Chapter 3 Current Situation of Water Sector

3.1 Outline of Water Supply Services in Zanzibar

3.1.1 History

The Zanzibar Water supply service started in the 1920's. The management of water supply services in Unguja had been carried out by the Technical and Public Works Department of Zanzibar Town (until Zanzibar's Independence in 1964), RGoZ (after Independence until 2006), and ZAWA (from 2006 to the present).

Table 3-1 shows the history of the water supply service in Zanzibar. Water supply service was provided for free for 25 years since 1982. For this, ZAWA, the current provider, has many difficulties for operation and maintenance, specifically with regard to the deterioration of facilities and the difficulties of customer registration and tariff collection.

Table 3-1 History of Water Supply Services in Zanzibar

Year	Responsible Agency	Event
1920's	TPWD	Started water supply project in Zanzibar Town (currently called Stone Town and its vicinity). Bububu spring and Mtoni spring were the water sources.
1935		Introduced the standards of services, tariff and water supply devices.
1964	RGoZ	RGoZ takes over TPWD water projects following Zanzibar's Independence
1982		Water Supply Services for domestic use became free of charge
2002		Published "Zanzibar Vision 2002-2020" by RGoZ
2004		Published National Water Policy by Ministry of Water, Construction, Energy, and Land (former organization of MLWEE)
2006	ZAWA	Enactment of Water Law and establishment of ZAWA
2007		-Issued ministerial ordinance and water tariff is changed to paid service -Commencement of The project for Zanzibar Urban Water Supply Development (Japanese Grant Aid Project), Phase I
2008		-Amendment of ministerial order (adding water tariff chart) -Completion of the construction of The project for Zanzibar Urban Water Supply Development (Japanese Grant Aid Project), Phase I
2009		Commencement of The project for Zanzibar Urban Water Supply Development (Japanese Grant Aid Project), Phase II
2010		Completion of the construction of The project for Zanzibar Urban Water Supply Development (Japanese Grant Aid Project), Phase II
2013		Amendment of ministerial order (Tariff revision)

Source: JICA Survey Team

3.1.2 Current Status of Water Supply

(1) Water Supply Area

According to the ministerial order, "A responsible organization can define the water supply area and its name". However, in reality, ZAWA has not distinguished the water supply area, and has carried out water supply projects for the entire Unguja and Pemba Islands.

(2) Water Supply Area Population and Water Service Population

(a) Water Supply Area Population

Since ZAWA does not distinguish specific water supply areas, the population of the water supply area is equal to the total population of Zanzibar. The total Population of Zanzibar is 1,303,569, and the population of Unguja is 896,721 (National Census 2012).

(b) Registered Served Population

According to the number of customers registered (50,964 as of March 2017) and the average number per household (5.04 persons/household, National Census 2012), registered ZAWA customers would total to around 256,900 persons in Unguja. These values indicate that a considerable number of residents using ZAWA supplied water are not registered, and as such, the registration/ management of customers is a main issue.

3.2 Review of Policies and Plans Relating to Water Supply Sector

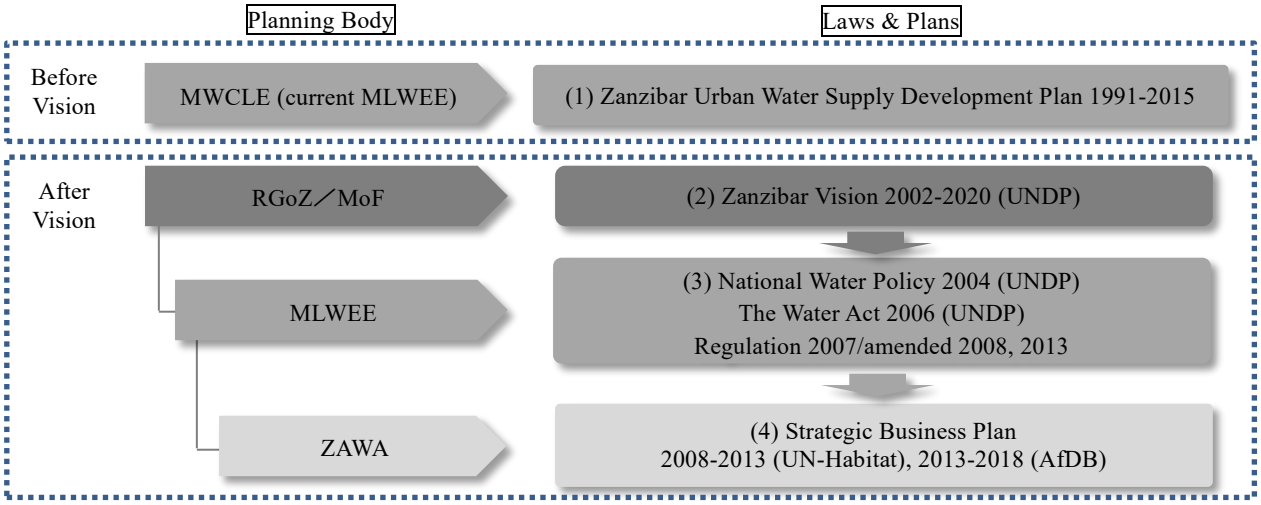
The policy and plans of the water supply sector have been formulated with donors' support.

The "Zanzibar Urban Water Supply Development Plan 1991-2015", planned with the support of FINNIDA, along with financial support from the said agency, carried out a project to develop distribution networks for the areas adjacent to the urban area with a rapidly growing population.

In 2002, "Zanzibar Vision 2020", which aims to eradicate absolute poverty in the society, was published by the Ministry of Finance and Planning with support from UNDP. Based on this, MLWEE published the "National Water Policy 2004". Subsequently, in 2006, the Water Act was issued and ZAWA was established. In 2007, the Water Regulation that set the water tariff structure was published (revised in 2008 and 2013).

The "Zanzibar Urban Water Supply Development Plan" is a long-term plan which has not been revised following the publication of the Vision and the Policy. As an alternative of the lack of a revised long-term plan, ZAWA has prepared a strategic business plan (hereinafter referred to as "SBP") for business operations. The SBP I (2008 – 2013), was formulated with support from United Nations Human Settlements Programme (hereinafter referred as "UN-Habitat"), and the SBP II (2013 – 2018), was formulated with support from AfDB and is currently under implementation.

The Framework of Water Supply Sector in Zanzibar is shown in **Figure 3-1**.



Source: JICA Survey Team

Figure 3-1 Policy and Plans for Water Supply Sector in Zanzibar

(1) Zanzibar Urban Water Supply Development Plan 1991-2015

This plan was implemented by FINNIDA in September 1991 for the development of urban water supply in Zanzibar Town (current Urban District) and the Pemba Island towns; Wete, Chake Chake and Mkoani. Outline of this plan is as follows;

(a) Project frame

- Target Area: Zanzibar Town, Wete, Chake Chake, Mkoani
- Target Population (2015): 483,000 (only Zanzibar Town)
- Target Amount of Supply (2015): 60,000 m^3/day (only Zanzibar Town)

(b) Water source

The planned amount of groundwater use (including agricultural use) was 10% of the recharge amount in Unguja (2015); and the aquifer contained sufficient amount of water to meet water demand.

- Amount of groundwater use (2015): 160,000 m^3/day (58.4 million m^3/year)
- Amount of groundwater recharge: 600,000,000 m^3/year

(c) Project for water supply system improvement

Since the existing water supply system has aged and the capacity is inadequate to supply water to current and future residents, this project is therefore aimed to supply water, with sufficient amount and quality, to all users including domestic, industrial and commercial, through rehabilitation of the existing water supply system.

The project was carried out in three phases, as shown in **Table 3-2**. According to ZAWA, FINNADA finished their supports in Phase 2 (2000) and facility developments in phase 3 were carried out by ZAWA.

The goal of each phase is shown below:

- Phase 1 (1991 - 1994): Development of water-related policies, financial situation of water suppliers and water-related systems.
- Phase 2 (1995 - 2000): Secure funds for project implementation and utilize donor support for facility construction and repair, if possible. Water supply facility rehabilitation and construction shall be outsourced. The water supplier shall be able to cover O&M costs from income.
- Phase 3 (2001 - 2015): Focus on further enhancement of the financial system. All operation and maintenance costs shall be covered by the revenue on water sales

Table 3-2 Facility Development and Rehabilitation Plan in ZWSUP

Phase	Plan of Consolidation and Rehabilitation of Facility
Phase 1 (1991-1994)	・ Rehabilitation of Saateni Water Supply (completed) ・ Installation of large capacity pump in Mtoni and Bububu spring, or installation of test/production well in water catchment area (completed) ・ Rehabilitation of protection shed in Mtoni and Bububu spring (completed) ・ Boring of test/production well in Kijito Upele I-II, Chunga, Mwembe Mchomeke, and Kianga, and boring test/production well in Mwembe Mchomeke II and North Kianga I (completed) ・ Rehabilitation of Welezo Reservoir (completed) ・ Rehabilitation and overhaul of reservoirs made by steel in Saateni and Welezo (completed) ・ Installation of pressure reducing valve or tank (cancelled), and chlorination equipment in Welezo (completed) ・ Building headquarter office of water supply management with office, workshop, laboratory and storage. (cancelled) ・ Installation of water supply pipes in urban area and city fringes (9.5 km) (completed)
Phase 2 (1995-2000)	・ Installation of water supply pipes in urban area and surroundings (31.4 km) (completed) ・ Installation of water pipes from Mwembe Mchomeke II to Welezo Reservoir (2.5 km) (completed) ・ Installation of new pipelines to Saateni booster pump station (due to increase of water amount in Bububu and Mtoni springs) (cancelled)
Phase 3 (2001-2015)	・ Renewal of pump in Chunga, Kijito Upele I-II, Mwembe Mchomeke I-II, Kianga, Mtoni, Bububu and Saateni (completed only Kijito Upele and Mwembe Mchomeke) ・ Boring production wells in Kimara, North Kianga I-II, Kizimbani I (cancelled) ・ Installation of water supply pipes in urban area and surroundings (48.2 km) (partially completed)

Source: Zanzibar Urban Water Supply Development Plan 1991-2015

(d) Progress status

Development of water supply facilities in this project was carried out under FINNIDA's grant project. Formulating visions, national water policies and starting fee-based services planned in Phase 1 were carried out after 2002, but the financial situation is still unable to cover the O&M cost.

(2) Zanzibar Vision 2020

(a) Outline of the Zanzibar Vision

This Vision provides the future image of every sector (water, economy, tourism, agriculture, industry, gender, infrastructure, etc.) as a roadmap for overall development. It aims for quality

improvement in social infrastructure and increasing accessibility to public services towards economic growth. 100% access to safe water is included in the main targets by 2020.

(b) Objectives and progress status of the Zanzibar Vision

The objectives and progress of the Vision are shown in **Table 3-3**. Achievement of the objectives by 2020, such as equitable water supply, sustainable water supply and maintenance of facilities to maintain capacity, which require investment and funds are difficult due to the financial difficulties of ZAWA.

Although the billing and water charge collection management system was introduced, it is not effective because accuracy of customer database is low.

Table 3-3 Policy Objectives and Progress of Zanzibar Vision 2020

Target	Progress/Achievement
Develop and promote an efficient water supply and management system that will ensure reliable water supply for all purposes at a reasonable cost	A reliable water supply has not been realized. Development/promotion of a water supply management system has not been realized.
Establish and protect specific areas for sources of drinking water and expansion of rainwater catchment systems	Terms related to water source construction location are controlled in the Water Regulation, but specific areas for source protection have not been registered.
Promote community ownership and rights to water supply	The promotion of ownership and rights to community ownership has not progressed.
Enhance equity of access, distribution and sustainable supply of clean water to households in rural and urban areas	Equal water distribution, sustainable water supply has not been realized.
Ensure that the installed capacity for water supply functions adequately and is properly maintained	Proper maintenance has not been practiced, for example, leakage has not improved.
Encourage a broad range of environmentally sound technologies in the provision of water, including gravity piped, pressure pumps, deep and shallow wells, open wells and dams	Solar power facilities have been developed, but the capacity is very limited.
Encourage the development of rain water harvesting technologies and activities	Actual activities have not been practiced.
Institute and maintain an efficient and effective water tariff, billing and timely revenue collection system for all water users	A tariff collecting system has been introduced, but the customer database is not managed properly. Accurate billing and tariff collecting activities have not been implemented.

Source: JICA Survey Team

(3) National Water Policy

(a) Outline of the National Water Policy

The objectives of the Policy are to supply clean water to all consumers by developing a social environment which shall contribute to the nation's growth, to secure water resources and to prevent contamination.

(b) Objectives and progress status of the National Water Policy

The objectives and progress status are shown in **Table 3-4**. Progress is confirmed for several items, such as "Water resource ownership" and "Ownership and management of water service", but the progress for items which require investment for improvement of water supply facilities and for securement of revenue from tariff is slow, such as "Satisfy basic

water needs" and "Finance". In addition, the data for water development possibility is inaccurate, and the progress of "Environmental Conservation" is not sufficient.

Table 3-4 Objectives and Status of Progress of National Water Policy

Policy's Objectives		Progress Status
Water resources ownership	All resources are public water, and a water resource management board shall be established to prevent pollution and salt water infiltration in the water resources.	The Water Resource section has been established in ZAWA's Water Development Department as an action of water resource protection organization. The section is planned to become an independent authority for water resource management in the future.
To satisfy basic water needs	Domestic water is the priority for water supply.	The current water supply service does not satisfy basic needs.
Ownership and management of water service	Transition of the ownership and management to the local community, and conversion of the government's role to business management monitoring, regulating and supporting.	ZAWA is in charge of the water supply business, and MLWEE is the supervising authority.
Finance	Fiscal independence at minimum to be able to cover the O&M cost.	ZAWA's balance has always been in red, and cannot afford the O&M cost.
Environment conservation	Development of water source should not harm the environment, and not have any impact to the future generation.	Concrete activities for water resource management are not promoted, and therefore the sustainability of water resource use cannot be evaluated.

Source: JICA Survey Team

(4) Strategic Business Plan (First Period)

Strategic Business Plan 2008-2013 (hereinafter referred as "SBP"), supported by UN-Habitat, set targets and deadlines for enhancement of the organization, proactive water resource management, provision of efficient and effective water supply service and the improvement of financial sustainability. Main activities of the SBP were development of customer information database, water resource management, reduction of non-revenue water, and water tariff billing and collection.

(5) Strategic Business Plan (Second Period)

The current Strategic Business Plan 2013-2018 (hereinafter referred as "SBP II"), supported by AfDB, was set concentrating on the implementation of the loan-project mentioned in **3.2.2**. SBP II analysed the status of ZAWA's capacity of business management, water resource management, water supply service, customer information management and financial management, and also set quantitative business targets. The issues mentioned in the SBP II recommendations are the same as the items of the FINNIDA long-term plan: change in awareness of ZAWA's management consciousness, customer information management (meter reading, billing, tariff collecting) and facility O&M.

Objectives and progress status of each item of SBPII is shown below;

(a) Facility: Demand and supply, intake and distribution

Since installation of flow meters to the water supply system is insufficient, quantitative

measurements for water flow, such as intake, distribution and usage is difficult. Pipeline improvement such as leakage repair is insufficient as well. Thus, achievement of the target is considered very difficult excluding the item of personnel expenses. Progress status is shown in **Table 3-5**.

Achieved Item: Personnel Expense (less than 40% of total expense)

Table 3-5 Progress Status of SBM II (Demand and supply, intake and distribution)

Item		Target value and Period	Progress
Supply and demand	Accessibility	85% of the total population by 2018 (1.2million)	Actual value is unclear, but 85% is difficult to achieve
	Supply amount (unit consumption)	Large-scale housing: 100L/person/day Mid-scale housing: 70L/person/day Small-scale housing: 30L/person/day	Average water consumption of metered customer is 75 L/person/day
	Increase of connection per year	Domestic:5.9% (99,814 by 2018) Public: 1.5% (272 by 2018) Commercial: 2.0% (609 by 2018) Accommodation: 3.0% (72 by 2018) Agriculture: 7.0% (182 by 2018) Total: 5.8% (100,950 by 2018)	50,964 customers in Unguja (as of March 2017), target number of customers by 2018 is 100,950.
	Leakage (from water source to supply)	-0.5%/year (21% by 2018)	immeasurable
	Maximum distribution amount	Under 97.5% of intake (throughout plan period)	immeasurable
	Supply time	Over 10 hours per day (by 2018)	achieved in the limited area
	Removal of unattended water	By middle of 2017	immeasurable
	Intake amount	86,553 m^3/day or 31,553,881 m^3/year	36,253m^3/day (2015)
Intake and distribution	Actual intake amount	Intake to meet demands (2017/18)	immeasurable
	Personnel cost	Under 40% of total cost (by end of 2017/18)	**21.6% (2014/15) (achieved)**
	Water quality	80% of samples meet standards (2017/18)	immeasurable
	Responding to complaints	Within 5 business days (by 2017/18)	No record
	Responding to new customers	Within 10 business days (by 2017/18)	No record
	Responding to meter installation	Within 10 business days (by 2017/18)	No record
	Unexpected supply suspension (% of households)	Under 24 hours: 25% (by 2017/18) 24 – 36 hours: 20% (by 2017/18) 36 – 48 hours: 15% (by 2017/18) Over 48 hours: 10% (by 2017/18)	immeasurable
	Connection with flow under 7L/min	15% of the connection (by 2017/18)	immeasurable
	Water revenue and expenditure	Prepare by end of 2014/15	unprepared

Source: JICA Survey Team

(b) Customer management: Water supply benefit and cost, business management

ZAWA is using the "Smart Billing Manager II" system (hereinafter referred to as "SBM II") to manage the data of customers in Unguja. The registered numbers of customers, installed meters, distributed bills and collected tariff are shown in **Table 3-6**.

Table 3-6 Numbers of Customers, Meters, Billing and Tariff Collection (March 2017)

Item	Number in Unguja	Number in Urban West Region	Remarks
SBM II registered customers	50,964	39,909	
Installed water meters	5,538	4,739	
Billed customers (a)	49,317	38,546	The number is on ZAWA's Billing Management System
Billed metered customers	5,412	4,625	
Billed flat-rate customers	43,905	33,921	
Bill distributed customers	5,412	4,625	Only metered customers
Paid customers (b)	3,135	2,870	
Metered customers	1,540	1,462	
Flat-rate customers	1,595	1,408	
Water Charge Collection Rate (%), (b/a)	6.4%	7.4%	
Household by 2012 Census	178,018	113,420	

Source: ICT, ZAWA

Water charge collection rate against the billed customers is very low, 6.4% for Unguja and 7.4% for Urban West district respectively. This is conceivable because of multiple factors such as low water quality service, undistributed bills to flat-rate customers who are in majority, etc. Under this situation, the achievement of the SBP II target is difficult. **Table 3-7** shows progress status of SBP II.

Although the target achievement is difficult, ZAWA is carrying out activities to improve the situation such a meter installation (twice per week), tariff payment service using mobile telephones, bill distribution by SMS, and meter reading outsourcing.

Achieved Item: Water Tariff Reflected Expenditure, Introduction of New System of Customer Database and Water Charge Collection

Table 3-7 Progress Status of SBP II (Revenue by Water Supply and Management)

Item		Target value and Period	Progress
Benefit and cost	Billed and unbilled	Unbilled: 32% (2012/13) to 7% (2017/18) Billed: 68% (2012/13) to 93% (2017/18)	Billed Rate (Unguja) 5,412/49,317＝11.0% (Regarding bill distribute rate as billed rate)
	Tariff collection rate	Over 87% (by 2018)	3,135 /49,317=6.4%
	Number of installed meters	33,500 (by 2018) 5,000 meters installed per year	5,538 (March 2017)
	Realize continuous facility management by water supply benefit	End of 2017/18	The O&M is not covered by revenue.
Business management	Water tariff reflecting the cost	By 2017/18	Tariff for metered-rate was put into operation from April 2016. Tariff revision for flat-rate customer or transition to metered customer is necessary.
	Development of new customer database and billing/collecting system	End of 2012/13	**SBM II was introduced. (SBM was updated to SBM II) (achieved)**
	Register data of all customers	End of 2013/14	50,964 customers registered in Unguja as of March 2017.
	Monthly meter reading of all metered customers	End of 2013/14	Meter reading of all metered customers is executed.
	Monthly billing to registered customers	End of 2013/14	Bills are not distributed to flat-rate customers.
	Bill delivery ratio	75% (by end of 2017/18)	5,412/49,317＝11.0% (March 2017)
Business management	Water sales by kiosks and outsourcing of bill delivery	No time limit	
	Water charge collection ratio	87% (by end of 2017/18)	3,135/49,317＝6.4% (March 2017)
	Bill payment period	Under 40 days (by end of 2015/16)	Immeasurable
	Allowances for bad debts	Under 10% (by end of 2017/18)	39.2% (2014/15)

Source: JICA Survey Team

(c) Finance: Finance, financial independence, accounting and management

The progress situation of ZAWA's finance, financial independence and accounting and management is shown in **Table 3-8**. Currently, ZAWA cannot manage its business without governmental subsidies. It does not have sufficient internal reserves, and cannot make investments using its own funds. When ZAWA needs funds, ZAWA borrows from the infrastructure-fund of RGoZ (funds by the government to be used for social infrastructure development, shown as "General Budget Subsidy" in **2.2.2 (3) (c)**) but the received amount does not always meet the requested amount.

A new accounting management system and fixed asset management system has been introduced in 2013 and is currently in operation. For the financial IT field, the activities have been implemented as planned, such as long-term budget management based on SBP II, quarterly financial reports and external audit.

Achieved Item: Management cost and expenses, Rigorous estimation of acid test ratio, Introducing new account system, Registration of Fixed Assets, Evaluation of Fixed Assets and Operation of Management System, Fair External Audit Report, Long-term Budget Preparation and Revision, Management/Analysis/Revision of Budget

Table 3-8 Progress Status of SBP II
(Finance, Financial Independence, Accounting Management)

Item		Target value and Period	Progress
Finance	Termination of subsidy	From 2015/16	7.48 billion TZS granted (2015/16)
	Management cost and expenses	Under 12% of total cost (2015/16)	**5.6% (2015/16) (achieved)**
	Cash necessary for water supply business management	Under 30% of tariff benefit	75.6% (revenue÷ (maintenance cost - power charge - depreciation cost)) (2015/16)
Financial independence	Current asset (cash, bank balance)	Over 20% of trial operation calculation	0.4% (cash and bank balance÷total asset) (2015/16)
	Rigorous estimation of acid test ratio (cash and bank balance/actual debt)	Over 1.0 (by 2015/16)	**3.56 (2015/16) (achieved)**
	Own fund investment	Reach 10% (by 2017/18) Reach 25% (long-term objective)	0.3% (2015/16)
Accounting management	Introduce new accounting system	End of 2013	**Introduced (achieved)**
	Register fixed assets	End of 2012/13	**started (achieved)**
	Evaluation of fixed assets and operation of management system	By 2013	**operated (achieved)**
	Completion and operation of inventory management	By 2013/14	System not completed.
	Fair external audit reports	By 2017/18	**started (achieved)**
	Long-term budget preparation and revision	By 2014/15	**started (achieved)**
	Quarterly financial reports	By mid-2014	**started (achieved)**
	Management, analysis and revision of budget	By mid-2014	**started (achieved)**

Source: JICA Survey Team

(d) Conclusion

Progress is not confirmed in the fields of water facility improvement, customer registration and management, and in the meter reading/billing/collection of water charges. To improve the water supply service and ZAWA's business, it is essential to concentrate on facility improvement and water charge collection management.

3.3 Organization of Water Sector

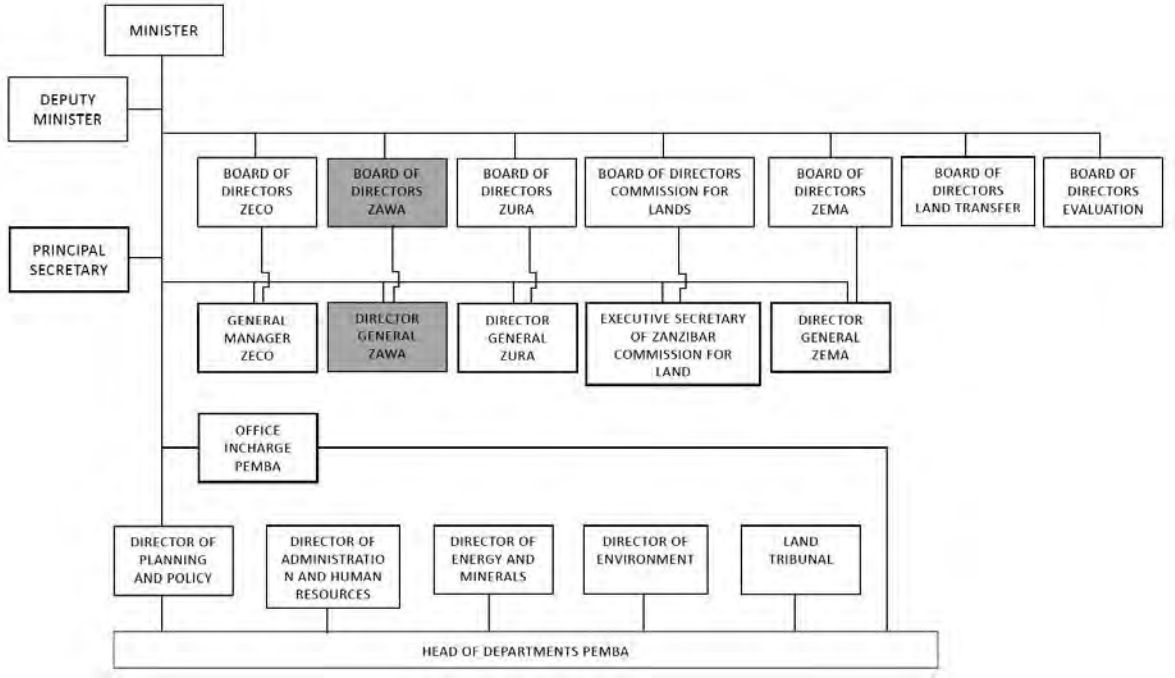
3.3.1 Competent Authority and Implementing Organization

MLWEE is the competent authority of public water supply, and ZAWA is a corporate authority established to fulfil the roles of operating and managing water supply facilities of Zanzibar (Unguja and Pemba Islands). The origin of ZAWA is DWD, established in 1964, and was formed into an autonomous body in 2006 through the enactment of the Water Act, No. 4 (2006) and is managed following the Water Regulations (2007), along with the Amendment of 2008 and Amendment of 2013.

(1) MLWEE

ZAWA falls under the MLWEE. MLWEE supervises a wide field of sectors outside the water sector, such as land, electricity and environment. The current structure of MLWEE has been reorganized after the elections of March 2016. Previously, the Ministry had often changed its name and jurisdiction such as MWCEL (Ministry of Water, Construction, Energy and Lands) and MLHWE (Ministry of Lands, Housing, Water and Energy).

The organization chart is shown in **Figure 3-2**.



Source: Ministry of Lands, Water, Energy and Environment

Figure 3-2 Organization Chart of MLWEE

(2) ZAWA

(a) Board of ZAWA

The Board of ZAWA is regulated in the Water Act, and is composed of a Chairperson, Director General (hereinafter referred to as "DG") and three other members. The Chairperson and DG are appointed by the President of Zanzibar, and other Members by the Minister of MLWEE (hereinafter referred to as "Minister"). The Board also has a Secretary who also acts as the lawyer for the organization.

All members of the Board may hold office for 3 years, and are eligible for reappointment. The Minister may terminate or suspend any member appointed by him if they conflict with any of the following;

- Inability to perform the functions of the member's office
- Misbehaviour or misconduct
- Convicted of a criminal offence involving fraud, dishonesty or moral turpitude
- Fails to comply with the regulations relating to disclosure of interest on a particular case
- Absent from 3 consecutive meetings of the Board without the leave of the Chairperson
- Any other sufficient reasons to be recorded in writing

Since the establishment of ZAWA in 2006, four offices of the Board have been established, although four of the five members of the second and third office have been reappointed including the chairperson and the DG. The fourth office, appointed in November 2016, saw four member changes including the chairperson but the DG had been reappointed again.

(b) Executives

The DG of ZAWA, who is appointed by the President, is the CEO and is in charge of all jurisdictional responsibilities in both Unguja and Pemba Islands.

The Directors of each Department are appointed by the Board. Aside from the Departments, 5 Units are established to assist the overall operation of ZAWA. The functions of each Department and Unit are described in **3.3.2 (3)**.

(3) Activity of ZAWA

The activities of ZAWA are regulated in the Water Act.

- Control, manage and protect all catchments areas and shall have the mandate to take legal actions against any violation
- Secure the continued supply of water
- Promote the conservation and proper use of water resources
- Manage production and distribution of water on sustainable basis

- Advise the RGoZ in formulation of policies relating to the development and conservation of water
- Specify standards of water quality, effluent and water equipment
- Enter transactions which the Board considers necessary
- Propose necessary amendments of water tariffs and water service charges to the Board
- Perform any other function in pursuit of the provisions of the Water Act

ZAWA also has the authority to establish a branch or sub-branch of Water Committees on the advice and recommendations of the Board for the proper performance of the organization's functions. In addition, ZAWA may restrict or suspend the supply of water should any of the following conditions occur.

- The available supply of water from the waterworks is judged as insufficient
- For the purpose of extending, altering, testing or repairing the waterworks, connection or fire service
- Public standpipe or public fountain is damaged, polluted or wasted
- Outbreak of fire or breakdown of waterworks
- Customer fails to pay water bill
- Upon interference, tampering or infliction of the waterworks
- In case of and breach by the customer under the Water Act

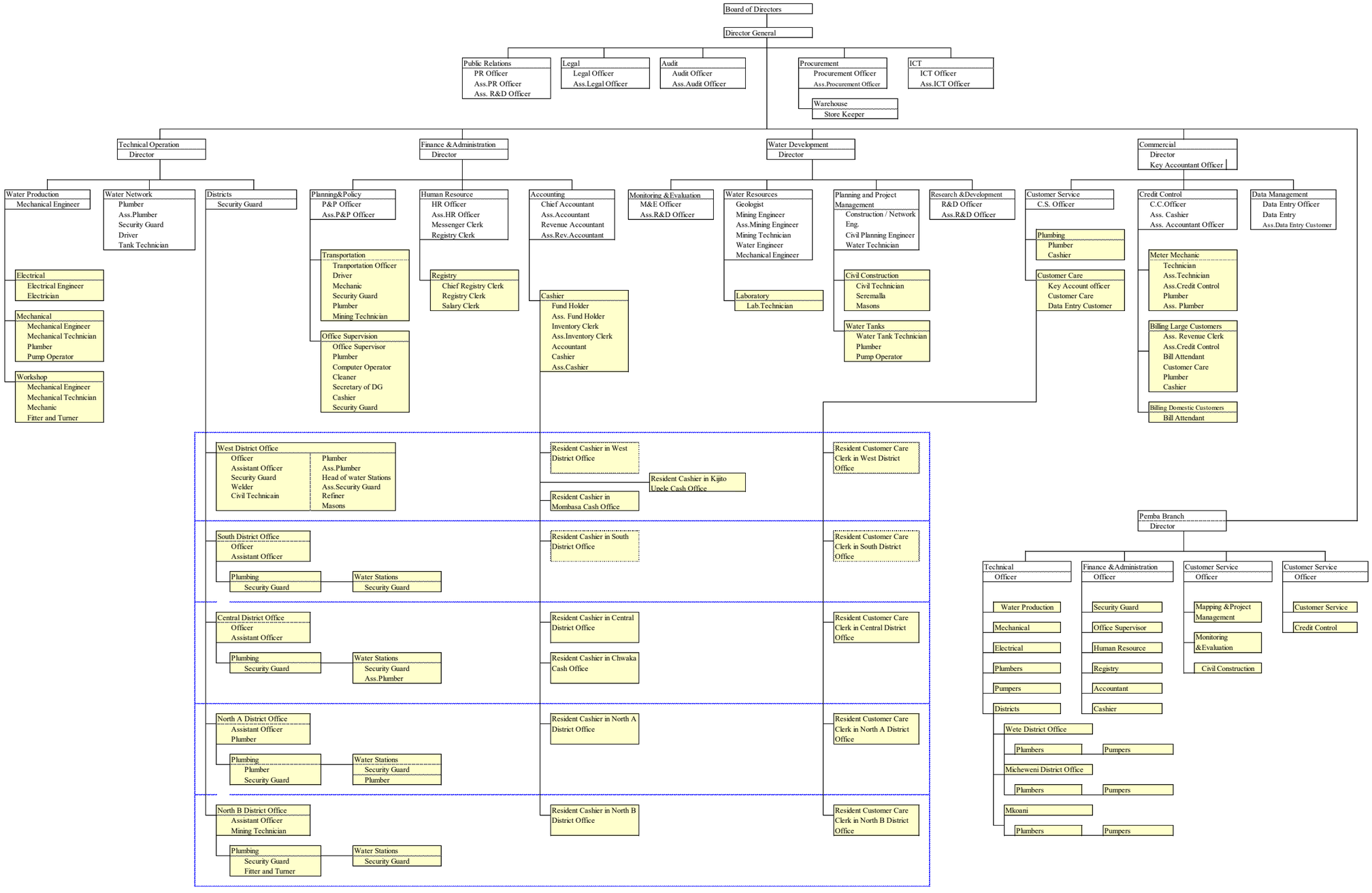
The funds and resources of ZAWA consist of the following;

- Sums provided by the RGoZ
- Sums or property which may be vested in ZAWA
- Sums ZAWA receives as fees, rates or charges for supplied water or services
- Donations, grants, bequests and loans the Board may receive

3.3.2 Organization of ZAWA

(1) Current Organization

ZAWA is managed by 5 Board members (including the DG), and consists of five Units and five Departments, with Sections and Sub-sections within each. As of July 2016, 375 regular staffs are assigned in Unguja Island accompanied by temporary staff stationed at District offices and also for meter reading and billing works. The current organization chart is shown in **Figure 3-3**.



Source: Prepared by JICA Survey Team based on information from ZAWA

Figure 3-3 Organogram of ZAWA

(2) Proposal of Organization Reform by Technical Cooperation Project Phase 2

The following two proposals had been submitted to ZAWA by the Technical Cooperation Project (Phase 2).

- 1st proposal (June 2014, Reform of organizational structure)
- 2nd proposal (February 2015, Segmentalization of employees)

Since the first proposal was issued during SBP II (Year of 2013 to 2018), ZAWA wished to keep their current structure. Therefore, the proposal remains under deliberation by the executive personnel. Meanwhile, the second proposal had already been authorized by the executive personnel, and the proposed organizational reform was carried out. The shape of current organizational structure was established through this process.

Major contents of the second proposal are following:

Table 3-9 Items and Status of 2nd Proposal

Proposed Item	Current Status
Merge ICT Unit and Data Management Section. Functions of system administration, technical support on computer hardware, software, network and data management are to be merged into one unit.	Although the organogram does not show any changes, the actual work is united to be managed/carried out by ICT.
GIS and SBM works are to be integrated into the daily routine of Planning and Project Management Section, with the ICT unit managing GIS data. GIS & Mapping Sub-Section shall be left for encoding and utilization of GIS data.	Not executed
Rename Research & Development Section as "Development & Innovation Section".	Not executed
Merge Planning & Policy Section and Monitoring & Evaluation Section to manage the technical, financial, administrative researches, as well as planning and evaluation for corporate management.	Not executed
Reallocate all plumbers and meter mechanics into Water Network Section.	Not executed
Merge Technical Operation Department and Water Development Department in order to enable the establishment of effective PDCA (Plan, Do, Check and Act) cycle.	Not executed
Nominate the officers of District Sections. The tasks of the Officer of the Section shall be to ensure that (1) suitably sized and staffed district offices are established; (2) necessary skills, resources and support exist; (3) functions, programs and staff are coordinated; and (4) full cooperation and coordination with ZAWA HQ are established.	Officers have been appointed. However, the proposed authority has not been granted.

Source: Prepared by JICA Survey Team base on the final report of the Project for Zanzibar Urban Water Supply Development in the United Republic of Tanzania Phase 2

(3) Duties of Each Department and Section

ZAWA is made up of 5 Units and 5 Departments, and there are 13 Sections under the Departments. The duties of each are shown in **Table 3-10**.

Table 3-10 Duties of the Each Department and Section

No.	Department Name	Duties
1	Public Relations Unit	-Promotional activities
2	Legal Unit	-Plan, organize, coordinate, direct, implement, monitor and control legal affairs -Transact business performance decision making and implementation
3	Internal Audit Unit	-Plan, organize, develop, coordinate, direct, monitor and control internal performance systems -Assure management auctioning
4	Procurement Unit	-Plan, organize, develop, direct, coordinate, monitor and control procurement and supplies activities
	Warehouse Sub-unit	-Enhance receiving, storing and issuing of goods to improve customer service
5	ICT Department	-Database management -Supply/maintenance of computers and meter readers
6	Technical Operation Department	-Construction, O&M and repair of water supply facilities and pipeline
	Water Production Section	-Monitor and control maintenance and repair of water network operating equipment to sustain and enhance water supply
	Water Network Section	-Monitor and evaluate water network operation
	District Offices	-Monitor and control water pump stations, networks and customer services in the district
7	Finance and Administration Department	-Plan, organize, develop, coordinate, direct, monitor and control financial policies, systems, procedures, rules and regulations
	Planning & Policy Section	-Coordinate planning and policy activities by devising, developing, and manifest strategic plans and policies
	Human Resources Section	-Coordinate, monitor and control acquisition, developing, utilization and retention of human resources
	Accounting Section	-Enhance tariff collection -Expenditure monitoring
8	Water Development Department	-Monitor and control water development activities in terms of projects, water resources production and development
	Monitoring & Evaluation Section	-Monitor and evaluate competencies in water production, networking, supply and deficits to elevate customer satisfaction levels -Water quality management
	Water Resources Section	-Conserve and develop water resources
	Planning & Project Management Section	-Project management for water resource conservation and development
	Research & Development Section	-Coordinating internal research -Coordinating knowledge sharing section -Operating ZAWA training centre
9	Commercial Department	-Plan, organize, coordinate, develop, direct, monitor and control customer care and related data management -Proactively and comprehensively facilitate billing and revenue collection
	Customer Service Section	-Attend to various customer complaints, including Districts -Promote registration
	Credit Control Section	-Control customer debts
	Data Management Section	-Monitor and control management of customer data -Bill preparation and distribution
10	Pemba Branch	- Takes charge of water supply activities in Pemba Island

Source: JICA Survey Team

3.3.3 Analysis of ZAWA's Organization

(1) Organization Analysis at the SBP Formulation

A SWOT analysis of the organization has been carried out for both the SBP I (2008-2013, UN

Habitat) and SBP II (2013-2018, AfDB). The common items focusing on institutional capacity among the two reports are shown in **Table 3-11**.

According to the analysis, weakness of the organization is lack of professionals though the number of employees is more than enough, low motivation and moral of employees, lack of ability of project implementation, and insufficiency and inaccuracy of data.

Table 3-11 Common Items among SBP I and SBP II SWOT Analysis

Items	Descriptions
Strengths	Existence of legislation necessary to regulate ZAWA activities as a corporate authority (Water Act, National Water Policy, Water Regulations)
	Existence of a strong deciding system (4 of the 5 members of the 3rd Board were reappointed)
Weaknesses	Overstaffing
	Limited qualified and trained staff
	Lack of staff motivation, low morals
	Inadequate ICT personnel
	Unreliable customer database
	Unable to enforce laws, regulations or ZAWA decisions
	Low quality MIS database
Opportunities	Government support (establishment of ZURA aiming to increase tariff income)
	Donor support (JICA, AfDB, Un-Habitat, Chinese Government)
Threats	Losing skilled staff to better job opportunities outside ZAWA
	Political interference and influence

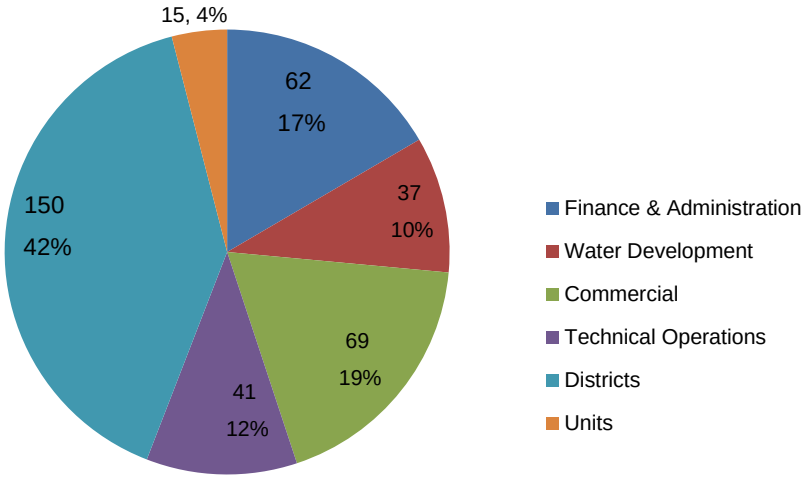
Source: JICA Survey Team

(2) Staff Number

Sub-sections (yellow highlighted in **Figure 3-3**) under a Section and the Sections under a Department are placed, and personnel are allocated to each.

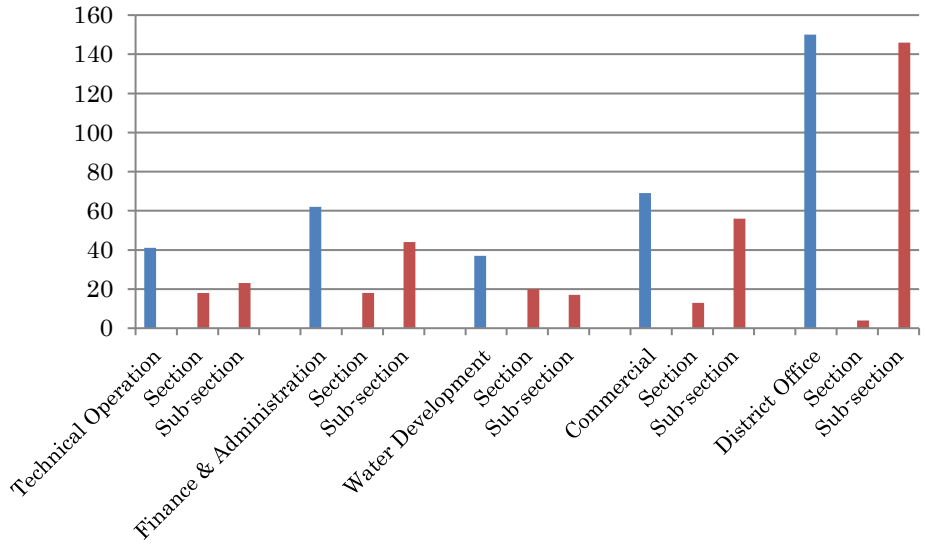
The composition of the personnel of ZAWA is shown in **Figure 3-4**, and of each Department is shown in **Figure 3-5**. The District Offices are isolated for the same aforementioned reason.

150 staff are allocated in the District Offices (42% of total staff), and 128 are security guards. The number of staff in the Sections (Customer Service, Credit Control and Data Management Section) of the Commercial Department is also large 56 with 16 bill attendants, and also the Finance & Administration Department Sections (Planning & Policy, Human Resources and Accounting Section) 44 with 9 drivers.



Source: JICA Survey Team

Figure 3-4 Staff Composition of ZAWA

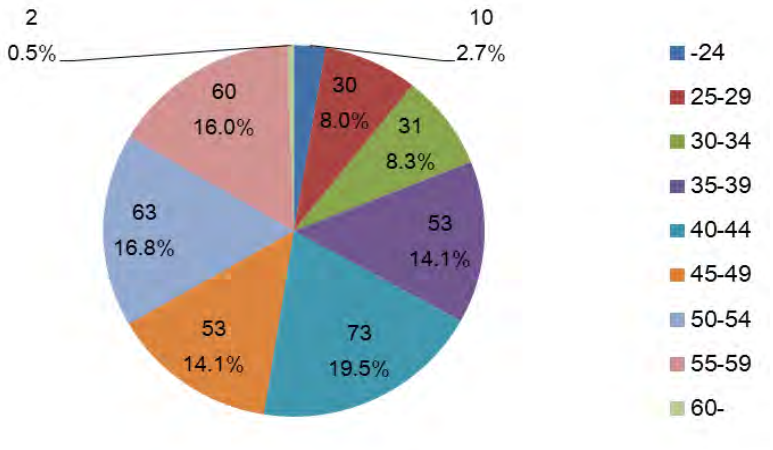


Note: Section and Sub-section in the graph show the allocated number of staffs in Department & Section, and Sub-section, respectively.
Source: JICA Survey Team

Figure 3-5 Staff Numbers for Each Department

(3) Age

47.4% of the staff are aged 45 and over (**Figure 3-6**). "High percentage of aged staff" was analysed as a weakness of ZAWA in SBP I, but currently the age strata bias is small. However, the number of staffs of age 34 and younger is relatively small.

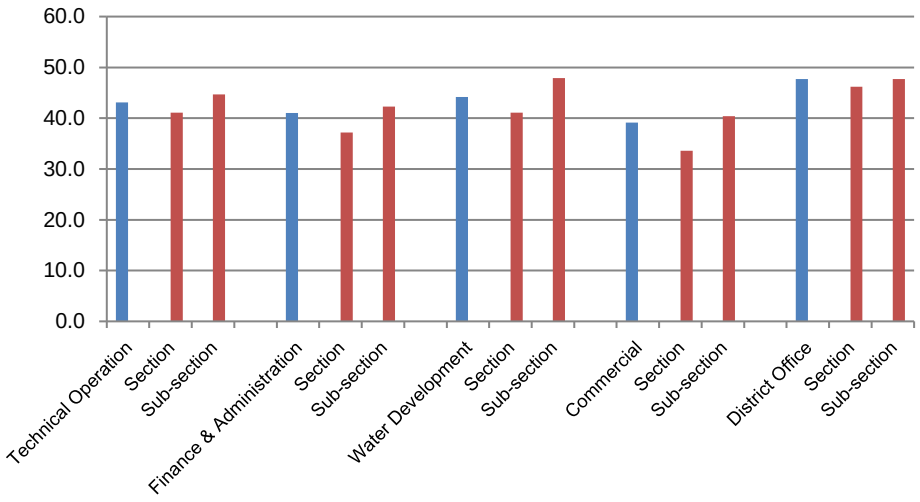


Source: JICA Survey Team

Figure 3-6 Age Distribution of ZAWA Staff

The average age of each department is shown in **Figure 3-7**. In the current organization the District Offices are included in the Technical Operations Department, but in order to compare the data within the actual activity fields for this section, the District Offices have been isolated.

The Commercial Department is the youngest (39.1) while the District Offices is the oldest (47.7). In all cases, the average age of the sub-sections tends to be higher than others. The main cause of this phenomenon is that most of the high-aged workers, such as plumbers, drivers and security guards (main jobs are to guard the pump stations of the water sources and water supply facilities, but also cover the works of pump operation monitoring, communication means upon an emergency and recovery from power failures) are assigned to the sub-sections.



Source: JICA Survey Team

Figure 3-7 Average Age of Departments

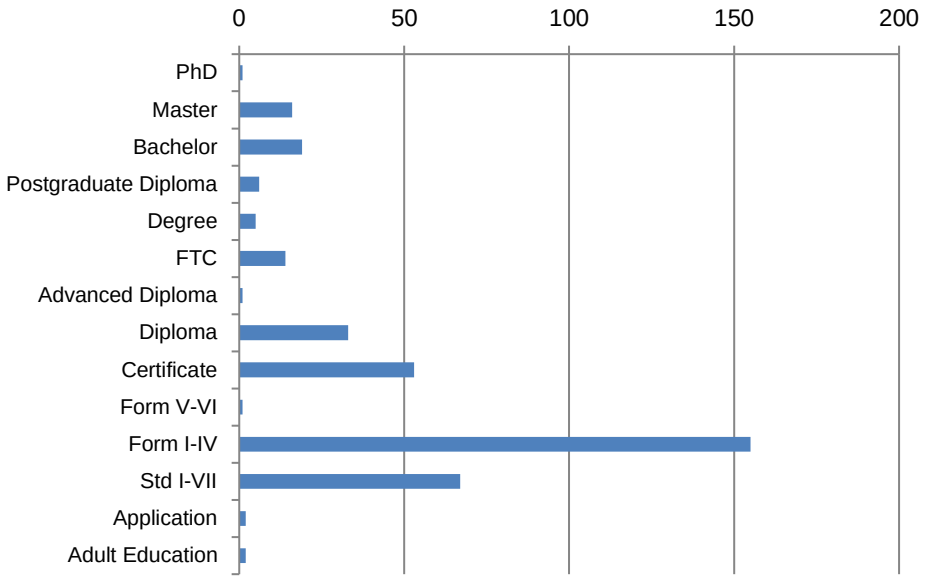
(4) Educational Background

The general education system of Zanzibar is based around a 2-7-4-2-3 structure. The breakdown is; 2 years of pre-primary school, 7 years of primary school, 4 years of ordinary secondary school (ordinary level), 2 years of advanced secondary school (advanced level) and at least 3 years of higher education. In addition, there are vocational schools, teacher training schools and colleges of various fields. The degrees received upon graduation from each grade are: primary education "(Standard) STD I-VII", ordinary secondary school "Form I-IV", advanced secondary school "Form V-VI". Secondary education comprises both an ordinary level and an advanced level. The ordinary level comprises forms I through IV, while the advanced level comprises forms V and VI. At the end of ordinary secondary school, students take an examination and only those who have achieved a satisfactory result may then attempt to attend an advanced secondary school. Other students may continue studying within secondary vocational education to receive Certificate and Diploma degrees, or attend to institutions to gain technical knowledge. The structure of the higher education system is divided into an undergraduate and postgraduate phase, each leading to attainment of a bachelor's, master's or doctorate degree, or postgraduate diploma.

The tuition fee for primary education has been free since 2002, but supplies such as uniforms and textbooks are to be borne by the family. In addition, only the students who have achieved a satisfactory result in the exams at the end of primary education can attend the low-fee public secondary schools, so the chances to enrol to advanced education depends on not only the student's performance but also the financial situation of the family.

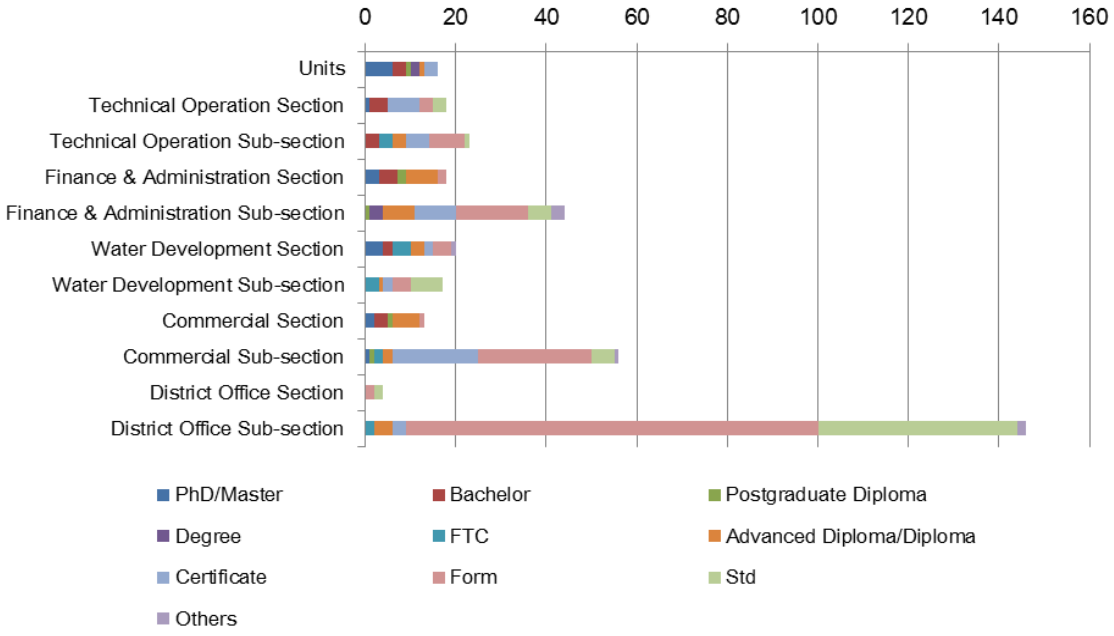
The educational background of ZAWA staff is shown in **Figure 3-8**, and of each Department in **Figure 3-9**. The District Offices are isolated for the same aforementioned reason.

60.3% (226) of the staff have completed up to Form IV or below. Said staff are concentrated in the Finance & Administration, Commercial and District Office Sub-sections, and occupy the jobs of plumbers, drivers, bill attendants and security guards.



Source: JICA Survey Team

Figure 3-8 Educational Background of ZAWA Staff



Source: JICA Survey Team

Figure 3-9 Educational Background of Each Department

3.3.4 Opinion of ZAWA Employees

In addition to the analysis of the current situation pointed out by outsiders, opinion of ZAWA employees are collected for better understanding of the situation inside ZAWA.

(1) Result of ZAWA Employees' Opinion Survey (Year 2014)

Summary of the ZAWA employees' opinion survey was carried out in September 2014 as a part of the technical assistance project in Phase II, is shown below.

(a) Objectives

To evaluate and find issues of operation and management of ZAWA.

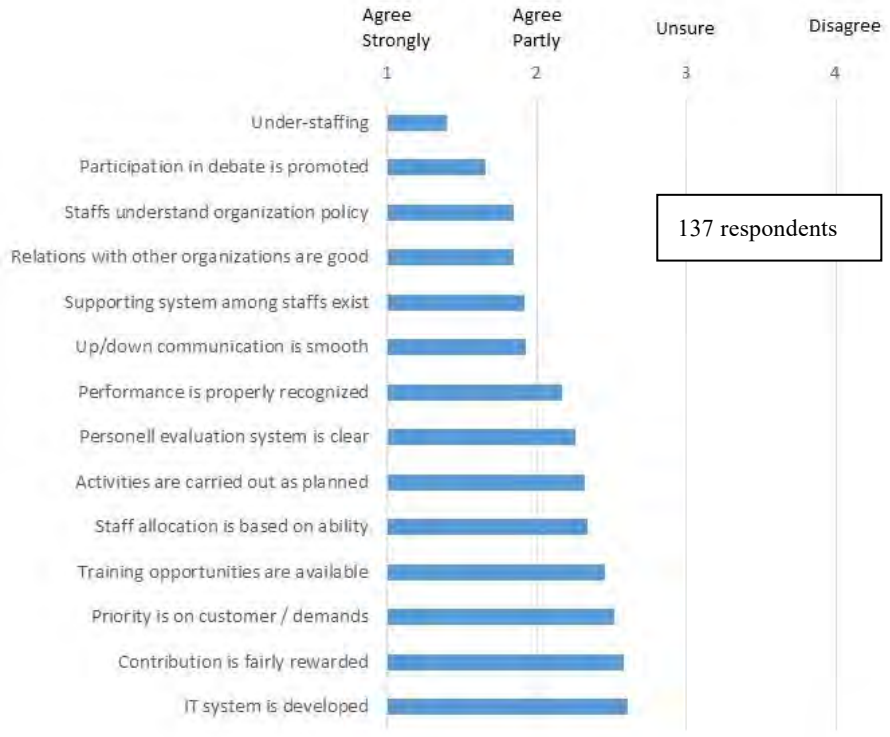
(b) Target staff

All positions higher than assistant officers, and selected employees in subordinate positions.

(c) Current situation by ZAWA employees

Figure 3-10 shows the result of the survey. Major opinions are followings:

- All customers are not identified
- Lack of staff
- Contribution to ZAWA is not reflected in employee's promotion and salary
- Lack of training
- IT system is not organized
- Too many meetings and documentation



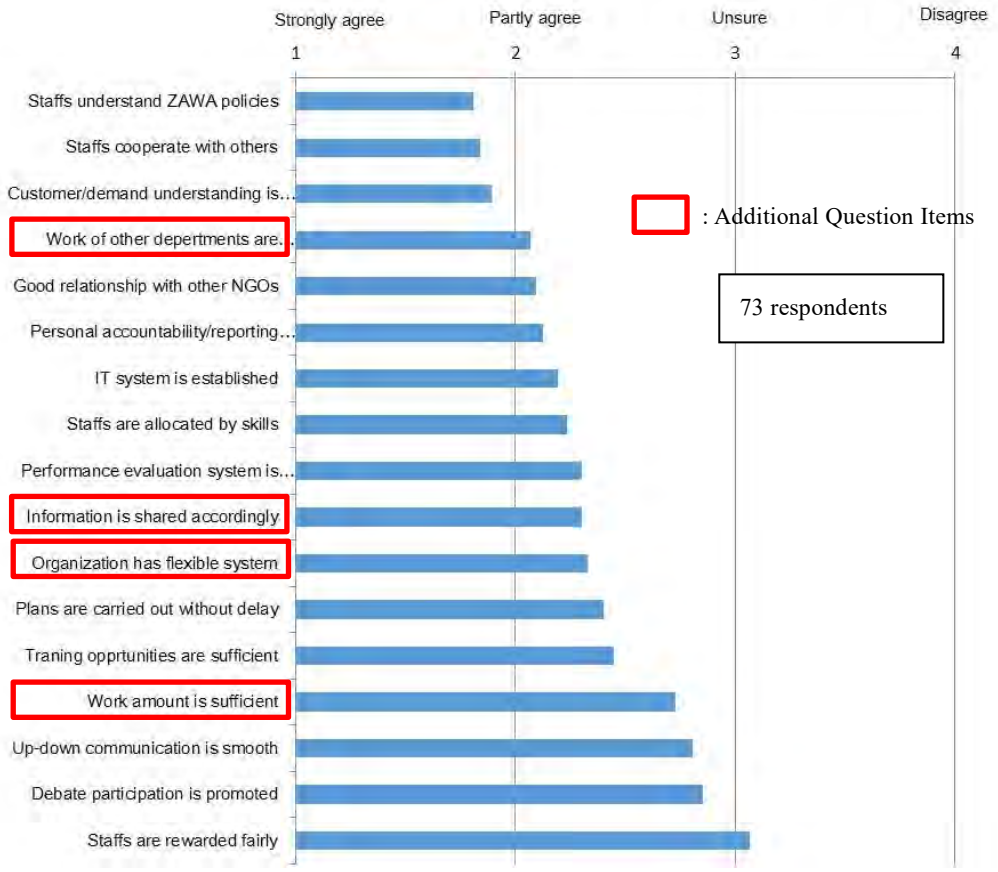
Note: Graph shows average score of the answers.
Source: Project Progress Report, No. 6, the Technical Cooperation Project for Enhancement of Water Supply Management of Zanzibar Water Authority Phase 2. October 2014.

Figure 3-10 Result of ZAWA's Employees Opinion Survey (2014)

(2) Result of ZAWA Employees' Opinion Survey (Year 2016)

(a) Summary of the survey

The Survey Team conducted an interview targeting the Unguja staff holding positions from assistant officers and higher. The questionnaire focused on the information sharing among the ZAWA staff that are expected to be the main C/Ps for the Project, and to discover issues. The results are shown in **Figure 3-11**.



Note: Graph shows average score of the answers.

Source: JICA Survey Team

Figure 3-11 Result of ZAWA Employees' Opinion Survey (2016)

(b) Result

The situation regarding the staff's work and salary has not improved: It was the most frequently mentioned opinion in the survey of year 2014.

In the open-question session, opinions about necessity of enhancement of database, such as customer information, salary raise, necessity of management's effort to communicate with employees, are frequently mentioned. Some suggested ideas for an improvement relationship between ZAWA and its customers, and others mentioned practical improvement plans for

communication of ZAWA central office and its branch offices. Enhancement of database, such as customer information was mentioned, as in the previous survey as well, since the situation of these issues had not improved, especially for management of customer information and establishment of IT System.

These negative opinions, such as "Involvement in organization plan", "Coincidence of values with organization" "Participation and debate allowed", and "Up/downwards communication" are newly mentioned in this survey. It may because communication between management and employees is not smooth. Another reason may be due to the distance between ZAWA central office and branch offices and tariff collection offices in remote areas. According to some opinions, it is a huge burden to visit the ZAWA office in terms of time requirement, cost, and human resource: Internet is not installed in several offices, therefore someone from the office has to visit the ZAWA central office in case of issues.

(3) Comparison of result and SWOT analysis

"Lack of human resource" is one of the most frequently mentioned opinions. Meanwhile, ZAWA recognizes that the number of employees is more than enough. Opinion of ZAWA and its employees are different on this issue.

In addition to "Rewarded Staff" being most frequently mentioned in questions in both surveys, topics of incentive and salary are mentioned frequently in open questions in this survey. It may be related to "low motivation and moral of employees" in the SWOT Analysis, but it has not improved.

Regarding the issue of "Lack of employee with professional technique and knowledge" which is mentioned in the SWOT Analysis, ZAWA had just started training for employees and future improvement is expected.

Meanwhile, "IT System and Database" has not sufficiently improved though it is mentioned in the opinion survey as well.

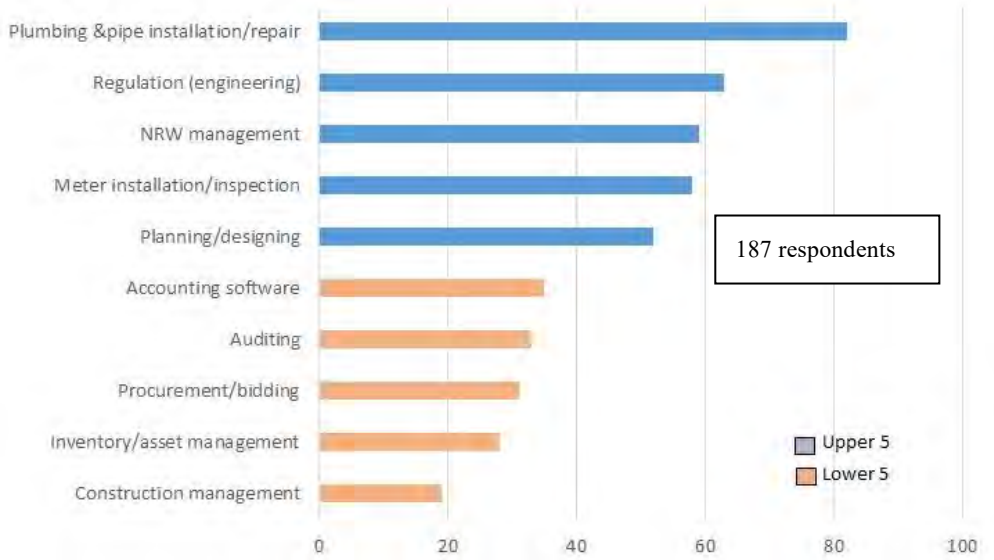
3.3.5 Survey for Training Demands

(1) Summary

In the Technical Cooperation Project Phase 2, a survey for training-needs was carried out to all employees in ZAWA. This survey aimed to collect information for planning of trainings in a training facility established by ZAWA. Result of the survey is shown in **Figure 3-12**.

Following issues are frequently mentioned in the survey.

- Technique of pipe arrangement, pipe laying operations and repair works
- Technique of installation of water meter, and using water flow meters
- Laws and regulations related to engineering and techniques



Source: Project Progress Report, No. 6, the Technical Cooperation Project for Enhancement of Water Supply Management of Zanzibar Water Authority Phase 2. April 2014

Figure 3-12 Desired Contents of Training by ZAWA Employees (2014)

(2) Training in ZAWA Training Facility

ZAWA has started its own training in January 2014, using a development centre in Mtoni. The lecturers are ZAWA staff, and the managers and the Human Resource Department select the trainees. The training covers various fields, such as mathematics/physics, piping techniques, customer/human resource management, etc. Generally, the trainings are held two day per week, and the training program is for four semesters (two years). The 1st training program (2014-15, 34 trainees) has been completed, and the 2nd program (2015-16, 29 trainees) is in the 4th semester as of August 2016.

The training curriculum is shown in **Table 3-12**. Training curriculum is organized with reference to the result of the survey.

The attendance ratio (90%: average of 1st and 2nd program) and completion ratio (95%: 1st program) are both high. Several reasons are considered for this distinguished progress. One reason is that a promotion is promised for the trainees who complete the program, and also that a Certificate will be granted upon completion. Another reason is that there are a certain number of staff who are anticipating an opportunity for training, which should be an important factor for increasing high-skilled staff for the implementation of the Project by maintaining and improving the training system.

Table 3-12 Training Curriculum

1st Semister			
1	Basic mathematics	9	Bending pipes
2	Maintaining tools	10	Performing pipe joint
3	Drawing	11	Servicing and repairing of meters
4	taps and valves	12	Maintaining laboratory safety
5	Basic physics	13	First aid
6	Communication skills/ customer care	14	Cutting pipes
7	Water policy	15	Installing domestic meter
8	Maintaining workshop safety	16	Introduction to IT

2nd Semister			
1	Basic mathematics	8	Bench drilling
2	Cutting using electrical saw	9	Perform hand shearing
3	Hand drilling	10	Perform sof soldering
4	Physics	11	Hacksaw cutting
5	Sheet metal forming	12	Water policy
6	Human resource management	13	Manual thread cutting
7	Metal filling	14	Perform machine shearing

3rd Semister			
1	Physics	7	Installing pipe network systems, exacting bedding laying and back pilling for pipe lines
2	Human resouces		
3	Harvesting rain water	8	Fabricating sheet metal work
4	Mathematics	9	Communication skills
5	Installing domestic and bulk meters	10	Design transmission/ distribution main
6	Supportive applied subjects -IT	11	Public relation

4th Semister			
1	Design water transmission mains	6	Communication skills/ customer care
2	Basic physics	7	IT
3	Drilling constructors well	8	Basic mathematics
4	Human resources	9	Water quality analysis and treament
5	Installing pumps and well head construction	10	Monitoring and evaluation

Source: Human Resources, Finance & Administration Department, ZAWA

3.3.6 Organizational Issues in ZAWA

Many of the organizational issues have been indicated in the Final Report of the Technical Cooperation Project (Phase 2), and the situation has not improved since. For appropriate O&M of the facilities developed by this Project, it is necessary to solve the following issues.

【ZAWA's cooperation with the organization reconstruction (draft)】

An organization reconstruction draft, including detailed divisions and staff allocations, had been prepared and proposed by the Technical Cooperation Project (Phase 2) based on studies and staff interviews. Although the proposal has been approved, actual organization reconstruction/staff allocation has not been realized.

【Clear work flow】

The work flow for each department/section has been sorted out by the Technical Cooperation Project (Phase 2), but the material has not been utilized and therefore the issues remain, such as works delayed by miscommunication among departments, and staff who do not understand

their position/duty.

【Human resource development】

ZAWA has started an original training system in January 2014. The 1st and 2nd training sessions have both been successful, each with approximately 20 attendants and positive reaction from the staff. The training was expected to improve the staff's abilities and gain certification from NACTE (National Council for Technical Education) to support the staff's career as public workers. Unfortunately, the training had been suspended from November 2016 because all staff have been mobilized for water meter installation activities. An early resumption of the training and an upgrade of training curriculum is necessary, since the O&M of the facilities of this Project shall require many skilled workers.

【Position and salary classification】

The salary classification for public workers in Tanzania, including ZAWA, were solely determined by the worker's educational background, and this system was an obstacle for the worker's motivation. To improve the situation, in 2011, the Public Service Law established that a Scheme of Service shall be set for all organizations. ZAWA has prepared a draft during the Technical Cooperation Project (Phase 2), but currently, it is not enforced.

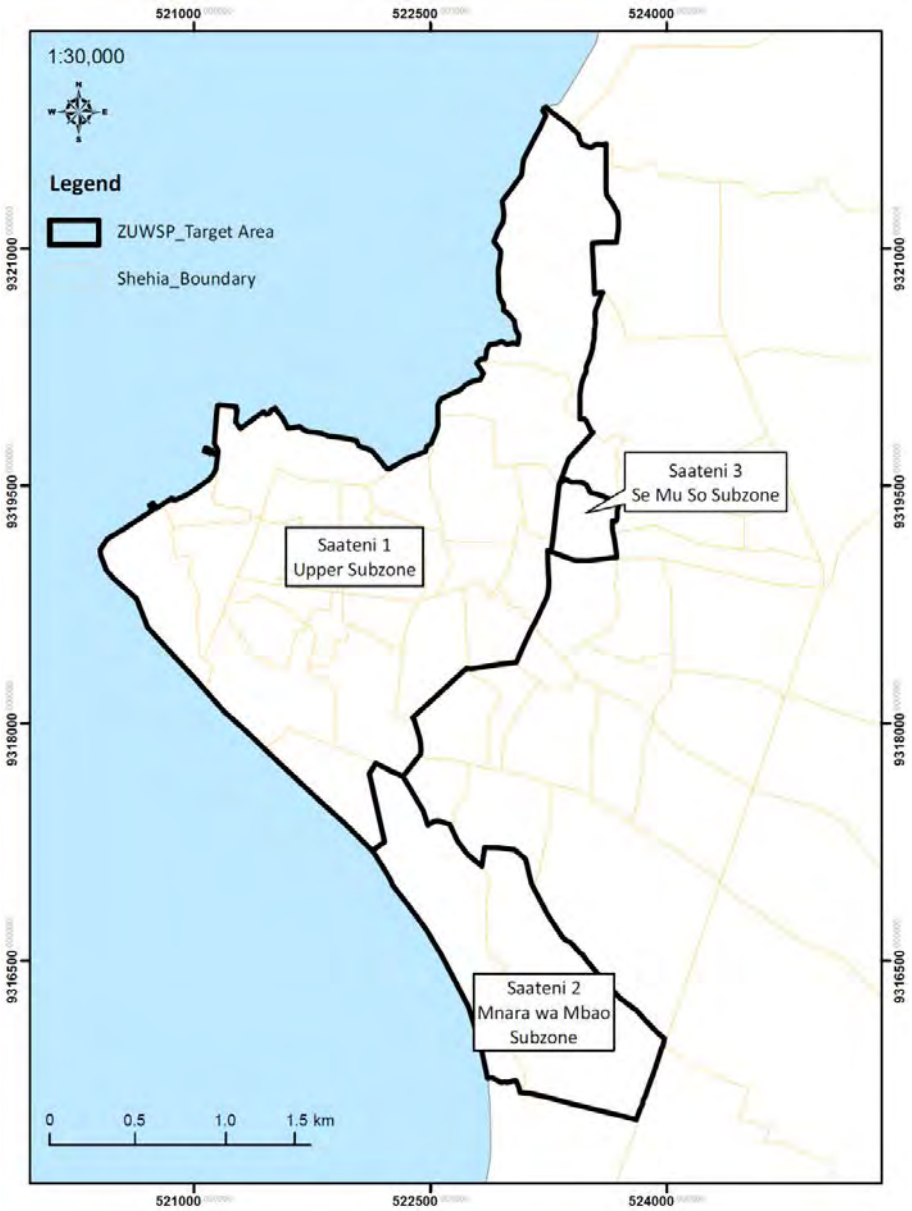
3.4 Review of Ongoing Projects

3.4.1 Zanzibar Urban Water and Sanitation Project (ZUWSP)

ZUWSP, funded by AfDB, is in the construction phase for Urban West Region.

(1) Target Area of ZUWSP

Target area of ZUWSP is shown in **Figure 3-13**. In the area, improvement of water distribution facilities is implemented by ZUWSP.



Source: JICA Survey Team based on ZUWSP Water Supply Scheme Design Report

Figure 3-13 Target Area of ZUWSP

(2) Details of ZUWSP

ZUWSP is divided into three packages.

- Package 1 :Development and rehabilitation of existing wells
- Package 2 :Distribution pipeline improvement and monitoring facility introduction
- Package 3 :Procurement of water meters

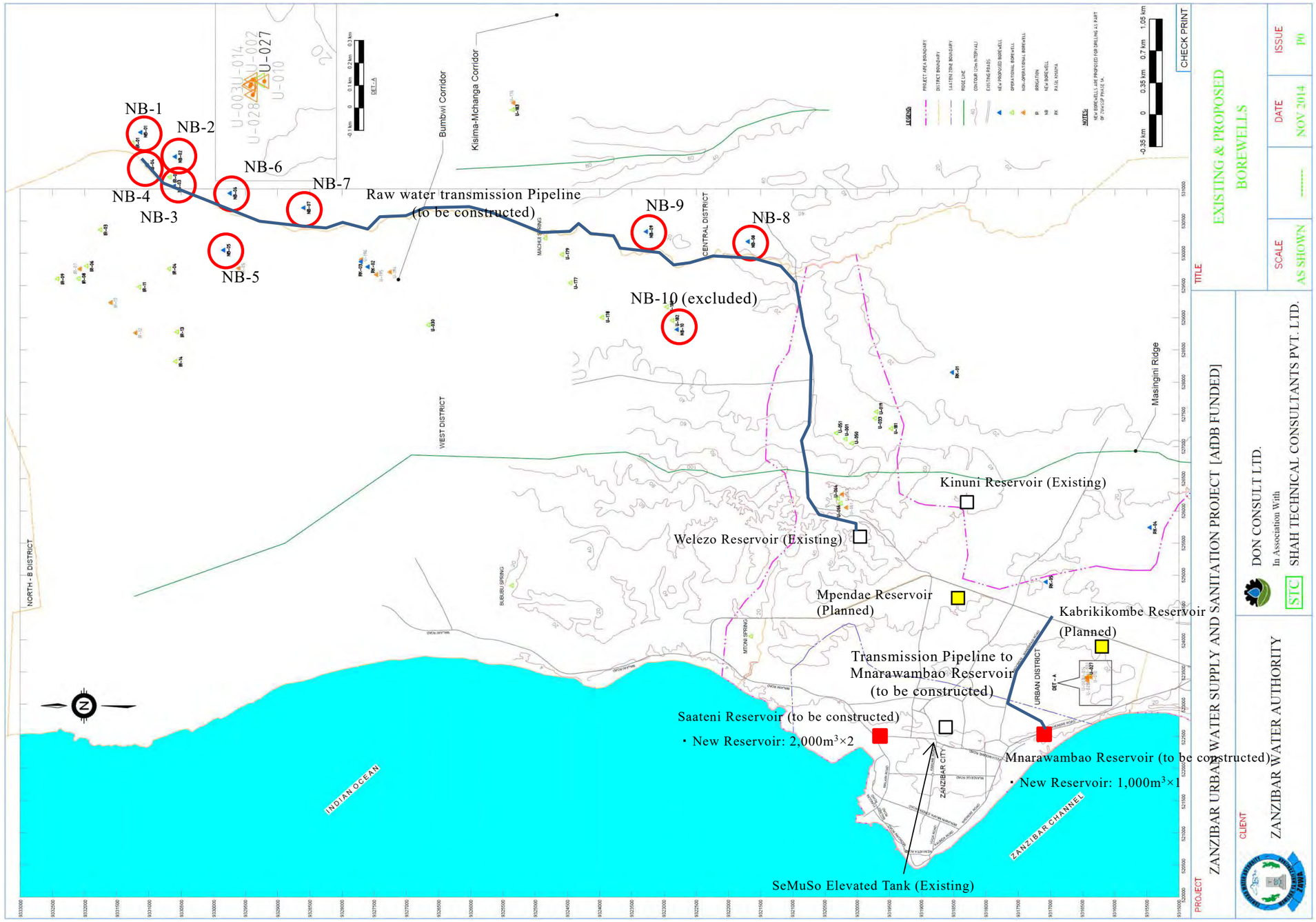
Initially, distribution pipeline improvement by replacing asbestos cement pipes was planned in Package 2, but with the support of Phase 2 of the Technical Cooperation Project, ZAWA negotiated with AfDB to introduce DMAs (Districted Metered Areas) and monitoring facilities for distribution management. **Table 3-13** shows the main components of each Package.

