Ministry of Local Government and Housing

The Republic of Zambia

THE SECOND PREPARATORY SURVEY REPORT ON THE PROJECT FOR THE IMPROVEMENT OF WATER SUPPLY CONDITION IN NDOLA CITY IN THE REPUBLIC OF ZAMBIA

May 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

SANYU CONSULTANTS INC.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the Preparatory Survey on the Project for The Improvement of Water Supply and Sanitation Condition in Ndola City in the Republic of Zambia, and organized a survey team headed by Toru Takahashi of Sanyu Consultants Inc. between August, 2010 to September, 2010.

The survey team held a series of discussion with officials concerned of the Government of the Republic of Zambia, and conducted field investigations. As a result of further studies in Japan, 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.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Zambia for their close cooperation extended to the survey team.

May, 2011

Shinya EJIMA
Director General
Global Environment Department
Japan International Cooperation Agency

SUMMARY

(1) Outline of Zambia (Landscape; Environmental, Social and Economic conditions)

Zambia is located in the southern part of the African continent, and its national territory is 750,000 km^2, which is as large as approximately 2 times of Japan. The population is 12.9 million[1]. Ndola city is the capital of the Copperbelt province, which is located in the central part of the country, and the urban area of Ndola city is located about 10 km from the border with the Democratic Republic of Congo (formerly the Republic of Zaire). The Kafubu River takes its water from the area around this border and is the source of water supply in Ndola city. This river is also used as the source of water supply in Luanshya city for which KWSC provides the water supply services, downstream of Ndola city. The Kafubu River unites with the Kafue River and the Zambezi River at the lower course of the river and flows through the Republic of Mozambique and then into the Indian ocean.

Ndola city is located at latitude 13 South and longitude 28 East in the Southern Hemisphere. Though in this low latitude of a tropical region, the altitude of Ndola is 1,300 m and its climate is classified as Temperate Winter Dry (Cw)[2]. The annual range of mean temperature is about 10 degrees C and its climate is benign in general. September to November is the hot season and mean maximum temperature is over 30 degrees C. May to August is the cold season and mean minimum temperature of June to July is less than 10 degrees C. Monthly precipitation in Ndola city indicates that a rainy season and a dry season are clearly defined. November to March of the next year is rainy season in summer and precipitation of each month is over 100 mm. April to October is the dry season in winter; it has almost no rain. The fluctuation range of annual precipitation of the past 10 years is from 800 mm to 1,500 mm having almost constant annual precipitation consisting of a rainy season and a dry season.

GNI per capita of Zambia is 970 US$[1]. Industrial structure consists of primary industry 19.7%, secondary industry 33.7%, and tertiary industry 46.6%[3]. Major industries are agriculture (corn, tobacco, peanuts, and cotton), mining (copper, cobalt, zinc, lead, coal), industry (food processing, textile, construction materials, fertilizer). Since a large copper mine was discovered in 1925, even after the independence from British rule in 1964, copper exports account for more than 70% of the total income. Copper prices slumped at one time, but in recent years, international economic growth such as in China and India caused the mineral prices to rise. And also, coupling with a booming of tourism and construction in Zambia, economic growth rate has risen to 6.3%[1] and inflation rate has fallen to 9.9%[1].

In April 2005, the World Bank and the IMF Board approved Zambia's completion of HIPC (heavily indebted poor countries) scheme, then donors and international authorities implemented debt relief, and Zambia's external debt decreased significantly. Zambia has aimed for becoming a middle-income country by 2030, and its government just drew up SNDP (Sixth National Development

[1] : World Bank, 2009
[2] : Climate Classification by Köppen (Köppen-Geiger Klassifikation)
[3] : CIA, 2010

Plan, 2011-2015) as a medium-term plan for achieving "Vision 2030", long term development policy. This plan is based on the achievement of FNDP 2006-2010, and sets the sustained economic growth and poverty reduction as the theme of the plan aiming at infrastructure development, economic growth and diversification, rural investment and poverty reduction and promotion of human development.

The government of Zambia conducted the privatization of the Zambia Copper Corporation in 2000 through the civil service reform associated with structural adjustment. In the same manner, oil, power, and telephone services/companies, commercial banks and other major governmental enterprises have denationalized so far. However, substitute employments replacing the copper related industry have not developed enough and measures against urban unemployment have become one of the chronic challenges. Over 70% of the population in Zambia belongs to the poverty group living on less than 1 US$ a day, and because of the rapid development of the copper industry in the past, the urbanization rate in Zambia is relatively high among the African countries. The lack of social infrastructure in urban areas and degradation of the residential environment as well as infectious diseases associated with it (and so on) have become problems. Adult morbidity due to HIV/AIDS in Zambia is as high as 13.5%, and the average life span is 52.36 years old[4].

(2) Background, Proceedings and Contents of Requested Project

In Zambia, the accessibility ratio for safe water is 87% in urban areas, 46% in rural areas[5], and 44% in per-urban areas[6]. The population in the cities and surrounding peri-urban areas has been rapidly increasing, and it is urgently necessary to raise the accessibility ratio of safe water for the poor class in the society. Also, there are some old water supply/sewerage systems in cities in Zambia which were constructed during British rule, before independence in 1964, and are still being utilized presently. These systems were built at a comparatively earlier time and found to be considerably deteriorated to date, having various defects causing leakage and other troubles which require possible renovation in the near future.

Regarding urban water supply, "Develop and provide sustainable water supply services in urban and peri-urban areas" is set as one of the 7 key strategies on the basic policy of water supply and sanitation in the SNDP. "Rehabilitation of 10 urban water systems by year 2014" is also set as the target of sector output in SNDP. Furthermore, the NUWSSP (National Urban Water Supply and Sanitation Programme) takes up two (2) major issues to be challenged during the period of 2009-2015. Those are countermeasures for non-revenue water and the renovation/improvement of the existing water supply systems for the major cities.

The population of Ndola city was estimated to be 483,000 in 2010, which makes this the third largest city after the national capital, Lusaka and Kitwe in the Copperbelt province. Because copper has been produced in this province mainly in Zambia, Ndola city is an economically important

[4] : CIA, 2011 estimated value
[5] : UNICEF, 2008
[6] : FNDP, 2007

city, and the future increase of its population is expected. Under these circumstances, improvement of water supply conditions has become an urgent issue. Water supply and sewerage service was under the Ndola municipality previously, and the services were transferred to the Kafubu Water Supply and Sewerage Company Limited (KWSC) at the time of the establishment of KWSC in 2000. According to the management indicator of KWSC, water supply coverage is 86%, and this rate is higher than the national average in urban areas even though the average water supply hours per day is only 16 hours and water stops in some areas due to serious leakage.

In the target water distribution area of this project, including the southern part of Ndola city, an estimated 317,000 people were living there in 2010, including many poverty groups. Adding to the developing conditions of the water supply service behind expanding urbanization, the deterioration of the existing water supply facilities causes the poor water supply conditions in wide areas. For example, of the inadequate water supply conditions, water supply hour in a day in the target area of the project is less than 12 hours, and 40,000 people get water under the low pressure of less than 0.01MPa or 1 mAq (meter of water). The treated water produced in the Kafubu water treatment plant, which provides water to the south part of Ndola city, decreased to 55,000 m^3/day compared with the originally planned value of 81,800 m^3/day, caused by deterioration of intake pumps, lifting pumps and others. Also, a transmission main (primary trunk) from the Nakaputa reservoir which stores water lifted from the Kafubu water treatment plant to the center of the city is severely deteriorated, and due to this, it is estimated that 6,500 m^3/day is leaked from the pipe.

To improve these inadequate water supply conditions, the Ministry of Local Government and Housing from the government of Zambia requested Japan's Grant Aid for renovation of the Kafubu water treatment plant, repair and expansion of the transmission main, and construction of a stabilization pond in the sewerage treatment plant in December 2009. In response to this, the Government of Japan conducted the primary preparatory survey (Survey 1) from April to May 2010 as a preliminary study for confirmation of the requested contents and consideration of the cooperation components.

(3) Outline of Study Result and Project Components

Based on the results of Survey 1, JICA decided to conduct the secondary preparatory survey (Survey 2) for outline design and project cost estimation and dispatched the survey team from August to September, 2010. The team held discussions with the Ministry of Local Government and Housing (MLGH) and KWSC, the executing agency of the Zambian side, and carried out a field survey in the project target area. After the design work in Japan, JICA dispatched the mission for explanation of the outline design of the project in February 2011. The mission held discussions with MLGH, KWSC and other concerned parties in Zambia and agreed on the outline design of the project.

The areas and scope for the cooperation under the Grant Aid have been worked out through the following procedures. DANIDA has a plan of cooperation for renovation and improvement of the

tri-city water supply and sewerage system which is managed by Kafubu water supply and Sewerage company limited (KWSC) including Ndola city. The study team of Japan took counsel with DANIDA and the government of Zambia through Survey 1 and Survey 2, and reviewed some parts of the requested components. Contents of the work items as originally requested and the reviews on each item are as tabulated in the table below.

Original Request and Review

Work Items		Requested Quantity	Review
Kafubu Water Treatment Plant	Intake pumps	7 units	Total 6 units (4 for regular use, existing and 2 for standby use, replacement, as per planned capacity and field survey
	Chemical feeding facilities	1set	In addition to coagulant feeding facilities, renovation of Chlorine feeding facilities was added. Presently prechlorination is fed by manual.
	Collecting trough in sedimentation tank	180 pieces	Fixed the quantity based on field inspection/survey at 136 pieces
	Filter sand	600 m^3	Presently 0.9 m depth and in good condition, then excluded from the scope.
	Filter nozzles	1set	Strainer found to be in good condition and judged no replacement necessary
	Backwashing facilities for filter	-	Replacement is needed for continuation of regular operation of rapid filter
	Transmission pumps	7 units	Based on design transmission flow, 5 units are replaced.
	Necessary minor repairs	-	Added intake tower drain equipment
Main Pipeline (Nakaputa-Skyways) ϕ 900mm		8km	By hydraulic calculation and field survey, modified to be 450-800 mm x 5.9 km
Water Kiosks[7] in Kaloko area		6 stations	6 stations but locations modified in field survey
Branch line to Upper Mushili area		1 place	Modified to be 3 due to hydraulic calculation
Main Pipeline (Chifubu) ϕ 600mm		2km	Fixed 700 mm x 2.1 km based on hydraulic calculation result
Main Pipeline (Northrise) ϕ 375mm		1.7km	Fixed 500 mm x 1.6 km based on hydraulic calculation result
Main Pipeline (Western ring) ϕ 700mm		12.8km	Beneficiaries number is small as compared with the scale of works and given lower priority and excluded from the scope.
Transmission pump (Dambo Sewage pump station)		4 units	To be considered under DANIDA assisted sewage project
Water quality analayzer in Kanini Laboratory		1set	For detection of mercury, arsenic and agricultural chemicals, accessories for AAS and gas chromatograph were selected.
Bulk water meter		1set	Fixed as 7 meters based on field survey
Construction of Sewage treatment pond		4 places	To be considered under DANIDA assisted sewage project
Sewer pipe		1km	

[7]: Water Kiosk is the term referring to a kiosk type communal water station set in the peri-urban area. One kiosk has some public water taps.

The basic policies of the project are as follows:

i. To consider the requested items and decide on the cooperation components in view of “population of beneficiary”, “degree of urgency for water”, and “degree of deterioration of facilities”.

ii. To select the south part of Ndola, where many poverty stricken groups live, as the main project target area.

iii. To set the year 2020 as a design period and verify the capacity of the facilities, with the basic design policy of performance recovery for the existing facilities.

iv. To set the recovery of the existing facilities as a principle. Based on the results of the field survey, to use the available facilities as present conditions and confine the replacement of equipment and new construction to the scope of the requisite minimum.

Based on the above described policies, the following aspects are considered.

- For the Kafubu water treatment plant, to recover the original capacity, 81,800m^3/day. With respect to treated water quality, to comply with the drinking water guidelines in Zambia, and for the sake of adequate purification, to recover the existing sedimentation, rapid filtering, chlorination, and adding to this, to rehabilitate the disabled flocculent injection system for the coagulation process and to introduce the pre-chlorination system as a measure against an inflow of algae.

- Considering the procurement and construction conditions of pipe materials, to adopt ductile cast iron pipe (DCIP dia. ø 150mm～ø 800mm) for the transmission/distribution main, and galvanized steel pipe (GI dia. ø 100mm) for the branched small distribution pipe network.

- Following the precedent project assisted by the Devolution Trust Fund (DTF[8]) in Zambia, to conform the structure of the water kiosk in the Kaloko area to the DTF Tool kit (project guideline).

- The installation of a water quality analyzer was not included in the original request to Japan, but the request was added in the field survey period in view of water quality conservation for the water source; accordingly, to select the analyzer for detection of organic pesticide and heavy metals.

- Though the replacement of filter sand and nozzle were requested originally, those functions and conditions such as thickness of sand layer, diameter of sand grain, and strainer of filter nozzle, were confirmed as still usable, and those are not listed on the project.

8 : DTF is an agency of a basket-fund provided by the Government of Zambia, GIZ, and other cooperating organizations. The DTF supports water kiosk projects in peri-urban areas applied by CU (commercial utilities) financially and technically. DTF issued the tool kit as a guideline for water kiosk projects. The tool kit puts together a set of project methods and flow on organization of inhabitants, hygiene education, construction, and O&M of water kiosks.

- The Western ring main pipeline has a small beneficiary population and is off the list considering the investment effect.
- DANIDA has produced a cooperation plan for assistance of sewerage components in Ndola city. As a result of the coordination, it was decided that the requested items concerning sewerage, namely sewage pumps, sewer pipe, and sewage ponds, were considered by DANIDA continuously.

The planned contents of the project as Japan's Grant Aid are as shown on the following table. The target of this project is repair and expansion of the water supply facilities in Ndola city, and in this project, the scope of Japan's Grant Aid includes the repair of the Kafubu water treatment plant and the transmission/distribution of the main pipeline, construction of water kiosks in the Kaloko area, installation of a water quality analyzer, and "soft component[9]" for operation and maintenance of these facilities.

Project Contents

No.	Facilities	Planned Work Items
1	Replacement of intake pumps and related facilities at Kafubu WTP	Intake pumps (Raw Water Pump) -- 2 standby units replacement for standby Chain block -- 1 set replacement Drainage pumps -- 2 units replacement Pump control panel -- renovation 400V phase advanced capacitor panel
2	Replacement of chemical feeding facilities at Kafubu WTP	Coagulant feeding facilities -- replacement (3 agitator and 3 injection pumps) Control panel and power distribution panel for Agitator and injector -- construction or renovation Chemical feeding facilities (pre-chlorination and post-chlorination) -- replacement
3	Replacement of collecting trough in sedimentation tank at Kafubu WTP	FRP trough (370×280×8,400mm) -- replacement Stage-1 40 sets, Stage-2 96 sets
4	Replacement of backwashing facilities for rapid filter at Kafubu WTP	3-backwashing pump and 2-blower (stage-2) -- replacement Blower control panel -- construction Valve for backwashing pipe -- 3×17sets replacement Stop logs at Conveyance channel -- construction Manual control equipment for siphon -- 17sets construction
5	Replacement of transmission pumps and related facilities at Kafubu WTP	Transmission pumps (High Lift Pump) -- 5sets replacement (regular use and 1 unit for standby) Drainage pumps -- 2 units replacement Surge tank -- repair Water level alarm for treated water reservoir -- construction Transmission pump control panel -- replacement 3.3kV condenser -- construction Supersonic flow meter -- construction

9 ：Soft component: A menu of short term technical assistance provided as a part of the Japan's grant aid scheme

No.	Facilities	Planned Work Items
6	Necessary minor repairs at Kafubu WTP	Intake tower drain pump -- 1set replacement Switch panel -- construction
7	Installation of transfer pipeline from Nakaputa reservoir to Skyways reservoir and incidental facilities	Ductile iron pipe (ϕ 800mm×5.03km, ϕ 450mm×0.81km, ϕ 600mm×0.02km) -- construction Valve (sluice valve, air valve, drainage valve) -- construction
8	Construction of extra water kiosks in the Kaloko area	Extra water kiosks -- 6sets construction Steel pipe (ϕ 100mm×3.13km) -- construction Valve (sluice valve, air valve, drainage valve) -- construction
9	Installation of branch lines to Upper Mushili area and incidental facilities	Branch pipe (ϕ 300mm×70m, ϕ 250mm×140m, ϕ 400mm×30m) -- construction Branch valve -- construction
10-1	Installation of Chifubu water main and incidental facilities	Ductile iron pipe (ϕ 700mm×2.06km, ϕ 300mm×0.07km) -- construction Valve (sluice valve, air valve, drainage valve) -- construction
10-2	Installation of Northrise water main and incidental facilities	Ductile iron pipe (ϕ 500mm×1.60km, ϕ 150mm×0.02km) -- construction Valve (sluice valve, air valve, drainage valve) -- construction
11	Installation of water quality analyzer in Kanini laboratory	Gas chromatograph -- construction Accessories for Atomic absorption spectrophotometer -- supply
12	Installation of necessary bulk water meters	Bulk water meters (ϕ 100-800mm) -- 7sets construction

Kafubu WTP has two lines. Stage-1 was constructed in 1966, and Stage-2 was constructed in 1975.

Contents of Soft Component

Item	Timing	Contents
Management of water purification process	Completion of WTP construction	Lecture and OJT on flocculation, sedimentation, filtering and chlorination at Kafubu WTP
Water quality analysis	After installation of analyzer	Lecture and OJT on water quality analysis and monitoring plan at Kanini laboratory
Flow measurement on pipeline	Completion of pipeline work	Lecture and OJT on flow measurement, record analysis for pipeline maintenance staff
Management of Water kiosk by resident organization	Before construction Under construction Before use of kiosk After use of kiosk	Support for resident organization's kiosk management (meeting, hygienic education, tariff collecting, kiosk maintenance) with RDC, KWSC peri-urban section, local consultant

(4) Project Implementation Schedule and Cost Estimation

For the implementation of the subject project, it will take 4.5 months for detailed design and 17.5 months for construction. The portion of the project cost to be borne by the government of the republic of Zambia is estimated at about 13 million Japanese Yen.

(5) Project Evaluation

1) Relevance of the Project

Based on the results of the preparatory survey, the implementation of this project is validated with cooperation from the Japan grant aid in view of the following aspects:

i. Under the condition of growing urban population in the project target area, there is an urgent need to improve the accessibility to the safe water in the city and peri-urban area. Therefore, the implementation of this project is consistent with Zambia's national development plans such as, SNDP and NUWSSP as previously mentioned in "(2) Background, Proceedings and Contents of Requested Project".

ii. This project deals with the high demand for water supply in the third largest city in Zambia. Estimated population of the beneficiary in 2020 is 354,000 persons and the target area includes low income areas and areas where the poor are living and facing water supply difficulty. The project enables the expansion of access to safe water in the target area, in order to fulfill Basic Human Needs (BHN) among the inhabitants. Improvement of hygienic conditions and the alleviation of daily water fetching tasks via the successful completion of the project will significantly contribute to the improvement of quality of life. Considering the existing deteriorated facilities, it is necessary to use Japanese technology, which has advantages such as industrial strength, durability, and recognizable high quality.

2) Effectiveness of the Project

The following effects are expected due to the improvement of water supply facilities in Ndola after the completion of this project:

Quantitative Effects

Indicators	Baseline (2010)	Target (2020)
Water supplied population, in Kaloko area and Upper Mushili area suffering from inadequate (at present) water supply conditions.	17,400 persons	45,000 * persons
Water supplied hours, in the area that water distributed through the pipeline to be repaired in this project.	12 hours per day	18 hours per day

* : 42,600 persons in 2016, three years after the completion of the project (at the time of ex-post evaluation)

Qualitative Effects

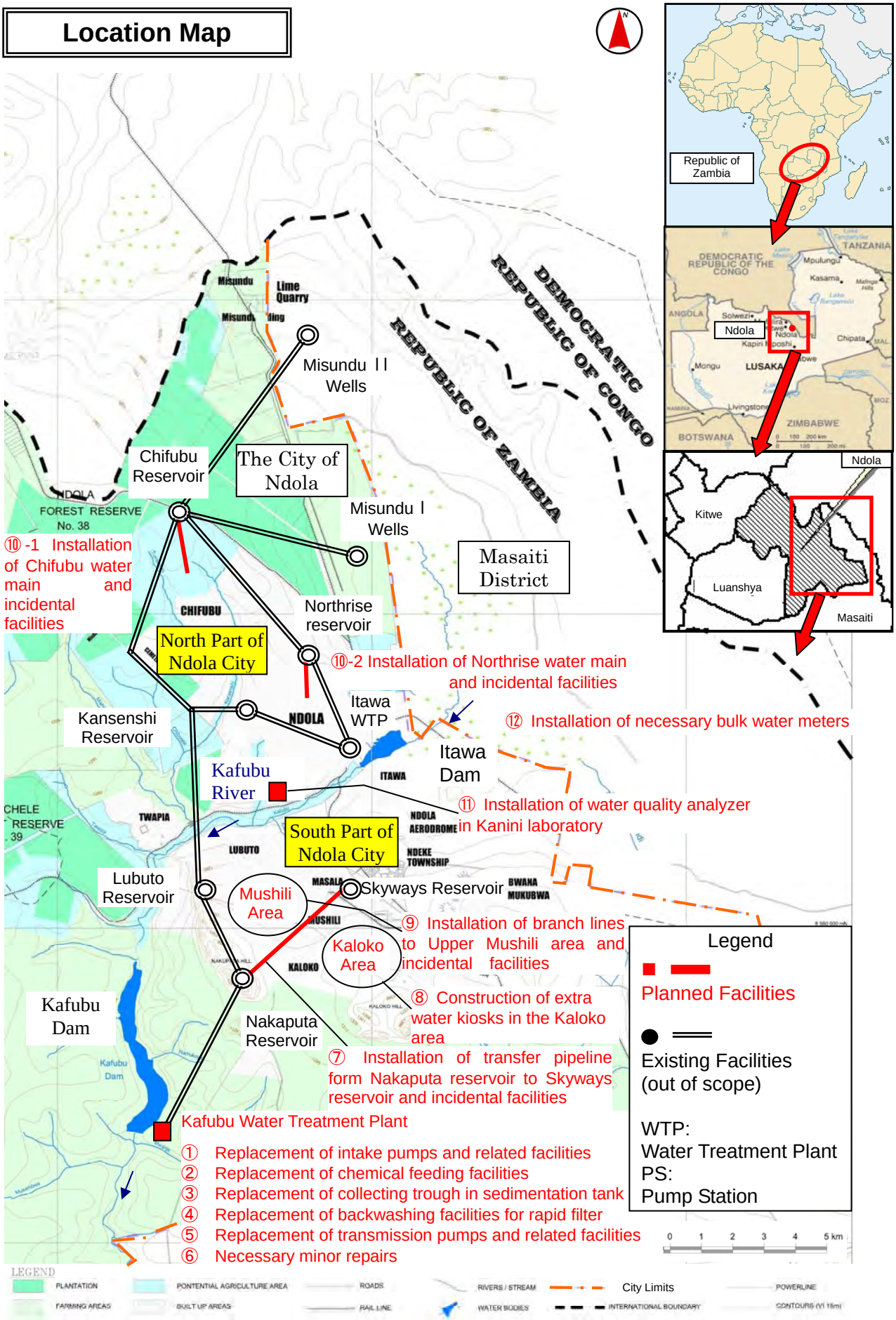
- Health conditions improve and affected cases of water borne diseases decrease in the area where accessibility to the safe water increases.
- Household task of manually obtaining and carrying water by children and women in the area of inadequate (at present) water supply is alleviated.
- Traffic safety improves due to the reduction of floodwater on the main road caused by leakage, fetching water work at the leakage points along the main road, and repair work for leaking pipe under the main road.

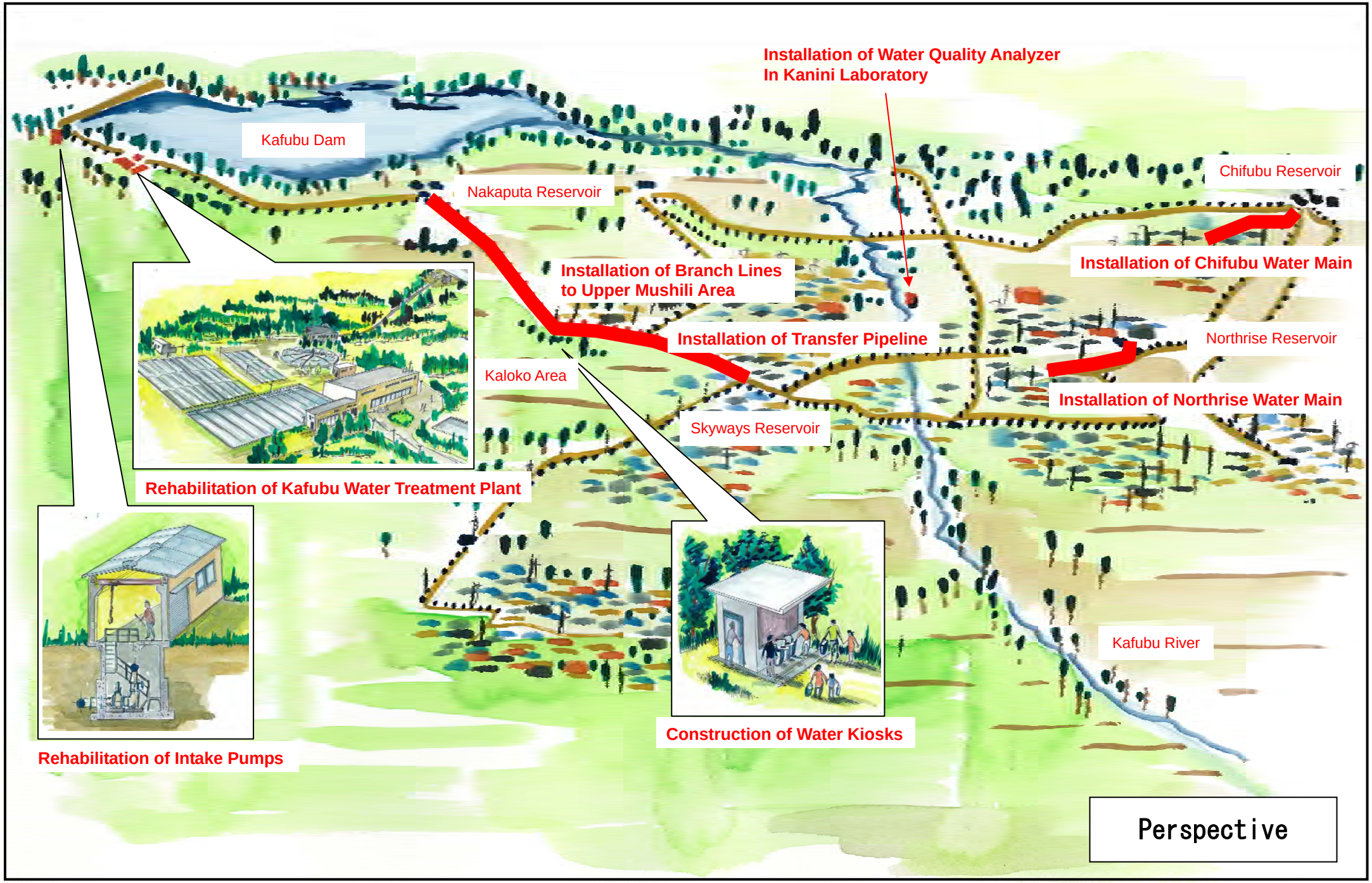
As stated above, this project contributes to the improvement of Ndola's citizens, prioritizes their healthy and hygienic lives, and also has a relevance of Japan's Grant Aid. Moreover, organization and system of Zambia in terms of operation and maintenance of the relevant facilities after the project implementation becomes steady and stable in both the personal and financial aspects. Therefore, this project has a high degree of relevance and an evident level of effectiveness.

CONTENTS

[Appendices]

Location Map




Installation of Water Quality Analyzer
In Kanini Laboratory
Kafubu Dam
Nakaputa Reservoir
Chifubu Reservoir
Installation of Chifubu Water Main
Installation of Branch Lines
to Upper Mushili Area
Installation of Transfer Pipeline
Northrise Reservoir
Kaloko Area
Installation of Northrise Water Main
Skyways Reservoir
Rehabilitation of Kafubu Water Treatment Plant
Kafubu River
Construction of Water Kiosks
Rehabilitation of Intake Pumps
Perspective

LIST OF FIGURES

LIST OF TABLES

ABBREBIATIONS

AC	Asbestos Cement
AfDB	African Development Bank
BOD	Biological Oxygen Demand
CIA	Central Intelligence Agency
CP	Cooperating Partner
CSO	Central Statistics Office
CUs	Commercial Utilities
DANIDA	Danish International Development Assistance
DCIP	Ductile Cast Iron Pipe
DO	Dissolved Oxygen
DTF	Devolution Trust Fund
ECZ	Environmental Council of Zambia
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPB	Environmental Project Brief
EU	European Union
FNDP	Fifth National Development Plan
FRP	Fiber Reinforced Plastic
GI	Galvanized Iron (Pipe)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit / German Agency for International Cooperation
GNI	Gross National Income
GRZ	Government of the Republic of Zambia
GSP	Galvanized Steel Pipe
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit / German Agency for Technical Cooperation
HIPC	Heavily Indebted Poor Countries
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome
ISO	International Standardization Organization
JASZ	Joint Assistance Strategy for Zambia

JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
KfW	KfW Bankengruppe/ German Development Bank
KWSC	Kafubu Water and Sanitation Company Limited
LDC	Least Developed Country
NAPSA	National Pension Scheme Authority
MEWD	Ministry of Energy and Water Development
MLGH	Ministry of Local Government and Housing
MTENR	Ministry of Tourism, Environment and Natural Resources
NUWSSP	National Urban Water Supply and Sanitation Programme
NWASCO	National Water Supply and Sanitation Council
PS	Pump(ing) Station
PUWSS	Peri Urban Water Supply and Sanitation
PVC	Polyvinyl Chloride
RBI	Regulation By Incentive
RDC	Resident Development Committee
SNDP	Sixth National Development Plan
SOMAP	Sustainable Operation & Maintenance Project for Rural Water Supply
T-N	Total Nitrogen
T-P	Total Phosphorus
TSS	Total Suspended Solids
UN	United Nations
UNICEF	UN Children’s Fund
VCS	Vacuum Circuit Switch
WHO	World Health Organization
WB	World Bank
WTP	Water Treatment Plant
ZESCO	Zambian Electricity Supply Corporation Limited

Scales and Measures :

μm	micrometer	%	percent
mm	millimeter	sec	second
cm	centimeter	min	minute
m	meter	hr	hour
km	kilometer	m/sec	meter per second
cm^2	square centimeter	m^3/sec	cubic meter per second
km^2	square kilometer	kg	kilogram
L, ℓ	liter	t	ton (1,000 kg)
m^3	cubic meter	kW	kilo Watt
N	Newton	μS	micro Siemense
Pa	Pascal (1Pa = $1N/m^2$)	NTU	Nephelometric Turbidity Unit
mAq	meter of water (= mH_2O)	pH	hydrogen-ion exponent
Lpcd	Liter per Capita per Day	V	Volt
G	gallon	A	Ampere
ft	feet	Ω	ohm
HP	horsepower		
bar	(1 bar = 0.1MPa)	abs	absolute (absolute vacuum)
mmCE	millimètre de colonne d'eau (1 mmCE = 1 mmAq = 9.80665 Pa)		
Hz	hertz	rpm	revolutions per minute

Currency **:** J. Yen : Japanese Yen
USD : US Dollar
ZMK : Zambia Kwacha

Exchange Rate **:** USD = 90.90 J. Yen
(September, 2010) ZMK = 0.0182 J. Yen

Chapter 1 Background of the Project

Chapter 1　Background of the Project

1-1　Background and Outline of the Project

In the Republic of Zambia (hereinafter referred to as “Zambia”), there are some water supply/sewerage systems in cities which had been constructed during British rule before independence in 1964, and are still being utilized today. These systems were built at a comparatively earlier time and found to be considerably deteriorated. To date, they have various defects causing leakage, among other problems which require possible renovation at an early date.

The objective of this project is to improve the capacity of the existing water supply system in the city of Ndola, the capital of Copperbelt province. It is expected that the water supply condition in Ndola may be improved through rehabilitation and needed expansion of the water supply system. Ndola and its peri-urban areas can improve the accessibility ratio to safe water and increase it. The estimated population in 2010 in the target water distribution area of this project, including the south part of Ndola is 317,000, where a large number of poor people are living there. Water supply service has not covered the whole city sufficiently, as the urbanization has only progressed to the peripheral area. Moreover, the existing decrepit facilities have caused the water supply condition to get worse in widely scattered areas of the city.

As an example of the inadequate water supply conditions, water supply time in a day within the target project area is less than 12 hours, where 40,000 people get water below the pressure of 0.01MPa or 1 mAq (meter of water). The treated water produced in the Kafubu water treatment plant, which provides water to the south part of Ndola, has decreased to 55,000 m^3/day compared to the originally planned value of 81,800 m^3/day, mainly caused by the deterioration of intake pumps, lifting pumps and others similar pumps. Also, a transmission main (primary trunk) from Nakaputa reservoir, which stores water lifted from Kafubu water treatment plant to the center of the city, is severely deteriorated and thus, is estimated to leak 6,500 m^3/day from the pipe due to this deterioration executed

To improve these inadequate water supply conditions, the Ministry of Local Government and Housing, as well as the government of Zambia in December 2009, have requested Japan’s Grant Aid for renovation of Kafubu water treatment plant, repair and expansion of the transmission main, and construction of a stabilization pond in the sewerage treatment plant. In response to this, the government of Japan conducted the primary preparatory survey (Survey 1) in April to May, 2010 as a preliminary study for confirmation of the requested content and consideration of the cooperation components, followed by the secondary

preparatory survey (Survey 2) for outline design and project cost estimation which has followed from August 2010 thus far.

The areas and scope for the cooperation under the Grant Aid has been worked out through the following procedures: DANIDA has a plan of cooperation for renovation and improvement of the tri-city water supply and sewerage systems which is managed by Kafubu water supply and Sewerage Company Ltd.(KWSC), including Ndola city. The study team of Japan coordinated with DANIDA and the government of Zambia through Survey 1 and 2, and reviewed some parts of the requested components. Contents of the work items as originally requested and the reviews on each item are as tabulated in the following Table 1-1-2 The numbers indicated in Table 1-1-2 shows timing of modifications made as referred to Table 1-1-1.

Table 1-1-1 Process for Cooperation Scope Demarcation

Timing	Month/Year	Activities
1	Dec/2009	Request by Government of Zambia
2	May/2010	Modified under Preparatory survey 1
3	Aug/2010	Modified in the Minutes of Discussions under Preparatory survey 2
4	Oct/2010	Modified based on field survey results after signing the Minutes under Preparatory survey 2
5	Nov/2010	Modified based on analysis in Japan after the field study of Preparatory survey 2

Table 1-1-2 Original Request and Review

Work Items		Requested Quantity	Timing	Review
Kafubu Water Treatment Plant	Intake pumps	7 units	5	Total 6 units (4 for regular use, existing and 2 for standby use, replacement, as per planned capacity and field survey)
	Chemical feeding facilities	1 set	4	In addition to coagulant feeding facilities, renovation of Chlorine feeding facilities were added. Presently, pre-chlorination is fed manually.
	Collecting trough in sedimentation tank	180 pieces	4	Fixed the quantity based on field inspection/survey at 136 pieces.
	Filter sand	600 m3	5	Presently 0.9 m depth and in good Condition. Has been excluded from the scope.
	Filter nozzles	1 set	4	Strainer found to be in good condition and no replacement deemed necessary.

Work Items		Requested Quantity	Timing	Review
	Backwashing facilities for filter	-	3	Replacement is needed for continuation of regular operation of rapid filtering.
	Transmission pumps	7 units	5	Based on design transmission flow, 5 units replaced.
	Necessary minor repairs	-	3	Added intake tower drain equipment.
Main Pipeline (Nakaputa-Skyways) ϕ 900mm		8 km	4	By hydraulic calculation and field survey, modified to be 450-800 mm x 5.9 km.
Water Kiosks[1] in Kaloko area		6 stations	4	6 stations but locations modified in field survey.
Branch line to Upper Mushili area		1 place	4	Modified to be 3 due to hydraulic calculation.
Main Pipeline (Chifubu) ϕ 600mm		2 km	4	Fixed 700 mm x 2.1 km based on hydraulic calculation results.
Main Pipeline (Northrise) ϕ 375mm		1.7 km	4	Fixed 500 mm x 1.6 km based on hydraulic calculation results.
Main Pipeline (western ring) ϕ 700mm		12.8 km	5	Beneficiary number is small as compared to the scale of works and given lower priority. Excluded from scope.
Transmission pump (Dambo Sewage pump station)		4 units	5	To be considered under DANIDA assisted sewage project.
Water quality analyzer in Kanini Laboratory		1 set	5	For detection of mercury, arsenic and agricultural chemicals, accessories for Atomic Absorption Spectrometer and gas chromatograph were selected.
Bulk water meter		1 set	4	Fixed 7 meters based on field survey.
Construction of Sewage treatment pond		4 places	2	To be considered under DANIDA assisted sewage project.
Sewer pipe		1 km	2	

[1]: Water Kiosk is the term reffering to a kiosk type communal water station set in the peri-urban area. One kiosk has some public water taps.

1-2 Natural Conditions

1-2-1 Topographical, Hydrological and Meteorological Features

Zambia is located in the southern part of the African continent with a national territory of 750,000 km^2, which is approximately twice as large as Japan. The city of Ndola is the capital of Copperbelt province, which is located in the central part of Zambia The urban area of Ndola is located about 10 km far from the border of the Democratic Republic of Congo (former Republic of Zaire). The Kafubu River takes its water from the area around this border and is the main water supply source in Ndola. This river is also used as the source of water supply for Luanshya city at the downstream of Ndola, for which KWSC provides the water supply services for. The Kafubu River unites with the Kafue and Zambezi Rivers at the lower course flows through the Republic of Mozambique, and then into the Indian Ocean.

Ndola is located at latitude 13 south and longitude 28 east in the Southern Hemisphere. Although it has low latitude of a tropical region, the altitude of Ndola is 1,300 m and its climate is classified as Temperate Winter Dry (Cw)[1]. Annual range of mean temperature is about 10 degrees C and its climate is benign in general. Mean maximum temperature and mean minimum temperature in Ndola from 1994 to 2003 is shown below. The months of September to November are the hot season and mean maximum temperature is over 30 degrees C. The months of May to August are considered the cold season, where mean minimum temperature of June to July is less than 10 degrees C.

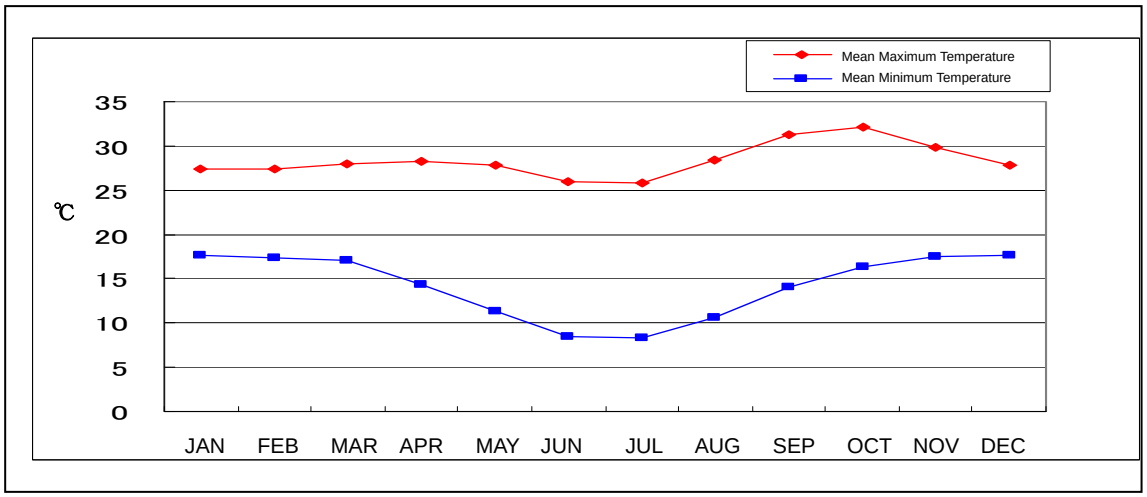


Fig. 1-2-1 Monthly Mean Maximum / Minimum Temperature in Ndola City

[1] : Climate Classification by Köppen (Köppen-Geiger Klassifikation)

Monthly precipitation in Ndola indicates that a rainy season and a dry season are clearly defined. From November until March of the next year, it is considered rainy season in summer and precipitation of each month is over 100 mm. On the other hand, April to October is the dry season in winter and has almost no rain. The fluctuation range of annual precipitation for the past 10 years is from 800 mm to 1,500 mm. Ndola has an almost constant annual amount of precipitation consisting of a rainy season and a dry season (1999-2009, Ndola airport meteorological observatory).

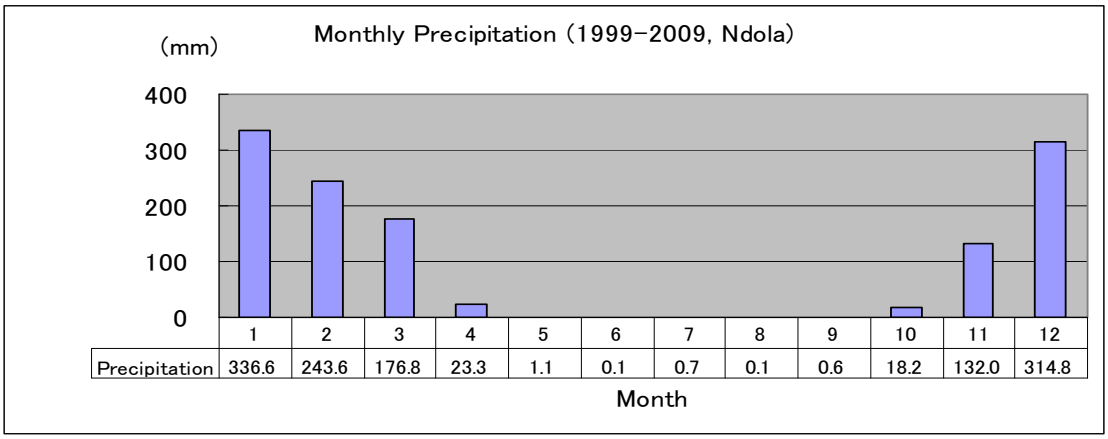


Fig. 1-2-2 Monthly Precipitation in Ndola City

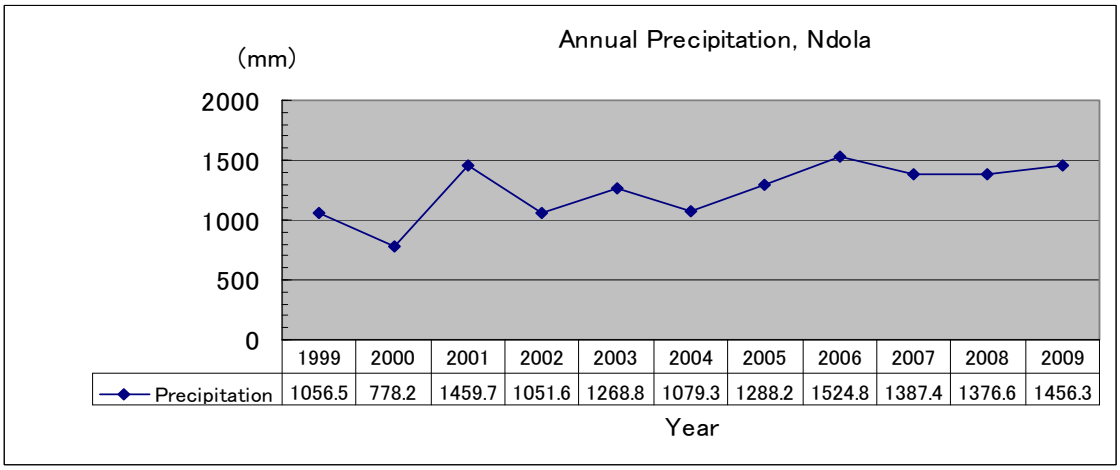


Fig. 1-2-3 Annual Precipitation in Ndola City

1-2-2 Natural Conditions Survey

(1) Topographical Survey

The study team conducted a topographical survey (plan survey, longitudinal survey, & cross section survey) along the pipeline routes and drafted the outline design drawings (refer to Article 2-2-3). For the pumping up sections, undulation of the route was surveyed. In Kafubu water treatment plant and reservoirs, the existing structures were measured. In the Kaloko and Mushili areas, distribution pipeline networks were made.

(2) Soil Survey

As for the geological features of Ndola city, the base ground is sedimentary and metamorphic rock formed in the Proterozoic to Cambrian Paleozoic era. The surface has weathered laterite. To get the basic information needed for the design of pipe material and pipeline foundation, and construction method plan and schedule, the study team conducted the boring test with a 5 m depth and standard penetration test at 10 points on the planned pipeline routes. Soil columnar diagrams based on the test results are shown on the outline design drawings of the pipeline (Article 2-2-3). As a result of the penetration test, N values were 1 to 60, the types of soil were classified as clay, sand or gravel, and the highest value of groundwater level was 1.8 m below ground.

(3) Excavation of the Existing Pipe

The study team excavated the existing pipeline at 10 places. Test pit size was 1.5 m by 1.5 m and 1.0 m deep. The buried pipe location were estimated from the existing drawings, exposed valves and pipes, leakage points and so on. Based on the excavation results, alignment of the newly installed pipeline under the road were decided, as to secure the required separation from the existing pipeline.

(4) Water Quality Survey

To verify the water quality of the source for tap water in Ndola and consider the required water treatment process, the study team conducted a water quality survey in September 2010. The results are shown in the Appendix 6-1 attached at the end of this report. Also, monthly data are shown on Article 2-2-2-2-2(1). Turbidity of raw water in Kafubu water treatment plant is in a manageable range with coagulation and sedimentation treatment.

September is the end of dry season in Ndola and the flow of the Kafubu River is weak, so the concentration of ammonia and nitrite nitrogen around the effluent points of the sewerage treatment plant were higher than the yearly average. Though harmful heavy metals have not been detected from the Kafubu River, Dieldrin, an organic compound was found. Pesticides within the water decrease progressively by dilution and microbial decomposition. Continuous monitoring of water quality is desirable to check the noxious substances.

(5) Flow Measurement of the Kafubu River

To confirm the amount of available water as a water source of Kafubu water treatment plant, the study team measured the flow of the Kafubu River during the dry season at the following 3 points on September 11th, 2010.

(Measured on September 11th, 2010)

Measurement Point	① Confluence of Effluent from Kanini STP[2]	② Midpoint between Kanini STP and Lubuto STP	③ Downstream of Lubuto STP
Flow Rate (m^3/s)	1.40	9.99	4.87

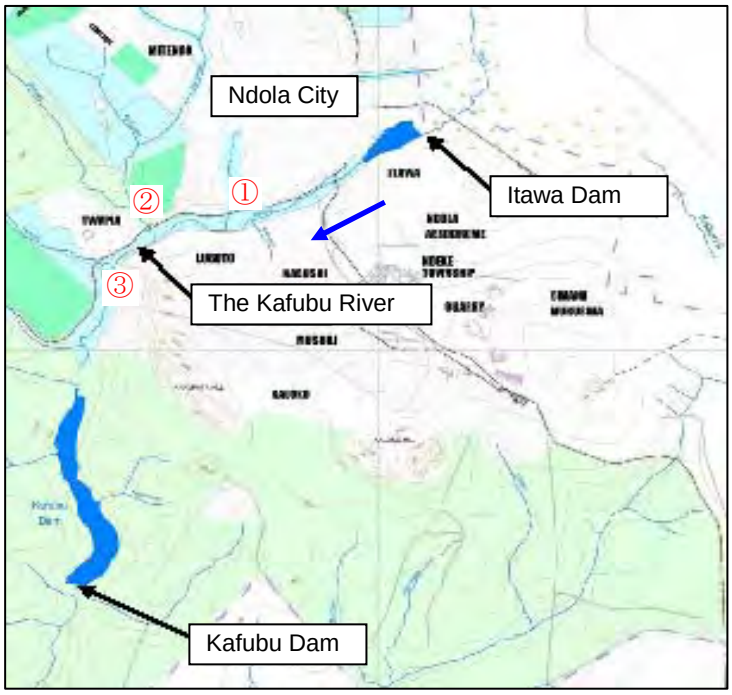


Fig. 1-2-4 Flow Measurement Point along the Kafubu River

[2] STP: Sewerage Treatment Plant

The following conditions were observed through the flow measurement and field survey:

- The downstream of Itawa Dam was wetland and no flow was observed in the section between Itawa Dam and the effluent point of Kanini sewerage treatment plant.
- At the effluent point of Kanini sewerage treatment plant, almost 100 percent of river flow was this effluent water and flow rate was roughly 1 to 2 m^3/s. The sewerage water treatment in this plant was incomplete, where the effluent water color was dark gray and visible suspended solids were included voluminously.
- At the downstream of Kanini sewerage treatment plant, inflow of spring water and increase of subsoil water were observed. Near the effluent point of Lubuto sewerage treatment plant, the flow rate recovered to approximately $10m^3/s$.
- At the point where the Kafubu River flows into Kafubu Dam, the transparency of water increased compared to the above mentioned effluent point of the sewerage treatment plant. This could be considered as dilution and filtration effects where the infiltrated subsoil water flows through the river bed and the surrounding soil.
- One of the major difficulties in Kafubu water treatment plant is the blockage of the sand filter caused by flourishing algae. Algae growth in Kafubu Dam, along with abundant nutrients of nitrogen and phosphorus were provided from the effluent of the sewerage treatment plant. To cope with this, pre-chlorination, which has an algaecide effect, has been used. Flocculation and sedimentation with coagulant are planned throughout this project also.

1-3 Social Conditions Survey

1-3-1 Outline of Survey

The Study team conducted a social conditions survey for collecting useful information such as water use, affordability of a water tariff, willingness to pay the tariff, household income, actual water supply conditions, and water-borne diseases. Those basic data can be used for the effective measurement after the project implementation.

The survey was done by the consigned Zambian consultant staff. Surveyors made interviews with inhabitants using questionnaires and measured water quality and pressure at the faucet in each house. They used a bourdon pressure gauge, a plastic tube test for residual chlorine, and a test strip for coliform detection.

Table 1-3-1 shows the target area of the social conditions survey. The 100 houses surveyed, shown in Appendix 6-2 attached at the end of this report were picked evenly from all water distribution blocks in Ndola city. Forty-three surveyed households were located in the northern area, which has its water source from the Itawa water treatment plant and the Misundu boreholes, and fifty-seven surveyed households were located in the southern area, which has its water source from the Kafubu treatment plant.

Table 1-3-1 Social Conditions Survey and Water Distribution Blocks

Area	Northern Area		Southern Area	
Water Source	Itawa Water Treatment Plant, Misundu Boreholes		Kafubu Water Treatment Plant	
Distribution Block	[Chifubu Reservoir] Chifubu Pamodzi [Northrise Reservoir] Kansensi Chipulukusu Northrize	[Kansensi Reservoir] Kanini Central Broadway [MisunduI, II Boreholes] Dola Hill Kawama Nkwazi Misundu	[Nakaputa Reservoir-Skyways Reservoir] Kafubu Kaloko Upper Mushili Mine Masala Lower Mushili Kabushi Main Masala Skyways Itawa Mckenzie Ndeke Bwana Mukubwa	[Nakaputa Reservoir-Western Ring Main] Lubuto Kantolomba Kanyala Twapia Monkey Fountain Hill Crest
No. of Household (Total 100)	57 households		43households	

1-3-2 Survey Results

(1) Use of Water

a) Hours of Water Supply

Average daily hours of water supply surveyed in the whole of Ndola city was 13.2 hours. The average hours in a day surveyed in the southern area is 4 hours shorter than those in the northern area. It seems the water supply is influenced by the deterioration of the Kafubu treatment plant and leakage from the main pipeline between the Nakaputa reservoir and the Skyways reservoir. Also, in the northern area, some houses in the Pamodji and Chifubu block in the Chifubu reservoir system and Northrise and Chipulukusu block in Northrise reservoir system answered “0-3 hours” or “3-6 hours”. This would confirm the necessity of repairing the water distribution main through this project.

Table 1-3-2 Hours of Water Supply in Ndola City

	Hours	0～3hours	3～6hours	6～12hours	12～24hours	Average
Northern Area	No. of Household	5	4	13	21	15.3hours
	Percentage	12%	9%	30%	**49%**	
Southern Area	No. of Household	4	11	28	14	11.5hours
	Percentage	7%	19%	**49%**	25%	
Total	No. of Household	9	15	41	35	13.2hours
	Percentage	9%	15%	**41%**	35%	

b) Water Pressure

Both direct measurement with the bourdon gauge at the faucet in each house and interview were conducted. As a result of the direct measurement done in the daytime, water stopped, or the pressure was low in more than half of the surveyed houses. Looking at the results by area in general, water pressure in the southern area was lower than that in the northern area. According to the answers on hourly conditions in the southern area, decreasing of water pressure in a day was observed. Also in the northern area, some houses in the Chifubu reservoir system and the Northrise reservoir system answered “No Water” or “Low Pressure”. This would also confirm the necessity of repairing the water distribution main through this project.

Table 1-3-3 Water Pressure at Faucet in Ndola City

	Water Pressure	Low Pressure / No Water	0.05-0.1MPa	0.1-0.2MPa	0.2-0.4MPa
Northern Area	No. of Household	20	8	13	2
	Percentage	**47%**	19%	30%	5%
Southern Area	No. of Household	37	8	6	6
	Percentage	**65%**	14%	11%	11%
Total	No. of Household	57	16	19	8
	Percentage	**57%**	16%	19%	8%

Table 1-3-4 Water Pressure in South area of Ndola City

	Water Pressure	Enough	Not enough
Morning	No. of Household	29	28
	Percentage	**51%**	49%
Afternoon	No. of Household	21	36
	Percentage	37%	**63%**
Nighttime	No. of Household	19	38
	Percentage	33%	**67%**

c) Water Quality

Survey staff sampled water from faucets in each surveyed house and made sensory inspections and simple kit tests. Looking at the results by area, water quality in the southern area was worse than that in the northern area. In the southern area, almost 30% of the samples showed color, and coliform were detected in more than 40% samples. The colored water had defects in odor (bad) and taste (odd). This is assumed to be due to the suction of dirty water into the pipe around the leaking points. After the project implementation, a massive amount of leakage from the main pipeline and low water pressure in the pipe will be improved; therefore, water quality at the faucet is expected to be better than now.

Table 1-3-5 Water Quality at Faucet in Ndola City, (Color)

	Conditions	No water	Normal	Colored
Northern Area	No. of Household	6	36	1
	Percentage	14%	84%	**2%**
Southern Area	No. of Household	8	33	16
	Percentage	14%	58%	**28%**
Total	No. of Household	14	69	17
	Percentage	14%	69%	**17%**

Table 1-3-6 Water Quality at Faucet in Ndola City, (Coliform)

	Conditions	No water	Normal	Detected
Northern Area	No. of Household	6	28	9
	Percentage	14%	65%	**21%**
Southern Area	No. of Household	8	25	24
	Percentage	14%	44%	**42%**
Total	No. of Household	14	53	33
	Percentage	14%	53%	**33%**

(2) Household Income and Water Tariff

In the southern area of Ndola city, 75% of the surveyed households answered that their monthly incomes were less than 1 million ZMK. This showed that a percentage of low-income population in the southern area was higher than that of the northern area. KWSC operates the graduated tariff system, and the tariff is distributed into different categories classified according to income level. The fixed rate is also set for the customer who does not install a water meter. Looking at the results, Distributions of household income and the paid tariff denoted the same tendency, and it appeared that the tariff collection was according to the customer income by and large. Survey results

on the consciousness of the water tariff showed that more than 60% of the surveyed households in high cost area and peri-urban area regarded their charged tariff as reasonable. On the other hand, less than half of the surveyed households answered that the tariff was fair in the medium cost area and low cost area. It appears then that the water supply conditions in the high cost area were relatively better than those in the other areas, which may be due to the low tariff in the peri-urban area. Approximately one third of the responses were invalid, such as “not using public water due to too low pressure or no water coming” or “they did not know their tariff actually”.

Table 1-3-7 Household Income in Ndola City

	(1,000ZMK)	Less than 1,000	1,000～2,000	2,000～5,000	More than 5,000
Northern Area	No. of Household	21	8	7	7
	Percentage	**49%**	19%	16%	16%
Southern Area	No. of Household	43	8	5	1
	Percentage	**75%**	14%	9%	2%
Total	No. of Household	64	16	12	8
	Percentage	**64%**	16%	12%	8%

Table 1-3-8 Water Tariff in Ndola City

	1,000ZMK /month	Not used / unknown	Less than 50	50～100	100～200	More than 200
Northern Area	No. of Household	14	8	9	9	3
	Percentage	33%	19%	**21%**	**21%**	7%
Southern Area	No. of Household	16	22	11	4	4
	Percentage	28%	**39%**	19%	7%	7%
Total	No. of Household	30	30	20	13	7
	Percentage	30%	**30%**	20%	13%	7%

Table 1-3-9 Consciousness of Water Tariff in Ndola City

	Consciousness	Expensive	A bit expensive	Fair
High Cost Area	No. of Household	6	6	22
	Percentage	18%	18%	**65%**
Medium Cost Area	No. of Household	2	7	8
	Percentage	12%	41%	**47%**
Low Cost Area	No. of Household	4	11	13
	Percentage	14%	39%	**46%**
Peri-Urban Area	No. of Household	4	4	13
	Percentage	19%	19%	**62%**
Total Average	Percentage	16%	28%	56%

(3) Alternate Water Recourses and Water Use

Forty-seven percent of the surveyed households utilized the water resources in their premises, such as water tap and well in the yard. The other fifty-three percent used the outside water resources alternatively, such as neighboring wells, rivers, and springs. Looking at the results by area, seventy-three percent of the surveyed households in the high cost area did not use alternative water resources. However, eighty-five percent of the peri-urban area people needed the alternatives. More than a few of households which did not have their own water resources answered that hours of water carrying work in a day was less than 1 hour.

Table 1-3-10 Hours of Water Carrying Work in Ndola City, classified by Area

	hours	Using house water	Less than1 hour	1～2 hours	More than 2 hours
Northern Area	No. of Household	26	12	3	1
	Percentage	**62%**	29%	7%	2%
Southern Area	No. of Household	20	17	3	15
	Percentage	**36%**	31%	5%	27%
Total	No. of Household	46	29	6	16
	Percentage	**47%**	30%	6%	16%

Table 1-3-11 Hours of Water Carrying Work in Ndola City, classified by Category

	hours	Using house water	Less than hour	1～2 hours	More than 2 hours
High Cost Area	No. of Household	24	4	3	2
	Percentage	**73%**	12%	9%	6%
Medium Cost Area	No. of Household	7	2	1	7
	Percentage	41%	12%	6%	41%
Low Cost Area	No. of Household	12	11	1	3
	Percentage	44%	41%	4%	11%
Peri-Urban Area	No. of Household	3	12	1	4
	Percentage	**15%**	60%	5%	20%

(4) Other Results

a) Water-borne Diseases and Hygienic Habits

Malaria was the most common disease in the surveyed area, and Diarrhea and Food poisoning followed. The answer of “Diarrhea” was chosen by sixty percent of the respondents in the southern area, and this would be due to drinking or cooking with unhygienic water. Almost all respondents answered that they practiced hygienic habits such as hand-wash before and after meals, hand-wash after toilet use, and washing foods before cooking.

Table 1-3-12 Water-borne Diseases in Ndola City

	Diseases	Diarrhea	Food poisoning	Malaria	Cholera	Typhoid	Dysentery
Northern Area	No. of Household	19	6	35	0	0	3
	Percentage	**44%**	14%	81%	0%	0%	7%
Southern Area	No. of Household	34	8	46	1	1	0
	Percentage	**60%**	14%	81%	2%	2%	0%
Total	No. of Household	53	14	81	1	1	3
	Percentage	53%	14%	81%	1%	1%	3%

b) Sewerage/Sanitary Conditions

The survey results show the consolidation of sewerage facilities of the surveyed households is delayed in the southern area of Ndola city in comparison with the northern area, as is the case with water supply development. Seventy percent of the surveyed households in the northern area are equipped with flush toilets, compared with fifty-six percent in the southern area. Looking at the results by area, 100% of the surveyed houses in the high cost area had flush toilets. Modernization of sanitary equipment depends on the areas’ categories, and only ten percent of the surveyed houses in the

peri-urban area was equipped with flush toilets.

Table 1-3-13 Sanitary Conditions in Ndola City, classified by Area

	Conditions	Flush Toilet	Pit Latrine
Northern Area	No. of Household	30	13
	Percentage	**70%**	30%
Southern Area	No. of Household	32	25
	Percentage	**56%**	44%
Total	No. of Household	62	38
	Percentage	**62%**	38%

Table 1-3-14 Sanitary Conditions in Ndola City, classified by Category

	Conditions	Flush Toilet	Pit Latrine
High Cost Area	No. of Household	34	0
	Percentage	**100%**	0%
Medium Cost Area	No. of Household	13	4
	Percentage	**76%**	24%
Low Cost Area	No. of Household	13	15
	Percentage	**46%**	54%
Peri-Urban Area	No. of Household	2	19
	Percentage	**10%**	90%

c) Satisfaction Level for Water Supply and Sewerage Service

Regarding customer satisfaction with the service provided by KWSC on water supply and sewerage, interviewers set four levels. More than half of the surveyed households responded “Good” or “Fair” on both water supply and sewerage. In contrast, less than half of the respondents in the southern area showed their satisfaction. These results would be caused by the areas’ differences of the services such as hours of water supply and water pressure.

Table 1-3-15 Satisfaction Level on Water Supply Service

	Level	Good	Fair	Ordinary	Bad
Northern Area	No. of Household	10	20	2	11
	Percentage	23%	47%	5%	26%
Southern Area	No. of Household	13	15	6	23
	Percentage	23%	26%	11%	40%
Total	No. of Household	23	35	8	34
	Percentage	23%	35%	8%	34%

Table 1-3-16 Satisfaction Level on Sewerage Service

	Level	Good	Fair	Ordinary	Bad
North Area	No. of Household	11	22	2	8
	Percentage	26%	51%	5%	19%
South Area	No. of Household	11	16	5	25
	Percentage	19%	28%	9%	44%
Total	No. of Household	22	38	7	33
	Percentage	22%	38%	7%	33%

1-4 Environmental and Social Consideration

1-4-1 Project and Alternatives

Ndola is the 3rd largest city in Zambia and the capital of Copperbelt province. Copperbelt province is located at the center of Zambia, which thus makes Ndola's location a key place connecting other cities. Most of the copper production, which is the major industry in Zambia, is carried out in the said province. As stated above, Ndola is important geographically, as well as economically in Zambia. The project service area is in the southern part of the city, which mainly covers the law income area and peri-urban area. There are no negative impacts on the wildlife and precious species because the national park and natural protective area are not located within the project area. The project implementation does not plan on cutting trees.

The project components have considered the social and environmental impacts on the rehabilitation work of water treatment plant (WTP), which includes rehabilitation work of pipelines and construction of water kiosks in Kaloko area.

As an analysis of alternatives, two cases were examined; (i) Zero Option (without the project) and (ii) Development of a new water source. In the case of zero option, the capacity of Kafubu water treatment plant will be decreased with continued deterioration of the facilities. Leakage from the primary transmission pipelines will become more serious. Both water quantity and water quality for people in the service area will be getting worse, which may cause adverse impacts to the social environment. Even more importantly, in areas hardly receiving water, the situation is horrendous. The people have begun using unsanitary alternative water sources, such as leakage water of the pipelines, dug wells, and so on. If the condition of the water supply is not improved, then waterborne diseases in the area might be increased.

In the case of new water source development, the groundwater development plan is taken as such: long-term evaluation for the potential of an aquifer and impact to the environment will be needed due to the retrieval of large volumes of groundwater. Furthermore, construction costs for the boreholes and water tanks required will be very expensive. Although, taking into account the future increase of water demand in the planned area the groundwater development should be considered continuously, it is suggested that rehabilitation of the existing facilities to respond to the urgent water demand of people is more critical and effective than the groundwater development plan.

1-4-2 Governmental Approval System in Zambia

The laws and regulations related to the environmental and social issues are administrated by the Ministry of Tourism, Environment and Natural Resources (MENR). The Environmental Council of Zambia (ECZ) is the subordinate organization of the MENR and is in charge of reviewing the Environmental Impact Assessment (EIA) for projects. Based on the EIA regulations, a developer should submit an EIA report to ECZ before any project commencement. The EIA regulations classify projects in two types according to the project components: the first schedule is the Environmental Project Brief (EPB) and the second schedule is the Environmental Impact Statement (EIS).

In this project, it is confirmed that the EPB should be applied to the EIA report during the first preparatory survey because of two reasons: first being that project is not a newly started construction project but instead a rehabilitation project; the second is that it is judged by the ECZ office through the site observation. In response to this, KWSC officially submitted the EPB for the project to the ECZ on September 24th, 2010. KWSC had already received the decision letter for the project on November 10th, 2010 (refer to the Appendix 6-5 attached at the end of this report). Collateral conditions mentioned in the decision letter can be manageable by taking necessary mitigation measures as shown in Table 1-4-2.

1-4-3 Project Evaluation and Monitoring based on JICA Guideline

Classification of the project is applied to “Category B”, based on the JICA Guidelines for Environmental and Social Consideration (April 2004). The evaluation results of the environmental and social impacts from the project are shown in Table 1-4-1. The major impacts on the condition of traffic during pipe installation works and drainage condition during pipe leakage test are taken into consideration. These adverse impacts can be reduced by taking of necessary mitigation measures and thus will be not expected.

Table 1-4-1 Results of the Evaluation on the Environmental and Social Impacts

Check item		Rating	Reason
(1) Social Environment			
1	Involuntary Resettlement	D	The project components consist of rehabilitation of the water treatment plant, installation of transmission pipelines and construction of new water kiosks. Rehabilitation work will be implemented at the existing water treatment plant. The rehabilitated pipeline will be installed along the public road or public lands. New water kiosks will be constructed on the public land. Therefore, involuntary resettlement will not be necessary.
2	Local Economy (i.e-employment, livelihood, etc.)	F	The project will create employment opportunities through large scale construction work. Therefore, it is expected to cause a positive impact on the local economy.
3	Land and Local Resource Utilization.	D	The project components consist of rehabilitating the water treatment plant, installation of transmission pipelines and construction of new water kiosks. Among these, rehabilitation works and installation of pipeline will be implemented at existing facilities and thus the adverse impacts on land use or of local resource utilization are not expected. Areas for soil disposal and stockyard of construction materials will be planned on public land. Approval of land use for these works of construction have been given by the city of Ndola and issued on November 8th, 2010. Also, 6 new water kiosks will be constructed on public land and approval of land use by Ndola City Council was already issued on September 16th, 2010.
4	Social Institutions (social infrastructure, local decision making institutions)	D	Since the project is the rehabilitation of existing facilities, no adverse impacts are expected. Community assembly meetings will be held in the Kaloko area for the formulation of the water kiosks O&M* organization system by soft-component (refer to the Appendix 5 soft component plan attached at the end of this report). (* O&M: Operation and Maintenance)
5	Existing Social Infrastructures and Services	B	1) Local traffic conditions during the pipe rehabilitation work on the main road between Nakaputa reservoir and Skyways reservoir need to be taken into consideration. 2) The water stoppage during the connecting of new and existing pipes needs to be taken into consideration.
6	Local Underprivileged Denizens	F	The project components include water supplying to the poor through construction of water kiosks; and thus has a positive impact.
7	Benefit and Damage Misdistribution	D	Since the project is the rehabilitation of existing facilities, no adverse impacts are expected. In addition, selection of the target area was conducted in a manner beneficial to the underprivileged.

Check item		Rating	Reason
8	Culture Property and Heritage	D	Since this is a rehabilitation project of existing facilities, there will be no adverse impacts on the culture property. There is no historical preservation conflicts with this project.
9	Local Conflict of Interests	D	After the construction of water kiosks at Kaloko area are complete, selection of water vendors and other issues need to be taken care of in such a way that the community participates in the decision processes, making such impacts are almost ignorable.
10	Water Usage or Water Rights and Common Usage Rights	D	KWSC holds the water rights through the application to the water board under the Ministry of Energy and Water Development. There is no construction place needed for the rights of common usage.
11	Public Health and Sanitation	F	Leakage points of the pipes used by the local people as an alternative source will be repaired through the pipe rehabilitation work. Thus, unsanitary water consumption and use among the poor will be reduced. Therefore, positive impacts on public health and sanitation are expected.
12	Hazard/Risk	D	No possibility of incurring hazards to landscape etc. There is a possibility of HIV/AIDS contraction among construction workers, but is almost ignorable by taking adequate mitigation measures such as educating and informing workers.
(2) Natural Environment			
13	Topography and Geology	D	No large scale quarrying, cutting and embankment works are planned.
14	Soil Erosion	D	Due to the project only being rehabilitation of existing water supply facilities, no adverse impacts are expected.
15	Groundwater	D	There are no components related to groundwater development in the project, therefore no adverse impacts are expected.
16	Lakes/River	D	Water intake from ponds or rivers (except the existing one) is not planned.
17	Coastal Zone	D	Project components do not include construction work in coastal zones.
18	Fauna, Flora and Biodiversity	D	The construction area is not located within a protective wildlife area or natural preserve. No adverse impacts are expected during either construction or operational phase.
19	Meteorology	D	Since the project is a rehabilitation of existing water supply facilities, no adverse impacts are expected.
20	Landscape	D	Since the project is a rehabilitation of existing facilities, no adverse impacts are expected.
21	Global Warming	D	Since the project is a rehabilitation of existing water supply facilities, no adverse impacts are expected.
(3) Environmental Pollution			
22	Air Pollution	D	Gas emissions during construction work are expected to be minimal.

Check item		Rating	Reason
23	Water Pollution	D	Water pollution during construction work will be prevented through effective construction management.
24	Soil Contamination	D	Toxic materials are not used for any construction work.
25	Waste	B	Large volume of soil will be excavated during pipe trench excavation work. Reuse of most excavated soil for backfilling is needed.
26	Noise and Vibration	B	Construction work with heavy machinery is planned during pipe rehabilitation works. Although no significant noise or vibration will be generated, some pipe rehabilitation work will be implemented near the residential area. Therefore, necessary mitigation measures are needed.
27	Ground Subsidence	D	No pumping up of groundwater is planned.
28	Offensive Odor	D	There is no factor that would cause offensive odors.
29	Sediment	D	There is no factor to cause sediments.
30	Accidents	B	There is the potential risk of accidents due to truck passage and heavy machinery construction work, etc. These risks can be avoidable by practicing adequate safety measures, and thus make such impacts almost ignorable.

Rating;
A: Serious impact is expected, B: Some impact is expected, C: Extent of impact is unknown
D: Negligible or No impact is expected, F: Positive impact is expected

Adverse impacts as mentioned above should be minimized and necessary mitigation measures should be taken, along with proper monitoring. The mitigation measures and monitoring plan expected are shown in Table 1-4-2. Costs for mitigation measures toward improving traffic, waste, noise and vibration, and construction as shown below are basically included in the indirect expenses of the construction cost, as items to be taken about health and safety concerns, etc. Therefore, no extra costs will be required for taking such mitigation measures. Notification of water stoppage will be done by the KWSC under their regular budget. Monitoring for the proposed mitigation measures will be also done by the KWSC. The scale of the monitoring activity is included in the normal periodic site observation to be taken by the project implementing agency of Zambian side. Its cost is covered by the KWSC's regular budget.

Table 1-4-2 Mitigation Measures and Monitoring Plan

Adverse Impact	Mitigation or Avoidance Plan	Monitoring Plan
【Traffic】 Local traffic conditions during the pipe rehabilitation work on the main road between Nakaputa reservoir and Skyways reservoir needs to be taken into consideration.	・ Installation of sufficient construction sign boards. ・ Allocating traffic controller. ・ Installation of speed bumps to help reducing speed of trucks.	(Method) ・ Site observation whether traffic jams occur or not. ・ Site observation whether necessary safety measures are taken. (Duration) During the pipe rehabilitation work. (Frequency) Once a month
【Water stoppage】 Water stoppage may occur during the connection of new and existing pipes.	・ Give adequate notice to the users about date and hours of the water stoppage in advance.	N/A (once-off)
【Waste】 Large volumes of excavated soil may be produced during pipe trench excavation work.	・ Use most of the excavated soil for backfilling after pipe installation.	(Method) Site observation for backfilling condition of the excavated soil. (Duration) During rehabilitation work of distribution pipe. (Frequency) Once a month
【Noise and Vibration】 Construction work with heavy machinery is planned during pipe rehabilitation work. Although no significant noise and vibration will be generated, some pipe rehabilitation work will be implemented near the residential area.	・ Use heavy machinery with adequate silencer or noise reducer to avoid disruptive effects. ・ Avoid construction work during night time near the residential area.	(Method) ・ Site observation for use of heavy machinery. ・ Supervision of complaints by residential people near the construction area. (Duration) During the pipe rehabilitation work. (Frequency) Once a month

The environmental checklist and monitoring form are shown in the Appendix 6-3, 6-4 attached at the end of this report. These documents were prepared together with KWSC and the JICA team with explanation about the contents of JICA Guideline for environmental and social consideration from JICA survey team to KWSC.

Chapter 2 Contents of the Project

Chapter 2　Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Super Goal and Project Purpose

2-1-1-1 Super Goal for the Project

"Develop and provide sustainable water supply services in urban and peri-urban areas" is set as one of the 7 key strategies on the basic policy of water supply and sanitation in the SNDP (Sixth National Development Plan, 2010-2015). "Rehabilitation of 10 urban water systems by 2014" is also set as the target of sector output in the SNDP. Furthermore, the NUWSSP (National Urban Water Supply and Sanitation Programme) takes up two major issues to be challenged during the period of 2009-2015. The issues are countermeasures for non-revenue water and the renovation / improvement of the existing water supply systems for the major cities. In view of the said policies, the super goal for the subject project is set to grade up the water supply services in Ndola and to drastically improve the living environment for the people.

2-1-1-2 Project Purpose

In Zambia, the service coverage of urban water supply is at 73.9% and as low as 44% in the peri-urban areas surrounding the cities (FNDP[1] 2007). The population in cities and surrounding peri-urban areas has been rapidly increasing and it has become an urgent necessity to raise the accessibility ratio of safe water to the underprivileged class in the society. There are some existing water supply/sewerage systems in some Zambian cities which had been constructed during the British rule, before independence in 1964, and still being utilized at present. These systems were built at a relatively earlier time period and found to be considerably deteriorated. Currently these systems have various defects causing leakage and other problems, which require possible renovation as soon as possible. Under the subject project however, the project purpose is aiming to improve the water supply condition in Ndola by rehabilitating /improving and expanding the water supply system within the city and its peri-urban areas.

1: Fifth National Development Plan

2-1-2 Outline of the Project

Under this project, the planned work items as indicated in the following Table 2-1-1 shall be implemented as to attain the project purpose as stated above. In addition, the project will be further strengthened by having various supporting activities on O&M[2] of facilities under the soft component[3] category. By implementing the project as above-mentioned, it is expected that the served population for water supply in the presently non-accessible areas will be increased by about 23,000 people. Not only that but the water supply service hours will be increased by about 6 hours in the service areas along with alignment improvement.

Table 2-1-1 Outline of the Project

No.	Facilities	Planned Work Items
1	Replacement of intake pumps and related facilities at Kafubu Water Treatment Plant	Intake pumps (Raw Water Pump) -- 2 standby units replacement for standby Chain block -- 1 set replacement Drainage pumps -- 2 units replacement Pump control panel -- renovation 400V phase advanced capacitor panel
2	Replacement of chemical feeding facilities at Kafubu Water Treatment Plant	Coagulant feeding facilities -- replacement (3 agitator and 3 injection pumps) Control panel and power distribution panel for Agitator and injector -- construction or renovation Chemical feeding facilities (pre-chlorination and post- chlorination) -- replacement
3	Replacement of collecting trough in sedimentation tank at Kafubu Water Treatment Plant	FRP trough(370×280×8,400mm) -- replacement Stage-1 40sets, Stage-2 96sets
4	Replacement of backwashing facilities for rapid filter at Kafubu Water Treatment Plant	3-backwashing pump and 2-blower (stage-2) -- replacement Blower control panel -- construction Valve for backwashing pipe -- 3×17sets replacement Stop Logs at Conveyance channel -- construction Manual control equipment for siphon -- 17 sets construction

[2] O&M: Operation and Maintenance
[3] Soft component: A menu of technical assistance provided as a part of the Japan's Grant Aid scheme.

No.	Facilities	Planned Work Items
5	Replacement of transmission pumps and related facilities at Kafubu Water Treatment Plant	Transmission pumps (High Lift Pump) -- 5sets replacement (regular use and 1 unit for standby) Drainage pumps -- 2 units replacement Surge tank -- repair Water level alarm for treated water reservoir -- construction Transmission pump control panel -- replacement 3.3kV condenser -- construction Supersonic flow meter -- construction
6	Necessary minor repairs at Kafubu Water Treatment Plant	Intake tower drain pump -- 1set replacement Switch panel -- construction
7	Installation of transfer pipeline from Nakaputa reservoir to Skyways reservoir and incidental facilities	Ductile iron pipe(ϕ 800mm×5.03km, ϕ 450mm×0.81km、 ϕ 600mm×0.02km) -- construction Valve (sluice valve ,air valve ,drainage valve) -- construction
8	Construction of extra water kiosks in the Kaloko area	Extra water kiosks -- 6sets construction Steel pipe (ϕ 100mm×3.13km) -- construction Valve (sluice valve ,air valve ,drainage valve) -- construction
9	Installation of branch lines to Upper Mushili area and incidental facilities	Branch pipe (ϕ 300mm×70m, ϕ 250mm×140m, ϕ 400mm×30m) -- construction Branch valve -- construction
10-1	Installation of Chifubu water main and incidental facilities	Ductile iron pipe (ϕ 700mm×2.06km, ϕ 300mm ×0.07km) -- construction Valve (sluice valve ,air valve ,drainage valve) -- construction
10-2	Installation of Northrise water main and incidental facilities	Ductile iron pipe (ϕ 500mm×1.60km, ϕ 150mm ×0.02km) -- construction Valve (sluice valve ,air valve ,drainage valve) -- construction
11	Installation of water quality analyzer in Kanini laboratory	Gas chromatograph -- construction Accessories for Atomic absorption spectrophotometer -- supply
12	Installation of necessary bulk water meters	Bulk water meters (ϕ 100-800mm) -- 7sets construction

Kafubu Water Treatment Plant has two lines. Stage-1 was constructed in 1966, and Stage-2 was constructed in 1975.

2-2 Outline Design of the Requested Japanese Assistance

2-2-1 Design policy

2-2-1-1 Basic policy

In December 2009, the Government of the Republic of Zambia represented by the Ministry of Local Government and Housing made a request to the Government of Japan for a Grant Aid for the mentioned subject project. The project was to improve water supply and sanitation conditions and heighten the accessibility to safe water through rehabilitation and expansion of the existing water supply systems in Ndola, the provincial capital city of Copperbelt province, Zambia. The basic policies of the project are as follows:

i. To consider the requested items and decide on the cooperation components in view of "population of beneficiary", "degree of urgency for water", and "degree of deterioration of facilities".

ii. To select the south part of Ndola, where many poverty stricken groups live, as the main project target area.

iii. To set the year 2020 as a design period and verify the capacity of the facilities, with the basic design policy of performance recovery for the existing facilities.

iv. To set the recovery of the existing facilities as a principle. Based on the results of the field survey, to use the available facilities as present conditions and confine the replacement of equipment and new construction to the scope of the requisite minimum.

2-2-1-2 Considerations on natural/environmental conditions

The matters that require attention in planning and design for the project facilities are as follows:

(1) Rainfall

The project area is located in the zone where climate conditions are clearly distinguished by rainy and dry seasons. In the rainy season, considerably localized torrential downpours happen rather often. Existing water pipelines under the project are situated on the

comparatively flat topography where sometimes roadways become submerged underwater. Accordingly, the design shall be adequate enough to counter and withhold the climate conditions, topography, drainage condition as well as underground water level condition in the area. Of the O&M facilities for pipeline systems, it is necessary to provide drain pipes in the valve chamber. It is also necessary to locate the drainage facilities properly so it does not cause ill drainage in the operation. Concerning the pipeline installation for refilling, sufficient overburden shall be secured so that serious erosion by rain waters can be avoided. Moreover, it shall be necessary to carry out pipe installation work during the dry season to ensure higher quality construction work. It is also noted that the lightening arrestor facility shall be equipped to the Kafubu WTP since damage on the mechanical and electrical systems was found, which was caused by lightening.

Table 2-2-1 Duration of Rainy and Dry Seasons and Monthly Mean Rainfall

Seasons	Duration	Monthly Mean Rainfall	Remarks
Rainy	Nov-Mar	337mm-1,321 mm	1999-2010
Dry	Apr-Oct	0mm-23 mm	Same as above

(2) Temperature

The monthly mean temperature in Ndola ranges 26-32°C. Sometimes however, the peak daily temperature may rise as high as 40°C. It is essential to secure construction quality as designed by having the construction plan match with the ideal local temperature conditions so that conducting proper temperature control and curing during concrete placing are done properly.

2-2-1-3 Considerations on socio-economic conditions

The city of Ndola has been equipped with the water supply and sewage systems since earlier times; however, the city has been expanding considerably and there are some areas that are in poor condition for water supply and sanitation. For the coming years, it is projected that the rapid increase of city population will not prevail due to the effects of HIV/AIDS. Therefore, it is essential to plan the capacity of project facilities to meet the requirements as confirmed through due examination on future population increase and the planned water supply projects in the project area.

Electric power supply in Zambia is primarily monopolized and the responsibility of

ZESCO, a semi-public power generator and supply agency operating for the whole country. In some areas of Zambia, there are several planned power cut times in a year for about three and a half hours, where the power cut schedule is informed to the general public in advance via newspapers and so on. For this case, the pump facilities under the project shall be designed so that the system will be able to bear strong water pressure in case of a power cut. Also, the electrical facilities are designed so that the effects of thrust current can be minimized during the power cut and recovery.

