	57,965
DAWASA	131,234	274,541	430,755	450,570	471,296	492,976	515,652	539,372	564,184	590,136
Total Supply Population	158,788	435,893	631,181	744,643	782,755	812,635	843,765	876,201	909,999	945,203
Water Supply Rate (%)	15.9	42.1	58.8	66.9	67.8	67.8	67.9	68.0	68.0	68.1
Total Population	998,165	1,034,997	1,073,302	1,113,148	1,154,588	1,197,706	1,242,554	1,289,235	1,337,800	1,388,328

11.4 FINANCIAL PLAN

Table 11.6 indicates the governmental budget both internal and external financing allocated for the development of water and livestock sectors, with its sub-sectors, for four fiscal years (i.e. 2002/03, 03/04, 04/05 and 05/06), along with percentage with respect to each internal and external budget. Steep rise budget during the period can be observed. Here sharp increase in budget for Urban Water Supply and Sewerage sub-sector is considerable, of which internal budget amount to 91 percent and 63 percent in fiscal year of 2005/06 and 2004/05, and 2003/04, respectively. As for the Rural Water Supply sub-sector, the budget amount was rather stable in a range of approximately USD 1.04 to 1.43 million from 2002/03 to 2004/05, however, it remarkably increased up to USD 3.16 million in 2005/06: It shows a 248 % increase over the previous year's.

It shall also be noted that the 2005/2006 budget prepared by MoWLD, for instance, amounts to USD 66.86 million as internal fund and a considerable amount of USD 50.49 million as external fund. Thus, it is obvious that the sector calls for the external funding for its development.

Table 11.6 Development Budget for Water and Livestock Sector during the Past Four Years

Unit: 1000 USD

Items	2002/2003 Budget				2003/2004 Budget				2004/2005 Budget				2005/2006 Budget			
	Internal	%	External	%	Internal	%	External	%	Internal	%	External	%	Internal	%	External	%
Research, Planning and Training	955.0	27	2,888.6	9	752.0	11	4,469.3	11	698.0	2	3,845.1	6	1,725.7	3	2,975.2	6
Urban Water Supply and Sewerage	1,075.9	30	17,904.3	55	4,285.7	60	12,368.6	31	27,033.3	91	42,000.9	60	60,573.3	91	22,027.2	44
Rural Water Supply	1,038.8	29	7,861.4	24	1,425.5	20	17,888.2	44	1,271.4	4	21,953.8	31	3,156.2	5	24,860.2	49
Veterinary Services	373.3	10	1,069.3	3	268.5	4	938.6	2	271.4	1	840.9	1	601.0	1	623.0	1
Animal Construction	153.9	4	2,746.1	8	418.7	6	4,663.2	12	437.1	1	1,238.1	2	807.6	1	-	0
Total	3,597.0	100	32,469.8	100	7,150.4	100	40,327.9	100	29,711.3	100	69,878.7	100	66,863.8	100	50,485.7	100
Grand Total	36,067				47,478				99,590				117,350			

Source: MoWLD, Proposed Annual Budget 2005/06, 2004/05 and 2003/04

Categorizing the Water Supply Plan prepared by the Study into the development of rural water supply, internal development budget for the rural water sub-sector is overviewed in order to assess its feasibility in a financial viewpoint. *Table 11.7* presents the trend of the development budget for rural

water supply in the past three fiscal years. The table also indicates the development budget allocated for the Study area, Coast and Dar es Salaam Region, for the four fiscal years.

Table 11.7 Development Budget for Rural Water Supply in Four Years

(Unit: USD)

Item	2002/2003				2003/2004				2004/2005		2005/2006	
	Budget		Fund Released		Budget		Fund Released		Budget		Budget	
	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External	Internal	External
Expansion of Rural Water Supply	195.2	3,914.5	47.6	-	466.7	5,400.0	270.7	-	352.4	3,899.0	774.3	5,803.6
Rehabilitation of Rural Water Supply	224.8	1,889.8	224.8	1,160.3	349.3	3,023.2	257.1	1,876.4	281.0	6,546.9	617.1	51.4
Borehole Drinking and Dam Construction	361.7	-	87.6	-	285.7	-	285.7	-	285.7	-	642.9	-
Rural Water Supply and Sanitation Project	71.4	2,057.1	-	-	57.1	9,465.0	-	-	57.1	9,655.4	476.2	19,005.1
Strengthening DDCA	157.1	-	79.0	-	266.7	-	266.7	-	295.2	-	645.7	-
TOTAL	**1,038.8**	**7,861.4**	**283.8**	**1,160.3**	**1,425.5**	**17,888.2**	**1,137.3**	**1,876.4**	**1,271.4**	**21,953.8**	**3,156.2**	**24,860.2**
Budget Allocated for Dar es Salaam and Coast Reagion	N.A	N.A.			85,714	-			85,714	-		-

Source: MoWLD, Proposed Annual Budget 2005/06, 2004/05 and 2003/04

As could be observed, the increase of this sub-sector development fund is rather stable and static. On the other hand, the implementation cost of the Water Supply Plan prepared by the Study is estimated at USD approximately USD 37.97 million. The priority project is planned to be implemented in five years from 2006 to 2010 and the implementation cost requires approximately USD 7.6 million/year in average. It is more than twice of the internal amount of the development budget allocated for the rural water supply sector in 2005/06. Furthermore, observing the limited budget allocation for the Study area of Coast and Dar es Salaam Regions amounting to approximately USD 86,000 for both the fiscal year of 2003/04 and 2004/05, financial capability of the government for the implementation of the Water Supply Plan prepared under the Study is seemed rather lacking. Thus, it is rather apparent that the implementation of the Plan requires additional grants from External Supporting Agencies (ESAs), such as donor agencies and NGOs.

11.5 ANNUAL DISBURSEMENT SCHEDULE

In order to raise the water supply level to 65 % by the year 2009, the projects shall be implemented as planned in *Table 11.3*. Taking this condition into consideration, the disbursement schedule is planned as shown in *Tabl 11.8*. The project period for Level-1 scheme is planned for five years from 2011 to 2015. The costs for Chalinze Water Supply Project Phase II and Mkuranga Water, Hygiene and Sanitation Project are excluded from the disbursement schedule of this Study because they are planned independent from this Study.

Table 11.8 Annual Disbursement Schedule

Unit: thousand USD

Project No.	Project		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
1	Piped Water Supply Scheme (Level-2)	Engineering	875.9	654.4	986.0								2,516.3
		Construction	4,865.8	3,635.7	5,477.8								13,979.3
		Sub-Total	5,741.7	4,290.1	6,463.8								16,495.6
2	Hand Pump (Level-1)	Engineering				138.0	138.0	138.0	138.0	138.0	138.0	138.0	965.7
		Construction				919.7	919.7	919.7	919.7	919.7	919.7	919.7	6,438.0
		Sub-Total				1,057.7	1,057.7	1,057.7	1,057.7	1,057.7	1,057.7	1,057.7	7,403.7
3	Rehabilitation	Engineering				27.2							27.2
		Construction				204.7							204.7
		Sub-Total				231.9							231.9

Note: (1) Engineering cost includes Detailed Design and construction supervision and is evenly allocated in eac year according to the construction cost.
(2) Engineering cost is evenly allocated to the project periods.
(3) The cost for Level-1 excludes the cost in Mkuranga District.

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Chapter 12

Environmental and Social Considerations

CHAPTER 12 ENVIRONEMNTAL AND SOCIAL CONSIDERATIONS

12.1 SETTINGS TO THE ENVIRONMENTAL AND SOCIAL CONSIDERATIONS IN THE STUDY

As concern has grown widely on environmental degradation and threat over the decade in the world, it is crucial to integrate environmental consideration into mainstream of development for human well-being and economic development in a sustainable manner. Apparently, precautionary, anticipatory and preventive approaches are the most effective and economical measures in achieving environmentally sound development.

JICA has been involved in various development projects in many countries as a leading technical cooperation agency and has fully made an effort to take into account environmental consideration to projects in accordance with "JICA Environmental Guideline for Infrastructures" since 1990. From these valuable experiences JICA amended "JICA Guideline for Environmental and Social Considerations in April 2004, which aims to achieve an appropriate decision-making process and ensure stakeholders participation, information transparency, accountability, efficiency and human rights for development. The amended guideline innovatively highlights the importance of consultation with local stakeholders at adequate stages, and minimizing impact on social change and mitigating any resistance, such as involuntary resettlement, affecting local economy including employment and livelihood condition, vulnerable social groups such as the poor and indigenous people, distribution of benefits and losses and equity in the development process gender and children's rights and local conflict caused by different interests as well as environmental influence to air, water, soil, waste, caused accidents by interventions etc. (JICA 2004).

Under these circumstances, preparatory study was carried out to determine the necessity environmental and social considerations in this full-scale Study. The results of rapid screening and scooping of key issues for environmental and social considerations in the preparatory study revealed essential factors, which require further investigation through Initial Environmental Examination (IEE). In general, IEE is equivalent to Preliminary Assessment which is commonly used in "Tanzanian Environmental Impact Assessment (EIA) Procedure and Guideline" to judge if it is necessary to conduct a full EIA or if the identified impacts can be mitigated or reduce to insignificant levels. As a result of the IEE, the Study added to conduct a supplemental indicator survey for monitoring in priority projects, which is practically help to develop knowledge and techniques of counterpart personnel monitoring on environmental and social considerations for further implementation stage.

12.2 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK OF TANZANIA

12.2.1 NATIONAL POLICIES IN TANZANIA

For the implementation of the Study, national policies in Tanzania, such as National Environmental Policy, National Water Policy, Forest Policy are examined in this section.

(1) National Environmental Policy

The National Environmental Policy was formulated in December 1997 as a framework which brings environmental consideration into the mainstream of decision-making for appropriate environmental management and improvement of quality of life. The policy provides guidance to the determination of actions, monitoring and regular reviews of plans and programs on environmental management for sustainable development. It includes sectoral and cross-sectoral policy for achievement of compatibility among related sectors and interest groups. It varies widely from addressing poverty, demographic dynamics, land tenure, biodiversity, public participation and education, the private sector and NGOs, role of women, agriculture, livestock, water and sanitation, health, transport, industry, tourism and wildlife etc. (Vice President's Office 1997).

In the environmental policy, the following factors are considered as priority policy instruments.

- Environmental Impact Assessment: to allow maximization of long time benefits of development while maintaining the natural resource base
- Environmental Legislation: to implement the regulatory elements of policy objectives, including the "polluter pays" principle in some case.
- Economic Instruments: these can be incentives through pricing, taxation and subsidies or in some cases can use the "polluter pays" principle.
- Environmental Indications and Standards: monitoring of pollution and setting national guideline for control.

Moreover, the policy addresses to avoid unnecessary damage to environment by assessing the adverse impact of any project through EIA process. In sectors such as industry, tourism and wildlife, application of EIA study is encouraged in order to minimize potentially harmful activities on the environment, and for careful assessment of natural heritage in flora and fauna fragile ecosystems and sites under pressure, and in wildlife conservation areas (Ministry of Tourism, Natural Resources and Environment 1994).

(2) National Water Policy of 2002

The National Water Policy, which was revised in 2002 so as to develop a comprehensive framework for sustainable development and management of Nation's water. It addresses cross-sectoral interests in water, watershed management and integrated and participatory approach for water resource planning, development in the changing roles of the Government from service provider to that of coordination, policy and guideline formulation and regulation. In section 4.1.1, Water is defined as a " common use resource" which means every Tanzanian has right to have access to adequate quantity and quality of water. The section 4.4.1 prescribe the importance of water resource assessment, which refers to all sector-wide basin and national level comprehensive collection and assembly of information on the quality, quality, character, location and patterns of use and user demands, pollution and water quality degradation process (Ministry of Water and Livestock Development 2002).

(3) National Forest Policy of 1998

The policy prescribed EIA as a planning tool used to integrate environmental consideration in the decision – making process to ensure that unnecessary damage can be avoided in the section 1.1. It stipulated that EIA would be required for the investment which convert forest land to other use or development which may cause potential damage to the forest environment. In this policy, investment and development activities defined as forest industries, mining, road construction, agriculture, dams, and settlements shrimp farming and tourism requires a full EIA (Ministry of Tourism, Natural Resources and Environment 1998).

