Ministry of Water Resources (MoWR)
The Federal Democratic Republic of Ethiopia

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE IMPROVEMENT OF THE EQUIPMENT FOR GROUNDWATER DEVELOPMENT

February 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

KOKUSAI KOGYO Co., LTD.

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Preface

In response to a request from the Government of the Federal Democratic Republic of Ethiopia, the Government of Japan decided to conduct a basic design study on the Project for the Improvement of the Equipment for Groundwater Development in the Federal Democratic Republic of Ethiopia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Ethiopia a study team from August 14 to September 10, 2008.

The team held discussions with the officials concerned of the Government of Ethiopia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Ethiopia in order to discuss a draft basic design, and as this result, the present report was finalized.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Federal Democratic Republic of Ethiopia for their close cooperation extended to the teams.

February 2009

Ariyuki MATSUMOTO
Vice President
Japan International Cooperation Agency

February 2009

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for the Improvement of the Equipment for Groundwater Development in the Federal Democratic Republic of Ethiopia.

This study was conducted by Kokusai Kogyo Co., Ltd., under a contract to JICA, during the period from August 2008 to January 2009. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Ethiopia and formulated the most appropriate basic design for the project under Japan's Grant Aid scheme.

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

Very truly yours,

Akira KAMATA
Project manager,
Basic design study team on
the Project for the Improvement of the
Equipment for Groundwater Development
in the Federal Democratic Republic of
Ethiopia
Kokusai Kogyo Co., Ltd.

Summary

1. Background of the Project

Given its low rate of access to safe water, Ethiopia launched a national water supply program called "Universal Access Program (UAP)" in 2005. The UAP aims to achieve water supply coverage of 98% in rural areas and 100% in urban areas by 2012. In order to achieve the UAP goal, more than 50,000 personnel from the government and private sectors are required both in rural and urban water supply sectors. However, only approximately half of the posts requiring staffing in the water supply sector are filled at present. This indicates a critical personnel shortage in the water supply sector nation-wide, in addition to the particularly low technical capability of these staff, which causes a serious impediment for implementation of water supply development and maintenance.

In response to this situation, Japan assisted in establishing the Ethiopia Water Technology Center (EWTEC) during a technical assistance project titled Groundwater Development and Water Supply Training Project from January 1998 to March 2008 (hereinafter referred to as "the EWTEC Project") (phase 1, follow up, and phase 2)). During the 10 years the project took place, JICA implemented various kinds of technical training courses such as drilling technology and O&M, etc., conducted groundwater resource investigations, and disseminated appropriate technologies for water resource development. Although much training equipment was introduced at the start of this technical assistance project (1998-1999), it is now necessary to replace some of the equipment that has gradually degraded over the past 10 years.

Moreover, due to Ethiopia's decentralization policy, the responsibility of rural water supply fell entirely to the Woreda water offices. However, due to a lack of experienced personnel and other staff, nine Water Technology Departments were established in March 2003 at the vocational training colleges, i.e. Technical Vocational Education and Training Colleges (TVETC) throughout the country. Each TVETC is operated by the regional government, however, educational aspects of the Water Technology Departments, such as developing the curriculum and recruiting teachers of technical subjects, as well as supplying training equipment, etc., is the responsibility of the central government's Ministry of Water Resources (MoWR). However, in the end, due to the lack of field training equipment and student transportation to field sites, training at the Water Technology Department has tended to be in the form of classroom lectures. This outcome has received criticism that this does not sufficiently fulfill the original request of cultivating actual practical skills necessary for rural water supply development.

Further, due to the strong desire from Ethiopia, Japan is planning to start phase 3 of the EWTEC Project over the next five years from 2009. This project plans to widen participation to include the general public and NGOs, and also to increase the number of training programs available. The introduction of new training equipment is necessary for the implementation of these new training programs.

Presently the EWTEC project falls under the umbrella of the Ministry of Water Resource, Rural Water Supply and Sanitation Bureau, which is a part in the ongoing Business Process Reengineering

(BPR), and is ultimately considered a permanent institute under the Water Sector Support and Capacity Building Process Team. In the future, EWTEC's place as a permanent cornerstone will be further cemented with the start of Phrase 3, planned for the beginning of 2009. In this phase, the operational capacity of EWTEC is to be strengthened to serve as the center of development of groundwater and water supply human resources.

This project is in response to a request by the Ethiopian government made in light of the above-stated conditions and submitted in fiscal year 2007 (originally submitted in fiscal 2006, but modified and resubmitted).

2. Outline of the study results and project contents

(1) Outline of the study in Ethiopia

Based on the request from Ethiopia, Japan International Cooperation Agency (JICA) sent a basic design study team to Ethiopia from August 14 to September 10. The study team had discussions with Ethiopian government officials and visited 9 TVETC located in regions to investigate their present condition. During the study in Ethiopia followed by a study in Japan, validity of each unit of equipment was examined based on the original list of requested equipment and specifications were compiled. After the study in Japan, the study team visited Ethiopia to explain draft report of the study from December 15 to December 23, 2008.

(2) Design policy

This grant aid was designed based on the following policy as a result of the study in Ethiopia and discussion with Ethiopian government officials considering development of human resources engaged with water supply activities and the UAP target.

① Basic policy

- The equipment necessary for the new training courses to be introduced in the technical assistance project, named "Ethiopia Water Technology Center Project Phase 3," shall be procured.
- The replacement or addition of new equipment shall be verified in cases where the equipment used in existing programs at EWTEC is obsolete or broken.
- Procurement of new equipment to be used for training at TVETC shall be verified with cost, needed personnel, and operation and maintenance standards in mind.

② Policy on operation and maintenance

- Operation and maintenance capability shall be verified based on the present condition of equipment operation, state of operation and maintenance, presence of someone to supervise the equipment, and budget.

- Operation and maintenance capacity, especially regarding vehicles, shall be verified based on fuel and maintenance costs calculated upon their planned use in the respective training curriculums of EWTEC and TVETC.
- Equipment that requires spare parts shall be procured with consideration given to the degree of difficulty in procuring them in Ethiopia.

③ Policy on equipment grade

- The grade and specification of equipment appropriate for use in EWTEC project phase 3 should be considered based on universality and possibility of future dissemination in Ethiopia.
- EWTEC equipment type and specifications should match the level of prospective trainees for the groundwater development and management technology courses.
- The model and specifications for a EWTEC drilling rig with completed well depth of 300m should be determined in consideration of the high level of target participants in EWTEC project phase 3 and the growing demand for deep well drilling in Ethiopia.
- The model and specifications of TVETC equipment should match the training course curriculums of the water technology departments and expected achievement of the trainees.
- The equipment should comply with the physical capacity of EWTEC. Equipment which requires renovations for installation should be eliminated unless the installation space is secured.
- The vehicles should be durable and powerful enough to be used for the field practice of EWTEC and TVETC in consideration of the weather and road conditions in Ethiopia.
- The specifications of EWTEC training course equipment should be selected keeping in mind its use in on-the-job (OJT) well drilling training and maintenance requirements.

(3) Contents and scale of the project

The contents and the scale of the project were planned to match new courses of EWTEC project phase 3. For TVETC, the contents and the scale were set for practical training equipment in the water technology department. The planned equipment to be procured in this project is shown in the table below.

Planned equipment for EWTEC

Category	Item	Purpose	Q'ty
Groundwater Investigation	Resistivity meter	Equipment for geophysical exploration to investigate groundwater using electromagnetic wave. The equipment is capable of an exploration depth range up to 300m.	1 unit
	Electro-magnetic meter	Commonly used equipment for geophysical exploration for ground water investigation. The equipment is used to select the location of well drilling.	1unit
	Logging equipment	Used for logging a well after drilling, and selecting a proper point for screen.	1unit
Drilling Technology	Service Rig and its tools	A rig for rehabilitation of existing wells, with a high pressure pump, and washes wells by	1set

Category	Item	Purpose	Q'ty
		jetting and brushing.	
	300m Rotary Rig and accessories	Truck mounted rotary rig with drilling capacity of 300 m. The equipment is used for drilling wells of 300m depth which is now in high demand in Ethiopia, and for practice by drilling successful wells in the field.	1set
	Air Compressor	Used for Down the Hole drilling method (DTH) with compressed air, and together with 300m rotary rig.	1 unit
	Air lifting and Pumping test equipment	Low pressure air compressor and its tools for washing wells after drilling, and pumping tests equipment. Used for investigating aquifer capacity and pumping discharge of the well by test pumping using submersible pump after drilling.	1 set
	Crane truck	For transportation of drilling rods, hammer, generator, reservoir and other tools necessary for 300 m rotary rig.	2 units
	Drilling tools for existing drilling machine	Tools required for the existing 150 m drilling rig in EWTEC.	1 set
Drilling Machinery Maintenance	Measuring and maintenance equipment and tools	Tools required for maintenance of rig and trucks. They are used for training of maintenance through practical work.	1 set
	Cut models	Cut away models of major vehicle parts to show the structure and function of each part.	1 set
Electric Machinery Maintenance	Electrical/electronics trainer and measuring equipment	Used to show the fundamentals of electric circuit required for maintenance of electrical equipment in common water supply facilities.	1 set
	Cut models	Cut away models of general electric motors in water supply facilities. Used to show the structure and function of each part.	1 set
Water Supply Engineering	Survey equipment	Equipment to detect water leakage from water supply pipes, which is becoming a big problem in urban areas.	1 set
	Incubator	For analyzing drinking water by microorganism test of Bacillus coli and so on.	1 set
Transportation	Bus	For transportation of trainees and instructors for field trips.	1 set
	4WD long wheel base hardtop	For transportation of tools and equipment for field trips such as groundwater investigation, well drilling, and well rehabilitation.	2 units

Planned equipment for TVETC

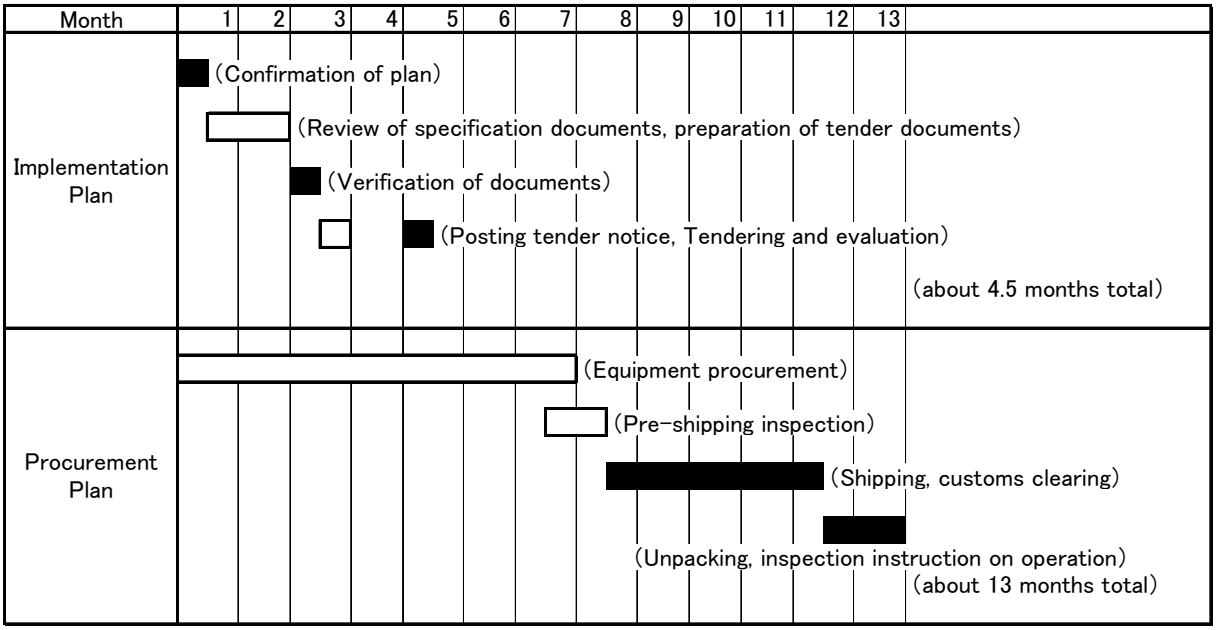
Category	Item	Purpose	Q'ty
Equipment for 9 TVETCs	Equipment for practical Training (Survey equipment, Geology/Soil Mechanics Equipment, Water quality, soil meter etc, Generator etc., Pump etc., Welding machine etc., Tools)	As stated in the left column, item list, the equipment is used for practical training such as; survey training, geological and soil mechanics survey training, water quality analysis training and so on.	9 sets
Transportation	Bus	For transportation of trainees and instructors for field trips.	9 sets