Electricity tariffs tend to be escalating in the country where the tariff rate was raised again on July 1st, 2010, repeating the previous escalation in 2009. Due to the said rise in electricity costs, operation costs for pump facilities in each Commercial Utility[1] will rise. It is expected that the tariff for water supply will most probably to be increased as well. Therefore, it is necessary for the facility design under the subject project to pay due attention to lower the O&M cost as much as possible.

2-2-1-4 Situation of construction industries

(1) Laws/regulations to be observed

In conformity with the Labor Standards Act of Zambia, an agreement on construction work has been made every year between the National Union of Building, Engineering & General Workers and the Association of Building & Civil Engineering Contractors. Therefore, the said agreement shall be referred to consider the minimum wage and working hours etc of the labor.

(2) Standards to be applied

Design criteria and standards on water works have not been prepared yet in Zambia, so the ISO and JIS standards shall be referred to for defining the specifications, quality and test methods, etc. of the facilities/materials and construction work. Furthermore, concerning the water quality, references shall be made to the standards/criteria of potable water as issued by the Zambia Bureau of Standard.

[1]: Commercial Utility (CU) is the term referring to the public corporation servicing water supply and sewerage in local urban area. As of 2011, 11 CUs have established in major provincial capital.

(3) Construction industry

In Zambia, the local contractors are mostly small scale and there are few engineers and technicians who have the required knowledge, experience, and skills about this projects construction work. Some of those construction companies are of foreign origin, like in South Africa, which holds the primary offices in Lusaka, the capital city, and having branch offices in major cities nationwide. They possess substantial construction machinery and foreign engineers and are considered qualified with sufficient records of construction experience. It is noted that securing of construction quality and obtaining a shorter construction period may be possible by practical use of the said qualified contractors.

(4) Equipment/materials for construction work

Materials commonly available in the Zambian market such as reinforcing bar (rebar), cement, sand, gravel and stones are to be locally procured. Common construction machines such as backhoes, bulldozers and cranes may be possible to procure locally, though it depends on the quantity. Pipe materials with a small diameter are available in the local market. However, medium-large size pipes are to be procured in large quantities under the subject project and will be procured from Japan and/or third party countries from the quality assurance and quantitative view points. Also, the pumps, electric motors and distribution panel are to be procured from Japan and/or third party countries as the local production of said items is very limited.

2-2-1-5 Considerations for practical use of local contractor and consultant

It is necessary for the WTP and pipeline installation work under the project to use a local contractor of foreign origin who has enough experience in similar work, taking into account the scale of work and the relative difficulty over a construction period of about one year. Also, the construction work under the project is scattered over a number of sites between 30 km length from Kafubu WTP to Chifubu reservoir, which will progress simultaneously, and thus, will be necessary to assign technically qualified local consultants responsible for construction supervision at each site.

2-2-1-6 Concept for project O&M

The implementation agency of the subject project is the KWSC (Kafubu Water Supply and Sewerage Company Limited) of Zambia. The KWSC has a public corporation status after

separating from Ndola city government and becoming financially independent, and enjoying a reasonable balance of profit and loss. Concerning the responsibility of O&M activities for the WTP and pipeline systems, KWSC is considered to have a certain level of technical capability. Under the project, KWSC will be responsible for the overall management and O&M of the facilities/systems.

Through the subject project implementation, the new water treatment process and O&M for the facilities with the following items will be newly added and it is necessary to implement such soft component activities under the project for support of O&M and securing project sustainability.

- Recovery of a flocculation process in the Water Treatment Plant (WTP)
- Treatment of pipeline system and new installation of flow meter
- Introduction of gas chromatography (New for water quality analysis)
- Construction of water kiosks without using the DTF[2] fund

2-2-1-7 Selection of grades for facilities and equipments / materials

Mains are pumps and ductile pipes which are supposed to be procured from Japan and/or third party countries. Therefore the quality and grade are guaranteed by ISO and/or JIS standards. For the WTP facilities, treatment is aimed to recover capacity to the original level, for which the grade shall be equivalent to the existing ones, but for those facilities found to have been severely deteriorated, such as pumps and sedimentation tank channels, a higher grade of durability and quality shall be provided. Concerning the water kiosks, a reference is made to the standard design in Zambia as indicated in the DTF manual. The equipment and materials for water quality analysis should be able to detect all the basic items involved in water quality standard in Zambia. Availability of spare parts and difficulty of O&M work also shall be considered.

[2] : DTF (Devolution Trust fund) is an agency of a basket-fund provided by the Government of Zambia, GIZ, and other cooperating organizations. The DTF supports water kiosk projects in peri-urban areas applied by CU (commercial utilities) financially and technically. DTF issued the tool kit as a guideline for water kiosk projects. The tool kit puts together a set of project methods and flow on organization of inhabitants, hygiene education, construction, and O&M of water kiosks.

2-2-1-8 Construction method, manner of procurement and construction period

(1) WTP works

Construction work shall be progress while the WTP is in service for daily water supply. In Kafubu, the WTP has 2 supply lines where the operation of one line will be suspended by closing the valves and stop log for rehabilitation work, while the other line is operational. Concerning the electrical equipment/facilities, attention shall be fully paid to safe handling because of high voltage danger, which requires a certain period for total closure of power supply during the work.

(2) Manner of pipe installation

In principle, the existing pipelines will not be removed, but the new pipelines will be installed along the existing ones. Considerable time has passed since the installation of existing pipes and it is necessary to pay careful attention to the possible gaps within pipeline locations. In some cases, the aged pipeline might be under the new residential area and/or upland crop fields. Prior to pipeline installation work, it is necessary to complete the confirmation of the location for pipe installation and necessary procedures for occupancy of roadway for construction purposes. For the case of new installations, test excavation is required to confirm the existence of any underground material such as electric wiring, telephone cables, pipes/ducts for water supply/sewerage and drainage culverts. If any do exist underground, it is necessary for the KWSC to request the owners of such material to relocate it.

The total length of the pipeline installation is 13 km and will be divided into different sections to be undertaken simultaneously. The construction sites are on roadways and therefore, attention must be paid for safe traffic of both vehicles and pedestrians. The ductile pipes to be installed are of heavy material and trucks with a crane shall be required for safe hanging and speedy work. After the pipe installation, water tests and refilling shall be completed as soon as possible, so as to cause minimal interference with the traffic at the site. In the case where temporary water supply stoppage is necessary for connecting of pipeline with the existing one, the planned suspension schedule shall be informed in advance to the beneficiaries through PR activities by the KWSC.

(3) Procurement method

Of the equipment/materials to be procured, ductile pipes (Straight and fitting), valves, equipment/materials for replacement and form material, scaffolding and supports are to be efficiently transported to the designated places by using containers, etc. After delivering materials and equipment to the sites, the equipment/materials shall be classified as per the construction sites and temporarily stored at the depots, where further transport to the construction sites will be done as required by using dump trucks and trucks with a crane, etc. The quantity of pipe material is considerable and thus, it is necessary to secure enough space for storing as well as to provide several numbers of depots to keep the transportation distance to the construction site minimal.

(4) Construction period

The construction period for the subject project implementation is estimated to be 17.5 months. The total period is expected to span over two rainy seasons (Nov-Mar). The project plans complete the required procurement in the rainy season of the first year and the construction work in the dry season shall be undertaken simultaneously at a number of working areas to obtain and allow for higher production in a shorter period.

2-2-2 Basic plan (Construction plan)

2-2-2-1 Master plan

(1) Water Supply System in Ndola city

The water supply system in the Ndola city is divided roughly into two major areas, the Northern area and Southern area. While the Southern area is served by Kafubu WTP, the Northern area is served by the Itawa Filtration Plant and the Misundu Well Group. The Kafubu River runs through the boundary of said service areas (two) as shown below. The Southern area supplies water for about 55% of the entire city's population.

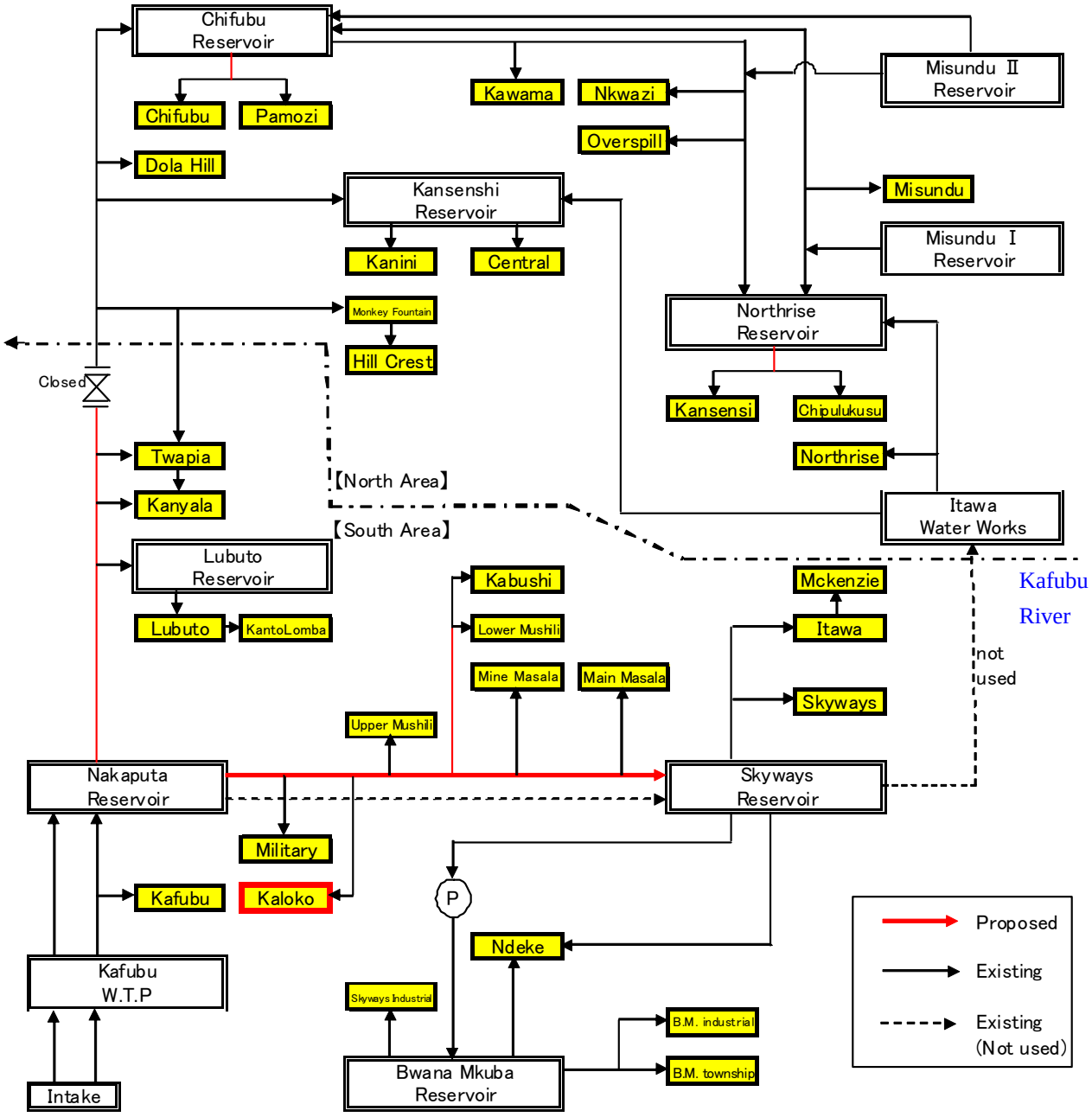


Fig. 2-2-1 Water Supply System in Ndola City

Table 2-2-2 Category of Water Supply Area in Ndola City

Northern area (Water source: Itawa WTP, Misundu Well Group)

Area	Category	Unit (LPCD)
Hill Crest	High cost	280
Monkey Fountain	High cost	280
Chifubu	Low cost	100
Pamodji	Medium Cost	160
Northrise	High cost	280
Kansenshi	High cost	280
Chipulukusu	Peri-Urban	60
Kawama	Peri-Urban	60
Nkwazi	Peri-Urban	60
Overspill	Peri-Urban	60
Dola Hill	Low cost	100
Misundu	Low cost	100
Central	High cost	280
Kanini	High cost	280

Southern area (Water source: Kafubu WTP)

Area	Category	Unit (LPCD)
Upper Mushili	Medium Cost	160
Lower Mushili	Medium Cost	160
Kabushi	Low cost	100
Main Masala	Low cost	100
Mine Masala	Low cost	100
Kafubu	Low cost	100
Kaloko	Peri-Urban	60
Skyways	Medium Cost	160
Skyways Industrial	Industrial	—
Ndeke	Medium Cost	160
Itawa	High cost	280
Makenzie	Peri-Urban	60
Bwana Mkubwa Industrial	Industrial	—
Bwana Mkubwa Township	Low cost	100
Lubuto	Medium Cost	160
KantoLomba	Peri-Urban	60
Kanyala	Peri-Urban	60
Tawapia	Peri-Urban	60

Table 2-2-3 Classification of Housing and Design Daily Average Water Consumption per Capita

Cost Classification of Housing	Description in Zambian Standard	Design Daily Average Water Consumption per Capita by KWSC
High Cost	Floor area greater than 120 square meters; Good building finish; Multiple taps, more than one Water Closet (W.C); Lavatory	280 lpcd
Medium Cost	90-100 square meters floor area; Average building finish; Multiple taps, one or more Water Closet (W.C); Lavatory	160 lpcd
Low Cost	Less than 60 square meters floor area; Basic building finish; Reduced number of taps, one Water Closet (W.C); Lavatory	100 lpcd
Peri-urban	Communal or shared standpipe, or one tap in the Plot; Pit Latrines	60 lpcd

Lpcd: Liter per Capita per day

Table 2-2-2 shows Area, Category and Design Daily Average Water Demand (liter per Capita per day) of each area partition by each water source. These categories are decided as shown on the Table 2-2-3 by applying the Zambian standard [WATER SUPPLY SYSTEMS-CONSUMPTION Figures for design-Guidelines (DZS361:2007 ICS: 91.140.60)]. Design Daily Average Water Demand is the value which is set in KWSC.

(2) Planning policy

- Water treatment plant is to be restored to the facilities' original capacity utilizing the existing system.
- Pipeline facilities are different from the original design capacity in each pipeline by the fact that the addition of water resource and the change in the water-supply area were effected after it had been constructed. Therefore, the Design period for planning of the pipeline facilities is set as the year 2020, ten years after this outline design, in considering the population growth and renewing of water distribution pipes, and the pipe diameter is designed according to the result of hydraulic calculation

(3) Design population served

According to the report of Census[1] Statistics organization (CSO), the population of Ndola city in 2010 is forecast to be 483,000 people (estimation made assuming the influence of HIV/AIDS), and the water service coverage in 2010 reported by KWSC is 86%[2]; therefore, the water supplied populations in Ndola city are computed as 415,000 people. Out of these, the total population served in the target water supply area under this project is 317,000 people. Currently, the population increase rate in Ndola city is projected to be 1.1%[3] and applying this value, the population to be served under this project is planned as 354,000 people in 2020.

1 2000 Census Population Projections Report, CSO
2 Urban and Peri-Urban Water Supply and Sanitation Sector Report2009/2010, NWASCO
3 Summary Report for the 2000 Census of Population and Housing, CSO

2-2-2-2 Outline Design of Facilities

2-2-2-2-1 Design water supply

(1) Design average daily water consumption (general household)

Design average daily water consumption in general household is calculated with Design population served in each water supply area in 2020 and the foregoing daily average water consumption per capita of each classification of housing. The designed value is 40,285m^3/day.

Table 2-2-4 Population of Service Area and Design Average Daily Water Consumption (general household)

Town	AREA		TYPE	No. OF CONNECIONS	AVERAGE PEOPLE PER HOUSEHOLD	TOTAL POPULATION		Liter Per Capita per day	Water Demand (liter per day)	
						2010	2020		2010	2020
Kafubu Treatment	Itawa		HC	842	8	6,736	7,515	280	1,886	2,104
	Ndeke		MC	1,994	8	15,952	17,796	160	2,552	2,847
	Lubuto		MC	3,995	8	31,960	35,655	160	5,114	5,705
	Skyways		MC	176	8	1,408	1,571	160	225	251
	Mushili		MC	3,492	8	27,936	31,166	160	4,470	4,986
	Main Masala		LC	1,716	8	13,728	15,315	100	1,373	1,532
	Mine Masala		LC	1,066	8	8,528	9,514	100	853	951
	Mwaiseni/Kanyala		LC	31	8	248	277	100	25	28
	Kafubu		LC	14	8	112	125	100	11	12
	Kabushi		LC	2,416	8	19,328	21,562	100	1,933	2,156
	Kantolomba	Kiosks	Peri Urban	8	1,500	12,000	13,387			
		Individual		22		1,000	1,116	60	780	870
	Kaloko	Kiosks	Peri Urban	6	1,500	9,000	10,040			
		Individual		59		3,000	3,347	60	720	803
	Twiapa	Kiosks	Peri Urban	20	1,500	30,000	33,468			
		Individual		424		13,000	14,503	60	2,580	2,878
	Mckenzie	Kiosks	Peri Urban	3	1,500	4,500	5,020			
		Individual		3		4,500	5,020	60	540	602
	Sub Total					202,936	226,397	−	23,062	25,725
Chifubu Reservoir	Pamodzi		MC	2,811	8	22,488	25,088	160	3,598	4,014
	Chifubu		LC	5,148	8	41,184	45,945	100	4,118	4,595
	Sub Total					63,672	71,033	−	7,716	8,609
Northrise Reservoir	Kansenshi		HC	1,310	8	10,480	11,692	280	2,934	3,274
	Chipulukusu	Kiosks	Peri Urban	24	1,500	36,000	40,162			
		Individual		690		4,000	4,462	60	2,400	2,677
	Sub Total					50,480	56,316	−	5,334	5,951
Sub Total(Project Site)						317,088	353,746	−	36,112	40,285

(KWSC planning section)

(2) Design average daily water consumption
(Total: general household + public institution + industrial use)

For Design average daily water consumption (total), it is necessary to add other uses (school and hospital, etc.) by 20% and industrial use 45%, on top of the Design average daily water consumption (general household) according to the ratio decided through the consultation meeting with KWSC.

Category	Factor (%)
Others (Education and health institutions and so on)	20
Industrial use	45

(3) Design average daily supply

Present amount of the water leak (NRW) is 48.2% according to the data provided by KWSC. The main pipeline is to be repaired under this project, and it is assumed that the amount of the water leak may be lowered down to be 40%. New water leaks arising from the distribution pipeline which is out of the project scope is a concern, and it is considered difficult to improve the amount of the water leak to be less than 40%. Therefore, Design effective water rate is set as 71.4 % (=1/1.4).

Design average daily water consumption (total)
= (Design average daily water consumption for housing)
× (1.00+school, hospital, etc;0.20+induatrial use;0.45)

Design average daily supply
＝ (Design average daily water consumption(total)) ÷ Design effective water rate (0.714)

(4) Design maximum daily supply

Design maximum daily supply can be obtained through dividing Design average daily supply with the Dedign rate of loading. The coefficient, in which the diurnal variation of the amount of the water supply is shown as a result of the consultation with KWSC, is 1.2, and the Design rate of loading is set as 83.3 %(=1/1.2).

Design maximum daily supply＝Design average daily supply ÷ Design rate of loading (0.833)

(5) Design maximum hourly supply

Design maximum hourly supply is computed on Design maximum daily supply with applying a coefficient. Design maximum daily supply of Kafubu WTP is estimated at about 75,000m^3. As per “Design criteria for waterworks facilities 2000 Japan Water Works Association” (Hereafter, called, Design criteria), the Hourly factor for the residential area for the amount 75,000m^3 of Design maximum daily supply is 1.45. Therefore, the Hourly factor is calculated as follows in consideration of 18 hours of water supply target in the project area.

1.45×24/18＝1.93 → 2.00

Design maximum hourly supply＝Design maximum daily supply × Hourly factor 2.0

(6)Summary of amount of water supply

The amount of the designed water supply as discussed in the foregoing (1)-(5) can be summarized as shown in the following table.

Table 2-2-5　List of Design Water Supply

Service area	Design average daily supply (general household)(m^3/day)	Design average daily supply (m^3/day)	Design maximum daily supply (m^3/day)	Design maximum hourly supply ($m^{3/}$day)
Kafubu WTP	25,725	59,449	71,339	142,678
Chifubu reservoir	8,609	19,895	23,874	47,748
Northrise reservoir	5,951	13,752	16,502	33,004
Total of Design area	40,285	93,095	111,714	223,428

(7) Facilities and Design water supply

The definition of each facility is made as shown in the figure below.

Intake facility → Water conveyance facility → Water treatment facility
→ Water transmission facility → Reservoir → Water distribution facility

The targeted amount of the plan water supply is set as shown in the table below.

Design water supply	Facilities to be applied
Design average daily supply	—
Design maximum daily supply	Intake facility, Water conveyance facility, Water treatment facility, water transmission facility, reservoir
Design maximum hourly supply	Water distribution facility

(8) Required capacity of each facility

① Kafubu WTP intake facility

The amount of Design intake flow expects allowance for the plant use to be 5% of Design maximum daily supply.

Design intake flow＝71,339m^3/day×1.05＝74,906m^3/day

② Kafubu WTP water conveyance facility

Necessary capacity of water conveyance facilities is designed to be similar to intake facilities (amount of Design intake flow) and is 74,906m^3/day. Design criteria p.129)

③ Kafubu WTP

Design filtration flow is 81,800m^3/day, the original capacity of the existing facilities. The project will recover the original capacity, and usually they operate the WTP in accordance with the actual intake flow.

81,800m^3/day is the value including the Design intake flow and the reserved capacity of approximately 10%. The reserved capacity is for the keeping the capacity at the time of plant improvement or renovation, also minimizing the influence of disaster, machine trouble, accident and accelerating the recovery.

④ Kafubu WTP water transmission facilities

The capacity of water transmission facilities is designed as the amount of Design maximum daily supply and is 71,339m^3/day.

⑤ Reservoir

The capacity of the existing facilities (detention time) is as shown in the table below.

Table 2-2-6 Detention Time of Reservoir

Reservoir	Design Maximum Daily Supply (m^3/day)	Actual Capacity (m^3)	Actual Detention Time (hour)
Nakaputa	78,891	45,600	13.9
Skyways	12,151	4,500	8.9
Bwana Mkubwa	12,267	4,300	8.4
Chifubu	47,318	15,900	8.1
Northrise	16,496	8,300	12.1

Actual detention time

＝Actual capacity(m^3)÷Design maximum daily supply (m^3/day) ×24 (hours/day)

The capacity of the existing reservoirs are from 8.1 hour to 13.9 hour as shown in the above table. Generally, the capacity of reservoir has to be enough to absorb the fluctuation of water demand and enough to supply water for a certain time in an emergency. The standard detention time of reservoir in Japan is 12 hours. The time fluctuations in this are less than Japan and the existing reservoirs have the capacity of more than 8 hours of detention time, therefore it is judged to be fairly enough for the capacity of the existing reservoirs. Moreover, pipeline facilities of this project are designed taking into the capacity of the existing reservoirs.

2-2-2-2-2 Outline Design of Kafubu Water Treatment Plant

(1) Water quality condition

The water quality of raw water and treated water of Kafubu WTP during September 2009 – March 2010 was investigated from the monthly report. The result is as shown in the table below with the data on the maximum value, the average value, and minimum value.

Table 2-2-7 Water Quality of Kaubu Water Treatment Plant

Raw Water

		pH	Cond.	TDS	TSS	Turb	Colour	es. Ch	Cl^-	SO_4^{-2}	T/Alk	T/H	Ca	Mg	TC	FC
		–	μS/cm	mgL^{-1}	mgL^{-1}	NTU	Hz	mgL-1	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	$100mL^{-1}$	$100mL^{-1}$
2009	Sep	7.8	355	237	60	34	10		32	8	190	187	47	17	TNTC	TNTC
〃	Oct	8.4	337	225	15	18	15		20	39	190	130	32	12	TNTC	92
〃	Nov	8.8	325	217	11	54.0	40		12	25	186	162	43	13	340	90
〃	Des	8.8	337	225	20	28.0	40		27	71	155	154	41	13	20	ND
2010	Jan	7.8	258	172	13	20.0	20		30	14	156	154	38	15	120	55
〃	Feb	6.8	315	210	14	9.0	10		18	13	75	128	40	7	90	10
〃	Mar	6.8	266	177	12	7.5	15		14	25	191	18	41	6	9	–
Max		8.8	355	237	60	54.0	40		32	71	191	187	47	17	340	92
Ave		7.9	313	209	21	24.4	21		22	28	163	133	40	12	116	62
Min		6.8	258	172	11	7.5	10		12	8	75	18	32	6	9	10

Stage-1 Treeated Water

		pH	Cond.	TDS	TSS	Turb	Colour	es. Ch	Cl^-	SO_4^{-2}	T/Alk	T/H	Ca	Mg	TC	FC
		–	μS/cm	mgL^{-1}	mgL^{-1}	NTU	Hz	mgL-1	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	$100mL^{-1}$	$100mL^{-1}$
2009	Sep	7.5	346	231	30	21	5	1.0	27	7	190	170	40	17		
〃	Oct	7.3	357	238	4	5	5	0.4	28	26	180	154	33	17		
〃	Nov															
〃	Des															
2010	Jan	7.7	321	214	7	11.8	10	0.2	20	9	160	156	42	13		
〃	Feb	6.8	338	225	2	0.6	5	0.6	22	29	78	130	48	2		
〃	Mar	7.0	286	191	2	6.1	5	0.1	17	34	184	120	41	4		
Max		7.7	357	238	30	21.0	10	1	28	34	190	170	48	17		
Ave		7.3	330	220	9	8.8	6	0	23	21	158	146	41	11		
Min		6.8	286	191	2	0.6	5	0	17	7	78	120	33	2		

Stage-2 Treated Water

		pH	Cond.	TDS	TSS	Turb	Colour	es. Ch	Cl^-	SO_4^{-2}	T/Alk	T/H	Ca	Mg	TC	FC
		–	μS/cm	mgL^{-1}	mgL^{-1}	NTU	Hz	mgL-1	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	$100mL^{-1}$	$100mL^{-1}$
2009	Sep	7.6	347	231	2	11	5	1.6	30	10	188	180	39	20		
〃	Oct	7.3	357	238	2	6	5	0.7	27	28	170	124	36	8		
〃	Nov	8.1	340	227	27	14.0	5	0.5	20	23	128	146	38	13		
〃	Des	7.3	364	243	4	7.3	10	0.5	40	64	147	156	46	10		
2010	Jan	7.5	326	217	6	13.1	10	0.2	20	10	158	158	44	12		
〃	Feb	7.0	300	200	6	0.9	5	1.2	20	25	75	134	48	3		
〃	Mar	7.0	262	175	4	3.4	5	0.2	18	30	179	120	42	6		
Max		8.1	364	243	27	14.0	10	2	40	64	188	180	48	20		
Ave		7.4	328	219	7	7.8	6	1	25	27	149	145	42	10		
Min		7.0	262	175	2	0.9	5	0	18	10	75	120	36	3		

Stage-1＋Stage-2 Treated Water

		pH	Cond.	TDS	TSS	Turb	Colour	es. Ch	Cl^-	SO_4^{-2}	T/Alk	T/H	Ca	Mg	TC	FC
		–	μS/cm	mgL^{-1}	mgL^{-1}	NTU	Hz	mgL-1	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	mgL^{-1}	$100mL^{-1}$	$100mL^{-1}$
Max		8.1	364	243	30	21.0	10	2	40	64	190	180	48	20		
Ave		7.3	307	205	9	7.9	7	1	23	27	138	143	43	9		
Min		6.8	262	175	2	0.6	5	0	17	7	75	120	33	2		

The qualities of treated water of Stage-1 and Stage-2 are similar with each other as per the above-mentioned result of the survey.

The comparison of raw water quality, treated water quality, and Zambian standard is shown in the table below.

Table 2-2-8 Water Quality of Kafubu WTP and the Zambian Standard

Item	Raw Water			Treated Water (Stage-1 + Stage-2)			Maximum permissible limit(Zambian Standard)
	Max	Ave	Min	Max	Ave	Min	
pH	8.8	7.9	6.8	8.1	7.3	6.8	6.5～8.5
Color (HU)	40	21	10	10	7	5	15
Conductivity μS/cm)	355	313	258	364	307	262	2,300
Dissolved solids (mg/ℓ)	237	209	172	243	205	175	1,000
Hardness(total)as calcium carbonate (mg/ℓ)	187	133	18	180	143	120	500
Calcium(Ca) (mg/ℓ)	47	40	32	48	43	33	200
Magnesium(Mg) (mg/ℓ)	17	12	6	20	9	2	150
Chloride (mg/ℓ)	32	22	12	40	23	17	250
Alkalinity	191	163	75	190	138	75	－
Turbidity (NTU)	54.0	24.4	7.5	21	8	1	5

As shown in the above table, the item that exceeds Zambian standard value is only turbidity. Therefore, it is necessary to construct the treatment water facilities where the turbidity can be removed. The turbidity of the river increases with rain. As a result of the on-site survey, the maximum value of the turbidity of Kafubu dam is 150 NTU. The plan with conditions concerning the turbidity of the Kafubu WTP is shown below.

Design Value	Max.	Ave.	Min.
Turbidity (NTU)	150	24.4	7.5

The raw water for the Kafubu WTP is taken from Kafubu dam. Most of water that flows into Kafubu dam is derived from sewage water (the water which is not treated enough is included) discharged to the Kafubu River. The sewage that flows in is assumed to be a source of nutrition for algae and the algae grow thickly in the water of the dam, and taking measures against the inflow of algae are necessary for the water treatment facilities.

Therefore, the items to be processed in Kafub treatment plant shall include the turbidity and algae.

(2) Treatment system on water quality condition

System of processing of the existing water treatment facilities is as follows.

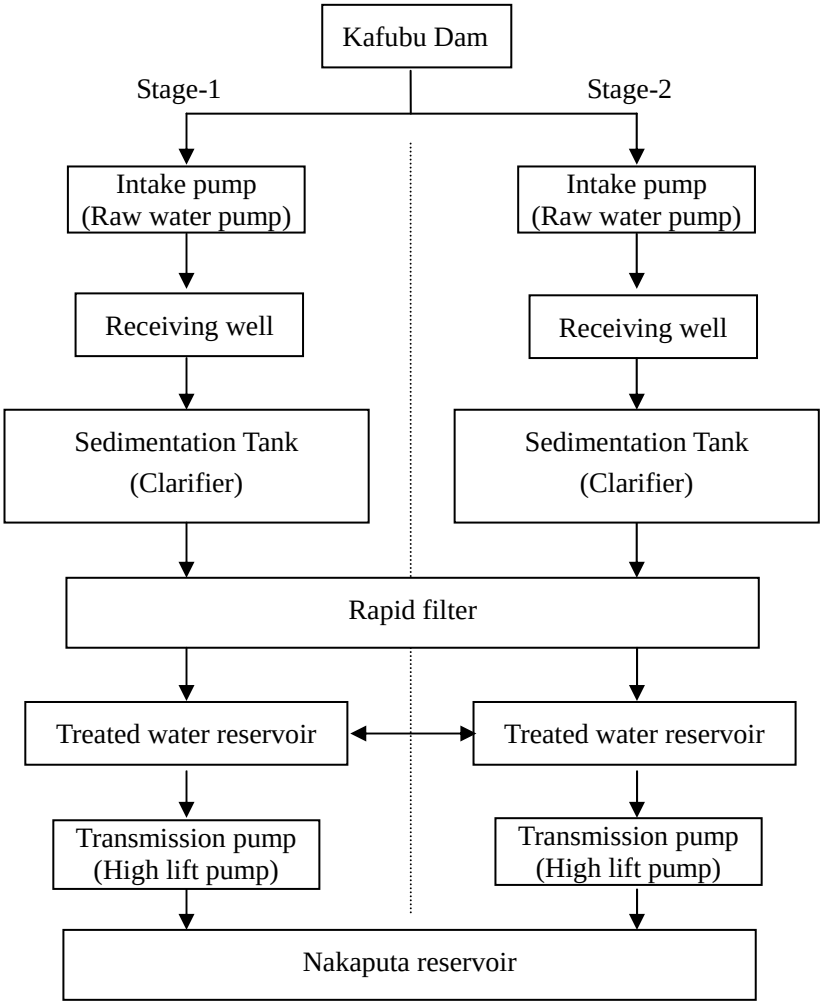


Fig. 2-2-2 Flow Sheet of Kafubu Water Treatment Plant

To reduce turbidity, coagulation-sedimentation processing and a rapid filtration are done in a system of the existing water treatment facilities in addition to feeding coagulant with a receiving well. As a result, an NTU value less than five degrees of the Zambian standards can be observed. Moreover, pre-chlorination is fed into a receiving well of the existing facilities as an algicide. Killed algae are removed through the coagulation-sedimentation processing.

(3) Volume of treated water

The facilities' capacity is set as same as at present and Design treated water flow is the following volume.

Stage-1 : 40,900 m^3／day
Stage-2 : 40,900 m^3／day
Total : 81,800 m^3／day

(4) Intake pump capacity

Three units of pumps cannot be driven at the same time from the limitation of the power supply capacity of the transformer. Therefore, the standby unit of the pump could be arranged for one in each system. Accordingly, two pumps (standby units) and four existing pumps ($792m^3$×20m) are designed to be equipped.

Design intake flow: 74,906m^3/day (3,121m^3/h)
Therefore,
Pump capacity＝3,121m^3/h÷4pump＝780m^3/h
It makes the capacity to be 792m^3/h/unit equivalent to the existing one.

Intake pump specification

Type:	Vertical shaft type double suction volume pump
Discharge rate:	13.2m^3/min/unit (792m^3/h/unit)
Pump head:	20m
Electric motor:	75kW
Quantity:	existing 4 units, new installation of 2 units (standby pump)

Stage-1 and Stage-2 are operated independently for coagulation-sedimentation processing up to the entrance to the rapid filtration as shown in the above-mentioned flow sheet. Therefore, the sedimentation tank processing performance in each system shall be equal to the flowing quantity of as much as two intake pumps driving.

The capacity of the existing intake pump at regular operation time: usually.
Stage-1 (Regular use) ＝792m^3/h×2 units＝1,584m^3/h＝38,016 m^3/day
Stage-2 (Regular use) ＝792m^3/h×2 units＝1,584m^3/h＝38,016 m^3/day

Capacity of the existing facilities is examined on the above-mentioned conditions.

(5) Transmission pump capacity

Transmission pump facilities are designed as 5 units (4 using regularly and 1 standby) for new installation

Design transmission flow: 71,339m^3/day (2,972m^3/h)
Therefore,
Pump capacity＝2,972m^3/h÷4 units＝743m^3/h

Transmission pump specification

Type:	Vertical shaft type double suction volute pump
Discharge rate:	743m^3/h/unit
Pump head:	134m
Electric motor:	400kW
Quantity:	new construction of 5 units (standby pump: 1 unit)

(6) Stage-1 Examination of facilities' capacity

Design criteria is applied to the following verification of the existing facilities. Though some facilities in the Kafub Water Treatment Plant have structural differences from the Design criteria , the existing system can treat the raw water properly judging from the past operation records. The basic policy of this project is to recover the capacity of the existing facilities with the basic structure of the existing facilities remaining unchanged in this project.

As for each component in the Kafub Water Treatment Plant, the criterion values of the similar type facility on the Design criteria can be applied as the referential value. These criterion values have an acceptable range between the necessary value for the performance assurance and allowable economic limit for the new construction. The main scope of this project is rehabilitation of the existing facilities, with the structural change not being included. Therefore the necessary values for the performance assurance are applied in the following verification.

1） Design filtration flow

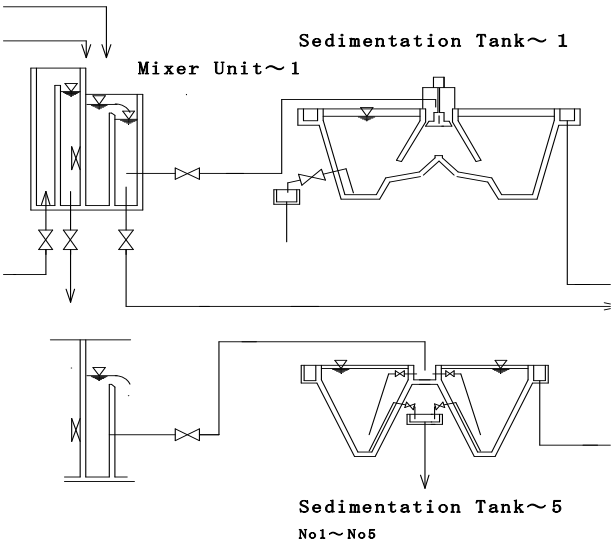
40,900m^3/day＝1,704 m^3/h＝28.4 m^3/min＝0.47 m^3/s

The existing capacity is examined on the above-mentioned condition.

2） Coagulation-sedimentation process facilities

① Treatment flow

The figure below shows the flow of coagulation-sedimentation process facilities Stage-1.



Raw water flows in receiving well of Stage-1, and feeds coagulant (solid alum) and pre-chlorination. After this, it is divided evenly into a sedimentation tank of the blanket type of ϕ 24.7m and a sedimentation tank of 8.1m×8.0m×10tanks.

② Receiving well

A) Shape of existing tank

Width of tank W_1	3.57 m
Length of tank L_1	5.0 m
Depth of tank H_1	4.0 m

B) Examination

Capacity of tank $V_1 = W_1 \times L_1 \times H_1 = 71.4\ m^3$

Detention time $T_1 = V_1 \div$ Design filtration flow $= 71.4\ m^3 \div 28.4\ m^3/min = 2.5$ min

The mixture time is 2.5 minutes and meets the Design criteria .
(The mixture time is more than 1 minute; Design criteria P.186)

③ Circular sedimentation tank (sludge blanket type ϕ 24.7 m)× 1 tank

Half of raw water flowing into Stage-1 line is treated in this circular clarifier.

Inflow water volume = Stage-1 inflow water volume÷2 lines
$= 40{,}900 m^3/day \div 2$ lines $= 20{,}450 m^3/day$

A) Shape of existing tank

Radius on surface：	$r_1 = 12.35$ m
Lower guess radius：	$r_2 = 8.2$ m
Height to lower guess radius:	$h = 7.6$ m
Radius in the upper part:	$r_3 = 1$ m
Number of tanks:	1 tank

B) Calculation

Capacity $V_2 = 1/3 \times \pi \times (r_1^2 + r_1 \times r_2 + r_2^2) \times h = 2{,}554\ m^3$

Surface area $S_2 = \pi \times (r_1^2 - r_3^2) = 476\ m^2$

C) Examination

The existing system has the flow as the following.

- Coagulant is added to the raw water in the receiving well (mixer unit).
- Small floc clusters are formed through the flow in the connecting trench and pipe in sedimentation tank (clarifier).
- The clusters rising up through the floc zone in sedimentation tank grow in size.
- Grown floc settle out by gravity.

Flocs can grow up efficiently in the presence of the existing floc. This feature is same with the “suspended solid contact type clarifier” on the Design criteria. Therefore the existing sedimentation tank can be classified into this type and the Design criteria can be applied.

Surface water loading ratio (water rising velocity in suspended solids contact clarifier)

＝inflow water volume÷S_2＝20,450m^3/day ÷476 m^2

＝0.0298 m/min≒30mm/min (real surface water loading ratio)

(The surface water loading ratio is less than 60 mm/min; Design criteria P.199)

Detention time T_2＝V_2÷inflow water volume＝2,554 m^3÷20,450m^3/day ＝180 min (real detention time)

(The detention time is more than 90 minutes; Design criteria P.199)

Both the necessary capacity for the surface water loading ratio and the detention time are secured, and processing by the existing facilities is possible.

After the separation of suspended solid in the sedimentation tank, the capacity of collecting trough is necessary to guide the clear upper water into the subsequent filtering stage. The existing concrete trough in the circular sedimentation tank is still not deteriorated and will continue to be used.

④ Sludge blanket type suspended solids contact clarifier 8.1m×8.0m×10 tanks

Half of raw water flowing into Stage-1 line is treated in this rectangle clarifier.

It is evenly distributed in 2 lines.

Inflow water volume ＝Stage-1 treated water volume÷2 lines

＝40,900m^3/day÷2 lines＝20,450m^3/day

A) Shape of existing tank

Width W_3＝8.0 m

Length L_3＝8.1 m

Number of tanks N_3＝10 tanks

B) Calculation

Capacity＝upper rectangle part＋prismoid part

Area of upper rectangle part＝L_3×W_3＝64.8m^2

Area of prismoid＝0.762×0.762＝0.58 m^2

Capacity of prismoid part

＝1/3× (area of upper rectangle＋√(area of upper rectangle × area of lower prismoid)＋area of lower prismoid) ×Height of prismoid part

＝1/3×(64.8＋√(64.8×0.58)＋0.58) ×6.96＝166 m^3

Capacity of upper rectangle＝area of upper rectangle × depth of water of upper rectangle

＝64.8×1.5＝97 m^3

Total capacity V_3＝(166＋97)×10＝2631m^3

Surface area S_3＝W_3×L_3×N_3＝648m^2

C) Examination

Design criteria for the sludge blanket type of the sedimentation tank of the suspended solids

contact clarifier can be applied as with the above mentioned circular sedimentation tank.

Surface water loading ratio (water rising velocity in suspended solids contact clarifier)
＝inflow water volume÷S_3＝20,450m^3/day ÷648 m^2
＝0.022 m/min＝22mm/min (real surface water loading ratio)
(The surface water loading rate is less than 60 mm/min; Design criteria P.199)

Detention time T_3＝V_3÷inflow water volume＝2631 m^3÷20,450m^3/day＝185 min
(real detention time)
(The detention time is more than 90 minutes; Design criteria P.199)

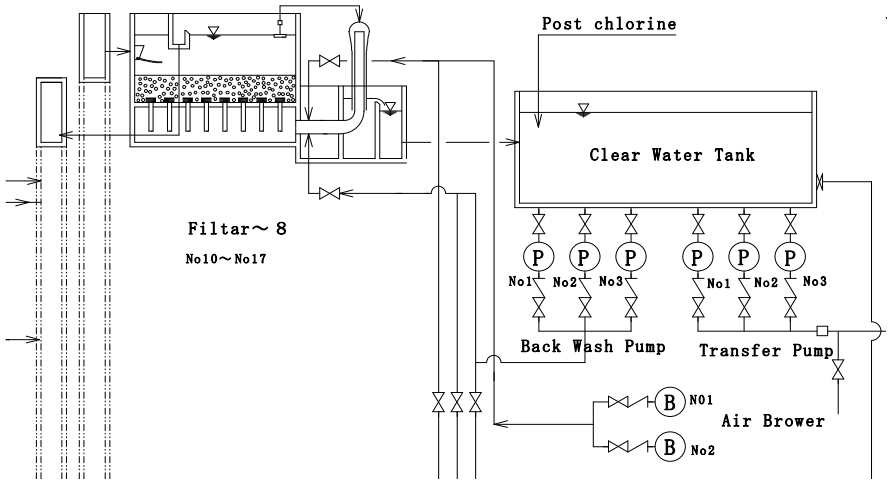
Both the necessary capacity for the surface water loading ratio and the detention time are secured, and processing by the existing facilities is possible.

The existing collecting trough in the Sludge blanket type suspended solids contact clarifier will be replaced. The material of the trough is fiber reinforced plastic (FRP) and some parts are cracked or deflected. Roofs or covers on the clarifier are not in place and the trough is exposed to direct rays of the sun. Though the concrete trough has high strength and weather resistance, it is so heavy that some supporting columns are required to set it anew. However, an added load on the existing concrete structure which has passed over 40 years is not appropriate. Therefore, a lightweight and weather proof FRP trough with an iron core is adopted as the replacement.

3） Rapid filter

① Treated flow

The figure below shows treated flow of Stage-1.



② Existing filter shape

Width　W_4＝4.877 m
Length　L_4＝9.754 m
Filter bed area＝widthW_4×lengthL_4＝4.877 m×9.754 m＝47.6 m^2
Number of tanks　N_4＝8 tanks
Total filter bed area S_1＝W_4×L_4×N_4＝381 m^2

③ Examination

There is no gravel stratum in the existing filter. The existing filter reduces the scale spacing of the strainer, and prevents sand from flowing out. The feature and capacity of the existing filter is similar to the one on the Design criteria. Therefore the Design criteria can be applied.

Filtration rate V_1 = treated water volume ÷ total filter bed area S_1
= 40,900m^3/day ÷381 m^2 = 107.5 m/day (real filtration rate)
(The filtration rate is less than 150 m/day; Design criteria P.213)

The filtration rate meets the Design criteria, and the existing filter can process the raw water without suspended solid leak through the filter.

④ Washing condition of filter

The calculation of the existing capacity and the service condition is shown in the following.

Specification of existing backwash pump discharge quantity = 320m^3/h/unit
(3 unit installation)

Backwash rate when one driving = discharge quantity of existing pump
÷ filtration bed area
= 320 m^3/h ÷ 47.6 m^2 = 6.73m/h=0.112m/min

Backwash rate when three driving = 6.73m/h×3unit = 20.2 m/h

Specification of existing air-scour blower; discharge quantity = 1260m^3/h/unit
(2 unit installation)

Air-scour rate when one driving = discharge quantity of existing blower ÷ filtration bed area
= 1260 m^3/h ÷ 47.6 m^2 = 26.5 m/h = 0.441m/min

Air-scour rate when two driving = 26.5 m/h×2unit = 53m/h

The above-mentioned calculated value and the optimal washing condition are indicated in the following table.

Optimal condition			Operation of Backwash Pumps and Air-Scour Blowers
Situation	Time (min.)	Condition (m/h)	
Start			
Backwash	4～6	6～7	Pump 1unit operation = 6.73 m/h
Air-scour	8～10	50～60	Blower 2 units operation = 53 m/h
Backwash shutdown			
Backwash	5～6	20	Pump 3 units operation = 20.2 m/h

As the result of the above consideration, it is necessary to use the 3 units of backwash pumps and 2 units of air-scour blowers. Those are totally reinstalled.

Judging from the operation condition of the existing water treatment plant, washing of rapid filter is possible with one machine in case of short-term maintenance. Thus, the standby machine will not set it up

4） Treated water reservoir

Existing tank capacity V_5＝965m^3
Detention time T_5＝tank capacity ÷ treated water volume＝965m^3÷28.4 m^3/min ＝34.0 min

The treated water reservoir is the regulating facilities for the purpose of stable water supply in the case of sudden changes of filtered water amount or required transmission water volume, and the maintenance work in the water treatment plant. The necessary detention time is 1.0 hours according to the Design criteria on p.264. Though the capacity of the existing treated water reservoir in Kafubu WTP does not satisfy this value, Nakaputa reservoir has a buffering function. Treated water of Kafubu WTP is once lifted to Nakaputa reservoir (volume; 45,600m^3) and then transferred to other reservoirs. On the other hand, in terms of the flow balance in Kafubu WTP, coordination of intake pumps operation and transmission pumps operation is necessary to reduce the fluctuation of water level in the treated water reservoir.

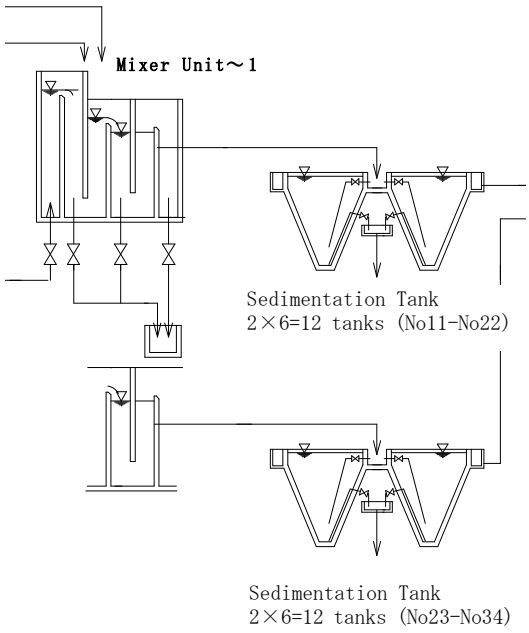
(7) Stage-2 Examination of the facilities' capacity

1） Design filtration flow

40,900m^3/day＝1,704 m^3/h＝28.4 m^3/min＝0.47 m^3/s
The existing capacity is examined on the above-mentioned condition as well as Stage-1.

2) Coagulation-sedimentation process facilities

① Treatment flow
The figure below shows the flow of Coagulation-sedimentation process facilities Stage-2.



Raw water flows in the receiving well of Stage-2 and feeds the coagulant (solid alum) and pre-chlorine. After this, it is divided evenly into 2 lines. Each line has 8.1m×8.0m×12 sedimentation tanks.

② Receiving well

A) Shape of existing tank

Width of tank W_1	3.77 m
Length of tank L_1	3.8 m
Depth of tank H_1	4.0 m

B) Examination

Capacity of tank $V_1 = W_1 \times L_1 \times H_1 = 57.3 m^3$

Detention time $T_1 = V_1 \div$ Design filtration flow $= 57.3\ m^3 \div 28.4\ m^3/min = 2.0$ min

The mixture time is 2.0 minutes and meets the Design criteria.
(The mixture time is more than 1 minute; Design criteria, P.186)

③ Sludge blanket type suspended solids contact clarifier 8.1m×8.0m×12tanks×2sets

Raw water flowing into Stage-2 line is evenly distributed in 2 sets.
Inflow water volume＝Stage-2 treated water volume÷2 sets＝40,900m^3/day÷2 sets＝20,450m^3/day

A) Shape of existing tank

Width $W_3 = 8.0$ m
Length $L_3 = 8.1$ m
Number of tanks $N_3 = 12$ tanks

B) Calculation

Capacity＝upper rectangle part＋prismoid part

Area of upper rectangle part＝$L_3 \times W_3$＝64.8m^2

Area of prismoid＝0.762×0.762＝0.58 m^2

Capacity of prismoid part

＝1/3× (area of upper rectangle＋√(area of upper rectangle × area of lower prismoid)＋area of lower prismoid) × Height of prismoid part

＝1/3×(64.8＋√(64.8×0.58)＋0.58) ×6.96＝166 m^3

Capacity of upper rectangle＝area of upper rectangle × depth of water of upper rectangle

＝64.8×1.5＝97 m^3

Total capacity V_3＝(166＋97)×12＝3,157m^3

Surface area S_3＝$W_3 \times L_3 \times N_3$＝778$m^2$

C) Examination

Design criteria for the sludge blanket type sedimentation tank of the suspended solids contact clarifier can be applied as with the sedimentation tank of Stage-1.

Surface water loading ratio (water rising velocity in suspended solids contact clarifier)

＝inflow water volume÷S_3＝20,450m^3/day ÷778 m^2

＝0.018 m/min＝18mm/min (real detention time)

(The surface water loading ratio is less than 60 mm/min; Design criteria P.199)

Detention time T_3＝V_3÷inflow water volume＝3,157 m^3÷20,450m^3/day＝222 min

(The detention time is more than 90 minutes; Design criteria P.199)

Both the necessary capacity for the surface water loading ratio and the detention time are secured, and processing by the existing facilities is possible. The existing collecting trough will be replaced just like the Sludge blanket type suspended solids contact clarifier of Stage-1.

3) Rapid filter

① Treated flow

It is similar to Stage-1.

② Existing filter shape

Width W_4＝4.877 m

Length L_4＝9.754 m

Filter bed area＝widthW_4×lengthL_4＝4.877 m×9.754 m＝47.6 m^2

Number of tanks N_4＝9 tanks

Total filter bed area S_1＝$W_4 \times L_4 \times N_4$＝428 m^2

③ Examination

Filtration rate V_1＝ treated water volume ÷ total filter bed area S_1

＝ 40,900m^3/day ÷428 m^2＝95.6 m/day (real filtration rate)

(The filtration rate is less than 150 m/day; Design criteria P.213)

The filtration rate meets the Design criteria and the existing filter can process the raw water without suspended solid leak through the filter.

④ Washing condition of filter

The shape and dimension of the filter and the washing condition are the same as Stage-1 and 2. Therefore, a single unit of washing facilities is designed for common usage of Stage-1 and 2.

4) Treated water reservoir

Existing tank capacity V_5＝1,752m^3

Detention time T_5＝tank capacity ÷ treated water volume＝1,752m^3÷28.4 m^3/min ＝61.7 min

The necessary detention time is 1.0 hours according to Design criteria p.264.
Therefore, existing facilities satisfy the necessary capacity.

(8) Alum feeder facilities

1) Design condition

Design filtration flow

Stage-1＋Stage-2＝40,900m^3/day＋40,900m^3/day＝81,800m^3/day

It is calculated on the above-mentioned condition.

2) Examination

① Solution concentration when existing dissolution tank is used

Volume of dissolution tank

1.88 m×1.90m×1.8m×1 tank＝6.43 m^3

Volume of existing alum basket

1.88 m×0.43m×0.7m×1 tank＝0.566 m^3

The apparent specific gravity of Alum is 0.7. Calculating with this value, the weight of Alum which can be put in the basket is as below.

0.566 m^3×0.7＝396kg

Solid alum capacity of one bag is 50kg; therefore, eight bags can be turned on to the basket at one time. The amount of the total input: when turning it on twice repeating the amount.

Input＝50kg×8bags×2times＝800kg

Solid alum density at this time: 800/6.43/1,000 ＝ 0.124

Amount of alum of the maximum dissolution: 87g/100 mℓ＝0.87, therefore, dissolution is possible.

Therefore, the density of alum is used by 12.4% with the existing dissolution tank.

② Alum dosage

The design condition of the turbidity of raw water is as follows.

Turbidity of raw water (NTU) Max.＝150　Ave.＝24.4　Min.＝7.5

Alum dosage is calculated based on the design condition of the above-mentioned turbidity as follows.

The maximum dosage＝$1.5\times\sqrt{150}$　＝18.3→20mg/ℓ

Designed maximum dosage is 20mg/ ℓ or less (As solid alum). In other condions (average turbidity = 24.4 NTU, minimum turbidity = 7.5NTU), dosage are similarly calculated, and the result is shown in the table below.

③ Volume of feeding alum

The maximum feeding volume = Design filtration flow × dosage

＝81,800m^3/day×20mg/ℓ＝1,636,000g/day＝1,636kg/day

The dissolution density of Alum is 12.4% as the above-mentioned calculation. Therefore, the amount of the maximum feeding volume is calculated as follows.

The maximum feeding volume＝feeding volume ÷ density

＝1,636kg÷0.124÷2＝6,597ℓ/day＝4.58ℓ/min

In other conditions (average turbidity = 24.4 NTU, minimum turbidity = 7.5NTU), feeding volume are similarly calculated;, and the result is shown in the following table.

		Stage-1			Stage-2		
Raw water Turbidity	(NTU)	150	24.4	7.5	150	24.4	7.5
Alum dosage	(mg/ℓ)	20	8	4	20	8	4
Feeding volume	(ℓ/min)	4.58	1.8	0.9	4.58	1.8	0.9

The storage time of existing 1 dissolution tank:

Volume of existing dissolution tank ÷ maximum feeding volume

＝6.43 m^3÷　(4.58＋4.58) ℓ/min＝702min＝11.7h

Volume of coagulant feeding pump＝4.58ℓ/min　→　5.0ℓ/min

Therefore, the following 3 new pumps will be set for alum feeding.

Stage-1 coagulant feeding pump　5.0ℓ/min～1set
Stage-2 coagulant feeding pump　5.0ℓ/min～1set
Common standby coagulant feeding pump　5.0ℓ/min～1set

It is possible to correspond by changing a dissolution solid alum density when the amount of a necessary feeding increases.

When three intake pumps of Stage-2 are operating, and one coagulant feeding pump is driving with the feeding volume of the same as above, dosage is as follows.

Dosage＝ 5.0ℓ/min ×0.124mg/ℓ×60min×24h ／ (792m^3/h ×3pumps×24h) ＝15.7 mg/ℓ

Therefore, without changing the density, up to 15.7 mg/ℓ is possible to be fed.

④ Stockpile of Alum

The stockpile for 20 days is as follows,

Stockpile＝quantity consumed × stock days＝1,636kg/day×20days＝32,720kg
Number of stock bags＝32,720kg÷50kg/bag＝654bags
Shape of a bag with 50kg＝0.4mW×0.8 mL×0.15 mH
5bags×14lines×5stages×2places＝700

Storing space;
Length＝0.8 mW×5bags×1.1 (allowance) ＝4.4m
Width＝0.4 mL×14lines＝5.6m
Height＝0.15 mH×5stages＝0.75m

The area of existing alum storage is 12.1m×15.5m. Therefore, it is possible to store the bags for 20 days.

(9) Slaked lime feeding facilities

1) Design condition

Design filtration flow 81,800 m^3/day
Alkali consumption by alum＝0.45mg/ℓ
Alkali consumption by chlorine＝1.41mg/ℓ
Amount of alkali of slaked lime＝0.77mg/ℓ
Note) about the amount of the decrease of the alkali
Amount of alkali decrease by alum
＝Alum dosage × Alkali consumption＝20mg/ℓ×0.45＝9mg/ℓ
Amount of alkali decrease by chlorine
＝pre-chlorine dosage × Alkali consumption by chlorine
＝prechlorine7mg/ℓ×1.41mg/ℓ＝9.87mg/ℓ

Total alkali consumption＝9mg/ℓ＋9.87mg/ℓ＝18.87 mg/ℓ

The figure below shows the alkalinity data of raw water of Kafubu WTP in 2009.

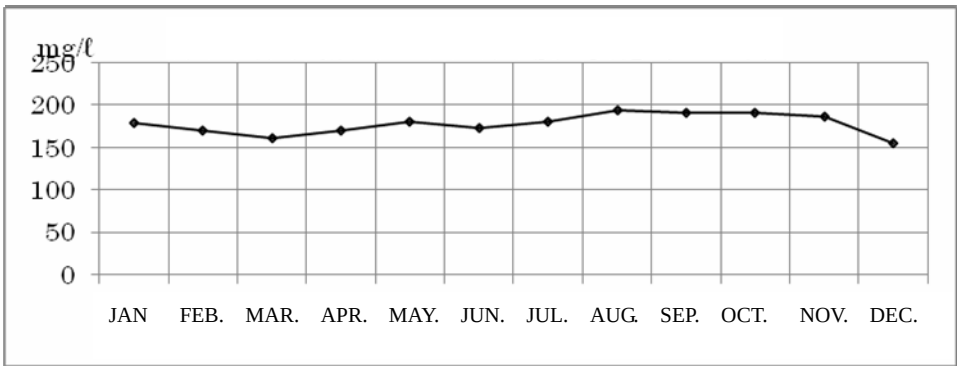


Fig. 2-2-2 Alkarinity in Kafubu Water Treatment Plant

150mg/ℓ is in the alkalinity of raw water over a year period (see above), and the feeding of alkaline chemicals is unnecessary.

(10) Chlorine feeding facility

1) Stage-1

① Design condition

Design filtration flow 40,900 m^3/day

Prechlorine dosage (chlorine gas)

Max.7mg/ℓ

Ave.3mg/ℓ

Min.1mg/ℓ

Post-chlorine dosage (chlorine gas)

Max.3mg/ℓ

Ave.2mg/ℓ

Min.1mg/ℓ

Kafubu River

② Calculation

Amount of pre-chlorine maximum feeding＝Design filtration flow × pre-chlorine dosage

＝40,900 m^3/day×7mg/ℓ＝286kg/day

In each conditions of the maximum turbidty, the average turbidity and the minimum turbidity, chlorination volume is similarly calculated and the results are as shown in the table below.

		Pre-chlorination			Post-chlorination		
Raw water Turbidity (NTU)		Max. 150	Ave. 24.4	Min. 7.5	Max. 150	Ave. 24.4	Min. 7.5
Chlorine dosage(mg/ℓ)		7	3	1	3	2	1
feeding volume	Kg/day	286	123	41	123	82	41
	Kg/h	12	5	2	5	3	2

2) Stage-2

Same as Stage-1.

3） Chlorine feeding facility

From the above-mentioned numerical result, the following facilities are designed as newly installed.

Pre-chlorine feeding facility

Stage-1	12kg/h	1set
Stage-2	12kg/h	1set
Common standby	12kg/h	1set

Post-chlorine feeding facility

Stage-1	5kg/h	1set
Stage-2	5kg/h	1set
Common standby	5kg/h	1set

4） Examination of incidental facility

① Examination of amount of gas cylinder use

Maximum hourly use

＝Stage-1 (pre-chlorine＋post-chlorine) ＋Stage-2 (pre-chlorine＋post-chlorine)

＝12＋ 5＋ 12＋ 5 ＝34 kg/h

Maximum amount taken out from one gas cylinder (chlorine gas stockpile 1,000kg)

＝8kg/h/cylinder

A necessary number of 1 ton gas cylinder in order to take out the chlorine gas of 34kg/h,

Necessary number (N) ＝34kg/h÷8kg/h/cylinder＝4.25cylinders→5cylinders

Therefore, five 1 ton gas cylinders are used.

Assuming the stockpile is for 10 days of the above-mentioned maximum use,

Necessary stockpile (K_1) ＝34 kg/h×24hour/day×10days

＝8,160kg → 9,000kg (nine 1 ton gas cylinders)

The space of the existing gas cylinder storage is as large as for 24 cylinders and it is possible to store the stockpile for 10 days.

② Examination of amount of pressure water

The chlorine gas is dissolved in the pressure water and fed.
Feeding facility uses wet pressure type. An necessary volume of water is calculated as follows.

At12kg/h, 80ℓ/min, at 5kg/h, 33ℓ/min necessary total volume of water (Q_2) is,

(Q_2) ＝80ℓ/min×2＋33ℓ/min×2＝226 ℓ/min

Diameter of existing pipe＝ ϕ 50mm×100m,　pressure loss (h_1) is,

$h_1 = \lambda \times \ell / d \times V^2 / 2g$ ＝ 0.03×100/0.05×1.92^2 /(2×9.8)＝11.3 mAq

λ : Pipe friction coefficient＝0.03(steel pipe)

ℓ : Length of pipe≒100 m

d : Diameter of pipe＝ ϕ 0.05m

V : Flow velocities of pipe＝226 ℓ/min÷(π/4×0.05^2)＝1.92m/s,

Diameter of existing pipe＝ ϕ 40mm×20m,　pressure loss(h2)is,

$h_2 = \lambda \times \ell / d \times V^2 / 2g$ ＝ 0.03×20/0.04×3.0^2 /(2×9.8)＝6.9 mAq

λ : Pipe friction coefficient＝0.03(steel pipe)

ℓ : Length of pipe≒20 m

d : Diameter of pipe＝ ϕ 0.04m

V : Flow velocities of pipe＝226 ℓ/min÷(π/4×0.04^2)＝3.0m/s,

Total pipe friction＝11.3 mAq＋6.9 mAq＝18.2 mAq

Water pressure at the injection point is 110 mAq; therefore, water pressure at the feeding point is as the following,

110mAq－18.2mAq＝91.8mAq

The feeding is possible.

Chlorine density (C_1) of chlorine solution at this time is,

C_1＝chlorine feeding volume ÷ necessary total water volume　(Q_2)　＝34 kg/h÷226 ℓ/min

＝2,510mg/ℓ

(11) Capacity calculation summary

The capacity of each facility is as shown in the table below.

Table 2-2-9 Capacity of Each Facility

Facility	Requiored Capacity (Design criteria)		Actual Capacity			
			Stage-1		Stage-2	
Receiving well (mixing tank)	Detention time	More than 1 minute	2.5min	250%	2.0min	200%
Sedimentation Tank (Clarifier) (circular tank with radial flow)	Detention time	More than 90 minutes	180min	200%	—	—
	Surface water loading ratio	Less than 60 mm/min	30mm/min	200%	—	—
Sedimentation Tank (Clarifier) (rectangle tank)	Detention time	More than 90minutes	185min	205%	222min	246%
	Surface water loading ratio	Less than 60 mm/min	22mm/min	272%	18mm/min	333%
Rapid filter	Filtration rate	Less than 150 m/day	107.5m/day	139%	95.5m/day	157%
Treated water reservoir	Detention time	More than 1 hour	34min	56%	62min	103%

(12) List of equipments

The lists of the equipment for replacement or repair are as follows.

Table 2-2-10 List of Equipments

Stage	Equipment name	Specification	Quantity
1. Intake pump (Raw water pump)			
1	Intake pump	Vertical shaft type double suction volute pump ($792m^3/h \times 20\ m \times 75kW$) Existing removal, foundation repair	1 unit
1	Drain pump	Submerged pump, $10m \times 0.1m^3/min \times 0.75kW$ Automatic operation, cable＝30 m, with piping material	1 unit
2	Intake pump	Vertical shaft type double suction volute pump ($792m^3/h \times 20\ m \times 75kW$) Existing removal, foundation repair	1 unit
2	Chain block	2ton, traveling, lifting, chain	1 set
2	Drain Pump	Submerged pump, $10m \times 0.1m^3/min \times 0.75kW$ Automatic operation, cable＝30 m, with piping	1 unit
2. Sedimentation Tank			
1	Collecting Trough	FRP trough, iron core 370mm(b)×280mm (d) ×8,400mm (l)	40 pieces
2	Collecting Trough	FRP trough, iron core 370mm(b)×280mm (d) ×8,400mm (l)	96 pieces
3. Filter control valve			
—	Backwash valve	ϕ 350mm flangeless butterfly valve, manual, Joystick L=3,500mm with piping	17 pieces
—	Air-scour valve	ϕ 150mm flangeless butterfly valve, manual, Joystick L=3,000mm with piping	17 pieces
—	Treated water valve	ϕ 275mm flangeless butterfly valve, manual, Joystick L=3,500mm with piping	17 pieces
—	Siphon flow controll valve	ϕ 50mm, ϕ 25mm needle valve	17 pieces
4. Backwash pump			
2	Backwash pump	Single suction volute pump $320m^3/h \times 16m \times 22kW$ Existing removal, basement repair Sluice valve, check valve, connecting pipe	3 units
5. Air-scour blower			
2	Blower	Roots blower, $1{,}260Nm^3/h \times 50kPa \times 30kW$ Sluice valve, check valve, connecting pipe	2 units

Stage	Equipment name	Specification	Quantity
6. Stop Logs			
—	Stop logs	910 mm(b)×300 mm(h), material : wood (corrosion-proof) , steel frame	5 pieces
7. Transmission pump (High lift pump)			
1	Transmission pump	Vertical shaft type double suction volute pump $744m^3/h \times 134$ m×400kW Existing removal, foundation repair Sluice valve, check valve, motor-operated discharge valve , connecting pipe	2 units
1	Drain pump	Submerged pump, 10m×$0.1m^3$/min×0.75kW Automatic operation, cable＝30 m, with piping	1 unit
2	Transmission pump	Vertical shaft type double suction volute pump $744m^3/h \times 134$ m×400kW Existing removal, foundation repair Sluice valve, check valve, motor-operated discharge valve , connecting pipe	3 units
2	Drain pump	Submerged pump, 10m×$0.1m^3$/min×0.75kW Automatic operation, cable＝30 m, with piping	1 unit
1,2	Water level gauge for surge tank	Level gauge	1 each
1,2	Compressor for surge tank	With piping material	1 each
1,2	Surge tank repair	Welding, painting	1 each
8. Coagulant (Alum) feeding facility			
—	Existing dissolution tank acid proof painting	Acid proof mortar paint	3 tanks
—	Strainer	Hard wood 1.9m×0.49m×30mm	3 sets
—	Dissolution tank mixer	Vertical shaft propeller 0.75kW	3 units
—	Coagulant feeding pump	Metering pump 5.0ℓ/min 0.4kW sluice valve, check valve	3 units
—	Drain valve	Diaphragm valve ϕ 50mm body : PVC, diaphragm : rubber, flange : JIS10K	4 nos
—	Storage tank drain valve	Diaphragm valve ϕ 100mm body : PVC, diaphragm : rubber, flange : JIS10K	3 nos
—	Level regulating valve	ϕ 40mm	3 nos
—	Sluice valve for water	ϕ 40 mm	3 nos
—	Main valve for washing water	ϕ 40mm	1 no

Stage	Equipment name	Specification	Quantity
—	Piping material for water	Galvanized steel pipe ϕ 40mm	1 unit
—	Indoor piping material	Polyvinyl chloride pipe ϕ 50mm, ϕ 100mm	1 unit
—	Outdoor piping material	Polyvinyl chloride pipe ϕ 50mm	1 unit
—	Feeder pipe stand	Structural rolled steel	1 unit
—	Ditch for outdoor piping	Concrete trough with Packing sand	1 unit
9. Chlorine feeding facility			
—	Chlorine steel bottle manifold	Galvanized steel pipe ϕ 20mm×5m	2 nos
—	Pre−chlorination injector manifold	Galvanized steel pipe ϕ 20mm×3m	1 no
—	Post-chlorination injector manifold	Galvanized steel pipe ϕ 20mm×3m	1 no
—	Pre-chlorination injector set	Wet pressure type 12kg/h wall hanging type	3 units
—	Post-chlorination injector set	Wet pressure type 5kg/h hanging type	3 units
—	Water control set	Structural rolled steel	1 unit
—	Chlorine gas valve	ϕ 20mm 20kg/cm^2	1 no
—	Chlorine gas valve	ϕ 10mm 20kg/cm^2	10 nos
—	Injection pipe valve	Diaphragm valve ϕ 50mm body : PVC, diaphragm : rubber, flange : JIS10K	13 nos
—	Sluice valve for water	ϕ 40mm 20kg/cm^2	4 nos
—	Sluice valve for water	ϕ 20mm 20kg/cm^2	6 nos
—	Chlorine gas piping material	Galvanized steel pipe ϕ 20mm	1 unit
—	Piping material for water	Galvanized steel pipe ϕ 40mm	1 unit
—	Injector stand	Structural rolled steel	1 unit
—	Indoor injection piping material	Polyvinyl chloride pipe ϕ 50mm	1 unit
—	Outdoor injection piping material	Polyvinyl chloride pipe ϕ 50mm	1 unit
—	Ditch for outdoor pipe	Concrete trough with Packing sand	1 unit
—	Fitting base for Chlorine 1 ton type cylinder	Concrete base	1 unit
—	Rubber sheet	for twenty two cylinders	1 unit

Stage	Equipment name	Specification	Quantity
10. Other			
—	Intake tower drain pump	Submerged pump, 20m×0.1m^3/min×1.5kw automatic operation, cable＝100 m, with connecting pipe	1 unit
11. Electric Facilities			
1	Main Incoming panel repair	11kV power receiving, insulator improvement, insulating, operation test of relay	1 set
1	Transmission pump control panel	750W×2,000D×2,500H	2 units
1	3.3kV condenser	Condenser, Reactor	2 sets
1	400V condenser panel	1,200W×1,000D×2,200H	2 units
2	Air Blower control panel	1,200W×1,000D×2,200H	1 unit
1	Intake pump control panel repair	Repair burnout part, interlock setup, operation test	1 set
2	Intake tower drain pump switch panel	800W×300D×600H	1 unit
1	Drain pump switch panel	800W×300D×600H	1 unit
1	Transmission pump discharge valve control panel	500W×300D×1,000H	1 unit
2	Alarm Device	Outdoor type	1 set
2	Level switch	5 points	1 set
1	Flow meter	600mm	1 set
1	Compressor panel repair	Thermal relay replacement, operation test	1 unit
2	Main incoming panel repair	11kV power receiving, insulator improvement, insulating, operation test of relay	1 set
2	Transmission pump control panel	750W×2,000D×2,500H	3 units
2	3.3kV condenser	Condenser, Reactor	3 sets
2	400V condenser panel	1,200W×1,000D×2,200H	1 unit
2	Intake pump control panel repair	Repair burnout part, interlock setup, operation test	1 set
2	Drain pump switch panel	800W×300D×600H	1 unit

Stage	Equipment name	Specification	Quantity
2	Transmission pump discharge valve control panel	500W×300D×1,000H	1 unit
2	Compressor panel repair	Thermal relay replacement, operation test	1 set
—	Power distribution panel for Coagulant pump and mixer	1,200W×1,000D×2,200H	1 unit
—	Coagulant pump and mixer control panel repair	Thermal relay replacement, operation test	1 set

2-2-2-2-3 Outline Design of Pipeline Facility

(1) Capacity of the facility

The capacity of the pipeline facility shall be designed based on the Hourly maximum supply quantity. Aside from the domestic needs, there would be demands for industrial and commercial uses and a factor on those purpose is set as 1.65. Design effective water ratio of the pipeline system is set as 0.714, while Design rate of loading is set as 0.833. Concerning the Hourly factor for water demands, 2.0 is applied in case of direct supply from the water main and 1.0 is applied for water conveyance through reservoirs.

① Nakaputa reservoir～Skyways reservoir (m^3/day)

	Area	Liter per capita per day	Design population served	Design maximum daily supply	Hourly factor	Design water supply
Direct Supply	Kaloko	60	13,387	2,227	2.0	4,454
	Mushili	160	31,166	13,828		27,656
	Kabushi	100	21,562	5,979		11,958
	Mine Masala	100	9,514	2,638		5,276
	Main Masala	100	15,315	4,247		8,494
Skyways Reservoir	Skyways	160	1,571	697	1.0	697
	Itawa	280	7,515	5,835		5,835
	Mckenzie	60	10,040	1,671		1,671
	Ndeke	160	8,898	3,948		3,948
	Skyways Reservoir Sub Total			12,151		12,151
Buwana Mkbuwa Reservoir	Ndeke	160	8,898	3,948	1.0	3,948
	Bwana Mkubwa	100	30,000	8,319		8,319
	Bwana Mkubwa Reservoir Sub Total			12,267		12,267
Total						82,256

* Water for industrial use is added as section flowing quantity in Bwana Mkubwa (number of population was caught from KWSC)

②Kaloko area (m^3/day)

Area	Liter per capita per day	Design population served	Design maximum daily supply	Hourly factor	Design water supply
Kaloko	60	13,387	2,227	2.0	4,454

③Mushili area (m^3/day)

Area	Liter per capita per day	Design population served	Design maximum daily supply	Hourly factor	Design water supply
Mushili	160	31,166	13,828	2.0	27,656
Kabushi	100	21,562	5,979		11,958
Total					39,614

④Chifubu (m^3/day)

Area	Liter per capita per day	Design population served	Design maximum daily supply	Hourly factor	Design water supply
Chifubu	100	45,945	12,741	2.0	25,482
Pamozi	160	25,088	11,131		22,262
Total					47,744

⑤Northrise (m^3/day)

Area	Liter per capita per day	Design population served	Design maximum daily supply	Hourly factor	Design water supply
Kansensi	280	11,692	9,078	2.0	18,156
Chipulusuku	60	44,624	7,425		14,850
Total					33,006

(2) Hydraulic calculation

Hydraulic calculation on the pipeline system is to be done by applying the following Hazen-Williams Coefficient.

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

Where,

H ; Friction Head Loss (m)

C ; Flow Velocity Coefficient (=110)

D ; Pipe Diameter (m)

Q ; Flow Rate (m^3/s)

L ; Length (m)

Calculation results can be tabulated as follows.

Table 2-2-11 Hydraulic Calculation

Starting point	End point	Length(m)	Upper water level	Lower water level	Flow rate (m3/day)	Flow rate (m3/s)	Diameter (m)	Hydraulic gradient	Friction head loss(m)	Flow velocity(m/s)
Nakaputa	Skyways	6,000	1,328	1,280	82,256	0.952	0.80	4.829	28.974	1.895
Chifubu	EP.	2,000	1,345	1,332	47,744	0.553	0.70	3.387	6.774	1.438
Northrise	EP.	1,700	1,320	1,300	33,006	0.382	0.50	8.795	14.952	1.946

For Mushili area, the same pipe diameter as presently existing is adopted, while for Kaloko area it is 100 mm diameter as same with the distribution pipe in the area.

(3) Selection of pipe material

ϕ 100mm, ϕ 250mm, ϕ 500mm, ϕ 700mm, and ϕ 800mm pipes are to be used for the subject pipeline system under the project. As for 100 mm pipe, GI (Galvanized Iron) pipe is selected as the same has been popularly used in other projects in Zambia and considered to have high market availability. DCIP (Ductile Casing Iron Pipe) pipe is selected for other large diameter pipe considering the material cost and construction cost as shown below. GI pipe is more expensive than DCIP because of the cost for the welding work at the site.

Table 2-2-12 Direct Construction Cost per Unit Distance

(Japanese Yen/m)

Diameter	DCIP	GI
ϕ 250mm	13,553	26,755
ϕ 500mm	35,115	49,202
ϕ 700mm	58,350	71,974
ϕ 800mm	72,479	90,067

The rainy season in the project area covers about 5 months from November to March, in which construction works can not be progressed efficiently. Steel pipe requires a longer time for welding and accordingly the construction period for pipe installation becomes longer too. As is the case, DCIP is selected for its shorter construction period and economic advantages.

(4) Summary of planning for pipeline system

The results of study on the pipe material and diameter as mentioned above can be summarized as the followings.

Table 2-2-13 Planning for Pipeline System

Starting point	End point	Design pipe diameter(mm)	Length (km)	Proposed diameter (mm)
Nakaputa	Skyways	DCIP ϕ 800	5.03	900
		DCIP ϕ 450	0.81	
		DCIP ϕ 600*	0.02	
Main falling	Kaloko	GI ϕ 100	3.13	100
Main falling	Mushili	DCIP ϕ 300*	0.07	225
		DCIP ϕ 250	0.14	
		DCIP ϕ 400*	0.03	
Chifubu	End Point	DCIP ϕ 700	2.06	600
		DCIP ϕ 300*	0.07	
Northrise	End Point	DCIP ϕ 500	1.60	375
		DCIP ϕ 150*	0.02	

* Short branch line

(5) Cross section for pipe installation work

1) Earth covering

The minimum earth covering shall be 1.0 m depth under roadway and it is 0.6 m under footway and grassland.

2) Foundation

Sand bed is adopted for foundation work and necessary bed depth shall be secured for correction of unevenness and protection of differential settlement. The bed depth shall be of 100 mm for the pipes with diameter less than 200 mm, 150 mm depth for 250-450 mm and 200 mm depth for 500-800 mm.

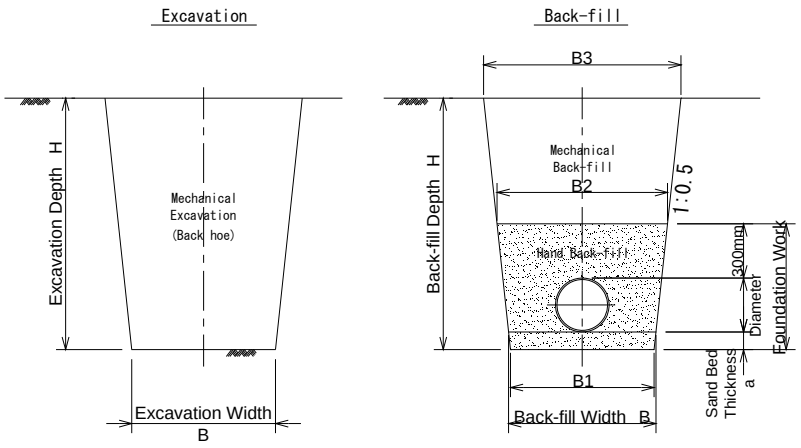
3) Side slope for excavation.

Side slope for excavation shall be 1:0.5 due to the soil nature of construction site which is sandy soil.

4) Cross section for excavation work

Taking into account the study results as above, the standard cross section has been fixed as follows.

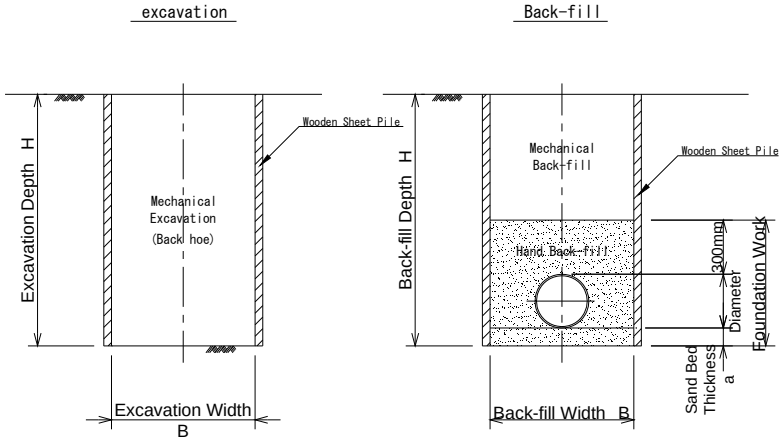
(Open Excavation)



Unsupported

Diameter (mm)	Back-fill Width B (mm)	Sand Bed Thickness a (mm)
100	500	100
150	500	100
200	500	100
250	500	150
300	550	150
350	600	150
400	650	150
450	700	150
500	750	200
600	850	200
700	950	200
800	1,050	200

(Sheet Pile Method)



Sheet Pile

Diameter (mm)	Back-fill Width B (mm)	Sand Bed Thickness a (mm)
100	700	100
150	750	100
200	800	100
250	850	150
300	900	150
350	950	150
400	1,000	150
450	1,050	150
500	1,150	200
600	1,250	200
700	1,350	200
800	1,450	200

Fig. 2-2-3 Excavation Profile

(6) Incidental Facilities

Incidental facilities attached for the subject pipeline include isolating valve, air valve, wash-out and flow meters as follows.

1) Isolating valve

Isolating valves shall be installed at the starting point and branching points of the pipeline system as well as at the wash-outs. The maximum interval between isolating valves is considered normally as around 1-3 km, however, in case of the subject project, it is a bit less than 3 km distance between the starting point and the branching point of the Mushili area. For the section of pipe diameter less than 100 mm, horizontal type valve for water work shall be installed and if it is larger than 150 mm, butterfly valve is installed so as to ease the discharge control. For the case of a section smaller than 400 mm, a valve cover is to be provided while for the section with a diameter larger than 450 mm, a valve chamber shall be provided, taking into account the required O&M activities.

2) Air valve

Air valve shall be installed at the convex portion of pipeline. The air valve shall be an isolating valve as a built-in device with rapid capacity for water works. The valve chamber for the air valve shall be made of reinforced concrete.

3) Wash-outs

Wash-out is to be installed at the concave portion of the pipeline. The wash-out is composed of a T-shape pipe, isolating valve and infiltration sump. Due to the difficulty to secure a receiving for drains, the infiltration sump shall be 900 mm x 900 mm size similar to the existing condition.