12.2.2 LEGAL FRAMEWORK

Overall of context of legal frameworks related to environment management, which includes "National Environmental Management Council Act, 2004", "The Forest Act, 2002", "The Wildlife Conservation Act 1974", "National Strategy for Growth and Reduction of Poverty (NSGRP), "Vulnerability and Resilience to Poverty in Tanzania: Causes, Consequences and policy implications" are illustrated in this sub section.

(1) National Environmental Management, 2004

The act established National Environmental Management Council (NEMC) as a statutory body in its advisory role to the Ministry of Natural Resource and Tourism (MoNRT). "The NEMC is responsible for developing the enabling context for the implantation of plan, particularly in monitoring environmental problems and developing the information system relevant both for problem definition and for policy and strategy refinement overtime." (Ministry of Tourism, Natural Resources and Environment 1994). As a practical advisory body which approves EIA

process, NEMC developed and published "Tanzania Environmental Impact Assessment Procedure and Guidelines".

(2) The Forest Act, 2002

The act established forest management plan, forest reserve, and conservation of trees, wild plants and animals. It stipulates "a national forest reserve may consist of a production forest reserve, a protection forest reserve, and a nature forest reserve for the purpose of production, protection and a nature forest reserve". For development in a forest reserve and private forest sensitive area, consideration and approval of EIA process are required. (Mkapa 2002).

(3) The Wildlife Conservation Act 1974

This is "an act to repeal and replace the Fauna Conservation Ordinance, to make provision for the protection, conservation, development, regulation and control of fauna and flora products. The act established "Conservation Area such as, a) "Game Reserve" which is declared by the president as any area of Tanganyika, b) a National Park established under the National Park Ordinance, c) the Ngorongoro Conservation area established by the Ngorongoro Conservation Area Ordinance and d) a Forest Reserve established under Forests Ordinance. And it regulated protection of vegetation in game reserves by prohibiting willfully or negligently cause any bush or grass fire, or fell, cut, burn, injure or remove any standing tree, shrub, bush, sapling, seedling or any part thereof in a game reserve except by and in accordance with the written permission previously sought and obtained from the Director (Nyererb 1974).

(4) Vulnerability and Resilience to Poverty in Tanzania: Causes, Consequences and Policy Implications, 2002/03 Tanzania Participatory Poverty Assessment (TZPPA)

The document provides undertaking Tanzania Participatory Poverty Assessment, which focused on issues of vulnerability. It provides qualitative information and insights as pointed out by community. And the findings supplement the results obtained through undertaking within the context of the Poverty Monitoring System (Vice President's Office, 2004).

(5) National Strategy for Growth and Reduction of Poverty (NSGRP)

"This is the second organizing framework for putting the focus on poverty reduction on the country's development agenda. The NSGRP is informed by the aspiration of Tanzanian's Development Vision for high and shared growth, high quality livelihood, peace, stability and unity good governance, high quality education and international competitive. It is committed to the Millennium Development Goals (MDGs), as international agreed targeted for reducing poverty, hunger, diseases, illiteracy, environmental degradation and discrimination against women by 2015." (Vice President's Office, 2005).

12.2.3 ENVIRONMENTAL IMPACT ASSESSMENT IN TANZANIA

(1) The needs of EIA

Economic welfare and maximization of profit approach for economic development in Tanzania, which had not taken account of environmental concern, resulted in land degradation, pollution of water sources etc. From these past experiences, Tanzania have put into place strategically environment management into her development agenda, considering the effective role of EIA. The EIA is considered as a planning tool which provides mitigations or alternatives of adverse effects of development interventions (projects, policies, programs or activities). As an advisory body in environmental management under Ministry of Natural Resources and Tourism (MoNRT), NEMC was set up, which supervise, practically EIA process, its review and approval of EIA (NEMC 2002).

(2) Tanzania EIA Procedure and Guidelines

The procedures and guidelines of Tanzania are organized totally five volumes.

- Volume 1 : General EIA Guidelines and Procedure

- Volume 2 : Screening and Scoping Guidelines
- Volume 3 : Report Writing Guidelines and Requirements
- Volume 4 : Review and Monitoring Guidelines
- Volume 5 : General Check List of Environmental Characteristics

(3) EIA Process

The EIA in Tanzania follows key steps: 1) registration, 2) screening, 3) impact assessment, 4) review, 5) implementation, 6) monitoring, 7) auditing and decommissioning. *Figure 12.1* shows EIA process combined with Tanzanian and JICA guidelines

In the EIA process in Tanzania, screening is done by NEMC whether EIA is required, or not required, or preliminary assessment, which is equivalent to IEE, is not required. After these reviews, NEMC give advice if EIA is required or not in terms of the project location, techniques to utilized, scale, and other factors.

12.3 INITIAL ENVIRONMENTAL EXAMINATION

12.3.1 APPROACH TOWARD INITIAL ENVIRONMENTAL EXAMINATION (IEE)

The amended JICA guideline stipulates that "JICA encourages the recipient governments by conducting cooperation activities to implement appropriate measures for environmental and social considerations, and at the same time, JICA gives support for and examination of environmental and social considerations according to the guideline"(JICA 2004).

In response to the guideline, at the Stage II of the Study, Tanzanian counterpart personnel in charge of environmental and social considerations initially examines measures for environmental and social consideration regarding water supply plan proposed in the Study, which is technically supported by the expert of the Study Team. The IEE includes "analysis of alternative plans, prediction and assessment of environmental adverse impacts, and preparation of mitigation measures on the basis of secondary data and simple survey"(JICA 2004).

In deed, the first meeting with Tanzanian counterpart personnel was held soon after to identify issues on environmental and social consideration, types of analysis, reviews, sources of relevant information and expertise, dividing responsibilities and scheduling for conducting the IEE. During entire IEE process, the Tanzanian counterpart and the JICA Study Team expert actively worked together and contributed to the achieving IEE objectives.

12.3.2 OBJECTIVES OF THE IEE IN THE STUDY

Ultimate Objective

- To examine potential environmental and social impacts of the water supply plan if the plan may result in adverse environmental and social impacts which require future detail environmental impact assessment (EIA) for priority projects at the Stage III

General Objectives

- To understand current environmental and social conditions as an baseline
- To identify environmental and social impacts of water supply plan
- To investigate mitigation measures which minimize adverse environmental and social impacts in the Study, which resolute effective sustainable development

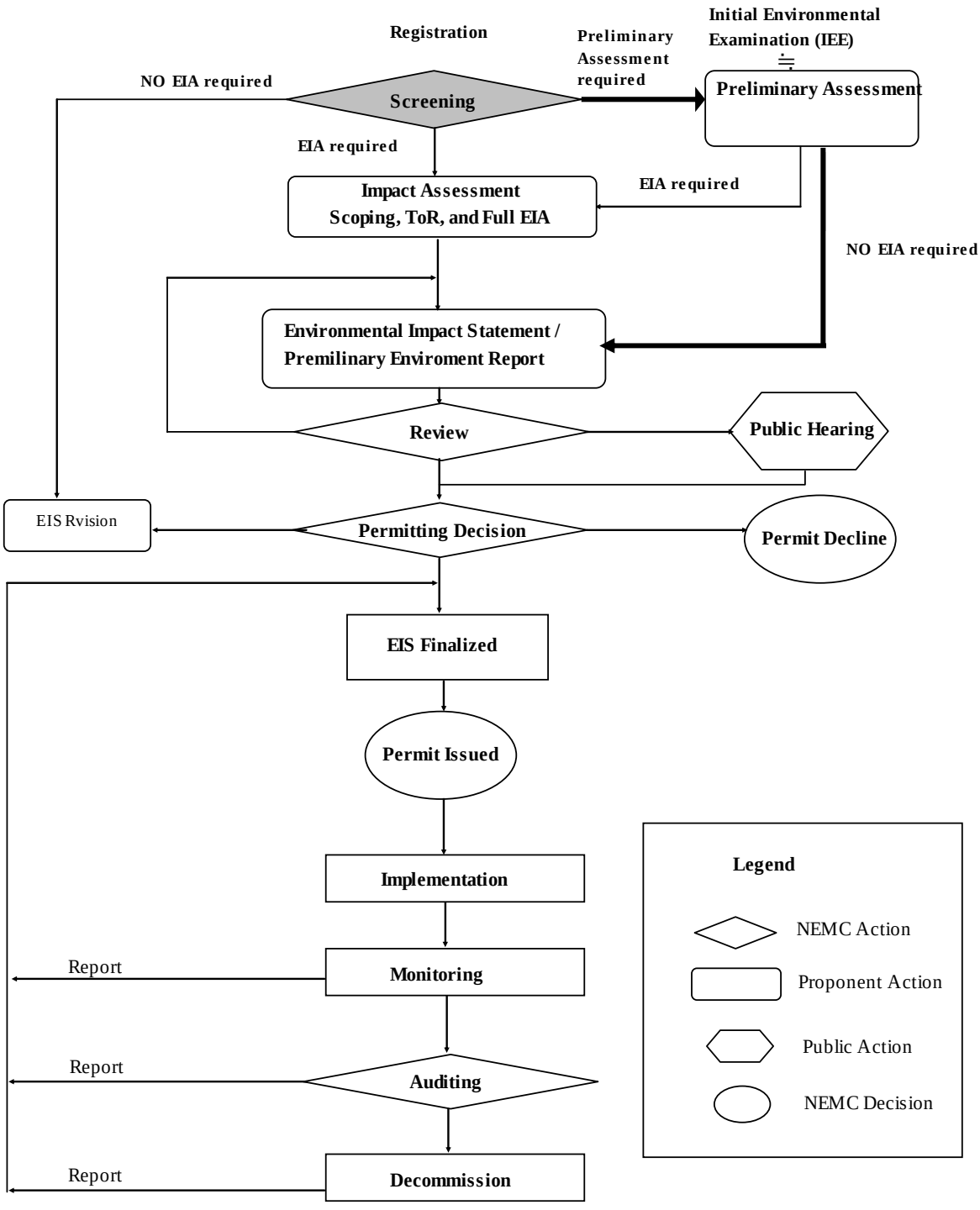

FIGURE 12.1 EIA PROCESS COMBINED WITH TANZANIA AND JICA GUIDELINES

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12.3.3 IEE PROCESS

Table 12.1 briefly illustrates the IEE process in the Study. As shown in *Table 12.2*, applicable villages for field work were chosen in terms of interests of environmental and social assessing.

Table 12.1 IEE Process

Examining Items \ Weeks	1	2	3	4
1 Literature Reviews				
Policy, Legal and Administrative Framework in	■			
Relevant Research Documents on Env.& Social	■			
2 Institutional Setting				
Contact with NEMC for IEE Process		■		
Interviews and Discussions with Related Institutions		■		
3 Examination of proposed Water Supply Plan				
Progress Report and Discussions	■	■	■	■
4 Field Work				
		■	■	■
5 Reporting				
				■

Table 12.2 Villages for Field Work

Regions	Districts/Municipality	Villages/Mittas
Coast Region	Bagamoyo	Kibindu, Kwamduma, Mbwewe, Lugoba, Matimbwa
	Kibaha	Kibaha, Zogowale
	Kisarawe	Msimbu, Chole, Kwala-Cho
	Mukuranga	Vikindu, Hoyoyo, Mbezi-Gongoni
Dar es Salaam Region	Ilala	Tabata
	Kinondoni	Msumi
	Temeke	Vijibweni, Kisiwani

(1) Assumptions

The IEE at the planning stage of the Study was applied based on proposed "outline of water supply plan completed stage II not water supply plan itself following the fixed schedule. Therefore, it cannot deny that IEE was done under restricted study conditions in which some analyses were still kept going on and some key data were missed at that time. The major assumption of the IEE in this Study is that all required information reflected the outline of the water supply plan so that it will not change much as it is. In addition, determination of criteria for priority projects and its selection were under processing as well, so that existing elements of the planning stage may change at the implementation stage of priority project.

(2) Limitation

The IEE activities were appointed within less than 4 weeks including preparation, collecting relevant information for literature review, sites visits and reporting etc. Time availability is extremely limited.

12.3.4 OUTLINE OF WATER SUPPLY PLAN

Outline of water supply plan was prepared for the target villages, which were classified due to type of water supply scheme and water source. For more details refers to Chapter 11.