3. Schedule and initial cost estimation of the project

(1) Schedule

The table below shows the schedule of implementation design, tender, and procurement

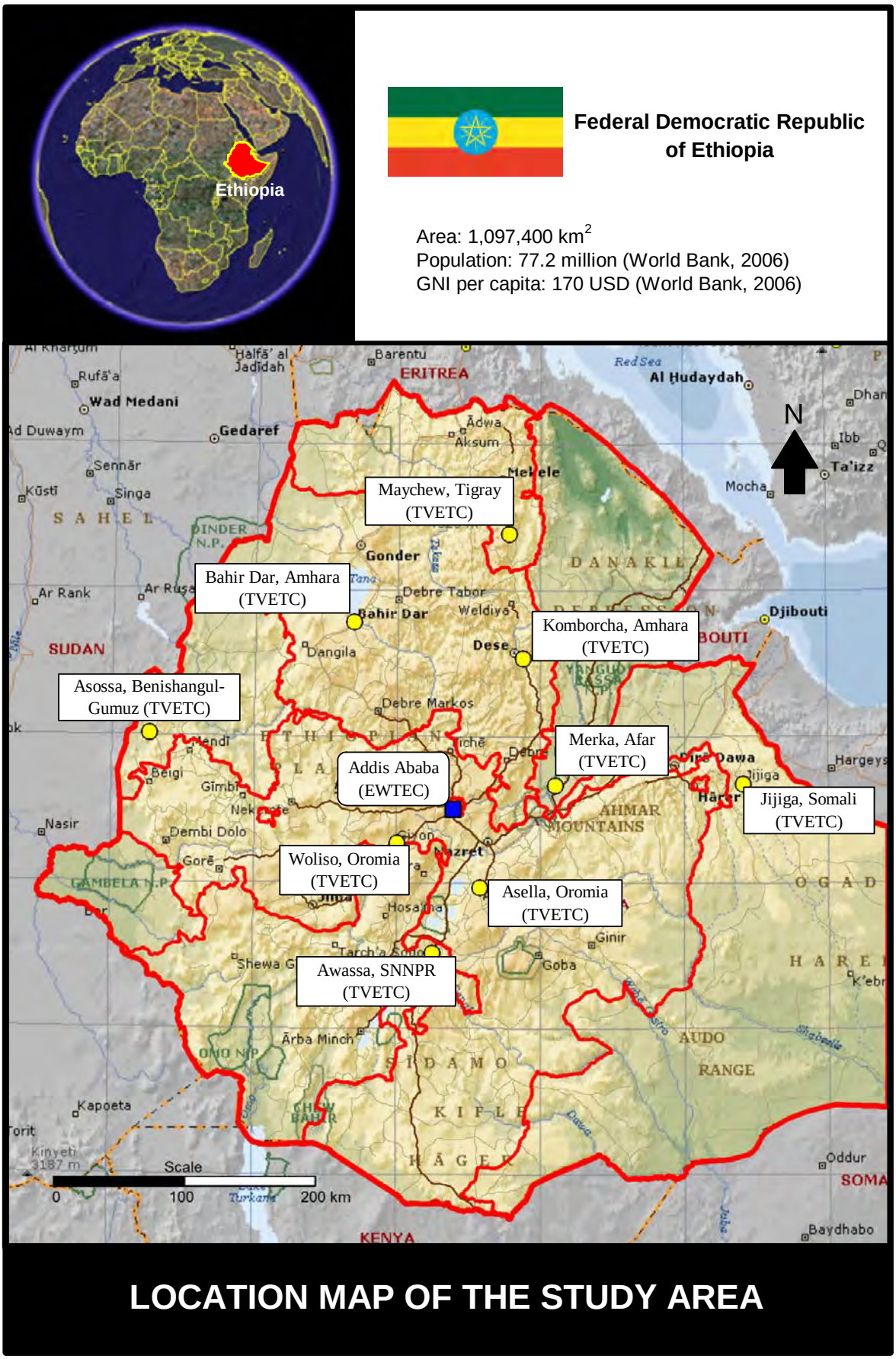
Implementation Schedule



(2) Initial cost estimation

The cost borne by the Government of Ethiopia will be 239.3 million yen. This cost estimation is provisional and would be further examined by the Government of Japan for the approval of the Grant.

Contents



LOCATION MAP OF THE STUDY AREA

List of Figures & Tables

Abbreviations

AAWSA	Addis Ababa Water Sewerage Authority
BPR	Business Process Reengineering
EWTEC	Ethiopia Water Technology Center
MoFED	Ministry of Finance and Economic Development
MoWR	Ministry of Water Resources
TVETC	Technical and Vocational Education and Training College
SDPRP	Sustainable Development and Poverty Reduction Paper
UAP	Universal Access Program
WATSAN	Water and Sanitation
WASH	Water, Sanitation and Hygiene
WSDP	Water Sector Development Program
WSSDP	Water Supply and Sanitation Development Program
WWCE	Water Works and Construction Enterprise
WWDSE	Water Works Design and Supervision Enterprise

Chapter 1 Background of the Project

1-1 Background

Given its low rate of access to safe water, Ethiopia launched an ambitious national water supply program called “Universal Access Program (UAP)” in 2005. The UAP aims to achieve water supply coverage of 98% in rural areas and 100% in urban areas by the target year 2012. In order to achieve the UAP goal, more than 50,000 personnel from the government and private sectors are required both in rural and urban water supply sectors. However, only approximately half of the posts requiring staffing in the water supply sector are filled at present. This indicates a critical personnel shortage in the water supply sector nation-wide, in addition to the particularly low technical capability of these staff which causes a serious impediment for implementation of water supply development and maintenance.

In order to improve this situation, Japan provided the following assistance.

① From January 1998 to January 2003, the technical assistance project titled ‘Groundwater Development and Water Supply Training Project’ was implemented. This involved the establishment of a training center on the outskirts of Addis Ababa. Here, training in a variety of disciplines for groundwater development and water supply technology were started, such as groundwater investigation and well drilling technology, drilling rig maintenance management, operation and management of water supply facilities.

② From 2003 to 2005, follow-up assistance of this project was implemented.

③ From 2005 to 2008, phase 2 of the project was implemented. The name of this training center was changed to Ethiopia Water Technology Center (EWTEC), and in addition to previous course content participants were invited from 15 different African countries. Under this third-country training system, advanced training is given by Japanese experts in groundwater development and management such as groundwater modeling, GIS, and remote sensing.

A certain degree of success has been achieved by the completion of project phase 2, with graduates of the EWTEC course totaling 1,856 people, comprised mostly from Ethiopia’s four main regions, Oromia, SNNPR, Amhara and Tigray. Although much training equipment was introduced at the start of this technical assistance project (1998-1999), it is now necessary to replace some of the equipment that has gradually degraded over the past 10 years.

Further, due to the strong desire from Ethiopia, Japan is planning to start phase 3 of the EWTEC Project over the next five years from 2009. This project plans to widen participation to include the general public and NGOs, and also to increase the number of training programs available (to a total of 20 courses). The introduction of new training equipment is necessary for the implementation of these new training programs.

Presently the EWTEC project falls under the umbrella of the Ministry of Water Resource (MoWR), Rural Water Supply and Sanitation Bureau, which is a part in the ongoing Business Process Reengineering (BPR), and is ultimately considered a permanent institute under the Water Sector Support and Capacity Building Process Team. In the future, EWTEC’s place as a permanent cornerstone will be further cemented with the start of Phrase 3, planned for the beginning of 2009. In this phase, the operational capacity of EWTEC is to be strengthened to serve as the center of development of groundwater and water supply human resources.

Moreover, due to Ethiopia's decentralization policy, the responsibility of rural water supply fell entirely to the Woreda water offices. However, due to a lack of experienced personnel and other staff, nine Water Technology Departments were established in March 2003 at the vocational training colleges, i.e. Technical Vocational Education and Training Colleges (TVETC) throughout the country. Each TVETC is operated by the regional government, however, educational aspects of the Water Technology Departments, such as developing curriculum and recruiting teachers of technical subjects, as well as supplying training equipment, etc., is the responsibility of the central government's Ministry of Water Resources (MoWR). However, in the end, due to the lack of field training equipment and student transportation to field sites, training at the Water Technology Department has tended to be in the form of classroom lectures. This outcome has received criticism that this does not sufficiently fulfill the original request of cultivating actual practical skills necessary for rural water supply development.

This project is in response to a request by the Ethiopian government made in light of the above-stated conditions and submitted in fiscal year 2007 (originally submitted in fiscal 2006, but modified and resubmitted).

1-2 Project Overview

The Universal Access Program (UAP) is the topmost plan in Ethiopia's water supply project, aiming to achieve water supply coverage of 98% in rural areas and 100% in urban areas by the target year 2012. Achievement of this objective will require a construction budget as well as some 50,000 personnel in the water supply sector.

In order to contribute to achievement of this objective, this project seeks to provide equipment provisions for ground water development necessary for training to strengthen existing personnel at EWTEC as well as toward cultivation of those trained at TVETC, eventual human resources for Woreda water offices. These equipment provisions to be used by the target organizations are as shown in Table 1 and Table 2 below.

Table 1 Equipment for EWTEC

Purpose	Items	Q'ty	Remarks
Groundwater Investigation	Resistivity meter	1 unit	2D image
	Electro-magnetic meter	1 unit	Time Domain
	Logging equipment	1 unit	
Drilling Technology	Service Rig	1 set	For well rehabilitation
	300m Rotary Rig and accessories	1 set	Truck mount
	Air Compressor	1 unit	Truck mount
	Air lifting	1 set	
	Pumping test equipment	1 set	
	Crane truck	2 unit	
	Drilling tools for existing drilling machine	1 set	
Drilling Machinery Maintenance	Measuring and maintenance equipment and tools	1 set	
	Cut models	1 set	
Electric	Electrical/electronics trainer and measuring	1 set	

Machinery Maintenance	equipment		
	Cut models	1 set	
Water Supply Engineering	Survey equipment	1 set	Leakage detector
	Incubator	1 set	
Transportation	Bus	1 pcs	For 30 people
	4WD long wheel base hardtop	2 units	

Table 2 Equipment for TVETC (for 9 TVETC)

Purpose	Items	Q'ty	Remarks
Education & Training for specialized knowledge and skills	Survey equipment	9 sets	Total station, planimeter, auto level etc.
	Geology/Soil Mechanics Equipment	9 sets	Compass, filtration meter, permeability test kit, soil sampler, Sieve etc.
	Water quality, soil meter etc.	9 sets	Conductivity/pH/temperature tester, water quality analysis kit etc.
	Generator etc.	9 sets	Diesel generator etc.
	Pump etc.	9 sets	Submersible pump, surface pump etc.
	Welding machine etc.	9 sets	Welding machine(mobile)etc.
	Tools	9 sets	Pipe wrench etc.
Transportation	Bus	9 sets	For 30 people

The items planned to be procured for EWTEC are shown in Table 1, starting with geophysical exploration and drilling equipment for field trips and practical exercises in phase 3 of the project, equipment needed for the operation and maintenance of the aforementioned items, cut models for theoretical study, and vehicles for the transportation of students and equipment. Items planned to be procured for TVETC are shown in Table 2, including pumps, tools, and small equipment to be used by the students of the water supply school in their classrooms as well as field study of geology, soil properties, surveying, and also vehicles for transporting students.