4) Flow meters

Flow meters shall be installed at the starting point of the pipeline system and every branching point. Of the various types of flow meters, such as a Venturi flow meter, vane wheel type flow meter, electromagnet flow meter and ultrasonic flow meter, the vane wheel type flow meter and the Ultrasonic flow meter (battery built-in type) shall be selected for a smaller diameter of less than 400 mm and medium size diameter of larger than 500 mm diameter, respectively.

2-2-2-2-4 Improvement in the areas facing difficulty

(1) Mushili area

The Mushili area is faced with the difficulty of getting any water supply due to the insufficient water head for branching caused by water leakage in the pipeline system between Nakaputa and Skyways. The following 3 branch lines from the Nakaputa-Skyways main line shall be set. Two of the three lines in the Upper Mushili area and the Lower Mushili area are replacements of the existing branch pipe. The branch to the Middle Mushili area is newly installed. Renovation of the main pipeline and these 3 branch works can supply water stably and resolve the insufficient water pressure conditions, especially in the Upper Mushili area.

Table 2-2-14 Improvement Plans for Mushili Area

Branching to	Facilities			
Upper Mushili	DCIP	ϕ 300mm,	70m,	Integrating flow meter
Middle Mushili	DCIP	ϕ 250mm,	140m,	Integrating flow meter
Lower Mushili	DCIP	ϕ 400mm,	30m,	Integrating flow meter

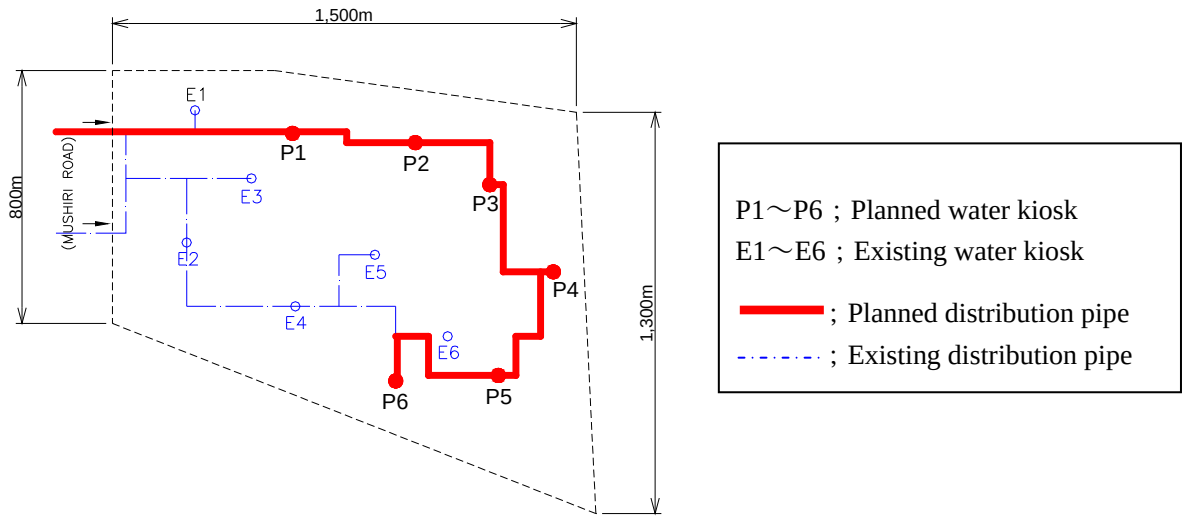
(2) The Kaloko area

The Kaloko area is a poor residential area with a population of about 12,000 people on 1.5 km^2 of land. The residential area has been put under the land readjustment project and divided into about 2,800 plots. Based on the plan assuming 8 members per family, the total population would be about 22,000 persons assuming all the residential areas are filled with families.

There have been as many as 6 water kiosks existing in the area; however, due to the insufficient water pressure as caused by water leakage in the water main, only 2 kiosks are able to get the water supply and only in the morning. Even at the kiosks where water is available, the water pressure is so low and the quantity is rather limited, and it takes considerable time to get the water supply. The majority of the residents in the area use the kiosk water for drinking, and they wash their clothes at the leakages of the water main.

For the distribution pipeline in the area too, asbestos cement pipe is used, and leakages are found in many places. The general layout and locations of the kiosks are shown in the following figure.

According to DTF, the optimum condition is set to have 1,200-1,500 beneficiaries to be served by one (1) kiosk, and the distance to the public water tap is to be within a 500 m radius (0.25 km^2). 6 new kiosks are planned in this project, and the area is to be served by 12 kiosks in total, combining the existing 6 kiosks. Judging from the DTF area, 1.5 km^2 divided by 12 is 0.125 km^2 and the distance between kiosks is planned to be shorter than 200 m; therefore, the number of kiosks is sufficient. The number of people to be served is 1,000 persons in the case of the present population and 1,800 persons with a future maximum projection of 22,000 persons, which satisfies the standard and is considered to be a reasonable amount.



The distribution pipeline between the water main and kiosks is designed as a pipe of diameter 100 mm. Also to avoid difficulty in securing the designed quantity of water supply due to the leakage at the existing pipeline, all the new distribution lines to the kiosks shall be directly connected with the water main. Concerning the pipe diameter, the survey team has agreed with KWSC to use 100 mm diameter to be ready for future expansion.

For the above mentioned distribution line between the existing pipeline network and newly installed water kiosks, in total, a pipeline as long as 3.13 km with a 100 mm diameter shall be necessary. The structure of the kiosk is to be in conformity with the standard as indicated in the DTF manual.

Table 2-2-15 Improvement Plans for the Kaloko Area

Works	Facilities
Pipe installation	Galvanized Iron pipe ϕ 100mm, 3,130m
Construction of Water kiosk	Water Kiosk 6 units, each kiosk has the following; ϕ 25mm water tap 3 sets, Integrating flow meter 1, Block building, Reinforced concrete (Roofing / Flooring) 2,000mm×2,150mm, Height2,450mm, Infiltration sump 1 piece

Table 2-2-16 Planned Water Kiosk Locations in the Kaloko Area

№	Address *
1	Free Space between Plot №0243 and the road
2	Free Space between Plot №1198 and the road
3	Free Space between the road, Plot №1699 and Plot №1742
4	Free Space between Plot №2003 and the road
5	Free Space between Plot №2434 and the road
6	Free Space between Plot №1426 and the road

* These addresses were confirmed on site with KWSC on September 3rd, 2010, as a revision after signing of “M/D of Outline Design Study” on August 25th, 2010 (refer to the Appendix 4-1 attached at the end of this report).

2-2-2-2-5 The Kanini Laboratory

KWSC is carrying out water quality analysis for the water supply and sewerage system in Ndola city at the Kanini Laboratory attached to the Kanini Sewerage Treatment Plant. Ndola city has some mining and industrial areas, and the Kanini laboratory is practicing analysis of heavy metals by using the AAS at present. However, due to the lack of devices for detecting mercury and arsenic, which are identified items of concern in Zambia's drinking water guidelines, it is necessary to procure accessories to AAS needed for said additional analysis. Also, it is necessary to install a gas chromatography so as to be able to detect any small amount of organic dissolutions in agricultural chemicals, etc.

Table 2-2-17 Plans for Water Quality Analysis Equipment

Equipment	Specifications
Gas Chromatography	Analysis items : Agricultural chemicals and etc. (Aldrin, Dieldrin, chlordane, DDT, Endonsulfan, Endrin, Heptachlor, Heptachlor epoxide, Hexachlorobenzene, Lindane (Gamma BHC), Methoxychlor) Detector : ECD (Electronic Catching type) Sample injection : Manual (Split/split-less injection) Separation tube : Capillary column Recording : Data processing device Flow control of carrier gas : Automatic Carrier gas : Helium gas cylinder Nitrogen gas cylinder
Accessories for AAS	Mercury detecting lamp, Arsenic detecting lamp

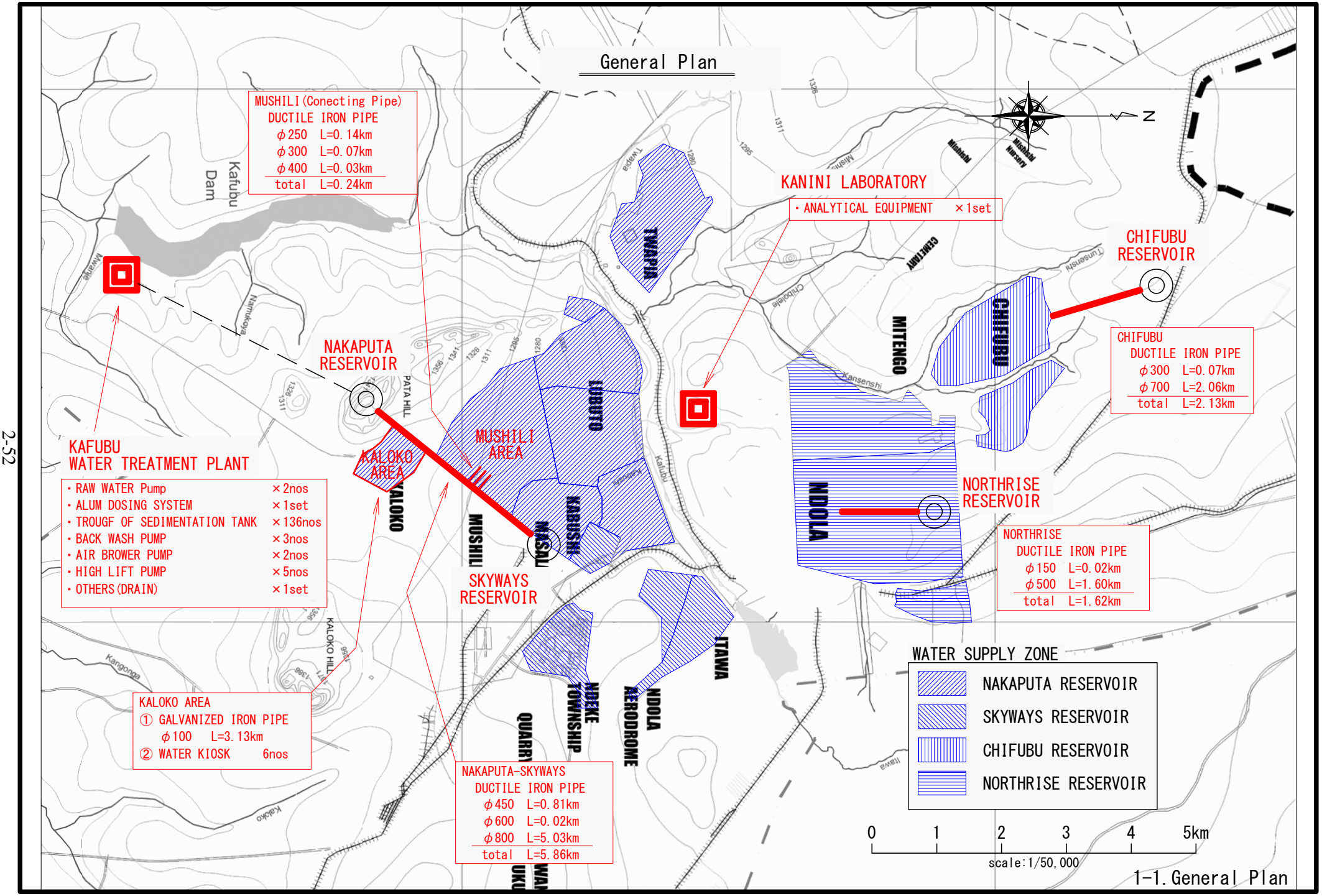
AAS: Atomic Absorption Spectrometer

2-2-3 Outline Design Drawing

THE SECOND PREPARATORY SURVEY
ON
THE PROJECT FOR THE IMPROVEMENT OF WATER SUPPLY CONDITION IN NDOLA CITY
IN
THE REPUBLIC OF ZAMBIA

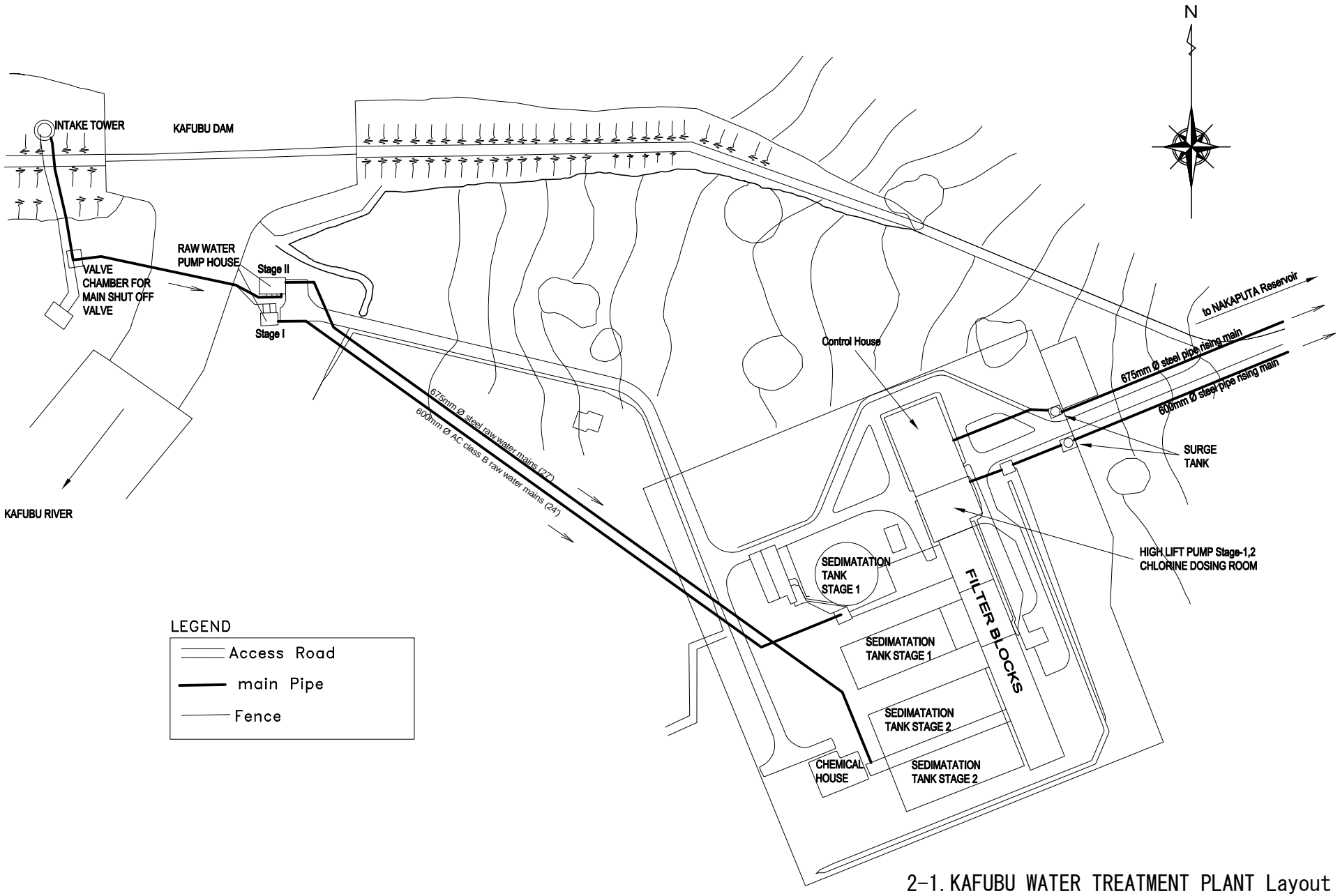
DRAWING LIST

Figure No.	Title	Nos	Remarks
1 — 1	General Plan	1	
2 — 1	KAFUBU WATER TREATMENT PLANT Layout	1	
3 — 1	Flowsheet (Purification)	1	
— 2	Flowsheet (Coagulation,Chlorination)	1	
4 — 1	Water Level	1	
5 — 1	Intake Tower	1	
6 — 1	Raw Water Pump (Stage1)	1	
— 2	Raw Water Pump (Stage2)	1	
7 — 1	Sedimentation Tanks	1	
8 — 1	Filter	1	
9 — 1	High Lift Pump (Stage1)	1	
— 2	High Lift Pump (Stage2)	1	
10 — 1	Alum Dosing System	1	
11 — 1	Chlorine Dosing System	1	
12 — 1 ～ 2	Single-Line Connection Diagram (Stage1)	2	
— 3 ～ 5	Single-Line Connection Diagram (Stage2)	3	
13 — 1 ～ 9	Plans & Longitudinal Sections (NAKAPUTA-SKYWAYS)	9	
— 10 ～ 13	Plans & Longitudinal Sections (CHIFUBU)	4	
— 14 ～ 16	Plans & Longitudinal Sections (NORTHRISE)	3	
14 — 1 ～ 2	Sluice Valve	2	
15 — 1	Air Valve	1	
16 — 1	Wash Out	1	
17 — 1	Flow Meter	1	
18 — 1	KALOKO Area	1	
19 — 1	MUSHILI Area	1	
20 — 1	WATER KIOSK	1	
	Total	43	

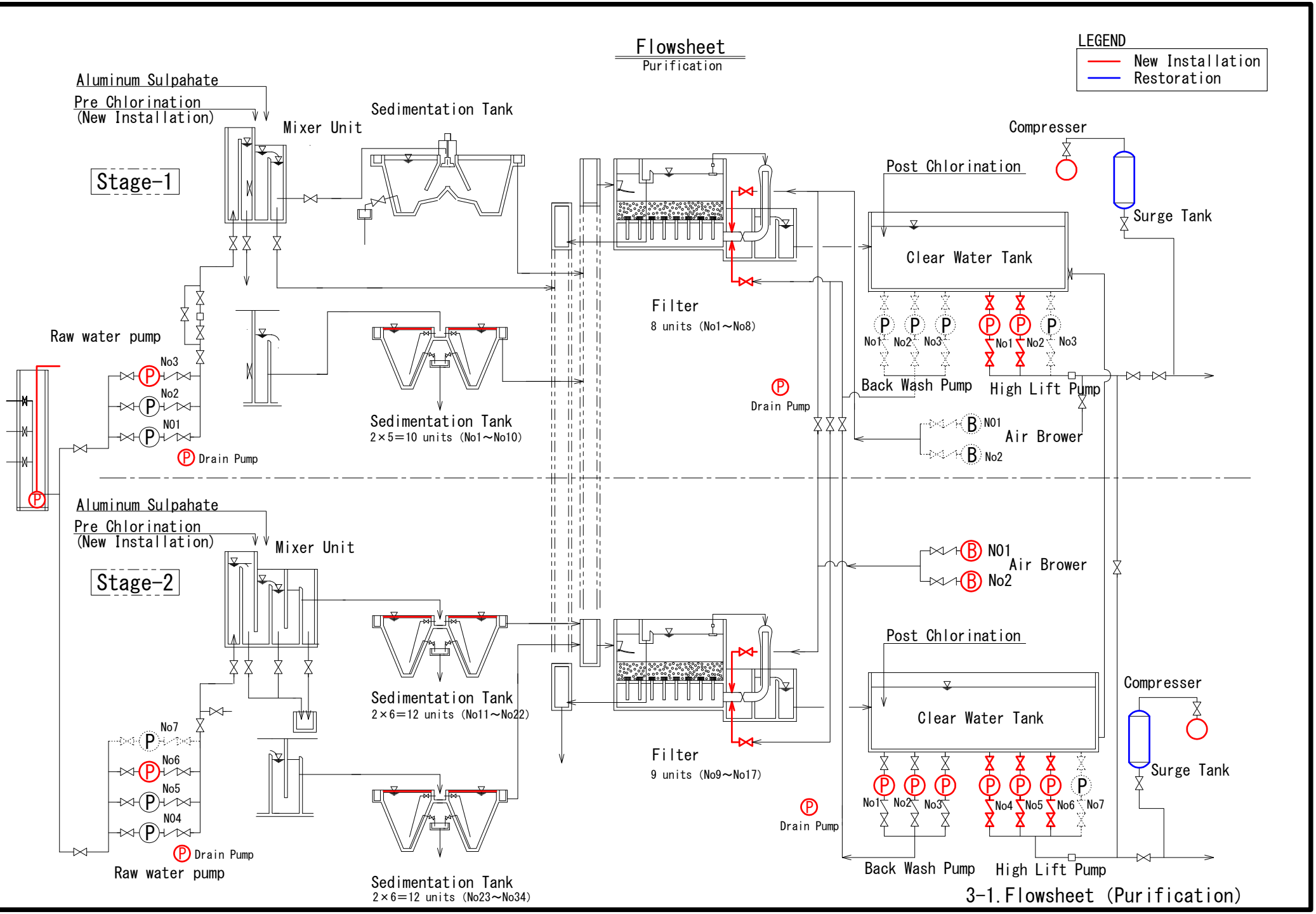

General Plan
MUSHILI (Conecting Pipe)
DUCTILE IRON PIPE
φ250 L=0.14km
φ300 L=0.07km
φ400 L=0.03km
total L=0.24km
Kafubu Dam
KANINI LABORATORY
・ANALYTICAL EQUIPMENT ×1set
CHIFUBU RESERVOIR
CHIFUBU
DUCTILE IRON PIPE
φ300 L=0.07km
φ700 L=2.06km
total L=2.13km
NAKAPUTA RESERVOIR
KAFUBU
WATER TREATMENT PLANT
・RAW WATER Pump ×2nos
・ALUM DOSING SYSTEM ×1set
・TROUGF OF SEDIMENTATION TANK ×136nos
・BACK WASH PUMP ×3nos
・AIR BROWER PUMP ×2nos
・HIGH LIFT PUMP ×5nos
・OTHERS(DRAIN) ×1set
KALOKO AREA
MUSHILI AREA
SKYWAYS RESERVOIR
NORTHRISE RESERVOIR
NORTHRISE
DUCTILE IRON PIPE
φ150 L=0.02km
φ500 L=1.60km
total L=1.62km
KALOKO AREA
① GALVANIZED IRON PIPE
φ100 L=3.13km
② WATER KIOSK 6nos
NAKAPUTA-SKYWAYS
DUCTILE IRON PIPE
φ450 L=0.81km
φ600 L=0.02km
φ800 L=5.03km
total L=5.86km
TWAPIA
LUBUTO
KABUSSA
MASAU
MUSHILI
KALOKO
PATA HILL
MITENGO
NDOLA
NDEKE TOWNSHIP
NDOLA AERODROME
ITAWA
QUARRY
WATER SUPPLY ZONE
NAKAPUTA RESERVOIR
SKYWAYS RESERVOIR
CHIFUBU RESERVOIR
NORTHRISE RESERVOIR
0 1 2 3 4 5km
scale:1/50,000
1-1. General Plan

KAFUBU WATER TREATMENT PLANT Layout

scale:1/1500



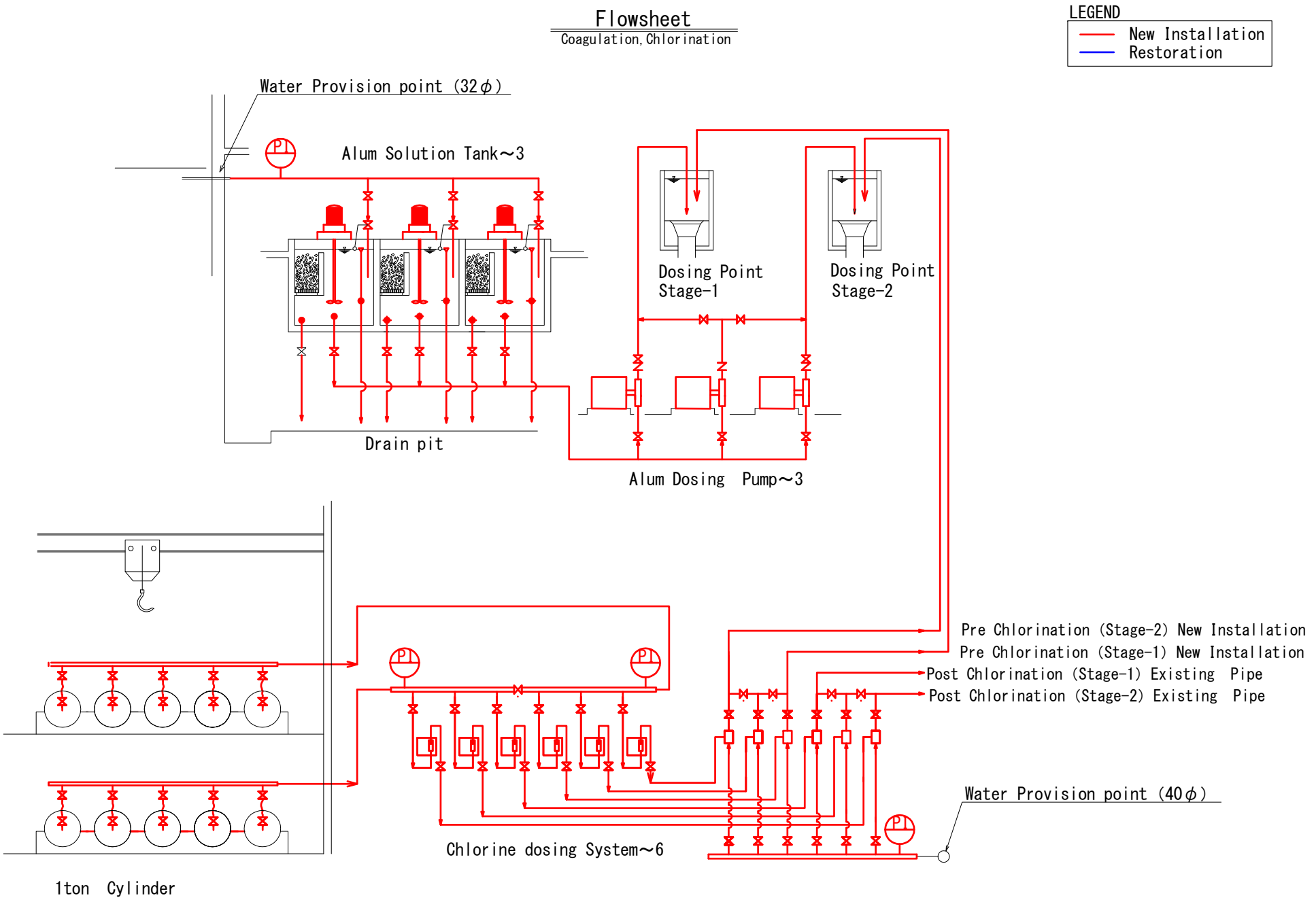
2-1. KAFUBU WATER TREATMENT PLANT Layout



3-1. Flowsheet (Purification)

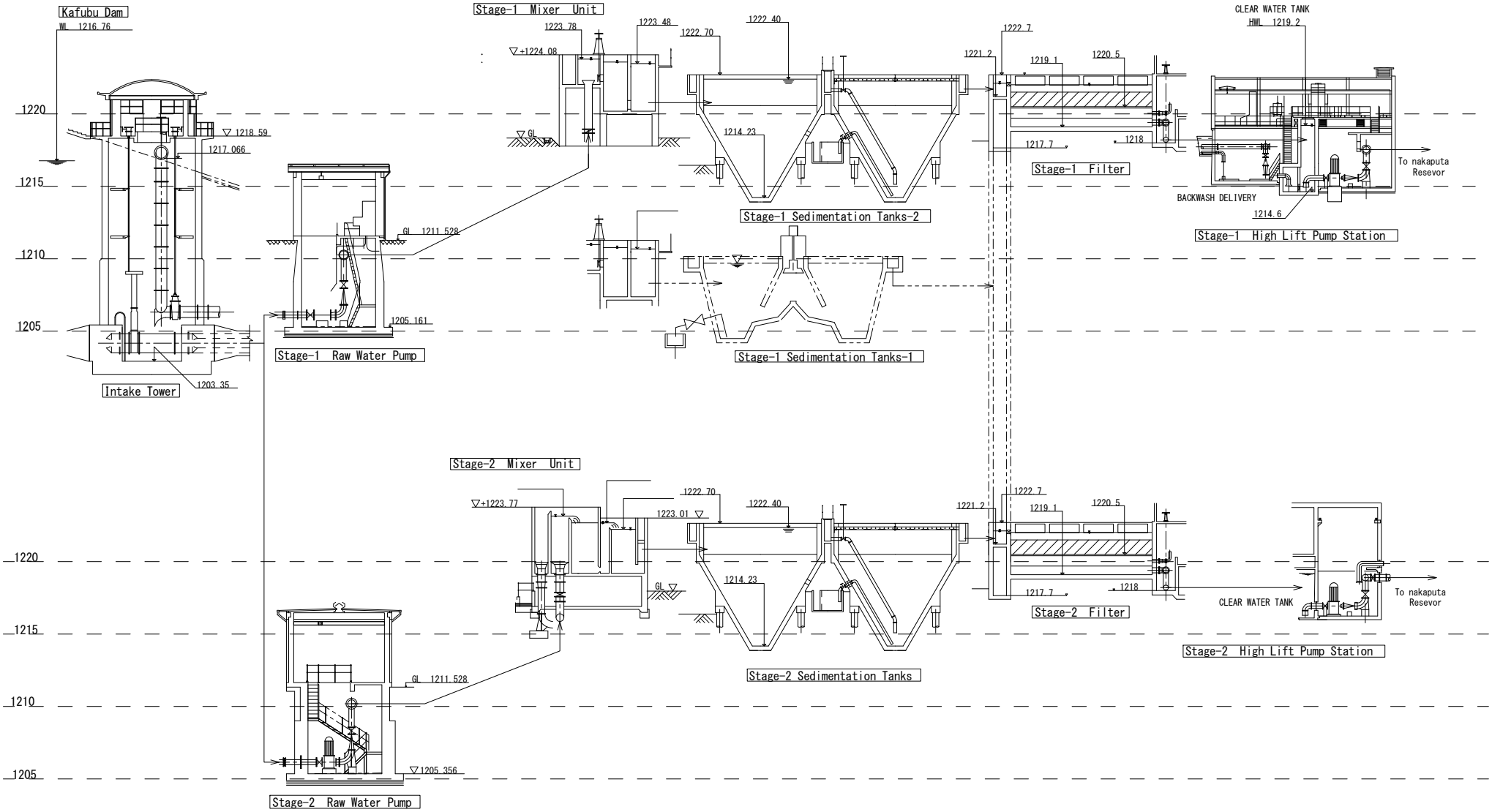
Flowsheet

Coagulation, Chlorination



3-2. Flowsheet (Coagulation, Chlorination)

Water Level


Kafubu Dam
WL 1216.76
1220
1215
1210
1205
1218.59
1217.066
1203.35
Intake Tower
GL 1211.528
1205.161
Stage-1 Raw Water Pump
Stage-1 Mixer Unit
1223.78
1223.48
+1224.08
GL
1222.70
1222.40
1214.23
Stage-1 Sedimentation Tanks-2
Stage-1 Sedimentation Tanks-1
1222.7
1221.2
1219.1
1220.5
1217.7
1218
Stage-1 Filter
CLEAR WATER TANK
HWL 1219.2
BACKWASH DELIVERY
1214.6
To nakaputa Resevor
Stage-1 High Lift Pump Station
Stage-2 Mixer Unit
+1223.77
1223.01
GL
1214.23
Stage-2 Sedimentation Tanks
Stage-2 Filter
CLEAR WATER TANK
To nakaputa Resevor
Stage-2 High Lift Pump Station
GL 1211.528
1205.356
Stage-2 Raw Water Pump

Intake Tower

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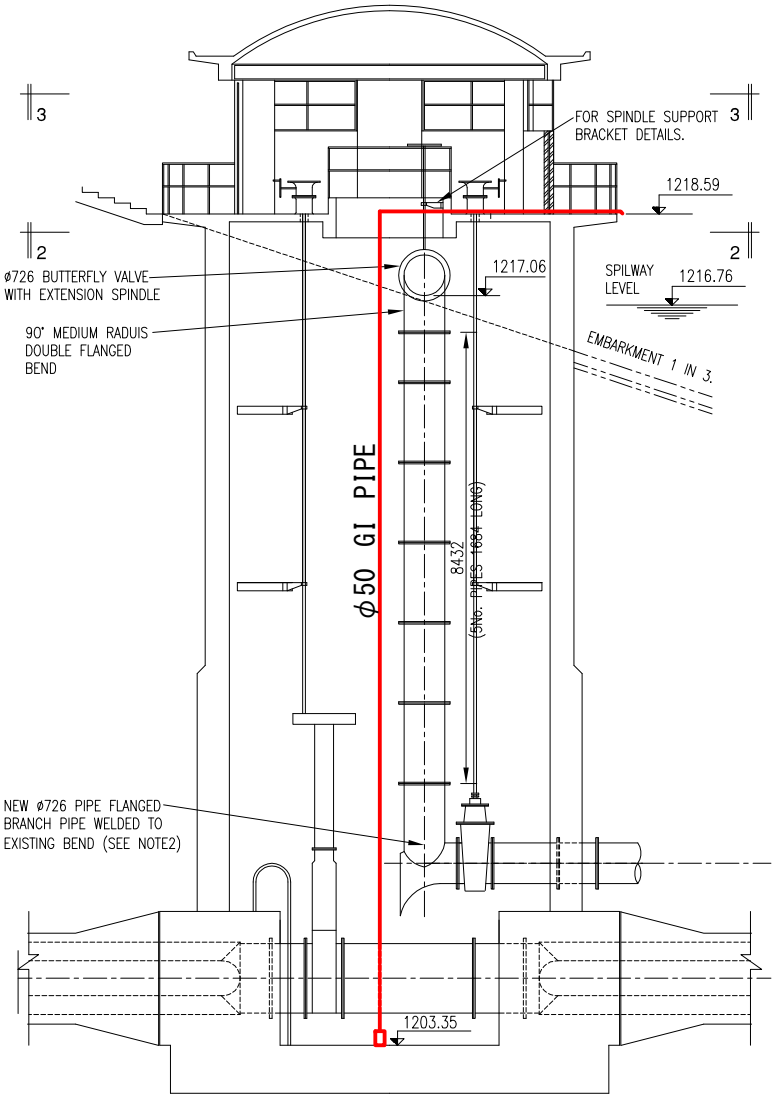
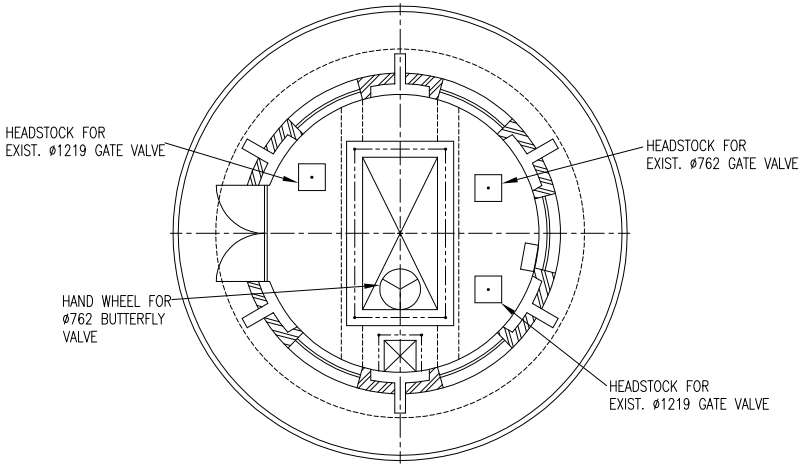
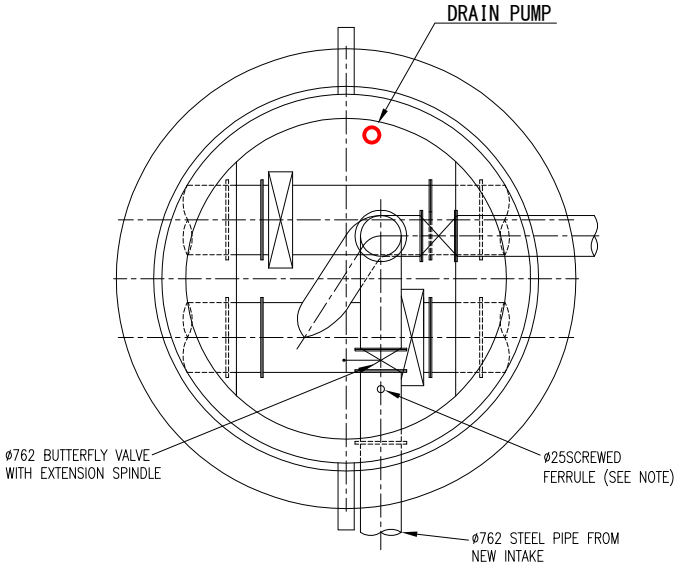


VALVE TOWER SECTION



SECTION 3-3

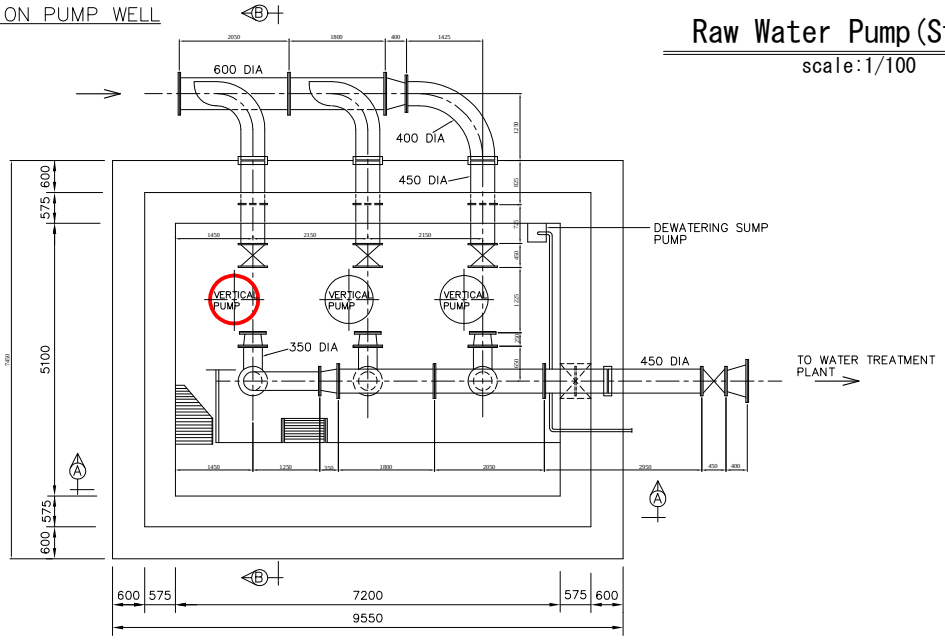


SECTION 2-2

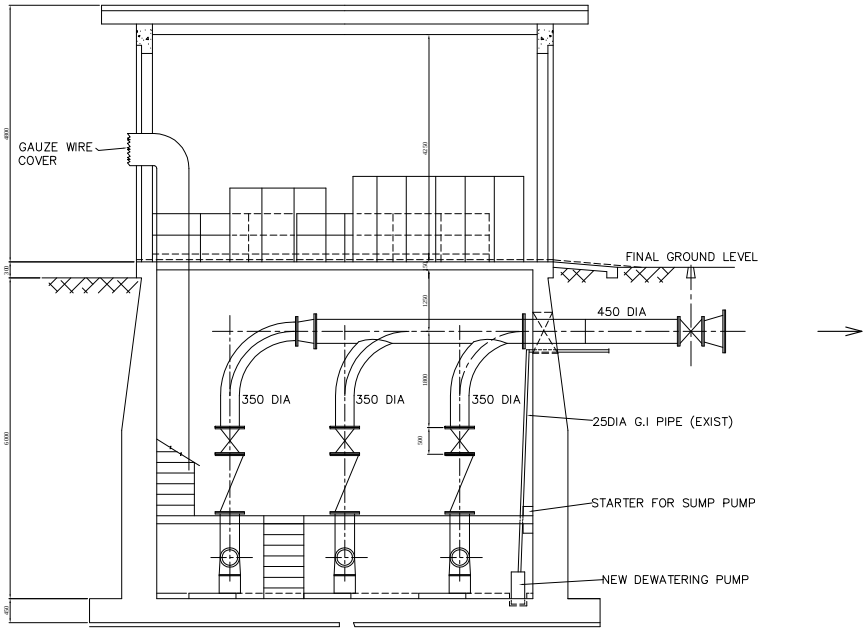
PLAN ON PUMP WELL

Raw Water Pump(Stage1)

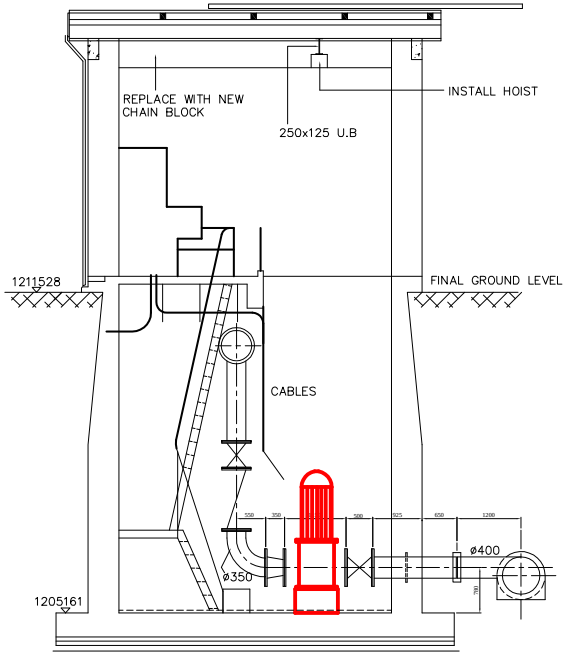
scale:1/100



SECTION A – A



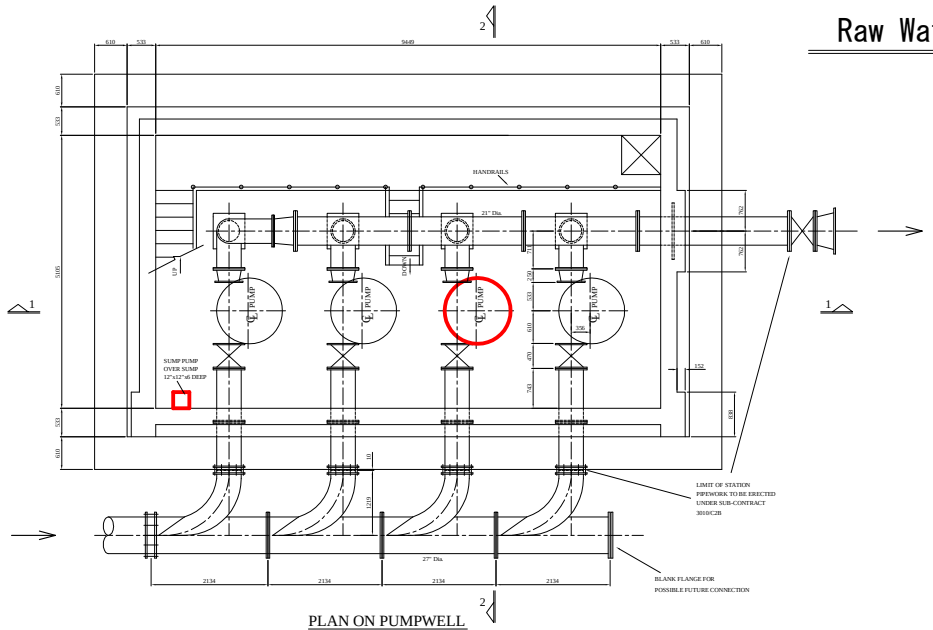
SECTION B – B



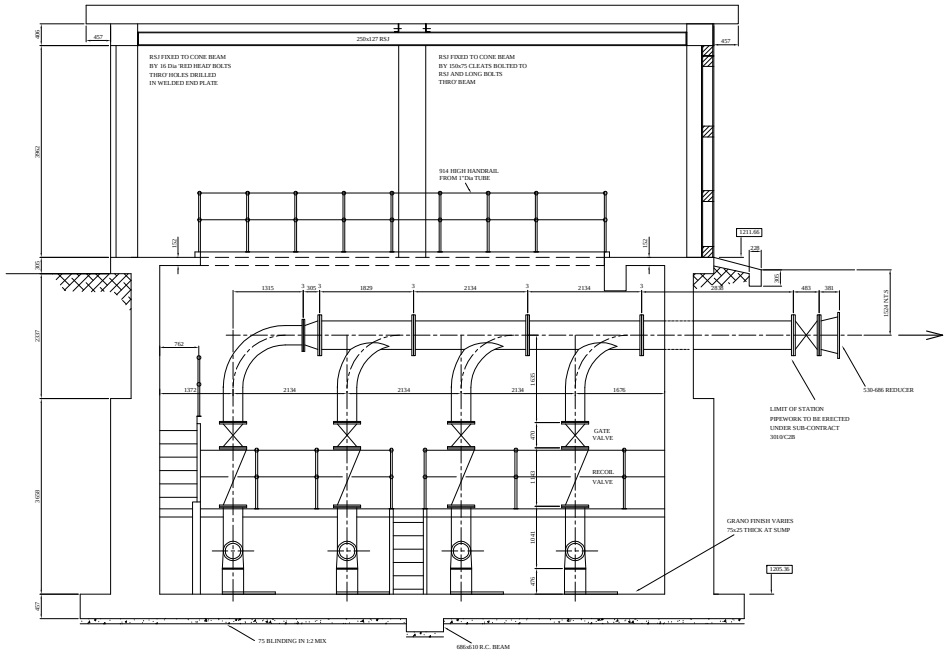
6-1.Raw Water Pump(Stage1)

Raw Water Pump(Stage2)

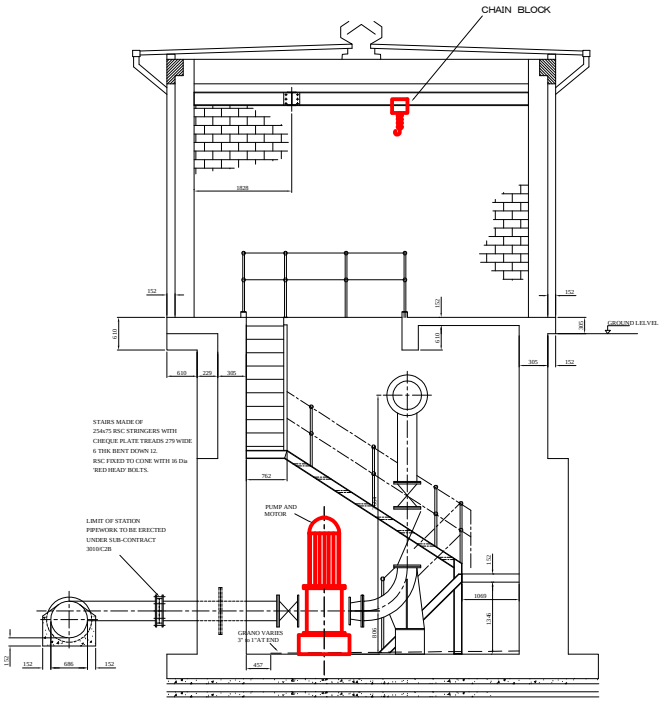
scale:1/100



PLAN ON PUMPWELL

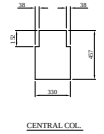


SECTION 1-1



SECTION 2-2

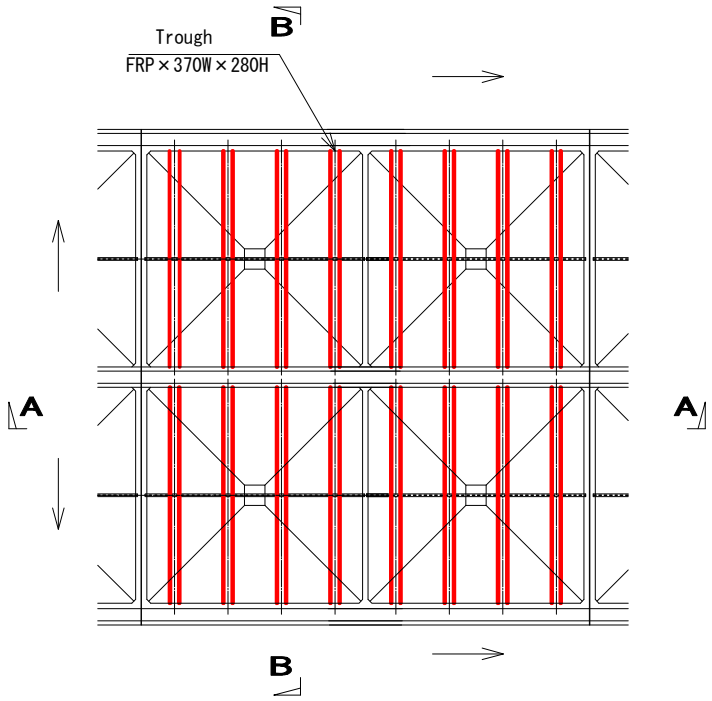
CORNER COL.



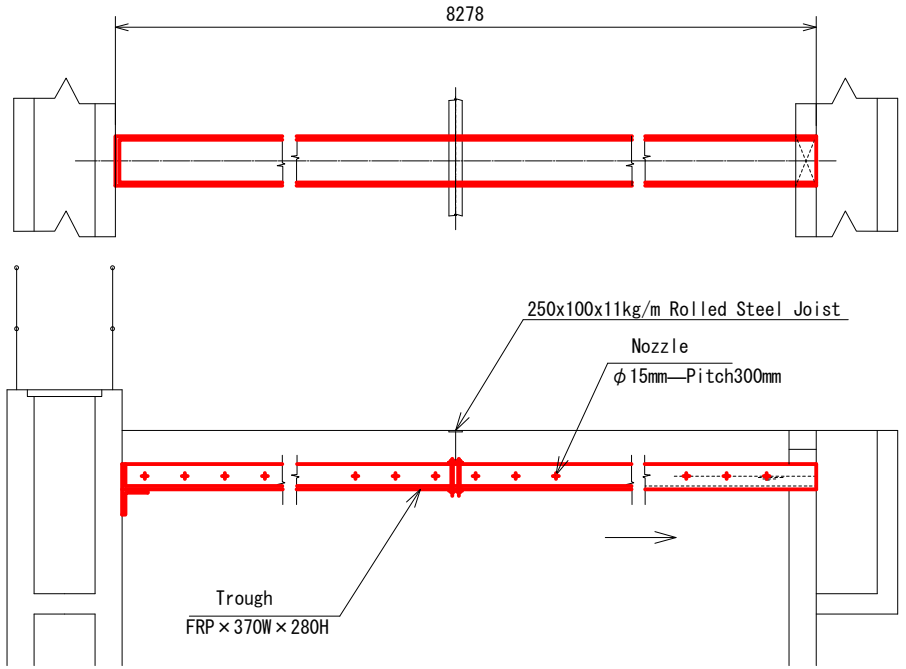
CENTRAL COL.

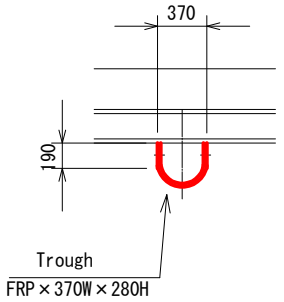
COLUMN DETAILS

Sedimentation Tanks

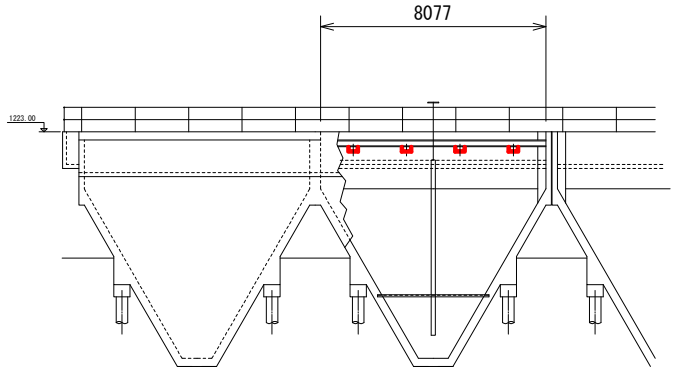


Sedimentation Tanks

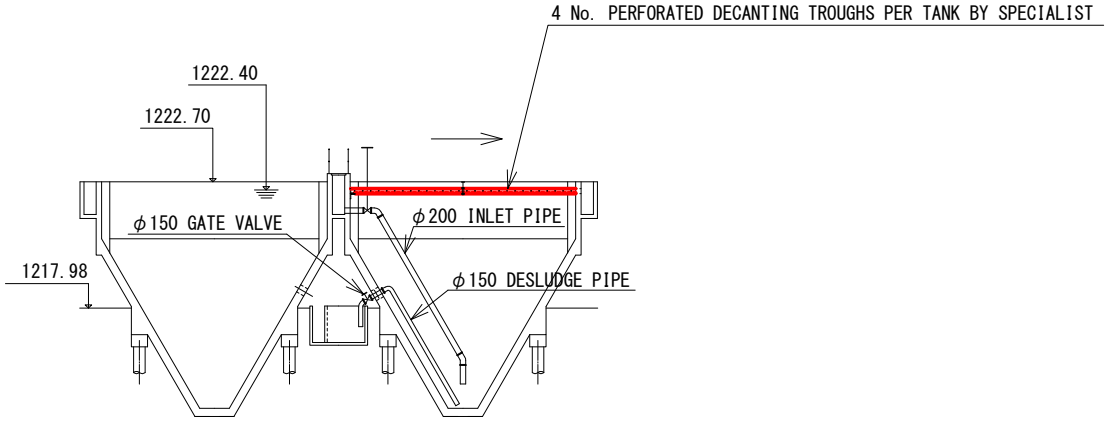




Trough Detail

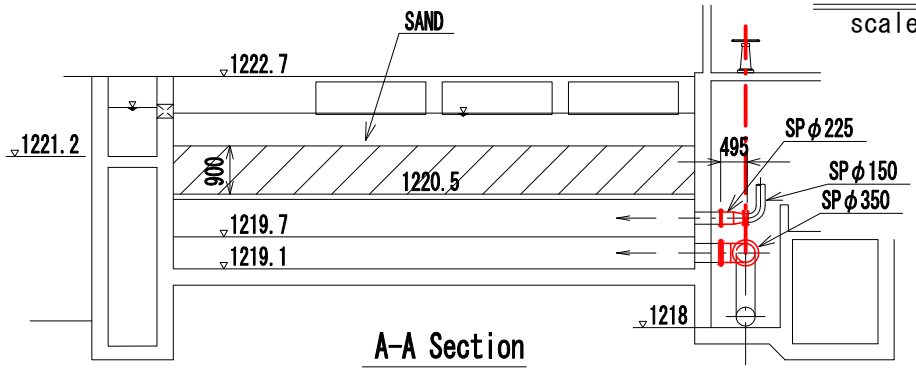


A-A Section

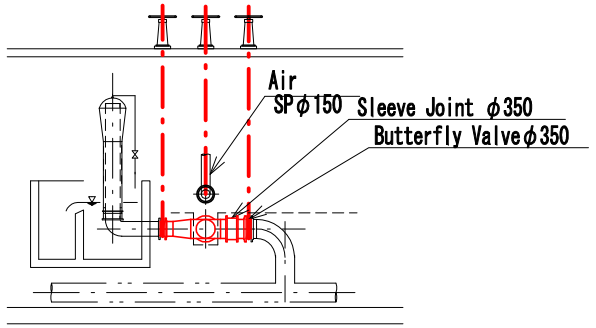


B-B Section

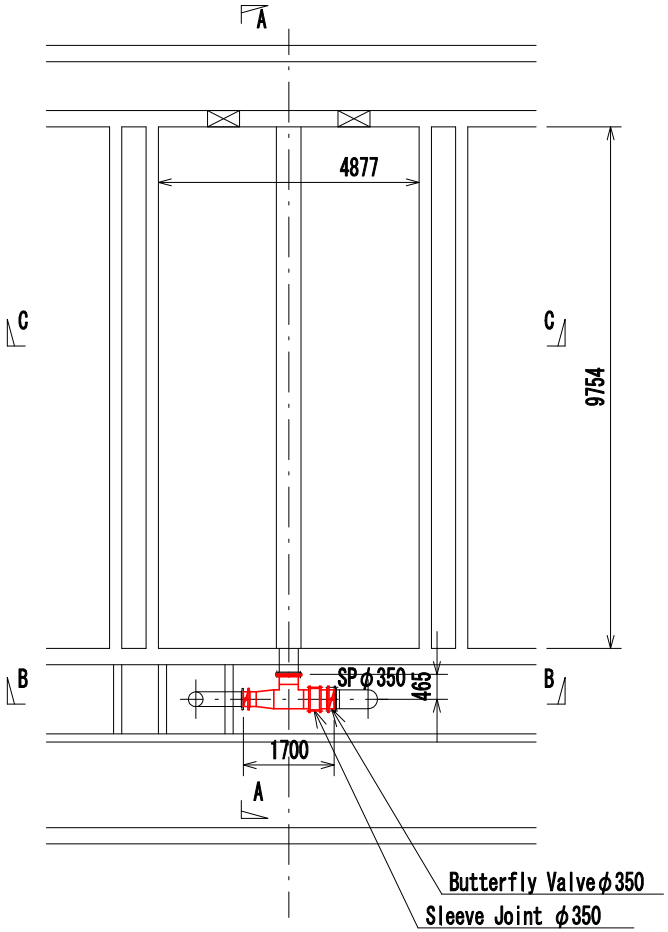
Filter
scale:1/100

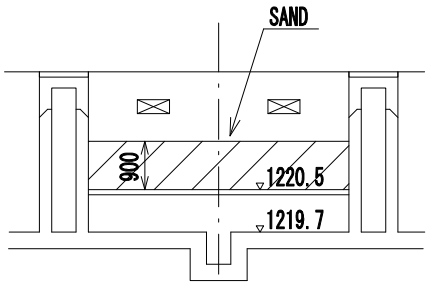


A-A Section



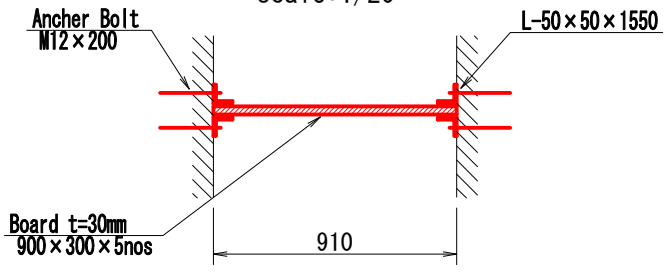
B-B Section





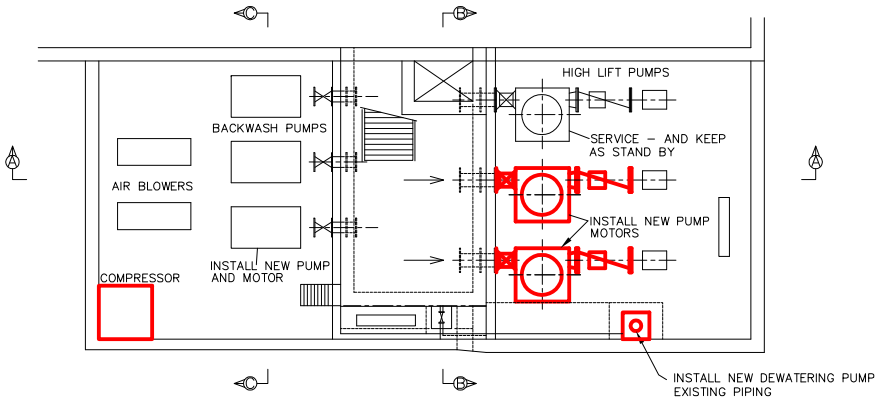
C-C Section

Stop-Log
scale:1/20

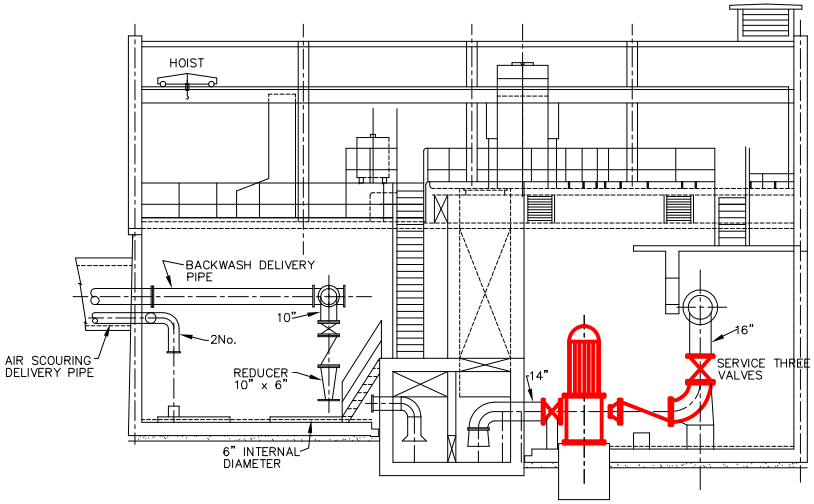


High Lift Pump (Stage1)

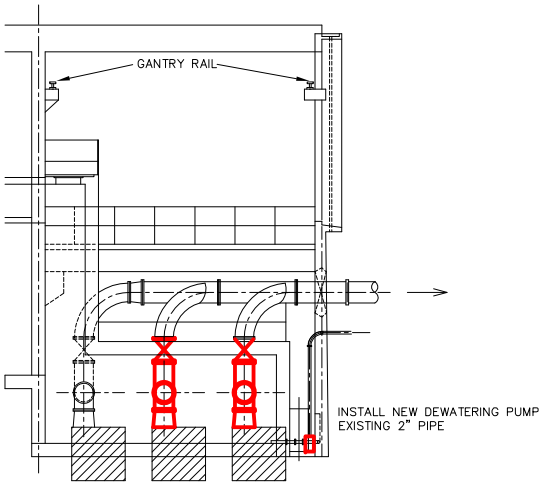
scale:1/100



PLAN AT 1.000M ABOVE FLOOR LEVEL



SECTION A – A

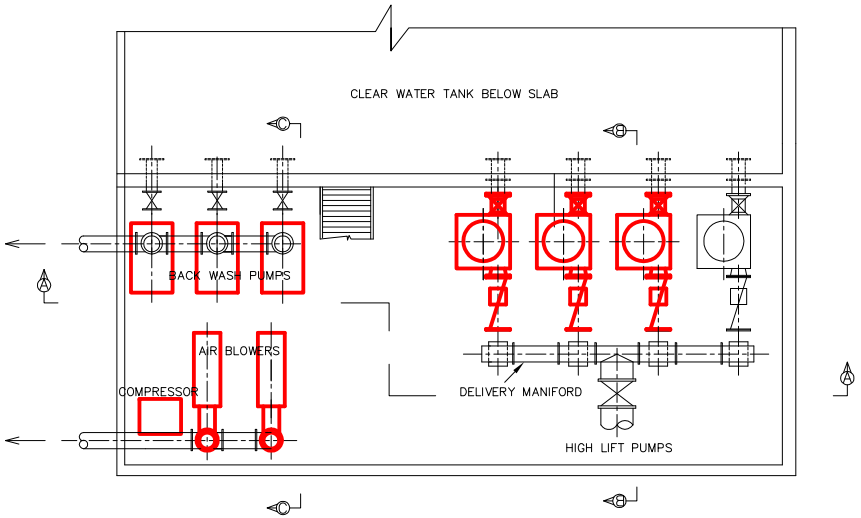


SECTION B – B

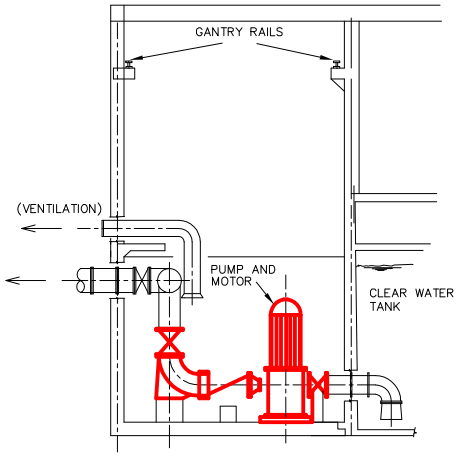
High Lift Pump Station (Stage2)

Back Wash Pumps & Air Blower Pumps

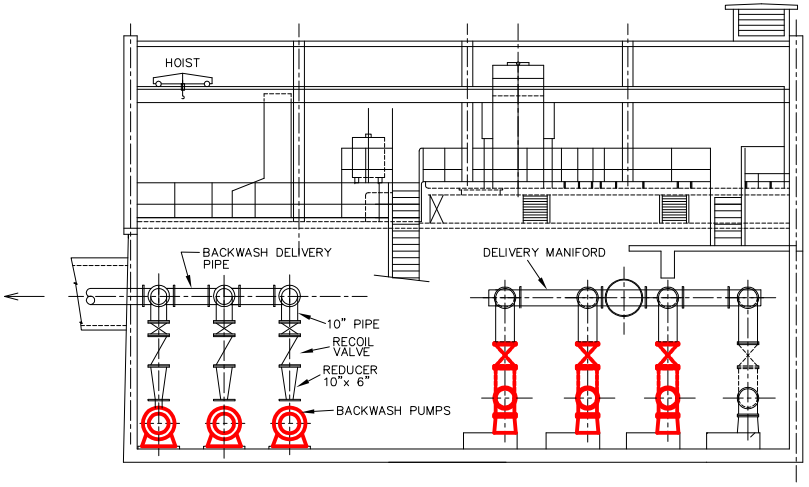
scale:1/100



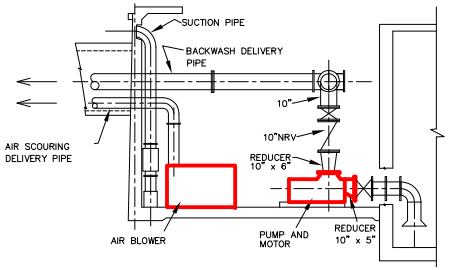
PLAN



SECTION B – B



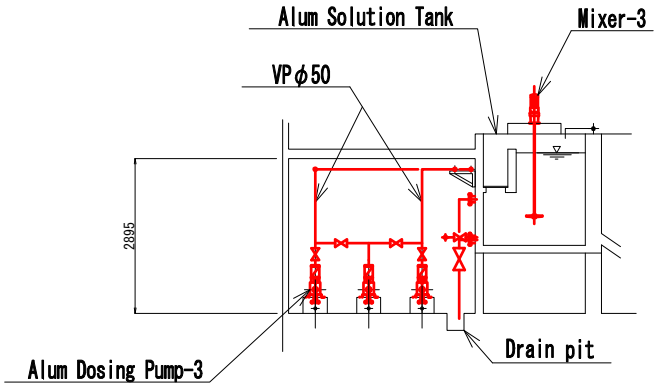
SECTION A – A



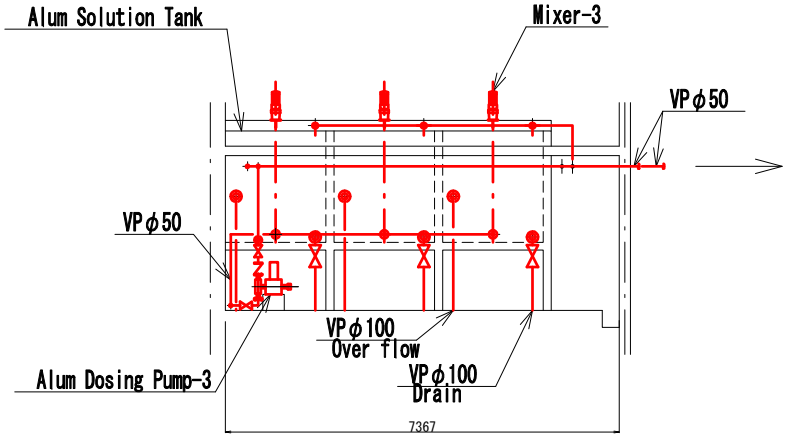
SECTION C – C

Alum Dosing System

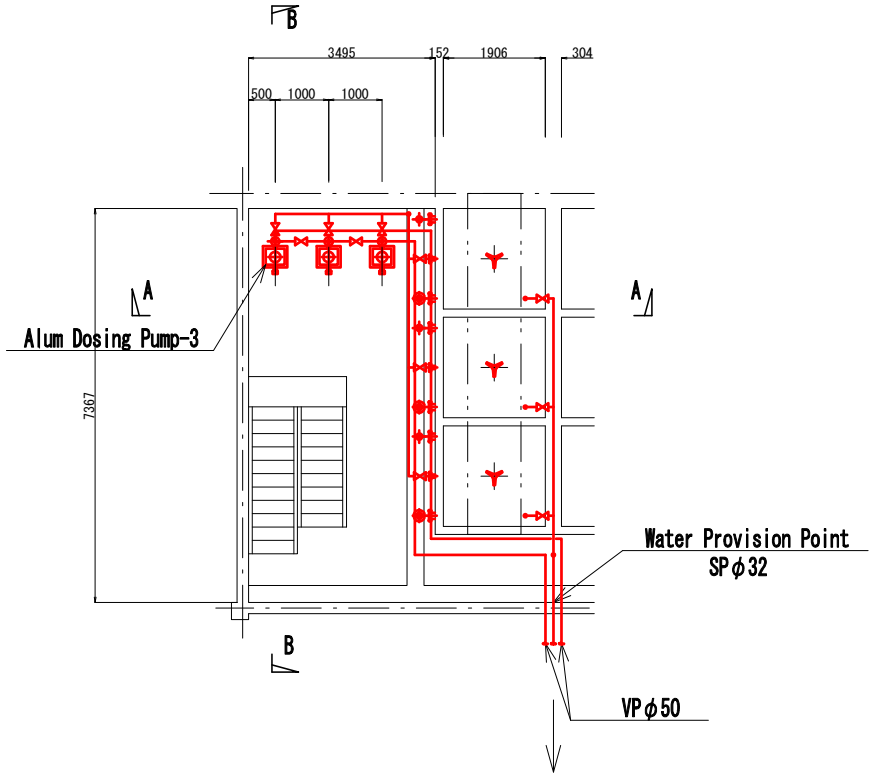
scale:1/100



A-A Section

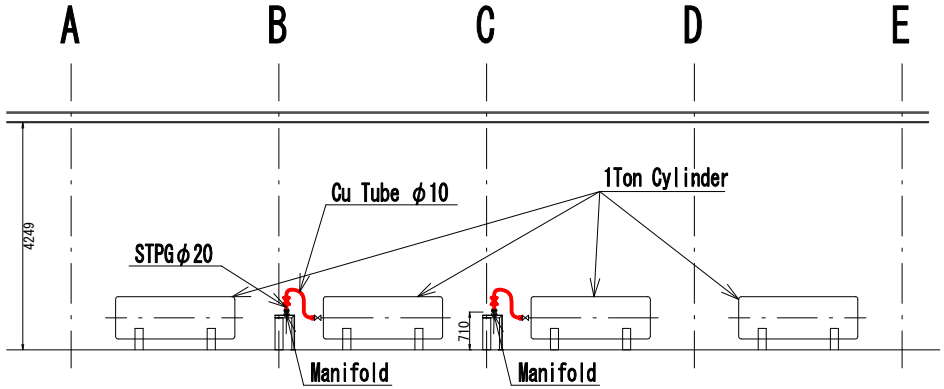


B-B Section

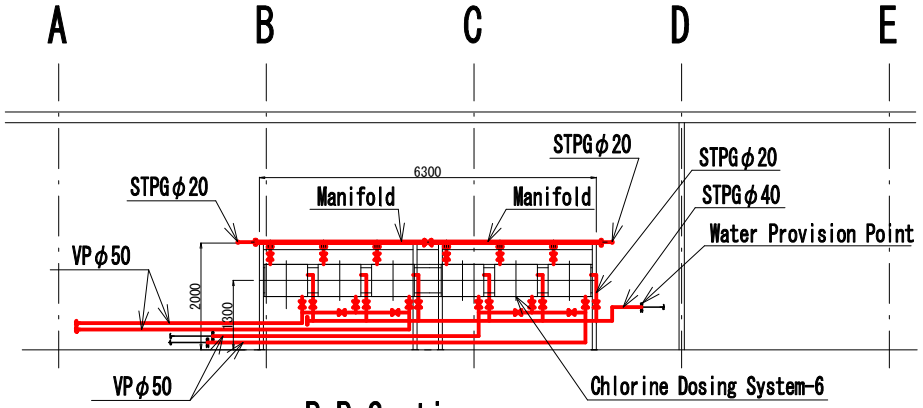


Chlorine dosing System

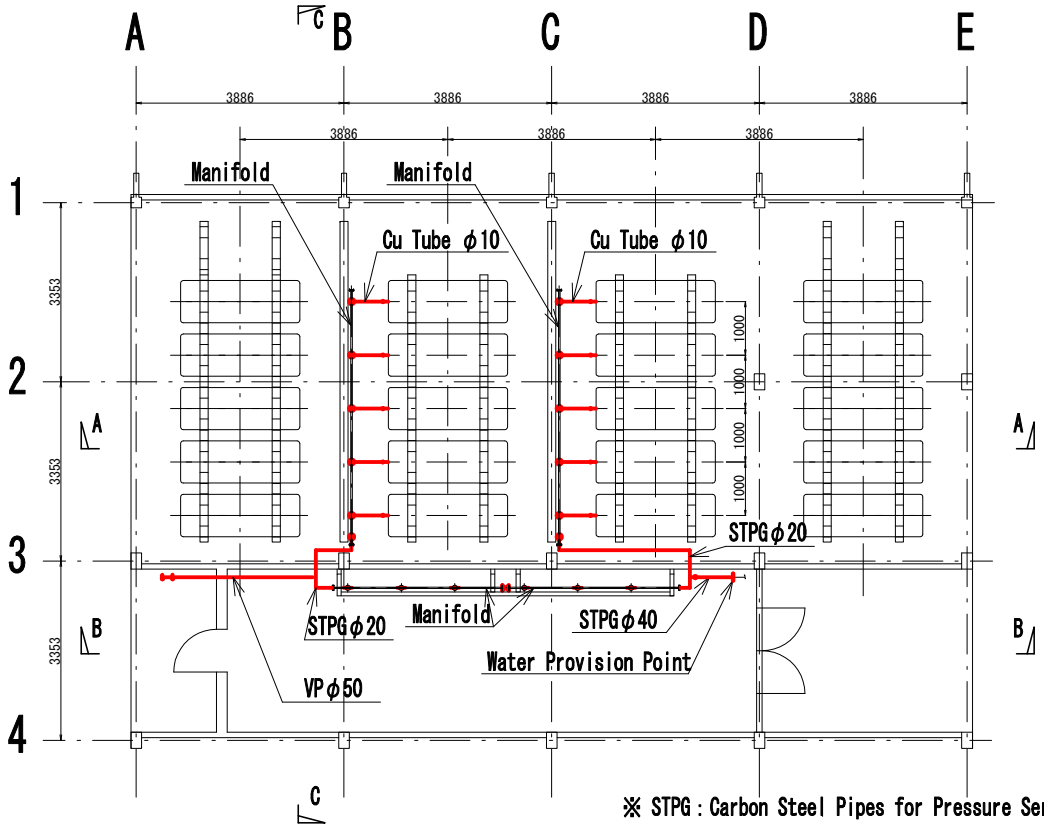
scale:1/100



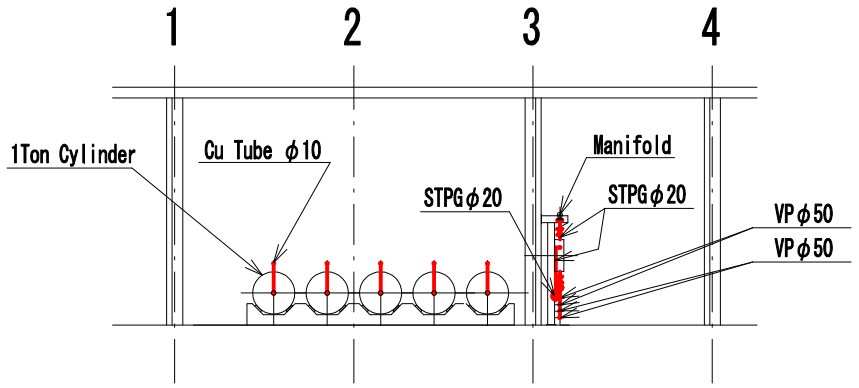
A-A Section



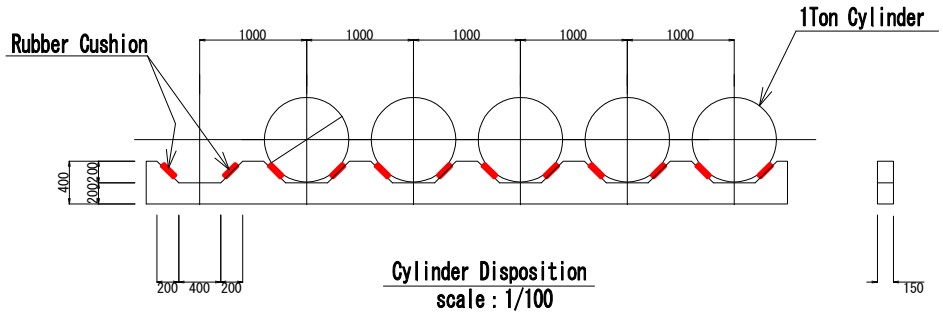
B-B Section



※ STPG : Carbon Steel Pipes for Pressure Service



C-C Section

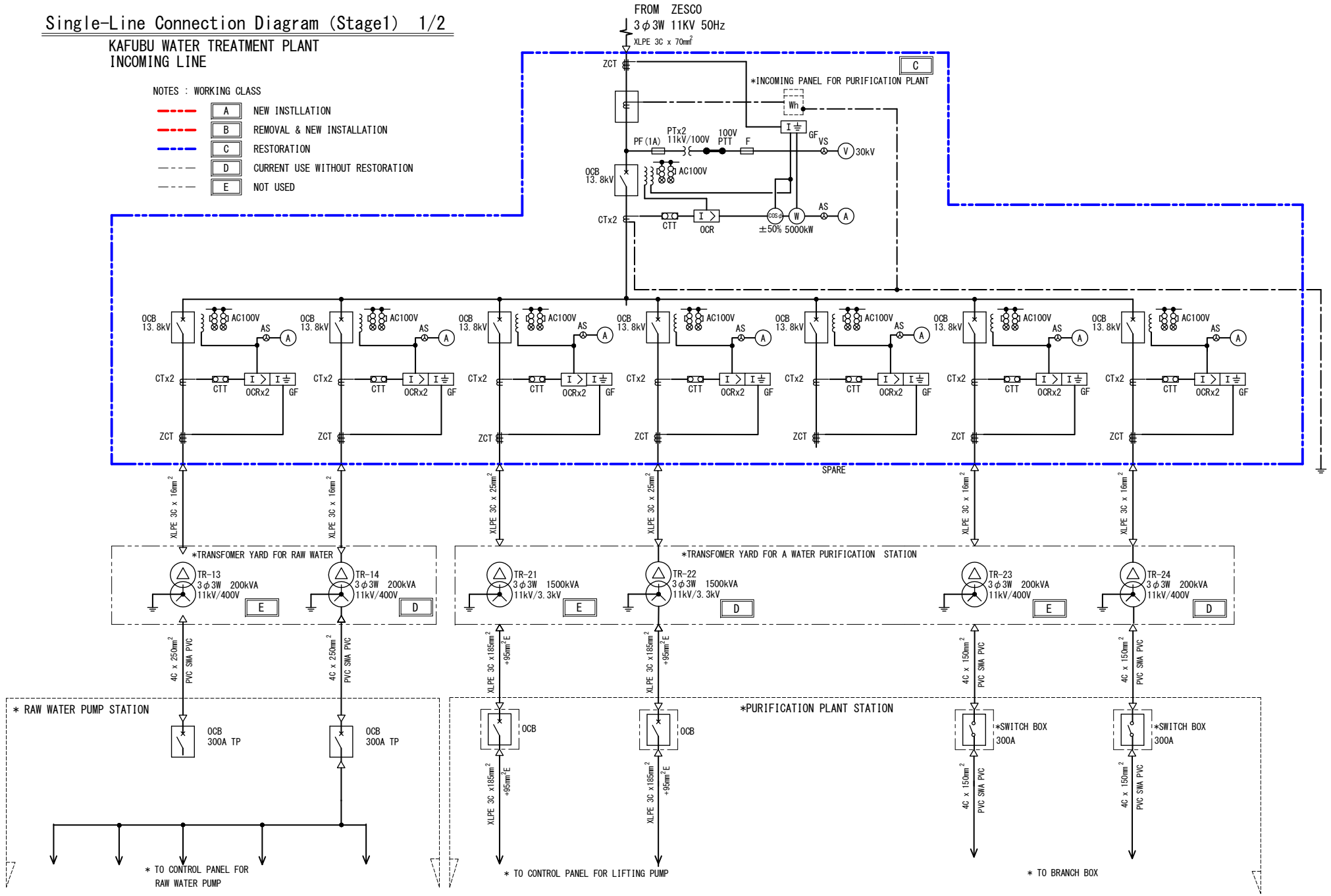


Cylinder Disposition
scale : 1/100

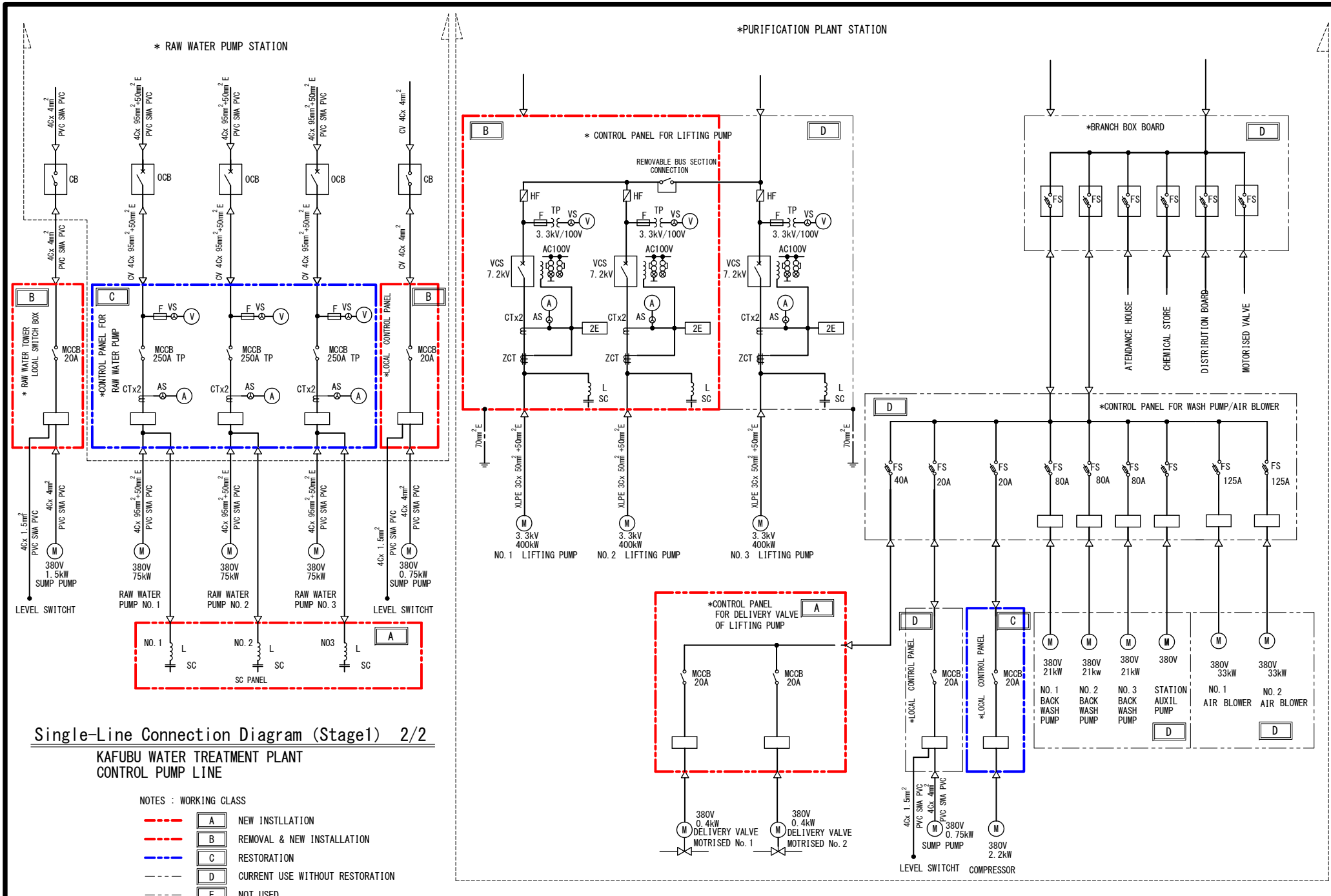
11-1. Chlorine dosing System

Single-Line Connection Diagram (Stage1) 1/2

KAFUBU WATER TREATMENT PLANT
INCOMING LINE



12-1. Single-Line Connection Diagram (Stage1) 1/2



Single-Line Connection Diagram (Stage1) 2/2

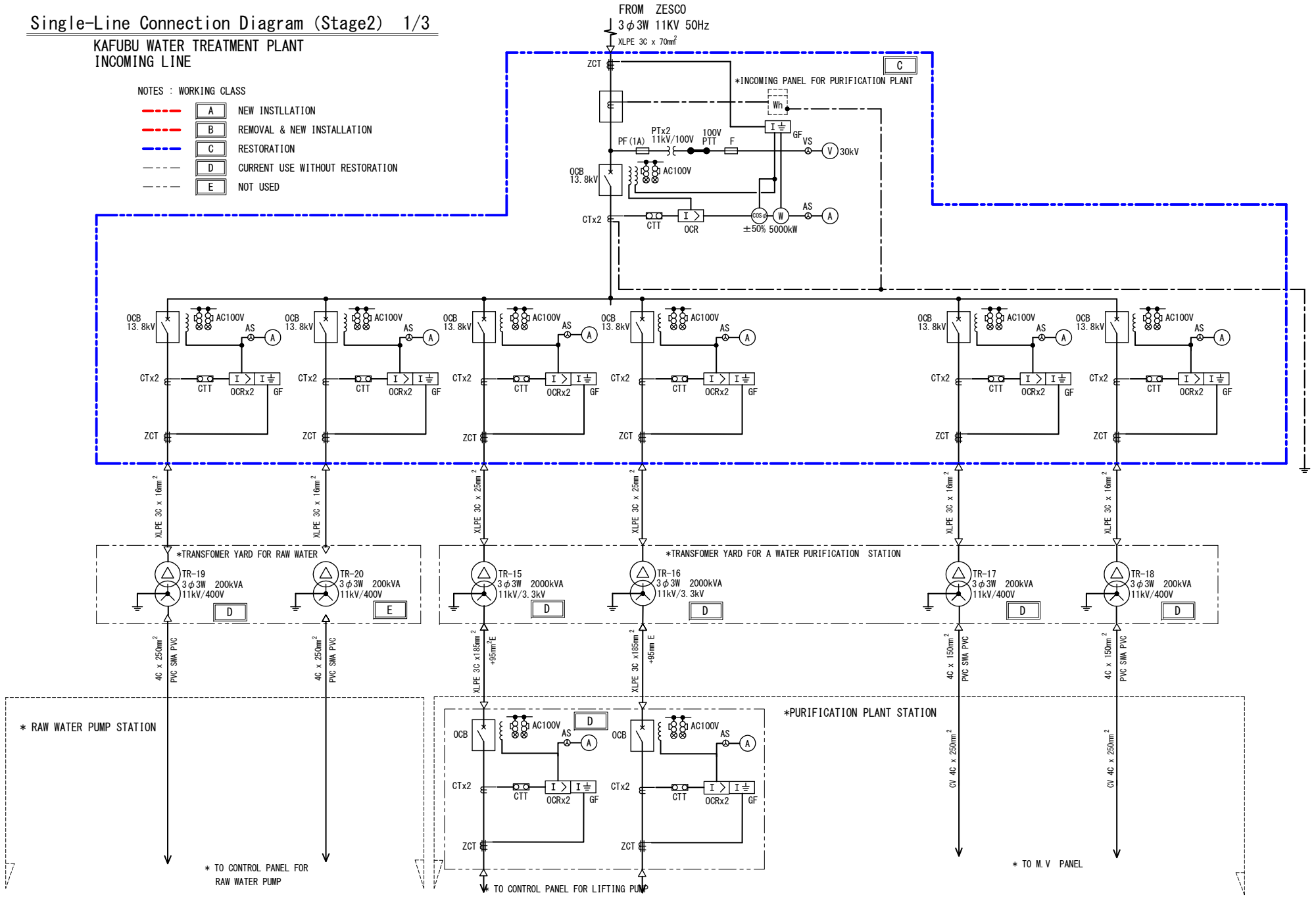
KAFUBU WATER TREATMENT PLANT
CONTROL PUMP LINE