12.3.5 DESCRIPTIONS OF THE ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

(1) Physical Environmental Condition

1) Topography and Geology

In north-western area in Bagamoyo, it is characterized by the plateau with 200 to 600 m high. The eastern fringe of the plateau is surrounded by generally flat hills of which height is approximately 100 to 300 m. The hilly topography is wide spread in the eastern half of the Study area. Two pairs of hills are recognized elongating in a NE-SW direction. River terraces and coastal terrace are recognized along the Wami River, the Ruvu River and the Indian Ocean. Major river systems are the Wami Rive, the Ruvu River, Kizinga River and Ngerengere River. Only the Wami and the Ruvu are the perennial rivers. The Wami River and its tributaries deeply eroded the plateau and formed steep and deep valleys. On the contrary, the Ruvu River formed wide gentle shape of valleys (JICA Study Team 2005).

In the Study area, six major geological formations such as 1) Precambrian, 2) Jurassic, 3) Cretaceous, 4) Neogene and 5) Quaternary are identified.

2) Hydrological and Metrology

Average annual total rainfall in 13 stations is shown *in Table 12.3*

Table 12.3 Average Annual Total Rainfall

Unit: mm

No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Station Name	Dar es Salaam International Airport	Kibaha agromat	Bagamoyo Salt mines	Ubena Prison	Ubena Zomozi	Kisarawa	Utete Bomani	Bagamoyo Bomani	Mandera Mission	Nghesse (Utari bridge)	Vikindu Forest	Mikula (Magogoni)	Mkuranga
Station Code	9639029	9638027	9638020	9638028	9638033	9639043	9838002	9638000	9638004	9738009	9739015	9738016	9739022
Annual Total Rainfall (mm)	1143.9	1002.3	942.4	1015.5	875.9	1529.9	849.7	983.2	992.2	921.8	1094.3	766.9	1141.3

Annual total rainfall varies greatly by the station. It ranges from 849.7 mm of Utete Bomani to 1529.9 of Kisarawe even in the Study Area. Average annual total rainfall over the Study Area is calculated at 1036.0 mm using GIS (JICA Study Team 2005).

(3) Fauna and Flora

Approximately one - third of the Tanzanian mainland is covered by woodlands, and about 13 million hectors have been set aside as permanent forest reserve. And fauna in Tanzania is notable for its remarkable variety, with 430 species and subspecies among country's more than four million wild animals. In order to protect this natural wealth, the government had set aside about 25 % of land as protected parks, game and forest reserves, and recently gazetted two national marine parks (Eldeand Tyrrell 2003).

The Study area is part of Coastal Forest of Tanzania, which is a inhabit of endemic species of 554 plants, 5 birds like *Sheppardingl Gunningl*, 3 mammal. 24 reptiles like *Rhampholeon Brevicaudatus.* (Tanzania Forest Conservation Group).

(4) Socio-Economic Condition

In this sub-section, socio-economic condition in the villages/mittas is illustrated to understand livelihood, level of economic development and general environment. For more details, refers to Chapter 5.

1) Population size

The number of population in the 278 target villages/mittas is 939,400, which consist of Coast Region Dar es salaam Region. The former region has a population of 457,442 in 215 villages while the latter region has a population of 481,958 in 61 villages/mittas. Comparing with size of village population in the two regions, there is relatively prominent tendency in population size

and the numbers. In Cost Region, small-scale of village population size with large numbers of villages comparatively exists, for example, 40 % of village population size in Kibaha ranges from between 500 and 1,000 persons in the village with relatively scattered condition, while in Dar es salaam Region of three municipalities, a large scale of village population with less numbers of villages, which means from 45 to 60 % of a village population size has more than 5,000 persons in a village.

2) Economic Activities

In Coast Region, more than 90 % of population depends on agriculture production, which has two main crops under cultivation such as food crops including paddy, maize, cassava, millets, on the other hand, cash crops are cashew nuts, cotton and coconuts. In addition, vegetables and forest products like charcoal and firewood are also one of income source in agriculture (The planning commissions Dar es Salaam and Regional Commissioner's Office Coast 1997). These agricultural products are produced mainly for local marketing as cash crops as well as for domestic subsistence. Public markets are only seen in junction of paved road, which includes small scale of petty businesses, tailors, and carpenters.

On the other hand, in Dar es Salaam, most of them are involved in the secondary and the third industries like retail activities and petty business and followed by farming. The lifestyle in Dar es Salaam has relatively been developed, particularly in downtown, large scale of public markets, bus stations, public facilities, banks, hotels, are gathered. However it cannot simply deny that the number of unemployed persons from rural area who are searching for job opportunities are obviously around.

3) Infrastructures

In the both regain, Coast and Dar es salaam, availability of power supply is limited, for example, only 11 % of communities in Coast regain receive power from the commercial line, while there is a area where no power supply connection in Dar es Salaam. On the other hand, telecommunication through mobile phone is relatively spread (JICA Study Team 2005). However, it is pretty doubtful if it had been practically used among users because of the high operation and maintenance cost.

4) Education

Due to encouraging support to enrolment to primary school, 94% of boys and 93% of girls have attended primary schools irrespective sex these days. However, the drop-out rate is also pretty high. As an example, about 40 % in Kurasini primary school in Dar es Salaam drop out after seven grades. For education level of adults, less than 10 % of female and male in cost region were completed primary school, while 17 % of female and 26% of male completed secondary school as their final education. It is necessary to mention that about 30 % of female adults in Coast Region has not been received any primary education at all. The issues of drop-out are not only the direct problem by children themselves but also reason that children are needed at home to perform duties. Most of them have to work in helping the mother in their daily work, such as fetching water and baby-sitting for their younger sisters or brothers. This phenomenon is strongly underpinned by other prevailing cultural values and norms. Many parents in rural areas lack interest or are openly hostile to the formal education of their children for reasons related to social and culture norms in general and marriage.

5) Public Health and hygiene

As for health problems in the Study area, it is the reality that a lot of diseases are commonly reported in order of the seriousness such as malaria which ranked at first, followed by diarrhea, cholera, typhoid and dysentery etc. In addition, fungus, skin and eyes diseases, which are likely to be caused by endemic disease, are also found in some villages. Regarding water – borne diseases, most respondents perceives that it results from inadequate quality of drinking water with muddy and salinity water brought from unprotected dug well, ring well and traditional well. Without better alternative water source, most of villagers responded that they cannot help take it.

In institutional setting for public health, in Kwamdoma, Kibindu, Bagamoyo, "participatory hygiene and sanitation protection program" was held by Ministry of Health last three times. And also, in Vikindu and Kumanduma, basic hygiene education is weekly provided by health centre in the district. However, it cannot be denied that the approach is underway so that effectiveness of learning followed by villagers has not been practically observed yet.

6) Water Source and Use

According to results of socio-economic survey, 53% of households in the surveyed villages depends on unprotected water source for domestic purpose including drinking, cooking and washing and the rest of them have selection to use protected water source, while productive purpose like livestock watering, gardening etc. And only 20 % of households in the surveyed villages have access to the water supply from piped schemes which are mostly communal water supply (JICA Study Team 2005). However, this dose not necessarily mean that these households are provided enough water properly. A women in Logoba showed her dissatisfaction that meter have not function correctly but stopped at 15 liter instead of 20 liter to fill water into a plastic tank. Some of villagers responded in Bagamoyo that they prefer to get water from traditional wells located near their houses in spite of having access to pipe scheme.

In terms of difficulty to get enough water, villagers in Msimbu responded that most of villagers get water only in dry season from boreholes with a certain payment while getting water from unprotected water source with free in rainy season. Thus, villagers have flexibly chosen water source depending on own preferable type of water usage and season.

12.3.6 ASSESSING ENVIRONMENTAL AND SOCIAL IMPACTS

In this section, potential environmental and social impacts, which might arise in implementation stage of the proposed water supply plan, are assessed.

First of all, *Table 12.4* shows results of screening of the preparatory study, in which some issues is clarified as Category B whose meaning is that "potential impact might happen so that further examination is necessary and considered that the impacts might be recognized as Category B during study progresses"(JICA 2004). Therefore, the IEE, particularly, focuses on these key issues, such as 1) Economic activities, 2) Water rights and rights of common, 3) Groundwater, 4) Hydrological situation, 5) Fauna and flora, 6) Land subsidence, by slightly details evaluation including field work, interviews and literature reviews. For other screening subjects, secondary data analysis is applied. In addition, *Table 12.4* includes Check List/ Exanimation Questions, which indicate practical assessing factors.

(1) Environmental Assessment

The Study investigated essential subjects in a ultimate scientific way, which properly have taken fully consideration toward formulating the water supply plan, such as 1) Meteorological and hydrological consideration, 2) Accurate understandings of geology by aerial photos and Landsat image analyses 3) Investigation of groundwater scientifically adequate approach by combination of geophysical exploration and analysis of test well groundwater in terms of yield and water quality, and quality analysis of existing water source in the Study. Following results of screening, assessments regarding 1) Groundwater, 2) Hydrological Situation, 3) Fauna and Flora and 4) Land Subsidence are presented in this sub section.

1) Groundwater

In the Study, groundwater evaluation was completed highly considering significant criteria 1) Yield, 2) Water Quality, 3) Geological Structure as profoundly explained in Chapter 9.

Potential Impact by the Water Supply Plan

As mentioned earlier, groundwater potential is considered based on sufficient scientific analysis and evaluation was done in terms of yield, user population, operation time, and water

Table 12.4 Results of Screening of Water Supply Project in the Preparatory Study and Check List for IEE

The Preparatory Study Results				The Full- Scale Study	
	Environmental Item	Description	Evaluation	Check Items / Examination Questions	IEE
Social Environment					
1	Resettlement	Resettlement due to an occupancy (transfer of rights of residence/land ownership)	C	Dose the project include large or small - scale of resettlement plan ?	○
2	Economic activities	Loss of bases of economic activities, such as land, and change of economic structure	B	Is there any influence to water vender's activities in any aspect?	●
3	Traffic and public facilities	Impacts on schools, hospitals and present traffic conditions such as the increase of traffic congestion and accidents	C	Does the Study activities affect public facilities like school hospitals ? Dose the Study activities disturb traffic or cause traffic accidents ?	○
4	Split of community	Community split due to interruption of area.	C	Dose any type of water supply system proposed include a way to disperse	○
5	Cultural property	Damage or loss of value of churches, temples, shrines, archaeological remains or other cultural assets	C	Dose the Study activities give damage or lose value of cultural property churches, temples etc.	○
6	Water rights and rights of common	Obstruction of fishing rights, water rights, rights of common property	B	Dose the Study make a plan of development of river water supply system ? In that case, what is condition of water right ? If groundwater is considered as common property, how the wells are managed in terms of ownership and e	●
7	Public health condition	Degeneration of public health and sanitary conditions due to generation of garbage and the increase of vermin	C	Dose the Study badly affect public health and sanitary condition ?	○
8	Waste	Generation of construction wastes, surplus soil and general	C	Do some activities like the drilling generate construction waste ?	○
9	Hazards (risk)	Increase in danger of landslides, cave-ins, etc.	C	Dose the Study activities cause any physical risk ?	○
Natural Environment					
10	Topography and geology	Changes of valuable topography and geology due to excavation or filling work	C	Dose the Study activates changes value of topography and geology ?	
11	Soil erosion	Topsoil erosion by rainfall after reclamation and deforestation	C	Dose the Study activates deteriorate soil erosion and deforestation ?	
12	Groundwater	Contamination caused by damage and filtrate water in excavation work and lowering of groundwater table due to overdraft	B	Dose it occur that contamination caused by damage and filtrate water in excavation work and lowering of groundwater table due to overdraft	●
13	Hydrological situation	Changes of river discharge and riverbed condition due to landfill and drainage inflow	B	Dose the Study make a plan of development of river water supply system ? In that case, dose the plan affect volume of river discharge and riverbed condition	●
14	Coastal zone	Coastal erosion and change of vegetation due to coastal reclamation and coastal changes	C	Dose the Study activities affect coastal erosion and change of vegetation ?	○
15	Fauna and flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	B	Dose the Study activities invade national parks or game reserves and affect the endangered species?	●
16	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	C	Dose the Study activities affect change of temperature, precipitation, wind by large- scale reclamation building construction ?	○
17	Landscape	Change of topography and vegetation due to reclamation. Deterioration of aesthetic harmony by structures	C	Dose the Study activities affect change of change of topography and vegetation ?	○
Pollution					
18	Air pollution	Pollution cause by exhaust gas or toxic gas from vehicles	C	Dose the Study cause air pollution ?	
19	Water pollution	Pollution cause by inflow of silt, sand and effluent from factories,	C	Dose the Study cause water pollution ?	○
20	Soil contamination	Contamination caused by dust and asphalt emulsion	C	Dose the Study cause soil pollution ?	○
21	Noise and vibration	Noise and vibration generated by vehicles	C	Dose the Study cause noise ?	○
22	Land subsidence	Deformation of land and land subsidence due to the lowering of groundwater table	B	Dose the Study activities and, moreover, the proposed water supply plan cause deformation of land or subsidence ?	●
23	Offensive odor	Generation of exhaust gas and offensive odor by facility construction and operations	C	Dose the Study cause exhaust gas and offensive odor by facility construction and operations	○
		Overall evaluation:			

Note 1: Evaluation categories:
A: Serious impact is expected
B: Potential impact might happen or extent of impact is unknown.
C: No impact is expected. IEE/EIA is not necessary.