1-3 Natural Conditions

Area of the country is 1.1 million km^2 and most of the area is high land represented by the Ethiopian plateau and the land is divided by African rift valley running from north to south. The target sites are located at Addis Ababa and 7 other regions. The geographical character differs from high land, which altitude is over 2,300m at Addis Ababa, to low land with dry and hot weather in the Somali region. The major rainy season is from June to September, and dry season is from October to May. There is a minor rainy season from January to February.

1-4 Environmental and social impact

There is no negative environmental and social impact by the project implementation.

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Overall goal and project objective

Based on the background mentioned in Chapter 1, this project plays an important role as one of human resource development activities in Ethiopia. Therefore, the overall goal is to improve quality of human resources, and the project objective is to improve environment for practical training of human resources engaged in water supply development, and operation and maintenance.

2-1-2 Outline of the project

This project is to procure equipment for practical training at EWTEC and 9 TVETC for groundwater development and water supply in Ethiopia.

In addition, the procured equipment will be utilized at EWTEC and TVETC, during EWTEC project phase 3, starting from January 2009, under the technical support of Japanese experts.

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic policy

- The equipment necessary for the new training courses to be introduced in the technical assistance project, named "Ethiopia Water Technology Center Project Phase 3," shall be procured.
- The replacement or addition of new equipment shall be verified in cases where the equipment used in existing programs at EWTEC is obsolete or broken.
- Procurement of new equipment to be used for training at TVETC shall be verified with cost, needed personnel, and operation and maintenance standards in mind.

2-2-1-2 Policy on operation and maintenance

- Operation and maintenance capability shall be verified based on the present condition of equipment operation, state of operation and maintenance, presence of someone to supervise the equipment, and budget.
- Operation and maintenance capacity, especially regarding vehicles, shall be verified based on fuel and maintenance costs calculated upon their planned use in the respective training curriculums of EWTEC and TVETC.
- Equipment that requires spare parts shall be procured with consideration given to the degree of difficulty in procuring them in Ethiopia.

2-2-1-3 Policy on equipment grade

- The grade and specification of equipment appropriate for use in EWTEC project phase 3 should be considered based on universality and possibility of future dissemination in Ethiopia.

- EWTEC equipment type and specifications should match the level of prospective trainees for the groundwater development and management technology courses.
- The model and specifications for a EWTEC drilling rig with completed well depth of 300m should be determined in consideration of the high level of target participants in EWTEC project phase 3 and the growing demand for deep well drilling in Ethiopia.
- The model and specifications of TVETC equipment should match the training course curriculums of the water technology departments and expected achievement of the trainees.
- The equipment should comply with the physical capacity of EWTEC. Equipment which requires renovations for installation should be eliminated unless the installation space is secured.
- The vehicles should be durable and powerful enough to be used for field practice of EWTEC and TVETC in consideration of the weather and road conditions in Ethiopia.
- The specifications of EWTEC training course equipment should be selected keeping in mind its use in on-the-job (OJT) well drilling training and maintenance requirements.

2-2-2 Basic Plan (Equipment Plan)

2-2-2-1 Equipment for EWTEC (A-F)

A. Groundwater Investigation

Among the basic courses at EWTEC, practical training for geophysical exploration is the most important part of the curriculum in the ground water investigation course. The geophysical exploration equipment EWTEC has are resistivity meters and electro-magnetic meters (frequency domain), which are used on every training course. Also, in EWTEC phase 3 a new advanced course specializing in geophysical exploration is planned for which the procurement of new geophysical exploration equipment was considered. As a result, procurement of the following equipment is planned.

A.1 Electro-magnetic meter (Time Domain)

The electro-magnetic meters with a frequency domain exploration depth range from 60 to 80m, has been the most common type in this field until now, and is used by EWTEC for field geophysical exploration training in the groundwater investigation course. Electro-magnetic meters with a time domain are capable of an exploration depth range more than 300m, and recently, these meters are becoming more commonly used since they were introduced in geological survey offices in Ethiopia, at the Addis Ababa Water and Sewerage Authority, and so forth. As mentioned later in the report, the drilling depth has increased in the last few years in Ethiopia, and thus the use of time domain meters, which can explore deeper than frequency meters, is on the rise.

The electro-magnetic meter for time domain measurement is considered suitable for practical training of the new specialized training course of geophysical survey in the EWTEC project phase 3, and the depth of measurement should be more than the 300m planned drilling depth. Considering the number of trainees planned for the geophysical survey course is 12 and the fact that other practical training using geophysical equipment will take place at the same time, procurement of one new meter, including cables and other accessories, is planned.

A.2 Resistivity meter (two-dimensional image)

The resistivity meters currently in use have only a small output of 50W and quite a shallow exploration depth. Presently they are only used for vertical or horizontal exploration. There is a need

for resistivity meters that are capable of two-dimensional exploration and have higher output (over 100W), for two main reasons. Firstly, a new advanced course specializing in geophysical exploration is planned in EWTEC phase 3. Secondly, with the planned procurement of 300m class drilling machines in this phase there is a need for geophysical exploration to yield a higher rate of drilling success. Yet another consideration is the use of this new resistivity meter in the geophysical exploration course. As the enrollment number is set at 12, it can be used together with the existing ones. Hence, the procurement of one new meter, along with cables and other accessories, is planned.

A.3 Logging equipment

At present, EWTEC has one logging unit which was bought nine years ago, but it shows considerable wear and tear and is unable to transfer collected data to a computer for analysis. Therefore, it should be replaced with a new one. The required specification is that the equipment can measure resistivity, temperature, gamma, self potential (SP) and has a cable length of more than 300 m.

B. Equipment related to Drilling Technology

B.1 Service rig

Service rigs are used for rehabilitation of existing wells, and some Regional Water Resource Bureaus have them, such as those in Oromia, Amhara, SNNPR, Tigray, and Afar. With the growing need to rehabilitate existing wells, the present defective wells located in rural areas will be rehabilitated through the practice of the well rehabilitation training course; one of the supplemental/advanced courses the EWTEC phase 3 project. Most of the existing wells are less than 200m deep, and the wells used for urban water supply have large diameter casings. Therefore, the new equipment shall be capable of rehabilitating wells which have an 8 inch diameter and a depth of 200m.

a. Truck

Service rigs should be loaded with the equipment necessary for operations which assist the main rig in well rehabilitation and such (main drum winch, sub-winch, mast, power supply equipment, water pump, hydraulic jack etc.) to ensure they are highly functional. The engine is specified for use in high elevations (up to 2,500m), with rear wheel drive (6x4) or four wheel drive (4x4).

b. Equipment for well rehabilitation

General techniques of well rehabilitation in Ethiopia are cleaning by bailing, brushing, and jetting. For this reason, new equipment should cover all of these procedures. Equipment needs to be applicable to 6 inch and 8 inch wells so as to meet existing well design.

c. High pressure pump for Jetting

The truck will be equipped with a high pressure pump with a feed rate of 500L/min and pressure of 2MP to be used within the normal bounds of jetting cleaning.

d. Air lifting compressor

Service rigs are often equipped with an air lifting compressor for well washing. However, in this plan the procured air lifting compressor will be used for the 300m rotary drilling rig (see below), and will not be mounted on the service rig. This allows for a more compact sized truck and avoids the service rig itself going out of service in case of compressor failure. Another air lifting compressor, (see B.4 below), will be selected for 300m well development.

e. Supporting vehicles for service rig

There is no separate plan for the service rig as the supporting vehicles planned for the 300m drilling rig should be used to transport pipes and other materials necessary for well rehabilitation.

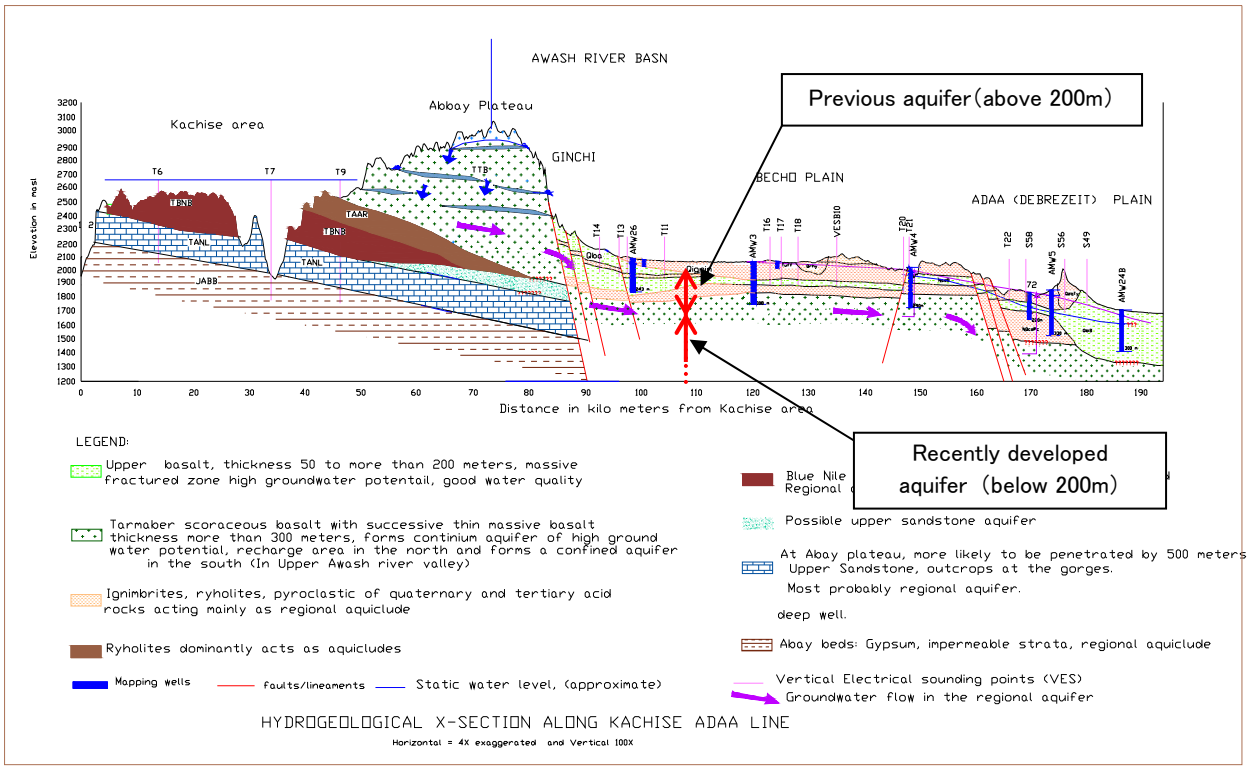
B.2 300m Drilling Rig

a. Current condition of well drilling in Ethiopia

According to Addis Ababa Water Sewerage Authority (AAWSA), urban water supply of Addis Ababa city has been dependent on surface water for the most part and is provided by two dams in the suburban area. On the other hand, water supply demand has been increasing with the expansion of the city area, and lack of water is thought to be a serious issue in the urban area despite the installation of the Akaki well field in 2002 in the southern area of Addis Ababa. The groundwater has been mainly withdrawn from an aquifer less than 200m in depth in the neighborhood of Addis Ababa, and it was considered there is little possibility to develop a deeper layer. However, a recent wide-reaching development survey in the Addis Ababa area revealed the existence of a preferable confined aquifer (porous and thick tertiary basalt) more than 200m deep (Figure 1). Accordingly, 47 wells that exceed 200m depth have been constructed since 2007. It clearly shows the fact that the water resource has shifted from surface water to groundwater, while development of an even deeper layer is underway (Table 3).

Table 3 Well drilling conducted by AAWSA

	No.	Depth	Remarks
Before year 2005	44	200m and less (Mostly 150m and less)	Previously, groundwater development was limited because main water resource of AAWSA was two dams. 29 of 44 the wells were put in Akaki well field in 2002.
Year 2006	39	150-200m	
Since 2007	47	200-250m	



Source: Water Works Design and Supervision Enterprise (2008)

Figure 1 Large scale cross section around Addis Ababa

The only major cities in Ethiopia using surface water as their main water source other than Addis Ababa, are Adama and Awassa. The other cities basically use groundwater, and to secure good quality water resource is a significant issue for all the cities. In the Tigray region, the groundwater development survey was conducted to install experimental wells which are more than 250m deep in 2006 in the Ainarem well field, the main water recourse of Mekele city. As a result, it was found to have groundwater capacity which has fine quality and quantity. Another case, in Lalibela, a well known tourist destination in Amhara, with the discovery of a good aquifer made of sandstone situated under a basaltic lava layer below 240m, a new development plan to install 11 deep-wells more than 400m deep is underway.

