No.

The Ministry of Water, Construction, Energy and Lands
The Revolutionary Government of Zanzibar
The United Republic of Tanzania

IMPLEMENTATION REVIEW STUDY REPORT
ON
THE PROJECT FOR ZANZIBAR URBAN WATER SUPPLY DEVELOPMENT PHASE II
IN
THE UNITED REPUBLIC OF TANZANIA

November 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

NJS CONSULTANTS CO., LTD.

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PREFACE

In response to a request from the Government of Tanzania, the Government of Japan decided to conduct the implementation review study on the Project for Zanzibar Urban Water Supply Development Phase II and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent the study team to Tanzania from 16th July to 30th July 2008.

The team held discussions with the officials concerned of the Government of Tanzania, and conducted field study at the study area. After the team returned to Japan, further studies were made and the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Tanzania for their close cooperation extended to the team.

November 2008

Masafumi Kuroki
Vice-President
Japan International Cooperation Agency

November 2008

LETTER OF TRANSMITTAL

We are pleased to submit to you the implementation review study report on the Project for Zanzibar Urban Water Supply Development Phase II, Tanzania.

This study was conducted by NJS Consultants Co., Ltd., under a contract to JICA, for three and half months, during the period June 2008 to November 2008. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation in Tanzania and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Hiroki Fujiwara
Project Manager,
Implementation Review Study Team on
the Project for Zanzibar Urban Water Supply Development Phase II, Tanzania

NJS Consultants Co., Ltd.

Summary

Summary

The United Republic of Tanzania (hereinafter Tanzania) consists of Zanzibar and Tanganyika. Zanzibar is a group of islands on the Indian Ocean and Tanganyika is on the continent. Zanzibar has population of 980,000, which 30% of the total population live in Zanzibar City. Fall of export price of clove and suspension of development assistance from international donors due to the political instability after 1995 stalled Zanzibar's economical development and enlarged the economical gap to Tanganyika.

Water supply development in Zanzibar started in 1920 using springs as water sources. By 1990 total length of water pipes reached 100 km and 7 clear water reservoirs were developed. Due to shortage of the funds, the Government of Zanzibar could not rehabilitate and expand the old facilities, which do not meet the current water demands. The 10% of urban population of Zanzibar do not receive drinking water supply, nor continuous 24-hour service supply. Contamination of drinking water by sewage through the old damaged pipes is suspected to cause high occurrence of water related infectious diseases. The improvement of the water supply system has the highest priority in public health projects.

The Government of Zanzibar has adopted an Economy Recovery Program, prioritising safe water supply for meeting Basic Human Needs. Under the above circumstances, the Government of Zanzibar requested a grant aid program to improve water supply facilities in Zanzibar Urban area.

In response to the above request, Japanese Government dispatched preliminary study team to Zanzibar in order to confirm justification, effectiveness and scope of the requested project as the grant aid scheme and to study current situation of the sector and capacity of implementation agency in 2002. This study confirmed the necessity of the project implementation, but also pointed out that no collection of water fees will cause difficulty in operation and maintenance of the water supply system. In this regard, the team recommend to set water fees collection as prerequisite for the implementation of the grant aid project.

Zanzibar adopted the suggestion and the Water Policy on Zanzibar was passed by the Zanzibar House of Representatives in 2004. The Japanese Government considered that Zanzibar met the above precondition, and dispatched a basic design study team to Zanzibar from October 23 to November 26 of 2004 to conduct a basic design through the investigations of current condition of water supply, water demand, water quality, water source, distribution network and fees collection.

The Project aims at improving the existing water supply of the study area through developing new wells, and extending water pipelines. At the same time, the project will support ZAWA staff to operate, maintain and manage the improved water supply system effectively.

The original request and proposed facilities are indicated in Table 1.

Table 1 The original request and proposed facilities

No.	Item	Original Request	Basic Design	Initial Implementation Review	Remarks
A	Facilities				
A 1	Distribution Stations				
A 1-1	Saateni Station				
(1)	Construction of underground reservoir	4,000 m^3×1	—	—	
(2)	Renewal of elevated tanks	450 m^3×2	—	—	
(3)	Construction of new elevated tanks	450 m^3×2	—	—	
(4)	Renewal of transmission pumps	540 m^3/hr×2 250 m^3/hr×2	Approx.400 m^3/hr×2 Approx.200 m^3/hr×2	Approx.400 m^3/hr×2 Approx.200 m^3/hr×2	
(5)	Disinfection facility	1 set	1 set	1 set	
A 1-2	Welezo Station				
(1)	Construction of reservoirs	4,000 m^3×1 3,000 m^3×2	Approx.4,000 m^3×2	Approx.4,000 m^3×2	
(2)	Disinfection facility	1 set	1 set	1 set	
A 1-3	Dole Station	—			
(1)	Construction of reservoir		Approx.1,200 m^3×1	Approx.1,200 m^3×1	
(2)	Disinfection facility	1 set	1 set	1 set	
A 1-4	Kinuni Station	—			
(1)	Construction of reservoirs		Approx.2,700 m^3×1	Approx.2,700 m^3×1	
(2)	Disinfection facility	1 set	1 set	1 set	
A 2	Construction of wells	100 m^3/hr×6	58.4 m^3/hr×11 (incl. 1stanby well)	58.4 m^3/hr×11 (incl. 1stanby well)	
A 3	Pipeline construction				
A 3-1	Transmission pipes	Total approx.20km	Total approx.24km	Total approx.24km	
A 3-2	Distribution pipes	Total approx.35km	Total approx.20km	Total approx.20km	
B	Equipment				
B1	Water Analysis	1 set	—	—	
B2	Workshop	1 set	Pickup trucks: 4 units	-	

They also dispatched the study team to provide an explanation of the draft final report in March 2005, however the project was postponed since the Act of Zanzibar Water Supply Authority, which prescribes water fees collection, had not yet become into the law.

In January 2006, the Government of Zanzibar submitted a letter to the Japanese Government stating that the Government of Zanzibar would forward the Act of Zanzibar Water Supply Authority to the Zanzibar House of Representatives in March 2006. Based on this act, the Government of Zanzibar would collect water fees from users. With this letter, the Japanese government recognised that Zanzibar met the

precondition, and decided to dispatch the primary implementation review study in March of 2006, which leads the both governments to agree on the implementation of the project. The first construction period commenced in 2006 and concluded in March of 2008.

The proposed scope of the Project is summarised in Table 2.

The Project for Zanzibar Water Supply Development (Phase II) was planned to conduct continuously with Phase I, however due to increase of the material cost, the project was suspended. In order to review the cost estimate, "The Implementation Review Study for the Project for Zanzibar Urban Water Supply Development Phase II" was conducted under a new project name.

Detailed Design for the Project for Zanzibar Urban Water Supply Development Phase II and Soft components in Table 3 were conducted in second construction period of Phase I.

Table 2 Items which constructed

Facility		Item	Specification	Quantity	Remarks
(1)	Well Pump Stations	Wells	Well diameter: 250 mm Well depth: 60 - 70 m	6	New
		Well Pumps	Submersible Pump 58.4 m^3/hr	6	
		Electrical equipment	Transformer, control panels, instrumentation	6	
		Well Pump House	For Power distribution/Control Panels, brick walls 50m^2/house	6	
(2)	Transmission/ Distribution Facilities				
	Saateni Station	Transmission Pump	Horizontal Centrifugal Pump 400 m^3/hr x 40m 200 m^3/hr x 40m	 2 2	Renewal (incl. 1 stanby) (incl. 1 stanby)
		Electrical Equipment	Instrumentation/control panels	2	Renewal
		Disinfection Facility	Powder Disinfection Solution Tank/Drip	2	Renewal
	Welezo Station	Reservoirs	Reinforced concrete, V=4,000m^3	2	New
		Disinfection Facility	Powder Disinfectant Solution Tank/Drip	1	New
(3)	Transmission Pipelines		DCIP ϕ 150 – ϕ 600	Approx. 13 km	New
(4)	Distribution Pipeline		DCIP ϕ 300 – ϕ 700	Approx. 9.6 km	New

Table 3 Soft Component

(1) Engineering training for facility operation
(2) Management training for institution development
(3) Support for public education programme

The implementation review study team was sent to Zanzibar to check the current condition of sites, implementation plan, construction costs and the progress of work done by the Zanzibar side from July 17th to 29th of 2008.

The next two conclusions were obtained from the field investigation:-

- With regard to the cost estimate, unit price will be revised from the viewpoints of fluctuation arisen on market trends.
- With regard to the cargo handling and customs clearing operations, working days required showed an increasing tendency because of the capacity limitations of existing facilities in Dar es Salaam port. It required 25 days to the cargo handling and customs clearing operations.

The proposed scope of the Project is summarised in Table 4.

Table 4 Scope of the Project

Facility		Item	Specification	Quantity	Remarks
(1)	Well Pump Stations	Wells	Well diameter: 250 mm Well depth: 60 - 70 m	5	New
		Well Pumps	Submersible Pump 58.4 m^3/hr	5	
		Electrical equipment	Transformer, control panels, instrumentation	5	
		Well Pump House	For Power distribution/Control Panels, brick walls 50m^2/house	5	
(2)	Distribution Facilities				
	Kinuni Station	Reservoirs	Reinforced concrete, V=2,700m^3	1	New
		Disinfection Facility	Powder Disinfectant Solution Tank/Drip	1	New
	Dole Station	Reservoirs	Reinforced concrete, V=1,200m^3	1	New
		Disinfection Facility	Powder Disinfectant Solution Tank/Drip	1	New
(3)	Transmission Pipelines		DCIP ϕ 150 – ϕ 400	Approx. 11 km	New
(4)	Distribution Pipeline		DCIP ϕ 300 – ϕ 400	Approx. 10 km	New

O&M on the said facilities was under the DWD's jurisdiction before and was placed under the control of ZAWA (a state-run public corporation shifted by DWD) established on August 2006 based upon the above-mentioned the Act of Zanzibar Water Supply Authority related. In addition, ZAWA carried out the water fees collection from September 2008.

The Project aims at improving the living standard in the study area through the improvement of safe drinking water. It will help to achieve the Basic Policies of Water Sector in "ZANZIBAR VISION 2020", which are intended to secure safe drinking water for all the people and sectors economically through

appropriate water resource management.

This Project will expand the facilities and renew the old facilities in order to meet the increasing water demand and to secure the safe drinking water supply. Direct and indirect benefits of the Project are as follows;

(1) Direct benefits of the Project

- Meeting the water demand of the target year by increasing the water production from 40,100 m^3/d to 54,100 m^3/d.
- Secure reliable and safe water supply by providing continuous service for the customers.

(2) Indirect benefits of the Project

- Improving health condition of people in Zanzibar by reducing water related infectious diseases, such as diarrhoeas and cholera.
- Supporting economic development of Zanzibar and securing resident’s income by developed to tourism with safe drinking water supply.

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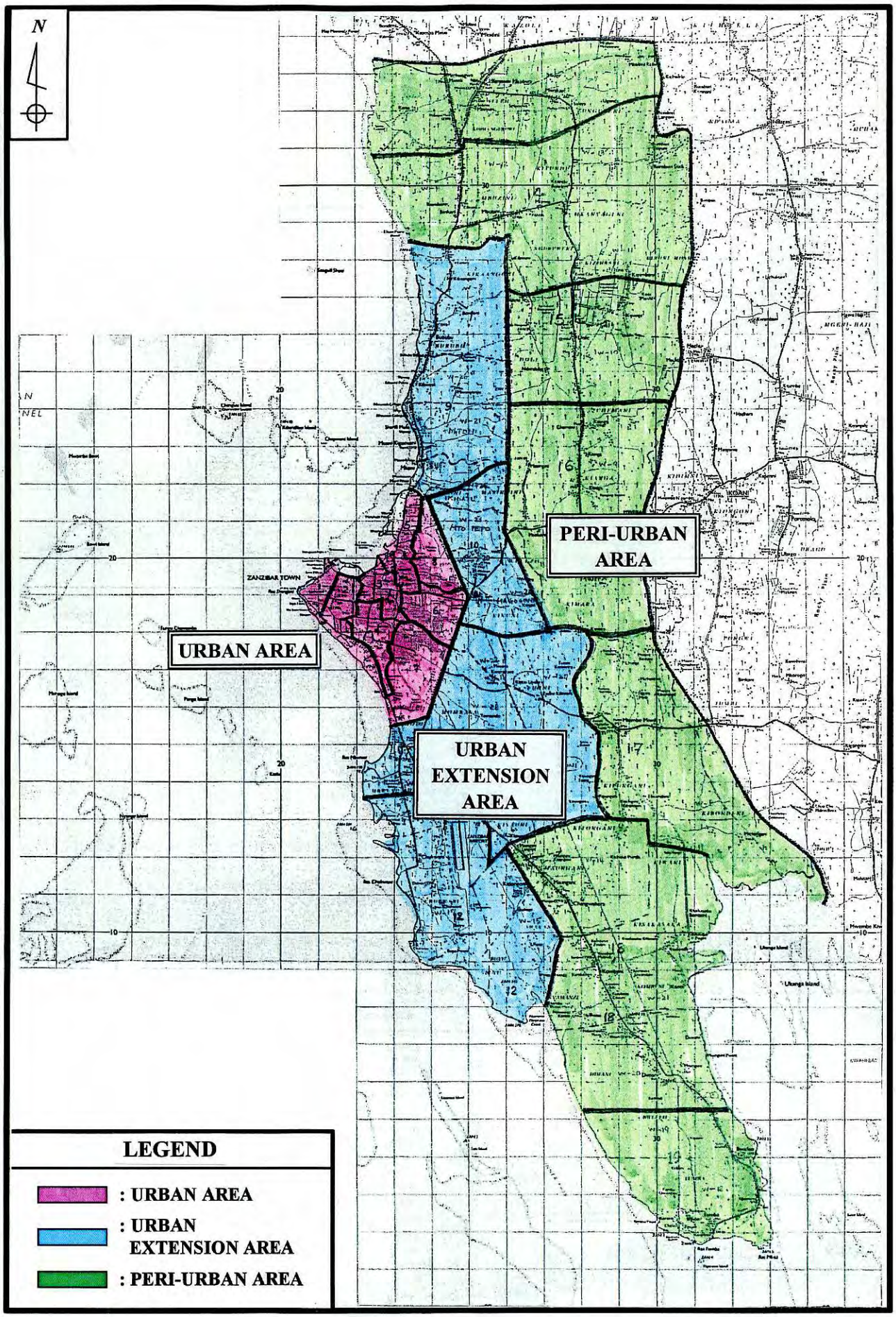
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PERI-URBAN AREA
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ZANZIBAR TOWN
LEGEND
: URBAN AREA
: URBAN EXTENSION AREA
: PERI-URBAN AREA

Study Area

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Abbreviations

A/P	Authorization to Pay
AfDB	African Development Bank
B/A	Banking Arrangement
BHN	Basic Human Needs
CEC	Commission of the European Communities
DWD	Department of Water Development, Zanzibar （DWD was abolished in Aug.2006 and ZAWA was newly established.）
E/N	Exchange of Notes
EAC	East African Community
EIA	Environmental Impact Assessment
FINNIDA	Finnish International Development Agency
GDP	Gross Domestic Product
GNI	Gross National Income
GNP	Gross National Product
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
KfW	German Bank for Reconstruction and Development
LWL	Low Water Level
MFEA	Ministry of Finance & Economic Affairs
MIS	Management Information System
MOF	Ministry of Finance
M/P	Master Plan
MWCEL	Ministry of Water, Construction, Energy and Lands
NGO	Nongovernmental Organization
OAU	Organization of African Unity
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
QC	Quality Control
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund
ZMC	Zanzibar Municipal Council
ZAWA	Zanzibar Water Management Authority

Chapter 1 Basic Concept of the Project

Chapter 1 Basic Concept of the Project

1-1 Present Condition of Water Sector

1-1-1 Present Condition and Need for the Project

Water supply development in Zanzibar started in 1920 using springs as water sources. By 1990 total length of water pipes reached 100 km and 7 clear water reservoirs were developed. Due to shortage of the funds, the Government of Zanzibar could not rehabilitate and expand the old facilities, which do not meet the current water demands. The 10% of urban population of Zanzibar do not receive drinking water supply, nor continuous 24-hour service supply. Contamination of drinking water by sewage through the old damaged pipes is suspected to cause high occurrence of water related infectious diseases. The improvement of the water supply system has the highest priority in public health projects.

Although the Project for Zanzibar Water Supply Development (Phase I) was constructed in 2007, increased water production could not meet the current water demands of the water supply area.

1-1-2 National and Sector Development Plans

The Zanzibar National Development Plan, namely ZANZIBAR VISION 2020, has been developed by Zanzibar Ministry of Finance and Economic Affairs in January 2000 with assistance from UNDP. Policy goals of water sector development are presented as follows.

“Basic Policies of Water Sector are intended to secure safe drinking water to all the people and sectors economically through appropriate water resource management. It will help social and economic development of Zanzibar. The water policies are:

a. Develop effective water supply and management system to secure affordable and reliable water supply
b. Rain water catchments will be protected as a drinking water recharging area
c. Community formation for water supply rights
d. Sustainable and fair water supply for urban and rural areas
e. Appropriate maintenance for water supply facilities
f. Water supply technology reinforcement in wells, dams, pumps and pipes
g. Establishment of rainwater recharging and harvesting technology
f. Establishment of effective water rates collection system”

1-1-3 Social and Economic Conditions

The United Republic of Tanzania (hereinafter Tanzania) was established in 1964 as a result of the merger of Zanzibar and Tanganyika. Tanzania adopted economic liberalization and structural adjustment policies since 1986 and achieved some success. Multiple political parties have been introduced since 1992 and the President Mkapa was elected in 1995 and re-elected in 2000 general election. The President

Kikwete was elected in 2005 general election. The Zanzibar President Kalume was re-elected in 2005 general election in Zanzibar.

Tanzania adopts non-alliance foreign policy and assumes a leadership role at AU (African Union), UN etc., emphasizing concept of the united Africa and independence for colonized area. It has a stable relationship with the near-by nations and contributed for the stability of Victoria Lake area, including Congo, and for solving dispute over Burundi. Tanzania together with Kenya and Uganda agreed on the framework of East African Community (EAC) in November 1999 and the Community is formally launched in January 2001. In March 2004, Customs Union agreement was signed among EAC countries. Tanzania is the chair of South Africa Development Community since August 2003. Tanzania assumes an important role in diplomatic relations of East Africa based on its stable foreign policy.

Agricultural production consists of approximately 45% of GDP in Tanzania. Its major products are maize, cassava, rice, beans, coffee and cotton. Gold and diamonds are produced in relatively small scale. Sisal, tobacco and agricultural product processing are the main industries. Earning from Tourism has increased steadily and is regarded as a potential foreign currency earner.

Based on 2006 Census, the population of Tanzania is 38.7 million (in 2006); GDP is 14,995 billion Tsh (in 2006); per Capita GNP is 319 US$ (in 2006); economic growth is 6.2% (in 2006) (source: Tanzania in Figures 2006). Population of Zanzibar is 1,140 thousands projection (in 2006). GDP is 512.4 billion Tsh (in 2006) and per Capita GDP is 390 US$ (in 2006); economic growth is 6.1% (in 2006) according from Tanzania in Figures 2006. 21% of GDP is agriculture, fishery and forestry. 13% is industry and 52% is service industry. Value added tax is 14%. (The National Account of Zanzibar 2/E, Office of Chief Government Statistician, June 2004、p1-3)

As a part of Tanzania Poverty Reduction Plan, Zanzibar Poverty Reduction Plan has been formulated. It emphasizes safe drinking water supply as a priority issue. In this respect, water supply related budget for the Ministry of Water Construction Energy and Lands has been increasing since 2002 fiscal year. Water policy related budget of the ministry is also approved as requested.

The study area, Urban and West district of Zanzibar, includes the Stone Town of Zanzibar which is inscribed by the UNESCO body as a World Heritage site in 2000. The population was estimated at 461,000 in 2006 and 390,000 in 2002. (Tanzania in Figures 2006)

Over 80,000 tourists visited Zanzibar in 2001. Their stay lasts 4 days in average. Lack of basic tourist infrastructure limits annual increase of tourism earning by mere 1%. (The National Accounts of Zanzibar, Second Edition, June 2004, Office of Chief Government Statistician)

1-2 Request from Recipient Country

The present water supply experiences frequent disruption of the service due to the aged water facilities and insufficient supply capacity. Contamination of drinking water by sewage through the old damaged pipes is suspected to cause high occurrence of water related infectious diseases. The Government of Zanzibar has adopted an Economy Recovery Program, prioritizing safe water supply for meeting Basic Human Needs. Under the above circumstances, the Government of Zanzibar requested a grant aid program to improve water supply facilities in Zanzibar Urban area.

In response to the above request, Japanese Government dispatched preliminary study team to Zanzibar in order to confirm justification, effectiveness and scope of as the requested project the grant aid scheme and to study current situation of the sector and capacity of implementation agency in 2002. This study confirmed the necessity of the project implementation, but also pointed out that no collection of water fees will cause difficulty in operation and maintenance of the water supply system. In this regard, the team recommend to get a water fees collection as prerequisite for the implementation of the grant aid project. Basic water policy for water fees collection has passed the Zanzibar House of Representative in 2004, which was regarded as a first step for the implementation of the Project. Japanese Government dispatched a basic design study team to Zanzibar, however the project was postponed since the Act of Zanzibar Water Supply Authority, which prescribes water fees collection, had not become the law. In 2006, the Government of Zanzibar submitted a Road Map so that the Japanese Government could start an implementation review study. According to the Road Map, Act of Zanzibar Water Supply Authority was approved in the Diet in March 2006 and the President signed up in April of 2006. Through the process, Phase I commenced in 2006, and completed in March 2008.

The Project for Zanzibar Water Supply Development (Phase II) was planned to conduct continuously with Phase I, however due to increase of the material cost, the project was suspended. In order to review the cost estimate, “Implementation Review Study for the Project for Zanzibar Urban Water Supply Development Phase II” was conducted under a new project name.

The government of Japan sent a second study team to Tanzania from 17th July to 29th July 2008. They reconfirmed site situation, construction planning survey, estimate survey and obligation of recipient country.

The original request and proposed scope of the project are shown in Table 1-1.