IEE Approach
●: Slightly details evaluation : Site visit and Interviews and Literature reviews
○: Secondary data analysis :Literature reviews , Interviews as IEE

quality enough. Therefore, no adverse impact is directly anticipating.

Follow-Up Activity

Groundwater condition is largely affected local condition. Therefore, periodical monitoring quantity of water in aquifers and fluctuation of water table are effective measures to prevent any risk. Objectives of the monitoring are follows;

- To keep the yield within that of proposed production well
- To grasp of groundwater condition such as water table level and groundwater quality by a periodical monitoring.

And key parameters for the monitoring and observation are;

a. Groundwater recharge potential:

   The estimated groundwater recharges potential in the Study area.

b. Population in the study area:

   Actual population who consume water in the Study area

c. Number of existing tube wells and locations:

Appropriate numbers of wells and the distance between the existing wells and production wells are considered in the Study because the water level might be depressed by the pumping of multiple wells.

2) Land Subsidence

Subsidence is defined as phenomena “cased by water draining from the pores in underground strata, causing the rock to compact”(UNEP 1996). As one of the main reasons, over - abstraction leads to land subsidence caused by falling water table.

Potential Impact

The yield of groundwater in the water supply plan is determined within the limited exploitable capacity in the area. Therefore, the groundwater yield would never bring about land subsidence and damage the existing groundwater level.

Follow-Up Activity

The basic activities are same as 1) Groundwater mentioned above.

3) Hydrological Situation

A potential amount and appropriate area for surface water development was analyzed for the purpose of providing basic information as a source of water supply.

Current Condition

The mainstreams of the Wami, Ruvu and the Kizinga are confirmed as perennial river in the Study area. Actually intake is conducted from the other rivers, however, these are not proper for stable water supply source because of drying up seasonally.

Potential Impact by Water Supply Plan

As shown in Chapter 11, full analysis of “Potential Amount and Area of Surface Water Development” in the Study, proved positive impact, which shows improvement of current condition and giving important recommendations for formulation of the water supply plan in terms of techniques and decision-making;

- The Wami River has enough potential for development in which total amount of 5.003 m^3/s is considered as a potential amount of surface water development.
- The Kizinga River is impossible to develop the surface water newly, because an actual intake amount is beyond the available discharge.
- As for the Ruvu River, available discharge is over the maintenance flow discharge, since

the actual total intake amount is less than available discharge. However, surface water development is considered to be possible if priority of surface water development is put up than maintenance flow. In such case, total amount of 2.197 and 2.207 m^3/s is considered as a potential amount of surface water development of upstream and downstream of Ruvu Bridge, respectively, taking into account of actual intake amount within the Study Area. At the same time, further surface water development is not recommended after all from the view of river maintenance.

Follow – Up Activity

For the maintenance flow of a river, multidiscipline monitoring approach for navigation, fishing, picturesque scenery, salt water intrusion, clogging of river mouth, riparian structures, groundwater table, flora and fauna, and river water quality are efficient for sustainable ecology.

4) Water Rights and Right of Common

Current Condition

For domestic water supply, industrial use and irrigation, intake of surface water and groundwater are considered from various points.

For rivers, the inventory of water right in the Wami and Ruvu rivers reveal current management condition as following rules. For example, "status of permit" indicates the present condition of water right, and "Application" means water right is under deliberation, "Provisional" means water right is provisionally permitted and consultation is needed after several years, "Final" means water right is permitted (JICA Study Team 2005).

For groundwater well inventory survey in Chapter 7 that indicates variety of owners rage from private, community, DAWASA, national and international NGOs etc. Abut water venders it described as details later on. They are informally involved in these activities, individually, and even water company selling groundwater has not managed under MoWLD.

Potential Impact

There would not be any miner change of river discharge and riverbed condition. This is because water right of these rivers in the water supply schemes will affect water rights documents according to what they are going to use as water demand to the population as per design. The water rights would only allow reasonable amount of water to be drown from the river. So that it would not affect the downstream dependent of the river.

5) Fauna and Flora

Current Condition

Figure 12.2 shows location of protection areas, such as National Park, Game and Forest Reserve, target villages and test wells. Any of target villages is not seriously included in these protected areas.

Potential Impacts

As shown in *Figure 12.2* all test wells are not located inside of these protected areas. During drilling construction, considerations on environment were thought by engineers, therefore, it was reported nothing affecting any surroundings. Even from villagers responded in the target are that there never happened air pollution or noise and bad influence on fauna and flora because of this activity. Regarding priority villages, there will be no negative impact on fauna and flora since the potential impact to environment in the Study is never beyond regenerative capability of fauna and flora in terms of the Study scale, location, and technique to use and without endemic spices.

Follow – Up Activity

Communicating with related institutions such as department of wildlife, forest and beekeeping,

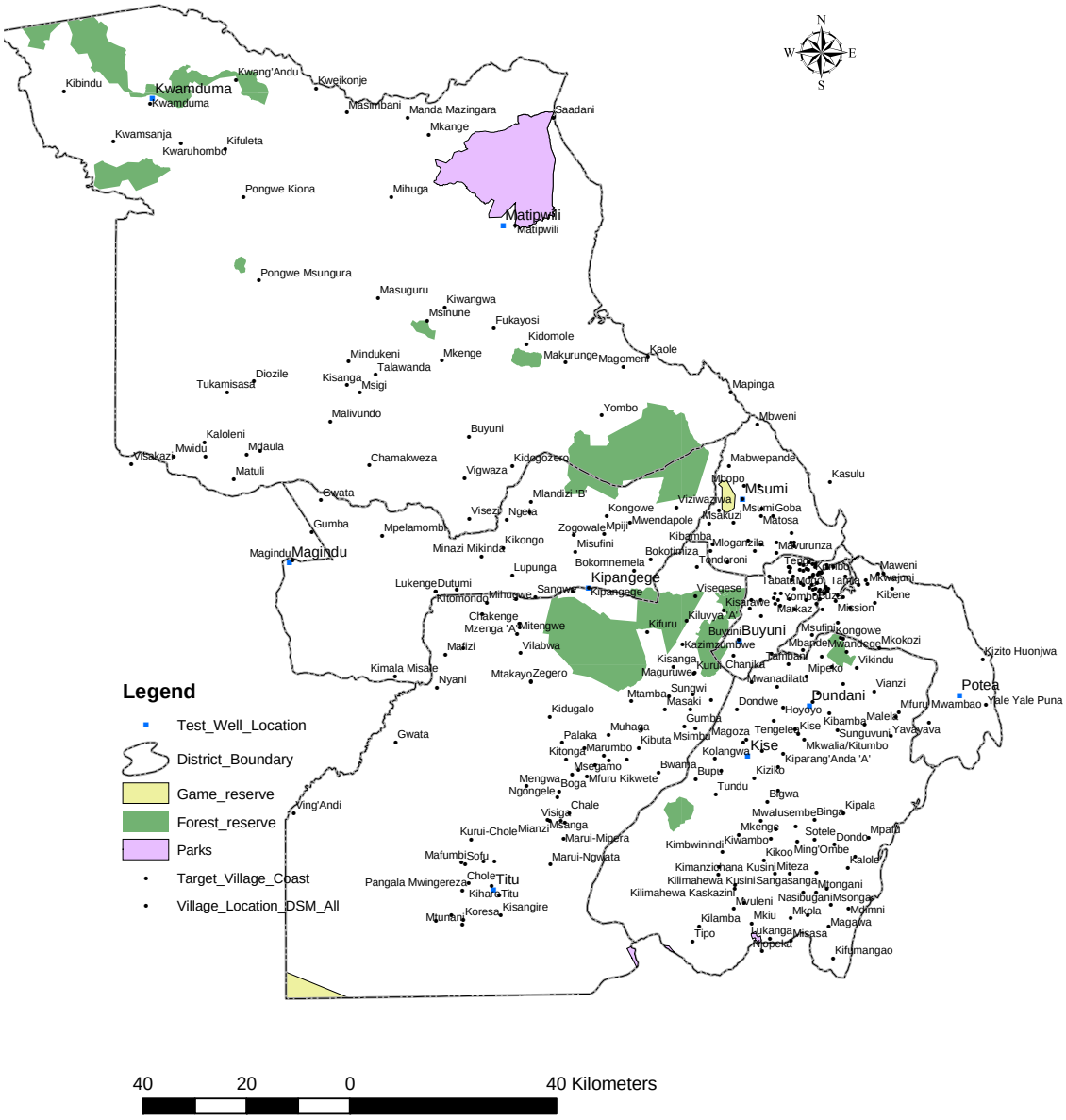

FIGURE 12.2 PROTECTION AREA IN THE STUDY AREA

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM	JICA

MoNRT, national and international NGOs and the target communities themselves, and periodical monitoring will be useful to observe further environmental condition.

(2) Social Assessment

For social impact assessment, a qualitative approach is applied, which include social analysis with socio-anthropological techniques, such as situation analysis, group interviews/discussions and brief narratives in order to deeply understand and assess beyond quantitative data. In particular, it is importantly attempted to give voice of marginalized people out and raise crucial issues to be considered, which never comes only from chairman of village or somebody with authority.

1) Women and Children Water Use in Cultural Context

Current Condition

The life of men and women differs in many respects. In rural area like Coast Region and some parts of Dar es Salaam, a woman's role is reproductive. Generally, men work primarily as agricultural labors or producers; they are likewise responsible for the selling of agricultural produce and for purchases on the markets. In contrast, almost all women in rural places are in charge of domestic work. Women are responsible for preparing and cooking foods, washing dishes, washing their clothes. And overwhelming majority of women in Tanzania is exposed to the burden of the dilemma presented by culture and tradition in several aspects for example, water fetching for domestic.

Although all women have perceived that it is a task of women and children not to let men do traditionally, every single interviewed woman responded that long distance on a bumpy paths and roads for fetching water keeps women from performing their housework within limited time each day. And a double burden for women and children in fetching water with carrying a big plastic tank, which weight more than 20 kg at least from 3 to 6 times per day for women and a bit smaller tank for children make them heavily exhausted. A woman mentioned Kibindu replied that she sometimes tries to buy water from her own pocket money if her own children are too tired to fetching water several time in loge distance if the tiredness disturb their studying. However, this is a very rare case since parents could not afford to buy water normally. In general, because of financial predicament in family, children are one of contributors to livelihood, taking care of sisters or brothers, fetching water, carrying vegetables. According to teachers in Kurasini primary school, high drop-out rate of about 40 % e.g. in primary school is attributed to engagement of family labors including fetching water. Comparing with a high enrolment rate in primary school like 94% of boys and 93% of girls and the drop-out rate, it can be understood that these burdens are one of factor to take children's willingness to study away.

Around 15 women in Kwamduma reacted in a group discussion that the fetching water activity includes gender issues, which put women in place of predicament. For example, most of them agreed that generally men have no interest in women's burden activities. Constrains are reported that some of men treat women harshly if it takes longer time to get water or cannot get enough water than he expected. As seen from this reality, inadequate water fetching environment badly affect to women's dignity as well as physical condition.