Table 3-13 Main Components of ZUWSP Package

Package	Facility	Outline
Package 1	Rehabilitation of existing deep wells	12 sites
	Construction of new deep wells	9 sites (initial 10)
Package 2	Development of Saateni elevated reservoir*	2,000m^3×2
	Development of Mnarawambao elevated reservoir	1,000m^3×1
	Development of Welezo reservoir water supply pipeline	19.95km
	Enhancement of existing water supply pipe	2.6km
	Development of water supply pipeline (Chumbuni U-075)	0.63km
	Development of water supply pipeline (U-010/U-028 to Mnarawambao)	2.02km
	Countermeasure facility for water hammer	1 set
	Replacement of chlorination Building	1 set
	Development of Saateni distribution pipeline	50.25km
	Development of Mnarawambao distribution pipeline	8.9km
	Development of SeMuSo distribution pipeline	4.16km
	Removal, transportation and disposal of asbestos cement pipes	Inside target area
	Installation of service connection equipment (manifold)	1 set
	Installation of electromagnetic flow meter for DMA	19 units
	Installation of monitoring equipment	1 set
	Rehabilitation of existing electric facilities	1 set
	Procurement of tools for electric construction	1 set
	Procurement of spare parts*	1 set
	Rehabilitation of existing building	1 set
	Site development (fence, draining facilities, etc.)	1 set
Package 3	Procurement of water meters	7,000 sets

*: Number of Saateni reservoir construction was reduced from 2 tanks to 1 tank, and procurement of spare parts was removed during the procurement of contractor (as of October 2017).

Source: ZUWSP Tender Document



Source: JICA Survey Team added on ZUWSP Tender Document

Figure 3-14 Location of Developed Facilities by ZUWSP

(3) Outline of ZUWSP Package 2

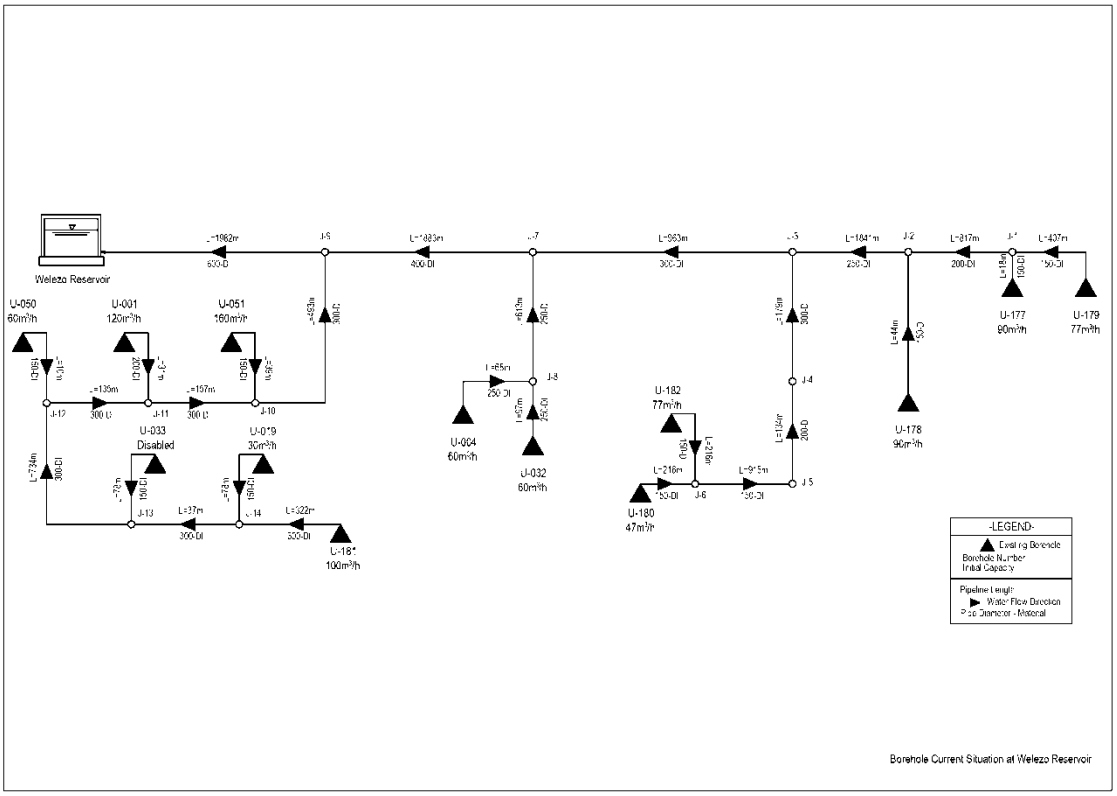
(a) Raw water transmission pipeline

Development of new raw water transmission mains to Welezo reservoir from 9 newly developed boreholes are planned. Said mains are to be laid parallel to the existing transmission main. Several existing boreholes (U-176, U-182 and U-196) are also planned to be connected to the new mains.

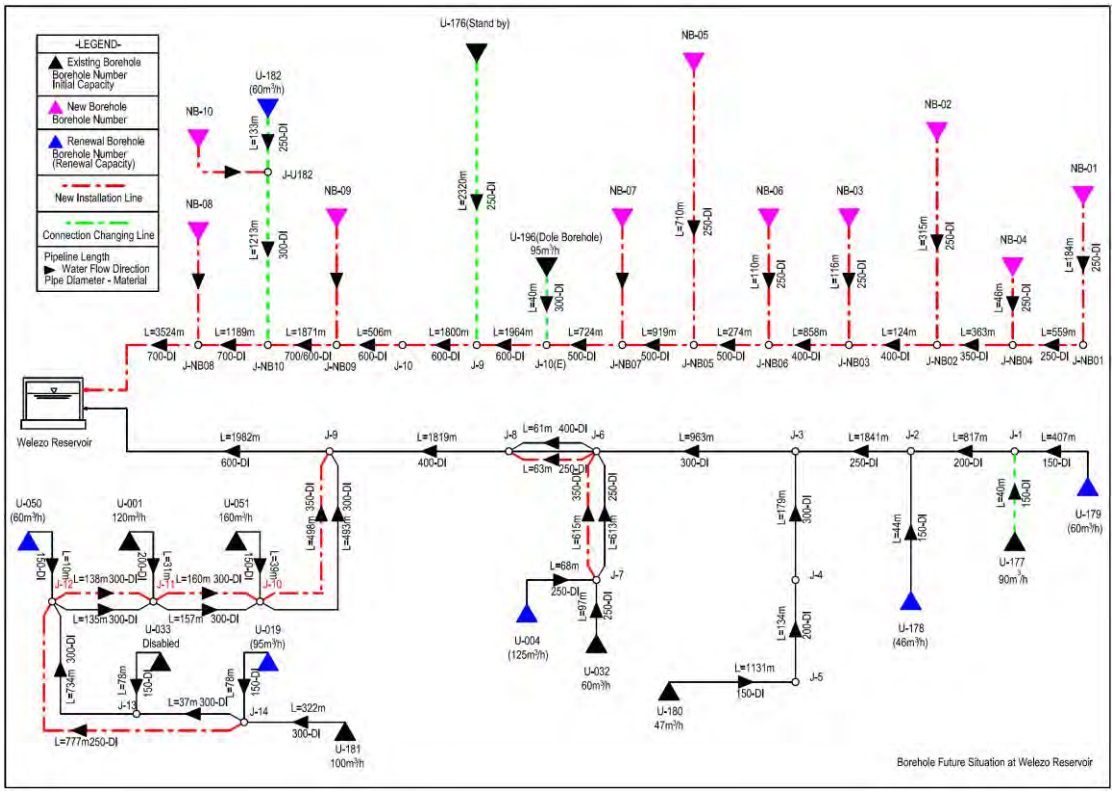
Table 3-14 Planned Length of Raw Water Transmission Main to Welezo by Diameter

Diameter	Length	Remarks
φ250 mm	1,480m	from new well to raw water transmission main
φ250 mm	559m	Laying new water transmission main
φ250 mm	2,453m	Changing destination of existing deep well water transmission
φ250 mm	840m	Adding transmission line
φ300 mm	1,253m	Changing destination of existing deep well water transmission
φ300 mm	298m	Adding transmission line
φ350 mm	363m	Laying new water transmission main
φ350 mm	1,113m	Adding transmission line
φ400 mm	982m	Laying new water transmission main
φ500 mm	1,917m	Laying new water transmission main
φ600 mm	4,270m	Laying new water transmission main
φ700 mm	6,584m	Laying new water transmission main
Total	22,112m	

Source: JICA Survey Team based on ZUWSP Water Supply Scheme Design Report



(Current)



(Planned)

Source: JICA Survey Team based on ZUWSP Water Supply Scheme Design Report

Figure 3-15 Diagram of Raw Water Transmission Plan to Welezo Reservoir

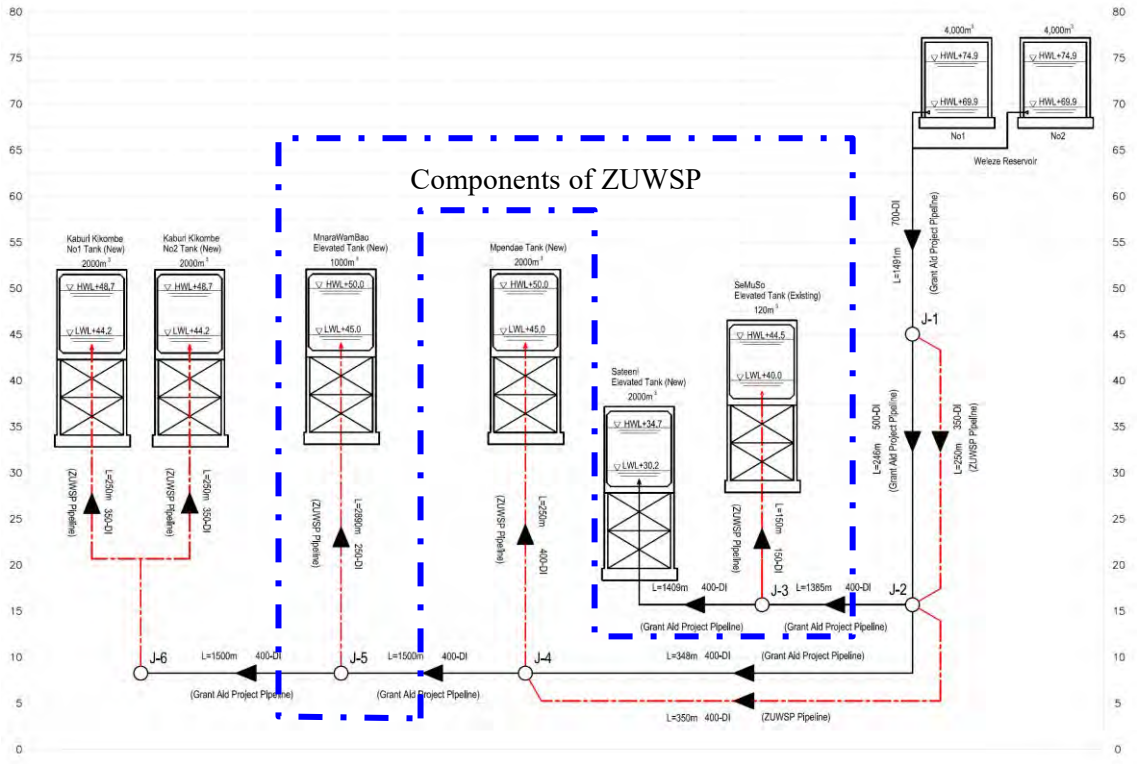
(b) Transmission main

The transmission main constructed under Phase 1 and Phase 2 of the Japanese Grant Aid Project shall serve as the main line from Welezo reservoir, to supply water to the elevated tanks at Saateni (new), Mnarawambao (new) and SeMuSo (existing). Kabrikikombe and Mpendae reservoirs (elevated tanks) were planned, but not included in the construction work of ZUWSP.

Table 3-15 Planned Length of Transmission Main from Welezo Reservoir

Diameter	Length	Remarks
φ150 mm	150 m	to SeMuSo Elevated Tank
φ250 mm	2,890 m	to Mnarawambao Elevated Reservoir
φ350 mm	250 m	Adding transmission main
φ350 mm	500 m	to Kabrikikombe Reservoir
φ400 mm	350 m	Adding transmission main
φ400 mm	250 m	to Mpendae reservoir
Total	4,390 m	

Source: JICA Survey Team based on ZUWSP Water Supply Scheme Design Report



Source: JICA Survey Team base on ZUWSP Water Supply Scheme Design Report

Figure 3-16 Diagram of Planned Transmission Main from Welezo Reservoir

(4) Progress status of ZUWSP

The deadline of the implementation was postponed in March 2015, since the completion of the project by the period stated in the L/A was difficult due to the delay in procurement of consultants, which required 14 months.

In terms of construction work, borehole development and rehabilitation (Package 1) commenced in March 2016. Water supply facility development (Package 2) has been delayed significantly due to termination of the contract and re-bidding. Water meter procurement (Package 3) was implemented and 7,000 water meters were delivered in May 2016. Accordingly, ZAWA requested AfDB for extension of the contract period to December 2018, but this is not approved as yet.

Table 3-16 Sequence of ZUWSP

Issue/Stage of the Project	Schedule
(1) L/A	
Signing L/A (AfDB and Ministry of Finance in Tanzania)	March 11, 2013 (21 Million USD, Deadline of Implementation: June 2016)
(2) Procurement of Consultant	
Public Invitation for Consultancy Service	August 2013 (Application by 6 companies)
Submission of Technical/Price Proposal	January 2014 (Application by 5 companies: 2 Envelops)
Contract Agreement / Authorization by AfDB	June 2, 2014
Submission of the Final Report by Consultant	January 2015
(3) Procurement of Contractor	
Public Invitation for Bidding (Construction Company, Without PQ)	—
Submission of Tender Document	October 2015
Agreement of Contract / Authorization by AfDB	December 2015, February 2016
(4) Construction	
Package 1	March 2016: Start construction
Package 2	October 2017: Contract agreement with successful bidder of re-bidding
Package 3	May 2016: Delivery of water meters
(5) Extension of Project Period	
Extension of Project Period (ZAWA – AfDB)	March 2015 (Deadline of Implementation is December 2017)
Request for Extension of Project Period (ZAWA-AfDB)	July 2016 (Deadline of Implementation: December 2018, pending approval)

Source: JICA Survey Team

3.4.2 Zanzibar Well Drilling Project

(1) Outline of the project

Implemented as a grant aid project by Ras al-Khaimah, an emirate of the United Arab Emirates (UAE), the major project components are drilling of 150 boreholes and providing borehole

pumps and control panels, and also the construction of six (6) elevated tanks of six (6) meter height and 120 m^3 capacity.

50 boreholes were constructed in Urban West Region by this project. List of the constructed boreholes and the locations are shown in **Table 3-18** and **Figure 3-17**.

Drilling boreholes (deep wells) was completed. However, since the pumps procured by the project were used for replacement of existing failed pumps, only 11 boreholes are available to operate.

Additionally, although 2 elevated tanks were constructed, they are not in operation because progress of submersible pump installation to boreholes was not enough.

Photo 3-1 Deep Well and Elevated Tank Constructed under Zanzibar Well Drilling Project

(2) Project period

Originally the project was planned as a one year project, but was extended and divided in three phases.

Table 3-17 Time Framework of Zanzibar Well Drilling Project

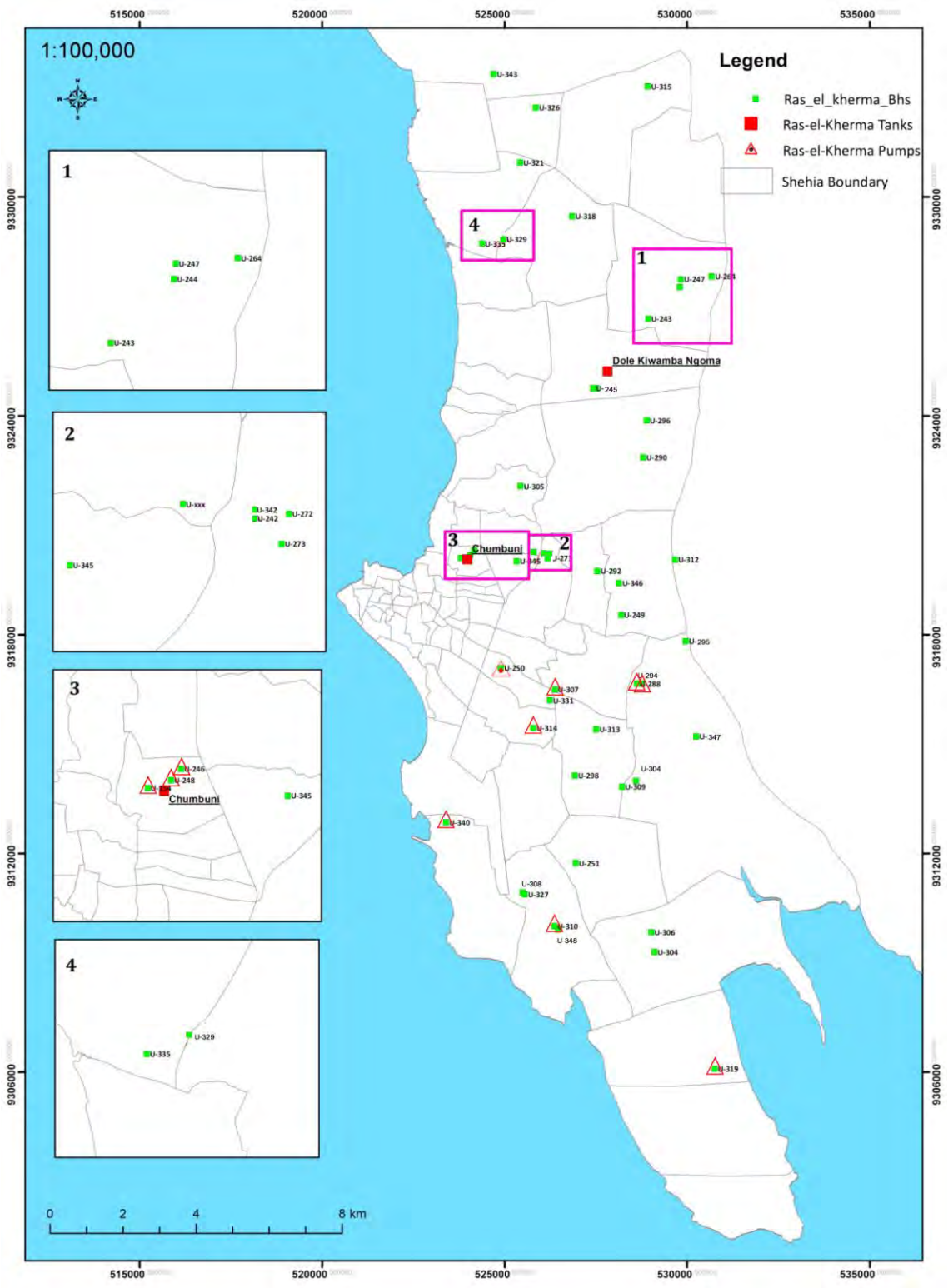
Phase	Duration	Number of Drilled Wells
Phase 1	June 2013 – May 2015	50 Locations
Phase 2	March 2015 – December 2015	50 Locations
Phase 3	November 2015 – May 2016	50 Locations

Source: Planning & Project Management, Water Development Department, ZAWA

Table 3-18 Boreholes in Urban West Region Developed by Zanzibar Well Drilling Project

No.	Source ID	Water Source Name	District	Pump capacity m^3/hour	Pump Status	Remarks
1	U-340	Bweni Afya	West	37	available	
2	U-321	Chuini Beit - el - mali	West	34		
3	U-248	Chumbuni 1	Urban	11	available	
4	U-246	Chumbuni 2	Urban	25	available	
5	U-254	Chumbuni 3	Urban	—	available	not complied with pumping test
6	U-288	Chunga between No26	West	80	available	
7	U-294	Chunga Jangamizini	West	94	available	
8	U-319	Dimani Njiakuu	West	64	available	
9	U-304	Fuoni Ijitmai Mchekeni	West	78		
10	U-347	Fuoni Kibonde Mzungu Sai	West	70		
11	U-309	Fuoni Kipungani	West	90		
12	U-306	FuonI-Birikani	West	75		
13	U-296	Kianga Cheman 2	West	—		pumping test failure
14	U-245	Kianga Mzungu Punda 1	West	60		
15	U-290	Kianga Mzungu Punda 2	West	68		
16	U-295	KiangaChemani 1	West	—		pumping test failure
17	U-307	Kijitoupele 2	West	68	available	
18	U-249	Kimara Minanasini	West	60		
19	U-346	Kinuni Bondeni 2	West	—		insufficient yield
20	U-304	Kisakasaka kutani 1	West	4		
21	U-306	Kisakasaka Miembeni 2	West	73		
22	U-329	Kitosa kwa Makonnde	West	12		
23	U-335	Kitosani Pwani	West	19		
24	U-244	Kizimbani 1	West	60		
25	U-247	Kizimbani 2	West	—		waiting the result of pumping test
26	U-243	Kizimbani Nussery	West	40		
27	U-298	Kwarara kidutani	West	67		
28	U-313	Kwarara Madrassa school	West	67		
29	U-250	M/kwerekwe c	West	25	available	
30	U-251	Maungani	West	81		
31	U-318	Mbuzini warabu	West	24		
32	U-331	Melinne Magirisi	West	70		
33	U-326	Mfenesin selem njian	West	15		
34	U-343	Mfenesini Vuga mkadini	West	—		not complied with pumping test
35	U-264	Miwani	Central	71		
36	U-305	Mtopepo Basra	West	12		
37	U-292	Muembe Mchomeke	West	—		not complied with pumping test
38	U-315	Mwachealale	West	48		
39	U-312	Mwera-Gudini	West	35		
40	U-308	Shakani Elimu kizani 2	West	4		
41	U-327	Shakani Elimu 1	West	53		
42	U-310	Shakani Muembe Ngoma	West	23	available	
43	U-348	Shakani Ufune	West	7		
44	U-314	Tomondo [ziwa maboga]	West	71	available	
45	U-xxx	Welezo KMKM	West	2		
46	U-273	Welezo Ras bondeni 3	West	36		
47	U-272	Welezo Ras Dry zoo	West	21		
48	U-242	Welezo Ras Njian 1I	West	36		
49	U-345	Welezo Tang la Bati	West	3		
50	U-342	Welezo zoo	West	21		
		Total		1,914		

Source: Water Resources, Water Development Department, ZAWA



Source: Prepared by JICA Survey Team, information by Water Resources, Water Development Department, ZAWA

Figure 3-17 Location of Wells in Urban West Region Developed by Zanzibar Well Drilling Project

3.5 Water Supply Facility in Urban West Region

Figure 3-18 shows locations of existing water supply facilities. Summary of the facilities are described below.

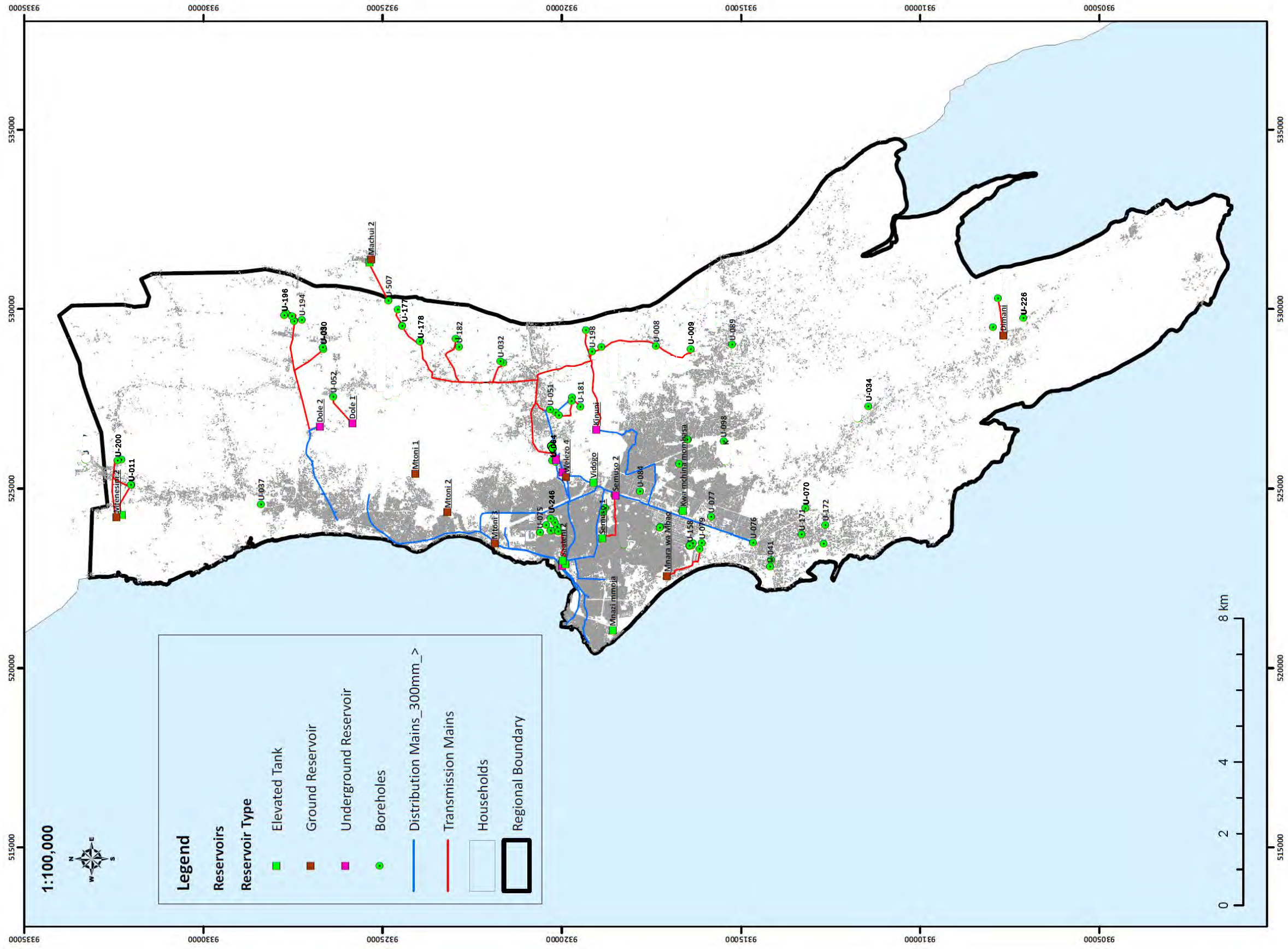
3.5.1 Outline of Water Supply System

(1) Outline of Water Supply System in Urban West Region

Water supply service has been carried out to 590,000 people (Census 2012) in Urban West Region using underground water and spring water. However, the system cannot suit the current situation because of population growth, water leakage, low water pressure, and time-limited water supply. Therefore, the number of ZAWA customers has not increased so much, with the number of registered customers being 39,909 customers (households) as of March 2017, and with the registered water supply population being only 210,000 people (39,909 customers × 5.24 pop/HH = 209,123 pop).

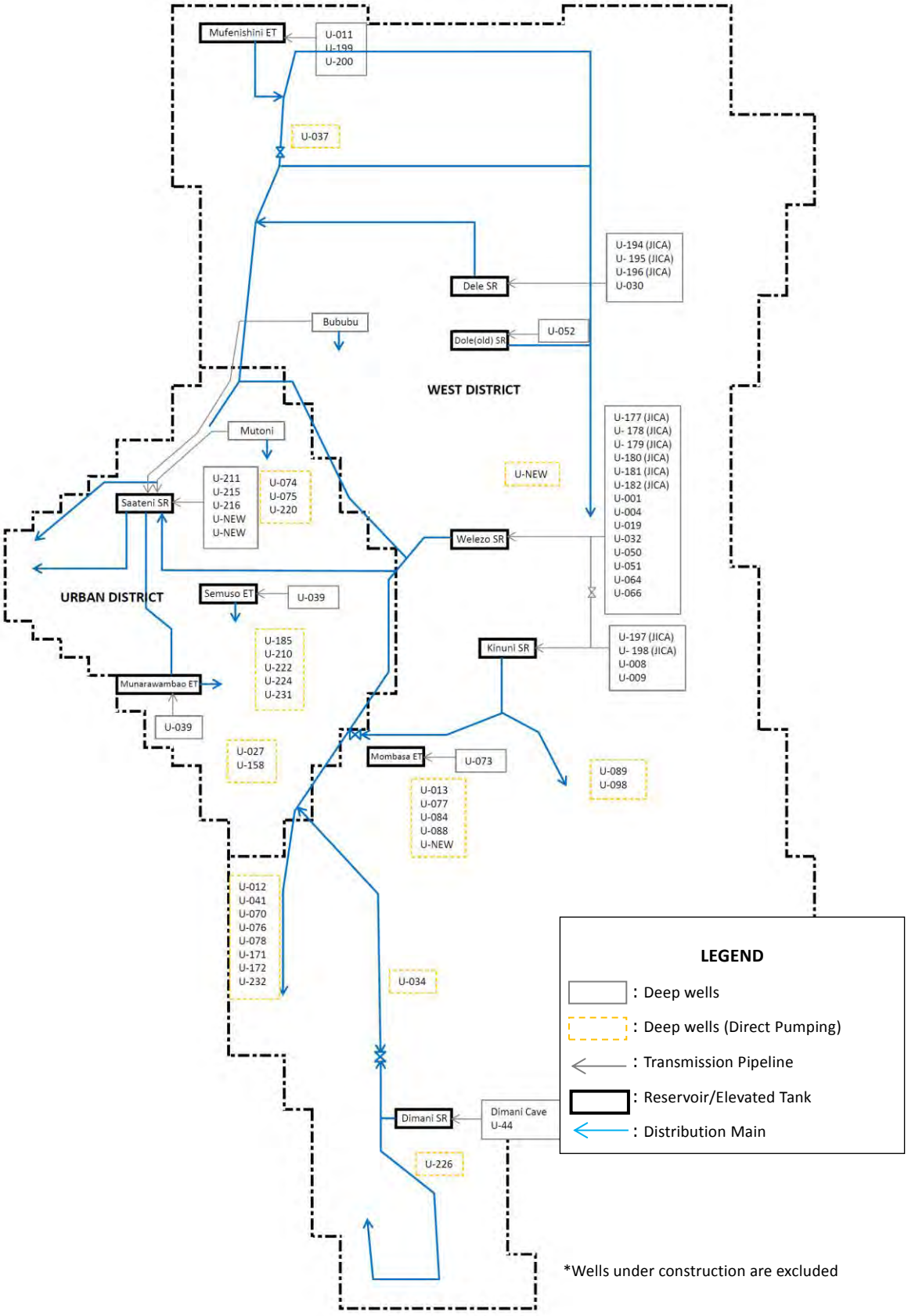
Following three water supply systems are implemented in Urban West Region, such as "Water distribution from reservoir by gravity", "Water distribution by elevated tank", "Direct water distribution from wells and springs". However, these systems are implemented without consideration of geography or water level of elevated tanks. Therefore, each distribution method is not always fit to the geography of each water supply area. As a result, water leakage is evident in many places with aging of water pipes, and water pressure is low resulting in no water supply in many areas especially at higher elevations.

- **Water Distribution from Reservoir by Gravity:** Taking water from boreholes in Bumbwi and sending it to three reservoirs in the hill areas (Welezo, Kinuni, and Dole), which was constructed by Japanese Grant Aid Project, and distributing water to service areas by gravity flow.
- **Water Distribution by Elevated Tank**: Taking water from springs and groundwater and send it either directly or through reservoir to elevated tank. Water shall be distributed from elevated tank to service area.
- **Direct Water Distribution from Wells and Springs**: Water from springs and boreholes shall be directly distributed to areas in the vicinity of the water source



Source: JICA Survey Team

Figure 3-18 Location Map of Existing Main Water Supply Facility



Source: JICA Survey Team

Figure 3-19 Schematic Figure of Existing Water Supply System

3.5.2 Water Source Facility

In Zanzibar, water supply for all purposes depend on groundwater. There are no large rivers in Zanzibar due to its highly permeable limestone geology.

As shown in **Table 3-19**, Currently, ZAWA owns 3 spring water sources and 62 boreholes (including 11 boreholes installed by the Japanese Grant Aid Project). In addition, AfDB supported ZUWSP is currently developing 9 new boreholes and renovating 12 boreholes.

Another project, the UAE supported Zanzibar Well Drilling Project, is developing 50 boreholes in the Urban West Region. Pumps for said boreholes have also been procured by the project, but ZAWA diverted the pumps to other sites to replace existing broken pumps, and therefore the number of operable boreholes after the project is only 11.

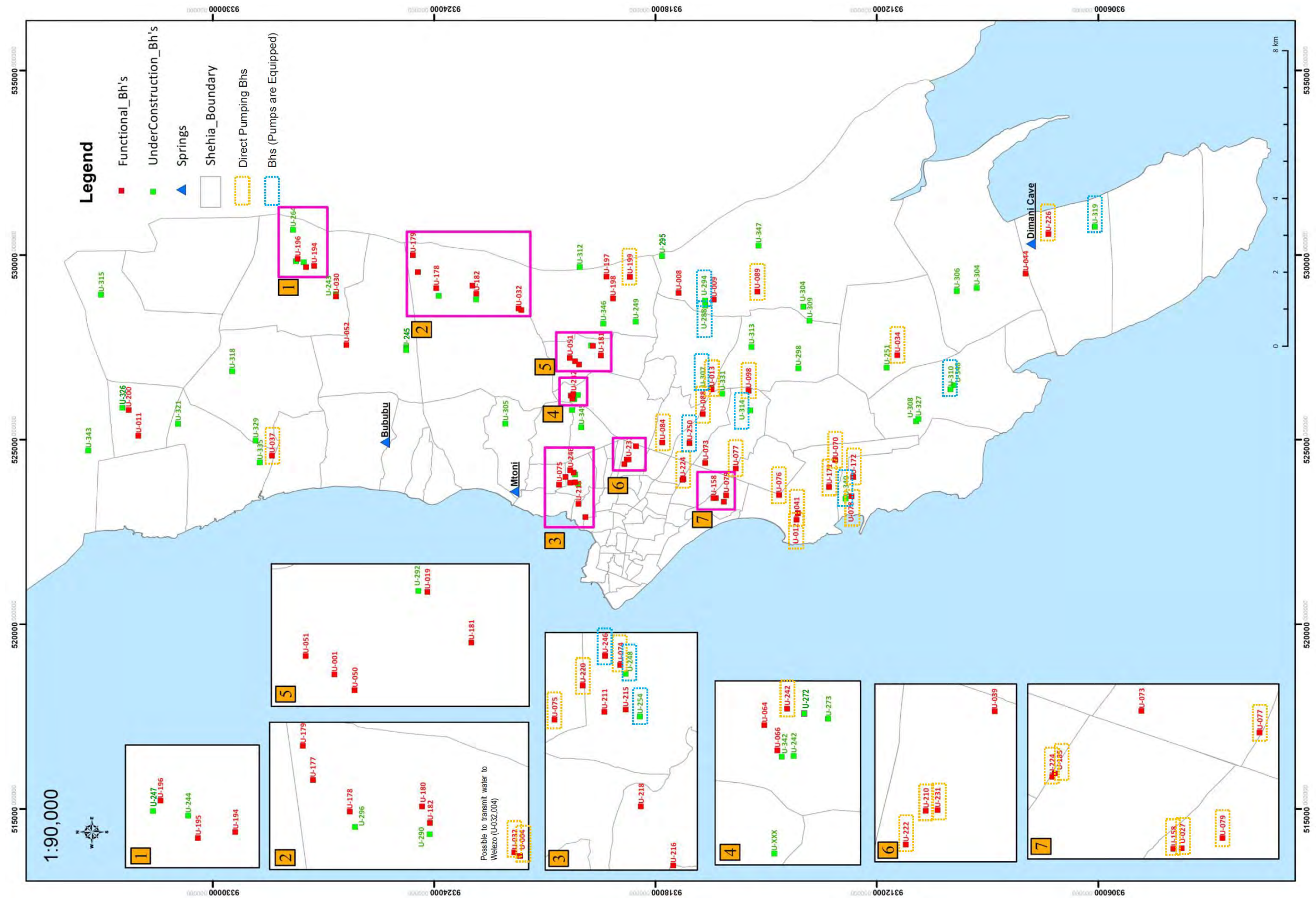
According to ZAWA, additional borehole pumps to replace the ones diverted will not be provided by the project, and ZAWA is planning to procure pumps by its own fund to start operation by 2020, if the budget is available.

Figure 3-20 shows the locations of water facilities in Urban West Region, and **Table 3-20** shows the existing and the new boreholes constructed under the Zanzibar Well Drilling Project in Urban West Region.

Table 3-19 Existing and Developed Water Sources

Item	Number
Spring sources	3
Existing boreholes	62
ZUWSP developed boreholes	9
Zanzibar Well Drilling Project developed boreholes	11
Total	85

Source: JICA Survey Team



Source: JICA Survey Team

Figure 3-20 Location of Existing and Under Construction Boreholes

Table 3-20 Existing and Under-construction Water Sources in Urban West Region

SN	Source Name	Source Code	Source Type	Destination	Construction Year	Design Pump Capacity (m3/h)	Pump Capacity After Replace by ZUWSP (in red)	Remarks
(1) Spring Water Sources								
1	Mtoni Spring	-	Spring	Direct/Saateni	1920	68	-	
2	Bububu Spring	-	Spring	Direct/Saateni	1923	68	-	
3	Dimani cave well	-	Cave	Dimani	1976	77	77	
(2) Existing Boreholes								
1	Dimani	U-044	BH	Dimani	1960	60	60	
2	Mwembe Mchomeke	U-001	BH	Welezo	1961	77	77	
3	Kianga	U-004	BH	Direct/Welwzo	1961	60	**125**	Direct pumping, possible to transmit to Welezo
4	Mfenesini	U-011	BH	Mfenishini	1963	60	60	
5	Chunga	U-008	BH	Kinuni	1974	125	**160**	
6	Chunga	U-009	BH	Kinuni	1974	100	**160**	
7	Mbweni Tractors' Workshop	U-012	BH	Direct	1985	17	17	
8	Kijito Upele	U-013	BH	Dire	1985	17	17	Pump fault
9	Mwembe Mchomeke	U-019	BH	Welezo	1993	80	**95**	Pump removed
10	Kaburi Kikombe	U-027	BH	Direct	1996	60	60	
11	Kizimbani	U-030	BH	Dole	1998	17	17	
12	Kianga	U-032	BH	Direct/Welwzo	2000	60	60	Direct pumping, possible to transmit to Welezo
13	Maungani	U-034	BH	Direct	2000	60	60	
14	Kitosani	U-037	BH	Direct	2000	47	47	
15	Semuso	U-039	BH	Semuso	2000	17	17	
16	Mbweni	U-041	BH	Direct	2001	47	47	
17	Mwembe Mchomeke	U-050	BH	Welezo	2002	60	**60**	Pump stacked
18	Mwembe Mchomeke	U-051	BH	Welezo	2002	160	160	Pump fault
19	Dole	U-052	BH	Old Dole	2003	47	47	
20	Welezo	U-064	BH	Welezo	2004	60	**77**	
21	Welezo	U-066	BH	Welezo	2004	60	60	
22	Kiembe Samaki - Airport	U-070	BH	Direct	2004	30	30	
23	Mombasa - Kwa Mchina	U-073	BH	Mombasa	2004	8	8	
24	Chumbuni - Wireless Station	U-074	BH	Direct	2004	30	30	
25	Mwembe Makumbi	U-075	BH	Direct	2004	30	30	
26	Kiembe Samaki - Ali_Yousef	U-076	BH	Direct	2004	30	30	Under repair
27	Mombasa - ZAWA office	U-077	BH	Direct	2004	17	17	
28	Mbweni - BLW	U-078	BH	Direct	2004	17	17	
29	Migombani Jeshini-2	U-079	BH	Direct	2004	60	60	
30	Migombani - TPDF camp	U-082	BH	Mnarawambao	2004	30	30	
31	Magogoni	U-084	BH	Direct	2004	30	30	
32	Masumbani	U-088	BH	Direct	2005	14	14	
33	Fuoni	U-089	BH	Direct	2005	30	30	
34	Dimani Bweleo	U-226	BH	Direct	2005	46	46	
35	Kwarara	U-098	BH	Direct	2006	30	30	
36	Kaburi Kikombe	U-158	BH	Direct	2006	60	60	
37	Kiembe Samaki - Masumbani	U-171	BH	Direct	2007	50	50	
38	Chukwani - Meteorology dept.	U-172	BH	Direct	2007	50	50	
39	N6 - Machui	U-177	BH	Welezo	2007	70	70	Constructed by Japanese Grant Aid, Trans fault
40	N7 - Kianga	U-178	BH	Welezo	2007	60	**46**	Constructed by Japanese Grant Aid
41	N8 - Machui	U-179	BH	Welezo	2007	77	**60**	Constructed by Japanese Grant Aid
42	N9 - Kianga Chemani	U-180	BH	Welezo	2007	47	47	Constructed by Japanese Grant Aid
43	N13 - Mwembe Mchomeke	U-181	BH	Welezo	2007	100	100	Constructed by Japanese Grant Aid
44	N9-2 - Kianga Mkadini	U-182	BH	Welezo	2007	75	**60**	Constructed by Japanese Grant Aid
45	Bint Amran-1	U-185	BH	Direct	2007	8	8	
46	N5 - Kizimbani	U-194	BH	Dole	2009	58	58	Constructed by Japanese Grant Aid
47	N4 - Kinumoshi	U-195	BH	Dole	2009	30	30	Constructed by Japanese Grant Aid, pump fault
48	N3 - Kinumoshi	U-196	BH	Dole	2009	90	90	Constructed by Japanese Grant Aid
49	N10 - Msikiti Mzuri	U-197	BH	Kinuni	2009	83	**30**	Constructed by Japanese Grant Aid
50	N12-1 - Msikiti Mzuri	U-198	BH	Kinuni	2009	30	**30**	Constructed by Japanese Grant Aid
51	Selem-1	U-199	BH	Mufenishini	2009	30	30	
52	Selem-2	U-200	BH	Mufenishini	2009	30	30	
53	Sebleni	U-210	BH	Direct	2011	8	8	
54	Chumbuni-2	U-211	BH	Saateni	2011	26	**30**	
55	Sebleni Wazee	U-222	BH	Direct	2011	10	10	
56	Chumbuni-1	U-215	BH	Saateni	2012	40	40	
57	Saateni Waterworks	U-216	BH	Saateni	2012	8	8	Pump fault
58	Saateni Workshop	U-218	BH	Saateni	2012	30	30	Pump fault
59	Chumbuni Mbunge	U-220	BH	Direct	2012	14	14	
60	Bint Amran-2	U-224	BH	Direct	2012	10	10	
61	Sebleni	U-231	BH	Direct	2013	15	15	
62	Welezo 1	U-242	BH	Direct	2015	25	25	
	Total					2,827	2,924	

Table 3-20 Existing and Under-construction Water Sources in Urban West Region

SN	Source Name	Source Code	Source Type	Destination	Construction Year	Design Pump Capacity (m3/h)	Pump Capacity After Replace by ZUWSP (in red)	Remarks
(3) Under Constraction Boreholes by Zanzibar Well Drilling Project (Ras al Khaimah)								
1	Bweni Afya	U-340	BH	Direct	2015	37	—	
2	Chumbuni 1	U-248	BH	Elevated Tank	2013	11	—	
3	Chumbuni	U-246	BH	Saateni		25	25	
4	Chumbuni 3	U-254	BH	Elevated Tank	2013	45	—	No Pumping Test
5	Chunga between No26	U-288	BH	Kinuni	2015	80	—	
6	Chunga Jangamizini	U-294	BH	Direct	2015	94	—	
7	Dimani Njiakuu	U-319	BH	Direct	2015	64	—	
8	Kijitoupele 2	U-307	BH	Direct	2015	68	—	
9	Mwanakwerekwe-C	U-250	BH	Direct	2015	25	—	
10	Shakani Muembe Ngoma	U-310	BH	Direct	-	23	—	
11	Tomondo [ziwa maboga]	U-314	BH	Direct	2015	71	—	
12	Chuini Beit - el - mali	U-321	BH	Direct	2015	34	—	No Pump
13	Fuoni Ijitmai Mchekeni	U-304	BH	Direct	2015	78	—	No Pump
14	Fuoni Kibonde Mzungu Sai	U-347	BH	Direct	2015	70	—	No Pump
15	Fuoni Kipungani	U-309	BH	Direct	2016	90	—	No Pump
16	FuonI-Birikani	U-306	BH	Direct	2015	75	—	No Pump
17	Kianga Cheman 2	U-296	BH	Direct	2015	45	—	Pump Test Failed, No Pump
18	Kianga Mzungu Punda 1	U-245	BH	Elevated Tank	2015	60	—	No Pump
19	Kianga Mzungu Punda 2	U-290	BH	Elevated Tank	2015	68	—	No Pump
20	KiangaChemani 1	U-295	BH	Direct	2015	45	—	Pump Test Failed, No Pump
21	Kimara Minanasini	U-249	BH	Direct	2013	60	—	No Pump
22	Kinuni Bondeni 2	U-346	BH	Direct	2016	45	—	Pump Test Failed, No Pump
23	Kisakasaka kutani 1	U-304	BH	Direct	2015	4	—	No Pump
24	Kisakasaka Miembeni 2	U-306	BH	Direct	2016	73	—	No Pump
25	Kitosa kwa Makonnde	U-329	BH	Direct	2016	12	—	No Pump
26	Kitosani Pwani	U-335	BH	Direct	2013	19	—	No Pump
27	Kizimbani 1	U-244	BH	Direct	2013	60	—	No Pump
28	Kizimbani 2	U-247	BH	Direct	2013	70	—	No Pump
29	Kizimbani Nussery	U-243	BH	Direct	2015	40	—	No Pump
30	Kwarara kidutani	U-298	BH	Direct	2015	67	—	No Pump
31	Kwarara Madrassa school	U-313	BH	Direct	2015	67	—	No Pump
32	Maungani	U-251	BH	Direct	2013	81	—	No Pump
33	Mbuzini warabu	U-318	BH	Direct	2013	24	—	No Pump
34	Melinne Magirisi	U-331	BH	Direct	2016	70	—	No Pump
35	Mfenesin selem njian	U-326	BH	Direct	2016	15	—	No Pump
36	Mfenesini Vuga mkadini	U-343	BH	Direct	-	17	—	No Pump
37	Miwani	U-264	BH	Direct	2015	71	—	No Pump
38	Mtopepo Basra	U-305	BH	Direct	2014	12	—	No Pump
39	Muembe Mchomeke	U-292	BH	Direct	2015	45	—	No Pumping Test, No Pump
40	Mwachealale	U-315	BH	Direct	2013	48	—	No Pump
41	Mwera-Gudini	U-312	BH	Direct	2015	35	—	No Pump
42	Shakani Elimu kizani 2	U-308	BH	Direct	2014	4	—	No Pump
43	Shakani Elimu 1	U-327	BH	Direct	2016	53	—	No Pump
44	Shakani Ufune	U-348	BH	Direct	2015	7	—	No Pump
45	Welezo KMKM	U-xxx	BH	Direct	2015	2	—	No Pump
46	Welezo Ras bondeni 3	U-273	BH	Direct	2013	36	—	No Pump
47	Welezo Ras Dry zoo	U-272	BH	Direct	2013	21	—	No Pump
48	Welezo Ras Njian 1I	U-242	BH	Direct	2013	36	—	No Pump
49	Welezo Tang la Bati	U-345	BH	Direct	2016	3	—	No Pump
50	Welezo zoo	U-342	BH	Direct	2016	21	—	No Pump
	Total					2,226		
(4) Under Construction Boreholes in ZUWSP								
1~5		xxx	BH	Welezo	—	625	—	125m3/h × 5 sets
6~10		xxx	BH	Welezo	—	380	—	95m3/h × 4 sets
	Total					1,005		

Note: Pump capacity of 5 sites of (3), which has no pumping test result, is adopted 45m^3/hour based on the average capacity of others.

Source: JICA Survey Team

(1) Borehole Water Sources

(a) Outline of facilities

Most of the borehole water sources owned by ZAWA have a depth of 60m to 70m, and submersible motors are utilized. Most of the boreholes are also equipped with pressure gauges and integrated flow meters. **Figure 3-21** shows the general drawing of existing deep well.

As of October 2016, water intake has been stopped in 10 boreholes (total 62 boreholes) due to removal or breakdown of pump and/or breakdown of electrical equipment. In addition, flow meters of all wells except for 3 are broken and the intake amount cannot be measured. Water level is not recorded at the boreholes and instead observation boreholes are installed, but not observed.

(b) Renewal and development plan of boreholes

Renewal and installation of submerged pumps for 12 boreholes and development of nine (9) new boreholes are planned by ZUWSP.

(c) Capacity of deep wells

The current capacity of boreholes is currently 2,827 m^3/hour, and it is expected to increase to 2,924 m^3/hour after the renewal of boreholes and pumps for the 12 boreholes by ZUWSP.

The total expected capacity of boreholes developed by Zanzibar Well Drilling Project, is expected to be 2,226 m^3/hour (pump installed 543 m^3/hour, no pump 1,683 m^3/hour).

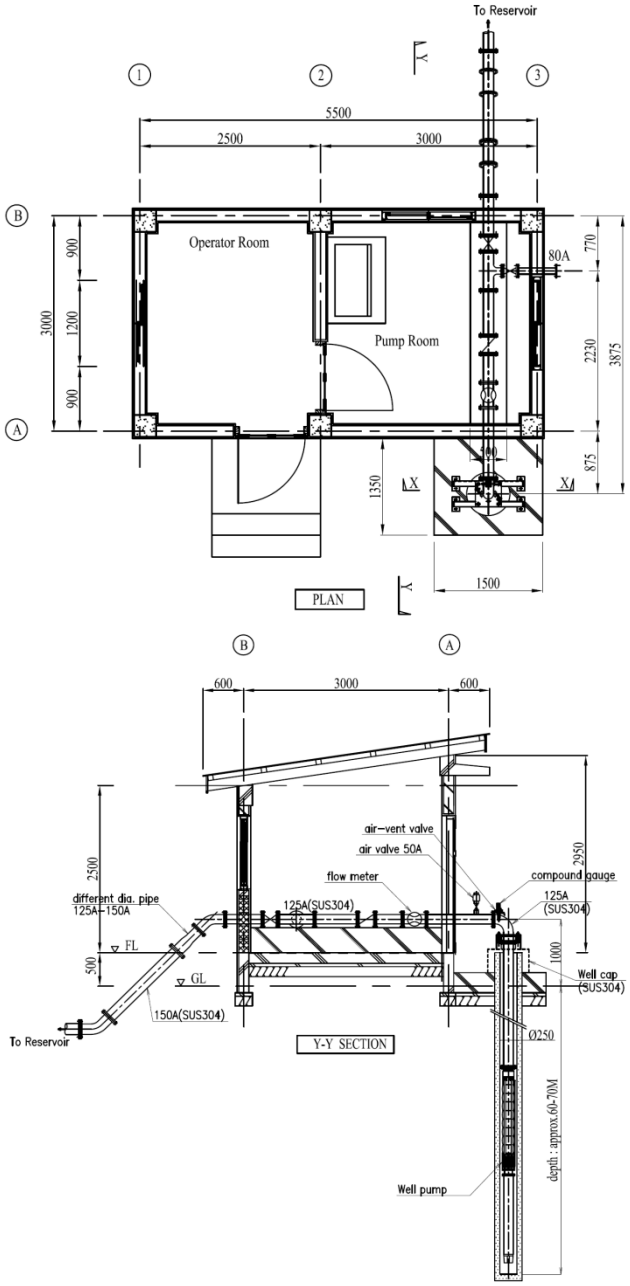
Capacity of nine (9) boreholes developed by ZUWSP is expected as 1,005 m^3/hour.

The total capacity is 6,155 m^3/hour after all projects are completed (**Table 3-21**). Assuming the pumps are operating 24 hours the total ability will be 147,720 m^3/day.

Table 3-21 Facility Capacity of Boreholes

Category	Item	Ability m^3/Hour	Remarks
Existing Boreholes	Current Situation	2,827	Including capacity of out of order boreholes
	(1) After Renewal by ZUWSP	2,924	+97 m^3/hour
New Boreholes	(2) Zanzibar Well Drilling Project	543	Pump Installed
		1,683	No Pump
	(3) ZUWSP	1,005	125m^3/hour 5 sets, 95m^3/hour 4 sets
Total of Expected Ability (Σ(1)-(3))		6,155	

Source: JICA Survey Team



Source: Zanzibar Urban Water Supply Development, Detailed Design Drawing

Figure 3-21 General Drawing of Existing Borehole

(d) Groundwater recharge

The Water Resource Assessment is reported by the ZWSSP (Zanzibar Water Supply and Sanitation Project) in 2014, and in this report, the annual acceptable yield was calculated using a tank model with existing geological data, rainfall amount and coefficient of permeability. The result is shown in **Figure 3-22**.

The areas of Urban West Region are labelled as levels 5 and 6, and the annual acceptable yield for the area is 24,000,000 m^3/year. The daily yield is 65,753 m^3/day, which surpasses

the capacity of the water source facilities shown in **Table 3-21**.

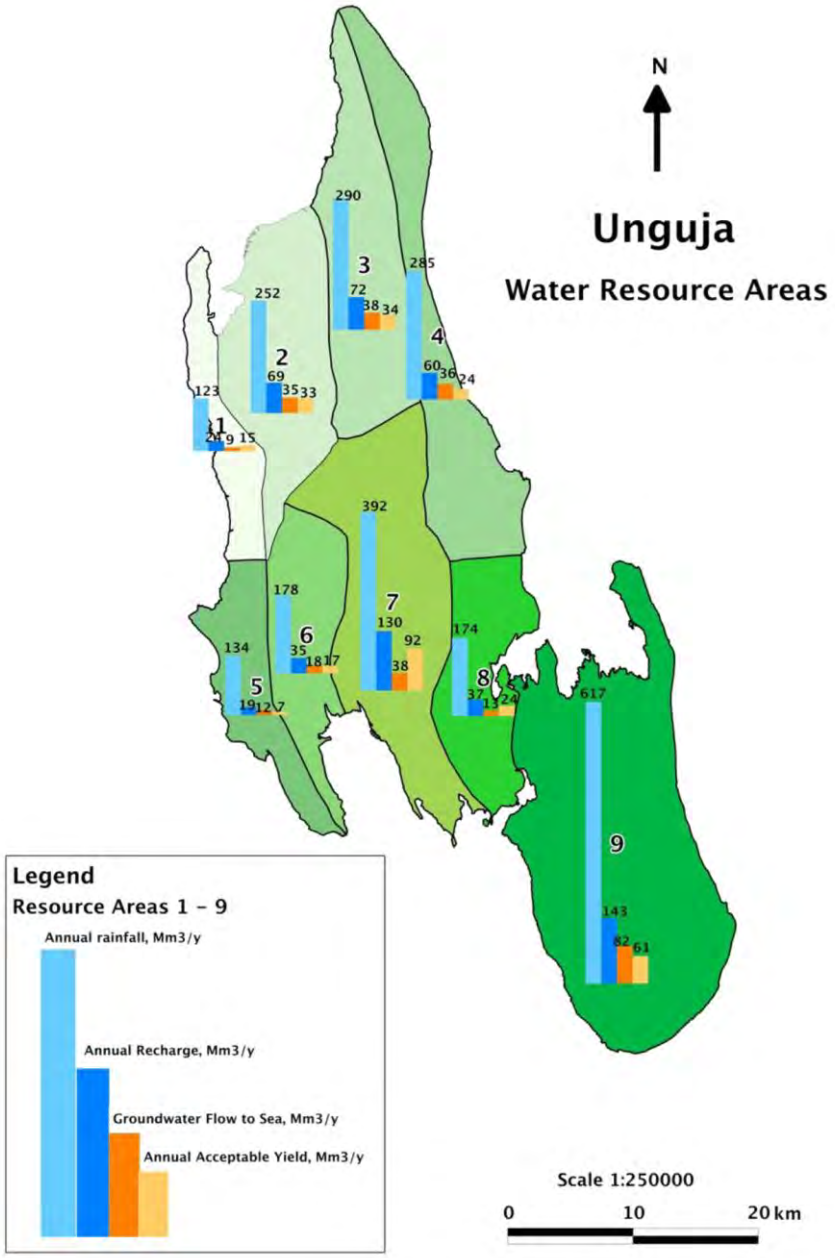


Figure 3-22 Annual Acceptable Yield

In the Water Resource Assessment report, the water balance expectation was calculated based on currently available data, and as shown in **Table 3-22**, the water resource can sufficiently meet water demands. The average usage amount is 37,000 m^3/day, and upon considering the water demand increase following population growth, the annual acceptable yield in Urban West Region will be short in the future.

Table 3-22 Water Balance Expectation of Water Resource Assessment Report

Area	Water usage amount (m^3/year)					Margin
	ZAWA	Private well	Agriculture	Business	Total	(m^3/year)
5	2,500,000	250,000	500,000	1,500,000	4,750,000	2,250,000
6	5,500,000	550,000	1,726,000	1,000,000	8,776,000	8,224,000
Total	8,000,000	800,000	2,226,000	2,500,000	13,526,000	10,474,000

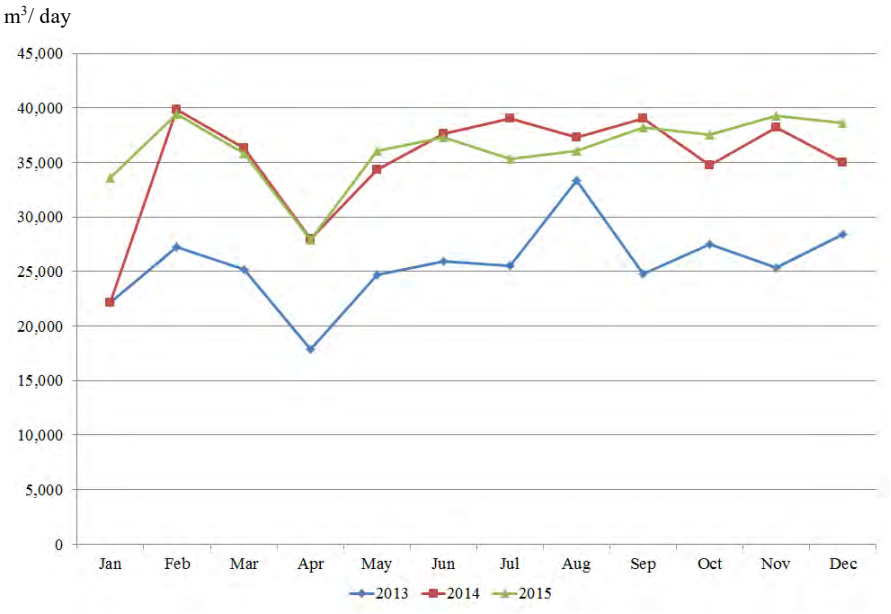
Source: Water Resource Assessment

(e) Borehole water yields

Borehole yields is not measured due to the broken meters, but the Water Production Department of ZAWA reports the monthly estimated yields at the meetings. **Figure 3-23** shows transition of monthly yields in Urban West Region, and **Table 3-23** shows average of monthly amount of intake water.

The intake amount is estimated using the capacity of the borehole pump times the running hours (estimated as 20 hours/day) and operating days. The operating days used for the calculation excludes the power failure days caused by the expansion works of ZECO. According to ZAWA, the estimated daily amount of water yield is between 35,000 and 40,000 m^3.

The intake amount has increased in February 2014, due to the repair works of pumps. Also, every April sees a drop in the yielding amount. This is related to the decrease of operating days in the month, due to power failures by lighting and fallen trees caused by the heavy rains of the rainy season.



Source: Water Production, Technical Operation Department, ZAWA

Figure 3-23 Transition of Estimated Daily Average Yields by Month

Table 3-23 Estimated Daily Average Yields by Month

Month	Average of Daily Intake Water (m^3)				
	2013	2014	2015	2016	Average
January	22,139	22,139	33,571	38,139	35,855
February	27,232	39,893	39,407	40,914	40,071
March	25,216	36,300	35,826	36,481	36,203
April	17,870	27,980	27,913	-	27,946
May	24,668	34,312	36,089	-	35,200
June	25,892	37,633	37,307	-	37,470
July	25,543	39,030	35,316	-	37,173
August	33,374	37,310	36,079	-	36,695
September	24,755	39,059	38,165	-	38,612
October	27,466	34,740	37,530	-	36,135
November	25,394	38,208	39,235	-	38,722
December	28,383	35,014	38,595	-	36,805
Average	25,661	35,135	36,253	-	36,407

Note: Figures after February 2014 is applied since amount of water is increased at that time
Source: JICA Survey Team

(f) Surveyed capacity of water sources

Since the data provided by ZAWA was based on estimation and not measurement, the Survey Team conducted a survey using ultrasonic flow meters for borehole yield measurement to make accurate evaluations of current borehole capacities, and to compare with the borehole pump capacities. For the survey, the boreholes investigated were selected considering the construction year in order to compare the planned borehole capacity and actual capacity according to the construction year and water source location. However, there were boreholes which could not be surveyed due to the lack of meter installation places or signal detection errors caused by air mixing. The number of investigated boreholes were increased to cope with the issues, and therefore the yields were measured in 24 boreholes, as shown in **Table 3-24**.

Table 3-24 Number of Existing Deep wells by Installation Year

Installation Year	Number of Surveyed boreholes	Breakdown of Surveyed Deep wells				
		Survey was Carried out	Impossible to Set Flow Meter	Pump Failure	Signal Detection Error	not surveyed
Before 1995	9	4	1	3	1	—
1996-200	6	2	—	—	4	—
2001-2005	19	6	3	5	5	—
2006-2010	18	11	1	2	4	—
After 2011	10	1	1	2	5	1
Total	62	24	6	12	19	1

Source: JICA Survey Team

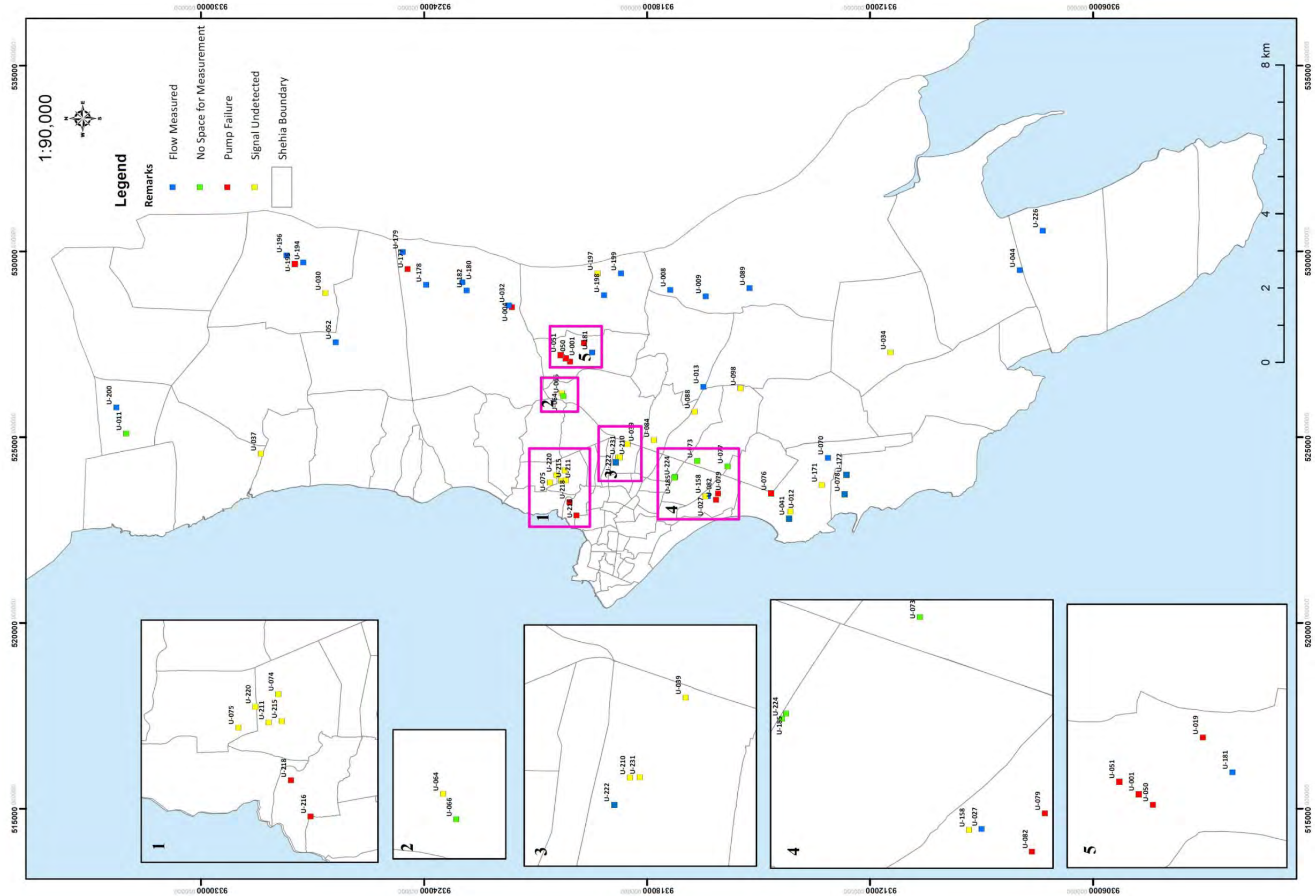
Table 3-25 and **Figure 3-25** show results of the investigation. There is no difference among the installation years, but the actual measured amount tends to be below of the pump capacity.

The regression line is y = 0.9424 x by prevarication figure, which indicates that the measured amount of yield is 90% of the designed pump capacity.

Table 3-25 Results of Borehole Yield Investigation

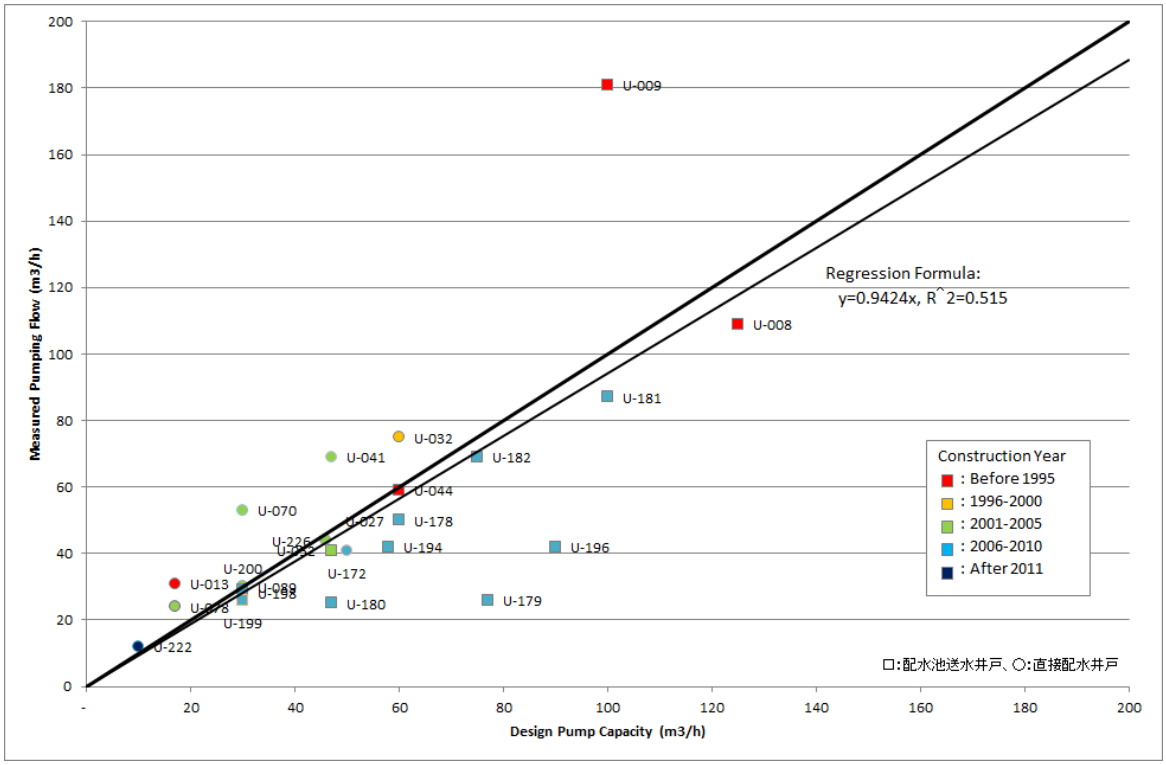
Source Code	Source Name	Destination	Construction Year	Design Pump Capacity (m^3/hour)	Measured Flow (m^3/hour)	Remarks
U-044	Dimani	Dimani	1960	60	59	
U-001	Mwembe Mchomeke	Welezo	1961	77	Pump Failure	
U-004	Kianga	Direct/ (Welezo)	1961	60	Pump Failure	
U-011	Mfenesini	Mfenisini	1963	60	Cannot measure	
U-008	Chunga	Kinuni	1974	125	109	
U-009	Chunga	Kinuni	1974	100	181	
U-012	Mbweni Tractors' Workshop	Direct	1985	17	No signal detected	
U-013	Kijito Upele	Direct	1985	17	31	
U-019	Mwembe Mchomeke	Welezo	1993	80	Pump Failure	
U-027	Kaburi Kikombe	Direct	1996	60	50	
U-030	Kizimbani	Dole	1998	17	No signal detected	
U-032	Kianga	Direct/ (Welezo)	2000	60	75	
U-034	Maungani	Direct	2000	60	No signal detected	
U-037	Kitosani	Direct	2000	47	No signal detected	
U-039	Semuso	SeMuSo	2000	17	No signal detected	
U-041	Mbweni	Direct	2001	47	69	
U-050	Mwembe Mchomeke	Welezo	2002	60	Pump Failure	
U-051	Mwembe Mchomeke	Welezo	2002	160	Pump Failure	
U-052	Dole	Old Dole	2003	47	41	
U-064	Welezo	Welezo	2004	60	Cannot measure	
U-066	Welezo	Welozo	2004	60	No signal detected	
U-070	Kiembe Samaki - Airport	Direct	2004	30	53	
U-073	Mombasa - Kwa Mchina	Mombasa	2004	8	Cannot measure	
U-074	Chumbuni - Wireless Station	Direct	2004	30	No signal detected	
U-075	Mwembe Makumbi	Direct	2004	30	No signal detected	
U-076	Kiembe Samaki - Ali_Yousef	Direct	2004	30	Under Maintenance	
U-077	Mombasa - ZAWA office	Direct	2004	17	Cannot measure	
U-078	Mbweni - BLW	Direct	2004	17	24	
U-079	Migombani Jeshini-2	Direct	2004	60	Electric Equip. Failure	
U-082	Migombani - TPDF camp	Mnarawambao	2004	30	Electric Equip. Failure	
U-084	Magogoni	Direct	2004	30	No signal detected	
U-088	Masumbani	Direct	2005	14	No signal detected	
U-089	Fuoni	Direct	2005	30	30	
U-226	Dimani Bweleo	Direct	2005	46	44	
U-098	Kwarara	Direct	2006	30	No signal detected	
U-158	Kaburi Kikombe	Direct	2006	60	No signal detected	
U-171	Kiembe Samaki - Masumbani	Direct	2007	50	No signal detected	
U-172	Chukwani - Meteorology dept	Direct	2007	50	42	
U-177	N6 - Machui	Welezo	2007	70	Pump Removed	Japanese Grant Aid Project
U-178	N7 - Kianga	Welezo	2007	60	50	Japanese Grant Aid Project
U-179	N8 - Machui	Welezo	2007	77	26	Japanese Grant Aid Project
U-180	N9 - Kianga Chemani	Welezo	2007	47	25	Japanese Grant Aid Project
U-181	N13 - Mwembe Mchomeke	Welezo	2007	100	87	Japanese Grant Aid Project
U-182	N9-2 - Kianga Mkadini	Welezo	2007	75	69	Japanese Grant Aid Project
U-185	Bint Amran-1	Direct	2007	8	Cannot measure	
U-194	N5 - Kizimbani	Dole	2009	58	42	Japanese Grant Aid Project
U-195	N4 - Kinumoshi	Dole	2009	30	Pump Failure	Japanese Grant Aid Project
U-196	N3 - Kinumoshi	Dole	2009	90	42	Japanese Grant Aid Project
U-197	N10 - Msikiti Mzuri	Kinuni	2009	83	No signal detected	Japanese Grant Aid Project
U-198	N12-1 - Msikiti Mzuri	Kinuni	2009	30	28	Japanese Grant Aid Project
U-199	Selem-1	Mfenisini	2009	30	26	
U-200	Selem-2	Mfenisini	2009	30	29	
U-210	Sebleni	Direct	2011	8	No signal detected	
U-211	Chumbuni-2	Saateni	2011	26	No signal detected	
U-222	Sebleni Wazee	Direct	2011	10	12	
U-215	Chumbuni-1	Saateni	2012	40	No signal detected	
U-216	Saateni Waterworks	Saateni	2012	8	Pump Removed	
U-218	Saateni Workshop	Saateni	2012	30	Pump Removed	
U-220	Chumbuni Mbunge	Direct	2012	14	No signal detected	
U-224	Bint Amran-2	Direct	2012	10	Cannot measure	
U-231	Sebleni	Direct	2013	15	No signal detected	
U-242	Welezo 1	Direct	2015	25	No investigation	

Source: JICA Survey Team



Source: JICA Survey Team

Figure 3-24 Location of Deep well Intake Flow Investigation



Source: JICA Survey Team

Figure 3-25 Result of Deep Well Intake Flow Investigation

(g) Raw water quality

(i) Raw water quality records of ZAWA

ZAWA periodically measures 5 raw water quality items (temperature, pH, EC, salinity and total dissolved solids) at the borehole water sources, shown in **Figure 3-26**, using portable measurement devices. The records for Urban West Region are shown in **Table 3-26**.

The pH is weak alkali, and the figures of total dissolved solids, which is thought to be due to the soil-related calcium, is relatively high, but are within the WHO standards of 1,000 mg/L. Although EC value in August 2016 is especially high at the boreholes U-008, U-034, U-044 and U-172, it is not suspected salt water contamination. There were no other particular quality changes during the period.