Table 1-1 Comparison between Original Request, Basic Design and Implementation Review

No.	Item	Original Request	Basic Design in 2004 1st Implementation Review Study in 2005	2nd Implementation Review Study in 2008	Remarks
A	Facilities				
A 1	Distribution Stations				
A 1-1	Saateni Station				*1
(1)	Construction of underground reservoir	4,000 m^3×1	—	—	
(2)	Renewal of elevated tanks	450 m^3×2	—	—	
(3)	Construction of new elevated tanks	450 m^3×2	—	—	
(4)	Renewal of transmission pumps	540 m^3/hr×2 250 m^3/hr×2	Approx.400 m^3/hr×2 Approx.200 m^3/hr×2	—	
(5)	Disinfection facility	1 set	1 set	—	
A 1-2	Welezo Station			—	*1
(1)	Construction of reservoirs	4,000 m^3×1 3,000 m^3×2	Approx.4,000 m^3×2	—	
(2)	Disinfection facility	1 set	1 set	—	
A 1-3	Dole Station	—		—	
(1)	Construction of reservoir		Approx.1,200 m^3×1	Approx.1,200 m^3×1	
(2)	Disinfection facility	1 set	1 set	1 set	
A 1-4	Kinuni Station	—			
(1)	Construction of reservoirs		Approx.2,700 m^3×1	Approx.2,700 m^3×1	
(2)	Disinfection facility	1 set	1 set	1 set	
A 2	Construction of wells	100 m^3/hr×6	58.4 m^3/hr×11 (incl. 1stanby well)	58.4 m^3/hr×5	*2
A 3	Pipeline construction				
A 3-1	Transmission pipes	Total approx.20km	Total approx.24km	Total approx.11km	*3 (Total approx. 13km)
A 3-2	Distribution pipes	Total approx.35km	Total approx.20km	Total approx.20km	
B	Equipment				
B1	Water Analysis	1 set	—	—	
B2	Workshop	1 set	Pickup trucks: 4 units	—	Japanese Government Policy

*1: These items were constructed in the Project for Zanzibar Urban Water Supply Development (Phase I) in 2007.

*2: 6 wells were constructed in the Project for Zanzibar Urban Water Supply Development (Phase I) in 2007.

*3: Approx.13km pipelines were installed in the Project for Zanzibar Urban Water Supply Development (Phase I) in 2007.

1-3 Activities of Other Donors

Activities of other donors were suspended once after the political instability in 1995. Most of the projects were implemented by international aid agencies such as UNDP. The Finland government (FINNIDA) developed the urban water supply development plan. Rural water supply plan was implemented by African Development Bank (AfDB). The German development bank (KfW) implemented

Zanzibar sewerage, drainage and solid wastes plan. Japanese Government has provided small-scale grant aids for rural water supply schemes through UNDP. UNICEF, USAID, DFID and Chinese Government have extended grant aids for water supply schemes in Zanzibar.

UNDP has played leading roles in assisting the development of water sector in Zanzibar. UNDP has supported formation of Water Policy, which in principle introduced user-pay. UNDP has already submitted water tariff collection improvement plan to former DWD but presently this plan is suspended.

UNICEF, UN joint programme, USAID and EU/ACRA are supporting the improvement of water supply for rural areas, including the construction of hand-pump wells, generators and pumps. The 12 generators were procured by UNICEF due to the blackout from 20th May 2008 to 18th June 2008. AfDB/UN HABITAT has also assisted them in making a strategic plan; based on this, the AfDB loan for the rehabilitation and instalment of facilities has been considered.

KfW has implemented Phase I of the Zanzibar urban sewerage, drainage and solid wastes plan in 1994 and 1995. It cleaned and rehabilitated the existing sewerage pipes in Stone Town. The sewerage and drainage systems will be extended to the other urban area in Phase II construction.

Chapter 2 Contents of the Project

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

The Zanzibar Government has been working on the basic policies set out in "ZANZIBAR VISION 2020", which is formulated by Ministry of Finance and Economic Affairs in January 2000. The Basic Policies of Water Sector in "ZANZIBAR VISION 2020" are intended to secure safe drinking water to all the people and sectors economically through appropriate water resource management, while it enables economical growth and development of the Zanzibar. The existing water supply system only manages to satisfy the fraction of the water demand in the study area, thus causing insufficient water supply pressure and deterioration in supply water quality.

The Project is aimed to improve the existing water supply of the study area through developing 11 new wells with 14,000 m^3/d total production, and extending water pipelines. With implementation of this Project, the water supply system will manage to meet the water demand in the Project target year of 2010. The Project will also renew the old facilities, and will support ZAWA in training its staff to effectively operate, maintain and manage the improved water supply system. Thus, it will enable ZAWA to secure safe and reliable water supply to 460,000 people in the study area.

The construction items of Project for Zanzibar Urban Water Supply Development (1st period of Phase I) in 2007 are shown in Table 2-1. The items of Soft Component for Project for Zanzibar Urban Water Supply Development (1st period of Phase I) in 2007 are shown in Table 2-2. The construction items for Implementation Review Study on the Project for Zanzibar Urban Water Supply Development Phase II are indicated in Table 2-3. The detailed design was already finished in the Project for Zanzibar Urban Water Supply Development (2nd period of Phase I).

Table 2-1 Construction Items (The Project for Zanzibar Urban Water Supply Development (Phase I))

Facility		Item	Specification	Quantities	Remarks
(1)	Pumping Station	Well	Well Diameter: ϕ 250 mm Well Depth: 60~70m	6	New
		Well Pump	Submersible Pump 58.4m^3/hr x 80~110m	6	
		Electrical Equipment	Transformers, Power Distribution/Control Panel, Instrumentation	6	
		Well Pump House	For Power distribution/Control Panels	6	
(2)	Transmission/ Distribution Facilities Sateni Station				
		Transmission Pump	400m^3/hr x 40m 200m^3/hr x 40m	 2 2	Update (incl. 1stanby) (incl. 1stanby)
		Electrical Equipment	Transformers, Power Distribution/Control Panel, Instrumentation	1	Update
		Disinfection facility	Powder Disinfection Solution Tank/Drip	1	Update

	Welezo Station	Reservoirs	Reinforced Concrete Volume: 4,000m^3	2	New
		Disinfection facility	Powder Disinfection Solution Tank/Drip	1	New
(3)	Transmission Pipelines		DCIP ϕ 150~600	Approx.13km	New
(4)	Distribution Pipeliens		DCIP ϕ 300~700	Approx.9.6km	New

Table 2-2 Soft Component

(1)	Engineering Training
(2)	Training for Organization Strengthening
(3)	Training for Developing Public Education Programme

Table 2-3 Construction Items (The Project for Zanzibar Urban Water Supply Development (Phase II))

Facility		Item	Specification	Quantities	Remarks
(1)	Pumping Station	Well	Well Diameter: ϕ 250 mm Well Depth: 60~70m	5	New (incl. 1stanby)
		Well Pump	Submersible Pump	5	
		Electrical Equipment	Transformers, Power Distribution/Control Panel, Instrumentation	5	
		Well Pump House	For Power distribution/Control Panels	5	
(2)	Distribution Facilities Kinuni Station				
		Reservoirs	Reinforced Concrete Volume: 2,700m^3	1	New
		Disinfection facility	Powder Disinfection Solution Tank	1	New
	Dole Station	Reservoirs	Reinforced Concrete Volume: 1,200m^3	1	New
		Disinfection facility	Powder Disinfection Solution Tank	1	New
(3)	Transmission Pipelines		DCIP ϕ 150~ ϕ 400	Approx.11km	New
(4)	Distribution Pipeliens		DCIP ϕ 300~ ϕ 400	Approx.10.3km	New

2-2 Basic Design of Japanese Assistance Requested

The Project followed the concept for Implementation Review Study on the Project for Zanzibar Urban Water Supply Development in 2006. However implementation review study was conducted for following purposes;

(1) Update of Project's Cost Estimate

With regard to the cost estimate, unit price will be revised from the viewpoints of fluctuation arisen on market trends after the detailed design on "The Project for Zanzibar Urban Water Supply Development (Phase II) in 2007". In addition, the fluctuation on exchange rate will be also reflected.

(2) Review of Construction Schedule and Components

The construction schedule and components will be revised to cope with the completion of project within the time limit of E/N together with the schedule specified during the detailed design on "The Project for Zanzibar Urban Water Supply Development (Phase II) in 2007."

(3) Confirmation of Present Status for Dar es Salaam Port / Zanzibar Port and Update of Cost Estimate

In case that the procurement and transport of materials necessary for the Project, it is absolutely required by way of the Dar es Salaam port and the Zanzibar port. However, it is said that all materials were only concentrated in the Dar es Salaam port because the Zanzibar port's capacity was temporarily lowering due to the anarchy caused by the nearby country's presidential election of Kenya in the end-of-2007 in addition to the insufficient equipment for both ports. Accordingly, the agents attribute the costs on cargo handling and customs clearing operations in both ports in addition to the appreciation of labour costs and prices of equipment and materials etc. as the tender disagreement cause for "The Project for Zanzibar Urban Water Supply Development (Phase II) in 2007". Therefore, the cargo handling and customs clearing operations on both ports will be restudied and thus reflected on the Project's cost estimate if required.

2-2-1 Design Policy

2-2-1-1 Project Objectives

- Sector Objectives: Improve the living environment of study area through additional safe drinking water
- Project Objectives: Provide reliable safe drinking water supply for study area

2-2-2 Basic Plan

2-2-2-1 Basic Water Supply Parameters

(1) Target Year

Target year is set at 2010. Tanzania government proposed 2015 as target year based on the Zanzibar Urban Water Supply Plan by FINNIDA, however year 2010 is better for the target year since this project includes facilities for emergency. The expected completion of the proposed facilities will be around March 2010.

(2) Study Area

Study areas are Zanzibar Urban and West districts. This area is divided into the following three areas according to the existing land use and population growth, based on the FINNIDA master plan.

1) Urban area

This area covers most of the Zanzibar Urban area. The area (15 km^2) includes the Stone Town and surrounding urban area. The most of the government offices, port facilities and hotels are located in this area. The area has limited open area and slow population growth. According to the 2002 Census, 98% of

the population are connected to the piped water supply.

2) Urban extension area

This area covers remaining Zanzibar Urban district, and West district surrounding the above urban area. This area (70 km^2) has very high population growth and receives migrant population from the surrounding cities. Development of executive residential area is also observed. Still many residents use common standposts. 90% of the population are connected to the piped water supply. (2002 Census)

3) Peri-urban area

The peri-urban area covers the remaining Zanzibar West district, which is an agricultural area far from the Stone Town. It has low population growth. This area (155 km^2) is mainly served by standposts, but electricity is not available in some area. 77% of the population are served by the piped water supply according to the 2002 Census.

(3) Design Service Population

The Censuses were performed only four times (1967, 1978, 1988, 2002) in Zanzibar. The future population is predicted based on those Census data. Census data and population projection are shown in Table 2-4 and Figure 2-1.

Arithmetic series and exponential series of population predictions are prepared based on two combinations of Census data: 1967 and 2002, 1988 and 2002. The results of 2010 population predictions are in the range from 245,000 to 560,000. The exponential series tend to give large predictions. Those predictions are regarded too large. Thus the prediction using arithmetic series based on the latest Censuses (1988 and 2002) would be used for this project. The population in year 2010 and 2015 will be 495,000 and 560,000 respectively, which is slightly higher than the prediction (483,000) by FINNIDA.

The present population of the study area (Zanzibar Urban and West districts) is estimated at 461,000 in 2006.

Table 2-4 Comparison of Various Population Predictions

Year	Actual	FINNIDA	Arithmetical series		Exponential series	
			1967-2002	1988-2002	1967-2002	1988-2002
1967	94,849					
1978	142,041					
1988	208,571					
2002	391,002					
2005			416,387	430,094	429,884	447,366
2010			458,694	495,248	526,195	559,933
2015		483,000	501,002	560,402	644,083	700,825
x	y		y=ax+b	y=ax+b	y=ax+b	y=abX
A			8461.5	13030.8	2.67508E-30	3.6635E-34
B			-16548921	-25696659.6	1.041259818	1.045910798

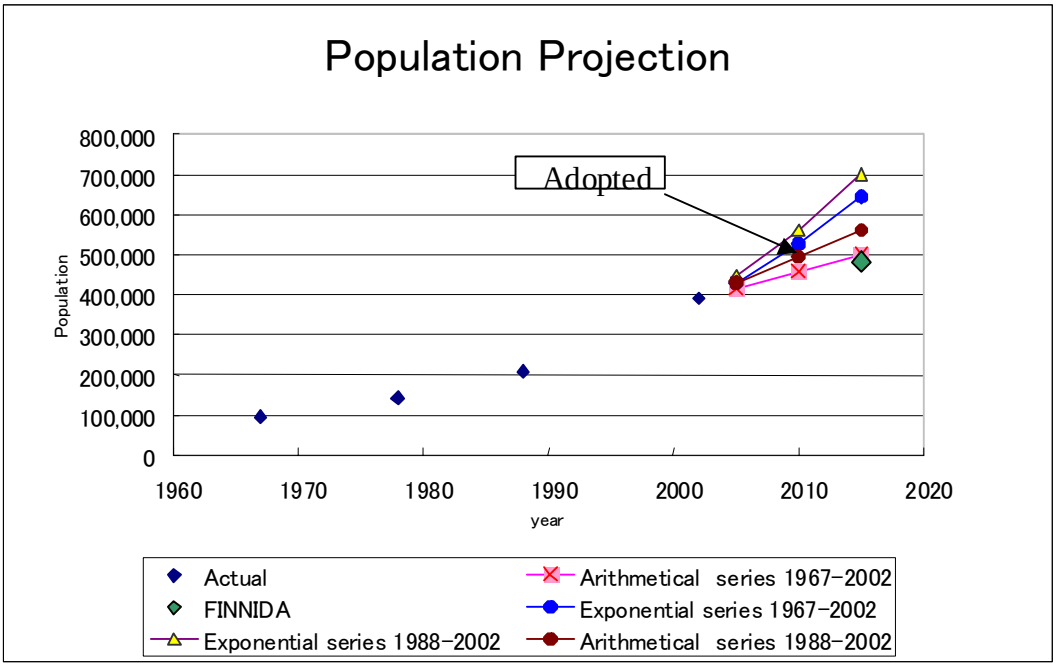

Figure 2-1 Population Projection

Table 2-5 Population Distribution among the Areas

	Census		Prediction		Remarks	
	1988	2002	2010		Ratio	2010/2002
Urban area	157,626	206,292	234,101	→ 234,000	47%	1.13
Urban extension	18,570	139,179	208,098	→ 208,000	42%	1.50
Peri Urban	32,375	45,531	53,049	→ 53,000	11%	1.16
Total	208,571	391,002	495,248	→ 495,000	100%	1.27

(4) Water Demand

1) Unit Water Consumption

Per Capita water demand is calculated as follows.

(Per Capita Water Demand) = (Effective Water) + (Ineffective Water)

(Effective water) = (Domestic Demand) + (Commercial Demand) + (Institutional Demand) + (Industrial Demand)

(Commercial, Institutional, Industrial) = (Per Capita Domestic Demand) x (Water Demand Ratio per category)

(Per Capita Domestic Demand with house connection) = (Per Capita Domestic Demand with house connection) x (Ratio per connection type)

(Unaccounted-for water) = (Effective Water) x (UFW ratio)

Those ratios are mostly taken from FINNIDA master plan.

Table 2-6 Per Capita Water Demand with House Connection

Unit: L/day/capita

Year	2005	2010	2015	Remarks
Per Capita Domestic Demand	55	60	65	

Table 2-7 Domestic Water Demand according to the Connection Types

	House Connection	Yard Connection	Stand Post	Remarks
Urban area	100%			
Urban extension area / Peri-urban area	40%	40%	20%	

Table 2-8 Water Demand Proportions for Various Uses

Use	Ratio	(Domestic demand as 1)	Remarks
Domestic	65%		
Commercial	15%	23%	Only in Urban area
Institutional	10%	15%	Only in Urban area and Urban extension areas
Industrial	10%	15%	Only in Urban area
Total effective	100%		
Unaccounted for Water	30%		
Total	130%		

Table 2-9 Per Capita Water Demand

Unit: L/day/capita

	Ratio	2010	
		Urban area	Urban extension area / Peri-urban area
Domestic	1	60	38
Commercial	0.23	14	
Institutional	0.15	9	6
Industrial	0.15	9	
Sub-total		92	44
UFW	0.3	28	13
Total		119 →120	57 →55

2) Peak Factors

Peak factors were based on the FINNIDA master plan.

(Daily Maximum Flow) / (Daily Average Flow) = 1.35

(Hourly Maximum Flow) / (Daily Maximum Flow) = 1.2

3) Target Water Pressure

The FINNIDA master plan recommend water supply pressure for floor levels (from ground to 7th) from

16 meter to 34-meter water head. It is not specify the minimum pressure requirement. At present, most of the area could not get water pressure more than 5 meter during the day due to the problem in the distribution systems (Preliminary study report 2002). Assuming that multi-storey buildings have pumps and elevated tanks, target water pressure is set at 15 meter water head while the minimum water pressure will be 5 meter water head, which is commonly used as design target in Tanzania.

4) Flow Calculations

The FINNIDA master plan recommend pipe flow velocity will be from 0.9 m/sec to 1.8 m/sec. Hazen-Williams formula would be used for calculating head losses based on the Japanese Water Facility Design Criteria.

$$H=10.666 \cdot C^{-1.85} \cdot D^{-4.87} \cdot Q^{-1.85} \cdot L$$

H: Friction Losses (m)

C: Velocity coefficient (110: for DI and PVC pipes, including fitting losses)

D: Pipe diameter (m)

Q: Flow (m^3/s)

L: Pipe length (m)

Maximum Flow Velocity: 3.0 m/sec

5) Design Water Supply Flow

Total Water Demand (Daily Maximum)	54,100 m^3/day
Current Water Production (Daily Maximum)	40,100 m^3/day
Deficit	14,000 m^3/day

Table 2-10 Design Water Supply Flow

	Area	2010	Remarks
Population			
	Urban	234,000	
	Urban Ex	208,000	
	Peri Urban	53,000	
	Total	495,000	
Service Population			
	Urban	229,320	
	Urban Ex	187,200	
	Peri Urban	40,810	
	Total	457,330	
Service Ratio			
	Urban	98%	
	Urban Ex	90%	
	Peri Urban	77%	
	Total	92%	
Per Capita Water Demand l/day/capita			
	Urban	120	
	Urban Ex	55	
	Peri Urban	55	
Total Water Demand			
Daily Average m^3/day	Urban	27,518	
	Urban Ex	10,296	
	Peri Urban	2,245	
	Total	40,059	40,100
Daily Maximum m^3/day	Urban	37,150	
	Urban Ex	13,900	
	Peri Urban	3,030	
	Total	54,080	54,100
Hourly Maximum m^3/day	Urban	44,580	
	Urban Ex	16,680	
	Peri Urban	3,636	
	Total	64,895	64,900
Cf. Service Population with House Connection			House connection and yard piping
Urban	1	229,320	
Urban Ex	0.8	149,760	
Peri Urban	0.8	32,648	
Total		411,728	
Service Ratio		83%	

6) Selection of Pipe Materials

Small diameter PVC and HDPE pipes are produced locally in Tanzania and commonly used in Zanzibar. Imported ductile iron pipes are used for large diameter pipelines. Those pipes have advantages due to the relatively low prices and maintenance skills of those pipes already acquired by ZAWA staff. PVC, HDPE and ductile iron pipes would be considered for use in this project.

Transmission pipeline will have maximum water pressure of 10kg/cm^2. PVC pipes which stand this high pressure is relatively expensive. Thus ductile iron pipes would be used for transmission pipelines.

Distribution pipelines will have maximum pressure less than 6kg/cm^2. Locally produced PVC and HDPE pipes with diameter less than 250 mm are readily available with reasonable prices. Comparing PVC and HDPE pipes, PVC is superior in joint connectivity and security with diameter over 200 mm. For this reason, HDPE pipes are only used for pipeline with diameter less than 150 mm in Japan. PVC pipes would be used for distribution pipelines with diameter less than 250 mm. Ductile iron pipes would be use for pipelines with over 300 mm diameters.

Table 2-11 Pipe Selection

Type	Diameter	Material	Remarks
Transmission pipes	150mm～600mm	Ductile Iron	High water pressure
Distribution pipes	200mm～250mm	PVC	Available locally in Tanzania
	300mm～700mm	Ductile Iron	

2-2-2-2 Water Resource Development Plan

In planning of water sources development, the following basic concepts were developed.

a) Total development volume of water sources:

Based on Section 5) “Design Water Supply Flow” of 2-2-1, total development flow of water sources shall equal to the shortage amount (14,000 m^3/day) that equals to difference between the sum of pumping rate of the existing wells and the daily maximum water demand in year 2010.

b) Water quality:

Quality of water sources shall satisfy the Zanzibar Drinking Water Quality Standards (ZDWQS)

c) Other constraints:

・To avoid saltwater intrusion in groundwater

・To avoid negative influence of new wells to the existing wells

Considering these premises, the development plan of water sources is established.

(1) Well Facility Planning

The study area has unique characteristics in aquifer condition and has several constrains including saltwater intrusion. Therefore, by investigating these conditions, project well facilities were planned. The selection of well field for project wells and the aquifer characteristics in the area were stated below.

1) Selection of well fields of project wells

For selection of well fields of project wells, the following conditions were discussed.

a) Saltwater intrusion area

UNDP (1987) specified saltwater intrusion areas on their hydrogeological map that the phenomenon is able to be naturally observed, depending on well depths. In the east side of the Zanzibar, saltwater intrusion areas were extended up to inland areas of some 2 to 4 km away from the seashore. In these areas, ZAWA had abandoned some of their deep wells due to changing of water quality from fresh water to saline water. Therefore, the basic design avoided the saltwater intrusion areas as well fields of new wells and selected the more inland areas.

b) High potential areas for groundwater development recommended by UNDP

The study of UNDP (1987) selected the Bumbwi Corridor area (refer to Figure 2-2) as a high potential area for groundwater development that extended in the North-South direction in the central area of the Unguja Island. ZAWA also planned the proposed sites for new wells in the Corridor area in the grant aid request plan. The Corridor area has no access road at present. Therefore, the basic design selected the neighbouring areas of the Corridor with good access roads because the area had a watershed boundary with the highest water level in a groundwater basin based on the UNDP hydrogeological map and is located in the inland area.

c) High potential areas for groundwater development recommended by FINNIDA

FINNIDA (1991) recommended the five (5) high potential areas (refer to Figure 2-2) for groundwater development, based on the groundwater development study that carried out pumping tests, water quality analyses, and construction of two test wells in every five sub-area, referring to the results of the UNDP study. Of these sub-areas, the Kizimbani North area located in the most northern side was cancelled by the consideration that it was inappropriate construction sites of new wells due to no access road.

Considering the above conditions, the basic design selected the four (4) sub-areas of Kizimbani, Kianga, Kimara, and M.Mchomeke as groundwater development area. Of these four sub-areas, the M.Mchomeke area has 8 existing deep wells for water supply concentrated in a small area. The well spacing is approximately from 100 to 500 m. In one of these existing wells, the drawdown was measured by recovery of ground water level after stoppage of pumping. It was only 2 meter, although the existing well pumps groundwater in large of quantity, 80 m^3/hour. According to pumping test data in the existing wells, the transmissivity of the aquifers in the area was 4,831 m^2/day. It was regarded as very large, thus, groundwater condition was evaluated as very good.

Based on the above conditions, M.Mchomeke area was selected as the well field for a new well because the aquifer is estimated to have large groundwater storage capacity even if one additional well was constructed near the existing wells.