As mentioned above, in recent years, groundwater development targeting aquifers around 300m deep has begun mainly in the suburban areas in Ethiopia. This trend is expected to expand toward the rural water supply.

b. Training needs for 300m depth drilling

Table 4 shows the information collected in this survey about existing drilling machines of 300m class. Most drilling machines in Ethiopia are of the 150m class, which are used for relatively shallow well installation of less than 100m deep.

Table 4 Number of drilling machines of 300m class in Ethiopia

Owner	Private/ Public	Total number of drilling machines*	300m class drilling machines	Remarks
SNNP WWCE	Public cooperation	7	3	One of 300m class was provided by Japanese grand aid (2006)
Amhara WWCE	Public cooperation	9	2	Two of 300m class was provided by Japanese grand aid (2006)
Saba Engineering	Private	6	4	
Tana WWD	Private	2	2	
Al Nile	Private	-	3	
Hydro Construction and Engineering	Private	3	3	
KLR	Private	4	1	

* The number of drilling machines was collected in the Survey on the situation and training needs of TVETC, public enterprises and private firms/companies engaged in the construction and maintenance of water supply scheme (JICA, Feb. 2008). The number of 300m class drilling machines, however, was collected in this survey.

According to the needs survey conducted by the JICA Ethiopia office in February 2008, with Water Works and Construction Enterprise (WWCE), and private well drilling companies, it was reported that the shortage of drilling engineers and poor drilling techniques were considered major problems, and the related training needs for drilling technique was very high. Especially, trouble like collapse within the well is much higher for the 300m class drilling than in shallow wells. Hence, more advanced skills are required in the process of air pressure adjustment and casing installation. As described previously, drilling depth is currently deepening, therefore the necessity and urgency for training of 300m class drilling is very high. Mostly private companies are expected to participate in the training course. Finally, it is concluded that the development of senior engineers who can operate 300m class drilling machines is considered an urgent issue.

f. Necessity of procurement of 300m class drilling machines

Currently, the training course for drilling technology uses EWTEC's 150m class drilling machine, and is designed for beginners or engineers with relatively little experience. The participants and their organizations evaluated the course very highly during phase 2 of the EWTEC project. Therefore this course is now a core course in EWTEC project phase 3. Real drilling machines should be used in the training course because no training machines for drilling exist, and the main purpose of the training is to learn how to actually solve problems when drilling. The 300m class drilling machine is indispensable for the drilling technology course planned for middle and high level engineers in EWTEC project phase 3.

Wells constructed as part of training courses will ultimately be developed as a water supply source; thereby it will provide benefit to local residents. Also when picking drilling sites and the timing of training courses, information needs to be gathered on drilling at water supply facility construction sites that are already planned by government agencies, UNICEF, NGOs, and other donors. When geophysical exploration is necessary before selecting a drilling site, it should be undertaken as part of the EWTEC course field training. Wells completed as part of training should be developed to a level so that they can be used as part of the planned water supply facilities for the benefit of the local villagers.

c. Selection of 300m class drilling machine and related tools

C.1 Conditions

A schematic diagram of a standard well structure is shown in Figure 2, which is based on the past experience of EWTEC for well drilling as well as the request from EWTEC.

The geological condition in Ethiopia mainly consists of volcanic rocks (basalt) and is generally hard and dense. Air drilling procedure by DTH is effective for hard rock drilling. Otherwise, for unconfined surface layers or weathered layers, the mud drilling procedure is used in order to prevent well collapse. The tools are selected to prepare for mud drilling, in cases when it is difficult to remove drilling cuttings when fractures and fissures are encountered during operation, or cases when collapsible layers or layers that discharge a large volume of groundwater appear. In order to estimate the number of consumable tools, the drilling target layer is set as follows:

1)	depth	0 - 35m	surface, weathered layer (soft rock)
2)		35 - 250m	hard volcanic rock (hard rock)
3)		250 - 300m	volcanic rock fractured zone, aquifer (middle-hard rock)

C.2 Selection of drilling machine

The size of the drilling machine is determined by maximum lifting capacity (drive-head and mast), mast length and capacity of the mud pump. The details are as follows.

1) Maximum lifting capacity

Assuming 300m maximum drilling depth and 9-7/8" diameter, the expected total weight of all tools related to the drilling process which are suspended from main body of the drilling machine is about 12,000 kg (Table 5). The machine should be able to lift all of these tools up and down in addition to the added load from collapsed soil. The additional weight is estimated at 20% and the drive head load capacity is determined to be a minimum of 14,000kg.

If the borehole wall should collapse during drilling and cause “stacking” of drilling equipment such as the drill bit, drilling pipe, etc., strong hoisting capacity is required. Consequently, the mast hook load is determined at 24,000kg, which is twice the hoisting load.

Table 5 Weight of tools

Name	Spec	No.	Unit weight (kg)	Total weight (kg)	Remarks
Drill head		1	ca.1,200	ca.1,200	
Drill pipe	O.D.4-3/4", 6.0m/piece	58	ca.160	ca.9,280	350m/6m
Drill collar	6-1/4” x 3.0m/piece	2	ca.409	ca.818	
Stabilizer	For 9-7/8", 3-1/2"IF	2	ca.210	ca.420	
Crossover sub	3-1/2"IF x 4-1/2"REG	1	ca.40	ca.40	
Hammer body	For 8"-10"	1	ca.206	ca.206	
Hammer bit	9-7/8”	1	ca.62	ca.62	
Total				ca.12,026	

*Condition: DTH drilling, max. depth 350m, final diameter 9-7/8"

2) Mast length

General length of drill pipes are 3m or 6m. The 6m pipe is selected with consideration of operational efficiency. The mast length should be long enough to handle a 6m drill pipe efficiently.

3) Mud pump

Generally, mud elevation speed in a borehole is from 0.25-0.40m/s. The total mud volume Qm passing between the wall of a well 12-1/4" [311.2mm] (D1) and drill pipe 4-3/4" [120mm] (D2) is calculated with the following equation.

$Qm = A \cdot vm$

When,

A = (cross-section area of drilling hole)－(cross-section area of outside rod diameter)

$=\pi$ x (D1 x D1－D2 x D2) /4 = 3.14 x (0.311 x 0.311－0.12 x 0.12) / 4 = 0.065m^2

Assuming that the condition of elevation speed vm is between 0.25-0.40m/s,

Q_m = (0.25-0.40) ×0.069 = (0.0163-0.0260) m^3/s = (978-1,560) lit/min

Based on the above discussion, the quantity of water supply is determined to be 1,500lit/min or more. Water supply pressure is determined to be 20kg/cm^2 or more for the possibility of hydrostatic circulation under the estimation that the static groundwater level is GL-200m in a 300m depth well.

4) Others

The drilling machine is determined to be a 6x4 loading type truck considering high mobility. The power resource is PTO from the truck engine.

C.3 Tools and accessories

The tools and accessories attached to the 300m class drilling machine are selected to be suitable for inserting 4 inch and 6 inch casing generally used in Ethiopia. The total number of tools and accessories is determined necessary for 2-3 wells drilled in a year and a total of 6-9 wells per three years. A diagram of the tools is shown in Figure 3.

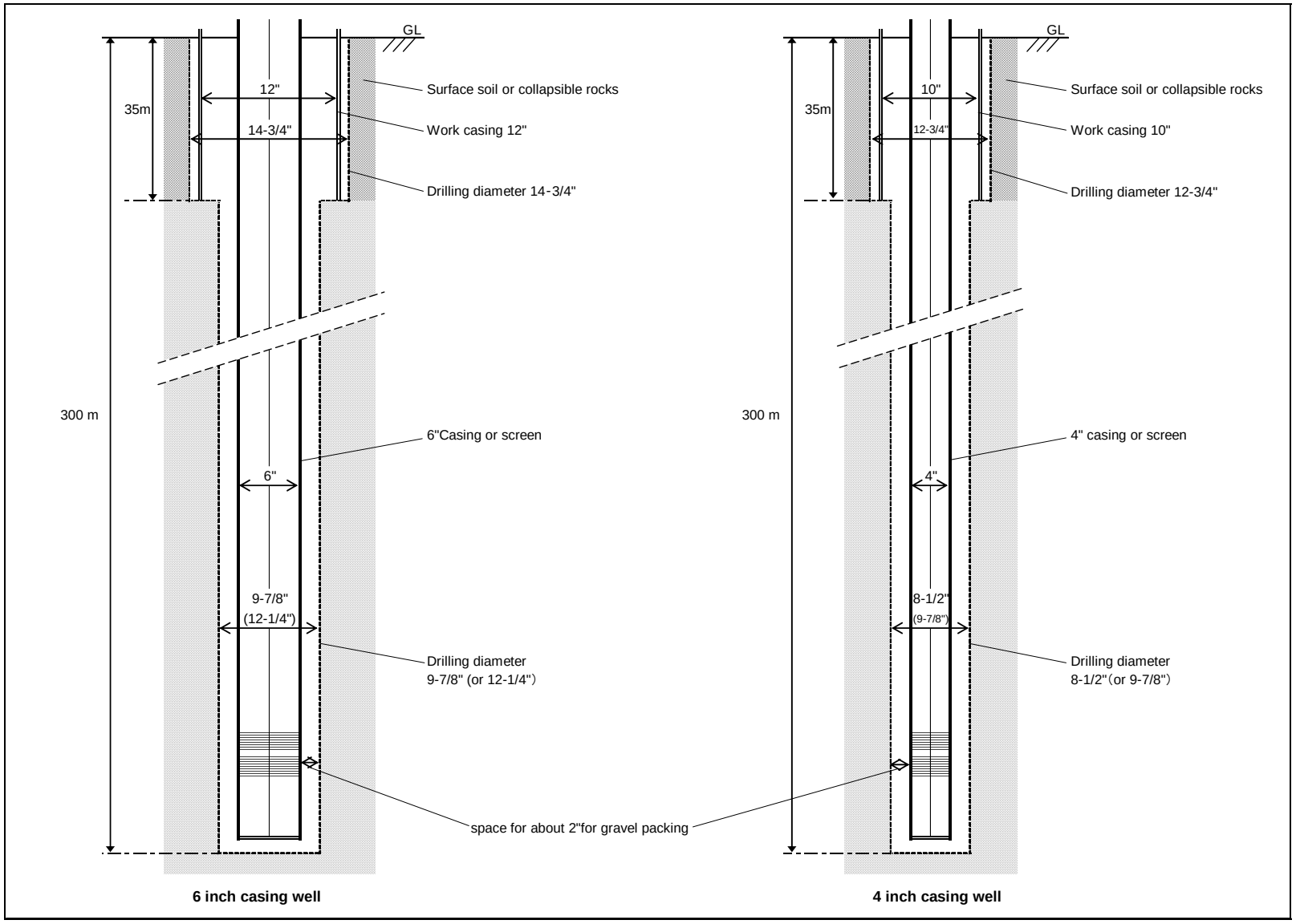


Figure 2 Standard well structure (300m class)