Table 3-26 Raw Water Quality

Source ID	Source Name	Water Quality Item	Unit	2015	2016						
				Oct	Feb	Mar	Apr	May	Jun	Jul	Aug
U-0558	DIMANI	pH		7.4	6.9	7.0		7.4	7.3	7.6	7.5
		Salinity	ppth	0.03	0.04	0.05		0.05	0.04	0.05	0.04
		EC	µS/cm	735	1,226	1,227		1,280	1,276	1,260	839
		Total Dissolved Solids	mg/L	340	614	613		644	640	628	419
		Water Temperature	℃	28.1	28.7	29.8		29.0	28.8	28.9	28.9
U0044	DIMANI	pH		7.5	7.1	7.2		7.6	7.2	7.3	7.6
		Salinity	ppth	0.04	0.03	0.04		0.04	0.03	0.04	0.05
		EC	µS/cm	1,297	832	839		812	811	812	1,241
		Total Dissolved Solids	mg/L	478	415	418		405	406	406	622
		Water Temperature	℃	28.7	28.5	29.4		28.1	29.1	28.1	29.1
	BWELEO	pH		7.4	7.1	7.0		7.4	7.5		
		Salinity	ppth	0.04	0.05	0.06		0.07	0.05		
		EC	µS/cm	1,628	1,502	1,477		1,589	1,208		
		Total Dissolved Solids	mg/L	578	751	739		797	604		
		Water Temperature	℃	29.3	30.4	31.3		28.8	27.7		
U-0034	MAUNGANI	pH		7.3	6.8	7.0		7.5	7.4	7.4	7.5
		Salinity	ppth	0.02	0.02	0.03		0.03	0.03	0.03	0.06
		EC	µS/cm	704	685	679		697	688	682	1,495
		Total Dissolved Solids	mg/L	265	343	339		348	344	340	749
		Water Temperature	℃	28.8	28.8	30.7		29.3	29.3	28.2	27.3
U0077	MOMBASA OFFICE	pH		7.4	7.1	7.1	7.2	7.5	7.3	7.6	7.5
		Salinity	ppth	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
		EC	µS/cm	814	812	794	754	776	778	790	740
		Total Dissolved Solids	mg/L	309	406	398	377	388	390	396	369
		Water Temperature	℃	28.9	28.5	31.1	30.5	29.8	29.2	29.6	29.3
U0002	KABURI	pH		7.3	7.2	7.2	6.9	7.4	7.4	7.7	7.3
		Salinity	ppth	0.02	0.04	0.05	0.05	0.05	0.05	0.05	0.03
		EC	µS/cm	1,024	1,056	1,103	1,167	1,160	1,145	1,055	796
		Total Dissolved Solids	mg/L	392	548	550	583	578	572	528	397
		Water Temperature	℃	28.9	37.0	36.7	26.7	27.1	29.4	30.0	30.0
U0003	KABURI	pH		7.4	7.2	6.9		7.4	7.5	7.7	7.4
		Salinity	ppth	0.03	0.04	0.05		0.05	0.05	0.05	0.05
		EC	µS/cm	1,169	1,158	1,153		1,083	1,135	1,132	1,122
		Total Dissolved Solids	mg/L	430	578	576		543	567	566	562
		Water Temperature	℃	28.6	30.0	33.3		32.3	29.6	30.3	28.3
	KABURI	pH		7.4							
		Salinity	ppth	0.04							
		EC	µS/cm	1,174							
		Total Dissolved Solids	mg/L	425							
		Water Temperature	℃	28.8							
U0073	KWA MCHINA	pH		7.5	7.2			7.4	7.3		
		Salinity	ppth	0.03	0.03			0.03	0.03		
		EC	µS/cm	747	729			718	718		
		Total Dissolved Solids	mg/L	273	364			357	355		
		Water Temperature	℃	29.5	29.8			29.1	28.8		
U0013	K/UPELE MASHINE	pH		7.4	7.6	7.1	7.4	7.3	7.4	7.9	7.4
		Salinity	ppth	0.04	0.03	0.04	0.04	0.04	0.03	0.03	0.04
		EC	µS/cm	875	824	831	835	832	776	796	830
		Total Dissolved Solids	mg/L	331	412	417	417	416	388	397	414
		Water Temperature	℃	32.4	29.3	30.3	29.6	29.2	26.6	27.0	30.6
U0172	HALI YA HEWA	pH		7.4	7.3	7.4	7.4	7.5	7.5	7.6	7.5
		Salinity	ppth	0.03	0.03	0.04	0.04	0.03	0.03	0.04	0.06
		EC	µS/cm	811	909	929	859	771	787	823	1,462
		Total Dissolved Solids	mg/L	328	455	464	427	386	393	412	732
		Water Temperature	℃	29.5	29.4	31.0	30.9	29.8	30.3	29.8	29.3
U-070	KWARAIS	pH		7.3			7.3	7.6	7.5	7.8	7.5
		Salinity	ppth	0.02			0.03	0.03	0.03	0.03	0.03
		EC	µS/cm	758			720	729	730	743	723
		Total Dissolved Solids	mg/L	228			360	365	364	372	362
		Water Temperature	℃	29.2			30.1	29.1	30.0	29.7	27.9
	BARAZANI	pH		7.3	7.1	7.2	7.3	7.5	7.2	7.2	7.4
		Salinity	ppth	0.04	0.05	0.07	0.06	0.06	0.06	0.06	0.03
		EC	µS/cm	1,624	1,571	1,580	1,506	1,448	1,492	1,446	675
		Total Dissolved Solids	mg/L	587	786	792	754	742	745	727	337
		Water Temperature	℃	29.1	30.1	33.2	30.1	30.3	30.5	30.7	29.2
U0012	MATRECTA	pH		7.4	7.1	7.1	7.2	7.5	7.3	7.3	7.4
		Salinity	ppth	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.04
		EC	µS/cm	750	745	744	719	723	718	722	825
		Total Dissolved Solids	mg/L	287	372	373	359	362	359	361	410
		Water Temperature	℃	28.4	30.5	31.8	30.8	28.1	29.1	31.1	29.9

Table 3-26 Raw Water Quality (Continuation)

Source ID	Source Name	Water Quality Item	Unit	2015	2016						
				Oct	Feb	Mar	Apr	May	Jun	Jul	Aug
U0098	KWARARA	pH		7.4	7.3	7.3		7.5	7.5	7.3	7.4
		Salinity	ppth	0.02	0.03	0.03		0.03	0.03	0.03	0.03
		EC	µS/cm	706	718	709		707	709	713	709
		Total Dissolved Solids	mg/L	270	359	355		354	354	375	355
		Water Temperature	℃	29.1	30.8	32.2		29.0	27.6	27.7	29.5
U0087	MELI 4 MASUMBANI	pH		7.4							
		Salinity	ppth	0.02							
		EC	µS/cm	773							
		Total Dissolved Solids	mg/L	293							
		Water Temperature	℃	29.2							
U0063	WELEZO	pH		7.4	6.7			7.5	7.4		7.5
		Salinity	ppth	0.01	0.01			0.01	0.01		0.01
		EC	µS/cm	267	254			261	203		237
		Total Dissolved Solids	mg/L	100	127			131	103		118
		Water Temperature	℃	28.7	28.0			32.3	30.6		29.1
U0064	WELEZO 2	pH		7.3	6.7		6.4				
		Salinity	ppth	0.01	0.01	0.01	0.01				
		EC	µS/cm	162	170	182	194				
		Total Dissolved Solids	mg/L	62	86	89	96				
		Water Temperature	℃	28.5	28.4	29.7	26.2				
U0074	CHUMBUNI	pH		7.4			7.5				
		Salinity	ppth	0.03			0.03				
		EC	µS/cm	715			733				
		Total Dissolved Solids	mg/L	358			366				
		Water Temperature	℃	30.1			30.5				
	WORK SHOP	pH		7.4							
		Salinity	ppth	0.04							
		EC	µS/cm	1,262							
		Total Dissolved Solids	mg/L	488							
		Water Temperature	℃	30.1							
U-009	CHUNGA 1	pH			7.2	7.3		7.2	7.4	7.4	7.5
		Salinity	ppth		0.02	0.03		0.03	0.03	0.02	0.02
		EC	µS/cm		637	639		646	634	430	588
		Total Dissolved Solids	mg/L		318	319		324	317	215	294
		Water Temperature	℃		28.3	29.5		28.5	28.0	27.3	28.6
U-008	CHUNGA 11	pH			7.5	7.7	8.2	7.5	7.2	7.6	7.5
		Salinity	ppth		0.02	0.03	0.02	0.02	0.02	0.03	0.05
		EC	µS/cm		633	635	438	463	426	623	1,101
		Total Dissolved Solids	mg/L		316	318	216	231	213	311	558
		Water Temperature	℃		28.5	29.9	29.4	26.9	27.9	29.3	29.7
U0050	M/MCHOMEKE	pH			7.1		7.1		7.3	7.2	7.4
		Salinity	ppth		0.02		0.02		0.02	0.01	0.02
		EC	µS/cm		562		565		573	288	577
		Total Dissolved Solids	mg/L		282		282		286	144	289
		Water Temperature	℃		29.0		29.2		28.7	28.0	29.4
U0039	SAMUSO	pH				6.3		7.5		7.3	7.2
		Salinity	ppth			0.03		0.03		0.02	0.03
		EC	µS/cm			602		609		463	620
		Total Dissolved Solids	mg/L			301		306		230	309
		Water Temperature	℃			31.5		30.1		28.0	29.1
U-004	KIANGA	pH					7.3	7.6	7.4	7.3	7.4
		Salinity	ppth				0.02	0.02	0.02	0.02	0.02
		EC	µS/cm				554	542	545	346	547
		Total Dissolved Solids	mg/L				276	272	273	273	273
		Water Temperature	℃				30.9	28.9	28.3	28.0	28.7
U0051	M/MCHOMEKE	pH								7.4	
		Salinity	ppth							0.02	
		EC	µS/cm							564	
		Total Dissolved Solids	mg/L							241	
		Water Temperature	℃							28.7	

Source: Laboratory, Water Resources, Water Development Department, ZAWA

Source: Laboratory, Water Resources, Water Development Department, ZAWA

Figure 3-26 Location of Raw Water Sampling Points

(ii) Surveyed water quality test results

The Survey Team conducted a detailed raw water quality survey at 5 boreholes developed by the Japanese Grant Aid project, which are the expected future main water sources. The results are shown in **Table 3-27**. In addition, to comprehend the salt water intrusion situation and water hardness, raw water quality tests limiting the test items were conducted (**Table 3-28**).

According to the results, the water quality shall satisfy the WHO drinking water guideline[1] if the water is chlorinated, but as shown in **Table 3-27**, ammonium nitrogen is high. This may a reduction action by nitrate nitrogen or nitrite-nitrogen, but organic matters and faecal coliform bacterium are also detected. Therefore, it is necessary to pay attention to contamination by domestic wastewater. Intrusion of saline water into aquifer was not detected by this survey.

Table 3-27 Raw Water Quality Survey Results - 1

Item	Unit	WHO Standard	U-178			U-181		
			4-Oct	16-Oct	29-Nov	4-Oct	16-Oct	29-Nov
pH			7.37	7.37	-	7.23	-	-
Electric conductivity	µS/cm	–	585	467	-	628	-	-
Color	mgpt/L	15 TCU	0	0	0	16	-	0
Odor		Acceptable	N.A.	N.A.	N.A.	N.A.	-	N.A.
Nitrate nitrogen	mg/L	50 (acute) mg/L	0.40	0.40	1.20	0.80	-	1.60
Nitrite nitrogen	mg/L	(acute) 0.2 (chronic) mg/L	0.0021	0.0032	0.0420	0.0053	-	0.0024
Ammonia nitrogen	mg/L	1.5 mg/L	0.380	0.227	0.184	0.258	-	0.137
Chloride	mg/L	250 mg/L	69.50	8.00	6.00	89.00	-	8.00
Iron	mg/L	0.3 mg/L	0.198	0.017	<0.01	<0.01	-	0.016
Manganese	mg/L	0.5 mg/L	0.091	<0.01	<0.01	<0.01	-	<0.01
Calcium hardness	mg/L	–	206	167	88	237	-	141
Ttotal hardness	mg/L	–	228	242	-	266	-	-
Organic substance	mg/L	–	174.80	4.00	2.80	16.40	-	3.20
Fecal coliform	count/100mL	N.D.	42	-	35	94	-	21
Coliform bacteria	count/100mL	N.D.	88	-	61	240	-	35

Item	Unit	WHO Standard	U-194			U-196			U-197		
			4-Oct	16-Oct	29-Nov	4-Oct	16-Oct	29-Nov	4-Oct	16-Oct	29-Nov
pH			7.60	7.62	-	7.22	7.35	-	-	-	-
Electric conductivity	µS/cm	–	588	519	-	496	524	-	-	-	-
Color	mgpt/L	15 TCU	15	4	-	20	0	3	-	4	0
Odor		Acceptable	N.A.	N.A.	-	N.A.	N.A.	N.A.	-	N.A.	N.A.
Nitrate nitrogen	mg/L	50 (acute) mg/L	0.40	0.50	-	0.50	0.40	0.90	-	0.90	1.00
Nitrite nitrogen	mg/L	(acute) 0.2 (chronic) mg/L	0.0039	0.0065	-	0.0290	0.0043	0.0033	-	0.0039	0.0025
Ammonia nitrogen	mg/L	1.5 mg/L	0.192	0.223	-	0.198	0.304	0.205	-	0.171	0.106
Chloride	mg/L	250 mg/L	77.00	6.00	-	69.00	5.00	9.00	-	8.20	7.80
Iron	mg/L	0.3 mg/L	0.060	0.098	-	0.094	0.060	0.124	-	0.030	0.021
Manganese	mg/L	0.5 mg/L	0.023	<0.01	-	<0.01	<0.01	0.013	-	<0.01	<0.01
Calcium hardness	mg/L	–	108	114	-	209	161	83	-	63	168
Ttotal hardness	mg/L	–	229	254	-	234	271	-	-	-	-
Organic substance	mg/L	–	16.40	8.40	-	30.40	5.60	6.00	-	6.00	5.20
Fecal coliform	count/100mL	N.D.	8	-	-	108	-	26	-	0	10
Coliform bacteria	count/100mL	N.D.	21	-	-	160	-	52	-	2	22

Source: JICA Survey Team

[1] There is no water quality standard in Zanzibar. In the main land, WHO guideline is applied for urban area, and Tanzania standard, which is a mitigation standard of WHO guideline, is applied for rural area. WHO guideline is applied in this plan because Urban West Region is categorized as urban area.

Table 3-28 Raw Water Quality Survey Results - 2

Well no.	Nitrite nitrogen mg/L	Nitrate nitrogen mg/L	Chloride ions mg/L	Calcium mg/L
WHO standard	3 (acute), 0.2 (chronic)	50 (acute)	250 (nature, taste)	—
Quality standard (Japanese)	Under 0.04mg/L	Under 10mg/L	Under 200mg/L	Under 300mg/L (hardness)
U-001	0.0040	1.2	9.5	289
U-004	0.0033	1.0	44.0	256
U-008	0.0056	1.1	12.0	285
U-009	0.0058	1.5	3.2	156
U-019	0.0068	0.9	26.0	284
U-032	0.0037	1.0	16.0	248
U-034	0.0033	1.2	34.0	320
U-037	0.0030	1.4	11.4	319
U-039	0.0105	3.5	28.9	107
U-041	0.0035	4.5	36.0	260
U-044	0.0038	1.0	36.0	325
U-051	0.0019	1.1	7.0	98
U-052	0.0021	1.0	6.0	148
U-064	0.0066	0.5	10.0	31
U-066	0.0033	0.7	12.0	15.5
U-074	0.0017	4.6	38.0	304
U-075	0.0071	5.6	70.0	298
U-076	0.0090	2.5	14.1	255
U-077	0.0036	3.6	19.0	229
U-078	0.0041	4.1	173.0	365
U-084	0.0192	6.2	39	239
U-089	0.0047	2.3	13.0	268
U-098	0.0034	1.1	29.0	277
U-158	0.0060	3.4	130.0	317
U-171	0.0045	4.0	48.0	222
U-172	0.0017	3.0	87.0	202
U-182	0.0035	0.5	11.0	164
U-198	0.0052	0.9	18.0	186
U-215	0.0019	1.7	21.0	185
U-220	0.0021	2.3	23.0	235
U-222	0.0010	3.7	43.0	210
U-224	0.0179	7.0	29.0	190

Source: JICA Survey Team

(h) Survey of existing boreholes by ZUWSP

Actual condition survey (pumping test and in-water TV test) of existing boreholes is carried out under ZUWSP of AfDB as a part of its detailed design. From the results, more than 50 ppm of sand lifting is found in all 26 surveyed boreholes. Reasons for sand lifting can be due to inappropriate screen design, installation of filtering layer, and excessive pumping. In addition, screen pipes were broken in 14 boreholes.

Removal of sediment is planned as rehabilitation of boreholes by ZUWSP.

(2) Spring Water Sources

Spring water sources are shown in **Table 3-29**, and the outline is described below.

(a) Mtoni Spring

Mtoni spring is used since the establishment of water supply in Zanzibar, and water springs out from two points. One supplies water to Zanzibar Port in Malindi in Stone Town and Saateni Reservoir by gravity flow. The other point supplies water to its vicinity by pumping.

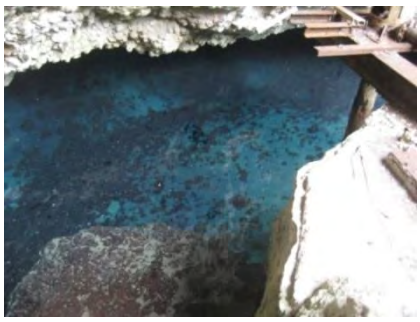
(b) Bububu Spring

Bububu Spring is also used since the establishment of water supply in Zanzibar, and it supplies to Saateni Reservoir and its vicinity by pumping. The vicinity of the spring is protected as a conservation area, but water pollution is now a concern due to the increase of illegal inhabitants.

(c) Dimani Cave

Water source in Dimani Cave has been used as a drinking water source since 1976. Water is distributed to Dimani Reservoir by pumping and is mixed with groundwater, and then distributed to Dimani area by gravity.

Table 3-29 Spring Water Sources in Urban West Region

Photo	Outline of Facility
	**Mtoni Spring 1** ・Construction: 1920 ・Supply to: Saateni Reservoir and Zanzibar Port in Malindi (Stone Town) by gravity ・Amount of Water: 2,822 m^3/day (Average from 2012 to 2015)
	**Mtoni Spring 2** ・Construction: 1920 ・Supply to: Vicinity of the spring
	**Bububu Spring** ・Construction: 1923 ・Supply to: Saateni Reservoir by gravity, and distribution to vicinity of the spring by pumping ・Amount of Water: 2,673 m^3/day (Average from 2012 to 2015)
	**Dimani Spring** ・Construction: 1976 A.D. ・Supply to: Dimani Reservoir by pumping, and flow to Dimani Division by gravity ・Amount of Water: Unknown, but capacity of pumping is 77 m^3/Hour.

Source: JICA Survey Team

(d) Intake amount records

Measurement facilities for intake amount of the springs are all weir-type flow meters. However, the amount of intake is not measured at the spring.

The flow amount of spring water is measured at the receiving well of Saateni Reservoir using a weir-type flow meter. Measurement is carried out once a day. Depth of the weir is measured

in the morning, and amount of water received is recorded by reference with calibration scale.

Water of Mtoni Spring is distributed not only to Saateni Reservoir but also to Zanzibar port and its vicinity, but the distribution amount is not measured.

Photo 3-2 Weir Type Flow meter at Bububu Spring

Photo 3-3 Weir Type Flow meter at Mtoni Spring

Table 3-30 shows the records of amount received at Saateni reservoir from 2012 to 2015.

Table 3-30 Amount received at Saateni Reservoir (2012-2015)

Item	from Mtoni Spring	from Bububu Spring
Daily Average Receiving flow	2,824 m^3/day	2,668 m^3/day
Daily Maximum Receiving flow	7,941 m^3/day	6,018 m^3/day
Daily Minimum Receiving flow	1,608 m^3/day	1,608 m^3/day

Source: Water Production, Technical Department, ZAWA

Monthly amount received at Bububu spring and Mtoni spring are shown in **Table 3-31**, **Figure 3-27** and **Figure 3-28**. The highest amount is recorded during March-May and November- December due to the rainy season. For the monthly amount, the highest record is in January 2012 and in May in other years, meanwhile the lowest amount is recorded in September-October and January-February just before the rainy season.

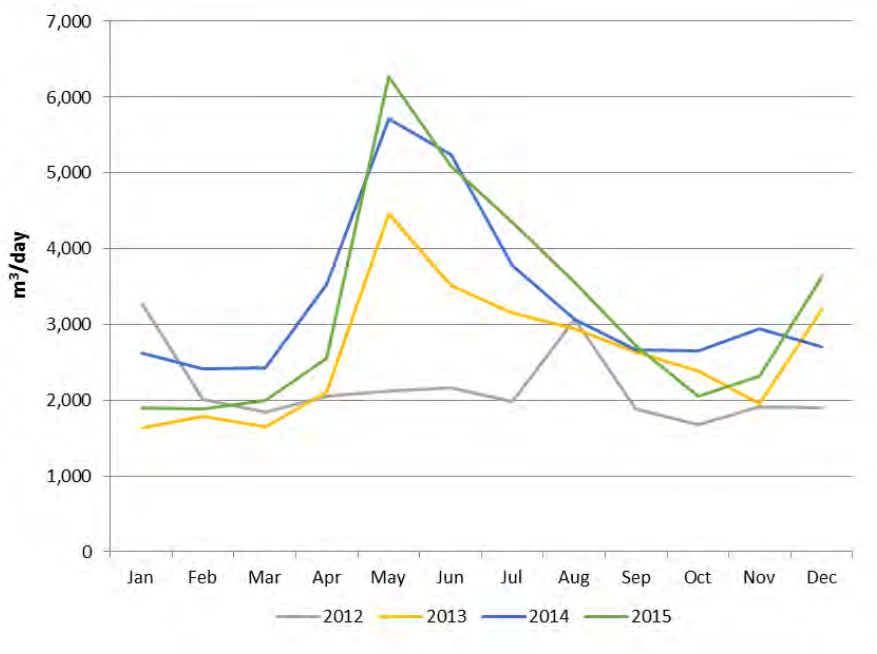
According to the results of the amount received at Saateni reservoir, it is assumed that the amount of spring water is affected by rainy season (condition of rain falls).

Table 3-31 Monthly Average Flow Received at Saateni Reservoir from Springs

unit: m^3/day

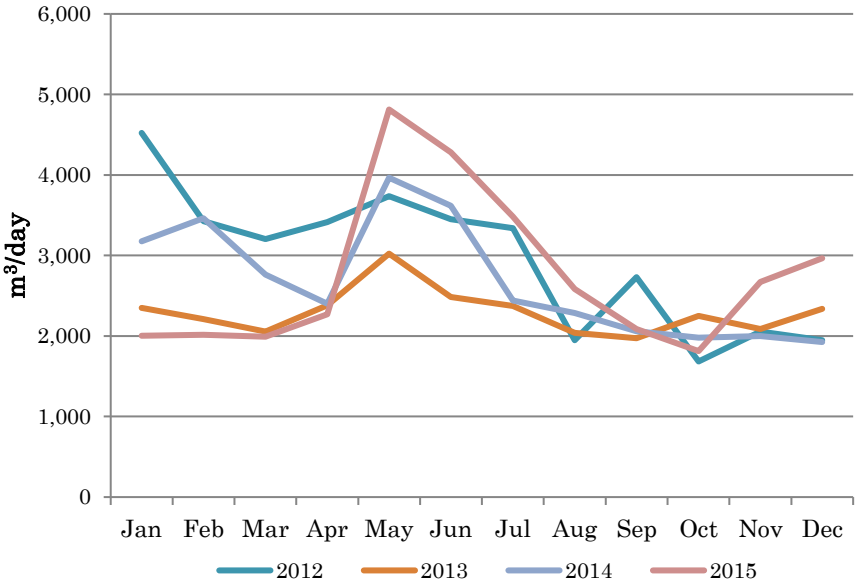
Month	2012		2013		2014		2015	
	Mtoni	Bububu	Mtoni	Bububu	Mtoni	Bububu	Mtoni	Bububu
Jan	3,277	4,522	1,634	2,348	2,618	3,174	1,902	2,004
Feb	2,008	3,425	1,788	2,209	2,417	3,462	1,879	2,015
Mar	1,836	3,204	1,646	2,056	2,424	2,761	1,993	1,991
Apr	2,048	3,413	2,101	2,381	3,531	2,400	2,549	2,269
May	2,123	3,737	4,462	3,023	5,706	3,966	6,273	4,813
Jun	2,168	3,450	3,517	2,485	5,233	3,618	5,085	4,280
Jul	1,987	3,338	3,146	2,375	3,771	2,443	4,343	3,481
Aug	3,061	1,947	2,935	2,041	3,066	2,287	3,549	2,585
Sep	1,888	2,731	2,630	1,973	2,665	2,058	2,716	2,085
Oct	1,676	1,684	2,381	2,252	2,652	1,979	2,044	1,813
Nov	1,918	2,055	1,960	2,088	2,946	2,000	2,319	2,672
Dec	1,897	1,947	3,191	2,338	2,705	1,926	3,621	2,967
Daily Average	2,157	2,955	2,616	2,297	3,311	2,673	3,189	2,748
Daily Maximum	3,277	4,522	4,462	3,023	5,706	3,966	6,273	4,813
Daily Minimum	1,676	1,684	1,634	1,973	2,417	1,926	1,879	1,813

Source: Water Production, Technical Department, ZAWA



Source: JICA Survey Team

Figure 3-27 Daily Average Flow Received at Saateni Reservoir from Mtoni Spring



Source: JICA Survey Team

Figure 3-28 Daily Average Amount Received at Saateni Reservoir from Bububu Spring

(3) Issues for Water Source Facilities

【Broken pumps】

- Ratio of broken pumps is high (16% as of October 2016)

【Broken Borehole flow meters (intake amount cannot be measured)】

- Borehole yield is estimated and the actual amount is unknown.
- Turbine flow meters installed at the boreholes are mostly broken, but the cause is unknown.

【Unmonitored groundwater level】

- Water level meters are not installed at the boreholes.
- Observation boreholes are not monitored.
- In case of abnormality of pumping amount, it cannot be judged if the cause is the pump or the borehole.

【Concerns of water source pollution】

- Detection of faecal coliform.

3.5.3 Water Transmission Pipe

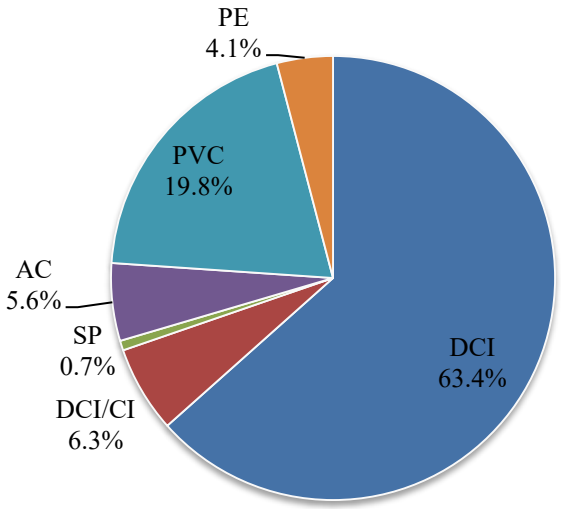
(1) Pipeline Length by Material

Table 3-32 shows the length of transmission pipeline by material and diameter, and **Figure 3-29** shows the ratio of transmission pipe material. Under ZAWA's definition, water transmission pipes are mostly the general raw water transmission pipes. The total length of the transmission pipelines is 38km, including 24km of ductile cast iron pipes installed by the Japanese Grant Aid project. Therefore, the ratio of ductile cast iron pipe length to total length is as high as 63%.

Table 3-32 Length of Transmission Pipelines by Material and Diameter

Nominal Diameter	Material						
	DCI	DCI/CI	SP	AC	PVC	PE	Total
600mm	1,998.3	0.0					1,998.3
450mm		139.0					139.0
400mm	4,663.6	0.0					4,663.6
375mm		85.7					85.7
300mm	7,747.2	1,028.8			1,792.9		10,568.9
250mm	3,267.5	0.0					3,267.5
225mm		0.0			485.6	137.9	623.5
200mm	3,642.6	0.0		65.4	2,691.1		6,399.1
150mm	2,978.1	1,114.1		2,099.0	1,697.9	1,357.4	9,246.5
100mm		47.5	144.7		934.3		1,126.5
75mm			25.0			7.4	32.4
63mm						59.8	59.8
50mm			102.8				102.8
Total	24,297.3	2,415.1	272.5	2,164.4	7,601.8	1,562.5	38,313.6
Composition Rate(%)	63.4	6.3	0.7	5.6	19.8	4.1	100.0

Source: Planning and Project Management, Water Development Department, ZAWA



Source: JICA Survey Team

Figure 3-29 Ratio of Transmission Pipe Material

(2) Installation Year of Transmission Pipes

Figure 3-30 shows type of pipe, pipe diameter, and location of water transmission pipes. There are no records of the year of installation of the pipes on the GIS database. However, it is estimated by the construction year of the reservoir that the raw water transmission pipelines connected to Old Dole reservoir (circled in red in the Figure) and Dimani reservoir would be more than 40 years old.

Table 3-33 Period of Pipeline Construction

Connected Reservoir	Type of Pipe	Year of Installation	Timing of Installation/Construction
Welezo Reservoir	DCIP	2006-2008	Instalment by Grant Aid Project
Kinuni Reservoir	DCIP	2008-2010	ditto
Dole Reservoir	DCIP	2008-2010	ditto
Saateni Reservoir	PE	Around 2011	Installation of Chumbuni well
Mnarawambao Reservoir	PE	Around 2013	Renewal of Mnarawambao elevated tank
SeMuSo Reservoir	PVC	Around 2003	Construction of SeMuSo reservoir
Old Dole Reservoir	PVC	Around 1960	Construction of old Dole reservoir
Mfenisini Elevated Tank	PVC	Around 2013	Renewal of the elevated tank by EU
Dimani Reservoir	ACP	Around 1968	Renewal of Dimani reservoir

Source: JICA Survey Team

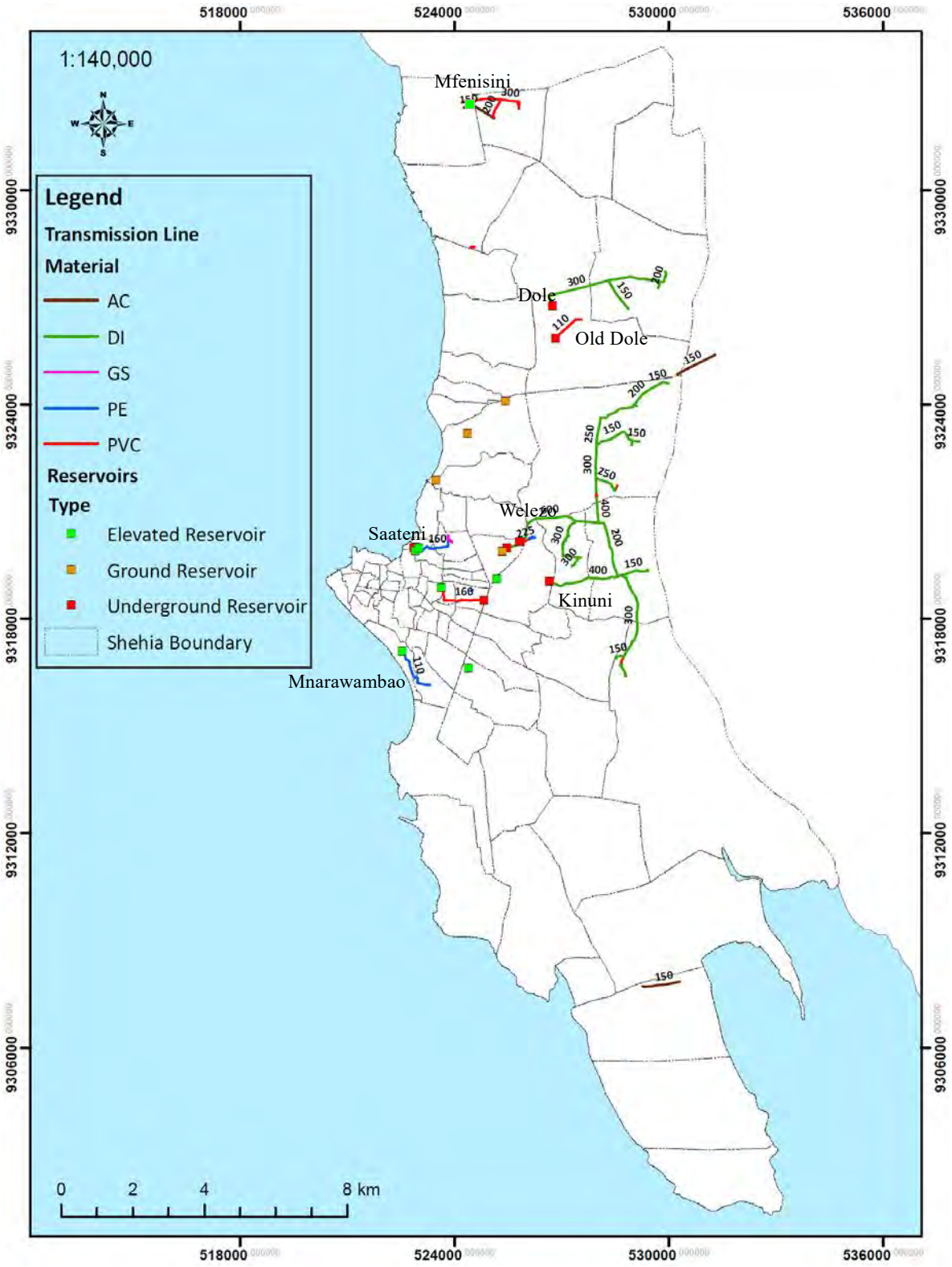
(3) Issues of Transmission Pipes

【Aging of several pipelines】

- Several pipelines are aging.

【Existence of AC pipe】

- AC pipeline for raw water transmission remains in the Dimani System.



Source: Planning and Project Management, Water Development Department, ZAWA

Figure 3-30 Material, Diameter and Location of Transmission Pipeline

3.5.4 Reservoirs and Elevated Tanks

(1) Outline of the Facilities

ZAWA owns 4 major reservoirs (Welezo, Kinuni, Dole, and Saateni), and other small-scale reservoirs and elevated tanks in the Urban West Region. Additionally, reservoirs are planned to be constructed at Saateni and Mnarawambao by ZUWSP. **Table 3-34** shows the outline of reservoirs and elevated tanks, **Table 3-35** shows the capacity of said facilities in the Urban West Region, and **Table 3-36** shows the reservoirs planned to be constructed by ZUWSP.

Table 3-34 Reservoirs and Elevated Tanks in Urban West Region

Photo	Outline of Facility
	**Welezo Reservoir** ・Number of Reservoirs: 4 ・Capacity:No.1-4,000 m^3, No.2-4,000 m^3, No.3-2,250 m^3, No.4-420 m^3 ・Disinfection Equipment: Available, but deteriorated. (Dosing pipe was broken.) ・Reservoirs No.1 and No.2 were constructed in 2008 by grant aid from Japan and are in operation ・No inlet flow meter, and distribution flow meter is broken.
	**Kinuni Reservoir** ・Number of Reservoir: 1 ・Capacity:2,700 m^3 ・Disinfection Equipment: Available, but deteriorated. ・Reservoir was constructed in 2010 by grant aid from Japan and is in operation ・No inlet flow meter, and distribution flow meter is broken.
	**Dole Reservoir** ・Number of Reservoir:1 ・Capacity:1,200 m3 ・Disinfection Equipment: Available, but deteriorated and no power supply. ・Reservoir was constructed in 2010 by grant aid from Japan and is in operation ・No inlet flow meter, and distribution flow meter is broken.

Table 3-34 Reservoirs and Elevated Tanks in Urban West Region (Continuous)

Photo	Outline of Facility
	**Saateni Reservoir** ・Number of Tanks: 3 Reservoirs and 2 Elevated Tanks ・Capacity: Elevated Tank: 450 m^3, Reservoir: 1,000m^3 x 2 ponds, 2,250m^3 x 1 pond ・Disinfection Equipment: Available, but deteriorated. ・Saateni reservoir, which started operation in 1923 and ground reservoir was expanded in 1943, is old facility (93 and 73 year-old facilities). Pumping facilities to elevated tank and disinfection equipment were installed by grant aid from Japan ・Although elevated tank was rehabilitated in 2006, water leakage has been observed. ・This is inside of ZUWSP Area. Two more elevated reservoirs (2,000m^3 x 2) are planned to be constructed. ・Although inlet flow meter for spring water is installed, inlet flow meter for groundwater is not available. Distribution flow meter is in service.
	
	**Mnarawambao Elevated Tank** ・Number of Tanks: 1 Reservoir and 1 Elevated tank ・Capacity: Ground reservoir 1000 m^3, Elevated tank 50 m^3 ・Disinfection Equipment: Not Equipped ・This facility started operation in 1954. New well construction and elevated tank replacement were constructed by ZAWA in 2013. ・This is inside of ZUWSP Area. A new elevated reservoir (1,000m^3 x 1) is planned to be constructed. ・No flow meter for inlet and outlet.
	**SeMuSo Elevated Tank** ・Number of Tank: 1 ・Capacity: 120 m^3 ・Disinfection Equipment: Not Equipped ・This facility started operation from 2003. Water is pumped from boreholes up to the tank, then is distributed to the vicinity from the tank. ・No flow meter for inlet and outlet.

Table 3-34 Reservoirs and Elevated Tanks in Urban West Region (Continuous)

Photo	Outline of Facility
	**Mombasa Elevated Tank** ・Number of Tank: 1 ・Capacity:150 m^3 ・Disinfection Equipment: Not Equipped ・This facility started operation from 2006. Water is pumped from a borehole up to the tank, and then is distributed to the vicinity from the tank. ・No flow meter for inlet and outlet.
	**Dole (Old) Reservoir** ・Number of Reservoir: 1 ・Capacity: 100 m^3 ・Disinfection Equipment: Not Equipped ・This facility started operation from 1960. Water is pumped from a borehole up to the tank, then is distributed to the vicinity from the tank. ・No flow meter for inlet and outlet.
	**Dimani Reservoir** ・Number of Tanks: 1 ・Capacity:450 m^3 ・Disinfection Equipment: Not Equipped ・Initial tank was constructed in 1968, and it was replaced 2006. Water is pumped from cave and a borehole to up the tank, and then is distributed to the vicinity from the tank. ・No flow meter for inlet and outlet.
	**Mfenesini Elevated Tank** ・Number of Tanks: 1 ・Capacity: 225 m^3 ・Disinfection Equipment: Not Equipped ・It was constructed by EU in 2013 since previous tank was broken. Water is pumped from boreholes up to the tank, and then is distributed to the vicinity from the tank. ・There is water leakage along connection points of panels. (to be repaired in 2016) ・No flow meter for inlet and outlet.

Source: JICA Survey Team

Table 3-35 Capacity of Reservoir and Elevated Tanks in Urban West Region

Facility	Type *	Structure	Capacity (m^3)	LWL	HWL	Year of Construction	Year of Repair	Remarks
Welezo No.1	1	RC	4,000	69.90	74.90	2008	－	
Welezo No.2	1	RC	4,000	69.90	74.90	2008	－	
Welezo No.3	1	RC	2,250	69.90	74.90	1975	－	41-years old
Welezo No.4	1	Steel	420	69.90	74.90	1975	－	41-years old
Saateni No.1	1	RC	2,250	5.80	6.40	1943	－	73-years old
Saateni No.2	1	RC	1,000	5.80	6.40	1923	－	93-years old
Saateni No.3	1	RC	1,000	5.80	6.40	1923	－	93-years old
Saateni No.4	3	Steel	450	31.50	35.00	1940	2006	Tank replaced
Saateni No.5	3	Steel	450	31.50	35.00	1940	2006	Tank replaced
SeMuSo	3	RC	120	40.00	44.50	2003	－	
Mnarawambao	1	RC	1,000	unk	unk	1954	－	62-years old
Mnarawambao	3	Steel	50	40.00	41.80	1954	2013	Tank replaced
Dimani	2	Steel	450	unk	unk	1968	2006	Tank replaced
Kinuni	1	RC	2,700	68.00	73.00	2010	－	
Dole	1	RC	1,200	98.70	103.70	2010	－	
Dole (Old)	1	RC	100	103.60	106.00	1960	－	56-years old
Mombasa	3	RC	150	unk	unk	2006	－	
Mfenesini	3	Steel	225	unk	unk	2013	to be repaired	Tank replaced
Total			21,815					

*1: Underground, 2: Above grade, 3: Elevated

Source: JICA Survey Team

Table 3-36 Capacity of ZUWSP's Planned Reservoirs

Facility Name	Type	Structure	Capacity(m^3)	LWL	HWL	Remarks
Saateni	Elevated	RC	2,000	30.20	34.70	ZUWSP
Saateni	Elevated	RC	2,000	30.20	34.70	ZUWSP
Mnarawambao	Elevated	RC	1,000	45.00	50.00	ZUWSP
Total			5,000			

*: Number of Saateni reservoir construction was reduced from 2 tanks to 1 tank during the procurement of contractor (as of October 2017), total capacity is 3,000 m^3.

Source: JICA Survey Team

(2) Situation of Reservoirs and Elevated Tanks

There are common problems for the reservoirs, including those constructed by the Japanese Grant Aid Project.

Major failures of the main reservoirs of this Project (Dole, Welezo and Kinuni) are shown in **Table 3-37**.

Table 3-37 Equipment Failures at Main Reservoirs

Reservoir	Water Level Gauge	Outlet Flow Meter	Chlorine Dosing Pipe	Remarks
Dole Reservoir	×	×	○	
Welezo Reservoir No. 1	×	×	×	
Welezo Reservoir No. 2, 3	×	×	×	
Kinuni Reservoir	△	×	△	

Note: ○ Working well, △ Partly working, × not working
Source: JICA Survey Team

(3) Issues of Reservoirs and Elevated Tanks

【Aging of reservoirs】

- Several main reservoirs are aging noticeably (Saateni underground reservoir, old Dole reservoir and Mnarawambao underground reservoir).

【Defectiveness of equipment】

- Inflow meters are not installed at the reservoirs.
- Reservoir flow meters are not installed, or broken.
- Adjusting of chlorine injection amount is difficult since the inflow/outflow amount is unknown.

【Unrepaired equipment】

- Broken facilities/equipment are not repaired.

3.5.5 Distribution Pipeline

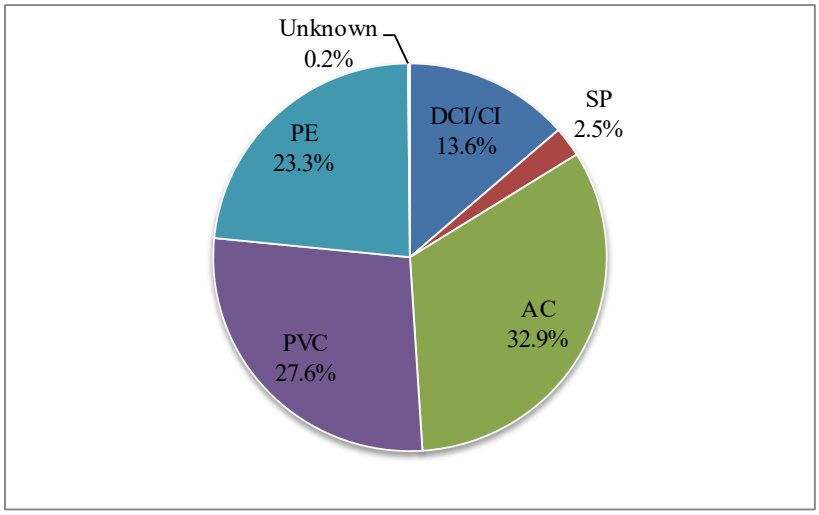
(1) Pipe Material

Table 3-38 shows the length of distribution pipe by material and diameter, and **Figure 3-31** shows the ratio of distribution pipe by material. The total distribution pipe length in Urban West Region is 370 km. In terms of materials, the distribution percentage is: asbestos cement pipe (AC) 32.9%, PVC pipe 27.6%, and polyethylene pipe (PE) 23.3%.

Table 3-38 Length of Distribution Pipe by Type and Diameter

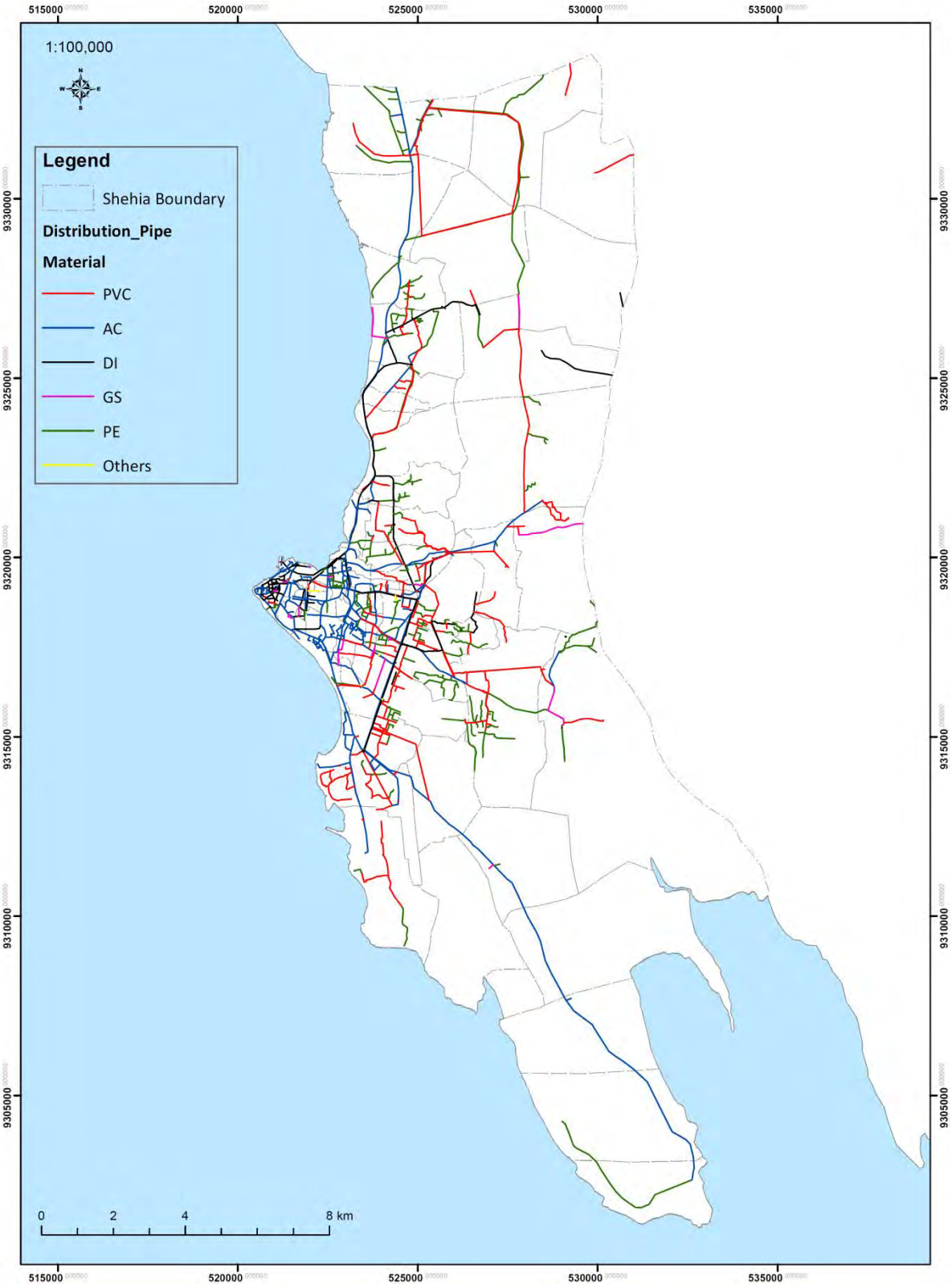
Nominal Diameter	Material						
	DCI/CI	SP	AC	PVC	PE	Unknown	Total
700mm	1,497.2						1,497.2
600mm	2,239.7						2,239.7
500mm	288.3						288.3
450mm	7,059.9						7,059.9
400mm	12,127.4						12,127.4
300mm	11,615.8		8,166.6	752.4	155.1		20,689.9
250mm	19.2				1,301.6		1,320.8
225mm	1,575.8		893.9	5,571.5	151.8		8,193.0
200mm	2,297.1		23,196.0	4,495.8	219.2		30,208.1
150mm	5,043.1		44,766.4	35,210.6	2,109.0		87,129.1
125mm					839.2		839.2
100mm	3,434.7	1,109.6	34,452.7	50,564.9	6,001.2	241.8	95,804.9
75mm	3,211.0	585.5	5,517.1	5,318.1	22,902.8		37,534.5
63mm		4,220.3	1,565.0	340.2	34,221.3		40,346.8
50mm		2,760.4	3,297.5		13,831.1		19,889.0
40mm		450.6					450.6
32mm					4,389.4		4,389.4
25mm		136.9			65.5		202.4
Unknown						350.1	350.1
Total	50,409.2	9,263.3	121,855.2	102,253.5	86,187.2	591.9	370,560.3
Composition Rate(%)	13.6	2.5	32.9	27.6	23.3	0.2	100.0

Source: Planning and Project Management, Water Development Department, ZAWA



Source: JICA Survey Team

Figure 3-31 Ratio of Distribution Pipe by Material



Source: Planning and Project Management, Water Development Department, ZAWA

Figure 3-32 Distribution Pipeline Location by Material

(2) Structure of Distribution Pipe Network

As mentioned in **3.5.1**, the existing pipe networks in Urban West Region are established without consideration of geographical conditions, such as the altitude. In addition, there is no distribution zone, and the pipe network is complicated. Therefore, low water pressure in high altitude areas and water distribution management are serious problems.

Another issue of the distribution pipeline is that, as in Welezo reservoir; there are distribution mains which send water to both the service areas and the reservoir. However, this transmission function has not been working because the pressure in the pipe is too low. Therefore, it is required that these two functions be separated.

(3) Situation of Buried Pipes

Buried pipe works are generally carried out by manpower in Zanzibar. Therefore, lack of earth covers are found in many existing pipe locations and some pipes are exposed on the ground.

It is same for the pipes recently installed by ZAWA, as shown in **Photo 3-4**.

This situation causes NRW due to damage to the pipes and illegal water supply connections.

Photo 3-4 Pipe Installation with Shallow Earth Covering

(4) Estimation of Installation Year

19.9 km (5.4% of total length) of the ductile cast iron (DCI) distribution main pipes is new pipelines installed by the Japanese Grant Aid project. The other cast iron pipes (CI) and asbestos cement pipes (ACP), are assumed to be more than 50 years old since they were installed before the independence of Zanzibar.

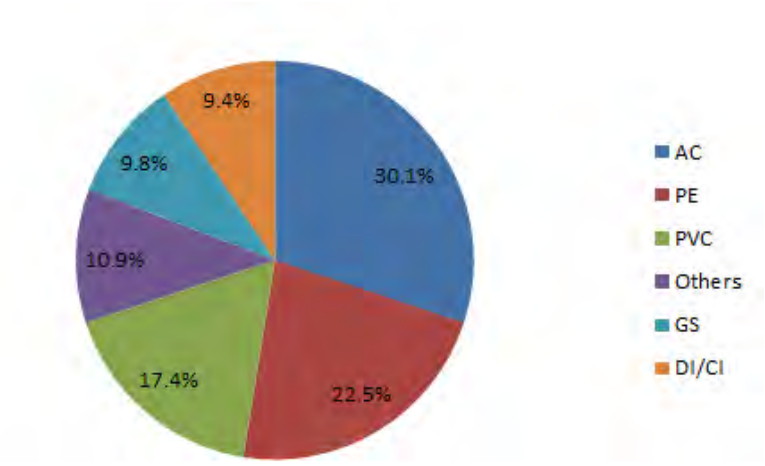
The PVC pipes are estimated to be around 25 years since installation, for most were installed with support from FINNIDA in the early 1990's.

Meanwhile, polyethylene pipes (PE) are the latest trend and hence are thought to be relatively new.

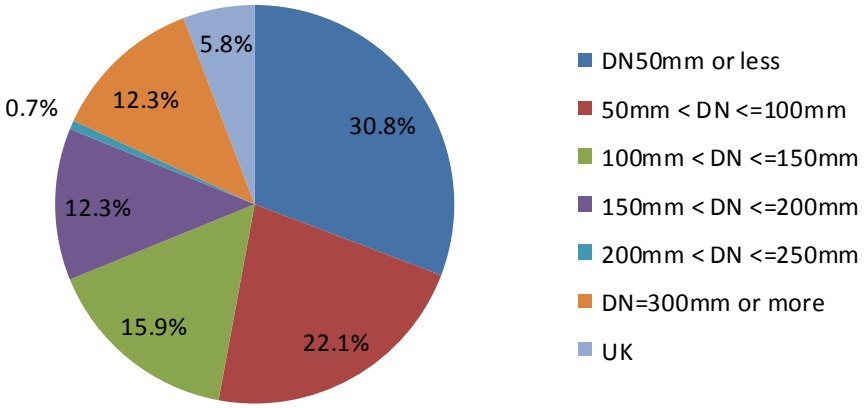
(5) Situation of Water Leakage

Figure 3-34 shows the water leakages found on the ground surface. These leakages are comparatively large scale, to be confirmed on the ground surface. Although the water supply hours are limited, said leakage have been found in many locations.

70.0% of the pipes with water leakage are made of ACP, PVC or HDPE. 81.1% of the pipes are smaller than 200mm in diameter.



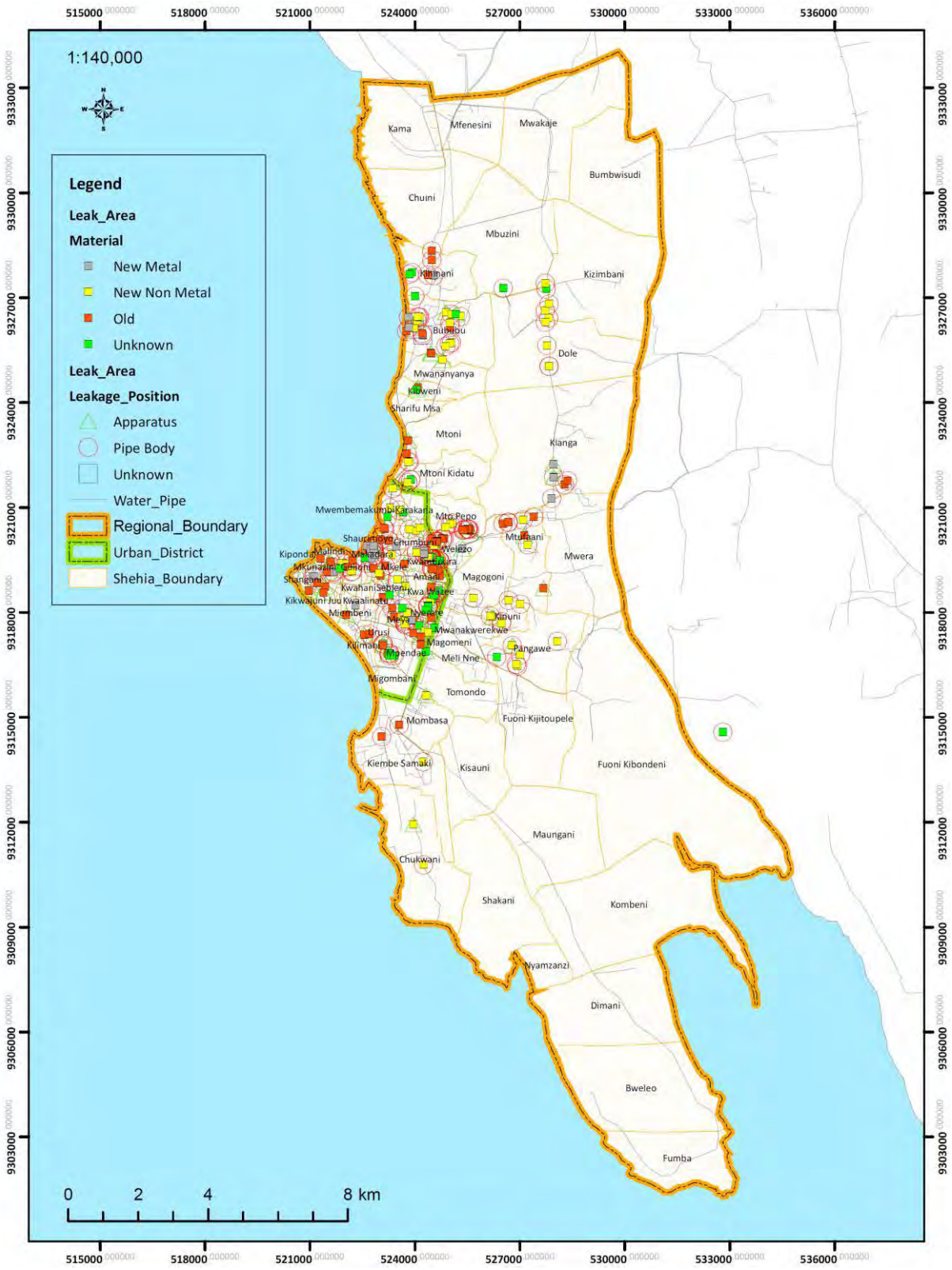
(a) Pipe Material



(b) Pipe Diameter

Source: Prepared by JICA Survey Team by reference of information of The Technical Cooperation Project for Enhancement of Water Supply Management of Zanzibar Water Authority Phase 2.

Figure 3-33 Water Leakage Situation of Pipe Material and Diameter



Source: Surface Leakage Survey, the Technical Cooperation Project for Enhancement of Water Supply Management of Zanzibar Water Authority Phase 2 (Dec. 2012 to Jan. 2013)

Figure 3-34 Surface Leakage Detected Locations

(6) Issues for Distribution Pipes

【Undefined water supply zones】

- Supply zones are not divided according to ground elevation.
- Distribution pipes are connected randomly without considering the reservoir water level, and wells are connected directly to pipelines.
- Lack of water pressure in many areas, including high altitude areas, caused by aging pipes and water leakage.

【Water leakage】

- Aging distribution pipes.
- High ratio of AC pipes.
- Leakage from relatively new PE pipes.

【Separation of transmission/distribution pipes】

- Leakage from distribution pipelines hinders transmission functions.

【Shallow earth cover】

- Shallow earth cover is a cause for pipe damage and illegal connections.

【Insufficient water distribution network development】

- Distribution network development has not reflected population growth.
- Further drops in water service quality.

3.5.6 Disinfection Equipment

(1) Existing Disinfection Equipment

As shown in **Table 3-34**, disinfection equipment is installed at only Welezo, Kinuni, Dole and Saateni reservoirs, all of which were constructed by the Japanese Grant Aid Project. Since other facilities have no chlorination equipment, non-chlorinated water is being currently distributed.

Photo 3-5 Disinfection Equipment

Calcium hypochlorite (bleach powder) is used for disinfectant, and it is purchased mainly by ZAWA, but some are donated by UNICEF, WHO, and Red Cross. However, apart from Saateni Reservoir, inlet flow is not measured at all other reservoir sites and as such chlorine has not been injected at these reservoir sites.

(2) Issues for Disinfection Equipment

【Lack of disinfection equipment】

- Not all facilities have disinfection equipment.
- Direct distribution boreholes do not have disinfection equipment.

【Difficulty of chlorine injection】

- Operation/control of disinfection equipment is difficult since inflow amount of reservoirs are unknown.

3.5.7 Service Connection

(1) Owner of Service Connection Device

According to the Water Regulation 2007, service connection is installed by ZAWA at the expense of the applicant. Thereafter, the service connection becomes ZAWA's property, and is maintained by ZAWA. Extracted related articles of the Regulation is shown below;

- Article 26 (4): All service connections and service laterals shall become the property of the Authority and shall be operated and maintained by the Authority.
- Article 54 (1): When the application for water service has been approved, the service connection shall be installed by the Authority at the expense of the applicant and thereafter shall be maintained by the Authority at its expense.

(2) Expense for Water Supply Application

All applicants are required to shoulder the expenses listed from (1) to (3) as shown in **Table 3-39** at the time of application. Connection fee depends on the diameter of the pipe, and the application and registration fees are the same regardless of pipe diameter.

Table 3-39 Expense for Water Supply Application

Item	Pipe Size	Amount
(1) Connection fee	Dia. 1/2" - 3/4"	46,000 TZS
	Dia. 1" - 1 1/2"	56,000 TZS
	Dia. 2" and more	126,000 TZS
(2) Application fee	All applicants	2,000 TZS
(3) Registration fee	All applicants	2,000 TZS

Source: Water Regulation (Amend) 2013

(3) History of Service Connection

ZAWA became a governmental corporation in 2006, and the water regulation was announced officially in 2007, but water service had begun before said developments. In that period, service connections had been installed without regulations and technical standards.

Poor quality service connection from that period can still be recognized currently, in types that the service connection is directly screwed to the distribution pipe without the tapping saddle, as shown in **Photo 3-6**. In addition, problematic water facilities are installed by the wrong methods, such as direct-mounting of water intake pump to distribution pipes because of low water pressure. Also, in order to soften the influence of ZAWA's short water supply time, not only hotels and office buildings but also some houses have receiving tanks (**Photo 3-7**). Overflowing from some tanks has been observed when they are filled with water.

Photo 3-6 Service Connection Branch

Photo 3-7 Receiving Tank

Following the formation of ZAWA, procurement support and installation of water meters were carried out by ZAWA in Makadara and Dole areas as pilot areas under the Technical Cooperation Project Phase 2.

In Makadara, bronze water meters made in Turkey (**Photo3-8**) were installed. In Dole, plastic water meters made in Turkey (**Photo 3-9**) were installed.

Photo 3-8 Bronze Body Water Meter

Photo 3-9 Plastic Body Water Meter

(4) Manifold Type Service Connection

One reason for the poor-quality pipe connections is the availability of parts. Some parts, such as tapping saddles, are not produced in Tanzania and therefore imported and expensive. For higher quality equipment, the manifold type connection system (**Photo 3-10**) was proposed to ZAWA in Technical Cooperation Project Phase II.

Benefits of the manifold system are as follows;

- Reduce connection points from water pipe (reduce leakage risk).
- Adding new connections is easier and cheaper, since the necessary work is only installation of water meter and supply pipe to manifold.

Distribution pipeline replacement in Makadara pilot area was carried out by ZAWA in the Technical Cooperation Project Phase 2, and manifold type service connection was adopted. The system was applied in ZUWSP areas as well.

Photo 3-10 Water Supply Facility in Manifold Type in Makadara

(5) Service Connection for Large Customers

The Survey Team and ZAWA surveyed the service connections of large customers (2 hotels and 1 hospital). The results are shown in **Table 3-40** to **Table 3-42**.

The 2 hotels receive water at receiving tanks, then the water is transmitted to elevated tanks or distributed by means of a water supply pump. The hospital has installed a pump directly connected to the distribution pipeline to pump water to the elevated tank. As observed, the connection equipment for large customers differ.

The service connection devices are ZAWA's property according to the Water Regulation, but most customers consider the devices as their own property.

Under this circumstance, it is not realistic for ZAWA to maintain the devices, and it may be necessary to review the regulations.

Table 3-40 Service Connection of Hotel A

Photo	Notes
	・ The concrete tank shown in front receives brackish water used for toilets. ・ The concrete tank shown in back receives ZAWA supply water used for cooking and guestroom showers.
	・ Water meter installed at the upstream of the concrete tank.
	・ Water is sent from the concrete tank shown above to this pump well and pumped to the elevated tank.
	・ Elevated tank. Water is sent by gravity flow to guestrooms.

Source: JICA Survey Team

Table 3-41 Service Connection of Hospital B

Photo	Notes
	・ Water meter installed in the in-house pipe connected to the distribution pipe outdoors. ・ A pump is directly connected to distribution pipeline to send water to the elevated tank.

Source: JICA Survey Team

Table 3-42 Service Connection of Hotel C

Photo	Notes
	・ Water meter installed at the in-house pipe connected to the distribution pipe outdoors.
	・ Water is sent from the above in-house pipe to the underground tank.
	・ Water is sent from the above concrete tank to this pump, and distributed directly to guest rooms from this pump units.

Source: JICA Survey Team

(6) Data Management of Service Connection

Customer ID, classification and installation status of water meter is installed in the SBM II, but device details (diameter and material of service connection, installation year, drawings, etc.) are not managed.

To improve the situation, Service Connection Survey was conducted by the Technical Cooperation Project Phase 2 to gather service connection information using ledgers, and the activity is currently continued. However, the survey speed, which was finally completed only in the ZUWSP area, is slow and sufficient information gathering for this Project is not completed. Current status of the survey is mentioned in **3.10.2 (2)**.

(7) Issues for Service Connection

(a) Inappropriate service connection

- No design standard for service connection facilities. Inappropriate devices, such as direct connection of feed pumps to distribution pipes and receiving tanks without a ball tap and a check valve, are not corrected.
- Unregistered customers using connections installed during the pre-ZAWA period.

(b) Insufficient information management

- Facility information (diameter and material of service connection, installation year, drawings, etc.) are not managed.
- The information gathering process by the Service Connection Survey is slow.

3.6 Current Situation of Facility Operation

3.6.1 Boreholes

(1) Operation System

Operation of boreholes is implemented by the Technical Operation Department of ZAWA. Teams consisting up to 5 persons are responsible for 24-hour management (**Table 3-43**). Boreholes which do not have an operation team are operated by automatic operation system or persons, who are not ZAWA's employees.

The allocation of operators is not even. The Technical Operation Department is reallocating personnel to enable efficient management and operation works by multiple operators, and is planning to assign operators to areas and not to boreholes. However, the reallocation is not progressing as planned, due to the lack of transportation means (most operators are using bicycles).

Effective reallocation of operators shall be necessary since the number of boreholes will increase in the future in case that new boreholes will be developed.

According to the Technical Operation Department, most operators own mobile phones hence there is no difficulty for communication.

Table 3-43 Staff Allocation for Borehole Operations

Deep well	Well ID	ZAWA's Operator	Notes
MWEMBE MCHOMEKE	U-001, 050, 051	3	
MWEMBE MCHOMEKE	U-019, 181	3	
MACHUI-JICA PHASE I	U-177, 178, 179	1	
KIANGA-JICA PHASE II	U-180, 182	2	Temporary Staffs
WELEZO	U-064, 066, 242	2	
CHUNGA	U-008, 009	5	
MSIKITI MZURI-JICA PHASE II	U-197, 198	1	Temporary Staff
DIMANI-BWELEO	U-226	1	
DIMANI	U-044	4	
DOLE	U-052	2	1 Temporary Staff
FUONI	U-089	0	Operation by Workshop Staff
KIANGA	U-004, 032	1	
KIJITO UPELE	U-013	0	Automatic Operation
KITOSANI	U-037	3	
KIZINBANI-NURSERY	U-030	1	Temporary Staff
KIZIMBANI	U-194, 195, 196	3	Temporary Staff
KWARARA	U-098	1	Temporary Staff
MAGOGONI	U-084	0	Automatic Operation
MAUNGANI	U-034	2	
MELI NNE MASUMBANI	U-088	1	
MFENESINI	U-011	3	
MFENESINI-SELEM		1	
MOMBASA AFISINI	U-077	0	ZAWA OFFICE, Automatic Operation
MOMBASA MCHINA	U-073	1	
KABURI KIKOMBE	U-027, 158	3	
KIEMBE SAMAKI - ALI YOUSEF	U-076	0	Operation by ALI YOSEF Staff
KIEMBE SAMAKI – MASUMBANI	U-171	1	Temporary Staff
MBWENI	U-041	2	
MBWENI BLM	U-078	0	Operation by BLM Staff
MBWENI TRACTOR WORKSHOP	U-012	0	Operation by Workshop Staff
MIGOMBANI CAMP	U-079	0	Operation by army
MWANAKWEREKWE-C	U-250	0	Automatic Operation
SEMUSO	U-039	1	
ZANZIBAR AIRPORT	U-070	0	Operation by Airport Staff
BINTI AMRANI	U-185, 224	1	
CHUKWANI-MATERIOLOGY	U-172	1	Temporary Staff
CHUMBUNI	U-074, 075	0	Operation by JKU Staff
SAATENI WATER WORKS	U-216	0	Operation by Workshop Staff
SAATENI WORKSHOP	U-218	0	Operation by Workshop Staff
計		50	

Source: Water Production, Technical Operation Department, ZAWA

(2) Operation

The work of the operators are as listed below.

- Restart borehole pump operation after power failures or voltage fluctuation.
- Visual inspection of borehole facilities.
- Guarding and cleaning of borehole facilities.

Operation of boreholes for 24 hours of water supply require operational decision making according to the operation plan (short-term demand prediction) and real-time monitoring (hourly water usage pattern, number of operating boreholes, distribution amount, reservoir water level, etc.), but the current water service of ZAWA is limited, hence the aforementioned operation is not carried out.

(3) Operation Management

For accurate operation management including detecting abnormalities and future O&M, it is necessary to keep records of borehole yields and groundwater level (hydrostatic state and active state). However, ZAWA is not carrying out monitoring activities, due to the broken flow meters and uninstalled water level meters.

Instead of installing water level meters to each borehole, ZAWA uses observation boreholes for groundwater level monitoring. The Water Resources sub-section (Water Development department) is in charge of the monitoring duties, but the monitoring is not carried out and groundwater level information is not recorded.

3.6.2 Reservoirs and Elevated Tanks

(1) Operation System

Operation duties of reservoirs and tanks are carried out by the Water Production sub-section (Technical Operation Department), and the operator allocation is shown in **Table 3-44**. The operators also take on security guard duties.

Table 3-44 Operators of Main Reservoirs

Reservoir/ Elevated tank	No. of operators	Notes
Mfenesini	1	
Dole	1	
Welezo	0	Under military control, Water Production staff does daily patrol
Kinuni	1	
Saateni	4	
Mnarawambao	0	Water Production staff patrols in case of abnormality
Dimani	1	

Source: Water Production, Technical Operation Department, ZAWA

(2) Operation

(a) Welezo, Kinuni and Saateni reservoir

The works for the operators are as follows.

- Operation of the reservoir outflow valve
- Operation of the disinfection injection equipment

- Visual inspection of facilities
- Cleaning and guarding

The valve operation is required to recharge the reservoir water for morning/evening water distribution, therefore this duty shall be unnecessary when 24 hour water supply is implemented. The disinfection is carried out by the operators, but Water Quality Laboratory staff of the Water Resource sub-section (Water Development Department) are responsible for management. The Laboratory staff used to regularly provide chlorine to each reservoir, but currently disinfection is not carried out at the reservoirs except Saateni because it is difficult to adjust the chemical injection amount due to the unknown inflow amount, and therefore chlorine is not delivered among reservoirs. The broken equipment are not repaired.

(b) Saateni reservoir

The works for the operators are as follows.

- Measuring spring water source receiving amount
- Operation of the elevated tank outflow valve
- Operation of the pump to send water to elevated tank
- Visual inspection of facilities
- Cleaning and guarding

Disinfection equipment is operated by Laboratory staff.

The valve operation is required to recharge the reservoir water for morning/evening water distribution, therefore this duty shall be unnecessary when 24 hour water supply is implemented.

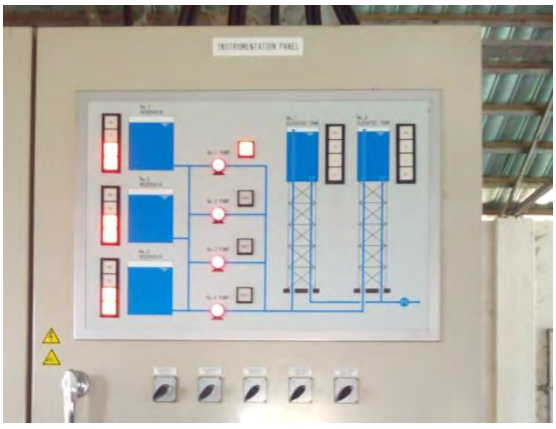
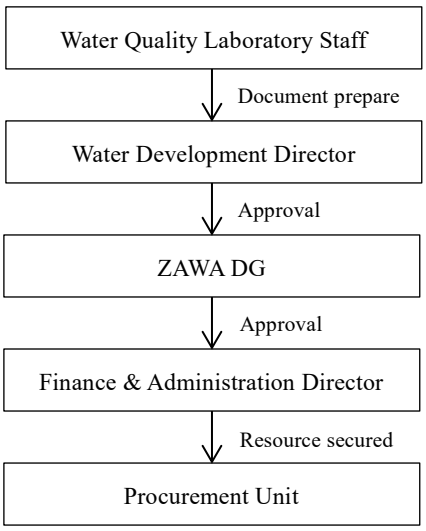


Photo 3-11 Reservoir Water Level Panel

The pump used to send water to the elevated tank is equipped with an automatic operation function (start/stop) by sensing the water levels of the reservoir and elevated tank. However, the inflow amount to the reservoir is small, and the level switch often turns off due to the low reservoir water level. Therefore, currently the pump is operated manually.

The disinfection equipment is operated by Laboratory staff, and the amount is adjusted based on the amount of spring water received which is measured every morning. The stock and procurement of the chlorine is also managed at the reservoir. The procurement flow is shown in **Figure 3-35**. The prepared documents are approved by the Director and DG, and passed on to the Finance & Administration Director. When there are sufficient resources, the

documents are sent to the Procurement Unit for purchase, but when resources are short the document is kept by the Finance & Administration Director until purchase is possible.



Source: JICA Survey Team

Figure 3-35 Chlorine Procurement

Chlorine is also provided from outside authorities, such as UNICEF, but the support is not regular and limited to the rainy season when the sanitary situation worsens or when cholera epidemics occur.

(3) Operation Management

Distribution plans (short-term water demand predictions for one day or one week) for distribution facility operation are not prepared. The actual situation is that the flow amount data is unknown due to breakdowns or lack of flow meters, and hence short term water demand prediction is difficult. Also, the lack of flow meters indicate that it cannot be judged if the operation is carried out according to plan or not.

Several records of intake amount and reservoir water level exist, however the inflow/distribution amount of reservoirs are not managed due to the lack of equipment, therefore operation information cannot be understood. There are also communication issues between the well and reservoir operators. The reservoir operators do not know the status of the boreholes, and are not giving pump operation directions to water source operators.

It is necessary to prepare operation plans (demand predictions for water supply/ distribution amount) for facility operation to determine the yield amounts, and to adjust the operation according to hourly water demand change, inflow amount, distribution amount and reservoir water level information. It is also required to keep operation records to prepare operation plans and future facility development plans.

Currently, the operation management mentioned above is not carried out at all.

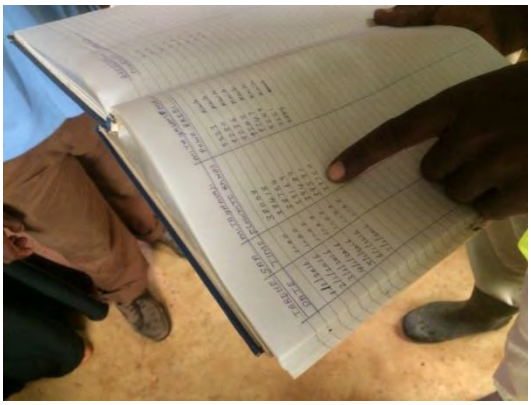


Photo 3-12 Record of Intake Amount

Photo 3-13 Record of Water Level

3.6.3 Issues for Operation Management

【Uneven allocation of borehole operators】

- Unbalance of operator allocation due to constraints of operator's transportation.

【Lack of flow meters】

- Difficulty in establishing borehole yields, reservoir inflow amount and distribution amount.
- Difficulty in preparing operation plans (short term water demand prediction).
- Difficulty in confirming operation status.
- Difficulty in keeping operation records.
- Difficulty in adjusting chlorine injection amount.

【Lack of cooperation between well and reservoir operators】

- Reservoir operators do not know the borehole operation status.
- Operators are not collaborating each other.

3.7 Current Situation of Facility Maintenance

3.7.1 Boreholes

(1) O&M system

The O&M for borehole facilities are carried out by 2 groups consisting of around 10 mechanical/electrical staff of the Water Production sub-department (Technical Operation Department) each in charge of the urban and rural areas. Simple repair and exchange works, such as pump repair or pump pipe exchange are carried out by the Workshop staff of the Water Production sub-department. **Table 3-45** shows the number of staff and duties, **Table 3-46** shows the main facilities at the workshop.

Table 3-45 Number and Duties of Workshop Staff

Position	Duty	Number
Pump Engineer	Dismantle pumps, exchange parts, reassemble, pipe repair	8
Electrical Engineer	Electric works	10
Mechanical Engineer	Operate machine tools, make parts	4
Cleaner	Cleaning	2

Source: JICA Survey Team

Table 3-46 Major Facilities of Workshop

	
Lathe: 2	Threading machine: 1
	
Bender: 1	Roller bender:1
	
Arc welder: 1	Pipe cutter: 2
	
Compresser: 1	Drill press: 1
	
Tester: 1	

Source: JICA Survey Team

(2) Facility Register

ZAWA does not keep facility register to record basic information for facility O&M, but are registering information to the GIS. However these records are incomplete, and repair records are missing.