2) Results of Electric Resistivity Survey

In the selected sites, electric resistivity survey was conducted. The results showed that the areas were covered by four to five geological layers and had some limestone layers. The fracture zones in limestone could not be revealed from analysis of the survey but it was confirmed to have the potential for groundwater development. In addition, since there were some well sites such as the M.Mchomeke area that we did not perform the survey, more detailed survey in the detailed study stage should be planned.

KIZIMBANI Area

Geological structures in the area are formed by four to six layers. In the area near the Bumbwi Corridor, there was limestone layer that could form aquifer. It is estimated to have groundwater development potential. However, hilly area in the western side is not appropriate for groundwater development because there are thick layers of clay and/or silt with apparently low resistivity values.

Table 2-12 Representative Result of Electric Resistivity Survey in KIZIMBANI Area

No.	Apparent Resistivity Value (Ohm-m)	Estimated Geological Layer	Layers Thickness
1	42	Surface Soil	1 m
2	84	Clay/Silt Layers	3.8 m
3	17.5	Weathered Limestone	27.2 m
4	27	Weathered Limestone	Unclear

Note: Geological layers are described from ground surface to deeper portion. Of the results of vertical electrical sounding (VES) points, the example of C-4 VES point with high groundwater development potential is shown.

KIANGA Area

Geological structures in the area are formed by four to eight layers. As the overview of the area, the geological structures are interpreted that limestone is interbeded in middle portion. Limestone is underlain by impervious layers of sandstone and clayey sand. It is interpreted that the area near the Bumbwi Corridor has higher potential for groundwater development.

Table 2-13 Representative Result of Electric Resistivity Survey in Kianga Area

No.	Apparent Resistivity Value (Ohm-m)	Estimated Geological Layer	Layers Thickness
1	48	Surface Soil	1.3 m
2	16	Weathered Limestone/Sand layers	6 m
3	47.5	Weathered Limestone	36.7 m
4	9.5	Sandy clay/ Weathered Limestone	23 m
5	38	Limestone	45 m
6	16	Clayey Layers	Unclear

Note: Geological layers are described from ground surface to deeper portion. Of the results of vertical electrical sounding (VES) points, the example of B-8 VES point with high groundwater development potential is shown.

KIMARA Area

Geological structures in the area are made of 3 to 8 layers and drastically change in the East-West direction. These changes may be controlled by geological structures with the North-South direction.

Sounding data shows that there are potential sites for groundwater development.

Table 2-14 Representative Result of Electric Resistivity Survey in Kimara Area

No.	Apparent Resistivity Value (Ohm-m)	Estimated Geological Layer	Layers Thickness
1	240	Surface Soil	2.2 m
2	40	Weathered Limestone/Sand layers	17.8 m
3	66	Weathered/Consolidated Limestone	60 m
4	10	Clayey sand / Limestone	Unclear

Note: Geological layers are described from ground surface to deeper portion. Of the results of vertical electrical sounding (VES) points, the example of A-5 VES point with high groundwater development potential is shown.

3) Aquifer Characteristics of Groundwater

According to the old survey report (J.H. Johnson: 1981-1984), groundwater aquifers are composed by consolidated limestone (M_1 formation) of Cenozoic era, Tertiary period, Miocene age, consolidated/coral limestone and sand layers (Q_3, Q_2 formations) of Quaternary period underlain by sand, maar, sandy clay, and clayey sand layers (M_2, M_3) of Cenozoic era, Tertiary period, Miocene age. Limestone of groundwater aquifers is formed in valleys of the old Rufiji River Delta developed in Tertiary period. At fractured portion in limestone, plenty of groundwater recharged by rainfall that fell on the Unguja Island discharges toward the seashore. The delta valleys had narrow width and stretched along old river courses as thread. If drilled boreholes encounter limestone in well construction, they may be able to obtain large yield. Otherwise, their yield shall become very small. The failure ratio of well construction, 20 % shall be derived from this reason.

In this area, transmissivity values of aquifers have large ranges from 158 to 15,000 m^2/day. Moreover, thickness of limestone layers changes with ranges from 2.8 m to 26 m. As thickness of limestone in the main aquifer is not consistent, flux of groundwater discharge and its layers thickness change largely in places. As well yield is determined by transmissivity values and thickness of aquifers, it largely changes. Therefore, representative values of hydrogeological conditions in aquifers cannot be determined. In the above report, in the aquifers that groundwater development was inappropriate, pumping tests were not carried out and only well structures and column sections are shown.

In the study area that is dominated by these aquifer conditions, several constrains are investigated. The details are shown in the Table below.

Table 2-15 Constrains for Groundwater Development

Constrains	Conditions Possible to be Estimated	Conditions Impossible to be Estimated
1. Avoidance of salt water intrusion into groundwater	In determination of groundwater development areas, saltwater intrusion areas as natural phenomenon are excluded. In addition, dynamic water level is kept	

	in more than 6.2 m above mean sea level, based on water levels of the existing wells.	
2. Seasonal variation of groundwater levels	According to the monitored data, the maximum seasonal variation shall be 7.8 m.	
3. Aquifer conditions	Conditions are not uniform.	Fractures of limestone and aquifer thickness are not uniform. Therefore, the aquifer conditions are different in places. As transmissivity and coefficient of permeability are not uniform, groundwater theory cannot be applied. Therefore, drawdown and well yield cannot be determined.
4. Safe flux of screens	According to Johnson Div. (1987), V = 0.03 m/sec	

Well production potential was examined by aquifer conditions. As mentioned in the above, investigations on constrains for groundwater development prevent us to determine production potential by using groundwater theoretical formula (Jacob Modified Equation) due to no uniformity of hydrogeological conditions including transmissivity values (T), permeability coefficients (K), Storage coefficients (S) even if they can be calculated.

Therefore, the well production potential was calculated by safe flux of screens. For this purpose, it is necessary to plan standard specifications for new wells. The standard specifications for new wells were determined based on the depths of the nearest existing wells.

a) Depth of New Well

The survey results reveal that salinity levels of the most existing wells are low. However, deep wells may to draw salt water, and on the other hand, shallow wells may not provide necessary well yield or may not reach the depth of fractured limestone. Electric resistivity survey was carried out in planned well fields. Results of the survey generally give information on the outlines of geological structures and the occurrence of saltwater intrusion and unsuitable sites for groundwater development covered by impervious and thick layers including clay and silt. However, it is difficult to locate fractured limestone.

For this reason, in case to determine specifications of new wells, it is desired to refer the specifications of the existing wells in inland areas whose conditions of geology and groundwater situations and land elevations approximately correspond to proposed well fields. In this way depth of project wells was determined.

Specifications of the existing wells for water supply located in inland areas near proposed well sites are shown below.

Table 2-16 Specifications of the Existing Wells located near the Proposed Well Sites

Well Number	Well Location	Operating Condition	Well Depth (m)	Casing Diameter (mm)	Year Constructed	Elevation (m)
U-051	M. Mchomeke	Operating	69.00	250	2002	43
U-001	M. Mchomeke	Operating	70.03	250	-	40
U-50	M. Mchomeke	Pump breakdown	63.00	200	2002	43
U-033	M. Mchomeke	Operating	52.97	200	2000	43
Dole	Dole	Operating	56.00	200	2003	55
U-004	Kianga	Operating	49.00	200	2000	32.08
U-009	Chunga	Operating	45.20	250	1979	16.4
U-026	Chunga	Operating	46.00	250	1995	17
U-008	Chunga	Operating	45.20	250	1979	18

① KIZIMBANI area

Kizimbani Area, a proposed site for new wells, has elevation of about 45 m while M. Mchomeke Area, where the existing wells for Zanzibar City's water supply are located, has elevation of 40 m to 43 m. Both areas have almost similar elevation. The Depth of the existing wells in M.Mchomeke area is from 53 m to 70 m. Supposing that groundwater levels of both areas are similar, project well depth for Kizimbani area was designed to be 70 m, same as the maximum depth of the existing wells.

Planned Well Depth: 70 m

② KIANGA area

Kianga area is located 1 to 2 km north of the existing wells and in midpoint between the existing well sites of Kizimbani and Kianga. Its elevation is also the mean between both well sites. Therefore, depth for project wells was supposed to be 60 m by adopting an intermediate value of depth of the existing wells in both areas.

Planned Well Depth：60 m

③ KIMARA area

Kimara area is located 1 to 2 km north of the existing Chunga well site and its elevation is higher than that of the Chunga site by about 10 m. Therefore, the depth of new wells was planned to be 60 m by adding 10 m to the depth of the existing wells.

Planned Well Depth：60 m

④ M. MCHOMEKE area

M. Mchomeke area has 5 existing deep wells for water supply with 100 m to 300 m spacing between the wells. The past study shows that there is a good aquifer with high transmissibity values ranging from 200 m^2/day to 4,831 m^2/day. The results of the observation performed by this study show that the drawdown in the U-051 well was only about 2 m at 84 m^3/day pumping rate. If one new well is additionally planned in the adjacent area of the existing wells, it is judged that it can pump up groundwater without interfering the

other wells. As the existing wells have the depth of from 63 m to 70 m, the new well was planned to have depth of 70 m by adopting the maximum depth.

Planned Well Depth : 70 m

b) Estimated Static Water Level

Since there were no existing wells near the proposed well field for new wells, groundwater level was estimated by relationship between ground levels and groundwater levels of the existing wells. The new wells with the same elevation as the existing wells were supposed to have the same groundwater levels of the existing wells. Moreover, in case that a project well at intermediate elevation of the two existing wells was planned, its groundwater level was estimated to have an intermediate depth of the two existing ones. The groundwater levels of the new wells were estimated as shown below.

Table 2-17 Estimated Groundwater Level of Project Wells

Propose well field and Project Well No.	(1) Ground Level (GL:m)	(2) Estimated Groundwater Level (SWL) (GL: m)	(3) SWL below GL (m)
KIZIMBANI (N-3, N-4, N-5)	+45	+23.0	22
KIANGA (N-6, N-7, N-8, N-9,N9-2)	+30.0～+36.0	+23.0	7～13
KIMARA (N-10, N-11, N-12)	+23.0～+26.0	+19.0	4～7
M.MCHOMEKE (N-13)	+43.0	+23.0	20

(Note: SWL: Static Water Level, GL: Ground Level)

c) Casing Diameter of Project Wells

Casing diameter of the existing wells ranges from 200 mm (8") to 250 mm (10") and their majority are 250 mm. According to the Japanese Guideline for Designing Water Supply Facilities (2000), the minimum diameter of well casing is 250 mm for pumping rate less than 1,500 m^3/day (62.5m^3/day). Therefore, the casing diameter for new wells was planned as 250 mm.

Casing Diameter of New Wells : 250 mm

d) Screen Length of New Wells

Screen length of the new wells was determined by the mean aquifer thickness in the existing wells. The thicknesses of aquifers were obtained by adopting thicknesses of fractured limestone below dynamic water level at the pumping tests, based on the existing well records. The obtained data were averaged to obtain a mean value. The thickness of aquifers in the existing 8 deep wells had the range of 8 m to 33 m and their average is 21 m. Therefore, this average was used to be the average length of screens in the new wells. This length is 30 % of total well length corresponding to the standard specifications (groundwater level,

drawdown, aquifer length, and material strength of well casing and screen, etc.) based on the many experiences in the past.

Screen Length of Project Wells: 21 m

e) Slit Width of Screens in New Wells

Available slit width for 250 diameter screens ranges from 0.75 mm to 3.0 mm. New screens would have 1mm in slit width that is generally adopted in the Zanzibar area since a large slit width may cause flow of sand into screens.

Screen Slit Width of Project Well: 1 mm

f) Well Structure

Well structure is designed to have the same diameter from the top of casing to well bottom. Telescope type well casing with a small casing diameter in deeper portion was not adopted due to the tendency to have incrustation at high flux into screen and difficulty to insert pump facility into deeper portion if water level lowers in the future by the progress of groundwater development. In addition, the well structure is planned to have gravel packing. The space between casings and boreholes is specified to be more than 50 mm.

g) Materials of Casings and Screens

The chief of water section of former DWD requested materials of casings and screens to be made of unplasticized polyvinyl chloride (uPVC) as steel casing pipes installed in the past were corroded. This is considered that steel materials may be corroded by inflow of salt water into the existing wells at the time of drought. Although new wells are planned in the inland so as to avoid salt-water intrusion, durable uPVC were adopted as a material for well casing and screen considering long-term use of wells.

h) Investigation of Well Yield Potential in View of Safe Flux into Screen

"Groundwater and Wells, Johnson Division (Dr. Fletcher G. Driscoll: 1987)" recommended that safe flux of screens in the conditions of not turbulent but laminar flow to be V=0.03 m/sec based on many previous experiences. Well yield was estimated based on the safe flux.

Calculation of well yield potential per well

Potential well yield (Q) = Surface area of screens x Opening ratio of screens x Safe flux into screens x (1-clogging ratio of screens)

$$Q = D \times \pi \times L \times Op \times V \times (1-C) \times 60 \times 60$$

Q: Potential well yield (m^3/hr)

D: Screen diameter (m)

L: Effective screen length (m) (=screen length (21m) x effective length ratio)

Op: Opening ratio of screens (%)

V: Safe flux of screens (0.03 m/sec)

C: Clogging ratio of screens (%)

According to the screen specifications of the existing deep wells for water supply, opening ratio of screens is specified to be 7.9 % of effective area of screens in case of 1 mm slit width in screen diameter of 250 mm. Also, effective length per a unit of screen (3 m) shall be equivalent to 88 % of total effective area of screens as it includes sleeve for connection. Clogging ratio of screens was percentage that screens were clogged by packed gravel. Based on previous experience, the clogging ratio of 40 % to 50 % was adopted.

Potential Well Yield

Q = 61 to 74 m^3/hr. (Well yield has the ranges of 61 to 74 m^3/hr, depending on clogging ratios of 40 to 50 %.)

Well yield of the new wells was estimated to be 60 m^3/day. The value was the same as recommended value by FINNIDA (1991).

Well Yield of New Wells: 60 m^3/hour

i) Number of New Wells

Necessary pumping flow of the new wells was amounted to be 14,000 m^3/day and well yield of each new well was estimated to be 60 m^3/hr by the above study. To secure the planned water supply volume, it shall be necessary that 10 project wells continuously operate for 24 hours. Number of project wells shall be 11 by adding a standby well in Kizimbani Area for Dole Service Area to planned 10 deep wells.

Project wells are planned for operation of 24 hours, every day and the pumping cannot be stopped. Otherwise, water supply shall be suffered by shortage of water in case of breakdown of submersible pumps without a standby well. Therefore, a standby well is planned. The survey of pump operation show that three out of the 24 existing wells do not operate due to breakdown of well pumps. The ratio of pump breakdowns against the sum of the existing wells is 13 %. By the above consideration, it is necessary to add a standby well.

Number of Planned Project Wells: 10 Wells for continuous use + a standby well = 11 Project Wells

Planned pumping flow of the new well is;

14,000m^3/day x 1/10 wells = 1,400 m^3/day・well = 58.4 m^3/hr・well

Summarizing the results stated in the above, number of the new wells is shown below,

Table 2-18 Proposed Sites and Number of New Wells

Proposed Construction Sites	Planned Number of Wells	Phase I	Phase II	Elevation
KIZIMBANI Area	3 wells (including one standby)	-	3 (1)	45 m
KIANGA Area	4 wells	5	-	27～38 m
KIMARA Area	3 wells	-	2	23～26 m
M.MCHOMEKE Area	1 wells	1	-	43 m
Total	11 wells (including one stand-by)	11 (1)		23～45 m

Note) The number of wells has changed from four to five in the Kianga area and three to two in the Kimara area at the time of construction.
Wells were constructed in Phase I in March 2008.

4) Failure Ratio of Well Construction

Well construction in the Unguja Island have been carried out by former DWD and ZAWA using their three drilling rigs, and by construction firms in the past. Well drilling had failure cases in the past such as small well yields because of unfavourable underground geological condition.

In the formulating construction plan of new wells, failure ratio was examined. Failure ratio of well construction carried out by former DWD and their reasons are shown below.

Table 2-19 Failure Rates of Well Construction by former DWD

Construction Year	Number of Drilled Wells	Number of Succeeded Wells	Number of Failure Wells	Failure Ratio of Well Construction	Reason
2002	7	5	1 (+1 due to saline water*)	17	Well yield<50m^3/hr *Saline water.
2003	8	5	3	60	Well yield<50m^3/hr
2004	25	22	3	14	Well yield<50m^3/hr
Total	40	32	7 (+ 1 well with saline water*)	21.9	

*Note: failure due to saline water is to be avoided in the project because the project conducts vertical electric sounding and utilizes the data of UNDP study.

Wells regarded as failure in this table are the case of the saline water or the well yield less than 50 m^3/hr. The well yield for new wells to be 60 m^3/hr and it is the similar to the above value of former DWD failure criteria. However, the cases of saline water intrusion shall be neglected in the project because the construction sites are selected in the inland area without saltwater intrusion phenomenon and based on analyzed results of electric resistivity survey. Limestone in aquifers is distributed in many places but the occurrence and extension of limestone with fractured zones could not be identified before drilling. Therefore, failure ratio based on the past records shall be applied on new well construction. According to the former DWD records of well drilling in the past three years, failure ratio became approximately 20 %. Therefore, failure ratio of 20% is adopted for the project.

5) Comparison between Requested Plan and Basic Design for Well Facilities

Comparative table between the requested plan and this basic design for the project is shown below.

Table 2-20 Comparison between the Requested and Proposed Wells

Plan	Planned Pumping Rate	Number of Wells	Proposed Construction Sites	Reasons of Change
Requested Wells	100 m^3/hr	6 wells	Bumbwi Corridor	Pumping rate is limited. No access roads for the requested wells.
Proposed Wells	58.4 m^3/hr	11 wells (including one standby)	4 sub-areas near Bumbwi Corridor (FINNIDA's recommendation)	

The 100 m^3/hr well yield of the requested plan is regarded too large based on the observation of inflow of sand particles through screens in the existing wells with high production flow ranging from 80 m^3/hr to 100 m^3/hr. This shall be caused by higher flux of groundwater into screens because pumping rate of the existing deep wells is fairly high. The inflow of sand damages impeller of submersible pumps and reduces life span of submersible pumps due to overload of motors.

Taking safe side, it shall be important to reduce pumping rate to less than 60 m^3/hr. In the project, planned pumping rate was designed to be 58.4 m^3/hr from this viewpoint.

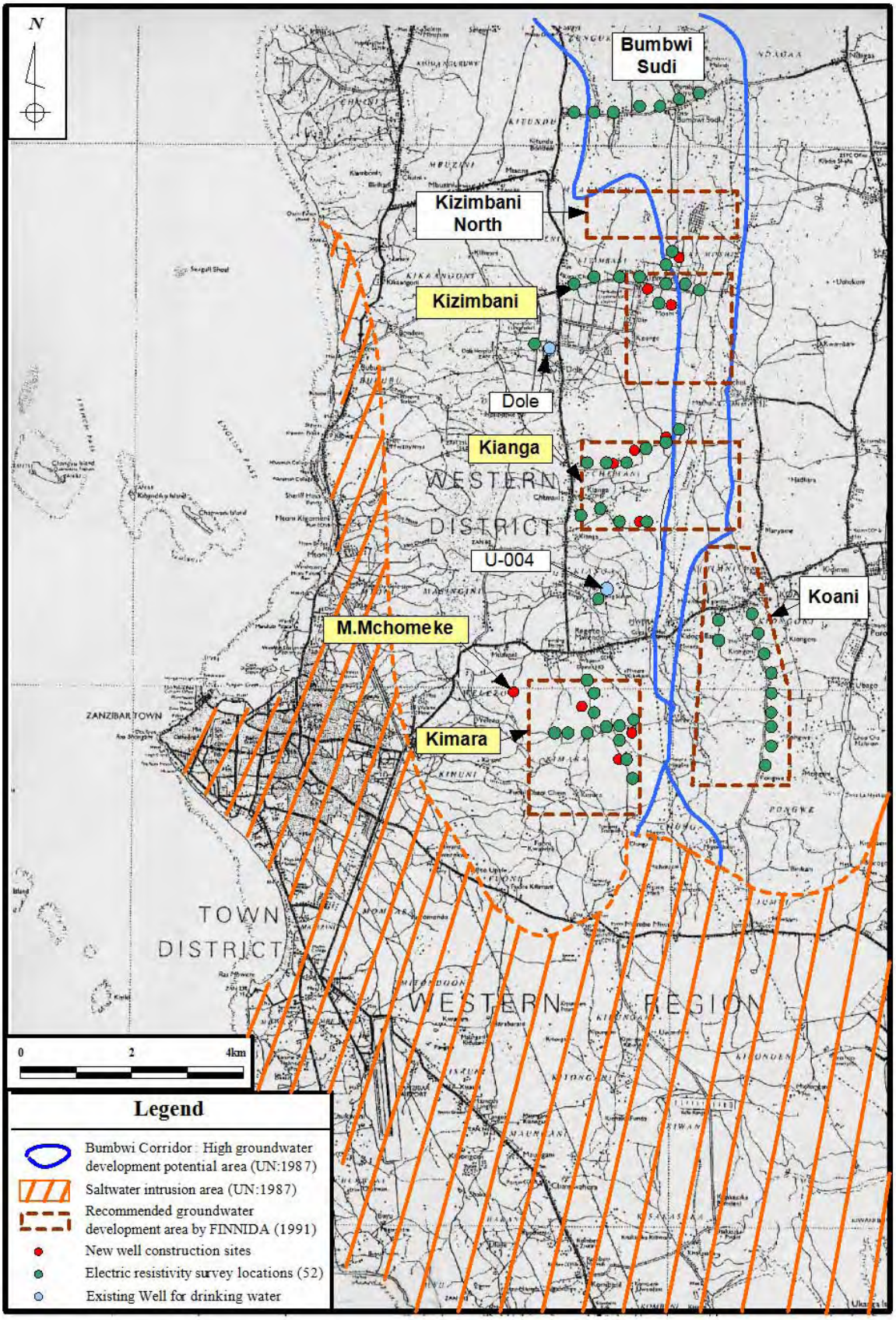

Figure 2-2 Proposed New Wells and Electiric Resistivity Survey Locations

6) Summary of Specifications of New Wells

Specifications of new wells were summarized below.

Table 2-21 Specifications of Proposed Wells

Well No.	Service Area	Well field	Quantity	Well Depth (m)	Borehole Diameter (mm)	Casing Diameter (mm)	Screen Length (m)
N-3～N-5	Dole	Kizimbani	3	70	350	250	21
N-10, N-12	Kinuni	Kimara	2	60	350	250	21

(2) Environmental Impact Assessment (EIA)

Environmental Impact Assessment on the proposed groundwater development was carried out. The potential for groundwater development has been studied for the entire area of the Unguja Island by the past studies. In this study, the potential was examined in the study areas.