NOTES : WORKING CLASS

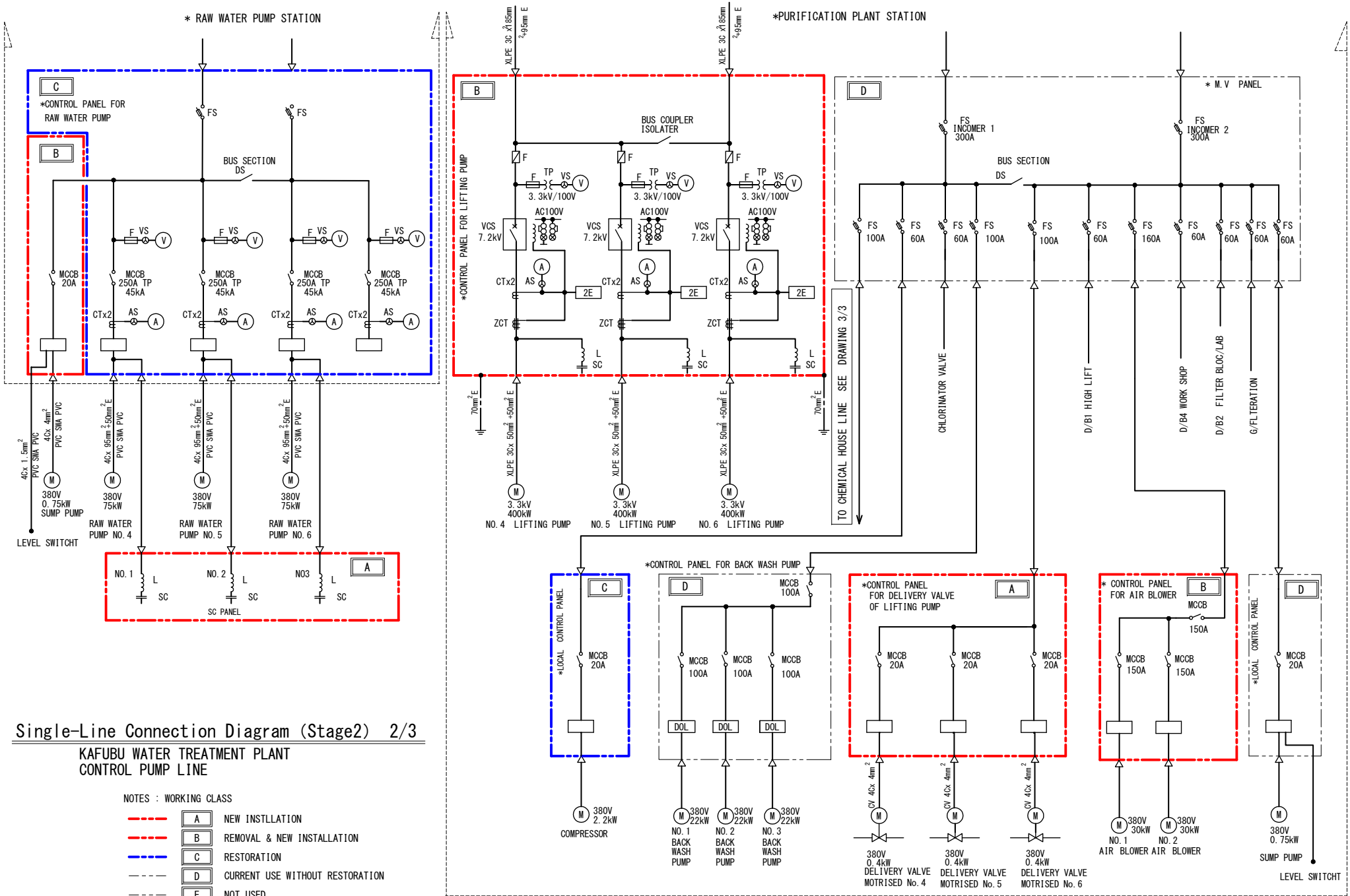
A	NEW INSTLLATION
B	REMOVAL & NEW INSTALLATION
C	RESTORATION
D	CURRENT USE WITHOUT RESTORATION
E	NOT USED

Single-Line Connection Diagram (Stage2) 1/3

KAFUBU WATER TREATMENT PLANT
INCOMING LINE



12-3. Single-Line Connection Diagram (Stage2) 1/3



Single-Line Connection Diagram (Stage2) 2/3

KAFUBU WATER TREATMENT PLANT
CONTROL PUMP LINE

NOTES : WORKING CLASS

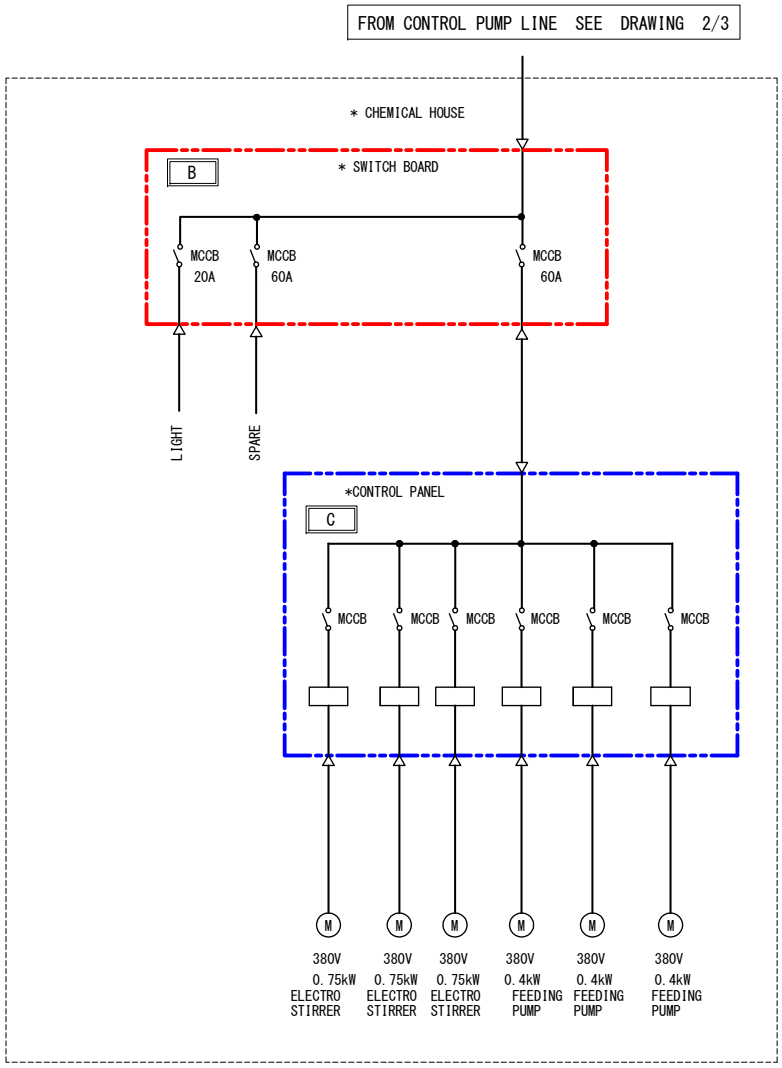
———	A	NEW INSTLLATION
———	B	REMOVAL & NEW INSTALLATION
———	C	RESTORATION
- - - -	D	CURRENT USE WITHOUT RESTORATION
- - - -	E	NOT USED

Single-Line Connection Diagram (Stage2) 3/3

KAFUBU WATER TREATMENT PLANT
CHEMICAL HOUSE LINE

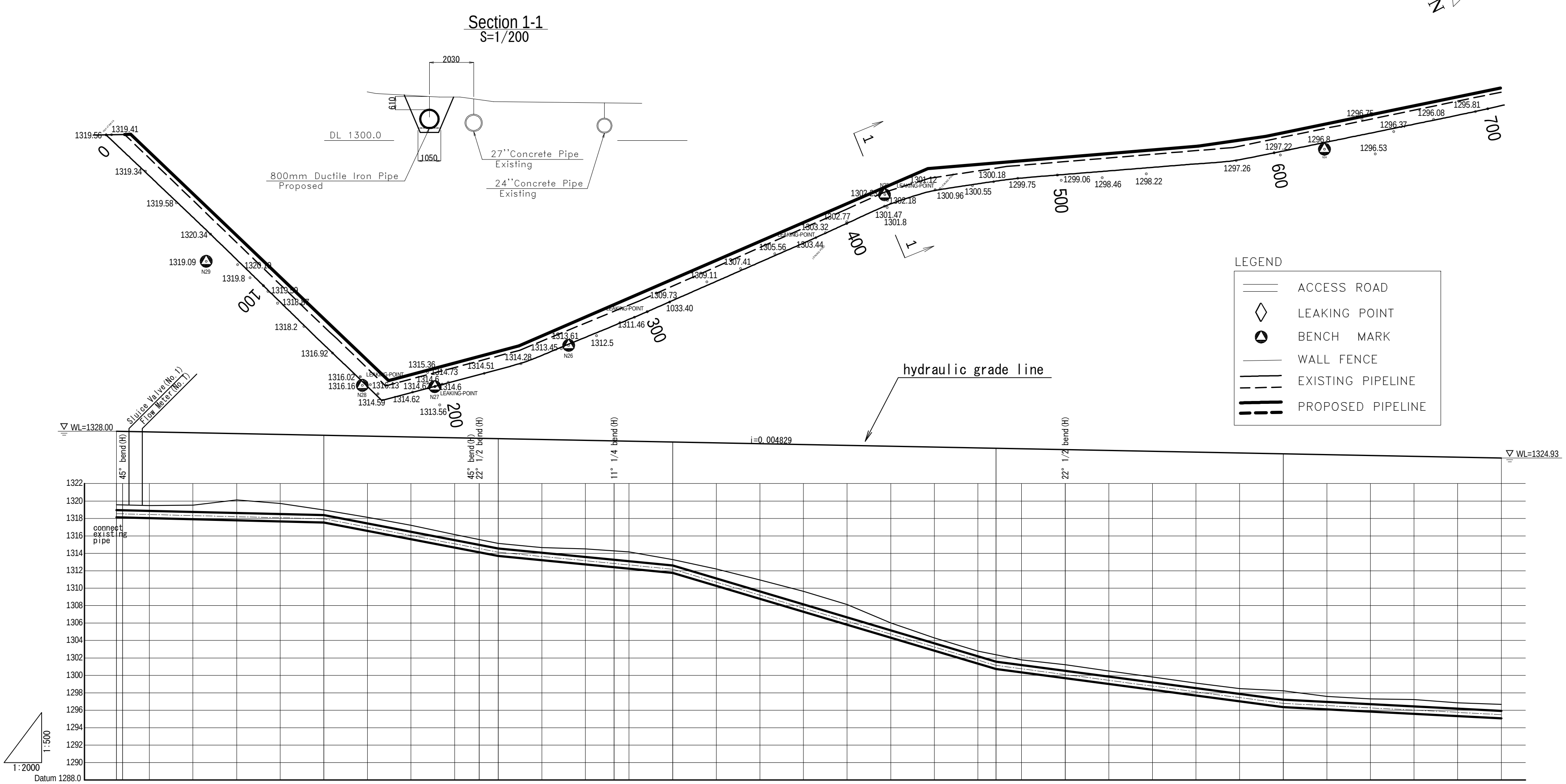
NOTES : WORKING CLASS

▬▬	A	NEW INSTLLATION
▬▬	B	REMOVAL & NEW INSTALLATION
▬▬	C	RESTORATION
▬ ▬ ▬	D	CURRENT USE WITHOUT RESTORATION
▬ ▬ ▬	E	NOT USED



Plans & Longitudinal Sections (1/9) V=1/500 H=1/2000

NAKAPUTA-SKYWAYS



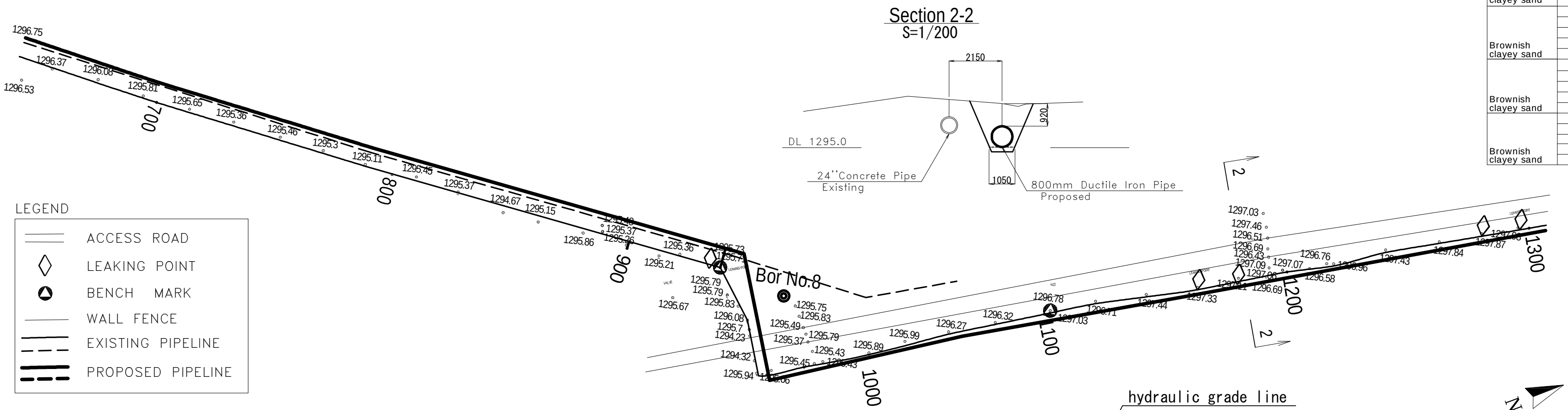
GROUND ELEVATION	EARTH COVERING	CENTER OF PIPE ELEVATION	DISTANCE	ACCUMULATE DISTANCE	GRADIENTS	PIPE NOMINAL
1319.56	0.60	1318.539	0	0	1318.539	DCIP φ800
1319.56	0.60	1318.536	2.8	2.8		
1319.49			12.3	15.1		
1319.52			20	35.1	i=0.00609	
1320.12			20	55.1		
1319.51			20	75.1		
1318.98	0.60	1317.960	20	95.1	1317.960	
1318.13			20	115.1		
1317.22			20	135.1	i=0.04789	
1316.17			20	155.1		
1314.66	0.63	1313.634	11.3	166.4		
1315.15	0.60	1314.129	8.7	175.1	1314.129	
1314.66			20	195.1		
1314.51			20	215.1	i=0.02429	
1314.29	0.93	1313.155	13.1	215.1		
1314.17			6.9	235.1		
1313.28	0.67	1312.186	20	255.1	1312.186	
1312.19			20	275.1		
1310.97			20	295.1		
1309.64			20	315.1	i=0.07446	
1308.13			20	335.1		
1306.01			20	355.1		
1304.30			20	375.1		
1302.79			20	395.1		
1302.37	0.81	1301.144	8.3	403.4	1301.144	
1301.78			11.7	415.1		
1301.24	0.73	1300.094	20	435.1		
1300.52			20	455.1		
1299.82			20	475.1	i=0.03307	
1299.11			20	495.1		
1298.48			20	515.1		
1298.23	1.02	1296.789	20	535.1	1296.789	
1297.60			20	555.1		
1297.30			20	575.1		
1297.23			20	595.1	i=0.01288	
1296.86			20	615.1		
1296.69	0.766	1295.503	20	635.1	1295.503	

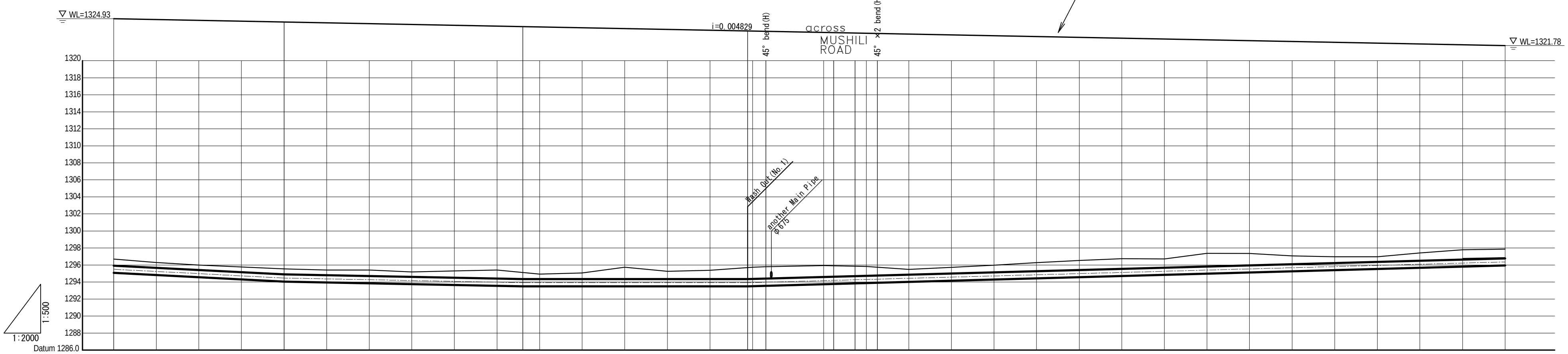
Plans & Longitudinal Sections (2/9) V=1/ 500 H=1/2000

NAKAPUTA-SKYWAYS

Bor No.8

DESCRIPTION	DEPTH (m)	blows	N	Wc
Brownish clayey sand	1	1 1 1	2	
Brownish clayey sand	2	1 1 1	2	
Brownish clayey sand	3	1 1 1	2	
Brownish clayey sand	4	1 1 1	2	WL=3.8m
Brownish clayey sand	5	1 1 1	2	





GRADIENTS: 1295.503 — i=0.01288 — 1294.470 — i=0.00492 — 1293.918 — LEVEL — 1293.918 — i=0.00689 — 1296.369

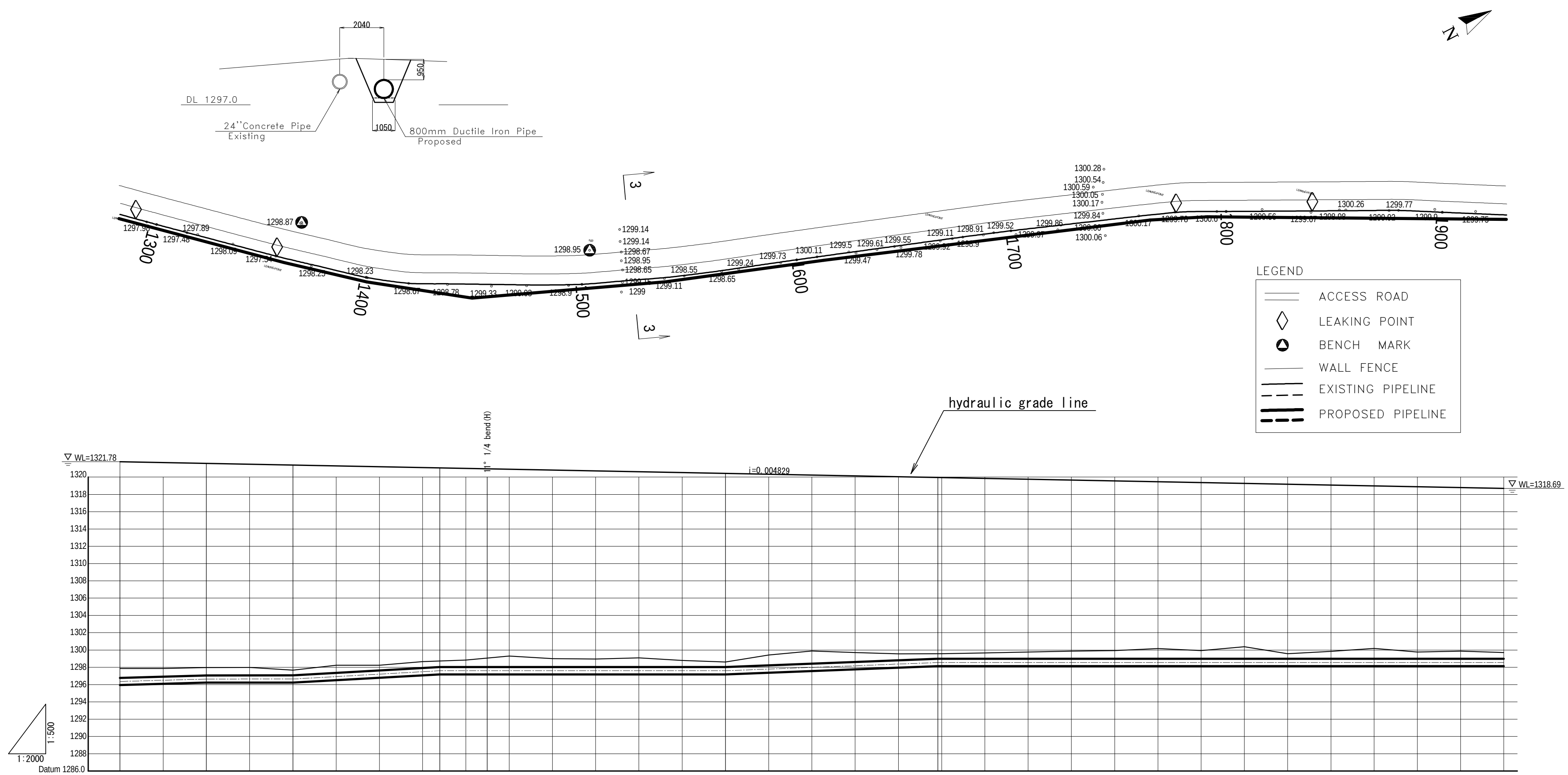
PIPE NOMINAL: DCIPφ800

ACCUMULATE DISTANCE	DISTANCE	GROUND ELEVATION	EARTH COVERING	CENTER OF PIPE ELEVATION
635.1	20	1296.69	0.766	1295.503
655.1	20	1296.31		
675.1	20	1296.01		
695.1	20	1295.76		
715.1	20	1295.55	0.66	1294.470
735.1	20	1295.40		
755.1	20	1295.39		
775.1	20	1295.20		
795.1	20	1295.29		
815.1	20	1295.40		
827.3	12.2	1295.12	0.78	1293.918
835.1	7.8	1294.94		
855.1	20	1295.06		
875.1	20	1295.74		
895.1	20	1295.26		
915.1	20	1295.39		
932.8	17.7	1295.71	1.37	1293.918
935.1	2.3	1295.75	1.41	1293.983
941.4	6.3	1295.81		
968.5	27.1	1295.93		
988.5	20	1295.82		
993.7	5.2	1295.82	0.97	1294.425
1008.5	14.8	1295.49		
1028.5	20	1295.73		
1048.5	20	1295.98		
1068.5	20	1296.26		
1088.5	20	1296.53		
1108.5	20	1296.73		
1128.5	20	1296.72		
1148.5	20	1297.37		
1168.5	20	1297.35		
1188.5	20	1297.08		
1208.5	20	1296.97		
1228.5	20	1296.98		
1248.5	20	1297.42		
1268.5	20	1297.79		
1288.5	20	1297.87	1.08	1296.369

Plans & Longitudinal Sections (3/9) V=1/ 500 H=1/2000

NAKAPUTA-SKYWAYS

Section 3-3
S=1/200



GRADIENTS: 1296.369 — i=0.00689 — 1296.645 — LEVEL — 1296.645 — i=0.01405 — 1297.599 — LEVEL — 1297.599 — i=0.00966 — 1298.549 — LEVEL — 1298.549

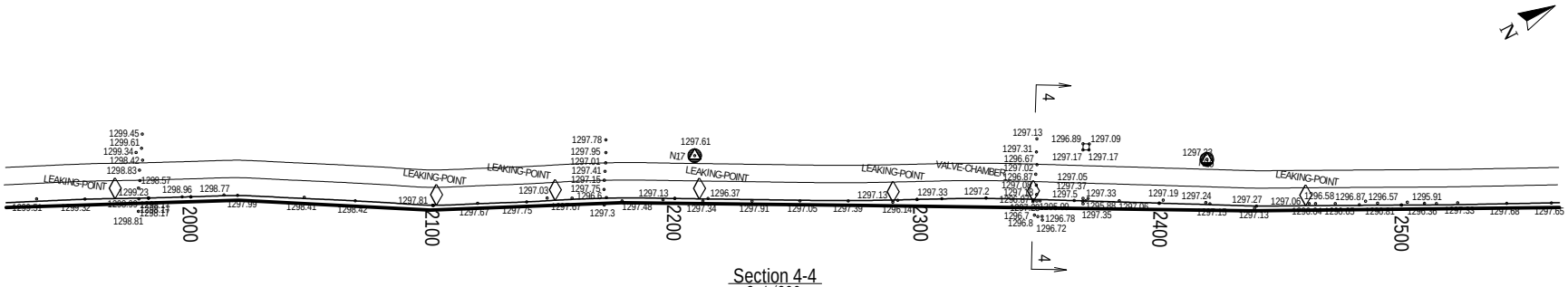
PIPE NOMINAL: DCIP φ800

ACCUMULATE DISTANCE	DISTANCE	GROUND ELEVATION	EARTH COVERING	CENTER OF PIPE ELEVATION
1288.5	20	1297.87	1.08	1296.369
1308.5	20	1297.86		
1328.5	20	1297.96	0.89	1296.645
1348.5	20	1297.99		
1368.5	20	1297.67	0.60	1296.645
1388.5	20	1298.25		
1408.5	20	1298.23		
1428.5	20	1298.67		
1436.4	7.9	1298.74	0.72	1297.599
1448.5	12.1	1298.84		
1458.4	9.9	1299.07	1.05	1297.599
1468.5	10.1	1299.30		
1488.5	20	1298.99		
1508.5	20	1298.97		
1528.5	20	1299.10		
1548.5	20	1298.80		
1568.5	20	1298.62	0.60	1297.599
1588.5	20	1299.42		
1608.5	20	1299.90		
1628.5	20	1299.70		
1648.5	20	1299.55		
1666.8	18.3	1299.57	0.60	1298.549
1668.5	1.7	1299.58		
1688.5	20	1299.67		
1708.5	20	1299.77		
1728.5	20	1299.87		
1748.5	20	1299.94		
1768.5	20	1300.16		
1788.5	20	1299.93		
1808.5	20	1300.39		
1828.5	20	1299.57		
1848.5	20	1299.84		
1868.5	20	1300.18		
1888.5	20	1299.77		
1908.5	20	1299.87		
1928.5	20	1299.70	0.73	1298.549

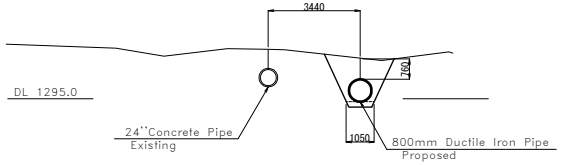
Plans & Longitudinal Sections (4/9)

V=1/ 500
H=1/2000

NAKAPUTA-SKYWAYS

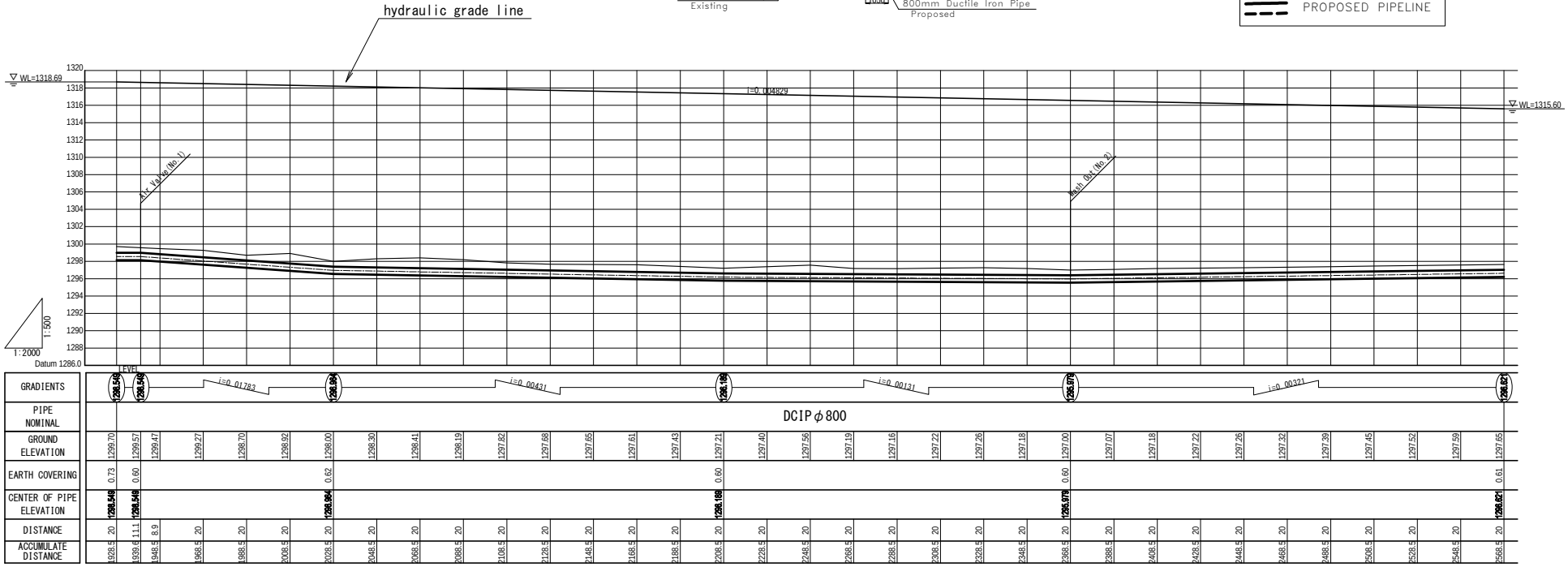


Section 4-4
S=1/200



LEGEND

- ACCESS ROAD
- LEAKING POINT
- BENCH MARK
- WALL FENCE
- EXISTING PIPELINE
- PROPOSED PIPELINE

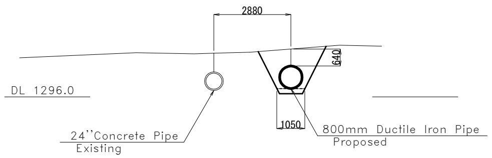


Plans & Longitudinal Sections (5/9)

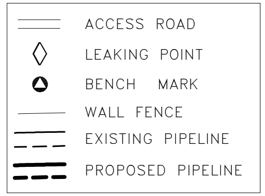
V=1/ 500
H=1/2000

NAKAPUTA-SKYWAYS

Section 5-5
S=1/200

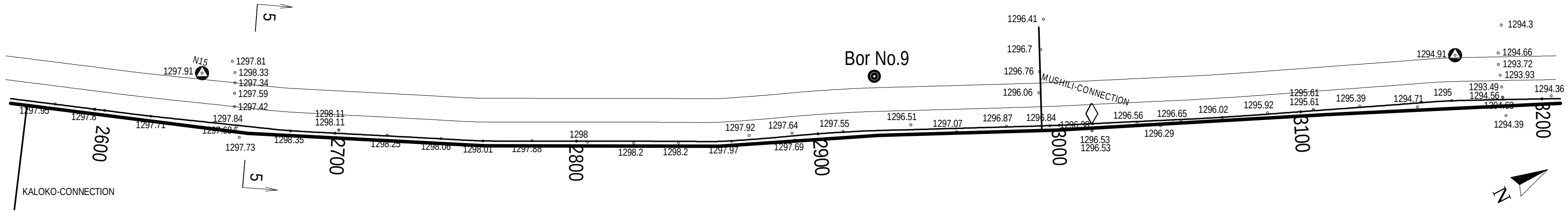


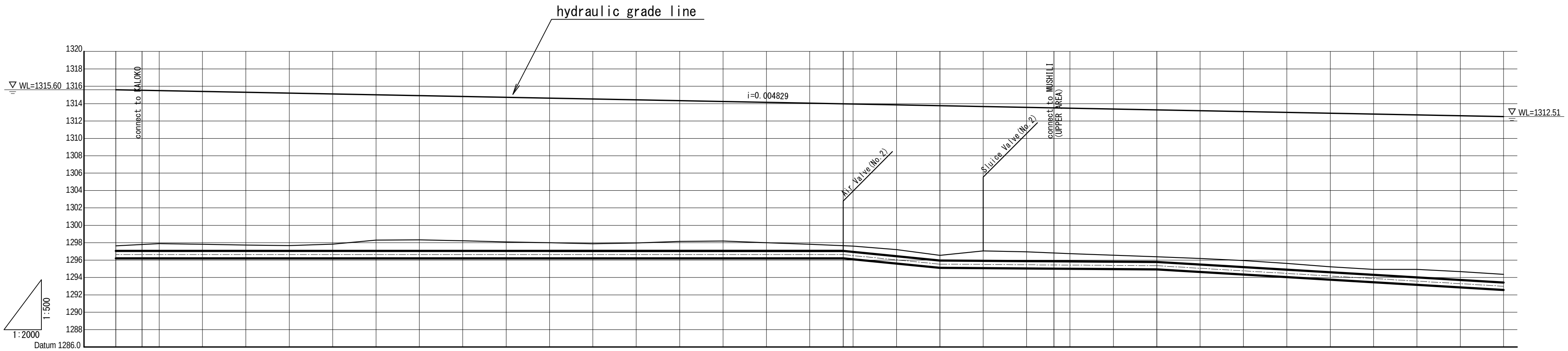
LEGEND



Bor No.9

DESCRIPTION	DEPTH (m)	blows	N	Wc
Brownish clay	1	4 4 3	7	
Brownish clay	2	2 3 3	6	
Brownish clay	3	2 2 4	6	
Brownish clay	4	6 8 4	12	
Yellowish-brown clay wth stones	5	4 4 5	9	





GRADIENTS: 1296.621 — LEVEL — 1296.621 — i=0.02426 — 1295.539 — i=0.00180 — 1295.359 — i=0.01479 — 1292.997

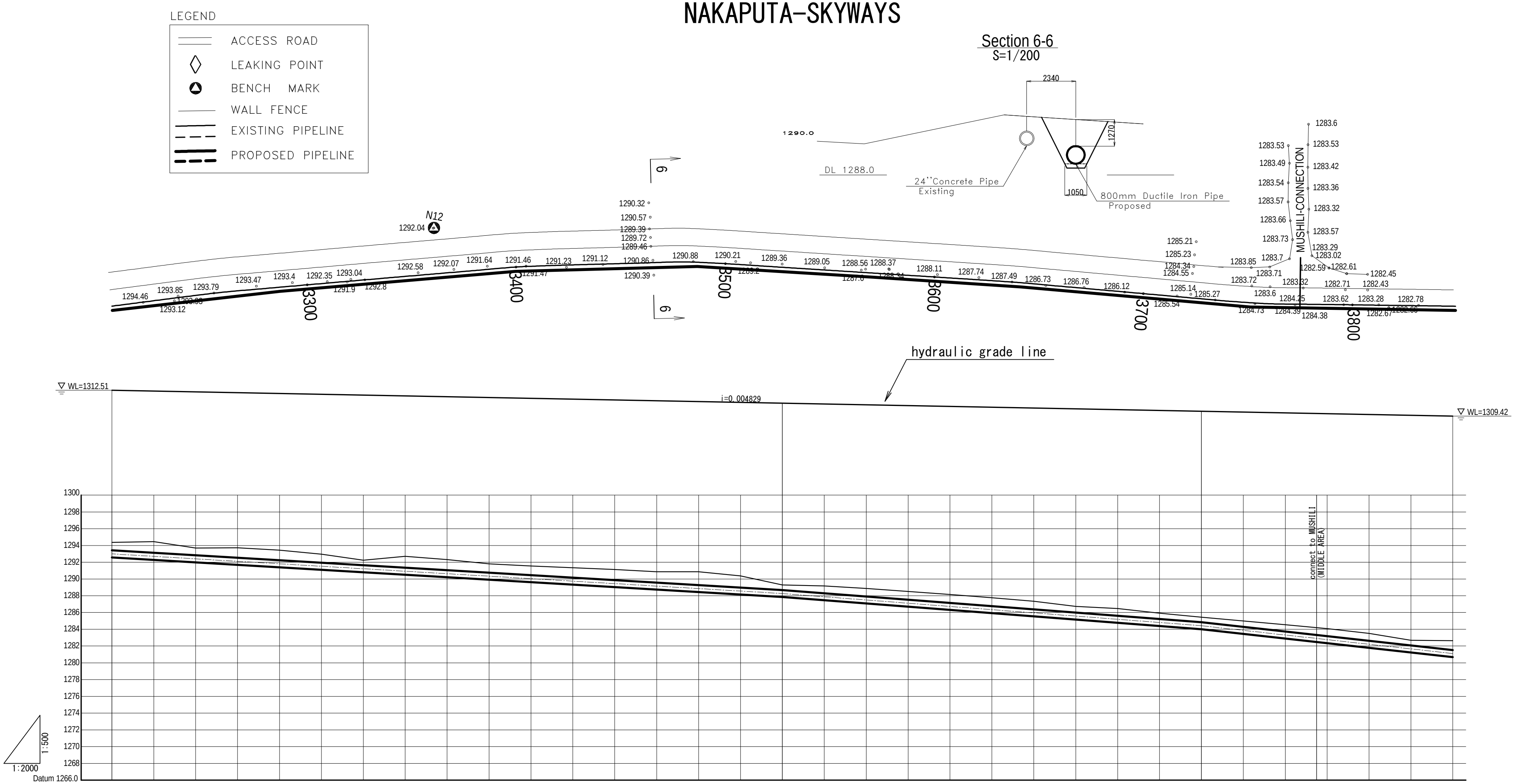
PIPE NOMINAL: DCIP ϕ 800

ACCUMULATE DISTANCE	GROUND ELEVATION	EARTH COVERING	CENTER OF PIPE ELEVATION	DISTANCE
2568.5	1297.65	0.61	1296.621	20
2580.6	1297.80	0.76	1296.621	12.1
2588.5	1297.90			7.9
2608.5	1297.83			20
2628.5	1297.73			20
2648.5	1297.68			20
2668.5	1297.83			20
2688.5	1298.31			20
2708.5	1298.26			20
2728.5	1298.23			20
2748.5	1298.09			20
2768.5	1298.01			20
2788.5	1297.89			20
2808.5	1297.98			20
2828.5	1298.16			20
2848.5	1298.20			20
2868.5	1298.01			20
2888.5	1297.81			20
2903.9	1297.65	0.61	1296.621	15.4
2908.5	1297.60			4.6
2928.5	1297.20			20
2948.5	1296.56	0.60	1295.539	20
2968.5	1297.05			20
2988.5	1296.61			20
3001.1	1296.74	0.95	1295.365	12.6
3008.5	1296.74			7.4
3028.5	1296.56			20
3048.5	1296.38	0.60	1295.359	20
3068.5	1296.18			20
3088.5	1295.95			20
3108.5	1295.61			20
3128.5	1295.24			20
3148.5	1294.95			20
3168.5	1294.94			20
3188.5	1294.68			20
3208.5	1294.38	0.96	1292.997	20

13-5. Plans & Longitudinal Sections (5/9)

Plans & Longitudinal Sections (6/9) V=1/500 H=1/2000

NAKAPUTA-SKYWAYS



Gradients: 1292.997 — i=0.01479 — 1288.259 — i=0.01915 — 1284.429 — i=0.02767 — 1281.111

Pipe nominal: DCIP φ800

ACCUMULATE DISTANCE	DISTANCE	GROUND ELEVATION	EARTH COVERING	CENTER OF PIPE ELEVATION
3208.5	20	1294.38	0.96	1292.997
3228.5	20	1294.45		
3248.5	20	1293.69		
3268.5	20	1293.72		
3288.5	20	1293.45		
3308.5	20	1292.95		
3328.5	20	1292.24		
3348.5	20	1292.70		
3368.5	20	1292.31		
3388.5	20	1291.81		
3408.5	20	1291.55		
3428.5	20	1291.35		
3448.5	20	1291.13		
3468.5	20	1290.86		
3488.5	20	1290.86		
3508.5	20	1290.37		
3528.5	20	1289.28	0.60	1288.259
3548.5	20	1289.16		
3568.5	20	1288.87		
3588.5	20	1288.52		
3608.5	20	1288.15		
3628.5	20	1287.77		
3648.5	20	1287.35		
3668.5	20	1286.74		
3688.5	20	1286.48		
3708.5	20	1285.92		
3728.5	20	1285.45	0.60	1284.429
3748.5	20	1285.00		
3768.5	20	1284.55		
3783.4	14.9	1284.20	0.88	1282.903
3788.5	5.1	1284.08		
3808.5	20	1283.52		
3828.5	20	1282.68		
3848.5	20	1282.65	1.12	1281.111

13-6. Plans & Longitudinal Sections (6/9)

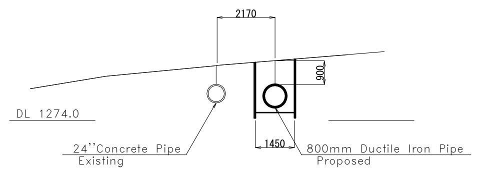
Plans & Longitudinal Sections (7/9) V=1/ 500 H=1/2000

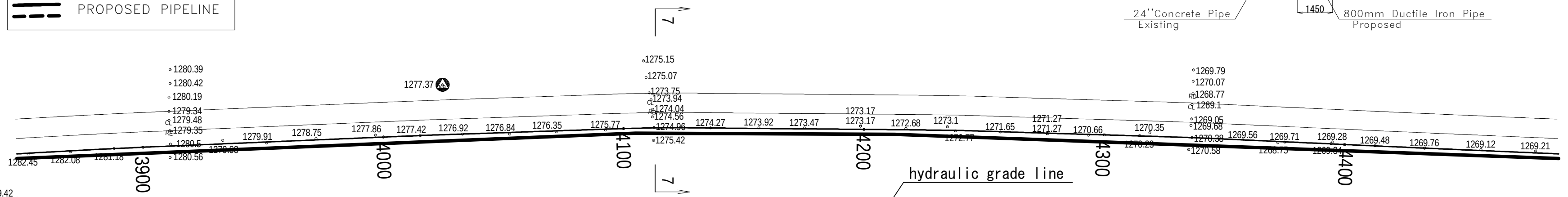
NAKAPUTA-SKYWAYS

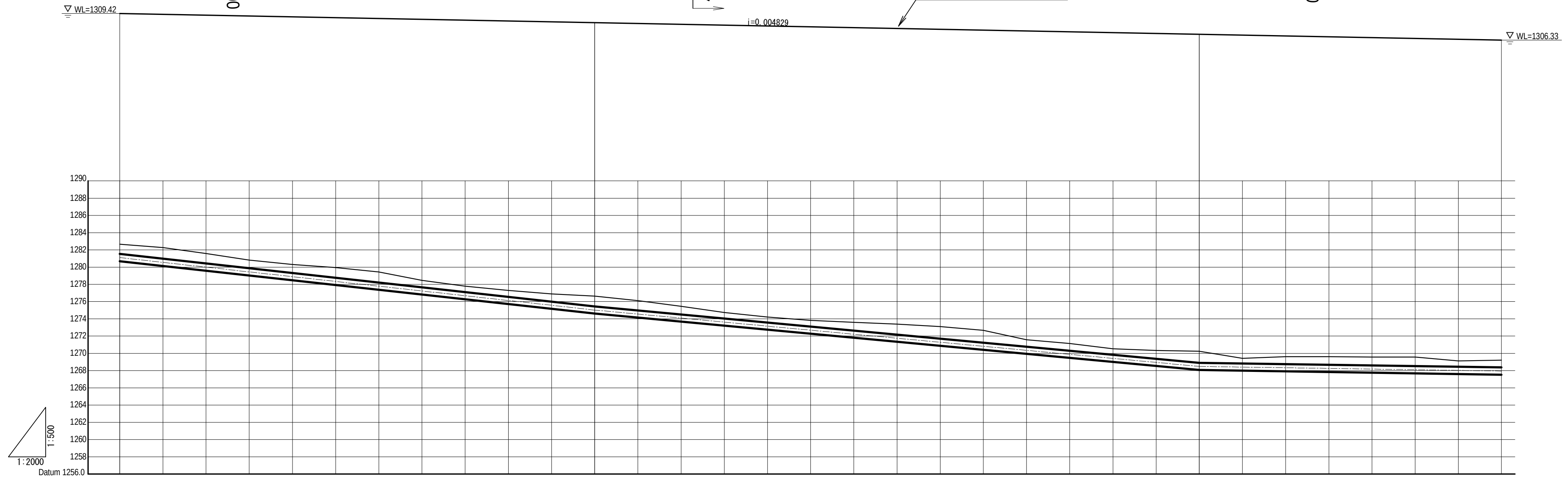
LEGEND

- ACCESS ROAD
- LEAKING POINT
- BENCH MARK
- WALL FENCE
- EXISTING PIPELINE
- PROPOSED PIPELINE

Section 7-7
S=1/200







GRADIENTS	1281.111					i=0.02767					
PIPE NOMINAL											
GROUND ELEVATION	1282.65	1282.29	1281.58	1280.84	1280.31	1279.96	1279.43	1278.46	1277.79	1277.29	1276.89
EARTH COVERING	1.12										
CENTER OF PIPE ELEVATION	1281.111										
DISTANCE	20	20	20	20	20	20	20	20	20	20	20
ACCUMULATE DISTANCE	3848.5	3868.5	3888.5	3908.5	3928.5	3948.5	3968.5	3988.5	4008.5	4028.5	4048.5

GRADIENTS	1275.021							i=0.02335			
PIPE NOMINAL						DCIP φ800					
GROUND ELEVATION	1276.65	1276.13	1275.45	1274.75	1274.20	1273.83	1273.59	1273.38	1273.12	1272.66	1271.58
EARTH COVERING	1.21										
CENTER OF PIPE ELEVATION	1275.021										
DISTANCE	20	20	20	20	20	20	20	20	20	20	20
ACCUMULATE DISTANCE	4068.5	4088.5	4108.5	4128.5	4148.5	4168.5	4188.5	4208.5	4228.5	4248.5	4268.5

GRADIENTS				1268.482			i=0.00379				1267.952
PIPE NOMINAL											
GROUND ELEVATION	1271.14	1270.52	1270.34	1270.24	1269.43	1269.62	1269.62	1269.58	1269.58	1269.14	1269.21
EARTH COVERING				1.34							0.84
CENTER OF PIPE ELEVATION				1268.482							1267.952
DISTANCE	20	20	20	20	20	20	20	20	20	20	20
ACCUMULATE DISTANCE	4288.5	4308.5	4328.5	4348.5	4368.5	4388.5	4408.5	4428.5	4448.5	4468.5	4488.5

13-7. Plans & Longitudinal Sections (7/9)

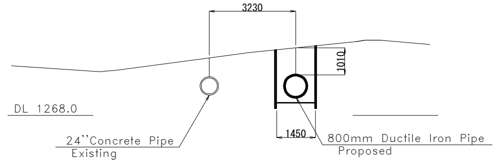
Plans & Longitudinal Sections (8/9) V=1/ 500 H=1/2000

NAKAPUTA-SKYWAYS

LEGEND

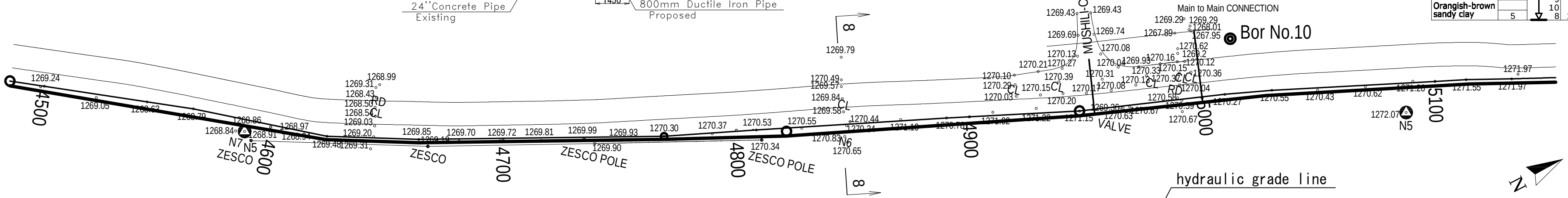
- ACCESS ROAD
- LEAKING POINT
- BENCH MARK
- WALL FENCE
- EXISTING PIPELINE
- PROPOSED PIPELINE

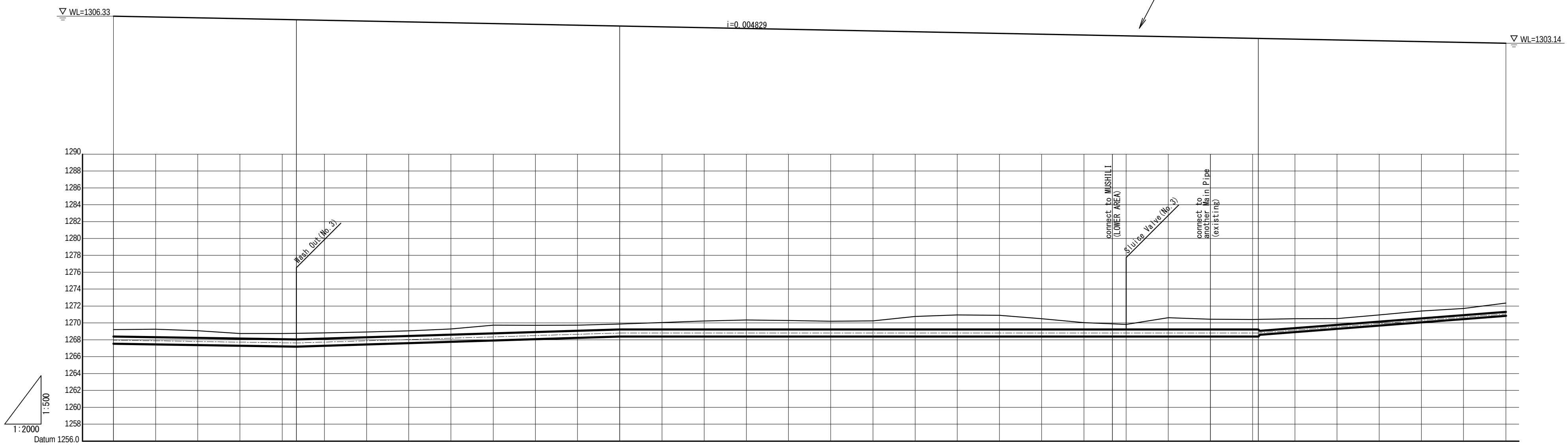
Section 8-8
S=1/200



Bor No.10

DESCRIPTION	DEPTH (m)	blows	N	Wc
Orangish-brown sandy clay	1	1 2 2	4	
Orangish-brown sandy clay	2	1 1 1	2	
Orangish-brown sandy clay	3	5 6 8	14	
Reddish-brown sandy clay	4	5 7 8	15	
Orangish-brown sandy clay	5	9 10 8	18	





Pipe nominal: DCIP φ800 (4488.5 – 5028.5); DCIP φ450 (5031.1 – 5148.5)

GRADIENTS	1267.952	i=0.00379				1267.622	i=0.00776						
GROUND ELEVATION	1269.21	1269.24	1269.08	1268.74	1268.74	1268.77	1268.82	1268.93	1269.07	1269.28	1269.73	1269.71	1269.73
EARTH COVERING	0.84					0.73							
CENTER OF PIPE ELEVATION	1267.952					1267.622							
DISTANCE	20	20	20	20	20	6.7	13.3	20	20	20	20	20	20
ACCUMULATE DISTANCE	4488.5	4508.5	4528.5	4548.5	4568.5	4575.2	4588.5	4608.5	4628.5	4648.5	4668.5	4688.5	4708.5

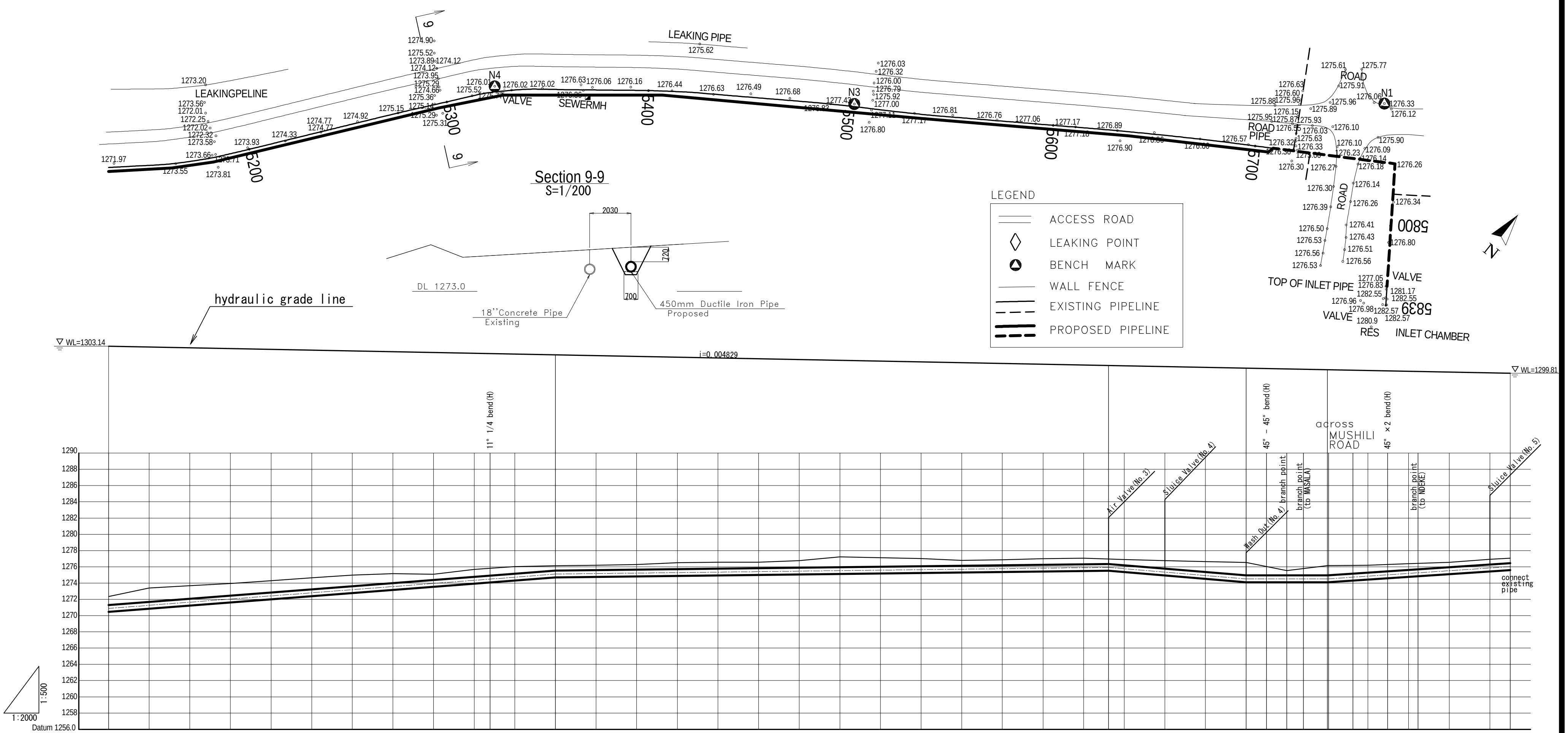
GRADIENTS	1268.811	LEVEL										
GROUND ELEVATION	1269.87	1270.04	1270.21	1270.34	1270.29	1270.20	1270.24	1270.78	1270.94	1270.90	1270.49	1270.03
EARTH COVERING	0.64											
CENTER OF PIPE ELEVATION	1268.811											
DISTANCE	20	20	20	20	20	20	20	20	20	20	20	20
ACCUMULATE DISTANCE	4728.5	4748.5	4768.5	4788.5	4808.5	4828.5	4848.5	4868.5	4888.5	4908.5	4928.5	4948.5

GRADIENTS					1268.811		i=0.01920					1271.064
GROUND ELEVATION	1269.89	1269.83	1270.63	1270.44	1270.41	1270.42	1270.49	1270.53	1270.94	1271.40	1271.69	1272.35
EARTH COVERING	0.66			1.21	1.19	1.37						1.05
CENTER OF PIPE ELEVATION	1268.811			1268.811	1268.811							1271.064
DISTANCE	13.5	6.5	20	20	20	2.6	17.4	20	20	20	20	20
ACCUMULATE DISTANCE	4962.0	4968.5	4988.5	5008.5	5028.5	5031.1	5048.5	5068.5	5088.5	5108.5	5128.5	5148.5

13-8. Plans & Longitudinal Sections (8/9)

Plans & Longitudinal Sections (9/9) V=1/500 H=1/2000

NAKAPUTA-SKYWAYS



GRADIENTS: 1271.064 — i=0.01920 — 1275.290 — i=0.00066 — 1275.110 — i=0.00620 — 1274.690 — LEVEL — 1274.690 — i=0.01689 — 1276.210

PIPE NOMINAL: DCIP ϕ450

ACCUMULATE DISTANCE	DISTANCE	GROUND ELEVATION	EARTH COVERING	CENTER OF PIPE ELEVATION
5148.5	20	1272.35	1.05	1271.064
5168.5	20	1273.39		
5188.5	20	1273.67		
5208.5	20	1273.94		
5228.5	20	1274.29		
5248.5	20	1274.66		
5268.5	20	1274.98		
5288.5	20	1275.15		
5308.5	20	1275.11		
5328.5	20	1275.69		
5336.3	7.8	1275.82	0.90	1274.676
5348.5	12.2	1276.02		
5368.5	20	1276.13	0.60	1275.290
5388.5	20	1276.19		
5408.5	20	1276.28		
5428.5	20	1276.52		
5448.5	20	1276.57		
5468.5	20	1276.58		
5488.5	20	1276.76		
5508.5	20	1277.22		
5528.5	20	1277.13		
5548.5	20	1277.01		
5568.5	20	1276.79		
5588.5	20	1276.88		
5608.5	20	1276.99		
5628.5	20	1277.05		
5640.8	12.3	1276.95	0.60	1275.110
5648.5	7.7	1276.88		
5668.5	20	1276.77		
5688.5	20	1276.63		
5708.5	20	1276.53	1.60	1274.690
5718.5	10	1276.03	1.10	1274.690
5728.5	20	1275.53	0.60	1274.690
5736.7	8.2	1275.79	0.86	1274.690
5748.5	11.8	1276.16	1.23	1274.690
5768.5	20	1276.20		
5778.1	9.6	1276.28	0.85	1275.189
5788.5	10.4	1276.30		
5793.1	4.6	1276.42	0.73	1275.448
5808.5	15.4	1276.61		
5828.5	20	1276.93		
5838.5	10	1277.05	0.60	1276.210

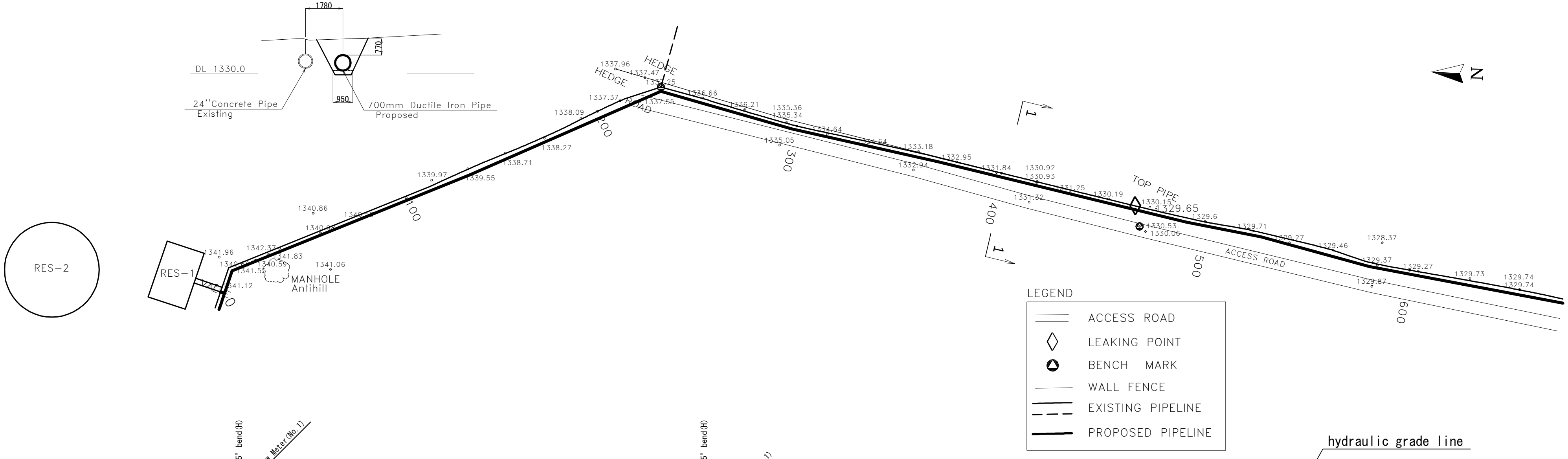
13-9. Plans & Longitudinal Sections (9/9)

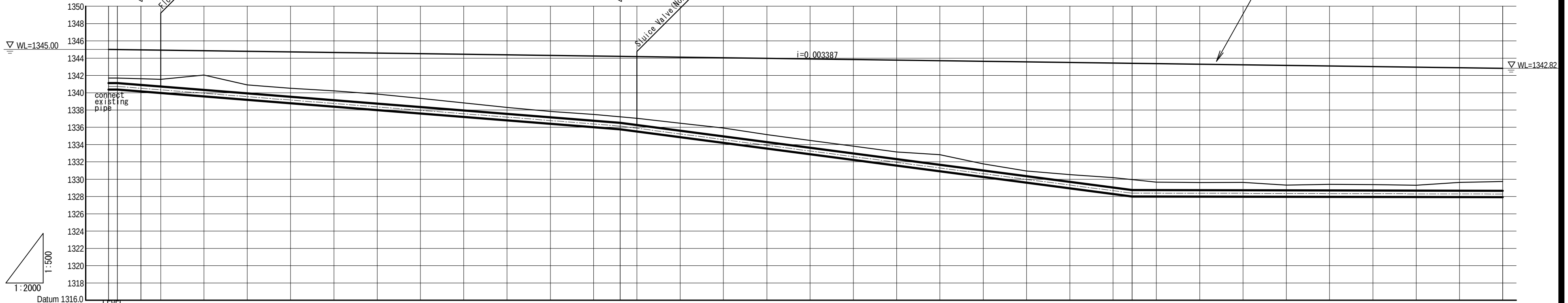
Plans & Longitudinal Sections (1/4)

V=1/ 500
H=1/2000

CHIFUBU

Section 1-1
S=1/200





GRADIENTS: 1340.731, 1340.731 — i=0.01973 — 1336.147 — i=0.03556 — 1328.387 — i=0.00054 — 1328.652

PIPE NOMINAL: DCIP ϕ 700

GROUND ELEVATION	1341.70	1341.70	1341.63	1341.56	1342.04	1340.90	1340.78	1340.52	1340.21	1339.84	1339.35	1338.83	1338.29
EARTH COVERING	0.60	0.60	0.74										
CENTER OF PIPE ELEVATION	1340.731	1340.731	1340.519										
DISTANCE	0	4.1	10.9	9.1	20	20	6.3	13.7	20	20	20	20	20
ACCUMULATE DISTANCE	0	4.1	15	24.1	44.1	64.1	70.4	84.1	104.1	124.1	144.1	164.1	184.1

GROUND ELEVATION	1337.82	1337.48	1337.21	1337.04	1336.48	1335.93	1335.15	1334.48	1333.84	1333.16	1332.84	1331.78	1330.95
EARTH COVERING			0.70										
CENTER OF PIPE ELEVATION			1336.146										
DISTANCE	20	20	12.3	7.7	20	20	20	20	20	20	20	20	20
ACCUMULATE DISTANCE	204.1	224.1	236.4	244.1	264.1	284.1	304.1	324.1	344.1	364.1	384.1	404.1	424.1

GROUND ELEVATION	1330.54	1330.36	1330.20	1329.96	1329.66	1329.62	1329.64	1329.31	1329.41	1329.38	1329.29	1329.63	1329.74
EARTH COVERING				1.20									1.08
CENTER OF PIPE ELEVATION				1328.387									1328.291
DISTANCE	20		20	8.8	11.2	20	20	20	20	20	20	20	20
ACCUMULATE DISTANCE	444.1		464.1	472.9	484.1	504.1	524.1	544.1	564.1	584.1	604.1	624.1	644.1

13-10. Plans & Longitudinal Sections (1/4)

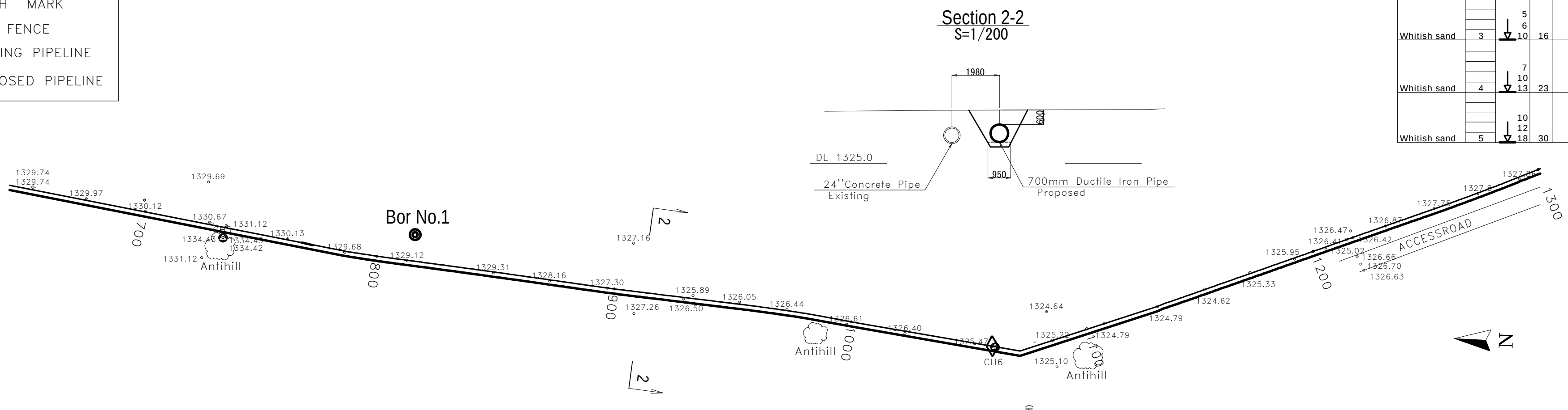
Plans & Longitudinal Sections (2/4)

V=1/ 500
H=1/2000

CHIFUBU

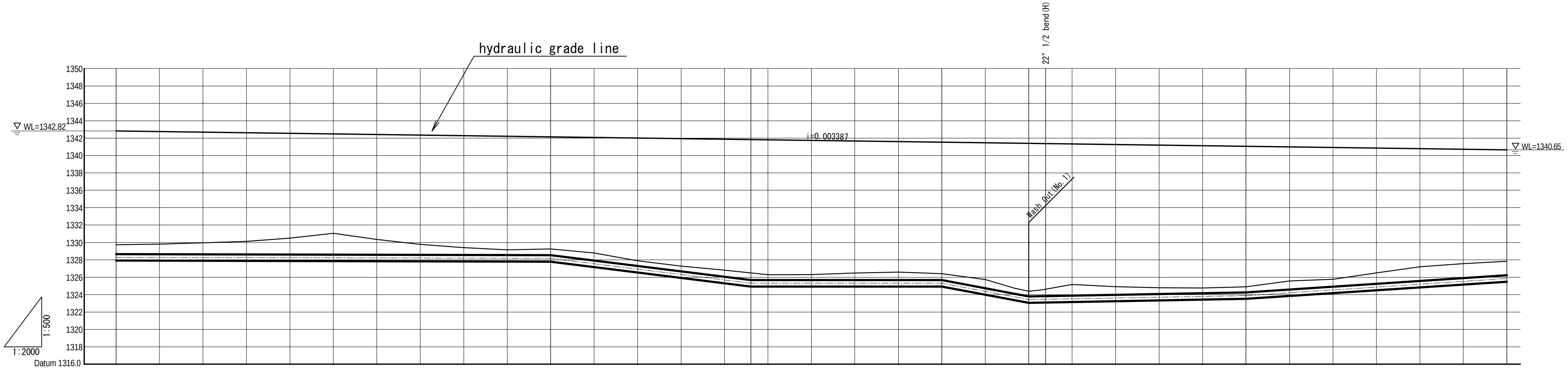
LEGEND

- ACCESS ROAD
- LEAKING POINT
- BENCH MARK
- WALL FENCE
- EXISTING PIPELINE
- PROPOSED PIPELINE



Bor No.1

DESCRIPTION	DEPTH (m)	blows	N	Wc
Whitish sand	1	1 2 2	4	
Whitish sand	2	4 7 9	16	WL=1.8m
Whitish sand	3	5 6 10	16	
Whitish sand	4	7 10 13	23	
Whitish sand	5	10 12 18	30	

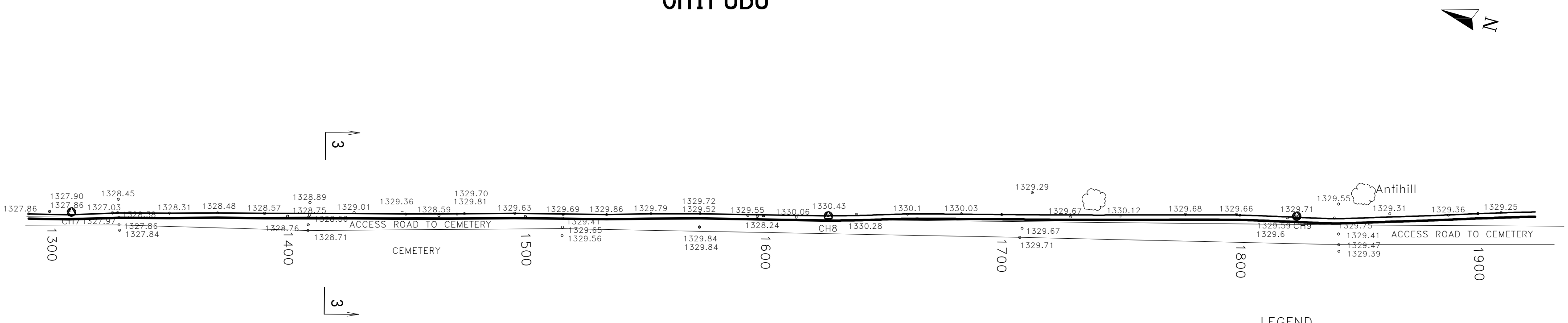


PIPE NOMINAL: DCIP ϕ 700

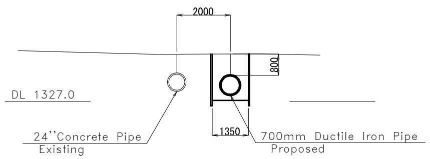
ACCUMULATE DISTANCE	DISTANCE	GROUND ELEVATION	EARTH COVERING	CENTER OF PIPE ELEVATION	GRADIENTS
644.1	20	1329.74	1.08	1328.291	1328.652
664.1	20	1329.80			
684.1	20	1329.96			
704.1	20	1330.12			
724.1	20	1330.50			i=0.00054
744.1	20	1331.06			
764.1	20	1330.36			
784.1	20	1329.79			
804.1	20	1329.41			
824.1	20	1329.15			
844.1	20	1329.26	0.72	1328.178	1328.178
864.1	20	1328.79			
884.1	20	1327.91			i=0.03102
904.1	20	1327.28			
924.1	20	1326.82			
936.2	12.1	1326.49	0.80	1325.321	1325.321
944.1	7.9	1326.29			
964.1	20	1326.31			LEVEL
984.1	20	1326.49			
1004.1	20	1326.59			
1024.1	20	1326.43	0.74	1325.321	1325.321
1044.1	20	1325.75			i=0.04725
1064.1	20	1324.40	0.60	1323.431	1323.431
1071.9	7.8	1324.70	0.86	1323.470	
1084.1	12.2	1325.17			
1104.1	20	1324.93			i=0.00458
1124.1	20	1324.78			
1144.1	20	1324.77			
1164.1	20	1324.90	0.64	1323.889	1323.889
1184.1	20	1325.58			
1204.1	20	1325.76			
1224.1	20	1326.50			i=0.01645
1244.1	20	1327.2			
1264.1	20	1327.56			
1284.1	20	1327.84	1.61	1325.863	1325.863

Plans & Longitudinal Sections (3/4) V=1/500 H=1/2000

CHIFUBU

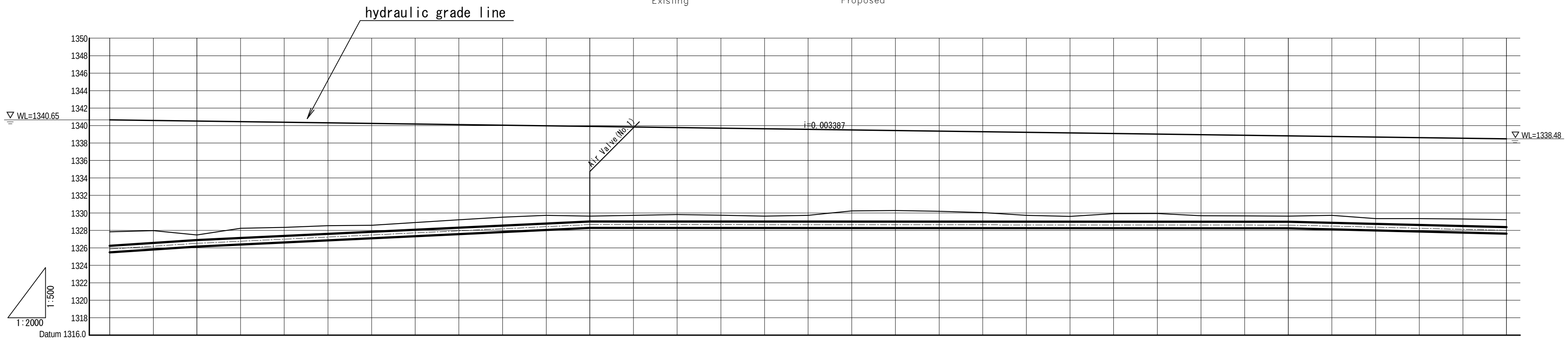


Section 3-3
S=1/200



LEGEND

Symbol	Meaning
(thin double line)	ACCESS ROAD
◊	LEAKING POINT
(triangle in circle)	BENCH MARK
(thin line)	WALL FENCE
(solid / dashed lines)	EXISTING PIPELINE
(thick line)	PROPOSED PIPELINE



PIPE NOMINAL: DCIP φ700

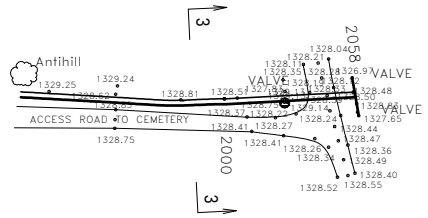
GRADIENTS: 1325.863 — i=0.01645 — 1326.521 — i=0.01189 — 1328.661 — i=0.00016 — 1328.609 — i=0.00603 — 1328.060

ACCUMULATE DISTANCE	DISTANCE	GROUND ELEVATION	EARTH COVERING	CENTER OF PIPE ELEVATION
1284.1	20	1327.84	1.61	1325.863
1304.1	20	1327.97		
1324.1	20	1327.49	0.60	1326.521
1344.1	20	1328.25		
1364.1	20	1328.35		
1384.1	20	1328.53		
1404.1	20	1328.59		
1424.1	20	1328.90		
1444.1	20	1329.22		
1464.1	20	1329.51		
1484.1	20	1329.72		
1504.1	20	1329.63	0.60	1328.661
1524.1	20	1329.71		
1544.1	20	1329.81		
1564.1	20	1329.75		
1584.1	20	1329.64		
1604.1	20	1329.72		
1624.1	20	1330.24		
1644.1	20	1330.28		
1664.1	20	1330.19		
1684.0	20	1330.04		
1704.1	20	1329.72		
1724.1	20	1329.59		
1744.1	20	1329.91		
1764.1	20	1329.94		
1784.1	20	1329.68		
1804.1	20	1329.65		
1824.1	20	1329.64	0.66	1328.609
1844.1	20	1329.73		
1864.1	20	1329.33		
1884.1	20	1329.35		
1904.1	20	1329.30		
1924.1	20	1329.24	0.81	1328.006