(3) Daily and Periodic Inspection

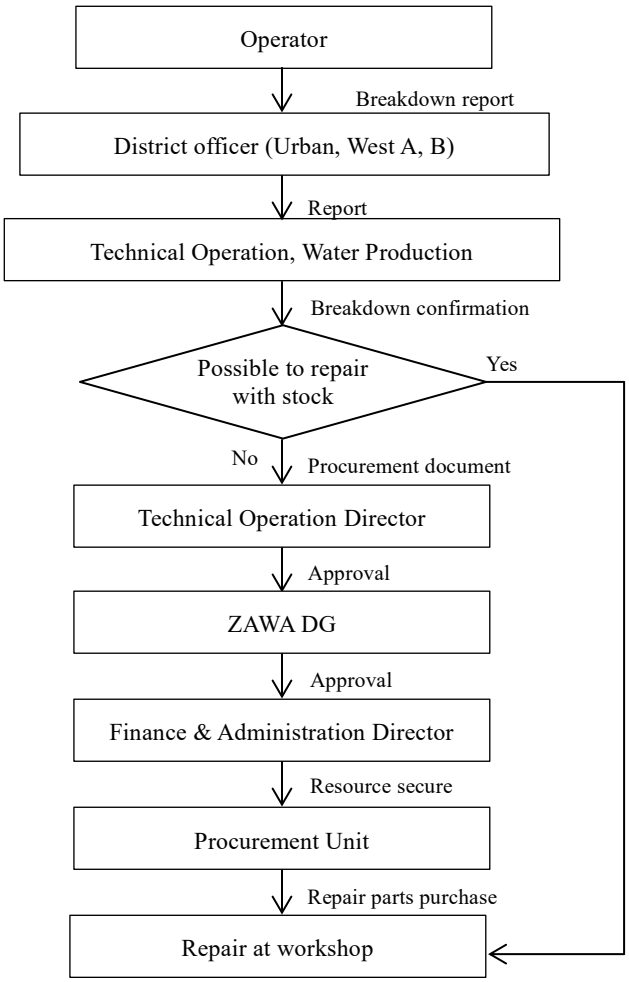
Operators check the boreholes when an abnormality occurs, but since the operators to not have mechanical/electrical knowledge, the inspection is limited to operation status confirmation. There are no inspection checklists, and daily inspection is not practiced. Regular inspection should be carried out by Water Production sub-department staff, but currently there are no checklists and the inspection is not practiced.

(4) Procedure from Failure Detection to Repair

The flow from the discovery of a breakdown to repair is shown in **Figure 3-36**. Upon discovering a breakdown, the operator informs the District Officer, who in turn informs the Water Production sub-department. The Water Production staff confirms the failure status and judges if repair is possible with stock parts or not, and if procurement is necessary, passes procurement documents to the Technical Operation Director. The documents are approved by the Director and DG, and passed on to the Finance & Administration Director. When there is sufficient budget, the documents are sent to the Procurement Unit for purchase, but when there is insufficient budget, the document is kept by the Finance & Administration Director until purchase is possible. Currently there are no staff assigned to the Urban District Office, therefore the breakdown is reported directly to the Water Production sub-department.

The followings are the issues of this flow.

- Basic facility information for O&M is lacking.
- Records of breakdown discovery/reports do not exist (it cannot be confirmed that the reports were made and communicated due to the lack of documents and reports).
- Outlines and numbers of repairs are recorded, but the details of each case are not documented and recorded.



Source: JICA Survey Team

Figure 3-36 Flow from Breakdown Discovery to Repair

(5) Failure and Repair Status of Deep Well Facilities

Monthly pump repair records are made by the staff. The repairs reported from August 2015 to July 2016 are shown in **Table 3-47**. The repair records simply show the type of repair work (submersible water pump installation/removal, renewal of electrical equipment, and repair at workshop) and the target borehole.

As shown in the Table, the number of electrical repair works stands out. According to Workshop engineers, since repair details are not recorded, the majority of electrical equipment failure are due to fuse damage, contactor damage and motor failure, which are generally repaired by changing parts.

The causes of breakdown are assumed to be the repeating of pump stopping and restarting within short durations due to lightning, voltage fluctuation, and also damaged winding due to overcurrent operation under low voltage circumstances. However countermeasures based on cause analysis are not carried out and therefore it is possible that the same failure has been repeated.

Table 3-47 Repair Records for Submersible Water Pump

Item	Monthly records (August 2015 – July 2016)											
	8	9	10	11	12	1	2	3	4	5	6	7
1. Submersible pump							No Data					
New pump exchange	1	5	3	0	7	2		1	0	3	5	3
New motor exchange	1	0	0	2	0	1		0	1	4	1	5
Pump exchange	0	1	0	2	0	2		1	1	1	1	2
Pump remove, waiting renewal	7	9	9	7	10	7		5	5	7	6	10
2. Borehole												
New borehole excavation	0	0	0	0	1	0		0	0	0	0	0
Borehole repair	2	0	5	1	1	1		2	0	0	0	0
3. Pump station with high failure occurrence	16	18	24	21	21	14		16	26	20	20	21
4. Pump/pipe repair (by Workshop)	2	1	0	3	1	1		1	2	3	1	4
5. Generator repair	0	0	1	0	0	0		0	0	0	2	0
6. New pump station construction	0	0	0	0	1	1		1	0	0	1	0

Source: ZAWA repair report

(6) Ability of Workshop Staff

The main cause for submersible pump failure is burn damage, and other causes are wear of moving parts, shaft joint damage and pump casing damage. Workshop engineers check the broken pumps and determine the measures. In case of pump part repair, the necessary parts are procured through the flow shown in **Figure 3-36**, and repaired/ reconstructed by the Workshop staff. In case of electric motor failure, repair by Workshop is difficult due to the structure of the motor (canned-motor type) and therefore, a new motor is purchased for exchange.

Repaired pumps are tested at the Workshop tank (**Photo 3-16**), and if the electricity flow is within the standards, the pump will be available for use. Although the Workshop facilities are not superior, the engineers have good experience and high ability in borehole facility repair.

Photo 3-14 Repair Workplace

Photo 3-15 Well Pipe Repair

Photo 3-16 Test Running Tank (Workshop)

Photo 3-17 Test Running Board

(7) Market Availability of Repair Parts

ZAWA procures mechanical/electrical repair parts through registered suppliers.

Large-sized mechanical equipment, such as pumps and motors are currently not produced in Tanzania. In most cases, main components made in Europe or India are assembled with other parts in Kenya and exported to Tanzania. The suppliers do not hold pumps and motors in stock, hence upon receiving an order, the supplier has to import from other countries. Repair works for pumps and pump operating boards can be done in Tanzania by local suppliers.

Procurement for electrical equipment is in the same situation, by importing completed equipment or by assembling parts in Kenya before importing. There are several suppliers who import parts manufactured in Europe, Egypt or South Africa to Tanzania to assemble, deliver and install.

Photo 3-18 Pump Supplier Warehouse

Photo 3-19 Assembling Space for Pump Operator Board

According to ZAWA regulations, procurements which cost under USD 10,000 are approved within one week of appraisal. The time necessary for the delivery depends on the registered

supplier and ordered item. ZAWA hold pipes and water meters in stock, but large equipment are not stocked. To procure parts upon a mechanical/electrical equipment failure, the deep well may need to be stopped for up to two (2) months.

(8) Management of Facility Information

The Water Resources sub-department (Water Development Department) is in charge of new well construction, and the O&M of constructed wells are managed by the Water Production sub-department (Technical Operation Department). The facility information is registered in the GIS by GIS/mapping staff of the Planning and Project Management sub-department (Water Development Department), but communication amongst the departments are not smooth and the information registration is not implemented accurately.

The information of repair/renewal works of borehole pumps carried out by the Water Resources sub-department is not reported to the Planning and Project Management sub-department, and therefore the repair/renewal information is not included in the GIS.

(9) Others

(a) Disposal of deep well facilities

The majority of ZAWA boreholes take water from multiple aquifers. To prevent pollution of the aquifers by salt water infiltration (caused by excessive intake) and nitrate nitrogen pollution (caused by infiltration of contaminated ground surface water), it is necessary to take accurate measures to block aquifer connection upon the disposal of the boreholes. However, ZAWA does not apply the required measures.

(b) Transportation to boreholes

In order to carry out repair activities, even during the rainy season when the road conditions are bad, it is necessary to secure a safe route to all boreholes throughout the year. Currently, this is not achieved.

(10) Issues for Deep Well Facility Management

【Lack of necessary facility information】

- Lack of facility ledger and equipment ledger.
- Incomplete GIS registration
- Flow to register facility information into GIS is unclear

【Daily/ regular inspection】

- Management activities are limited to repair works after breakdown (reaction measure)
- Lack of checklists for daily/regular inspection

【Insufficient maintenance records】

- Repair report forms are not prepared and no records exist
- Lack of details of repair works (broken point, repair method)
- Incomplete failure cause analysis
- Records are not kept due to lack of communication between maintenance records and GIS information registration

【Aging of Workshop equipment】

【Market availability of repair parts】

- Long period required for procurement when there are no stocks
- Selecting and securing repair parts for stock considering the failure frequency and market availability is not executed.

【Accurate disposal methods for boreholes are not taken】

【Badness access to some deep boreholes】

3.7.2 Reservoir and Elevated Tank

(1) O&M System

The chlorination equipment is managed by the Water Quality Laboratory of the Water Resources sub-department (Water Development department). The other facilities are managed by the Water Production sub-department (Technical Operation department).

(2) O&M Status

(a) Disinfection equipment

The disinfection equipment at each reservoir can be operated, but as mentioned in **3.5.6**, all reservoirs except Saateni has stopped chlorinate injection. Therefore, the deteriorated injection pipes have not been repaired, and there is no disinfection at the Dole facility due to ZECO cutting power supply to the facility.

At Kinuni reservoir, corrosion of the operation board handle can be observed. This was caused by the operators touching the board with chlorine on their hands. On restarting the chlorine injection, it shall be necessary to make sure the corroded board door does not open and cause breaks in the circuit or accidents.

Photo 3-20 Broken Injection Pipe

Photo 3-21 Corroded Handle

(b) Water level meter, flow meter

Most of the mechanical water level/flow meters are broken. The water level is visually monitored through manholes, but the flow amount is not measured.

ZAWA adopts turbine-type integrated flow meters, which are mostly broken. The water level meters are mechanical types, which are also mostly broken. The cause is supposed to be the high-hardness in the water quality and shocks to the meter blades caused by rapid flow speed change and air mixture due to the limited time of water supply, but investigations into the cause have not been carried out.

Due to the high malfunction rate, renewal and other O&M actions are not practiced.

(c) Pumps

At Saateni reservoir, leakage can be observed at the shaft seal part of the water pump leading to the elevated tank. This is due to the wear of the gland packing and the leakage creates ponding on the facility floor when the pump is operating. In addition, the lime included in the water splashes and ends up encrusting the pump and its surroundings (**Photo 3-22**). The valves of the pipes cannot be moved because of this lime and therefore the flow to the gland cannot be adjusted. Most of the pressure meters are not operating, which makes it impossible to comprehend the decline of pump performance from the outflow water pressure. Considering the above mentioned situation, O&M such as regular gland packing replacement, cleaning and performance testing is not carried out.

Photo 3-22 Lime Encrust due to Leakage at Pump Shaft

(3) Equipment Register

Facility registers for chlorination equipment at reservoirs and pumps at elevated tanks are not prepared/ kept. Said information is not registered in the GIS.

(4) Daily and Regular Inspection

There are no checklists listing the required inspection items, and daily inspection is not practiced. Regular inspection should be carried out by the engineers of Water Production sub-department, but there are no checklists and inspections are not practiced.

(5) O&M Records

O&M activities of borehole facilities are recorded in the repair reports, but those of the reservoir facilities are not recorded.

(6) Issues for Reservoir/elevated Tank O&M

【Equipment ledger】

- Equipment ledges for water pumps and chlorination equipment at reservoirs are not prepared.
- Data is not registered in GIS.
- An overall management system for all facilities/equipment is not developed.

【Daily/ regular inspection】

- Checklists for daily/regular inspection are not prepared.

【O&M record】

- O&M records for reservoir equipment is not maintained.

3.7.3 Leakage Repair

(1) Leakage Repair System

Leakage repair for transmission/distribution pipelines are carried out by the Water Network sub-department (Technical Operation Department), and currently 30 staff are assigned. One team consisting of five members (including a chief) attends to general leakage repairs. In case of a large scale leakage, all staff attend to the works.

Photo 3-23 Leakage Repair

The number of leakages is expected to largely decline after the Project implementation. In the future, a part of the staff shall be relocated to departments which require more workers.

(2) Leakage Repair Situation

The current remaining leakage repair records (since January 2015) for each Shehia are shown in **Table 3-48**. Although the monthly average of leakage repair works is nearly 40, the distribution status has not improved. The Shehias with most repair works (from January 2015 to October 2016) are Shaurimoyo (75), Kwaalinatu (71) and Kilimani (48).

Table 3-48 Leakage Repair Records

Shehia Name	2015												2016									
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT
SHANGANI	1	1	2	1	1	0	0	2	0	1	1	1	0	0	0	0	0	1	0	0	1	0
MKUNAZINI	0	3	5	1	1	0	1	3	1	0	2	1	1	2	0	1	1	1	1	1	1	0
KIPONDA	0	0	1	1	5	2	2	0	0	0	1	0	1	2	1	1	1	2	1	1	0	0
MALINDI	3	2	4	2	2	1	0	0	1	0	2	2	0	1	2	1	1	1	0	0	0	0
MCHANGANI	5	1	1	4	3	2	1	2	1	4	4	2	0	0	0	1	1	2	3	0	0	1
VIKOKOTONI	2	0	0	0	1	1	1	1	2	0	1	0	0	1	0	1	1	2	2	0	0	0
MWEMBETANGA	1	0	1	0	0	3	2	1	0	0	0	0	0	1	2	1	0	1	3	2	0	1
KISIWANDUI	0	0	1	1	1	0	6	3	4	1	1	3	1	1	2	1	1	0	0	1	1	0
KIKWAJUNIBONDEN	3	1	1	0	0	2	2	4	3	0	0	1	1	0	0	0	0	1	2	1	1	0
KIKWAJUNI JUU	1	0	2	4	3	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1
KISIMA MAJONGOO	4	3	3	5	2	0	2	3	2	1	3	2	0	0	1	1	1	0	1	1	1	0
MIEMBENI	3	1	1	0	4	2	1	0	0	0	2	1	3	2	1	1	0	1	1	0	2	2
KILIMANI	6	2	5	2	4	5	2	2	3	1	3	2	4	1	2	1	0	0	1	1	0	1
MLANDEGE	0	0	1	2	0	0	0	3	1	0	0	0	0	0	0	1	0	0	0	0	0	1
MWEMBELADU	1	1	1	0	0	2	1	1	2	2	1	0	3	1	2	2	0	0	0	0	0	1
RAHALEO	1	0	0	0	2	1	0	0	1	1	0	3	2	1	3	1	1	1	1	1	2	1
MIKUNGUNI	4	2	2	1	3	4	3	2	1	1	1	3	1	2	1	1	3	1	0	1	0	1
MKELE	1	1	1	3	2	2	1	3	2	2	1	3	0	0	0	1	1	0	0	1	0	0
MWEMBESHAURI	0	5	2	2	1	2	3	4	2	3	1	5	1	0	0	0	0	0	0	0	1	1
KWAHANI	2	1	3	1	1	3	6	4	3	5	6	2	2	1	1	1	0	0	0	0	0	0
KWAALINATU	6	5	6	4	3	5	6	2	2	3	5	4	4	1	2	3	1	2	2	1	3	1
KWAALIMSHA	2	0	1	2	3	6	4	1	5	2	3	1	5	2	1	4	1	1	3	1	2	1
SHAUROMOYO	5	3	3	2	2	1	3	0	1	6	2	4	6	5	4	3	5	4	3	7	2	4
MWEMBEMAKUMBI	3	0	1	4	2	2	1	3	1	1	1	1	3	4	1	0	4	2	4	3	2	1
MIGOMBANI	4	1	3	1	1	0	0	1	0	1	2	1	6	2	1	4	3	2	1	1	3	1
MAKADARA	2	1	1	0	1	0	0	1	1	1	2	1	1	3	5	2	1	2	2	1	3	1
GULIONI	1	1	3	2	3	0	0	1	1	3	1	1	0	1	2	3	2	4	2	2	1	2
Total	61	35	55	45	51	46	48	48	41	40	46	44	45	34	34	36	29	31	33	28	27	22

Source: Water Network, Technical Operation Department, ZAWA

(3) Leakage Repair Techniques

The staff in charge of leakage repair all have accumulated basic repair techniques, such as pipe cutting and pipe connecting using joints.

(4) Procurement of Leakage Repair Material

The repair team confirms the leakage and decides the required materials for repair work, and if the materials are in stock the work is started immediately, but if the materials are lacking, then procurement is necessary. In this case, if the materials need to be imported and ZAWA's budget is not sufficient, a certain amount of time shall be required.

Pipe materials for repair works are stocked at the Mtoni training centre. Bolts, nuts and small diameter joints are stored inside a warehouse, but DCIP and valves are left outdoors. It is required to build a warehouse to store materials avoiding direct sunlight, wind and weather.

(5) Leakage Repair Records

Leakage repair information is not shared with GIS/Mapping staff, therefore the information is not registered in GIS. Manuals for repair works are not prepared, and record keeping for the works is not systematically practiced.

(6) Issues for Leakage Repair

The issues for leakage repair works are listed below.

【Difficulty in material procurement】

- Selecting/procurement of repair materials is difficult since various pipe types are adopted (pipes of the Target Area shall be unified during Project).

【Securing a place for storage of repair material】

- Exposed material storage space

【Recording repair works】

- Accumulate repair information for future pipe renewal planning.

3.7.4 Service Connection

(1) Maintenance System

The O&M responsibility for service connection devices belong to ZAWA, according to the Water Act and other regulations. Service connection installation and O&M duties are carried out by Plumbing section of the Customer Service sub-department (Commercial Department), and water meters are managed by the Meter Mechanics of Credit Control sub-department (Commercial Department).

The number of water meters shall increase after the Project implementation and the workload of O&M (meter exchange, etc.) is expected to increase considerably. It shall be necessary to construct a system to cover all meters.

(2) Information of Service Connections

Information related to water charge collection is registered in SBM II. However, the information required for service connection management (location, connection diameter, material, water meter, etc.) was not registered. The Technical Cooperation Project Phase 2 conducted a series of service connection surveys, and the survey results were recorded in service connection ledgers and GIS.

The service connection survey is still in progress, and the areas of ZUWSP project are the priority. Information of other areas is not sufficient.

ZAWA is also undergoing the process of water meter installation. The meter number and customer house number is recorded and registered in SBM II by Customer Service sub-department (Commercial Department). Afterwards, GIS operators check the newly registered data online and add the information to GIS. This information does not include location data, unlike the service connection data.

(3) Issues for Service Connection Maintenance

The issues for leakage repair works are listed below.

【Enhancement of maintenance system】

- Construct a system to meet the increased workload after Project implementation.

【Service connection equipment management】

- Service connection ledger is not sufficient (complete ledger along Project implementation).
- Clarify procedure for new connection registration.

3.8 Water Quality Management

3.8.1 System of Water Quality Management

There are 4 water quality staffs in the water test laboratory in Saateni Reservoir. Main activities are examination of raw water in Unguja Island, measurement of residual chlorine in Urban West Region and chlorination at Saateni reservoir. In addition, if residents request, shallow well water quality tests can be carried out for a fee.

Photo 3-24 Chlorine Residual Survey

3.8.2 Current Situation of Water Quality Management

Laboratory staff basically conduct raw water quality examination and residual chlorine test every Tuesday. According to ZAWA staff, sometimes they do not conduct the activities because of the lack of transportation. Raw water quality is tested by portable water quality tester and residual chlorine is tested by color metric

method.

Charged water quality test service for private clients is suspended as of now because of the lack of reagent.

3.8.3 Record of Water Quality Test

Record of water quality test is maintained on paper currently because of malfunction of lap-top.

3.8.4 Issues of Water Quality Management

【Lack of staff in Water Quality Management section】

- Lack of staff for water quality management.
- Lack of staff who can handle chlorine and disinfection facilities.
- Secure transportation methods for inspection.

【Inadequate water quality management】

- Lack of items tested for raw water quality inspection (tests covering more items are required, even if the frequency drops).
- Water quality management plan (sampling method, location, frequency, test items, analysis) is not prepared.
- Record keeping of test results.

3.9 Current Situation of Water Supply and Supplied Water Quality

3.9.1 Water Consumption by Metered Customer

Water consumption is confirmed in this section based on the meter reading (total number is 3,131 connections) records from July 2015 to June 2016.

(1) Domestic

Table 3-49 shows domestic meter reading data. Average number of metered customers is 2,939, and daily average water consumption is 1,177 m^3, while the daily per household consumption is 400.4 L/household/day. Daily per capita consumption is 75.5 L/capita/day, calculated using an average of 5.3 persons per household based on the 2012 Census.

Table 3-49 Meter Reading Data of Domestic Users

Period	Consumption		No. of Connection	Consumption per Connection		Consumption per cap
	(m^3/month)	(m^3/day)		(m^3/connection /month)	(L/connection/ day)	(L/cap/day)
Jul 2015	42,984	1,387	2,788	15.4	497.5	93.9
Aug 2015	34,972	1,128	2,794	12.5	403.7	76.2
Sep 2015	34,426	1,148	2,818	12.2	407.4	76.9
Oct 2015	28,147	908	2,903	9.7	312.8	59.0
Nov 2015	36,301	1,210	2,944	12.3	411.0	77.5
Dec 2015	30,747	992	2,960	10.4	335.1	63.2
Jan 2016	37,841	1,221	2,974	12.7	410.6	77.5
Feb 2016	27,394	945	2,964	9.2	318.8	60.2
Mar 2016	31,600	1,019	3,009	10.5	338.7	63.9
Apr 2016	44,774	1,492	3,010	14.9	495.7	93.5
May 2016	32,742	1,056	3,027	10.8	348.9	65.8
Jun 2016	48,796	1,627	3,055	16.0	532.6	100.5
Average	35,894	1,177	2,939	12.2	400.4	75.5

Source: SBM II Data

(2) Commercial (excluding hotel)

Table 3-50 shows meter reading data of commercial. Average of meter-read customers is 60, and an average of 1.0 m^3 of water is used daily. Amount of water consumption in the commercial sector is equal to 5.0% of the amount of domestic usage of water.

Table 3-50 Meter Reading Data of Commercial excluding Hotels

Period	Consumption		No. of Connection	Consumption per Connection	
	(m^3/month)	(m^3/day)		(m^3/connection /month)	(m^3/connectio n/day)
Jul 2015	1,155	37	58	19.9	0.6
Aug 2015	1,350	44	58	23.3	0.8
Sep 2015	2,685	90	59	45.5	1.5
Oct 2015	2,515	81	60	41.9	1.4
Nov 2015	2,085	70	60	34.8	1.2
Dec 2015	1,841	59	60	30.7	1.0
Jan 2016	2,337	75	60	39.0	1.3
Feb 2016	1,132	39	60	18.9	0.7
Mar 2016	774	25	60	12.9	0.4
Apr 2016	1,787	60	60	29.8	1.0
May 2016	354	11	60	5.9	0.2
Jun 2016	3,643	121	60	60.7	2.0
Average	1,805	59	60	30.3	1.0

Source: SBM II Data

(3) Commercial (hotels)

Table 3-51 shows meter reading data of hotels. In this section, average of number of meter-read customers is 51, and an average of 17.9 m^3 of water is used daily. The amount of water consumption of hotels corresponds to 77.2% of the amount of domestic water consumption.

Table 3-51 Meter Reading Data of Hotels

Period	Consumption		No. of Connection	Consumption per Connection	
	(m^3/month)	(m^3/day)		(m^3/connection /month)	(m^3/connection/day)
Jul 2015	22,941	740	50	458.8	14.8
Aug 2015	25,432	820	50	508.6	16.4
Sep 2015	32,943	1,098	50	658.9	22.0
Oct 2015	28,038	904	50	560.8	18.1
Nov 2015	28,841	961	50	576.8	19.2
Dec 2015	29,418	949	51	576.8	18.6
Jan 2016	38,963	1,257	51	764.0	24.6
Feb 2016	25,622	884	51	502.4	17.3
Mar 2016	22,699	732	52	436.5	14.1
Apr 2016	33,412	1,114	52	642.5	21.4
May 2016	19,907	642	52	382.8	12.3
Jun 2016	24,530	818	52	471.7	15.7
Average	27,729	909	51	544.9	17.9

Source: SBM II Data

(4) Institutions

Table 3-52 shows meter reading data of institutions. In this section, average number of meter-read customers is 48, and an average of 2.6 m^3 of water is used daily. Amount of water consumption in this sector is equal to 10.6% of the amount of domestic usage of water.

Table 3-52 Meter Reading Data of Institutions

Period	Consumption		No. of Connection	Consumption per Connection	
	(m^3/month)	(m^3/day)		(m^3/connection /month)	(m^3/connection/day)
Jul 2015	5,170	167	43	120.2	3.9
Aug 2015	5,215	168	44	118.5	3.8
Sep 2015	3,861	129	45	85.8	2.9
Oct 2015	5,763	186	45	128.1	4.1
Nov 2015	2,925	98	46	63.6	2.1
Dec 2015	3,622	117	47	77.1	2.5
Jan 2016	3,487	112	52	67.1	2.2
Feb 2016	3,727	129	52	71.7	2.5
Mar 2016	2,283	74	52	43.9	1.4
Apr 2016	3,272	109	52	62.9	2.1
May 2016	2,846	92	52	54.7	1.8
Jun 2016	3,487	116	52	67.1	2.2
Average	3,805	125	48	79.6	2.6

Source: SBM II Data

(5) Agriculture

Table 3-53 shows meter reading data of agriculture. In this section, average number of meter-read customers is 33, and an average of 0.4m^3 of water is used daily. Amount of water consumption in this section is equal to 1.2 % of the amount of domestic usage of water.

Table 3-53 Meter Reading Data of Agriculture

Period	Consumption		No. of Connection	Consumption per Connection	
	(m^3/month)	(m^3/day)		(m^3/connection /month)	(m^3/connection/day)
Jul 2015	0	0	28	0.0	0.0
Aug 2015	621	20	28	22.2	0.7
Sep 2015	158	5	33	4.8	0.2
Oct 2015	123	4	34	3.6	0.1
Nov 2015	912	30	34	26.8	0.9
Dec 2015	78	3	34	2.3	0.1
Jan 2016	171	6	34	5.0	0.2
Feb 2016	1,268	44	34	37.3	1.3
Mar 2016	100	3	34	2.9	0.1
Apr 2016	98	3	34	2.9	0.1
May 2016	78	3	34	2.3	0.1
Jun 2016	1,645	55	34	48.4	1.6
Average	438	14	33	13.2	0.4

Source: SBM II Data

(6) Seaport

Table 3-54 shows meter reading data of the seaport. In this section, an average of 21.5m^3 of water is used daily.

Table 3-54 Meter Reading Data in Seaport

Period	Consumption		No. of Connection	Consumption per	
	(m^3/month)	(m^3/day)		(m^3/connection/month)	(m^3/connection/day)
Jul 2015	1,061	34	1	1,061.0	34.0
Aug 2015	201	6	1	201.0	6.0
Sep 2015	1,149	38	1	1,149.0	38.0
Oct 2015	306	10	1	306.0	10.0
Nov 2015	228	8	1	228.0	8.0
Dec 2015	2,114	68	1	2,114.0	68.0
Jan 2016	472	15	1	472.0	15.0
Feb 2016	1,086	37	1	1,086.0	37.0
Mar 2016	202	7	1	202.0	7.0
Apr 2016	475	16	1	475.0	16.0
May 2016	0	0	1	0.0	0.0
Jun 2016	569	19	1	569.0	19.0
Average	655	21	1	655.3	21.5

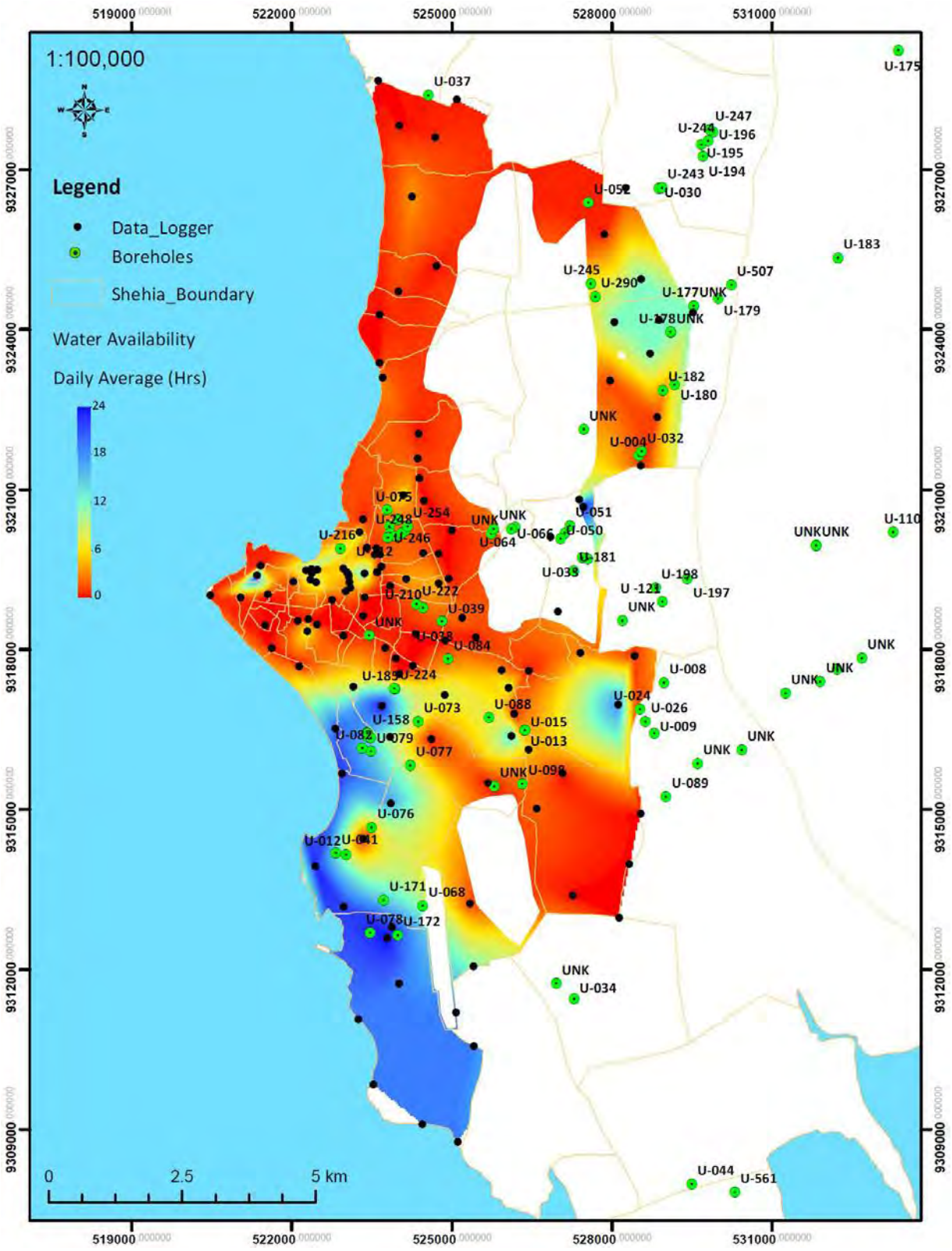
Source: SBM II Data

3.9.2 Current Situation of Water Supply Service

Figure 3-37 shows the situation of water supply in Urban West Region. This map shows water supply hours with more than 1.0 m of residual water head at water taps based on the water pressure survey conducted by the Technical Cooperation Project Phase 2.

According to this map, ZAWA is not supplying water equitably.

The area where water is always available is limited only to the periphery of the direct pumping deep wells. It is expected that in some areas water is available sometimes due to relatively good hydraulic conditions e.g. nearer to the distribution mains. Areas further from the direct pumped deep wells would have poor hydraulic conditions and will therefore face difficulty in getting water.



Source: Result of Baseline Survey in the Technical Cooperation Project, Phase 2

Figure 3-37 Current Situation of Water Supply in Urban West Region

3.9.3 Supplied Water Quality

(1) Residual Chlorine Measurement by ZAWA

Currently, there is disinfection equipment at the only four sites – Welezo, Kinuni, Dole and Saateni Reservoirs. There is no equipment at the other reservoirs and elevated tanks. Therefore, chlorinated water is not supplied to the whole of the urban water supply area.

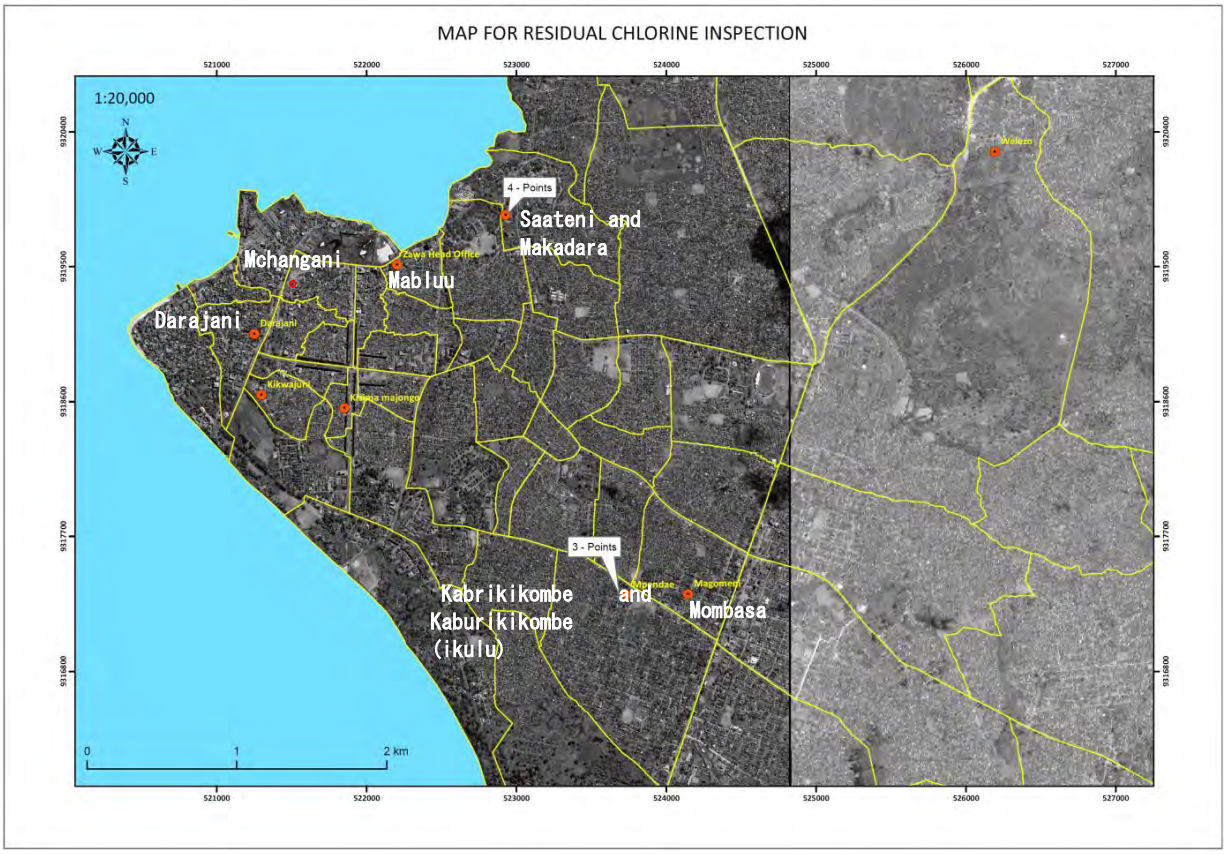
Sampling points for residual chlorine measurement is shown in **Figure 3-38**. To confirm the existence of residual chlorine in the distribution network, sampling points should be at distal water taps or distal points of the network. However, sampling points were not selected based on this.ve.

Residual chlorine measurement record is shown in **Table 3-55**. Data of residual chlorine provided from ZAWA is limited. Although not shown in the Table, residual chlorine at Saateni reservoir is examined every day, and the result of the concentration is from 0.40 to 0.60 mg/L.

Table 3-55 Residual Chlorine Measurement Record (ZAWA)

Place/Street	Residual Chlorine (mg/L)											
	2016										2017	
	5/22	5/30	11/3	11/4	11/7	12/2	12/13	12/15	12/21	12/27	1/11	1/12
Mabluu	0.50	0.35	-	-	-	-	-	-	-	-	-	-
Mchangani	0.55	0.40	-	-	-	-	-	-	-	-	-	-
Darajani	0.40	0.40	-	-	-	-	-	-	-	-	-	-
Makadara	0.45	0.45	-	-	-	-	-	-	-	-	-	-
Saateni	0.60	0.50	-	-	-	-	-	-	-	-	-	-
Kaburikikombe	-	-	2.00	0.40	0.40	0.60	0.60	0.60	0.30	0.50	0.30	0.50
Kaburikikombe (ikulu)	-	-	-	0.80	-	-	-	0.60	0.60	0.60	-	0.20
Mombasa	-	-	-	-	-	0.40	-	-	-	0.40	-	-

Source: ZAWA



Source: Laboratory, Water Resource, Water Development Department, ZAWA

Figure 3-38 Location of Measurement Points of Residual Chlorine

Following an epidemic of cholera in Zanzibar in April 2016, highly-concentrated chlorination was executed. When the residual chlorine in the distribution network was measured by ZAWA's laboratory staff, residual chlorine was detected in the public tap water in the town.

(2) Residual Chlorine Measurement by Survey Team

The Survey Team conducted a residual chlorine survey using a portable device, to confirm the tap chlorine concentration of the Saateni reservoir distribution zone.

The public tap in Darajani Market was chosen as the sampling location upon discussions with ZAWA. The measurement results are shown in **Table 3-56**.

Several samples were taken on November 4, and the concentration was measured from 0.04 mg/L to 0.43 mg/L, confirming that the concentration differs largely during the day. It is possible that the water from Welezo reservoir, which is non-chlorinated, is mixed. This result shows that it is difficult to maintain stable chlorine concentration without distribution zoning.

Table 3-56 Residual Chlorine Measurement Record

Date	Sampling time	Measurement	Note
October 24, 2016	PM 1:55	0.02 mg/l	Chlorination suspended at Saateni
October 27, 2016	PM 4:10	0.12 mg/l	Chlorination suspended at Saateni
November 2, 2016	PM 2:45	0.06 mg/l	Chlorination suspended at Saateni
November 3, 2016	PM 4:10	0.24 mg/l	
November 4, 2016	AM 8:40	0.04 mg/l	
November 4, 2016	AM 11:10	0.11 mg/l	
November 4, 2016	PM 2:45	0.43 mg/l	

Source: JICA Survey Team

3.9.4 Issues of Water Supply

【Unequitable water supply】

- Time and pressure of water supply differs by areas.

【Distribution of non-chlorinated water】

- Distribution of non-chlorinated water

3.10 Tariff System and Situation of Water Charge Collection

3.10.1 Tariff System

(1) Tariff System

After the establishment of ZAWA, Water Regulation was issued in 2007 and water tariff was shifted from free of charge to paid service. In 2008, a water tariff schedule was issued by revision of the Regulation. In July 2013, the Regulation was amended again and the tariff schedule was revised. The Regulation became effective in April 2016, and the revised tariff schedule (**Table 3-57**) were applied. Unit price for metered customers is drastically raised. However, flat rate, shown in **Table 3-58,** has not changed. As a result, a difference has emerged between the metered rate and the flat rate.

Table 3-57 Water Tariff for Metered-Rate

Category	Volume of Consumption	Tariff (TZS/m^3)	
		2008	2013
Kiosk/Pipe-stand		150	667.45
Domestic Use	0 - 8	250	667.45
	8> - 12	300	821.48
	12> - 15		1,026.45
	15> - 17		1,232.22
	17>		1,540.28
Institution	0 - 15	300	924.17
	15> - 30	350	1,026.85
	30> - 50		1,129.54
	50> - 100		1,232.22
	100> - 250		1,437.60
	250> - 500		1,642.97
	500> - 1000		1,951.02
	1000>		2,259.08
Industry and Commercial	0 - 15	300	821.48
	15> - 30	400	924.17
	30> - 50		1,062.85
	50> - 100		1,232.22
	100> - 250		1,437.60
	250> - 500		1,642.97
	500> - 1000		1,951.02
	1000> - 5000	500	2,259.08
	5000>	1,000	2,259.08
Guest house	0 - 15	-	1,129.54
	15> - 30	-	1,437.60
	30> - 50	-	1,848.34
Hotel	50> - 100	-	3,080.56
	100> - 250	-	4,107.42
	250> - 500	-	5,647.70
	500> - 1000	-	6,161.12
	1000>	-	7,167.98
Agriculture	0 - 50	350	718.80
	50> - 200	400	872.83
	200>	500	1,026.85

Source: The Water Regulations (Amendment) of 2008, 2013

Table 3-58 Water Tariff for Flat Rate

Category			Fare (TZS/month)
Kiosk/Pipe-stand			—
Domestic Use			4,000
Institution	Less than 50 Employees		20,000
	50 to 100 Employees		50,000
	More than 101 Employees		200,000
	Community, Religious Place, NGO		3,000
Industry and Commercial	Guest House	0 - 10 Rooms	20,000
		10> - 20 Rooms	40,000
		20 Rooms>	75,000
	Hotel	Grade B	500,000
		Grade A	700,000
		1 Star	2,000,000
		2-3 Stars	3,000,000
		4-5 Stars	5,000,000
	Restaurant, Bakery		20,000
	Construction		120,000
	Retail		30,000
	Gas Station		20,000
	Car Wash		40,000
Agriculture	Small Scale		20,000
	Medium Scale		90,000
	Large Scale		150,000

Source: The Water Regulations (Amendment) of 2008, 2013

(2) Procedure of Tariff Revision

In future, it is supposed that tariff revision must be approved by ZURA (Zanzibar Utility Regulatory Authority, established in July 2013).

Currently, ZURA is in charge of price adjustment in mainly in the petroleum sector. However, in future, they are going to expand their activities to include price regulation of public services, such as water supply.

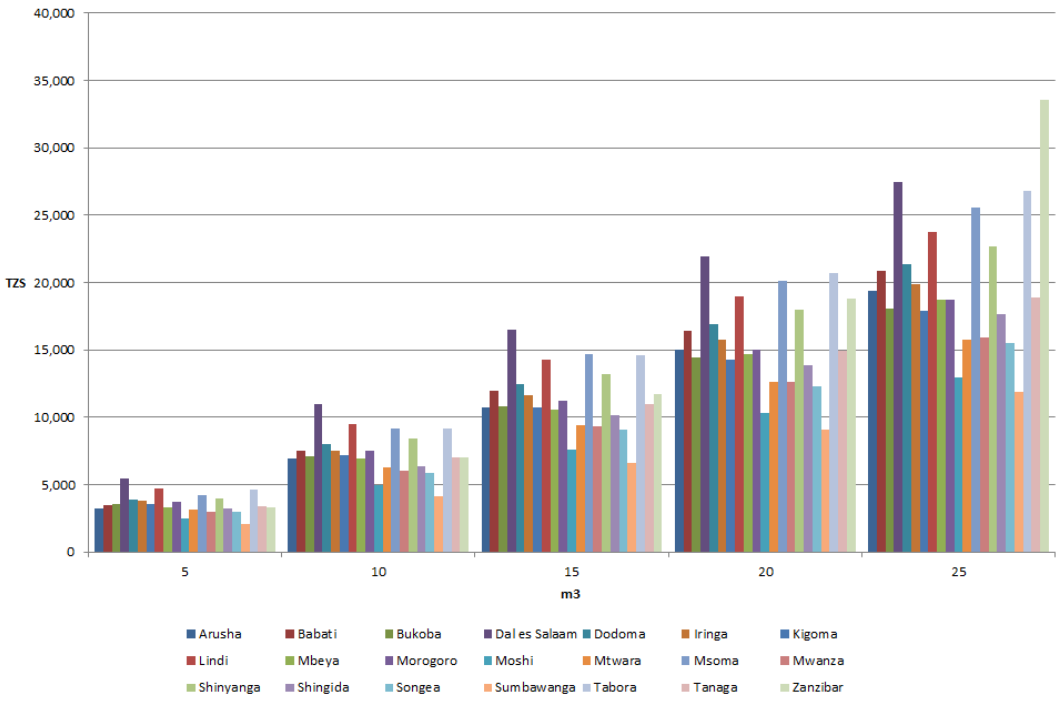
(3) Water Tariff Comparison to Other Water Utilities

Table 3-59 and **Figure 3-39** show water rates of major cities in Tanzania. 21 water utilities adopt the progressive water rate system. ZAWA's water rate is relatively low when water consumption is small, but it is the most expensive when water consumption is 25 m^3/month.

Table 3-59 Water Rates of Major Cities in Tanzania (Domestic)

City	Water Consumption (m^3/month)					Remarks
	5	10	15	20	25	
Arusha	3,200	6,950	10,700	15,050	19,400	Progressive water rates
Babati	3,450	7,500	11,950	16,400	20,850	Progressive water rates
Bukoba	3,525	7,125	10,775	14,425	18,075	Progressive water rates
Dal es Salaam	5,490	10,980	16,470	21,960	27,450	
Dodoma	3,900	8,050	12,490	16,930	21,370	Progressive water rates
Iringa	3,775	7,550	11,650	15,750	19,850	Progressive water rates
Kigoma	3,575	7,150	10,725	14,300	17,875	
Lindi	4,750	9,500	14,250	19,000	23,750	
Mbeya	3,350	6,950	10,550	14,650	18,750	Progressive water rates
Morogoro	3,750	7,500	11,250	15,000	18,750	
Moshi	2,475	4,950	7,625	10,300	12,975	Progressive water rates
Mtwara	3,150	6,300	9,450	12,600	15,750	
Msoma	4,250	9,200	14,650	20,100	25,550	Progressive water rates
Mwanza	3,000	6,000	9,300	12,600	15,945	Progressive water rates
Shinyanga	3,950	8,450	13,200	17,950	22,700	Progressive water rates
Shingida	3,200	6,400	10,150	13,900	17,650	Progressive water rates
Songea	2,950	5,900	9,100	12,300	15,500	Progressive water rates
Sumbawanga	2,050	4,100	6,600	9,100	11,850	Progressive water rates
Tabora	4,600	9,200	14,600	20,700	26,800	Progressive water rates
Tanaga	3,400	7,000	10,950	14,900	18,850	Progressive water rates
Zanzibar	3,337	6,983	11,705	18,790	33,577	Progressive water rates
Rank	14	13	8	5	1	

Source: EWURA (Energy and Water Utilities Regulatory Authority) Web Site



Source: JICA Survey Team

Figure 3-39 Water Rates by Consumption (for domestic)

3.10.2 Status of Service Connections and Customer Registration

(1) Number of Connections by "Household Budget Survey 2009-2010"

Eighty percent of households in Zanzibar are connected to piped water supply, according to "Household Budget Survey 2009-2010"[2]. Though there are many problems in water supply service of ZAWA, the result shows high connection rate to water supply service.

(2) Situation of Customer Registration in ZAWA

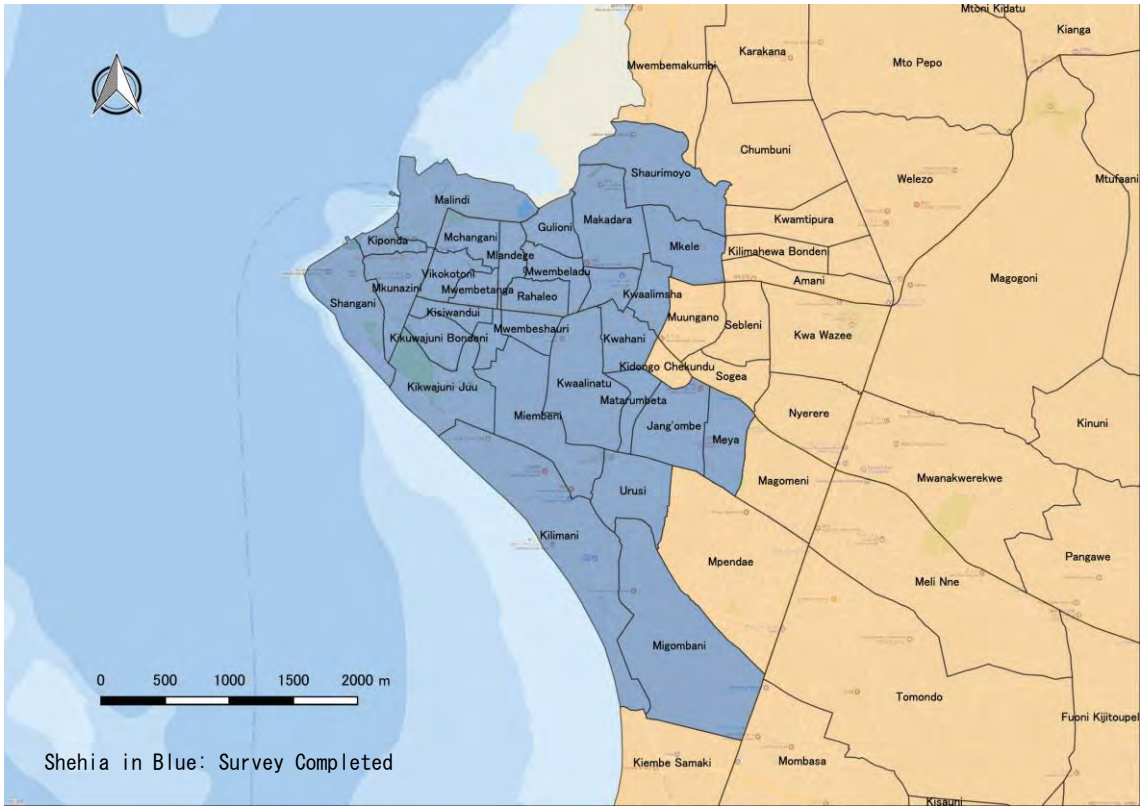
Service connection survey has been conducted in the Technical Cooperation Project Phase 2 to study the ZAWA service connection and registration status. As of July 2017, the survey has been completed in 31 shehias. The results are shown in **Table 3-60**, and the surveyed shehias are shown in **Figure 3-40**.

Table 3-60 Service Connection Survey Result

No.	Shehia	No. of Connection Supplied by ZAWA							No. of Non ZAWA User				Surveyed No.	Non-Surveyed No.	Total
		Registered			Non Registered			Total	Private Source	Un-official Provider	Unknown	Total			
		Metered	Flat Rate	Total	Public Tap	Illegal Connection	Total								
13	Gulioni	2	237	239	0	181	181	420	0	0	0	0	420	0	420
14	Jang'ombe	0	2	2	524	48	572	574	18	274	0	292	866	142	1,008
22	Kikuwajuni Bondeni	0	33	33	0	378	378	411	0	0	0	0	411	23	434
23	Kikuwajuni Juu	0	13	13	5	383	388	401	3	0	0	3	404	36	440
26	Kilimani	2	78	80	66	98	164	244	20	143	0	163	407	232	639
28	Kiponda	0	4	4	0	131	131	135	10	103	0	113	248	6	254
30	Kisima Majongoo	0	75	75	3	432	435	510	2	14	0	16	526	0	526
31	Kisiwandui	0	65	65	1	243	244	309	0	2	0	2	311	20	331
35	Kwaalimsha	0	28	28	5	148	153	181	5	126	139	270	451	45	496
36	Kwaalinatu	0	5	5	244	103	347	352	31	173	0	204	556	58	614
37	Kwahani	0	7	7	14	214	228	235	6	228	99	333	568	110	678
41	Makadara	756	56	812	1	44	45	857	1	0	0	1	858	0	858
42	Malindi	0	101	101	0	301	301	402	1	50	0	51	453	54	507
43	Matarumbeta	0	0	0	49	198	247	247	9	115	0	124	371	61	432
46	Mchangani	0	169	169	3	27	30	199	126	45	0	171	370	0	370
48	Meya	0	51	51	237	139	376	427	12	288	0	300	727	135	862
50	Miebeni	0	45	45	1	793	794	839	16	8	0	24	863	23	886
51	Migombani	0	238	238	93	207	300	538	7	316	0	323	861	105	966
52	Mikunguni	0	24	24	0	278	278	302	0	1	0	1	303	18	321
53	Mkele	0	28	28	11	230	241	269	10	333	350	693	962	82	1,044
54	Mkunazini	0	26	26	0	324	324	350	3	280	0	283	633	55	688
55	Mlandege	0	124	124	2	236	238	362	12	17	0	29	391	48	439
55	Mwembeladu	0	85	85	1	313	314	399	17	24	0	41	440	73	513
57	Mpendae	0	165	165	992	488	1,480	1,645	78	66	0	144	1,789	26	1,815
62	Mwembetanga	0	132	132	1	366	367	499	0	8	0	8	507	11	518
69	Mwembeshauri	0	3	3	4	320	324	327	0	8	0	8	335	17	352
74	Rahaleo	0	46	46	0	312	312	358	4	7	0	11	369	26	395
77	Shangani	0	21	21	0	204	204	225	27	260	0	287	512	44	556
79	Shaurimoyo	0	288	288	26	667	693	981	3	90	0	93	1,074	310	1,384
82	Urusi	0	88	88	615	216	831	919	9	108	0	117	1,036	16	1,052
83	Vikokotoni	0	63	63	0	240	240	303	9	13	0	22	325	60	385
	Total	760	2,300	3,060	2,898	8,262	11,160	14,220	439	3,100	588	4,127	18,347	1,836	20,183

Source: Final Report, the Technical Cooperation Project for Enhancement of Water Supply Management of Zanzibar Water Authority Phase 2 (October 2016)

[2] Statistical survey by OCGS (Office of Chief Government Statistical)

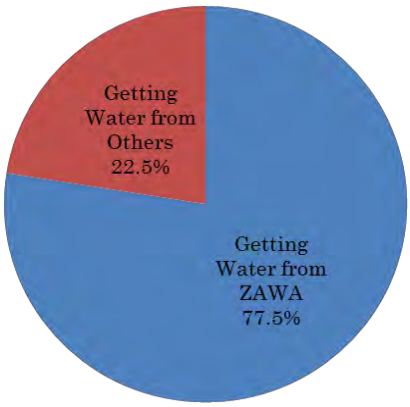


Source: JICA Survey Team

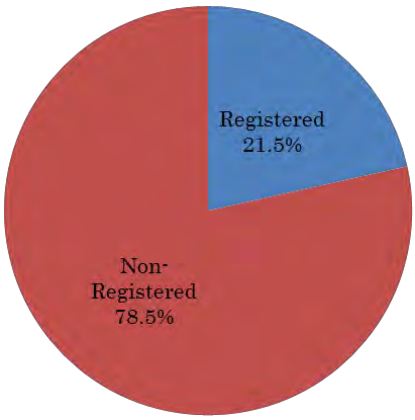
Figure 3-40 Shehias which Completed Service Connection Survey

Major findings are as follows:

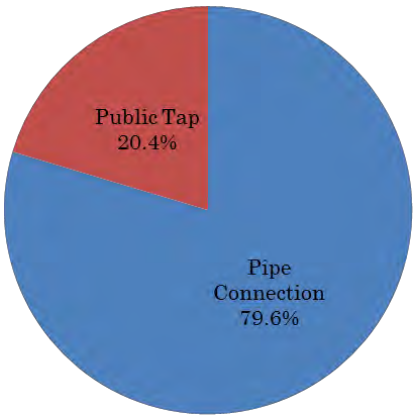
- 77.5% of residents use water supplied by ZAWA, and this figure is almost the same as the "Household Budget Survey"
- Within users of water supplied by ZAWA, seventy nine point six percent (79.6%) are connected to water supply service and twenty point four percent (20.4%) use public taps.
- Water source of non-ZAWA users are their own wells (10.6%), water supply from vendors (75.1%), and unknown (14.2%)



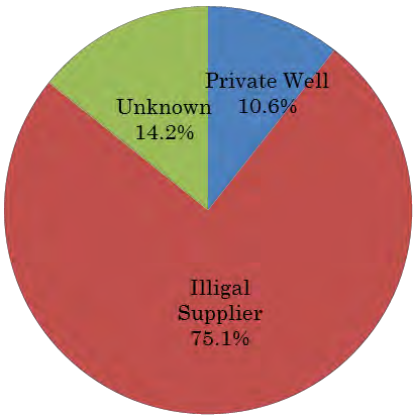
(1) Water Sources



(2) Status of Registration of ZAWA Users



(3) Status of Connection of ZAWA Users



(4) Water Source of Non ZAWA Users

Source: JICA Survey Team

Figure 3-41 Result of Service Connection Survey

3.10.3 Situation of Water Charge Collection

(1) Methods of Water Charge Collection

Table 3-61 shows the system of water charge collection in ZAWA. Customers are categorized as metered-rate customers or flat-rate customers depending on water meter installation, and other cases, such as hotels, are categorized as large scale customers. Though ZAWA employees visit large scale customers for water charge collection, payment of other customers is made at the teller windows of ZAWA.

In addition, Kata-kata, or the collection of previously uncollected water charges' collection activity, was carried out every Thursday. Employees of ZAWA visit all households in selected areas, and verify the record of water tariff payments with the original receipts. In case they find that payment was not done, they request for immediate settlement. In the event that payment is

not made immediately, the water supply pipe is disconnected.

This activity was suspended from June 2016 by the instruction of the new Minster.

Table 3-61 Water Charge Collection System in ZAWA

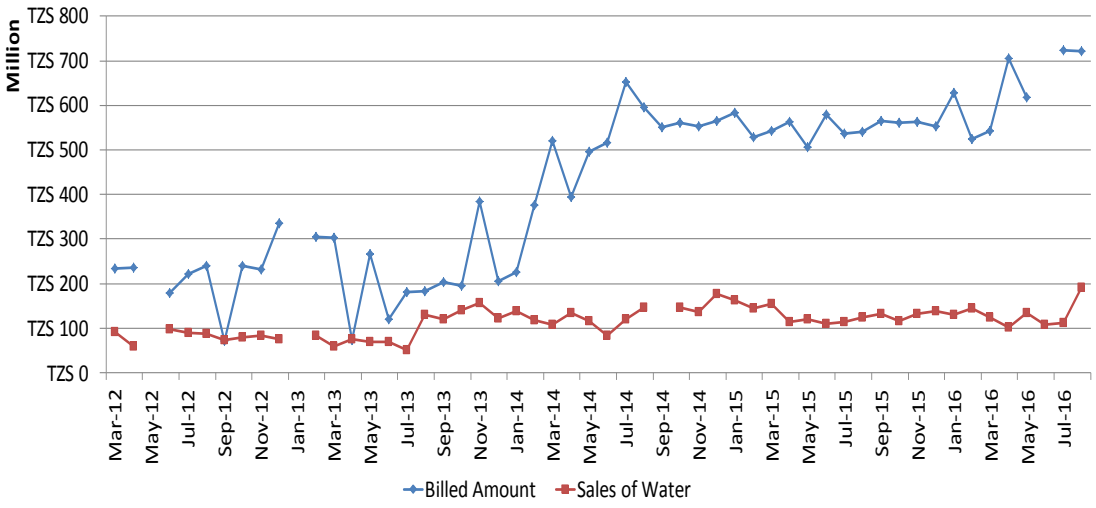
Category		Meter Reading	Distribution of Bill	Water Charge Collection	Number* (July. 2017)
Metered-rate	Large Scale Customers	○	○	Visit	5,412
	Ordinary Customers			Window	
Flat-rate	Large Scale Customers	×	×	Visit	43,905
	Ordinary Customers			Window	
Total					49,317

*: in Unguja
Source: JICA Survey Team

(2) Situation of Water Charge Collection

Figure 3-42 shows passage of billed amount and sales of water between March 2012 and August 2016. In the later years, sales of water falls much below billed amount, and the ratio of sales amount to billed amount is only an average 27.4% over this period.

Basic technical support for meter reading and billing is carried out in the Technical Cooperation Project Phase 2. Ability of employees has improved in this field, but there is no recognised positive impact to actual tariff collection works yet.



Note: The graph shows total value of flat-rate and metered rate, and billed amount includes the amount for flat-rate customers who are not delivered bill.

Source: MIS Data, Planning & Policy, Finance & Administration Department, ZAWA

Figure 3-42 Transition of Billed Amount and Sales of Water

(a) Transition of billed amount

Table 3-62 shows transition of billed amount in Unguja Island.

Billing on SBM II is categorized by usage (domestic, commercial, agriculture, institution, kiosk and stand pipe). Billed amount for domestic customers, which occupied 65% of total billed amount in 2015, increased at an annual growth rate of 20% for 3 years from 2013. Billed amount for Kiosks and Stand-pipes also increased drastically. As a side note, since some large and flat-rate customers are not registered to SBM II, billed amount is different between MIS data and SMB II.

Table 3-62 Transition of Billed Amount in Unguja Island

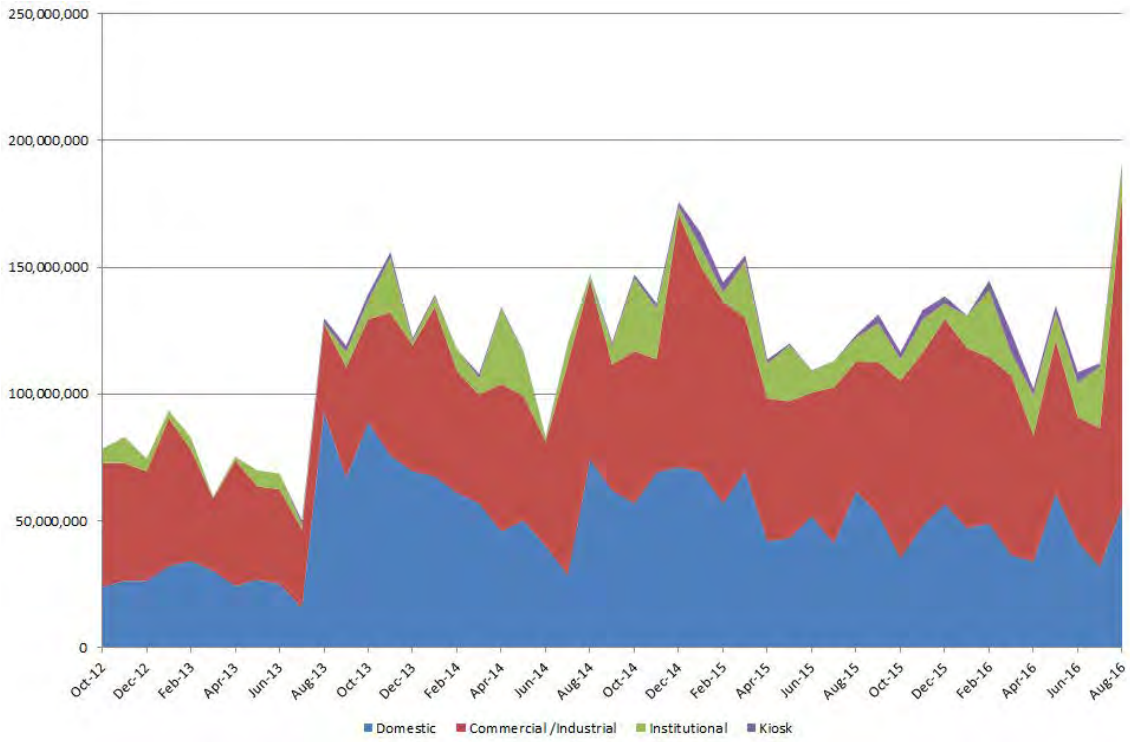
Billed Amount	Category	FY2013		FY2014		FY2015		Annual Growth Rate
		Billed Amount (1,000TZS)	%	Billed Amount (1,000TZS)	%	Billed Amount (1,000TZS)	%	
Monthly billed Amount (Consumption and Service Charge)	Agriculture	14,333	1%	17,872	1%	22,323	1%	25%
	Commercial	978,414	35%	1,021,773	31%	936,337	27%	-2%
	Domestic	1,616,073	57%	2,046,219	62%	2,309,172	65%	20%
	Institution	181,593	6%	197,956	6%	176,026	5%	-2%
	Kiosk	1,750	0%	458	0%	3,881	0%	49%
	Non category	830	0%	0	0%	0	0%	-100%
	Stand Pipe	23,957	1%	3,927	0%	78,455	2%	81%
	Total	2,816,950	100%	3,288,205	100%	3,526,194	100%	12%

Source: JICA Survey Team based on SBM II data

(b) Transition of collected amount

Figure 3-43 shows transition of collected amount. Collected amount for domestic use increased after the commencement of Kata-Kata in August 2013. This is due to customers settling their outstanding arrears to avoid disconnection of service.

After that, collected amount has not improved. It is conceivable that number of customers, who have enjoyed satisfactory water supply service, has not increased.



Source: MIS data

Figure 3-43 Transition of Collected Amount by Usage

(3) Issues of SBM II

From the following viewpoints, issues of the SBM II were sorted out as part of the improvements to the ICT section of ZAWA in the Technical Cooperation Project Phase II.

- Verification of SBM II support contract (Comparison to same kind of contract for other systems)
- Information collection of other customer management system (Kenyan systems, visiting and interviewing ZECO)
- Complaints and request survey from SBM II users in ZAWA

(a) System issues, workflow of billing and influence to the Yen-Loan Project

There following problems obstruct issuance and management of bills. It is a concern that these problems may continue to obstruct smooth billing and billing management even after the expected dramatic increase of customers with the Yen-Loan Project.

- Multiple account numbers are issued for one reference number at the registration of new customers
- Other account number is given at the editing of existing customer data
- The system does not have functions to print out the major lists

(b) Working on the improvement of existing system

Maintenance of SBM II has been contracted between ZAWA and OIKOS. Outline of the contract is shown below;

- 10 days dispatch of a maintenance staff twice a year (5 days for Unguja, 5 days for Pemba)
- Contract amount is 9,400,000 TZS per year
- Additional cost for dispatch extension (400,000 TZS per day)

Current contract had expired in June 2016, and renewal of the contract is necessary. Maintenance fee is more expensive than the contract amount of ZAWA's other system maintenance. Furthermore, the contract is advantageous to OIKOS because it is based on the number of dispatch days. Actually, ZAWA has requested system improvement to OIKOS, but system has not been improved by the reason of dispatch expiration.

(c) Survey for system improvement

From the above, changing the system has been studied as one of the countermeasures for system improvement. Although compatibility of database is necessary, "M@JICS" and "Aquilium" (being used by ZECO) are candidates for the alternative system.

3.10.4 Issues for Tariff Collection

【Low Customer Registration Rate】

- Insufficient registration of users who was supplied water for free before establishment of ZAWA

【Low Collection Rate of Water Charge】

- Bills are not distributed to flat-rate customers who constitute a large part of customers
- Low willingness to pay due to the inadequate service provided by ZAWA

【Issues of Billing System】

- Low efficiency of billing and bill management works.
- Difficulty of billing management due to the increase of metered customers by water supply facility development

3.11 Financial Condition

3.11.1 Finance and Budget of ZAWA

(1) Schedule of Budget Preparation

Generally, annual draft budget of ZAWA is prepared by the Planning & Policy Section, Finance & Administration Department until June end. The Draft is approved by the Director General and Director of FAD, and finalized by the Committee whose members include the DG and all Directors of ZAWA. Approval of 2016/17's budget was delayed due to the presidential election, it was approved under the new system in March 2017.

(2) Situation of Budget Preparation

Non-disclosure Information

(3) Budget Analysis per FY 2014/15 Annual Account

Non-disclosure Information

3.11.2 Operating Result of ZAWA from Profit and Loss Statement

Non-disclosure Information

3.11.3 Financial Analysis of ZAWA from Balance Sheet

Non-disclosure Information

3.11.4 Issues of Financial Management

【Lack of Accuracy in Budgeting】

- There is a large deviation between the budget and actual income/ outcome (necessary to examine preconditions carefully; number of households, meter installation ratio, billing/collecting ratio, electric equipment operation ratio, etc.)
- Budget implementation is not managed.

【Weak Revenue Capability】

- Operation in red is continuing (improvement can be observed).
- Low customer registration rate caused by insufficient water supply service
- Insufficient water charges collection work, such as non-delivery of bill

【Fund Shortage and Degradation of Service】

- Insufficient investment for O&M/improvement of facilities required by the business environment, such as population increase.
- Low customer payment willingness caused by degradation of service quality.

3.12 Survey of Residents' Opinion

3.12.1 Outlines of the Survey

(1) Objectives

This survey aims to collect opinion of residents for ZAWA water supply services, and situation of households without connection to water supply in Urban West Region.

(2) Method

(a) Survey Area

Survey area is 43 Shehias in Urban West Region. (2 representative shehias within ZUWSP area, and shehias which have many houses outside of ZUWSP area were selected.)

(b) Sampling

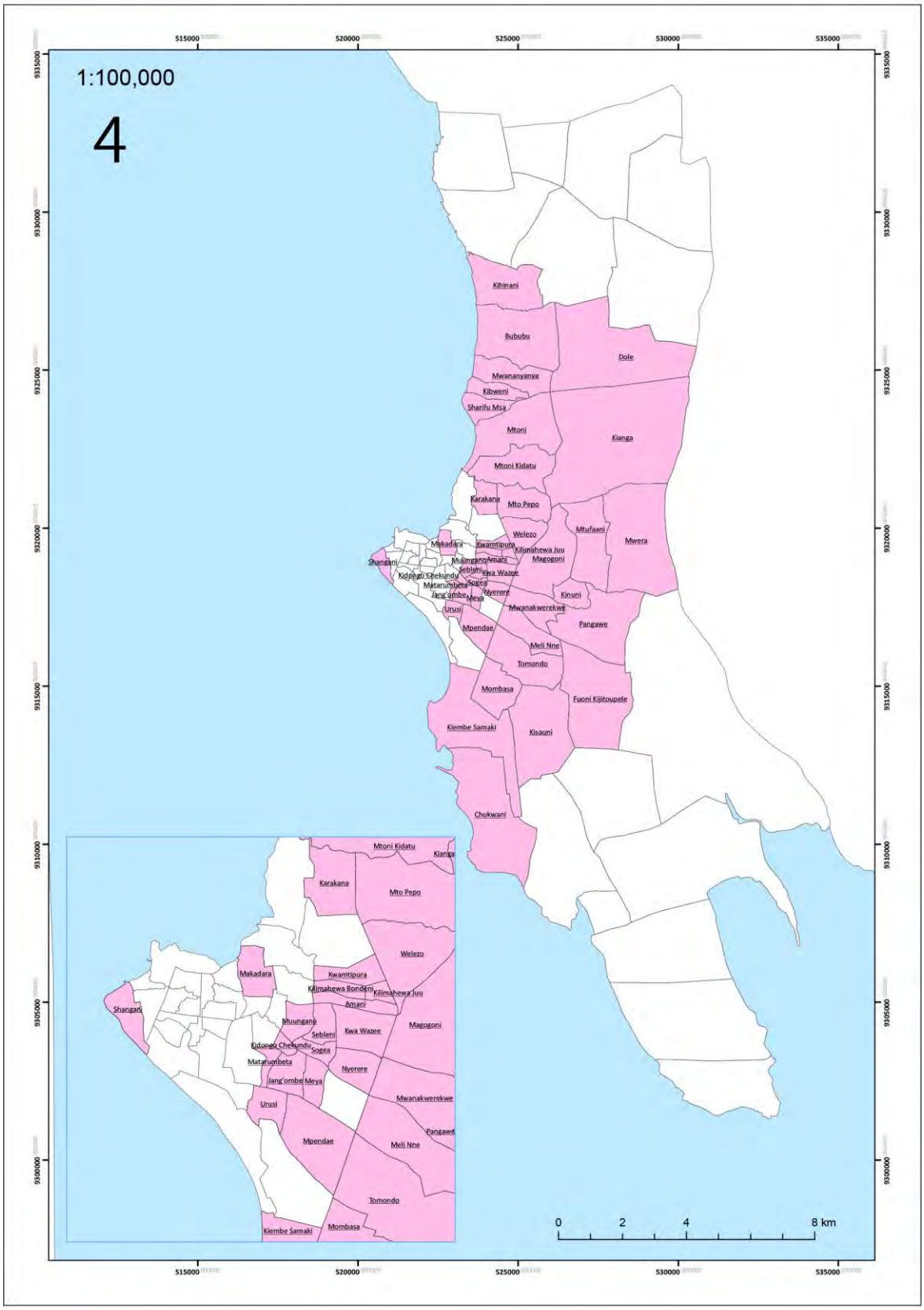
Total number of survey sample is 436 households. Around 10 households are selected as survey sample in each Shehia.

(c) Survey Method

Field survey and data entry was carried out by ZAWA. Meanwhile, questionnaire preparation and analysis was carried out by JICA Survey Team.

In the field survey, interviewers (24 ZAWA permanent and non-permanent employees) brought the questionnaire, visited the survey area and interviewed respondents. Answers are recorded by the interviewers. Three teams worked simultaneously, and they were divided to a team to interview male respondents, a team for female respondents, and a team without gender restriction.

Survey duration was from May 2 to June 26, 2016.



Source: JICA Survey Team

Figure 3-44 Target Shehia of the Survey

3.12.2 Survey Results

(1) Attribute of Respondents

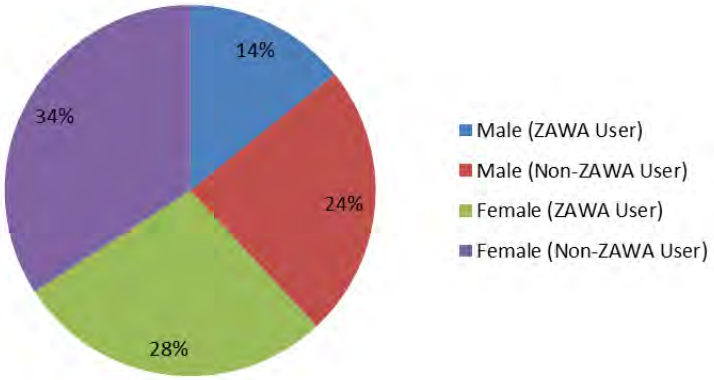
Within the 436 responding households, 183 were connected to ZAWA water supply and 253 were not connected (**Table 3-63**).

There are 166 male respondents and 270 female respondents, and average age of respondents was 48.44 years for males and 39.69 years for females; 43.02 years old overall. Regarding information of household members, total number of household members in respondents' households were 2,008 persons, comprising 981 males and 1,015 females, and the average age of all household members was 28.39 years.

Table 3-63 Category of Respondents

Item	Target (Household)	Gender of Respondents (people)		
		Male	Female	Total
Total	436	166	270	436
ZAWA connected	183	62	121	183
Non-ZAWA	253	104	149	253
Average age	—	48.44	39.69	43.02

Source: JICA Survey Team



Source: JICA Survey Team

Figure 3-45 Category of Respondents

Table 3-64 Information of Household Members of Respondents

Item	Male	Female	No Record	Total
Average of Age (Years)	29.21	27.59	28.33	28.39
Total Number of Household Members (Persons)	981	1,015	12	2,008
Average of Household Members (Persons)				4.606

Source: JICA Survey Team

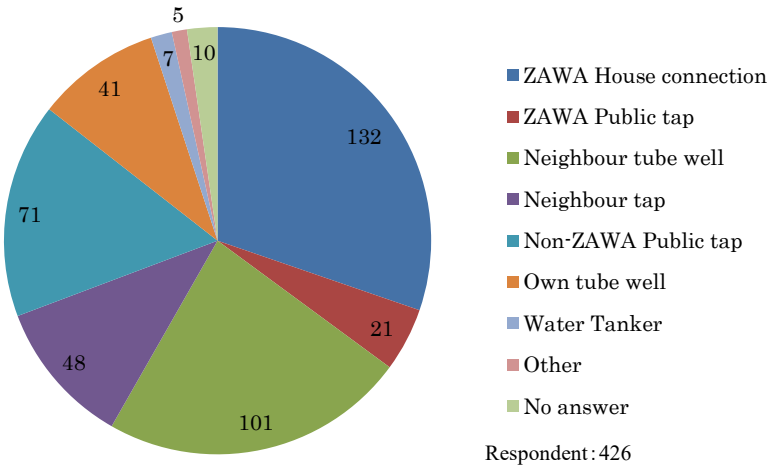
(2) Water Source Status

The water source breakdown is shown in **Table 3-65** and **Figure 3-46**. The number of ZAWA water users is 132, which is lower than the number of connections at 183. The fact that the pressure of ZAWA supply water is insufficient and the water cannot reach the users is thought to be the main reason for the difference. Only 36% of the households are supplied by ZAWA, including public water taps, while the remaining residents rely on other water sources.