1) Groundwater Development Potential in the Unguja Island

In the Unguja Island, surface water disappears under ground in the limestone area of Quaternary period. Therefore, no surface water is discharged to the sea. Many streams flow in limestone caves and disappear. Several streams only appear on ground surface as springs after infiltrating to underground. Therefore, groundwater in the Unguja Island is in unconfined condition and discharges with slow speed toward the seashore. Groundwater recharge is only by rainfall that raises water level. Remaining discharge factor is evapotranspiration releasing from ground surface and tree leaves. FINNIDA study (1994) and Halcrow (1994) ‘s estimation is shown below,

Estimation of groundwater development potential by FINNIDA (1994)

Minimum mean yearly rainfall is approximately 1,100 mm in the drought year of 10% rainfall probability. Observation of groundwater level recovery in the past indicates that 30 % of rainfall actually recharges groundwater. Aquifers distributed in the seashore areas of the Unguja Island can be excluded from groundwater recharge area because groundwater development is difficult by the risk of saltwater intrusion. Moreover, as to minimise negative impact on island’s environment by the project, the study introduces reduction coefficient of 20 %. As a result, groundwater development potential in the island comes to 105.6×10^6 m^3/year.

Unguja Island: Area ($1,600\times10^6$ m^2) x Rainfall (1.1 m) x Recharge ratio for groundwater (30%) x 0.2
= 105.6×10^6 m^3/year.

The study estimates that sustainable groundwater development is possible up to 100 million m^3/year.

Estimation of Groundwater Development Potential by Halcrow (1994)

Total water demand in the year of 2015 is estimated to be 57.2×10^6 m^3 as the sum of those of city residents, rural population, agricultural irrigation, tourism industry, and the other industries. The water demand corresponds to half of safe groundwater yield estimated by FINNIDA (1994) and one sixth of the values calculated by Halcrow (1994). According to the past studies considering water balance in the Unguja Island, the groundwater development potential was large enough and it was judged to be able to cover water demand until the year of 2015.

2) Environmental Impact Assessment against Groundwater Extraction for the Project

Environment impact of groundwater extraction of the proposed volume in the project is evaluated. Groundwater discharges to the sea in a groundwater basin. The boundary of groundwater basin is determined by geological structure and the height of groundwater level. Considering these factors, the boundaries of groundwater basin including groundwater development areas were determined. Figure 2-3 shows the groundwater basin.

Establishment of Boundary of Groundwater Basin

As shown in Figure 2-3, boundaries of groundwater basin in the western and the north sides were according to Hydrogeological Map made by FINNIDA (1994). Eastern boundary of groundwater basin was determined by the estimated groundwater watershed and the groundwater flow directions based on groundwater table of the hydrogeological map. Southern boundary of groundwater basin was determined by approximate locations of project wells and the contour lines of groundwater levels, considering that project wells draw groundwater from upper stream of groundwater flow.

Area of Groundwater Basin for Groundwater Development

Basin area measured by the planimeter: 72 km^2.

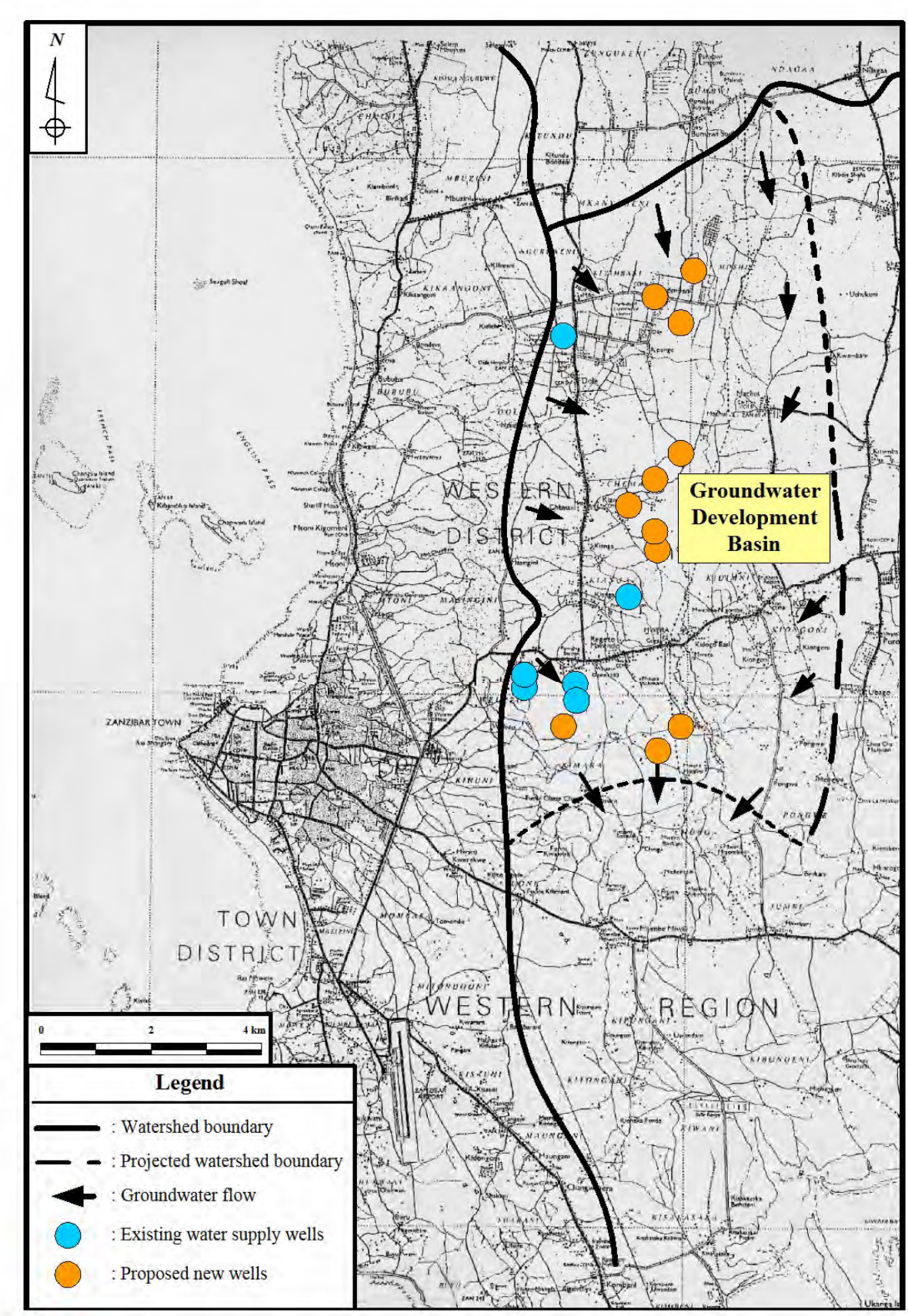

Figure 2-3 Proposed Well Fields and Groundwater Basin

Estimation of Groundwater Development Potential

Of the above two studies on groundwater development potential, FINNIDA (1997) estimates it assuming more severe conditions. Therefore, the potential was estimated by the FINNDA method.

Q = 74×1,000,000 (Area of groundwater basin)×1.1 (yearly rainfall with 10% probability)×0.3×0.5
= 11,800,000 m^3/year

Groundwater Development Potential: 11,800,000 m^3/year

Groundwater Extraction by Existing and Planned New Wells

Groundwater extraction by the existing and project wells distributed in the groundwater basin was estimated. The extraction volume is shown in Table 2-22. In the basin, there are only a few irrigation wells besides the above wells, no industrial parks and residential development with own water sources.

Table 2-22 Water Balance between Groundwater Development Potential and Groundwater Extraction

Description	Area	Water Volume (m^3/year)	Remarks
Groundwater Development Potential: A	Proposed Groundwater Basin	11,800,000	
Groundwater Extraction of Existing Wells	Chunga	2,172,480	
	Kianga	700,800	
	M.Mchomeke	2,794,440	
	Dole	210,240	
Groundwater Extraction of Project Wells	Construction Well fields	5,256,000	
Total Groundwater Extraction: B		11,133,960	B/A =94 %

Environmental Impact of Groundwater Extraction by New Wells

indicates water balance between the estimated groundwater development potential and the groundwater extraction by the existing and new wells. The groundwater recharge is much larger than the groundwater extraction. Therefore, the groundwater development may not give a significant impact on the environment. It shall not have an impact on the environment even if irrigation wells in addition to the existing and new wells pump up groundwater.

(3) Well Pumps

1) Capacity and Number of Well Pumps

① Design Flow

Total Design Flow for New Wells = Daily Maximum Flow - Current Water Production (Daily Maximum)

＝54,100m^3/d - 40,100m^3/d

＝14,000m^3/d

② Number of New Wells

Operating 10 wells + Stand-by 1 well = 11 wells

③ Capacity per well

q = 14,000m^3/d/24hr/10 wells = 58.4m^3/hr/well

And the actual pumping quantity of well facility of the Project for Zanzibar Urban Water Supply Development (Phase I) in 2007 is shown in Table 2-23. The value was reliable.

Table 2-23 The Real Pumping Quantity in Phase I (As reference)

Well No.	Groundwater extraction of project wells (m^3/hr)	Actual groundwater extraction (m^3/hr)	Maximum groundwater development potential (m^3/hr)	Remarks
N-6	58.4	70	70	
N-7	58.4	40	40	
N-8	58.4	65	65	
N-9	58.4	35	35	
N-9-2	58.4	66	85	
N-13	58.4	100	106	
Total	350.4	376	401	

2) Type of Well Pumps

- Pumps will be submersible pump same as the existing well pumps.
- Electrical equipment is to be housed in pump house for ease of maintenance works.

3) Total Head of Well Pumps

The head losses of transmission pipelines are calculated based on the transmission pipeline plan in Section 2-2-3. The total heads of well pumps are calculated as follows.

H= Actual Head + Head Losses

= (Reservoir Water Level – Well Low Water Level) + Transmission Pipeline Losses + Pump Piping Losses

Dole Service Area N-3,4,5: 110m

Welezo Service Area N-6,7,8,9, 9-2: 100m N-13: 90m

Kinuni Service Area N-10,12: 90m

4) Proposed Well Facilities for Phase II

Table 2-24 Proposed Well Facilities

Item	Specification	Quantity	Remarks
[Mechanical Equipment]			New
Well Pumps	Submersible Pump N-3,4,5 : For Dole Service Area ϕ 125 x 58.4m^3/hr x 110m x 37kW ϕ 125 x 58.4m^3/hr x 90m x 30kW N-10,12 : For Kinuni Service Area ϕ 125 x 58.4m^3/hr x 90m x 30kW	 3 - 2	 Include a stand-by
Piping and Valves around Pumps	Discharge pipes, Valves, Flow Meters	1	5 wells
[Electrical Equipment]			New
Transformers	Oil/Self-cooling 33 or 11kV／415V, 50kVA	5	Breaker Lightning arrestors
Power distribution/Control Panel	Steel/Indoor/Self-standing For 37kW motor (with soft starter) For 30kW motor (with soft starter)	 3 2	 For N-3,4,5, For N-10,12
Water Level Detector	Electrode	5	Low water level detection
Power and Instrumentation Cables		1	5 wells
[Civil and Architecture]			New
Wells	Well Diameter: ϕ 250mm Design Well Depth: Dole Service Area N-3,4,5: 70m Kinuni Service Area N-10,12: 60m	 3 2	
Well Pump House	For Power distribution/Control Panels	5	

2-2-2-3 Water Transmission and Distribution Facilities

(1) Service Areas

In addition to the existing Saateni service area and Welezo service area, a new reservoir will be constructed in Dole at 100 m elevation in order to supply water to the north area, which includes Bububu area which is to be a new site for the government offices and experiences rapid population growth. This area will be called Dole Service area.

For south and east parts of the study area, in order to facilitate water supply to Urban Extension area whose population is growing rapidly, a new reservoir is proposed. The location of the reservoir is Kinuni area at the east of Urban area near the proposed new wells to be constructed in the central area, avoiding possible salinization of wells mainly observed in south area. This Kinuni Service area also includes area served by the existing Mbweni and Magogoni wells and the Dimani spring. Those service areas are shown in Figure 2-4.

Daily maximum demand and population for the above service areas in year 2010 are shown in Table 2-25. Those service areas are further divided into the 19 zones according to the land uses in order to analyze water demand in details.

Table 2-25 Daily Maximum Demand and Population for Service Area

Zone No.	**Total Demand (Daily Max.)** m^3/day	**SAATENI Service Area** m^3/day	**WELEZO Service Area** m^3/day	**DOLE Service Area** m^3/day	**KINUNI Service Area** m^3/day
Urban					
1	1,894	1,894			
2	3,343	3,343			
3	4,324	4,324			
4	2,507	1,504	1,003		
5	4,197	1,049	3,148		
6	6,344		6,344		
7	8,004		8,004		
8	6,537		6,537		
Urban Ext.					
9	3,950		1,707	2,243	
10	3,030		2,730		300
11	6,399				6,399
12	521				521
Peri-Urban					
13	369			369	
14	583			583	
15	234			234	
16	793		793		
17	474				474
18	461				461
19	117				117
Total	**54,080**	**12,115**	**30,265**	**3,428**	**8,272**
Service Population	**457,330**	**74,781**	**256,675**	**18,213**	**107,661**

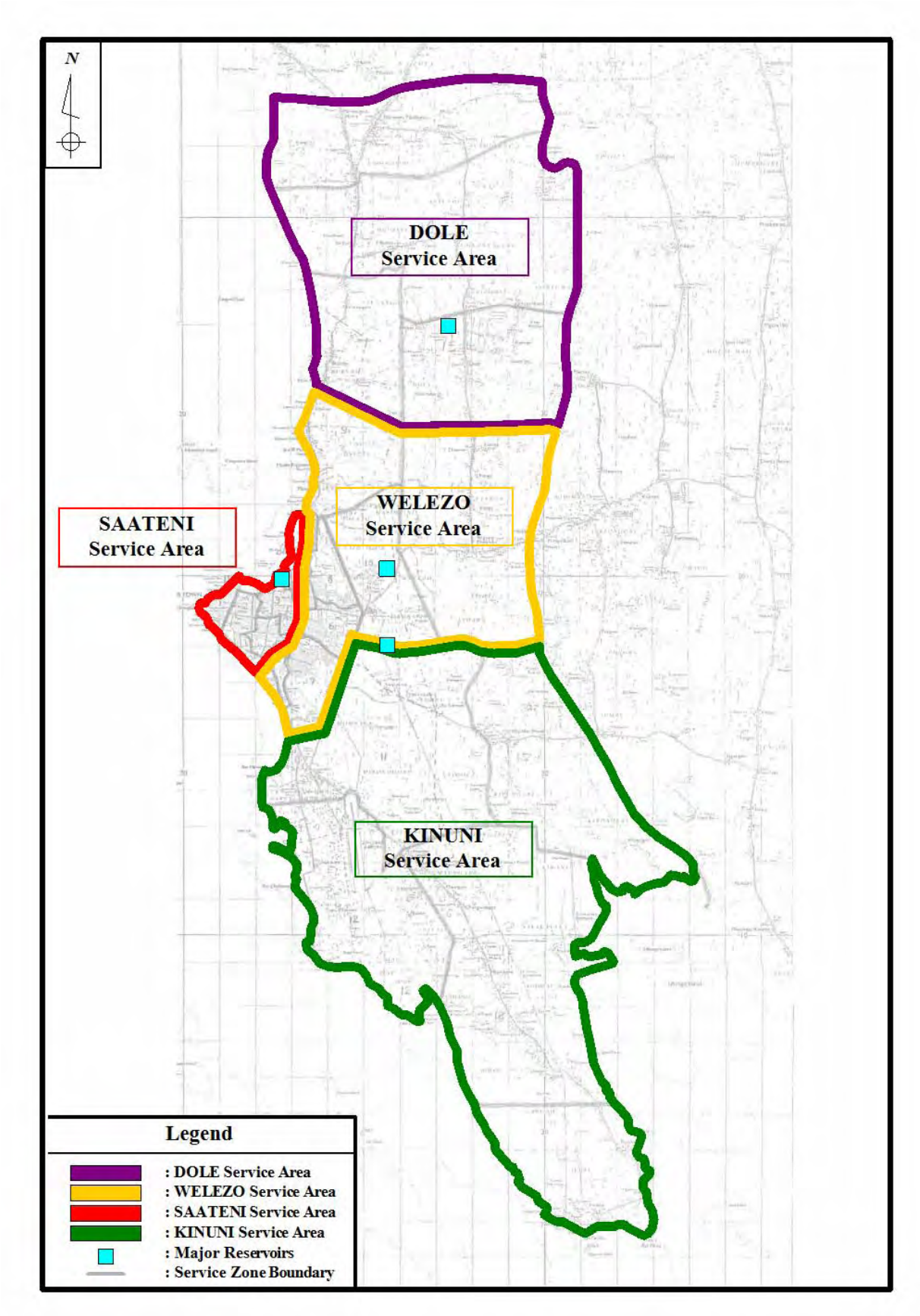

Figure 2-4 Service Areas

(2) Transmission Pipeline Plan

1) Development Strategy for Transmission Pipeline

Transmission pipes would be laid mainly in the existing roads to facilitate maintenance works. Diameters of the pipelines were designed to maintain flow velocity around 1 m/s in order to prevent excessive head losses. Badly damaged existing transmission pipeline from Chunga wells to Welezo reservoirs would be replaced to prevent water losses. The flow from those wells would be lead to the new Kinuni reservoirs. The part of this pipeline would also be used by the new wells.

2) Transmission Pipeline Plan

The proposed transmission pipelines from the proposed wells to the reservoirs are shown in Figure 2-5. Length of transmission pipelines is shown in Table 2-26 according to the service areas.

Table 2-26 Length and Diameter of Transmission Pipelines (m)

Service Area		KINUNI	DOLE	Total
Diameter	**Material**	**(m)**	**(m)**	**(m)**
150	DI	1,600	200	1,800
200	DI	300	500	800
250	DI	500	3,400	3,900
300	DI	2,300	0	2,300
400	DI	2,200	0	2,200
Total Length		**6,900**	**4,100**	**11,000**

3) Additional Facilities for Transmission Pipelines

The following additional facilities for transmission pipelines will be constructed.

a) Intermediate Sluice Valve

For maintenance works of well pumps and transmission pipelines, emergency valve operation for cross-boundary water supply, sluice valves would be installed.

b) Air Valves

Transmission pipeline routes have some ups and downs. Air valves would be installed at summits of pipelines before and after invert crossing of underground structure such as culverts to release air automatically and prevent air binding and pressure build-up.

c) Drain Pipes

In order to remove debris left in pipelines after pipe and well pump maintenance works, drainpipes would be installed to the transmission pipelines. Drainpipes will be located at the near end of the pipelines and at the rivers and channels.

d) Appurtenances

Other fittings were to be connected with the existing pipes.

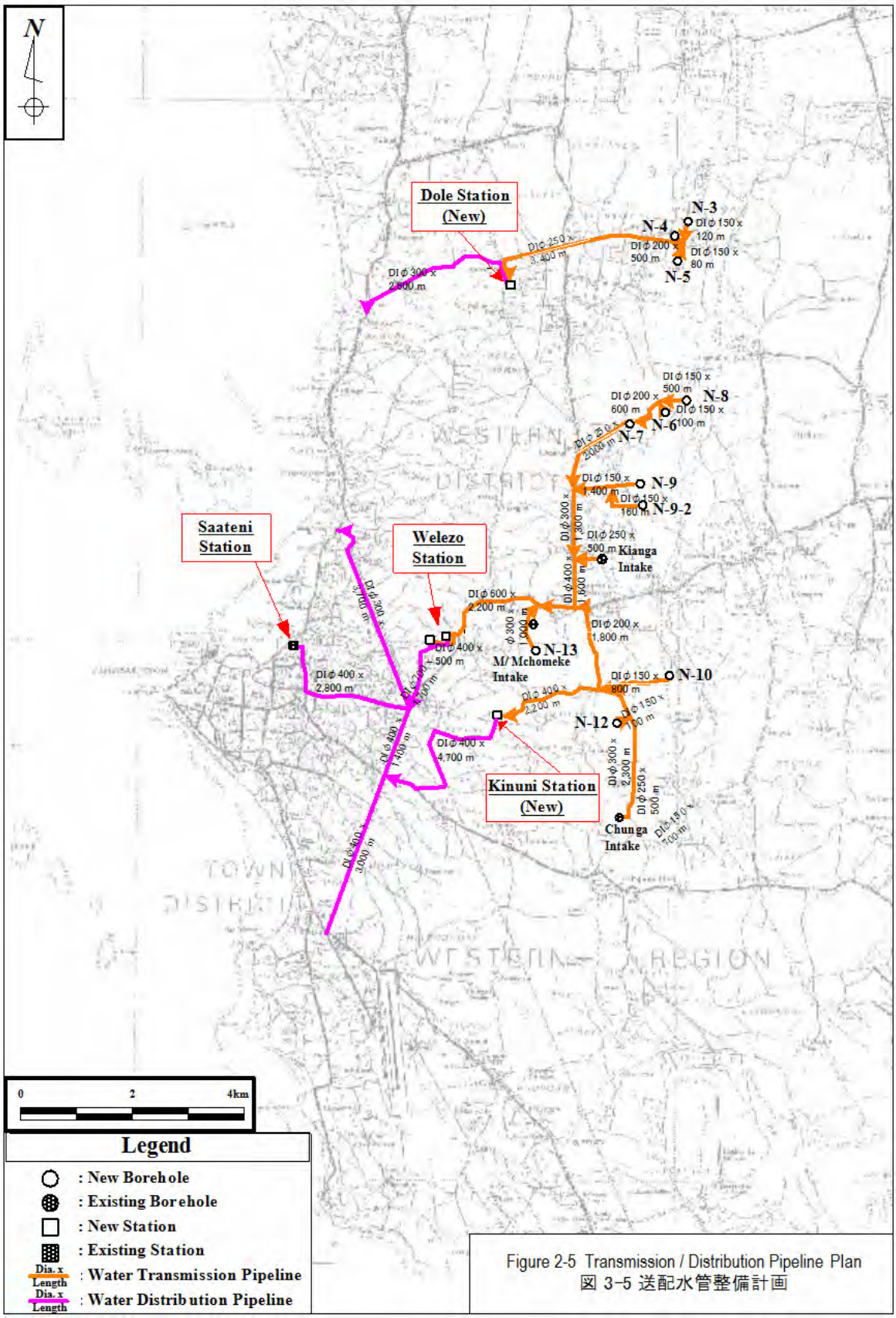

Figure 2-5 Transmission/Distribution Pipeline Plan

(3) Water Reservoir Plan

1) Development Strategy for Reservoirs

Reservoir development plan was prepared based on the FINNIDA master plan (1991). The reservoirs were designed for the following purposes.

a) Attenuate Diurnal Fluctuation of Water Demand

Reservoir capacity required to attenuate diurnal fluctuation of water demands is 17.5% of daily water demand (FINNIDA Master Plan).

b) Uninterrupted Water Supply during Pump stops due to Power Failures

17.5% of daily water demand will be stored in the reservoirs in order to secure uninterrupted water supply during 3 hours pump stops during the peak hours (FINNIDA Master Plan).

c) Storage required for Fire Flow Demand

Reservoir capacity required for specifically fire fighting is 1% of daily demand (FINNIDA Master Plan).

The required reservoir capacity, the sum of the above 3 items, is 36%, equivalent to 8.6 hours of daily water demand.