13-12. Plans & Longitudinal Sections (3/4)

Plans & Longitudinal Sections (4/4) V=1/ 500 H=1/2000

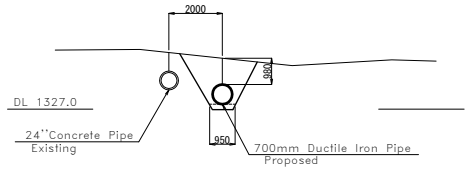
CHIFUBU

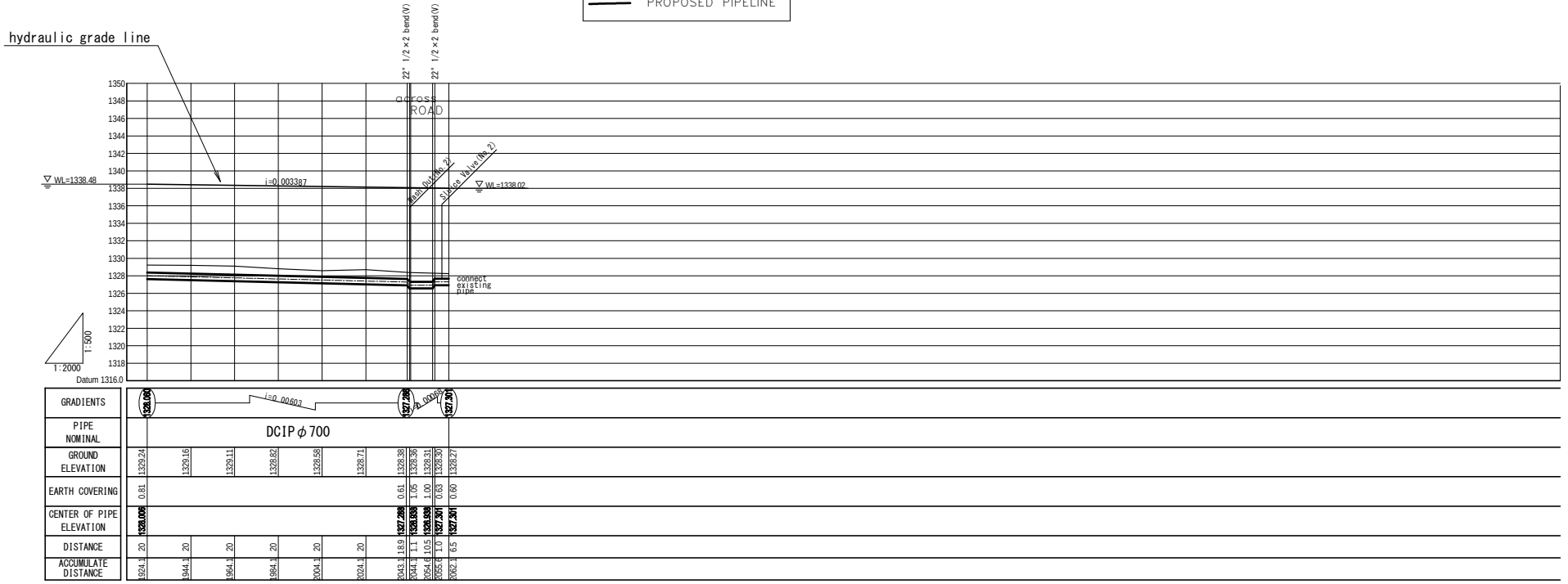


LEGEND

- ACCESS ROAD
- LEAKING POINT
- BENCH MARK
- WALL FENCE
- EXISTING PIPELINE
- PROPOSED PIPELINE

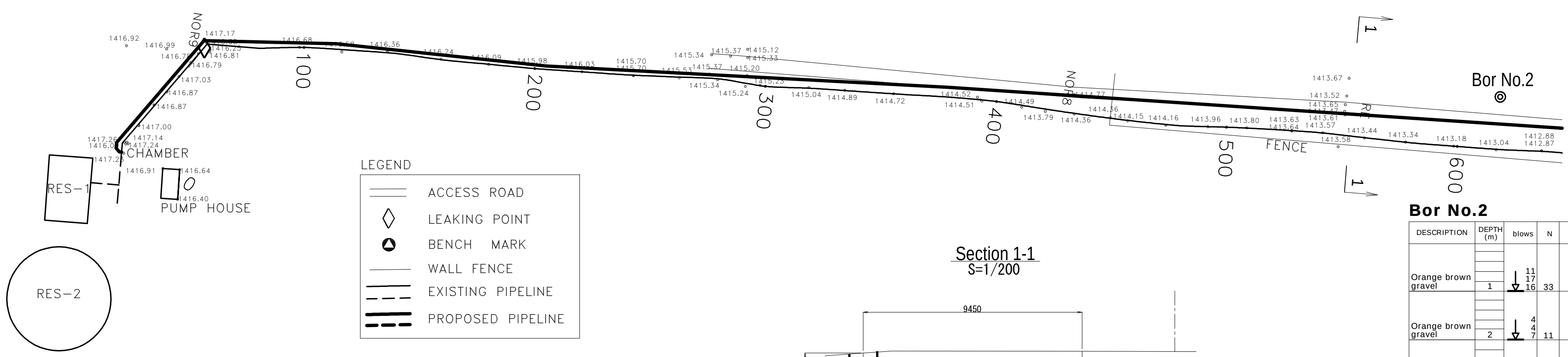
Section 4-4
S=1/200





Plans & Longitudinal Sections (1/3) V=1/500 H=1/2000

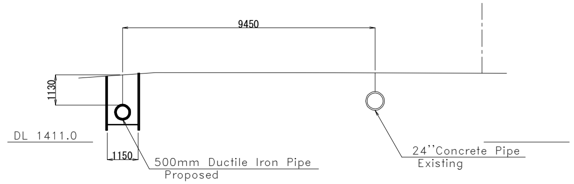
NORTHRISE

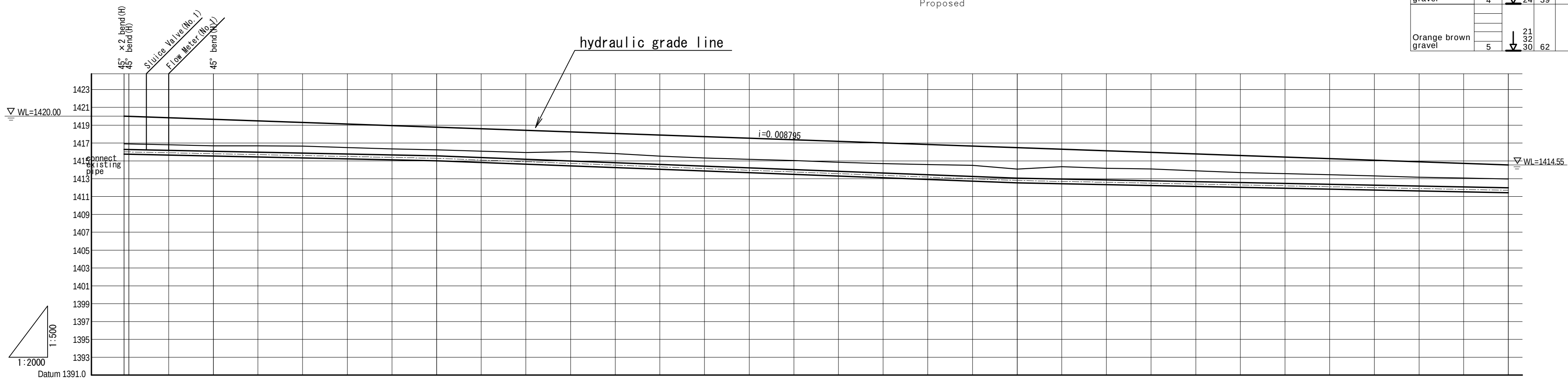


Bor No.2

DESCRIPTION	DEPTH (m)	blows	N	Wc
Orange brown gravel	1	11 17 16	33	
Orange brown gravel	2	4 4 7	11	
Orange brown gravel	3	10 12 14	26	
Orange brown gravel	4	7 15 24	39	
Orange brown gravel	5	21 32 30	62	

Section 1-1
S=1/200





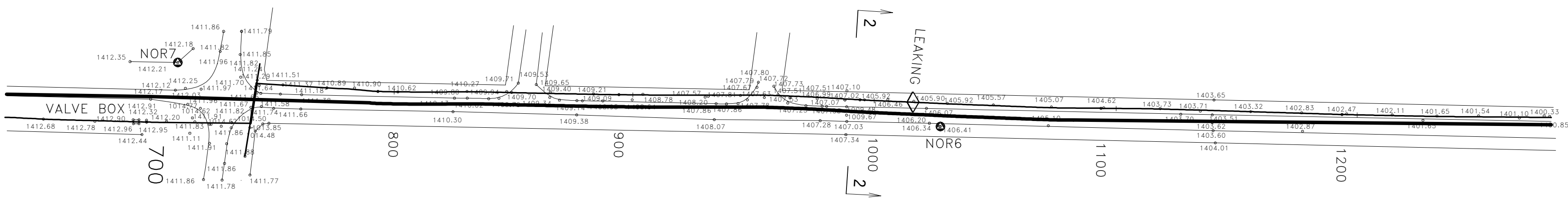
GRADIENTS: 1416.013 — i=0.00516 — 1415.290 — i=0.00957 — 1412.802 — i=0.00499 — 1411.705

PIPE NOMINAL: DCIP φ500

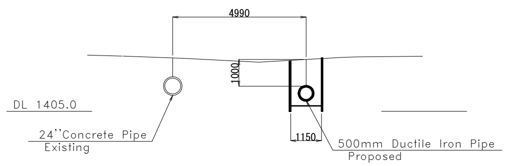
ACCUMULATE DISTANCE	DISTANCE	GROUND ELEVATION	EARTH COVERING	CENTER OF PIPE ELEVATION
0	0	1416.92	0.64	1416.013
2.1	2.1	1416.91	0.64	1416.002
20	17.9	1416.81		
40	20	1416.68	0.61	1415.806
60	20	1416.68		
80	20	1416.66		
100	20	1416.50		
120	20	1416.34		
140	20	1416.23	0.67	1415.290
160	20	1416.09		
180	20	1415.98		
200	20	1416.03		
220	20	1415.82		
240	20	1415.55		
260	20	1415.33		
280	20	1415.19		
300	20	1415.02		
320	20	1414.85		
340	20	1414.70		
360	20	1414.59		
380	20	1414.51		
400	20	1414.07	1.00	1412.802
420	20	1414.36		
440	20	1414.17		
460	20	1414.09		
480	20	1413.88		
500	20	1413.70		
520	20	1413.58		
540	20	1413.44		
560	20	1413.32		
580	20	1413.17		
600	20	1413.08		
620	20	1412.98	1.01	1411.705

Plans & Longitudinal Sections (2/3) V=1/500 H=1/2000

NORTHRISE

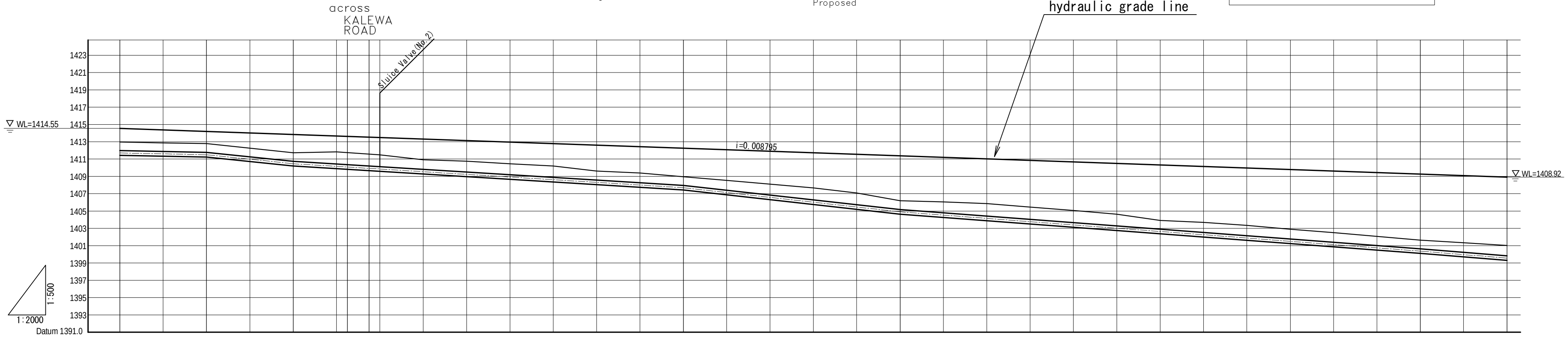


Section 2-2
S=1/200



LEGEND

- ACCESS ROAD
- LEAKING POINT
- BENCH MARK
- WALL FENCE
- EXISTING PIPELINE
- PROPOSED PIPELINE



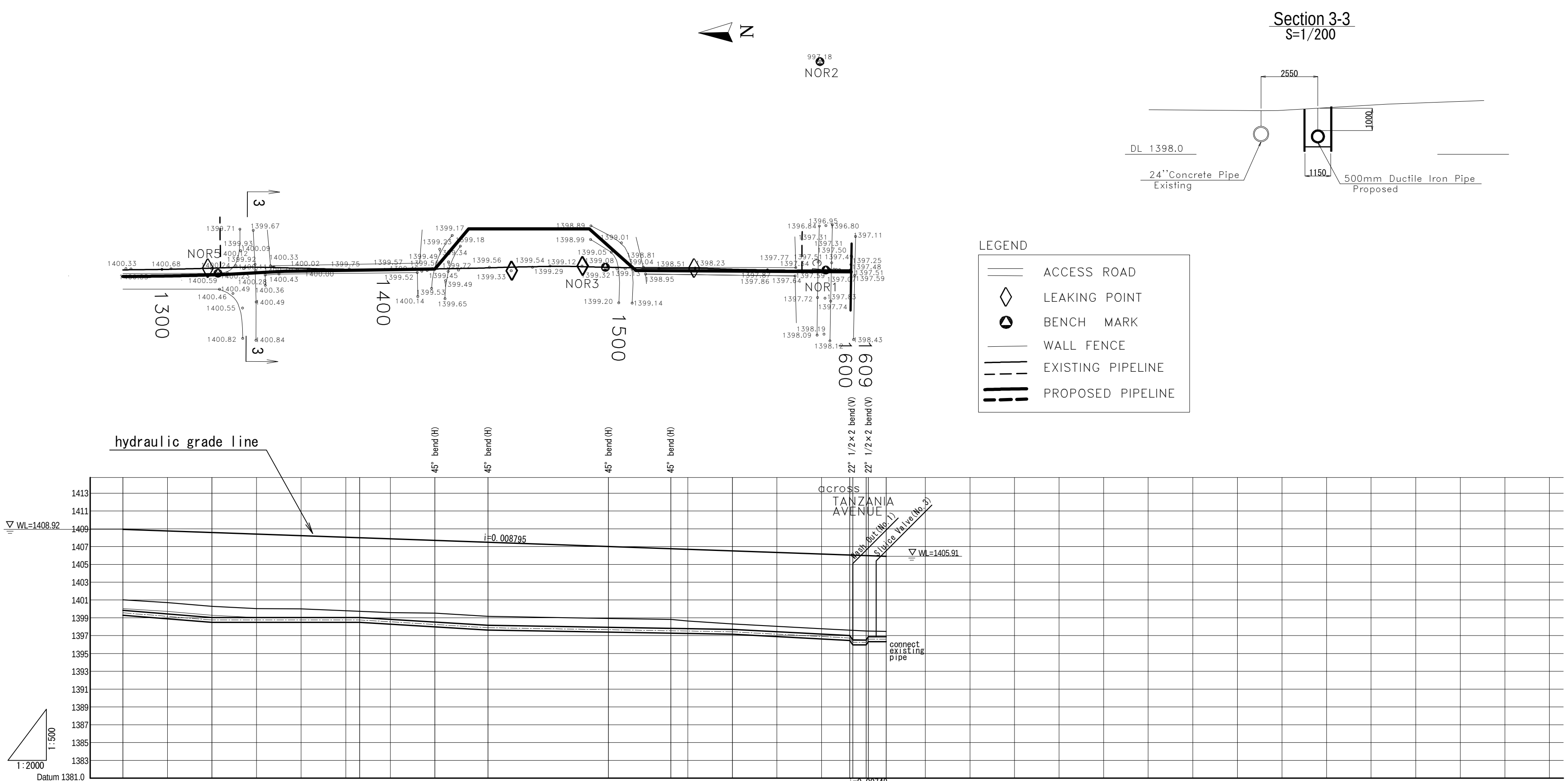
	620	640	660	680	700	720	740	760	780	800	820	840	860	880	900	920	940
GRADIENTS	1411.705	i=0 00499	1411.505	i=0 02590	1410.469				i=0 01540					1407.697			i=0 02791
PIPE NOMINAL	DCIPϕ500																
GROUND ELEVATION	1412.98	1412.88	1412.78	1412.33	1411.74	1411.84	1411.49	1410.93	1410.75	1410.46	1410.20	1409.62	1409.41	1408.97	1408.53	1408.11	1407.66
EARTH COVERING	1.01		1.01		1.01									1.01			
CENTER OF PIPE ELEVATION	1411.705		1411.505		1410.469									1407.697			
DISTANCE	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
ACCUMULATE DISTANCE	620	640	660	680	700	720	740	760	780	800	820	840	860	880	900	920	940

	960	980	1000	1020	1040	1060	1080	1100	1120	1140	1160	1180	1200	1220	1240	1260
GRADIENTS		1404.906						i=0 01890						1400.370	i=0 02010	1399.566
PIPE NOMINAL																
GROUND ELEVATION	1407.09	1406.17	1406.05	1405.86	1405.47	1405.06	1404.65	1403.92	1403.70	1403.35	1402.91	1402.51	1402.08	1401.64	1401.34	1401.03
EARTH COVERING		1.00												1.00		1.20
CENTER OF PIPE ELEVATION		1404.906												1400.370		1399.566
DISTANCE	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
ACCUMULATE DISTANCE	960	980	1000	1020	1040	1060	1080	1100	1120	1140	1160	1180	1200	1220	1240	1260

13-15. Plans & Longitudinal Sections (2/3)

Plans & Longitudinal Sections (3/3) V=1/500 H=1/2000

NORTHRISE

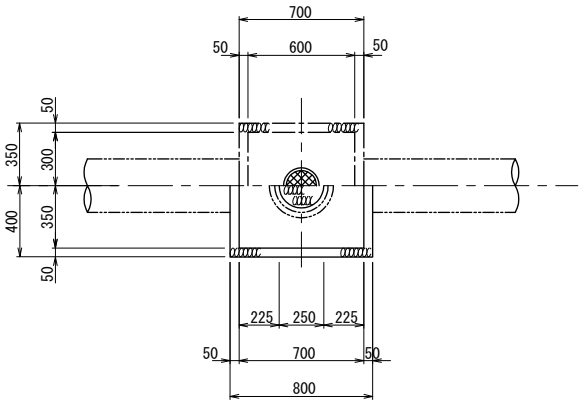


GRADIENTS	1399.566	i=0.02010	1398.762		LEVEL		1398.762	i=0.01506		1397.896	i=0.00422			1397.434	i=0.01324		1396.736		i=0.00748		1396.614
PIPE NOMINAL	DCIP ϕ500																				
GROUND ELEVATION	1401.03	1400.72	1400.29	1400.03	1400.02	1399.82	1399.74	1399.60	1399.52	1399.17	1398.94	1398.83	1398.65	1398.34	1398.05	1397.77	1397.61	1397.59	1397.51	1397.51	1397.48
EARTH COVERING	1.20		1.26				0.71		1.00	1.01	1.01	1.01		0.64			0.61	1.09	1.01	0.63	0.60
CENTER OF PIPE ELEVATION	1399.566		1398.762				1398.762		1398.254	1397.896	1397.668	1397.550		1397.434			1396.736	1396.239	1396.239	1396.614	1396.614
DISTANCE	20	20	20	20	20	20	6.3	13.7	20	23.8	54	28	7.6	20	20	20	12.7	1.0	6.3	1.0	8.0
ACCUMULATE DISTANCE	1260	1280	1300	1320	1340	1360	1366.3	1380	1400	1423.8	1477.8	1505.8	1513.4	1533.4	1553.4	1573.4	1586.1	1587.1	1593.4	1594.4	1602.4

Sluice Valve （φ１００～φ４００）

scale:1/30

Plan



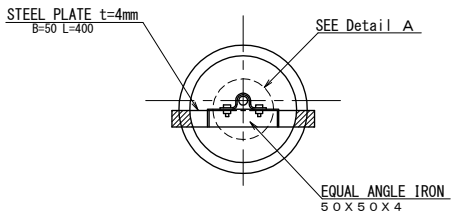
Size

(mm)

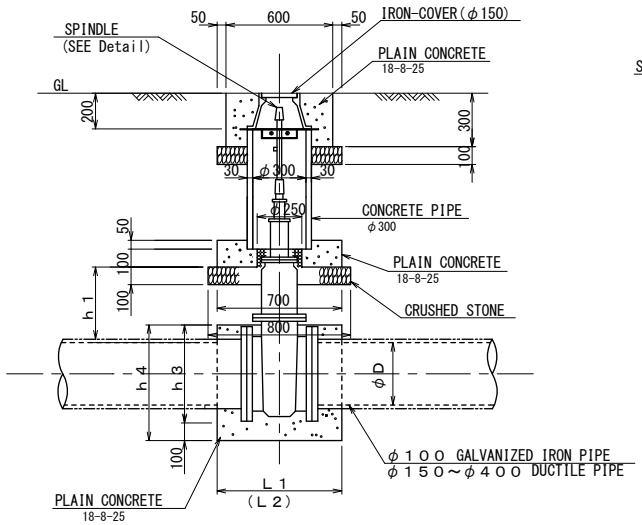
D	L1	L2	h1	h3	h4
φ100	600	600	250	250	350
φ150	600	600	300	300	400
φ200	600	600	350	350	450
φ250	700	700	500	400	500
φ300	700	700	550	450	550
φ350	700	700	600	550	650
φ400	800	800	650	600	700

Spindle

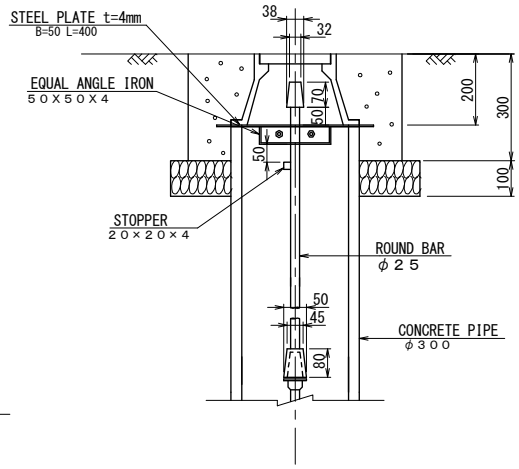
Plan



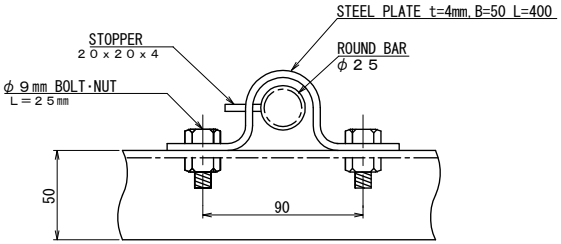
Profile



Detail



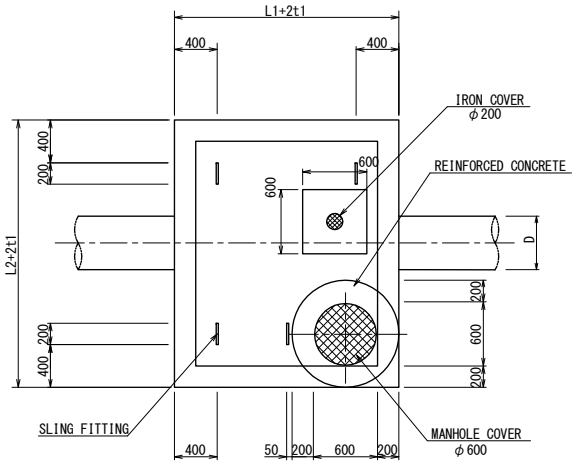
Detail A



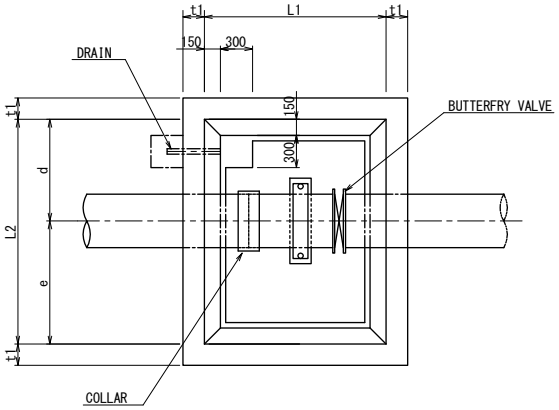
Sluice Valve （φ450～φ900）

scale:1/50

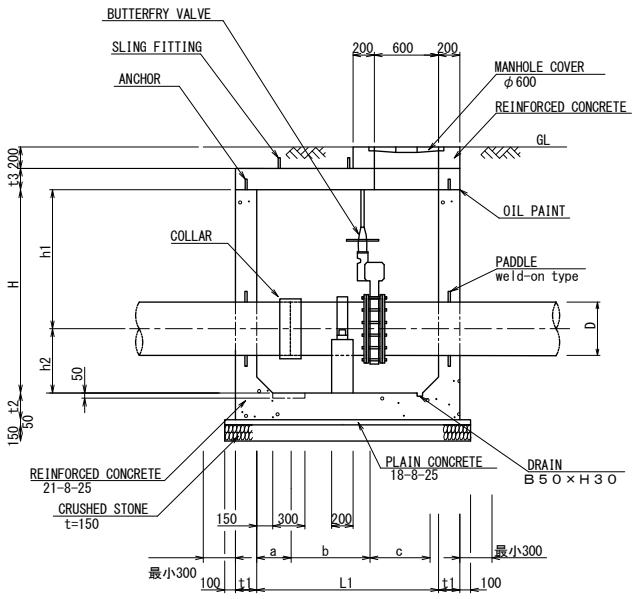
Roof Plan



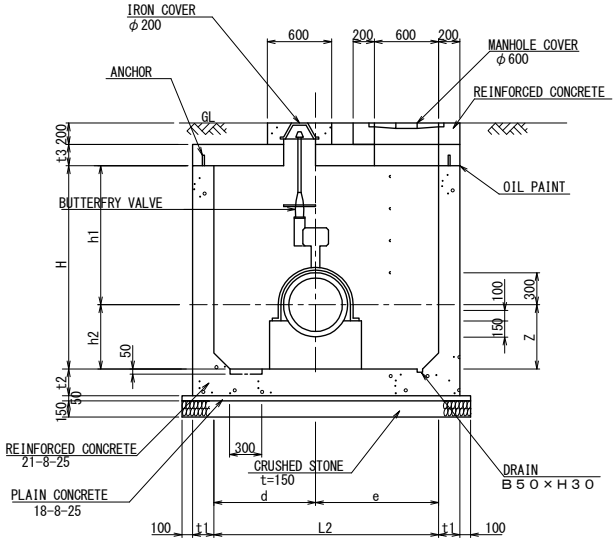
Plan



longitudinal Section



Cross Section



Size

(mm)

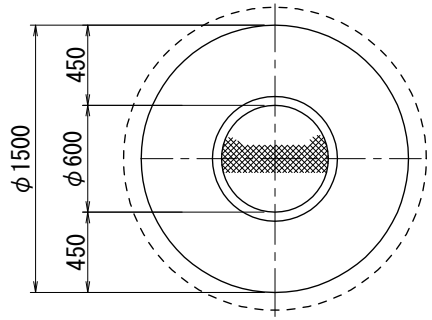
D	L 1	L 2	a	b	c	d	e
φ450	1600	2000	430	550	620	900	1100
φ500	1700	〃	〃	640	630	〃	〃
φ600	2200	2100	750	560	250	950	1150
φ700	2300	2200	750	610	250	1000	1200
φ800	2300	2300	750	690	250	1050	1250

D	H	h 1	h 2	t 1	t 2	t 3	Z
φ450	850	400	450	200	250	200	400
φ500	1000	450	500	〃	〃	〃	500
φ600	1150	550	600	〃	〃	〃	600
φ700	1300	600	700	〃	〃	〃	800
φ800	1450	650	800	〃	〃	〃	1000

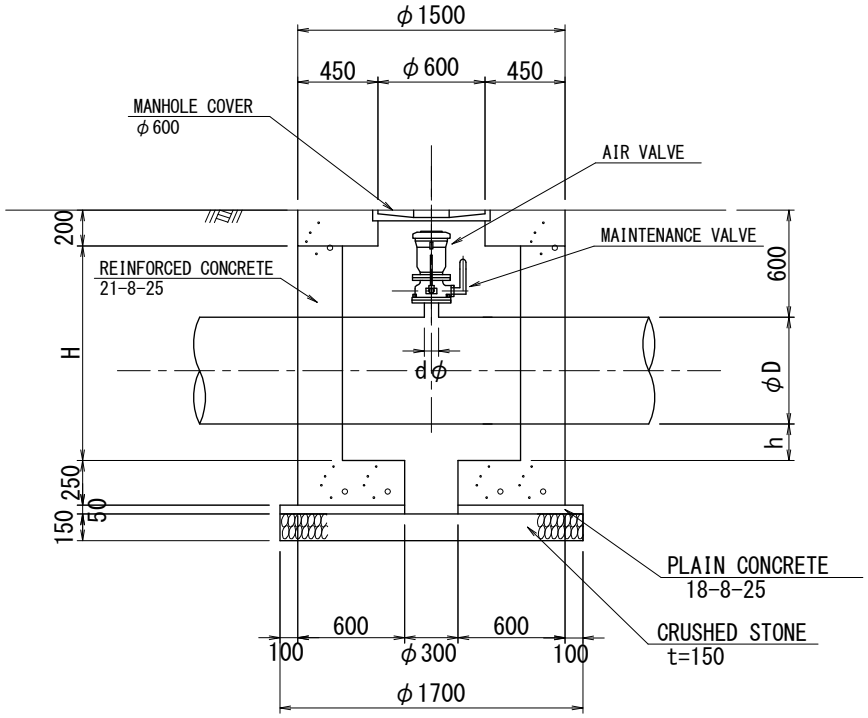
Air Valve

scale:1/30

Plan



Cross Section



Size

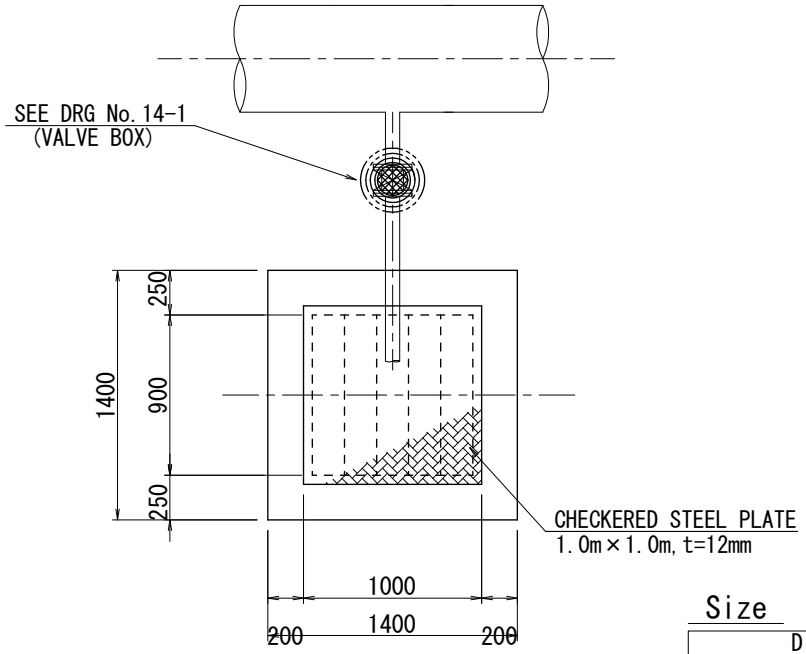
(mm)

Diameter				H	h
Nominal	Outside	RISER PIPE	AIR VALVE		
φ100	114.3	φ 75	φ 75	600	136
φ150	170.0	φ 75	φ 75	700	180
φ200	220.0	φ100	φ 75	700	130
φ250	274.0	φ125	φ 75	800	176
φ300	326.0	φ150	φ 75	800	124
φ350	378.0	φ200	φ 75	900	172
φ400	429.0	φ200	φ 75	900	121
φ450	480.0	φ250	φ 75	1000	170
φ500	532.0	φ250	φ 75	1000	118
φ600	635.0	φ300	φ 75	1100	115
φ700	738.0	φ350	φ100	1200	112
φ800	842.0	φ400	φ100	1300	108

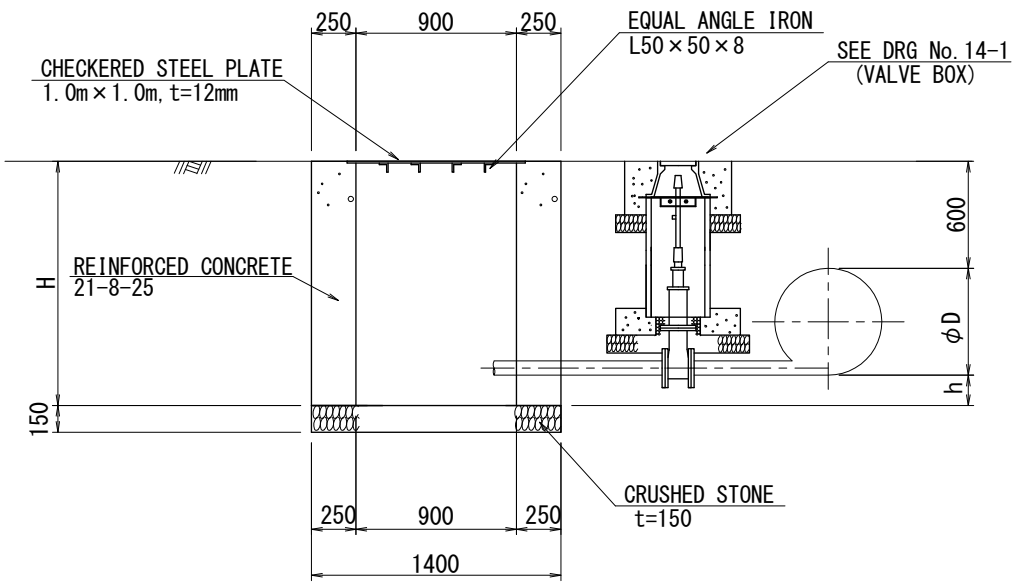
Wash Out

scale:1/30

Plan



Sectional Plan



Size

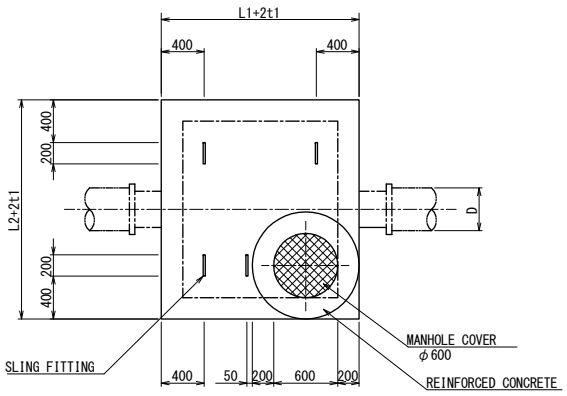
(mm)

Diameter		H	h
Nominal	Outside		
φ100	114.3	900	186
φ150	170.0	900	130
φ200	220.0	1000	180
φ250	274.0	1000	126
φ300	326.0	1100	174
φ350	378.0	1100	122
φ400	429.0	1200	171
φ450	480.0	1200	120
φ500	532.0	1300	168
φ600	635.0	1400	165
φ700	738.0	1500	162
φ800	842.0	1600	158

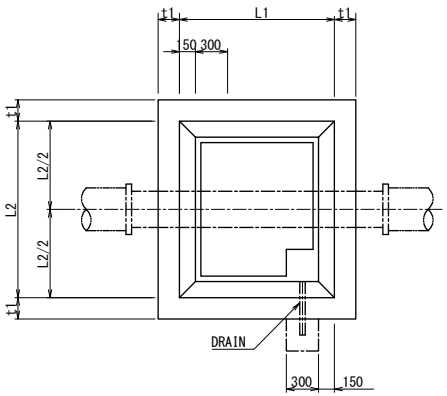
Flow Meter

scale:1/50

Roof Plan

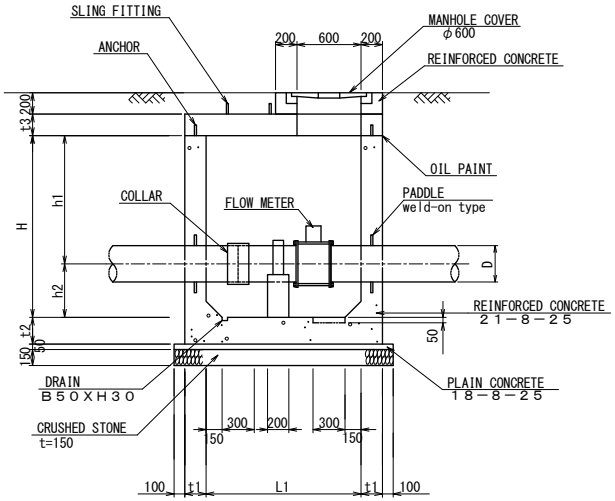


Plan

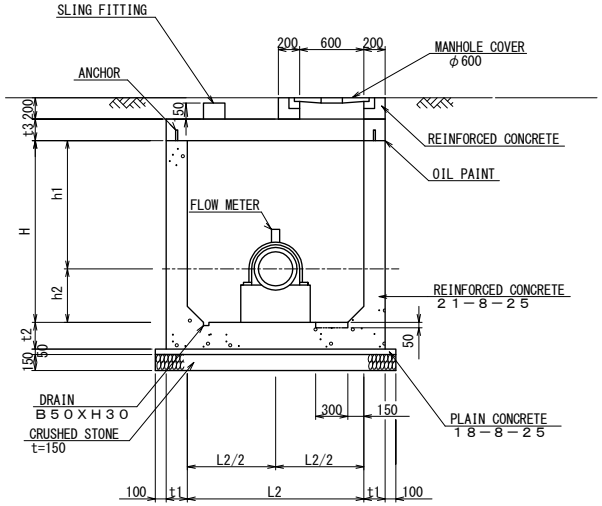


Diameter	Flow Meter
φ100～φ300	Turbin type
φ350～φ900	Ultrasonic type

longitudinal Section



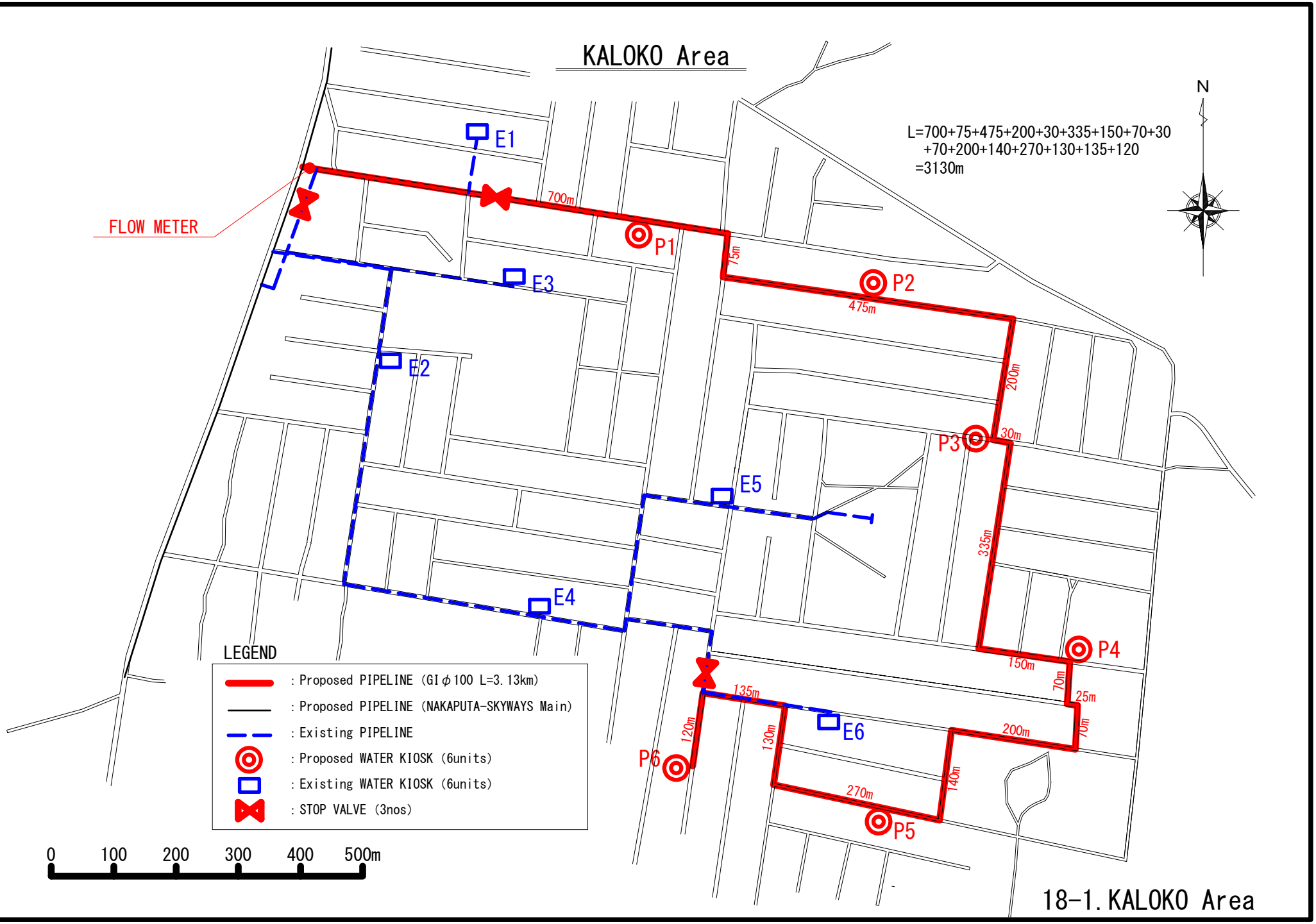
Cross Section

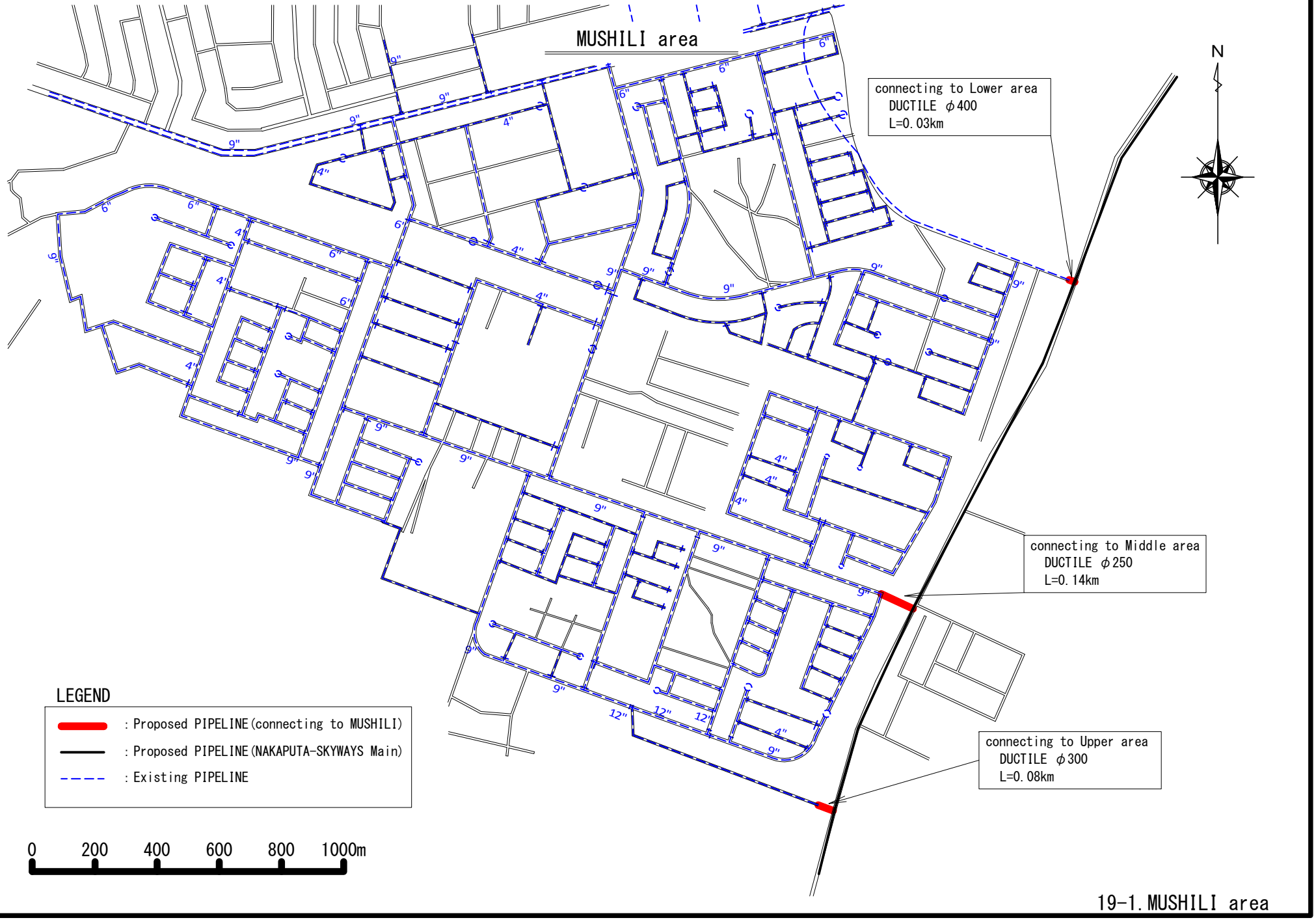


Size

(mm)

D	L1	L2	H	h1	h2	t1	t2	t3
100	1200	1400	500	250	250	200	300	250
150	2000	1400	500	250	250	200	300	250
200	2200	1400	600	300	300	200	300	250
250	2300	1550	600	300	300	200	300	250
300	2700	1550	700	350	350	200	300	250
350	1700	1550	700	350	350	200	300	250
400	1700	1650	800	400	400	200	300	250
450	1700	1650	800	400	400	200	300	250
500	1800	1800	900	450	450	200	300	250
600	1800	1800	1000	500	500	200	300	250
700	1900	2000	1100	550	550	200	300	250
800	1900	2000	1200	600	600	200	300	250

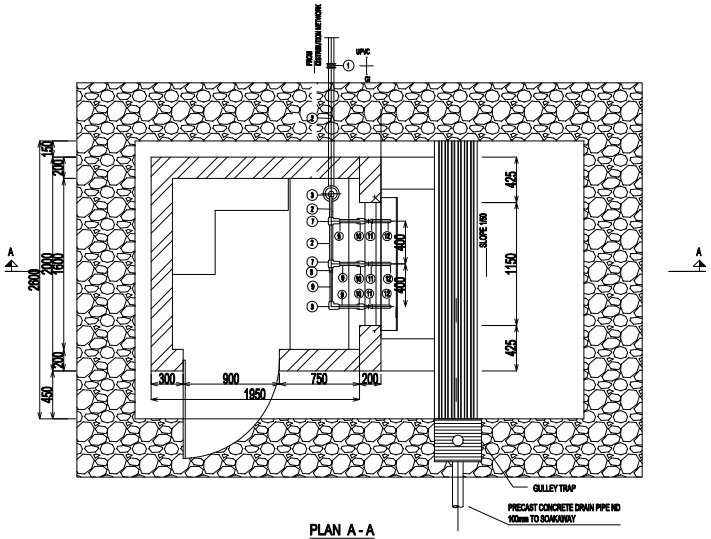

KALOKO Area
N
L=700+75+475+200+30+335+150+70+30
+70+200+140+270+130+135+120
=3130m
FLOW METER
E1
E2
E3
E4
E5
E6
P1
P2
P3
P4
P5
P6
700m
75m
475m
200m
30m
335m
150m
70m
25m
70m
200m
140m
270m
130m
120m
135m
LEGEND
: Proposed PIPELINE (GI φ100 L=3.13km)
: Proposed PIPELINE (NAKAPUTA-SKYWAYS Main)
: Existing PIPELINE
: Proposed WATER KIOSK (6units)
: Existing WATER KIOSK (6units)
: STOP VALVE (3nos)
0 100 200 300 400 500m
18-1. KALOKO Area



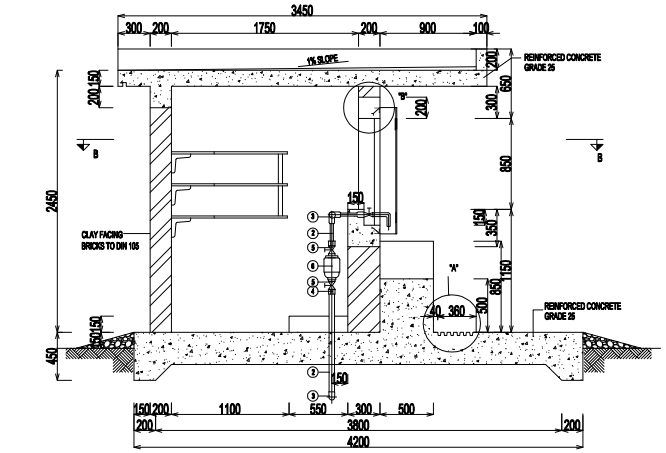
19-1. MUSHILI area

WATER KIOSK

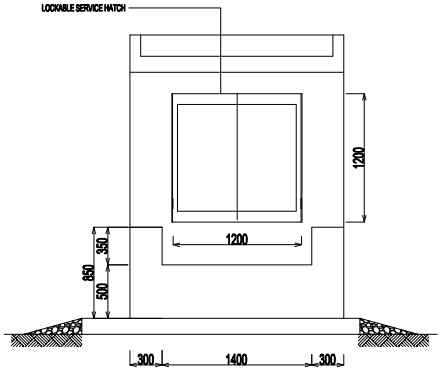
scale:1/50



PLAN A-A

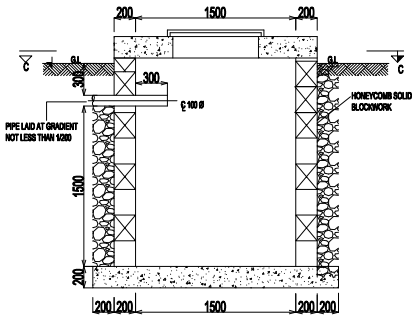


SECTION A-A

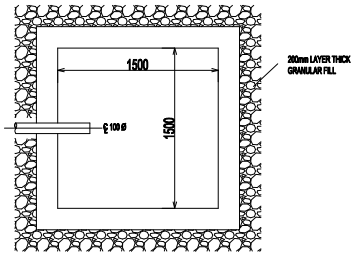


FRONT VIEW

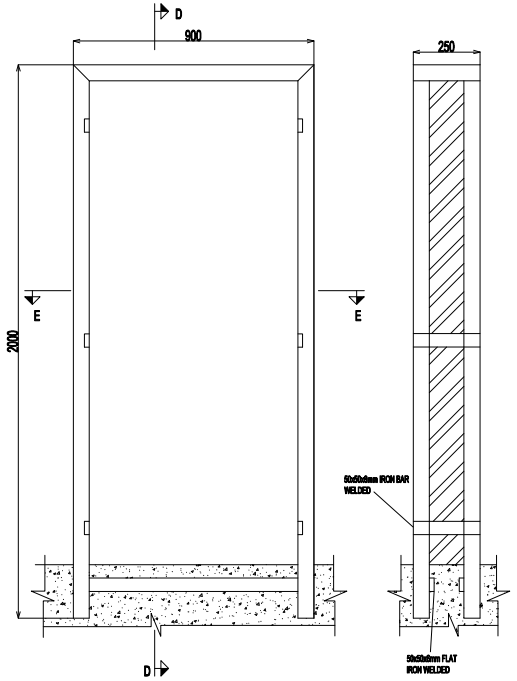
SOAKAWAY DETAIL



LONGITUDINAL SECTION THROUGH SECTION C-C

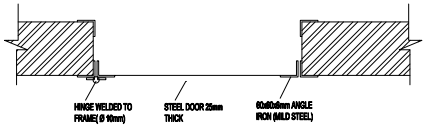


PLAN C-C

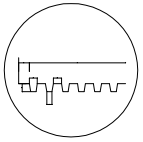


DOOR FRAME DETAIL
scale:1/20

SECTION D-D



PLAN E-E



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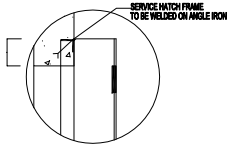

DETAIL "B"
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BILL OF QUANTITIES

ITEM	DESCRIPTION	ND in mm	L in mm	QTY
1	COUPLING	50/80		1
2	GALVANIZED IRON PIPE	2"	Variable	3
3	GALVANIZED IRON 90° BEND	2"		2
4	FLANGED ADAPTOR	50/80		2
5	RESILIENT SEATED GATE VALVE	2"		2
6	TURBINE WATER METER	80		1
7	GALVANISED IRON TEE	2"/1"		2
8	GALVANISED IRON REDUCER	2"/1"		1
9	GALVANIZED IRON PIPE	1"	Variable	1
10	GALVANISED IRON SOCKET	1"		3
11	HEAVY DUTY WATER TAP	1"		3
12	GALVANIZED IRON 90° BEND	1"		3

2-2-4 Implementation Plan

2-2-4-1 Implementation policy

(1) General

The subject project is to be implemented under the framework of a grant aid program being executed by the Government of Japan (GOJ). In case the project implementation is approved by GOJ after the completion of the outline design, an Exchange of Note (E/N) should be signed and entered into by and between GOJ and GOZ (Government of Zambia), and the project will enter into the implementation stage. For project implementation, the manner of contracting shall be a single contract with a lump sum payment condition.

Under the project, the major work items to be constructed include the following:

- Rehabilitation of Kafubu WTP in Ndola city, Zambia
- Installation of pipeline between Nakaputa and Skyways
- New installation of Chifubu and Northrise distribution pipelines
- Branching facilities for water supply to Mushili area
- Construction of extra water kiosks in Kaloko area
- Provision of water quality analysis equipment/devices for Kanini laboratory

(2) Active use of local consultant and contractors

In Zambia, there are two types of contractors. One is a purely locally managed local contractor and the other is the contractor of foreign origin like South Africa, etc. Among the contractors of foreign origin, some are qualified with construction capabilities for sub-contracting works with foreign contractors having a reasonable number of construction machinery as well as engineers and technicians. Under the subject project, it is planned that these qualified contractors shall be utilized for smooth progression of the project construction works. Construction working sites would be scattered over the Ndola city and construction works would be simultaneously undertaken, mostly during the dry season; therefore, it is necessary to actively use local consultants for the required construction supervision services.

(3) Necessity for dispatching engineers

In Zambia, there are few engineers and skilled technicians who have enough knowledge and technique/experience concerning the installation, adjustment/tuning and test operation for large size pipelines and mechanical/electrical facilities. Accordingly, it is considered necessary to dispatch the following engineers and technicians.

- Civil engineer to supervise pipeline works
- Mechanics and electricians for mechanical/electrical works at WTP
- Mechanical and Electric engineers to supervise the works by technicians

(4) Implementation organization from the Zambian side

KWSC is the project implementation agency. At the stage of detailed design and bidding under the project, the administrative department of KWSC will be in charge, and when the project enters into the construction stage, the divisions/sections responsible for Ndola city of the engineering department will be in charge of subject project implementation. Those offices and sections to be in charge for each of work item are as shown below.

Construction sites	Offices/sections in charge under Engineering Dept
Kafubu WTP	Water Production Section
Pipeline (Nakaputa-Skyways)	Network south, Water Distribution Section
Chifubu pipeline	Network north, Water Distribution Section
Northrise pipeline	Network north, Water Distribution Section
Mushili branching work	Network south, Water Distribution Section
Kaloko extra water kiosks	Peri-urban Section
Kanini laboratory	Laboratory Section

2-2-4-2 Implementation Conditions

(1) Construction planning

1) Kafubu WTP

Rehabilitation works for WTP shall be undertaken one after another by dividing it into two systems, one suspended for rehabilitation and the other in operation. For suspension, a

temporary closing between the two systems would be made by using valves and stop logs. During the time replacement of pumps and relevant electrical works are undertaken, the water supply capacity will be lowered, causing lowered water pressure and an insufficient supply quantity in the service areas. However, a back-up water supply by the installation of temporary pipeline system shall not be considered, taking into account the presently prevailing conditions that there has been water supply stoppage during night time rather often and suspension of water supply longer than a day in case of power breakdown and inspection of water supply facilities. In spite of the above-mentioned considerations, it is considered necessary to assign a water tank truck owned by KWSC to serve the beneficiaries in case of emergency.

Electrical works at WTP include very high voltage facilities, so it is necessary to demarcate the off-limit area clearly. Further attention for safe measures is needed during the time of power recovery at the working areas that are apart from each other. In this case, adequate notice by signboard and use of wireless phones are effective in carrying out safety measures and avoiding possible accidents. Moreover, in the pumping station areas, there are water leakages in many parts, so electrical works there need careful attention to prevent any accidents from electrical shock.

2) Pipeline installation works

Prior to the installation works, checking on paper materials and test excavation are required to confirm the existence of any underground articles, and if necessary, relocation shall be requested of the owners through KWSC. Relocation of underground articles is necessary to be completed before the commencement of the pipeline installation works.

In the project area, the period from November to March is the rainy season, and high production in pipeline installation works cannot be expected during this period. Therefore, the total length of pipeline shall be divided into some number of sections for a simultaneous undertaking of the work in the dry season so as to enable the work's completion within the limited construction period. For the areas with a high groundwater level and for the excavation (open cut) works during the rainy season, dewatering measures shall be provided to secure safety and high quality of the works.

Under the construction works for the project, it is planned that roadways for general use will be disturbed by open cuts, so measures to mitigate the probable negative effects on traffic shall be taken. One measure is an appropriate dividing of working sections for simultaneous progress, and the other is to provide the working areas with safety fencing and to

assign a traffic guide. In the working areas where space is limited but in need of deep excavation, some measures for slope protection is necessary so as not to cause negative effects on the neighboring locations. This is a substantial protective measure needed for safety of the construction workers, too. Among others, especially in the Kaloko area, the working areas are successive ones in the residential area having a number of kids as well as the aged generation living there, so protective measures in general, including those for traffic shall be fully considered.

Pipeline materials under the project include medium-large diameter pipes. The cast-iron ductile pipes are of heavy articles, and installation will be handled by crane, for which a slinging shall be made by a licensed skilled technician. Most of the construction areas are on the un-paved roadways, and it is necessary to pay attention so as not to cause any turn-over accidents of the crane due to the uneven ground height to fix the out-rigger. Furthermore, the area within the radius of the crane's jib swing is to be off-limits for the safety of walkers and workers nearby.

For the concrete works, like the construction of the valve chamber, attention shall be paid to the rise of temperature, and adequate control of the time required for mixing, hauling and placing are important, including curing condition after placing.

When the pipeline facilities are tested for water leakage and cleaned/washed after installation, a securing of drain water received is very important so as not to cause troubles in the neighboring areas. Also, if water supply suspension for a long period during the works for the branching facilities becomes necessary, the affected areas shall be properly informed in advance.

3) Kanini laboratory

The water quality analysis equipment/device to be introduced to the Kanini laboratory is precision gauge equipment, and careful attention shall be paid to the transportation and installation/testing. It is planned that the installation and adjustment/tuning shall be done by the specific specialist engineer from the manufacturer of the equipment.

(2) Procurement plan

Based on the findings on the construction works in Zambia, it is a common practice as a traditional custom to employ common laborers from the communities in the construction area or nearby. Many of the laborers are in a jobless situation, and it is considered necessary to

employ the laborers in rotation of about 2-week periods. As is the case, the productivity of common laborers cannot be expected to be high enough, and only simple and easy jobs can be undertaken by them. Based on these understandings, the construction period shall be planned.

2-2-4-3 Scope of Works

The obligations of GOJ and GOZ regarding work items under the overall project implementation shall be demarcated as indicated below.

Table 2-2-18 Demarcation of Work Items / Obligations

Items	Japanese side	Zambian side
Kafubu Water Treatment Plant	- Rehabilitation of WTP - Soft component for water - Treatment/purification	- To provide stocking yard for removed equipment/materials - Drainage pond and sun-drying yard - To notice water stoppage under construction work to the citizen
Pipelines	- Installation works - Soft component for flow quantity measurement	- To secure lands for pipe laying - To secure spoil bank and lands for pipe materials - To provide materials of underground articles and relocation work - Coordinate with traffic police - To provide water for leakage test and washing inside pipes
Kaloko area	- Construction of extra water kiosks - Soft component on enlightenment on sanitation	- Decision of construction location and secure of lands - Coordination with RDC
Kanini Laboratory	- Installation of water quality Analysis equipment - Soft component on water quality analysis	- Secure of electricity source - Rack/table for equipment installation

2-2-4-4 Consultant Supervision

(1) Primary tasks and matters to be considered

In performing the supervision works under the project, the following shall be paid due attention.

1) Primary tasks

- To fully grasp the contents and processes of outline design and detailed design
- To understand the framework and arrangements of the grant aid program by GOJ
- To grasp the contents of E/N and G/A signed by and between GOJ and GOZ
- To grasp the tendency and activities of DANIDA and other Cooperating Pertners
- To cooperate with KWSC for smooth implementation of the project
- To re-confirm the obligations by the Zambian side as agreed upon during outline design

2) Matters to be considered in construction supervision

Schedule

- To confirm the required procedures for custom clearance and tax exemption, etc. with regard to the imports of equipment/materials and to undertake necessary consultation with MLGH and KWSC so as to avoid delays in implementation schedule
- To grasp the construction schedule, taking into consideration relocation of underground articles and difficulty of construction works in rainy season

Quality

- To secure required quality of concrete, paying due attention to temperature and working conditions
- To secure quality of construction works so as not to cause any leakages from the newly installed pipeline systems

Safety

- Safety first shall be observed during the construction period to avoid traffic accidents and

electric shocks

Documents/Drawings

- To manage documents/drawings related with construction works including shop drawings, construction drawings, as-built drawings, records of inspection, meeting minutes and monthly reports, etc.

(2) Organization for construction/procurement supervision and tasks

Consultant services for construction supervision of the subject project include the following.

- Consultation meeting among parties concerned before commencement of works
- Approval on the shop drawings and construction drawings
- Supervision on schedule/quality/safety controls of construction works
- Inspection of articles before shipping, checking on quantity of work, various tests, quality inspection and inspection for work completion
- Required report preparation during the construction period
- Issuance of certificate for construction work completion and for payment

For the organizational arrangement of the construction supervision, a resident supervisor shall be assigned for overall management of construction works at the project site through the entire construction period, and for the occasions of commencement and completion of construction works, the advisory supervising engineer will participate and support the resident supervisor. For the pipeline installation and mechanical/electrical works at WTP, spot supervising service is considered necessary, and specific engineers of related fields will be dispatched to the site. An inspection for the construction work completion shall be done by inspectors. Also, it is planned that the resident supervisor will be assisted by a civil engineer from the third countries (Countries except Zambia and Japan).

2-2-4-5 Quality Control plan

Items to be covered by the quality control under the construction supervision for the project are as tabulated in the following table. A compression test for concrete shall be done with the sample once a day for each class of strength. A water pressure test is to be done for a

certain distance of pipeline length so as to confirm the leakage. Concerning the equipment which turns on an axis, controls on alignment/position and centering are required.

Table 2-2-19 Plans for Quality Control

Work Items	Control Items	Methods	Frequency
Concrete	Aggregate	Grain size analysis	Once
	Cement	Physical/Chemical	Once
	Concrete	Slump	Once/class/day
		Compression test	Once/class/day
	Strength	Tensile strength	Once
Reinforcing	Arrangement	inspection	Every parts
	Position	Locating/manner	Locating/manner
Form/support			
Structure	Strength	Design calculation	As required
	Dimensions	Measuring	Every parts as-built
Mechanical equipment	Installation accuracy	Positioning and measure on centering	All equipment
Electrical equipment			
	Function	Test run	All at trial run
	Strength, dimension	Check of mill test	Each approval
	Appearance, dimension	visual size check	Each delivery
Pipe material	Torque	Torque wrench	As required
	Joint	gap gauge	As required
Pipe install Work	Welding	color check (Liquid penetration)	As required
	Leakage	Water pressure test	Entire line

2-2-4-6 Procurement plan

(1) Equipment/materials for construction works

Reinforcing bars, cement, sand and gravels are available at the local markets in Zambia. All the other kinds of material are mostly imported ones from South Africa and the third countries and the prices in Zambia are rather high and tend to rise up with a higher ratio. Pipeline material is the major one under the subject project procurement exceeding the large quantity of more than 10 km length in total. This requires a comparative study taking into account the guarantee on the quality as well as the cost for transportation, and the materials are to be imported from Japan and/or third countries. Concerning the mechanical and electrical equipment, those are of precision machines and with a limited quantity of procurement, the design and manufacturing works are expected to be done in Japan and/or third countries. The following table shows the origins of major equipment/facilities as well as materials to be procured under the subject project.

Table 2-2-20 Origins of Equipments / Materials

Items	Country for Procurement			Remarks
	Zambia	Japan	Third country	
Sand	○			
Fine aggregate ,coarse aggregate	○			
Cement	○			
Reinforcing	○			
Timber	○			
Plywood	○			
Steel scaffold ,scaffold board	○			
Form	○			
Ductile iron pipe (Large/Medium)			○	India
Valve and accessories (Large/Medium)			○	India
Ductile iron pipe (Small Diameter)			○	South Africa
Valve and accessories (Small Diameter)			○	South Africa
Pumps		○		
Electrical equipment		○		

(2) Construction machineries

Such commonly used construction machineries as backhoe, bulldozer and crane are owned by local contractors of foreign origins and ready to be availed on a rental basis. The repair or exchange of spare-parts at the time of machine trouble is also easy under the prevailing condition in Zambia. However, the rental cost stays at a higher level as the owner or contractors imported the machines from neighboring countries at a high cost. Under the subject project, it is

planned to use the aforementioned locally available machines, though the procurement from third countries may result in lower prices sometimes in case of use for a longer period.

(3) Transportation route for procured goods

Those equipment/materials to be procured from Japan and India are to be shipped to either the Beira port of Mozambique or the port of Durban in South Africa, and after unloading, custom clearance and in-land transportation, the goods shall be delivered to the construction sites in Ndola city, Zambia. The main truck road from said ports to Ndola city is in good condition in terms of the pavement condition and road width and capable for use by large trucks and trailers for smooth in-land transportation of imported project procurement items.

2-2-4-7 Training plan for initial operation and maintenance

Concerning the intake pumps/related facilities and chemical dosing system to be installed at Kafubu WTP, the O&M expert of these facilities will undertake initial O&M training for the O&M staff of Kafubu WTP. Furthermore, of the water quality testing equipment/devices to be installed at the Kanini laboratory, the specific expert from the manufacturer of the gas chromatography system will provide training for the KWSC personnel on the operation of the system and analytical methods[1].

Table 2-2-21 Plans for Training on Initial Operation and Maintenance

Locations	Trainee	Training subjects
Kafubu Water Treatment Plant	Operators /Technician	- Operation/inspection on pump, blower and compressor - Operation for coagulant churning and chemical feeding and quantity control - Operation of chlorine feeding facility Training method: Practice at WTP Training period: 3 days

[1] : Above mentioned initial training is a guidance of operation and maintenance for the newly installed equipment. Operation and total management system of the facilities is supported through Soft component activities.

Locations	Trainee	Training subjects
Kanini Laboratory	Analyst	- Operation of gas chromatograph system including method for sample injection, detection of organic agrichemicals and manner of data recording, discharge control of carrier gas and handling of gas Training method: Practice at Laboratory Training period: 3 days

2-2-4-8 Soft Component (Technical Assistance) plan

(1) Background of soft-component planning

Various items have been planned under the soft component category, including new installation of coagulation process with rehabilitation of Kafubu WTP, rehabilitation of transmission pipeline system and new installation of water flow meter, new installation of gas-chromatograph (equipment for water analysis) etc. Departments under KWSC are responsible for operation and maintenance of the facilities and equipment after their construction/installment. KWSC became a public corporation in 2000, and since then, it has been financially self-managed without receiving any subsidies from the Government, and it has been well managed. Different from the way of management by the local administration, it attached importance on such managerial dimensions as cost-effectiveness and efficiency, fully conscious of relevant response to claims by customers as well as the collection of a water tariff.

Notwithstanding the above, however, as regards to technical dimensions such as operation/maintenance of WTP and the transmission pipeline system, the performance is still not sufficient to maintain the facility at a higher level for supplying better quality water and for reducing leakage as planned and expected possible under the project, though KWSC has already acquired a certain level for routine mechanical operations of the existing facilities. Once the level of services for water supply is improved, it is expected that trust by the customers will be enhanced, thus enabling a higher recovery rate of water tariff collection, eventually leading to higher profits for the corporation. Also, from the viewpoint to secure a necessary budget for procurement of operation/maintenance (O/M) necessities in the future, the implementation of soft-component for better O/M of the facilities and equipment to be constructed and introduced by this project is considered highly important.

The soft-component to be implemented under this project consists of 4 major components, and the details of them are as shown in the following:

1) Technical support for water treatment process

Kafubu WTP is currently operated without injecting coagulants. Since this project is to install a facility for injecting coagulants aiming at improving water for stable treated quality, a different system of O/M management will be required, which is quite different from what has been applied to date. Assured knowledge and techniques will be necessary for managing the facilities/equipment properly relevant to the water purifying process, including determination of optimum quantities of chemicals corresponding to changing quality of intake water from the source. Thus, technical support is essential for a newly introduced treatment process from the viewpoints of both promoting smooth introduction of a starting operation and keeping the cooperation effects sustainable. Instruction on O/M for other equipment in the system that are to be rehabilitated (including equipping raw water/treated water pumps, etc) is also planned in this project.

2) Technical support for water quality analysis

New analytical equipment is to be supplied in this project to the laboratory of KWSC with the objective of analyzing water quality of the raw water for the WTP. Targeting analyses for organic agro-chemicals, it is planned to provide equipment for gas-chromatography, also attached to the analyzing equipment, thus enabling analyses of heavy-metals (mercury/arsenic) that had not been possible by the existing atomic absorption photometer. Accordingly, technical support will be necessary for a smooth start, including creation of a base for effective use of such newly installed equipment and preparation of the water quality monitoring plan, preparation of the O&M manuals and so on.

3) Technical support for discharge measuring in pipeline

Since increasing water pressure in the existing water distribution pipes branched from the major pipeline is expected through the rehabilitation of the major pipeline of this project, it may induce increased water leakage from the existing water distribution pipes. Because the cumulative flow meter as the countermeasures against water leakage are to be provided by this project, technical support will be required for creating a discharge data collection system as well as a regular monitoring system, thereby assisting smooth initiation of effective utilization of introduced equipment.

4) Support for operating the water kiosks by the inhabitants

Water kiosks are to be installed by this project in 6 sites in the Kaloko Area, one of the Peri-Urban Areas. As against components of (1) ~ (3) that assist techniques of O/M for such hard work consisting of water supply facilities and equipment, this activity provides technical assistance for KWSC in the process of developing O/M organizations at the inhabitants' level,

including nurturing/training water vendors (selected from related communities) who are responsible for operating/maintaining water kiosks, as well as provision of hygienic enlightenment education to the inhabitants concerned, etc.

A manual based on a Tool Kit by DTF is to be applied to a series of processes covering the construction of new water kiosks management thereof[2]. KWSC has up till now carried out a series of water kiosk projects under the umbrella of the DTF fund covering from hygienic enlightenment education to the inhabitants concerned to construction as well as O/M of water kiosks. However, it hasn't any experience of implementing projects by its own budgetary source, so far technically assisted by the consultants hired by DTF for their implementation. In considering implementation of a water kiosk project through this project, technical support by a soft component will be necessary as observed in the case of DTF projects in order to materialize fruit of the project and also to make it sustainable in the future. For these reasons, construction of water kiosk works as a basis of a grant aid project and support to the inhabitants for water kiosks as that of the soft-ware one, educational activity on hygienic enlightenment to the inhabitants concerned as well as creation of their organizations will be planned as the components of the project.

(2) Goals of soft component

1) Goals of the entire soft components

- The staff of KWSC is engaged, taking responsibility in relevant O/M management of water supply system, thus attaining increased water supply beneficiaries and extended hours of water supply in the target water supplying area.

2) Goals of technical support on the water treatment process

- Treated water quality at WTP is stabilized, always satisfying drinking water quality standard.
- Excessive injection of chemicals at water treatment facility, thereby cost of O/M can be rationalized.
- Relevant O/M for newly provided water treatment equipment is materialized.

3) Goals of technical support on water quality analyses

- Water quality of the Kafubu Dam and Kafubu River is properly monitored/supervised; therefore, safety as the raw water quality of WTP can be confirmed.

4) Goals of technical support on discharge measurement in pipeline

- Discharges flowing in the pipeline is properly monitored/supervised, thus reflected in the

[2] Refer to footnote on page 2-8.

plans of repairing as well that of O/M for lessening leakage quantities.

5) Goals of the support on operating water kiosks by the inhabitants concerned

- Unsanitary state of water use by the inhabitants in Kaloko Area does not exist anymore.
- Water kiosks in the Kaloko Area are properly operated and managed.

(3) Achievement of Soft Components

The following direct benefits can be expected through the introduction of soft-components.

1) Achievement of technical support on the water treatment process

① Determination on concentration of coagulants to be injected in the treatment basin, according to water quality of intake water source, can be realized. [Achievement: WT①]

② Once it is possible to pre-determine suitable amount of chemical agents, it leads to avoid their excessive injection, thus optimizing the O/M cost. [Achievement: WT②]

③ In the case that algae proliferate/out-break in water source, it is possible to inject pre-chlorine in order to eliminate/exterminate them. [Achievement: WT③]

④ A new treatment process can be learnt and practiced so that the entire treatment process (comprising sedimentation basin, rapid filtering basin, and delivery/distribution pumps) including the process of chemical injection can be managed and operated. [Achievement: WT④]

⑤ As a result of improved O/M techniques for water purification facilities, it becomes possible to shift from post-accidental conservation to a preventive one, thereby enabling saving of O/M cost. [Achievement: WT⑤]

2) Achievement of technical support on water analyses

① Monitoring plan for the raw water quality of the WTP will be prepared. [Achievement: WQ①]

② Through the OJT program of the water quality analysis, KWSC staff will be able to understand/evaluate the property of target water quality. [Achievement: WQ②]

③ Through the OJT program of the water quality analysis, O&M manual adapted to the raw water quality analysis for the WTP will be prepared. [Achievement: WQ③]

3) Achievement of technical support on the flow measurement in the pipeline

① Monitoring plan for the state of discharges in the pipeline will be prepared. [Achievement: FM①]

② Through the OJT program of the water discharge measurement in the pipeline, KWSC staff will be able to measure the actual discharge quantity and record the result. [Achievement: FM②]

③ The KWSC staff will be able to understand/evaluate the state of discharges in the pipeline, then make the plan of a pipeline network rehabilitation works by reflecting the monitoring result. [Achievement: FM③]

4) Achievement of supporting management for water kiosks by the inhabitants concerned

① The inhabitants concerned understand the system of newly installed water kiosks, thus payment of a water tariff is made according to their purchase of water. [Achievement: KI①]

② A water tariff is collected by water vendors elected by the inhabitants concerned, thereby enabling management of water kiosks. [Achievement: KI②]

③ The vendors pay collected water tariff to KWSC, which manages, operates and repairs water kiosks, thus a coordination system can be created. [Achievement: KI③]

④ Comprehending a series of process on the installment of water kiosks, KWSC can carry out required activities. [Achievement: KI④]

(4) Method of identifying degree of targeted achievement

The degree of targeted achievement of soft-component is identified through the following methods:

No.	Component	Indices of fruit	How to identify the degree of accomplishing fruit
1	Water treatment process	1)-1 Operators are able to test water by jar-test. 1)-2 Turbidity of treated water is lowered below the water quality standard. 2) Color of treated water is lowered below the water quality standard. 3) In collaboration between KWSC and the consultant, the manual on O/M for (the whole) new treatment process is completed.	1) Judging the result of the test by training as well as the water quality analyses 2) The water quality analyses 3) O&M Manual and operation record

2	Water quality analysis	1) In collaboration between KWSC and the consultant, a water quality monitoring plan is formulated. 2) Raw water quality of WTP is tested and result data is analyzed through OJT program. 3) In collaboration between KWSC and the consultant, O&M manual adapted to the raw water quality analysis for WTP is provided.	1) Water quality monitoring plan 2) OJT report 3) O&M manual for water quality analysis
3	Discharge measurement in pipeline	1) In collaboration between KWSC and the consultant, a pipeline discharge monitoring plan is formulated. 2) Actual discharge quantity by distribution line is measured and recorded through OJT program. 3) In collaboration between KWSC and the consultant, a distribution map showing current state of pipeline discharges by distribution lines is provided. 4) In collaboration between KWSC and the consultant, a pipeline repairing plan is designed.	1) Pipeline discharges monitoring plan 2) OJT report 3) Pipeline discharges distribution map 4) Pipeline repairing plan
4	Support for the management of water kiosks	1) Inhabitant's awareness of hygiene is improved. 2) Water tariff is collected from water kiosks according to consumed water quantities recorded in tap-water current meters. 3) Monitoring of the management of water kiosks is made once in a quarter by KWSC 4) Activity with DTF tool kit is practiced.	1) Survey on inhabitant's state of water use 2) Monitoring reports on kiosks 3) Monthly progress reports by KWSC

(5) Activities of components (Input plan)

1) Technical supporting activity on the water treatment process

Necessary techniques to be acquired through this soft-component are an operational management skill, water quality management skill, chemical injection control skill and facility inspection skill. KWSC operators do not have the O&M skill and water quality control skill about the chemical treatment process (coagulation process/pre-chlorination) since chemical injection is not executed in the existing operation. Furthermore, O&M items and water quality control items to be managed for the sedimentation process and filtration process are to be changed because of chemical treatment process installation. Initial training carried out by the contractor is only for the O&M method of newly installed equipment itself and not to cover the training of the whole water treatment process. Therefore, technical support in this soft-component aims at the O&M method for the whole water treatment process so that KWSC operators can acquire necessary skills for proper operation.

An OJT training course mainly by classroom lectures coupled with actual site-training at a water treatment facility is provided. About 22 target trainees in this course are planned in total, selecting from operators positioned at the Kafubu water treatment facility (3 persons × 4 shifts ＝ 12 persons) and technical supervisors (3 persons), O/M staff in charge of routine/regular O/M of the equipment (5 persons) and technical supervisor (2 persons). The detailed contents of activities and the schedule are as shown below:

No.	Item	Content of activities	Applied Achievement	Target trainees	Instruction manuals etc (Visible fruit)	Place of activities	Term in day	Vehicle
1	Preparation of training texts	・ Training texts (water treatment process, operation and O/M manual draft) ・ Preparation of questionnaire sheets and a small test	WT ①-⑤	-	・ Training texts (including water treatment process, operation and O/M manual draft) ・ Preparation of questionnaire sheets and a small test	Japan	7 days	-
2	Moving route	Japan→Zambia	-	-	-	-	2days	1car (1day)
3	Training preparation	・ identifying current operation and technical level of the staff ・ reflection into training texts	WT ①-⑤	Operation staff	・ Result of questionnaire ・ Result of work-shop	Classroom/ Water treatment facility	3days	1car (23 days)
4	Training (lectures)	・ Lectures on water treatment process ・ Lectures on operation and O/M ・ Carrying out a small test			Records of training (including result of small test and evaluation)	Classroom	3 days	
5	Training (sites)	・ Site training (on-the-site practices on calculating concentration of coagulant, jar-test, pre-chlorination control, adjustment/ control of discharges in filtering ponds, drainage of sludge/ slurry, daily and periodic O/M methods on whole equipments etc)			Records of training (including judgment on the result of tests)	WTP	10 days	
6	Evaluation/ summary	・ Monitoring of operating water treatment plant and the evaluation on quality of treated water by the operators who received training ・ Preparation of report on the result of training			・ Result of operation record ・ Result on quality of treated water ・ Report on the result of training	WTP	7days	
7	Moving route	Zambia→Japan	-	-	-	-	2Days	1car (1day)
【scale of input】A Japanese consultant×34days ＝34 man-day (of which site working-days 27days), 1vehicle×25days ＝25･car-day								

2) Activity of technical support on water quality analysis

Necessary techniques to be acquired through this soft-component are detection and monitoring skills of organic agro-chemicals and heavy-metals (mercury/arsenic) in raw water for WTP. At present, general water quality items such as turbidity, inorganic chemicals, etc., are tested in the laboratory. Thus, laboratory technicians have a basic knowledge. However, they do not have enough techniques about analysis of organic agro-chemicals and heavy-metals. Therefore, training is provided on a series of procedures including planning, measurements and subsequent analysis on organic agro-chemicals and heavy-metals (mercury/arsenic) through OJT so that laboratory technicians can analyze and evaluate raw water quality for WTP.

Although an initial training on O&M for the analysis equipment is carried out by the contractor, initial training aims at the O&M methods for analysis equipment itself but not covering the necessary items required for a series of water quality analysis works. Furthermore, it is important to analyze an actual sample repeatedly in order to grasp the property of raw water quality empirically, such as concentration range, etc. Therefore, technical support in this soft component encourages laboratory technicians' understanding.