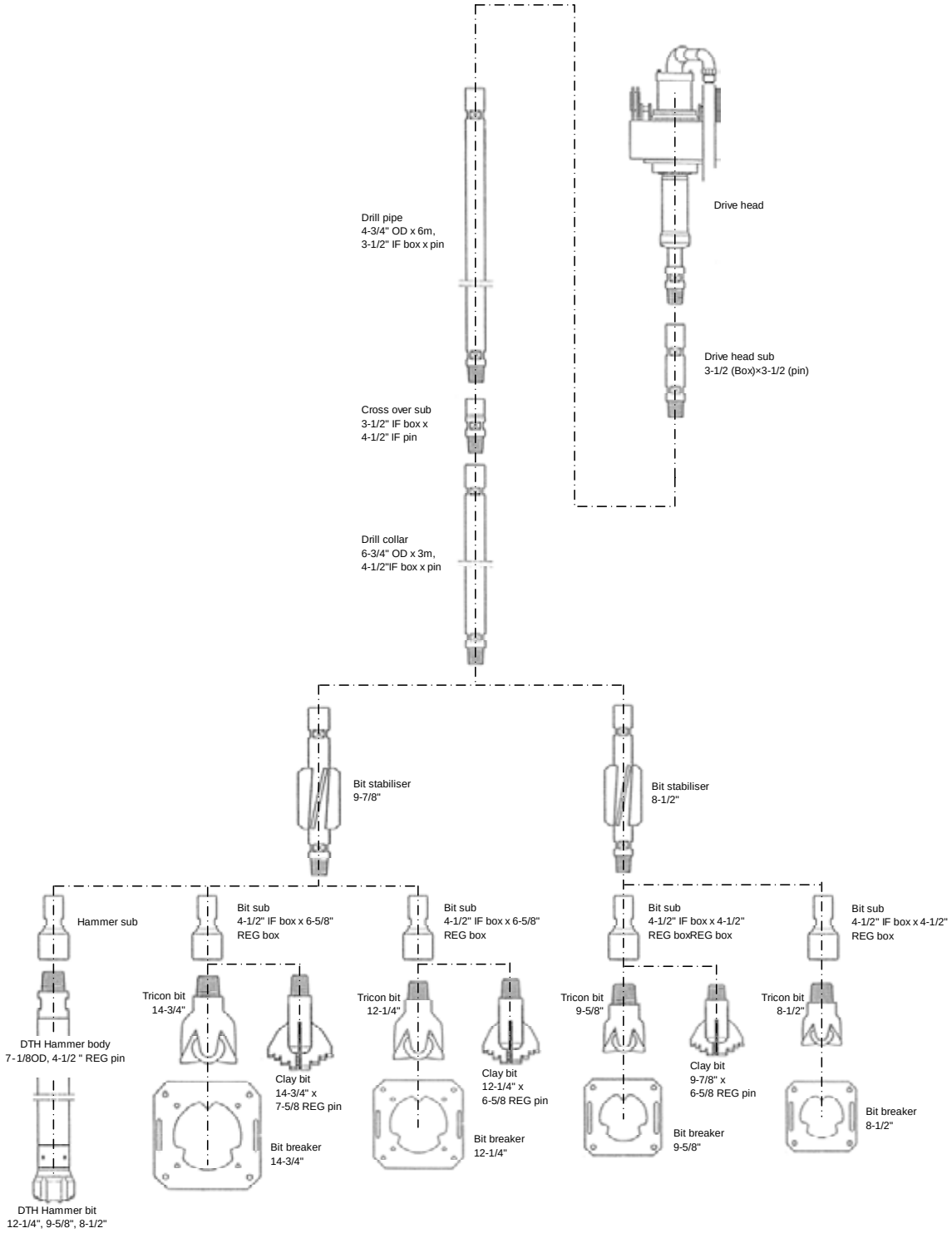
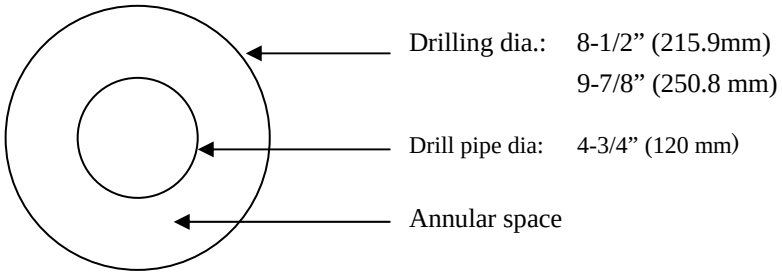


Figure 3 Standard tools

B.3 High pressure compressor

Required air discharge is calculated by following equation using the DTH method.



A flow rate of 900-1,200m/min is required at the annular space (the space between the drill rod and the wall of a borehole) in order to smoothly remove the cutting slime from the well. The flow rate at the annular space is calculated by the following equation:

$V=Q/A$ .....(1)
$A=\pi (D2 – d2) / 4$ .....(2)

V = Air flow velocity at the annular space (m/min.), Q = Necessary air volume (m^3/min.),
A = Annular space area (m^2), D = Well diameter (m), d = Rod diameter (m)

The basic condition is assumed as 4-3/4" (0.12 m) rod diameter and D1:8-1/2" (0.216 m) borehole diameter or D2:9-7/8" (0.251 m) borehole diameter, flow rate 900-1200 m/min for DTH drilling method of a C type well in this plan. The necessary air discharge is calculated using the following equations:

Q1 = 3.14 x (0.216 x 0.216 - 0.12 x 0.12) / 4 x (900 - 1,200) = (22.79 - 30.39) m^3/min.
Q1 = 3.14 x (0.251 x 0.251 - 0.12 x 0.12) / 4 x (900 - 1,200) = (34.34 - 45.78) m^3/min.

Theoretical flow rate is calculated to be approximately 25m^3/min for 8-1/2" DTH hammer bit, and 35m^3/min or more for a 9-7/8" DTH hammer bit. However, a compressor which meets the required flow rate of 35m^3/min is very heavy (more than 7 tons including fuel). These heavy compressors require a large truck for loading and are impractical from a cost-benefit perspective. Further, the fuel consumption rate of a 35m^3/min class compressor is 30% more than that of 25m^3/min class compressor, and it is considered uneconomical. In the case of slime discharge difficulties due to low air volume/flow or water spring, the discharge efficiency of slime can be improved by the addition of a foaming agent into the air during the drilling process.

Based on the above discussion, the specification of a high pressure compressor is determined to be 25m^3/min. (900cfm) or more.

Usually, higher air pressure increases stroke frequency and the rate of drilling, which brings about improvement of operational efficiency. However, too much air pressure might break the hammer itself (acceptable air pressure of hammer is 2.5MPa). Considering the air pressure loss in the water and possible hammer damage, the compressed air pressure should therefore be around 2.0MPa to 2.41MPa.

B.4 Equipment for airlifting and pumping test

a. Compressor for airlifting

Inadequate finishing of drilling work often causes a well to malfunction even if all processes like drilling, casing and screen installation, and gravel packing are completed. The finishing work is to bring out the full capacity of a well by cleaning mud after casing installation and gravel packing. Air lifting is part of finishing, to remove mud from the borehole completely by using a compressor while circulating groundwater in the well. It requires a compressor with relatively low pressure. This is not replaced by a compressor with high pressure like in B.3 because the discharged air volume and pressure of the high pressure compressor would be too high and simply result in air bubbling up to the surface making it difficult to get a suitable pumping rate of cleaning water. Moreover, too high a volume and pressure of discharged air may cause the well to break down. PVC casing used for well construction has relatively low strength compared to steel and FRP casing, resulting in high risk of well break down. Moreover, because the high pressure compressor is not designed for low discharge volume use, it could easily be the cause of damage. The detailed specification is shown below.

The basic theory of air lifting cleaning is the same as air lift pumping usually used in hot spring pumping. The compressor capacity has been calculated using the following table called a diagram of air compressor operation (*Hot spring development and design*, Chijin Shokan Co., Ltd.).

At the beginning of the finishing work, it is assumed that a well is filled up to the well mouth with mud and the static water level is GL-0m. Additionally, airlifting is assumed to be carried out at the maximum water level drawdown of 50m and a minimum soaking ratio of 50%. In this case, H and Hs are calculated according to Figure 4 as follows.

H =50m

Hs=50m

In this case, the required air discharge can be read as Qa=6.2m^3/min from the figure, the value is seen straight above the intersection point of assumed lifting height (H) 50m and water soaking ratio curve of 50%.

However, the pumping material is not water but mud, and Qa is a value for 1m^3/min liquid pumping, so finally, the air discharge volume is determined to be 8.5m^3/min or more in order to secure sufficient pumping volume.

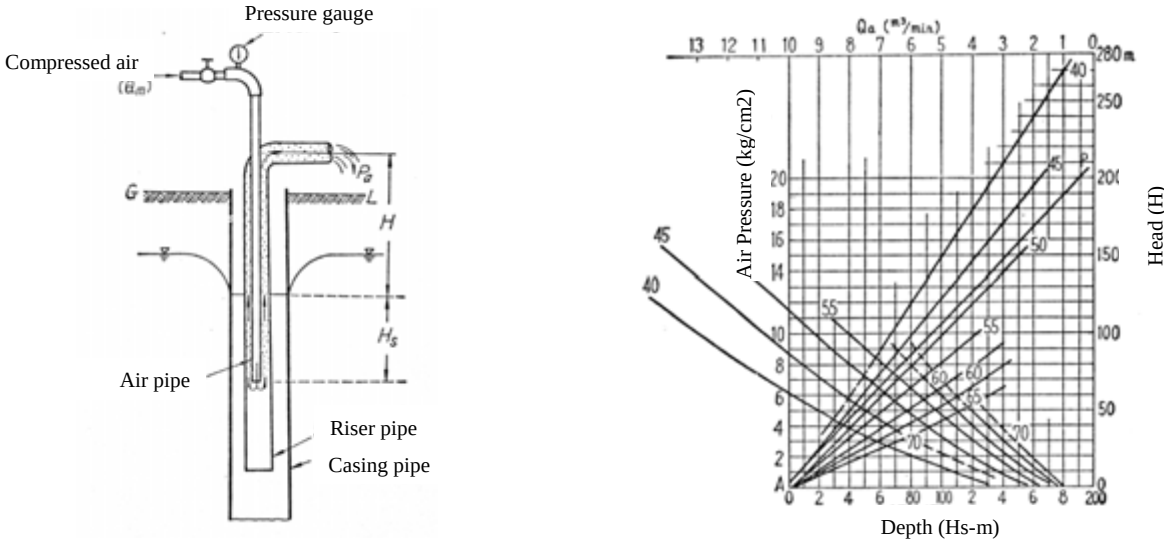


Figure 4 Structure of airlifting (left) and diagram of air compressor operation (right)

In addition, the riser pipe is set at the bottom of the well (GL-300m) in order to clean around the bottom; air pipe is set at the position of GL-100m depth in the beginning and added until GL-200m with drawdown processing. The air pressure capacity of a compressor is determined as 10kgf/cm^2 (1.0MPa) or more.

This compressor for air lifting is also used for well rehabilitation work with a service rig, and it is transported by a crane truck.

b. Equipment for pumping test

For a 300m class well with 6 inch casing, capacity is planned with a flow rate of 400L/min at 200m head. Additionally, a triangular-notch weir for flow rate measurement and a simple water level gauge are necessary. A generator is not procured in this plan because the existing generator in EWTEC is available.

B.5 Crane truck

Crane trucks carry standard accessories of the drilling machine, tools, screens, casings, and daily necessities for the drilling team. It is ideal to minimize travel times to increase working efficiency. However, the total weight of the drilling tools alone is more than 12 tons for 300m drilling. In addition, the truck needs to transport the generator, welding machine, air lifting compressor, etc., many times between the stock yard (EWTEC yard) and well sites (Table 6). Furthermore, the truck will likely spend a large amount of time carrying a great deal of water indispensable for well drilling, but usually difficult to obtain near the site. Furthermore, the truck needs more than twenty 200 liter drums for gasoline, as it is estimated to use between 4,000 and 5,000 liters of fuel for drilling. Considering these points, the payload should be more than 6 tons, so two trucks are necessary from the view point of high efficiency and versatility.

The trucks should be equipped with a crane because all the tools and equipment are made of heavy metals which are difficult to transport by hand and could otherwise cause an accident. The capacity of

the crane is 3.0 tons so as to hoist the air lifting compressor, the heaviest equipment (around 1,900kg). The platform length is determined to carry casing and screens 6m in length.