2) Reservoir Plan

New reservoirs are proposed to secure 8.6 hours of daily demand in each service area. The proposed reservoirs are shown in Table 2-27.

Table 2-27 Proposed Reservoirs

Service Area		Dole	Welezo	Saateni	Kinuni	Remarks
Daily Maximum Flow	m^3/d	3,428	30,265	12,115	8,272	
Required Reservoir Volume (A)	m^3	1,228	10,845	4,341	2,964	=Qday.max.x8.6/24 (8.6hrs 分)
Existing Reservoirs (B)	m^3	(40x2)*	2,250x1 420x1 120x1(Begamoja)	2,250x1 1,000x2 90x1(Mbao)	250x1(Dimani)	
	Total		2,790	4,340	250	
Balance	m^3	1,228	8,055	1	2,714	=A-B
Proposed Reservoirs		**1,200m^3x1**	**4,000m^3x2 (Phase I completed)**	**Not required**	**2,700m^3x1**	

Note) ＊: The existing reservoir is designed for the vocational school and hospitals.

3) Necessity of Elevated Tanks

After the implementation of the proposed project, Saateni service area will be served through two

elevated reservoirs. In order to secure continuous water supply during power failures, elevated tanks shall store 2 - 3 hours of daily demand.

Daily Average Demand of SAATENI Service Area = Daily Maximum Demand x 1/1.35＝12,115/1.35＝8,974 m^3/d

Required elevated tank capacity = 8,974 x (2~3) hours / 24 = 748～1,121m^3

・Existing elevated tank = 450m^3 x 2 = 900m^3 ＞ 748m^3 (2 hours of daily average demand)

Thus, new-elevated tanks are not required.

4) Disinfection Facilities

Every reservoir would have disinfection facilities to disinfect drinking water.

・Disinfection type: Solution of powder disinfectant / drip dosing method

(The same method being used at the Saateni Station)

・Application: At the inlet of each reservoir

5) Additional Facilities for Reservoirs

The following facilities will be provided for the proposed reservoirs.

a) Water Level Meters

One water level meters will be installed to each reservoirs for efficient reservoir operation.

6) Proposed Reservoir Facilities for Phase II

Table 2-28 Proposed Reservoir Facilities

Item	Specification	Quantity	Remarks
Kinuni Station			
[Civil and Architectural]			
Reservoir	Volume: 2,700m^3	1unit	New
Structure	Reinforced Concrete		
Dimensions	22.5 mW x 12.5 m L x 5 m H x 2 tanks		
High / Low Water Level	65.0m/60.0 m (elevation)		
[Mech. / Elect. Equipment]			
Disinfection Facility	Powder Disinfectant Solution Tank/Drip	1set	New
Dole Station			
[Civil and Architectural]			
Reservoir	Volume: 1,200m^3	1 unit	New
Structure	Reinforced Concrete		
Dimensions	14.6 mW x 8.9 m L x 5 m H x 2 tanks		
High / Low Water Level	103.7m/98.7 m		
[Mech. / Elect. Equipment]			
Disinfection Facility	Powder Disinfectant Solution Tank/Drip	1set	New

(4) Distribution Pipeline Plan

1) Development Strategy for Distribution Pipelines

Through the preliminary study and the site survey of this study, the areas that experience water supply disruptions are investigated and shown in Figure 2-6. While the most of the problem areas are within the Welezo service area, Saateni service area also has low-pressure area. Thus even in the Zanzibar Urban area, the existing pipes laid from 1950's to 1970's do not have sufficient capacities.

In order to solve the above problems, different strategies were developed for Urban area and Urban Extension/Peri-Urban area.

① Urban Area (SAATENI Service Area, A Part of WELEZO Service Area)

Urban area, which includes the Stone Town, is a built-up area with the fixed land use plan. Its future population growth is relatively small. Proposed distribution pipelines (main pipes) are designed to achieve the minimum water pressure of 5-meter water head.

② Urban Extension/Peri-Urban Area (WELEZO Service Area, DOLE Service Area, KINUNI Service Area)

Most of this area does not have fixed land use plan and future distribution of its population is not clear. Thus only minimum distribution pipelines (main pipes) enabling distribution of increased water production from the proposed wells are proposed for this area.

2) Distribution Pipeline Plan

Proposed distribution pipelines following the above strategy are shown in Figure 2-5. Lack of proper pipe replacement plan encouraged duplicated small diameter pipelines in the some routes in order to meet the increasing water demand. Those pipes are regarded as minor distribution pipes, which house connections are directly tapped into. The proposed distribution pipelines will form trunk distribution pipelines, whose role is to supply sufficient water as well as to maintain the minimum water pressure in Urban area. The proposed pipelines will be connected to the existing minor distribution pipelines at appropriate intervals. House connections will not be tapped directly into the proposed pipelines.

The proposed pipeline replaces the existing asbestos cement pipeline from Welezo station to Saateni Station. The most of the other existing pipelines will be used even after the completion of the proposed project since house connections are tapped into those pipes. The total length of the existing pipes to be abandoned after the project completion is estimated to be 3 km, 1.5% of the total length of the existing distribution pipelines.

Length of the proposed distribution pipelines is shown in the Table 2-29.

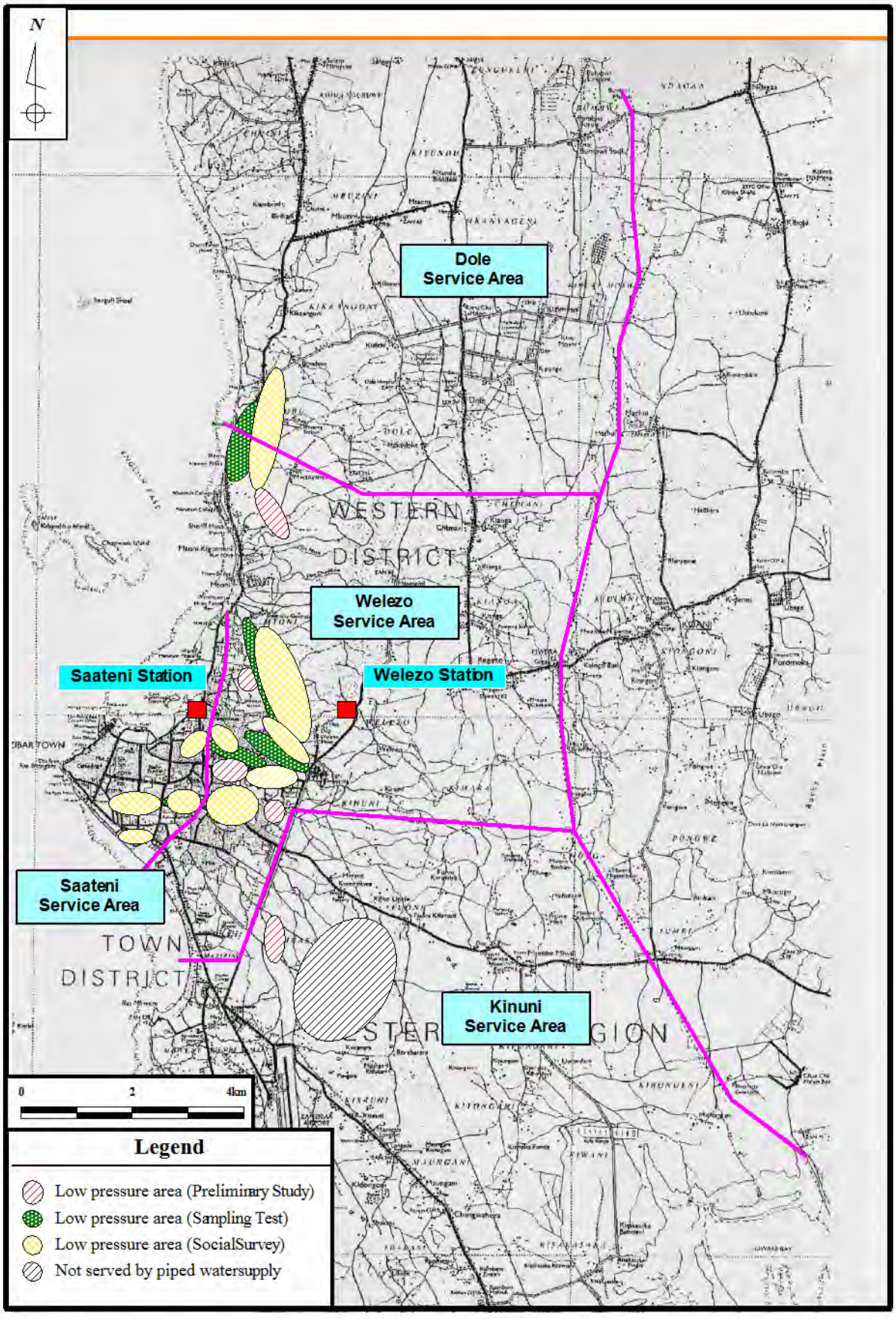

Figure 2-6 Areas with Service Disruption

Table 2-29 Length of Proposed Distribution Pipelines (m)

Service Area		KINUNI	DOLE	Total
Diameter	**Material**	**(m)**	**(m)**	**(m)**
300	DI	0	2,600	2,600
400	DI	7,700	0	7,700
Total		**7,700**	**2,600**	**10,300**

3) Results of Water Supply System Simulation

In order to analyze problems of the existing water supply systems and to confirm the proposed pipelines rectify the problems in the most efficient manner, computer simulation of the existing and the future water supply systems are developed using EPANET as a simulation program. The results of the simulation of the existing system at the morning peak-demand hour are shown in Figure 2-7. Red nodes in the Figure show the points with no water pressure, thus experiencing supply disruption. Distribution of the red nodes overlaps that of service disruption area shown in Figure 2-6.

The simulation results of the future water supply system in 2010 are shown in Figure 2-8. Even at the peak-demand hour, the minimum water pressure (5m) is achieved in the Urban area. Most of the Urban Extension/Peri-Urban area will enjoy the improved water pressure during the peak-hours, thus service disruption will be minimized.

4) Additional Facility for Distribution Pipelines

a) Sluice Valve

Sluice valves would be installed at the pipe junctions, connection pipes to the existing pipelines, etc. to facilitate maintenance works of the distribution pipelines.

b) Flow Meters

In order to appropriate water distribution, flow meters would be installed mainly at the outlets of the reservoirs.

c) Pressure Reducing Valves

Pressure reducing valves would be introduced to control water pressure in the low elevation sections of Welezo and Dole service areas, which have reservoirs at the high elevations. The pressure reducing valves will be placed on the proposed distribution pipeline maintaining the water pressure less than 60 m.

d) Drain Pipes

In order to remove debris left in pipelines after pipe maintenance works, drainpipes would be installed to the distribution pipelines. Drainpipes will be located at the near end of the pipelines and at the rivers and channels.

e) Appurtenances

Other fittings were to be connected with the existing pipes.

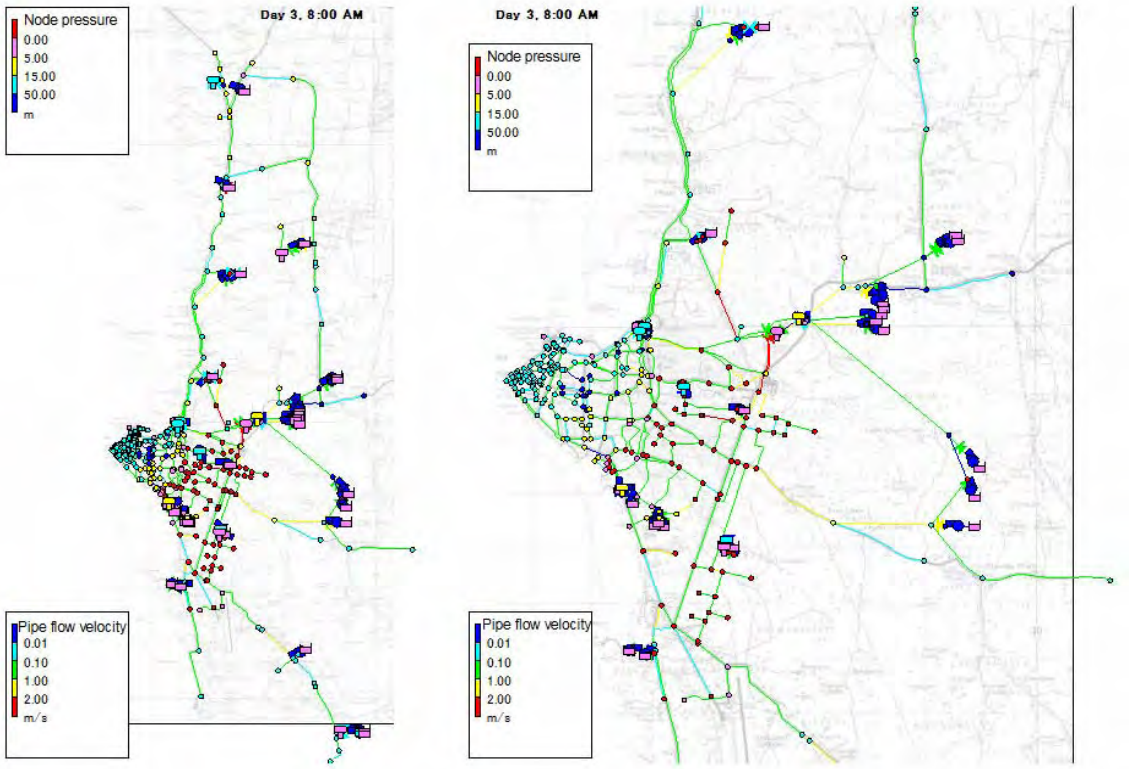

Figure 2-7 Simulation Result of the Existing Pipe Network (Peak Hour in 2004)

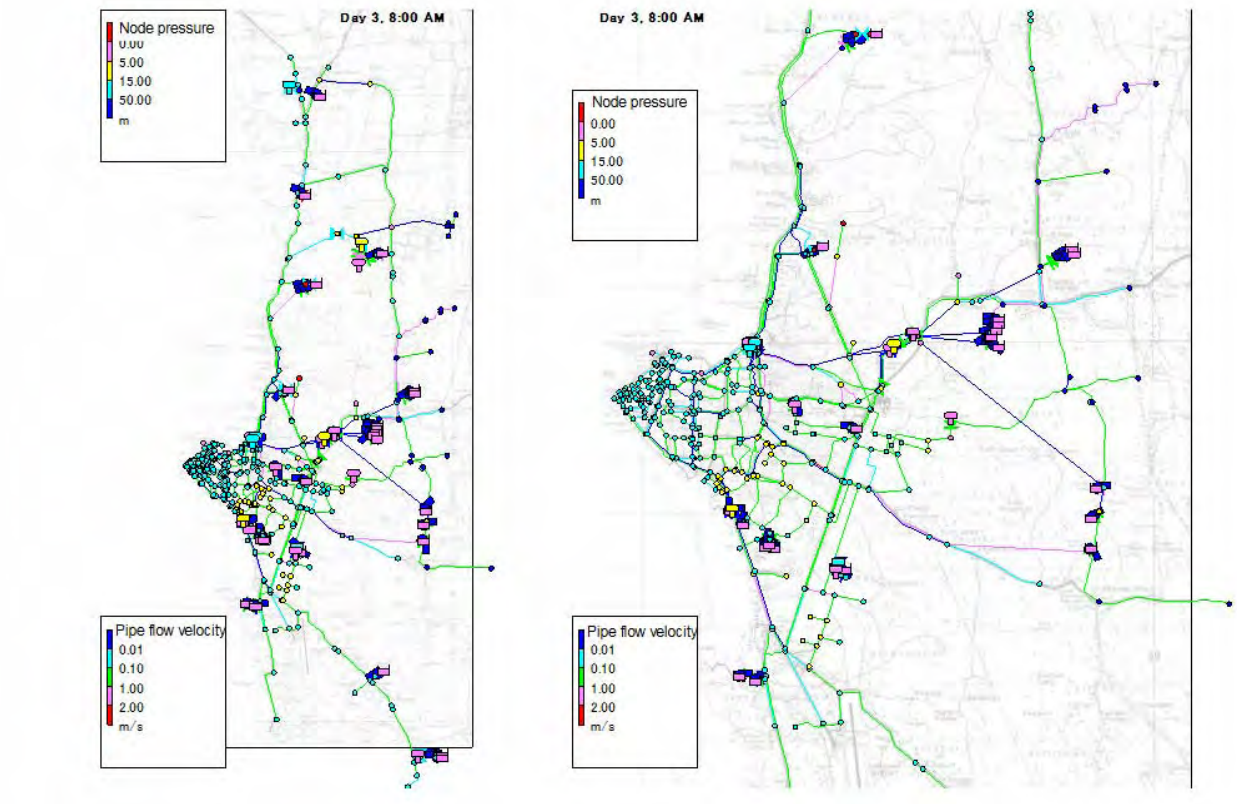

Figure 2-8 Simulation Result of the Future Network (Peak Hour in 2010)
Proposed Facilities for Distribution Pipelines

Table 2-30 Proposed Facilities for Distribution Pipelines

Item	Specification	Quantity	Remarks
[Civil Facilities]			
Flow Meters	Axial-flow Propeller Type Dole Service Area: ϕ 200 Kinuni Service Area: ϕ 300	 1 set 1set	New
Pressure Reducing Valves	Automatic Water-Pressure Driven Type Dole Service Area: ϕ 200	 1 set	New

2-2-2-4 Equipment Procurement Plan

Among the requested water quality laboratory equipment and maintenance equipment, former DWD emphasized that urgent need for four pickup trucks. The study team evaluated this need and found out that former DWD needs 3.5 – 4.8 trucks for routine operation and maintenance works, 1 truck for non-routine works. Thus, procurement of four trucks is regarded as a high priority. But these vehicles are excluded from this project because of the Japanese Government's ODA Policy.

	Purpose	Department	Work load/Manpower	Required trucks
1	Pump Maintenance	Plant and Mechanics	The existing well pumps - 27: After completion of this project - 38 Manpower: 250, Manpower working in the study area is 41.	*1) 38 trucks x 1/6 = 6.2 /month 6.3 trucks/month/21.4 = 0.3 trucks Required trucks: 0.3
2	Chemical Transportation, Water Quality Sampling	Water resources	The existing reservoirs: 2, After completion of the project - 4 Manpower: 77, Manpower working in the study area is 5.	*2) Chemical Transportation: 2 days/week Sampling: 1 day/week Required trucks: 0.6
3	Pipeline Maintenance	Water Supply	Length of the existing pipelines: 180km 126 pipe repair works in 9 month (2004): 14 repairs/month Manpower: 88, Manpower working in the study area is 26.	*3) 14 repairs/month x 2 x (2 - 3) /21.4 = 2.6 - 3.9 Required trucks: 2.6 - 3.9
4	Facility Maintenance	Planning & Design / Administration	Planning/Design: 7 + Administration: 37	*4) No routine works (Required trucks: 1)
Total				3.5～4.8 + (1)

*1) Pump requires maintenance works once in 6 months.

38 x 1/6 ＝ 6.3 pumps/month

Pump maintenance works consist of taking-out (1 hour), re-installation (1 hour), and transportation (1 hour). Within the working hours (8 hours/day), actual operation hours for truck is 4 hours/day, thus using one truck, former DWD maintain one pump in a day. Saturday and Sunday are off for the government agencies; working days are 30 day/month x 5/7 = 21.4 days.

6.3 trucks/month/ 21.4 = 0.3 trucks are required.

*2) Chemical Transportation is required once per every week for each reservoir.

Within one day, one truck loads, unloads and transports disinfection chemical for 2 reservoirs. It will take 2 days per week for 4 reservoirs.)

Drinking water sampling at the reservoirs could be done at the time of chemical loading and unloading. Sampling at wells and springs in the region could be done in one day per week.

Thus 0.6 trucks are required. (3 days per week (5days))

*3) Pipeline repairs were done at average 14 locations/month in 2004. Repair of one pipe damage will take 2 – 3 days in average. (source: former DWD workshop) It does take 2 trucks for 2 - 3 days for transportation of engineers, labours, materials and tools in order to repair one pipe break, the required trucks are 14 x 2 x (2 - 3)/21.4 = 2.6 - 3.9 trucks.

*4) Although facility maintenance works does not have clear routine works, design of pipeline extension, regional water resource management, and customer service (attending complains) do require one truck.