Table 3-65 Breakdown of Water Source

Water source	Respondents	Ratio (respondents only)
ZAWA connection	132	31.0%
ZAWA public water tap	21	4.9%
Neighbours private well	101	23.7%
Neighbours water tap	48	11.3%
Public water tap (non-ZAWA)	71	16.7%
Private well	41	9.6%
Purchase (water tanker, etc.)	7	1.6%
Other	5	1.2%
Non-response	10	—
Total	436	100.0%

Source: JICA Survey Team



Source: JICA Survey Team

Figure 3-46 Breakdown of Water Source

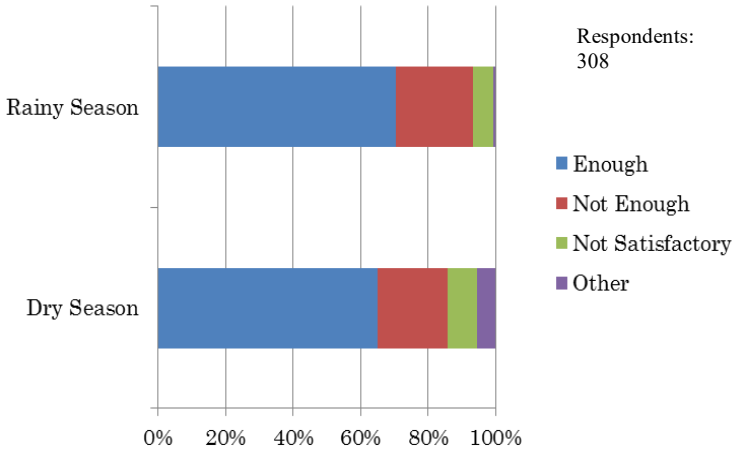
(3) Users Opinions of ZAWA Service

Regarding ZAWA supply hours, water supply starts in the morning and most cases it continues

"1-6 hours" or "7-12 hours".

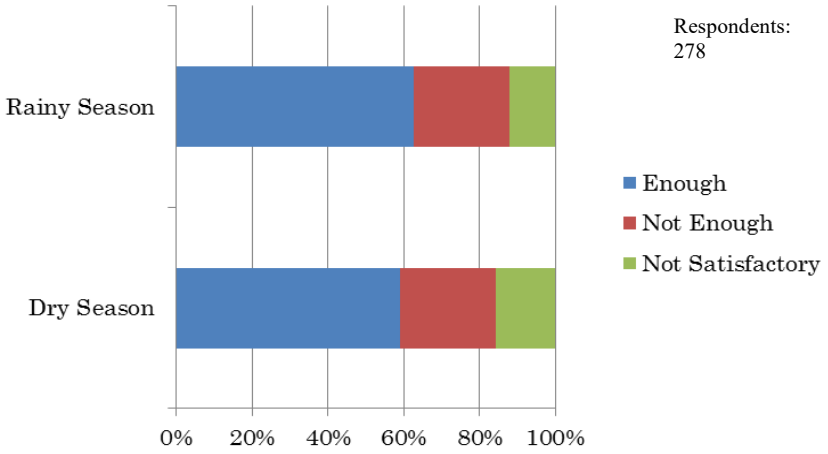
60% of ZAWA users are satisfied with the water amount and water pressure in both dry and rainy seasons, and 80% of users are satisfied with the water quality in both seasons.

High priority issues in water supply service is improvement of water supply hours and water supply amount, and both share more than half of the opinions. Not many complained about water tariff at the time of the field survey.



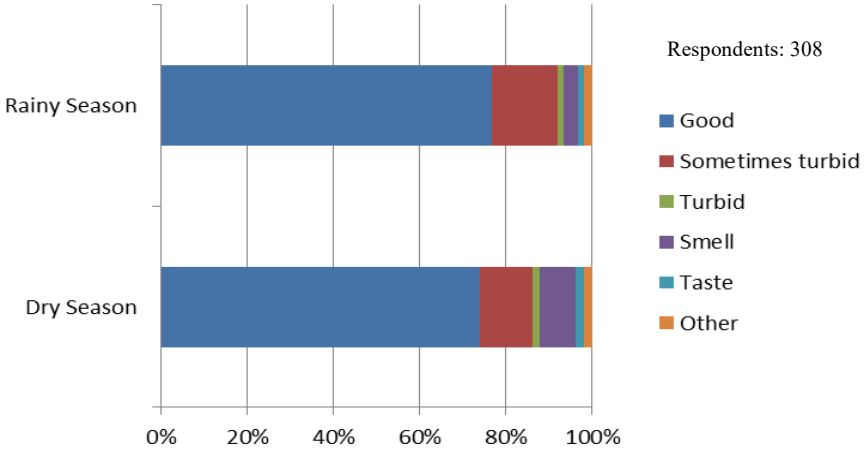
Source: JICA Survey Team

Figure 3-47 ZAWA Users' Opinion for Water Supply Amount



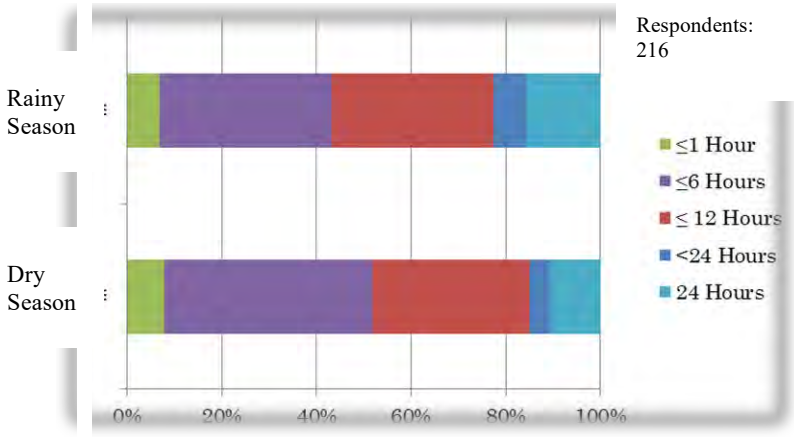
Source: JICA Survey Team

Figure 3-48 ZAWA Users' Opinion for Water Pressure



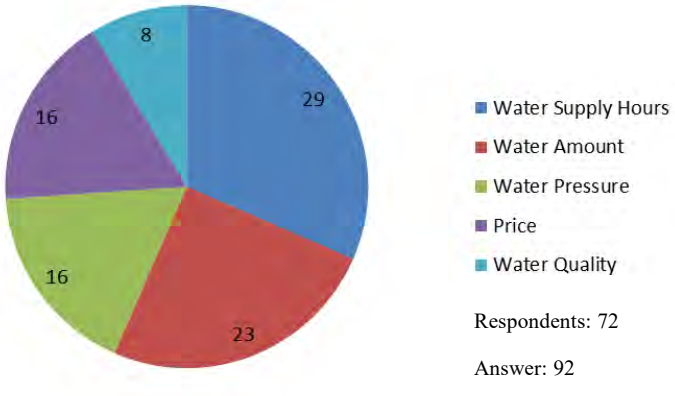
Source: JICA Survey Team

Figure 3-49 ZAWA Users' Opinion for Water Quality



Source: JICA Survey Team

Figure 3-50 Water Supply Hours in A Day of ZAWA Water Supply



Source: JICA Survey Team

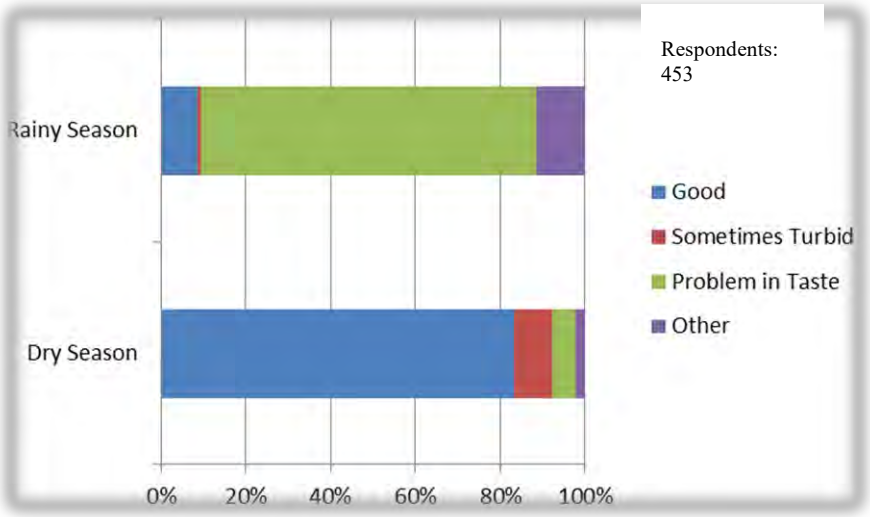
Figure 3-51 High Priority Issues for Improvement of ZAWA Service

(4) Situation and Opinions of Non-ZAWA Users

Major water sources of Non-ZAWA users are "Neighbour's well" "Non-ZAWA public water tap", "Own well", and "Neighbour's water tap". Non-ZAWA users have no complaints of their water source in the dry season, but some mentioned taste of water as a problem in the rainy season.

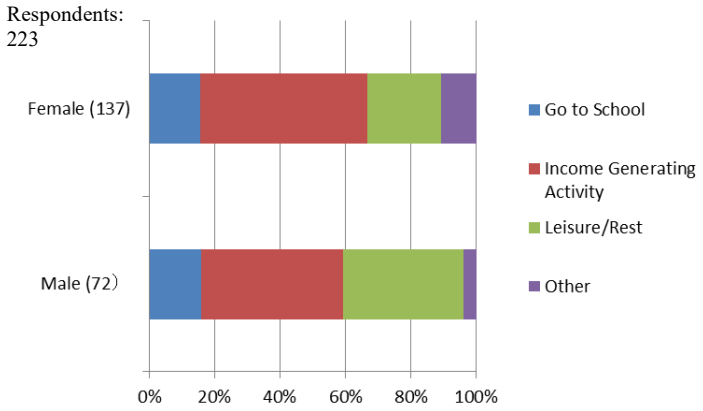
On average, Non-ZAWA users fetch water 3.56 times in a day; one round trip taking 13.36 minutes; and they bring 9.22 containers from fetching. The most common containers carry 20 litres. Some households decide who goes to fetching water in their family, and gender ratio of these "water-fetching persons" is almost equal: 46% is male and 56% is female. There are no significant differences in water fetching times and type of containers between males and females, but duration of water fetching trip is slightly longer in females compared to males.

If Non-ZAWA users do not have to go to fetch water, they would like to take the time for "Income generating activities". In Zanzibar, the amount of water carried to households is huge, compared to other countries. Therefore, if ZAWA's services improve and these households connect to ZAWA, then they do not have to carry out water fetching activities any more. This may change the lives in a positive way.



Source: JICA Survey Team

Figure 3-52 Opinions regarding Water Sources



Source: JICA Survey Team

Figure 3-53 Things to Do if Water Fetching is Not Necessary

(5) Willingness to Pay

(a) Target Amount of Willingness to Pay

In order to maintain accuracy of the statistics, the "Two-step two-answer method" was adopted for this investigation. This method shows a certain price and asks if the customer is willing or not to pay over the shown price, and the question is asked twice per interviewee.

The price asked in the question was determined by the following calculation. The annual available payment amount is calculated by multiplying 4% to the average income of a Zanzibar household (including infiltration adjustment). Dividing the result by 12 shall show the available monthly payment amount. Management cost for ZAWA shall be added to that amount for monthly tariff. The standard price for the first question was set at TZS 15,000 for the willingness survey.

- Average annual household income (urban area):(3,291,694 [3] TZS × 1.2 [4] ≒ 3,950,000 TZS)
- 4%[5] of average annual household income: 158,000 TZS
- Monthly amount of above: 158,000 TZS÷ 12 ≒ 13,200 TZS (monthly available amount)
- Monthly amount of TZS 13,200 also meets the calculation below:
  - Persons per household: 5, 110 L/day/person for estimation
    5×110 L×30 days÷1000 L / m^3＝16.5 m^3/month

[3] OCGS "Household Budget Survey 2009/2010"

[4] OCGS "Consumer Price Index 2016 April"

[5] page15, Monitoring "Affordability" of water and sanitation services after 2015: Review of global indicator options, 20th March 2012, Guy Hutton, PhD

Current domestic metered rate for 16.5 m^3/month is approx. 13,200 TZS/month
0 - 8 m^3 - 667.45 TZS/m^3, > 8 ≤ 12m^3 - 821.48 TZS/m^3, > 12 ≤ 15m^3 - 1,026.45 TZS/m^3

- Question standard (higher than available payment amount): 15,000 TZS/month

In the survey, stating that the water supply service quality is improved as a precondition, the first question was if the respondent is willing to pay 15,000 TZS monthly. For respondents who answered "Yes", the second question was to pay 18,000 TZS monthly. For respondents who answered "No" to the second question, they were asked how much they were willing to pay. For respondents who answered "No" to the first question, they were asked if they would pay 12,000 TZS monthly, and if the answer was "No", they were asked how much they were willing to pay.

(b) Willingness to Pay of All Respondents

This interview was carried out with both ZAWA users and Non-ZAWA users.

Before the interview, following issues (the Scenario) were explained and later interview of willingness to pay was carried out.

- Water facilities in Zanzibar are old and lack incapacity; therefore, residents have not been supplied sufficient and safe water. Therefore, ZAWA plans a project for replacing and strengthening the pipelines and supplying facilities
- If ZAWA improve the water facilities, residents will be supplied sufficient and safe drinking water in one's house tap. On the other hand, it is necessary for ZAWA to cover the costs through the water tariff from residents based on the volume of water use.
- Because of the additional costs for the improvement of water service, it is assumed that the water tariff will need to be set higher than the current flat rate of 4,000 TZS/month.
- After the project implementation, residents will not need water supply from other sources. Therefore, payments to the providers other than ZAWA will no longer be necessary.

After explanation of the above issues, following questions were carried out:

Question 1: Do you understand the scenario?
Question 2: Do you think the project necessary?
Question 3: Do you agree to the project if average water tariff will be about 15,000 TZS/month?
Question 4: If you answered "Yes" to 3) above, do you agree to the project if average water tariff will be about 18,000 TZS/month?
Question 5: If you answered "No" to 3) above, do you agree to the project if average water

tariff will be about 12,000 TZS/month?

272 respondents (109 ZAWA users and 163 Non-ZAWA users) answered that they understood the Scenario, and 360 respondents (183 ZAWA users and 253 Non-ZAWA users) answered that the project is necessary. More respondents agreed necessity of the project compared to the number of respondents who understood the Scenario. It may be because necessity of safe water is obvious without understanding the Scenario.

Although necessity of the Project is recognized in 80% of respondents, it means that 20% of the respondents did not. The reason was because of the current bad service of ZAWA. Some respondents mentioned ZAWA's low accountability. ZAWA must take into account these customers' complaint when renewing the water tariff system.

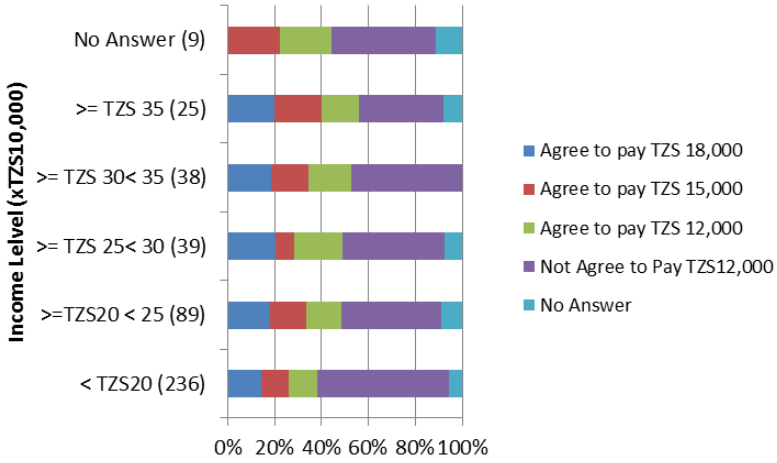
Table 3-66 and **Figure 3-54** show the responses to payment willingness. 57 respondents agreed to the first option, to pay 15,000 TZS. 70 respondents agreed to the second, to pay 18,000 TZS, and 63 respondents agreed to the third option, to pay 12,000 TZS. However, 219 respondents did not agree with the proposed minimum water tariff of 12,000 TZS. The average amount that the 219 respondents were willing to pay was 5,414 TZS.

From a detailed breakdown of the respondents who did not agree to pay 12,000 TZS, 56% (133 nos.) of the respondents with an annual income of under 200,000 TZS are categorized in this group. This value is followed by 42% (38 respondents) with an income of 200,000 – 250,000 TZS; 44% (17 respondents) of 300,000 – 350,000 TZS; and 36% (9 respondents) with an income of over 350,000 TZS. Although the number of respondents who did not agree to pay 12,000 TZS is high among the lower income groups, 36% of the highest income group also had the same answer. Therefore, it is understood that the relationship between payment willingness and annual income is complicated.

Table 3-66 Relationship of Payment Willingness and Annual Income

Income level (x TZS10,000)	Agree to TZS18,000	Agree to TZS15,000	Agree to TZS12,000	Not agree to TZS12,000	No response	Total
< TZS20	34	27	29	133	13	236
>=TZS20< 25	16	14	13	38	8	89
>= TZS 25< 30	8	3	8	17	3	39
>= TZS 30< 35	7	6	7	18	0	38
>= TZS 35	5	5	4	9	2	25
Unknown	0	2	2	4	1	9
Total	70	57	63	219	27	436

Source: JICA Survey Team



Source: JICA Survey Team

Figure 3-54 Relation of Payment Willingness and Annual Income

(c) Payment Willingness of ZAWA Users and Non-ZAWA Users

Table 3-67 and **Figure 3-55** show the payment willingness of ZAWA and non-ZAWA users. No significant difference is evident between the two groups.

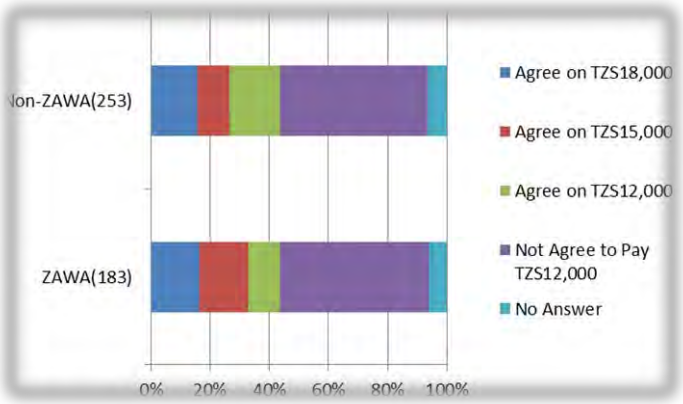
For the ZAWA users, 16% (30 respondents) agreed to pay a monthly water tariff of 18,000 TZS; 16% (30 respondents) to pay 15,000 TZS; and 11% (20 respondents) to pay 12,000 TZS. 50% (92 respondents) did not agree to pay 12,000 TZS. For the non-ZAWA users, 16% (40 respondents) agreed to pay a monthly water tariff of 18,000 TZS; 11% (27 respondents) to pay 15,000 TZS; and 17% (43 respondents) to pay 12,000 TZS. 50% (127 respondents) did not agree to pay 12,000 TZS.

Of the respondents who agreed to pay any of the shown options, the ratio of non-ZAWA users who agreed to 12,000 TZS is higher than ZAWA users. This is possibly due to the fact that a certain ratio of non-ZAWA households have never paid monthly water tariffs and have preferred not a reasonable price but a lower price.

Table 3-67 Willing Payment Amount of ZAWA Users and Non-ZAWA Users

Payment willingness	ZAWA	Non- ZAWA	Total
Agree to pay TZS18,000	30	40	70
Agree to pay TZS15,000	30	27	57
Agree to pay TZS12,000	20	43	63
Do not agree to pay TZS12,000	92	127	219
No answer	11	16	27
Total	183	253	436

Source: JICA Survey Team



Source: JICA Survey Team

Figure 3-55 Relation of Payment Willingness and Annual Income (ZAWA Users)

3.12.3 User Needs for ZAWA Water Supply Service

【Improvement of Water Supply Service】

- Improvement of water service time, water amount and water pressure.

【Publication to Residents】

- Explanation to residents before Project implementation including project details, effects and meter rate application.

3.13 Summary of Current Issues of Water Sector in Zanzibar

Table 3-68 shows summary of current issues though the surveys in water supply sector.

Table 3-68 Summary of Current Issues of Water Sector in Zanzibar

Item		No	Issues	Detail of Issues
Policy and Plan		A-1		It is difficult to achieve vision and national water policy goals, i.e. water supply service level target and financial goal.
Project implementation Management		B-1	Implementation management of AfDB Project	In ZUWSP, implemented through loan from AfDB, management of project progress is not smooth. It took 14 months from L/A signing to consultant agreement, and construction period was extended until March 2015 since the project cannot complete before the end of L/A. In addition, since there are some problems regarding contractors, commencement of construction was delayed.
Organization		C-1	Insufficient Action by ZAWA	Though some problems were already mentioned in previous survey, they still remain as “problems” without any improvement. For example, no reward to employees’ effort, customer database, and IT system had been mentioned at the timing of formulation of SBP and opinion survey in previous year, but they have not been improved so far. Since these issues are important for management of ZAWA, effort to improve is necessary.
		C-2	Insufficient Communication within ZAWA	Survey result shows “Involvement in organizational plan” “Coincidence of values with organization” “Participation and debate allowed” are major opinions amongst ZAWA employees. It reveals ZAWA employees are wishing to be involved in the improvement of operation and management of ZAWA. In reality, however, there are no such opportunities because of problems in “Up/downwards communication”. ZAWA must try to create opportunities to fulfil these employees’ opinions to improve technical level of employees and their motivation.
Water Supply Facilities	Water Source Facility	D-1	Uncertain Water Resource Potential Based on Latest Data	It has been 25 years since amount of developable ground water was calculated. The data has never been updated, and intrusion of saltwater was not considered. Therefore, new estimation of water resource capacity with consideration of amount of irrigation water and intrusion of saltwater is needed
		D-2	Number of Pumps Broken	When the yielding flow survey was conducted, 12 pumps out of 62 pumps were out of order. It means 20% of pumps are out of order. However, for stable water intake, it is necessary to minimize the number of non-operational pumps by shortening the period of repair, replace and procurement of repair parts.
		D-3	Broken Flow Mater of Deep well	Most of the turbine flow meters of deep wells are broken. It is necessary to install flow meters, which meet usage environment of Unguja, for not only intake flow management but detecting signs of failure of pumps and deep wells as well.
		D-4	Unmonitored Level of Groundwater	Water level of deep wells are not monitored in individual deep wells. Therefore, when intake flow decreases, it is impossible to distinguish whether this is due to deterioration of the pump or problems with the deep well itself.
		D-5	Concern for Pollution by Waste Water	Faecal coliform was detected and concentration of ammonia nitrogen is high in raw water of deep well. Pollution is suspected by waste water. Though there is not a problem for water supply through chlorination, conservation of raw water is necessary to prevent from further pollution.
	Raw Water Transmit pipeline	D-6	Aging of Some Transmission Pipelines	Some of the transmission pipes are aging since it has been many years after installation.
		D-7	Existence of AC Pipe	AC raw water transmission pipeline is still in use in the Dimani System.
	Reservoir and Elevated Tank	D-8	Aging of Reservoir	It has been many years since construction of some of the water facilities, such as Saateni underground reservoir, Old Dole reservoir, and Mnarawambao underground reservoir. Renewal of Saateni and Mnarawambao are planned in ZUWSP. Meanwhile, it is better that the Old Dole reservoir be either discontinued or integrated with another reservoir since the situation of Old-Dole area has drastically changed especially in terms of population growth.
		D-9	Defectiveness of Flow meter	It is impossible to know the amount of inflow water since inlet flow meter is not installed at the reservoir. In addition, the amount of distribution water is also unknown since distribution flow meters are either not installed or broken. For management of distribution of water, flow meters must be installed and kept running in service.
	Distribution Pipeline	D-10	Undefined Water Supply Zones	Although there are differences of elevation between the hillside and the coastal area, water supply service zones are not divided by reference to altitude, and it makes the water supply network complicated. As a result, many water leakages are evident because of aging of pipes, and it leads to low water supply pressure as well. Problem of low pressure is serious over a wide area especially in the high altitude zones.
		D-11	Separation of Transmission/Distribution Pipes	There are water supply pipes which function both as transmission and distribution mains. It is ideal that these two functions be separated so that the individual pipes do not impact on the other’s function.
		D-12	Shallow Earth Covering on Pipes	Shallow earth cover is found on many pipes, and this contributes to water leakages and increase of non-revenue water through illegal water supply taps. Renewal of pipe network is necessary to improve this situation.
		D-13	Surface Water Leakage on the Ground by Pipe Aging	ZAWA has never carried out large scale distribution pipeline replacement, and this leads to water leakages at many locations on aging pipes. Water leakages are detected mainly on distribution sub mains, both on the older asbestos cement pipes and the relatively newer PVC pipes. Comprehensive distribution pipeline replacement is required for drastic reduction in water leakage.
		D-14	Insufficient Water Distribution Network Development	Water distribution network development responding to the increase in population has not been conducted because of lack of finance.
	Disinfection Equipment	D-15	Lack of Disinfection Equipment	It is a problem that not all water distribution facilities have disinfection equipment. It is necessary to start introducing the equipment for supplying of chlorinated water for all users.
Water Supply Facilities	Service Connection	D-16	Inappropriate Service Connection	Although all service connections are assets of ZAWA, necessary maintenance is not carried out by ZAWA. For example, direct-connection of suction pump to distribution pipes and overflow of receiving tanks have not been addressed. In addition, some customers have been connecting to the water supply service without customer registration. These connections must be eliminated at the timing of replacement of distribution pipes.
		D-17	Promotion of Introducing Water Meter	Currently, water meters are installed in limited areas, and majority of customers are charged a flat rate. Therefore, there is no motivation for the customers to save water, and overflow of receiving tanks is found in households. It is better to introduce water meter system at the time of replacement of distribution pipes.

Table 3-68 Summary of Current Issues of Water Sector in Zanzibar (Continuation)

Item		No	Issues	Detail of Issues
Operation & Maintenance	Water Sources	E-1	Lack of Operators	Currently, operators are not allocated to all boreholes. This situation results in no patrolling for the facility and no monitoring of the operation of pumps. Moreover, when the pumps stop, no operator is in charge of restarting. Increase of operators and introduction of remote control systems should be considered.
		E-2	No Daily and Periodic Inspection	Usually repair works are carried out only after failures occur, and no daily and periodic inspection is implemented.
		E-3	Inaccessible Boreholes	In the rainy season, it is impossible to gain access to some of the water sources because the access road becomes muddy. In these situations, repair of the water supply facility becomes difficult. Accessibility to facilities is necessary to be ensured at all times.
		E-4	Aging of Workshop Equipment	Although a series of equipment is installed in the workshop, all equipment are second-hand and not fully maintained. Currently, repair works are somehow carried out, but there are some instances when repair works become impossible because of breakdown of workshop equipment. In addition, electrical measurement instruments are necessary to understand the reason behind breakdowns and to avoid frequent failures.
		E-5	Marketability of Spare Parts	Since no pumps are produced in Tanzania, it takes a long time for repairs in the event that spare parts are not in stock. Market availability of stocks and spares should be considered to ensure ready supply of the same.
		E-6	Management of Record of Repair Works	Currently, there is no system for smooth registration of newly implemented facilities and equipment to GIS. In addition, no record for failures and repair works are registered. Documentation of information of failures and repair works are necessary because it is a useful reference for deciding on the specifications in the design and selection of spare parts in stock.
		E-7	Shielding for Abandoned Boreholes	No specific procedure is done while boreholes are abandoned currently. However, appropriate process should be taken in terms of conservation of aquifer.
	Reservoirs & Elevated Tanks	E-8	Operation Based on Time-Limit Water Supply	Operation of reservoirs is just by opening the outlet valves when the reservoirs become full and shutting the valves when the reservoirs become empty since operators cannot get the information of inlet/outlet flow because of insufficient measurement devices. In other words, the necessary information for reservoir operation, such as water level and inlet/outlet flow, is not provided for the operators. After the improvement of water supply facilities and it becomes possible to supply water 24-hours, current manner of operation should be changed drastically.
		E-9	Maintaining of Operation Records	Maintained records of facilities' operation are limited because of failure and lack of measurement devices. In addition, ZAWA does not have a system of utilizing operational information.
		E-10	Insufficient Maintenance	Broken flow meters, water gauges, and chemical dosing pipes are left as they are, and consumables, such as packing for pump shaft, are not changed. In addition, there is no delivery of electricity to Dole but no request has been made to ZECO.
	Leakage Repair	E-11	Procurement of Materials for Water Leakage Repair	Pipelines are installed in different periods, and specifications of materials are different according to the year of installation. Therefore, some materials are not available, and some repairs are made using cheap and non-standard materials, such as covering with rubber sheet.
		E-12	Storage of Leakage Repair Materials	Currently, some materials for leakage repair are stored outdoors. It is better to be kept under cover.
		E-13	Management of Leakage Repair Records	Records of water leakage and its repair are not available to be utilized. Since information of water leakage is important for planning of pipe replacement and selection of repair materials, the records should be maintained for use, for example, in the GIS database.
Weakness of Water Management Organization		F-1	Weakness of Water Management Section	Capacity of water management section is weak because number of allocated staff is small and procurement of reagent is not managed. It is necessary to enhance the water quality management section by securing enough number of staff, staff training and budget improvements.
		F-2	Lack of Procedures and Manuals for Water Quality Management	Procedures and manuals for water quality management, that regulate sampling method, location, frequency, tested items and test result evaluation, are not prepared. Additionally, maintaining of water quality test result is not enough.
Current Situation of Water Supply and Water Quality		G-1	Unequitable Water Supply	Current water supply is unequitable: Total length of water supply hours is different in each location.
		G-2	Distribution of Non-chlorinated Water	Non-chlorinated water is distributed. Chlorinated water supply is necessary since Cholera epidemic sometimes happens in the area.
Collection of Water Charge		H-1	Low Customer Registration Rate	According to the service connection survey, 77.5% of residents use water supplied by ZAWA, but only 21.5% are registered as customers.
		H-2	Low Collection Rate of Water Charge	Tariff collection rate within billing amount shares only 27% (average between March 2012 and August 2016).
		H-3	Problems on Billing System	There are problems in the billing system. For example, several accounts are issued to the same customer and it makes billing management complicated. For future increase of customers, shifting to a new system shall be considered for smooth operation of billing.

Table 3-68 Summary of Current Issues of Water Supply Sector in Zanzibar (Continuation)

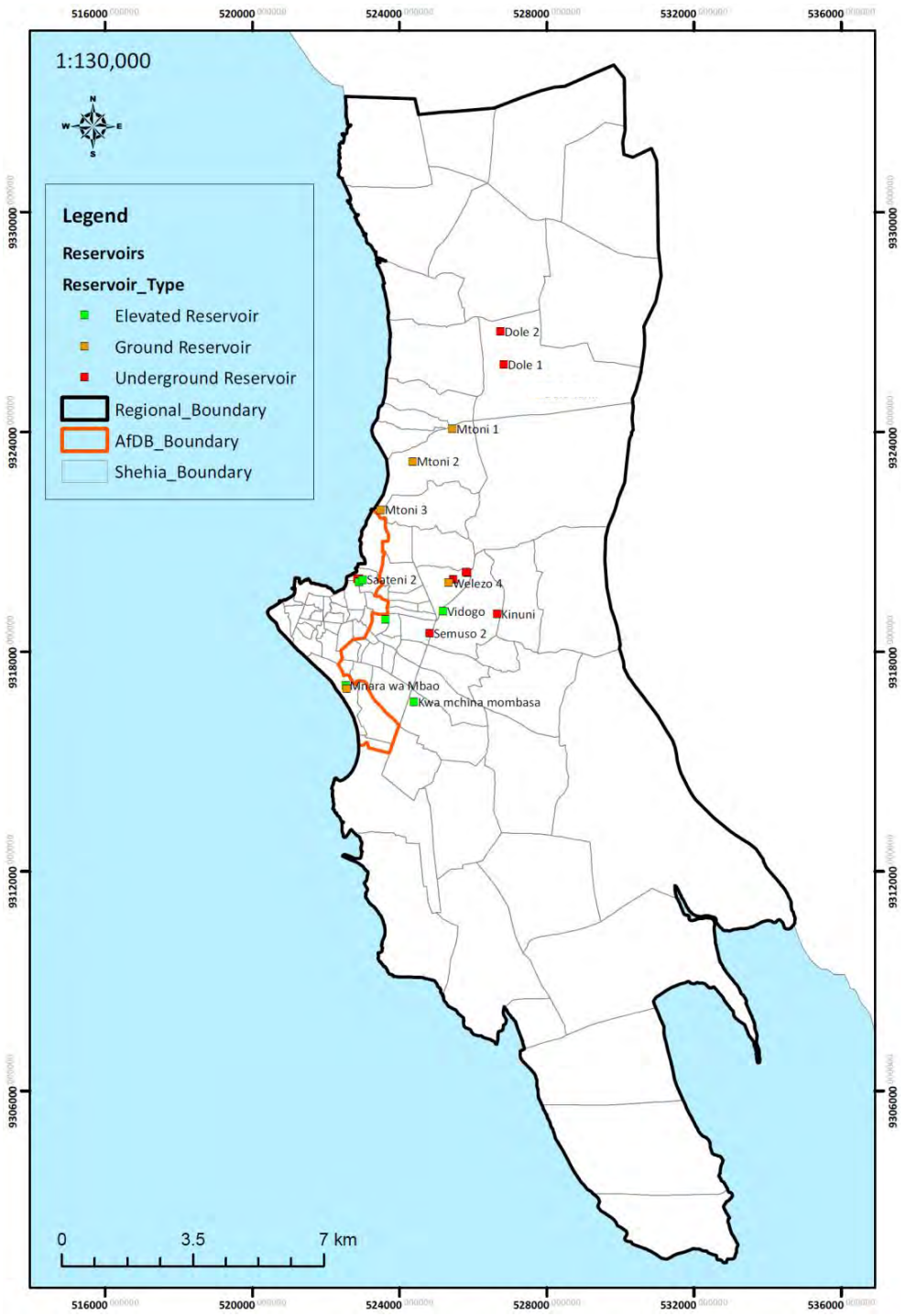
Item	No	Issues	Detail of Issues
Financial Condition	I-1	Lack of Accuracy in Budgeting	There is significant gap between budget and actual result, and budget progress is not monitored timely and sufficiently because key assumptions for budgeting, especially, precondition of water revenue (number of households connected; number of meters installed; billing rate and collection; utilization of water treatment facilities, etc.) are not considered and analysed appropriately for next year's budgeting process. ZAWA needs to establish its budget based on current information and also ZAWA needs to implement the process to monitor monthly budgetary progress and to take corrective action if there is a gap.
	I-2	Weak Revenue Capability	Water service business is improving; however, ZAWA still suffers operating losses. ZAWA needs to improve water service quality, encourage user registration, and enhance water bill collection rate to increase more water revenue.
	I-3	Insufficient Facility Investment	ZAWA needs to invest enough to maintain and enhance water supply facilities and its functionality as the number of users grow and the business environment changes. But ZAWA may not spend sufficient level of investment as due to depreciation. This would result in lowered service quality and lowered willingness of customers to pay. To avoid that scenario and further worsen its financial situation, ZAWA needs to keep up sufficient level of facility investment to maintain appropriate levels of service.
Residents' Opinion (Needs)	J-1	Improvement of Water Supply Service	Users are wishing for longer water supply hours, increase of water amount and water pressure.
	J-2	Publication to Residents	Though residents agreed on the necessity of the Project, 'Willingness to Pay' is lower than expected before the survey. It is necessary to make the residents understand the components of the Project, its intent and effects, and the need for application of a meter-rated tariff system.

Source: JICA Survey Team

Chapter 4 Water Supply Facility Plan for Urban West Region

4.1 Planning Area

The Planning Area of this Survey, the Urban West Region of Unguja, is shown in **Figure 4-1**.



Source: JICA Survey Team

Figure 4-1 Planning Area

4.2 Target Year

Generally, target year is about 15 to 20 years later from the planning. In this plan, considering the target year of 2035 of the Zanzibar Urban Development Plan, 2032 after 15 years of this survey shall be the planned as the target year of this plan.

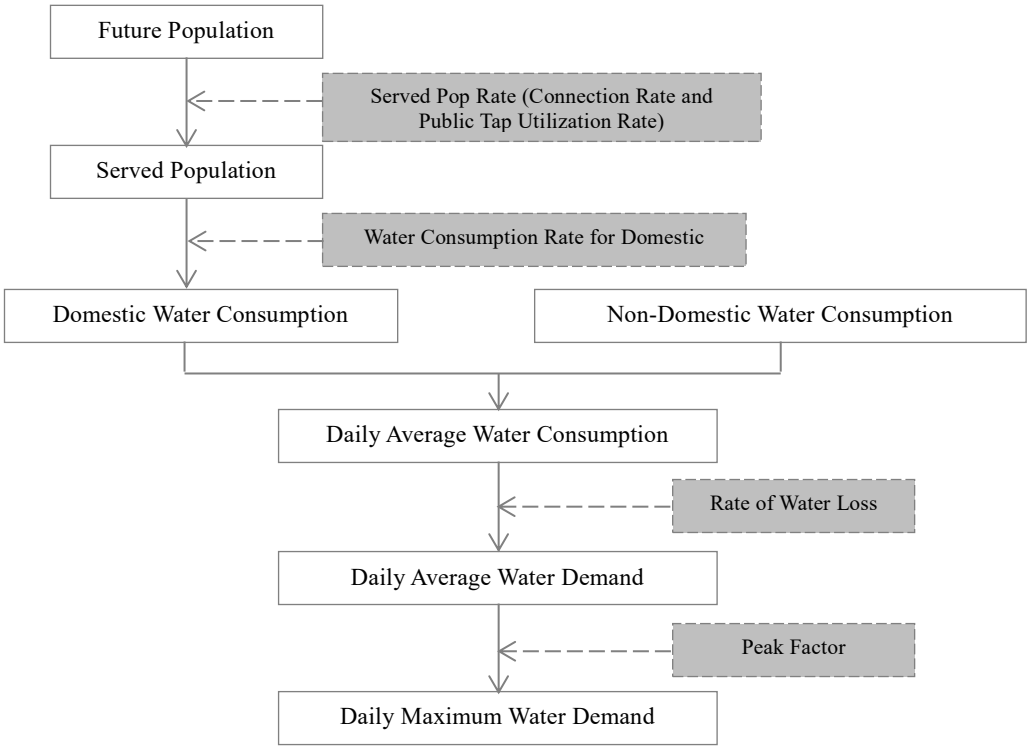
4.3 Water Demand Projection

Since MLWEE and ZAWA do not have a planned value of future water demand, served population and water demand shall be projected in this survey to determine the planned water demand.

4.3.1 Method of Water Demand Projection

In this section, the method of water demand projection is described in reference to the "Design Manual for Water Supply and Waste Water Disposal" (hereinafter referred as "Design Manual") issued by Ministry of Water and Irrigation, Tanzania mainland. Flowchart of water demand projection is shown in **Figure 4-2**. As mentioned above, the target year is 2032, although the water demand is projected until 2037 as a reference.

Details of the projection are shown in the **Appendix**.



Source: JICA Survey Team

Figure 4-2 Flowchart of Water Demand Projection

4.3.2 Future Population

(1) Population transition

Table 4-1 and **Table 4-2** show the population and growth rate of the Zanzibar and Urban West Region, respectively. The main trends of population transition during 1998 to 2012 are listed below:

- Population growth rate in Unguja is higher than in Pemba.
- Growth rate in the recent 20 years in Unguja is flat, in Pemba is decreasing.
- Growth rate in Urban West Region is the highest in Unguja.
- Growth rate in Urban West and Central South Regions is decreasing, and increasing in North Region.
- In Urban West Region, increase of population in Urban District has become small, and in West District has become large.

Table 4-1 Population and Growth Rate in Zanzibar

Area		Population			Growth Rate (%)	
		1988	2002	2012	1988-2002	2002-2012
Unguja	North Region	97,028	136,953	187,455	2.5	3.2
	Central South Region	70,184	94,504	115,588	2.1	2.0
	Urban West Region	208,327	391,002	593,678	4.6	4.3
	Total	**375,539**	**622,459**	**896,721**	**3.7**	**3.7**
Pemba	North Region	137,399	186,013	211,732	2.1	1.3
	South Region	127,640	176,153	195,116	2.3	1.1
	Total	**265,039**	**362,166**	**406,848**	**2.2**	**1.2**
Zanzibar Total		**640,578**	**984,625**	**1,303,569**	**3.1**	**2.8**

Source: Population and Housing Census 1988, 2002, 2012

Table 4-2 Population and Growth Rate in Urban District and West District

District	Population			Growth Rate (%)	
	1988	2002	2012	1988-2002	2002-2012
Urban District	157,634	206,292	223,033	1.9	0.8
West District	50,693	184,710	370,645	9.7	7.2
Urban West Region	208,327	391,002	593,678	4.6	4.3

Source: 2012 Population and Housing Census

(2) Projection method

(a) Population in Urban West Region

In Urban West Region, the population growth rate has been decreasing but the population is still increasing. Assuming that the population growth in Urban West Region continues in the same manner, the future population is estimated by the following formula;

$$y = y_0(1+r)^n$$

Herein y: Population after n years
y_0: Initial population (2012 census population)
r: Annual average growth rate (%)
n: Number of years elapsed

Assuming that the past population growth rate (negative 0.3%) of Urban West Region, shown in **Table 4-2** , continues, the annual average growth rate values used for the projection shall be 4.0% for 2012 to 2022, 3.7% for 2022 to 2032, and 3.4% after that.

As mentioned in **2.2.1 (2) (c)**, the population density in Urban District is already high and saturated. Therefore, 0.8% of population growth rate is used for the population projection in the district. The population for West District shall be calculated by subtracting the population of Urban District from the Urban West Region.

(b) Population Distribution of Shehias

In the Structure Plan report, the population by each planning area in 2035 is estimated as shown in **Table 4-3**. To determine the population of each shehia, the estimated 2037 population is distributed proportionately to the composition rate shown in the table. The population of intermediate years between 2012 and 2037 is calculated by linear interpolation. The distributed projected population is then proportionately divided according to the proportion of the 2012 shehia population.

Table 4-3 Future Population Composition according to Structure Plan

Plan Area	Shehia	Population in 2035	Composition Rate
Stone Town	Shangani, Mkunazini, Kiponda, Malindi	10,000	4.52%
City Centre	Mchangani, Mlandege, Mwembeladu, Gulioni, Miembeni, Kikwajuni Juu, Kikwajuni Bondeni, Kisimamajongoo, Vikokotoni, Mwembeshauri, Rahaleo, Kisiwandui	30,000	13.57%
Inner City	Makadara, Kwamtipura, Kilimahewa Juu, Amani, Nyerere, Sebleni, Magomeni, Mpendae, Urusi, Mwembetanga, Kwaalimsha, Mikunguni, Mkele, Muungano, Sogea, Jang'ombe, Kidongo Chekundu, Matarumbeta, Kwahani, Kwaalinatu, Kilimahewa Bondeni, Kwa Wazee, Meya	130,000	58.83%
Maruhubi	Shaurimoyo, Mwembemakumbi, Chumbuni, Karakana	28,000	12.67%
Mazizini	Kilimani, Migombani	23,000	10.41%
Total (Urban District)		**221,000**	**100.00%**
Mtoni	Mtoni, Mtoni Kidatu, Mto Pepo, Welezo	56,000	4.97%
Mwanakwerekwe	Mombasa, Tomondo, Melinne, Mwanakwerekwe	100,000	8.87%
Kiembesamaki	Chukwani, Kiembesamaki	53,000	4.70%
Kisauni	Kisauni	93,000	8.25%
Bububu	Bububu, Kihinani, Mwanyanya, Sharifu Msa, Kibweni	125,000	11.09%
Chuini	Chuini, Mbuzini	91,000	8.07%
Fuoni/Rural 2,3	Fuoni Kijitoupele, Pangawe, Kinuni, Mwera, Fuoni Kibondeni	185,500	16.46%
Kombeni	Shakani, Nyamanzi, Kombeni, Maungani	167,000	14.82%
Fumba	Dimani, Bweleo, Fumba	182,000	16.16%
Mwera	Mtufaani, Magogoni	40,000	3.55%
Rural 1	Kama, Mfenesini, Mwakaje, Bumbwisudi, Kizimbani, Mwera, Kianga	34,500	3.06%
Total (West District)		**1,127,000**	**100.00%**

Source: Structure Plan Report, Department of Land, MLWEE

If allocated population falls under the following, allocated population ratio is adjusted;

- Allocated population of the Plan Area is lower than the actual population in 2012
- Allocated population changes irregularly increasing or decreasing.

4.3.3 Served Population

The served population is calculated by the following formula;

Served Population = Served Population with Connection + by Public Tap
Served Population with Connection = Inhabited Population × Connection Rate (%)
Served Population by Public Tap = Inhabited Population × Utilization Rate (%)

(1) Connection Rate in Urban District

Water sources and usage composition according to the SC survey (**Table 3-60**) is shown in **Table 4-4**. The initial connection rate is 64% based on the table. Immediately after completion

of construction work, it is assumed that 15% of households getting water from un-official providers and 2% of households getting water from private wells, will shift to ZAWA's water supply, with the connection rate at the time (2025: assumed year) becoming 81%. Thereafter, it is assumed that the percentage of households getting water from public taps will gradually decrease to 10%, with the connection rate in 2032 being 90%. The connection rates of intermediate years, immediately after improvement right up to 2032, is calculated through linear interpolation from 2025. After that the rate is kept constant at the value of 2032.

Table 4-4 Water Source and Usage Composition in Urban District

	Water Source		Composition Rate	Future Connection Rate	
	ZAWA Usage Rate	Breakdown		after improvement 2025*	2032
House-Hold	Approx. 80% (ZAWA user)	80% (Service pipe connection)	**64%**	**81%**	**90%**
		20% (Public tap)	**16%**	**16%**	**10%**
	Approx. 20% (non-ZAWA user)	10% (Private well)	**2%**	**0%**	**0%**
		75% (Un-official provider)	**15%**	**0%**	**0%**
		15% (Unknown)	**3%**	**3%**	**0%**
Total			**100%**	**100%**	**100%**

*: Assumed completion year of facility improvement on the demand projection
Source: JICA Survey Team

(2) Connection Rate in West District

Table 4-5 shows water source and usage composition in West District based on "residents" opinion survey (**Table 3-65**). The initial connection rate is 31% based on the table. Immediately after completion of construction work, it is assumed that households getting water from public taps (non-ZAWA), private well, neighbour's wells and water sellers will shift to ZAWA's water supply, with the connection rate at that time (2025: assumed year) becoming 55%. Thereafter, it is assumed that the percentage of households getting water from public taps (non-ZAWA) will gradually decrease to 10%, and the percentage of households getting water from neighbour's wells will switch to ZAWA's supply, with the connection rate in 2032 being 80%. The connection rate of intermediate years from immediately after improvement right up to 2032 is calculated through linear interpolation.

After that the rate is kept constant at the value of 2032.

Table 4-5 Water Source and Usage Composition in West District

	Current water source			Future connection	
	Water source	Details	Ratio	After Development 2025*	2032
House-Hold	ZAWA (36%)	86% (water connection)	**31%**	**55%**	**80%**
		14% (public water tap)	**5%**	**5%**	**5%**
	Non-ZAWA (64%)	26% (public water tap)	**17%**	**15%**	**10%**
		15% (private well)	**9%**	**5%**	**5%**
		55% (neighbours well or water tap)	**35%**	**20%**	**0%**
		3% (tanker, other purchase)	**2%**	**0%**	**0%**
		2% (others)	**1%**	**0%**	**0%**
Total			**100%**	**100%**	**100%**

*: Assumed completion year of facility improvement on the demand projection

Source: JICA Survey Team

4.3.4 Served households

The number of served households was computed by the following formula;

Number of Households = Served Population / Number of Household Members

Table 4-6 shows the number of household members. The latest value in 2012 is used for the projection.

Table 4-6 Number of Household Members

District	Number of Household Members		
	2002	2012	Planned Value
Urban District	5.6	5.3	5.3
West District	5.0	5.2	5.2
Urban West Region	5.3	5.2	-

Source: Population and Housing Census 2002, 2012

4.3.5 Domestic Water Consumption

(1) Domestic Water Consumption

The Domestic water consumption is calculated by the following formula based on the water consumption rate by each housing class shown in the Design Manual. Water consumption of households connecting water supply and using public tap is projected respectively.

Domestic Water Consumption (m^3/day) ＝ Served Population × Water Consumption Rate (L/cap/day) / 1,000

(2) Housing Class and Composition Rate

Based on the housing situation in Zanzibar reported in "Household Budget Survey 2009/2010", the composition rate of housing classes is set as shown in **Table 4-7** .

Table 4-7 Composition of Housing Classes

Housing Class		Characteristics	Composition Rate
DP	Low Income Housing (LIG-I)	・ Mainly illegal settlements constructed of temporary materials ・ Spread in the urban area or crowding outskirts of an urban area ・ No water taps, and receive water from public taps or water sellers ・ Pit latrine	・ 20% (80% households get drinking water from water supply ⇒ 20% households get water from Kiosk or water sellers)
LC	Low Income Housing (Multi generation households) (LIG-F)	・ Mainly in crowding outskirts of an urban area ・ Constructed of permanent material ・ No indoor pipe, only yard tap connection ・ Pit latrine	・ 40% (Remaining)
	Low Income Housing (LIG-M)	・ Spread in the urban area or crowding outskirts of an urban area ・ Constructed of permanent material ・ Provided as rental houses to singles or couples without children ・ Yard tap for dish and cloth washing, and equipped shower room and flush toilet	
MC	Middle Income Housing (MIG)	・ Density is lower than low income housing ・ Indoor pipe for kitchen, and gas/electrical stove are equipped ・ Shower room and toilet connected to sewage of septic tank are equipped ・ Yard tap for cloth washing is equipped	・ 35% (Approximately 40% households are supplied electricity ⇒ Over middle class housing is 40%)
HC	High Income Housing (HIG)	・ Density is lower than middle income housing ・ Multiple taps which can use cold/hot water are equipped ・ Electricity is supplied, and bath/shower room, indoor taps for dish/cloth washing and flash toilet are equipped ・ Connecting to sewerage or septic tank ・ Multiple buildings and indoor taps, shower room and flush toilet are equipped at each building	・ 5% (Housings which have vehicle, PC and printer are less than 5%)

DP= Public water tap, LC= Low income household, MC= Middle income household, HC= High income household
Source: JICA Survey Team

It was assumed that composition rate of DP decreases 5% and MC increases 5% by 2022, the rate of DP and HC becomes 10% by 2032. **Table 4-8** shows the planned housing composition rate. The rate in 2037 is as same as the value of 2032.

Table 4-8 Housing Composition Rate Projection

Housing Class	2012	2022	2032
DP	20%	15%（▲5%）	10%（▲5%）
LC	40%	40%（±0%）	40%（±0%）
MC	35%	40%（＋5%）	40%（±0%）
HC	5%	5%（±0%）	10%（＋5%）

DP= Public water tap, LC= Low income household, MC= Middle income household, HC= High income household
Source: JICA Survey Team

(3) Domestic Water Consumption Rate

The domestic water consumption rate for each housing class is adopted from the Design Manual, and the values are shown in **Table 4-9** . The domestic water consumption rate used for this projection (**Table 4-10**) is calculated using the weighted average of housing compositions shown in **Table 4-8** , and **Table 4-9** .

Although water consumption rate of public tap users is 25 L/cap/day, 45 L/cap/day, which is as same as the rate of low income housing, is used in this plan considering a shift from public tap use to piped water use in the future.

Current most connected users are applied flat-rate, however all users are applied metered-rate in 2025. Therefore, consumption rate of flat-rate and metered-rate are used in 2017 and 2025, respectively, and interpolated consumption rate is used between 2017 and 2025.

The domestic water consumption unit calculated using the meter reading results mentioned in **3.9.1(1)** was 75.5 L/cap/day. This value is almost as same as the rate of metered customers shown in **Table 4-10**.

Table 4-9 Domestic Water Consumption Rate by Housing Class

Housing Class	Urban（L/cap/day）		Remarks
	FR	M-PBT	
Low income housing (Kiosk) (LIG-I)	45	45	No service connection
Low income housing (LIG)	70	50	Only yard tap
Medium income housing (MIG)	130	90	Indoor piping, connection to sewerage or septic tank
High income housing (HIG)	250	150	Indoor piping, connection to sewerage or septic tank

FR = Flat Rate, M-PBT = Metered Progressive block tariff
Source: “Design Manual for Water Supply and Waste Water Proposal” Third Edition, March 2009

Table 4-10 Domestic Water Consumption Unit Rate

Area	Unit	2012	2022	2032
Flat-rate	L/cap/day	108	109	117
Metered-rate	L/cap/day	74	75	79

Source: JICA Survey Team

4.3.6 Non-Domestic Water Consumption

(1) Schools

Water consumption at schools is calculated by the following formula;

Water Consumption at Schools (m^3/day) = Number of Enrolments × Water Consumption Rate of School (L/cap/day) ÷ 1,000

(a) Number of Enrolments

The number of enrolments in 2015 is based on the data provided from the Ministry of Education and Vocational Training. The value for after 2016 in Urban District is estimated that the number of enrolments is directly proportional to the population growth of Urban District. The values for West District are also calculated by the same way.

(b) Water Consumption Unit of School

Water consumption unit of schools based on the Design Manual is shown in **Table 4-11**.

Table 4-11 Water Consumption Unit of Schools

Item	Unit	Urban (l/d)	Remarks
Day school	L/cap/day	25	
Boarding school	L/cap/day	70	

Source: "Design Manual for Water Supply and Waste Water Proposal" Third Edition, March 2009

(2) Hospital

Water consumption at hospitals is calculated by the following formula;

Water Consumption at Hospitals (m^3/day) = Number of beds × Occupancy Rate of Beds (%) × Water Consumption Rate of Hospital (L/bed/day) ÷ 1,000

(a) Number of Beds

The number of hospitals was provided from the Ministry of Health, and number of beds of hospitals was collected from each hospital. The number of beds is shown in **Table 4-12** . Since plans for future hospital construction is not known, it is assumed that the number of hospitals will not change in the future.

Table 4-12 Number of Beds of Hospitals

District	Hospital Name	Shehia	Number of Beds
Urban	Kidongo Chekundu Mental Hospital	Kidongo Chekundu	110
Urban	Mnazi Mmoja Hospital	Shangani	400
		Mwembeladu	36
Urban	Al-Rahma Hospital	Kilimani	100
Urban	Marie Stopes Hospital	Kilimani	12
Total			658

Source: Each Hospital

(b) Occupancy Rate of Beds

Since there is no statistics data of bed occupancy rate in Zanzibar, it is assumed as 70% for the projection, based on the "Medical Facility Survey 2015" (the statistical data for medical facilities in Japan, 74.8% for 2014 and 75.0% for 2015).

(c) Water Consumption Rate of Hospitals

Water consumption unit of hospitals based on the Design Manual, is shown in **Table 4-13**.

Table 4-13 Water Consumption Unit of Hospitals

Item	Unit	Urban (L/d)	Remarks
Public Hospital	L/bed/day	200	Flush toilet, connecting sewerage

Source: "Design Manual for Water Supply and Waste Water Proposal" Third Edition, March 2009

(3) Dispensary

Water consumption at dispensaries is calculated by the following formula;

Water Consumption at Dispensaries (m^3/day)
= Number of Dispensary × Number of Outpatient (outpatient/place)
× Water Consumption Rate of Dispensary (L/outpatient/day) ÷ 1,000

(a) Number of Dispensaries and Outpatient per One Dispensary

The number of dispensaries was provided from the Ministry of Health. The average number of daily outpatient per dispensary in 2015 was 80, as shown in **Table 4-14**, and this value is used in the projection. The number of daily outpatients is estimated to increase proportionately to the population.

Table 4-14 Number of Outpatients

Dispensary name	No. of outpatients	Dispensary name	No. of outpatients
Bwefum	23	Shakani	22
Chukwani	52	Selem	55
Chuini	35	Kibweni kmkm	397
Fuoni	200	Welezo camp	32
Fuoni kibondeni	16	St. camillus	77
Kiembe samaki	110	KKKT dispensary	33
Kizimbani	40	SOS	42
Kisauni	31	Sanasa dispensary	94
Kombeni	24	Care clinic	30
Magogoni	200	**Average**	**80**

Source: Ministry of Health

(b) Water Consumption Unit of Dispensary

Water consumption unit of dispensaries based on the Design Manual, is shown in **Table 4-15**.

Table 4-15 Water Consumption Unit of Dispensary

Item	Unit	Urban (L/d)	Remarks
Dispensary	per outpatient	10	Only outpatients

Source: "Design Manual for Water Supply and Waste Water Proposal" Third Edition, March 2009

(4) Institution

Water consumption at institutions is calculated by the following formula;

Water Consumption at Institutions (m^3/day)
= Number of Institution × Water Consumption Rate of Institution (m^3/place/day)

(a) Number of Institutions

The number of institutions in 2015 was provided from ZAWA.

(b) Water Consumption Unit of Institution

3.0 m^3 is adopted as the daily average water consumption of institutions, based on the meter reading result data mentioned in **3.9.1 (4)**.

(c) Water Consumption of Institutions

Water consumption of institutions in 2015 was calculated from the number of institutions and the water consumption unit rate. After 2016, it is assumed that it increases proportionately to the population.

(5) Mosques

Water consumption at mosques is calculated by the following formula;

Water Consumption at mosques (m^3/day)
= Number of Worshipers × Water Consumption Rate of Mosque (L/worshiper/day)
÷ 1,000

(a) Number of Worshipers

It is estimated that the ratio of worshipers is 40% (7 years old and older, 70% male, 30% female) of the population.

(b) Water Consumption Unit of Mosques

It is estimated that a worshiper consumes 25 L of water per day (5 L per worship/5 times per day).

(6) Hotels

Water consumption at hotels is calculated by the following formula;

Water Consumption at Hotels (m^3/day)
= Total Number of Beds ×Occupancy Rate of Beds (%)
× Water Consumption Rate of Hotel (L/bed/day) ÷ 1,000

(a) Total Number of Beds

The number of hotels, rooms and beds in 2015 were provided from the Ministry of Information, Culture, Tourism and Sports.

(b) Occupancy Rate of Beds

Occupancy rate of beds was calculated from the data published in "Tourism Statistics Release", which show only values in May and June, and the monthly tourist number for the past five years (2010 to 2014). As a result of calculation, average occupancy rate of bed used for the projection shall be 45%.

(c) Water Consumption Unit rate of Hotels

Water consumption unit of hotels based on the Design Manual, is shown in **Table 4-16**.

Table 4-16 Water Consumption Unit of Hotels

Item	Unit	Consumption	Remarks
Hotel	L/bed/day	300	In Stone Town, average of high and medium classes
Hotel	L/bed/day	200	In other areas, medium class

Source: "Design Manual for Water Supply and Waste Water Proposal" Third Edition, March 2009

(d) Water Consumption at Hotels

Water consumption at hotels in 2015 is calculated by the above formula. After 2016, it is estimated that the water consumption increases proportionately to the number of tourists.

(7) Other Commercial Use

Water consumption for other commercial use is calculated by the following formula;

Water Consumption for Commercial (m^3/day) = Domestic Water Consumption (m^3/day) × Water Consumption Rate for Commercial (%)

This consumption includes commercial use excluding hotels, and agriculture uses.

Based on the meter reading results mentioned in **3.9.1(1)**, **(2)** and **(5)**, the ratio of other commercial use compared to domestic use is estimated as; 6.25% ((1,805 + 438) /35,894 × 100=6.25%).

(8) Industry

Currently, there are no factories using water in Urban West Region, and therefore there are no industry consumed water. However, new industrial areas development is planned in the Structure Plan. Since the implementation of said plan is unclear, it is proposed that industrial water consumption is not added to the planned water demand. Upper water demand estimation including industry water consumption is shown in the **Appendix**.

(9) Others

(a) Water Consumption at Airport

Water is supplied to the Zanzibar International Airport by the borehole owned by ZAWA. According to ZAWA, the capacity of the well is 600 m^3/day. Therefore, water consumption at the airport is estimated at 600 m^3/day.

(b) Water Consumption at Seaport

From the meter reading record shown in **3.9.1 (6)**, 25 m^3/day is adopted as the water consumption at the seaport.

(c) Water Consumption by New Development Plan

Of the Structure Plan and other development plans mentioned in **Chapter 2**, projects which does not directly affect the water consumption like transport infrastructure are included. In this Survey, water demand is projected based on the transition of population, and the transition includes reflection of past urban development. Therefore, since the projection already includes increase of water consumption by new urban development plan, increase of water consumption is not added particularly.

4.3.7 Daily Average Water Demand and Actual Loss

Daily Average Water Demand (DAD) is calculated from the daily water consumption and Actual Loss by the following formula;

Daily Average Water Demand (DAD) (m^3/day)
= Daily Average Water Consumption (m^3/day) ÷ (100 – Actual Loss) (%)

Actual Loss based on the Design Manual, is shown in **Table 4-17**. Assuming that all of planned pipelines are replaced from 2018 to 2025 following implementation of the current AfDB project, the water-loss rate is estimated to decrease by 5% annually from 2018 and reach 20% in 2025. After 2025, the rate shall be fixed at 20%.

Table 4-17 Chargeable Water Rate by Area

	Item	Current	Facility Improved Area
(i)	Distribution Flow	100%	100%
(ii)	Water Loss from Distribution /Supply Pipes	2%	2%
(iii)	Water Loss from Water Main	26%	8%
(iv)	Water Loss from Branch Lines	26%	5%
(v)	Water Loss from Service Connections	6%	3%
(vi)	Customer Metering Inaccuracy	-	2%
(vii)	Actual Loss	60%	20%

Source: "Design Manual for Water Supply and Waste Water Proposal" Third Edition, March 2009

4.3.8 Peak Factor

The peak factor is estimated at 1.3 (served population 100,000 or more) based on the Design Manual.

4.3.9 Result of the Demand Projection

(1) Planned Population

(a) Inhabitant population

The estimated inhabitant population of Urban West Region is shown in **Table 4-18** and **Figure 4-3**. Using the population growth trend of the past years, the inhabitant population in 2032 reached 1,263,800. This figure is twice of the value of 2012.

As for the inhabitant population estimation for each district in 2032, it is at 261,600 for Urban district and 1,002,200 for West District. The population increase is especially large in West District, as the population in 2032 is to be estimated at 2.7 times the value of 2012, but the population density of West District is 26% of Urban District in 2032.

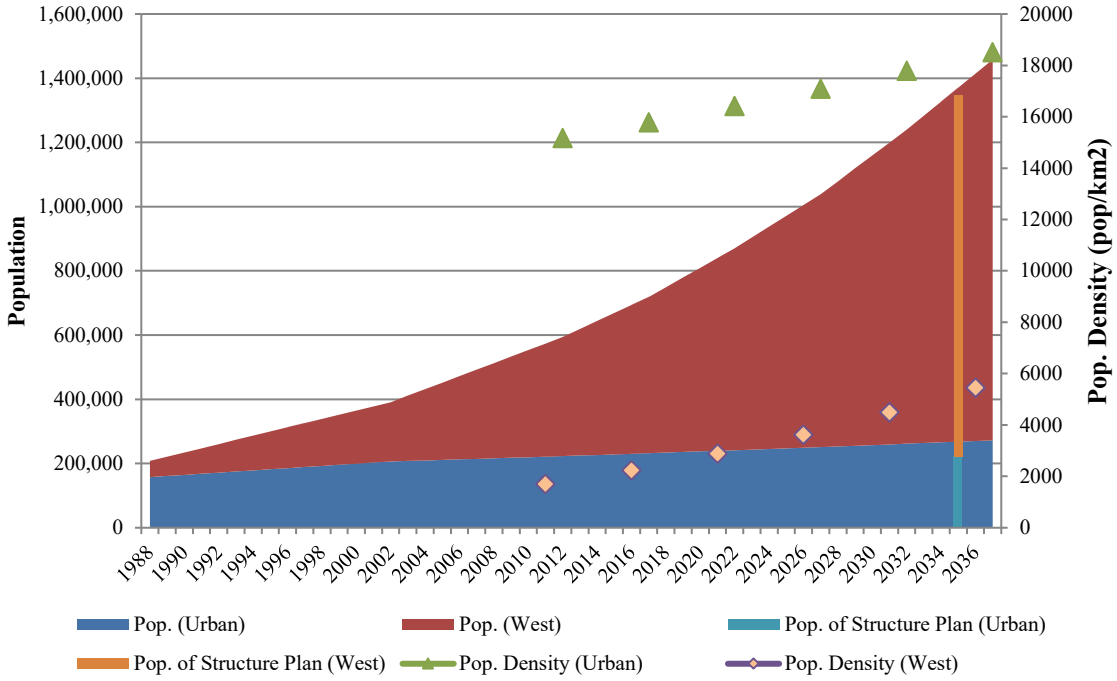
According to the Structure Plan planned by Lands Department of MLWEE, the planned

population in 2035 is 1,348,000 (221,000 for Urban district and 1,127,000 for West District). **Figure 4-3** shows that the projected population by Structure Plan is almost as same as projected population in this Survey.

Table 4-18 Estimated Result of Inhabited Population

Item	District	Actual Value			Estimated Value				
		1988	2002	2012	2017	2022	2027	2032	2037
Inhabitant population (person)	Urban	157,634	206,292	223,033	232,100	241,500	251,300	261,600	272,200
	West	50,693	184,710	370,645	490,200	637,300	802,600	1,002,200	1,221,600
	Total	208,327	391,002	593,678	722,300	878,800	1,053,900	1,263,800	1,493,800
Pop density (person/km^2)	Urban	—	—	15,172	15,789	16,428	17,095	17,796	18,517
	West	—	—	1,704	2,254	2,931	3,691	4,609	5,618

Source: JICA Survey Team



Source: JICA Survey Team

Figure 4-3 Served Population

(b) Allocation of projected population

Table 4-19 , **Table 4-20** , **Figure 4-4** and **Figure 4-5** show allocated projected population to each shehia. The target area fell within the revised conditions mentioned in **4.3.2 (2) (b)**, therefore the following corrections were performed.

(i) Urban District

- Maruhubi: The population shall decrease when following **Table 4-3**, therefore it shall

be fixed at the 2012 value.

- Inner city: The population difference caused by the above correction is adjusted for this most populated area.

(ii) West District

- Mtoni: The population shall decrease after a short increase when following **Table 4-3**, therefore it shall be interpolated by the values of 2037 and 2012.
- Mwanakwerekwe: The population shall decrease when following **Table 4-3**, therefore it shall be interpolated by the values of 2037 and 2012.
- Rural 1: The population shall decrease when following **Table 4-3**, therefore it shall be interpolated by the values of 2037 and 2012.
- Fuoni/ Rural 2, 3: The population difference caused by the above corrections is adjusted for this most populated area.