As the target personnel of the training, 5 laboratory technicians (including a technical supervisor) are scheduled. Detailed contents of the activity as well as the schedule are shown in the following table:

No.	Item	Content of activities	Applied Achievement	Target trainees	Instruction manuals etc (Visible fruit)	Place of activities	Term in day	Vehicle
1	Moving route	Japan→Zambia	-	-	-	-	2days	1car (1day)
2	Preparation for water quality analysis	・ Identification of current level of analytical techniques and equipment ・ Provision of water quality monitoring plan (items of analyses, sites of sampling, frequency thereof etc)	WQ①	Laboratory technician	Water quality monitoring plan	Laboratory	3days	1car (16days)
3	Site training for water quality analysis	・ OJT training on sampling and analysis	WQ②		・ Manual of water quality analysis with newly introduced equipment ・ Report on the result of training ・ Record of training (including the judgment of the training result) Record of water quality analysis	Laboratory, sampling sites	5days	

4	Interpretation on the result of water quality analyses	・ OJT training on interpreting the result of water quality analyses	WQ②		Record on the interpretation of the result of the analysis	Laboratory	3days	
5	Summary and others	・ Evaluation of the result of analysis and feedback to the site operations (water treatment plant etc) ・ Training on such O/M services as inventory/ management of expendables and spare parts of the equipment, routine/ regular inspection etc ・ Provision of the reports on the result of the training	WQ② WQ③		・ manual of O/M for newly introduced equipment ・Report on the result of training	Laboratory	5days	
6	Moving route	Zambia→Japan	-	-	-	-	2days	1car (1day)
【scale of input】A Japanese consultant 1person×20days ＝20 man-day、1vehicle ×18days = 18 car-day								

3) Activity of technical support on the discharge measurement in the pipeline

Necessary techniques to be acquired through this soft-component are skills of measuring and monitoring the discharge quantity in the pipeline and the planning of the pipeline repair plan. In the present state of O&M of the pipeline, leakage water is not observed quantitatively, but repairing is made according to the scale of water leakages from sections of the pipeline by visual observation. The target level is that the O&M staff can measure the discharge in the pipeline and observe the pipe leakage by a measurement result, then reflect it to the pipeline repair plan.

In this soft component, training on preparation of the pipeline discharge monitoring plan, actual measurement by the distribution system through OJT, analysis of measurement results (preparation of maps showing distribution of discharges in the pipeline) and preparation of the pipeline repairing plan are scheduled. The target level of training is that the O&M staff can measure and record actual discharge in the pipeline, then reflect it to the subsequent analysis and pipeline repairing plan. The O&M staff of the water distribution division is targeted as the trainees of the training (around 15 staff, including two technical supervisors). The contents of activity and the schedule are tabulated below:

No.	Item	Content of activities	Applied Achievement	Target trainees	Instruction manuals etc (Visible fruit)	Place of activities	Term in day	Vehicle
1	Moving route	Japan→Zambia	-	-	-	-	2days	1car (1day)
2	Preparation for measuring discharges	・ Identification of current technical level, the system of O/M for pipeline ・ Formulation of the plan on monitoring of discharges in pipeline (monitoring system, places of measurements, frequency etc)	FM①	Staff of O/M of pipeline	Monitoring plan of discharges in pipeline	Office/ at sites	6days	1 car (23days)
3	Practical measurement training	・ Practice on-the-site measurements of discharges by means of cumulative flow meter	FM②		・ Training records (including result of the test) ・ Measurement records	At sites	7days	
4	Interpretation of the result of measure-ments	・ Interpretation of the state of discharges in pipeline by means of the result of discharges' measurements (state of discharges by series of distributing lines etc)	FM③		Maps showing distribution of discharges in pipeline	Office	5days	
5	Summary and others	・ Provision of pipeline repairing plan reflecting the result of mapping of current pipeline discharges ・ Training of O/M for the management of expendables and spare-parts etc ・ Provision of the report on the result of training	FM③		・ Pipeline repairing plan (elaboration on ranking priority orders of repairing in future) ・ Report on the result of training	Office	5days	
6	Zambia→ Japan	-	-	-	-	2days	1car (1day)	Zambia → Japan
【scale of input】A Japanese consultant 1person×27days ＝27 man-days、vehicle: 1car×25days ＝25 car-days								

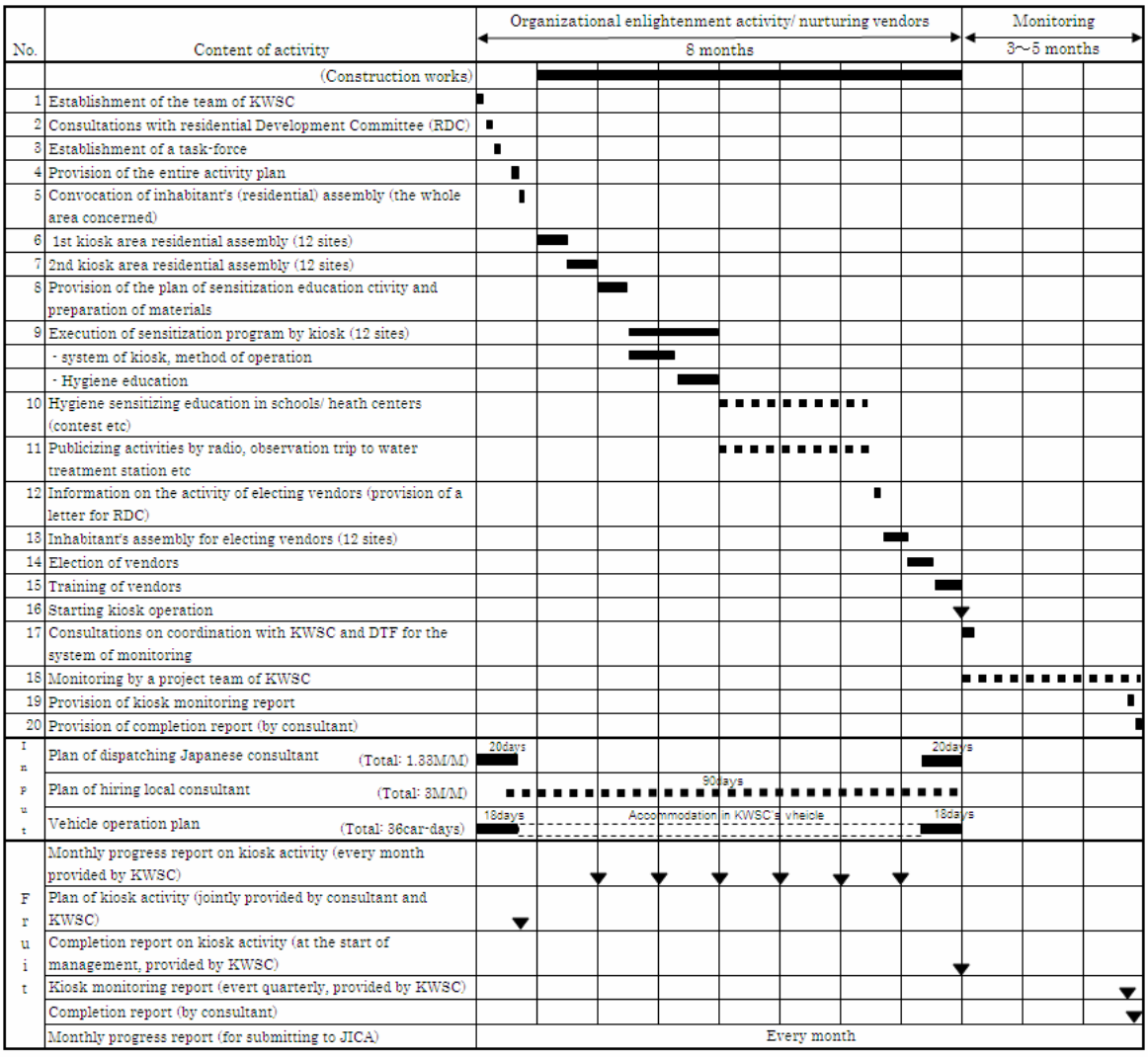
4) Activity of technical support on the management on Water kiosks by inhabitants

This part of the soft component aims to keep the selling water on water kiosks by means of sensitization activity and hygiene instructions to inhabitants. The peri-urban section of KWSC has mainly been liaisoning among the municipality office of Ndola City and relates inhabitants' organizations as well as collecting a water tariff from each water kiosk. Meanwhile, a consultant contracted/entrusted by DTF has been extending direct enlightenment activity and hygienic instructions toward inhabitants, whereas very few experts specialized in such activity are found in KWSC.

In this project, a Japanese consultant is dispatched to the sites at the initial stage of starting enlightenment/sensitization activity and at the completing stage thereof (initial stage of starting use of water kiosks) to promote smooth progress of management activity for these water

kiosks in collaboration with a local consultant. The local consultant is to practically develop enlightenment/sensitization activity with the staff of KWSC at the beginning stage of the activity, and later at the latter-half stage to instruct the activity by the staff of KWSC, thus transferring techniques. Regarding the monitoring after the kiosk operation, submission of a quarterly monitoring report is obligatory in the DTF project. In the case of this project, DTF agreed to accept the monitoring report submitted by KWSC and make advice to KWSC the same as the DTF project.

Currently, water kiosks have so far been installed at 6 sites in the Kaloko Area which is the target area of installing new water kiosks; however, due to a problem of insufficiency of supplying water pressure, etc., 4 sites of which have not been able to operate and the remaining 2 sites have failed sufficient management due to scarce water quantity. Rehabilitation work through this grant aid project will improve water pressure in six water kiosks, thereby enabling to resume the operation. It is required to consider the entire state of water supply in the target area including those which have already been installed in the support activity for the management of these water kiosks, therefore the planned activity will include in total twelve sites of water kiosks (the existing 6 sites + 6 newly installed sites). The whole action plan is shown in the following table:



■ ■ ■ continuing with pauses

The detailed contents of progress supervision/technical support by the Japanese consultant as well as by local consultant are summarized in the following tables. A local consultant is desirable to have a similar experience of the community organizing and hygiene instruction on DTF project.

① Input plan of dispatching Japanese consultant

[First travel plan]

No.	Item	Applied Achievement	Content of activities	Visible effect	Place of activity	Number of days	Vehicle
1	Moving route : Japan→Zambia	-	-	-	-	2days	1car (1day)
2	Consultations with KWSC (the whole schedule, system of implementation, principles of activity)	KI④	Division concerned in KWSC	The whole schedule and system	Office	2days	1car (16days)

3	Preparation and execution of consultations with inhabitants' organizations（RDC） (the whole schedule, principles of project activity, selection of target persons to form a task-force etc)	KI④	Division concerned in KWSC, inhabitant's committee	Minute of consultations	At the site or in the office	2days	
4	Preparation and execution of task-force meetings (※Task-force is composed of relevant division of KWSC, representatives of the inhabitants, staff of health center etc)	KI④	Task-force	Minute of consultations	At village or in the office	2days	
5	Execution of basic survey (a survey on planned number of beneficiary persons by kiosk, beneficiary area of kiosk plan, current state of water use by inhabitants)	KI④	Task-force	Number of final beneficiary persons, result of state of water use	At the site	5days	
6	Formulation of detailed plan of activity (inhabitant's assembly by kiosk-area, hygiene sensitizing extension activity, establishment of evaluation indices etc)	KI④	Task-force	Kiosk activity plan	At the site or in the office	3days	
7	Preparation and execution of the first inhabitant's assembly (the whole inhabitants)	KI④	Task-force	Explanatory pamphlet of inhabitant's assembly etc		2days	
8	Zambia→Japan	-	-	-	-	2days	1 car (1day)
【scale of input】A Japanese consultant 1person×20days＝20 man-days, vehicle 1 car×18days＝18 car-days							

[Second travel plan]

No.	Item	Applied Achievement	Content of activities	Visible effect	Place of activity	Number of days	Vehicle
1	Moving route : Japan→Zambia	-	-	-	-	2days	1car (1day)
2	Execution of task-force meeting (identification of the progress state)	KI④	Task-force	Minutes of the meeting	Office	1day	1 car (16 days)
3	Confirmation and Evaluation of the results on hygiene sensitizing extension activities for inhabitants	KI④	Division concerned in KWSC	-	Sites, Office	2days	
4	Identification of the state of vendor's election, that of the state of training vendors	KI②	Task-force and venders	Election of vendors, state of their training	At sites	3days	
5	Identification and improvement of O/M system by kiosk	KI③	Task-force and vendors	O/M system by kiosk	At sites	3days	
6	Evaluation of the Report on the completion of kiosk-activity plan (KWSC prepares), consultations towards monitoring	KI③	Division concerned in KWSC	Report on the completion of kiosk-activity plan (KWSC prepares)	Office	3days	
7	Consultations on future coordinated support for monitoring system with DTF	KI③	Related division in KWSC, DTF	-	Office	2days	
8	Reporting by the consultant	-	-	Final report	Office	2days	
9	Zambia→Japan		-	-	-	2days	1car (1day)
【scale of input】A Japanese consultant 1person×20days ＝20man-days, vehicle 1 car×18days ＝18car-days							

② Input plan of local consultant

No.	Item	Applied Achievement	Content of activities	Visible effect	Place of activity	No. of days/ site	Vehicle
1	1st inhabitants assembly in kiosk-area	KI④	Task-force, inhabitants	Record of activity	Each kiosk	1day	12days
2	2nd inhabitants assembly in kiosk-area	KI④	Task-force, inhabitants	Record of activity, sketch of beneficiary area by kiosk	Each kiosk	1day	12days
3	Preparation of texts for inhabitant's sensitization activity	KI①	Task-force	Inhabitant's sensi-tization texts	Office	common	3days
4	Execution of sensitization activities by kiosk area （kiosk operating system/ rule）	KI①	Task-force, inhabitants	Record of activity	Each kiosk	2 days	24 days
5	Execution of sensitization activities by kiosk area （hygiene sensitization）	KI①	Task-force, inhabitants	Record of activity	Each kiosk	2 days	24 days
6	Preparation and execution of hygiene sensitization in schools/ health center	KI①	Task-force, inhabitants	Sensitization texts, Record of activity	At sites	common	5 days
7	Preparation and execution of inhabitant's assembly for electing vendors Election of vendors	KI②	Task-force, inhabitants	Record of electing vendors	At sites	common	5 days
8	Vendor's training	KI②	Task-force and venders	Textbooks for training vendors	At sites	common	5 days
【scale of input】A local consultant 1person×90days ＝90man-days, vehicle: accommodated in KWSC's vehicles							

2-2-4-9 Implementation schedule

(1) Obligations of the Government of Japan and the Government of Zambia

Obligations to be borne out by the Government of Japan and the Government of Zambia are as demarcated as follows.

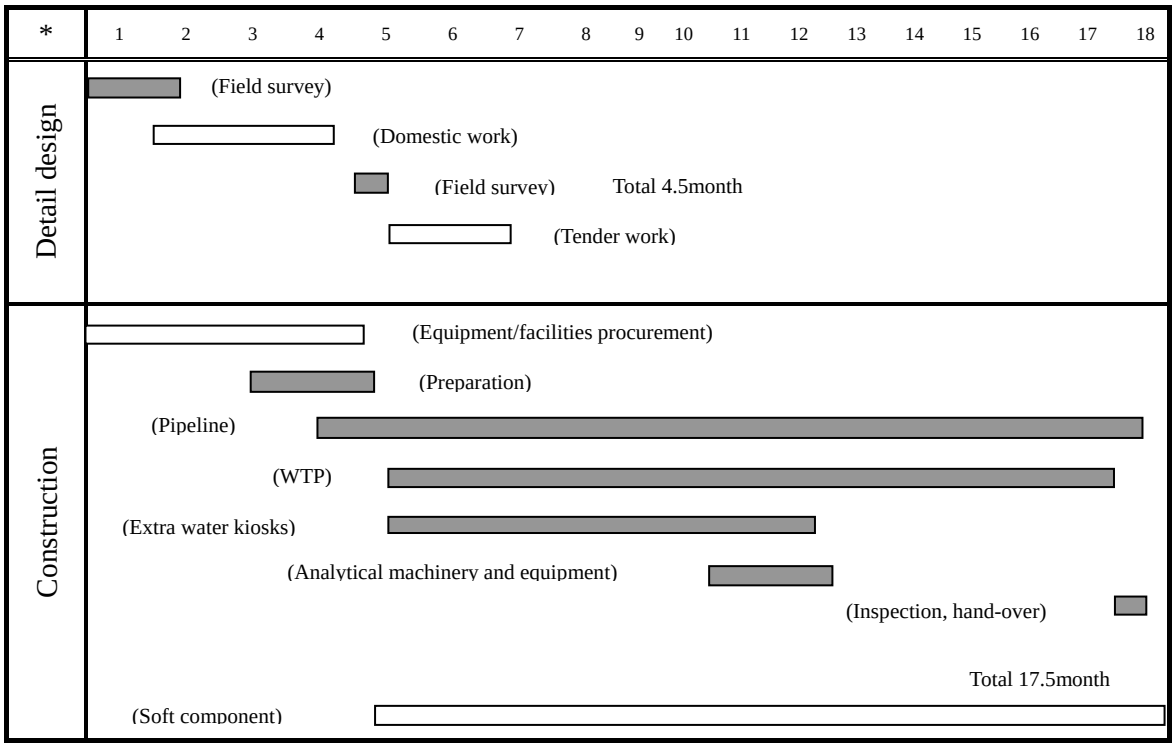
Obligations by Japanese side	Obligations by Zambian side
- Improvement of Kafubu WTP - Installation of pipe facilities - Construction of extra water kiosks - Installation of water quality testing equipment - Project supporting by soft Component	- Secure of lands for pipe installing and construction of water kiosks - Relocation of underground wirings and pipes existed on alignment - Provision of drainage pond at Kafubu WTP

(2) Implementation schedule

As for the obligations of the Government of Japan, required periods for detailed design

and construction under the subject project are estimated as shown in the figure below. In Ndola city, the rainy season covers the 5-month period from November to March. Construction planning shall be so made that pipe installation progresses during the dry season period for higher working efficiency. For the improvement of Kafubu WTP, consideration shall be given in a way that the water supply suspension period may become the shortest.

Actual schedule chart



*: Number of Months

2-3 Obligations of the Government of Zambia

In order to ensure smooth project implementation, operation, and maintenance, obligations of the measures to be undertaken by the Government of Zambia during preparation, procurement of equipment, construction and operation and maintenance under the Grant Aid Project is outlined as follows:

(1) General

1) To secure lands necessary for the facilities to be constructed on, including installation of the materials and equipment.

2) To provide electrical and other project implementing facilities needed.

3) To bear the necessary commission for the bank based on the Banking Arrangement and to issue the Authorization to Pay (A/P).

4) To obtain all necessary customs clearances and ensure prompt execution of unloading of the materials and equipment to be brought into for use of the project

5) To exempt Japanese nationals from customs duties, internal taxes, and other fiscal levies that would be imposed in Zambia with respect to the supply of materials, equipment, and services or to bear the same.

6) To allow Japanese nationals who offer services for the project entrance into Zambia and stay therein for the performance of their works.

7) To operate and maintain the facilities and equipment provided under the Grant Aid properly and effectively, and to inform the Japanese party of the conditions of operations and maintenance of the facilities and equipment upon request.

8) To bear all the expenses other than those to be incurred by the Grant Aid, necessary for the implementation, operation, and maintenance of the project.

9) To give due environmental and social consideration in the implementation of the project.

(2) Obligations to be undertaken prior to and during the implementation of the project

1) To complete land acquisition required for new pipe laying and construction of water kiosks before tender stage of the project.

2) To liaison and coordinate with the RDC (Resident Development Committee) on construction of water kiosks.

3) To provide required lands for stocking pipe materials and the spoil bank, as well as to secure

stocking yard for removed equipment/materials.

4) To provide data/information about the underground wirings and pipes (electric lines, telephone cables, water distribution pipes, sewerage pipes and drainage culverts etc.) existing on the alignment for planned pipe laying before the detailed design stage. Where there are underground wirings and pipes, excavation of test pit is required and the relocation work shall be completed before commencement of the construction.

5) To inform the local residents and other beneficiaries concerned with the water supply suspension schedule as caused by the construction work for the treatment plant and pipe laying under the project and to supply water by water tank truck as needed.

6) To supply necessary water for pipe leakage test and pipe flushing before use.

7) To request the traffic police for their due cooperation during the pipe laying work.

8) To provide a drainage pond and a sun-drying yard for sludge disposal handling at Kafubu WTP.

9) To assign necessary counterpart personnel during the project implementation.

10) To mend the damaged roof, window, door and related parts of the water treatment plant and pump station which are objects of the project.

(3) Obligations to be undertaken after the implementation of the project

1) To keep appropriate operation and maintenance of the water supply system as per described in 2-4, Chapter 2 of this report, including new assignment of necessary staff in the water Production Section and Laboratory Section of KWSC.

2-4 Project Operation Plan

2-4-1 Organization for O&M and Required Staff

Engineering sections of the KWSC shall be in charge of the project O&M activities after the completion of the project implementation. The organizational set-up for the project O&M is shown in the following figure:

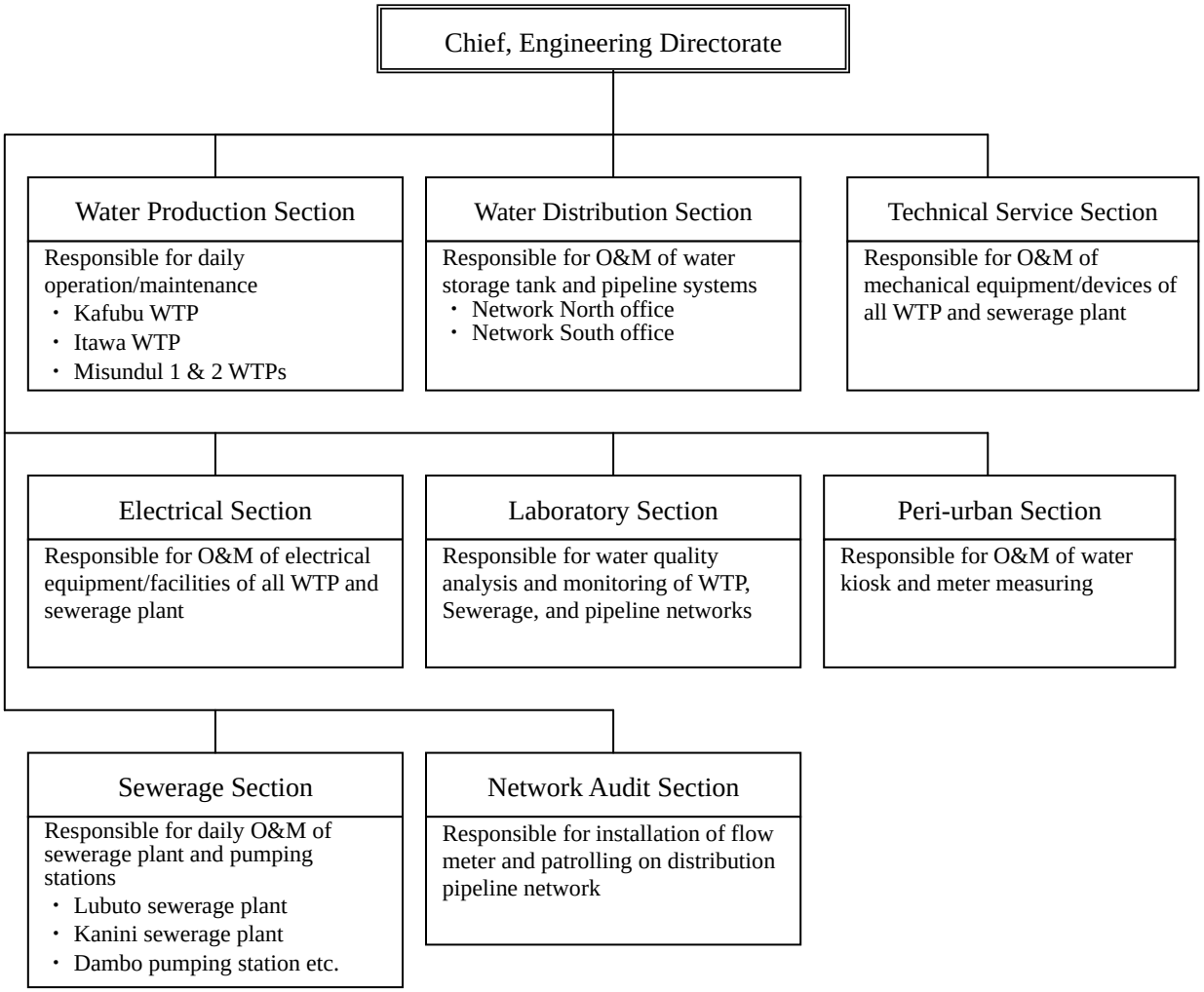


Fig. 2-4-1 Organization Chart of Engineering Sections in KWSC

Daily O&M activities for Kafubu WTP to be rehabilitated under the subject project is the responsibility of the Water Production Section, while regular O&M and repairing/replacement work shall be the responsibilities of the Technical Service Section for the mechanical part and of Electrical Section for the electrical part. At the same time, O&M and repairing on main pipeline systems to be rehabilitated are undertaken by the Water Distribution Section. The O&M of the water quality analysis equipment/devices to be newly introduced shall

be the responsibility of the Laboratory Section. Furthermore, the Peri-urban Section will regularly undertake monitoring on operation conditions and technical O&M activities for the water kiosk, which shall be managed by the beneficiaries of each locality.

The number of staff and allocation of responsibilities under the O&M plan for the facilities/equipment to be rehabilitated or newly introduced under the subject project are shown below. The underlines in the table show increasing numbers of staff from the existing amount. Necessary allocation of increased staff shall be prepared.

Table 2-4-1 Necessary Organization for O&M of the Rehabilitated or Newly Installed Facilities

Component	Section in charge of O&M	O&M works	Necessary manpower for the rehabilitated or installed facilities
Kafubu WTP	Water Production Section	Daily O&M and cleaning of WTP	Manager: 1, Superintendent: 1, Plant manager: 1, Operator:2 x 4 shift =8, Operator (chemical): 1 x 4 shift =4 (existing: 0), General worker: 3 x 4 shift =12 **[Total: 27 nos.]**
	Technical Service Section	Regular O&M and repair of mechanical equipment/devices	Manager: 1, Superintendent: 1, Mechanical fitter: 5 **[Total: 7 nos.]**
	Electrical Section	Regular O&M and repair of electrical equipment/devices	Manager: 1, Superintendent: 1, Electrician: 5 **[Total: 7 nos.]**
Transmission pipelines	Water Distribution Section	Daily and periodic O&M of water storage tanks, pipeline systems	Manager: 1 [Network north] Superintendent: 1, Plumber: 5, General worker: 10 [Network south] Superintendent: 1, Plumber: 5, General worker: 10 **[Total: 33 nos.]**
Water quality analysis equipment/devices	Laboratory Section	Water quality analysis of raw water, treated water quality of WTP, and pipeline networks	Chemist: 1, Laboratory technician: 4 (existing 2) **[Total: 5 nos.]**
Water kiosk	Peri-urban Section	Collection of water tariff, monitoring of kiosks, repairing of small pipes, etc.	Manager 1, Plumber 3, Peri-urban officer: 4 **[Total: 8 nos.]**

2-4-2 Operation and Maintenance Works

(1) Kafubu WTP

Basic concept for the O&M of Kafubu WTP:

Operations: Operations of WTP are to be controlled quantitatively and qualitatively.
In terms of quantity, a target shall be fixed and the number of systems and unit number of equipment to be operated be decided to satisfy the target quantity. An operations plan on this basis shall be prepared and according to the plan, equipment and facilities shall be controlled.

For water quality, samples are tested in each of the treatment processes and adjusted to the quantity of injecting chemicals so as to meet the required quality. Records of operation, amount of chemicals injected and records of quality control shall be processed and analyzed for use for the data of decision-making.

Maintenance: Regular patrolling/inspection and preventive measures shall be taken.

For regular inspection, a check list shall be prepared to indicate the items to be inspected for the related equipment/facilities. At the same time, necessary consumables such as lubricating oil, etc. shall be replenished as required. It is also necessary to secure sustainable supply of needed chemicals (Coagulant and chlorine) to be safely stored.

Concerning the preventive measures, the idea is to convert the concept from repairing/replacement after serious damages/malfunctioning to it's possible protection in advance. For this case, an interval shall be fixed depending on the specific nature/characteristic of each equipment/device and well-planned cares shall be provided. By implementing the said preventive measures, it is possible to avoid occurrences of serious damages/malfunctioning.

Practical items to be undertaken for running and O&M of Kafubu WTP are as shown in the following table. For the new items to be added, rehabilitation will be associated with necessary technical guidance of soft components and through having a joint works with the O&M staff in charge of KWSC, a new O&M manual suitable for new treatment process matching with the local condition shall be prepared. KWSC shall bear the responsibility to keep sustainable operations and maintenance on WTP utilizing a new O&M manual.

Table 2-4-2 Practical Items for Running and O&M of Kafubu WTP

Classifications	Daily Operation (Water Production Sect.)	Regular Inspection/maintenance (Tech. Service & Elect. Sections)
Manager level engineer	・Prep. Production plan ・Control production records ・Manage quality monitoring ・Control of chlorine injection ・Control on WTP running cost	・Prep. Regular Inspection plan/ Maintenance program ・Manage on inspect/repair records ・Manage on procurement records and agent list ・Manage repair/protection costs
Site engineer	・Ensures running of pumps for raw water and water supply and monitor/inspection ・Run and monitor of chemical injection facilities	・Regular inspection/monitoring work as per the plan (equipment for water pumps and electrical)

	・Inspection on sedimentation basin and remove of sludge ・Run and monitor of filtration pond ・Inspect./monitor on chlorine injection condition ・Quality analysis on raw water, treated water at filtration pond and purified water ・Work records and cleaning	

(2) Pipeline Facilities

Necessary work items for O&M of pipeline facilities are as shown in the following table. This, in addition to the existing tasks, requires organizational set-up for data measurement, processing and analysis on the measurement results as derived from the introduction of integrating flow meter under the project. For this, technical support in the form of the soft component shall be implemented concerning the organizational set-up for data measurement by using the introduced integrating flow meter, as well as data analysis based on the measured data. KWSC shall be needed to keep sustainable operation and maintenance on pipeline facilities through utilizing the benefits of the soft component fully.

Table 2-4-3 Practical Work Items for O&M of Pipeline Systems

Classifications	Daily Operation	Regular inspection/maintenance
Manager level engineer	・Control of flow condition for each distribution system ・Manage daily working reports	・Regular inspection/manage repair records ・Manage records of replacement of spare-parts/reserves ・Manage repair/protection costs
Site engineer	・Record of flow meter working condition and flow data ・Inspection of exposure pipe zone and detection of pipe leakage ・Repair of leakage pipe	・Inspection of the sluice valve, air valve, drain valve and fireplug ・Inspection of the sign of underground pipe and valve

(3) O&M of Water Kiosk

Daily functionality and O&M of newly constructed kiosks are to be undertaken chiefly by the resident beneficiaries of each locality, where the peri-urban section of the KWSC shall be responsible for regular monitoring on the operation conditions and due support for technical aspects of required O&M activities. Monitoring work shall be undertaken in accordance with the manual (Tool kit) of the DTF. Concerning the technical aspects of O&M for Kiosk type water taps, KWSC will undertake the tasks by using the water fee paid by water vendors. O&M activities include repairs on buildings, water meters, and distribution pipes.

In the city of Ndola, water kiosks funded by the DTF have been constructed and operated in peri-urban areas. The KWSC peri-urban section staff has knowledge of the project

operation of the Kiosk project, but the local consultants hired by KWSC have done the work of disseminating information about such a project. Therefore there are few opportunities needed to inform the inhabitants directly with KWSC staff. The Kaloko area, which is the target area of this project, can only have 2 kiosks operated properly due to the lack of water pressure.

In this project, through the soft component, the consultant team is to develop KWSC staff capacity by doing the dissemination/ sensitization activity together with the capacity of Kaloko inhabitants in the area for the sustainable management of the facilities.

In Kaloko, KWSC staff monitors the 6 newly constructed and 6 existing, water kiosks, which totals to 12 water kiosks. KWSC staff monitors the inhabitants' organizational activities, such as tariff collection, daily operation recording, sales amount distribution, payment to the KWSC and so on, then encourages the inhabitants to solve the problem by themselves. KWSC staff also carries out repair work when the facility fails to work properly.

Inhabitants' organization plan for the management of water kiosk in the Kaloko area is as follows:

Table 2-4-4 Inhabitants' Organization Plan for O&M of Water Kiosks in Kaloko Area

Water Tariff	Metered method (for example, 50ZMK/20 ℓ) Discuss among users
User Amount	Design about 1,500 persons per kiosk
Water Vendor	Select some numbers of water vendors among inhabitants and make rotating shift
Operational Hours	Discuss among users (for example 3 hours in the morning, 3 hours in the afternoon, and so on)
Sales Amount	Salary of water vendors is 40% of the sales amount. KWSC collects the tariff based on reading value of the meter installed in the kiosk. (Collection rate in 2010 is 1,518ZMK/m^3) Remaining amounts shall be subject to discussion among users for its spending such as deposit for minor repairs.

KWSC monitors each water kiosk quarterly for the next 2 years. KWSC submits the monitoring report to the DTF and the DTF gives necessary advice. Monitoring items described in the DTF tool kit are shown below.

Table 2-4-5 Monitoring Items of Water Kiosk described in the DTF Tool Kit

Classification	View point
Users	Is there improvement in the sanitary conditions? Is the time of access to water shortened? Is water quality of water taps is acceptable? Is the water tariff payable by users?

Water Vendor/Supervisor	Are facilities are operated properly? Does water vendor get the proper sales amount? Is water quantity sufficient enough? Are users satisfied with the services?
Commercial Utilities	Is there proper collection of water tariff from water kiosk? Are repair costs for the facilities covered by collected tariffs? Is the design water supplied satisfying the population? Is there unmetered water due to the leakages present?

(4) Water quality analysis and O&M of equipment/devices

Items to be analyzed by the Laboratory Section under KWSC are indicated below. Through the introduction of gas chromatography and AAS equipment, analysis on agricultural chemicals and heavy metals (Mercury and arsenic) can be made possible. For this same aspect, technical guidance in the form of soft component will be implemented and a manual for water quality analysis methods and O&M will be prepared. KWSC shall be needed to keep sustainable O&M on the water quality analysis equipment/devices while utilizing a new O&M manual.

Table 2-4-6 Water Quality Analysis Items by the Laboratory Section

WTP	Raw water/ Treated	pH. Turbidity, Color, Residual chlorine, Total coliforms, Fecal coliforms, EC, Dissolved solids. Suspended solid, Alkalinity, Hardness, Calcium, Magnesium, Sulfate, Copper, Manganese, Iron, Zinc, Cadmium, Lead, Chrome, Mercury, Arsenic, Agricultural chemicals
Pipelines	Water tap	pH, Turbidity, Color, Residual Chlorine, Total coliforms, Fecal coliforms
Sewerage	Treated	Temperature, pH, Color, Turbidity, BOD, EC, Total Dissolved solids, Total Suspended Solid, Sodium, Ammonia, Phosphorus, Chloride, Algae, Total coliforms, Fecal coliforms

Remarks: The underlined text shows analyzed items to be made possible by use of newly introduced equipment/devices.

Daily/regular inspection and O&M on the gas chromatography equipment shall be undertaken by the Laboratory Section of KWSC, and the periodical checking and repairs shall be contracted and carried out by the appointed agent of the equipments manufacturer.

Table 2-4-7 O&M Items of Gas Chromatography Equipment

Classifications	Responsibility of:	Work items
Daily inspection Maintenance	Laboratory Section of KWSC	Fulfillment of carrier gas and cleaning
Periodical Checking	Agent contracted	Calibration and exchange of spare-parts, frequency: bi-annually

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

2-5-1-1 Cost to be borne by the Government of Zambia

The breakdown of costs to be incurred by the Government of Zambia is indicated with the following table which applies such estimation conditions as noted below.

Cost Items	Estimated Amount	
Relocation of underground wirings and pipes	US$ 100,000	
Provision of drainage pond and sun-drying yard	US$ 20,000	
Commission to the Bank concerning Banking Arrangement	US$ 24,422	
Total	US$ 144,422	721.32 Million ZMK

2-5-1-2 Estimation Conditions

(1) Date of estimation: September 2010

(2) Exchange Rate: 1 US$=90.90 J.Yen, 1 ZMK=0.0182 J.Yen

(3) Schedule: Construction and procurement periods are as shown in the project implementation schedule.

(4) Others: Cost estimation shall be carried out based on the guidelines set for the grant aid project by the Government of Japan.

2-5-2 Operations and Maintenance Cost

The cost required for operations and maintenance of the object facilities (repair of Kafubu WTP, installation of transmission pipe, installation of analytical machinery and equipment, construction of extra water kiosks) of this plan are as estimated below:

Table 2-5-1 Project Cost for Operation and Maintenance of the Object Facilities

Object	Segment	Yearly Cost (1,000 ZMK)	Remarks
Kafubu WTP	Labor	1,998,545	Staff average allowance(1) 48,745,000ZMK/year x 41 staffs
	Electricity	2,138,737	Yearly electric energy of WTP after repairs 16,810,002 kWh x unit cost of electricity bill 127.23ZMK/kWh(3)
	Coagulant	1,908,459	Alum average dosage 20mg/l(2) x filtration flow 81,800m^3/day x 365days x unit cost 3,196ZMK/kg(3)
	Prechlorination	1,127,968	Chlorine gas Average dosage 3mg/l x filtration flow 81,800m^3/day(2)x 365days x unit cost 12,593ZMK/kg(3)
	Post chlorination	751,978	Chlorine gas Average dosage 2mg/l(2) x filtration flow 81,800m^3/day(2) x 365days x unit cost 12,593ZMK/kg(3)
	Repair, spare parts	1,186,813	Equipment cost x 3% 720 million yen/0.0182 x 0.03
	Sub total i	9,112,500	
Transmission Pipe	Labor	1,608,585	Staff average allowance(1) 48,745,000 ZMK/year x 33 staffs
	Repair, spare parts	708,791	Pipe cost x 3% 430 million yen/0.0182 x 0.03
	Sub total ii	2,317,376	
Analysis & O&M of Analytical Machinery and Equipment	Labor	243,725	Staff average allowance(1) 48,745,000 ZMK/year x 5 staffs
	Career gas for analysis	6,600	Gas cylinder ;two times per year changed x 3,300,000ZMK/cylinder
	Regular service, maintenance	27,473	The regular service and maintenance are consigned to the agency. 500,000 yen/1time 500,000 yen/0.0182
	Repair ,spare parts	16,484	Equipment cost x 3% 10 million yen/0.0182 x 0.03
	Sub total iii	294,282	
Kiosk Type Public Water Taps	Labor	389,960	Staff average allowance(1) 48,745,000 ZMK/year x 8 staffs
	Repair, spare parts	9,890	Direct construction cost x 3% 6 million yen/0.0182 x 0.03
	Sub total iv	399,850	
Total		12,124,008	i + ii + iii + iv

(1): The total amount of staff salary of 2009 - 2010 was divided by the number of total staff in September, 2010, and the amount of average salary calculated during the year.
(2): Design value
(3): Value in 2010

The cost increase after the project implementation from the above manner is indicated as shown in the table below. About 4,080,165 thousand ZMK a year is considered an incremental yearly cost.

Table 2-5-2 KWSC's Cost Increase after the Project Implementation

Segment	Yearly cost (1,000 ZMK)	Remarks
i. Labor	292,470	Staff average allowance 48,745,000ZMK/year x increase 6 staffs (water production 4 staffs + Laboratory 2 staffs)
ii. Electricity	700,711	Increase from actual WTP to existing 2,138,737,000ZMK x (81,800 m^3/day - 55,000 m^3/day) / 81,800 m^3/day
iii. Coagulant	1,908,459	-
iv. Chlorination	1,127,968	Pre-chlorination 1,127,968,000ZMK
v. Analysis & O&M of analytical machinery and equipment	50,557	Carrier gas for analysis 6,600,000 ZMK + regular service and maintenance cost 27,473,000ZMK + Repair and spare parts cost 16,484,000ZMK
Total	4,080,165	

On the other hand, KWSC'S financial condition for the past 3 years is as shown in the table below. This table shows that KWSC could cover necessary running costs via their income in 2008/2009 and 2009/2010. Furthermore, it is anticipated that KWSC's profit will increase because the water supply cost[1] reduction will be expected due to the 6,500m^3/d leakage water reduction from the main pipe between Nakaputa reservoir and Skyways reservoir, which is to be rehabilitated under this project.

[1] Water supply cost: average cost required for 1m^3 of water production

Table 2-5-3 KWSC's Financial Condition for the Past 3 Years (Unit: 1,000 ZMK)

Year	Income			Expenditure					Balance
	Turnover	Others	Total	Staff cost	Chemical	Electrical	Others	Total	
2007/ 2008	28,140,759	44,246	28,185,005	8,357,122	1,001,087	3,427,133	9,514,811*	22,300,153	5,884,852
2008/ 2009	46,433,728	204,904	46,638,632	21,207,009	1,670,221	7,078,517	7,887,402	37,843,149	8,795,483
2009/ 2010	45,622,751	382,322	46,005,073	20,531,510	1,727,266	9,641,212	11,683,850	43,583,838	2,421,235

*: Exclusive of payment for National Pension Scheme Authority 29,274,196 thousand ZMK

The table below shows the transition of the KWSC budget which grows every year with an income increase through the executed project for distribution meter installation. Budget growth each year is higher than 4,080,165 thousand ZMK, which is the increased O&M cost after the project. In consideration with the water supply cost reduction and increasing income from the distribution meter installation, KWCS's financial situation will be expected to improve after the project. Due to these reason, it is judged that KWSC is able to secure the increased budget for the said repair cost of the maintenance.

Table 2-5-4 Changes in KWSC's Annual Budget (Unit: 1,000 ZMK)

Item	2007/2008	2008/2009	2009/2010	2010/2011
Transition of KWSC budget	27,395,524	44,293,685	58,634,953	71,379,415
Increased amount	-	16,898,161	14,341,268	12,744,462

(KWSC Finance Section)

2-6 Other Relevant Issues

(1) Application and Approval of Land Use

The document of comprehensive approval on land utilization for construction work of this project was issued on November 8th, 2011 by Ndola municipality to KWSC. With regarding to this matter, it is necessary that KWSC and the consultant confirm the details of each location and document them through the detailed design study to the time of approval of the contractor's construction plan on the implementation stage. The following are the required land and matters to be dealt with:

1) Approval for laying pipe under the road before the tender stage of the project.
2) Construction permit and agreement with the RDC for each water kiosk.
3) Permission to use the required lands for stocking pipe materials and spoil bank.
4) Ensure an existing stocking yard for the removed equipment / materials.

(2) Relocation of underground cables and pipes.

The following procedures are planned for the relocation of underground properties:

1) The KWSC will collect and provide data/information about the underground wirings and pipes (Electric lines, telephone cables, water distribution pipes, sewerage pipes, drainage culverts, etc.) existing on the alignment of the planned pipe laying, before the detailed design stage.
2) The consultant will excavate the crossing points of planned pipeline and the existing underground materials, during the detailed design stage.
3) The KWSC will coordinate the relocation plan with concerned authorities/proprietors and complete the relocation work before commencement of the construction.

(3) Effluent Processing at Kafubu Water Treatment Plant

1) The KWSC will set a drainage pond and a sun-drying yard for sludge disposal handling on the grounds of Kafubu water treatment plant.

Chapter 3 Project Evaluation

Chapter 3 Project Evaluation

3-1 Recommendation

3-1-1 Pre-conditions for Project Implementation

(1) Approval on Land Utilization

Construction work in this project consists of major 4 components: renovation of the water treatment plant is done in the existing plant area; pipeline is laid under the public roads; kiosks are built on public land: and water quality analyzer is installed in the existing laboratory. Accordingly, no forcible expropriation of land or dislocation will occur. The comprehensive approval on land utilization for construction work of this project was already issued by Ndola municipality and it is required to specify the detail of each location as described on "2-6 (1) Application and Approval of Land Use".

(2) Construction Authorizations

In Kafubu, the water treatment plant (WTP) is in the KWSC's possession, where construction authorization is not required for repair this WTP. However, regarding the handling of power utilities, coordination with ZESCO, which manages adjacent substation, is necessary. Pipeline work needs confirmation of underground materials. KWSC provides the information on the buried cables and conduits of power, telephones and others. Test pit excavation is done during the detailed design stage and the KWSC manages the required relocation work under proper coordination with relevant administrators so as to complete the relocation work before the commencement of the pipeline work. Also, the KWSC takes counsel from Ndola municipality, road administrators and traffic police.

(3) Other obligations required of Zambia

Other obligations on the project are shown below (refer to Article 2-2-4-3, 2-3, 2-6).

Classification	Obligations and Responsibilities of Zambia
Kafubu Water Treatment Plant	* To provide stocking yard for removed equipment/materials * To prepare drainage pond and sun-drying yard * To alert citizens of water stoppage due to construction work

Classification	Obligations and Responsibilities of Zambia
Pipline Work	* To secure lands and road occupation for pipe laying * To secure spoil bank and lands for pipe materials * To provide the materials of underground articles and relocation work * To coordinate with traffic police * To provide water for leakage test and washing inside pipes
Kaloko Area	* Decide on a construction location and secure its lands up to the commencement of construction * Coordination with the RDC
Kanini Laboratory	* Secure an electricity source * Rack/table for equipment installation

3-1-2 Important Assumptions for Attainment of Overall Project Plan

(1) Issues to be addressed by the involved Zambian parties

Challenges by Zambian side for the expression and lasting of the project effects are the following.

1) Kafubu Water Treatment Plant

As described in “2-2-4-8 Soft Component (Technical Assistance) Plan”, it is important to establish an operation and control system of flocculants dosing to ensure the water quality of the treated water in the Kafubu WTP. Also, managing operating hours of intake pumps and lifting pumps in accordance with water demand is necessary to cut off the ineffective/unused water amount and reduce water supply cost and to continue total maintenance for both existing and newly repaired facilities as needed. For these issues, it would be effective to develop a system of maintenance and inspection, as well as repairing troubling equipment and documenting the work history in each field of civil, architectural, mechanical and electric engineering. Also, speedy repair of the roof, windows, and doors of facilities are to be launched early to prevent further deterioration of equipment and allow improvement in the operating environment.

2) Pipeline

It has been said that another leakage occurred on the existing distribution pipeline branched from the main pipeline that will be renewed in this project. Because water pressure in the pipe will increase after the project, continued supervision and the detection and repair of leakage points are important. Flow integrators are installed on the pipeline through this project. It’s necessary to improve the collection of flow data and conduct periodical monitoring with

these measuring devices. Moreover, the project should follow through with analysis of the obtained data and specifying pipeline route, which has much of the leakage, planning of pipeline network renovation in medium to long term, followed by progressively replacing the deteriorated pipeline route. These deliberate measures are effective for leakage reduction. For these renovation plans and implementation, it is preferable to computerize the drawings of the pipeline in terms of the whole city and revise those drawings according to the replacement, so as to keep proper asset management and tracking for the pipeline property.

3) Water Quality Analysis

With this project, gas chromatograph for analysis of organic agrochemicals and accessory equipments of atomic absorption spectrometer for detection of heavy metals such as mercury and arsenic, which cannot be detected with the existing equipment, will be installed. To utilize this newly introduced equipment for water quality analysis of water sources, a continuous budget is needed to purchase the reagent, the carrier gas and other consumables. Adding to the technical learning on operation and maintenance of the equipment, it is necessary to make use of the work manual and guidelines on planning of water quality for monitoring and utilization of analyzed data and so on. Furthermore, efforts for water conservation, such as administrative guidance to offices and firms that discharge water exceeding effluent standard to public water body and activities for reduction of pesticide use in the whole area, should be done.

4) Support for Management of Kiosks by Resident Organization

Through this project, water kiosks are built in the Kaloko area that is categorized as peri-urban. The project effects on water kiosks become sustained under the conditions that CU and municipality support the resident organization’s activities. For example, training of a water vender who is selected within the community and manages the water kiosk proficiently is a step toward self sufficiency, along with hygienic education for the habitants. Regarding support on each process in the flow from construction to kiosk management, the method based on the Tool Kit as a guideline issued by the DTF is applied. KWSC has conducted some kiosk projects with the support of the DTF in the past. It is necessary that KWSC staff acquire the managing methods and the KWSC project management improves proactively. These developments ensure the expansion and sustainability of the project effects far ahead into the future.

5) Succession of KWSC Staff

To approach the above different described issues, there are preconditions that the skilled technical staff in charge of each specialized field continue their job, so that expertise and experience is succeeded and integrated into the KWSC. Currently KWSC has introduced a reward system for CU (RBI: Reguration By Incentive) devised by the NWASCO, which has

increased awareness among workplaces and individuals for the target achievement through the routine work. Utilizing these institutions and incentives and maintaining the technical level and heightened consciousness are the challenges for the futures.

(2) Important Assumptions for Sustention of Effects.

For the project to be implemented according to the plan, the followings are necessary:

- Fluctuating or increasing prices beyond the assumption does not occur during the project period.
- Labor and materials can be procured as scheduled.

For the stable operation of the repaired water supply system after the project, the followings are required:

- Stable supply of power that lasts for long duration.
- Cheap yet acceptable quality of chemicals (flocculent and chlorine gas) needed for water purification are supplied steadily.
- Climate change affecting quality and quantity of raw water does not occur, such as prolonged rainy seasons or drought.
- Raw water does not become contaminated by pollution, such as infiltration of residual agrochemicals from the soil or inflow of harmful industrial effluent.

(3) Supplements from other Projects

The improvement of water supply conditions in the project target area caused by the increase of treated water amount and reduction of leakage through the project is the main effect of the project's implementation. Adding to this, supplemental effects from the following other projects are expected:

- Water meter installation on each house with DTF assistance improves the profitability delegated as the index of "accounted for water as percent of total". This can make the management of KWSC all the more stable and enable sustainable operation of the water supply facilities.
- With the implementation of DANIDA's loan project of repair and functional enhancement of sewerage facilities in Ndola, which is proceeding around the same time as Japan's

project for water supply improvement, improvement of the raw water quality and reduction of water treatment cost are expected.

- Also, in view of forwarding the improvement on both water supply and sewerage as a simultaneous unit, it is expected that the improvement of sewerage by the DANIDA's project makes a certain effect against the increase of wastewater from houses in the target area of Japan's project which improves the water supply condition.
- Moreover, the effect of this project on water kiosks is ensured through the utilization of project experience and examples of preceding projects done by GIZ and other cooperating partners, concerning the method of resident participation on the operation and management of water kiosks.

3-2 Project Evaluation

3-2-1 Relevance of the Project

Based on the results of the preparatory survey, the implementation of this project is validated with cooperation by the Japan's grant aid in view of the following aspects:

i. This project deals with the high demand for water supply in the third largest city in Zambia. Estimated population of the beneficiary in 2020 is 354,000 persons and the target area includes low income areas and areas where the poor are living and facing water supply difficulty.

ii. The goal of this project is improve the water supply conditions in Ndola. The project enables the expansion of access to safe water in the target area, in order to fulfill Basic Human Needs (BHN) among the inhabitants. Improvement of hygienic conditions and the alleviation of daily water fetching tasks via the successful completion of the project will significantly contribute to the improvement of quality of life.

iii. This project mainly involves the renovation of the existing facilities where overly high level technology is not required. The large structural changes from the existing WTP or pipelines are not planned. Even for the newly introduced systems and equipment, appropriate O&M of the facilities is possible to carry out with the present staff, technical level, and the budget of the KWSC, by implementing of the technical assistance on each new system through the project. As described above, it is expected that the reduction of

leakage through the project enables the KWSC to stabilize their business management and can afford the improvement of O&M more thoroughly.

iv. In the policy on water supply and sanitation in the SNDP of Zambia (2011-2015), “development of safe water and sustainable water supply for the cities and surrounding peri-urban areas” is cited as one of seven key strategies. The implementation of the renovation project of water supply facilities in more than 10 cities is cited as the target by 2014. Also, in the NUWSSP, measures for reduction of leakage and rehabilitation of the existing urban water supply facilities is set as issues to be addressed from 2009 to 2015. This project is consistent with these national development plans.

v. This project is a public works project in Ndola and is not a high profitable activity with commercial capital. Although the increase of revenue by collecting water tariffs is expected after the improvement of water supply conditions in the project area, this profit is allocated to the personnel cost of KWSC, facilities operation and repair costs, and accumulation for future renovations, so that KWSC can make their business management more stable.

vi. The main component of this project is to repair the existing facilities, which does not affect the lives, agriculture and fishery of residents living in the vicinity of the facilities. Adverse impacts to the environment and social conditions through the project implementation such as resettlement, community severance, damage of archaeological sites or cultural assets, are not expected. It is possible that some issues occurring in the construction period, such as traffic safety, vibration, and waste of soil to be mitigated with appropriate measures.

vii. The construction work of this project consists of general civil constructions and engineering works in a water treatment plant. Japanese contractors can conduct these works alongside local contractors under supervision of a Japanese engineer. Materials and construction machinery are planned to be procured from Zambia, Japan, and other countries such as South Africa without difficulties.

viii. Considering the existing deteriorated facilities, it is necessary to use Japanese technology, which has advantages such as industrial strength, durability, and recognizable high quality.

3-2-2 Effectiveness of the Project

The following effects are expected due to the improvement of water supply facilities in

Ndola after the completion of this project:

(1) Quantitative Effects

Indicators	Baseline (2010)	Target (2020)
Water supplied population, in Kaloko area and Upper Mushili area suffering from inadequate (at present) water supply conditions.	17,400 persons	45,000 * persons
Water supplied hours, in the area that water distributed through the pipeline to be repaired in this project	12 hours per day	18 hours per day

* : 42,600 persons in 2016, three years after the completion of the project (at the time of ex-post evaluation)

(2) Qualitative Effects

- Health conditions improve and affected cases of water borne diseases decrease in the area where accessibility to the safe water increases.
- Household task of manually obtaining and carrying water by children and women in the area of inadequate (at present) water supply is alleviated.
- Traffic safety improves due to the reduction of floodwater on the main road caused by leakage, fetching water work at the leakage points along the main road, and repair work for leaking pipe under the main road.

As stated above, this project contributes to the improvement of Ndola's citizens, prioritizes their healthy and hygienic lives, and also has a relevance of Japan's Grant Aid. Moreover, organization and system of Zambia in terms of operation and maintenance of the relevant facilities after the project implementation becomes steady and stable in both the personal and financial aspects. Therefore, this project has a high degree of relevance and an evident level of effectiveness.

Appendices

Appendix-1 Member List of the Study Team

1-1 Members of the Outline Study Team

Name	Job Title	Organization
Mr. Shiro Nabeya	Team Leader	Chief Representative, Zambia Office, Japan International Cooperation Agency (JICA)
Ms. Junko Uno	Project Officer (Planning Management)	Assistant Director, Water Resources Management Division 2, Water Resources and Disaster Management Group, Global Environment Department, Japan International Cooperation Agency (JICA)
Mr. Toru Takahashi	Chief Engineer / Water Supply and Sewerage Planning	Manager, Project Operation Division No.2, International Department, Sanyu Consultants Inc.
Mr. Yoshiji Sakemoto	Water Treatment Design / Water Quality	Advisor, Project Operation Division No.2, International Department, Sanyu Consultants Inc.
Mr. Kazunori Takasaki	Pump Station Planning	Senior Engineer, Project Operation Division No.2, International Department, Sanyu Consultants Inc.
Mr. Tsuneyoshi Ogiso	Pipeline Design	Senior Engineer, Project Operation Division No.2, International Department, Sanyu Consultants Inc.
Mr. Kozo Fujiwara	Electric System Design	Senior Engineer, Project Operation Division No.2, International Department, Sanyu Consultants Inc.
Mr. Takayuki Oishi	Operation and Maintenance Planning / Environment and Social Consideration	Engineer, Project Operation Division No.2, International Department, Sanyu Consultants Inc.
Mr. Masayoshi Miura	Cost Estimation / Procurement・Construction Planning	Advisor, Project Operation Division No.2, International Department, Sanyu Consultants Inc.

1-2 Members of the Explanation on Draft Outline Design Study

Name	Job Title	Organization
Mr. Junji Wakui	Team Leader	Director, Water Resources Management Division 2, Water Resources and Disaster Management Group, Global Environment Department, Japan International Cooperation Agency (JICA)
Mr. Takanori Obayashi	Project Officer (Planning Management)	Officer, Grant Aid Project Management Division 3, Financing Facilitation and Procurement Supervision Department, Japan International Cooperation Agency (JICA)
Mr. Toru Takahashi	Chief Engineer / Water Supply and Sewerage Planning	Manager, Project Operation Division No.2, International Department, Sanyu Consultants Inc.
Mr. Yoshiji Sakemoto	Water Treatment Design / Water Quality	Advisor, Project Operation Division No.2, International Department, Sanyu Consultants Inc.

Appendix-2 Study Schedule

2-1 Schedule of Outline Design Study

No.	Date		JICA	JICA	Consultant	Consultant	Consultant	Consultant	Consultant	Consultant	Consultant
			Team Leader	Project Management	Chief Engineer / Water Supply and Sewerage Planning	Water Treatment Plant Design / Water Quality	Pump Station Planning	Pipeline Design	Electric System Design	Operation and Maintenance Planning / Environment and Social Consideration	Cost Estimation / Procurement・Construction Planning
			Shiro NABEYA	Junko UNO	Toru TAKAHASHI	Yoshiji SAKAMOTO	Kazunori TAKASAKI	Tsuneyoshi OGISO	Kozo FUJIWARA	Takayuki OISHI	Masayoshi MIURA
1	17th August	Tue		Trip (Narita - Singapore)	Trip (Narita - Hong Kong)						
2	18th August	Wed		Trip (Johannesburg - Lusaka) Meeting at JICA							
3	19th August	Thu	Courtesy Call to EOJ, MLGH, MFNP	Courtesy Call to EOJ, MLGH, MFNP Meeting with DANIDA, GTZ							
4	20th August	Fri		Trip（Lusaka - Ndola） Meeting at KWSC Site Survey at, Kafubu Dam, Kafubu WTP, Nakaputa Reservoir							
5	21st August	Sat		Site Survey at Mushili Area, Kaloko Area, Skyways Reservoir, Dambo Sewerage Pump Station, New Kanini Sewage Works, Northrise Reservoir Internal Meeting							
6	22nd August	Sun		Reporting of Site Survey Drafting draft M/D							Trip (Narita - Hong Kong)
7	23rd August	Mon		Discussion with KWSC, Courtesy Call to Ndola City Council Trip（Ndola - Lusaka）	Discussion with KWSC Courtesy Call to Ndola	Discussion with KWSC Courtesy Call to Ndola	Discussion with KWSC Courtesy Call to Ndola Trip（Ndola - Lusaka）	Discussion with KWSC Courtesy Call to Ndola	Discussion with KWSC Courtesy Call to Ndola	Discussion with KWSC Courtesy Call to Ndola	Trip (Johannesburg - Lusaka)
8	24th August	Tue	Discussion on M/D with MLGH, KWSC	Discussion with Water Aid Draft M/D Discussion with MLGH, KWSC	Site Survey at Kafubu WTP	Site Survey at Kafubu WTP	Discussion with Water Aid, MLGH, KWSC	Site Survey at Kafubu WTP	Survey on the Environmental Issues	Discussion with Water Aid, MLGH, KWSC	
9	25th August	Wed	Sign M/D	Discussion with DTF Sign M/D	Site Survey at Kafubu WTP	Site Survey at Kafubu WTP	Discussion with DTF Sign M/D	Site Survey at Kafubu WTP	Survey on the Environmental Issues	Survey on Cost Estimation	
10	26th August	Thu	Report to EOJ	Visiting Project in Lusaka Report to EOJ	Site Survey at Kafubu WTP	Site Survey at Kafubu WTP	Visiting Project in Lusaka Report to EOJ	Site Survey at Kafubu WTP	Survey on the Environmental Issues	Trip（Lusaka - Ndola）	
11	27th August	Fri		Trip (Lusaka - Johannesburg)	Arrangement of Social Survey	Site Survey at Kafubu WTP	Site Survey at Kafubu WTP	Arrangement of Topo&Soil Survey	Site Survey at Kafubu WTP	Survey on the Environmental Issues	Survey on Construction Planning
12	28th August	Sat		Trip (Singapore - Narita)	Trip（Lusaka - Ndola）	Site Survey at Kafubu WTP	Site Survey at Kafubu WTP	Trip（Lusaka - Ndola）	Site Survey at Kafubu WTP	Survey on the Environmental Issues	Survey on Construction Planning
13	29th August	Sun			Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials
14	30th August	Mon			Survey on Basic Plan of Water Supply and Sewerage in Ndola	Site Survey at Kafubu WTP	Survey on Pipeline Route	Survey on Pipeline Route	Site Survey at Kafubu WTP	Survey on O&M	Survey on Construction Planning
15	31st August	Tue			Survey on Basic Plan of Water Supply and Sewerage in Ndola	Site Survey at Kafubu WTP	Survey on Pipeline Route	Survey on Pipeline Route	Site Survey at Kafubu WTP	Survey on O&M	Survey on Construction Planning
16	1st September	Wed			Survey on Basic Plan of Water Supply and Sewerage in Ndola	Site Survey at Kafubu WTP	Survey on Pipeline Route	Survey on Pipeline Route	Site Survey at Kafubu WTP	Survey on O&M	Survey on Construction Planning
17	2nd September	Thu			Survey on Basic Plan of Water Supply and Sewerage in Ndola	Site Survey at Kafubu WTP	Survey on Pipeline Route	Survey on Pipeline Route	Site Survey at Kafubu WTP	Survey on O&M	Survey on Construction Planning
18	3rd September	Fri			Survey on Basic Plan of Water Supply and Sewerage in Ndola	Site Survey at Kafubu WTP	Survey on Pipeline Route	Survey on Pipeline Route	Site Survey at Kafubu WTP	Survey on O&M	Survey on Construction Planning
19	4th September	Sat			Survey on Basic Plan of Water Supply and Sewerage in Ndola	Site Survey at Kafubu WTP	Survey on Pipeline Route	Survey on Pipeline Route	Site Survey at Kafubu WTP	Survey on O&M	Survey on Construction Planning
20	5th September	Sun			Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials
21	6th September	Mon			Discussion with KWSC	Discussion with KWSC	Discussion with KWSC	Discussion with KWSC	Discussion with KWSC	Discussion with KWSC	Discussion with KWSC
22	7th September	Tue			Survey on Water Source of Kafubu WTP	Site Survey at Kafubu WTP	Site Survey at Kafubu WTP	Survey in Mushili Area, Kaloko Area	Site Survey at Kafubu WTP	Survey on O&M	Survey on Cost Estimation
23	8th September	Wed			Survey on Water Source of Kafubu WTP	Site Survey at Kafubu WTP	Site Survey at Kafubu WTP	Survey in Mushili Area, Kaloko Area	Site Survey at Kafubu WTP	Survey on O&M	Survey on Cost Estimation
24	9th September	Thu			Survey on Technical Assistance	Site Survey at Kafubu WTP	Site Survey at Kafubu WTP	Survey in Mushili Area, Kaloko Area	Site Survey at Kafubu WTP	Survey on O&M	Survey on Cost Estimation
25	10th September	Fri			Survey on Technical Assistance	Site Survey at Kafubu WTP	Site Survey at Kafubu WTP	Survey in Mushili Area, Kaloko Area	Site Survey at Kafubu WTP	Survey on O&M	Survey on Cost Estimation
26	11th September	Sat			Survey on Technical Assistance	Site Survey at Kafubu WTP	Site Survey at Kafubu WTP	Survey in Mushili Area, Kaloko Area	Site Survey at Kafubu WTP	Survey on O&M	Survey on Cost Estimation
27	12th September	Sun			Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials	Arranging the collected materials
28	13th September	Mon			Survey on Sewerage Planning	Survey on Laboratory Equipment	Survey at Dambo Sewerage Pump Station	Survey on Flow Meter	Survey at Dambo Sewerage Pump Station	Survey on the Environmental Issues	Survey on Cost Estimation
29	14th September	Tue			Survey on Sewerage Planning	Survey on Laboratory Equipment	Survey at Dambo Sewerage Pump Station	Survey on Flow Meter	Survey at Dambo Sewerage Pump Station	Survey on the Environmental Issues	Survey on Cost Estimation
30	15th September	Wed			Survey on Sewerage Planning	Survey on Laboratory Equipment	Survey at Dambo Sewerage Pump Station	Survey on Flow Meter	Survey at Dambo Sewerage Pump Station	Survey on the Environmental Issues	Survey on Cost Estimation
31	16th September	Thu			Report to KWSC	Report to KWSC	Report to KWSC	Report to KWSC	Report to KWSC	Report to KWSC	Report to KWSC
32	17th September	Fri			Trip（Ndola - Lusaka）	Trip（Ndola - Lusaka）	Trip（Ndola - Lusaka）	Trip（Ndola - Lusaka）	Trip（Ndola - Lusaka）	Trip（Ndola - Lusaka）	Trip（Ndola - Lusaka）
33	18th September	Sat			Meeting with Topo Survey and other Companies	Trip (Lusaka - Johannesburg)	Meeting with Topo Survey and other Companies	Meeting with Topo Survey and other Companies	Trip (Lusaka - Johannesburg)	Survey on the Environmental Issues	Survey on Cost Estimation
34	19th September	Sun			Arranging the collected materials	Trip (Hong Kong - Narita)	Arranging the collected materials	Arranging the collected materials	Trip (Hong Kong - Narita)	Arranging the collected materials	Arranging the collected materials
35	20th September	Mon			Meeting with Topo Survey and other Companies		Meeting with Topo Survey and other Companies	Meeting with Topo Survey and other Companies		Survey on the Environmental Issues	Survey on Cost Estimation
36	21st September	Tue			Preparation for Report		Preparation for Report	Preparation for Report		Preparation for Report	Preparation for Report
37	22nd September	Wed			Preparation for Report		Preparation for Report	Preparation for Report		Preparation for Report	Preparation for Report
38	23rd September	Thu			Report to JICA		Trip (Lusaka - Johannesburg)	Report to JICA		Report to JICA	Report to JICA
39	24th September	Fri			Trip (Lusaka - Johannesburg)		Trip (Hong Kong - Narita)	Trip (Lusaka - Johannesburg)		Trip (Lusaka - Johannesburg)	Trip (Lusaka - Johannesburg)
40	25th September	Sat			Trip (Hong Kong - Narita)			Trip (Hong Kong - Narita)		Trip (Hong Kong - Narita)	Trip (Hong Kong - Narita)

EOJ: Embassy of Japan, MLGH: Ministry of Local Government and Housing, MFNP: Ministry of Finance and National Planning, KWSC: Kafubu Water Supply and Sewerage Company, DTF: Devolution Trust Fund

2-2 Schedule of Explanation on Draft Outline Design Study

No.	Date		JICA	JICA	Consultant	Consultant
			Team Leader	Project Management	Chief Engineer / Water Supply and Sewerage Planning	Water Treatment Plant Design / Water Quality
			Junji WAKUI	Takanori OBAYASHI	Toru TAKAHASHI	Yoshiji SAKAMOTO
1	6-Feb	Sun	Trip (Narita - Hong Kong -)		Trip (Narita - Singapore -)	
2	7-Feb	Mon	Trip (- Johannesburg - Lusaka) Meeting at JICA, Meeting at DANIDA			
3	8-Feb	Tue	Trip（Lusaka －Ndola） Explanation of Outline Design and Meeting on Minutes of Discussion at KWSC			
4	9-Feb	Wed	Site Survey at Kafubu Water Treatment Plant Meeting on Minutes of Discussion at KWSC			
5	10-Feb	Thu	Trip（Ndola －Lusaka） Report to Embassy of Japan, Report to JICA			
6	11-Feb	Fri	Signature on Minutes of Discussion	Final Meeting and Signature on Minutes of Discussion		
7	12-Feb	Sat	Courtesy Call at Lusaka Water Supply and Sewerage Company、Visit to George Compound		Site Survey at Lusaka Water Treatment Plant	
8	13-Feb	Sun	Trip（Lusaka －Nairobi）	Trip（Lusaka －Johannesburg －）	Arranging the Collected Materials	
9	14-Feb	Mon		Trip（－ Hong Kong － Narita）	Trip（Lusaka －J Johannesburg －）	
10	15-Feb	Tue			Trip（－ Singapore － Narita）	

MLGH: Ministry of Local Government and Housing　MFNP: Ministry of Finance and National Planning　KWSC: Kafubu Water Supply and Sewerage Company　DTF: Devolution Trust Fund

Appendix-3 List of Parties Concerned

No.	Name	Organization
Ministry of Finance and National Planning (MFNP)		
1	Mr. Justin C. Mubanga	Director, Economic Management Department
2	Mr. Paul Lupunga	Chief Economist, Economic Management Department
Ministry of Local Government and Housing (MLGH)		
1	Mr. Timothy Hakuyu	Permanent Secretary
2	Mr. Nkumbu Siame	Acting Director, Department of Housing & Infrastructure Development
3	Mr. Douglas Singanga	Senior Engineer Other Services, Department of Housing & Infrastructure Development
4	Mr. Mweelwa Muleya	Communication Specialist, Department of Housing & Infrastructure Development
National Water Supply and Sanitation Council (NWASCO)		
1	Mr. Kelvin Chitumbo	Director
Kafubu Water Supply and Sewerage Company (KWSC)		
1	Mr. Ian Nzali Banda	Managing Director
2	Mr. A. K. Mwaba	Director, Planning and Development
3	Mr. Billima Paul	Manager, Planning
5	Mr. Rabson Ngulube	Head Peri-Urban
6	Mr. Kabimba Nyirenda	Director, Engineering
7	Mr. Dennis Kapoya	Manager, Water Distribution
8	Mr. Benson J Mwale	Manager, Technical Service
9	Mr. Jeconiah Sichone	Manager, Electric
10	Mr. Bernard Phiri	Sewerage Engineer
11	Ms. Monica M Mwichg	Chemist
12	Mr. Austin Kayanda	Director, Customer Service
13	Ms. Margaret Zulu	Public Relations Office
Devolution Trust Fund (DTF) (Water and Sanitation to the Urban Poor)		
1	Mr. Victor Muyeba	Socio-Economist
2	Mr. Jacson Mulenga	Engineer, Water Supply and Sanitation
German Technical Cooperation (GTZ)		
1	Mr. Eberhard Goll	Programme Manager, Lusaka Office
Danish International Development Agency (DANIDA)		
1	Mr. Peter Sievers	Counsellor, Development, Royal Danish Embassy
2	Mr. Jorgen Bygvraa Hansen	Grontmij | Carl Bro aktieselskab (A/S) (Danish consultant)
Environmental Council of Zambia (ECZ)		
1	Mr. Joseph Ngwira	Acting Senior Inspector-EIA, Ndola office
Embassy of Japan in Zambia		
1	Mr. Akio Egawa	Ambassador
2	Mr. Toshihiko Horiuchi	Minister-Counsellor
3	Mr. Kaoru Tsurita	Counsellor
4	Mr. Junichi Kubo	Secretary (Economic Cooperation)
Japan International Cooperation Agency (JICA) Zambia Office		
1	Mr. Shiro Nabeya	Chief Representative
2	Ms. Miku Okada	Assistant Resident Representative

MINUTES OF DISCUSSIONS
ON
THE SECOND PREPARATORY SURVEY
ON
THE PROJECT FOR THE IMPROVEMENT OF
WATER SUPPLY AND SANITATION CONDITION IN NDOLA CITY
IN
THE REPUBLIC OF ZAMBIA

In response to a request from the Government of the Republic of Zambia (hereinafter referred to as "Zambia"), the Government of Japan decided to conduct the Second Preparatory Survey on the Project for the Improvement of Water Supply and Sanitation Condition in Ndola City (hereinafter referred to as "the Project") and entrusted the study to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Zambia the Second Preparatory Survey Team (hereinafter referred to as "the Team"), which is headed by Mr. Shiro Nabeya, the Chief Representative of JICA Zambia Office, and is scheduled to stay in the country from 18th August to 24th September, 2010.

The Team held a series of discussions with officials concerned of Zambia and conducted a field survey in the study area. In the course of discussions and field survey, both parties have confirmed the main items described in the attached sheets. The team will proceed with further works and prepare the Outline Design Study Report.

Lusaka, 25th August, 2010

Mr. Shiro Nabeya
Leader
Second Preparatory Survey Team
Japan International Cooperation Agency

Mr. Peter Lubambo
Acting Permanent Secretary
Ministry of Local Government and Housing
Government of the Republic of Zambia

ATTACHMENT

1. Reconfirmation of the previous Minutes of Discussions

The Minutes of Discussions (M/D) signed on 23rd of April, 2010, by the Permanent Secretary of the Ministry of Local Government and Housing representing the Government of Zambia and the leader of the First Preparatory Survey Team was reviewed, and both sides confirmed the contents of the M/D were relevant, except for the modification made on Annex-3 of the M/D (Items requested by the Zambian side).

2. Schedule of the Study

2-1 The consultant members of the Team will undertake further in-depth studies in Zambia until 24th of September, 2010.

2-2 JICA will prepare a draft report of the survey in English and explain its contents in the middle of February, 2011.

2-3 In case the contents of the draft report are accepted in principle by the Government of Zambia, JICA will complete the final report and send it to the Government of Zambia in June, 2011.

3. Other Relevant Issues

3-1 Scope of the Project

Both sides confirmed that the scope of the Project is to recover the original capacity of safe water supply at Kafubu Water Treatment Plant and to increase supply hours and number of people to be served.

3-2 Items requested by the Zambian side

As a result of the discussions and the site visit, both sides agreed that the requested items of the Project and priorities of the Zambian side were revised from the previous Minutes of Discussions and are as shown in Annex-1 and Annex-2.

Both sides also agreed that the final scope of works (including quantities) of the Project would be decided after the analysis in Japan in accordance with appropriateness under Japan's Grant Aid and budget allocation to the Project by the Government of Japan.
In case further prioritaization would be necessary, the main criteria to consider priority among the items shall be as follows ;

a. Number of beneficiary population
b. Urgency (level of distress for water supply)
c. Level of deterioration of the facilities

3-3 Locations for water kiosks at Kaloko Area

The Zambian side submitted the list of six candidate locations for the water kiosks to be constructed in the Project, which were decided upon with the consent of the beneficiary communities as Annex-3.
To avoid any unnecessary dispute in future on land use, Kafubu Water and Sewerage Company Limited (KWSC) will facilitate related authorities and communities to prepare

documentation on the confirmation of land use for each water kiosk, and submit a copy of them to JICA Zambia Office on or before 12th Januay, 2011.

3-4 Permission for land use related to the Project

The Team requested the Zambian side to obtain permission for land use related to the Project from the authorities concerned and submit a copy of the permission to JICA Zambia Office on or before 12th January, 2011.

3-5 Environmental and Social Considerations

KWSC prepared a draft Environmental Project Brief (EPB) of the Project and is going to submit to Environmental Council of Zambia (ECZ) by the end of August, 2010, for ECZ's examination and decision. After submission of the EPB, a decision letter on the Project shall be issued by ECZ.

The Team explained that necessary approval on environmental impact assessment was a prerequisite for dispatch of the next study team scheduled in the middle of February, 2011. The Zambian side agreed that KWSC was responsible for environmental impact assessment and would report the completion of the necessary procedure of it to JICA Zambia Office on or before 12th January, 2011.

3-6 Coordination with the other interventions

The Team had a discussion with DANIDA to exchange information, avoid duplication and acheive synergy on support to KWSC by DANIDA and JICA. The Team also had a discussion with GTZ to align with its support to Devolution Trust Fund (DTF), regarding set-up, operation and management of water kiosks.

The Government of Zambia will assist KWSC to coordinate the various cooperating partners and ensure that any interventions will not duplicate each other but being well coordinated.

3-7 Operation and Maintenance of the Facilities

The Zambian side reassured of proper operation and maintenance of the facilities to be constructed and/or rehabilitated by the Project. Especially, solid financial status is essencial for sustainability and KWSC and the Team will discuss further on the issue including proper tariff application, collection and sufficient budget allocation. The result of the further study will be incorporated into the draft outline report.

3-8 'Soft-component' and technical assistance programme

The Zambian side requested technical assistance on the 'soft-component' of the Project which includes operation and maintenance of the facilities to be constructed and/or rehabilitated by the Project. The Team will convey the request to Japan.

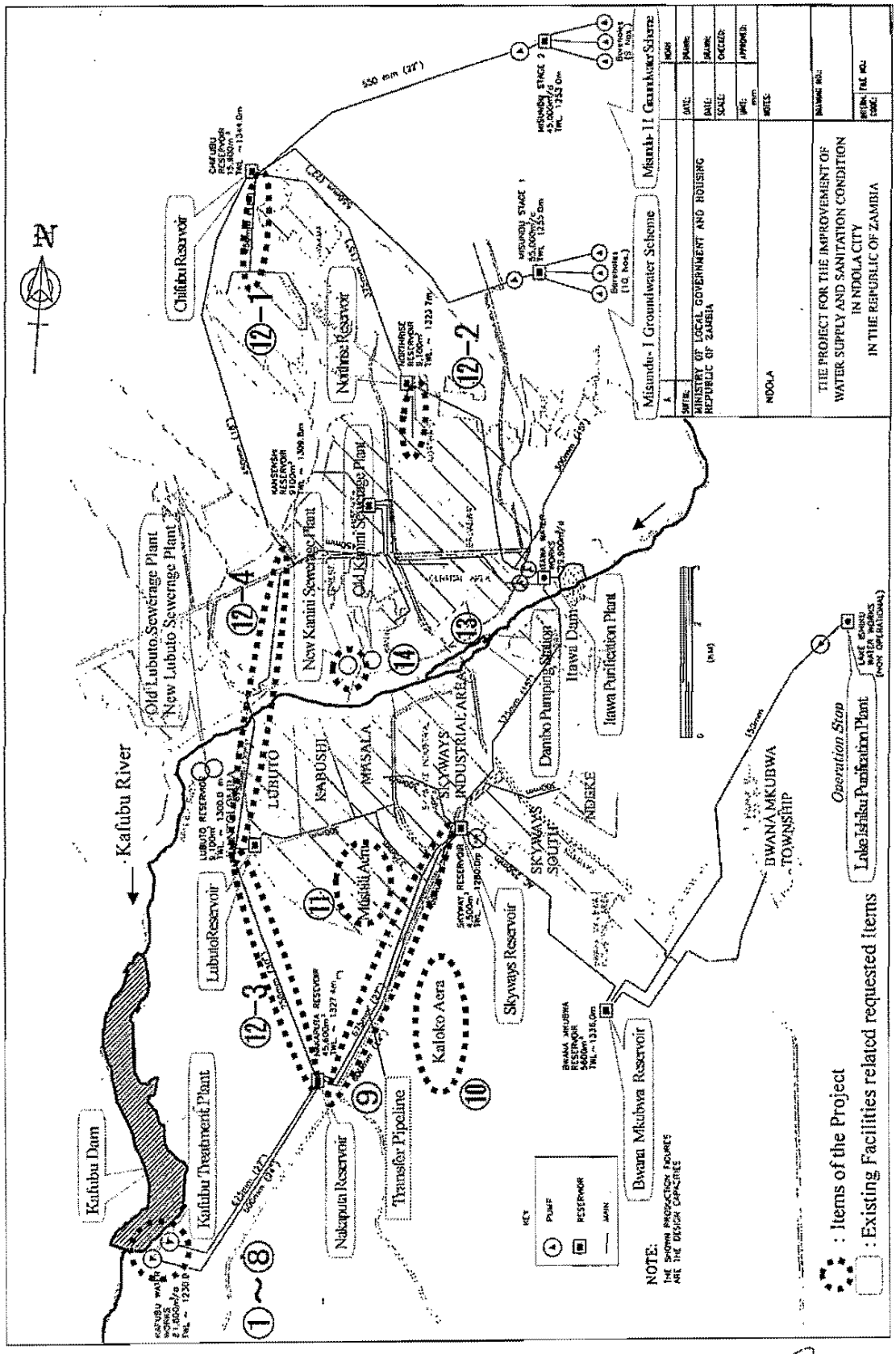
END

Annex-1

Items requested by the Zambian side

No.	Priority by Zambian Side	Description
①	1	Replacement of 7 nos of intake pumps and related facilities at Kafubu WTP
②	1	Replacement of 1 set of chemical dosing system at Kafubu WTP
③	1	Replacement of 180 nos sedimentation tank channels at Kafubu WTP
④	1	Replacement of 600 m3 filter sand at Kafubu WTP
⑤	1	Replacement of filter nozzles at Kafubu WTP
⑥	1	Replacement of back-wash facilities for filter at Kafubu WTP
⑦	1	Replacement of 7 nos of lifting pumps and related facilities at Kafubu WTP
⑧	1	Necessary minor repairs at Kafubu WTP (e.g. leakage at plant facilities)
⑨	1	Installation of 900 mm×8 km transfer pipeline and accessaries from Nakaputa reservoirs
⑩	1	Construction of 6 no. extra water kiosks in the Kaloko area
⑪	2	Installation of main water supply line and accessaries for upper Mushili
⑫-1	2	Installation of 600 mm× 2 km Chifubu concrete type water mains and accessaries
⑫-2	2	Installation of 375 mm× 1.7 km Northrise concrete type water mains and accessaries
⑫-3	3	Installation of 700 mm× 5 km Western ring concrete type water mains from Nakaputa Reservoir to Lubuto Reservoir and accessaries
⑫-4	3	Installation of 700 mm× 7 km Western ring concrete type water mains from Lubuto Reservoir to the end and accessaries
⑬	1	Installation of 4 no. lift pumps and related facilities at Dambo sewage pumping station
⑭	1	Installation of analytical machinery and equipment for the Kanini laboratory
⑮	1	Installation of necessary bulk water meters concerning above request

Annex-2



Proposed Project Sites in Ndola city

5

Annex-3

Candidate Locations for Water Kiosks

No.	Site Location Description
1	Opposite Anglican and New Apostolic Church
2	Free Space between Plot No. 1118 and the road
3	Free Space between the road, Plot No. 1527 and Plot No. 1741
4	Free Space between Plot No. 1982 and the road
5	Free Space between Plot No. 2434 and the road
6	Free Space between Plot No. 2254 and the road

MINUTES OF DISCUSSIONS
ON
THE SECOND PREPARATORY SURVEY
ON
THE PROJECT FOR THE IMPROVEMENT OF
WATER SUPPLY CONDITION IN NDOLA CITY
IN
THE REPUBLIC OF ZAMBIA
(Explanation of Draft Outline Design)

In August 2010, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Second Preparatory Survey Team on the Project for the Improvement of Water Supply Condition in Ndola City (hereinafter referred to as "the Project") to the Republic of Zambia (hereinafter referred to as "Zambia"), and through discussion, field survey and technical examination of the results of the survey in Japan, JICA prepared a Draft Outline Design of the Survey.