On the other hand, a woman in Matimbwa spoke out about affordability of payment for drinking water. In her village, pipeline water from DAWASA is available, however, only a few villagers afford to pay. She described her case that she uses freely traditional dug well every day through all seasons by sharing with her relatives although the water quality from the well is not totally satisfied, which is impure with milk color and cause diarrhea sometimes. She ended her comment "*affordability of payment and easier access to water is crucial in my life than anything, even my health condition, I can compromise*". This comment implies life is not simple but complex, for example, perception of villager to water differs in a way, and understanding of hygiene issues and taking action is rarely putting into agenda.

Potential Impact by the Water Supply Plan

Ultimate goal in the Study is to provide adequate water supply by encouragement of group piped scheme. It is greatly expected to contribute to lightening the burden imposed heavy fetching water activities of women and children. This is because adequate water quality and quantity from appropriate water source newly brought in much nearer than existing location. Water supply plan will obviously minimize distance and time spending for fetching water, which mitigate tiredness causing from carrying heavy plastic tanks. Moreover, easier access to much better water quality with acceptable water price will give this water access to marginalized people and potentially prevent from water-born diseases, which have badly affected children and women's health condition.

Thus, the proposed water supply plan directly give positive impact on women and children of life condition, and even better, implementation of the water supply possibly provide spare time to improve further women and children's life, e.g. more time for schools for children, literacy training or improving faming condition or holding petty shop etc.

Follow– Up Activity

There is no anticipation of negative impact on this issue but absolutely positive impact. For better improvement, combination of hygiene education and training and understanding of gender leaning in relevant villages will be powerful tools to add values for improve their life condition in reality

2) Water Vendors in the Study

Current Condition

As pointed out in preparatory study in 2004, it is known that water venders who sell water by plastic tanks which is 20 liter in large, are commonly seen in the Study area. No institutions or organization have ever investigated the actual condition of existing water venders so far. In order to accumulate basic data at of water venders for the first time, interviews based on intentional samplings were carried out. The summary of the characteristics is shown in *Table 12.5*.

Table 12.5 Variety of Water Venders

Regions	Organization	Vehicles for Selling		Tanks for Selling		Water Source	Buying Cost	Selling Cost	
		Type	Common Ranking	Size	No. of Tanks / one time			Within Same Village	Without Village / Market
Coast Regain	Individual Individual	Bicycle Hand Cart	1 2	20 liter	4 6-10	*Any water source such as* Unprotected Shallow wells Unprotected Chaco/Ponds Protected Shallow, Deep wells and Spring	free free 0.5-1.0 Tsh/ liter	2.5-6.0 Tsh/ liter	7.5-15 Tsh/ liter
Dar es Salaam	Individual Individual	Bicycle Hand Cart	2 1	20 liter	4 10-12	*Any water source such as* Unprotected Shallow wells Unprotected Chaco/Ponds Protected Shallow, Deep wells and Spring Public Tap	free free	2.5-6.0 Tsh/ liter	7.5-15 Tsh/ liter
	A group (sorts of Informal Company	Truck	3	3,000 liter	2	Protected Deep wells	1.0 Tsh/ liter	-	5 Tsh/liter

In Coast Region and some parts of Dar es Salaam, there are from 5 to 10 water venders in each village only if there is available quantity of water to sell and demand to buy. Therefore, water venders are found within same village that goes to outside of villages or market. Selling cost can remarkably range from 2 to 6 times higher than within village, moreover, in out side of villages or shortage area like in north part of Bagamoyo and center in Dar es Salaam, the cost can increase from 7.5 to 15 times higher of buying cost. However, these high price doses not

guarantee water quality at all. In Bagamoyo, near Kibindu, it is observed a water vender collected water from a pond covered with full of rotten alga and reptiles swimming and animals also come for drinking and bathing.

As an another aspect, it is considered that a water vender of household head is engaged in the activity as a side job in order to supplement income from agriculture, while younger boys also do the work out to help with family. This tendency implies the issues of poverty in the area, which can be considered that people's life depends on totally agriculture with low productions and income regardless of heavy labor.

In rural area of Dar es Salaam, Kishiwani, more than 50 villagers are engaged in water vender to sell water from own village to ferry stop and neighbor villages. Different aspects are found out from other villagers. Each water vender has own regular costumers, and most of water venders are adolescent. This implies that these adolescent men depend on water vender activities fully since there are no opportunities to get involved in other jobs.

One the other hand, in central area of Dar es Salaam, there are groups selling water by 3,000 liter in a large scale as brokers from a water company.

It is confirmed that there is no water vender cooperatives. Almost all individual water venders, except for groups using truck to carry, responded that the work is very tough comparing to the income.

Potential Impact by the Water Supply Plan

With respect to vender issues, this is sort of black box, which is not simple to anticipate the impact of water venders general at this moment. Therefore, it is meaningful to assume several different impacts and to have a discussion in this sub section.

In terms of economic development, implementation of water supply plan might affect these water venders's job environment by losing current customers who will get better water from implementation of the water supply plan. This evaluated as potential negative impacts in the preparatory study. However, the water supply plan in the Study include mitigation and consideration to these existing water venders to bring positive impact like increasing economic benefits by proposing job opportunities to get involving in O&M water organizations in better work environment and income (See Chapter 9 in Main Report for details). In short, the assessment of the impact on water vender concludes negative impact for water vender could possibly turn into positively impact to lead them to life improvement in long term.

In terms of situational, cultural and habitual aspects, it also anticipate increasing numbers of water venders if they recognize more developed water sources become available. This is based on analysis of current tendency of water vender's involvement. The influx of an unexpected number of invading water venders might have predicable social pressure on beyond estimated water demand in each village.

Mitigation Measures

For the first issue, encouragement of new job opportunity approach by establishment of O&M water organizations is an effective mitigation measure, which might also help improve adolescent unemployment problems. For the second issue, communication with these newly joining waters venders is important to make them understood water supply estimated based on village population not including unexpected invaders. Therefore, regulations by laws or rules might need to be stipulated a certain rule including penalties to avoid unexpected invaders. In addition, continuous monitoring is one of mitigation measure as well at this moment.

3) Management for Sharing Water Supply Facilities among Adjacent Villages

Current Condition

In villages like Minazi Mikinda and Kitomodo in the water supply plan, adjustment approach, which means to share water supply facilities among neighbor villages within same ward is applied in terms of management and capacity of groundwater.

Potential Impact by the Water Supply Plan

Although the potential impact is not beyond suspicion since adjacent villages have not been illustrated yet at this moment. However, anticipating negative impact to social equity to have groundwater as a resource whose legal ownership (UNEP 1996) might be happened. For example, it could split adjacent villages by issues of advantage and disadvantage in terms of division of responsibility of water management and role of operation and maintenance of the facilities for sharing water source.

Mitigation Measures

In order to find mitigation measures of above mentioned impact, Vikindu in Mukuranga, which neighboring Mwandege, was examined. According to Vikindu, it has cooperation work and activities with Mwandege, such as "building primary school and managing the facility and education system together". These villages have regular district meeting among representatives of these villages every two or three months to determine something important issues and rule. Chairman of the Vikindu village emphasized that discussion in common issue from early stage is a key if the procedure is appropriately applied in right process, it will never give any negative impact.

4) Villager's Perceptions the Poor and Attitude to Payment

Current Condition

Any village is diverse, having own characteristics and issues. In Msimbu, Kisaraue, two wells located just away from 3 m each other. The one is unprotected dug well used freely while the other is a borehole with payment. According to a tariff collector, division secretary in the village, he charge 10 Tsh commonly for 10 and 20 liter, and even he dose not charge to the poor sometimes who wish to use the borehole water for urgent reasons. He commented that collecting 5,000 Tsh for per day is enough for maintenance the borehole for dry season when villagers often use. The way of Msimbu to the poor is encouraging them not excluded but there is definitely lack of full recovery of O& M concept.

In Lougoba, Mukuranga, villagers informed that they are generally satisfied with water quality and quantity from Charinze supply scheme, which charge 1 Tsh/liter. However, there are still the poor who do not manage to pay so that those are still only having an access to unsanitary pond water. It was observed in community meeting villagers themselves are looking for better solution how to treat and involve the poor in the village.

Potential Impact by the Water Supply Plan

As illustrated in two cases above, there are two major points, the one is villager's perception to the poor. In applying water supply plan, it can be anticipated to bring about new issue how to treat and include the poor in water supply plan implementation "within" the village. On the other hands, there is obviously a lack of perception "user's pay" and "O& M for full cost recovery" in these villages. Without considering and improving this current condition, it can be anticipated to keep implementation of water supply plan from succeeding enough.

Follow – Up Activity

"Facilitation and Capacity Building Plan" in Chapter 7, Main Report indicates major and concrete activities in terms of O & M and community involvement. For taking any plan, it is important take process stakeholders understood from viewpoints of villagers and related stakeholders through communication in periodical meetings.

5) Indigenous group/ Tribes – *Massai*

Current Condition

Massai is one of 130 diverse tribes in Tanzania, which is divided into 12 sub tribes and composed of numerous smaller sub tribes, well known as brave fighters against wild animals,

herds of numbers of cattle with fashionable traditional costume and maintaining own norm, habit and culture. Majority of *Massai* spend nomadic life in east –center of Tanzania, but also small groups are seen in Bagamoyo as well. It is a life of *Massai* to stays in certain village for certain years. Therefore, *Massai* need to get common property like water for drinking and cattle from the staying area, even *Massai* children go to school in the area. It is traditionally accepted for neighbor villages to live together with newcomer, *Mas*sai in the area. It is in a way of agreement to share common properties with the village, lands and water etc. by negotiation, bartering water for cattle and land for certain amount of money.

Villagers and *Massai* in Lugoba, Bagamoyo expressed their satisfaction to live together in this way and nothing serious problem have happened so far.

Potential Impact by the Water Supply Plan

It is wandering matter although it is s less possibility, but also need to be considered as a potential influence on *Massai's* living condition who are not permanent residents in the area by introduction of water supply plan whether *Massai* can keep same traditional life style without any change and marginalized.

Mitigation Measures

Water Supply Plan attempts to provide much water with better quality to any village, therefore, there is not negatively impact to minority group like *Massai* but help to have more access to water ever before. As long as taking same procedure for negotiation and appropriate introduction of water supply plan by considering *Massai's* traditional and cultural life style, it shall not give any negative impact at all. There will several ways to include *Massai* to decision making if *Massai* want.

6) Discrepancy of Water Management Policy

Current condition

National Water Policy (2002) stipulated participation of community and its ownership for water management such as collection of information, preparation of water utilization plans, conservation and protecting water sources and efficient and effective water use. In reality, Water Community - Owned Water Supply Organizations (COWSOs) have taken various organizational form (JICA Study Team 2005) and developed by own preferable way. Although the COWSOs approach is not always a successful model, there is a community, Kisiwani in Temeki, in progress of development by putting efforts to better community-based water management with limited finance and human resources in order to achieve the scheme of the National Water Policy.

However, the community has been faced confusion of the discrepancy of water management policy between National and District Council. That is, the latter suddenly give a notification on duty of equal payment rule of any water user in the community. However, as already mentioned, the community have water utilization plan and efficient water use system, which was already determined based on collective discussions with community stakeholders. Namely, the rule of payment for water in the community is that water venders and other villagers need to pay for water, but villagers are allowed to get water with free. And, O& M cost have met revenue from only water venders and other villages so far. That is to say, an opinion of the community is that discrepancy of management policy is nothing else than obstacle.

Potential Impact by the Water Supply Plan

It is a wandering matter although it is less possibility, but also needed to be considered in the IEE if there is potential influence of this kind of discrepancy of water management to villager's water management by the water supply plan.

Follow- Up Activity

It is a matter of coordination of policy and institution's capability to avoid overlapped

responsibility between local and national level, not because of the implementation of the water supply plan. Therefore, mitigation measures are not applicable in IEE to propose. As learning lessons, however, concrete investigation is necessary to understand current local condition as well as national policy.

12.3.7 EVALUATION OF ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

In summary, *Table* 12.6 shows Positive and Negative Impact Matrix as result of Environment and Social assessment. This Matrix helps to understand that the water supply plan has basically potential positive impacts regarding these aspects.