Table 4-19 Allocation of Projected Population to Shehias (Urban District)

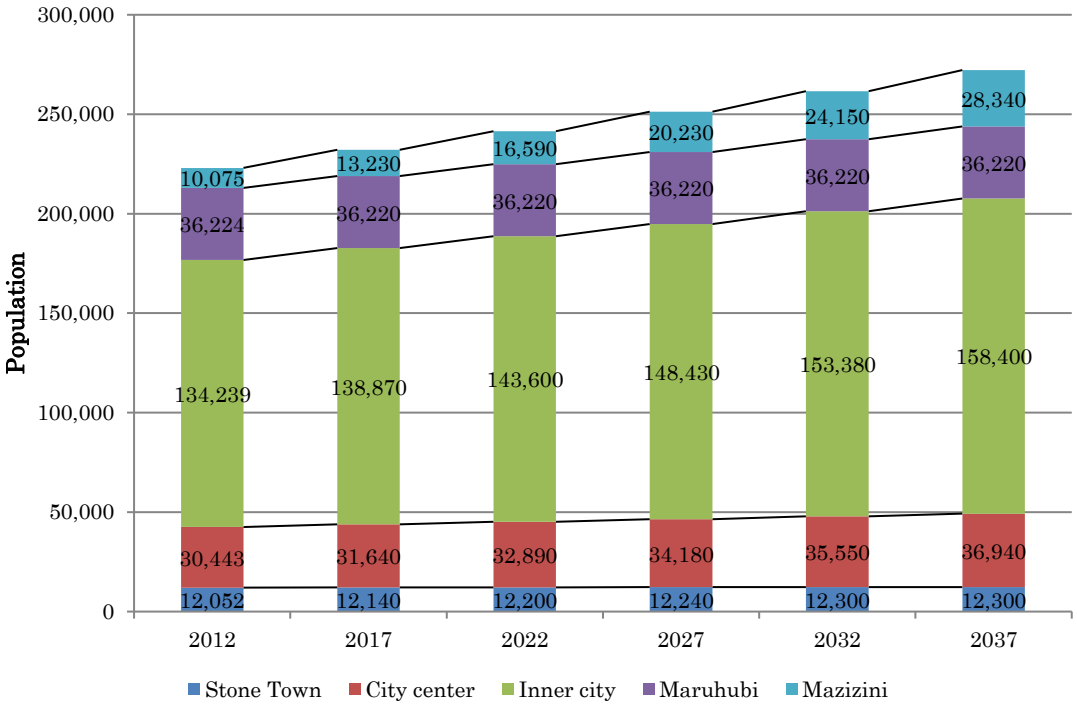
No	Plan Area	Shehia	Area km²	Population							Pop. Density (pop./km²)					
				2012		2017	2022	2027	2032	2037	2012	2017	2022	2027	2032	2037
				Pop	Composition											
1	Stone Town	Shangani	0.3651	3,886	32.25%	3,920	3,930	3,950	3,970	3,970	10,642	10,735	10,763	10,818	10,872	10,872
2		Mkunazini	0.2196	3,308	27.45%	3,330	3,350	3,360	3,380	3,380	15,064	15,164	15,255	15,300	15,391	15,391
3		Kiponda	0.0883	1,654	13.72%	1,670	1,670	1,680	1,690	1,690	18,742	18,923	18,923	19,037	19,150	19,150
4		Malindi	0.4167	3,204	26.58%	3,220	3,250	3,250	3,260	3,260	7,688	7,726	7,798	7,798	7,822	7,822
		Total	**1.0897**	**12,052**	**100.00%**	**12,140**	**12,200**	**12,240**	**12,300**	**12,300**	**11,059**	**11,140**	**11,195**	**11,232**	**11,287**	**11,287**
5	City center	Mchangani	0.1479	2,211	7.26%	2,300	2,390	2,480	2,580	2,680	14,946	15,548	16,156	16,764	17,440	18,116
6		Mlandege	0.1026	2,070	6.80%	2,150	2,240	2,320	2,420	2,510	20,174	20,954	21,831	22,610	23,585	24,462
7		Mwembeladu	0.1401	2,954	9.70%	3,070	3,190	3,320	3,450	3,580	21,090	21,918	22,775	23,703	24,631	25,559
8		Gulioni	0.1410	2,488	8.17%	2,580	2,690	2,790	2,900	3,020	17,647	18,299	19,080	19,789	20,569	21,420
9		Miembeni	0.4922	6,095	20.03%	6,340	6,590	6,850	7,120	7,400	12,383	12,880	13,388	13,916	14,465	15,034
10		Kikwajuni Juu	0.4095	2,408	7.91%	2,500	2,600	2,700	2,810	2,920	5,881	6,105	6,350	6,594	6,862	7,131
11		Kikwajuni Bondeni	0.1401	2,257	7.41%	2,340	2,440	2,530	2,630	2,740	16,108	16,701	17,414	18,057	18,770	19,555
12		Kisimamajongoo	0.0731	2,615	8.59%	2,720	2,830	2,940	3,050	3,170	35,777	37,214	38,719	40,224	41,729	43,371
13		Vikokotoni	0.1251	1,872	6.15%	1,950	2,020	2,100	2,190	2,270	14,966	15,590	16,150	16,789	17,509	18,148
14		Mwembeshauri	0.1078	1,933	6.35%	2,010	2,090	2,170	2,260	2,350	17,927	18,641	19,383	20,125	20,959	21,794
15		Rahaleo	0.1310	1,950	6.41%	2,030	2,110	2,190	2,280	2,370	14,883	15,494	16,105	16,715	17,402	18,089
16		Kisiwandui	0.0874	1,590	5.22%	1,650	1,700	1,790	1,860	1,930	18,191	18,878	19,450	20,479	21,280	22,081
		Total	**2.0978**	**30,443**	**100.00%**	**31,640**	**32,890**	**34,180**	**35,550**	**36,940**	**14,512**	**15,082**	**15,678**	**16,293**	**16,946**	**17,609**
17	Inner city	Makadara	0.3727	5,048	3.76%	5,220	5,400	5,580	5,770	5,960	13,543	14,004	14,487	14,970	15,480	15,989
18		Kwamtipura	0.3439	11,572	8.62%	11,970	12,380	12,790	13,220	13,650	33,652	34,809	36,001	37,194	38,444	39,695
19		Kilimahewa Juu	0.2111	4,714	3.51%	4,870	5,040	5,210	5,380	5,560	22,330	23,069	23,874	24,679	25,485	26,337
20		Amani	0.2632	6,156	4.59%	6,370	6,590	6,810	7,040	7,270	23,391	24,204	25,040	25,876	26,750	27,624
21		Nyerere	0.3870	9,657	7.19%	9,980	10,320	10,670	11,030	11,390	24,956	25,791	26,670	27,574	28,504	29,435
22		Sebleni	0.2327	5,102	3.80%	5,280	5,460	5,640	5,830	6,020	21,923	22,688	23,461	24,235	25,051	25,867
23		Magomeni	0.4182	6,165	4.59%	6,370	6,590	6,810	7,040	7,270	14,741	15,231	15,757	16,283	16,833	17,383
24		Mpendae	1.0468	13,252	9.88%	13,720	14,190	14,660	15,150	15,650	12,660	13,107	13,556	14,005	14,473	14,951
25		Urusi	0.3015	7,532	5.61%	7,790	8,060	8,330	8,600	8,890	24,986	25,842	26,737	27,633	28,528	29,491
26		Mwembetanga	0.0869	2,610	1.94%	2,690	2,790	2,880	2,980	3,070	30,049	30,970	32,122	33,158	34,309	35,345
27		Kwaalimsha	0.1319	3,479	2.59%	3,600	3,720	3,840	3,970	4,100	26,367	27,284	28,193	29,103	30,088	31,073
28		Mikunguni	0.1140	2,984	2.22%	3,080	3,190	3,300	3,410	3,520	26,187	27,029	27,994	28,960	29,925	30,890
29		Mkele	0.2726	7,140	5.32%	7,390	7,640	7,900	8,160	8,430	26,190	27,107	28,024	28,977	29,931	30,921
30		Muungano	0.2358	5,304	3.95%	5,490	5,670	5,860	6,060	6,260	22,491	23,279	24,043	24,848	25,696	26,544
31		Sogea	0.1682	4,801	3.58%	4,970	5,140	5,310	5,490	5,670	28,535	29,540	30,550	31,560	32,630	33,700
32		Jang'ombe	0.3240	6,122	4.56%	6,330	6,550	6,770	6,990	7,220	18,894	19,536	20,215	20,894	21,573	22,283
33		Kidongo Chekundu	0.0768	2,290	1.71%	2,370	2,460	2,540	2,620	2,710	29,821	30,863	32,035	33,077	34,119	35,291
34		Matarumbeta	0.1139	2,711	2.02%	2,810	2,900	3,000	3,100	3,200	23,800	24,669	25,459	26,337	27,215	28,093
35		Kwahani	0.1785	4,815	3.59%	4,990	5,160	5,330	5,510	5,690	26,977	27,957	28,910	29,862	30,871	31,879
36		Kwaalinatu	0.4757	5,438	4.05%	5,620	5,820	6,010	6,210	6,420	11,431	11,814	12,234	12,633	13,054	13,495
37		Kilimahewa Bondeni	0.1837	5,116	3.81%	5,290	5,470	5,660	5,840	6,040	27,844	28,791	29,771	30,805	31,784	32,873
38		Kwa Wazee	0.5640	6,454	4.81%	6,680	6,910	7,140	7,380	7,620	11,444	11,845	12,253	12,661	13,086	13,512
39		Meya	0.2258	5,777	4.30%	5,990	6,150	6,390	6,600	6,790	25,588	26,532	27,240	28,304	29,234	30,075
		Total	**6.7289**	**134,239**	**100.00%**	**138,870**	**143,600**	**148,430**	**153,380**	**158,400**	**19,950**	**20,638**	**21,341**	**22,059**	**22,794**	**23,540**
40	Maruhubi	Shaurimoyo	0.5110	8,335	23.01%	8,330	8,330	8,330	8,330	8,330	16,311	16,301	16,301	16,301	16,301	16,301
41		Mwembemakumbi	0.9261	8,354	23.06%	8,350	8,350	8,350	8,350	8,350	9,021	9,016	9,016	9,016	9,016	9,016
42		Chumbuni	0.6433	10,925	30.16%	10,920	10,920	10,920	10,920	10,920	16,983	16,975	16,975	16,975	16,975	16,975
43		Karakana	0.7394	8,610	23.77%	8,620	8,620	8,620	8,620	8,620	11,644	11,658	11,658	11,658	11,658	11,658
		Total	**2.8198**	**36,224**	**100.00%**	**36,220**	**36,220**	**36,220**	**36,220**	**36,220**	**12,846**	**12,845**	**12,845**	**12,845**	**12,845**	**12,845**
44	Mazizini	Kilimani	0.9126	2,911	28.89%	3,820	4,790	5,840	6,980	8,190	3,190	4,186	5,249	6,400	7,649	8,975
45		Migombani	1.0513	7,164	71.11%	9,410	11,800	14,390	17,170	20,150	6,815	8,951	11,225	13,688	16,333	19,168
		Total	**1.9638**	**10,075**	**100.00%**	**13,230**	**16,590**	**20,230**	**24,150**	**28,340**	**5,130**	**6,737**	**8,448**	**10,301**	**12,298**	**14,431**
Total			**14.7001**	**223,033**		**232,100**	**241,500**	**251,300**	**261,600**	**272,200**	**15,172**	**15,789**	**16,428**	**17,095**	**17,796**	**18,517**

Source: JICA Survey Team

Table 4-20 Allocation of Projected Population to Shehias (West District)

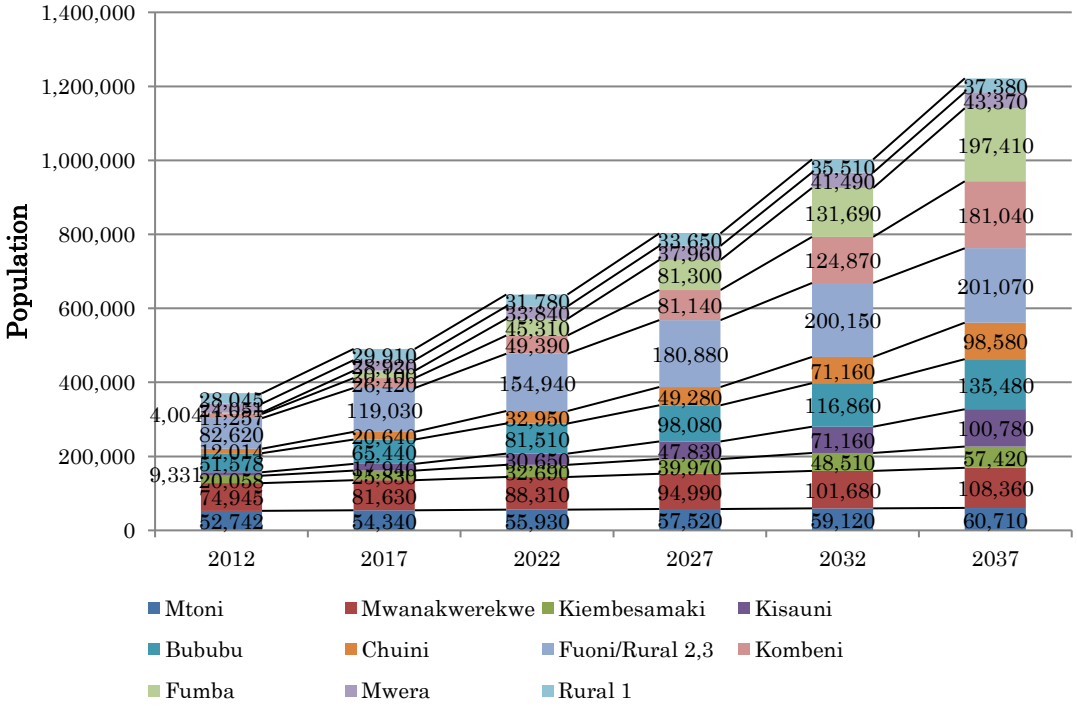
Plan Area	Shehia	Area km²	Population							Pop. Density (人/km²)					
			2012		2017	2022	2027	2032	2037	2012	2017	2022	2027	2032	2037
			Pop.	Composition											
Mtoni	Mtoni	3.8168	6,571	12.46%	6,770	6,970	7,170	7,370	7,560	1,722	1,774	1,826	1,879	1,931	1,981
	Mtoni Kidatu	2.6053	16,612	31.50%	17,120	17,620	18,120	18,620	19,120	6,376	6,571	6,763	6,955	7,147	7,339
	Mto Pepo	1.6308	16,440	31.17%	16,940	17,430	17,930	18,430	18,920	10,081	10,388	10,688	10,995	11,301	11,602
	Welezo	1.1592	13,119	24.87%	13,510	13,910	14,300	14,700	15,110	11,318	11,655	12,000	12,336	12,681	13,035
	Total	**9.2120**	**52,742**	**100.00%**	**54,340**	**55,930**	**57,520**	**59,120**	**60,710**	**5,725**	**5,899**	**6,071**	**6,244**	**6,418**	**6,590**
Mwanakwerekwe	Mombasa	1.8178	14,492	19.34%	15,790	17,080	18,370	19,660	20,960	7,972	8,686	9,396	10,105	10,815	11,530
	Tomondo	2.6216	23,254	31.03%	25,330	27,400	29,480	31,550	33,620	8,870	9,662	10,452	11,245	12,035	12,824
	Meli nne	1.4737	16,984	22.66%	18,500	20,010	21,520	23,040	24,550	11,525	12,553	13,578	14,603	15,634	16,659
	Mwanakwerekwe	1.3981	20,215	26.97%	22,010	23,820	25,620	27,430	29,230	14,458	15,742	17,037	18,324	19,619	20,906
	Total	**7.3113**	**74,945**	**100.00%**	**81,630**	**88,310**	**94,990**	**101,680**	**108,360**	**10,251**	**11,165**	**12,079**	**12,992**	**13,907**	**14,821**
Kiembesamaki[1)]	Chukwani	7.2023	8,298	41.37%	10,690	13,520	16,540	20,070	23,750	1,152	1,484	1,877	2,296	2,787	3,298
	Kiembesamaki	5.3536	11,760	58.63%	15,140	19,170	23,430	28,440	33,670	2,197	2,828	3,581	4,377	5,312	6,289
	Total	**12.5559**	**20,058**	**100.00%**	**25,830**	**32,690**	**39,970**	**48,510**	**57,420**	**1,597**	**2,057**	**2,604**	**3,183**	**3,864**	**4,573**
Kisauni[1)]	Kisauni	4.8206	9,331	100.00%	17,940	30,650	47,830	71,160	100,780	1,936	3,722	6,358	9,922	14,762	20,906
	Total	**4.8206**	**9,331**	**100.00%**	**17,940**	**30,650**	**47,830**	**71,160**	**100,780**	**1,936**	**3,722**	**6,358**	**9,922**	**14,762**	**20,906**
Bububu[1)]	Bububu	4.5097	15,666	30.37%	19,870	24,750	29,790	35,490	41,150	3,474	4,406	5,488	6,606	7,870	9,125
	Kihinani	2.9936	14,139	27.42%	17,940	22,350	26,890	32,040	37,150	4,723	5,993	7,466	8,983	10,703	12,410
	Mwanyanya	1.9047	9,683	18.77%	12,280	15,300	18,410	21,930	25,430	5,084	6,447	8,033	9,665	11,513	13,351
	Sharifu Msa	0.9509	4,975	9.65%	6,310	7,870	9,460	11,280	13,070	5,232	6,636	8,276	9,949	11,863	13,745
	Kibweni	0.8439	7,115	13.79%	9,040	11,240	13,530	16,120	18,680	8,431	10,712	13,319	16,033	19,102	22,136
	Total	**11.2028**	**51,578**	**100.00%**	**65,440**	**81,510**	**98,080**	**116,860**	**135,480**	**4,604**	**5,841**	**7,276**	**8,755**	**10,431**	**12,093**
Chuini[1)]	Chuini	5.9341	6,158	51.26%	10,580	16,890	25,260	36,480	50,530	1,038	1,783	2,846	4,257	6,148	8,515
	Mbuzini	7.9959	5,856	48.74%	10,060	16,060	24,020	34,680	48,050	732	1,258	2,009	3,004	4,337	6,009
	Total	**13.9300**	**12,014**	**100.00%**	**20,640**	**32,950**	**49,280**	**71,160**	**98,580**	**862**	**1,482**	**2,365**	**3,538**	**5,108**	**7,077**
Fuoni/Rural 2,3	Fuoni Kijitoupele	5.5804	19,374	23.45%	27,910	36,330	42,420	46,940	47,150	3,472	5,001	6,510	7,602	8,412	8,449
	Pangawe	4.3358	26,275	31.80%	37,850	49,270	57,520	63,650	63,940	6,060	8,730	11,363	13,266	14,680	14,747
	Kinuni	0.8449	11,333	13.72%	16,330	21,260	24,820	27,460	27,590	13,414	19,328	25,163	29,377	32,501	32,655
	Mwera	8.2063	10,238	12.39%	14,750	19,200	22,410	24,800	24,910	1,248	1,797	2,340	2,731	3,022	3,035
	Fuoni Kibondeni	24.0847	15,400	18.64%	22,190	28,880	33,710	37,300	37,480	639	921	1,199	1,400	1,549	1,556
	Total	**43.0521**	**82,620**	**100.00%**	**119,030**	**154,940**	**180,880**	**200,150**	**201,070**	**1,919**	**2,765**	**3,599**	**4,201**	**4,649**	**4,670**
Kombeni[1)]	Shakani	7.5896	2,760	24.52%	6,480	12,110	19,900	30,620	44,390	364	854	1,596	2,622	4,034	5,849
	Nyamanzi	2.2815	1,287	11.43%	3,020	5,650	9,270	14,270	20,690	564	1,324	2,476	4,063	6,255	9,069
	Kombeni	13.1328	3,162	28.09%	7,420	13,870	22,790	35,080	50,850	241	565	1,056	1,735	2,671	3,872
	Maungani	7.0886	4,048	35.96%	9,500	17,760	29,180	44,900	65,110	571	1,340	2,505	4,116	6,334	9,185
	Total	**30.0925**	**11,257**	**100.00%**	**26,420**	**49,390**	**81,140**	**124,870**	**181,040**	**374**	**878**	**1,641**	**2,696**	**4,150**	**6,016**
Fumba[1)]	Dimani	8.1709	2,052	51.25%	10,300	23,220	41,670	67,490	101,170	251	1,261	2,842	5,100	8,260	12,382
	Bweleo	9.8667	971	24.25%	4,870	10,990	19,720	31,930	47,870	98	494	1,114	1,999	3,236	4,852
	Fumba	4.2491	981	24.50%	4,930	11,100	19,910	32,270	48,370	231	1,160	2,612	4,686	7,594	11,383
	Total	**22.2868**	**4,004**	**100.00%**	**20,100**	**45,310**	**81,300**	**131,690**	**197,410**	**180**	**902**	**2,033**	**3,648**	**5,909**	**8,858**
Mwera	Mtufaani	3.0012	9,123	37.93%	10,970	12,840	14,400	15,740	16,450	3,040	3,655	4,278	4,798	5,245	5,481
	Magogoni	3.2824	14,928	62.07%	17,950	21,000	23,560	25,750	26,920	4,548	5,469	6,398	7,178	7,845	8,201
	Total	**6.2836**	**24,051**	**100.00%**	**28,920**	**33,840**	**37,960**	**41,490**	**43,370**	**3,828**	**4,602**	**5,385**	**6,041**	**6,603**	**6,902**
Rural 1	Dole	8.4400	3,933	14.02%	4,190	4,460	4,720	4,980	5,240	466	496	528	559	590	621
	Kama	5.0636	2,921	10.42%	3,120	3,310	3,510	3,700	3,890	577	616	654	693	731	768
	Mfenesini	3.1586	2,803	9.99%	2,990	3,170	3,360	3,550	3,730	887	947	1,004	1,064	1,124	1,181
	Mwakaje	10.3697	2,907	10.37%	3,100	3,300	3,490	3,680	3,880	280	299	318	337	355	374
	Bumbwisudi	8.0280	2,269	8.09%	2,420	2,570	2,720	2,870	3,020	283	301	320	339	357	376
	Kizimbani	8.2597	3,304	11.78%	3,520	3,740	3,960	4,180	4,400	400	426	453	479	506	533
	Kianga	13.3931	9,908	35.33%	10,570	11,230	11,890	12,550	13,220	740	789	838	888	937	987
	Total	**56.7127**	**28,045**	**100.00%**	**29,910**	**31,780**	**33,650**	**35,510**	**37,380**	**495**	**527**	**560**	**593**	**626**	**659**
Tota		**217.4601**	**370,645**		**490,200**	**637,300**	**802,600**	**1,002,200**	**1,221,600**	**1,704**	**2,254**	**2,931**	**3,691**	**4,609**	**5,618**

Source: JICA Survey Team



Source: JICA Survey Team

Figure 4-4 Inhabited Population in Each Plan Area (Urban District)



Source: JICA Survey Team

Figure 4-5 Inhabited Population in Each Plan Area (West District)

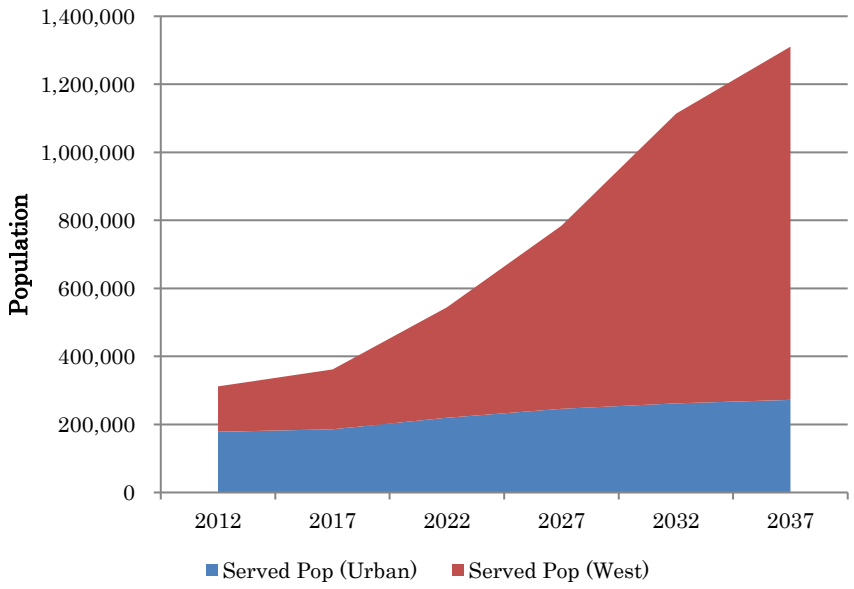
(2) Service population

The estimated service population (including public taps) is shown in **Table 4-21** and **Figure 4-6**.

Table 4-21 Estimated Served Population

Area		2012	2017	2022	2027	2032	2037
Urban	Service connection	142,770	148,530	181,080	211,090	235,370	244,970
	Public taps	35,720	37,150	38,640	35,180	26,210	27,230
	Total	178,490	185,680	219,720	246,270	261,580	272,200
West	Service connection	114,900	151,910	293,070	497,680	801,700	977,280
	Public taps	18,490	24,520	31,850	40,130	50,100	61,060
	Total	133,390	176,430	324,920	537,810	851,800	1,038,340
Total	Service connection	257,670	300,440	474,150	708,770	1,037,070	1,222,250
	Public taps	54,210	61,670	70,490	75,310	76,310	88,290
	Total	311,880	362,110	544,640	784,080	1,113,380	1,310,540

Source: JICA Survey Team



Source: JICA Survey Team

Figure 4-6 Estimated Service Population

(3) Planned Water Demand

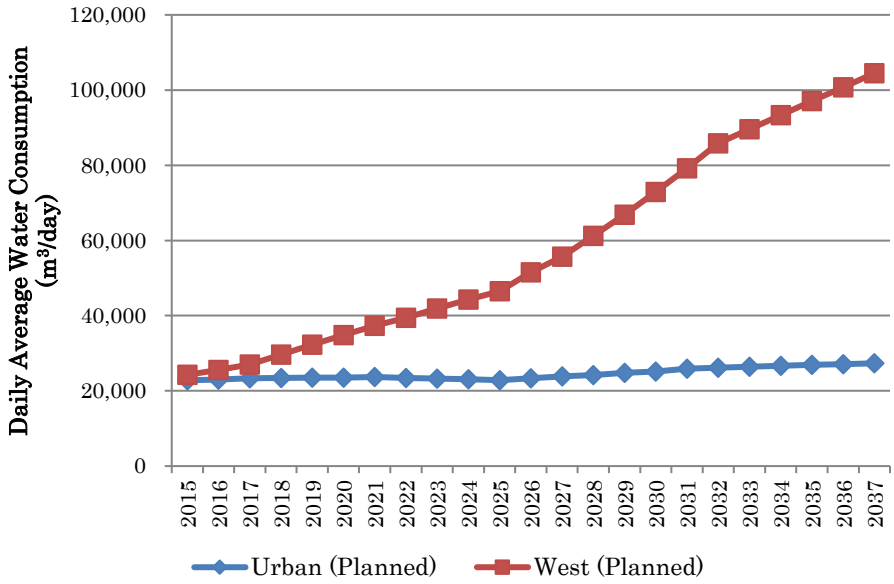
(a) Average daily water consumption

The estimated daily water consumption is shown in **Figure 4-7** and **Table 4-22**.

The planned daily average consumption in 2032 is 26,204 m^3/day for Urban District, and

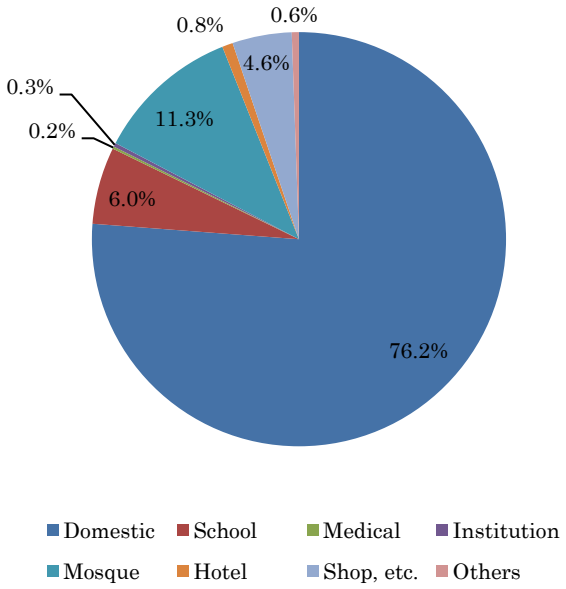
85,848 m^3/day for West District, and the total for Urban West Region is 112,052 m^3/day. The consumption per capita (the total of service connection and public taps) per day is 100 L/cap for Urban District, 101 L/cap for West District, and 101 L/cap for overall Urban West Region.

The composition ratio shown in **Figure 4-8** in descending order is, 76.2% for domestic, 11.3% for mosques, 6.0% for schools and 4.6% for commercial.



Source: JICA Survey Team

Figure 4-7 Estimated Daily Consumption



Source: JICA Survey Team

Figure 4-8 Composition of Estimated Daily Consumption

(b) Daily average demand and daily maximum demand

The estimation result of the average daily average demand (hereinafter referred to as "DAD") and the daily maximum water demand (hereinafter referred to as "DMD") are shown in **Figure 4-9** and **Table 4-22**.

(i) Daily average water demand

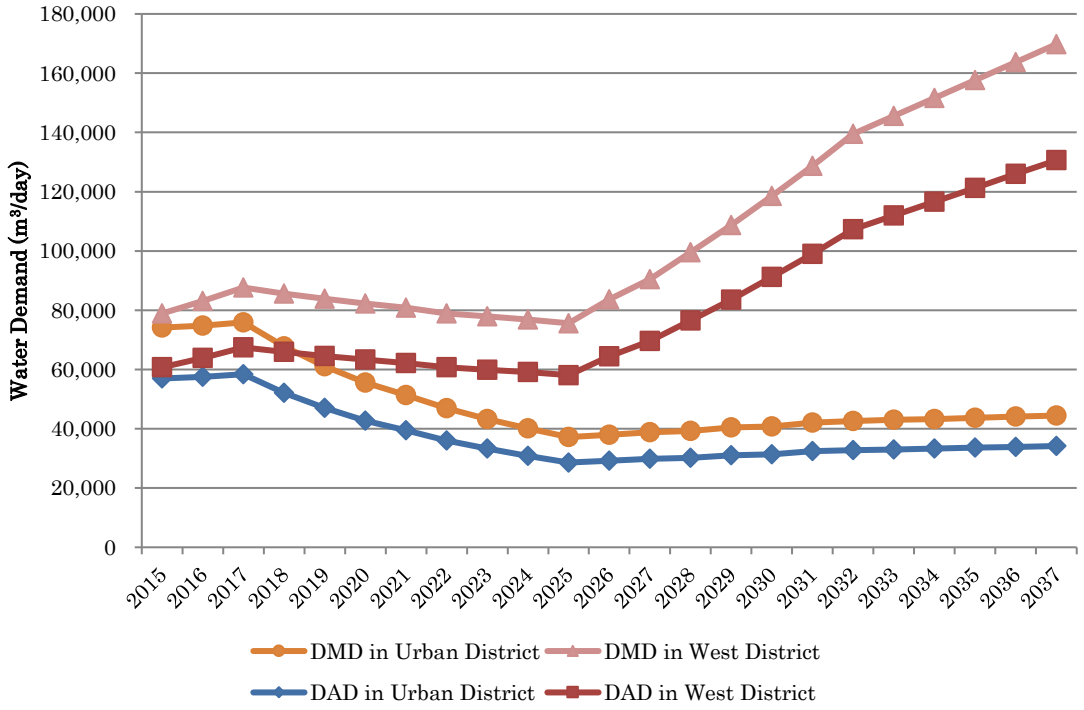
The estimated DAD for 2032 is 32,800 m^3/day for Urban District, 107,300 m^3/day for West District, and the total for Urban West Region is 140,100 m^3/day.

The DAD per capita per day (the total of service connection and public taps) is estimated as 125 L/cap/day for Urban District, 126 L/cap/day for West District, and the total for Urban West Region is 126 L/cap/day.

(ii) Daily maximum water demand

The estimated DMD (proposal) for 2032 is 42,600 m^3/day for Urban District, 139,500 m^3/day for West District, and the total for Urban West Region is 182,100 m^3/day.

The DMD per capita per day (the total of service connection and public taps) is estimated as 163 L/cap/day for Urban District, 164 L/cap/day for West District, and the total for Urban West Region is 164 L/cap/day.



Source: JICA Survey Team

Figure 4-9 Estimated DAD and DMD

Table 4-22 Estimated Water Demand

District	Item				2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Urban	Inhabited Population			[pop]	228,470	230,290	232,100	233,960	235,870	237,730	239,640	241,500	243,460	245,430	247,370	249,340	251,300	253,370	255,410	257,490	259,530	261,600	263,760	265,840	267,960	270,040	272,200
	Served Population (Piped Water)			[pop]	146,240	147,390	148,530	154,410	160,420	166,420	174,910	181,080	187,480	193,910	200,340	204,460	211,090	215,420	219,670	223,990	230,950	235,370	237,420	239,260	241,160	243,070	244,970
	Served Population (Public Tap)			[pop]	36,560	36,850	37,150	37,450	37,790	38,030	38,370	38,640	38,970	39,290	39,610	37,430	35,180	32,940	33,240	30,880	28,580	26,210	26,390	26,640	26,840	27,060	27,230
	Connected Households (Piped Water)			[HH]	27,593	27,809	28,030	29,139	30,267	31,400	33,001	34,165	35,372	36,584	37,799	38,578	39,826	40,645	41,444	42,264	43,576	44,408	44,799	45,143	45,505	45,867	46,218
	Served Population Rate	Connection Rate		[%]	64.0	64.0	64.0	66.0	68.0	70.0	73.0	75.0	77.0	79.0	81.0	82.0	84.0	85.0	86.0	87.0	89.0	90.0	90.0	90.0	90.0	90.0	90.0
		Public Tap Utilization Rate		[%]	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.0	14.0	13.0	13.0	12.0	11.0	10.0	10.0	10.0	10.0	10.0	10.0
	Water Consumption	Domestic		[m^3/day]	17,438	17,576	17,864	17,899	17,901	17,852	17,995	17,675	17,501	17,281	17,006	17,426	17,838	18,072	18,634	18,863	19,527	19,777	19,946	20,103	20,261	20,421	20,575
		Non-Domestic	School	[m^3/day]	1,201	1,212	1,220	1,229	1,240	1,248	1,261	1,271	1,282	1,290	1,300	1,314	1,320	1,331	1,345	1,354	1,365	1,376	1,386	1,398	1,408	1,419	1,430
			Medical	[m^3/day]	128	128	128	128	128	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131
			Institution	[m^3/day]	201	201	202	203	205	207	209	210	211	211	211	221	221	222	224	226	226	229	230	230	239	239	240
			Mosque	[m^3/day]	2,288	2,305	2,324	2,340	2,362	2,382	2,400	2,419	2,436	2,456	2,479	2,499	2,515	2,538	2,556	2,580	2,602	2,620	2,639	2,664	2,684	2,706	2,728
			Hotel	[m^3/day]	443	465	488	510	529	550	574	593	615	640	660	680	703	726	746	766	789	810	833	856	877	896	916
			Shop, etc.	[m^3/day]	1,093	1,099	1,117	1,118	1,119	1,113	1,125	1,107	1,097	1,078	1,064	1,092	1,114	1,131	1,170	1,182	1,221	1,236	1,249	1,260	1,271	1,278	1,288
			Industry	[m^3/day]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Others	[m^3/day]	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
			Total	[m^3/day]	5,379	5,435	5,504	5,553	5,608	5,656	5,725	5,756	5,797	5,831	5,870	5,962	6,029	6,104	6,197	6,264	6,359	6,427	6,493	6,564	6,635	6,694	6,758
		Total		[m^3/day]	22,817	23,011	23,368	23,452	23,509	23,508	23,720	23,431	23,298	23,112	22,876	23,388	23,867	24,176	24,831	25,127	25,886	26,204	26,439	26,667	26,896	27,115	27,333
	Per Capita Consumption			[L/cap/day]	125	125	126	122	119	115	111	107	103	99	95	97	97	97	98	99	100	100	100	100	100	100	100
	Daily Average Water Demand (DAD)			[m^3/day]	57,000	57,500	58,400	52,100	47,000	42,700	39,500	36,000	33,300	30,800	28,600	29,200	29,800	30,200	31,000	31,400	32,400	32,800	33,000	33,300	33,600	33,900	34,200
	Daily Maximum Water Demand (DMD)			[m^3/day]	74,200	74,800	75,900	67,800	61,100	55,600	51,400	46,900	43,300	40,100	37,200	38,000	38,800	39,300	40,400	40,800	42,100	42,600	43,000	43,300	43,700	44,100	44,400
	Billiable Water Ratio			[%]	40.0	40.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
	Daily Peak Factor			–	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	Per Capita DAD			[L/cap/day]	312	312	315	272	237	209	185	164	147	132	119	121	121	122	123	123	125	125	125	125	125	125	126
	Per Capita DMD			[L/cap/day]	406	406	409	353	308	272	241	213	191	172	155	157	158	158	160	160	162	163	163	163	163	163	163
West	Inhabited Population			[pop]	442,390	466,300	490,200	519,600	549,030	578,470	607,900	637,300	670,350	703,420	736,480	769,550	802,600	842,500	882,470	922,330	962,300	1,002,200	1,046,060	1,089,950	1,133,850	1,177,740	1,221,600
	Served Population (Piped Water)			[pop]	137,150	144,560	151,910	176,650	203,150	231,390	261,420	293,070	328,450	365,760	405,030	454,040	497,680	556,080	608,910	673,320	731,350	801,700	836,810	871,930	907,080	942,200	977,280
	Served Population (Public Tap)			[pop]	22,140	23,340	24,520	25,990	27,500	28,920	30,420	31,850	33,570	35,180	36,820	38,510	40,130	42,160	44,150	46,140	48,130	50,100	52,330	54,570	56,730	58,880	61,060
	Connected Households (Piped Water)			[HH]	26,373	27,802	29,212	33,971	39,067	44,498	50,271	56,361	63,162	70,339	77,889	87,320	95,707	106,933	117,099	129,488	140,645	154,171	160,923	167,678	174,437	181,195	187,939
	Served Population Rate	Connection Rate		[%]	31.0	31.0	31.0	34.0	37.0	40.0	43.0	46.0	49.0	52.0	55.0	59.0	62.0	66.0	69.0	73.0	76.0	80.0	80.0	80.0	80.0	80.0	80.0
		Public Tap Utilization Rate		[%]	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Water Consumption	Domestic		[m^3/day]	15,805	16,666	17,664	19,714	21,762	23,740	25,683	27,229	29,104	30,843	32,441	36,694	40,129	44,721	49,481	54,600	59,942	65,594	68,471	71,346	74,219	77,086	79,956
		Non-Domestic	School	[m^3/day]	2,366	2,495	2,623	2,780	2,939	3,098	3,252	3,410	3,591	3,765	3,940	4,116	4,295	4,507	4,724	4,936	5,149	5,364	5,599	5,832	6,065	6,303	6,535
			Medical	[m^3/day]	34	37	38	38	38	38	38	39	42	46	46	47	47	67	67	68	68	72	76	76	76	77	80
			Institution	[m^3/day]	45	46	48	56	57	60	60	63	71	73	75	77	79	87	90	93	101	103	105	109	117	120	123
			Mosque	[m^3/day]	4,424	4,667	4,905	5,201	5,492	5,793	6,082	6,379	6,703	7,037	7,371	7,697	8,029	8,430	8,826	9,223	9,625	10,026	10,460	10,897	11,341	11,784	12,223
			Hotel	[m^3/day]	71	73	77	81	84	87	93	96	99	102	105	109	112	116	118	121	128	130	135	139	141	143	145
			Shop, etc.	[m^3/day]	926	971	1,032	1,165	1,280	1,404	1,521	1,618	1,727	1,833	1,929	2,186	2,395	2,679	2,968	3,283	3,616	3,959	4,132	4,309	4,483	4,652	4,831
			Industry	[m^3/day]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Others	[m^3/day]	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
			Total	[m^3/day]	8,466	8,889	9,323	9,921	10,490	11,080	11,646	12,205	12,833	13,456	14,066	14,832	15,557	16,486	17,393	18,324	19,287	20,254	21,107	21,962	22,823	23,679	24,537
		Total		[m^3/day]	24,271	25,555	26,987	29,635	32,252	34,820	37,329	39,434	41,937	44,299	46,507	51,526	55,686	61,207	66,874	72,924	79,229	85,848	89,578	93,308	97,042	100,765	104,493
	Per Capita Consumption			[L/cap/day]	152	152	153	146	140	134	128	121	116	110	105	105	104	102	102	101	102	101	101	101	101	101	101
	Daily Average Water Demand (DAD)			[m^3/day]	60,700	63,900	67,500	65,900	64,500	63,300	62,200	60,700	59,900	59,100	58,100	64,400	69,600	76,500	83,600	91,200	99,000	107,300	112,000	116,600	121,300	126,000	130,600
	Daily Maximum Water Demand (DMD)			[m^3/day]	78,900	83,100	87,700	85,600	83,900	82,300	80,900	78,900	77,900	76,800	75,600	83,700	90,500	99,500	108,700	118,500	128,700	139,500	145,600	151,600	157,700	163,700	169,800
	Billiable Water Ratio			[%]	40.0	40.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
	Daily Peak Factor			–	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	Per Capita DAD			[L/cap/day]	381	381	383	325	280	243	213	187	165	147	131	131	129	128	128	127	127	126	126	126	126	126	126
	Per Capita DMD			[L/cap/day]	495	495	497	422	364	316	277	243	215	192	171	170	168	166	166	165	165	164	164	164	164	164	164
Urban West Region	Inhabited Population			[pop]	670,860	696,590	722,300	753,560	784,900	816,200	847,540	878,800	913,810	948,850	983,850	1,018,890	1,053,900	1,095,870	1,137,880	1,179,820	1,221,830	1,263,800	1,309,820	1,355,790	1,401,810	1,447,780	1,493,800
	Served Population (Piped Water)			[pop]	283,390	291,950	300,440	331,060	363,570	397,810	436,330	474,150	515,930	559,670	605,370	658,500	708,770	771,500	828,580	897,310	962,300	1,037,070	1,074,230	1,111,190	1,148,240	1,185,270	1,222,250
	Served Population (Public Tap)			[pop]	58,700	60,190	61,670	63,440	65,290	66,950	68,790	70,490	72,540	74,470	76,430	75,940	75,310	75,100	77,390	77,020	76,710	76,310	78,720	81,210	83,570	85,940	88,290
	Connected Households (Piped Water)			[HH]	53,966	55,611	57,242	63,110	69,334	75,898	83,272	90,526	98,534	106,923	115,688	125,898	135,533	147,578	158,543	171,752	184,221	198,579	205,722	212,821	219,942	227,062	234,157
	Served Population Rate	Connection Rate		[%]	42.2	41.9	41.6	43.9	46.3	48.7	51.5	54.0	56.5	59.0	61.5	64.6	67.3	70.4	72.8	76.1	78.8	82.1	82.0	82.0	81.9	82.0	81.9
		Public Tap Utilization Rate		[%]	8.7	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.8	7.5	7.1	6.9	6.8	6.5	6.3	6.0	6.0	6.0	6.0	5.9	5.9
	Water Consumption	Domestic		[m^3/day]	33,243	34,242	35,528	37,613	39,663	41,592	43,678	44,904	46,605	48,124	49,447	54,120	57,967	62,793	68,115	73,463	79,469	85,371	88,417	91,449	94,480	97,507	100,531
		Non-Domestic	School	[m^3/day]	3,567	3,707	3,843	4,009	4,179	4,346	4,513	4,681	4,873	5,055	5,240	5,430	5,615	5,838	6,069	6,290	6,514	6,740	6,985	7,230	7,473	7,722	7,965
			Medical	[m^3/day]	162	165	166	166	166	169	169	170	173	177	177	178	178	198	198	199	199	203	207	207	207	208	211
			Institution	[m^3/day]	246	247	250	259	262	267	269	273	282	284	286	298	300	309	314	319	327	332	335	339	356	359	363
			Mosque	[m^3/day]	6,712	6,972	7,229	7,541	7,854	8,175	8,482	8,798	9,139	9,493	9,850	10,196	10,544	10,968	11,382	11,803	12,227	12,646	13,099	13,561	14,025	14,490	14,951
			Hotel	[m^3/day]	514	538	565	591	613	637	667	689	714	742	765	789	815	842	864	887	917	940	968	995	1,018	1,039	1,061
			Shop, etc.	[m^3/day]	2,019	2,070	2,149	2,283	2,399	2,517	2,646	2,725	2,824	2,911	2,993	3,278	3,509	3,810	4,138	4,465	4,837	5,195	5,381	5,569	5,754	5,930	6,119
			Industry	[m^3/day]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Others	[m^3/day]	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
			Total	[m^3/day]	13,845	14,324	14,827	15,474	16,098	16,736	17,371	17,961	18,630	19,287	19,936	20,794	21,586	22,590	23,590	24,588	25,646	26,681	27,600	28,526	29,458	30,373	31,295
		Total		[m^3/day]	47,088	48,566	50,355	53,087	55,761	58,328	61,049	62,865	65,235	67,411	69,383	74,914	79,553	85,383	91,705	98,051	105,115	112,052	116,017	119,975	123,938	127,880	131,826
	Per Capita Consumption			[L/cap/day]	138	138	139	135	130	126	121	115	111	106	102	102	101	101	101	101	101	101	101	101	101	101	101
	Daily Average Water Demand (DAD)			[m^3/day]	117,700	121,400	125,900	118,000	111,500	106,100	101,700	96,700	93,200	89,900	86,700	93,600	99,400	106,700	114,600	122,600	131,400	140,100	145,000	150,000	154,900	159,900	164,800
	Daily Maximum Water Demand (DMD)			[m^3/day]	153,000	157,800	163,700	153,400	145,000	137,900	132,300	125,700	121,200	116,800	112,700	121,700	129,300	138,700	149,000	159,300	170,800	182,100	188,500	195,000	201,400	207,800	214,200
	Billiable Water Ratio			[%]	40.0	40.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
	Daily Peak Factor			–	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	Per Capita DAD			[L/cap/day]	344	345	348	299	260	228	201	178	158	142	127	127	127	126	126	126	126	126	126	126	126	126	126
	Per Capita DMD			[L/cap/day]	447	448	452	389	338	297	262	231	206	184	165	166	165	164	164	163	164	164	163	164	163	163	163

Source: JICA Survey Team

(4) Verification of Demand Projection Results

According to the ZUWSP project funded by AfDB, the DMD in Urban District in 2025 is 62,407 m^3/day, which is a larger value than the DMD for 2032 estimated in this Survey (42,600 m^3/day).

Compared to the results of this Survey, the estimated domestic water consumption in ZUWSP is relatively larger. ZUWSP calculates the domestic water consumption per capita as 109 L/cap/day. According to the meter reading results mentioned in **3.9.1**, the value is calculated as 75.5 L/cap/day. Taking into consideration that the user's awareness for water saving shall rise following the change to metered rate from flat rate, it is conceivable that the estimated demand mentioned by ZUWSP is large and the result of this Survey is appropriate.

Although there are differences in the projected values, the Project shall adopt the proposed DMD for 2032 of this Survey as the planned demand for the facility plan.

Table 4-23 Projected Demand Comparison with ZUWSP Projection

Item	Unit	ZUWSP	Survey		Remarks
		2025	2025	2032	
Served population (connected population)	Cap	244,146	200,340	235,370	(a)
Served households (connected households)		37,733	37,799	44,408	
Water consumption	m^3/day	37,147	22,876	26,204	
Domestic	m^3/day	26,612	17,006	19,777	
(Water consumption rate for domestic)	L/cap/day	109	85	84	
Non-domestic	m^3/day	10,536	5,870	6,427	
Water loss rate	-	20%	20%	20%	
DAD	m^3/day	44,577	28,600	32,800	(b)
Peak factor	-	1.4	1.3	1.3	
DMD	m^3/day	62,407	37,200	42,600	(c)
DAD per capita	L/cap/day	183	143	139	(b)/(a)× 1,000
DMD per capita	L/cap/day	255	186	181	(c)/(a)×1,000

Source: JICA Survey Team

4.4 Necessity of New Water Source Development

4.4.1 Capacity of Existing and Under Development Boreholes

(1) Borehole Water Sources

(a) Concept of water source capacity

According to ZAWA, existing boreholes are not able to perform at their full design capacity due to broken/aging pumps.

It is necessary to set the water source capacity with a margin against the demand, taking into consideration of the situation of ZAWA, such as the poor marketability of spare parts and power failures during the rainy season.

(i) Operation Ratio of Boreholes

According to the pumping flow measurement survey for existing boreholes conducted in October 2016 by this Survey, 12 out of 62 pumps (20%) were out of order.

The ZAWA plan for normal operation ratio of boreholes is 70%. However, the operation ratio shall be set at 80% for this Project, in order to enable to manage intake amount and to install flow meters so it shall be possible to detect failures at an early stage. To achieve this ratio, it shall be necessary for ZAWA to manage the stock and smooth procurement of spare parts, and to shorten the repair time of facilities.

(ii) Capacity Degradation of Boreholes

According to the pumping flow measurement survey, the averaged measured flow was 94% of design capacity. Considering continuous usage of pumps and the capacity degradation, the effectiveness ratio of both existing and new pumps shall be set at 90%.

(iii) Shortening of Operation Time due to Power Failures

During the rainy season, especially in April and May every year, power failures are caused by lightning and fallen trees. The Project shall not consider the shortening of operation hours due to power failures, since the design capacity shall be set to meet the day requiring the maximum water supply amount of the target year, and shall not provide security for the power failure which may occur on the specific day.

(iv) Target Water Source Capacity for Boreholes

Using the operation ratio and effectiveness ratio of borehole water sources, the water source capacity is calculated by the following formula;

$$\text{Water Source Capacity } (m^3/day) = \text{Design Capacity } (m^3/h) \times 24 \text{ hours} \times \text{operation ratio } (0.8) \times \text{effectiveness ratio } (0.9)$$

(b) Planned Capacity of Borehole Water Sources

Table 4-24 shows the capacity of existing and under development boreholes. The total capacity of the boreholes is 6,155 m^3/hour (147,720 m^3/day), but the planned capacity considering operation and effectiveness rate shall be 106,358 m^3/day.

Table 4-24 Capacity of Existing and Under Development Boreholes

Category	Item	Capacity		Remarks
		m^3/hour	m^3/day	
Existing	(1) After rehabilitation by ZUWSP	2,924	70,176	
Under Development	(2) Zanzibar Well Drilling Project	543	13,032	Pump is available
		1,683	40,392	Pump is not installed
	(3) ZUWSP	1,005	24,120	125 m^3/hour × 5 pumps, 95 m^3/hour×4 pumps
Borehole capacity after development （Σ(1)-(3))		6,155	147,720	

Source: JICA Survey Team

This capacity exceeds the 24,000,000 m^3/year (65,700 m^3/day) of annual acceptable yield mentioned in **3.5.2 (1) (d)**. Therefore, boreholes developed by the Zanzibar Well Drilling Project but pumps are not installed, are not planned to be included as water sources for this Project. (**Photo 4-1**, **Photo 4-2**)

Photo 4-1 Boreholes Developed by Zanzibar Well Drilling Project (Pump is available)

Photo 4-2 Boreholes Developed by Zanzibar Well Drilling Project (Pump not installed)

From the above, the facility capacity of boreholes is 107,328 m^3/day, and the planned capacity is 77,276 m^3/day, as shown in **Table 4-25**.

Table 4-25 Capacity of Existing and Under Development Boreholes Used in the Planning Area

Category	Item	Capacity		Planned capacity (m^3/day)	Remarks
		(m^3/hour)	(m^3/day)		
Existing	(1) After rehabilitation by ZUWSP	2,924	70,176	50,527	
Under Development	(2) Zanzibar Well Drilling Project	543	13,032	9,383	Operational
	(3) ZUWSP	1,005	24,120	17,366	125 m^3/hour×5 pumps, 95 m^3/hour×4 pumps
Borehole facility capacity after development (Σ(1)-(3))		4,472	107,328	77,276	

Source: JICA Survey Team

(2) Spring Water Sources

The water source capacity of Mtoni and Bububu springs is set at the minimum flow amount, 1,608 m^3/day. The capacity of Dimani Cave water source is 1,330 m^3/day (77 m^3/hour×24 hours×0.8×0.9), calculated from the pump capacity. Therefore, the total capacity of spring water sources is 4,546 m^3/day.

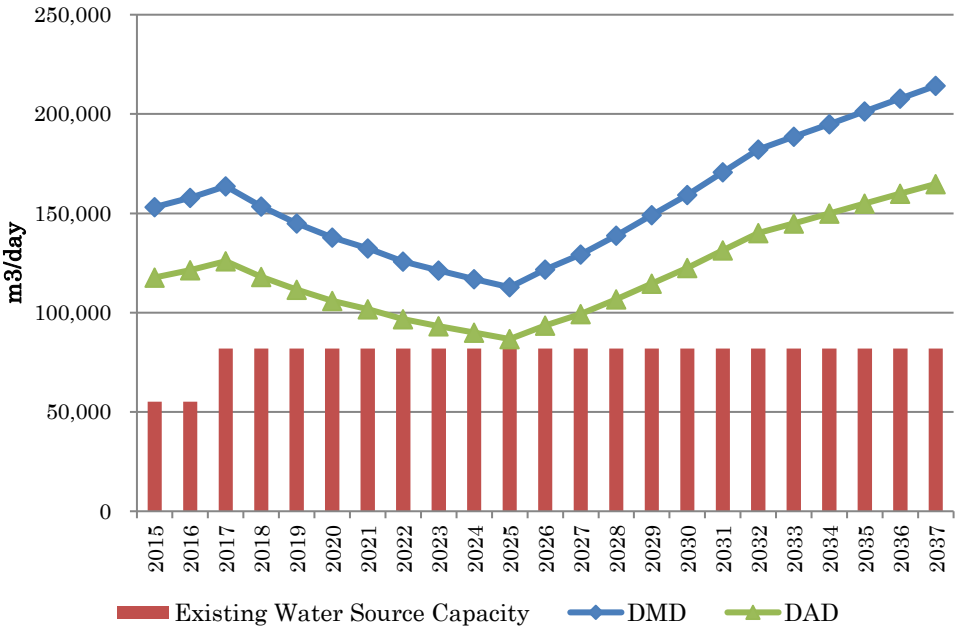
(3) Planned Water Source Capacity

From the above, the planned water source capacity of boreholes and springs is 81,822 m^3/day (=77,276+4,546).

4.4.2 Necessity of New Water Source Development

(1) Necessity of New Water Source Development

As shown in **Figure 4-10**, the planned water demand for this Survey is 182,100 m^3/day, which exceeds the planned existing water source capacity 81,822 m^3/day. New water source development shall be necessary, but since the excess amount is large, implementation of plans to promote water saving, such as introducing water meters and metered-rate water tariffs, and advertising water saving methods shall also be important.



Source: JICA Survey Team

Figure 4-10 Balance of Water Demand and Source in Urban West Region

(2) Consideration for New Water Source Development

The water source capacity of existing and under development water source is almost as same as acceptable yield of Urban West Region, mentioned in **3.5.2 (1) (d)**. Since a yield exceeding acceptable amount may cause intrusion of salt water into water source, it is not recommendable to develop new water sources in the Urban West Region.

To avoid bad influence to the future water use, new water sources should be developed in areas which have water source margin and send water to the Urban West Region. Currently, the information regarding water source is not sufficient. Therefore, construction sites and scale of new boreholes should be determined after further investigation and evaluation of water resource capacity.

4.5 Plan of Water Supply Facilities Improvement

4.5.1 Planning Policy of the Water Supply System

Policy of the water supply plan is described below.

(1) Policy of Water Supply System Planning

The policies of water supply system planning are listed below:

- Build a distribution system based mainly on gravity flow using the Mazizini Ridge.
- Divide the distribution zones considering the geometrical conditions (altitude and main roads), the location of water supply facilities (water sources and distribution bases) and the water demand.
- Shift from borehole direct water supply to water supply via reservoirs as much as possible.
- Separate functions of water transmission and distribution to avoid mutual interference.
- Introduce District Metered Area (hereinafter referred to as "DMA") to realize detailed distribution management in each area. Additionally, introducing Leakage Monitoring Block (hereinafter referred to as "LMB") to monitor the leakage situation easily.
- Build a system to distribute thoroughly chlorinated water.

(2) Policy of Existing Facility Utilization

The policies of existing facility utilization are listed below:

- Use facilities developed by Japanese Grant Aid Projects such as water sources, reservoirs (Welezo, Kinuni and Dole) and water supply mains.
- Existing water sources are utilized. Boreholes which transmit water to a reservoir are used continuously, and boreholes which distribute water directly are used after shifting to water supply via a reservoir.
- Disuse facilities which are aging. Consolidate facilities that have capacities which are too small to be effective. (**Table 4-26**, **Table 4-27**).
- Renew all pipelines and service connections to solve leakage caused by aging pipes and inappropriate water connections.

Table 4-26 Reservoirs to be Disused in the Future

Facility	Type	Structure	Capacity (m^3)	LWL	HWL	Completion	Repair	Remarks
Welezo No.4	Ground	Steel	420	69.90	74.90	1975	–	Old and small
Saateni No.4	Elevated	Steel	450	31.50	35.00	1940	2006	Renewal (ZUWSP)
Saateni No.5	Elevated	Steel	450	31.50	35.00	1940	2006	Renewal (ZUWSP)
Dole (old)	Under ground	RC	100	103.60	106.00	1960	–	Old and small
Mombasa	Elevated	RC	150	Unk	Unk	2006	–	Small
Total			1,570					

Source: JICA Survey Team

Table 4-27 Reservoirs to be Used in the Future

Facility	Type	Structure	Capacity (m^3)	LWL	HWL	Completion	Repair	Remarks
Welezo No.1	Under Ground	RC	4,000	69.90	74.90	2008	–	
Welezo No.2	Under Ground	RC	4,000	69.90	74.90	2008	–	
Welezo No.3	Under Ground	RC	2,250	69.90	74.90	1975	–	41 years old
Saateni No.1	Under Ground	RC	2,250	5.80	6.40	1943	–	73 years old
Saateni No.2	Under Ground	RC	1,000	5.80	6.40	1923	–	93 years old
Saateni No.3	Under Ground	RC	1,000	5.80	6.40	1923	–	93 years old
Saateni*	Elevated	RC	2,000	30.20	34.70	Under construction	–	ZUWSP
SeMuSo	Elevated	RC	120	40.00	44.50	Unknown	–	
Mnarawambao	Under ground	RC	1,000	Unk	Unk	1954	–	62 years old
Mnarawambao	Elevated	Steel	50	40.00	41.80	1954	2013	Tank renewal
Mnarawambao	Elevated	RC	1,000	45.00	50.00	Under construction	–	ZUWSP
Dimani	Under ground	Steel	450	Unk	Unk	1978	2006	Tank renewal
Kinuni	Under ground	RC	2,700	68.00	73.00	2010	–	
Dole	Under ground	RC	1,200	98.70	103.70	2010	–	
Mfenisini	Elevated	Steel	225	Unk	Unk	2013	Planned	Tank renewal
Total			25,325					

*: Number of Saateni reservoir constructed in ZUWSP was reduced from 2 to 1 during the procurement of contractor (as of October 2017)

Source: JICA Survey Team

(3) Policy for Distribution Areas

Non-disclosure Information

4.5.2 Planning of Distribution Zones

The distribution zones are planned according to the policies of distribution zone dividing.

(1) Northern Area

Non-disclosure Information

(2) Central Area

Non-disclosure Information

(3) Southern Area

Non-disclosure Information

4.5.3 Water Operation of the Distribution Zones

(1) Water Demands of the Distribution Zones

Non-disclosure Information

(2) Water Source Amount of Reservoirs and Distribution Zones

Non-disclosure Information

(3) Water Supply Plan of Distribution Zones

Non-disclosure Information

4.6 Water Supply Facility Improvement Plan for Urban West Region

4.6.1 Water Source Facility (New Borehole Development)

Non-disclosure Information

4.6.2 Water Source Facility (Improvement of Existing Direct Pumping Boreholes)

Non-disclosure Information

4.6.3 Water Transmission Facility

Non-disclosure Information

4.6.4 Reservoir

Non-disclosure Information

4.6.5 Pump Facilities for Elevated Reservoirs and Tanks

Non-disclosure Information

4.6.6 Pressure Release Tank

Non-disclosure Information

4.6.7 Disinfection Facility

Non-disclosure Information

4.6.8 Distribution Pipe Network

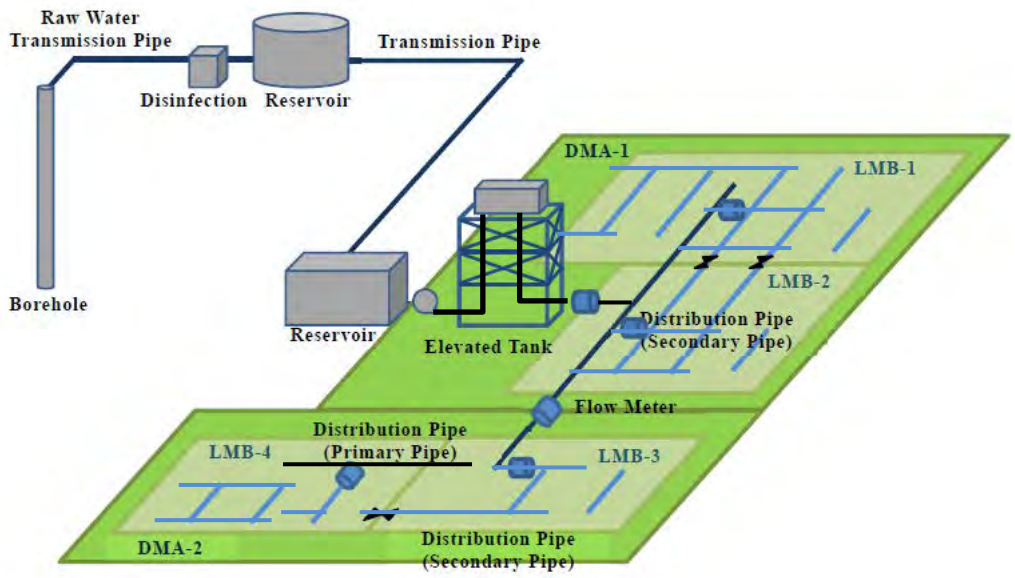
(1) Policy of Distribution Pipe Network Planning

(a) Network structure

As mentioned in the water supply plan policies in **4.5.1**, zoning distribution system shall be introduced in the pipe network plan. The distribution zone shall be divided into several

DMAs for distribution management, and LMBs shall be established for each DMA to monitor leakage by measuring the minimum night flow.

In this Survey, the pipeline distributing water from the reservoir to DMA is called a distribution main (primary main), and the pipeline which branches off the main to distribute water inside the DMA is defined as a distribution pipe (secondary pipe). A diagram of the distribution zoning is shown in **Figure 4-11**.



Source: JICA Survey Team

Figure 4-11 Distribution Zoning Diagram

(b) Pipe material

Non-disclosure Information

(2) DMA Planning

Non-disclosure Information

(3) LMB Planning

Non-disclosure Information

(4) Distribution Pipe Network Planning

Distribution mains and pipelines shall be planned to distribute water from reservoirs to and inside each DMA.

(a) Route selection for distribution pipelines

(i) Route plan for distribution main (Primary Pipelines)

The initial planed route was selected using Google Map, and the actual route was surveyed on the site. Alternative routes were selected in case the actual route survey showed that the initial planned route was not appropriate due to the road circumstances.

(ii) Route plan for distribution pipelines (Secondary and Tertiary Pipelines)

Distribution pipelines branch from distribution mains to supply water to each user in DMAs. The route shall be selected considering the road situations using Google Map.

(b) Network analysis

The pipe diameters are to be determined using the pipe network analysis software "Water Cad". The network model includes primary, secondary and major tertiary pipes. The conditions for pipe network analysis are shown in **Table 4-28**.

Table 4-28 Conditions for Pipe Network Analysis

Item	Conditions
Pipe Material	Primary: DCIP Others: HDPE
Formula	Hazen-Williams Formula
Coefficient of Velocity	DCIP: 110 HDPE: 130
Acceptable Minimum Effective Head	15.0m

Source: JICA Survey Team

(c) Water Distribution Network Plan

Non-disclosure Information

4.6.9 Remote Monitoring Facility

A remote monitoring/control system shall be implemented in order to manage the water operation. The construction of an overall system covering from intake to water distribution is necessary for appropriate O&M and effective operation.

Boreholes, Reservoirs and their pump stations and DMAs will be the target facilities for remote monitoring. Remote control (on/off) of pumps shall also be necessary for boreholes without fulltime on-site staff.

(1) Situation of Current Monitoring

Most monitoring facilities are out of order due to instrument failure. Currently the Water Production Department of ZAWA estimates the yielding volume using pump type, operation time and days. However the figures are too far from actual operation to utilize for management.

(2) Planning Policy

Non-disclosure Information

4.6.10 Electrical and Instrumentation Facility

Non-disclosure Information

4.6.11 Service Connections

Non-disclosure Information

4.6.12 Summary of Facility Plan

Non-disclosure Information

Chapter 5 Operation and Maintenance

5.1 Operation and Maintenance Plan

The O&M system for the facilities planned to be developed in Urban West Region in **Chapter 4** shall be planned based on the O&M situations mentioned in **Chapter 3**.

5.1.1 O&M Policy

Currently in Urban West Region, numerous scattered boreholes are operated individually and comprehensive water distribution management is not implemented. Additionally, daily and periodic inspections of the facilities is also not implemented. To secure stable and safe water supply, O&M is planned following the policies mentioned below in this Plan.

(1) Organization of Facility Operation Systems Centered Upon Reservoirs

- Performing facility O&M centered upon reservoirs by gathering the required information at the reservoir, such as borehole yield, well pump operation status, reservoir inflow amount, reservoir water level and distribution amount.
- Realizing systematic operations management by preparing reservoir demand estimations and distribution plans based on the measured distribution data.
- Strengthening coordination between reservoir and water source operations using remote monitoring systems.

(2) Centralized Management of Facility Operation Status and Distribution Status

- Monitor the distribution status of the whole area by consolidating the distribution data of each DMA at one location
- Recording and accumulating information on facility operations and water supply

(3) Preventive Maintenance through Regular Inspection

- Preventing accidents and securing stable water supply through regular inspection
- To supply safe water continuously, water quality tests to be executed at least once a year on selected items from WHO drinking water quality guidelines, taking into consideration the characteristics of Zanzibar.
- For managing maintenance, prepare daily recording system comprising facility ledgers, inspection records, water quality test reports and repair records.

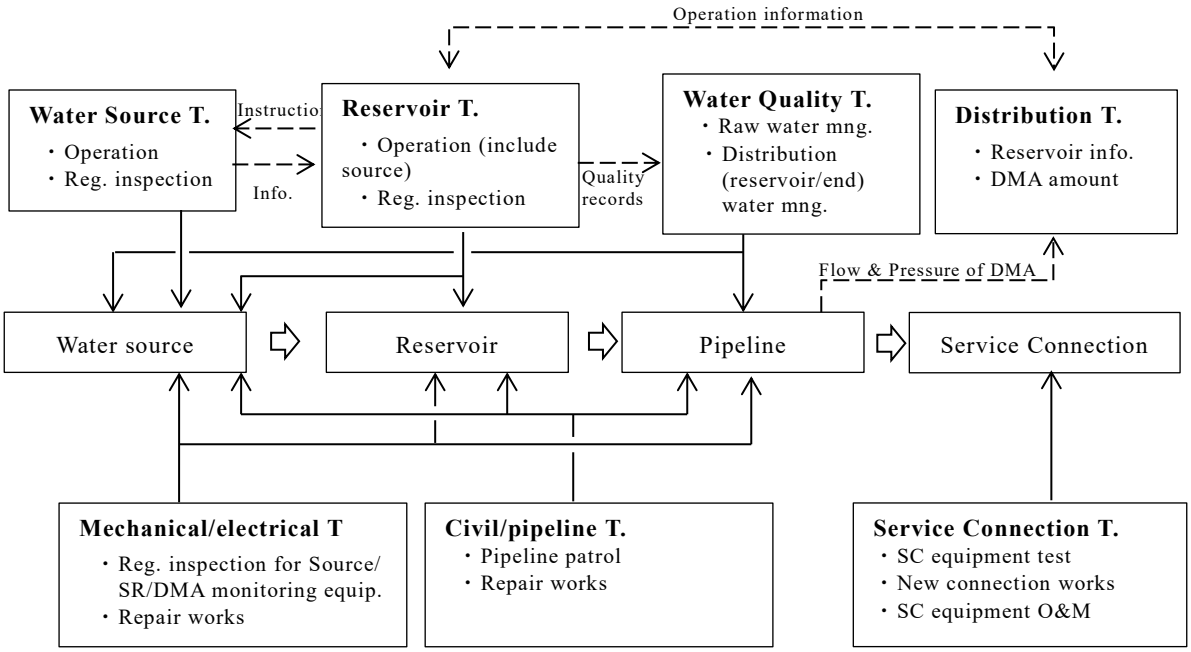
5.1.2 O&M System

The O&M system shall be planned based on the above policies. The main target facilities for operation are the water source facilities and reservoirs, and operating staff shall be required for each facility. Maintenance teams shall also be required to carry out regular facilities inspections and repair works. The maintenance teams are to be divided into the mechanical/electrical management teams for borehole pumps and disinfection facilities, and the civil/pipeline

maintenance teams for reservoir/pipeline facilities.

In addition, with the aim of securing stability of the water amount and quality, distribution management teams for overall water supply management and water quality management teams for water quality management shall be established.

Maintenance teams for service connection equipment shall also be established for new service connections and meter maintenance/renewal. The outline of the system is as shown in **Figure 5-1.**



Source: JICA Survey Team

Figure 5-1 Facility O&M System

The duties for each O&M team shall be as listed in **Table 5-1**.

Table 5-1 Duties for O&M Team

O&M Team	Duty
Water Source Team	・ Facility operation of water source ・ Daily inspection, notification of issues
Reservoir Team	・ Facility operation of reservoir ・ Daily inspection, notification of issues, daily water quality test
Mechanical/electrical Team	・ Maintenance and regular inspection for mechanical/electrical equipment for water source, reservoir and DMA flow meter
Civil/pipeline Team	・ Patrol inspection of pipelines ・ Confirmation/repair of civil/pipeline issues
Service Connection Team	・ Technical examination for new service connection; connection works; meter renewal; equipment repair
Distribution Team	・ Distribution management based on DMA flow amounts and reservoir information
Water Quality Team	・ Raw water/DMA water quality tests; management of test records

Source: JICA Survey Team

Details of each O&M team are described in the following sections.

5.1.3 Water Source Operation

(1) Number of Water Source Facilities

Non-disclosure Information

(2) Structure of Water Source Operation Team

Non-disclosure Information

(3) Comparison of Current and Planned Personnel Allocations

Table 5-2 shows the comparison of the number of current and planned staff. 13additional staff shall be required, due to the current lack of staff and the necessity of staff for borehole operation after completion of planned facilities' development.

Table 5-2 Number of Water Source Operation Staffs

Item	Current	Plan	Increase
Water Source Operation	50	63	+13
Total	50	63	+13

Source: JICA Survey Team

5.1.4 Reservoir Operations

Currently, 8 security guards are allocated at reservoirs for outflow valve operation, visual facility inspection and cleaning. After Project completion, the reservoir staff shall undertake various duties, including managing inflow amount from water source to reservoir, managing supply amount to downstream reservoirs and operating disinfection facilities.

(1) Planned Reservoir Facilities

Non-disclosure Information

(2) Structure of Reservoir Operation Team

Non-disclosure Information

(3) Comparison of Current and Planned Personnel Allocations

Table 5-3 shows the comparison of current and post-project reservoir operating staff. 81 additional staff shall be required, due to the current lack of staff and the necessity of staff to perform additional O&M duties after completion of planned facilities development.

Table 5-3 Planned Number of Reservoir Operation Staffs

Reservoir	Current	Plan	Increase	Note
Non-disclosure Information				
Total	8	89	+81	

Source: JICA Survey Team

5.1.5 Mechanical/Electrical O&M

As mentioned in **Chapter 3.7.1**, currently 24 Water Production Department staff are in charge of mechanical/electrical O&M, mainly focusing on existing borehole pumps. The works are only repair works after a breakdown, and regular inspections are not performed.

This Project shall introduce a system to perform regular inspections and to detect facility issues before breakdowns occur. Specifically, monthly inspections for the pumps, disinfection equipment, flow meters and electrical instruments for the water sources, reservoirs and DMA facilities shall be planned.

(1) Target Facilities and Required Days for Inspection

Non-disclosure Information

(2) Structure of Regular Inspection Team

Non-disclosure Information

(3) Structure of Repair Team

The current team for repair works consists of 24 staff, but repair works are expected to reduce after completion of planned facilities' development due to renewal of the facilities. 6 of the current 24 staff shall be transferred to the regular inspection team, and another 6 staff shall be allocated to the repair team.

(4) Comparison of Current and Planned Personnel Allocations

Table 5-4 shows the planned number of mechanical/electrical O&M staff. As the necessity for repair works are expected to decrease after the development due to the introduction of new facilities, the required number of technical/electrical O&M staff shall be reduced by 12, including the regular inspection team.

Table 5-4 Planned Number of Mechanical/Electrical O&M Staff

Item	Current	Plan	Increase
Regular inspection	0	6	+6
Repair	24	6	-18
Total	24	12	-12

Source: JICA Survey Team

5.1.6 Civil/pipeline Maintenance

(1) Structure of Civil/pipeline Maintenance Team

Non-disclosure Information

(2) Comparison of Current and Planned Personnel Allocations

Table 5-5 shows the planned number of civil/pipeline maintenance staffs. As the necessity of leakage repair works are expected to decrease after the development completion due to the reduction of leakage, the required number of civil/pipeline maintenance staff shall be reduced by 11.

Table 5-5 Planned Number of Civil/Pipeline Maintenance Staffs

Item	Current	Plan	Increase
Pipeline patrol	0	4	+4
Civil/pipeline O&M	30	15	-15
Total	30	19	-11

Source: JICA Survey Team

5.1.7 Service Connection Maintenance

Currently, plumbers from the Customer Service Section of the Commercial Department are in charge of new installations and maintenance of service connections. The sub-sections of the Credit Control Section of the Commercial Department, namely 'Meter Mechanics' and 'Billing Large Customers', are in charge of water meter installations. The staff have also received service connection installation training during the Technical Cooperation Project Phase 1, and have acquired the necessary skills.

(1) Number of Water Meters

Non-disclosure Information

(2) Structure of New Service Connection Team

Non-disclosure Information

(3) Structure of Water Meter Maintenance Team

Non-disclosure Information

(4) Comparison of Current and Planned Personnel Allocations

Table 5-6 shows the planned number of service connection maintenance staffs. As the number of meters are expected to increase largely after the development, the required number of service connection maintenance staff shall be increased by 27.

Table 5-6 Planned Number of Service Connection Maintenance Staffs

Item	Current	Plan	Increase
New service connection	25	30	+27
Water meter O&M		22	
Total	25	52	+27

Source: JICA Survey Team

5.1.8 Distribution Management

Currently, there is no distribution management system. This Project shall introduce a system to manage the distribution status for the whole distribution area, based on the flow amount of each DMA and the operational data of each reservoir. The distribution management shall be carried out at the central monitoring station, for 7 hours per day and 365 days per year.

(1) Structure of Distribution Management Team

The management shall be carried out by 1 chief and 2 monitoring staff. With 3 persons working 7 hours per day, the total workload will be 630 man hours /month (one month = 30 days). Assuming that the work amount for 1 distribution management staff is 140 man-hours/month (7 hours/day, one month = 20 working days), therefore 5 staff will be necessary.

(2) Comparison of Current and Planned Personnel Allocations

Table 5-7 shows the comparison of current and post-development distribution management staff. As currently there are no posts for this duty, 5 staff shall be allocated for this new team.

Table 5-7 Number of Water Distribution Management Staffs

Item	Current	Plan	Increase
Distribution management	0	5	+5
Total	0	5	+5

Source: JICA Survey Team

5.1.9 Water Quality Management

Currently, 4 staff are in charge of water quality management such as raw water quality tests and residual chlorine measurements, and also the O&M of the chlorination facilities. The raw water quality tests use portable instruments and measure only 5 items; pH, chlorine ion, electric conductivity, water-soluble substance and water temperature. The residual chlorine measurements use colorimetric analysis, but other items are not measured. Therefore, the current situation is not sufficient for safe water supply.

(1) Structure of Water Quality Test Team

Non-disclosure Information

(2) Comparison of Current and Planned Personnel Allocations

Table 5-8 shows the comparison of current and post-development water quality management staff. After completion of the Project, the required number of water quality test staff shall be increased by 3.

Table 5-8 Number of Water Quality Management Staffs

Item	Current	Plan	Increase
Water quality management	4	7	+3
Total	4	7	+3

Source: JICA Survey Team

5.1.10 Staff Number and Allocation

(1) Staff increase and allocation

The change of staff numbers and allocations mentioned in the above is listed in **Table 5-9**. Currently, there are 141 O&M related staffs working in the target area. This Plan proposes to add 106 staff, which will make the total number 247 for O&M staff after development of all planned facilities.

Additionally, ZAWA is formulating decentralization management system by reallocating pipe repair and water charges collection staffs from ZAWA HQ to Sub-Offices by the end of 2108 to improve water supply service. New staff recruitment and allocation shall be implemented taking this situation into account.

Table 5-9 Increase and Allocation for O&M Staffs

Item	Current	Plan	Increase	Expected Department/Section
Water Source Operation	50	63	+13	Technical Operation / Water Production
Reservoir Operation	8	89	+81	Technical Operation / Water Production
Mechanical/electrical O&M	24	12	-12	Technical Operation / Water Production
Civil/pipeline Maintenance	30	19	-11	Technical Operation / Water Network
Service Connection Maintenance	25	52	+27	Commercial / Customer Service
Distribution Management	0	5	+5	Technical Operation / Water Network
Water Quality Management	4	7	+3	Water Development / Water Resources
Total	141	247	+106	

Source: JICA Survey Team

(2) Transportation for O&M Works

The current issue regarding the transportation for water source operators is that they are using bicycles, and therefore the travel area is limited and travelling takes time. Patrolling for

maintenance and water quality management is also hindered due to the lack of vehicles. To perform the O&M activities and water quality management proposed by the Project, the vehicles listed in **Table 5-10** shall be necessary.

As shown in **Table 5-11**, ZAWA has 12 vehicles which can be used for O&M purposes. However more vehicles shall be necessary after the planned facilities are developed.

Table 5-10 Vehicles Required for O&M and Water Quality Management

Item	Transportation	Number of Teams	Required vehicles	Notes
Water Source Operation	Foot/bicycle	21	0	Allocate staffs living near source
Reservoir Operation	None	11	0	No travelling from reservoirs
Mechanical/electrical O&M	Vehicle	3	3	Regular inspection 2, Repair 1
Pipeline Patrol	Vehicle	2	2	
Pipeline Maintenance	Vehicle	3	3	
Service Connection Maintenance	Vehicle	10	10	For plumbers of new service connections
Distribution Management	None	-	0	No travelling from monitoring room
Water Quality Management	Vehicle	2	2	
Total		52	20	

Source: JICA Survey Team

Table 5-11 ZAWA Vehicles Required for O&M

Department	Type	Number	Remarks
Technical Operation	Dump	1	MITSUBISHI CANTER
	Pick Up	4	NISSAN HARD BODY, TOYOTA HILUX
	Ban	4	TOWN ACE
	Total	9	
Water Development	SUV	1	SUZUKI ESCUDO
	Pick Up	2	NISSAN HARD BODY
	Total	3	
Grand Total		12	

Source: ZAWA

5.2 Plan for Water Charge Collection

The collecting system water charges for Urban West Region after the planned facilities are developed shall be planned based on the work situations mentioned in **Chapter 3**.

5.2.1 Current Tariff Collection Works

(1) Meter Reading and Billing

(a) Flow meter reading and billing

The flow meter reading and billing works (as of January 2017) is shown in **Figure 5-2**.

Most of the works are managed by the Data Management Section of the Commercial Department, and the ICT Unit is in charge of meter reading data management for smartphone devices. According to the related staff, the system has been recently changed and the work is more efficient than it was prior to and in 2016, when the Credit Control Sub-Department was also included.

The installation of meters is currently carried out at a moderate pace, and ZAWA is lacking meter reading and billing staff, therefore there are 5 temporary staff added to the ZAWA's regular staff. There are a total of 17 meter readers, but ZAWA possess only 10 meter reading devices (smartphone-type), therefore 7 staff are performing meter readings manually.

Source: JICA Survey Team

Figure 5-2 Flow of Meter Reading and Billing

(b) Meter reading and billing performance

The meter reading and billing records for domestic customers of Urban West Region, as of December 2016, is shown in **Table 5-12**.

Table 5-12 Domestic Customer Meter Reading and Billing Record (December 2016)

Meter reading	Billed	Not billed
3,055	2,747	308

Source: ICT Unit, ZAWA

Of the 3,055 meter reading records, 308 customers were not billed. Several reasons cited were; discordance with the SBM II data, disconnection of supply pipes due to *kata-kata*[1] and

[1] An activity of collecting fees from the customer who have not paid for three months or more, by individual visiting after creating a list of unpaid customers within limited areas. The officer processes as paid if the fee is paid on the spot. If the customer refuse payment, the officer disconnects the water supply pipe. ZAWA calls this activity "Kata-kata".

unregistered customers. There were also 139 bills which were not delivered, due to discrepancies in the printed information (name and/or address not found), rejection by customers, and the absence of customers.

Houses in Zanzibar do not have mailboxes, so the bill delivery staff directly hand the bill to residents. If a resident is not at home, the staff may stick the bill in the door frame or window frame, or may bring it back to ZAWA. After several attempts to deliver the bill, it will be handled as a not-billed case.

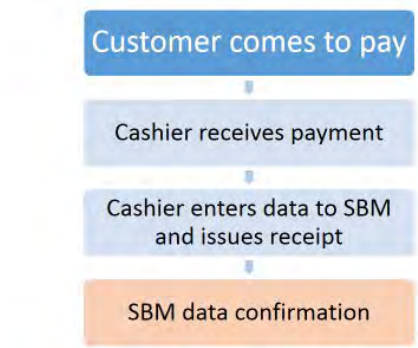
The discordance with the SBM II data occurs when the data of the meter reading cannot match with the customer data and hence the bill cannot be printed, mainly caused by double-meter reading and data input error. In addition, since the works for meter installation has been enforced in the autumn of 2016, the meter data and customer data have been causing discrepancies, and in several cases, meters of non-customers have been read by ZAWA.

The bills which were not printed or delivered are handled as unpaid tariffs, and for the next month, bills are issued following the next month's meter reading records. Customers who have not paid the bills for 3 consecutive months will be listed as *kata-kata* targets.

(2) Tariff collection works

(a) Tariff collection flow

Customers pay their bills directly at the ZAWA HQ or payment offices, as shown in **Figure 5-3**.



Source: JICA Survey Team

Figure 5-3 Tariff Collecting Flow

There are 6 payment offices in Unguja, and 3 of them (ZAWA HQ, Kijito Upele & Mombasa) are located in Urban West Region. These 3 offices can use the internet to access to SBM II, and are able to share the same customer data as the ZAWA HQ. The money collected at the payment offices are regularly collected by ZAWA HQ staff, but there are cases which the payment office staff deliver the money to the HQ, especially when the amount is small.

(b) Tariff collecting performance

The domestic customer tariff collection records of December 2016 is shown in **Table 5-13**.

This data is of whole of Unguja area, although domestic metered customers only exist in Urban West Region.

It shall be noted that the record shows the number of payments made in December 2016, and not the number of the paid bills issued in December.