Table 6 List of equipment to transport and its weight

Name	Spec.	No.	Unit weight (kg)	Total weight (kg)	Remarks
Drilling tools	Drilling pipe, Drilling collar, Bit, DTH hammer etc.	1set	ca.12,026	ca.12,026	Refer to Fig.5
Airlifting compressor		1	ca.1,900	ca.1,900	
Submerged pump and pumping tube		1	ca.1700	ca.1700	
Generator	60kVA	1	ca.1400	ca.1400	
Attachments for drawdown test	Pumping tube 2.75m×25, console panel, triangular-notch weir, valves etc	1set	ca.800	ca.800	
Daily use items	Tent, chairs, etc	1set	ca.50	ca.50	
Concrete material	Cement, gravel, sand, reinforcing steel	1set	ca.1,500	ca.1,500	
Steel pipe casing	6 inch	300m	ca.27	ca.8,100	
Total				ca.27,476	

B.6 Drilling tools for existing drilling machine

Tools required for the existing drilling machine (Schramm T300M Roto Drill) are planned to be procured, which are to be used for the drilling technology training course at EWTEC.

C. Drilling Machinery Maintenance Technology

C.1 Measuring and maintenance equipment/tools

C.1.1 Diesel tacho-tester

A diesel tacho-tester is used to measure maximum output power by reading the rotation speed of an engine. It is also possible to use it to measure the rotation speed of a pump or diesel generator. Until now, only theoretical training was conducted using textbooks, therefore one tester will be procured for practical training.

C.1.2 Nozzle tester

A nozzle tester is used to test the pressure and degree of angle of injected fuel from the injection nozzle and its pattern. Until now, only theoretical training was conducted using textbooks, therefore one tester will be procured for practical training. The standard manual operation type is planned.

C.1.3 Diesel compression gauge

A diesel compression gauge is used for the measurement of compression pressure of engine cylinder to check the condition of pistons, piston ring, gasket and valves. Until now, only theoretical training was conducted using textbooks, therefore one gauge will be procured for practical training.

C.1.4 Valve spring tool

The valve spring tool is necessary for assembling or disassembling the engine valve spring. Until now, there was no suitable tool for this, and EWTEC training course participants assembled or broke down the valve spring using an undesirable method. This is considered a basic and highly necessary engine maintenance tool, so it is to be procured for practical training in this plan. It should be applicable for everything from small vehicles like pickups to heavy vehicles.

C.1.5 Valve lifter and compressor

This equipment is necessary for fixing or unfixing engine valves. Until now, only theoretical training was conducted using textbooks, therefore one valve lifter and compressor will be procured for practical training.

C.1.6 Valve lapper

A valve lapper is used for valve lapping of engine valves. The valve is adsorbed onto the tool and moved by air pressure up and down for lapping. This is considered a basic and highly necessary engine maintenance tool, so it is procured for practical training in this plan. Hand valve lapper (manual type) for fine adjustment and valve lapping compound (polishing agent) are included.

C.1.7 Piston ring compressor

A piston ring compressor is for assembling or disassembling the piston ring. Until now, there was no suitable tool for this and EWTEC training course participants disassembled and assembled the valve spring using an undesirable method. This is considered a basic and highly necessary engine maintenance tool, so it is to be procured for practical training in this plan. It should be applicable for both small vehicles like pickups to heavy vehicles.

C.1.8 Piston ring tool

A piston ring tool is for disassembling or assembling the piston ring. This is considered a basic and highly necessary engine maintenance tool, so it is procured for practical training in this plan.

C.1.9 Torque wrench with angle scale

These tools are necessary to adjust the bolts of the engine head and connecting rod. These are considered basic and highly necessary engine maintenance tools, so one torque wrench with angle scale will be procured for practical training in this plan. It should be applicable for small vehicles like pickups as well as heavy vehicles.

C.1.10 Socket for engine head bolt

The socket for the engine head bolt is necessary to adjust bolts for engine assembly and disassembly. This tool is considered a basic and highly necessary for engine maintenance, so one set will be procured for practical training in this plan. It should be applicable for small vehicles like pickups as well as heavy vehicles.

C.1.11 Cylinder gauge

A cylinder gauge measures the inner diameter of an engine cylinder to check distortion of the cylinder. This tool is considered basic and highly necessary for engine maintenance, so one unit will be procured for practical training in this plan.

C.1.12 Connecting rod aligner

A connecting rod aligner is necessary to adjust the connecting rod position in an engine. This tool is considered basic and highly necessary for engine maintenance, so one unit will be procured for practical training in this plan.

C.1.13 Camber caster-king pin inclination gauge

A camber caster-king pin inclination gauge measures alignment of tire wheels and adjusts their position. It is a basic tool for car maintenance and highly necessary, so one will be procured for practical training in this plan.

C.1.14 Brake bleeder wrench set

A brake bleeder wrench set is used to remove air in a hydraulic break system. It is a basic tool for vehicle break system maintenance and highly necessary, so one will be procured for practical training in this plan.

C.1.15 Brake spring pliers

Brake spring pliers are used to pull out a break spring from a master cylinder. It is a basic tool for vehicle break maintenance and highly necessary, so one set is procured for practical training in this plan.

C.1.16 Brake lining riveter

A riveter is used to put in break lining. It is basic tool for vehicle break maintenance and highly necessary, so it is procured for practical training in this plan.

C.1.17 Brake drum gauge

A brake drum gauge measures the inner diameter of a brake drum to check its level of wear. It is a basic tool for vehicle break maintenance and highly necessary, so one will be procured for practical training in this plan.

C.1.18 Portable brake booster tester

It is a calibration tool to measure pressure of the brake booster. It is a basic tool for vehicle break maintenance and highly necessary, so one portable tester will be procured for practical training in this plan.

C.1.19 Diesel smoke meter

A diesel smoke meter measures CO_2 and CO concentration in car exhaust to check completeness of fuel burning. It is used to determine the deterioration level of the injection nozzle and piston ring, timing of valve action and fuel injection, condition of the air filter, and so on. Until now, only theoretical training was conducted by textbook, therefore one meter will be procured for practical training.

C.1.20 Arc welding machine

The arc welding machine is used for welding training. There was only one welding machine in EWTEC, but it is insufficient for 10 trainees per class. Consequently, two welding machines are to be

procured. The specification of the machine should be no less than 300A in output with a 40% usage rate.

C.1.21 Jet washer

This is washing equipment for the engine body, engine head, and so on for parts cleaning during engine maintenance. Until now, engine parts were cleaned manually by, for instance, using fabric soaked in benzene to clean adherent oil or fuel parts. Because foreign particles in the cylinder cause unexpected mechanical failure, washing equipment is necessary for cylinder maintenance. Therefore, one is planned to be procured. The size will be suitable for cleaning the engines of drilling supporting vehicles.

C.2 Cutaway models

It has been pointed out by trainees and instructors that the training course mainly consisted of theoretical lessons, and the structure of parts and maintenance procedure was seen only in the textbook, with little opportunity for hands on experience with the real thing. Therefore, cut away models of major vehicle parts are planned. The cutaway models to be selected are those normally supplied to car mechanics' schools and such in Japan.

C.2.1 Fuel injection pump (Cutaway model)

This model is used to show the inner structure of an injection pump. There are different injection pump types with different inner structures. At present, EWTEC has a cutaway model of an inline injection pump. In addition, a PT injection pump is planned that applies to diesel engines (Cummins Co. product) of the drilling machine made in U.S.A. (Gesco Co., Ingersoll Rand Co. etc.) that are often used in Ethiopia.

C.2.2 Manual transmission (Cutaway model)

This model is used to show actual motion and function of each part of a car transmission. For the purpose of practical training, one cutaway model of a common vehicle is planned.

C.2.3 Steering gear assembly (Cutaway model)

This model is used to show actual motion and function of a steering gear. For the purpose of practical training, one cutaway model of steering gear of a common vehicle is planned.

C.2.4 Brake valve (Cutaway model)

A brake valve is necessary for adjusting air volume in the brake line. For the purpose of practical training, one cutaway model of a brake valve of a common vehicle is planned.

C.2.5 Disc brake (Cutaway model)

This is a model of a disc brake. For the purpose of practical training, one cutaway model of a disc brake of a common vehicle is planned.

C.2.6 Drum brake (Cutaway model)

This is a model of a drum brake. For the purpose of practical training, one cutaway model of a drum brake of a common vehicle is planned.

C.2.7 Torque converter (Cutaway model)

A torque converter transfers engine power to the transmission shaft. For the purpose of practical training, one cutaway model of a torque converter of a common vehicle is planned.

C.2.8 Diaphragm cylinder (Cutaway model)

A diaphragm cylinder is a general part used in a common truck brake system. For the purpose of practical training, one cutaway model of a diaphragm cylinder of a common vehicle is planned.

C.2.9 Differential with mechanical lock (Cutaway model)

A differential is part of the power transmission, and is a gear to adjust rotation difference between the right and left wheels when cornering. For practical training purposes, one cutaway model of a differential of a common vehicle is planned.

C.2.10 Exhaust turbocharger (Cutaway model)

An exhaust turbocharger uses exhaust gas to rotate a turbine at high speed and send compressed air into an engine. For the purpose of practical training, one cutaway model of turbocharger of a common vehicle is planned.

C.2.11 Diesel fuel feed pump (Cutaway model)

A feed pump is used for pumping up the fuel from the fuel tank. For practical training purposes one cutaway model of a feed pump of a common vehicle is planned.

D. Electro-Mechanical Maintenance Technology

D.1 Measurement tools for electric/electronic training

D.1.1 Practical training machine for DC motor & DC generator

DC motors and DC generators are commonly used for submersible motor pumps, generators, and other pumps. This practice machine is used for practical training to learn basic characteristics of a DC motor and a DC generator, generator excitation, starting or operational condition. Until now, the training was conducted only by theoretical lecture; therefore this equipment will assist in practical training.

There are a total of 20 trainees per class in the electro-mechanical maintenance technology course. There are two other practice devices described in D.1.2, D.1.3, which can be used at the same time, and furthermore, 6-7 trainees can operate one machine. Therefore, one unit is planned.

D.1.2 Practice machine for AC motor & DC generator

AC motors and AC generators are commonly used for submersible motor pumps, generators and other pumps. This practice machine is used in practical training to learn the basic characteristics of an AC motor and AC generator, generator excitation, starting or operational condition. Until now, the training was conducted only by theoretical lecture; therefore this equipment will assist in practical training.

There are a total of 20 trainees per class in the electro-mechanical maintenance technology course. There are two other practice machines described in D.1.1, D.1.3, which can be used at the same time, and furthermore, 6-7 trainees can operate one machine. Therefore, one unit is planned.

D.1.3 Practice machine for synchronous motor

Synchronous generators are generally very common. This practice machine is used in practical training to learn the basic characteristics of this type of motor and generator, generator excitation, starting or operational condition. Until now, the training was conducted only by theoretical lecture; therefore this equipment will assist in practical training.

There are a total of 20 trainees per class in the electro-mechanical maintenance technology course. There are two other practice machines described in D.1.1, D.1.2, which can be used at the same time, and furthermore, 6-7 trainees can operate one machine. Therefore, one unit is planned.

D.1.4 Low voltage switch gear experimental device

This is usually used in a medium-scale pump station as a circuit controller. This device provides practical training of a switch gear control system to prevent excess voltage, short circuit, grounding problems, and so on. Until now, the training was conducted only by theoretical lecture; this equipment will assist in practical training.

About 10 trainees can attend the practice at once. If all trainees are divided into appropriate sized groups and use the machine in turns, only one machine will meet the requirement.

D.1.5 Basic Circuit Trainer

This is basic equipment to learn the characteristics of alternative current in a resistance circuit and inductive circuit through the measurement of resistivity, voltage and current. Until now, the training in EWTEC was conducted by only theoretical lecture; therefore the trainer is procured for practical training.

6 to 7 trainees can use the trainer at the same time, and a total of 20 trainees are expected. Therefore, three trainers will be procured for three groups each consisting of 6 or 7 members.

D.1.6 Analog Trainer (OP-AMP experiment trainer)

This is an experiment trainer for a basic analog circuit using OP-AMP (operational amplifier). The training provides knowledge on how to use an OP-AMP and what behavior is seen when used in combination with other electric devices. Until now, the training in EWTEC was conducted by only theoretical lecture; therefore the practice machine is procured for practical training.