In order to explain to and consult with the Government of Zambia regarding the components of the Draft Outline Design, JICA sent to Zambia the Draft Outline Design Explanation Team (hereinafter referred to as "the Team") , which is headed by Mr. Junji Wakui, Director, Water Resources Management Division 2, Global Environment Department, JICA Headquaters, and is scheduled to stay in the country from 7th to 14th February, 2011.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Lusaka, 11th February, 2011

Mr. Junji Wakui
Leader
Draft Outline Design Explanation Team
Japan International Cooperation Agency
(JICA)
Japan

Mr. Timothy Hakuyu
Permanent Secretary
Ministry of Local Government and Housing
(MLGH),
The Republic of Zambia

ATTACHMENT

1. Components of the Draft Outline Design (Draft Preparatory Survey Report)

The Zambian side agreed and accepted in principle the components of the Draft Outline Design (Draft Preparatory Survey Report) explained by the Team.

2. Responsible and Implementing Organization

2-1. The responsible organization is Ministry of Local Government and Housing (hereinafter referred to as "MLGH").

2-2. The implementing organization is the Kafubu Water and Sewerage Company Limited (hereinafter referred to as "KWSC"), Zambia.

3. Japan's Grant Aid Scheme

The Zambian side understood the Japan's Grant Aid Scheme and would take the necessary measures and allocate necessary budget properly for smooth implementation of the Project, as a condition for the Japan's Grant Aid to be implemented. The Grant Aid Scheme and necessary measures were described in the Annex-4, Annex-5 and Annex-6 of the Minutes of Discussions signed by both sides on 23rd April, 2010.

4. Schedule of the Survey

JICA will complete the final report in accordance with the confirmed items and send it to the Government of Zambia by the end of May 2011.

5. Other Relevant Issues

5-1. Project Cost Estimate

The Team explained to the Zambian side the project cost estimate as attached in Annex-1. Both sides confirmed that this cost estimate is provisional and will be examined further by the Government of Japan for its approval as the Grant.

Furthermore, both sides agreed that this project cost estimate should never be duplicated in any form nor released to any other parties until the relevant contracts are awarded by MLGH. This embargo is for securing fairness of tender procedure.

5-2. Necessary Budget to be covered by the Zambian Side

The Japanese side explained necessary project cost to be covered by the Zambian side and necessary operation and maintenance cost as attached in Table-B of Annex-1 and Annex-2.The Zambian side promised to secure necessary budget as attached.

5-3. Undertakings of the Zambian Side

The Zambian side agreed to take the following necessary measures in addition to the general

undertakings mentioned in the above "3. Japan's Grant Aid Scheme";

1) To complete land acquisition required for new pipe laying and construction of water kiosks before the tender stage of the project;
2) To do the liaison and coordination with WDC (Ward Development Committee) on construction of water kiosks ;
3) To provide required land premises for stocking pipe materials and spoil bank and also to secure stocking yard for removed equipment/materials ;
4) To provide data/information about the underground wirings and pipes (electric line, telephone cable, water distribution pipes, sewerage pipes and drainage culverts etc.) existing in the alignment for planned pipe laying before the commencement of the detailed design. Where there are underground wirings and pipes, relocation works shall be completed before the commencement of construction.
5) To inform the local residents and other beneficiaries concerned of the water supply suspension schedule which will be caused by the construction works for the treatment plant and pipe laying under the project, and alternative water supply ;
6) To supply necessary water for pipe leakage test and pipe flushing before use ;
7) To request to the traffic police for their due cooperation during the pipe laying works ;
8) To provide at Kafubu Water Treatment Plant a drainage pond and a sun-drying yard for sludge disposal handling ;
9) To assign necessary counterpart personnel during the project implementation ;
10) To repair the damaged roof, windows, doors and other internal fixtures of the buildings that house the water production and treatment infrastructure at the Kafubu water treatment plant ;
11) To keep appropriate operation and maintenance of the water supply system as per described in Chapter 4 of the Draft Preparatory Survey Report, including new assignment of necessary staff in the Water Production Section and Laboratory Section of KWSC.

5-4. Title of the Project

After technical examination of results of the survey in Japan, the Draft Outline Design did not include sewerage component, therefore the title of the Project has been changed to read as follows ;

- Current title : The Project for the Improvement of Water Supply and Sanitation Condition in Ndola City
- Revised title : The Project for the Improvement of Water Supply Condition in Ndola City

5-5. Capacity Development

Both sides agreed on the necessity of a technical assistance programme referred to as 'Soft-component' in the Project and confirmed the contents of it as described in the Draft Preparatory Survey Report.

5-6. Coordination with the other interventions

The Government of Zambia will assist KWSC to coordinate the various cooperating partners and

ensure that any interventions will not duplicate but supplement the interventions outlined in this project.

5-7. Environmental and Social Considerations

Monitoring for the environmental and social considerations will be conducted by KWSC in accordance with the attached monitoring form as Annex-3. The results will be provided to JICA by filling in the form, as part of progress reports during the construction phase.

End

Annex-1 : Project Cost Estimate
Annex-2 : Annual Operation and Maintenance Cost in 2020
Annex-3 : Monitoring Form

CONFIDENTIAL

Annex-1: Project Cost Estimates

This part is closed due to the confidentiality.

Table-B. Cost borne by the Government of Zambia

Items	Cost (million ZMK)	Cost (million JPY)
Relocation of underground wirings and pipes	499.5	9.1
Provision of drainage pond and sun-drying yard	99.9	1.8
Banking Arrangement	122.0	2.2
TOTAL	721.4	13.1

Note: The above costs are estimated based on prices and exchange rate (USD1.0 = JPY90.90, ZMK1.0 = JPY0.0182), as of September, 2010

Annex-2: Annual Operation and Maintenance Cost in 2020

Items	Cost/ year (ZMK)	Cost/ year (JPY)
1. Personnel Cost	4,240,815,000	77,182,833
2. Electricity Cost	2,138,737,000	38,925,013
3. Chemical Cost	3,795,005,000	69,069,091
4. Spare Parts Cost	1,949,451,000	35,480,008
Total	12,124,008,000	220,656,945

Annex-3

MONITORING FORM

-When necessary, the project proponent should refer to the following monitoring form for submitting reports.

-When monitoring plans including monitoring items, frequencies and methods are decided, project phase or project life cycle (such as construction phase and operation phase) should be considered.

1. Responses/Actions to Comments and Guidance from Government Authorities and the Public

・Common phase

Monitoring Item	Monitoring Results during Report Period
Responses/Actions to Comments and Guidance from Government Authorities	

2. Mitigation Measures

- Air Quality (Emission Gas / Ambient Air Quality)

Monitoring Item	Monitoring Results during Report Period
Not Applicable	

- Water Quality (Effluent/Wastewater/Ambient Water Quality)

Monitoring Item	Monitoring Results during Report Period
Not Applicable	

- Waste

・Construction phase

Monitoring Item	Monitoring Results during Report Period
(Method) Site observation of backfilling condition of the excavated soil (Duration) During rehabilitation work of distribution pipe (Frequency) Once a month	

- Noise / Vibration

・Construction phase

Monitoring Item	Monitoring Results during Report Period
(Method) ・Site observation on use of heavy machineries ・Hearing of complaints by residential people near the construction area (Duration) During the pipe rehabilitation work (Frequency) Once a month	

- Odor

Monitoring Item	Monitoring Results during Report Period
Not applicable	

- Traffic, accidents

・Construction phase

Monitoring Item	Monitoring Results during Report Period
(Method) ・Site observation whether traffic jam occurs or not ・Site observation whether necessary safety measures is taken. (Duration) During the pipe rehabilitation work (Frequency) Once a month	

3. Natural Environment

- Ecosystem

Monitoring Item	Monitoring Results during Report Period
Not applicable	

4. Social Environment

- Resettlement

Monitoring Item	Monitoring Results during Report Period
Not applicable	

- Living / Livelihood

Monitoring Item	Monitoring Results during Report Period
Not applicable	

- Local conflict of interests

・Construction phase and operation phase

Monitoring Item	Monitoring Results during Report Period
(Method) Site observation (Duration) During and after the construction (Frequency) Quarterly basis	

- HIV/AIDs among construction workers

・Construction phase

Monitoring Item	Monitoring Results during Report Period
(Method) Hearing to construction firms (Duration/ Frequency) On commencement of construction works	

Ministry of Local Government and Housing

The Republic of Zambia

SOFT COMPORNENT PLAN
(TECHNICAL ASSISTANCE)
ON
THE PROJECT FOR THE IMPROVEMENT OF WATER SUPPLY CONDITION IN NDOLA CITY
IN
THE REPUBLIC OF ZAMBIA

May 2011

SANYU CONSULTANTS INC.

Soft Component (Technical Assistance) plan

(1) Background of soft-component planning

Various items have been planned under the soft component category, including new installation of coagulation process with rehabilitation of Kafubu WTP, rehabilitation of transmission pipeline system and new installation of water flow meter, new installation of gas-chromatograph (equipment for water analysis) etc. Departments under KWSC are responsible for operation and maintenance of the facilities and equipment after their construction/installment. KWSC became a public corporation in 2000, and since then, it has been financially self-managed without receiving any subsidies from the Government, and it has been well managed. Different from the way of management by the local administration, it attached importance on such managerial dimensions as cost-effectiveness and efficiency, fully conscious of relevant response to claims by customers as well as the collection of a water tariff.

Notwithstanding the above, however, as regards to technical dimensions such as operation/maintenance of WTP and the transmission pipeline system, the performance is still not sufficient to maintain the facility at a higher level for supplying better quality water and for reducing leakage as planned and expected possible under the project, though KWSC has already acquired a certain level for routine mechanical operations of the existing facilities. Once the level of services for water supply is improved, it is expected that trust by the customers will be enhanced, thus enabling a higher recovery rate of water tariff collection, eventually leading to higher profits for the corporation. Also, from the viewpoint to secure a necessary budget for procurement of operation/maintenance (O/M) necessities in the future, the implementation of soft-component for better O/M of the facilities and equipment to be constructed and introduced by this project is considered highly important.

The soft-component to be implemented under this project consists of 4 major components, and the details of them are as shown in the following:

1) Technical support for water treatment process

Kafubu WTP is currently operated without injecting coagulants. Since this project is to install a facility for injecting coagulants aiming at improving water for stable treated quality, a different system of O/M management will be required, which is quite different from what has been applied to date. Assured knowledge and techniques will be necessary for managing the facilities/equipment properly relevant to the water purifying process, including determination of optimum quantities of chemicals corresponding to changing quality of intake water from the source. Thus, technical support is essential for a newly introduced treatment process from the

viewpoints of both promoting smooth introduction of a starting operation and keeping the cooperation effects sustainable. Instruction on O/M for other equipment in the system that are to be rehabilitated (including equipping raw water/treated water pumps, etc) is also planned in this project.

2) Technical support for water quality analysis

New analytical equipment is to be supplied in this project to the laboratory of KWSC with the objective of analyzing water quality of the raw water for the WTP. Targeting analyses for organic agro-chemicals, it is planned to provide equipment for gas-chromatography, also attached to the analyzing equipment, thus enabling analyses of heavy-metals (mercury/arsenic) that had not been possible by the existing atomic absorption photometer. Accordingly, technical support will be necessary for a smooth start, including creation of a base for effective use of such newly installed equipment and preparation of the water quality monitoring plan, preparation of the O&M manuals and so on.

3) Technical support for discharge measuring in pipeline

Since increasing water pressure in the existing water distribution pipes branched from the major pipeline is expected through the rehabilitation of the major pipeline of this project, it may induce increased water leakage from the existing water distribution pipes. Because the cumulative flow meter as the countermeasures against water leakage are to be provided by this project, technical support will be required for creating a discharge data collection system as well as a regular monitoring system, thereby assisting smooth initiation of effective utilization of introduced equipment.

4) Support for operating the water kiosks by the inhabitants

Water kiosks are to be installed by this project in 6 sites in the Kaloko Area, one of the Peri-Urban Areas. As against components of (1) ~ (3) that assist techniques of O/M for such hard work consisting of water supply facilities and equipment, this activity provides technical assistance for KWSC in the process of developing O/M organizations at the inhabitants' level, including nurturing/training water vendors (selected from related communities) who are responsible for operating/maintaining water kiosks, as well as provision of hygienic enlightenment education to the inhabitants concerned, etc.

A manual based on a Tool Kit by DTF is to be applied to a series of processes covering the construction of new water kiosks management thereof[1]. KWSC has up till now carried out a series of water kiosk projects under the umbrella of the DTF fund covering from hygienic enlightenment education to the inhabitants concerned to construction as well as O/M of water kiosks. However, it hasn't any experience of implementing projects by its own budgetary source, so far technically assisted by the consultants hired by DTF for their implementation. In considering implementation of a water kiosk project through this project, technical support by a soft component will be necessary as observed in the case of DTF projects in order to materialize fruit of the project and also to make it sustainable in the future. For these reasons, construction of water kiosk works as a basis of a grant aid project and support to the inhabitants for water kiosks as that of the soft-ware one, educational activity on hygienic enlightenment to the inhabitants concerned as well as creation of their organizations will be planned as the components of the project.

(2) Goals of soft component

1) Goals of the entire soft components

- The staff of KWSC is engaged, taking responsibility in relevant O/M management of water supply system, thus attaining increased water supply beneficiaries and extended hours of water supply in the target water supplying area.

2) Goals of technical support on the water treatment process

- Treated water quality at WTP is stabilized, always satisfying drinking water quality standard.
- Excessive injection of chemicals at water treatment facility, thereby cost of O/M can be rationalized.
- Relevant O/M for newly provided water treatment equipment is materialized.

3) Goals of technical support on water quality analyses

- Water quality of the Kafubu Dam and Kafubu River is properly monitored/supervised; therefore, safety as the raw water quality of WTP can be confirmed.

4) Goals of technical support on discharge measurement in pipeline

- Discharges flowing in the pipeline is properly monitored/supervised, thus reflected in the plans of repairing as well that of O/M for lessening leakage quantities.

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[1] DTF (Devolution Trust Fund) is the basket fund consists of Zambia government and other international cooperative agencies. DTF supports the water and sewerage service commercial utilities (CU) financially and technically for the implementation of water kiosks projects on peri-urban area. DTF has prepared the Tool Kit which includes technical package of the kiosk construction, community organizing, hygienic enlightenment, and other necessary works. Tool Kit is utilized as a guideline for the water kiosks projects supported by DTF.

5) Goals of the support on operating water kiosks by the inhabitants concerned

- Unsanitary state of water use by the inhabitants in Kaloko Area does not exist anymore.
- Water kiosks in the Kaloko Area are properly operated and managed.

(3) Achievement of Soft Components

The following direct benefits can be expected through the introduction of soft-components.

1) Achievement of technical support on the water treatment process

① Determination on concentration of coagulants to be injected in the treatment basin, according to water quality of intake water source, can be realized. [Achievement: WT①]

② Once it is possible to pre-determine suitable amount of chemical agents, it leads to avoid their excessive injection, thus optimizing the O/M cost. [Achievement: WT②]

③ In the case that algae proliferate/out-break in water source, it is possible to inject pre-chlorine in order to eliminate/exterminate them. [Achievement: WT③]

④ A new treatment process can be learnt and practiced so that the entire treatment process (comprising sedimentation basin, rapid filtering basin, and delivery/distribution pumps) including the process of chemical injection can be managed and operated. [Achievement: WT④]

⑤ As a result of improved O/M techniques for water purification facilities, it becomes possible to shift from post-accidental conservation to a preventive one, thereby enabling saving of O/M cost. [Achievement: WT⑤]

2) Achievement of technical support on water analyses

① Monitoring plan for the raw water quality of the WTP will be prepared. [Achievement: WQ①]

② Through the OJT program of the water quality analysis, KWSC staff will be able to understand/evaluate the property of target water quality. [Achievement: WQ②]

③ Through the OJT program of the water quality analysis, O&M manual adapted to the raw water quality analysis for the WTP will be prepared. [Achievement: WQ③]

3) Achievement of technical support on the flow measurement in the pipeline

① Monitoring plan for the state of discharges in the pipeline will be prepared. [Achievement: FM①]

② Through the OJT program of the water discharge measurement in the pipeline, KWSC staff will be able to measure the actual discharge quantity and record the result. [Achievement: FM②]

③ The KWSC staff will be able to understand/evaluate the state of discharges in the pipeline, then make the plan of a pipeline network rehabilitation works by reflecting the monitoring result. [Achievement: FM③]

4) Achievement of supporting management for water kiosks by the inhabitants concerned

① The inhabitants concerned understand the system of newly installed water kiosks, thus payment of a water tariff is made according to their purchase of water. [Achievement: KI①]

② A water tariff is collected by water vendors elected by the inhabitants concerned, thereby enabling management of water kiosks. [Achievement: KI②]

③ The vendors pay collected water tariff to KWSC, which manages, operates and repairs water kiosks, thus a coordination system can be created. [Achievement: KI③]

④ Comprehending a series of process on the installment of water kiosks, KWSC can carry out required activities. [Achievement: KI④]

(4) Method of identifying degree of targeted achievement

The degree of targeted achievement of soft-component is identified through the following methods:

No.	Component	Indices of fruit	How to identify the degree of accomplishing fruit
1	Water treatment process	1)-1 Operators are able to test water by jar-test. 1)-2 Turbidity of treated water is lowered below the water quality standard. 2) Color of treated water is lowered below the water quality standard. 3) In collaboration between KWSC and the consultant, the manual on O/M for (the whole) new treatment process is completed.	1) Judging the result of the test by training as well as the water quality analyses 2) The water quality analyses 3) O&M Manual and operation record

2	Water quality analysis	1) In collaboration between KWSC and the consultant, a water quality monitoring plan is formulated. 2) Raw water quality of WTP is tested and result data is analyzed through OJT program. 3) In collaboration between KWSC and the consultant, O&M manual adapted to the raw water quality analysis for WTP is provided.	1) Water quality monitoring plan 2) OJT report 3) O&M manual for water quality analysis
3	Discharge measurement in pipeline	1) In collaboration between KWSC and the consultant, a pipeline discharge monitoring plan is formulated. 2) Actual discharge quantity by distribution line is measured and recorded through OJT program. 3) In collaboration between KWSC and the consultant, a distribution map showing current state of pipeline discharges by distribution lines is provided. 4) In collaboration between KWSC and the consultant, a pipeline repairing plan is designed.	1) Pipeline discharges monitoring plan 2) OJT report 3) Pipeline discharges distribution map 4) Pipeline repairing plan
4	Support for the management of water kiosks	1) Inhabitant's awareness of hygiene is improved. 2) Water tariff is collected from water kiosks according to consumed water quantities recorded in tap-water current meters. 3) Monitoring of the management of water kiosks is made once in a quarter by KWSC 4) Activity with DTF tool kit is practiced.	1) Survey on inhabitant's state of water use 2) Monitoring reports on kiosks 3) Monthly progress reports by KWSC

(5) Activities of components (Input plan)

1) Technical supporting activity on the water treatment process

Necessary techniques to be acquired through this soft-component are an operational management skill, water quality management skill, chemical injection control skill and facility inspection skill. KWSC operators do not have the O&M skill and water quality control skill about the chemical treatment process (coagulation process/pre-chlorination) since chemical injection is not executed in the existing operation. Furthermore, O&M items and water quality control items to be managed for the sedimentation process and filtration process are to be changed because of chemical treatment process installation. Initial training carried out by the contractor is only for the O&M method of newly installed equipment itself and not to cover the training of the whole water treatment process. Therefore, technical support in this soft-component aims at the O&M method for the whole water treatment process so that KWSC operators can acquire necessary skills for proper operation.

An OJT training course mainly by classroom lectures coupled with actual site-training at a water treatment facility is provided. About 22 target trainees in this course are planned in total, selecting from operators positioned at the Kafubu water treatment facility (3 persons × 4 shifts ＝ 12 persons) and technical supervisors (3 persons), O/M staff in charge of routine/regular O/M of the equipment (5 persons) and technical supervisor (2 persons). The detailed contents of activities and the schedule are as shown below:

No.	Item	Content of activities	Applied Achievement	Target trainees	Instruction manuals etc (Visible fruit)	Place of activities	Term in day	Vehicle
1	Preparation of training texts	・ Training texts (water treatment process, operation and O/M manual draft) ・ Preparation of questionnaire sheets and a small test	WT ①-⑤	-	・ Training texts (including water treatment process, operation and O/M manual draft) ・ Preparation of questionnaire sheets and a small test	Japan	7 days	-
2	Moving route	Japan→Zambia	-	-	-	-	2days	1car (1day)
3	Training preparation	・ identifying current operation and technical level of the staff ・ reflection into training texts	WT ①-⑤	Operation staff	・ Result of questionnaire ・ Result of work-shop	Classroom/ Water treatment facility	3days	1car (23 days)
4	Training (lectures)	・ Lectures on water treatment process ・ Lectures on operation and O/M ・ Carrying out a small test			Records of training (including result of small test and evaluation)	Classroom	3 days	
5	Training (sites)	・ Site training (on-the-site practices on calculating concentration of coagulant, jar-test, pre-chlorination control, adjustment/ control of discharges in filtering ponds, drainage of sludge/ slurry, daily and periodic O/M methods on whole equipments etc)			Records of training (including judgment on the result of tests)	WTP	10 days	
6	Evaluation/ summary	・ Monitoring of operating water treatment plant and the evaluation on quality of treated water by the operators who received training ・ Preparation of report on the result of training			・ Result of operation record ・ Result on quality of treated water ・ Report on the result of training	WTP	7days	
7	Moving route	Zambia→Japan	-	-	-	-	2Days	1car (1day)
【scale of input】A Japanese consultant×34days ＝34 man-day (of which site working-days 27days), 1vehicle×25days ＝25･car-day								

2) Activity of technical support on water quality analysis

Necessary techniques to be acquired through this soft-component are detection and monitoring skills of organic agro-chemicals and heavy-metals (mercury/arsenic) in raw water for WTP. At present, general water quality items such as turbidity, inorganic chemicals, etc., are tested in the laboratory. Thus, laboratory technicians have a basic knowledge. However, they do not have enough techniques about analysis of organic agro-chemicals and heavy-metals. Therefore, training is provided on a series of procedures including planning, measurements and subsequent analysis on organic agro-chemicals and heavy-metals (mercury/arsenic) through OJT so that laboratory technicians can analyze and evaluate raw water quality for WTP.

Although an initial training on O&M for the analysis equipment is carried out by the contractor, initial training aims at the O&M methods for analysis equipment itself but not covering the necessary items required for a series of water quality analysis works. Furthermore, it is important to analyze an actual sample repeatedly in order to grasp the property of raw water quality empirically, such as concentration range, etc. Therefore, technical support in this soft component encourages laboratory technicians' understanding.

As the target personnel of the training, 5 laboratory technicians (including a technical supervisor) are scheduled. Detailed contents of the activity as well as the schedule are shown in the following table:

No.	Item	Content of activities	Applied Achievement	Target trainees	Instruction manuals etc (Visible fruit)	Place of activities	Term in day	Vehicle
1	Moving route	Japan→Zambia	-	-	-	-	2days	1car (1day)
2	Preparation for water quality analysis	・ Identification of current level of analytical techniques and equipment ・ Provision of water quality monitoring plan (items of analyses, sites of sampling, frequency thereof etc)	WQ①	Laboratory technician	Water quality monitoring plan	Laboratory	3days	1car (16days)
3	Site training for water quality analysis	・ OJT training on sampling and analysis	WQ②		・ Manual of water quality analysis with newly introduced equipment ・ Report on the result of training ・ Record of training (including the judgment of the training result) Record of water quality analysis	Laboratory, sampling sites	5days	

4	Interpretation on the result of water quality analyses	・ OJT training on interpreting the result of water quality analyses	WQ②		Record on the interpretation of the result of the analysis	Laboratory	3days	
5	Summary and others	・ Evaluation of the result of analysis and feedback to the site operations (water treatment plant etc) ・ Training on such O/M services as inventory/ management of expendables and spare parts of the equipment, routine/ regular inspection etc ・ Provision of the reports on the result of the training	WQ② WQ③		・ manual of O/M for newly introduced equipment ・Report on the result of training	Laboratory	5days	
6	Moving route	Zambia→Japan	-	-	-	-	2days	1car (1day)
【scale of input】A Japanese consultant 1person×20days ＝20 man-day、1vehicle ×18days = 18 car-day								

3) Activity of technical support on the discharge measurement in the pipeline

Necessary techniques to be acquired through this soft-component are skills of measuring and monitoring the discharge quantity in the pipeline and the planning of the pipeline repair plan. In the present state of O&M of the pipeline, leakage water is not observed quantitatively, but repairing is made according to the scale of water leakages from sections of the pipeline by visual observation. The target level is that the O&M staff can measure the discharge in the pipeline and observe the pipe leakage by a measurement result, then reflect it to the pipeline repair plan.

In this soft component, training on preparation of the pipeline discharge monitoring plan, actual measurement by the distribution system through OJT, analysis of measurement results (preparation of maps showing distribution of discharges in the pipeline) and preparation of the pipeline repairing plan are scheduled. The target level of training is that the O&M staff can measure and record actual discharge in the pipeline, then reflect it to the subsequent analysis and pipeline repairing plan. The O&M staff of the water distribution division is targeted as the trainees of the training (around 15 staff, including two technical supervisors). The contents of activity and the schedule are tabulated below:

No.	Item	Content of activities	Applied Achievement	Target trainees	Instruction manuals etc (Visible fruit)	Place of activities	Term in day	Vehicle
1	Moving route	Japan→Zambia	-	-	-	-	2days	1car (1day)
2	Preparation for measuring discharges	・ Identification of current technical level, the system of O/M for pipeline ・ Formulation of the plan on monitoring of discharges in pipeline (monitoring system, places of measurements, frequency etc)	FM①	Staff of O/M of pipeline	Monitoring plan of discharges in pipeline	Office/ at sites	6days	1 car (23days)
3	Practical measurement training	・ Practice on-the-site measurements of discharges by means of cumulative flow meter	FM②		・ Training records (including result of the test) ・ Measurement records	At sites	7days	
4	Interpretation of the result of measure-ments	・ Interpretation of the state of discharges in pipeline by means of the result of discharges' measurements (state of discharges by series of distributing lines etc)	FM③		Maps showing distribution of discharges in pipeline	Office	5days	
5	Summary and others	・ Provision of pipeline repairing plan reflecting the result of mapping of current pipeline discharges ・ Training of O/M for the management of expendables and spare-parts etc ・ Provision of the report on the result of training	FM③		・ Pipeline repairing plan (elaboration on ranking priority orders of repairing in future) ・ Report on the result of training	Office	5days	
6	Zambia→ Japan	-	-	-	-	2days	1car (1day)	Zambia → Japan
【scale of input】A Japanese consultant 1person×27days ＝27 man-days、vehicle: 1car×25days ＝25 car-days								

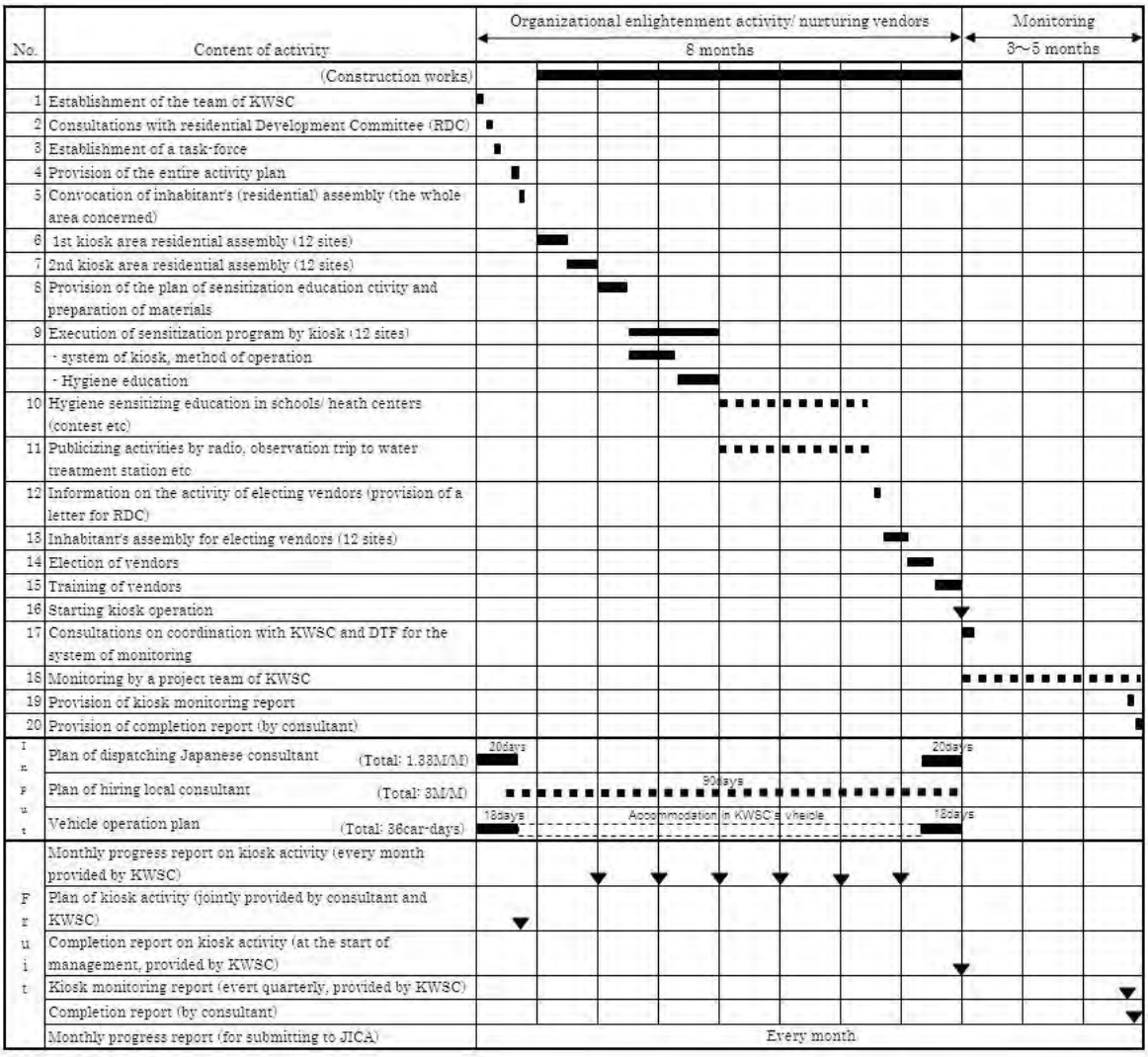
4) Activity of technical support on the management on Water kiosks by inhabitants

This part of the soft component aims to keep the selling water on water kiosks by means of sensitization activity and hygiene instructions to inhabitants. The peri-urban section of KWSC has mainly been liaisoning among the municipality office of Ndola City and relates inhabitants' organizations as well as collecting a water tariff from each water kiosk. Meanwhile, a consultant contracted/entrusted by DTF has been extending direct enlightenment activity and hygienic instructions toward inhabitants, whereas very few experts specialized in such activity are found in KWSC.

In this project, a Japanese consultant is dispatched to the sites at the initial stage of starting enlightenment/sensitization activity and at the completing stage thereof (initial stage of starting use of water kiosks) to promote smooth progress of management activity for these water

kiosks in collaboration with a local consultant. The local consultant is to practically develop enlightenment/sensitization activity with the staff of KWSC at the beginning stage of the activity, and later at the latter-half stage to instruct the activity by the staff of KWSC, thus transferring techniques. Regarding the monitoring after the kiosk operation, submission of a quarterly monitoring report is obligatory in the DTF project. In the case of this project, DTF agreed to accept the monitoring report submitted by KWSC and make advice to KWSC the same as the DTF project.

Currently, water kiosks have so far been installed at 6 sites in the Kaloko Area which is the target area of installing new water kiosks; however, due to a problem of insufficiency of supplying water pressure, etc., 4 sites of which have not been able to operate and the remaining 2 sites have failed sufficient management due to scarce water quantity. Rehabilitation work through this grant aid project will improve water pressure in six water kiosks, thereby enabling to resume the operation. It is required to consider the entire state of water supply in the target area including those which have already been installed in the support activity for the management of these water kiosks, therefore the planned activity will include in total twelve sites of water kiosks (the existing 6 sites + 6 newly installed sites). The whole action plan is shown in the following table:



The detailed contents of progress supervision/technical support by the Japanese consultant as well as by local consultant are summarized in the following tables. A local consultant is desirable to have a similar experience of the community organizing and hygiene instruction on DTF project.

① Input plan of dispatching Japanese consultant

[First travel plan]

No.	Item	Applied Achievement	Content of activities	Visible effect	Place of activity	Number of days	Vehicle
1	Moving route : Japan→Zambia	-	-	-	-	2days	1car (1day)
2	Consultations with KWSC (the whole schedule, system of implementation, principles of activity)	KI④	Division concerned in KWSC	The whole schedule and system	Office	2days	1car (16days)

3	Preparation and execution of consultations with inhabitants' organizations（RDC） (the whole schedule, principles of project activity, selection of target persons to form a task-force etc)	KI④	Division concerned in KWSC, inhabitant's committee	Minute of consultations	At the site or in the office	2days	
4	Preparation and execution of task-force meetings (※Task-force is composed of relevant division of KWSC, representatives of the inhabitants, staff of health center etc)	KI④	Task-force	Minute of consultations	At village or in the office	2days	
5	Execution of basic survey (a survey on planned number of beneficiary persons by kiosk, beneficiary area of kiosk plan, current state of water use by inhabitants)	KI④	Task-force	Number of final beneficiary persons, result of state of water use	At the site	5days	
6	Formulation of detailed plan of activity (inhabitant's assembly by kiosk-area, hygiene sensitizing extension activity, establishment of evaluation indices etc)	KI④	Task-force	Kiosk activity plan	At the site or in the office	3days	
7	Preparation and execution of the first inhabitant's assembly (the whole inhabitants)	KI④	Task-force	Explanatory pamphlet of inhabitant's assembly etc		2days	
8	Zambia→Japan	-	-	-	-	2days	1 car (1day)
【scale of input】A Japanese consultant 1person×20days＝20 man-days, vehicle 1 car×18days＝18 car-days							

[Second travel plan]

No.	Item	Applied Achievement	Content of activities	Visible effect	Place of activity	Number of days	Vehicle
1	Moving route : Japan→Zambia	-	-	-	-	2days	1car (1day)
2	Execution of task-force meeting (identification of the progress state)	KI④	Task-force	Minutes of the meeting	Office	1day	1 car (16 days)
3	Confirmation and Evaluation of the results on hygiene sensitizing extension activities for inhabitants	KI④	Division concerned in KWSC	-	Sites, Office	2days	
4	Identification of the state of vendor's election, that of the state of training vendors	KI②	Task-force and venders	Election of vendors, state of their training	At sites	3days	
5	Identification and improvement of O/M system by kiosk	KI③	Task-force and vendors	O/M system by kiosk	At sites	3days	
6	Evaluation of the Report on the completion of kiosk-activity plan (KWSC prepares), consultations towards monitoring	KI③	Division concerned in KWSC	Report on the completion of kiosk-activity plan (KWSC prepares)	Office	3days	
7	Consultations on future coordinated support for monitoring system with DTF	KI③	Related division in KWSC, DTF	-	Office	2days	
8	Reporting by the consultant	-	-	Final report	Office	2days	
9	Zambia→Japan		-	-	-	2days	1car (1day)
【scale of input】A Japanese consultant 1person×20days ＝20man-days, vehicle 1 car×18days ＝18car-days							

② Input plan of local consultant

No.	Item	Applied Achievement	Content of activities	Visible effect	Place of activity	No. of days/ site	Vehicle
1	1st inhabitants assembly in kiosk-area	KI④	Task-force, inhabitants	Record of activity	Each kiosk	1day	12days
2	2nd inhabitants assembly in kiosk-area	KI④	Task-force, inhabitants	Record of activity, sketch of beneficiary area by kiosk	Each kiosk	1day	12days
3	Preparation of texts for inhabitant's sensitization activity	KI①	Task-force	Inhabitant's sensi-tization texts	Office	common	3days
4	Execution of sensitization activities by kiosk area （kiosk operating system/ rule）	KI①	Task-force, inhabitants	Record of activity	Each kiosk	2 days	24 days
5	Execution of sensitization activities by kiosk area （hygiene sensitization）	KI①	Task-force, inhabitants	Record of activity	Each kiosk	2 days	24 days
6	Preparation and execution of hygiene sensitization in schools/ health center	KI①	Task-force, inhabitants	Sensitization texts, Record of activity	At sites	common	5 days
7	Preparation and execution of inhabitant's assembly for electing vendors Election of vendors	KI②	Task-force, inhabitants	Record of electing vendors	At sites	common	5 days
8	Vendor's training	KI②	Task-force and venders	Textbooks for training vendors	At sites	common	5 days
【scale of input】A local consultant 1person×90days ＝90man-days, vehicle: accommodated in KWSC's vehicles							

(6) Procurement plan of implementation resources

Desirable experts for the technical support on water purification process, water quality analysis and flow measurement on pipeline are Japanese consultants because they are specialized how to operate Japanese equipments installed under project. Different experts are required for each component because required technical knowledge is also different by components. Water purification process expert must have knowledge about coagulation treatment system, water quality analysis expert must have knowledge how to analyze agro-organic chemicals and heavy metals, and expert for flow measurement on pipeline must have knowledge about leakage control skill.

Both of Japanese and local consultant are required as experts for the technical support on water kiosk management by inhabitants. Japanese expert, rural water supply/hygiene enlightenment expert, controls overall schedule through several site trips at important events. Local expert, who can speak a tribal language, supports KWSC's water kiosk set-up activity. Criteria on the local consultants selection is whether they have similar experience of the community organizing and hygiene instruction on DTF project, or not.

(7) Implementation schedule

Soft-component implementation schedule should be planed in consideration with construction works and equipments installation works schedule. Overall schedule is as shown in attachment-1

(8) Completion report and other accomplishment materials on Soft-component

Soft-component overall completion report is prepared in Japanese version (for submission to JICA) and English version (for Zambian government) at the completion of overall soft-component activities. Training reports and accomplishment materials such as training text by components are as shown in table below.

[Accomplishment materials]

Soft-component	Accomplishment materials (Japanese/English)
Water purification process	*Training text(inclusive of O&M manual） *Training report(inclusive of test result, training record, operation record by the trainee, treated water quality result, etc）
Water quality analysis	*Water quality monitoring plan *Water quality analysis and O&M manual *Training report (inclusive of training record, water quality analysis/interpreting result by trainee, etc)
Discharge measurement in pipeline	*Pipe discharge monitoring plan *Pipe discharge distribution map *Repair plan on pipeline network *Training report (inclusive of training result, discharge measurement/interpreting record by trainee, etc)
Water kiosk management	*Water kiosk set-up/sensitization activity plan (prepared by together with KWSC and consultant) *Water kiosk set-up/sensitization activity completion report(inclusive of inhabitants' water use condition, monthly report prepared by KWSC, O&M organization by water kiosks, water kiosk monitoring report prepared by KWSC)

(9) Cost estimation of soft-component

Cost estimation of soft-component is as shown below table.

Item	Approximate cost (thousand Japanese Yen)
Expert cost	2,939
Direct cost	9,199
Indirect cost	3,762
Total	15,900

(10) Major undertakings to be taken by KWSC side

Major undertakings to be taken by KWSC side are as follows;

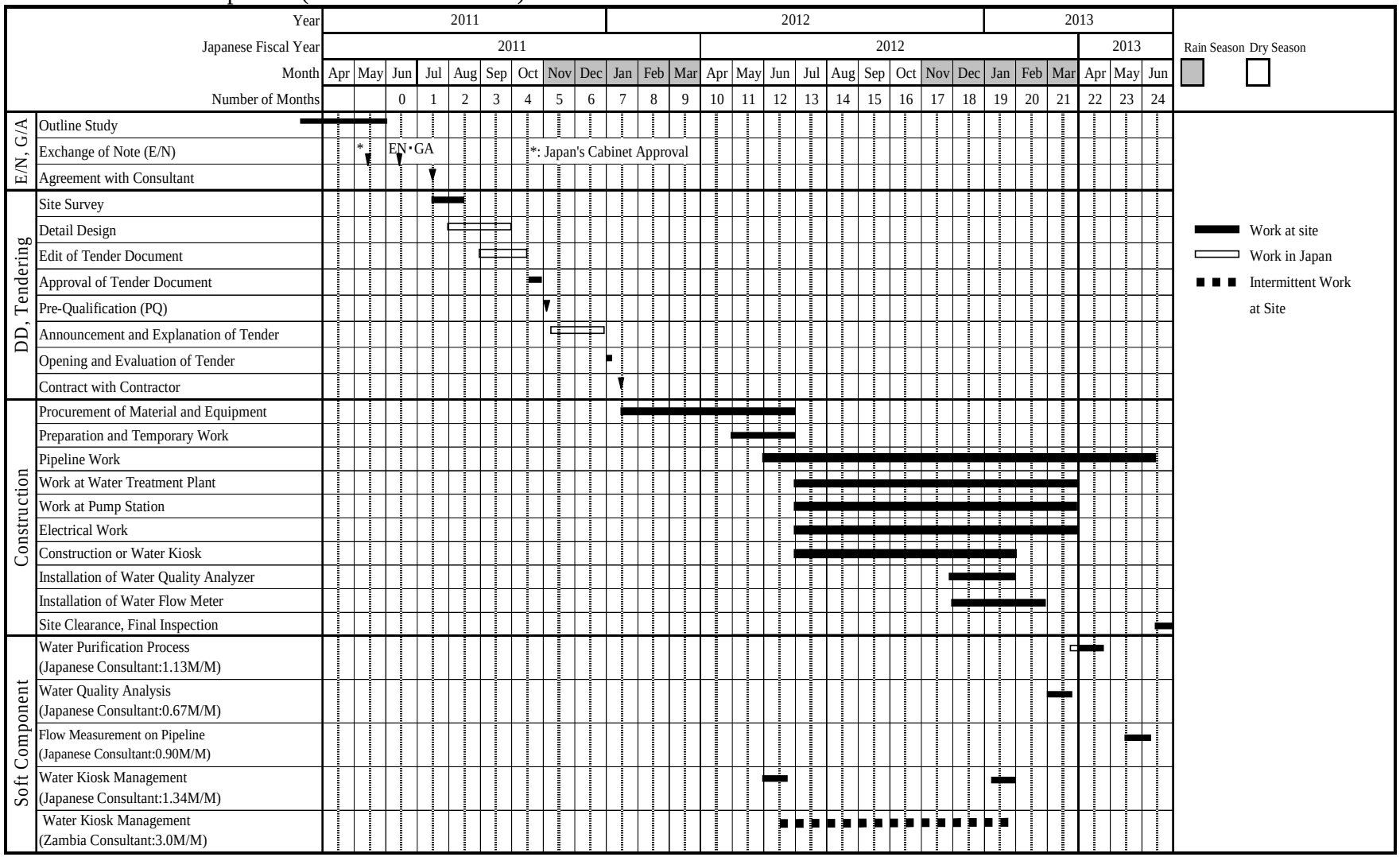
1) At implementation stage

- To ensure the necessary O&M staffs and their schedule for training
- To prepare the computer, printer and other necessary OA equipments using for trainings
- To prepare a vehicle for KWSC staff on water kiosk set-up/sensitization activity

2) After Completion of soft-component

- To keep long-term O&M organization and necessary budget.

Schedule of Soft Component (Technical Assistance)



Appendix-6 References 6-1 Water Quality Survey

1.1 Water Quality Analysis – Samples Collected: Sept 1-3, 2010

Parameter	Kafubu Stream Upper Itawa Dam (1.01)	Kafubu Steam lower Itawa Sewerage Pump Station (1.02)	Kafubu Steam Dambo Upper Stream (1.03)	Kafubu stream lower dambo sewerage pump station (1.04)	Kanini stream upper Kanini discharge (1.05)	Kafubu stream lower Kanini sewerage plant discharge (1.06)	Kafubu river upper stream of Lubuto STP (1.07)	Kafubu stream lower Lubuto to STP (1.08)	Upper stream of Kafubu dam (1.09)	Upper Kafubu dam (1.10)	Middle point of Kafubu dam (1.11)	(Maximum Permissible value for drinking water)	MIN	MAX
pH	8.11	7.81	7.69	7.75	7.49	7.51	6.98	7.17	7.05	7.58	7.64	6.5- 8.5	6.98	8.11
Total Dissolved Solids	140	141	146	166	154	152	139	102	136	128	144	1000	102	166
Conductivity (µS/cm)	268	289	296	300	294	278	172	203	186	210	211	1500	172	300
Total Suspended Solids	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2	<1.0	10	-	2	10
Turbidity (NTU)	1.53	1.7	1.04	0.62	1.41	1.98	3.4	3.34	7.66	2.66	31.6	1500	0.62	31.6
Total Hardness (as mg $CaCO_3$/l)	272	320	268	280	240	240	176	188	186	204	204	500	176	320
Calcium (mg/l)	68.8	68.8	72	68.8	67.2	54.4	25.6	49.6	41.6	40	41.6	200	25.6	72
Iron (mg/l)	0.34	1.09	0.96	0.88	0.34	0.86	0.33	0.34	0.94	0.83	0.94	0.3	0.33	1.09
Chlorides (mg/l)	20	10	15	10	10	5	5	15	15	10	15	250	5	20
Alkalinity (as mg	260	312	204	304	272	276	160	184	188	200	180	500	160	312
Sulphates (mg/l)	0.25	3.2	1.05	1.25	165	3.3	33.85	28.8	4.45	24	21.75	250	0.25	165
Total Phosphates (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	5	<0.01	<0.01
Phenol	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002
Nitrates (as mg NO_3–N mg/l)	<0.01	<0.01	<0.01	<0.01	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10	<0.01	0.1
Nitrites (as mg NO_2–N mg/l)	0.017	0.038	0.28	0.033	0.243	0.487	0.079	0.069	0.975	0.022	0.204	0.1	0.017	0.975
Fluoride (mg/l)	0.14	0.13	0.09	0.13	0.11	0.13	0.12	0.12	0.11	0.11	0.13	1.5	0.09	0.14
Ammonia (as mg NH_4 –N mg/l)	<0.01	1.01	0.82	0.22	39	4.2	0.51	0.02	0.25	0.77	0.27	1.5	0.02	39
Total Nitrogen (as mg N mg/l)	0.08	0.14	0.09	0.34	0.28	0.33	0.14	0.13	0.11	0.2	0.28	-	0.08	0.34
Biochemical Oxygen Demand (as mg O_2 mg/l)	22	16	18	8	16	16	18	16	16	32	48	-	8	48
Chemical Oxygen Demand (as mg O_2 mg/l)	46	39	44	30	48	39	40	48	46	44	72	-	30	72
Dissolved Oxygen (as mg O_2 mg/l)	4.8	5.6	5	4.8	4.6	4.3	5	4.8	4.7	4.7	5.6	-	4.3	5.6
Copper (mg/l)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	2	<0.003	<0.003
Cobalt	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.5	<0.005	<0.005
Manganese (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.5	<0.01	<0.01
Cadmium (mg/l)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.005	<0.002	<0.002
Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Mercury (mg/l)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001	<0.0002	<0.0002
Silver (mg/l)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.05	<0.002	<0.002
Arsenic (mg/l)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.05	<0.003	<0.003
Selenium (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	<0.005	<0.005
BACTERIOLOGICAL RESULTS	TNTC: too numerous to count													
Total coliforms (#/100ml)	TNTC	TNTC	TNTC	TNTC	52	TNTC	TNTC	56	52	21	60	0	21	TNTC
Feacal coliforms (#/100ml)	TNTC	TNTC	TNTC	TNTC	23	TNTC	TNTC	40	23	10	0	0	0	TNTC
Green Algae (#/100ml)	46	52	50	46	38	38	22	30	38	44	40	-	22	52
Blue Algae (#/100ml)	4	8	2	2	8	3	4	2	8	3	3	-	2	8

1.2 Water Quality Analysis – Samples Collected: Sept 1-3, 2010

Parameter	Misundu I underground water (2.01)	Misundu II underground water (2.02)	Kafubu stream intake of itawa plant	Weir of Kafubu dam (2.04)	Lake Ishiku (2.05)	Kafubu water work treated water (3.01)	Nakaputu reservoir (4.01)	Skyways reservoir (4.02)	Mushili house # 5832 (4.03)	Koloko kiosk # 2 (4.04)	Chifubu reservoir (4.05)	Northrise reservoir (4.06)	Lubuto reservoir (4.07)	(Maximum Permissible value for drinking water)	MIN	MAX
pH	7.71	7.55	8.16	7.75	7.79	7.78	7.75	7.89	7.92	7.9	7.8	7.63	8.22	6.5- 8.5	7.55	8.22
Total Dissolved Solids	156	158	166	128	122	122	128	126	126	128	154	158	129	1000	122	166
Conductivity (µS/cm)	245	274	282	212	210	294	212	212	212	213	241	247	212	1500	210	294
Total Suspended Solids	<1.0	<1.0	<1.0	2.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	2.8	2.8
Turbidity (NTU)	0.51	0.28	0.44	3.27	0.46	1.13	0.84	0.87	0.79	0.59	0.18	0.29	4.14	1500	0.18	4.14
Total Hardness (as mg $CaCO_3$/l)	236	260	232	220	220	212	196	220	172	196	224	208	176	500	172	260
Calcium (mg/l)	54.4	59.2	44.8	48	65.6	52.8	57.6	49.6	48	44.8	62.4	64	44.8	200	44.8	65.6
Iron (mg/l)	0.09	0.16	<0.01	0.04	0.13	0.33	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	0.3	0.04	0.33
Chlorides (mg/l)	10	10	5	15	10	15	15	15	15	25	10	10	15	250	5	25
Alkalinity (as mg	260	272	230	224	200	204	188	228	216	244	256	220	180	500	180	272
Sulphates (mg/l)	22.4	19.35	3.45	16.1	23.7	8.1	15.8	13.35	14.5	7.65	14.95	18.25	6.25	250	3.45	23.7
Total Phosphates (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.06	0.05	0.02	<0.01	<0.01	<0.01	<0.01	5	0.02	0.06
Phenol	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002
Nitrates(as mg $NO_3 - N$ mg/l)	1.18	<0.01	0.15	1.06	1.5	1.07	1.15	1.2	1.17	1.06	1.5	2.92	2.5	10	0.15	2.92
Nitrites(as mg $NO_2 - N$ mg/l)	0.122	0.012	0.024	0.014	0.06	0.015	0.015	0.013	0.012	0.013	0.012	0.012	0.055	0.1	0.012	0.122
Fluoride (mg/l)	0.18	0.14	0.12	0.09	0.09	0.13	0.08	0.07	0.12	0.14	0.12	0.12	0.09	1.5	0.07	0.18
Ammonia (as mg NH_4 –N mg/l)	<0.01	<0.01	0.1	0.27	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.09	0.06	1.5	<0.01	0.27
Total Nitrogen (as mg N mg/l)	0.34	0.22	0.14	0.26	0.28	0.19	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	<0.10	0.34
Biochemical Oxygen Demand (as mg O_3 mg/l)	16	18	22	24	16	18	8	8	12	8	8	8	8	-	8	24
Chemical Oxygen Demand (as mg O_3 mg/l)	60	38	38	46	38	48	22	36	28	22	22	22	24	-	22	60
Dissolved Oxygen (as mg O_2 mg/l)	5	4.8	4.8	4.6	3.9	4.4	4.6	4.3	4.3	4.6	5	4.8	4.3	-	3.9	5
Copper (mg/l)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	2	<0.003	<0.003
Cobalt	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.5	<0.005	<0.005
Manganese (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.5	<0.01	<0.01
Cadmium (mg/l)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.005	<0.002	<0.002
Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Mercury (mg/l)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001	<0.0002	<0.0002
Silver (mg/l)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.05	<0.002	<0.002
Arsenic (mg/l)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.05	<0.003	<0.003
Selenium (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	<0.005	<0.005
Aldrin (µg/l)	0	0	0	0	0	0	-	-	-	-	-	-	-	0.03	0	0
Dieldrin (µg/l)	2.19	0.629	0.297	0.127	0.081	0.073	-	-	-	-	-	-	-	0.03	0.073	2.19
DDE (µg/l)	0.0259	0.016	0.0248	0.313	0	0.0229	-	-	-	-	-	-	-	1	0	0.313
DDD (µg/l)	0	0.003	0.0032	0.0018	0.0027	0	-	-	-	-	-	-	-	1	0	0.0032
DDT (µg/l)	0.0533	0.005	0	0	0	0	-	-	-	-	-	-	-	1	0	0.0533
Endosulfan(µg/l	0	0	0	0	0	0	-	-	-	-	-	-	-	2	0	0
Heptachlor (µg/l	0	0	0	0	0	0	-	-	-	-	-	-	-	0.1	0	0
Heptachlor epoxide (µ	0	0	0	0	0	0	-	-	-	-	-	-	-	0.1	0	0
Lindane (gamma BHC) (µg/l	0	0	0	0	0	0	-	-	-	-	-	-	-	3	0	0
Methoxychlor (µg/l	0	0	0	0	0	0	-	-	-	-	-	-	-	30	0	0
Endrin (µg/l	0	0	0	0	0	0	-	-	-	-	-	-	-	0.2	0	0
BACTERIOLOGICAL RESULTS	TNTC: too numerous to count															
Total coliforms (#/100ml)	8	TNTC	55	7	35	0	21	0	0	10	0	0	0	0	0	TNTC
Feacal coliforms (#/100ml)	0	TNTC	10	0	16	0	0	0	0	0	0	0	0	0	0	TNTC
Green Algae (#/100ml)	0	0	14	22	42	4	4	4	2	2	0	0	2	-	0	42
Blue Algae (#/100ml)	0	0	0	0	3	0	0	0	0	0	0	0	0	-	0	3

2.1 Water Quality Analysis – Samples Collected: Sept 20-22, 2010

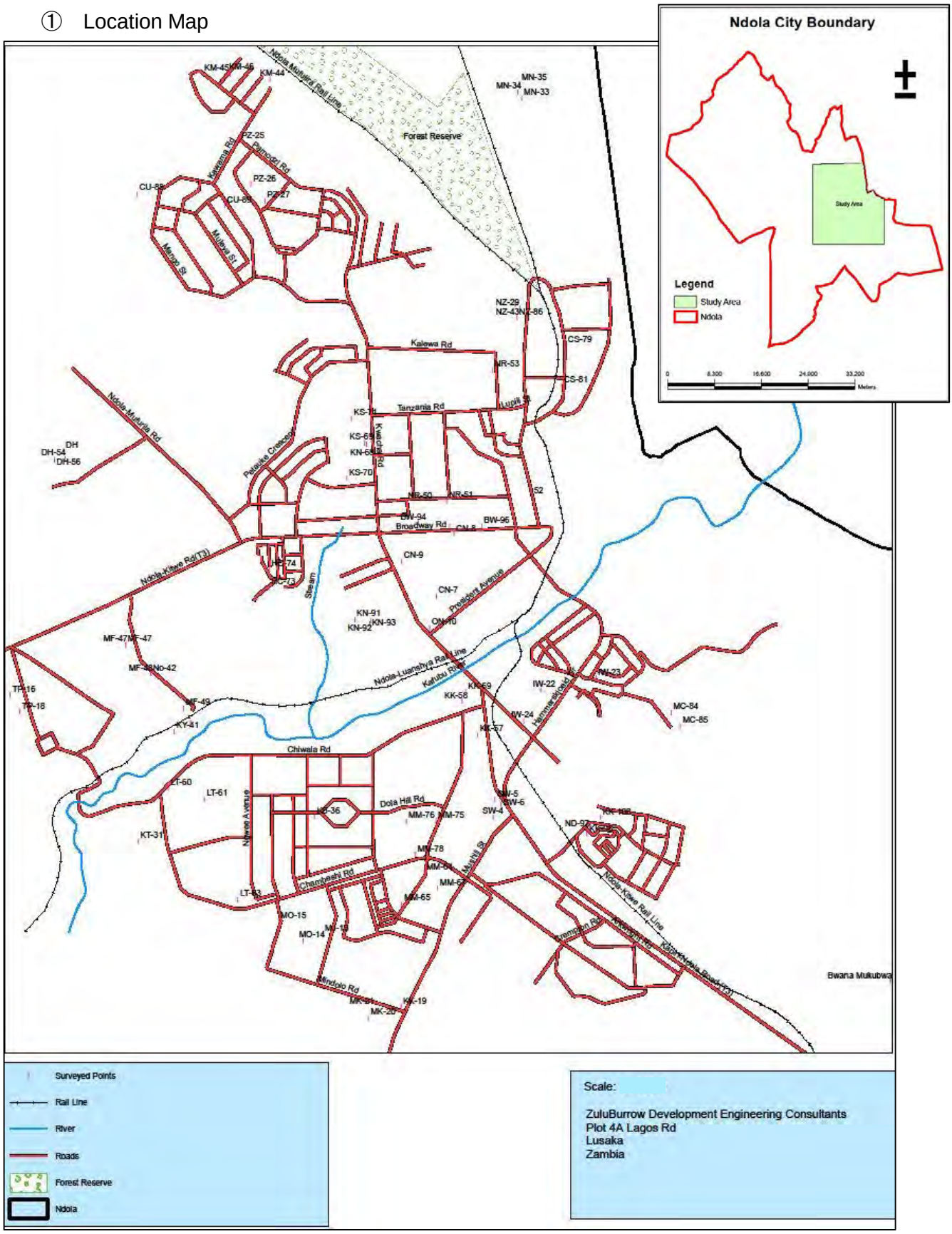
Parameter	Kafubu River (Upper Steam Itawa Dam) (1-1)	Kafubu River(lower stream of Itawa Sewerage Pump Station (1-2)	Kafubu River (Upper Steam of Dambo Sewerage Pump Station) (1- 3)	Kafubu River (lower stream of dambo sewerage pump station) (1-4)	Kafubu River (upper stream of Kanini Sewerage Treatment Plant) (1-5)	Kafubu River (Lower stream of Kanini Sewerage Treatment Plant) (1-6)	Kafubu River(upper stream of Lubuto Sewerage Treatment Plant (1-7)	Kafubu River(lower stream of Lubuto Sewerage Treatment Plant (1-8)	Kafubu River (Upper stream of Kafubu dam) (1-9)	Upper side of Kafubu dam (1-10)	Middle point of Kafubu dam (1-11)	(Maximum Permissible value for drinking water)	MIN	MAX
pH	8.01	7.58	7.61	7.74	7.75	7.71	7.38	7.35	7.6	7.58	7.5	6.5- 8.5	7.35	8.01
Total Dissolved Solids	166	200	202	208	199	181	143	159	168	151	170	1000	143	208
Conductivity (µS/cm)	327	309	311	321	307	295	220	306	259	233	264	1500	220	327
Total Suspended Solids	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.8	<1.0	5.8	-	4.8	5.8
Ammonia (as mg NH_4 –N mg/l)	0.05	<0.01	0.18	0.23	<0.01	2.84	0.42	2.96	<0.01	1.16	1.13	1.5	0.05	2.96
Total Nitrogen (as mg N mg/l)	0.09	0.12	0.14	0.22	0.32	0.28	0.22	0.12	0.34	0.19	0.3	-	0.09	0.34
Total Phosphates (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	5	<0.01	<0.01
Biochemical Oxygen Demand (as mg O_2 mg/l)	32	18	14	16	16	22	18	18	18	36	52	-	14	52
Chemical Oxygen Demand (as mg O_2 mg/l)	49	44	48	42	46	48	44	48	44	58	88	-	42	88
Dissolved Oxygen (as mg O_2 mg/l)	5	5.2	5.8	5.2	4.4	4.8	4.6	4.6	5	4.2	4.8	-	4.2	5.8
BACTERIOLOGICAL RESULTS														
Green Algae (#/100ml)	58	36	44	38	22	28	18	24	48	50	37	-	18	58
Blue Algae (#/100ml)	7	4	0	2	5	4	6	3	6	2	2	-	0	7

2.2 Water Quality Analysis – Samples Collected: Sept 20-22, 2010

Parameter	Misundu Stage1 underground water (2-1)	Misundu Stage II underground water (2-2)	Kafubu River (Intake of Itawa Treatment Plant (2-3)	(Intake of Kafubu Water Treatment Plant) (2-4)	Lake Ishiku (2.5)	Purified water at Kafubu water treated Plant (2-1)	Nakaputu Reservoir (4-1)	Skyways Reservoir (4-2)	Water Tap in Mushili Area (4-3)	Water Kiosk in Koloko area (4-4)	Chifubu Reservoir (4-5)	Northrise Reservoir (4-6)	Lubuto Reservoir (4 -7)	(Maximum Permissible value for drinking water)	MIN	MAX
pH	8.31	7.94	7.91	7.77	7.81	7.94	7.8	7.87	7.65	7.47	7.6	8.4	8.06	6.5- 8.5	7.47	8.4
Total Dissolved Solids	189	185	189	206	163	160	161	154	165	169	182	168	164	1000	154	206
Conductivity (µS/cm)	290	285	291	317	256	252	248	238	255	260	280	259	252	1500	238	317
Total Suspended Solids	<1.0	<1.0	<1.0	4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	4	4
Turbidity (NTU)	3.68	0.18	0.47	8.86	0.21	0.26	0.54	0.65	0.75	0.73	0.36	0.21	0.69	1500	0.18	8.86
Total Hardness (as mg	120	108	196	124	192	190	186	240	144	132	204	164	152	500	108	240
Calcium (mg/l)	37.6	36	67.2	38.4	64	64	62.4	64.4	36	38.4	73.6	44.8	51.2	200	36	73.6
Iron (mg/l)	0.11	0.14	0.03	0.15	0.14	0.21	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.3	<0.01	0.21
Chlorides (mg/l)	28	24	16	22	12	26	20	22	22	18	16	12	20	250	12	28
Alkalinity (as mg	118	100	188	120	188	172	170	218	140	128	198	160	148	500	100	218
Sulphates (mg/l)	20.2	17.6	1.4	2	17.95	3.1	5.9	6.35	1.05	9.55	14.4	16.25	1.15	250	1.05	20.2
Total Phosphates (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.14	<0.01	<0.01	<0.01	<0.01	<0.01	5	<0.01	0.14
Phenol	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	0
Nitrates(as mg NO_3 – N mg/l)	0.87	1.02	<0.01	0.69	0.72	0.3	0.29	0.49	<0.01	2.5	1.07	0.67	2	10	<0.01	2.5
Nitrites(as mg NO_2 – N mg/l)	0.004	0.006	0.002	0.385	0.002	0.003	0.012	0.004	0.024	0.056	<0.001	0.001	0.017	0.1	<0.001	0.385
Fluoride (mg/l)	0.16	0.14	0.16	0.14	0.11	0.14	0.08	0.08	0.12	0.14	0.14	0.14	0.09	1.5	0.08	0.16
Ammonia (as mg NH_4 –N mg/l)	<0.01	<0.01	<0.01	0.1	<0.01	0.08	<0.01	0.02	0.06	<0.01	<0.01	<0.01	0.05	1.5	<0.01	0.1
Biochemical Oxygen Demand (as mg O_2 mg/l)	12	16	34	24	14	16	12	8	8	8	8	12	18	-	8	34
Chemical Oxygen Demand (as mg O_2 mg/l)	34	30	74	68	30	30	18	22	18	24	22	24	48	-	18	74
Dissolved Oxygen (as mg O_2 mg/l)	4.8	4.9	5.6	4.3	5.8	5.6	5.8	5.6	5.8	4.9	5.4	5.2	5.2	-	4.3	5.8
Copper (mg/l)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	2	<0.003	<0.003
Cobalt	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.5	<0.005	<0.005
Manganese (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.5	<0.01	<0.01
Cadmium (mg/l)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.005	<0.002	<0.002
Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Mercury (mg/l)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001	<0.0002	<0.0002
Silver (mg/l)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.05	<0.002	<0.002
Arsenic (mg/l)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.05	<0.003	<0.003
Selenium (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	<0.005	<0.005
Aldrin (µg/l)	0	0	0.1179	0	0	0	-	-	-	-	-	-	-	0.03	0	0.1179
Dieldrin (µg/l)	5.22	6.317	21.71	6.85	20.58	12.035	-	-	-	-	-	-	-	0.03	5.22	21.71
DDE (µg/l)	0	0	0	0	0	0	-	-	-	-	-	-	-	1	0	0
DDD (µg/l)	0	0.0028	0	0.0025	0	0	-	-	-	-	-	-	-	1	0	0.0028
DDT (µg/l)	0.0027	0	0.00167	0	0	0	-	-	-	-	-	-	-	1	0	0.0027
Endosulfan(µg/l	0	0	0	0	0	0	-	-	-	-	-	-	-	2	0	0
Heptachlor (µg/l	0.134	0	0	0	0	0	-	-	-	-	-	-	-	0.1	0	0.134
Heptachlor epoxide (µ	0	0	0	0	0	0	-	-	-	-	-	-	-	0.1	0	0
Lindane (gamma BHC) (µg/l	0	0	0	0	0	0	-	-	-	-	-	-	-	3	0	0
Methoxychlor (µg/l	0	0	0	0	0	0	-	-	-	-	-	-	-	30	0	0
Endrin (µg/l	0	0	0	0	0	0	-	-	-	-	-	-	-	0.2	0	0
BACTERIOLOGICAL RESULTS	TNTC: too numerous to count															
Total coliforms (#/100ml)	0	98	TNTC	TNTC	42	9	22	2	15	19	12	0	0	0	0	TNTC
Feacal coliforms (#/100ml)	0	41	TNTC	TNTC	10	0	0	0	6	0	0	0	0	0	0	TNTC

Appendix-6-2 Social Conditions Survey

① Location Map



② Households List

(1/3)

Q.No	Name of Respondent	House/Plot Number	Street Name	Area	Tel. No.	Cell. No.
1	GRACE MWAMBWA	253		KALOKO	.	.
2	ALINA PHIRI	457		KALOKO	.	978071321
3	MARY KATONGO	677		KALOKO	.	.
4	BEATRICE CHAMA	3242	MUYOMBE ROAD	SKYWAYS	.	976757134
5	MAUBA SIMBALASHE	3141	MUYOMBE	SKYWAYS	.	916574757
6	PRISCILLA MASHILLI	3277	KABWE ROAD	SKYWAYS	.	966228926
7	SITALI IMUKUKA	50	INDEPENDENCE WAY	CENTRAL	.	977440066
8	DICKSON CHITAMBALA	2	KANDABWE ROAD	CENTRAL	.	955782152
9	PHILIPA MUNUNKA	3	MUMBI CLOSE	CENTRAL	.	955335400
10	BIBISHI KAHOZI	FLAT 3	PRESIDENT AVENUE	CENTRAL	.	966990624
11	GRACE BWEMBYA	E2		BWANA MKUBWA	.	.
12	ANNETTE MWABA	E18		BWANA MKUBWA	.	978250305
13	BEAUTY SIWILA	1007		MUSHILI (OLD)	.	964185638
14	RABECCA CHANGALA	916		MUSHILI (OLD)	.	969657704
15	RACHEL MULENGA	2321		MUSHILI (OLD)	.	.
16	SWAZE NGOYI	990		TWAPIA	.	.
17	RACHEL SAKALA	908		TWAPIA	.	978410549
18	ALBINO NKOLE	542	KANKASA	TWAPIA	.	977267866
19	IREDY MUSONDA	4212	MINDOLO ROAD	MUSHILI (NEW) (KANSENGO)	.	977969970
20	ROSEMARY CHANDA	4289		MUSHILI (KANSENGO)	.	.
21	BRIDGET MULENGA	3581	MUSHILI (NEW) (KASENGO)	MUSHILI (NEW) (KANSENGO)	.	979390853
22	NANCY SIKAZWE	FLAT 188	COUNCIL FLATS	ITAWA	.	955452435
23	PATRICK KATOTI	7	CHIKOLA	ITAWA	.	978215024
24	MABLE ZIMBA	23 PROFOUND	AIRPORT ROAD	ITAWA	617444	.
25	JANE KABAMBA	3502	SATYA SAI	PAMODZI	.	967511024
26	GIDEON MWILA	2205	SATYA SAI	PAMODZI S/S	.	977203968
27	BARBARA KALUMBA	1966	HURU ROAD	PAMODZI	.	975924556
28	SYLVIA KAMBIKAMBI	3027		PAMODZI	.	.
29	ESNART MWANSA	3167		NKWAZI	.	975966616
30	AFLESS JERE	V.21		KANTOLOMBA	.	.
31	FERISTA MAKASA	K5		KANTOLOMBA	.	.
32	CHRISTOPHER CHILUFYA	B05	KANTOLOMBA CEMENTORY ROAD	KANTOLOMBA	.	78568832
33	ANN CHENIER	4	CHERY FARM COMPLEX 1ST QUANTUM	MISUNDU	.	977781335
34	COURNEY BARKER	7 CHERY FARM ESTATE		MISUNDU	616340	.
35	HUNTER	10	CHERRY FARM	MISUNDU	.	96699674
36	FREDA CHAMA	PLOT NO. 445		KABUSHI	.	976889754
37	ELINA MUSHILI	904		KABUSHI	.	975104640
38	ALINEDI TEMBO	1714		KABUSHI	.	976577113
39	MARY ZIMBA	135		KANYALA	.	.

(2/3)

Q.No	Name of Respondent	House/Plot Number	Street Name	Area	Tel. No.	Cell. No.
40	THERESA CHISALA	A20		KANYALA	.	.
41	CHARITY KANDALA	A136		KANYALA	.	975216939
42	ESTHER KANGUNGU	441		NKWAZI OVERSPILL	.	979359396
43	NOAH BWALYA	3398		NKWAZI	.	977651733
44	GODWIN BANDA	1474	KAWAMA ROAD	KAWAMA	.	.
45	SARAH KABEMBA	1325	KAPATA ROAD	KAWAMA	.	97407554
46	CHARITY MUTALE	1255	KAPUTA ROAD	KAWAMA	.	.
47	EMMANUEL SIKAUNDI	14	MONKEY FOUNTAIN	MONKEY FOUNTAIN	681124	977854931
48	MRS. M NKHATA	PLOT 1863	MONKEY FOUNTAIN ZOO ROAD	MONKEY FOUNTAIN	680609	977512048
49	MRS TINA MBEWE	120M	MONKEY FOUNTAIN	MONKEY FOUNTAIN	.	977308697
50	MRS. PRECIOUS PHIRI	FLAT1 KABELENGACO URT	LUANGWA/ KABELENGA	NORTHRISE	.	966600358
51	ESTHER SENDAMA	43	KABELENGA	NORTHRISE	.	966601413
52	DERICK CHENGO	3 MONETRY FLATS	KABELENGA	**NORTHRISE**	.	955415676
53	DAKA CHITALAKA	NO.7C	CHIWANANGALA	NORTHRISE	.	977330870
54	IRENE MUSONDA	C6	C ROAD	DOLA HILL	.	.
55	STANLAS BWALYA KABWE	S 13		DOLA HILL	.	968931120
56	ANNETTA KAMWENDO	D4		DOLA HILL	.	.
57	MRS. EMILY BANDA	NO.12	ANGEL STREET	KX(KAFUBA)	.	979816855
58	ELISE CHUNGA	6049		KX(KAFUBU)	.	976216147
59	BRENDA KAMEME	6009		KX(KAFUBU)	.	969707521
60	G. MULENGA	3110		LUBUTO	.	979244990
61	TEBAISHIBA SIKANZWE	5444	MONKEY FOUNTAIN ROAD	LUBUTO	.	966788617
62	GIVEN ZIMBA KALENGA	K57412	NGWEE	LUBUTO	.	977691834
63	ANNE MULENGA	2731	IKELENGE	LUBUTO	.	977799636
64	VICTORIA BANDA	2629		MINE MASALA	.	979538246
65	SILOS KAMANGA	15	MASALA	MINE MASALA	.	.
66	LENTRY MOONDE	269	MINE MASALA	MINE MASALA	.	964020498
67	MULENGA KATONGO	695	CHIPILI	MINE MASALA	.	976186464
68	AGNESS MWANGO	1001 PREMIUM FLATS	KWACHA ROAD	KANSENSHI	.	966921770
69	FLORENCE NAMBELA	105 FIRST FLOOR	KWACHA	KANSENSHI	681522	.
70	BERNADETTE CHIRWA	11	MAKANTA AVENUE	KANSENSHI	.	977747100
71	GRACE HANYUMA	18	LUBWA ROAD	KANSENSHI	.	966430528
72	LENNI BANDA	4376	TWISAMBE ROAD	HILL CREST	680733	976454470
73	SUSAN CHIRWA	9513	HILL EXTENSION	HILL CREST	.	977784159
74	SUYA MUKUNDA	B4 COUNCIL	TWISAMBE	HILL CREST	.	955014167
75	CLARA NKANDU	2115	ILINGA	MAIN MASALA	.	978358964
76	ADRIAN MWANZA	1623	NYIKA ROAD	MAIN MASALA	.	.
77	GRACE CHISANGA	1363	FANTASY	MAIN MASALA	.	.
78	CHISHIMBA NAKAWALA	1186	KAMANA ROAD	MAIN MASALA	.	.
79	GODFRIDAH SUMBUKENI	717		CHIPULUKUSU	.	967932499
80	BARBARA KABASO	891	CHIBESA KUNDA	CHIPULUKUSU	.	964441424

(3/3)

Q.No	Name of Respondent	House/Plot Number	Street Name	Area	Tel. No.	Cell. No.
81	MAJORY CHILAMBWE	KT39/3	KACHELE	CHIPULUKUSU	.	976265267
82	MEMORY LUNGU	205		CHIPULUKUSU	.	979321704
83	HILDA MULENGA	MKC1	CHILUMBA	MACKENZIE	.	976652256
84	ROBERTA NDLOVU	MKA50	CHILUMBA ROAD	MACKENZIE	.	978270702
85	LEYA NGUNI	MKA 162		MACKENZIE	.	966603732
86	VIVIAN NGONI		OFF MISUNDA	NKWAZI	.	978598882
87	ABRAHAM KASUNKA	CH127	MANGO STREET	CHIFUBU	.	964112425
88	ALICE CHIWELE	4053		CHIFUBU	.	969640533
89	PAMELA MUMBA	CHT 1367		CHIFUBU	.	966755504
90	GRACE KABOKO	F221	MULEYA	CHIFUBU	.	979654380
91	FLORENCE NAMUNKONDYA	833	TAGORE	KANINI	.	955811202
92	CHARITY MBAMBE		TAGORE	KANINI	.	.
93	FLORENCE CHALIKOSA	FLAT 3 FORMER INDECO	TAGORE	KANINI	.	977882398
94	VIVIAN KAPAMBA	3 BROADWAY FLATS	BROADWAY	BROADWAY	.	969902665
95	CECILIA CHAMPWA	108 BROADWAY	BROADWAY	BROADWAY	.	978454030
96	PAMELA YIKONA	1	DR. DAMIE	BROADWAY	.	966907747
97	EUNICE MWANSHYE	1205	IPUSUKILO	NDEKE	.	979486764
98	FLAVIA MUKELABAI	1120	MAFUNDE	NDEKE	.	977447039
99	LYDIA CHISHIMBA	839		NDEKE	.	.
100	IREEN H. BANDA	502	DENGWE	NDEKE	.	.