Table 5-13 Record of Domestic Customer Tariff Collection (December 2016)

Type	Customer number	Collected number	Collect ratio (%)	Note
Metered	3,055	871	28.5	Bill delivered
Flat rate	45,591	1,821	4.0	Bill not delivered
Total	48,646	2,692	5.5	

Source: Data Management, Commercial Department, ZAWA

(c) Collection of unpaid charges

In the past, ZAWA performed *kata-kata* (collection of unpaid tariffs) activities by almost all staff allocated at the HQ, but since the water meter installation activities became the priority works from the autumn of 2016, *kata-kata* is carried out only by the Credit Control sub-department.

The area for *kata-kata* is decided randomly, and not all of the customers with unpaid bills are targeted and there are no official records of the activities. There are only records of the collected amount of money, but there are cases in which the customer pays only a portion of the bills, and therefore the details are not clear. **Table 5-14** shows the amount collected by *kata-kata* from October to December 2016.

Table 5-14 Tariff Collected by *Kata-kata* (2016)

Month	October	November	December	Total
Amount (TZS)	2,674,000	794,500	4,370,000	7,838,500

Source: Credit Control, ZAWA

(d) ZAWA charges collection improvement plans

ZAWA is considering introducing a water tariff payment system using mobile phones to improve convenience of tariff payment, in advance to the increase of water meters and in order to improve the low tariff collection rate.

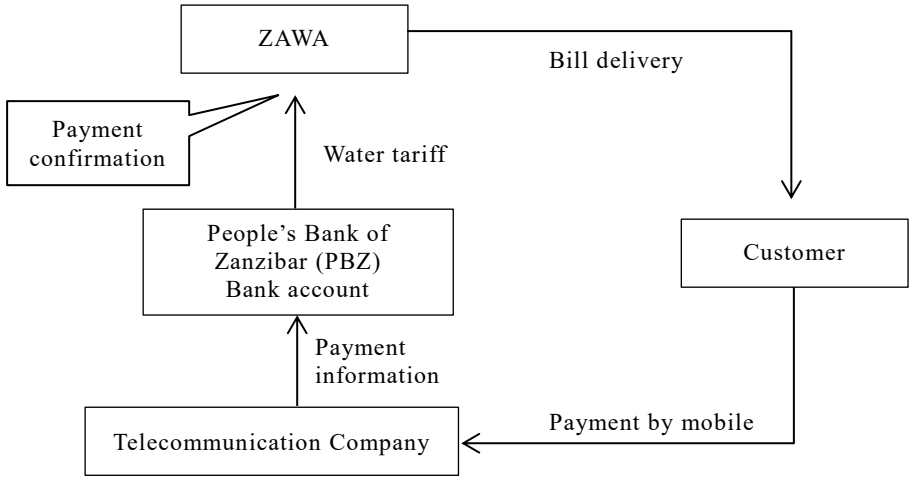
The payment system using mobile phones is largely divided into two types; one where the user (ZAWA) contracts with a bank or alternatively the user (ZAWA) contracts with the telecommunications company. ZAWA is currently interested in the former type.

According to ZAWA, they have negotiated and entered into contract with the Bank, and are presently waiting for remodeling the system of the bank in order to introduce the new service. The new water tariff payment system using mobile telephones are expected to start operating

in January 2018.

The flow of tariff payment system which ZAWA is considering is shown in **Figure 5-4**. The work flow of meter reading to bill delivering is basically the same as when the payment is made at payment offices. However, billing by SMS is an option for the mobile phone payment system, and ZAWA is considering the use of this option in future.

ZAWA is also planning to increase the number of payment offices, and a new office was opened at the end of April 2017 during the period of this Survey.



Source: JICA Survey Team

Figure 5-4 Cash Flow of Payment by Mobile Phone

The status of ZAWA's actions for improvement of water charges collection is shown below;

【On-going】

- Registration promotion activities: In order to improve the registration rate, registration fee is discounted to half-price if the users register to ZAWA within 14 days after the detection of unofficial connection.
- Meter installation activity by ZAWA staffs
- Promotional activities on media such as television and radio and promotional vehicles

【Future Plan】

- Introduction of POS device for payment of water service fee (mobile equipment capable of printing invoices and payment on the spot): December 2017

5.2.2 Tariff Collection Work Plan

The number of water meters shall largely increase after the planned facilities are developed. It shall be necessary to organize work flows and staff allocation to handle the increased numbers of meters.

(1) Preconditions

(a) Number of water meters

Non-disclosure Information

(b) Frequency of meter reading

A large number of staff shall be required to continue the current monthly meter reading and billing. However, the Water Regulation specifies monthly billing for the water tariff. Therefore, this Plan proposes bimonthly meter reading and monthly billing.

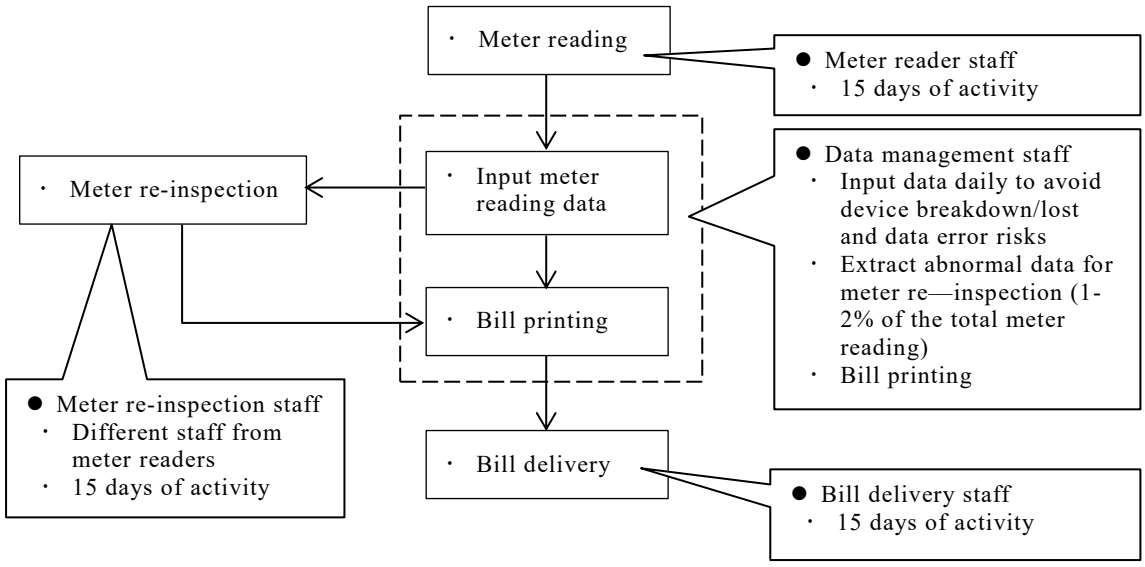
(c) Meter reading device

Meter reading using smartphones is proposed, since the device can be used by a meter reader by installing an application and no specialized equipment is required. The Technical Cooperation Project Phase 2 has completed OJT for meter readers using smartphones.

(2) Meter reading and billing work

(a) Work flow

The meter reading and billing work flow proposed by this Plan is shown in **Figure 5-5**. The days spared for meter reading works will not be sufficient when the number of meters increase, therefore it shall be necessary to specify and divide the work among meter reading staff and data management staff to input the meter reading data and print bills, and the bill delivery staff.



Source: JICA Survey Team

Figure 5-5 Meter Reading and Billing Work Flow

(b) Structure of meter reading and billing

(i) Structure for meter reading

Non-disclosure Information

Table 5-15 shows the comparison of current and post-development meter reading staff.

Table 5-15 Comparison of Current and Post-Project Meter Reading Staff Numbers

Item	Current	Plan	Increase
Meter reader	17	70	+53

Note: Currently meter readers are also in charge of bill delivering

Source: JICA Survey Team

(ii) Structure for meter re-reading

Non-disclosure Information

Table 5-16 shows the comparison of current and after the development meter re-reading staff.

Table 5-16 Number of Meter Re-reading Staffs

Item	Current	Plan	Increase
Meter re-reading	0	7	+7

Source: JICA Survey Team

(iii) Structure for data management

To maximize the work efficiency, the number of meter reading devices shall be twice the number of staff. This means that the data management staff can input the data of the day before into the meter management system, while the meter readers are performing their daily activities. The data management staff shall also check the inputted data, and extract abnormal data for re-reading.

After the above work is completed, the data management staff will transfer the customer data for the next day meter reading to the smartphones.

Non-disclosure Information

The number of staff required for data management shall be 5 in total; 1 chief, 2 meter reading data operators, 1 bill printing operator and 1 assistant. **Table 5-17** shows the comparison of current and post-development data management staff.

Table 5-17 Number of Data Management Staffs

Item	Current	Plan	Increase
Chief	1	1	±0
Operator	2	4	+2
Total	3	5	+2

Source: JICA Survey Team

(iv) Structure for bill delivery

The main reason for the current low efficiency of bill delivering is the re-delivering to absent households. To solve this issue, the Project proposes to install a post box to each customer's house for bill delivery.

Non-disclosure Information

Table 5-18 shows the comparison of current and post-project bill delivery staff.

Table 5-18 Number of Bill Delivery Staffs

Item	Current	Plan	Increase
Bill delivery	17	70	+53

NOTE: Currently bill delivery staffs are also in charge of meter reading

Source: JICA Survey Team

(3) Tariff collection work

(a) Basic policy

ZAWA is acting to improve tariff collection by considering introduction of a payment system using mobile phones and by increasing the number of payment offices. Said actions are considered effective, therefore the tariff collection plans proposed by the Plan shall be based on the policy that payments by both mobile phone and payment office are used.

However, the number of payment offices are not sufficient, therefore it shall be necessary to open an office in the north part of Urban West district, where there are currently no offices.

In addition, due to the difficulty in estimating the user ratio of the mobile phone payment service, the increase in payment offices shall be kept to a minimum during the initial period, and new offices shall be opened as necessary.

(b) Staff organization for water charges collection work

The policies for the tariff collection structure are listed below. **Table 5-19** shows the comparison of current and after the development tariff collection staff.

- Tariff shall be collected by means of the mobile phone payment system and 5 payment offices (currently 4 offices including 1 office that opened in April 2017).

- Structure for payment offices outside of ZAWA HQ shall be 5 staff: 1 chief, 2 customer service staff and 2 cashiers.
- Payment offices outside of ZAWA HQ shall be equipped with an internet system to enable connection to the customer management system in order to automatically synchronize the payment data.
- Staff responsible for collection of money from the payment offices shall be secured.

Table 5-19 Number of Tariff Collection Staffs

Item	Current	Plan	Increase
ZAWA HQ	5	5	±0
Kijito Upele	5	5	±0
Mombasa	2	2	±0
New office (opened in April 2017)	0	5	+5
New office (for future)	0	5	+5
Money collection	1	1	±0
Total	13	23	+10

Source: JICA Survey Team

(4) Staff number and allocation

(a) Staff numbers and allocation

The change of staff numbers and allocations mentioned in the above is listed in **Table 5-20**. Currently, there are 50 tariff collection related staff working in the target area. This Project proposes to add 125 staff, which will make the total number 175 for tariff collection staff.

Additionally, ZAWA is formulating decentralization management system by reallocating pipe repair and water charges collection staffs from ZAWA HQ to Sub-Offices by the end of 2108 to improve water supply service. New staff recruitment and allocation shall be implemented taking this situation into account.

Table 5-20 Increase and Allocation for Tariff Collection Staffs

Item	Current	Plan	Increase	Expected Department/Section
Meter reading	17	70	+53	Commercial / Credit Control
Meter re-reading	0	7	+7	Commercial / Credit Control
Data management	3	5	+2	Commercial / Data Management
Bill delivery	17	70	+53	Commercial / Credit Control
Tariff collection	13	23	+10	Commercial / Credit Control
Total	50	175	+125	

Source: JICA Survey Team

(b) Transportation for tariff collection works

To perform the tariff collection activities proposed by the Plan, the vehicles listed in **Table**

5-21 shall be necessary.

As shown in **Table 5-22**, ZAWA has 5 vehicles which can be used for tariff collection purposes. However more vehicles shall be necessary after the planned facilities are developed.

Table 5-21 Vehicles Required for Tariff Collection

Item	Transportation	Number of Teams	Required vehicles	Notes
Meter reading	Vehicle (share)	70	4	Van for 6 people/ shuttle service 3 time
Meter re-reading	Vehicle (share)	7	2	Vehicle for 4 people
Data management	None	-	0	
Bill delivery	Vehicle (share)	70	4	Van for 6 people/ shuttle service 3 time
Tariff collection	None	1	1	From HQ to collect payment office money
Total		148	11	

Source: JICA Survey Team

Table 5-22 ZAWA Vehicles Required for Tariff Collection

Department	Type	Number	Remarks
Commercial	Mini Bus	2	MITSUBISHI, TOYOTA
	Pick Up	2	NISSAN HARD BODY
	SUV	1	SUZUKI VITARA
	Total	5	

Source: ZAWA

5.3 Human Resource Development Plan

5.3.1 Required Capacity for Facility O&M

(1) Issues of Facility O&M

The issues related to facility O&M, based on the field study results mentioned in **Chapter 3**, are listed below for considering the human resource development plans for facility O&M.

- Borehole yields, inflow quantity of reservoirs and distribution quantity is not managed due to defects and/or breakdowns of meters.
- There is no information sharing between reservoir operators and borehole operators. Reservoir operators do not know the operational status of borehole, and borehole operators operate regardless of the reservoir situation.
- Regular inspection is not performed. Repairing is the main work.
- There are no ledgers or reports which can be used to provide basic information for O&M activities. Equipment ledgers, operations records, flow volume records, inspection records, breakdown reports and repair records are not sufficient. Facility and equipment information is registered in GIS, but the information is incomplete.

To solve the above issues, this Project proposes the following O&M plans, as detailed in **5.1.1**.

- Gather water source and reservoir operation information at the reservoir by using remote monitoring systems, and centralize control of the facilities.

- Perform regular inspections to prevent breakdowns and to detect abnormalities, to enhance the operational stability of the facilities.
- Improve O&M capabilities by sorting ledgers and keeping records.
- Implement accurate and speedy renewal/repair of the large number of water meters which will be installed.

(2) Capacity building items

To perform a comprehensive facility O&M after the development, it shall be necessary to enhance the capacities mentioned in the following.

(a) Facility operation

- Understand the overall water supply/ distribution system.
- Acquire operation methods of monitoring equipment to monitor/ record accurate information of well intake amount, borehole pump status, reservoir inflow amount, reservoir water level and distribution amount.
- Acquire the knowledge to understand the overall operational information gathered by the monitoring equipment to make correct decisions and operations.
- Acquire the knowledge to predict short-term distribution amounts based on past distribution records (day, season, weather, etc.), and to plan/ implement operation plans for water sources, water supply and distribution based on the prediction.

(b) Facility maintenance

- Understand the items which require regular inspection for each facility/ equipment, and understand the necessity for inspection.
- Acquire the knowledge required for accurate implementing and recording of daily/ regular inspections. Also, acquire knowledge to decide the necessity to change consumables based on the inspection records.
- Understand the necessity of ledgers to record basic information of facilities and equipment. Also, acquire the methodology of keeping ledgers, facility records and O&M information, and to preserve repair records.
- Understand the methods to repair a breakdown.

(c) Service connection maintenance

- Understand the issues caused by aging meters, such as under-measurement.
- Acquire techniques to manage water meter equipment and information.
- Acquire techniques to change water meters.

(d) Water quality management

- Understand the necessity of water quality management, quality standards, measurement frequency and measurement locations. Also, acquire knowledge to

prepare water quality management plans.

- Acquire knowledge to perform basic water quality tests for raw water using portable measurement equipment, and to make records.
- Acquire knowledge to perform basic water quality tests such as pH, turbidity, color and residual chlorine, for reservoirs and supply taps using portable measurement equipment, and to make and keep records.
- Understand the methods required when an abnormality is detected by the water quality tests.
- Understand the methods to aggregate/ analyze/ preserve/ report the records.

5.3.2 Required Capacity for Tariff Collection

(1) Issues of Water Charge Collection

The Technical Cooperation Project Phase 2 has performed technical transfer for meter reading using smartphone devices and for billing, therefore the ZAWA staff who are currently involved in the said activities already possess basic capacity for the works.

The main issues for tariff collection are listed below.

- Adapt to the increasing workload related to the large numbers of water meters which are to be installed
- Information management of the customers who are register after the development

(2) Capacity Building Items

To perform accurate water charges collection after the development, it shall be necessary to enhance the capacities listed below.

- Acquire the knowledge required to prepare meter reading work plans, such as meter reading area setting, schedule making and staff assignment. Also, acquire the knowledge to review the plans according to the business environment changes, such as the increase of customers, to maintain accurate meter readings.
- Acquire the operation methods of the billing/ tariff collecting system which shall be newly introduced (methods to register new customer information, to confirm billing and payment status, etc.).

5.3.3 Related Capacity Development Items

(1) Issues Based on Achievements of the Technical Cooperation Projects

- During the period of the Technical Cooperation Projects, the intake amount was not monitored due to the non-installation/ malfunction of flow meters, the distribution amount was not monitored, and the NRW amount was not managed since the water meters were not installed at the households.

- During the period of the Technical Cooperation Projects, surface leakage was frequent, and the underground leakage detection techniques were not completely transferred due to insufficient conditions.
- The organizational re-structuring plans were approved by the Board, but the actual organization has not been changed accordingly. The work flow improvement drafted by the Technical Cooperation Projects are stalled.
- It is necessary to secure a budget to enhance O&M and to complete water charges collection works, in order to improve the tariff income of ZAWA and to maintain improved water supply services. Although a budget became to be allocated to necessary activities due to the preparation of ABP, issues on budget management such as accuracy and implementation management are still remain.

(2) Ability Enhancement Items

- Acquire techniques to use analyzed data to manage NRW, and to form NRW improvement plans.
- Acquire techniques to use analyzed DMA distribution amount data to manage leakage of the distribution zones, and to detect leakage by LMB flow monitoring.
- Acquire techniques to improve job performance by organizational analysis, evaluation and improvement.
- Acquire techniques for accurate budget planning and management.

5.3.4 Human Resource Development Plan

(1) Development Policy

The human resource development policies are listed below.

- The ideal plan is to achieve the capacity targets through the self-efforts of ZAWA. If capacity development by only the self-efforts of ZAWA is expected to be difficult, human resource development through technical support is considered.
- Capacity development shall also target staffs who manage the works, not only the staff who perform the works.
- To promote self-sustainability of ZAWA, the veteran ZAWA staff shall guide and instruct the other staff.

(2) Development Plan

Table 5-23 shows the proposed training details for technique and knowledge acquiring.

Table 5-23 Proposed Training Details for Staff Development

Team	Training details (draft)
Water source operation	・ Lecture for record keeping of patrol inspection of unmanned operated boreholes. Pump operation and inspection shall be done by OJT. ZAWA veteran staffs who have knowledge and duty experience shall be the trainer. This training shall be given several times each year, to share issues and caution points. ・ Lectures for keeping daily reports and regular inspection records using unified formats for well monitors of man operated boreholes shall be given periodically. Trainings for emergency contacts shall also be given at the same time.
Reservoir operation	Joint training to understand the overall intake/ distribution system. OJT type training for the following items. ・ Demand prediction: understand the deciding factors (temperature, weather, etc.) of demand prediction by analyzing the accumulated everyday distribution data. Create/ use prediction calculations required for distribution planning based on the data analysis, and enhance the accuracy. ・ Supply operating: Training program for; adjusting yield (on/off of pumps), modifying inflow amount/ water level of reservoir (manual valve operation), monitoring reservoir outflow, communication structures among different distribution systems, keeping daily reports/ inspection records, measures for unmanned periods. ・ Disinfectant injection/ residual chlorine concentration management: Lecture/ OJT for; powder substance dissolving method, amount and method of disinfectant injection to raw water, measurement method of residual chlorine.
Mechanical/technical maintenance	Training for regular inspection operators to create equipment ledger to serve as the basis of O&M and inspection records. Training for repair workers of basic mechanical/electrical knowledge by ZAWA staff. OJT training of actual inspection/ repair by veteran staff.
Civil/pipeline maintenance	Create valve ledgers and supply/ distribution system pipeline system drawings for patrol inspection of pipelines. Team-by team training for patrol inspection using A3 paper size drawings. Training to use distribution drawings for leakage correspondence.
Service connection maintenance	OJT for new service connection staff of the total flow of service registration, technical inspection and connection construction. Lectures to update and activate new customer registration information in the customer management system. Water meter exchange and service connection equipment repair trainings shall be of basic knowledge lectures and OJT by team leaders for technique improvement.
Distribution management	Create pipeline floor plans of DMAs to record the daily input flow amount for accurate DMA management. DMA water pressure measurement to create water pressure distribution map. Understand NRW ratio by analyzing monthly input amount and used amount. Request detailed inspection for DMAs with abnormally high NRW.
Water quality management	Lectures to acquire latest chemistry. Create database of raw water quality and water quality test results for record keeping.
Water charges collection	OJT for setting meter reading areas of approximately 100 meters, assignment of meter reading staffs, meter reading work planning.
Finance & Administration Dep.	Acquire techniques to analyze the current work flow and the issues and causes, and to analyze the organization and jobs to form improvement plans.
	Analyze the current budget deciding process, budget management/ evaluation/ analysis flow to improve budget planning and management abilities.

Source: JICA Survey Team

(3) Implementation Methods for Human Resource Development

(a) Methods of training

Training is planned to be through combination of lectures and OJT as mentioned above.

(b) Planned Implementation Method

Some training items require a long time to develop the capacity of ZAWA's staff. Therefore, training by the Contractor and the soft component by the Consultant are proposed as the minimum necessity, as regards technical support in developing ZAWA's staff capacity.

For items that require continued training over a long period of time, ZAWA's self-help efforts are the basis.

(c) Training Details and Periods

Non-disclosure Information

(4) Implementation Schedule

Non-disclosure Information

Chapter 6 Implementation Plan of Yen-Loan Project

6.1 Priority Project Zones

In this section, priority for development of each zone is evaluated.

6.1.1 Purpose of the Project

This project aims to improve the living environment of Zanzibar by providing safe and stable water supply services to urban water supply area in Urban West Region through development and renewal of water supply facilities.

The objective of this project is consistent with one of the goals set out in the Zanzibar Vision and the national water policy, i.e. stable supply of safe water.

6.1.2 Selection of Priority Project Area

Non-disclosure Information

6.2 Project Implementation Plan

Non-disclosure Information

6.2.1 Project Component Plan

Non-disclosure Information

6.2.2 Contract Package

Non-disclosure Information

6.2.3 Project Implementation Schedule

(1) Considerations for Project Implementation Schedule

Non-disclosure Information

(2) Project Implementation Schedule

The project implementation schedule was planned according to the above idea. The details are described in **Chapter 8**.

6.3 Procurement Plan

6.3.1 Employment of Consultants

(1) Selection Policy of Consultants

Non-disclosure Information

(2) Scope of Consulting Service

Non-disclosure Information

(3) Personnel plan and cost of consulting service

This item is described in **Chapter 8**.

6.3.2 Procurement of Contractors

(1) Bidding Method, Terms of Contract

Non-disclosure Information

(2) Selection Procedure of Contractors

Non-disclosure Information

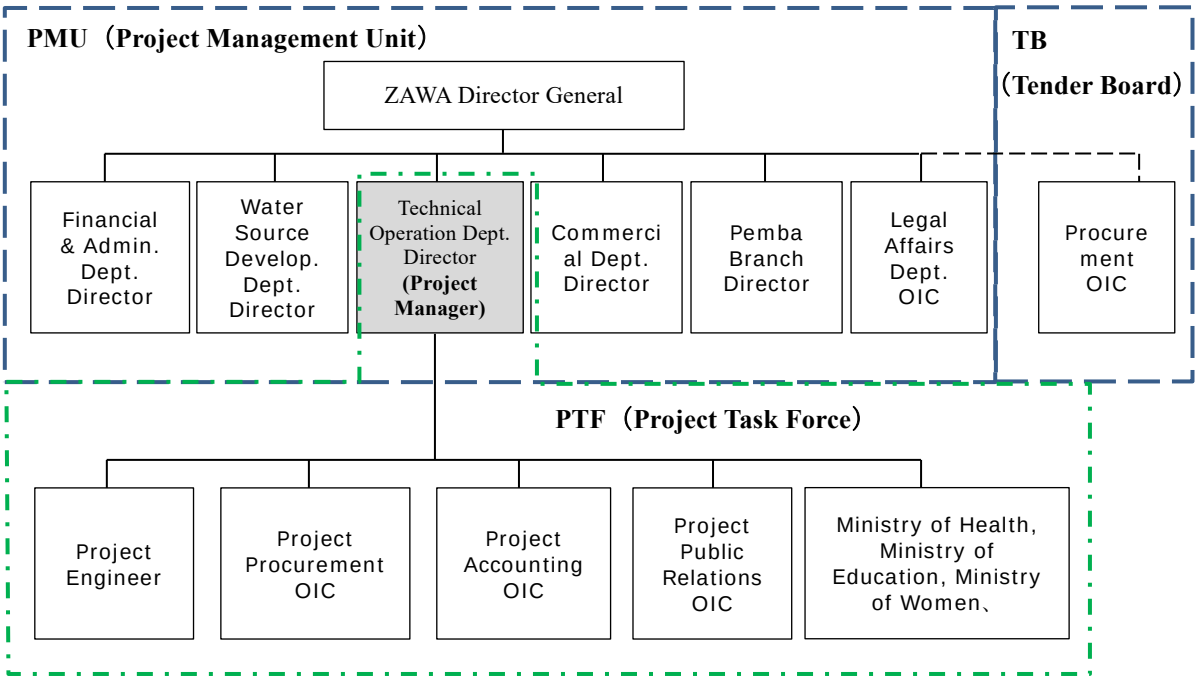
6.4 Project Implementation Organization

(1) Project Implementation Management System with ZUWSP

The project implementation management system of ZUWSP supported by AfDB consists of PMU (Project Management Unit), PTF (Project Task Force), and TB (Tender Board).

PMU manages the entire project, consisting of ZAWA's Director General, 5 Directors and Legal Department staff. TB manages procurement of consultants and contractors, and it consists of PMU members and staff in charge of procurement, a Legal Officer and the Chief Accountant of ZAWA. PTF works with contractors and consultants for project implementation. PTF is composed of engineers, procurement managers, accounting officers, and public relations officials. In the case of ZUWSP, staff members of related organizations (Ministry of Health, Ministry of Education, and Ministry of Women's Social Advancement) are included in PTF as they work with other related projects.

Figure 6-1 shows the project implementation management organization structure of ZUWSP.



Source: JICA Survey Team

Figure 6-1 ZUWSP Project Implementation Management Organization Structure

(2) Issues of ZUWSP Project Implementation Management

The director of the Technical Operations Department is the project manager of the ZUWSP project. Since directors are the main leaders of ZAWA and are busy attending to business management issues, it is difficult to manage other projects.

The project construction covers many fields, such as civil, mechanical, electrical and pipelines, but only one project engineer is assigned. Therefore, additional personnel are required for construction works, and it often takes a long time.

Further, members in charge of the environmental field are absent.

(3) Basic Policy for Establishing Project Implementation Management System

The basic policy concerning the project implementation management system is shown below.

- This project is bigger in scale than ZUWSP and has many packages for construction work. In order to carry out the project smoothly, it is necessary to build a project implementation system led by leaders with strong leadership, so it is desired to establish a system led by DG of ZAWA.
- Plan a two-layer structure of an organization that manages and approves the entire project and an organization that supervises contractors with consultants in the field.
- Project Manager is assigned as a field manager and manages the project implementation

at the sites

- Since the project involves many fields of work such as civil engineering, mechanical and electrical engineering, piping, service connection, monitoring system, customer management system, etc., necessary number of staff in charge shall be allocated.
- Since the project involves renewal of service connections and new service connection work to newly subscribed customers, public relations activities for residents and others shall be strengthened.
- Place staff in charge of the environment in order to manage monitoring activities by contractors according to the environmental monitoring plan during the construction period.

(4) Proposed Project Implementation Management System

Non-disclosure Information

(5) Organization Structure after Project Implementation

The organizational structures for O&M and water charges collection after the development of the planned facilities for the whole Urban West Region are mentioned in **Chapter 5**. Using the same methods, the number of staff required after the Project was calculated, and the results are shown in **Table 6-1** and **Table 6-2**. Detailed information is show in the **Appendix**. Increase and reallocation for 27 staff shall be required for O&M and tariff collection works.

Proposed number of staff increase is in 2025, and it is necessary to stepwisely increase the staffs during the Project period considering advance preparations for the work.

Table 6-1 Facility O&M Staff

Item	Current	Plan	Increase
Water Source Operation	50	50	±0
Reservoir Operation	8	45	+37
Mechanical/electrical O&M	24	14	-10
Civil/pipeline Maintenance	30	19	-11
Service Connection Maintenance	25	8	-17
Distribution Management	0	5	+5
Water Quality Management	4	5	+1
Total	141	146	+5

Source: JICA Survey Team

Table 6-2 Tariff Collection Staff

Item	Current	Plan	Increase
Meter reading	17	23	+6
Meter re-reading	0	3	+3
Data management	3	5	+2
Bill delivery	17	23	+6
Tariff collection	13	18	+5
Total	50	72	+22

Source: JICA Survey Team

6.5 Operation and Effect Indicators

As performance indicators of outcome level, operational and effect indicators are applied for the main sector in Yen-Loan projects. The definition of each indicator is as follows.

- Operation Indicator: Indicators to quantify the status of the operation
- Effect Indicator: Indicators to quantify the status of the effect expression

Specifically, **Table 6-3** shows general operation and effect indicators for water supply projects. Billed metered consumption rate, metered rate of service connection and rate of continuous disinfection in Welezo Reservoir and Migombani Reservoir are proposed as indicators for the Project. This is because the Project aims at applying metered rate by installing water meters to improve ZAWA's financial condition, improving water supply service by leakage reduction and supplying safe disinfected water. The Project monitoring indicators are shown in **Table 6-4** and **Table 6-5**.

Table 6-3 General Operation and Effect Indicators of Water Supply Project

Category	Area	Type	Indicator
Operation indicator	Project Area	Basic	Served population
		Basic	Water Meter Installation/ Registration Tally
		Basic	Water Supply Volume (m^3/d)
			Utilization Ratio (%)
		Basic	Non-Revenue / Revenue Water Ratio (%)
		Aux.	Leakage Ratio (%)
		Aux.	Intake Volume (m^3/d)
		Aux.	Water Quality
Effect indicator	Project Area	Basic	Service Ratio (%)
		Aux.	Per Capita Water Supply (L/capita/d)
		Aux.	Land Subsidence (cm/year)
		Aux.	Collected Tariff
	Whole Area	Aux.	Service Ratio (%)

Source: JICA Survey Team, Based on Operation / Effect Indicator Reference (2nd Edition)

Table 6-4 Project Monitoring Indicators

Indicator*	Indicator Measuring Method	Timing	Reference (2017)	Target (2025**)
Billed Metered Consumption Rate inside Project Area	This indicator is calculated as Billed Amount / DMA Input Amount*** inside the Project Area	Yearly Basis	No data	80%
Metered Rate of Service Connection inside Project Area	It is calculated as calculated as Number of Metering / Number of Connections inside the Project	Quarterly Basis	No data	100%
Rate of Continuous Disinfection in Welezo Reservoir and Migombani Reservoir	This indicator will be recorded at Welezo Reservoir and Migombani Reservoir.	Daily Basis	No data	100%

*: within the Project Area, **: 2 years later after the completion of the Project, ***: total inlet flow of DMA
Source: JICA Survey Team

Table 6-5 Project Monitoring Indicators for Reference

Indicator	Indicator Measuring Method	Timing	Reference (2017)	Target (2025****)
Number of Served Population in the Project Area	This indicator is calculated as number of domestic service connections x average household members	Quarterly Basis	152,000	225,000
Number of Served Population in the Project Area + ZUWSP Area	This indicator is calculated as number of domestic service connections x average household members	Quarterly Basis	232,000	331,000

****: 2 years later after the completion of the Project
Source: JICA Survey Team

Chapter 7 Construction Plan

This chapter examines the construction plan for the facilities as proposed in **Chapter 6** under the Yen-Loan project.

7.1 Summary of Construction Works in the Project

Non-disclosure Information

7.2 Procurement of Materials and Construction Machinery

Although the major industries in Zanzibar are agriculture and tourism, availability of construction materials is limited. Therefore, most of the construction materials will have to be procured from the Tanzanian mainland or other countries.

(1) Construction Material

Table 7-1 shows the availability of materials and equipment.

Table 7-1 Availability of Materials and Equipment

Type of Construction	Human Resource/ Material/Equipment	Zanzibar	Tanzania Main Land*	Overseas
Civil Engineering Works	Labor	△	○	
	Sand	○		
	Cement	△	○	
	Form	△	○	
	Reinforcing bar	△	○	
	Fuel (e.g. diesel, gasline)	△	○	
	Crushed rock		○	
Pipe Installation Works	HDPE Pipe		○	
	Ductile cast-iron pipe			○
	Steel pipe (small diameter)	△	○	
Mechanical-Electrical and Equipment Works	Pump			○
	Valve			○
	Control Panel			○
	Transformer			○
	Generator			○
Construction Machinery	Excavation machine	△	○	
	Crane	△	○	
	Dump truck	△	○	
Architectural Works	Brick		○	
	Interior material		○	
Temporary Works	Concrete Plant		○	
Procured Equipment	Vehicles		○	
	Water meter calibration equipment			○
	Water quality test equipment			○
	Customer Management System			○

*Major supplying area is Dar es Salaam
**○: available, △: available but it is difficult to secure enough quantity for the Project
Source: JICA Survey Team

(a) Concrete

There is no ready-mixed concrete plant in Zanzibar. Therefore, concrete batcher plant must be brought into Zanzibar.

(b) Pipe Material

Ratio of asbestos pipes used in existing pipes is high, and water leakage occurs frequently. In this plan ductile cast iron, which was used in the Japanese Grant Aid Projects, is planned to be used for raw water transmission pipelines and distribution mains, and HDPE pipes are used for distribution pipelines.

HDPE pipes are produced in Tanzania and widely distributed. ZAWA has procured these HDPE pipes and quality is not a problem since it is produced on ISO Standards.

Ductile cast iron pipes are not produced in Tanzania and condition of its distribution is not good. Therefore it should be imported. In the Japanese Grant Aid Project, ductile cast iron pipes produced by a Japanese company was procured.

(c) Mechanical and Electrical Equipment

Electro-mechanical equipment, such as pumps and other equipment, are not produced in Tanzania. Therefore, imported materials will be used in the project.

(2) Construction Machinery

Regarding construction of reservoirs, overhead tanks and installation of pipes, most of construction works can be carried out using general construction machinery, such as backhoe, crane, dump truck, and concrete pump truck. However, it is difficult to arrange for these equipment in Zanzibar, and all of these will therefore be needed to be brought in from mainland Tanzania.

(3) Labor and Contractors

Although construction works for tanks are not specialized works, the tanks require high water tightness, and as such only Contractors who have experience in water retaining structures must be selected. In terms of pipeline works, connection works of ductile cast iron pipes and HDPE pipes are not specialized work but it requires good skill and experience.

There are some experienced laborers available in Zanzibar and therefore, the available skilled and unskilled labor in Zanzibar has to be utilized as much as possible. If the necessary number of laborers are not secured, skilled and unskilled laborers from the mainland will have to be employed.

7.3 Outline of Construction Plan

In order to estimate unit prices, construction methods suiting the local conditions shall be planned in this section.

7.3.1 General Civil Works and Piping Works

(1) Earthwork

Earthwork (excavation and backfilling) for facility construction; reservoirs for example, are carried out using heavy machinery such as backhoe and dump truck.

Earthwork for piping shall be carried out using machinery in general. However, in case there are buried objects such as existing pipes in the trench or there is insufficient space for excavation in high density housing areas, earthwork will have to be carried out manually.

(2) Earth Retaining Work

General style of digging for facility construction is open-excavation; therefore earth retaining works are not carried out. For excavation for piping, trenching shall be carried out for depths shallower than 1.5 meters, while open-excavation with side slopes will be done for depths in excess of 1.5 meters. In the event that space constraints do not permit open excavation, appropriate earth retaining measures shall be incorporated.

(3) Concrete Work

As mentioned before, there is no ready-mixed concrete plant in Zanzibar and as such concrete batcher plant shall have to be installed at the construction site where the concrete will be mixed. The concrete mix shall be carried to the casting sites by concrete mixer trucks and casting shall be by means of concrete pump truck.

(4) Pipe Installation Work

Heavy ductile cast-iron pipes are laid using cranes, while HDPE pipes are generally laid manually by hand.

7.3.2 Mechanical and Electrical Equipment Work

Cranes shall be used for installation of machineries, such as pumps and panels. After installation, commissioning shall be carried out to ensure full functionality of the equipment.

7.3.3 Works Requiring Special Techniques

(1) PC Construction

Since PC cable tensioning work for PC Tank is difficult for local contractors, it will have to be carried out by specialized contractors from overseas with prior experience. The contractor would need to also provide the necessary equipment for carrying out the works.

(2) Pipe Branching Method under Pressure

Connections and branches to existing pipelines without water supply interruption. The works are carried out on existing mains and has to be done by specialized overseas contractors with prior experience in carrying out such works without interruptions to the existing water supply. The oversea contractor would need to bring the necessary equipment and materials for the works.

7.4 Schedule of Construction

Non-disclosure Information

Chapter 8 Project Cost

8.1 Composition of the Project Cost

The following items are included in the Project Cost.

1) Construction costs
2) Consulting fees
3) Contingency for construction costs and consulting fees
4) Price escalation for construction costs and consulting fees
5) Interest rate during construction
6) Front-end-fee
7) Compensation for land acquisition
8) Tax
9) Administrative cost of implementing agency

8.2 Condition for Project Cost Estimation

Non-disclosure Information

8.3 Project Cost

8.3.1 Construction Cost

Non-disclosure Information

8.3.2 Consulting Fees

Non-disclosure Information

8.3.3 Project Cost

Non-disclosure Information

8.4 Operation and Maintenance Cost

Non-disclosure Information

8.5 Project Implementation Schedule

Non-disclosure Information

Chapter 9 Environmental and Social Considerations

9.1 General

9.1.1 Project Components Which May Affect Local Environment and Community

Non-disclosure Information

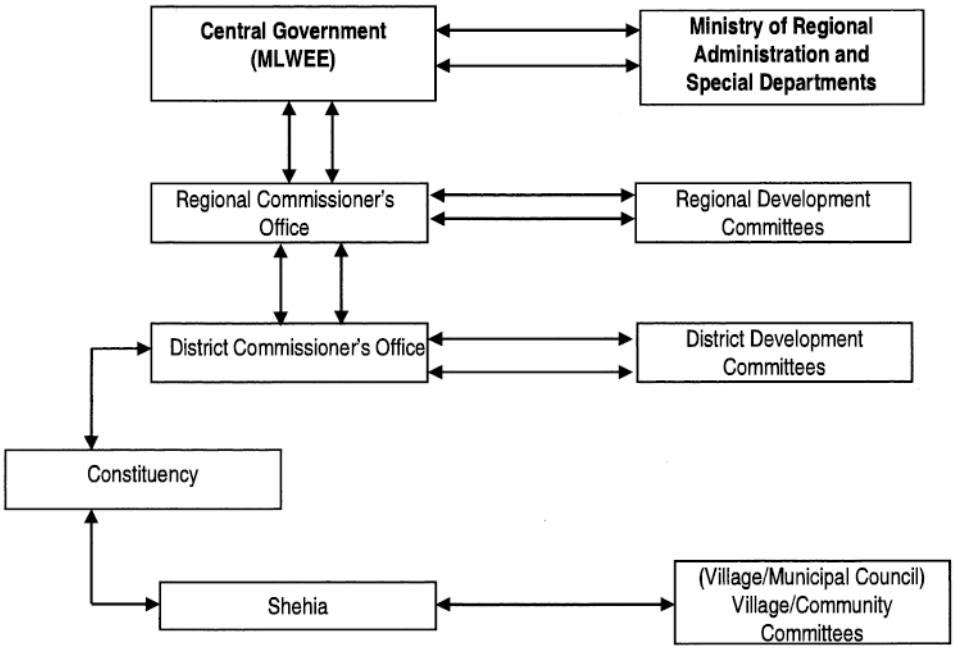
9.1.2 Environmental Setting

(1) Administrative Boundary in the Project Site

Zanzibar is the archipelago belonging with the United Republic of Tanzania. Tanzania was established when Tanganyika and Zanzibar, which both gained independence from the British in the 1960's, merged to form the United Republic of Tanzania in April 1964. Since its establishment, RGoZ governs the archipelago with a strong autonomy granted by mainland.

Zanzibar is located in the Indian Ocean some 35 kilometers east of the coast of the Tanzanian mainland and composed of Unguja and Pemba Islands. Unguja Island, which is about 80 km long and 30 km wide, is elongated in a North-South direction with a strong North-South lineation in its physical features. The topography of the island is generally low lying with some gently undulating hills. The highest areas of the island are found in the central and western part, rising up to an elevation of about 123 m above mean sea level at the Mazizini Ridge. The general topography of this part of the Island is very flat and well suited for industrial operations.

The highest level of local government is "Region" and there are 5 Regions in Zanzibar. After "Region", "District" and "Shehia" follows (**Figure 9-1**). The project area is located in Urban District and West District. There are 39 Shehias in West District and 45 Shehias in Urban District. Total population of Zanzibar is 1,303,569 persons with half of the population (593,678 persons) living in Urban West Region (National Census, 2012).



Source: JICA Survey Team

Figure 9-1 Administrative System in Zanzibar

(2) Socio-Economic Situation in Zanzibar

According to National Accounts Main Aggregates Database by the United Nations, per capita GDP of Zanzibar is 935 USD (Year 2014) while GDP of Tanzania is 952.2 USD in the same year. There is no significant difference in GDP between the Tanzanian Mainland and Zanzibar.

Currently agriculture is the most important sector of the economy in terms of its contribution to GDP and employment, and it shares 27.9% of GDP Industrial Structure (National Accounts Main Aggregates Database). Fishing within the project area is mainly artisanal. Silva (2006), reported that about 95% of the total marine catch is estimated to come from small scale artisanal fishery. Fishing is an attractive activity for the poor sector of society as it does not necessarily require the ownership of any assets and has very low start-up costs.

Tourism generates a substantial amount of revenue in Zanzibar. According to National Accounts Main Aggregates Database, Tourism shares 15.7% in current GDP industrial composition, and it is growing rapidly. It may share the major position instead of agriculture in future. Number of tourists is 42,141 persons in 1990, but 140,237 persons in 2008. Indeed, other data shows 45,000 persons in Zanzibar in charge of tourism work, and it contribute to 35% of GDP. Tourism generates a substantial amount of revenue in Zanzibar.

(3) Transportation

Airways are important transportation for the islands of Zanzibar. Each Unguja and Pemba has one airport. There is an international airport which links Dar es Salaam, the EAC, Middle East cities (as Dubai, Oman, Doha and others) and the EU (largely Italy, Spain and Portugal).

Additionally, there are fast moving ferry boats which travel between Zanzibar and Dar es Salaam and Pemba.

(4) Literacy

Adult literacy in Zanzibar is 76.60% in 2008 (Tanzania Data Portal).

(5) Public Health

Infant mortality in 4 weeks in Zanzibar is 25/1,000 in 2010 (Tanzania Data Portal), and life expectancy is 57 years old[1].

(6) Natives and Indigenous People

The population of Zanzibar mostly consists of Africans and people of mixed African-Persian ancestry - the Shirazi, and Arabs. The majority of the Africans population belongs to the Bantu-speaking Hadimu ethnic group. Hadimu became small number in 1920'S. Zanzibar has another ethnic group of the Tumbatu (who live on Tumbatu and in the northern part of Zanzibar) and they are migrants from the East Africa mainland and from the Comoros Islands.

In terms of indigenous people, there are no indigenous people who are applicable for World Bank OP 4.10 in Zanzibar.

(7) Cultural and Historical Heritage and Monument

The Stone Town, which is located in Urban District, is registered for UNESCO World Heritage. Stone Town is one of the popular tourist attractions.

(8) Poverty Group

According to Zanzibar Household Budget Survey 2014-2015, Poverty group is categorized in two groups, such as Poverty (or "Basic Needs Poverty) and Extreme Poverty (or "Food Poverty"). The economic boarder line of Poverty is monthly consumption is 53,377TZS, and 38,071TZS in Extreme Poverty. At the timing of survey, 30.4% is applicable for Poverty, and 10.8% is for Extreme Poverty. Ratio of poverty is relatively high in rural area compare to city area, and the ratio of Poverty is 17.9% in city area and 40.2% in rural area, meanwhile the ratio of Extreme Poverty is 4.5% in city area and 15.7% in rural area.

In terms of poverty of the Project area, ratio of Poverty and Extreme Poverty is 19.2% and 5.0% in Urban District, and 14.6% and 3.5% in West District respectively.

Since average of household members is 4.8 person in Zanzibar (National Census 2012), expected monthly consumption of Poverty household is 25,6210TZS (12,631JPY) and 182,751TZS (9,010JPY) in Extreme Poverty household (Exchange rate: 1TZS=0.0493).

[1] Zanzibar: Social Protection Expenditure and Performance Review and Social Budget", Social Security Department, International Labour Office, Geneva, Switzerland, January 2010, page 22

(9) Natural Environment

(a) Climate

The Island's climate is tropical monsoon and mainly oceanic, and is therefore predominantly warm and humid. The island has over 2,000 hours of sunshine per year. The minimum annual temperature was 21.6°C and maximum annual temperature was 33.1°C in 2015 and 2016 as shown in **2.1.2 (1)**.

The mean annual rainfall is 1,532 mm with a large seasonal variation. The climate is characterized by two rainy seasons, the long rains in the months of March to May and short rains in November and December. During short rains, there are at least 4 to 5 rainy days per month in June and July and up to 20 rainy days in April during the long rains.

(b) Vegetation

Besides conservation areas, there is no natural forest, and all areas are secondary formed by human activities. Vegetation classification was based on by White (1983)[2], and the project area is categorized as "Secondary Grassland". Vegetation type of the area is characterized by a land covered by the grass species with few herbs and forbs. **Table 9-1** shows common grass species in the project area.

Table 9-1 Flora in Project Site

Forb	Herb	
Hyparrhenia filipendula *Cynodon dactylon* *Dichanthium annulatum* *Eragrostis stapfianus* *Euphorbia. Ethiopica* *Digitaria milanjianus* *Digitaria ciliaris* *Heteropogon contortus* *Panicum corolatum,P. maximum* *Sporobolus virginicus* *Eleusine indica*	Major Spiecies *Acalypha ornate* *Tridax procumbens* *Rhynchosia minima* *Phyllanthus Numulariifolius* *Waltheria indica* *Sida acuta* *Euphorbia hirta* *Euphorbia heterophylla* *Indigofera arrecta*	Few scattered species of bushes/shrubs *Lamprothamnus zanguebaricus* *Euclea natalensis* *Diospyros usambarensis*

Source: JICA Survey Team

(c) Fauna (Birds)

The dominant groups of wildlife fauna in the project area were birds and insects. Sparrow and Great white Egrets were in relatively large numbers compared to other species of birds. The most common bird species recorded in point counts and field observations are shown in **Table 9-2**.

[2] White, F. 1983. The vegetation of Africa. A descriptive memoir to accompany the UNESCO/AETFAT/UNSO Vegetation Map of Africa (3 Plates, Northwestern Africa, Northeastern Africa, and Southern Africa, 1:5,000,000). UNESCO, Paris.

Table 9-2 List of Birds Observed in the Project Site

N.	Common Name	Academic Name
1	Gray-backed camroptera	*Camaroptera brevicaudata*
2	Fork tailed drongo	*Dicrurus adsimilis*
3	House sparrow	*Passer domesticus*
4	Dimorphic egret	*Egretta dimorpha*
5	Ruddy turnstone	*Arenaria interpres*
6	White-browed coucal	*Centropus superciliosus*
7	Zanzibar Sombre Greenbul	*Andropadus importunes*
8	Indian House Crow	*Corvus splendens*
9	Zitting cisticola	*Cisticola juncidis*
10	Spotted flycatcher	*Muscicapa striata*
11	Olive sunbird	*Cyanomitra olivacea*
12	Crab plover	*Dromas ardeola*
13	***Curlew sandpiper***	*Caldris ferruanea*
14	Common tern	*Sterna hirundo*
15	Cattle egret	*Bubulcus ibis*
16	Yellow vented bulbul	*Pycnonotus barbatus*

Source: JICA Survey Team

(d) Agricultural Product

The vegetation type comprises land where the natural vegetation has been cleared and replaced by agricultural crops. Crops such as cassava, maize, mangoes, rice, sweet potatoes, sugar cane and banana are common in Zanzibar. Crop species recorded from the project area are shown in **Table 9-3**.

Table 9-3 Crop Species Recorded from the Project Area

N.	Common Name	Botanical Name	N.	Common Name	Botanical Name
1	Sweet Potato	*Ipomoea batatus*	7	Mango	*Mangifera indica*
2	Orange	*Citrus sinensis*	8	Banana	*Musa cultivars*
3	Cashew nut	*Anacardium occidentale*	9	Palm Tree	*Elaies guineense*
4	Cassava	*Manihot esculenta*	10	Papaya	*Carica papaya*
5	Cowpea	*Vigna unguiculata*	11	Passion Fruit	*Passiflora edulis*
6	Custard Apple	*Annona muricata*	12	Pigeon Pea	*Cajanus cajan*

Source: JICA Survey Team

(e) Ambient Air

No data are available with respect to ambient air quality within the project area. However, it is generally believed to be good since there are no major sources of pollution near the project site and the area is not likely to be affected by long range transport of pollutants.

(f) Noise and Vibration

There is no available data for the project site regarding noise and vibration. Measurements were made on site using standard calibrated instruments and present noise levels in the vicinity of the proposed development (baseline conditions) have been recorded at an average of 46 decibels and this is from passing vehicles on the nearby road (Welezo and Migombani sites), trees and grass waving (TRES, 2016). Most of the project sites are in rural setting, where noise from occasional vehicles passing-by can be heard.

(g) Ecologically Protected Areas

There are no protected areas within the project area. The only nearby Forest reserve is Mazizini Forest Reserve. However, the site is outside of the project area and therefore there will be no impact from the construction works at the project site. From field observations neither of the flora nor the fauna species falling under any of the IUCN threatened category was identified in the proposed project area.

9.1.3 Legal and Regulatory Framework

(1) Laws and Regulation Related to Environmental and Social Considerations in Zanzibar

Table 9-4 shows the laws and regulations related to environmental and social considerations in Zanzibar. The laws and regulations are classified into 3 categories, the first being directly related to approval of EIA (Environmental Impact Assessment); the second is concerning the study of Environmental and Social Considerations; while the third is related to other issues such as indicators and goals.

Table 9-4 Laws and Regulations Related to Environmental and Social Considerations in Zanzibar

Type	No.	Title
A: Laws and Regulation related to EIA	A1	The Zanzibar Environmental Management Act No. 3 of 2015
	A2	The Environment Impact Assessment (procedures) Regulations, 2002
	A3	Environmental Impact Assessment Guidelines and Procedure (Draft)
	A4	Environmental Management For Sustainable Development Act (1996)
	A5	Conservation, Protection, Enforcement and Management of Environment of Zanzibar (2015)
	A6	The Zanzibar Environmental Policy (RGoZ, 2013)
B: Laws and Regulation related to environmental and social issues (except A)	B1	Zanzibar Water Act. No. 4 of 2006
	B2	The Zanzibar Forest Reserves Management and Conservation Act No. 10 of 1996
	B3	The National Water Policy (RGoZ, 2004)
	B4	The Zanzibar Forest Policy (RGoZ, 1996)
	B5	Zanzibar Land Acts
	B6	The Zanzibar Ancient Monuments Preservation Act, 2002
	B7	The National Health Policy (RGoZ, 2011)
	B8	The Energy Policy (RGoZ, 2009)
	B9	The Zanzibar Local Government Authority Act of 2014
	B10	The Contractors Registration Act, No. 6 of 2008
	B11	The Occupational Safety and Health Act No.8, 2005
	B12	The Labour Relations Act No. 1, 2005
	B13	Zanzibar Strategy for Growth and Reduction of Poverty (ZSGRP or MKUZA)
C: Related Goals and Vision	C1	Zanzibar Vision 2020
	C2	Millennium Development Goals (MDGs)

Source: JICA Survey Team

(2) Comparison of Rules and Institution between JICA Guideline and Policy in Zanzibar in terms of Environmental and Social Considerations

Table 9-5 and **Table 9-6** show difference of rules and institution between JICA Guideline and policy in Zanzibar in terms of environmental and social considerations. Table 5 focus on basic policy and Table 6 focus on targeted each project.

Table 9-5 Comparison of Rules and Institution between JICA Guideline and Policy in Zanzibar in terms of Environmental and Social Considerations (Basic Policy)

[1] JICA Guidelines	[2] Laws and Regulations in Counterpart Country (Zanzibar)	Gaps between [1] and [2]	Measures to fulfill gaps
1. A wide range of impacts must be addressed: The types of impacts addressed by JICA/Counterpart Country cover a wide range of environmental and social issues.	The Zanzibar Environmental Management Act (ZEMA), 2015 require ESIA to be mandatory to all development projects and ESIA should cover a wide range of environmental and social issues.	Both Guidelines and laws of Zanzibar cover a wide range of environmental and social issues.	Not necessary
2. Measures for environmental and social considerations must be implemented from an early stage to a monitoring stage: JICA applies a Strategic Environmental Assessment (SEA) when conducting Master Plan Studies etc., and encourages project proponents etc. to ensure environmental and social considerations from an early stage to a monitoring stage.	The Zanzibar Environmental Management Act, 2015 requires that Environmental and Social Impact Assessment (ESIA) be undertaken to all new projects that may cause adverse environmental and social impacts and encourages project proponents etc. to ensure environmental and social considerations from an early stage to a monitoring stage.	JICA applies SEA when conducting Master Plan Studies etc. while Zanzibar laws require ESIA to be undertaken before project implementation. There are no significant discrepancies.	Not Necessary (This issue is not applicable since SEA is not necessary for this project.)
3. JICA/Counterpart Country is responsible for accountability when implementing cooperation projects: JICA ensures accountability and transparency when implementing cooperation projects.	The ZEMA requires on accountability and transparency when implementing projects requirement are equivalent to JICA Guideline.	There are no significant discrepancies between JICA requirements and Zanzibar Laws requirements.	Not necessary
4. JICA/Counterpart Country asks stakeholders for their participation: JICA incorporates stakeholder opinions into decision-making processes regarding environmental and social considerations by ensuring the meaningful participation of stakeholders in order to have considerations for environmental and social factors and to reach a consensus accordingly. JICA replies to stakeholders' questions. Stakeholders who participate in meetings are responsible for what they say.	The ZEMA Act make stakeholder participation and consultation as a pre-requisite for all development projects or programs that are intended to take place. The outcomes of the stakeholder consultations are analyzed and addressed in the ESIA report. The depth of participation reflects the long-term success of a project.	Both JICA and ZEMA Act call for public consultation and specify the timing and process for notification of the public at key steps in the EIA process. Also requires the public opinion to be considered in decision making.	No conflict between [1] and [2], but the Project will give emphasis for stakeholder participation of affected people in planning, implementation, and monitoring of project implementation.

[1] JICA Guidelines	[2] Laws and Regulations in Counterpart Country (Zanzibar)	Gaps between [1] and [2]	Measures to fulfill gaps
5. JICA/Counterpart Country discloses information: JICA itself discloses information on environmental and social considerations in collaboration with project proponents etc., in order to ensure accountability and to promote the participation of various stakeholders.	According to the ZEMA Act (2015) and Environmental Management for Sustainable Development Act, No 2 of 1996, the project proponents are required to consult with stakeholders on the preparation and results of their EIA and to disclose to the public the results of the EIA process. On-going consultation is also required during construction and operation phases of the project.	There are no significant discrepancies	No conflict between [1] and [2], but ZEMA and project proponent have a role of disclosing the information on environmental and social considerations in order to ensure accountability and to promote the participation of various stakeholders.
6. JICA/Counterpart Country makes serious attempts at promptness: JICA addresses request of acceleration for the prompt implementation of projects while undertaking environmental and social considerations.	Zanzibar law requires the EIA as a planning tool to be used to integrate environmental considerations in the decision – making process in order to ensure un-necessary damage to the environment is avoided while ensuring the project is timely implemented Related Law: The Zanzibar Environmental Management Act No.3 of 2015	There are no significant discrepancies.	No conflict between [1] and [2], but ZEMA and project proponent have a role of disclosing the information on environmental and social considerations in order to ensure accountability and to promote the participation of various stakeholders.

Source: Prepared by JICA Survey Team based on JICA Environmental and Social Considerations Guidelines

Table 9-6 Comparison of Rules and Institution between JICA Guideline and Policy in Zanzibar in terms of Environmental and Social Considerations (for the Project)

[1] JICA Guidelines	[2] Laws and Regulations in Counterpart Country (Zanzibar)	Gaps between [1] and [2]	Measures to fulfill gaps
1. Underlying Principles			
1-1. Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.	The ZEMA Act (2015) and the Environmental Management for Sustainable Development Act, No 2 of 1996 require to assess environmental impacts, which may be caused by projects. It must be assessed and examined in the earliest possible planning stage. It is the requirement of the Zanzibar Environment Management Act (ZEMA), 2015 and Environmental Impact Assessment Regulation of 1996 (which is under review) to include in the EIA report the (1) alternatives, (2) mitigation measures to avoid adverse impact, or (3) mitigation measures to minimize adverse impact. So these are taken	None	Not necessary

[1] JICA Guidelines	[2] Laws and Regulations in Counterpart Country (Zanzibar)	Gaps between [1] and [2]	Measures to fulfill gaps
	fully into account in Zanzibar law. The EIA report will not be complete in Zanzibar without including those items.		
1-2. Such examinations must be endeavored to include an analysis of environmental and social costs and benefits in the most quantitative terms possible, as well as a qualitative analysis; these must be conducted in close harmony with the economic, financial, institutional, social, and technical analyses of projects	The Zanzibar law requirement are equivalent to JICA Guideline Related Law: The Zanzibar Environmental Management Act No.3 of 2015.	None	Not necessary
1-3. The findings of the examination of environmental and social considerations must include alternatives and mitigation measures, and must be recorded as separate documents or as a part of other documents. EIA reports must be produced for projects in which there is a reasonable expectation of particularly large adverse environmental impacts	EIA reports must be produced for projects in which there is a reasonable expectation of particularly large adverse environmental impacts. Also this EIA report should include findings of the examination of environmental and social considerations, alternatives and mitigation measures. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.	EIA reports must be produced for projects in which there is a reasonable expectation of particularly large adverse environmental impacts. Also this EIA report should include findings of the examination of environmental and social considerations, alternatives and mitigation measures.	Not necessary. EIA report is produced includes findings, alternatives and mitigation measures for the project.
1-4. For projects that have a particularly high potential for adverse impacts or that are highly contentious, a committee of experts may be formed so that JICA may seek their opinions, in order to increase accountability.	Any new development or undertakings is required to be registered and screened by the Zanzibar Environment Management Authority (ZEMA) before their commencement to guide the due course of action. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.	Zanzibar law requires all project to be screened by the team of experts[3] while JICA guideline requires a committee of experts for projects that have a particularly high potential for adverse impacts or that are highly contentious	Not necessary as the screening at ZEMA include a team of expert.
2. Examination of Measures			
2-1. Multiple alternatives must be examined in order to avoid or minimize adverse impacts and to choose better project options in terms of environmental and social considerations. In the	The environmental assessment shall include an analysis of alternative (in terms of sitting, design, technology, phasing etc.) that were considered or examined in the course of developing the proposed project activities and identify other reasonable alternatives	The Zanzibar law requirements are equivalent to JICA Guideline.	No measurement will be set for this issue since Zanzibar law requirements are equivalent to JICA Guideline.

[3] Team of Experts refers to the Cross-sectoral Technical Advisory Committee which review the ESIA report before ZEMA approve it. The ZEMA is required to set up cross-sectoral technical advisory committees at national level and, where appropriate at a local government authority level to advise it on reviews of environmental impact assessment related reports. The terms of reference and rules of procedure of a cross-sectoral technical advisory committee are drawn by the ZEMA in depending on the project under review.

[1] JICA Guidelines	[2] Laws and Regulations in Counterpart Country (Zanzibar)	Gaps between [1] and [2]	Measures to fulfill gaps
examination of measures, priority is to be given to avoidance of environmental impacts; when this is not possible, minimization and reduction of impacts must be considered next. Compensation measures must be examined only when impacts cannot be avoided by any of the aforementioned measures.	that meet the ultimate project objective. However, a "Zero-Option," whereby project is not carried out at all, must be included as an alternative. Also compensation measures must be examined only when impacts cannot be avoided by any of the aforementioned measures. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.		
2-2. Appropriate follow-up plans and systems, such as monitoring plans and environmental management plans, must be prepared; the costs of implementing such plans and systems, and the financial methods to fund such costs, must be determined. Plans for projects with particularly large potential adverse impacts must be accompanied by detailed environmental management plans.	Environmental and social management plan including proposed work programs, budget estimates, schedules, staffing and training requirements and any other necessary support services to implement the mitigation measures should be prepared. A detailed plan to monitoring the implementation of mitigation measures and the impacts of the project during construction and operation is required. The plan should include an estimate costs and a description of other inputs needed to carry it out. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.	The Zanzibar law requirements are equivalent to JICA Guideline.	Not necessary
3. Scope of Impacts to Be Assessed			
3-1. The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and	The National Environment Management Act (EMA)[4], 2004 - Section 180 (1) states that the Minister may, in consultation with relevant Ministries, initiate discussion with relevant authorities of neighboring countries on environmental management programmes and measures to avoid and minimize such transboundary environmental impacts. Further the ZEMA, 2015 requires assembling, evaluating and presenting baseline data on the relevant environmental characteristics	The EMA, 2004 and ZEMA, 2015 requirements are equivalent to JICA Guideline.	Not necessary

[4] International affairs in Tanzania are dealt at the Union Level. That is why there is no specific laws at the level of Zanzibar which deals with transboundary issues. We refers to the National Environment Management Act, 2004.

[1] JICA Guidelines	[2] Laws and Regulations in Counterpart Country (Zanzibar)	Gaps between [1] and [2]	Measures to fulfill gaps
livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.	of the study area. Include information on any changes anticipated before the project commences. **Physical environment:** Geology; topography; soils; climate and meteorology; ambient air quality; surface and ground water hydrology; existing sources of air emissions; existing water pollution discharges, receiving water quality, existing stream and drainage etc. **Biological environment:** flora; fauna; rare or endangered species; sensitive habitats; including parts or reserves; significant natural sites etc.; species of commercial importance and potential to become nuisances, vectors or dangerous. **Social-cultural environment** land use; planned development activities; community structure; employment, distribution of income, goods and services; recreation public health; cultural, heritage properties and values; tribal issues; customs, aspirations and attitudes		
3-2. In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project.	The Zanzibar law requirement are equivalent to JICA Guideline Related Law: The Zanzibar Environmental Management Act No.3 of 2015.	None	Not necessary
4. Compliance with Laws, Standards, and Plans			
4-1. Projects must comply with the laws, ordinances, and standards related to environmental and social considerations established by the governments that have jurisdiction over project sites (including both national and local governments). They must also conform to the environmental and social	The project should be implemented in line with the requirement of the policy, legal, regulations and institutional arrangement as well as standards governing environmental quality, health and safety, marine and terrestrial protection of area, protection of endangered species, sitting, land use	The Zanzibar laws and requirements are equivalent to JICA Guideline.	Not necessary

[1] JICA Guidelines	[2] Laws and Regulations in Counterpart Country (Zanzibar)	Gaps between [1] and [2]	Measures to fulfill gaps
consideration policies and plans of the governments that have such jurisdiction	control, waste management, local authority, investment, etc. at international, national, regional and local levels. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.		
4-2. Projects must, in principle, be undertaken outside of protected areas that are specifically designated by laws or ordinances for the conservation of nature or cultural heritage (excluding projects whose primary objectives are to promote the protection or restoration of such areas). Projects are also not to impose significant adverse impacts on designated conservation areas.	The Act requires that a person shall not carry out or cause to be carried out; any activity which is likely to have significant impact on the environment and society without EIA Certificate issued by ZEMA. Related Law: The Zanzibar Environmental Management Act No.3 of 2015, and the Zanzibar Ancient Monuments Preservation Act, 2002.	The law does not prohibit undertaking the project on the protected areas however it require the EIA to be undertaken. This requirement provides that the projects should not impose significant adverse impacts on designated conservation areas.	Adequate assessment should be carried out to ensure the projects are not imposing significant adverse impacts on designated conservation areas. However, it is not necessary to take into account this issue since protected areas are not included in the project target area.
5. Social Acceptability			
5-1. Projects must be adequately coordinated so that they are accepted in a manner that is socially appropriate to the country and locality in which they are planned. For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans.	Stakeholder consultations are crucial in preparing an effective and sustainable project. The consultations should identify key issues and determine how the concerns of all parties will be addressed in the EIA for the projects. To facilitate meaningful consultations, the project implementers provide all relevant material and information concerning the projects in a timely manner prior to the consultation, in a form and language that are understandable and accessible to the groups being consulted. Depending on the public interest in the potential impacts of the projects, a public hearing may be requested to better convey concerns. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.	The Zanzibar laws and requirements are equivalent to JICA Guideline.	Not necessary
5-2. Appropriate considerations must be given to vulnerable social groups, such as women, children, the elderly, the poor, and ethnic minorities, all members of which are susceptible to environmental and social impacts and may have little access to decision-making	A thorough program of consulting the public also should involve youth, persons with disabilities, older persons and other vulnerable groups. The purpose of the program is to assist the proponent to both inform all interested parties project and solicit their views about it.	The Zanzibar laws and requirements are equivalent to JICA Guideline.	Not necessary

[1] JICA Guidelines	[2] Laws and Regulations in Counterpart Country (Zanzibar)	Gaps between [1] and [2]	Measures to fulfill gaps
processes within society.	Related Law: The Zanzibar Environmental Management Act No.3 of 2015.		
6. Ecosystem and Biota			
6-1. Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests.	Environmental and Social Impact Assessment shall specifically focus on these ecological components in the environment to ensure that the proposed development does not harm the well-being of these characteristics. Related Law: The Zanzibar Environmental Management Act No.3 of 2015 and the Zanzibar Forest Reserves Management and Conservation Act No. 10 of 1996.	The Zanzibar laws and requirements are equivalent to JICA Guideline.	Not necessary
6-2. Illegal logging of forests must be avoided. Project proponents etc. are encouraged to obtain certification by forest certification systems as a way to ensure the prevention of illegal logging.	Haphazardly clearance of vegetation must be avoided. Related Law: The Zanzibar Environmental Management Act No.3 of 2015 and the Zanzibar Forest Reserves Management and Conservation Act No. 10 of 1996.	Outside the protected area no certification is required to cut trees. Certification is needed only on the protected forests.	Not necessary
7. Indigenous Peoples			
7-1. Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses.	Any adverse impacts that a project may have are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate peoples for their losses. Related Law: The Land Tenure Act, No 12 of 1992, Land Acquisition Decree Cap 95.	There is no specific law in Zanzibar dealing with compensation of indigenous peoples. The laws which covers general public covers indigenous people.	Effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses. However there are no indigenous people in Zanzibar.
7-2. When projects may have adverse impacts on indigenous peoples, all of their rights in relation to land and resources must be respected in accordance with the spirit of relevant international declarations and treaties, including the United Nations Declaration on the Rights of Indigenous Peoples. Efforts	No specific law on indigenous peoples. However all of their rights in relation to land and resources are respected in accordance with other national laws, the spirit of relevant international declarations and treaties, including the United Nations Declaration on the Rights of Indigenous Peoples. Efforts must be made to	No specific law on indigenous peoples.	Indigenous peoples and their rights in relation to land and resources must be respected. However there are no indigenous people in Zanzibar.

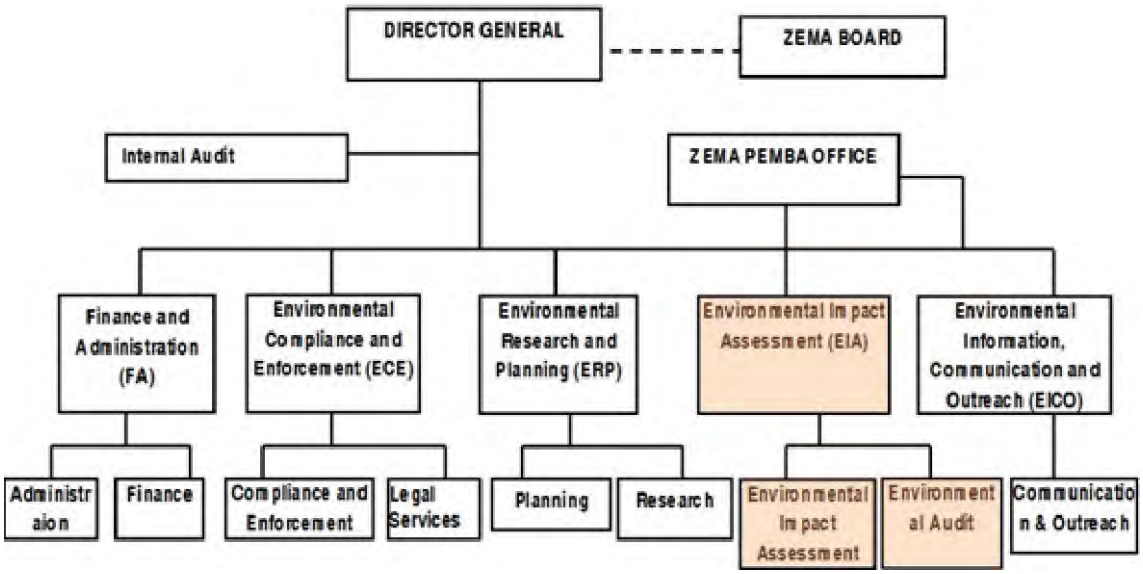
[1] JICA Guidelines	[2] Laws and Regulations in Counterpart Country (Zanzibar)	Gaps between [1] and [2]	Measures to fulfill gaps
must be made to obtain the consent of indigenous peoples in a process of free, prior, and informed consultation.	obtain the consent of indigenous peoples in a process of free, prior, and informed consultation.		
7-3. Measures for the affected indigenous peoples must be prepared as an indigenous peoples plan (which may constitute a part of other documents for environmental and social considerations) and must be made public in compliance with the relevant laws and ordinances of the host country. In preparing the indigenous peoples plan, consultations must be made with the affected indigenous peoples based on sufficient information made available to them in advance. When consultations are held, it is desirable that explanations be given in a form, manner, and language that are understandable to the people concerned. It is desirable that the indigenous peoples plan include the elements laid out in the World Bank Safeguard Policy, OP4.10, Annex B.	The ESIA document should cover all measures for the affected people including the indigenous peoples. There is no requirement of preparing a separate Indigenous Peoples Plan. The requirement is to make ESIA report public document in compliance with the relevant laws. In preparing the ESIA report, consultations must be made with the affected peoples based on sufficient information made available to them in advance. No specific law on indigenous peoples. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.	Currently there are no people in Zanzibar who are called indigenous and the language used is Swahili. With that there are no specific laws on indigenous peoples.	No measurement will be set for this issue since there are no indigenous people in Zanzibar.
8. Monitoring			
8-1. After projects begin, project proponents etc. monitor whether any unforeseeable situations occur and whether the performance and effectiveness of mitigation measures are consistent with the assessment's prediction. They then take appropriate measures based on the results of such monitoring.	Monitoring should be carried out throughout the project implementation to mitigate the impacts and enhance the benefits of the project. The monitoring work ensures that the project complies with all applicable laws and regulations related to environmental impacts and impact mitigation. The monitoring deals with all mitigation required for the physical, biological and socio-economic impacts. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.	Both Guidelines and laws of Zanzibar requires monitoring after commencement of the project	Monitoring should be carried out during the project implementation.
8-2. In cases where sufficient monitoring is deemed essential for appropriate environmental and social considerations, such as projects for which mitigation measures should be implemented while monitoring their effectiveness, project proponents etc. must	The correct and successful implementation of impact mitigation measures in order to reduce adverse impacts on environmental conditions needs to be ensured by a proper monitoring programme. So the the Environmental and social monitoring plan (EMP) should	The Zanzibar laws and requirements are equivalent to JICA Guideline.	Not necessary

[1] JICA Guidelines	[2] Laws and Regulations in Counterpart Country (Zanzibar)	Gaps between [1] and [2]	Measures to fulfill gaps
ensure that project plans include feasible monitoring plans.	be developed. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.		
8-3. Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders.	Implementation of the EMP is the solely the responsibility of the project proponent who is required submit the annual report to ZEMA and other relevant stakeholder for public consumption. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.	The Zanzibar laws and requirements are equivalent to JICA Guideline.	Not necessary
8-4. When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents etc. should make efforts to reach an agreement on procedures to be adopted with a view to resolving problems.	The ZEMA play a key role in monitoring the project during all phases to ensure that the mitigation measures set out in are fully implemented. The final audit report, together with monitoring data is distributed to the relevant Ministries, the ZEMA, DoE, and the District Council through the District Environmental Management Officer for review, guidance and comments. Related Law: The Zanzibar Environmental Management Act No.3 of 2015.	The Zanzibar laws and requirements are equivalent to JICA Guideline.	Not necessary

Source: Prepared by JICA Survey Team based on JICA Environmental and Social Considerations Guidelines

(3) Relevant Agencies and Organizations on Environmental and Social Considerations

The leading agency on environmental management is Zanzibar Environment Management Authority (ZEMA). **Figure 9-2** shows Organogram of ZEMA. There is a section which in charge of EIA in ZEMA.



Source: ZEMA

Figure 9-2 Organogram of ZEMA

(4) Necessity of EIA Approval and Relevant Procedures

(a) Regulated process of EIA on Environmental and Social Considerations

According to Environmental Management for Sustainable Development Act 1996 (EMSDA) and Environmental Impact Assessment Guidelines and Procedures (EIAGP), process of EIA Study and its approval are as follows. **Figure 9-3** shows the EIA Process.

a) After project registration in ZEMA, Initial Environmental Report shall be submitted to ZEMA

- In case the submitted report (contents of the project) is applicable for "Activities which require an EIS" in EMSDA, ZEMA requests to applicant (proponent of the project) to carry out an EIA Study.

b) In case EIA Study is Necessary:

- In Zanzibar, only consultants registered with ZEMA carry out EIA Studies. There are 23 applicable consulting firms in 2016. Therefore, the proponent of the project shall commission an EIA Study to one of these consulting firms.
- The EIA report shall be submitted to ZEMA. After review, the report of the project is defined as proposed, or revised.
- A defined scope and Work Schedule shall be approved at the same time by ZEMA

c) EIA Study

- The applicant shall prepare Environmental Impact Statement (EIS) with reference to EIAGP, 2-4 Report Writing Guidelines and Requirements, matters to be mentioned

while preparing reports. Normally, preparation takes within 6 months and submitted to ZEMA.