Three of these will be procured for three groups each consisting of 6 or 7 members that can practice with this equipment at the same time.

D.1.7 Digital Trainer (Logic circuit trainer)

Because theory of a digital circuit is different from that of an analog circuit, this equipment is used to conduct training on integrated circuit troubleshooting. Until now, the training in EWTEC was conducted by only theoretical lecture, so the practice machine is procured for practical training.

Three of these will be procured for three groups each consisting of 6 or 7 trainees that can practice with this equipment at the same time.

D.1.8 PLC trainer

In recent years, pumping station control technology using PLC (Programmable Logic Controller) has been introduced in the irrigation area and relatively large towns such as Bahir Dar and Gondar. This training equipment will be used for basic PLC training. Until now, the training in EWTEC was only conducted theoretical lecture, now the practice machine is procured for practical training.

Three of these will be procured for three groups each consisting of 6 or 7 trainees that can practice with this equipment at the same time.

D.1.9 Electric leakage breaker experiment unit

This unit is designed to conduct experiments of breaking current earth leakage and leakage time to study earth resistance. Until now, the training in EWTEC was conducted only by theoretical lecture; therefore one experimental device is to be procured for practical training.

D.1.10 Frequency counters

Frequency counters measure the frequency of alternative current. It is necessary to measure the frequency at a number of circuit points for practical training on electric circuits. Until now, the training in EWTEC was conducted only by theoretical lecture; therefore, this device is procured for practical training.

Frequency counters are not used frequently, and therefore two units are procured for 20 trainees.

D.1.11 AC/DC power supply

This is power supply source for practical training on electric circuits using resistance, transistor, capacitor, etc. The 20 trainees are divided into groups of five members, so four power supply units are to be procured.

D.1.12 Soldering iron desolder & solder lead set

These are used for assembly and disassembly of electric parts on a circuit board. A desoldering pump is contained for the use of detaching parts. Five sets are planned for procurement; one for each of the 5 trainee groups each consisting of four members.

D.1.13 Variable resistor

Variable resistors adjust current and voltage. It is necessary and important to comprehend characteristics of the basic three items—resistance (R), capacitor (C), and inductor (L)—when learning about electric circuits. A variable resister is needed to observe each component action when electricity flows through the circuit (RC、RL、LC, and RLC). One variable resistor with standard specifications will be procured for practice.

D.1.14 Variable capacitor

Variable capacitors are necessary to understand the behavior of motors under capacitive load and induction load. One capacitor is planned to be procured for the same reasons as equipment D.1.13. The specification is standard.

D.1.15 Variable inductor

Variable inductors are necessary to understand the behavior of motors under capacitive load and induction load. One inductor is planned to be procured for the same reason as equipment D.1.13. The specification is standard.

D.1.16 Digital multimeter

Digital multimeters are maintenance tools to measure current, voltage and resistivity. They are used frequently in the training course. One multimeter is provided per two trainees, so a total of ten multimeters are to be procured. The specification is standard.

D.1.17 Oscilloscope

Oscilloscopes measures voltage and frequency of a circuit, and also shows wave patterns. Four will be procured to be used the 20 trainees divided into five groups.

D.1.18 Signal generator

Signal generators input certain frequency signals to a circuit prepared by the trainee. Four will be procured; one for each of the four groups consisting of five trainees.

D.1.19 Logic probe

A logic probe is used to check the condition of the digital circuit by LED light. Four will be procured; one for each of the four groups consisting of five trainees.

D.1.20 Wattmeter

Wattmeters measure electrical power in watts of any given circuit. Five will be procured for 3 training groups consisting of 6 to 7 trainees each.

D.1.21 Galvanometer

Galvanometers can measure very low current and voltage not measurable by a multimeter. Five will be procured for five training groups consisting of four trainees each.

D.1.22 Electrical hand drill

Electrical hand drills will be used to prepare wood panel board to mount electric or electronic parts such as relay, timer etc. Five are planned to be procured because they can be used in turn.

D.1.23 Circular saw (electrical)

Circular saws (electrical) are used to craft wood panel board for circuit assembly practical training. Two are planned to be procured.

D.2 Cutaway model

D.2.1 Cutaway model of DC motor

This model is used to show the inner structure of a DC motor. One is to be procured for practical training.

D.2.2 Cutaway model of AC motor

This model is used to show the inner structure of AC motor. One is to be procured for practical training.

E. Water Supply Engineering

E.1 Survey Equipment

E.1.1 Pipe locator

A pipe locator explores the position of buried pipeline. At present, high leakage ratio of supply water is considered a serious problem in relatively big cities in Ethiopia. For instance, it is said that the

leakage ratio is about 50% in Addis Ababa. At present, only AAWSA has introduced pipe locators and leak detectors, however, they will become necessary in provincial cities as well. It is considered very significant to hold a leak detection training course for local engineers, introducing the pipe locator in EWTEC. For this reason, it is planned to procure one pipe locator.

E.1.2 Leak detector

A leak detector is used for detection of a leak point by listening to ground noise. As described above, water leakage is currently a problem in Ethiopia, so the leak detection training course for local engineers is highly effective. For that reason, one leak detector is procured for the EWTEC water supply technology course. The detector uses headphones to detect vibration directly from buried pipes, with a leak sound detection bar for pre-survey and electronic sound detector as attachments.

E.2 Incubator and accessories

An incubator is used for bacteriological testing of drinking water. In previous water supply technology courses by EWTEC, participants visited a water quality lab in Oromia without any hands on training. Bacteriological test of coliforms is a common drinking water quality test in Ethiopia, so practical training on this is very important. The membrane filter method has been selected because it is the dominant procedure in Ethiopia. Equipment necessary for this procedure are also to be procured, such as an autoclave for sterilization, sterilized Petri dish, forceps, and so on.

F. Transportation

At present EWTEC has 9 vehicles, except for drilling assistance vehicles (truck and crane truck). All of these were procured in phase 1 project in 9 to 10 years ago, and travel distance of almost all vehicles exceeds 200,000km. These are all in working condition with frequent maintenance without any fatal breakdowns despite the bad condition of roads in Ethiopia (Table 7).

Table 7 Current condition of vehicles of EWTEC

	Type	Number	Travel distance (km)	Date of purchase	Duration of service (year)	Main use	Condition
1	Pickup	16-038	201,130	1999.2	9.5	Equipment transport for fieldwork	Working Maintenance is required
2	Pickup	4-07265	202,000	1999.2	9.5	Equipment transport for fieldwork	Working Maintenance is required
3	Landcruiser (Station wagon)	16-037	269,000	1999.2	9.5	JICA experts, local staff transport / field surveys	Working Maintenance is required
4	Landcruiser (Station wagon)	4-03879	200,000	2000.2	8.5	JICA experts, local staff transport / field surveys	Working Maintenance is required
5	Landcruiser (Station wagon)	4-00697	230,324	2000.2	8.5	JICA experts, local staff transport / field surveys	Working Maintenance is required

	Type	Number	Travel distance (km)	Date of purchase	Duration of service (year)	Main use	Condition
6	Landcruiser (Station wagon)	4-02810	210,251	2000.2	8.5	JICA experts, local staff transport / field surveys	Working Maintenance is required
7	Landcruiser (Hard top)	4-09136	200,000	2000.2	8.5	Equipment and trainee transport for fieldwork	Working Maintenance is required
8	Landcruiser (Hard top)	4-09137	200,694	2000.2	8.5	Equipment and trainee transport for fieldwork	Working Maintenance is required
9	Coaster bus	4-00658	158,568	1999.2	9.5	Equipment and trainee transport for fieldwork	Working Maintenance is required

It is expected that the training course in the EWTEC project phase 3 is total 20 courses including existing course on the basis of preparatory study. Figure 5 shows the vehicle driving plan which meets the training course schedule of EWTEC project phase 3 with consideration of the above information. The capacity of accommodation facility of EWTEC is 40 persons, which limits the training schedule. However, third-country training and such can be carried out despite the limitations of the EWTEC facilities by using a hotel in Addis Ababa. MoWR has a plan to expand the facility from the current accommodation capacity of 40 to 120 people by March 2010, using KR2 counterpart fund. For this purpose, 5.9 million Ethiopian birr (about 67 million yen) has already been approved by MoFED (Ministry of Finance and Economic Development) and the request letter was submitted to Japanese government on November 26, 2008. As a result of this expansion plan, the number of participants for each training course is expected to increase and additional training courses will also be planned with additional instructors. Therefore, the course schedule shown in Figure 5 is the least number of courses envisaged at this stage.

F.1 Bus

EWTEC has a 28 seat bus highly utilized for trainees' field training transport. The three core training courses of EWTEC are: Groundwater Investigation, Drilling Technology, and Drilling Machine Maintenance. They are related to each other and usually held at the same time. As practical field training is very important to these courses, it is better to spend more time in the field. However, the actual training schedule was limited by bus availability. Though bus use was high during project phase 2 as the training scheduled was tight and all training courses have field trips to water supply facilities in provincial areas.

A total of 306 bus days are needed based on the whole training schedule, including the 5 new courses started in phase 3, as shown in Figure 5. There is a period of 6 months where it is inevitable that two buses be used despite designing the operational schedule as efficiently as possible. Also, it is expected that the number of trainees in one of the courses will frequently exceed 20 students, so a bus the same size as the present one will be needed. Further, the fact that the bus cannot be used for 10% of the time due to maintenance etc. is not considered in Figure 5. Therefore, another bus will be able to cover such situations.

The areas where field training of well drilling or geophysical exploration are usually located far from major arterial roads and with no public transport. In the case of travel during the training program where trainees visit local water supply facilities and drilling companies, they travel long distances all over the country for 1-2 weeks. In cases such as this it would be difficult to use public transport, and bus rental is not common in Ethiopia. Another bus of the same capacity is necessary considering the current training courses are restricted by bus availability and that new training courses will start in EWTEC project phase 3.

F.2 Long Wheel Base 4x4 Wagon

Presently EWTEC has two 13 seat Landcruiser hard tops. These vehicles are used for the transportation of equipment that must be protected from wind and weather such as for geophysical exploration, logging equipment, and borehole camera for field practice of the training courses. In the case of the Drilling Technology course, trainees travel by bus from Addis Ababa to the accommodation near training sites in provincial areas. The Landcruisers are used daily between the accommodation and site for longer periods. For the field study, four wheel drives are the best because road conditions are usually too poor for normal cars, which are also not large enough to transport trainees and equipment.

It is planned to start new courses on drilling technology and geophysical exploration in phase 3 of the project. These courses are mainly held at field training sites, so the four wheel drives are highly necessary. For smooth operation of the training courses, two 4WDs are allocated for each training course in accordance with their transportation needs.

Table 8 Purpose of 4WD use during field training

	Training course	Head-count (Trainee+ instructor)	Equipment and required space	Car assignment for training
1	Groundwater investigation	23	Resistivity meter (Main body, Drums, cables) 2sets, Electro -magnetic meter (FDEM) 2sets (2.5m x 1.5m x 2sets)	Two 4WDs for transport of equipment Bus for transport of people between site and accommodation
2	Drilling technology (1)	14	Well logging equipment (Main body, Drums, cables) (2mx1.5m)	Two 4WDs for daily transport of people between site and accommodation Bus for transport between Addis Ababa and site (First and final day only)
3	Drilling technology (2)	10-15	Well logging equipment (Main body, Drums, cables) (2mx1.5m)	One 4WD for daily transport of people between site and accommodation and another for equipment Bus for transport between Addis Ababa and site (First and final day only)
4	Diagnosing/rehabilitation of well	14	Borehole camera, cable type bore hole cleaner (2.5mx1.5m)	Two 4WDs for daily transport of people between site and accommodation One those to be used for equipment transport as well
5	Geophysical survey	14	Resistivity meter (Main body・cables), Electro-magnetic meter (TDEM, FDEM: sensor cable fixed to body)(2.5m x 1.5m)	Two 4WDs for transport of equipment Bus for trainees transport between site and accommodation

Based on Figure 5, gross working days of 4WDs is calculated at 541 days considering the whole training schedule. In some periods of schedule, four 4WDs are necessary due to more than one course running at the same time even if the operational schedule is designed efficiently. The period that the four 4WDs are needed is more than 20% of the year shown in Figure 5. Further, the fact that the 4WDs cannot be used for 10% of the time due to maintenance etc. was not considered in Figure 5. Therefore, the other 4WDs will be able to cover such situations.