2-2-3 Basic Design Drawings

(1) General Plan of the Proposed Facilities (Figure 2-9)

(2) Water Distribution and Hydraulic Profile (Figure 2-10)

(3) Wells

(4) Borehole Structure (Figure 2-11)

(5) Borehole Equipment (Figure 2-12)

(6) Dole Station

(7) Layout (Figure 2-13)

(8) Reservoir Structure (Figure 2-14)

(9) Kinuni Station

(10) Layout(Figure 2-15)

(11) Reservoir Structure (Figure 2-16)

(12) Transmission/Distribution Pipeline

(13) Plan (Figure 2-17)

(14) Chlorine Dosing House

(15) House Structure (Figure 2-18)

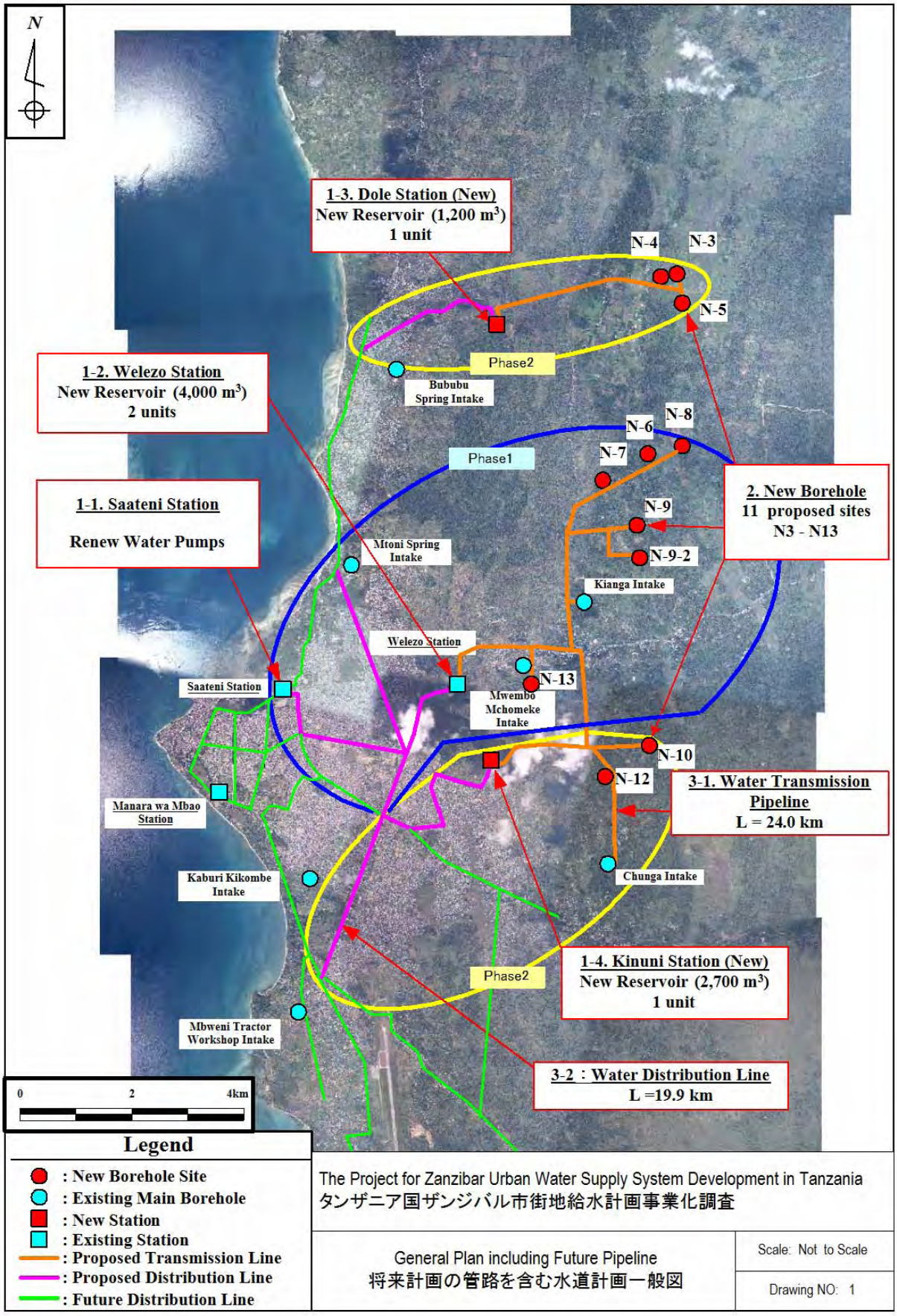

Figure 2-9 General Plan

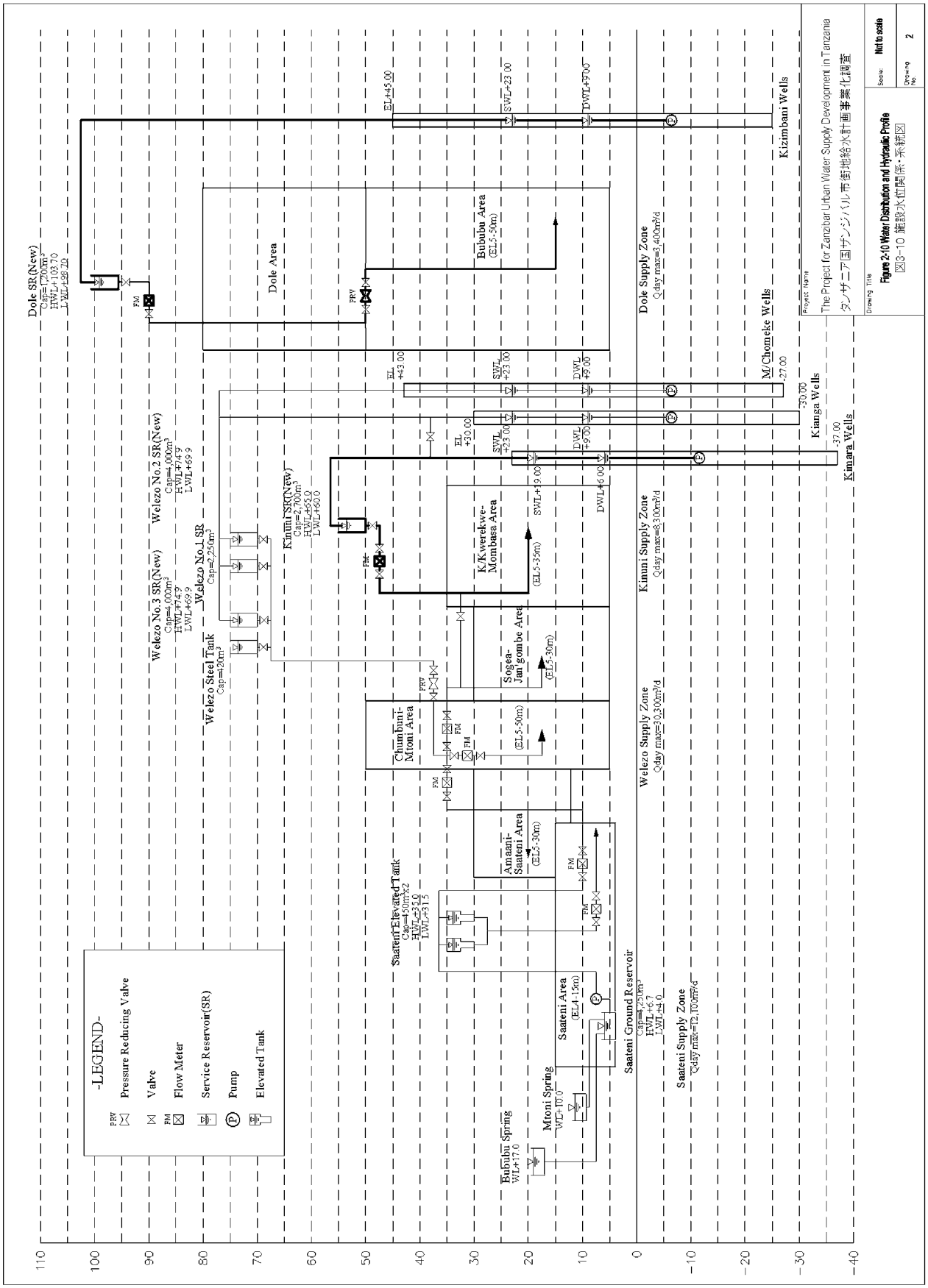

Figure 2-10 Water Distribution and Hydraulic Profile

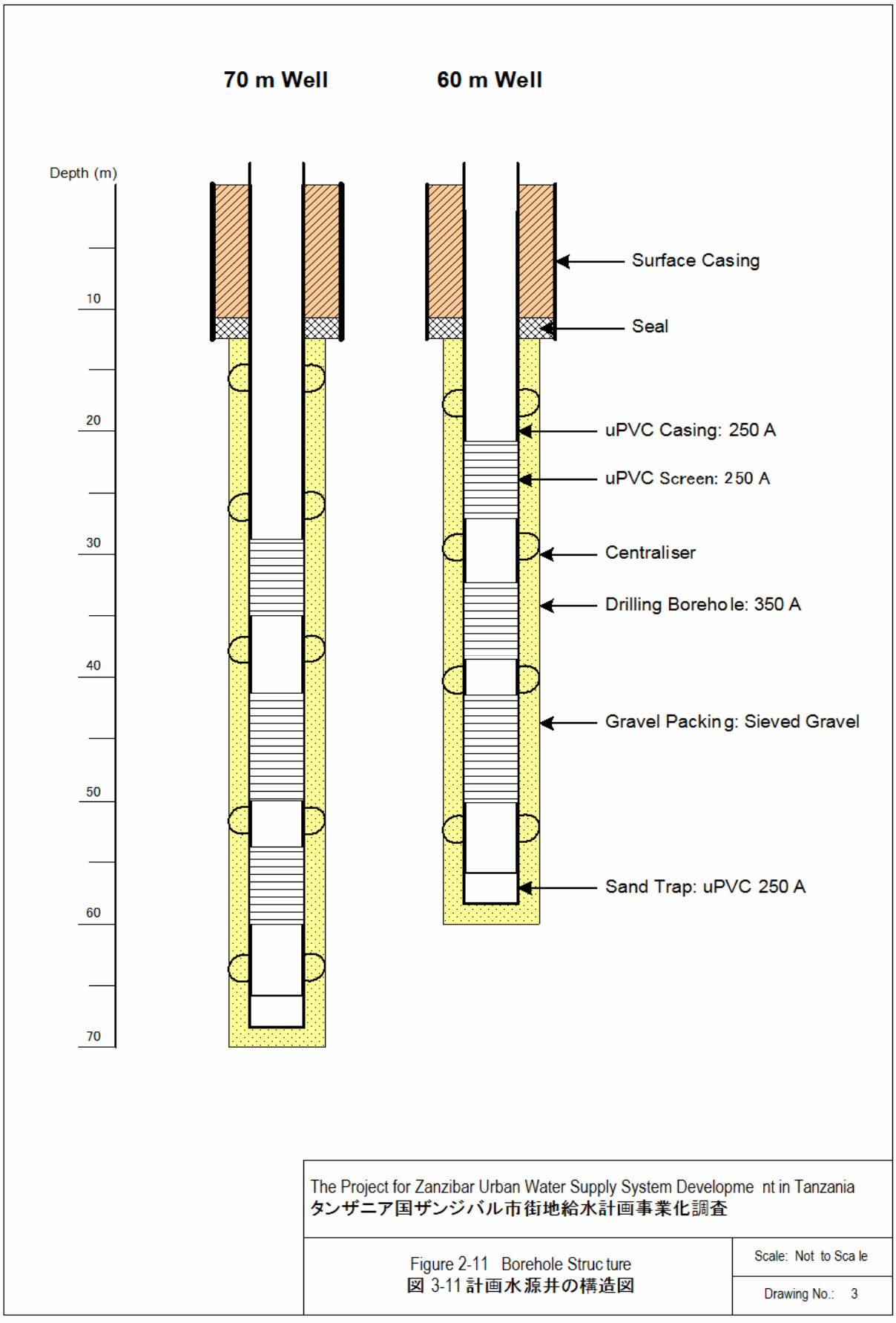

Figure 2-11 Borehole Structure

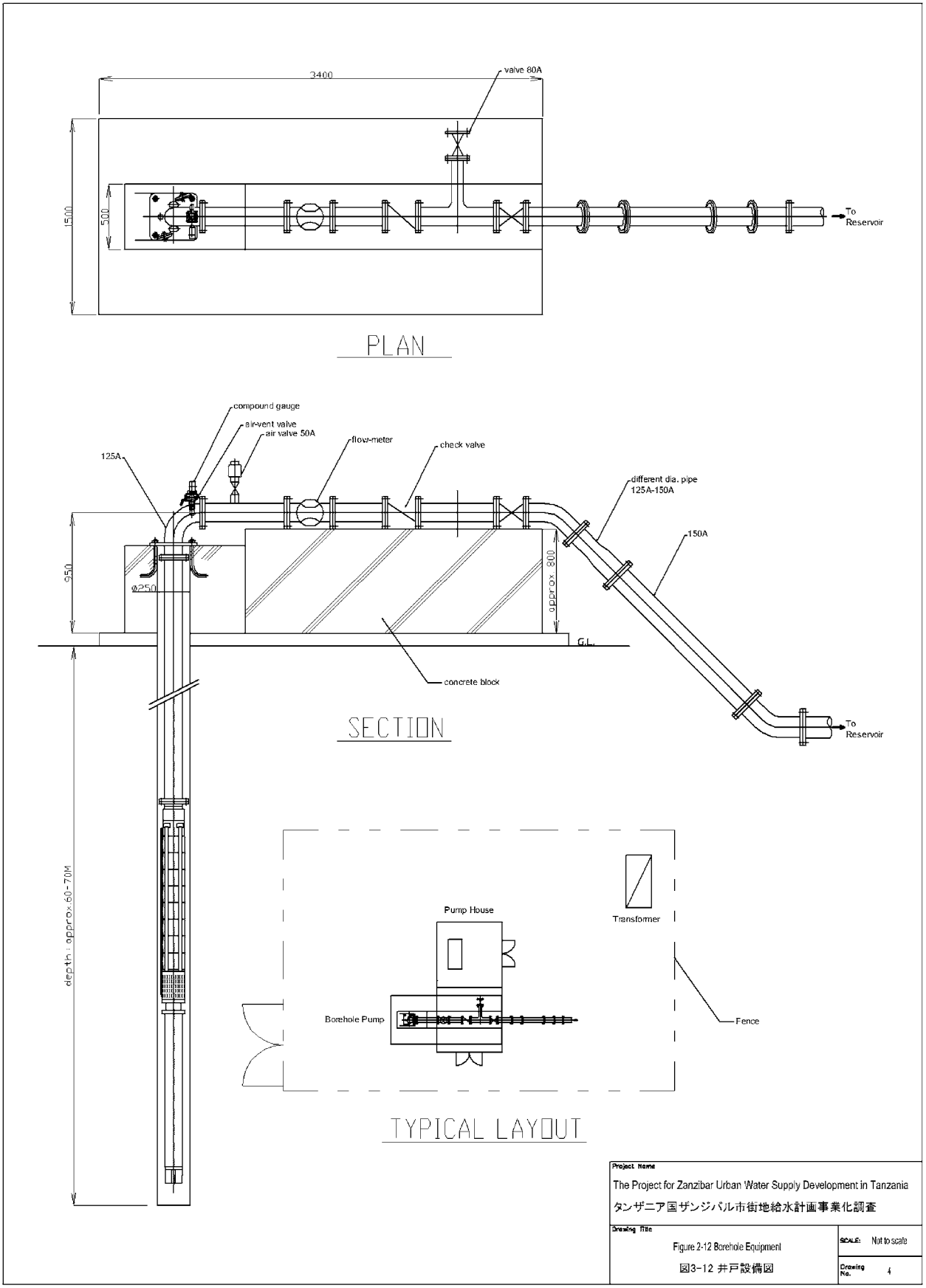

Figure 2-12 Borehole Equipment

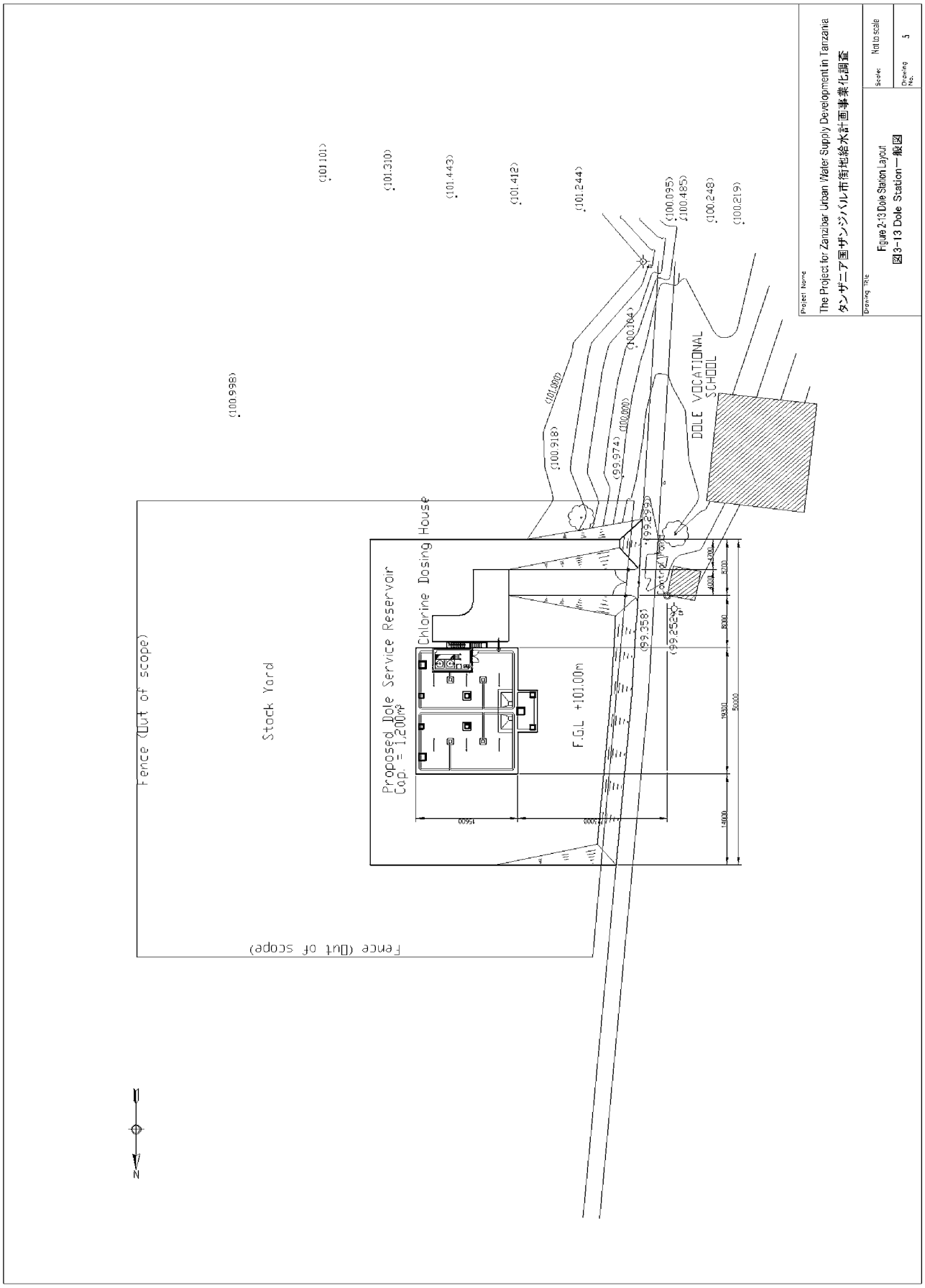

Figure 2-13 Dole Station Layout

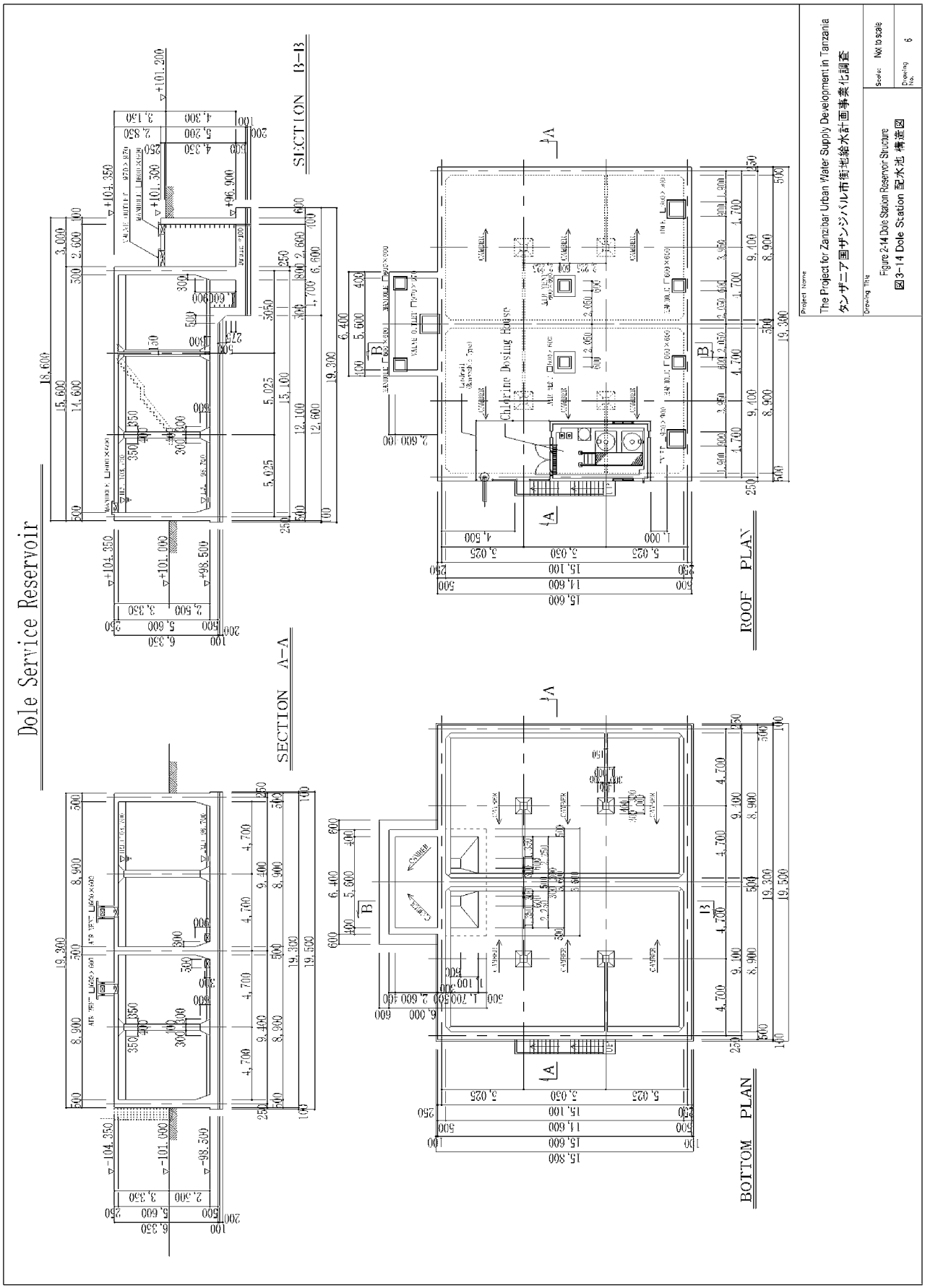

Figure 2-14 Dole Station Reservoir Structure

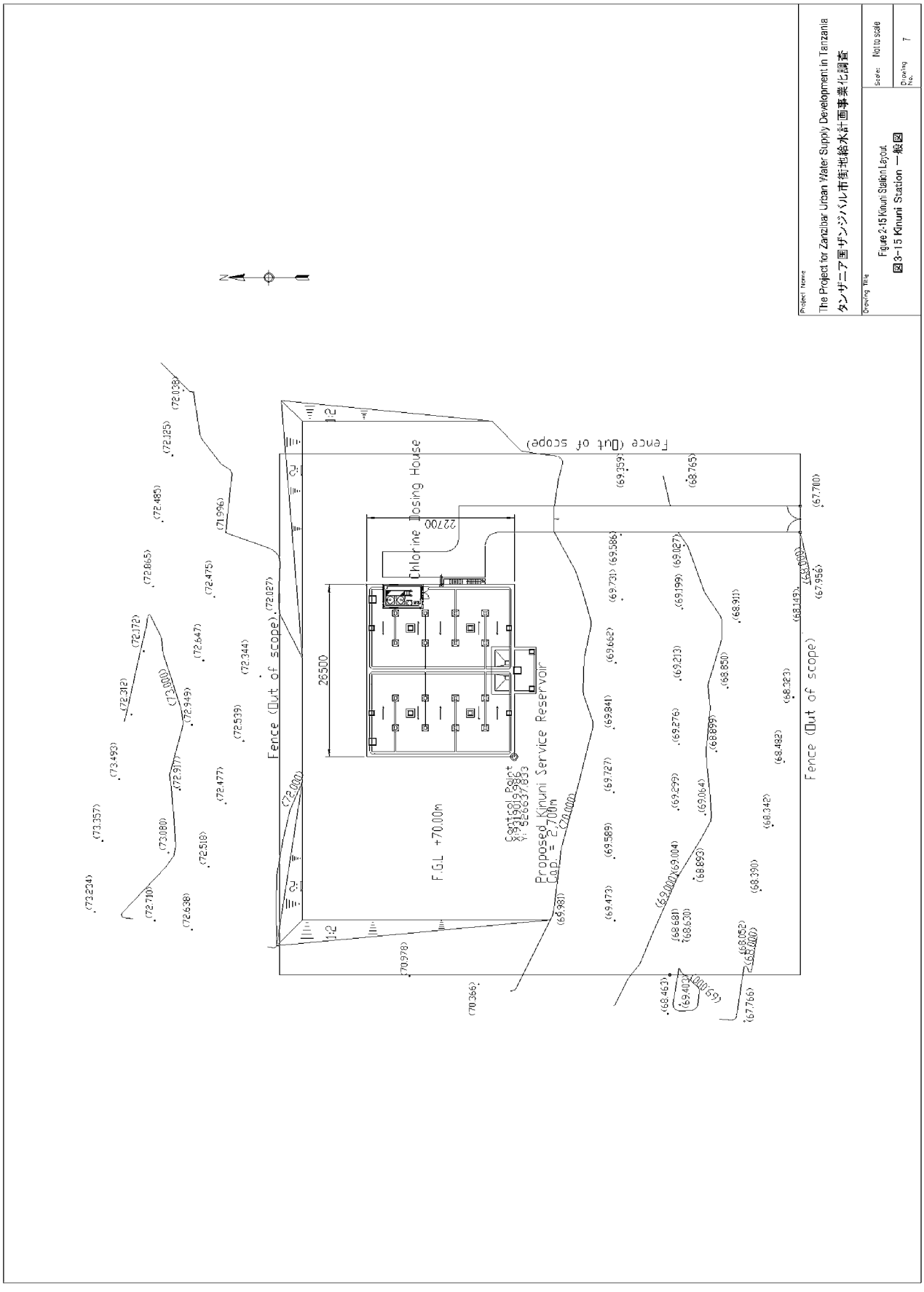

Figure 2-15 Kinuni Station Layout

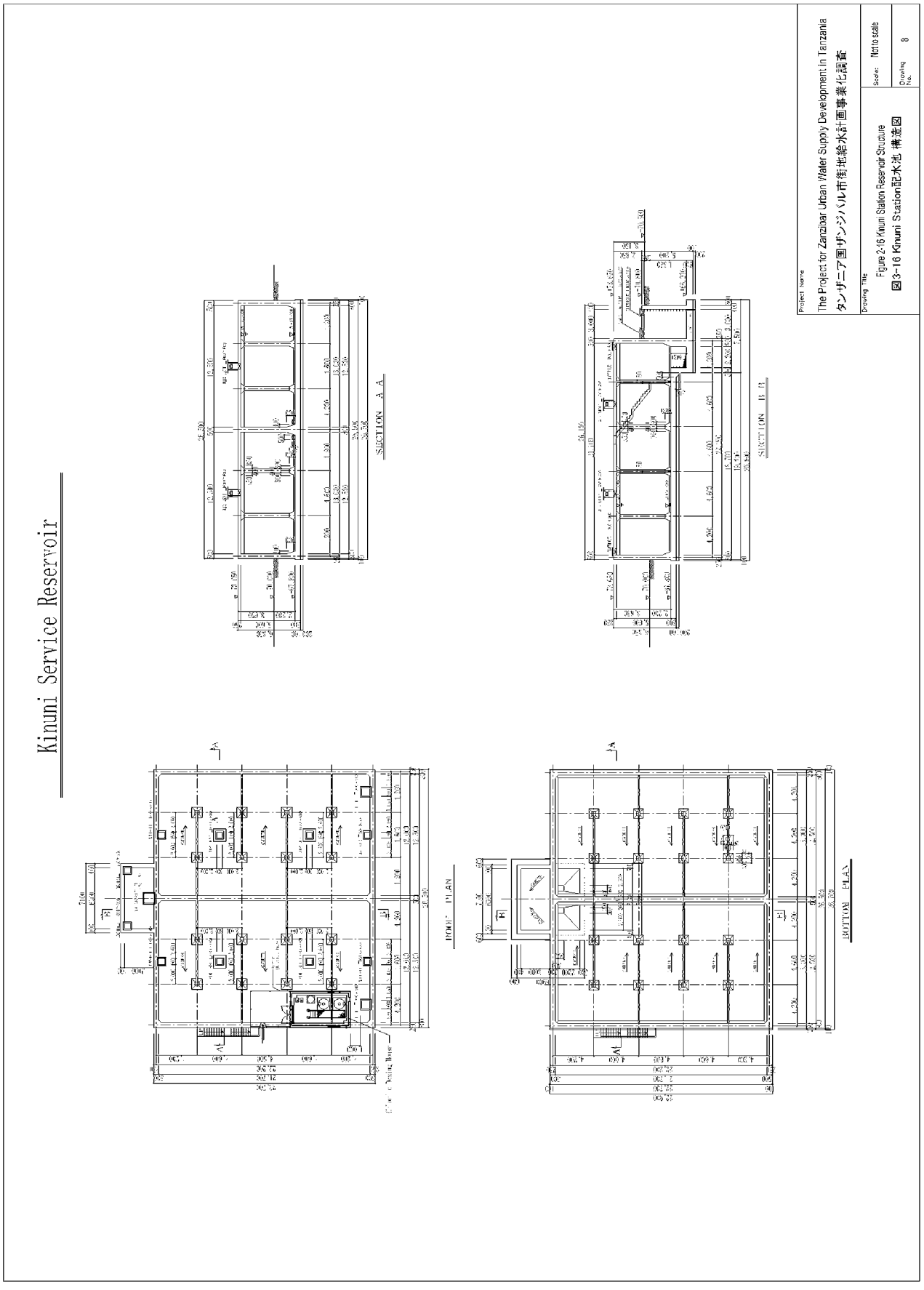

Figure 2-16 Kinuni Station Reservoir Structure

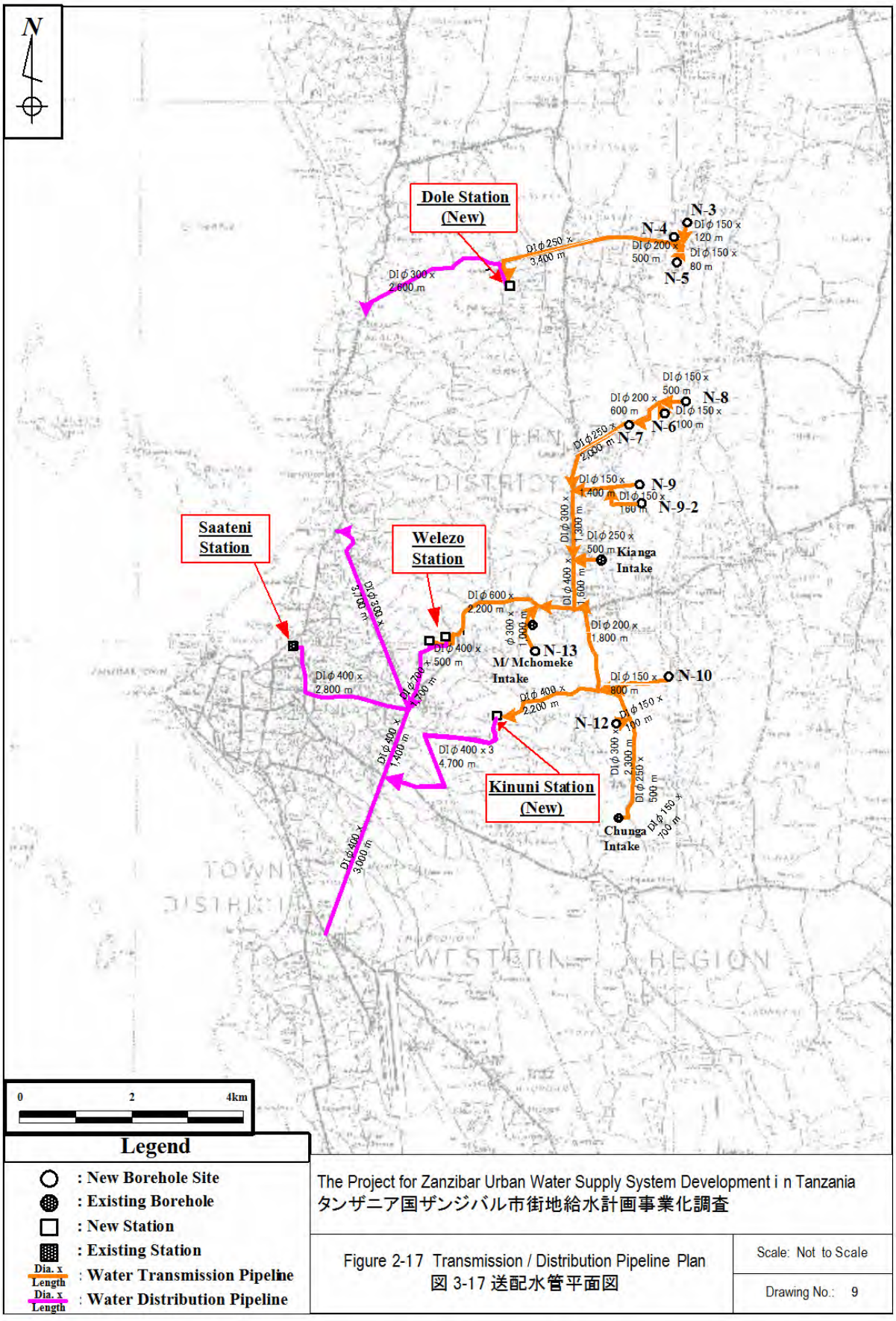

Figure 2-17 Transmission/Distribution Pipeline Plan

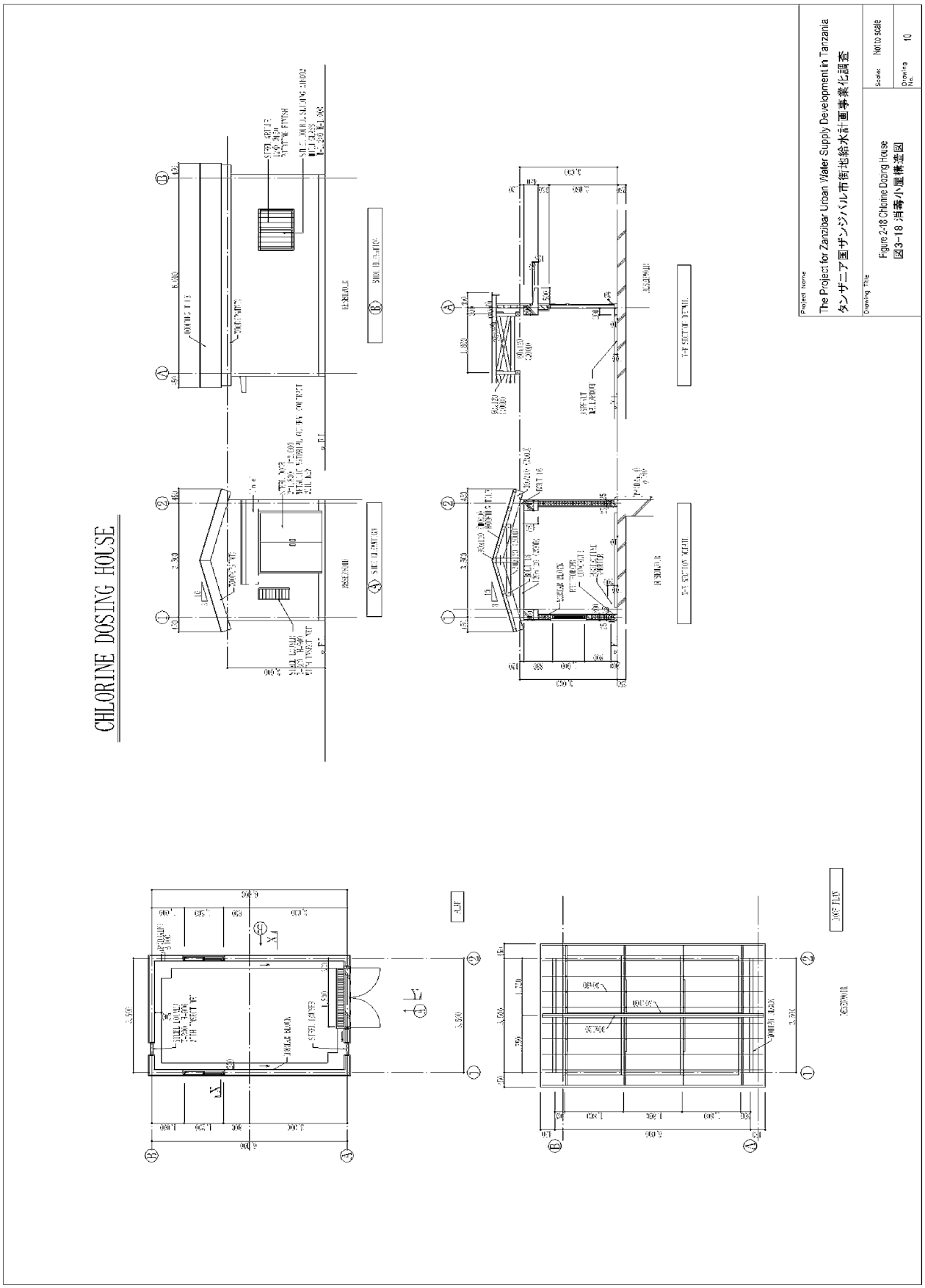

Figure 2-18 Chlorine Dosing House

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

Implementation agency of the project is ZAWA under the Ministry of Water, Construction, Energy and Lands (MWCEL). Project Implementation Diagram is shown in Figure 2-19.

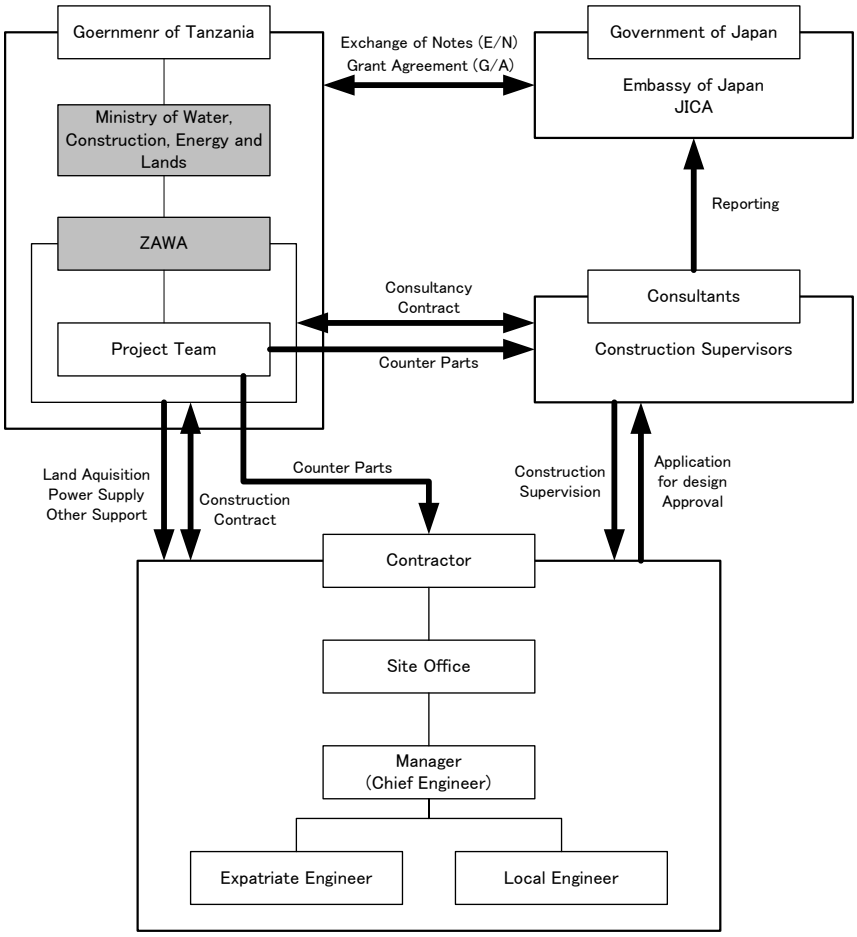

Figure 2-19 Project Implementation Diagram

The project team to be organized in ZAWA will be in charge of the project implementation from the detailed design stage. The project team will be responsible for the following works:

a. To represent ZAWA for the project implementation
b. To liaise with and coordinate Zanzibar and Tanzania Government Agencies
c. To liaise with and coordinate the related external agencies such as UNDP
d. To work as counter parts for consultants in designing and tendering
e. To secure manpower for additional survey and tests, if required.

The selected Japanese Consultants will undertake detailed design, tendering, construction supervision, aiming for project completion within the given time frame. Thus the consultants will dispatch a resident engineer who will supervise construction works on behalf of former DWD. The consultants will also

dispatch borehole, civil, mechanical and electrical engineers for construction supervision.

As the project consists of drilling works, civil works, plumbing works and mechanical/electrical works, it is considered appropriate that a Japanese civil contractor with experience in the similar construction works will undertake the works. The public bidding system will be used for selection of the contractor. The consultants, in consultation with ZAWA, will prepare tenderers' qualification requirement and selection criteria for contractor.

During the construction works, the Japanese contractor will dispatch resident engineers at site, and supervise and instruct the local sub-contractors. The construction industry in Tanzania is well matured and the local construction companies can work on this project as sub-contractors.

2-2-4-2 Implementation Conditions

Construction works include borehole drilling, reservoir construction, transmission/distribution pipe laying, and mechanical and electrical equipment renewal at the transmission pump house. Open space for a site office and stockyards is readily available around the Stone Town through ZAWA. The followings will require special attention during the construction works.

- Manual labour is readily available in Zanzibar, while skilled engineer, some construction materials and heavy machineries are to be procured in the mainland Tanzania.
- The average annual rainfall is 1,600 mm. They have rainfall every month. Days with more than 10 mm rainfall will be regarded as off days for construction.
- Special construction method for renewal of transmission pumps will be selected to minimize disruption of water supply.
- No ready mixed concrete is available in Zanzibar. Thus concrete will be mixed at the construction sites.
- Drilling, pump installation and test run will be done under the strict supervision of the Japanese engineers.
- Tanzania VAT will be waived for the construction works upon official applications.
- The proposed well sites have normal soil and sand in the surface layer, and limestone at the depth over 5 meters. The appropriate drilling machines will be selected for this condition. The limited construction period may make procurement of drilling machines difficult.
- All the proposed well sites are in the government owned lands. There are some private owned lands around the sites and confirm the land availability with ZAWA.
- Although this project does not require EIA, implementation plan shall give due consideration for the surrounding environment.

2-2-4-3 Scope of Works

The scope of works for both Japanese and Tanzania governments is shown in . The scope of undertakings of Tanzania side has been discussed and accepted by the Tanzania Government, which follows the Japanese grant aid policy shown in Table 2-32.

Table 2-31 Project Scope for Tanzania and Japanese Governments

Item	Works	To be undertaken by Tanzania Gov.	To be undertaken Japanese Gov.
Construction of new wells, reservoirs and transmission/distribution pipelines	Equipment procurement		○