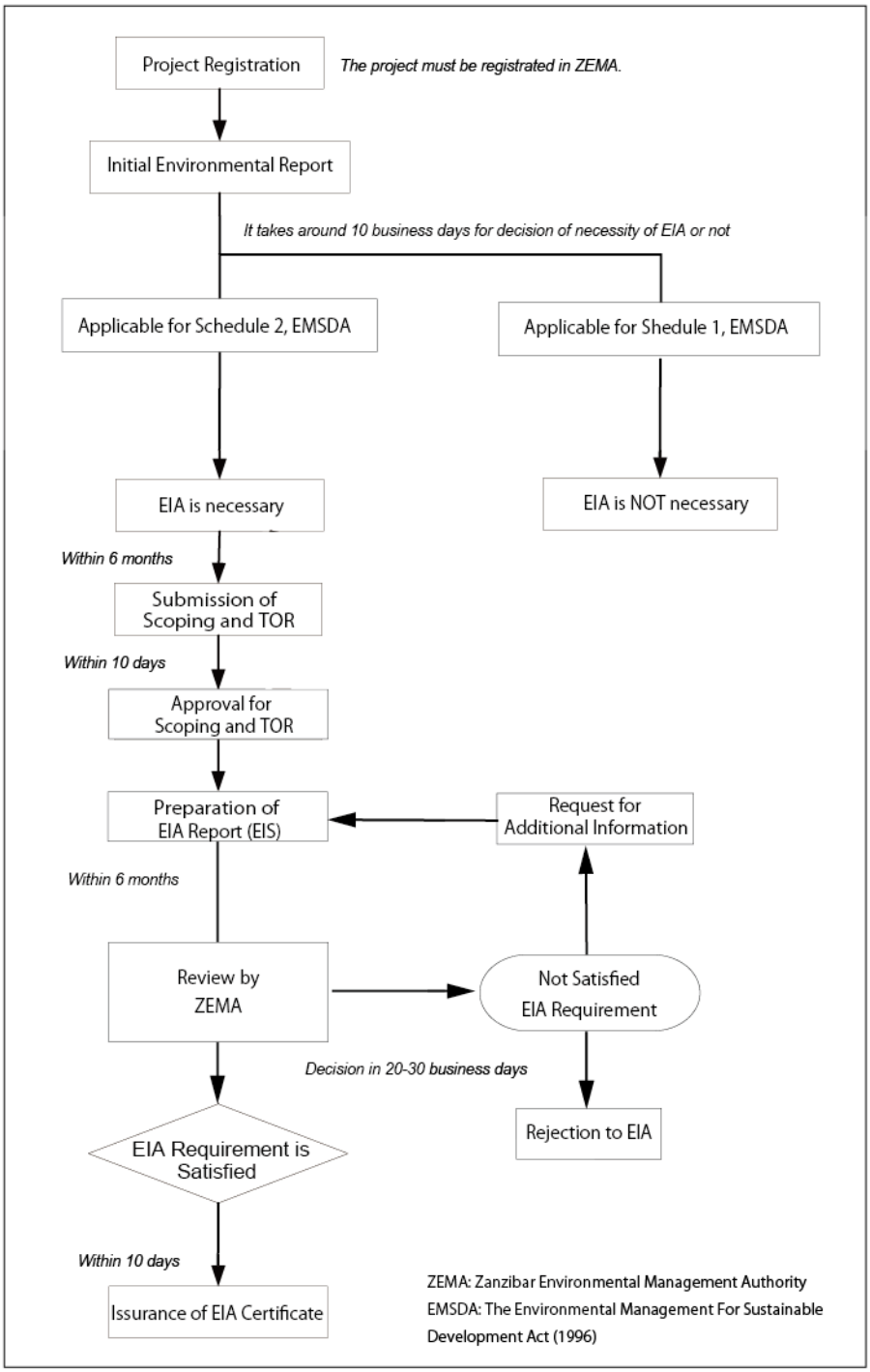
- In ZEMA, submitted EIA Study Report is circulated in 5 days, and comments shall be published in 20-30 business days.
- After publishing of the comments, EIS review takes place within 30 business days.
- In case additional information is necessary to add in EIS, it is informed in 5 business days after the review
- The additional information shall be submitted to ZEMA within 20 business days
- If it is confirmed that there is no major impact to the environment after the review, EIA license shall be issued by ZEMA within 10 business days.

(b) Duration of EIA Approval

Although the length of time from application to approval in EIA differs depending on the type of project, it normally takes 6 months for the total process as shown in **Figure 9-3.**

(c) EIA Process in the Project

For the Project, an EIA study is required based on the description in EMSDA, Schedule 2, Activities Which Requires an EIS. In there, it is listed that "6. Operating water supply system" is a project which requires EIA. Therefore, local EIA consultant was selected, and EIA study started in August 2016.



Source: Prepared by JICA Study Team by reference with The Environmental Management For Sustainable Development Act (1996) and Environmental Impact Assessment Guidelines and Procedure (Draft)

Figure 9-3 EIA Process

9.1.4 Review of Alternative Plans (Zero-Option)

Table 9-7 shows a comparison of the alternative plans, including Zero-Option. The two alternative options are:

- Plan-A: No project implementation (Zero-Option)
- Plan-B: Planned Project implementation

Plan-A has no impact on the environment, but there is no improvement of the water supply situation in this plan. Meanwhile, there are some impacts on the environment, such as noise and generation of waste by construction work in Plan-B, but these impacts are temporary and are not the type of impacts that totally change the local environment. In case Plan-B is carried out, equal distribution of water is expected as well as catering for future water demand.

Table 9-7 Comparison of Alternatives

Category	Plan-A/Zero-Option	Plan-B (Selected as the Best Plan)
Project Component		
Component of the Project	None (No project)	**Non-disclosure Information**
Natural Environment		
Air Pollution/Noise and Vibration	No Impact	Problems with dust and dirt, noise and vibration during construction phase. However, no air pollution noise or vibration issues after construction phase or during operation.
Geography	No Impact	Land forming will be carried out for construction of reservoirs and overhead tanks, but the area of land forming is limited and there is no impact to geography and terrain.
Impact to Water Sources	No Impact	New water resource in groundwater is not developed in this project. Currently, available information regarding groundwater in Zanzibar is not reliable, and then it is impossible to predict future impact to environment by water source development.
Vegetation and Ecology	No Impact	There is no important forest land in the project area.
Environmental and Social Considerations		
Selection of the Project Site	No Impact	Since all 5 project sites are public land, and nobody live or use the land, there is no problem regarding land acquisition and involuntary resettlement.
Water Use/Water Quality	Because of fixed rate system, there is no motivation or benefit to resident for conserving water. Currently there are no complaints about water quality from residents.	Because of change of fixed rate system to metered rate system, residents will have motivation for conserving water to reduce their payment. It has positive impact to efficient use of water.
Landscape	No Impact	Basically the area is not within a landscape protection area. Except overhead tank and overhead reservoir, facilities that constructed by the Project are one-storied, and three is no impact to local landscape. Because of construction of overhead tank and overhead reservoir, there are some impacts to local landscapes.
Important Cultural and Historical Buildings and Monuments	No Impact	There are no important cultural and historical buildings and monuments near the project area.
Conflict in Local Community Because of the Project	No Impact	After the project, the number of hours water will be supplied will reduce in some areas. However, the number of supply hours throughout the ZAWA water supply area will become more balanced.

Gender	Generally speaking, women are in charge of water fetching in rural Zanzibar. However, sometimes men are in charge of it as well maybe because they use mainly 20L tanks for water fetching. Meanwhile, many men are in charge of water fetching in urban areas because of security reasons. In case ZAWA water supply area is not expanded and number of household connections stay the same, these gender-related water fetching activities will be continued.	Financial situation of ZAWA will be improved because of the project. It may contribute to increase of house connections, and the situation of water gender-related fetching activities, such as the one has to go water fetching the person is man/woman, will be decreased.
Local Economy (e.g., Employment and livelihood)	No employment or use of local materials expected	Implementation of the project makes a somewhat positive impact on local economy through new employment and use of / purchase of local materials.
Evaluation	There is no impact on local environment and community. However, the problem of unequal distribution is not solved, and it cannot satisfy future water demand.	**Comparison to Plan-A** In Plan-B, it is possible to solve problems of water pressure and unequal water distribution, and prepare to meet future water demand **Impact to Environment** Impact to Environment is bigger than Plan-A since Plan-B includes construction of several reservoirs and overhead tanks and installment of distribution main and distribution sub main as well. Meanwhile, new water source development is excluded in Plan-B, and it also excludes unpredictable impact to environment. **Significance of implementation of the project** Plan-B will bring on solution for unequal water distribution, and it contributes to improvement of water supply situation in the project area. Since new water source development is excluded in Plan-B, unpredictable impact to environment is also excluded. In addition, Plan-B includes decrease of water leakage and it will bring on tariff income. Therefore, Plan-B will have positive effect in terms of both of technical and financial aspect in ZAWA. According to these reasons, significance of implementation is high in Plan-B.

Source: JICA Survey Team

9.1.5 Scoping (Draft)

Table 9-8 shows list of scoping.

Table 9-8 Scoping

Category	No	Items	Evaluation		Reason
			U-Const	Operating	
Pollution control	1	Air pollution	B-	D	Under-construction: Degradation of air quality will be temporary and will be caused by operation of construction machinery and vehicles. Operating stage: No degradation of air quality because usually electric power is used for pumps and motors.
	2	Water Pollution	D	D	U-Const: Water pollution may occur by discharge water from construction site, heavy machinery, and vehicles. There is no harmful drainage by construction works. There will be some muddy water by well-digging, but this water will be absorbed into ground in short time and not become problems. Operating stage: There is no discharge of polluted water from reservoirs and overhead tanks.
	3	Solid Waste	B-	D	U-Const: Construction solid waste; soils and scrap wood will be produced. Operating stage: General waste will be produced by workers at reservoirs and overhead tanks.
	4	Soil contaminati on	B-	D	U-Const: Soil contamination may be caused by oil spill from construction machinery. Operating stage: It may not have any adverse impact on environment.
	5	Noise and excessive vibrations	B-	D	U-Const: Noise and vibration from construction works, operation of construction machinery and vehicles. Operating stage: Noise etc. from operation of pumps and generator.
	6	Land subsidence	D	D	Construction works which may cause land subsidence is not envisaged.
	7	Bad odor	D	D	U Const & Operating stages: Facilities emitting foul smell are not expected.
	8	Bottom sediment	D	D	U Const: Construction works will be taking place only in land, and there is no dredging. In addition, all construction works are carried out in dry season and no risk of landslides. Therefore, no impact to bottom sediment is expected. Operating stages: Adverse impact to bottom sediment may not occur.
Natural Environm ent	9	Protected area	D	D	There is Mazizini Forest Reserve located near Site 2. However, this forest reserve is not included in the Project area and the project provides no impact to the forest reserve.
	10	Ecosystem	D	D	None of the endangered species which is registered in International Union for Conservation of Nature (IUCN) is reported in the project area. The locations for the planned construction sites for the facilities do not have any rare species of fauna and flora. Therefore, no adverse impact on the ecosystem is expected.
	11	Hydrology	D	D	Although new water resource development is not included in the Yen-Loan project, it is necessary to carry out for future demand (refer to 4.4.2, Chapter 4). The necessary amount of new water source development is estimated as in 100,000m3/day. This amount is within local water conservation capacity and then there will be no harmful impact to environment by new water resource development. Lifted sand is recognized in the current situation. This problem will be solved by renewal of pumps by the

Category	No	Items	Evaluation		Reason
			U-Const	Operating	
					Project.
	12	Topography /geology	D	D	All project sites are located west side of Mazizini hills, and the area slopes down all the way to the ocean. Since no huge-scale cut earth and earth filling are planned in construction works, the project will not change current topography of the area, nor provide negative impact to the environment. Basic geological condition in Unguja island was formed in the Miocene of Tertiary era, and major components are sandstone and argilliferous soil. It is not applicable for important nor vulnerable geologically. In addition, general construction method is applied to this project in terms of construction of reservoirs, overhead tanks, and transmission/distribution pipes. No huge scale excavation is planned and then there is no possibility that construction works provide negative impact to local geological condition.
Social Environment	13	Resettlement	D	D	There is no resettlement in this project. Regarding installation works of pipe networks, pipes (transmission pipes and distribution main/sub-main) are planned to be buried under public roads, and then it causes no land acquisition and involuntary resettlement. Even if any objects on public road, design of pipe network is flexibly changed and neither land acquisition nor involuntary resettlement will be necessary.
	14	Poverty group	D	B-	The Project aims to provide safe water to everybody, including poverty group, and to contribute to improve better life of local residents. However, water tariff system change from fixed rate to metered rate after the Project, water tariff will be increased in some households. Because of this, some households will have impact for their household economy.
	15	Ethnic Minorities and Indigenous People	D	D	There are no ethnic minorities and indigenous people that are applicable as per World Bank, OP. 4.10.
	16	Local economy of employment & livelihood	B+	B+	U-Const: Because of employment of construction works and consumption of construction materials, positive effect to local economy is expected. Operating Stage: Employment opportunities for O&M of reservoirs and overhead tanks will be offered to the locals.
	17	Land use and utilization of local resources	D	D	All sites are public land (including ZAWA's property), and there is no land acquisition and involuntary resettlement. Regarding consumption of local resource, no negative impact to local environment since water supply will be carried out by gravity, and new water resource development is not carried out.
	18	Water Use	D	B+	U-Const: Normally, water must be stopped during pipe works. However, Pipe Branching Method Under Pressure is applied in some parts of the Project and it is not necessary to stop water flow. Meanwhile, it is not necessary to apply Pipe Branching Method Under Pressure in other area, since water supply is not 24 hours in these area and then construction works will be carried out that the timing of water is not supplied. Therefore, there is no impact to residents because of construction works. Operation Stage: Water supply conditions in Zanzibar

Category	No	Items	Evaluation		Reason
			U-Const	Operating	
					city are not adequate because of intermittent supply. The project is expected to improve water supply. This will have a positive impact on the town economy, as well as on living conditions.
	19	Existing social infrastructure and social services	B-	D	U-Const: Since there is little traffic volume at the project sites, no major impact is assumed to local traffic by the project. However, some impact to local traffic may occur in installment of water pipes in center of Zanzibar. Operating stage: The project contributes to improve of water supply service, and there is no negative impact to existing infrastructure. There are no objections to the project from local residents as well.
	20	Social organization such as social capitals and local authority	D	D	The water supply system forms a part of the social infrastructure. An augmented water supply system is operated and managed by ZAWA.
	21	Bias distribution of damage and benefit	B-	D	U-Const: Households which are located near construction site will have impact of vibration by pipe driving method. Operation Stage: There will be no damage to the environment, such as noise, vibration, and odor. Improvement to the water supply conditions through the project will widely benefit the citizens. Thus, no issues on bias distribution of damage and benefit.
	22	Conflict of interest in the project area	D	D	Water supply hours will be shortened in some areas after the project. However, the Project will result in evenly distributed water in Zanzibar. Therefore, no conflict of interest in the project area.
	23	Cultural heritage	D	D	Stone Town, a part of Urban District, is registered as a UNESCO World Heritage site. However, Stone Town is not included in the project area.
	24	Landscape	B-	B-	There is no impact to local landscape since the project facilities, except overhead tanks, are one-story building. Heights of overhead tanks are around 30 meters, and it will have an impact to local scenery and landscape. Meanwhile, tourism is one of the major industries in Zanzibar and Stone Town and beautiful sceneries of beaches are famous. The Project sites are not overlapped these important areas of tourism, and location of overhead tanks are far enough to not to invade these sceneries.
	25	Gender	D	B+	For households which are not connected to water supply service, water fetching is a daily burden to the women in rural areas and for men in the city area. Normally water fetching is recognized as a woman's task, but men are in charge of this work because of security reasons in city areas. Financial situation and quality of service will be improved by the project. As a result of this improvement, number of household connection will be increased, and neither women nor men have to go to fetching water because of their gender.
	26	Children's right	D	B+	Number of house connection will be increased after the project. Because of this change, water fetching by children will be decreased.
	27	Infectious diseases of	B-	D	U-Const: There is a possibility that construction workers may be affected by HIV/AIDS.

Category	No	Items	Evaluation		Reason
			U-Const	Operating	
		HIV/AIDS			Operating stage: Facilities operated by ZAWA employees, not temporary workers, therefore may be lesser risk of HIV/AIDS.
	28	Work environment (Including safety control)	B-	D	U-Const: Since possibilities of accidents in the working environment (construction sites) are not zero, safety of construction workers shall be paid attention in construction site. Operating stage: Since facilities which provided by the project is simple structure, accidents in operation may not occur.
Others	29	Accidents	B-	B-	U-Const: There are some possibilities that accidents will be caused by machinery and vehicles related to construction work. Operating stage: There are some possibilities that accidents in operation of facilities will be caused.
	30	Trans-boundary impact and climate change	D	D	No impact is expected.

(Note)

U-Const*: Under construction stage,

Operating*: Operating stag

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progress.)

D: No impact is expected.

Source: JICA Survey Team

9.1.6 TOR on Environmental and Social Considerations

Table 9-9 shows TOR on Environmental and Social Considerations which was prepared by reference to Scoping.

Table 9-9 TOR on Environmental and Social Considerations

No.	Item	Issues
1	Air Pollution	・ Since air pollution data is not available, contractor shall record the situation before construction start, and use it as baseline data, and make comparison with regular monitoring during construction. ・ During construction, air pollution may occur due to imperfect combustion by construction machinery. The operation of construction machinery will also create dust and dirt.
3	Waste	・ During construction: All construction waste shall be disposed following Zanzibar laws under responsibility of the contractor. Waste materials and construction waste soil must be disposed legally under the supervision of the construction company. ・ Operational stage: Since there will be little general waste from the WTP and sedimentation tank, this waste shall be treated in the same way as normal general waste.
4	Soil Contamination	・ During the construction period: Problems with oil flow out and soil contamination are likely, however, these issues can be avoided by regular check out and maintenance.
5	Noise and Vibration	・ Noise and vibration may occur because of construction works. Since data is not available, contractor shall record the situation before construction starts, and use it as baseline data, and make comparisons through regular monitoring during construction.

No.	Item	Issues
		・ Operational stage: The facilities use little electricity and no equipment generating intense noise will be used. Some noise will be made when an electrical generator is running but this can be managed by closing the doors and windows of the generator room.
14	Poverty Group	・ Water tariff system will be changed from fixed rate system to metered rate system after the Project. Therefore, this change will make impact to household economy in some households. ・ ZAWA continues to maintain its public taps after the Project as well. Unit price of water in public tap is cheaper than other categories, such as house connection. ・ Since ZAWA does not have detailed information of customers, it is not sure that how many ZAWA customers are applicable as in "Poverty" and "Extreme Poverty" group. If many households will have problems on new water tariff (metered rate) after the Project, revision of tariff system on income level will be considered as one of solution.
19	Current Social Infrastructure and Services	・ Traffic jams are expected on site for pipe laying in Zanzibar city. It would be better to propose adequate and appropriate traffic management measures to avoid traffic jams and traffic accidents when applying for permission for construction. ・ To plan for construction work after sunset, safety measures, such as an application for lighting, shall be made. Where construction works takes place on roads, the work should always be carried out on one side of the road at a time and traffic, including pedestrians, should always be controlled by a traffic supervisor. ・ There is no direct impact to residents' lives since there is no house nearby the construction sites of reservoirs and overhead tanks. ・ Some construction works, such as pipe networks, are carried out in the city center area. To avoid negative impact from the works, construction works shall be carried out only in one lane of road in case it is two-lane road, or detour route shall be set. Local residents have to wait since traffic became slow because of the construction works. However, traffic may not completely stop, and it will be not a serious problem in normal life. ・ Construction works on pipe network will provide impacts to residents' lives since it is carried out in center of Zanzibar City.
24	Landscape	・ Since overhead tanks need some "height" for its purpose, it is impossible to make it lower and this height may have impact to local scenery. However, there are some possible countermeasure, such as design of its structure and selection of color of paint application. These countermeasures shall be considered.
27	Risk of HIV/AIDS	・ During construction: The implementing company is responsible to ensure workers are aware of the risks of HIV and how it is transmitted. Lectures should be carried out if necessary.
28	Labor Environment (Including work safety)	・ During construction: Occupational Safety and Health Act (2005) identified to protect other persons against hazards to safety and health arising out of or in the connection with the activities at workplaces. ・ Operation period: Same as "During construction". ZAWA has a responsibility to provide a safe environment.
29	Accidents	・ During construction: Preventative measures for traffic accidents and traffic jams have to be considered. A work plan shall be submitted to Zanzibar city for construction work to lay pipeline in the city center. Where construction works will continue after sunset, safety measures, such as the use of lights, shall be carried out. Construction works are always carried out in one side of the road at a time and traffic including pedestrians is always controlled by traffic supervisors. ・ Operation period: Traffic accident may occur by a vehicle which delivers bleach powder to reservoirs and overhead tanks regularly.

*Number in Scoping
Source: JICA Survey Team

9.2 Impact Assessment

9.2.1 Environment Impact Assessment

Table 9-10 shows result of Environmental Impact Assessment.

Table 9-10 Result of Environmental Impact Assessment

Category	No	Items	Evaluation in Scoping		Evaluation after Environmental Impact Assessment		Reason
			U-Const	Operating	U-Const	Operating	
Pollution control	1	Air pollution	B-	D	B-	D	Under-Const: Air pollution will be caused by imperfect combustion from construction machines. In addition, degradation of air quality will be caused by operation of construction machinery and vehicles. Operating stage: No degradation of air quality because facility will be running by electric power.
	2	Water Pollution	D	D	D	D	U-Const: Water may become cloudy by discharge water from construction site, heavy machinery, and vehicles. However, the amount is not a lot to affect downstream rivers, and it may not cause water pollution. Operating stage: Constructed facilities (reservoirs and overhead tanks) treat clean water, and there are no possibilities of these facilities discharging dirty water and bringing about water pollution.
	3	Solid Waste	B-	D	B-	D	U-Const: Construction solid waste; soils and scrap wood will be produced. Operating stage: General waste will be produced by workers at reservoirs and overhead tanks. However, amount of e waste is not much, and it will be disposed as general waste
	4	Soil contamination	B-	D	B-	D	Under-const: There are some possibilities that roads in the site and to the site will be contaminated with oil and dirty sand from vehicles. Operating stage: No major impact is expected regarding soil contamination.
	5	Noise and excessive vibrations	B-	D	B-	D	U-Const: Noise and vibration from construction works, operation of construction machinery and vehicles. Operating stage: No noise problems from operation of facilities
	6	Land subsidence	D	D	D	D	Not applicable
	7	Bad odor	D	D	D	D	No work which cause bad odor is planned.

Category	No	Items	Evaluation in Scoping		Evaluation after Environmental Impact Assessment		Reason
			U-Const	Operating	U-Const	Operating	
	8	Bottom sediment	D	D	D	D	U-Const & Operating stages: Adverse impact to bottom sediment may not occur.
Natural Environment	9	Protected area	D	D	D	D	There is Mazizini forest conservation in West District. However, Site 3 and the conservation area are 10km apart, and no negative impact is assumed to the conservation area by the project.
	10	Ecosystem	D	D	D	D	U-Const & Operating stages: There is no forest with rare species of fauna and flora in the locations for the planned construction sites. Therefore, no adverse impacts on the ecosystem are expected.
	11	Hydrology	D	D	D	D	Although new water resource development is not included in the Yen-Loan project, it is necessary to carry out for future demand (refer to 4.4.2, Chapter 4). The necessary amount of new water source development is estimated as in 100,000m3/day. This amount is within local water conservation capacity and then there will be no harmful impact to environment by new water resource development.
	12	Topography /geology	D	D	D	D	Since large-scale excavation is not planned in the project, no adverse impact on the topography and geology is expected.
Social Environment	13	Resettlement	D	D	D	D	No resettlement is necessary on this project. In case any obstructions and illegal occupation are found during construction time, routing of pipe network can be flexibly changed, therefore it does not pose a problem.
	14	Poverty group	D	B-	D	B-	Nearly the entire project site is used for nothing currently, and there are no slum areas nearby. Improvement to the water supply conditions targets all living in the town. An improved supply of clean and affordable water will have a positive impact on the socio-economics of Zanzibar. Water tariff system will be changed from fixed rate system to metered rate system after the Project. Therefore, payment for water may increase in some households. In case many households have problem in terms of payment for water, the tariff system will be reconsidered. Meanwhile, ZAWA will maintain public taps and try to provide safe water to all residents

Category	No	Items	Evaluation in Scoping		Evaluation after Environmental Impact Assessment		Reason
			U-Const	Operating	U-Const	Operating	
							even after the Project. The price of water in public taps is cheaper than all other rate of water, such as house connection.
	15	Ethnic Minorities and Indigenous People	D	D	D	D	There are ethnic minorities and indigenous people applicable for World Bank OP. 4.10.
	16	Local economy of employment & livelihood	B+	B+	B+	B+	U-Const: Construction works from the project and the resulting employment opportunities will bring on positive impacts to the local economy. Operation stage: Employment opportunities of ZAWA will be increased for operation and maintenance of reservoirs and overhead tanks.
	17	Land use and utilization of local resources	D	D	D	D	No major impact on land use and utilization of local resources is assumed because of the project.
	18	Water Use	D	B+	D	B+	Water supply conditions in Zanzibar city are not adequate because of intermittent supply and lack of quantity. The project is expected to improve water supply and meet future demand. This will have a positive impact on the town economy, as well as on living conditions.
	19	Existing social infrastructure and social services	B-	D	B-	D	U-Const: Vehicles which related to construction works may make negative impact to local road and traffic. U-Const: Some roads will be blocked because of construction works (pipe layout). However, amount of traffic is not huge in most of places and serious traffic problem, such as serious traffic jam, may not be caused. Operating stage: Only limited numbers of vehicles are sent to reservoirs and overhead tanks for transporting bleach powder. Therefore, there are very few possibilities that the vehicles make negative impact to local road and traffic.
	20	Social organization such as social capitals and local authority	D	D	D	D	The water supply system forms a part of the social infrastructure. An augmented water supply system is operated and managed by ZAWA.

Category	No	Items	Evaluation in Scoping		Evaluation after Environmental Impact Assessment		Reason
			U-Const	Operating	U-Const	Operating	
	21	Bias distribution of damage and benefit	D	D	D	D	U-Const: The construction sites for the new water supply system are located on public land with no human settlement. Therefore no households will be impacted by the construction works. Operating stage: Since water supply facilities are not malodorous, they do not cause damage. On the other hands, improvement of supplied water quality through the project will widely benefit the citizens. Thus, there are no issues on bias distribution of damage and benefit.
	22	Conflict of interest in the project area	D	D	D	D	The project will result in evenly distributed water in Zanzibar. In terms of water distribution, it makes the situation equal for everybody. Therefore, there is no conflict of interest in the project area.
	23	Cultural heritage	D	D	D	D	Stone Town, a UNESCO World Heritage site, is located in Urban District. However, Stone Town is not included in the project area.
	24	Landscape	B-	B-	B-	B-	There is no impact to local landscape since the all project facilities are one story building, except overhead tanks. Overhead tank may have impact to local community. However, construction sites are not overlaid with recreation places and important tourism places, therefore no negative impact to tourism is expected.
	25	Gender	D	B+	D	B+	For households which are not connected to water supply service, water fetching is a daily burden to the women in rural areas and for men in the city area. Normally water fetching is recognized as a woman's task, but men are in charge of this work because of security reasons in city areas. Financial situation and quality of service will be improved by the project. As a result of this improvement, number of household connection will be increased, and neither women nor men have to go to fetching water because of their gender.
	26	Children's right	D	B+	D	B+	Number of house connections will be increased after the project. Because of this change, water fetching by children will be decreased.
	27	Infectious diseases	B-	D	B-	D	U-Const: There is a possibility that construction workers may be

Category	No	Items	Evaluation in Scoping		Evaluation after Environmental Impact Assessment		Reason
			U-Const	Operating	U-Const	Operating	
		of HIV/AIDS					affected by HIV/AIDS. Operating stage: Facilities operated by ZAWA employees, not temporary workers, therefore may be lesser risk of HIV/AIDS.
	28	Work environment (Including safety control)	B-	B-	B-	B-	U-Const: The Project has some impact to working environment (safety of construction workers). Operating stage: There are some risk to workers during the operation and maintenance of facilities developed by the Project.
Others	29	Accidents	B-	B-	B-	B-	U-Const: There are some possibilities that accidents will be caused by machinery and vehicles related to construction work. Operating stage: There are some possibilities that accidents in operation of facilities will be caused.
	30	Trans-boundary impact and climate change	D	D	D	D	No impact is expected.

(Note)

U-Const*: Under construction stage,

Operating*: Operating stag

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progress.)

D: No impact is expected.

Source: JICA Survey Team

9.3 Mitigation Measures

9.3.1 Environmental Management Plan in Construction Phase and After Construction

(1) Environmental Management Plan in Construction Phase

Table 9-11 shows Environmental Management Plan in construction phase.

Table 9-11 Environmental Management Plan in Construction Phase

No*	Category	Impact	Countermeasures	(1) Responsible Organization and (2) Supervising Agency	Responsible Organization for Cost
1.	Air pollution	Temporary air pollution caused by operation of construction machinery	Contractor shall use the latest construction machinery which is in good working condition (specifically taking into consideration engine, exhaust), and is environmentally friendly.	(1) Contractor, (2)Consultants, ZAWA, Zanzibar City	Included in construction costs
		Dust and dirt during construction	To minimize dust and dirt during construction and provide mitigation measures	(1) Contractor, (2)Consultants, ZAWA, Zanzibar City	Included in construction costs
3.	Solid Waste	Construction waste and disposal of waste in construction site	Construction site must be kept clean. Construction waste must be kept at a location with a low risk of natural disaster, such as flood, and disposal is the responsibility of the contractor. The process of disposal must follow the relevant Zanzibar laws, and contact should be made with Zanzibar, as necessary. General waste shall be disposed of appropriately and separately to dangerous items. There is no applicable Zanzibar law regarding waste soil, the Project must contact Zanzibar Municipal Council and discuss the method of its disposal.	(1) Contractor, (2)Consultants, ZAWA, Zanzibar City	Included in construction costs
4.	Soil contamination	Soil pollution in surface soil by oil, grease, and construction sewerage	Construction machinery must not be stored near drains. Clean the area where construction machinery is stored and avoid pollution by oil and fuel. Avoid accidents by appropriate maintenance of construction machines.	(1) Contractor, (2)Consultants, ZAWA	Included in construction costs
5.	Noise and vibrations	Noise and vibration during construction	The site for reservoir and overhead tanks are used for nothing currently, and there are no temples or schools nearby. However, construction works must be carried out during the day time. In addition, small – medium sized machinery must be sound-proof, and checking out and maintenance of heavy machinery must be carried out. With all these effort, loud sounds and vibration should be avoided	(1) Contractor, (2)Consultants, ZAWA, Zanzibar City	Included in construction costs

No*	Category	Impact	Countermeasures	(1) Responsible Organization and (2) Supervising Agency	Responsible Organization for Cost
			where possible. Meanwhile, some of construction sites of reservoirs and distribution main/submain are located in the center of Zanzibar. Noise and vibration must be prevented. Although the pilling construction method is being used in the Project, but the construction sites are far from residential area and it is estimated no impact to human life because of construction works.		
19.	Social organization such as social capitals and local authority	Traffic jam in construction site in Zanzibar city and accidents occurred by construction vehicles	・ It is necessary to propose plans for traffic safety and measures to avoid traffic congestion. ・ Necessary equipment for traffic safety and congestion shall be laid out. ・ Construction works on roads shall be carried out in one lane always, and a guard shall control pedestrians to ensure a safe environment.	(1) Contractor, (2)Consultants, ZAWA, Zanzibar City	Included in construction costs
27.	Infectious diseases of HIV/AIDS	Increasing risk of HIV/AIDS	Risk of HIV/AIDS is increasing because of influx of construction workers. The supervisors of the construction sites must control these risks, and should speak to all construction workers in meetings, such as during morning assembly.	(1) Contractor, (2)Consultants, ZAWA, Zanzibar City	Included in construction costs
28.	Working Environment (Including Work Safety)	Workers Safety	According to Occupational Safety and Health Act (2005) and Labor Relations Act (2005), the contractor has to provide appropriate work breaks. Any person entering a construction site must be suitably equipped, such as wearing a safety helmet and protective shoes. The Supervisor of the construction site must hold small meetings for all workers every morning and make all necessary safety notifications. The construction site must be managed in such a way as to provide a safe working environment. Only authorized personnel are permitted to enter areas where heavy machinery are operating.	(1) Contractor, (2)Consultants, ZAWA	Included in construction costs
29.	Accidents	Traffic accidents at the construction	Only authorized personnel are permitted to enter the construction sites. Local	(1) Contractor, (2)Consultants, ZAWA, Zanzibar	Included in construction costs

No*	Category	Impact	Countermeasures	(1) Responsible Organization and (2) Supervising Agency	Responsible Organization for Cost
		site gate	residents should be kept out via a fence and notices. At least one security guard / banksman should be at the construction site entrance gate to avoid/prevent traffic accidents. Drivers of all construction vehicles must take care to drive safely.	City	

*Item Number in Scoping
Source: JICA Survey Team

(2) Environmental Management Plan after Construction

Table 9-12 shows Environmental Management Plan after construction.

Table 9-12 Environmental Management Plan after Construction

No*	Category	Impact	Countermeasures	(1) Responsible Organization and (2) Supervising Agency	Responsible Organization for Cost
29.	Accidents	Traffic accidents caused by vehicles	Drivers must take care, especially at the gate to the site and road. A security guard shall be in charge of traffic control near the gate.	ZAWA	Included in normal operational cost in ZAWA
		Accidents by wrong operation of facilities	Installment and operation of machinery and facilities shall be carried out under supervision of experienced persons. If necessary, safety fence shall be arranged and operation shall be carried out using manuals.	ZAWA	Included in normal operational cost in ZAWA

*Item Number in Scoping
Source: JICA Survey Team

9.3.2 Environmental Management Plan and Monitoring Plan

(1) Monitoring Plan

Table 9-13 shows the negative impact which may be generated during the construction phase and **Table 9-14** shows relevant mitigation measures and a monitoring plan for the operations phase. A hard copy shall be kept of the results of monitoring. Monitoring Form is shown in **Appendix**.

(2) Cost of Monitoring

The operation of reservoirs and overhead tanks may not have any negative impact on the natural environment. ZAWA employees are responsible for environmental monitoring, as well as regular maintenance works and monitoring cost shall be expensed as regular maintenance cost.

(3) Monitoring System

(a) Monitoring System in Construction Stage

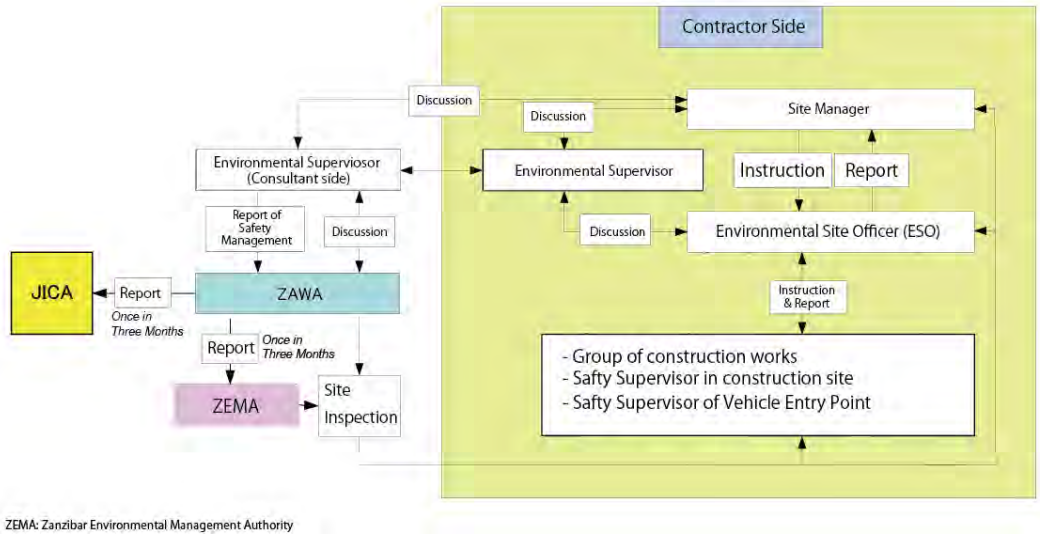
In relation to all the project's construction sites, it is necessary to avoid injuries arising from construction activities, produce a healthy working environment, and create as little disturbance as possible for the public. Construction sites must be enclosed by a fence and only authorized persons are permitted entry. If any construction work takes place at night, an appropriate number of lights shall be used, and all workers must wear protective gear, such as a helmet and gloves.

Since there are no important forests or rare species of animals within the project sites, environmental management shall focus on a safe working environment, traffic safety, the quality of discharge water from the construction site and general waste. However, attention must be given to any traffic accidents as there are some steep slopes on the route to the project sites. Special attention to be paid to avoidance of risk of falling objects in the overhead tank construction. In addition, the construction work for the reservoirs and distribution mains and submains will be carried out in the center of Zanzibar, and safety controls to prevent traffic accidents would be the major issue in these areas.

The Contractor and consultant should hold meetings at least once a week during the construction phase and safety management shall be discussed during that meeting. A notice should be erected on the project sites with the details of who to contact with any grievances, including noise. Should a resident make a complaint, the Environmental Supervisor should contact them directly and a solution must be discussed with a manager from the contractors, as well as with the consultants.

The Project Manager employed by the contractor for the construction works must select and appoint an Environmental Officer, who will work under the Site Manager. He shall select a trained engineer as the Environmental supervisor from the engineering staff and safe environmental management must be adhered to for the entire period of construction works. **Figure 9-4** shows the environmental management system for a construction site.

According to **Table 9-13**, Environmental Supervisor (Contractor side) shall carry out the monitoring quarterly, and the result shall be reported to ZAWA. Contents of the result shall be checked in ZAWA, and ZAWA shall report to ZEMA and JICA. Report to ZEMA is mandatory according to EIA approval.



Source: JICA Survey Team

Figure 9-4 Monitoring Structure during Construction

(b) Monitoring In Operational Stage

ZAWA employee(s) will be in charge of monitoring during the operational stage. Since there is no dangerous work for operation and maintenance of reservoirs and overhead tanks, special supervision is not necessary. Therefore, monitoring methods of new reservoirs and overhead tanks are the same as existing ones. The method is: in case any problems happen, appropriate section is in charge of fixing and reporting. For example, in case an electrical problem happens, Electrical Unit in Technical Operation Department shall take care of it. Water Production Unit in the Technical Operation Department takes care of all these records from each unit/section.

(c) Preparation and Submission of Monitoring Form

a) Construction Stage

The Contractor is responsible for the preparation and submission of the monitoring form. This form should include environmental management, safety management, and other planned monitoring (regular monitoring) and should be submitted to a consultant. The consultant then adds their opinion and approves it, before submitting it to ZAWA. ZAWA shall submit the monitoring form to JICA once every three months.

b) Operational Stage

Monitoring records shall be prepared by each section that have addressed problems. These records are collected by the Water Production Unit in the Technical Operation Department, and the monitoring report is then prepared by them. After checking by

ZAWA's Director, the monitoring report is submitted to JICA every 6 months, within a year after completion of construction.

Table 9-13 Environmental Management Plan in Construction Phase

Item	Parameter to be Monitored	Monitoring Frequency	Monitoring Area	Measurement Unit	Measuring Method	Standard in Tanzania/ Zanzibar	Responsibility	Estimated Costs [USD]
Air Quality	SO_2	Quarterly	All construction sites	µg/Nm^3	Detector tubes	Average 100 µg/Nm^3 (0.129mg/kg) for 24hour	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
	NO_2	Quarterly	All construction sites	µg/Nm^3	Detector tubes	150 µg/Nm^3 for 24-hours average value	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
	CO	Quarterly	All construction sites	µg/Nm^3	Mini-Vol Sampler	10mg/Nm^3 for 8 hours	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
	PM_{10}	Quarterly	All construction sites	µg/Nm^3	Mini-Vol Sampler	PM_{10}: 60-90µg/Nm^3 (0.05-0.116mg/kg)	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
	Dust level	Quarterly	All construction sites	mg/Nm^3	Dust level meter/ Mini-Vol ampler	PM 2.5 not to exceed 250 mg/Nm3 (peak readings)	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
Soil Contamination	Soil pollution in surface soil by oil, grease, and construction sewerage	Quarterly	All construction sites	N/A	Site inspection, especially pay attention to change of vegetation, color of soil, and oil around machinery	Comparison of reported contamination level with the baseline figure	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
	Pollution by dirty tires of vehicles which transport construction materials and construction waste soil	Quarterly	All construction sites	N/A	Observation at, entrance and exit of the site	Comparison of reported contamination level with the baseline figure	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
Construction waste	Quantity of waste generated, waste disposal document	Quarterly	All construction sites	Volume/ weight of waste (by weight bridge or size of vehicle capacity (7 ton or 3 tons)	Site inspection, Observation, Quantity analysis	To consult ZEMA	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
Noise	Noise levels, sound abatement measures in place	Quarterly	All construction sites/ Route of the project	dB(A)	Noise level meter	Shall not exceed 75 dB(A) daytime	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost

Item	Parameter to be Monitored	Monitoring Frequency	Monitoring Area	Measurement Unit	Measuring Method	Standard in Tanzania/ Zanzibar	Responsibility	Estimated Costs [USD]
			related vehicles					
Vibration	Vibration levels	Quarterly	Around the source of vibration	dB(A)	Vibration measuring instrument	Shall not exceed 85 dB(A) (ILO vibration limit)	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
Road traffic safety risks	Traffic control measures in place	Quarterly	Entrance and Exit of Reservoir Sites	Number and duration of disruption	Visual inspection	As minimum disruption as possible	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
Infectious diseases of HIV/AIDS	Incidence of medical reports of HIV/AIDS or other disease	Quarterly	All construction sites (reference the record)	Number of employees who take blood test	HIV blood tests and surveys	Comparison of number of HIV/AIDS positives with the baseline figure	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
Work environment (Including safety control)	Registered worker Injury /illness, Proper use PPE	Quarterly	All construction sites	Number of cases, Personal Protective Equipment (PPE) users	Medical records, and site inspection	OSHA 2005, Low risk to workers, No exposure	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
Road traffic safety risks	Traffic control measures in place	Quarterly	Entrance and Exit of Reservoir Sites	Number and duration of disruption	Visual inspection	As minimum disruption as possible	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost
Accidents by wrong operation of facilities	Number/type of accidents	Quarterly	All Facilities	Number of cases and accidents	Facility maintenance record	Per case/accident	Contractor, Consultant, ZAWA, ZEMA	Included in normal operational cost

Source: JICA Survey Team

Table 9-14 Environmental Management Plan in Operation Phase

Item	Parameter to be Monitored	Monitoring Frequency	Monitoring Area	Measurement Unit	Measuring Method	Standard in Tanzania/ Zanzibar	Responsibility	Estimated Costs [USD]
Accidents by Wrong Operation of the Facility	Number/type of accidents	Quarterly	All Facilities	Number of cases and accidents	Facility maintenance record	Per case/accident	ZAWA	Included in normal operational cost in ZAWA
Impact to Poverty Group	Impact of change of water tariff system to household economy of poverty group	Quarterly	ZAWA Water Supply Area (ZAWA User Households)	Results of survey "Impact of New Tariff System to Household Economy in Poverty Group" (in Environmental Monitoring Form)	Interview to Residents	N/A	ZAWA	Included in normal operational cost

Source: JICA Survey Team

9.4 Stakeholder Meeting

Stakeholders meetings were held twice, in September 2016 and February 2017. Details of each meeting are as follows:

(1) The First Stakeholder Meeting

In September 2016, the First Stakeholder Meeting was held as a part of the EIA Survey. The First Stakeholder Meeting consisted of 8 meetings in the District Commissioner's Office and 7 Shehia offices; the 7 Shehias being project target areas in September 2016.

Table 9-14 shows the results of the meetings. Since meetings were held in each office, technically 8 meetings were held in each location. However, all 8 meetings were covered in the First Stakeholder Meeting since objectives of each meeting is same. Major opinions of the Meeting are as follows:

1) Local residents recognized problems of chronic water shortage, and necessity of water supply project

2) Many of the interviewees mentioned future water demand in project implementation since many residents thought current water shortage has occurred due to wrong water demand estimation in past projects. In addition, they are afraid that future population increase will bring serious water shortage.

3) In past projects, residents around construction sites (project area) were expecting that their water supply situation would be improved by the project. However, the constructed facilities contributed to improvement of the situation in the city center, but not around the construction site. Because of this, some of these residents have objections to the project implementation. Project side must explain the benefit in detail to avoid these complaints from residents.

4) No access to ZAWA is one of complaints of residents. It is necessary that ZAWA enhance its customer services to receive reports on technical problems and water leakages.

Table 9-14 Summary of the First Stakeholder Meeting

No.	Venue	Date	Type of Stakeholder, Number of Attendance	Major Opinions
1.	District Commissioner Office, Urban District	September 16, 2016	Shehia Office and , Environmental Committee, 6 persons	・ Water shortage is a problem for a long time in this area, and residents welcome the project. ・ One of the project sites belong to the Army, and the area is not open to public and not used for residents' activity. Therefore, there is impact to residents' life that the site is applied for the project. ・ Residents request that the project carefully take into account future water demand. ・ In previous cases, residents claimed compensation to the project and total cost of project increase. The project side must avoid these situations. ・ The Commissioner willingly cooperates with the Project.
2.	Welezo	September 16, 2016	Shehia Office: 1 person, Environmental Committee: 4 persons	・ Past projects never focus on shortage of demand; therefore the problem of water shortage is not solved in this area. ・ Although reservoir was constructed in this area by a past project, problem of water shortage in this area was not solved. Residents are unhappy with this situation. ・ To keep sustainability of the project, ZAWA must develop customer service that residents can easily contact ZAWA technicians for reporting of water leakage and other technical problems.
3.	Kinuni	September 15, 2016	Shehia Office, Environmental Committee, and the Public: 6 persons	・ ZAWA water supply service stops when someone in charge is absent. Residents wish ZAWA improve this situation. ・ It is necessary that ZAWA allocate local-level technician in each Shehia. ・ Residents wish that the project will carefully take into account future water demand and allocate necessary facilities for it.
4.	Fuoni/Kijito Upele	September 15, 2016	Shehia Office: 2 persons	・ There is no reliable water source in this area. Therefore, residents recognize the project is a necessity. ・ Cooperation between ZAWA and Shehia is necessary.
5.	Migombani	September 15, 2016	Shehia Office: 7 persons	・ Residents recognized the project is a necessity for the area. ・ In case facilities are constructed in the area belonging to the military, it may not benefit local residents' life. ・ There is no reliable water source in the area, and they depend on water from borehole. The water from borehole is not enough for future demands.
6.	Sharifu Msa	September 14, 2016	Shehia Office: 2 persons, Environmental Committee: 1 person	・ According to population increase, current facility cannot meet future water demands. ・ Increase of water tariff is not a problem as long as ZAWA ensure sustainable water supply (Residents willingly accept increase of water tariff)
7.	Bububu	September 14, 2016	Shehia Office & Environmental Committee, and the Public: 5 persons	・ Water shortage is a problem for this area for a long time. ・ In serious water shortage area, women have to fetch water from far away.
8.	Dole	September 14, 2016	Shehia Office: 2 persons	・ Water shortage in the area is a serious problem and the project is a necessity. ・ Since all residents recognize the project is necessary for the area, no problem (or conflict) will be brought on because of the project.

Source: JICA Survey Team

(2) The Second Stakeholder Meeting

The Second Stakeholder Meeting was held on February 22 and 23, 2017. **Table 9-15** provides the summary of the Meeting. In the Meeting, component of the project and its effect to environment was explained.

Targeted stakeholders are general residents and socially vulnerable people in the project area. In Zanzibar, a *Shaha* (leader of Shehia) is recognized as the representative of each Shehia, so all *Shaha*s in the project area were invited. As socially vulnerable people, women, elders, and handicapped people are invited. Women are not socially vulnerable people in terms of the number of its population. However, the area is a Muslim society and it is not easy to take into account women's opinion in the normal decision making processes. Therefore, women were invited as a category of socially vulnerable people.

There was no objection to the project from local stakeholders. On the other hand, it seems stakeholders were disappointed when they learned the total length of the project. Although this meeting was to address the project, many stakeholders raised general complaints to ZAWA and the current water supply project. This situation is the same as the First Stakeholder Meeting. Improvement of ZAWA's customer service is an important issue for the future.

Table 9-15 Summary of the Second Stakeholder Meeting

<table>
<tr><th>No</th><th>Item</th><th colspan="3">Contents</th></tr>
<tr><td>1</td><td>Meeting Objectives</td><td colspan="3">・ To inform contents of the project to stakeholders in all targeted areas:
Participants of the first stakeholder meeting are residents near the construction sites of reservoirs and elevated tanks, and opinions from the residents living in the of pipeline construction areas are not collected. Therefore, to explain about the Project to all stakeholders in the Project Area, and to obtain their opinions, the second stake holder meeting was held.
・ To collect opinions from varies kinds of stakeholders:
In the first stakeholder meeting, opinions from mainly Shehia leaders were collected and it was not paying attention to gather opinions from local stakeholders, socially vulnerable people and minorities. Therefore, to collect opinions about the Project widely from general residents, socially vulnerable people and minorities, the second stakeholder meeting was held.</td></tr>
<tr><td>2</td><td>Date</td><td colspan="3">February 22, 2017, 9:00-16:00 (N. of Targeted Shehia: 20)
February 23, 2017, 9:00-16:00 (N. of Targeted Shehia: 27)</td></tr>
<tr><td>3</td><td>Venue</td><td colspan="3">Mental Hospital Hall, Zanzibar</td></tr>
<tr><td>4</td><td>Organizer</td><td colspan="3">ZAWA</td></tr>
<tr><td rowspan="5">5</td><td rowspan="5">Type of Attendance</td><td>Type of Attendance</td><td>Feb. 22</td><td>Feb. 23</td></tr>
<tr><td>(1) Representative of the Public (Shaha*)</td><td>14</td><td>16</td></tr>
<tr><td>(2) Representatives of Minorities (Woman, handicapped persons, elderly, and other minorities)</td><td>16</td><td>20</td></tr>
<tr><td>(3) Project Side (ZAWA／MLWEE, ZEMA, District Office, JICA Survey Team)</td><td>31</td><td>26</td></tr>
<tr><td>Sub Total</td><td>61</td><td>62</td></tr>
<tr><td></td><td></td><td>Grand Total</td><td colspan="2">123</td></tr>
<tr><td rowspan="2">6</td><td rowspan="2">Targeted</td><td>February 22</td><td colspan="2">February 23</td></tr>
<tr><td>Non-disclosure Information</td><td colspan="2">Non-disclosure Information</td></tr>
</table>

No	Item	Contents	
7	Program**	1. Opening Remarks 2. Outline of the Project (1) Background of the project (2) Purpose of the project (3) Target area of the project (4) Project component 3. Influence of the Project to Beneficiaries (1) Benefits of the project	(2) Side-effects of the project (3) EIA and Environmental Considerations (4) Security during construction works (5) Change of tariff system 4. Project Implementation Schedule 5. Question and Answer Session 6. Closing Remarks
8	Major Opinions	・ Stakeholders were of concern that the project implementation schedule is more than 7 years which is a long time. ・ Water supply projects in Zanzibar are taking a long time to be implemented. This is much more discouraging to the community as they need reliable water now. ・ Quality control and accuracy of new metering system to be installed by the new project as previously people have been receiving high meter readings against the actual water usage. ・ Existing water bills under unmetered flat-rate system will be incorporated to the new metered tariff system (bill) during operational phase. ・ Impact of the project on peoples' properties. ・ Any correlation between the proposed project with the on-going water supply pipeline exchange project and existing water tanks' construction. ・ Informal connections of water supply. ・ Job opportunities to local stakeholders within the project area.	

*Head of Shehia
**Same program in both February 22
Source: JICA Survey Team

9.5 Environmental Checklist

Attached in **Appendix**.

9.6 Land Acquisition and Involuntary Resettlement

9.6.1 Necessity of Land Acquisition and Involuntary Resettlement

There are project sites in Urban District and West District. Land acquisition and involuntary resettlement are not necessary in all the five sites as well as in the total Yen-Loan project area.

9.6.2 Framework for Land Acquisition in Zanzibar

Although there is no necessary of land acquisition and involuntary resettlement in the Yen-Loan Project, followings are general situation of landholdings and land acquisition in Zanzibar.

(1) Landholding System in Zanzibar

In Zanzibar, all land is possessed by RGoZ. In case someone uses specific part of land exclusively, the one must hold Right of Occupancy, which is explained in Land Allocations Regulations (2008).

(2) Process of Land Acquisition

According to Land Tenure Act (2003), President of Zanzibar can declare Right of Use for any land as long as the purpose is addressed to public welfare, such as road construction, drainage,

and electricity transmission. In this case, RGoZ shall terminate the resident's (user's) Right of Occupancy, but it allows only the minimum area to execute the public purpose, and appropriate compensation must be paid.

In case land acquisition is carried out for public purpose, prior announcement is mandatory. According to Land Acquisition Decree Cap 95, District Commissioner must publish the information of land acquisition in public notice and gazette. Compensation shall be paid by RGoZ or private company which in charge of the land acquisition. Claims shall be reported to District Commissioner. According to Land Tribunal (Amendment) Act 2008, in case actions by District Commissioner are not sufficient and problems are not solved, anyone have right to sue in high court.

(3) Legal Framework of Land Acquisition and Responsible Organization

Several organizations get involved for the process of land acquisition and involuntary resettlement in some projects. However, MLWEE (Ministry of Land, Water, Energy and Environment) is responsible for land acquisition and involuntary resettlement and always in charge of it.

Land Tribunal Act (2008) establishes the Land Tribunal to deal with all meters of land disputes in Zanzibar. The Act demands that the Tribunal preside over any land that is acquired.

(4) Necessity of Preparation of Resentment Action Plan (RAP)

In Zanzibar, land acquisition and involuntary resettlement must be planned in minimum scale according to Land Tenure Act (2003). However, preparation of Resettlement Action Plan (RAP) is not mandatory.

9.7 Residents' Survey

Details of Social Survey is described in **3.12**. The following is a brief summary of the social survey.

9.7.1 Objectives

This survey aims to collect information of residents' situations and opinions for current water supply. It is targeted to both ZAWA users and non-ZAWA users. In questions for non-ZAWA users, current situation of water fetching activities is recorded.

9.7.2 Method

Questionnaire was prepared by JICA Survey Team, and household interview was carried out by 24 ZAWA employees. The survey was carried out from May 2, 2016 to June 26, 2016, and total number interviewed is 436. Interviews took place in 44 Shehias in Urban District and West District. Within the 436 respondents' households, 183 are connected to ZAWA water supply and 253 are not connected to ZAWA.

9.7.3 Result

(1) ZAWA Water supply

- Water Supply Starts: in the morning
- Water Supply Continue:
  - Less than 10% have 24 hours continuous supply.
  - Besides that, half of respondents have" 1-6 hours" of continuous water supply and the other half have "7-12 hours" of water supply
- Current Situation of Supply:
  - Water Volume: Not enough in rainy season
  - Water quality: No problem though out a year
  - Water Pressure: Not enough in dry season
- High priority of improvement in ZAWA service (Customer's opinion):
  - Increase water volume
  - Water supply hours continue longer
  - Not many complains in terms of current tariff

(2) Non-ZAWA customers water use

- Four major water sources of Non-ZAWA users:
  - Neighbors' well
  - Non-ZAWA public water tap
  - Own well
  - Neighbors' water tap
- Problems in water use: "Taste" of water in rainy season
- Water fetching activity:
  - Average of time taking for 1 water fetching (round-trip): 13.36 Minutes
  - Average of number of water fetching per day: 3.56 Times
  - Average of number of containers bringing for water fetching: 9.22 containers
  - Size of the most common water fetching container: 20 Liter
- Gender of Water fetching person:
  - Male in 71 households
  - Female in 83 households
  - Gender of water fetching works are not fixed in other households
- Time taking in water fetching: Relatively longer in Female
- Preferred time use instead of water fetching (in case there is no necessity to go water fetching): Using the time for "Income generating activities"

Chapter 10 Economic and Financial Analysis

10.1 Financial Analysis

10.1.1 Financial Position and Challenges of ZAWA

ZAWA suffers from a weak financial position due to insufficient increase in revenue from water charges, increasing costs (including human resource costs) and electricity charges which ZAWA does not actually pay. ZAWA sometimes faces difficulty in maintaining its monthly payroll and O&M costs on time, and ZAWA's current financial position is far from break even. This results in insufficient O&M activity and incomplete water charges.

To deal with such a situation, ZAWA needs to initiate countermeasures such as establishing connection and registration of unconnected potential users and encouraging conversions from fixed rate contract to metered-rate contracts with water meters. Further ZAWA should adhere to issuing and submitting water bills to all active users and add more options to collect water charges other than through ZAWA offices so that its collection rate can increases.

Public services, such as water supply, seldom earn excessive profits within a short period and in some cases, part of the costs may need to be covered by other funds such as grants, in addition to the service revenue collected from users. Therefore, it is difficult to apply valuation methods, which are generally used for normal businesses, to assess the financial feasibility of a public project. The ultimate purpose of a water service company is to improve the living environment and enhance public hygiene utilizing the same methods as private and commercial businesses, which focuses on financial profit and cost recovery.

In this survey, we shall analyze and determine whether O&M costs and replacement costs can be recovered, and assess the financial position assuming that the project cost itself is recovered through the water tariff revenue of ZAWA. We will perform case studies to determine how much amount of capital grant or subsidy is needed to make ZAWA financially sustainable, if the results of our analysis indicate that the required tariff increase will exceed the amount that domestic users can afford to pay, which in turn will impact on the tariff collection rate.

Under the present tariff system, users with metered and variable tariff rates need to pay more than users with fixed tariff amounts, even though they use the same amount of water. There is therefore an opportunity for increasing revenue by promoting the transition to the metered tariff system. Therefore, the necessity and timing of rate revision are greatly influenced by the extent of promotion of the shift to the metered tariff system (proportion of transition of users with quantity-based tariff system) and improvement of billing rate and collection rate. We shall refine the project cost as much as possible at the present time, identify depreciation cost of each fiscal year and the re-investment cost of the facilities and consider future tariff structure. (Refer to **10.3**)

10.1.2 Precondition of Financial Analysis

Non-disclosure Information

10.1.3 Initial Investment Cost

Non-disclosure Information

10.1.4 Re-Investment Cost

Non-disclosure Information

10.1.5 O&M Cost

Non-disclosure Information

10.1.6 Water Tariff, Revenue Water Rate and Collection Rate

The current water tariff (**Chapter 3.10.1 (1)**) is used for the analysis. The assumption of the NRW rate and leakage rate is shown in **Table 10-1**.

Table 10-1 Revenue Water Rate, Tariff Collection Rate

	2017	2022	2027	2032	2037	2042
Revenue water ratio (Billable Ratio) : Consumed water (Meter reading) / Produced water	40%	65%	80%	80%	80%	80%
Collection rate (Domestic): Collected tariff / Billed tariff	18%	33%	48%	63%	78%	80%
Collection rate (Non-domestic): Collected tariff / Billed tariff	38%	53%	68%	83%	90%	90%

Source: JICA Survey Team

It is assumed that there are still considerable numbers of unconnected users and non-contracted persons amongst domestic households, small and medium-sized commercial business owners, and industrial users. By promoting connection and registration activities for unconnected and unregistered households, it will be possible to collect water charges, connection fees and meter service charges. The more accurate are these measures, the more positive the effects that can be expected in the cash flow of ZAWA.

10.1.7 Weighted Average Capital Cost（WACC）

Non-disclosure Information

10.1.8 Financial Cash Flow Forecast

Non-disclosure Information

10.1.9 Fiscal Budget Prospect of ZAWA

The impact of this Project on ZAWA's fiscal balance and discussions on future water charges and sub-lending conditions are documented in **10.3**.

10.2 Economic Analysis

10.2.1 Prerequisites

Non-disclosure Information

10.2.2 Economic Costs

Non-disclosure Information

10.2.3 Economic Benefits

According to the general economic analysis method for the water service business, the economic benefits of this project are estimated under (1) non-incremental benefits, (2) incremental benefits. There are users who are already connected to ZAWA's water supply in this project area and users who are not connected (to be connected to ZAWA's water supply for the first time in this project), and the analysis covers economic benefits for both of them.

(1) Non Incremental Benefit

Non-incremental benefits for ZAWA's unconnected users are estimated from the cost of alternative water sources. Beneficiaries of this project, that is, users without ZAWA water in the project area are assumed to use alternative water sources, and it is considered that by implementing this project, alternative water source costs will be saved. Based on the results of the residents' opinion survey, the majority of households not receiving ZAWA's water service use community wells as water sources for domestic use and bottled water for cooking and drinking. The alternative water source costs are estimated from the sum of these costs.

The average used water volume is estimated from per capita water consumption. As per **3.9.1 (1)**, per capita water consumption in this project area is 75.5 LPCD. Assuming that the average household size is 5.2 people (on Census 2012), the daily water consumption per household will be 393 liters. Also, it is assumed that 5 liters of bottled water per household is used for drinking and cooking, and the rest (388 liters per day) is used other than for drinking and cooking from other water sources.

The cost of alternative water sources is calculated to be 10,349 TZS / month from the household budget survey result. When the cost per 5 liters of bottled drinking water is 1,500 TZS and the daily water usage cost combined with the cost of other water sources is 1,845

TZS per day, the average alternative water source cost (non-incremental benefit) for users not connected to ZAWA, is estimated to be 4,699 TZS / m^3.

On the other hand, even users who are already connected to ZAWA cannot cover all their water needs from the ZAWA water source, so the non-incremental benefit from the cost of the alternative water source to compensate for the shortage is calculated. The cost of the water source that complements the ZAWA water source is calculated as 2,925 TZS / month (98 TZS / day) from the household budget survey result. When the cost of water for drinking and cooking is about the same as that of ZAWA unconnected users, the average alternative water source cost (non-incremental benefit) of users already connected to ZAWA is estimated at 4,069 TZS / m^3. **Table 10-2** 13 below shows the results of the calculations for the average alternative water source cost (non-incremental benefit) per unit of water consumption.

Table 10-2 Calculation Results of Non-Incremental Benefits

Cost of Alternative Water Source for Non-ZAWA Domestic users

Alternative Water Source	Consumption per day (L/HH)	Cost per day (TZS)	
Water for drinking and cooking: Bottled Water	5	1,500	Average Water Cost
Water for other use: Tube Well, etc	388	345	(TZS/m^3)
Total	393	1,845	4,699

Cost of Alternative Water Source for ZAWA Domestic users

Alternative Water Source	Consumption per day (L/HH)	Cost per day (TZS)	
Water for drinking and cooking: Bottled Water	5	1,500	Average Water Cost
Water for other use: Existing ZAWA network	388	98	(TZS/m^3)
Total	393	1,598	4,069

Source: JICA Survey Team

(2) Incremental benefits

The Project not only replaces existing water consumption from other suppliers (non-incremental benefits) but also increases the water consumption of beneficiaries (incremental benefits) with the willingness to pay for new water services. The incremental benefit is estimated from the result of the household budget survey. As shown in **Table 10-3**, the average amount each household is willing to pay is 10,552 TZS/month for ZAWA connected users, 9,643 TZS/month for non-ZAWA connection households, and 10,053 TZS/month for the overall average.

Table 10-3 Average Willingness to Pay per Households

Willingness to Pay (TZS/month)	
ZAWA Users	10,552
Non ZAWA Users	9,643
Avarage	10,053

Source: JICA Survey Team

Likewise, from the result of discussion in **Chapter 4**, it is assumed that the average water consumption rate of the new water service will increase from 75.5 L/cap/day to 79 L/cap/day,

as estimated for 2032 (**Table 10-4**). Assuming that the average household size is 5.2 people/household, this corresponds to 12.3 m^3/month per household. Therefore, the average willingness to pay per m^3 is estimated to be 856 TZS/m^3 for current ZAWA users and 782 TZS/m^3 for users without ZAWA connection, respectively (10,552 TZS/12.3 m^3, 9,643 TZS/12.3 m^3).

Table 10-4 Calculation Results of Incremental Benefits

Basis of Economic Benefit for Non-ZAWA Domestic users

	Water Consumption	Water Price (TZS/m3)
With Project	79	782
Without Project	75.5	4,699

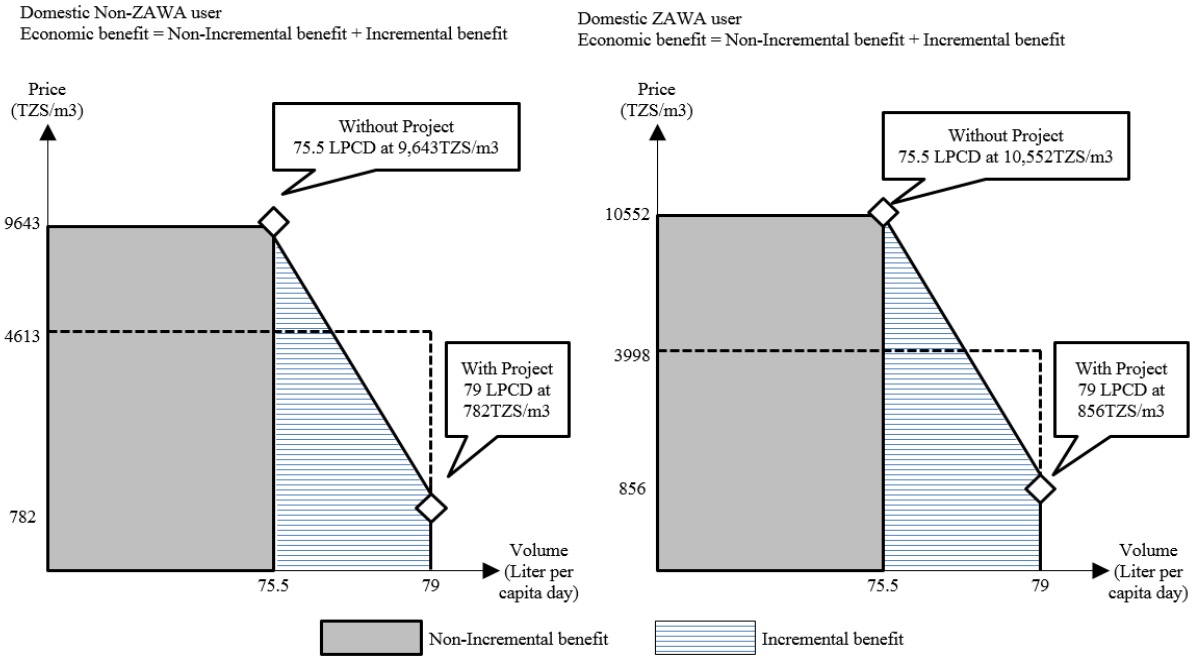
Basis of Economic Benefit for ZAWA Domestic users

	Water Consumption	Water Price (TZS/m3)
With Project	79	856
Without Project	75.5	4,069

Source: JICA Survey Team

(3) Estimation of economic benefits

From the aforementioned non-incremental benefits and incremental benefits, the average economic benefit of this Project for ZAWA connected users and non-connected households is estimated to be 3,998 and 4,613 TZS/m^3 for ZAWA connected users and non-connected households, respectively (**Figure 10-1**).



Economic Benefit per cubic meter

ZAWA users $3{,}998 = 4{,}069\ \text{TZS/m3} \times \frac{75.5\ \text{LPCD}}{79\ \text{LPCD}} + \frac{4{,}069 + 856}{2} \times \frac{79\ \text{LPCD} - 75.5\ \text{LPCD}}{79\ \text{LPCD}}$

Non ZAWA users $4{,}613 = 4{,}699\ \text{TZS/m3} \times \frac{75.5\ \text{LPCD}}{79\ \text{LPCD}} + \frac{4{,}699 + 782}{2} \times \frac{79\ \text{LPCD} - 75.5\ \text{LPCD}}{79\ \text{LPCD}}$

Non-incremental benefit per m3 Non-incremental benefit per m3

Source: JICA Survey Team

Figure 10-1 Estimation of Economic Benefits

10.2.4 Estimation of EIRR

Non-disclosure Information

10.3 ZAWA's Financial Forecast for the Project

10.3.1 Prerequisites

As analyzed in **10.1**, this Project is not financially feasible due to the extremely low water tariff revenue.

In this section, the options shall be analyzed from two financial points of view. One, to secure feasibility by raising tariffs for ZAWA's water service customers as a whole, and two, to clarify the extent of subsidies and sub-lending debts from RGoZ.

Non-disclosure Information

10.3.2 Analyzed Options

Financial forecasts are based on the assumptions as follows.

- Base case : ZAWA will pay back the loan and tariff is not raised.
- Case 1 : ZAWA will pay back the loan. ZAWA's water tariff will be increased in 2029 (5 years after the planned start year of operations) to reach 4% of household income
- Case 2 : RGoZ will pay back the loan and the tariff is not raised.
- Case 3 : RGoZ will pay back the loan. ZAWA's water tariff will be increased in 2029 (5 years after the planned start year of this Project) to reach 4% of the household income

10.3.3 Results of Financial Forecasts

Non-disclosure Information

10.3.4 Analysis of Financial Forecasts Results

In the case that RGoZ will pay back the loan and the water tariff is increased (Case 3), the accumulated cash flow of the Project will be positive. With support to debt service from Government, the financial feasibility will be significantly improved.

However, it is important to consider how high the water charge collection rate can be increased. In the analysis, it is assumed that the collection rate can be raised to 80% for domestic (personal) users and 90% for non-domestic users. It is important to improve the collection rate which exceeds above the mentioned percentage to ensure financial feasibility of the Project.

Chapter 11 Recommendations

11.1 Recommendations for Project Implementation

(1) Cost and Financial Aspects

In the financial aspect, the following risks are considered:

- Increase of facility construction cost
- Increase of expenses for facility O&M
- Lack of revenue

(a) Increase of facility construction cost

An increase of facility construction cost leads to an increase in cost to be shouldered by RGoZ and a reduction of the Project scope. The reduction of the scope may affect the project's effect.

At the detailed design stage, facility designs shall be tailored to suit required cost reduction; setting of specifications to ensure competitiveness of bids; and sizing of contract packages, will be conducted. In addition, it is also necessary to consider the trend of inflation, and labor and equipment procurement issues.

(b) Increase of expenses for facility O&M

There is a risk of an increase in O&M cost due to external factors, such as rises in personnel expenses and electricity fees, as well as the cost for equipment repairs. In existing facilities, the failure of borehole pumps and flow meters have led to a decline in services. In addition, the use of generators during power failures also causes cost increase.

As measures against such risks, it is necessary to consider countermeasures against the causes of previous failures; reduction of failures through appropriate O&M; reduction of maintenance and management cost by equipment specification standardization; minimization of maintenance cost by reducing leakage; proper staffing; preparation / use of the O&M manual and improvement of work efficiency in the detailed design stage.

(c) Insufficient revenue

Factors that contribute to revenue shortage are high non-revenue water ratio, low unit water rate, and low collection ratio of water charges, amongst others. If it is not possible to absorb the rise of cost through cost reduction efforts such as improving efficiency of works and improving procurement activities, it is necessary to consider the revision of the water tariff.

In the financial analysis of this survey, financial modeling on water tariff revision to cover the necessary cost was carried out, based on assumed conditions such as the revenue water volume, collection rate of water charges, and the presence or absence of subsidies. RGoZ and ZAWA shall decide future policies to cover cost taking this modeling into consideration, and

ZAWA shall revise the water tariff structure based on the corresponding financial model. Also, it is necessary to prepare in advance and make adjustments with stakeholders at an early stage because revising water tariff structure takes time due to necessity of revision of ministerial ordinance.

In order to maintain the collection ratio at a high level, it is required to ensure reliable meter reading, billing and fee collection work. It is important not only to expect the introduction of new technology, such as smart meters and systems which use mobile phones, but also to maintain good service by appropriate customer information management. Since it is expected that the number of customers who require meter reading will increase dramatically after completion of the construction, it is necessary to prepare for the employment and training of staff in advance so that work can be reliably performed at that time. It is also important to set a target value for the fee collection ratio at the actual operation stage to raise incentives to achieve the goal.

In addition, it is also necessary to conduct public relations activities targeting the consumers, to raise awareness on fee payment. The activities should commence from the start when the start of the project is decided and be continuously and systematically managed.

(2) Smooth Implementation of the Project

Construction work related to the improvement of water distribution facilities are planned to start in 2021, following the signing of the Yen-loan agreement, and subsequent selection of consultants and contractors.

Judging from the reaction at the stakeholders' meeting, the residents strongly hope for improvement of the water service as soon as possible, and the improvement of the water service is considered as an urgent and a high priority project for Zanzibar.

After the implementation of the loan project is confirmed, it is necessary to promptly procure and prepare a system to manage Project implementation and proceed with the various packages without delay, in accordance with the Project implementation plan. ZAWA needs to coordinate with the relevant ministries and agencies and proceed with necessary procedures for construction with strong leadership while receiving advice and guidance from the Yen-Loan project promotion experts.

On the other hand, not only equipment but most of the materials are also to be procured from outside Zanzibar, so if there are problems at the port facility, the impact on the procurement schedule is inevitable. It is necessary to formulate a procurement plan that also takes such risks into consideration.

(3) Securing Necessary Staff for Appropriate O&M and Water Charge Collection Work

Currently, the staff can only focus on O&M activities and necessary activities for a stable water

supply system are not executed enough. To improve the water supply service quality by using the facilities developed by this Project, activities related to O&M have to be increased as proposed in this plan, and ZAWA needs to secure the required human resources.

Additionally, to collect water charges from the customers whose number is expected to be increased by this Project, the number of staff for collection of water charges requires to be increased.

To secure the necessary staff in time for the commencement of facility operations, ZAWA has to start securing staff before the completion of construction works. This would mean that, in the interim, ZAWA would have to expend funds before the revenue starts to increase. Therefore, if it is difficult to secure staff utilizing ZAWA's own budget, ZAWA would have to request financial support from MLWEE to secure the necessary budget.

(4) Risk of Power Outage

Zanzibar receives electricity from the mainland, and ZECO owns equipment capable of covering electrical power demand for the time being. The power situation is not bad as discussed in **Chapter 2**. On the other hand, power failure do occur due to inadequate maintenance of the electricity grid of the island and heavy rains during the rainy season.

Since ZAWA relies on boreholes for the majority of water sources, boreholes stop yielding water during power failures.

Therefore, in addition to preparing for power failure due to ZECO's construction work by sharing construction information with ZECO, it is necessary to establish an operational method that ensures continuous water supply by utilizing the water storage capacity of the distribution reservoir, to compensate in the event of power failure.

11.2 Recommendations for Improvement of Urban Water Supply Service

(1) Human Resource Development

In order to implement high quality water service efficiently and continuously, in the short term, it is necessary to secure and train staff who can properly operate, maintain and manage the facilities and equipment constructed in this Project. Therefore, O&M guidance by contractor and consultants are planned in this Project.

On the other hand, in order to improve the municipal water service for medium to long term, it is indispensable to train senior officials who can judge the circumstances surrounding the water supply service such as population trends and urban development, and direct the planning and execution of business plans.

As training of senior officials takes time to accomplish, implementation of the training program formulated in this survey is required. Besides that, if necessary, it is recommended that ZAWA's

human resource development and organization strengthening to be promoted in collaboration with other government agencies other than ZAWA, water business entities and private companies in mainland Tanzania.

(2) Water source Development and Management, and Preservation of Water Resources

Zanzibar is highly permeable due to its geological characteristics as a limestone island. For this reason, there is no big river, and therefore no alternative but to utilize groundwater as the water source. In addition, because of its high permeability, there is a high possibility that contaminated water generated from domestic wastewater and garbage dump deposits reach groundwater without being purified by the soil. Furthermore, since the island is surrounded by the sea, saltwater intrusion occurs when excessive groundwater is pumped out.

Therefore, in order to use the water resources continuously in the future, management of quantity and quality of groundwater sources are very important. In parallel with the strengthening of the management and conservation system, it is also necessary to promote projects related to other environments, such as final garbage disposal sites and maintenance of sewer systems so as not to cause groundwater contamination.

In this Survey, the necessity of developing a new water source was confirmed in order to satisfy the increasing water demand with the increase of the population. In the "Water Resource Assessment" compiled in 2014, the localization of water resources is indicated. But that, as water resource management, is not sufficient because of issues such as the lack of continuous monitoring. It is necessary to collect data and increase the accuracy of estimating the allowable yielding amount for each area, and it is also necessary to accurately measure the water amount supplied by ZAWA and the amount used by customers. As a result, once the permissible amount of yielded water is determined, it needs to also be adjusted with irrigation usage, so that the water resources are developed and used in a well-managed state.