Table 12.6 Positive and Negative Impact Matrix

Screening Subjects			Social Aspects							Environmental Aspects			
Water Supply Plan Impact	Degrees of Impact ◎ : Very much Impact ○ Fairly Impact	**Issues**	Women and Children in Water Use	Water Vendors	Indigenousgroup/ Tribes – Massai	Management for Sharing Water Supply Facilities	Villagers Perceptions and Attitude to Payment	Discrepancy of Water Management	Water Rights and Right of Common	Groundwater	Land Subsidence	Hydrological Situation	Fauna and Flora
Impact													
Positive	Direct Positive Impact		◎										
	Indirect Positive Impact												
	Positive Direct Impact with Appropriate Considerations/Mitigations Measures					◎	○	○		◎		◎	
	Positive Indirect Impact with Appropriate Considerations/Mitigations Measures			◎	○				○		○		○
	No Impact												
Negative	Indirect Negative Impact												
	Negative Positive Impact												

Same as ultimate objective of the Study, improvement of women and children in water use is considered to have direct large positive impact. Positive direct /indirect impact with "appropriate considerations" such any mitigations or follow-up activities turn any impact into positive definitely. However, it also needs to empathies that without any consideration in appropriate stage, the project might precede wrong direction.

Through IEE in the Study, screening results evaluated Category C as a whole, shown in *Table 12.7*. The remarks reflect assessment and evaluation, linking with mitigation measures and follow-up actives. And it is concluded that a full EIA at further stage is not required as proved by results of evaluation. It is concluded that the water supply plan has absolutely positive impacts in accompany with appropriate consideration or mitigation measures.

12.4 INDICATOR SURVEY FOR MONITORING IN PRIORITY PROJECTS

12.4.1 JUSTIFICATION OF THE BASELINE SURVEY FOR MONITORING INDICATOR

As IEE follow-up activity in terms of environmental and social considerations in the Study, an indicator survey for monitoring, which covered 22 priority projects, is applied in order to inquire

Table 12.7 The Final Screening Results in the IEE

No.	Environmental Item	Evaluation	Reasons
Social Environment			
1	Resettlement	C	The Water Supply Plan dose not include any large-scale of resettlement plan.
2	Economic activities	C	For water venders, which is one concerned aspect in the Study, mitigation and follow-up activities are clearly presented through the IEE. By carrying out these measures adverse imapct could be mitigated.
3	Traffic and public facilities	C	The Water Supply Plan dose not include activity conmponents which affect trafic or public facilies.
4	Split of community	C	New construction, which might split community, will not be conducted while pipelines exisit already, which have not affected the community.
5	Cultural property	C	In the Study area, there is no valuable cultural heritage such as important churches, temples, shrines etc.
6	Water rights and Rights of common	C	IEE has evaluated the Water Supply Plan at preparation stage, the relevant issues are already covered carefully.
7	Public health condition	C	IEE has evaluated that the Water Supply Plan will have positive impact to improve currently affected public health and sanitation.
8	Waste	C	Sludge is processed appropriately.
9	Hazards (risk)	C	Large- scale consutracution is not carried out in the Water Supply Plan.
Natural l Environment			
10	Topography and geology	C	Not relevant (the Plan is not such a large scale).
11	Soil erosion	C	Not relevant (the Plan is not such a large scale).
12	Groundwater	C	IEE has evaluated that the Water Supply Plan will have positive impact with appropriate consideration and mitigations.
13	Hydrological situation	C	IEE has evaluated that the Water Supply Plan will have positive impact to improve current hydrological situation.
14	Coastal zone	C	The Study are is not directly related to coastal zone.
15	Fauna and flora	C	IEE has evaluated that the Water Supply Plan has no negative impact on Fauna and Fora.
16	Meteorology	C	Not relevant (the Plan is not such a large scale).
17	Landscape	C	Not relevant (the Plan is not such a large scale).
18	Air pollution	C	Not relevant (the Plan is not such a large scale), For drilling of test wells, the subject was carefully considered.
19	Water pollution	C	Not relevant (the Plan is not such a large scale), For drilling of test wells, the subject was carefully considered.
20	Soil contamination	C	Not relevant (the Plan is not such a large scale), For drilling of test wells, the subject was carefully considered.
21	Noise and vibration	C	Appropriate treatment during construction works.
22	Land subsidence	C	IEE has evaluated that the Water Supply Plan has no negative impact with mitigation measure.
23	Offensive odor	C	Not relevant (the Plan is not such a large scale).

Note 1: Evaluation categories:

A: Serious impact is expected.

B: Potential impact may occur or Extent of impact is unknown.

C: No impact is expected. EIA is not necessary.

Information on practical environmental and social indicators for the purpose of further monitoring. Although outputs of the IEE reveals that water supply plan have fallen into Category C, it dose not automatically mean that adverse impact will never occur in the future *unless* continuous environmental and social monitoring is properly carried out in a long-term. For this reason, counterpart initiatives for monitoring in priority projects is enormously important to take a sep for establishment of monitoring system institutionally among related agencies on environmental and social considerations in Tanzania. It is found that these agencies including counterpart substantially need to strengthen skills of systematic data collection and storing information as database for effective use of water management entirely.

Therefore, the survey functions to gather preliminary monitoring indicators to measure change of condition "before and after" project, which is applicable for social aspects such as water fetching condition of women which shows how much their current predicament condition would be improved by implementation of priority projects. On the other hand, regarding natural environment, a major focus is assessment on environmental condition "with" and "without" these projects, for example, location of schemes, including impact to topology, groundwater, fauna and flora etc. along with paying attention to construction stage by site visit. In other words, the results of assessment help to reconsider both the importance of technically making right decision and environmentally sound as well.

Apart from the indicators survey through check list (See 12.4.3.Methods) on collection of baseline data "poverty" indicator for monitoring should be addressed by different approach due to the sensitiveness of the topic, and related to villager's ability to pay water tariff, characteristics of complexity and abstruse, which ultimately require qualitatively approach to get into people's real life. For this reason, some part of Rapid Rural Appraisal (RRA) was applied. Behind the idea of this approach, the degree and recognition of poverty differs from place to place, which cannot easily measure in quantitative way.

As limitation of the survey, time availability for site survey was not sufficient. Therefore, the survey techniques needed the RRA not participatory learning approach (PLA), which more encourages the learning process of villagers to improve current condition through the survey.

12.4.2 OBJECTIVES

The indicator survey for monitoring includes three objectives shown as follows;

Objectives

- To collect basic information on current water user's condition as preliminary monitoring data in order to measure to what extent the priority projects either improves currently predicament situation or no better impact.
- To assess whether location, size and applied techniques of proposed facility are accepted in around environment.
- To find appropriate consideration approach to the poorer in community

12.4.3 METHODS

(1) Check List of Environmental and Social Indicators for Monitoring

Taking into consideration of the results of IEE, environmental and social items narrowed down to specific items which are likely to get impact and require monitoring in the stage of construction and operation. It was determined by discussion with counterpart in charge of environmental and social considerations.

For management, monitoring was put into one form of structured check list. In deed, this preliminary check list aims to assess 20 targeting village conditions which are expected to be useful to make a construction plan not to compare each condition as analysis. In this report, only current condition and some points for attention during construction are described. Main context is briefly shown in *Table 12.8*. The completed actual sheets on all 20 villages are

documented in Data Book.

Table 12.8 Check List of Environmental and Social Indicators

Environmental and Social Indicators	Check Items	Purpose
Water Vender	- Internal water vender number	Understanding of actual number
	- Cost of water from water vender	As basic data to compare with normal water cost
	- Social condition including Education level and social status	For understanding water vender's basic knowledge and social condition for making use of giving O & M training course
	- Outsider water vender	As current figures of outsider
Water Use	- Time to reach water source	To get a figure which indicate the distance difficulty by current time to reach water source which
	- Waiting time getting water	To get a figure which indicate last of yield of the current water source by current time to water source and use for monitoring indicator for further
	- Children involvement	To examine involvement of children to water fetching
Road Condition to Village	- Main, second and the third road	To check roads condition whether it allow big trucks for construction of facilities
Water Source	- Location of planning water source	To confirm less giving damaging place
	- Road condition to water source	For possibility to make pass truck and machines
	- Land ownership of the planning water source place	To confirm procedure of negation and compensation of the land
Storage Tank	- Location of planning storage tank	Same as water source
	- Road condition to storage tank	Same as water source
	- Land ownership of the planning storage tank place	Same as water source
Transmission route	- Location of planning storage tank	Same as water source
	- Road condition to storage tank	Same as water source
Waste	- Waste during construction and operation	To make sure if construction might generate waste which is over capacity of village
Hazards (risk)	- Physical risk during construction of facilities like borehole, storage tank and transmission route etc.	To give attention to anticipating risk during construction work
Topography and Geology	- Impact to Topography and Geology by setting up facilities like borehole, storage tank and transmission route etc.	To confirm if truly construction and operation will not give any damage to Topography and Geology before staring
Groundwater	- 100 m interval between planning well and others	To avoid interfering incidents
Latrine condition	- Type of latrine	To understand sanitary condition
	- Certain distance from planning water source	To avoid pollution of colon bacillus and others
Fauna and Flora	- Impact to Fauna and Flora by setting up facilities like borehole, storage tank and transmission route etc.	To take an appropriate mitigation measure if there are important Fauna and Flora before staring
Noise and vibration	- Noise and vibration Impact to villagers who lives near by planning facilities like borehole, storage tank and transmission route etc.	To take an appropriate mitigation measurement not to avoid sound

(2) Poverty Indicators

As mentioned earlier, definition of poverty differs in places and actors around. In order to understand how targeted communities consider the poor and treat them in reality not from points of outsiders, community poor investigation was attempted using social and anthropological techniques such as key informant interviews, snowballing sampling to reach the poor and then RRA. As it have already recognized, ability to pay is not always equivalent to willingness to pay. For this reason, understanding recognition of the poor among community, living conditions including number of family, education level, type of work, income and expenditure, foods to eat and nutrition, a day and year activity etc. is one of crucial points in community development plan such as water supply.

Major research questions are as follows;

1) Community recognition of the poor in own community (Key Informant Interviews)

- Which type of people is considered as the poor in the community?
- How dose the poor live in the community?

2) The differences among the poor and average community considered by community

In order to see to some extend of the differences among the poor and average, information on foods to take, expenditure, general day activity among them are collected to compare. This research gives an ideas, the poor is facing predicament than others. Due to limitation of time and accessibility and aims to get qualitative data, the investigation is tried in Nijopeka, Pugu Station, Kingugi, Mwanambaya village only.

12.4.4 FINDINGS

(1) Environmental Indicators

After completing check list in all priority project sites, major indicators to be concerned on environmental condition of the priority projects, actual issues and its countermeasures are summarised in *Table 12.9*. The summary of check list in each village gives important and concrete information to be considered, which specifically requires consideration and preparations beforehand.

In addition, common tendency in all villages are follows:

1) Road and paths condition to planning facilities

In general, almost all width of roads and paths are narrow without paved. However it is also true that any narrow foot paths are already used by villagers which do not bring any house moving back at all. It needs to make wider some roads and paths during construction stage considering trucks and machines. However, these periods are temporally so that villagers will understand and cooperate with appropriate explanations beforehand.

2) Land ownership of planning water source and storage tank location

Land ownership pattern divides into public like school, mosque, community reserve, or private like agricultural farm cultivating Cassava, Coconuts and Cashew nuts mostly and there is one case in which villagers illegally use riverbed as farm. In all cases, negotiation with village chairman and these land owners including teacher if it belong to school, and preferably, a local government officer such as ward executive officer and district water engineer is first step to take. As a facilitator for this negotiation process, the counterpart in charge of environmental and social considerations is expected to play central role.