③ Questionnaire

(1/4)

House Monitoring strip			
0-1	Date	August , 2010	
0-2	Surveyor name	Mr. / Ms.	
0-3	Answerer name	Mr. / Ms.	
0-4	Answerer address	House No. Street Area	
0-5	Area Category	High Cost Area / Middle Cost Area / Low Cost Area / Peri Urban Area	
0-6	Contact	Telephone Number / Mobile Phone Number	
	Category	Question	Answer (unit)
1-1	1. Basic data	How many are you in the family (during night time)	□ person
1-2		How many are you in the family? (during day time)	□ person
1-3		How long have you lived here?	from □ years ago
2-1	2. House economy	Which person in the family earn? (father, mother, etc.,)	
2-2		Approximate income per month in family totally.	□ZMK per month
3-1	3. Water tariff	Water tariff per month actually paid in the past	□ZMK in June 2010
3-2		Sewerage service charge per month actually paid in the past	□ZMK in June 2010
3-3		Electricity charge per month actually paid in the past (for reference)	□ZMK in June 2010
3-4		Did you have water disconnected because of your non-payment in the past?	outage | not yet
3-5		How much can you pay for water and sewerage service per month from now on?	□ZMK per month
4-1	4. Tariff collection	Water meter of KWSC is installed on the distribution pipe or not?	meter | no meter

	Category	Question	Answer (unit)
4-2		Water meter of KWSC is actually working or not?	Working | not working
4-3		Has the KWSC Meter Reader visit in the past or not?	Reader came | not come
4-4		Have you received the KWSC Water Bill bill in the past or not?	Charged | not charged
4-5		How do you pay the charged tariff? (go to Paying Office of KWSC, or etc.,)	pay at _____
5-1	5. House conditions	Apartment building (on which floor?)/ Isolated house (on the ground)	living on the □th floor
5-2		Water tank on the roof is used or not?	Using tank | not using
5-3		Personal booster pump is used or not?	Using pump | not using
6-1	6. Water supply conditions	How long ago was public water supply connected to your house?	From □ years ago
6-2		Do you share one water tap with your neighborhood?	Personal | shared by □ houses
6-3		How many hours in total in a day do you have water in your tap?	☐ hours per day
6-4		From what time to what time does tap water come in a day?	From □o'clock to □o'clock
6-5		Total days of water cuts all the day in a year ?	□ days in a year
7-1	7. Water pressure	Water pressure from the tap, measured with Bourdon Pressure Meter	□Mpa at □o'clock
7-2		Water pressure in the morning is enough or not?	Enough | not enough
7-3		Water pressure in the afternoon is enough or not?	Enough | not enough
7-4		Water pressure in the night is enough or not?	Enough | not enough
8-1	8. Water quality	Color (Surveyor's visual check)	clear | not clear

	Category	Question	Answer (unit)
8-2		Taste (Surveyor's drinking check)	no taste | odd taste
8-3		Smell (Surveyor's sniffing check)	no smell | odd smell
8-4		Residual chlorine (Surveyor conducts the site test with a pack test tube.)	□ ppm
8-5		Colon bacillus (Surveyor conducts the 24 hours test with a culturing test paper)	□ dot per 1 mg
9-1	9. Other water sources	river / spring / personal well / communal handpump / communal tap (water kiosk) / public water wagon / personal water vender / pipe leakage point / others	getting water from _____
9-2		How many hours do you spend in a day for fetching water and carrying back?	□ hour per day
9-3		How many bootles of water do you buy for drinking each day (liter per day)	□ liter per day
9-4		How much do you spend on buying bottled water for drinking (price per day)	□ ZMK per day
9-5		Buying water for domestic use (liter per day)	□ liter per day
9-6		Buying water for domestic use (price per day)	□ ZMK per day
9-7		Selling water to other people or not	yes | no
9-8		Selling water to other people (liter per day)	□ liter per day
9-9		Selling water to other people (price per day)	□ ZMK per day
10-1	10. Use of water	drink / wash dish / wash hand / wash face / wash body / toilet / gardening / wash car / selling water / others	using water for
11-1	11. Drainage	Drainage pipe from house is connecting to where? (sewer /ditch / soak in the ground)	connecting to
11-2		Toilet is connecting to where? (sewer / septic tank / unknown)	connecting to

	Category	Question	Answer (unit)
12-1	12. Hygienic customs	Wash hand before meal always or not?	yes | no
12-2		Wash hand after toilet always or not?	yes | no
12-3		Wash clothes everyday or not?	yes | no
12-4		Wash body everyday or not?	yes | no
12-5		Wash dish after meal sufficiently or not?	yes | no
12-6		Wash vegetable and fruits before cooking sufficiently or not?	yes | no
13-1	13. Medical and Health care	Disease in the past (diarrhea / food poisoning / malaria / cholera / typhoid / dysentery)	Disease name
13-2		Medical cost of the family per year (examination + treatment + medicine)	□ZMK per year
14-1	14. Degree of Satisfaction	Degree of satisfaction to public water supply service	good | fair | enough| bad
14-2		Degree of satisfaction to public sewerage service	good | fair | enough| bad
14-3		Problems or Requests to KWSC (if any)	

Appendix 6-2 Social Conditions Survey ④ Survey Data (1/10)

No.	Q0-1.	Q0-2.	Q0-3.				Q0-5.	Part	Area	Type of connection for the main source of water	GPS Readings			
	Date of Interview	Name of Surveyor	Answerer name	Sex of respondent	Age of respondent	Relationship of respondent to the household head	Area Category				South degrees	South minutes	South seconds	East degrees
1	06.09.2010	ANNIE K. TEMBA	GRACE MWAMBWA	Female	23	Spouse	Peri-Urban	South	KALOKO	Kiosk	13	2	20.8	28
2	06.09.2010	ANNIE K. TEMBA	ALINA PHIRI	Female	47	Spouse	Peri-Urban	South	KALOKO	Pipeline	13	2	23.3	28
3	06.09.2010	ANNIE K. TEMBA	MARY KATONGO	Female	38	Spouse	Peri-Urban	South	KALOKO	Kiosk	13	2	33.7	28
4	06.09.2010	ANNIE K. TEMBA	BEATRICE CHAMA	Female	45	Spouse	Medium cost Area	South	SKYWAYS	Pipeline	13	0	11.2	28
5	06.09.2010	ANNIE K. TEMBA	MAUBA SIMBALASHE	Male	22	SON	Medium cost Area	South	SKYWAYS	Pipeline	13	0	3.5	28
6	06.09.2010	ANNIE K. TEMBA	PRISCILLA MASHILLI	Female	30	Spouse	Medium cost Area	South	SKYWAYS	Pipeline	13	0	5.6	28
7	04.09.2010	ANNIE K.TEMBA	SITALI IMUKUKA	Male	74	Household head	High cost Area	North	CENTRAL	Pipeline	12	58	35.7	28
8	04.09.2010	ANNIE K. TEMBA	DICKSON CHITAMBALA	Male	43	Household head	High cost Area	North	CENTRAL	Pipeline	12	58	8.9	28
9	04.09.2010	ANNIE K. TEMBA	PHILIPA MUNUNKA	Female	30	Household head	High cost Area	North	CENTRAL	Pipeline	12	58	20.9	28
10	04.09.2010	ANNIE K. TEMBA	BIBISHI KAHOZI	Female	29	SISTER	High cost Area	North	CENTRAL	Pipeline	12	58	49.5	28
11	06.09.2010	ANNIE K. TEMBA	GRACE BWEMBYA	Female	38	Household head	Low cost Area	South	BWANA MKUBWA	Pipeline	13	1	27.5	28
12	06.09.2010	ANNIE K. TEMBA	ANNETTE MWABA	Female	40	Spouse	Low cost Area	South	BWANA MKUBWA	Pipeline	13	1	21.6	28
13	02.09.2010	ANNIE K. TEMBA	BEAUTY SIWILA	Female	26	Spouse	Medium cost Area	South	MUSHILI (OLD)	Kiosk	13	1	2.6	28
14	03.09.2010	ANNIE K. TEMBA	RABECCA CHANGALA	Female	18	DAUGHTER	Medium cost Area	South	MUSHILI (OLD)	Pipeline	13	1	5.4	28
15	03.09.2010	ANNIE K. TEMBA	RACHEL MULENGA	Female	33	DAUGHTER	Medium cost Area	South	MUSHILI (OLD)	Pipeline	13	0	57	28
16	02.09.2010	ANNIE K. TEMBA	SWAZE NGOYI	Female	52	Spouse	Peri-Urban	South	TWAPIA	Pipeline	12	59	20	28
17	02.09.2010	ANNIE K. TEMBA	RACHEL SAKALA	Female	34	DAUGHTER	Peri-Urban	South	TWAPIA	Kiosk	12	59	19.9	28
18	02.09.2010	ANNIE K. TEMBA	ALBINO NKOLE	Male	42	Household head	Peri-Urban	South	TWAPIA	Kiosk	12	59	27.2	28
19	03.09.2010	ANNIE K. TEMBA	IREDY MUSONDA	Female	42	Household head	Medium cost Area	South	MUSHILI (NEW) (KANSENGO)	Pipeline	13	1	33.7	28
20	03.09.2010	ANNIE K. TEMBA	ROSEMARY CHANDA	Female	52	Household head	Medium cost Area	South	MUSHILI (KANSENGO)	Pipeline	13	1	38.9	28
21	03.09.2010	ANNIE K. TEMBA	BRIDGET MULENGA	Female	31	Household head	Medium cost Area	South	MUSHILI (NEW) (KANSENGO)	Pipeline	13	1	28.7	28
22	02.09.2010	ANNIE K. TEMBA	NANCY SIKAZWE	Female	29	Spouse	High cost Area	South	ITAWA	Pipeline	12	59	16.1	28
23	02.09.2010	ANNIE K. TEMBA	PATRICK KATOTI	Male	17	SON	High cost Area	South	ITAWA	Pipeline	12	59	10.6	28
24	02.09.2010	ESTHER DAKA	MABLE ZIMBA	Female	30	Spouse	High cost Area	South	ITAWA	Pipeline	12	59	29.5	28
25	01.09.2010	ANNIE K. TEMBA	JANE KABAMBA	Female	35	Spouse	Medium cost Area	North	PAMODZI	Pipeline	12	55	18.6	28
26	01.09.2010	ANNIE K. TEMBA	GIDEON MWILA	Male	40	Household head	Medium cost Area	North	PAMODZI S/S	Pipeline	12	55	31.5	28
27	01.09.2010	ANNIE K. TEMBA	BARBARA KALUMBA	Female	35	Spouse	Medium cost Area	North	PAMODZI	Pipeline	12	55	44.7	28
28	01.09.2010	ANNIE K. TEMBA	SYLVIA KAMBIKAMBI	Female	76	Household head	Medium cost Area	North	PAMODZI	Pipeline	12	55	37.3	28
29	01.09.2010	ANNIE K. TEMBA	ESNART MWANSA	Female	26	Spouse	Low cost Area	North	NKWAZI	Kiosk	12	56	31	28
30	04.09.2010	MUTUNWA DORIS	AFLESS JERE	Female	30	DAUGHTER	Peri-Urban	South	KANTOLOMBA	Kiosk	13	0	19.2	28
31	04.09.2010	MUTUNWA DORIS	FERISTA MAKASA	Female	32	Spouse	Peri-Urban	South	KANTOLOMBA	Kiosk	13	0	23.1	28
32	04.09.2010	MUTUNWA DORIS	CHRISTOPHER CHILUFYA	Male	31	Household head	Peri-Urban	South	KANTOLOMBA	Pipeline	13	0	30.8	28
33	07.09.2010	ESTHER DAKA	ANN CHENIER	Female	26	Spouse	High cost Area	North	MISUNDU	Pipeline	12	54	59.1	28
34	06.09.2010	ANNIE K. TEMBA	COURNEY BARKER	Female	24	Spouse	High cost Area	North	MISUNDU	Pipeline	12	54	56.3	28
35	07.09.2010	MUTUNWA DORIS	HUNTER	Male	52	Household head	High cost Area	North	MISUNDU	Pipeline	12	54	52.9	28
36	06.09.2010	MUTUNWA DORIS	FREDA CHAMA	Female	22	Spouse	Low cost Area	South	KABUSHI	Pipeline	12	59	45.4	28
37	06.09.2010	MUTUNWA DORIS	ELINA MUSHILI	Female	55	Household head	Low cost Area	South	KABUSHI	Pipeline	13	0	11.6	28
38	06.09.2010	MUTUNWA DORIS	ALINEDI TEMBO	Female	74	Spouse	Low cost Area	South	KABUSHI	Pipeline	13	0	11.7	28
39	02.09.2010	MUTUNWA DORIS	MARY ZIMBA	Female	53	Household head	Peri-Urban	South	KANYALA	Pipeline	12	59	31.5	28
40	02.09.2010	MUTUNWA DORIS	THERESA CHISALA	Female	38	Spouse	Peri-Urban	South	KANYALA	Pipeline	12	59	31.5	28
41	02.09.2010	MUTUNWA DORIS	CHARITY KANDALA	Female	32	Spouse	Peri-Urban	South	KANYALA	Pipeline	12	59	35.5	28
42	01.09.2010	MUTUNWA DORIS	ESTHER KANGUNGU	Female	26	Spouse	Peri-Urban	North	NKWAZI OVERSPILL	Pipeline	12	56	2.6	28
43	01.09.2010	MUTUNWA DORIS	NOAH BWALYA	Male	28	Household head	Peri-Urban	North	NKWAZI	Kiosk	12	56	29.3	28
44	01.09.2010	MUTUNWA DORIS	GODWIN BANDA	Male	63	Household head	Peri-Urban	North	KAWAMA	Pipeline	12	54	51.5	28
45	01.09.2010	MUTUNWA DORIS	SARAH KABEMBA	Female	29	Household head	Peri-Urban	North	KAWAMA	Kiosk	12	54	49.4	28
46	01.09.2010	MUTUNWA DORIS	CHARITY MUTALE	Female	25	Spouse	Peri-Urban	North	KAWAMA	Kiosk	12	54	48.8	28
47	02.09.2010	MUTUNWA DORIS	EMMANUEL SIKAUNDI	Male	42	Household head	High cost Area	South	MONKEY FOUNTAIN	Pipeline	12	58	58.2	28
48	02.09.2010	MUTUNWA DORIS	MRS. M NKHATA	Female	60	Spouse	High cost Area	South	MONKEY FOUNTAIN	Pipeline	12	59	10.6	28
49	02.09.2010	MUTUNWA DORIS	MRS TINA MBEWE	Female	58	Spouse	High cost Area	South	MONKEY FOUNTAIN	Pipeline	12	59	25.2	28
50	04.09.2010	DORIS MUTUNWA	MRS. PRECIOUS PHIRI	Female	33	Household head	High cost Area	North	NORTHRISE	Pipeline	12	57	55	28

Appendix 6-2 Social Conditions Survey ④ Survey Data (2/10)

No.	GPS Readings		Q1-1.	Q1-2.	Q1-3.	Q2-1.	Q2-2.	Q3-1.	Q3-2b.	Q3-3.	Q3-4.	Q3-5a.	Q3-5b.	Q4-1.	Q4-2.	Q4-3.
	East minutes	East seconds	How many are you in the family? (during night time)	How many are you in the family? (during day time)	How long have you lived here?	Who is the main income earner in the family?	What is the total income for the family per month (please include from all sources)?	How much do you pay for water per month? (consider what was paid in July, 2010	How much do you pay per month for sewerage charges? (consider what was paid in July, 2010)	How much do you pay per month for electricity? (consider what was paid in July, 2010)	Have you had water disconnected because of non payment in the past six months?	Wht is your perception on the mount you pay for water?	How much are you willing to pay for water and sewerage service per month?	Is there a water meter installed by KWSC?	Is the water meter working?	Has the KWSC meter reader visited in teh past six months?
1	38	2.5	4	3	2	Household head	ZMK 500, 001 - 1,000,000	4500	No data	N/A	Yes	Fair	Don't know	No	N/A	N/A
2	38	0.6	9	3	25	Household head	ZMK 500, 001 - 1,000,000	21000	N/A	N/A	Yes	Fair	Don't know	No	N/A	N/A
3	38	9.6	7	3	3	Household head	Less than ZMK500, 000	6000	N/A	N/A	Yes	Fair	Don't know	No	N/A	N/A
4	38	48.5	8	1	24	Household head	ZMK 2,000,001 - 5,000,000	65000	10000	100000	Yes	Fair	N/A (Free)	Yes	Yes	Yes
5	38	49.3	5	3	28	Household head	ZMK 1,000,001 - 2,000,000	70000	Don't know	150000	Yes	Fair	50000	Yes	Yes	N/A
6	38	52.3	5	2	6	Household head	ZMK 2,000,001 - 5,000,000	100000	Don't know	70000	Yes	Fair	30000	Yes	Yes	Yes
7	38	23	4	3	31	Household head	ZMK 500, 001 - 1,000,000	400000	73000	400000	Yes	Very Expensive	150000	Yes	Yes	Yes
8	38	30.6	6	3	10	Household head	ZMK 2,000,001 - 5,000,000	250000	60000	300000	N/A	Very Expensive	120000	Yes	Yes	Yes
9	38	7.6	4	2	2	Household head	Above ZMK 5,000,001	200000	Don't know	300000	Yes	Very Expensive	50000	Yes	Yes	Yes
10	38	20.2	3	2	0	Household head	Above ZMK 5,000,001	80000	23000	Don't know	Yes	Fair	Don't know	No	N/A	N/A
11	41	47.7	4	2	12	Household head	Less than ZMK500, 000	N/A	N/A	80000	Yes	Expensive	N/A (Free)	No	N/A	N/A
12	41	44.9	8	6	7	Household head	ZMK 500, 001 - 1,000,000	N/A	N/A	N/A	Yes	Expensive	N/A (Free)	No	N/A	N/A
13	37	33.8	3	4	3	Household head	Less than ZMK500, 000	N/A	N/A	N/A	Yes	Expensive	N/A (Free)	No	N/A	N/A
14	37	25.1	7	7	0	Household head	Less than ZMK500, 000	30000	N/A	N/A	Yes	Expensive	15000	No	N/A	N/A
15	37	14.2	5	1	28	Household head	Less than ZMK500, 000	Don't know	N/A	N/A	Yes	Fair	Don't know	No	N/A	N/A
16	35	15.1	9	1	42	Household head	Less than ZMK500, 000	50000	N/A	120000	N/A	Very Expensive	10000	Yes	Yes	Yes
17	35	12.8	6	6	3	MOTHER	Less than ZMK500, 000	15000	N/A	Don't know	Yes	Fair	15000	N/A	N/A	N/A
18	35	19.3	12	5	23	Household head	Less than ZMK500, 000	N/A	N/A	Don't know	Yes	Expensive	10000	No	N/A	N/A
19	38	8.4	6	6	29	GRAND DAUGHTER	Less than ZMK500, 000	50000	Don't know	Don't know	Yes	Expensive	40000	No	N/A	N/A
20	37	54	3	3	10	Household head	Less than ZMK500, 000	Don't know	150000	Don't know	Yes	Fair	20000	No	N/A	N/A
21	37	44.6	4	1	3	Household head	ZMK 500, 001 - 1,000,000	Don't know	Don't know	50000	Yes	Fair	Don't know	No	N/A	N/A
22	39	9.4	3	1	1	Household head	Above ZMK 5,000,001	90000	47000	200000	Yes	Very Expensive	50000	No	N/A	N/A
23	39	33.9	5	4	15	Household head	ZMK 2,000,001 - 5,000,000	225000	77000	300000	Yes	Very Expensive	100000	Yes	Yes	Yes
24	39	2	6	3	5	Household head	ZMK 2,000,001 - 5,000,000	Don't know	N/A	200000	N/A	Fair	60000	No	N/A	N/A
25	36	54.9	5	2	2	Household head	ZMK 1,000,001 - 2,000,000	180000	N/A	100000	N/A	Very Expensive	80000	Yes	Yes	Yes
26	37	11.3	8	4	4	Household head	ZMK 1,000,001 - 2,000,000	N/A	N/A	120000	Yes	Expensive	N/A (Free)	No	N/A	N/A
27	37	6.6	9	7	14	Household head	ZMK 1,000,001 - 2,000,000	150000	N/A	200000	N/A	Expensive	30000	No	N/A	N/A
28	37	0.2	4	3	-1	DAUGHTER	ZMK 500, 001 - 1,000,000	80000	N/A	100000	Yes	Expensive	Don't know	No	N/A	N/A
29	38	59	7	6	0	Household head	ZMK 500, 001 - 1,000,000	15000	N/A	N/A	Yes	Expensive	6000	No	N/A	N/A
30	36	10.3	10	4	-1	Household head	Less than ZMK500, 000	6000	N/A	N/A	Yes	Expensive	6000	Yes	Yes	Yes
31	36	12.1	3	1	6	Household head	ZMK 500, 001 - 1,000,000	12000	N/A	N/A	Yes	Fair	50000	Yes	Yes	Yes
32	36	5.9	7	3	4	Household head	Less than ZMK500, 000	20000	N/A	5000	Yes	Fair	17000	Yes	Yes	No
33	38	59.7	3	3	4	Household head	Above ZMK 5,000,001	Don't know	N/A	N/A	Yes	Fair	N/A (Free)	No	N/A	N/A
34	38	58.1	3	2	0	Household head	Above ZMK 5,000,001	Don't know	N/A	N/A	Yes	Fair	N/A (Free)	N/A	N/A	N/A
35	38	58.7	2	2	3	Household head	Above ZMK 5,000,001	N/A	Don't know	Don't know	Yes	Expensive	N/A (Free)	No	N/A	N/A
36	37	27.7	4	3	0	Household head	Less than ZMK500, 000	Don't know	N/A	N/A	Yes	Fair	Don't know	No	N/A	N/A
37	37	29.8	4	2	30	Household head	Less than ZMK500, 000	200000	N/A	N/A	Yes	Very Expensive	5000	No	N/A	N/A
38	37	29.7	5	2	47	Household head	ZMK 500, 001 - 1,000,000	20000	N/A	100000	Yes	Very Expensive	15000	No	N/A	N/A
39	36	34.8	6	3	18	Household head	Less than ZMK500, 000	3000	N/A	N/A	Yes	Fair	3000	Yes	Yes	Yes
40	36	34.8	11	9	40	Household head	ZMK 500, 001 - 1,000,000	3000	N/A	N/A	Yes	Fair	3000	Yes	N/A	Yes
41	36	27.5	9	9	15	Household head	Less than ZMK500, 000	3000	N/A	N/A	Yes	Expensive	2000	No	N/A	N/A
42	38	3.8	4	2	7	Household head	Less than ZMK500, 000	60000	N/A	100000	Yes	Very Expensive	Don't know	Yes	Yes	Yes
43	38	57.1	9	6	12	Spouse	Less than ZMK500, 000	N/A	N/A	N/A	#N/A	Expensive	3000	N/A	N/A	N/A
44	37	8.2	4	4	15	Household head	Less than ZMK500, 000	50000	N/A	N/A	Yes	Very Expensive	Don't know	Yes	Yes	No
45	36	50.9	3	2	5	Household head	Less than ZMK500, 000	3000	N/A	N/A	Yes	Very Expensive	1500	No	N/A	N/A
46	36	49.4	5	4	0	Household head	ZMK 2,000,001 - 5,000,000	3000	N/A	N/A	Yes	Fair	3000	Yes	Yes	Yes
47	36	6	6	1	5	Household head	ZMK 500, 001 - 1,000,000	20000	N/A	10000	Yes	Fair	20000	No	N/A	N/A
48	36	17.3	2	2	-1	JOINTLY BY 1 AND 2	ZMK 500, 001 - 1,000,000	350000	N/A	400000	N/A	Very Expensive	100000	Yes	Yes	No
49	36	31.6	4	3	18	Household head	ZMK 1,000,001 - 2,000,000	100000	No data	417000	Yes	Fair	100000	Yes	Yes	Yes
50	38	9.1	5	3	-1	Household head	Above ZMK 5,000,001	N/A	23000	100000	Yes	Expensive	50000	No	N/A	N/A

Appendix 6-2 Social Conditions Survey ④ Survey Data (3/10)

No.	Q4-4.	Q4-5.	Q5-1a.	Q5-1b.	Q5-2a.	Q5-2b.	Q5-3.	Q6-1.	Q6-2.	Q6-3.	Q6-4.							Q6-5a.
	Do you normally receive the KWSC water bills?	How do you pay the charged tarrif?	What type of dwelling do you have?	If answer to 5-1 is '2' Apartment building, what floor do oyu live in?	Do you use an overhead water tank?	Do you have ground storage tank?	Do you use a booster pump?	How many years ago was the public water supply connected to your house?	Do you share one tap with your neighbourhood ?	How many hours in total do you have water in a day?	What period(s) does tap water come in a day? 1. From	What period(s) does tap water come in a day? 2. From	What period(s) does tap water come in a day? 3. From	What period(s) does tap water come in a day? 1. to	What period(s) does tap water come in a day? 2. to	What period(s) does tap water come in a day? 3. to	Have you experienced any water shortage for a whole day in the past years?
1	N/A	WATER VENDOR	Stand alone house	N/A	No	No	No	N/A	N/A	9	7	.	.	16	.	.	No
2	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	N/A	No	10	6	.	.	18	.	.	Yes
3	No	KIOSK VENDOR	Stand alone house	N/A	No	No	No	Don't know	N/A	5	6	.	.	11	.	.	Yes
4	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	8	6	.	.	14	.	.	Yes
5	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	9	8	.	.	17	.	.	Yes
6	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	24	.	.	.	.	.	.	Yes
7	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	24	.	.	.	.	.	.	Yes
8	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	24	.	.	.	.	.	.	Yes
9	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	3	.	.	.	.	.	.	Yes
10	Yes	Go to KWSC payment office	Apartment building	N/A	No	No	No	Don't know	No	24	.	.	.	.	.	.	Yes
11	N/A	N/A	Stand alone house	N/A	No	No	No	Don't know	Yes	8	8	17	.	14	20	.	No
12	N/A	N/A	Stand alone house	N/A	No	No	No	Don't know	No	3	8	17	.	14	20	.	Yes
13	N/A	N/A	Stand alone house	N/A	No	No	No	N/A	N/A	0	.	.	.	.	.	.	Yes
14	N/A	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	4	16	.	.	10	.	.	Yes
15	N/A	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	8	8	.	.	16	.	.	Yes
16	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	5	7	14	24	8	17	.	Yes
17	N/A	KIOSK (VENDOR)	Stand alone house	N/A	No	No	No	N/A	N/A	10	8	.	.	18	.	.	Yes
18	No	N/A	Stand alone house	N/A	No	No	No	N/A	N/A	6	6	17	.	11	18	.	Yes
19	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	28	No	11	6	.	.	17	.	.	Yes
20	No	N/A	Stand alone house	N/A	No	No	No	Don't know	Yes	5	.	.	.	.	.	.	Yes
21	No	LANDLORD	Stand alone house	N/A	No	No	No	3	No	12	6	.	.	18	.	.	Yes
22	Yes	Go to KWSC payment office	Apartment building	1	No	No	No	Don't know	No	11	7	.	.	18	.	.	Yes
23	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	20	.	.	.	.	.	.	Yes
24	N/A	N/A	Apartment building	3	Yes	Yes	Yes	17	No	12	5	18	.	18	5	.	Yes
25	No	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	24	.	.	.	.	.	.	Yes
26	No	N/A	Stand alone house	N/A	No	No	No	Don't know	N/A	0	.	.	.	.	.	.	Yes
27	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	6	6	.	.	12	.	.	Yes
28	No	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	6	6	.	.	12	.	.	Yes
29	No	VENDOR	Stand alone house	N/A	No	No	No	N/A	N/A	8	8	14	.	12	18	.	Yes
30	No	KIOSK	Stand alone house	N/A	No	No	No	N/A	N/A	9	8	14	.	12	19	.	No
31	No	VENDOR (KIOSK)	Stand alone house	N/A	No	No	No	1	N/A	13	6	.	.	19	.	.	No
32	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	1	No	24	.	.	.	.	.	.	Yes
33	N/A	N/A	Stand alone house	N/A	No	No	No	Don't know	No	24	.	.	.	.	.	.	No
34	N/A	N/A	Stand alone house	N/A	No	No	No	Don't know	No	21	.	.	.	.	.	.	No
35	No	COST BORNE BY EMPLOYER	Stand alone house	N/A	Yes	No	Yes	3	No	24	.	.	.	.	.	.	No
36	N/A	N/A	Stand alone house	N/A	No	No	No	5	Yes	8	7	.	.	15	.	.	Yes
37	No	KWSC EMPLOYEE	Stand alone house	N/A	No	No	No	7	No	2	10	.	.	12	.	.	Yes
38	N/A	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	11	6	.	.	17	.	.	Yes
39	N/A	KWSC COMES TO COLLECT	Stand alone house	N/A	No	No	No	N/A	Yes	6	6	15	.	9	18	.	No
40	No	COMMUNITY TAP ATTENDANT	Stand alone house	N/A	No	No	No	11	Yes	6	6	15	.	9	18	.	No
41	No	COLLECTED BY KWSC	Stand alone house	N/A	No	No	No	6	Yes	6	6	16	.	12	17	.	Yes
42	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	2	2	.	.	4	.	.	Yes
43	N/A	N/A	Stand alone house	N/A	No	No	No	3	N/A	8	7	14	.	12	17	.	Yes
44	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	4	No	24	.	.	.	.	.	.	Yes
45	N/A	KIOSK	Stand alone house	N/A	No	No	No	2	N/A	9	6	14	.	12	17	.	Yes
46	No	N/A	Stand alone house	N/A	No	No	No	N/A	N/A	9	6	14	.	12	17	.	Yes
47	Yes	Through my employer	Stand alone house	N/A	Yes	No	No	9	N/A	24	.	.	.	.	.	.	Yes
48	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	N/A	24	.	.	.	.	.	.	Yes
49	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	N/A	24	.	.	.	.	.	.	Yes
50	Yes	Go to KWSC payment office	Apartment building	0	No	No	No	Don't know	Yes	3	5	.	.	8	.	.	Yes

Appendix 6-2 Social Conditions Survey ④ Survey Data (4/10)

No.	Q6-5b.	Q7-1.		Q7-2.	Q7-3.	Q7-4.	Q8-1.	Q8-2.	Q8-3.	Q8-4.	Q8-5.	Q9-2.	Q9-3a.	Q9-3b.	Q9-4.	Q9-5a.	Q9-5b.	Q9-6.
	If answer to 6-5a is '1' Yes, approximately how many total days in a year?	Water pressure from the tap, measured with bourdon pressure meter (Pa/cm2)	Time	Is water pressure in the morning enough?	Is water pressure in the afternoon enough?	Is water pressure in the night enough?	Color (surveyor's visual cheack)	Taste (surveyor's drinking check)	Smell (surveyor's sniffing check)	Residual chlorine (surveyor conducts pack test)	Colon bacillus (surveyor conducts the 24 hours test with test paper)	How many hours do you spend in a day for fetching water and carrying back?	Do you buy bottled water for drinking?	How many litres of bottled water do you drink per day as a household?	How much do you spend on bottled water as a household per day?	Do you spend money on water for domestic use?	How many litres of water do you use for domestic use per day?	How much do you spend on domestic water per day?
1	Don't know	Low pressure	9.21	No	No	No	Clear	No taste	No smell	0.1	1	1	Yes	3	4500	No	N/A	N/A
2	20	200000000	9.49	Yes	No	No	Clear	No taste	No smell	0.1	0	2	No	N/A	N/A	Yes	200	1000
3	Don't know	Low pressure	10.19	Yes	No	No	Clear	No taste	No smell	0.2	0	2	No	N/A	N/A	No	N/A	N/A
4	36	Low pressure	10.58	No	No	No	Clear	No taste	Odd smell	0.2	3	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
5	24	60000000	11.22	No	Yes	No	Not clear	Odd taste	Odd smell	0.2	1	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
6	Don't know	50000000	11.56	No	Yes	No	Not clear	Odd taste	Odd smell	0.1	29	Use domestic water points only	Yes	2	2000	No	N/A	N/A
7	3	300000000	8.49	No	No	No	Clear	No taste	No smell	0.2	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
8	3	100000000	9.23	Yes	Yes	Yes	Clear	No taste	No smell	1	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
9	250	50000000	9.56	No	No	No	Clear	No taste	No smell	0.2	0	Use domestic water points only	Yes	2	3000	No	N/A	N/A
10	3	90000000	10.23	Yes	Yes	Yes	Clear	No taste	No smell	0.2	0	Use domestic water points only	Yes	10	10000	No	N/A	N/A
11	Don't know	No supply	.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
12	Don't know	No supply	.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
13	N/A	No supply	.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Less than 1 hour	No	N/A	N/A	Yes	120	167
14	Don't know	Low pressure	11.16	Yes	No	No	Not clear	No taste	No smell	0.1	0	4	No	N/A	N/A	Yes	120	1500
15	Don't know	Low pressure	11.56	No	No	No	Not clear	No taste	No smell	0.2	0	2	No	N/A	N/A	Yes	100	2500
16	Don't know	Low pressure	11.05	Yes	No	Yes	Clear	Odd taste	Odd smell	0.1	5	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
17	90	Low pressure	10.3	No	No	Yes	Clear	No taste	No smell	0.2	1	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
18	90	No supply	11.42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	No	N/A	N/A	Yes	80	N/A
19	Don't know	Low pressure	9	No	No	No	Clear	No taste	No smell	0.2	0	2	No	N/A	N/A	No	N/A	N/A
20	6	Low pressure	9.34	No	No	No	Not clear	Odd taste	No smell	0.1	1	2	No	N/A	N/A	Yes	100	1000
21	180	Low pressure	10.09	No	No	No	Not clear	Odd taste	No smell	0.1	2	Use domestic water points only	Yes	2	5000	No	N/A	N/A
22	90	50000000	14.21	No	No	No	Not clear	Odd taste	Odd smell	0.1	6	2	Yes	3	7000	No	N/A	N/A
23	Don't know	50000000	15.13	Yes	No	No	Not clear	Odd taste	No smell	0.1	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
24	365	50000000	14	Yes	No	No	Not clear	Odd taste	Odd smell	0.1	3	Use domestic water points only	No	N/A	N/A	Yes	80	N/A
25	Don't know	150000000	10.39	Yes	Yes	Yes	Clear	No taste	No smell	0.2	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
26	Don't know	No supply	.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
27	180	100000000	11.57	Yes	No	No	Not clear	No taste	No smell	0.2	0	Use domestic water points only	Yes	9	45000	No	N/A	N/A
28	4	50000000	12.28	No	No	No	Clear	No taste	No smell	0.2	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
29	2	100000000	13.56	Yes	No	No	Clear	No taste	No smell	0.2	0	1	No	N/A	N/A	No	N/A	N/A
30	Don't know	300000000	12.34	Yes	Yes	Yes	Clear	No taste	No smell	0.4	0	Less than 1 hour	No	N/A	N/A	Yes	120	300
31	Don't know	350000000	12.55	Yes	Yes	Yes	Not clear	Odd taste	Odd smell	0.4	0	2	No	N/A	N/A	Yes	100	250
32	10	100000000	13.58	Yes	Yes	Yes	Clear	No taste	No smell	0.4	0	Less than 1 hour	No	N/A	N/A	Yes	40	100
33	Don't know	100000000	9.38	Yes	Yes	Yes	Clear	No taste	No smell	0.1	3		No	N/A	N/A	No	N/A	N/A
34	Don't know	150000000	9.19	Yes	Yes	Yes	Clear	No taste	No smell	0.1	15	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
35	Don't know	200000000	9.37	Yes	Yes	Yes	Clear	No taste	No smell	0.4	4	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
36	10	50000000	10.58	No	No	No	Clear	No taste	Odd smell	0.4	6	5	No	N/A	N/A	No	N/A	N/A
37	60	Low pressure	11.3	No	No	No	Clear	No taste	No smell	0.4	0		No	N/A	N/A	No	N/A	N/A
38	36	Low pressure	12.14	No	No	No	Clear	No taste	No smell	0.4	0	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
39	Don't know	200000000	12.35	Yes	Yes	Yes	Clear	No taste	No smell	0.2	0	Less than 1 hour	No	N/A	N/A	Yes	30	N/A
40	Don't know	200000000	12.35	Yes	Yes	Yes	Clear	No taste	No smell	0.2	0	Less than 1 hour	No	N/A	N/A	Yes	30	N/A
41	1	300000000	13.37	Yes	Yes	Yes	Clear	Odd taste	Odd smell	0.2	0	Less than 1 hour	No	N/A	N/A	Yes	200	100
42	Don't know	No supply	.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Use domestic water points only	Yes	N/A	Don't know	Yes	Don't know	2000
43	14	100000000	.	No	No	No	Clear	No taste	No smell	0.2	0	Less than 1 hour	No	N/A	N/A	No	200	500
44	36	50000000	10	Yes	Yes	Yes	Clear	No taste	No smell	0.4	0	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
45	30	Low pressure	10.41	No	Yes	Yes	Clear	No taste	No smell	0.4	0	Less than 1 hour	No	N/A	N/A	Yes	40	100
46	2	Low pressure	10.41	Yes	Yes	Yes	Clear	No taste	No smell	0.4	0	Less than 1 hour	No	N/A	N/A	Yes	40	100
47	14	100000000	10.45	Yes	Yes	Yes	Clear	No taste	No smell	0.1	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
48	14	No supply	.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Use domestic water points only	Yes	4	5700	No	N/A	N/A
49	4	300000000	12.14	Yes	Yes	Yes	Clear	No taste	No smell	0.2	0	Less than 1 hour	No	N/A	N/A	Yes	Don't know	Don't know
50	300	No supply	9.03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.5	No	N/A	N/A	Yes	100	15000

Appendix 6-2 Social Conditions Survey ④ Survey Data (5/10)

No.	Q9-7. Do you sell water?	Q9-8. How many litres per day do you sell?	Q9-9. How much do you sell per day?	Q11-1a. Is there a drainage pipe from your house?	Q11-1b. Where is the drainage pipe from your house connected to?	Q11-2a. What type of toilet do you have?	Q11-2b. Where are the toilet outlet pipes connecting to?	Q12-1. Do you wash your hands before and after meals?	Q12-2. Do you always wash your hands after using the toilet?	Q12-3. Do you wash your clothes everyday?	Q12-4. Do you wash your body everyday?	Q12-5. Do you wash your dishes sufficiently after meals?	Q12-6. Do you wash the vegetable and fruits sufficiently before cooking?	Q13-2. Medical cost of the family per year (examination + treatment + medicine)	Q14-1. Degree of satifaction to public water supply service	Q14-2. Degree of satisfaction to public sewerage service
1	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	No	No	Don't know	Enough	Enough
2	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	30000	Good	Good
3	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Don't know	Good	Good
4	No	N/A	N/A	Yes	Sewer	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
5	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
6	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
7	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
8	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	600000	Good	Good
9	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
10	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	Don't know	Fair	Fair
11	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	Don't know	Enough	Enough
12	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
13	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	Don't know	Enough	Enough
14	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	Don't know	Enough	Enough
15	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
16	No	N/A	N/A	Yes	Ditch	Flash toilet	Septic tank	Yes	Yes	No	Yes	Yes	Yes	500000	Bad	Bad
17	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	Don't know	Good	Good
18	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	No	Yes	Yes	40000	Enough	Enough
19	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	No	Yes	Yes	Don't know	Bad	Bad
20	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
21	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Enough	Bad
22	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
23	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Fair
24	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	1000000	Bad	Bad
25	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Good	Good
26	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	700000	Bad	Bad
27	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	100000	Enough	Enough
28	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
29	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Don't know	Good	Good
30	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	Yes	Yes	50000	Good	Good
31	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	30000	Good	Good
32	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	50000	Fair	Fair
33	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
34	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	N/A (Don't pay)	Fair	Good
35	No	N/A	N/A	Yes	Soak in the ground	Flash toilet	Septic tank	Yes	Yes	Yes	Yes	Yes	Yes	N/A (Don't pay)	Good	Good
36	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	Septic tank	Yes	Yes	No	Yes	Yes	Yes	20000	Good	Good
37	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	12000	Fair	Bad
38	No	N/A	N/A	Yes	Sewer	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	500000	Good	Bad
39	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	50000	Good	Good
40	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	50000	Good	Good
41	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	100000	Good	Good
42	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	Septic tank	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
43	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	Yes	Yes	25000	Fair	Fair
44	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	500000	Good	Good
45	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	No	Yes	500000	Good	Good
46	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	3500	Good	Good
47	No	N/A	N/A	Yes	Soak in the ground	Flash toilet	Septic tank	Yes	Yes	No	Yes	Yes	Yes	500000	Fair	Good
48	No	N/A	N/A	Yes	Soak in the ground	Flash toilet	Septic tank	Yes	Yes	No	Yes	Yes	Yes	N/A (Don't pay)	Bad	Bad
49	No	N/A	N/A	Yes	Soak in the ground	Flash toilet	Septic tank	Yes	Yes	No	Yes	Yes	Yes	100000	Fair	Fair
50	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	3500000	Bad	Fair

Appendix 6-2 Social Conditions Survey ④ Survey Data (6/10)

No.	Q0-1.	Q0-2.	Q0-3.				Q0-5.	Part	Area	Type of connection for the main source of water	GPS Readings			
	Date of Interview	Name of Surveyor	Answerer name	Sex of respondent	Age of respondent	Relationship of respondent to the household head	Area Category				South degrees	South minutes	South seconds	East degrees
51	04.09.2010	MUTUNWA DORIS	ESTHER SENDAMA	Female	41	Spouse	High cost Area	North	NORTHRISE	Pipeline	12	57	54.5	28
52	04.09.2010	MUTUNWA DORIS	DERICK CHENGO	Male	30	Household head	High cost Area	North	NORTHRISE	Pipeline	12	57	51.7	28
53	04.09.2010	MUTUNWA DORIS	DAKA CHITALAKA	Male	29	Household head	High cost Area	North	NORTHRISE	Pipeline	12	56	58.2	28
54	06.09.2010	DORIS MUTUNWA	IRENE MUSONDA	Female	26	Spouse	Low cost Area	North	DOLA HILL	Pipeline	12	57	37.3	28
55	06.09.2010	MUTUNWA DORIS	STANLAS BWALYA KABWE	Male	47	Household head	Low cost Area	North	DOLA HILL	Pipeline	12	57	33.9	28
56	06.09.2010	MUTUNWA DORIS	ANNETTA KAMWENDO	Female	38	Household head	Low cost Area	North	DOLA HILL	Pipeline	12	57	37.9	28
57	03.09.2010	MUTUNWA DORIS	MRS. EMILY BANDA	Female	35	Spouse	Low cost Area	South	KX(KAFUBA)	Pipeline	12	59	35.5	28
58	03.09.2010	MUTUNWA DORIS	ELISE CHUNGA	Female	31	Household head	Low cost Area	South	KX(KAFUBU)	Pipeline	12	59	21.1	28
59	03.09.2010	MUTUNWA DORIS	BRENDA KAMEME	Female	34	PARENTS	Low cost Area	South	KX(KAFUBU)	Pipeline	12	59	16.9	28
60	04.09.2010	MUTUNWA DORIS	G. MULENGA	Female	64	Household head	Medium cost Area	South	LUBUTO	Pipeline	12	59	59.8	28
61	04.09.2010	MUTUNWA DORIS	TEBAISHIBA SIKANZWE	Female	36	Household head	Medium cost Area	South	LUBUTO	Pipeline	13	0	4.6	28
62	06.09.2010	MUTUNWA DORIS	GIVEN ZIMBA KALENGA	Female	29	Spouse	Medium cost Area	South	LUBUTO	Pipeline	12	59	53.7	28
63	06.09.2010	MUTUNWA DORIS	ANNE MULENGA	Female	38	DAUGHTER	Medium cost Area	South	LUBUTO	Pipeline	13	0	47.8	28
64	03.09.2010	ESTHER DAKA	VICTORIA BANDA	Female	28	SISTER	Low cost Area	South	MINE MASALA	Pipeline	13	0	35.5	28
65	03.09.2010	ESTHER DAKA	SILOS KAMANGA	Male	83	FATHER	Low cost Area	South	MINE MASALA	Pipeline	13	0	49.1	28
66	06.09.2010	ESTHER DAKA	LENTRY MOONDE	Female	32	Spouse	Low cost Area	South	MINE MASALA	Pipeline	13	0	56.3	28
67	03.09.2010	ESTHER DAKA	MULENGA KATONGO	Male	56	Household head	Low cost Area	South	MINE MASALA	Pipeline	13	0	42.2	28
68	02.09.2010	ESTHER DAKA	AGNESS MWANGO	Female	51	Household head	High cost Area	North	KANSENSHI	Pipeline	12	57	30.2	28
69	02.09.2010	ESTHER DAKA	FLORENCE NAMBELA	Female	30	SISTER	High cost Area	North	KANSENSHI	Pipeline	12	57	29.6	28
70	02.09.2010	ANNIE K. TEMBO	BERNADETTE CHIRWA	Female	65	Household head	High cost Area	North	KANSENSHI	Pipeline	12	57	45.2	28
71	04.09.2010	ANNIE K. TEMBA	GRACE HANYUMA	Female	40	Household head	High cost Area	North	KANSENSHI	Pipeline	12	57	19.3	28
72	02.09.2010	ESTHER DAKA	LENNI BANDA	Female	56	Household head	High cost Area	South	HILL CREST	Pipeline	12	58	20.2	28
73	02.09.2010	ESTHER DAKA	SUSAN CHIRWA	Female	29	Spouse	High cost Area	South	HILL CREST	Pipeline	12	58	32.7	28
74	02.09.2010	ESTHER DAKA	SUYA MUKUNDA	Male	51	Household head	High cost Area	South	HILL CREST	Pipeline	12	58	25	28
75	03.09.2010	ESTHER DAKA	CLARA NKANDU	Female	26	DAUGHTER	Low cost Area	South	MAIN MASALA	Pipeline	13	0	13	28
76	03.09.2010	ESTHER DAKA	ADRIAN MWANZA	Male	33	Household head	Low cost Area	South	MAIN MASALA	Pipeline	13	0	13.4	28
77	03.09.2010	ESTHER DAKA	GRACE CHISANGA	Female	21	Household head	Low cost Area	South	MAIN MASALA	Pipeline	13	0	21.6	28
78	03.09.2010	ESTHER DAKA	CHISHIMBA NAKAWALA	Female	16	NIECE	Low cost Area	South	MAIN MASALA	Pipeline	13	0	27.7	28
79	06.09.2010	ESTHER DAKA	GODFRIDAH SUMBUKENI	Female	48	Household head	Low cost Area	North	CHIPULUKUSU	Pipeline	12	56	47.2	28
80	06.09.2010	BALASI MUZE	BARBARA KABASO	Female	19	DAUGHTER	Low cost Area	North	CHIPULUKUSU	Pipeline	12	56	57.4	28
81	06.09.2010	ESTHER DAKA	MAJORY CHILAMBWE	Female	29	Household head	Low cost Area	North	CHIPULUKUSU	Pipeline	12	57	4.8	28
82	06.09.2010	ESTHER DAKA	MEMORY LUNGU	Female	16	DAUGHTER	Low cost Area	North	CHIPULUKUSU	Pipeline	12	57	4.1	28
83	06.09.2010	ESTHER DAKA	HILDA MULENGA	Female	28	Spouse	Peri-Urban	South	MACKENZIE	Pipeline	12	59	25.1	28
84	06.09.2010	BALASI MUZE	ROBERTA NDLOVU	Female	26	Spouse	Peri-Urban	South	MACKENZIE	Pipeline	12	59	25.1	28
85	06.09.2010	ESTHER DAKA	LEYA NGUNI	Female	31	Spouse	Peri-Urban	South	MACKENZIE	Pipeline	12	59	31.3	28
86	01.09.2010	ESTHER DAKA	VIVIAN NGONI	Female	27	Spouse	Peri-Urban	North	NKWAZI	Pipeline	12	56	35.1	28
87	01.09.2010	BALASI MUZE	ABRAHAM KASUNKA	Male	26	Household head	Low cost Area	North	CHIFUBU	Pipeline	12	55	49.9	28
88	01.09.2010	ESTHER DAKA	ALICE CHIWELE	Female	16	DAUGHTER	Low cost Area	North	CHIFUBU	Pipeline	12	55	41.6	28
89	01.09.2010	ESTHER DAKA	PAMELA MUMBA	Female	37	Spouse	Low cost Area	North	CHIFUBU	Pipeline	12	55	46.7	28
90	01.09.2010	ESTHER DAKA	GRACE KABOKO	Female	38	Spouse	Low cost Area	North	CHIFUBU	Pipeline	12	56	15.7	28
91	04.09.2010	ESTHER DAKA	FLORENCE NAMUNKONDYA	Female	15	DAUGHTER	High cost Area	North	KANINI	Pipeline	12	58	46.2	28
92	04.09.2010	ESTHER DAKA	CHARITY MBAMBE	Female	27	Household head	High cost Area	North	KANINI	Pipeline	12	58	46.6	28
93	04.09.2010	ESTHER DAKA	FLORENCE CHALIKOSA	Female	45	Household head	High cost Area	North	KANINI	Pipeline	12	58	48.1	28
94		ESTHER DAKA	VIVIAN KAPAMBA	Female	30	Household head	High cost Area	North	BROADWAY	Pipeline	12	58	4.1	28
95	04.09.2010	ESTHER DAKA	CECILIA CHAMPWA	Female	37	Spouse	High cost Area	North	BROADWAY	Pipeline	12	58	5.3	28
96	04.09.2010	ESTHER DAKA	PAMELA YIKONA	Female	38	Household head	High cost Area	North	BROADWAY	Pipeline	12	58	4.9	28
97	06.09.2010	ESTHER DAKA	EUNICE MWANSHYE	Female	48	Household head	High cost Area	South	NDEKE	Pipeline	13	0	16.5	28
98	06.09.2010	ESTHER DAKA	FLAVIA MUKELABAI	Female	37	Spouse	High cost Area	South	NDEKE	Pipeline	13	0	18.5	28
99	06.09.2010	ESTHER DAKA	LYDIA CHISHIMBA	Female	28	Spouse	High cost Area	South	NDEKE	Pipeline	13	0	15.1	28
100	06.09.2010	ESTHER DAKA	IREEN H. BANDA	Female	39	Spouse	High cost Area	South	NDEKE	Pipeline	13	0	11	28

Appendix 6-2 Social Conditions Survey ④ Survey Data (7/10)

No.	GPS Readings		Q1-1.	Q1-2.	Q1-3.	Q2-1.	Q2-2.	Q3-1.	Q3-2b.	Q3-3.	Q3-4.	Q3-5a.	Q3-5b.	Q4-1.	Q4-2.	Q4-3.
	East minutes	East seconds	How many are you in the family? (during night time)	How many are you in the family? (during day time)	How long have you lived here?	Who is the main income earner in the family?	What is the total income for the family per month (please include from all sources)?	How much do you pay for water per month? (consider what was paid in July, 2010	How much do you pay per month for sewerage charges? (consider what was paid in July, 2010)	How much do you pay per month for electricity? (consider what was paid in July, 2010)	Have you had water disconnected because of non payment in the past six months?	Wht is your perception on the mount you pay for water?	How much are you willing to pay for water and sewerage service per month?	Is there a water meter installed by KWSC?	Is the water meter working?	Has the KWSC meter reader visited in teh past six months?
51	38	27.4	9	2	1	Household head	ZMK 1,000,001 - 2,000,000	315000	Don't know	300000	Yes	Fair	300000	Yes	Yes	Yes
52	39	4.8	5	3	1	Household head	ZMK 1,000,001 - 2,000,000	100000	40000	150000	N/A	Fair	150000	Yes	Yes	Yes
53	38	47.2	5	1	3	Household head	Above ZMK 5,000,001	80000	1967	100000	Yes	Fair	100000	Yes	Yes	Yes
54	35	38.4	6	3	0	Household head	Less than ZMK500, 000	N/A	N/A	N/A	N/A	Expensive	15000	No	No	N/A
55	35	37.8	5	1	-1	Household head	ZMK 500, 001 - 1,000,000	15000	N/A	70000	Yes	Very Expensive	10000	No	N/A	N/A
56	35	33.9	6	1	5	Household head	ZMK 1,000,001 - 2,000,000	10000	N/A	N/A	Yes	Fair	10000	No	N/A	N/A
57	38	41.5	6	2	2	Household head	ZMK 2,000,001 - 5,000,000	250000	Don't know	300000	N/A	Fair	150000	No	N/A	N/A
58	38	34.6	10	4	43	Household head	Less than ZMK500, 000	N/A	N/A	N/A	N/A	Expensive	N/A (Free)	N/A	N/A	N/A
59	38	36.1	14	7	30	Household head	ZMK 500, 001 - 1,000,000	3000	N/A	120000	Yes	Fair	3000	N/A	N/A	N/A
60	36	25.1	10	10	10	Household head	Less than ZMK500, 000	120000	Don't know	50000	Yes	Very Expensive	60000	Yes	Yes	Yes
61	36	41.1	14	2	3	Household head	ZMK 1,000,001 - 2,000,000	85000	35000	160000	Yes	Fair	80000	Yes	Yes	Yes
62	37	0.7	3	3	28	Household head	ZMK 500, 001 - 1,000,000	75000	Don't know	150000	Yes	Fair	70000	Yes	Yes	Yes
63	36	56.1	6	4	38	DAUGHTER	Less than ZMK500, 000	150000	Don't know	100000	N/A	Expensive	50000	Yes	Yes	Yes
64	38	18.4	5	3	30	Household head	ZMK 500, 001 - 1,000,000	Don't know	Don't know	150000	Yes	Fair	50000	No	N/A	N/A
65	38	8.6	4	5	29	DAUGHTERS	ZMK 500, 001 - 1,000,000	Don't know	Don't know	200000	Yes	Fair	Don't know	No	N/A	N/A
66	38	15.6	4	2	1	Household head	ZMK 1,000,001 - 2,000,000	50000	N/A	N/A	Yes	Fair	Don't know	No	N/A	N/A
67	38	24.3	4	3	21	Household head	ZMK 500, 001 - 1,000,000	35000	Don't know	160000	N/A	Fair	35000	No	N/A	N/A
68	37	51.6	7	3	0	Household head	ZMK 1,000,001 - 2,000,000	Don't know	Don't know	150000	Yes	Fair	Don't know	No	N/A	N/A
69	37	51	3	1	10	Household head	Less than ZMK500, 000	Don't know	N/A	Don't know	Yes	Fair	Don't know	No	N/A	N/A
70	37	43.2	12	4	22	Household head	Less than ZMK500, 000	80000	N/A	150000	Yes	Fair	60000	Yes	Yes	Yes
71	37	44.7	4	2	13	Household head	ZMK 500, 001 - 1,000,000	100000	30000	100000	Yes	Fair	100000	Yes	Yes	Yes
72	37	11.3	6	7	35	CHILDREN'S SOURCES	ZMK 1,000,001 - 2,000,000	176000	69000	200000	N/A	Expensive	100000	Yes	Yes	Yes
73	37	9.2	7	9	0	Household head	Less than ZMK500, 000	11000	Don't know	150000	N/A	Fair	50000	No	N/A	N/A
74	37	9.3	6	2	10	Spouse	ZMK 1,000,001 - 2,000,000	57827	23131	200000	Yes	Fair	60000	No	N/A	N/A
75	38	23.4	7	4	26	Household head	Less than ZMK500, 000	Don't know	N/A	50000	Yes	Fair	Don't know	No	N/A	N/A
76	38	10.3	10	3	33	Household head	Less than ZMK500, 000	N/A	N/A	N/A	Yes	Expensive	Don't know	No	N/A	N/A
77	38	17.9	6	5	0	Household head	Less than ZMK500, 000	N/A	N/A	50000	Yes	Expensive	Don't know	No	N/A	N/A
78	38	14.4	3	2	20	Household head	ZMK 500, 001 - 1,000,000	Don't know	Don't know	200000	N/A	Fair	Don't know	No	N/A	N/A
79	39	19.3	16	3	27	Household head	ZMK 500, 001 - 1,000,000	160000	N/A	200000	N/A	Very Expensive	80000	Yes	Yes	Yes
80	39	17.6	6	4	-1	Household head	ZMK 500, 001 - 1,000,000	50000	N/A	75000	Yes	Fair	50000	Yes	Yes	Yes
81	39	17.7	7	1	-1	Household head	Less than ZMK500, 000	Don't know	N/A	N/A	Yes	Fair	Don't know	Yes	Yes	Yes
82	39	26.2	8	6	-1	Spouse	ZMK 500, 001 - 1,000,000	100000	N/A	150000	Yes	Expensive	50000	Yes	Yes	Yes
83	40	7	4	3	1	Household head	Less than ZMK500, 000	250000	N/A	N/A	Yes	Fair	2500	Yes	No	Yes
84	40	7	5	4	3	Spouse	Less than ZMK500, 000	3000	N/A	N/A	Yes	Fair	Don't know	Yes	No	Yes
85	40	11.3	8	4	15	Household head	ZMK 500, 001 - 1,000,000	3000	N/A	N/A	Yes	Fair	2500	Yes	Yes	Yes
86	38	57.8	6	4	-1	Household head	Less than ZMK500, 000	Don't know	Don't know	Don't know	Yes	Fair	Don't know	No	N/A	N/A
87	36	19	6	4	26	ALL MEMBERS OF HH	Less than ZMK500, 000	N/A	N/A	N/A	N/A	Expensive	10000	No	N/A	N/A
88	36	10	9	0	5	Household head	ZMK 500, 001 - 1,000,000	Don't know	Don't know	100000	Yes	Fair	Don't know	No	N/A	N/A
89	36	48.7	11	2	11	Household head	ZMK 1,000,001 - 2,000,000	200000	Don't know	300000	Yes	Expensive	70000	No	N/A	N/A
90	36	51.2	10	2	14	Household head	ZMK 500, 001 - 1,000,000	N/A	N/A	200000	Yes	Expensive	40000	No	N/A	N/A
91	37	47.1	6	2	3	Household head	ZMK 2,000,001 - 5,000,000	106949	Don't know	250000	Yes	Fair	110000	Yes	Yes	N/A
92	37	54.3	2	1	2	Household head	ZMK 500, 001 - 1,000,000	20000	Don't know	50000	Yes	Expensive	10000	Yes	Yes	Yes
93	37	53.7	6	3	6	Household head	ZMK 2,000,001 - 5,000,000	150000	155000	300000	Yes	Expensive	70000	No	N/A	N/A
94	38	14.8	4	5	2	Household head	ZMK 2,000,001 - 5,000,000	60000	15000	100000	Yes	Fair	60000	Yes	Yes	No
95	38	28.7	4	1	13	Household head	ZMK 2,000,001 - 5,000,000	150000	63000	300000	N/A	Fair	150000	Yes	Yes	Yes
96	38	42.4	9	4	1	Household head	ZMK 2,000,001 - 5,000,000	120000	64000	200000	Yes	Expensive	150000	Yes	Yes	Yes
97	39	30.2	5	3	17	Household head	ZMK 500, 001 - 1,000,000	100000	13000	Don't know	Yes	Fair	50000	Yes	Yes	Yes
98	39	30.2	4	3	5	Household head	ZMK 500, 001 - 1,000,000	50000	2000	150000	Yes	Fair	50000	Yes	Yes	Yes
99	39	39.7	3	0	1	Household head	ZMK 1,000,001 - 2,000,000	100000	Don't know	150000	N/A	Fair	100000	Yes	Yes	Yes
100	39	36.2	7	8	4	Household head	ZMK 1,000,001 - 2,000,000	75000	20000	150000	Yes	Fair	70000	Yes	No	N/A

Appendix 6-2 Social Conditions Survey ④ Survey Data (8/10)

No.	Q4-4.	Q4-5.	Q5-1a.	Q5-1b.	Q5-2a.	Q5-2b.	Q5-3.	Q6-1.	Q6-2.	Q6-3.	Q6-4.							Q6-5a.
	Do you normally receive the KWSC water bills?	How do you pay the charged tarrif?	What type of dwelling do you have?	If answer to 5-1 is '2' Apartment building, what floor do oyu live in?	Do you use an overhead water tank?	Do you have ground storage tank?	Do you use a booster pump?	How many years ago was the public water supply connected to your house?	Do you share one tap with your neighbourhood ?	How many hours in total do you have water in a day?	What period(s) does tap water come in a day? 1. From	What period(s) does tap water come in a day? 2. From	What period(s) does tap water come in a day? 3. From	What period(s) does tap water come in a day? 1. to	What period(s) does tap water come in a day? 2. to	What period(s) does tap water come in a day? 3. to	Have you experienced any water shortage for a whole day in the past years?
51	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	24	.	.	.	.	.	.	Yes
52	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	1	N/A	24	.	.	.	.	.	.	Yes
53	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	N/A	3	5	21	.	7	22	.	Yes
54	No	N/A	Stand alone house	N/A	No	No	No	Don't know	Yes	24	.	.	.	.	.	.	Yes
55	No	Through my employer	Stand alone house	N/A	No	No	No	Don't know	Yes	24	.	.	.	.	.	.	Yes
56	N/A	Through my employer	Stand alone house	N/A	No	No	No	Don't know	Yes	11	6	.	.	17	.	.	Yes
57	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	24	.	.	.	.	.	.	Yes
58	N/A	N/A	Stand alone house	N/A	No	No	No	N/A	Yes	24	.	.	.	.	.	.	Yes
59	N/A	PRIVATE TAP OWNERS	Stand alone house	N/A	No	No	No	N/A	N/A	24	.	.	.	.	.	.	Yes
60	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	N/A	24	.	.	.	.	.	.	Yes
61	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	3	N/A	11	7	.	.	11	.	.	No
62	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	10	6	.	.	16	.	.	Yes
63	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	5	6	.	.	12	.	.	Yes
64	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	8	8	8	.	16	14	.	Yes
65	No	N/A	Stand alone house	N/A	No	No	No	Don't know	No	8	6	.	.	20	.	.	Yes
66	No	N/A	Stand alone house	N/A	No	No	No	Don't know	No	12	6	.	.	18	.	.	Yes
67	No	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	12	7	6	.	18	17	.	Yes
68	No	N/A	Apartment building	10	No	Yes	Yes	Don't know	No	24	.	.	.	.	.	.	Yes
69	N/A	THROUGH RENT	Apartment building	1	No	Yes	Yes	Don't know	No	24	.	.	.	.	.	.	No
70	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	11	6	16	.	12	21	.	Yes
71	N/A	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	16	6	.	.	22	.	.	No
72	Yes	Go to KWSC payment office	Stand alone house	N/A	No	Yes	Yes	35	Yes	24	.	.	.	.	.	.	Yes
73	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	12	6	.	.	18	.	.	Yes
74	Yes	Through the bank	Apartment building	0	No	No	No	Don't know	No	24	.	.	.	.	.	.	Yes
75	No	N/A	Stand alone house	N/A	No	No	No	Don't know	Yes	3	7	9	.	9	14	.	No
76	No	Through the bank	Stand alone house	N/A	No	No	No	Don't know	Yes	8	9	.	.	16	.	.	Yes
77	No	Through the bank	Stand alone house	N/A	No	No	No	Don't know	Yes	9	7	9	10	15	15	15	Yes
78	Yes	Go to KWSC payment office	Stand alone house	N/A	Yes	Yes	Yes	Don't know	Yes	8	8	.	.	15	.	.	Yes
79	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	26	Yes	6	6	.	.	12	.	.	Yes
80	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	16	Yes	24	.	.	.	.	.	.	Yes
81	Yes	DOES NOT KNOW HUSBAND PAYS	Stand alone house	N/A	No	No	No	1	Yes	10	6	10	17	10	15	22	Yes
82	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	5	No	24	.	.	.	.	.	.	Yes
83	No	KAFUBU WATERCOME	Stand alone house	N/A	No	No	No	6	Yes	24	.	.	.	.	.	.	Yes
84	No	VENDOR	Stand alone house	N/A	No	No	No	N/A	Yes	11	6	13	.	12	18	.	Yes
85	Yes	OFFICER COLLECTS MONEY	Stand alone house	N/A	No	No	No	Don't know	No	9	6	14	.	12	17	.	Yes
86	No	DO NOT KNOW	Stand alone house	N/A	Yes	No	No	1	Yes	12	6	18	.	17	22	.	Yes
87	No	N/A	Stand alone house	N/A	No	No	No	N/A	Yes	11	6	14	.	12	19	.	No
88	No	LANDLORD PAYS	Stand alone house	N/A	No	No	No	Don't know	Yes	4	8	.	.	11	.	.	Yes
89	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	12	9	21	.	18	6	.	Yes
90	No	N/A	Stand alone house	N/A	No	No	No	Don't know	No	8	9	.	.	12	.	.	Yes
91	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	24	.	.	.	.	.	.	Yes
92	No	THROUGH RENT	Stand alone house	N/A	No	No	No	Don't know	Yes	24	.	.	.	.	.	.	Yes
93	Yes	Go to KWSC payment office	Apartment building	1	No	No	No	Don't know	No	12	18	.	.	6	.	.	Yes
94	Yes	Through the bank	Apartment building	N/A	No	No	No	Don't know	No	12	21	.	.	6	.	.	Yes
95	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	24	.	.	.	.	.	.	No
96	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	24	.	.	.	.	.	.	No
97	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	8	7	18	.	15	22	.	Yes
98	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	5	6	.	.	11	.	.	Yes
99	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	Yes	5	7	.	.	12	.	.	Yes
100	Yes	Go to KWSC payment office	Stand alone house	N/A	No	No	No	Don't know	No	7	7	.	.	16	.	.	Yes

Appendix 6-2 Social Conditions Survey ④ Survey Data (9/10)

No.	Q6-5b.	Q7-1.		Q7-2.	Q7-3.	Q7-4.	Q8-1.	Q8-2.	Q8-3.	Q8-4.	Q8-5.	Q9-2.	Q9-3a.	Q9-3b.	Q9-4.	Q9-5a.	Q9-5b.	Q9-6.
	If answer to 6-5a is '1' Yes, approximately how many total days in a year?	Water pressure from the tap, measured with bourdon pressure meter (Pa/cm2)	Time	Is water pressure in the morning enough?	Is water pressure in the afternoon enough?	Is water pressure in the night enough?	Color (surveyor's visual cheack)	Taste (surveyor's drinking check)	Smell (surveyor's sniffing check)	Residual chlorine (surveyor conducts pack test)	Colon bacillus (surveyor conducts the 24 hours test with test paper)	How many hours do you spend in a day for fetching water and carrying back?	Do you buy bottled water for drinking?	How many litres of bottled water do you drink per day as a household?	How much do you spend on bottled water as a household per day?	Do you spend money on water for domestic use?	How many litres of water do you use for domestic use per day?	How much do you spend on domestic water per day?
51	15	Low pressure	9.4	No	No	No	Clear	Odd taste	Odd smell	0.2	0	Use domestic water points only	Yes	N/A	N/A	No	N/A	N/A
52	1	50000000	10.2	Yes	Yes	Yes	Clear	No taste	No smell	0.2	0	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
53	96	No supply	11.23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	No	N/A	N/A	No	N/A	N/A
54	12	Low pressure	14.43	No	Yes	Yes	Clear	No taste	No smell	1	0	2	No	N/A	N/A	Yes	100	N/A
55	12	Low pressure	14.12	Yes	No	Yes	Clear	No taste	No smell	1	0	Less than 1 hour	No	N/A	N/A	Yes	60	N/A
56	36	Low pressure	15.12	Yes	Yes	Yes	Clear	No taste	No smell	0.4	0	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
57	10	Low pressure	14.12	Yes	Yes	Yes	Clear	No taste	No smell	0.2	0	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
58	24	No supply	14.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
59	5	Low pressure	14.5	Yes	Yes	Yes	Clear	No taste	No smell	0.1	1	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
60	Don't know	50000000	15.15	Yes	Yes	No	Clear	No taste	No smell	0.4	0	1.3	No	N/A	N/A	No	Don't know	Don't know
61	Don't know	Low pressure	15.48	No	No	No	Not clear	No taste	Odd smell	0.2	0	2	No	N/A	N/A	No	N/A	N/A
62	40	Low pressure	9.3	Yes	Yes	No	Clear	No taste	No smell	0.2	0	2	Yes	1	300	No	N/A	N/A
63	48	Low pressure	9.55	No	No	No	Clear	Odd taste	Odd smell	0.4	0	2	No	N/A	N/A	Yes	120	6000
64	90	Low pressure	11.11	No	No	No	Clear	No taste	No smell	0.1	100	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
65	90	Low pressure	11.4	Yes	Yes	Yes	Clear	No taste	No smell	0.2	8	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
66	30	Low pressure	12.12	No	No	No	Clear	No taste	Odd smell	0.4	0	Use domestic water points only	Yes	2	25000	No	N/A	N/A
67	90	Low pressure	12.36	Yes	No	No	Clear	No taste	No smell	0.2	15	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
68	N/A	Low pressure	12.35	Yes	No	Yes	Clear	No taste	No smell	0	1	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
69	Don't know	200000000	13	Yes	No	Yes	Clear	No taste	No smell	0	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
70	Don't know	100000000	12.42	Yes	No	No	Clear	No taste	No smell	0.1	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
71	Don't know	90000000	10.23	Yes	Yes	No	Clear	No taste	No smell	0.2	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
72	20	Low pressure	10.17	Yes	Yes	Yes	Clear	No taste	No smell	0.2	1	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
73	Don't know	50000000	10.39	Yes	Yes	Yes	Clear	No taste	No smell	0.1	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
74	4	Low pressure	11.08	Yes	Yes	No	Clear	No taste	No smell	0	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
75	Don't know	Low pressure	9.1	No	No	No	Clear	No taste	No smell	0.1	1	2	No	N/A	N/A	No	N/A	N/A
76	90	No supply	9.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
77	90	No supply	10.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
78	90	Low pressure	10.4	Yes	No	Yes	Clear	No taste	No smell	0.4	5	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
79	30	No supply	.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
80	30	Low pressure	13.56	Yes	No	Yes	Clear	No taste	No smell	0.1	9	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
81	90	250000000	.	Yes	No	No	Clear	No taste	No smell	0	0	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
82	10	Low pressure	.	Yes	Yes	Yes	Clear	No taste	No smell	0	0	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
83	Don't know	400000000	11.18	Yes	Yes	Yes	Not clear	No taste	Odd smell	0.1	1	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
84	Don't know	400000000	11.4	Yes	Yes	Yes	Clear	No taste	No smell	0.1	1		No	N/A	N/A	Yes	60	100
85	10	200000000	12.08	Yes	Yes	Yes	Not clear	Odd taste	Odd smell	0.1	1	Less than 1 hour	No	N/A	N/A	No	N/A	N/A
86	90	100000000	13.05	Yes	Yes	Yes	Clear	No taste	No smell	0.4	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
87	Don't know	150000000	10.2	Yes	Yes	Yes	Clear	No taste	No smell	0.2	1	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
88	90	Low pressure	10.56	Yes	No	No	Clear	No taste	No smell	0.4	0	Use domestic water points only	Yes	N/A	Don't know	No	N/A	N/A
89	Don't know	Low pressure	11.45	No	No	No	Clear	No taste	No smell	0.1	9	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
90	100	No supply	12.15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
91	90	50000000	8.51	No	No	No	Clear	No taste	No smell	0.2	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
92	90	Low pressure	9.28	Yes	Yes	Yes	Clear	No taste	No smell	0.2	0	Use domestic water points only	No	N/A	N/A	Yes	20	N/A
93	Don't know	Low pressure	10.07	Yes	Yes	Yes	Clear	No taste	Odd smell	0.2	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
94	30	Low pressure	10.58	Yes	Yes	No	Clear	No taste	No smell	0.1	6	Use domestic water points only	No	N/A	N/A	Yes	40	N/A
95	N/A	50000000	11.23	Yes	Yes	Yes	Clear	No taste	No smell	0.1	0	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
96	Don't know	100000000	12.05	Yes	Yes	Yes	Clear	No taste	No smell	0.1	2	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
97	90	Low pressure	9.05	Yes	No	No	Clear	No taste	No smell	0.1	30	1	No	N/A	N/A	No	N/A	N/A
98	60	Low pressure	9.29	No	No	No	Not clear	Odd taste	No smell	0.1	1	5	No	N/A	N/A	No	N/A	N/A
99	60	Low pressure	10.11	No	No	No	Not clear	Odd taste	Odd smell	0.2	2	Use domestic water points only	No	N/A	N/A	No	N/A	N/A
100	90	Low pressure	10.3	Yes	No	No	Not clear	Odd taste	Odd smell	0.1	0	Less than 1 hour	Yes	2	15000	No	N/A	N/A

Appendix 6-2 Social Conditions Survey ④ Survey Data (10/10)

No.	Q9-7. Do you sell water?	Q9-8. How many litres per day do you sell?	Q9-9. How much do you sell per day?	Q11-1a. Is there a drainage pipe from your house?	Q11-1b. Where is the drainage pipe from your house connected to?	Q11-2a. What type of toilet do you have?	Q11-2b. Where are the toilet outlet pipes connecting to?	Q12-1. Do you wash your hands before and after meals?	Q12-2. Do you always wash your hands after using the toilet?	Q12-3. Do you wash your clothes everyday?	Q12-4. Do you wash your body everyday?	Q12-5. Do you wash your dishes sufficiently after meals?	Q12-6. Do you wash the vegetable and fruits sufficiently before cooking?	Q13-2. Medical cost of the family per year (examination + treatment + medicine)	Q14-1. Degree of satifaction to public water supply service	Q14-2. Degree of satisfaction to public sewerage service
51	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
52	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	Don't know	Fair	Fair
53	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	No	Yes	Don't know	Bad	Enough
54	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	30000	Good	Good
55	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	Yes	Yes	10000	Fair	Fair
56	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	50000	Fair	Fair
57	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	200000	Fair	Fair
58	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	Yes	Yes	250000	Bad	Fair
59	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	Yes	Yes	500000	Fair	Fair
60	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	60000	Fair	Fair
61	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	3000000	Bad	Fair
62	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	60000	Good	Good
63	Yes	1	4000	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	200000	Good	Bad
64	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	Don't know	Bad	Bad
65	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
66	No	N/A	N/A	No	Soak in the ground	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
67	No	N/A	N/A	No	N/A	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	120000	Bad	Bad
68	No	N/A	N/A	No	N/A	Flash toilet	Sewer	Yes	Sometimes	No	Yes	Yes	Yes	Don't know	Fair	Fair
69	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
70	No	N/A	N/A	Yes	Soak in the ground	Flash toilet	Septic tank	Yes	Yes	No	Yes	Yes	Yes	Don't know	Enough	Fair
71	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Good	Good
72	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	300000	Bad	Bad
73	No	N/A	N/A	No	N/A	Flash toilet	Septic tank	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
74	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	5000000	Fair	Fair
75	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	500000	Bad	Bad
76	No	N/A	N/A	No	N/A	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
77	No	N/A	N/A	No	N/A	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	Don't know	Bad	Bad
78	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
79	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
80	No	N/A	N/A	Yes	Soak in the ground	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
81	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	50000	Fair	Fair
82	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	No	Yes	Yes	Yes	50000	Fair	Fair
83	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Don't know	Fair	Fair
84	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Don't know	Good	Bad
85	No	N/A	N/A	No	N/A	Pit/V.I.P latrine	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Don't know	Fair	Fair
86	No	N/A	N/A	No	N/A	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	24000	Fair	Fair
87	No	N/A	N/A	No	N/A	Flash toilet	Sewer	Yes	Sometimes	Yes	Yes	Yes	Yes	Don't know	Good	Good
88	No	N/A	N/A	No	N/A	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
89	No	N/A	N/A	No	N/A	Flash toilet	Sewer	Yes	Yes	No	No	Yes	Yes	Don't know	Fair	Fair
90	No	N/A	N/A	No	N/A	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
91	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Fair
92	No	N/A	N/A	No	N/A	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Bad	Bad
93	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	500000	Bad	Bad
94	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	200000	Bad	Bad
95	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	100000	Fair	Fair
96	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	Don't know	Fair	Fair
97	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	100000	Fair	Fair
98	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	100000	Bad	Bad
99	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	No	Yes	Yes	Yes	100000	Bad	Bad
100	No	N/A	N/A	Yes	Sewer	Flash toilet	Sewer	Yes	Yes	Yes	Yes	Yes	Yes	500000	Fair	Fair

Appendix 6-3 Check List on Environmental and Social Consideration

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	① Have EIA reports been officially completed? ② Have EIA reports been approved by authorities of the host country's government? ③ Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? ④ In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	① Have submitted EPB to ECZ (Environmental council of Zambia) in the month of September, 2010. ② Decision letter would be issued within 40 days after the submission date. ③ Have not received the decision letter yet. ④ No necessary permission from other authorities or government are needed except from the regulator ECZ.
	(2) Explanation to the Public	① Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? ② Are proper responses made to comments from the public and regulatory authorities?	① Initial announcement of the project has been done to the major stakeholders. Necessary communication would be continued with them time to time as the project progression. Public meeting for the Kaloko communities which is located in the peri-urban area would be planned before the construction phase. ② There is no negative comments to the project from stakeholders so far. Comments from public or regulatory authorities would be reflected to the project implementation plan.
2 Mitigation Measures	(1) Air Quality	① Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	① Chlorine gas is contained by proper steel cylinder and kept in good condition in the chlorine storage facilities, and there is no possibility to affect to the inhabitants because Kafubu WTP (Water Treatment Plant) is located far from the residential area.
	(2) Water Quality	① Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	① Influent sewerage to the Dambo PS (Pumping Station) shall be delivered to the Kanini sewerage treatment plant, then dischrged to the river within the effluent standard.
	(3) Wastes	① Are wastes, by the construction properly disposed of in accordance with the country's standards?	① Generated excavated soil due to the pipe trench excavation work would be backfilled properly.
	(4) Noise and Vibration	① Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	① Noise and vibration generated from newly installed major pumps of the Kafubu WTP and Dambo PS would comply with the standard. These facilities are located far from the residential areas.
	(5) Subsidence	① In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	① Extraction of a large volume of groundwater is not planned.

3 Natural Environment	(1) Protected Areas	① Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	① Project site is not located in the conservation area.
	(2) Ecosystem	① Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? ② Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? ③ If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? ④ Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	① Project site is not located in such area. ② Project site is not located in such area. ③ Significant ecological impacts are not anticipated. ④ Significant adversely impact to the water source would be not occurred because the water intake source of the Kafubu WTP is Kafubu dam in present, and does not change after the rehabilitated.
4 Social Environment 4 Social Environment	(1) Resettlement	① Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? ② Is adequate explanation on relocation and compensation given to affected persons prior to resettlement? ③ Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? ④ Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? ⑤ Are agreements with the affected persons obtained prior to resettlement? ⑥ Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? ⑦ Is a plan developed to monitor the impacts of resettlement?	① There is no involuntary resettlement caused by project implementation.
	(2) Living and Livelihood	① Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? ② Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?	① Project does not adversely affect to the inhabitants. ② Amount of water used by the project does not adversely affect to the existing water uses and water area uses.
	(3) Heritage	① Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	① Project does not affect to the heritage.

	(4) Landscape	① Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	① Project does not affect to the landscape.
	(5) Ethnic Minorities and Indigenous Peoples	① Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples? ② Are considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples?	①,② Project does not affect to the ethnic minorities and indigenous peoples.
5 Others	(1) Impacts during Construction	① Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? ② If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? ③ If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? ④ If necessary, is health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers? ⑤If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	①,②,③,④Adequate measures would be considered by the contractor accordance with the construction agreement.
	(2) Monitoring	① Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? ② Are the items, methods and frequencies included in the monitoring program judged to be appropriate? ③ Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? ④ Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	①Monitoring program by the implement would be conducted. ②Refer to the monitoring plan. ③Monitoring framework would be established including the budget plan. ④No, the existing company monitoring framework will be used.
6 Note	Note on Using Environmental Checklist	① If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	① Not apply

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are made, if necessary.

In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan' experience).

2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Appendix 6-4 Monitoring Form on Environmental and Social Consideration

MONITORING FORM

-When necessary, the project proponent should refer to the following monitoring form for submitting reports.

-When monitoring plans including monitoring items, frequencies and methods are decided, project phase or project life cycle (such as construction phase and operation phase) should be considered.

１．Responses/Actions to Comments and Guidance from Government Authorities and the Public

・Common phase

Monitoring Item	Monitoring Results during Report Period
Responses/Actions to Comments and Guidance from Government Authorities	

２．Mitigation Measures

- Air Quality（Emission Gas / Ambient Air Quality）

Monitoring Item	Monitoring Results during Report Period
Not Applicable	

- Water Quality（Effluent/Wastewater/Ambient Water Quality）

Monitoring Item	Monitoring Results during Report Period
Not Applicable	

- Waste

・Construction phase

Monitoring Item	Monitoring Results during Report Period
(Method) Site observation of backfilling condition of the excavated soil (Duration) During rehabilitation work of distribution pipe (Frequency) Once a month	

- Noise / Vibration

・Construction phase

Monitoring Item	Monitoring Results during Report Period
(Method) ・Site observation on use of heavy machineries ・Hearing of complaints by residential people near the construction area (Duration)	

During the pipe rehabilitation work (Frequency) Once a month	

- Odor

Monitoring Item	Monitoring Results during Report Period
Not applicable	

- Traffic, accidents

・Construction phase

Monitoring Item	Monitoring Results during Report Period
(Method) ・Site observation whether traffic jam occurs or not ・Site observation whether necessary safety measures is taken. (Duration) During the pipe rehabilitation work (Frequency) Once a month	

３．Natural Environment

- Ecosystem

Monitoring Item	Monitoring Results during Report Period
Not applicable	

４．Social Environment

- Resettlement

Monitoring Item	Monitoring Results during Report Period
Not applicable	

- Living / Livelihood

Monitoring Item	Monitoring Results during Report Period
Not applicable	

- Local conflict of interests

・Construction phase and operational phase

Monitoring Item	Monitoring Results during Report Period
(Method) Site observation (Duration)	

During and after the construction (Frequency) Quarterly basis	

- HIV/AIDs among construction workers

・Construction phase

Monitoring Item	Monitoring Results during Report Period
(Method) Hearing to construction firms (Duration/ Frequency) Om commencement of construction works	

Appendix 6-5 Approval by Environmental Council of Zambia

ENVIRONMENTAL COUNCIL OF ZAMBIA

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Corner Suez & Church Roads
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Chirundu Border Office
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Chirundu, Zambia
Tel/Fax: +260 211 515261

In reply please quote
No. ECZ/INS/101/4/1

November 10, 2010

The Managing Director
Kafubu Water and Sewerage Company Limited
P.O. Box 71278
NDOLA

Dear Sir,

REF: PROPOSED WATER SUPPLY AND SANITATION IMPROVEMENT PROJECT IN BY KAFUBU WATER AND SEWERAGE COMPANY LIMITED IN NDOLA DISTRICT

Reference is made to the above captioned project report submitted to the Environmental Council of Zambia (ECZ) on October 4, 2010 for consideration in accordance with the requirements of the Environmental Impact Assessment (EIA) Regulations, Statutory Instrument No. 28 of 1997.

The ECZ has since reviewed the Environmental Project Brief (EPB) and based on the information provided by yourselves and from written and verbal comments from interested and affected parties and our site verification inspection findings, the said EPB has been **approved.**

Find attached to this Decision Letter, conditions governing this approval.

Yours faithfully,

Patson Zulu
ACTING DIRECTOR
ENVIRONMENTAL COUNCIL OF ZAMBIA

Cc: The Town Clerk– Ndola City Council, **NDOLA**

ENVIRONMENTAL COUNCIL OF ZAMBIA (ECZ)

DECISION LETTER

1.0 PROJECT BACKGROUND

1.1 PROJECT TITLE:

Proposed Water Supply and Sanitation Improvement Project in the City of Ndola by Kafubu Water and Sewerage Company Limited

1.2 PROJECT PROPONENTS:

The Managing Director
Kafubu Water and Sewerage Company Limited
Stand B12, Vitanda Street
P.O. Box 71278
NDOLA

Contact Person:

Name:	Mr. Athanasius K. Mwaba
Designation:	Director – Project and Development
Tel:	+260 212 622425/0966 788699
Email:	kafubuws@kafubu.co.zm

1.3 PROJECT LOCATION:

The project is located in the southern part of the City of Ndola. The boundary between the northern and southern zone in Ndola is the Kafubu River.

1.4 DATE OF SUBMISSION BY PROPONENT:

October 4, 2010

1.5 DATE OF CONSIDERATION BY COUNCIL:

November 4, 2010

2.0 DETAILS OF THE PROJECT:

Kafubu Water and Sewerage Company Limited (KWSC) proposes to rehabilitate the water and sanitation services in the southern part of the Ndola. This project is one of the projects that were formulated in order to fulfill the National Urban Water Supply and Sanitation Programme which the Government of the Republic of Zambia instituted.

This programme is primarily a planning instrument that serves as a link into the overall planning framework enshrined in the Vision 2030 whose principal objective is to make Zambia "a prosperous middle income nation by the year 2030."

The project aims at improving the existing water network system to restore the Kafubu water treatment plant from the current production capacity of 55,000m^3 per day production to its designed capacity of 75,000m^3 per day. The project will also involve improvement of sanitation services in Ndola by increasing the sewage pumping capacity at Dambo Sewage Pump Station.

The rehabilitation works will include the following:

i. Complete replacement of obsolete facilities at the Kafubu Water Treatment Plant. Facilities to be replaced at the water treatment plant include intake pumps, the chemical dosing system, sedimentation tank channels, sand filters, filter nozzles, back wash facilities and lifting pumps.
ii. Complete replacement of all existing concrete treated water mains in the Southern Zone of the City of Ndola. The main pipeline for treated water in the Southern Zone of Ndola is called the Nakaputa falling mains.
iii. Complete replacement and increased pump capacity of the pumps at Dambo Sewage Pump Station and installation of a standby generator. The pumps will be increased from the current 2 functional sewer pumps to 6 sewer pumps.
iv. Installation of an additional 6 kiosks in Kaloko Compound.

3.0 DECISION BY COUNCIL:

3.1 The Project is **approved** subject to the following conditions:

3.1.1 Kafubu Water and Sewerage Company Limited shall implement the project and all the environmental management commitments as proposed in the Environmental Project Brief (EPB) **with changes** as proposed by Environmental Council of Zambia (ECZ) in the Decision Letter and any other conditions that may be issued thereafter.

3.1.2 Kafubu Water and Sewerage Company Limited shall ensure that all mitigation measures proposed in the EPB are implemented, taking into consideration the conditions of this approval and any other amendment that the ECZ may communicate to Kafubu Water and Sewerage Company Limited.

3.1.3 Kafubu Water and Sewerage Company Limited shall conduct progressive revegetation of areas that shall be disturbed by the project.

3.1.4 Kafubu Water and Sewerage Company Limited shall take all necessary measures to ensure that its operations shall not pollute the Kafubu River at any given time.

3.1.5 Kafubu Water and Sewerage Company Limited shall not discharge raw sewage into the Kafubu River at any given time.

3.1.6 Kafubu Water shall employ sustainable methods of water treatment and shall as much as is practically possible recycle the back wash water into the water treatment system.

3.1.7 All hazardous waste that may arise from the proposed project shall be managed in accordance with the Hazardous Waste Management Regulations, 2001.

3.1.8 Kafubu Water and Sewerage Company Limited shall repair all leaking parts along the existing Nakaputa falling mains so as to ensure that the surrounding communities are not using the dirty water arising from such leakages.

3.1.9 Kafubu Water and Sewerage Company Limited shall drain out all the stagnant water along the leaking parts on the Nakaputa failing mains to avert mosquito breeding grounds.

3.1.10 Kafubu Water and Sewerage Company Limited shall employ dust suppression techniques in areas with loose soil.

3.1.11 Kafubu Water and Sewerage Company Limited shall maintain the speed limit in all access roads that shall not endanger life or cause dust.

3.1.12 Kafubu Water and Sewerage Company Limited shall conduct its activities in such a way as not to cause soil erosion which can lead to sedimentation of the nearby surface water bodies.

3.1.13 Kafubu Water and Sewerage Company Limited shall maintain noise levels within acceptable levels throughout the project cycle.

3.1.14 Kafubu Water and Sewerage Company Limited shall prepare a closure report outlining implementation of all the environmental management commitments presented in the Environmental Project Brief at the end of the project for verification by the Environmental Council of Zambia.

3.1.15 Kafubu Water and Sewerage Company Limited shall obtain permits from ECZ and comply in full with the following regulations throughout the project cycle:

a) Waste Management Regulations, SI No.71 of 1993;
b) Water Pollution Control Regulations, SI No. 72 of 1993;
c) Hazardous waste Management Regulations, SI No. 125 of 2001; and,
d) Air Pollution Control (Licensing and Emission Standards) Regulations, 1996.

3.2 The Council **advises** Kafubu Water and Sewerage Company Limited:

3.2.1 To obtain any other relevant authorizations such as but not limited to:

a) The Workers Compensation Act;
b) The Public Health Act;
c) The Factories Act;
d) The Town and Country Planning Act; and,
e) The Employment Act.

3.2.2 To make available information on HIV/AIDS, safety, health and environment to employees before commencement of the project.

3.3 The project shall be implemented within **three years** from the date of approval. Failure to implement the project within the said period shall render this Decision Letter invalid and the developer shall re-submit the EPB.

3.4 Kafubu Water and Sewerage Company Limited shall comply with environmental standards and/or specific limits of particular pollutants as its responsibility. Thus, compliance with ECZ recommended measures **does not** exempt the developer from its responsibility if such measures do not achieve compliance with environmental control standards.

3.5 The Council may suspend or cancel this Decision Letter **without notice** should Kafubu Water and Sewerage Company Limited fail to comply with any of the approval conditions.

.....
Date

.....
Patson Zulu
ACTING DIRECTOR
ENVIRONMENTAL COUNCIL OF ZAMBIA