	Civil construction works		○
	Equipment installation		○
	Land acquisition	○	
	Fencing	○	
	Installation of Power transmission lines	○	
	Obtaining construction approval	○	
	Removal of the existing pipes	○	

Table 2-32 Major Undertakings to be taken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed		●
3	To construct gates and fences in and around the site		●
4	To construct the parking lot	●	
5	To construct roads		
	1) Within the site	●	
	2) Outside the site		●
6	To construct the building	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities		
	1) Electricity		
	a. The distributing line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site	●	
	3) Drainage		
	a. The city drainage main (for storm sewer and others to the site)		●
	b. The drainage system (for toilet sewer, ordinary waste, storm drainage and others) within the site	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) for the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
8	To bear the following commissions to the Japanese bank for banking service based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
9	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine (Air) transportation of the products from Japan to the recipient	●	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	(●)	(●)
10	To accord Japanese nationals, whose service may be required in connection with the supply of the products and the services under the verified contract, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
11	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contacts		●
12	To maintain and use properly and effectively the facilities contracted and equipment provided under the Grant		●
13	To bear all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●

Remarks B/A: Banking Arrangement, A/P: Authorization to Pay

2-2-4-4 Consultant Supervision

After the completion of this basic design study, the project is subject to the GOJ cabinet approval of GOJ Upon the cabinet approval, Japanese and Tanzania Governments will sign the Exchange of Notes (E/N) on grant aid for the project. JICA and Tanzania Governments will sign the Grant Agreements (G/A) on grant aid for the project.

1) Detailed Design

Based on the E/N and G/A, MWCEL will hire consultants for detailed design works for the project. After the GOJ verification of the detailed design contract, the consultants will perform detailed site survey and prepare detailed design, cost estimate and tender documents in Japan. .

2) Tendering and Evaluation

All the tender documents are subject to MWCEL approval. After the approval, the consultants will immediately proceed with tendering.

a. To allow one week for bidders to prepare an application for prequalification
b. To evaluate prequalification submissions from the bidders immediately
c. To allow one and half months for prequalified bidders to prepare bidding documents after providing tender documents to each prequalified bidder.
d. To recommend the lowest qualified bidder for MWCEL as a successful bidder and assist MWCEL in contract negotiation.

3) Construction Supervision

Construction works include civil works, well drilling works, plumbing works, mechanical/electrical works. Besides a resident civil engineer, the consultants will dispatch, civil engineers for drilling, plumbing and structures, mechanical and electrical engineers to the construction site in a few occasions, as construction works requires supervision by the above specialists. The consultants will hire local engineers to support their works.

The resident engineer of the consultants will maintain close contact with former DWD and the contractors throughout the project implementation. The resident engineer will submit progress reports to the JICA Tanzania Office and to the JICA headquarters at the agreed interval.

2-2-4-5 Procurement Plan

1) The Countries of Origins

For grant aid projects, the countries of origins are limited to Japan and the recipient country in principle. Materials and equipment required for this project shall be procured in Tanzania as much as possible. Some items that are not available in Tanzania, or whose supply and price is not consistent in the local market will be procured in Japan or the third countries with due consideration for cost effectiveness, ease of

maintenance, and reliability of suppliers. Kenya, South Africa and EU will be considered for procuring locally unavailable items.

a) Civil Materials

Civil construction industry in Zanzibar is not matured and supply of civil materials such as sand, timber is not consistent in regard to quality, quantity and delivery time. Reinforcing bars, cement, aggregate (sand and gravel) are readily available in Tanzania mainland, so those civil materials will be procured within Tanzania.

b) Equipment for Transmission Pump Station (It has already been completed in Phase I)

The existing transmission pumps are made in EU, which are regarded as reliable, serviceable and economical. Suppliers were selected after comparing Japanese products with EU products.

c) Equipment for Wells

PVC casing and screens are made locally in Tanzania and has been used for most of the existing wells. Submersible pumps for wells are manufactured and imported by the EU companies.

d) Pipes

PVC pipes and ductile iron pipes to be used in this project follow the standard specifications of JIS and ISO, thus those pipes could be procured in any countries. PVC pipes are readily available in Tanzania. Ductile iron pipes are usually imported from Kenya, South Africa, and EU.