Table 12.9 The Summary of Check List

No	Districts	Villages	Key Indicators	Major Issues / Remarks	Countermeasures during construction stage
1	Bagamoyo	Kibindu	Noise and vibration	Planning storage tank locates only 5-10 m away from some houses	To inform the residents about construction properly in right time
2	Bagamoyo	Kuwandum a	Road condition	Access roads within the village is around 2.5 m narrow.	To use appropriate size of truck, and if need, make the path wider a bit.
3	Bagamoyo	Matipwili	Hazards(risk)	Crocodiles inhabit in Wami river which easily attack people.	To warn about crocodiles during construction
4	Kibaha	Minazi Mikinda	NIL , not specifically	NIL	NIL
5	Kibaha	Kitomondo	Road condition	During rainy season, roads become very muddy.	To consider constriction season and measure
			Storage tank location	There is a school near the proposed storage tank area.	To inform school about construction and avoid free time in school and call student's attention
6	Kibaha	Msimbu	Hazards(risk)	During rainy season, flood happens.	To consider construction season and measure
7	Kibaha	Chole	Road condition	Access road to water source is narrow.	To use appropriate size of truck, and if need, make the path wider a bit.
			Transmission routes condition	Graves gathers near transmission routes	To discuss with village chairman about the handling including compensation way
			Noise and vibration	Planning storage tank locates only 30 m away from houses	To inform the residents about construction properly in right time
8	Mukuranga	Mwandege/ Kiopala	NIL , not specifically	NIL	NIL
9	Mukuranga	Kisemvule	Community Reserve	Planning facilities are out of the community development reserve	NIL
10	Mukuranga	Marogoro	NIL , not specifically	NIL	NIL
11	Mukuranga	Vianzi	Community Reserve	Planning facilities are out of the community development reserve	NIL
12	Mukuranga	Njopeka	NIL , not specifically	NIL	NIL
13	Mukuranga	Kitunda	General Road conditions	Roads to Muzinga in the village are extremely narrow and will be even worse getting ramify	To consider appropriate road arrangement including making it wider etc.
			Road condition (Water Source Mzinga)	Roads are pretty narrow and there are many villagers walking around.	To use appropriate size of truck, and call villager's attentions
			Road condition (Storage Tank in Kivule-Mbonea, near ward office)	Storage tank faces a main road where villagers are walking around.	To call villager's attentions
			Transmission routes condition	There are a existing pipe 2 m below from ground. This area kept for development.	To make transmission route along with this existing pipe, which is useful
14	Ilala	Msongola	NIL , not specifically	NIL, not specifically	NIL
15	Ilala	Pugu Station	Road condition (Water Source in Pugu Mnadani)	There are sellers of livestock to water source	To pay attention to sellers of livestock
			Road condition (Storage Tank in Mr. Mchems farm)	Existing path to the location is ultimately narrow.	To use appropriate size of truck, and if need, make the path wider a bit.
			Transmission routes condition	Across road where water pipe is planned to pass and it is about transmission in depth from the round and 0.3 m diameter.	To make transmission route along with this existing pipe, which is useful
			Noise and vibration	Water Source locates only 30 m away from houses	To inform the residents about construction properly in right time
			Noise and vibration	Planning storage tank locates only 20 m away from houses	To inform the residents about construction properly in right time
				Transmission route locates near by house.	To inform the residents about construction properly in right time
16	Kinodoni	Matosa	Noise and vibration	Water Source locates only 10 m away from houses	To inform the residents about construction properly in right time
17	Temeke	Yale Yale Puna	Not specifically	NIL	NIL
18	Temeke	Tundwi Songani	Road condition to Water Source in Pugu Mnadani	Food path to reach the location is narrow,	To consider another road to reach
			Hazards(risk)	For students since there is a primary school	To inform school about construction and avoid free time in school and call student's attention
			Community Reserve	Planning facilities are out of the community development reserve	NIL
			Road conditions to Water Source Mzinga Refer to the location in Figure ****	During rainy season, roads become very muddy.	To consider construction season and measure
19	Temeke	Mjimwema	Road condition to Water Source	Path to reach water source is slope, and some people live	To prepare road condition and call resident's attentions live near.
20	Temeke	Kibugumo	Road condition to village	Road is pretty narrow.	To consider appropriate road arrangement including making it wider etc.
			Hazards(risk)	There is a primary school near by	To inform school about construction and avoid free time in school and call student's attention

3) Sanitary condition

Except for one village, pit latrines are commonly used in each house, which has dried leaves fence without roof. Villagers have knowledge on using own latrine but without any concern about the location, maintaining condition and cleanliness. In some villages, unfortunately, current water intake from traditional dug wells or spring locate near by pit latrines or a garbage dump so these area are likely polluted which mean surely affect vulnerable people physically. In implementation stage of this project, integration of improvement sanitary knowledge and hygiene education collaborated with applying renew water source and facilities will ensure the achievement.

4) Topography and Geology

Based on results of the survey which confirming each location of planning facilities, scale and techniques applied during construction will not damage topography and geology in all priority project sites.

5) Fauna and Flora

As explained in section 12.3.6, overall of national park and reserve area for the purpose of protection of special fauna and flora were examined based on existing information in the IEE. Although the results of IEE showed no scientifically important fauna and flora in the study areas, actual environmental conditions which might get influence. Therefore, planning facilities are examined through interviews from villagers in this survey. These results showed that all interviewed villagers responded that there are no rare fauna and flora to permanently protect. Therefore, stakeholders accompanies with the survey concluded no any adverse impact on fauna and flora by implementation of the priority projects from points of the scale.

(2) Social Indicators

Table 12.10 shows basic social indicators which have narrowed down as a result of screening in the preparatory study and the IEE in this Study, such as present water sources, actual number of water vender and its water cost, time of fetching water etc appears.

Most of water source are traditional wells like hand dug wells. Almost all village concern bad water quality for drinking which cause water- born diseases, containing saline, and with dull and impurities rather than distance or time for fetching water;

Internal water vender take water from certain points and then sell it in isolated place where water demand is higher than other areas by three to five times higher price. This informal business by adolescent men is one of measure to help livelihood in family who complete or left primary school work but no permanent job.

(3) Poverty

1) How community define “Poor people” in the community

All interviewees in different community responded in same context, for example, “the "Poor " is considered as people who have no capability, cannot spend money for expenses, and rapidly and easily get sick, however no medical treatment. For example, old people (more than 60 years old), disability, orphans, widows and widow are considered. These orphans are taken care of by relatives, but no support from Government. Therefore, reality is that the poor have to depend on neighbour support. As seen from these words, listed social categories such as old people more than 60 years old, disability people, widows are recognised as poor in community, it is effective way to reach them closely to understand their condition in details and then put them in agenda for community development including water management.

Table 12.10 Basic Social Indicators for Monitoring

No.	Districts	Villages	Current Water Condition		Problems for Water fetching	Water Vender			Fetching Water	
			Current Water Source	Cost		No. of Water Vender in villages (persons)	Selling Cost		To reach (Dry)	To reach (Dry)
							Rainy Season (Tsh)	Dry Season (Tsh)	(minutes)	(minutes)
1	Bagamoyo	Kibindu	Traditional wells	Free	Water Quality	No	-	-	60	60
2	Bagamoyo	Kuwanduma	Traditional wells	Free	Water Quality	No	-	-	60	60
3	Bagamoyo	Matipwili	Wami River Traditional wells	Free Free	Water Quality	8	20	80	10	0
4	Kibaha	Minazi Mikinda	Wami River	Free	Water Quality	20	-	-	10	0
5	Kibaha	Kitomondo	Wami River	Free	Water Quality	Unknown	-	-	30	60
6	Kibaha	Msimbu	Borehole	10 Tsh/ bucket for villagers, 20 tsh for outsiders	Water Quality	No	-	-	20-30	60- 180
7	Kibaha	Chole	Traditional wells	Free	Water Quality	1	-	-	30	60
8	Mukuranga	Mwandege/ Kiopala	Private borehole	20 Tsh/butket	Water Quality	30	100	100	30	10
9	Mukuranga	Kisemvule	Ring well which needs boil	Free	Water Quality ,Quantity	10	60	70	15	120
10	Mukuranga	Marogoro	Boreholes, Spring (dry up)	Free	Water Quality ,Quantity	No	-	-	60	30
11	Mukuranga	Vianzi	Boreholes, spring (dry up) , Ring well	20 Tsh/bucket	Water Quality	Unknown	-	-	30	60
12	Mukuranga	Njopeka	Traditional wells, Hand dug well	Water free	Water Quality ,Quantity	No	-	-	90	90
13	Mukuranga	Kitunda	Boreholes, Shallow wells, River	Free	Water Quality, Village path	10-15	Unknown	Unknown	40	0
14	Ilala	Msongola	Traditional wells	Free	Water Quality	Unknown	-	-	30	60
15	Ilala	Pugu Station	Ring well	20, 50 Tsh/buket	Water Quantity	4	150	120	30	180
16	Kinodoni	Matosa	Borehole water provided from factory, Traditional wells		Water Quality, Quantity	some	150	200	30	180-240
17	Temeke	Yale Yale Puna	Traditional wells and Ring wells		Water Quality, Location, Topography	5	150	-	45	60
18	Temeke	Tundwi Songani	Dug wells, and Shallow wells	Water free	Distance	3	150	-	60	30-40
19	Temeke	Mjimwema	Traditional hand dug well	Water free	Water Quality	40	100		20-30	15-20
20	Temeke	Kibugumo		Water free	Location, Topography	No	-	-	30	30

2) Routes causes of poor

In addition to physically difficult conditions of disability, old people and widow's double burdens such as role of breadwinner as well as a mother to take care of family and house work etc, community people responded that *"low quality of agriland, lack of market to sell products drive the poor into much poor day by day"*. And also some responded *"lack of education don not drive these people to find a way out of any difficulties."*

3) Condition of the Poor

Almost all responders of poor replied that they have own humble house and land with small farm. However, because of their physical difficulties which disturb them to work for income, the poor living condition come worse and worse. Although there is no subsidy from government, there are some communities like Pugu Station have attempted to help by exemption of medical and water charge for extremely poor.

Table 12.11 Foods the Poor Ate One Day in Niopeka and Pugu Station

M: Market, O: from Own products

	Morning	From Where		Lunch	From Where		Supper	From Where
	Village :Njopeka							
	Peson 1							
1	Boiled Cassava	O	1	Cassava Ugari	O	1	Cassava Ugari	O
2	A glass of Water	O	2	Cassava	O	2	Cassava	O
			3	A glass of Water	O	3	A glass of Water	O
	Peson 2							
1	Tea	M: Market	1	Ugari (Cassava)	O	1	Rice	O
2	Rice	O	2	Fish	M: Market	2	Beans	M
			3	A glass of Water	O	3	A glass of Water	O
	Village :Pugu Station							
1	Tea	M: Market	1	Maiz Flour	M: Market	1	Nothing	
2	Cassava	M: Market	2	Beans	M: Market	2		
3			3	Water				
4				From Ring Well, not salaince, free for him. For others need to pay				

Table 12.11 shows foods the poor eat a day in Njopeka and Pugu Station village. Although degrees of nutrition condition is one of factors defined poverty, measuring exact quantity of foods in houses have not tried because out of the study scope. These findings give ideas of which kinds of foods are available for the poor and how they get it. As seen *Table 12.11* shows most of foods are coming from own farm such as Cassava as main foods to satisfy with their hanger. And sometimes have a chance to buy fishes and beans from market but no chance to buy clothes or shoes and pay for medical treatment. A poor without job with disability beg money from 200 to 500 Tsh/day for eat a day. The variety of foods is almost nothing; it is not nutritionally balanced diet at all. Any of the poor drink water or tea, the informant in Pugu Station responded community allow him to get water free.

Income of the poor varies in village. Lowest monthly income of the poor varies from 0 to 6,000Tsh/month while highest monthly income of the poor varies from around more than 7,000 Tsh/month. Interesting point is that the poor situation also varies among communities due to location. For example, the poor in Pugu Station in peri urban, income of poor is around 30,000 to 40,000 Tsh/month in which average people earn between 200,000 and 300,000 Tsh/month. In this area there are active markets which allow wife to do small business such as making chapatti or juice etc. On the other hands, in rural remote area, the poor income is considered below 5,000 Tsh/month while the average person's is around 10,000 Tsh/moth where most of them are involved in agriculture.

4) Conclusions on poverty indicator

The findings indicated that representative of the poor could be identified such as old people (more than 60 years old), disability, orphans, widows and widows concretely which are not always invisible basically. For consideration on the poor in water management, it is needed to have community discussion from different actors about how to treat the poor in own community regarding water management from points of community. As mentioned already, the poor condition varies in community and community, even the community itself has also vary due to economically and politically powerful or not. The results show that there are some community gives water totally free in current situation. For introducing innovative water management system proposed in the Study, appropriate step for consensus decision based on some agreement among stakeholders in community are greatly important.