Table 2-33 Procurement Plan

Category	Item	Expected Country of Origins		
		Tanzania	Third Countries EU	Japan
Civil Materials	Cement, Aggregate, Bricks, Reinforcing bars:	○ ○ ○		
Equipment for wells	Casing Screens Submersible Pumps Electrical Equipment	○ ○	 ○ ○	 ○ ○
Pipes	PVC Pipes Ductile Iron Pipes	○	 ○	 ○

2) Loading and customs clearance

Although freights are increasing in Dar es Saram port, the existing port capacity is difficult to manage the exceeding freights.

According to the interview, the Tanzania Port Bureau said 20 to 25 days is needed for loading and customs clearance as average. As a result, this project will estimate 25 days for loading and customs clearance.

3) Delivery and Storage of Trucks

Procured pickup trucks will be delivered to and stored at ZAWA head quarters.

2-2-4-6 Implementation Schedule

The project will implement Dole Station and Kinuni Station.

The project was divided into 2 continuous periods (2 single-year projects) with each separate benefit. However the project can not be implemented continuously, it was necessary to extend 1.5 months from the schedule planned in the detailed design.

Satani Station and Werezo Station including main water facilities which established in Zanzibar urban area were constructed on Project for Zanzibar Urban Water Supply Development (Phase I) in 2007.

Table 2-34 Construction Items of the Project

Dole Service Area		**Kinuni Service Area**	
・Reservoir Construction	1,200m^3 x 1	・Reservoir Construction	2,700m^3 x 1
・Disinfection Facility		・Disinfection Facility	
・Well Construction	58.4m^3/hr x3 (1 standby)	・Well Construction	58.4m^3/hr x 2
・Transmission Pipes	φ150～200: 4.1km	・Transmission Pipes	φ150～400: 6.9km
・Distribution Pipes	φ300: 2.6km	・Distribution Pipes	φ400: 7.7km

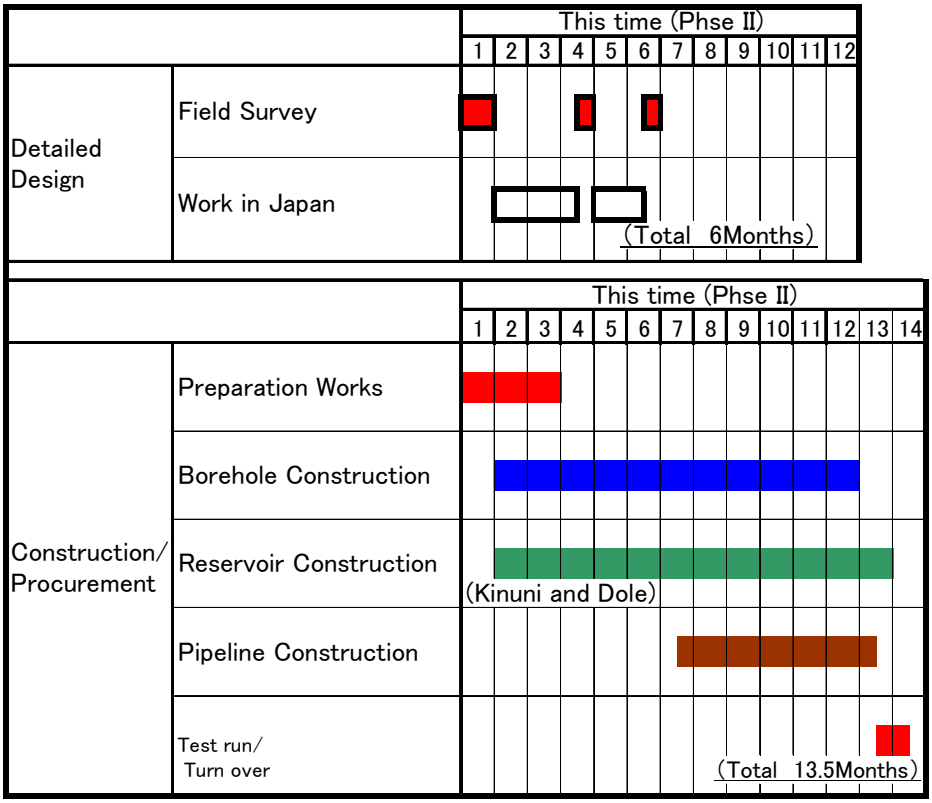

Figure 2-20 Project Implementation Schedule

2-3 Obligation of Recipient Country

The Tanzania Government and ZAWA will undertake the works described in Section 2-4-3 for the completion of the Phase II project. Those works are listed below in details.

a.	Land Acquisition	Reservoirs	2
		New Wells	5
		Transmission/Distribution Pipelines	
b.	Fencing	Reservoirs	2
		New Wells	5
c.	Power Lines for	New Wells	5
		Reservoirs	2
		(Kinuni, Dole)	

2-4 Project Operation Plan

2-4-1 Organization Strengthening Plan

The Zanzibar Government established Zanzibar Water Authority (ZAWA) as an executing agency of water supply services which is independent from governmental organization and is aiming to improve customer service and self- support accounting. Additionally, JICA has started a technical cooperation project named “Enhancement of Water Supply Management of Zanzibar Water Authority”. This project was commenced from January 2008. The project is summarized as follows:

Table 2-35 Expected Output of the Project

	Overall	《First year》 January to December, 2008	《Second Year》 January to December, 2009	《Third Year》 January to December, 2010
Output 1	Business mindset of a parastatal organization is ingrained in the staff of ZAWA.	Business mindset of a parastatal organization is ingrained in the staff of ZAWA.		
Verifiable Indicator	– All ZAWA staff members have participated in seminars on the mid-term vision. – All ZAWA staff members have participated in seminars on the rules of conduct. – All the departments and sections have prepared their job descriptions. – All ZAWA staff members have participated in annual review meetings on ZAWA's performance every year during the cooperation period.	– All ZAWA staff members have participated in seminars on the mid-term vision. – All ZAWA staff members have participated in seminars on the rules of conduct. – All the departments and sections have prepared their job descriptions.	– All ZAWA staff members have participated in annual review meetings on ZAWA's performance every year during the cooperation period.	– All ZAWA staff members have participated in annual review meetings on ZAWA's performance every year during the cooperation period.
Output 2	A customer administration system is established.	A customer administration system is established.	A customer administration system is maintained.	A customer dministration system is maintained.
Verifiable Indicator	– Information on locations and types of water supply facilities have been input into a database. – Information on about 47,000 domestic customers and other customers have been input into a database. – At least 30 staff members have been trained in operating customer administration system. – Customer administration data have been regularly updated at least for 12 consecutive months at an average of 200 water facility data and 30 customer data per month.	– Information on locations and types of water supply facilities have been input into a database. – Information on about 47,000 domestic customers and other customers have been input into a database. – At least 30 staff members have been trained in operating customer administration system.	– Customer administration data have been regularly updated at least for 12 consecutive months at an average of 200 water facility data and 30 customer data per month.	– Customer administration data have been regularly updated at least for 12 consecutive months at an average of 200 water facility data and 30 customer data per month.
Output 3	A water tariff table is prepared based on proper estimates ofZAWA's revenue and expenditure.	A water tariff table is prepared based on proper estimates ofZAWA's revenue and expenditure.	A water tariff table is revised, if necessary.	A water tariff table is revised, if necessary.
Verifiable Indicator	– Preparation and review of ten-year annual estimates of revenue and expenditure of ZAWA.	– Preparation of ten-year annual estimates of revenue and expenditure of ZAWA.	– Number of public kiosk water communities organized (500	– Review of ten-year annual estimates of revenue and

	– Preparation and review of the tariff table. – Number and frequency of public relation activities carried out – Increase in the number of customers who shows willingness to pay the tariff – Number of public kiosk water communities organized (500 communities)	– Preparation of the tentative tariff table. – Preparation of the tariff table. – Number and frequency of public relation activities carried out	communities) – Review the tariff table if necessary. – Increase in the number of customers who shows willingness to pay the tariff	expenditure of ZAWA, if necessary. – Review the tariff table if necessary. – Increase in the number of customers who shows willingness to pay the tariff
Output 4	ZAWA's staff becomes conversant with practical work pertaining water fees collection, claim handling.	ZAWA's staff becomes conversant with practical work pertaining water fees collection, claim handling.	ZAWA's staff becomes conversant with practical work pertaining water fees collection, claim handling.	ZAWA's staff becomes conversant with practical work pertaining water fees collection, claim handling.
Verifiable Indicator	– Staff members have been trainewater fees collection. (30 staffs) – Staff members are trained in handling claims.(30 staffs) – Collection rate: more than 50% of the customers	– Prepared water fees collection Manual – Prepared customer are manual – Staff members have been trained in water fees collection. (30 staffs) – Staff members are trained in handling claims.(30 staffs)	– Staff members with enough skills in wate fees collection. (30 staffs) – Staff members with enough skills in handling claims.(30 staffs) – Collection rate: more than 30% of the customers	– Staff members with enough skills in wate fees collection. (30 staffs) – Staff members with enough skills in handling claims.(30 staffs) – Collection rate: more than 50% of the customers
Output 5	A monitoring system of water consumption of the customers is established.		Preparation for ZAWA staff training of water meter installation and reading.	ZAWA staff get skills of water meter reading.
Verifiable Indicator	– Conduct meeting for customers of water meter installation. – Number of water meters installed (about 300). – At least 20 staff members have been trained in meter reading. – Meter reading records by ZAWA staffs. (six consecutive months)		– Conduct meeting for customers of water meter installation. – Number of water meters installed (about 300).	– At least 20 staff members have been trained in meter reading – Meter reading records by ZAWA staffs. (six consecutive months)

2-4-2 Project Operation and Maintenence Plan

The proposed water supply facilities will be divided into water intake facilities (wells) and water transmission/distribution facilities. Operation and maintenance for facilities are described below. New staff will belong to the proposed new technical department. O&M works will be performed under supervision of the former DWD supervisors.

(1) Water Intake Facilities

Water intake facilities consist of wells and well pump equipment. Well flow and water quality will be recorded. Water flow will be measured by flow meters. Water samples will be taken and analyzed by staff

of the former DWD laboratory.

Ten new intake facilities are newly constructed and 40 additional staff (10 teams with 4 staff per team) for monitoring and controlling this new facility is necessary.

Table 2-36Additional Staff for Intake Facility

Facility	New/Renew	Current Staff	Additional Staff
New Intake 10 Wells	New	0	40 (4 staff x 10 teams)
Total Additional Staff			40

(2) Transmission/Distribution Facilities

The proposed facilities include new reservoirs, renewed pumping station, new transmission pipelines and new distribution pipelines. The transmission and distribution facilities will be extended and renewed in the future according to a long-term maintenance plan. Replacement schedule of the existing pipes shall be developed according to pipe material, construction year, leakage records and actual observation of the pipes.

Former DWD has now dispatch 6 staff for existing facility in Welezo. New reservoir and pumping station will be constructed; add 2 additional staff for the operation and maintenance of this new facility.

Table 2-37 Additional Staff for Transmission/Distribution Facilities

Facility	New/Renew	Current Staff	Additional Staff
Welezo Station and Pipelines	New reservoirs/new disinfection facilities	6	2 additional staff Total 8
Saateni Station and Pipelines	Renew transmission pumps/ disinfection facilities	26	-
Kinuni Station and Pipelines	New reservoir/new disinfection facility	-	2 additional staff
Dole Station and Pipelines	New reservoir/new disinfection facility	-	2 additional staff
Total Additional Staff			6 additional staff

(3) Financial Plan

3-1) Water tariff

The water fees collection schedule has already been collected from August 2008 as shown below.

Table 2-38 Water Fees Collection Schedule (Flat Rate)

Customer category			**Flat rate (Tshs./month)**
Water kiosks/ standpipes			n/a
Domestic			4,000
Institutions	Less than 50 staffs		20,000
	>50 ≤100 staffs		50,000
	>100 staffs		200,000
	Community and religious, NGOs		3,000
Industrial / commercial	Guest houses	0 to 10 rooms	20,000
		>10 ≤20 rooms	40,000
		>20 rooms	75,000
	Hotels	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
	Restaurants/ bakeries		20,000
	Building constructors		120,000
	Small scale industries		30,000
	Petrol stations		20,000
	Car washes		40,000
Agricultural	Small scale		20,000
	Medium scale		90,000
	Large scale		150,000

Table 2-39 Water Fees Collection Schedule (Metered Rate)

Customer category	**Block (m^3)**	**Tariff (Tshs./m^3)**
Water kiosks/ standpipes	n/a	150
Domestic	0 to 8	200
	>8	300
Institutions	0 to 15	300
	>15	350
Industrial / commercial	0 to 15	300
	>15 ≤1,000	400
	>1,000 ≤5,000	500
	>5,000	1,000
Agricultural	0 to 50	350
	>50 ≤200	400
	>200	500

Source: Strategic Plan Final Draft

2-4) Cash forecast

Table 2-40 shows the projection of income and expenditure from the Strategic Plan by ZAWA. This indicates that income will exceed the expenditure of O&M in 2010 and 2011, as well as the expenditure of depreciation allowance in 2013 and 2014. The Government of Zanzibar is planning to obtain a loan of AfDB and replace a distribution network system. It seems that it will be difficult for them to balance out so quickly using this plan, but starting to collect water fees will bring more support from other donors and increased management stability.

Table 2-40 Projection of income and expenditure

	2008/9	**2009/10**	**2010/11**	**2011/12**	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**
Income										
Water sales										
Public fountains/kiosks	420	604	877	962	1,330	1,396	1,760	1,847	2,263	2,376
Private Connections	2,299	3,549	4,992	5,698	7,653	8,946	12,024	13,951	18,292	21,103
Connection fees	204	252	252	252	252	414	443	474	508	543
Meter rental/ Service charge	490	546	602	658	715	807	906	1,011	1,124	1,245
Others	790	830	871	915	960	1,008	1,059	1,112	1,167	1,226
Total income	**4,203**	**5,781**	**7,594**	**8,485**	**10,910**	**12,572**	**16,191**	**18,395**	**23,354**	**26,493**
Expenditure										
Operation:										
Salaries & wages	1,522	1,598	1,678	1,762	1,850	1,943	2,040	2,142	2,249	2,361
Restructuring costs/gratuities		39	80	139	130	136	143	150	158	166
Water production costs (Electricity, Chemicals & reagents)	2,778	2,916	3,062	3,215	3,376	3,545	3,722	3,908	4,104	4,309
Water Distribution expenses	0	0	0	0	0					
Maintenance and repair expenses	1,048	1,100	1,155	1,213	1,273	1,337	1,404	1,474	1,548	1,625
Business Promotion Expenses	153	160	168	177	186	195	205	215	226	237
Administration Expenses	831	873	916	962	1,010	1,061	1,114	1,169	1,228	1,289
Charity, Subscription and Donations	63	66	69	73	77	80	84	89	93	98
Fees Payable	28	29	30	32	33	35	37	39	41	43
Financial Expenses	9	9	10	10	11	11	12	13	13	14
Other overhead expenses						0	0	0	0	0
Other expense						0	0	0	0	0
Total O & M	**6,431**	**6,791**	**7,170**	**7,583**	**7,946**	**8,344**	**8,761**	**9,199**	**9,659**	**10,142**
Operating surplus	-2,227	-1,011	424	902	2,964	4,228	7,430	9,196	13,695	16,351
Depreciation allowance	2,750	2,943	3,148	3,369	3,605	3,857	4,127	4,416	4,725	5,056
Net income after depr.	**-4,977**	**-3,953**	**-2,725**	**-2,467**	**-641**	**371**	**3,303**	**4,780**	**8,970**	**11,296**
Interest and Debt service	0	0	0	0	0	0	0	0	0	0
Net income after depr & interest	**-4,977**	**-3,953**	**-2,725**	**-2,467**	**-641**	**371**	**3,303**	**4,780**	**8,970**	**11,296**

Source: Strategic Plan Final Draft

2-5 Project Cost Estimate

2-5-1 Project Cost

(1) The Project Cost borne by the Tanzania Government

1) Fencing	28,300 thousand Tsh	(Approx. 2.52 million Yen)
2) Power Line	2,300 thousand Tsh	(Approx. 0.20 million Yen)
3) Bank Arrangement	8,430 thousand Tsh	(Approx. 0.75 million Yen)
Total	39,030 thousand Tsh	(Approx. 3.47 million Yen)

Implementation Period: Phasing plan is shown in Figure 2-20.

Others: The project implemented will follow strictly the rules of Japanese Grant Aid.

2-5-2 Operation and Maintenance Costs

(1) Operation and Maintenance Costs

The increment of operation and maintenance costs by the implementation of the project is calculated for labour, electricity, disinfection chemical and repair costs. The electricity costs for well pumps are calculated for the increment of flow by this project (Daily average 13,912 m^3/d x 1/1.35 = 10,305 m^3/d). The disinfection chemicals are calculated for daily average flow.

Table 2-41 Increment of Operation and Maintenance Costs by the Project

Item	Calculation	O&M Costs (thousand Tsh/year)	Remarks
Labour costs (Increment)	O&M staff for wells and transmission/distribution pipes: 46 46 x 1,800,000 Tsh/year/person = 82,800 thousand Tsh/year/person	82,800	
Electricity costs (Increment)	Unit cost: 141 Tsh/kWH Well pumps (increment: 10 wells) Operation hours: 10,370 m^3/d x 1/(60 x 24 x 10) x 24 (daily average) =17.2 hrs/d Electricity costs: (37 kW x 6 + 30kW x 2 + 22 kW x 2) x 0.75 (loading rate) x 17.3 hrs/d x 365d/yr x 141 Tsh/kWH = 199,546 thousand Tsh/year	216,431	
Disinfection Chemical (Increment)	Unit cost: 1,000 Tsh/kg (Powder Chlorine) Chlorine dosing rate: 2 mg/l Chemical consumption (daily average) Kinuni: 6,128 m^3/d x 2 mg/l x 1/0.7 x 10^{-3}= 17.5 kg/d Dole: 2,540 m^3/d x 2 mg/l x 1/0.7 x 10^{-3}= 7.3 kg/d Welezo: 22,453 m^3/d x 2 mg/l x 1/0.7 x 10^{-3}= 64.2 kg/d Total: 89 kg/d = 32,485 kg/yr Disinfection Chemical Costs: 32,485 kg/yr x 1,000 Tsh/kg = 32,485 thousand Tsh/yr	32,485	Exclude Saateni Station where disinfection chemical is injected now.
Equipment Repair (Increment)	Mechanical / Electrical Equipment x 0.3% /yr 987,000,000 Tsh x 0.3%/yr = 2,961 thousand Tsh/yr	2,961	
Total (Increment)		334,677	

After the project is implemented, an additional 30 million Yen will be required for operation and maintenance. This additional funding will be collected through the implementation of a water tariff.

2-6 Other Relevant Issues

2-6-1 Water Source preservation

The water source of this project consists of boreholes and springs. According to the geotechnical feature of Unguja island, the surface water infiltrates easily to the underground water level. So the groundwater may easily contaminated if the surface water is polluted.

To prevent the water sources from the contamination by livestock, fencing is necessary for the intake from boreholes and/or springs. And more, to restrict the garbage disposal not only the borehole /spring but also wide spread of the catchment of water sources.

2-6-2 Operation of water source facilities

1) Continuous operation of borehole pumps

Borehole pump should be operated continuously. An intermittent operation may cause filler disarrangement and it may cause screen blockage.

2) Prevention from salt water pumping

The new borehole sites are located out of the salt water detected areas, however, the risk of salt water pumping is still remain when extremely dry season/year.

Not to draw salt water, the borehole pumps should be stopped when the pumping water level is below averaged sea water level. The water level meter will be installed in the boreholes and the borehole pumps can be stopped as the signal from the meter. The pump stop level should not be set below averaged sea water level.

2-6-3 Disinfection

To provide safe water is essential for water works. The chlorine dosing equipment will be installed by this project for each station, disinfection of supply water should be conducted everyday. To estimate the proper dosing rate, water quality should be examined periodically.

2-6-4 Distribution Pressure Adjustment

Pressure reducing valves are installed at Dole distribution area to prevent the pipe breakage and water leakage causing from the high pressure. Water leakage increases as the inner pressure increase, the lower pressure operation is desirable while the distribution is performing.

2-6-5 Water Management Considerations

2-6-5-1 Welezo and Kinuni

To supply water to the southern areas, two distribution tanks, Welezo and Kinuni, and one transmission line is planned in this project. The distribution pressure of these area is varied depend on the setting of the pressure reduce valve and/or the water demand fluctuation. Gate valves and pressure reduction valve should be operated properly monitoring the flow meter.

Chapter 3 Project Evaluation and Recommendation

Chapter 3 Project Evaluation and Recommendation

3-1 Project Effect

The expected project on the Project for Zanzibar Urban Water Supply development Phase I and Phase II effects are shown in Table 3-1.

Table 3-1 Expected Project Effects

Present Condition	Measures	Project Effects
A: Direct Effects		
The water supply capacity is much smaller than the water demand increasing by population growth.	・Develop 14,000 m^3/day of raw water by construction of new 11 boreholes.	・The water supply capacity will be equal to the water demand of 2010 as much as 54,100 m^3/day including existing water source of approx. 40,100 m^3/day.
Distributed water has problem in quality because of low pipe pressure and an intermittent distribution.	・Review the water distribution networks, construction/renewal of water distribution stations and pipelines. ・Construct disinfection facilities for each distribution stations.	・The minimum distribution pressure will be assured and stable water supply will be realised. ・The water supply quality will be improved.
The existing water supply facilities are aged. The pump equipment of Saateni Station looks difficult to operation and the leakage from the network pipes are estimated as 30 % as distributed.	・Renewal of four (4) sets of transmission pump. ・Renewal of 6.5 % of pipeline.	・The transmission capacity will be equipped. ・The leakage rate will be reduced.
Operation and maintenance, business management are not evaluated as sufficient level.	・Soft Component for these items.	・Water business management and the operation and maintenance will be improved.
B: Indirect Effects		
High morbidity of water caused disease because of the poor water supply system.	―	・Morbidity of water caused disease will be reduced by the water supply system improvement.
Tourism is not well developed because of the poor water supply system.	―	・Tourism will be promoted by the water supply system improvement.

3-2 Recommendations

For further effective display and sustain of project effects, the former DWD, the execution agency, shall undertake the following items to improve the water supply system management.

a. To establish the new water authority and build the organization for tariff collection, operation and maintenance. Then collect enough money to maintain the water supply system and manage the water works properly.
b. To repair/replace the existing facilities including borehole pumps, roof of Saateni Station, pipelines made of asbestos. Especially to conduct a non revenue water reduction measures.
c. To expand the distribution network to meet the population growth and urban expansion.
d. To make necessary measures to protect the water sources, such as the prohibition of building construction and garbage disposal near the water source.
e. To treat or discharge the wastewater increased by this project in accordance with the Ministry of States, Regional Administration and local Government and/or Zanzibar Municipal Council.
f. Items related to this project;
    - To prepare the budget for the cost undertaken by Tanzanian side. They shall be disbursed based on the implementation schedule.
    - To obtain/issue necessary permission/licence for the implementation of the works for the project.
    - To organize the implementation team for the project from the beginning of the detailed design to understand the project components and to master technology.
g. Secure budget for providing new house connections to new users.