12.5. MONITORING PLAN

12.5.1 JUSTIFICATIONS

Through water quality test for determination of available water source for planning facilities and the IEE, it was found that institution of governmental laboratory for water analysis has still some weakness in technical skills and water quality management. In addition, counterpart agency regardless of the responsibility of water development and management, it has not understood the importance of managing private groundwater sector at all. These realities imply some sorts of weakness of counterpart agency to keep data collecting, analysing, recording, up-dating which mean lack of process thinking and monitoring intention. On the other hands, assessing social benefit or negative influence through social change is not simple enough so that it requires socio-anthological skills possessing qualitative and quantitative social research skills focusing communication for identifying and understands people's confrontations or problems.

As seen, targeted sphere on environmental and social considerations is wider and complex. Therefore, integrated monitoring system is encouraged in technically scientific monitoring such as water quality, groundwater capacity like continuous level and its yield measurement and even including management of private wells. On the other hand, social monitoring whose indicators could be predicament condition of women which include gender issues, water vender's condition, management system of common facilities beyond one village for maintenance and operation in Minazi Mikinda and Kitomondo villages.

For selection of integrated monitoring team, further discussion with counterpart personnel is required. Certain thing is that the counterpart in charge of environmental and social considerations in this Study should play a central role to carry out the monitoring team which compose from multidisciplinary beyond national, regional, district, and municipal level.

12.5.2 MONITORING INDICATORS

(1) Environmental Aspects

For further step toward sustainable water management, following activities are recommended as continuous monitoring.

1) Groundwater

a. Controlling of groundwater abstraction

Rational and concrete groundwater management system is required to function thoroughly regard to the overall yield, and the right of borehole users or effect on salt water intrusion and subsidence. For controlling abstraction of groundwater, legal and administrative steps are required.

Step 1) The establishment of legal precedent for controlling and management

The MoWLD and related agencies are required further management thoroughly such as permits for groundwater development including well digging, spring capture and borehole drilling. The permit specifies the depth, diameter and allowed intake of instillation. For effective and efficient management in sustainable way, management with digitations of these data is highly recommended since it functions as data bank of groundwater condition. The counterpart appointed for database construction in the Study is to play a role practically up-data of all collected data regularly.

Step 2) Issue to license to abstract groundwater

Charges to license based on appropriate volume of water abstracted and the use will be effective as the first controlling means. Moreover, the license of construction permit under within certain volume is expected to generate income to finance regulatory function.

Although these regulations are not simply accepted, particularly in area in which groundwater has historically regarded as a common good freely available to anyone. This is a case of some village in the Study area as well, so that for public understanding, public campaign to inform the reason and provision of free advice drilling contractors are required.

b. Controlling of groundwater pollution

The risk of groundwater pollution is determined by the vulnerable of aquifer to pollution and loading of potential pollutant to which it may be subjected.

Step 1) Investigation of mechanism of groundwater vulnerability in the area

Step 2) Copying strategy to avoid any pollution to groundwater

Such as land - use planning regulations, application of “polluter pays” principle need to be thoroughly as Environmental Policy announced.

In sum, for controlling of abstraction and pollution in groundwater management, continuous regular monitoring and assessment programs are required.

2) Fauna and Flora

Even if some part of the selected priority villages cover part of forest reserve, taking EIA for the priority projects will not be applicable to the Study since it dose not include any large scale of development which is pointed out by forest act 2002. However, it is recommended to get consultation from the advisory body, NEMC and contact with related agencies (MoNRT) and NGOs who have been get involved in the area.

(2) Social Aspects

As recommendations of social aspect, monitoring programs is required with preparation based on following subjects for certain period periodically.

1) Women and Children in Water Use

For double positive impact on improvement of women and children water in use,

- Mobilization of a learning package of hygiene education and gender understanding in water at village level in participatory approach, namely, “learning by doing each other”.
- Application of hygiene training and environmental education to school curriculum

2) Water Vender

- Applying for Cost-Benefit Analysis to verify the involvement of existing water venders to O & M water management organization which encourage them to learn new technical skills and new employment opportunity in terms of economic

- Applying for Socio-Anthropological Approach for monitoring water vender's livelihood whether they are getting to marginalization or not
- Establishment of legal precedent for monitoring and controlling of newly participating in water venders

3) Discrepancy of Water Management Policy

- Investigation of any overlap or conflict with national, regional, district, villages level in water management policy, if found, immediate arrangement among them is required.

4) Management for Sharing Water Supply Facilities

- Developing effective communication in order to make relevant villagers understood about the meanings and effectiveness of the water supply plan and their role in decisions.
- And also, appropriate consultation process and negotiation with stakeholders, particularly, villagers as major actors

5) Villagers to Perception to the Poor and Attitude to Payment and Ingenious group/ Tribes – Massai

- Observation of the transformation of these relevant stakeholders issues and presence

12.5.3 PLANNING MONITORING PROGRAMS

With respect to each monitoring indicators, it is needed to make a monitoring program plan to make monitoring in practice and sustainable. The general outline is as follows;

1) Monitoring Program Strategy

2) Monitoring Objectives

4) Core and Supplemental Monitoring Indicators

5) Quality Assurance

6) Data Management

7) Data Analysis

8) Reporting

9) Programmatic Evaluation

10) General Support and Infrastructure Planning

12.6 FURTHER ROLE OF ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

12.6.1 RESPONSIBILITIES AND TASK OF COUNTERPART OF ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

The counterpart personnel had conducted IEE and indicator survey for monitoring with high motivation and positive attitude to get new knowledge and skills as his duty. He had dedicated his most of work time to the Study, in particular, did great contributions in site visits. Due to his efforts with support from JICA Study Team, two - third work of environmental and social assessment in NEMC guideline have been done so far.

In order to confirm the progress of environmental and social considerations, summary of the process which follows NEMC guideline are shown in *Table 12.12*. The counterpart is recommended to follow this schedule and conduct own task in projects.

Counterpart personnel did such as process: 1) Registration, 2) Preliminary Environmental Assessment=IEE, 3) Follow Up for Priority Projects were completed supported with JICA Study

expert. After examination of the these results including context of this final report in the Study, the counterpart personnel are going to prepare Preliminary Environmental Report (PER), following a official format from NEMC. Due to recommendation by NEMC to include results of follow up

Table 12.12 Role and Task of Counterpart in EA process

Stage		Activities	Roles		Submitted Documents	Time	Remarks
			The First Stakeholder (Responsible Organization)	**The Second Stakeholder (Technical Assistance)**			
(1)	Pre-Planning	Registration	MoWL (CP)				It was not registered by any organization before screening by JICA Preparatory Study Team
2	Pre-Planning	Screening	NEMC	JICA Preparatory Study Team			The JICA Preparatory Study Team reached a conclusion that IEE is required in terms of 6 items whose expecting impact is unknown at that moment.
1	Planning	Registration	MoWL (CP)	JICA Study Team	Inception Report & Progress Report (JICA Study Team)	January, 2005	MoWL (CP) did finally made a registration. However, it is an impression that NEMC's response pretty slow and it needed more time to get information on legal proper procedure
3	Planning	Preliminary Environmental Assessment=IEE	MoWL (CP)	JICA Study Team	Interim Report (JICA Study Team)	March, 2005	It was concluded that EIA is not required regarding water supply plan, however, follow- up for further priority projects will grantees completed environmental and social consideration.
4	Planning	IEE Follow Up for Priority Projects(Toward Implementation)	MoWL (CP)	JICA Study Team	Draft Final Report (JICA Study Team)	October,2005	
5	Planning	Preliminary Environmental Report (PER) Completion	MoWL (CP)	(JICA Study Team)			
6		Review	NEMC				
7	If Necessary	Public Hearing	Public Action				
8		Permitting Decision-Acceptance or Decline	NEMC				
9	If Necessary	PER Revision	MoWL (CP)				
10		Permitted Issue	NEMC				
11	Implementation	Construction and Operation		Implementing Agency			
12	Implementation	Monitoring		Implementing Agency	Report		
13	Implementation	Auditing	NEMC		Report		
14	Implementation	Decommission			Report		

in priority projects, PER will be prepared by counterpart personnel after completing this final report, which was already agreed by EIA director of NEMC who are in chart of the IEE in the Study. After PER, the NEMC will prepare for reviewing, and public hearing if necessary. And then, permitting decision-acceptance or decline and after that it will response to counterpart to review officially.

After submission of the PER, the NEMC will compose Technical Review Committee (TRC) for reviewing from different Ministries. The review activities consist of these items shown *Table 12.13*. For this, the counterpart personnel needs to manage budget in advance, approximate estimation though NEMC staff about the project, it may be around 2,000,000 Tsh.

Table 12.13 Review Context by NEMC

Items
A: Review Preparation
Communication
Distribution of document
Statioary(Cartridge, paper, photocopy etc.)
B: Site visite
3 Experts X DSA of 55,000 X days
Review
C: Internal Review by NEMC experts
12P X 30,000/
Snacks and sofct drinks
D: Techincal Review Commuttee (TRC) meeting
Sitting allowance 12P X 60,000/ = days
Snacks & Tea
Conference hall.
E: Secretariat for consolidation of TRC comments
3 experts X 60,000 X days
1 secretary X 30,000 X days

12.7. RECOMMENDATIONS TO THE FURTHER PROJECT IN TERMS OF ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

12.7.1 INSTITUTIONAL CONFRONTING ISSUES ON ENVIRONMENTAL AND SOCIAL CONSIDERATION IN PROJECTS

(1) NEMC

As an advisory body of environmental management in Tanzania, it has put efforts for smooth and appropriate management of EIA. However, it seems that it has been struggle to make it institutionally function properly. Confronting issues based on lack of consistent system of EIA management are listed as follows, which are against staff enthusiastic attempts to work

- Lack of human resource over capacity of handling projects numbers, which cause such as;
- Late response and less communication from NEMC side
- Obscure responsibility among staff and weak of filing documents skills
- Limitation to go by all complicated procedure based on rule and guidelines regardless of project type

(2) Counterpart

The counterpart has greatly contributed to EIA activities in general. Against individual attempt, there is a confronting issue.

- Difficulty to prepare budget in necessary moment,

(3) Study Team

Because of inappropriate information on EA registration system from preparatory study team, there were confusion such as:

- EA registration should have done at the end of preparatory study or just after this full scale study starting points not after IEE conclusion, according to Tanzanian guideline.

12.7.2 Strengthening Capacity of Stakeholders of Environmental and Social Considerations

(1) NEMC

In order to overcome above mentioned issues, following approaches are recommended.

- Increasing staff number and strengthening their management skills with flexibility

For this techniques improvement, training course in environmental management in Japan might be interesting.

- Giving lessens to improve communication skills of NEMC staff
- Collectively conduct division of role and demarcation task, for filing matter, making use of digital methods to store.
- It might be better to distinguish projects of private sector of invest, like power supply and development projects which aims to meet human needs from governmental or NGOs

Basically, international or national projects planned already considering environmental and social aspect not to give negative impacts, while projects from private sector tend to try develop for pursuing own benefits as much as possible with less concern environmental and social aspects.

(2) Counterpart

- Ensuring enough budget for fiscal year in advance if the counterpart agency plans to have projects

(3) Study Team

Based on discussion on Director of EIA for convenient procedure of NEMC and Study Team, registration time was agreed in

- In soon after the full scale of Study started project in Tanzania

For response about examination of registration of environmental assessment, NEMC requires practically around two weeks, so the screening results by NEMC to decide the Study require a full EIA, or IEE only or no need any assessment will provide the Study Team in proper time.

12.7.3 Synthesis

In sum, establishment of monitoring programs, and frequent consultation and active participation of stakeholders are core for environmental and social consideration in the Study. As recognized, environmental and social consideration is “process” not something needs to be done within only certain period. Therefore, the role of the counterpart personnel who conducted IEE with JICA is enormous important and has a fully responsibility to lead environmental and social considerations into development agenda and all process in any project, even after implementation of water supply plan. Thus, the periodical monitoring on importance subjects will guarantee that any project or plan never give negative impact but better positive impacts. And through consultation with and active participations of stakeholders, particularly villagers will inspire the implementation of water supply plan and lead to further success. For any achievement, initiatives of responsible authority, MoWLD are crucial so that the actual action for better water management is strongly

recommended.

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