For that reason, procurement of two additional 4WDs is considered reasonable to ensure the smooth operation of training courses of EWTEC project phase 3.

Practical training of bore hole camera (monitor and winch are used from within vehicle)

Well logging machine and probe (small generator is needed to operate)

Electromagnetic exploration equipment (FDEM)

High-density exploration equipment (at least 4 drums of cable are necessary for each resistivity meter)

Training Course	Existing/ New	Major place for the training	Duration (weeks)	No. of Trainees	Operational Day (total day) Bus	Operational Day (total day) 4WD Wagon	Remarks
1 Basic Course							
Groundwater Investigation	Existing	Addis Ababa/ Region	12	20	48	40	
Drilling Technology (1)	Existing	Addis Ababa/ Region	12	10	24	160	
Drilling Machinery Maintenance Technology	Existing	Addis Ababa	12	10	44		
Water Supply Engineering	Existing	Addis Ababa	8	20	17		
Electro-mechanical Maintenance Technology	Existing	Addis Ababa	8	20	14		
2 Advance Course							
Groundwater Modeling	Existing	Addis Ababa (hotel)	5	27	4	4	International
GIS/Information Management	Existing	Addis Ababa	4	20			
GIS for Groundwater Management	Existing	Addis Ababa (hotel)	4	27	3	3	International
Water Supply Engineering (Planning and Designing)	Existing	Addis Ababa	4	20	10		
Remote Sensing	Existing	Addis Ababa (hotel)	4	27	4	4	
							International
3 Supplementary Course							
Well Diagnosis	Existing	Region	2-4	10		56	Conducted in dry season
Well Rehabilitation	Existing	Region	2-4	10		84	Conducted in dry season
Rural Water Supply Scheme Development	New	Region	2-4	20	42		
Water Quality Management	New	Addis Ababa	4	10	8		
Various Geophysical Exploration Methods	New	Region	4-6	10	60	120	
Volcanic Geology	New	Addis Ababa	4	20	20		
Drillinig Technology (2)	New	Region	6	5-10	8	70	Conducted in dry season
					306	**541**	Total days

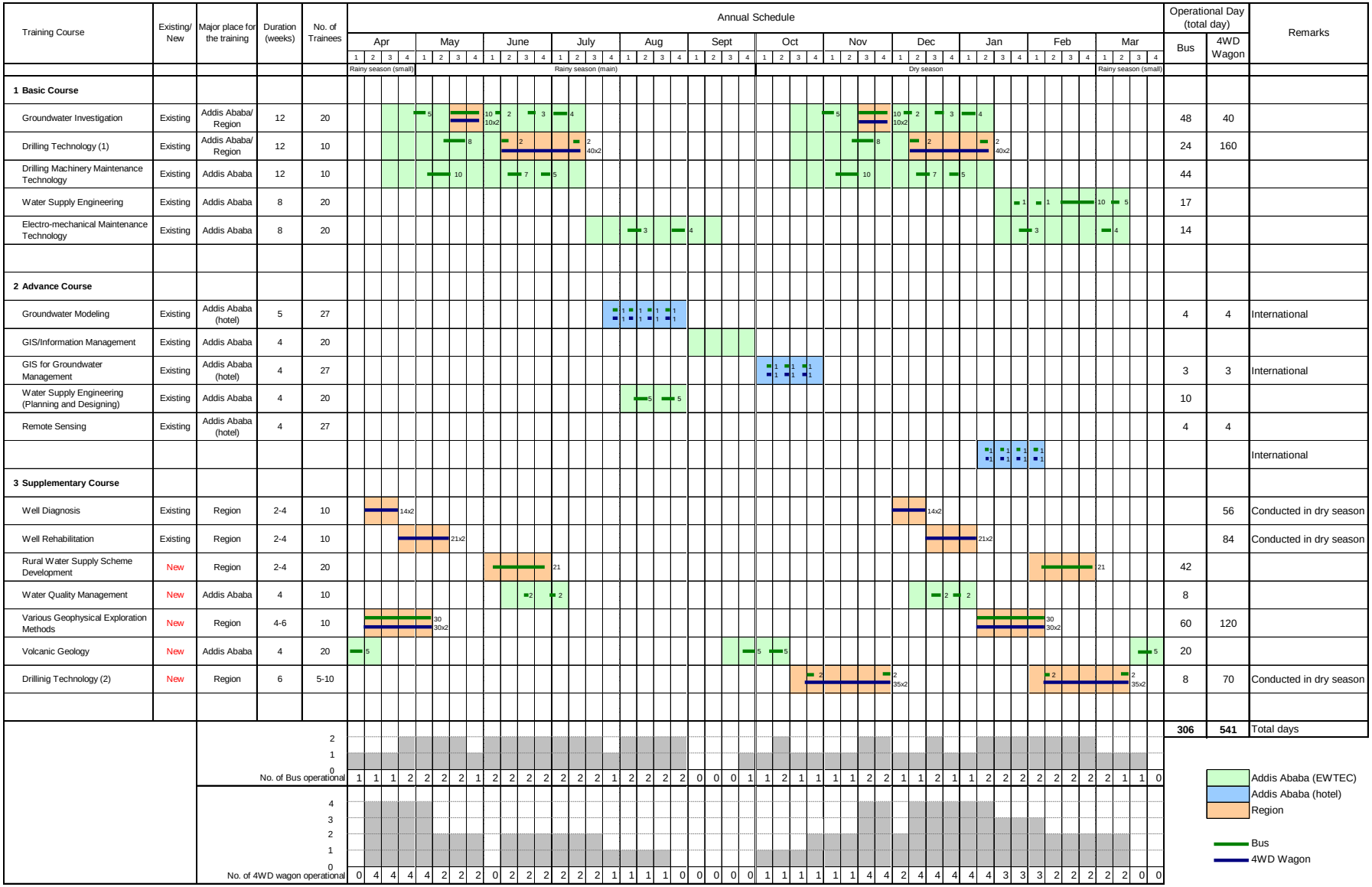


Figure 5 EWTEC project phase 3 Training Course Schedule (draft)

2-2-2-2 Equipment for TVETC (G)

G. Equipment for TVETCs

G.1 Equipment for practical training

There are nine TVETCs in Ethiopia. Each water supply department of these nine TVETCs has the same curriculum. According to the curriculum, the time ratio of lecture and practice is supposed to be 3:7. However, in reality, not enough practice is held because of a shortage of vehicles and practice equipment. This project plans to procure enough equipment necessary to implement practice in the curriculum.

MoWR has already provided all of the equipment planned in this project to the nine TVETCs, except for the diesel generators (G.1.15), submersible pumps (G.1.16), and field bacteriological & physiochemical water analysis kits (G.1.13). One more set of equipment for each TVETC is provided by this plan so that each TVETC will have two full sets.

Each water department of these nine TVETCs has been opened for less than 5 years and is still in the early stage. Taking into consideration the possibility that, in the future, MoWR may purchase additional equipment for each TVETC, one set of equipment to each school (9 sets in total) provided in this plan is seen to be appropriate.

Table 9 shows the relation between the planned equipment and existing TVETC curriculum.

Table 9 Comparison between equipment and TVETC curriculum

No.	Name	Number	Course *	Academic Year	Subject
G.1.1	Total station	9 sets	RWSS	1	• Survey
			SSID	1	• Survey
			RWSS	3	• Rural water supply facility design • Rural water supply facility construction management
			SSID	3	• Small irrigation system design • Discharge system design
G.1.2	Digital Planimeters	9 sets	RWSS	3	• Rural water supply facility design
			SSID	3	• Small irrigation system design
G.1.3	Automatic Level	9 sets	RWSS	1	• Survey
			SSID	1	• Survey
			RWSS	3	• Rural water supply facility design • Rural water supply facility construction management
G.1.4	Geological Compass	9 sets	RWSS	3	• Water resource survey for rural water supply
			SSID	3	• Small irrigation system design • Water resource survey
G.1.5	Cylinder infiltrometer	9 sets	RWSS	3	• Water resource survey for rural water supply
			SSID	3	• Small irrigation system design • Water resource survey
G.1.6	Permeability test kit	9 sets	RWSS	3	• Water resource survey for rural water supply
			SSID	3	• Small irrigation system design • Water resource survey
G.1.7	Soil color chart	9 sets	RWSS	3	• Water resource survey for rural water supply • Rural water supply facility design

No.	Name	Number	Course *	Academic Year	Subject
					• Rural water supply facility construction management
			SSID	3	• Small irrigation system design • Water resource survey
G.1.8	Pick hammer	9 sets	RWSS	3	• Water resource survey for rural water supply
			SSID	3	• Small irrigation system design • Water resource survey
G.1.9	Magnifying lens	9 sets	RWSS	3	• Water resource survey for rural water supply
			SSID	3	• Small irrigation system design • Water resource survey
G.1.10	Sieve	9 sets	RWSS	3	• Rural water supply facility design • Rural water supply facility construction management
			SSID	3	• Small irrigation system design • Water resource survey
G.1.11	Conductivity meter	9 sets	RWSS	3	• Water resource survey for rural water supply
			SSID	3	• Small irrigation system design • Water resource survey
G.1.12	pH meter	9 sets	RWSS	3	• Water resource survey for rural water supply • Rural water supply facility operation
			SSID	3	• Small irrigation system design • Water resource survey
G.1.13	Field bacteriological & physiochemical water analysis kit	9 sets	RWSS	3	• Water resource survey for rural water supply • Rural water supply facility operation
			SSID	3	• Small irrigation system design • Water resource survey
G.1.14	Hand auger	9 sets	RWSS	3	• Water resource survey for rural water supply • Rural water supply facility design
			SSID	3	• Water resource survey • Discharge system design
G.1.15	Diesel generator	9 sets	EMT	3	• O&M of diesel/gasoline fuel discharge pump/engine • Installation of generator set and pump • O&M of pump
G.1.16	Submersible pump	9 sets	EMT	3	• Installation of generator set and pump • O&M of pump
G.1.17	Surface pump (electrical)	9 sets	EMT	3	• Installation of generator set and pump • O&M of pump
G.1.18	Arc welding machine	9 sets	RWSS	3	• Rural water supply facility design • Rural water supply facility construction management

No.	Name	Number	Course *	Academic Year	Subject
G.1.19	Dewatering pump (petrol)	9 sets	EMT	3	• O&M of diesel/gasoline fuel discharge pump/engine • Installation of generator set and pump • O&M of pump
G.1.20	Chain pipe vice	9 sets	RWSS	3	• Rural water supply facility design • Rural water supply facility construction management
G.1.21	Chain wrench	9 sets	RWSS	3	• Rural water supply facility design • Rural water supply facility construction management
G.1.22	Pipe wrench set	9 sets	RWSS	3	• Rural water supply facility design • Rural water supply facility construction management
G.1.23	Pipe threader	9 sets	RWSS	3	• Rural water supply facility design • Rural water supply facility construction management
G.1.24	Torque wrench set	9 sets	EMT	3	• O&M of diesel/gasoline fuel discharge pump/engine • Installation of generator set and pump • O&M of pump

* RWSS (Rural Water Supply Sanitation), SSID (Small Scale Irrigation Drainage), EMT (Electric Machinery Technology)

G.1.1 Total Station

A total station is survey equipment used to measure distance by electro-optical distance measuring and horizontal/vertical angle. Regional Water Resources Bureaus have this type and it has replaced the theodolite as the mainstream survey equipment. It is fundamental for field surveys, and the planning and implementation of water supply projects. Each total station needs a tripod to stabilize it and a reflection board to reflect light waves. Specification is standard, which can measure a distance of 1000m or more, suitable for practical use in the construction of water supply facilities in Ethiopia. In the present curriculum it is used for practical survey training in the RWSS and SSID courses, and for practical training of rural water supply facility design and construction management in the RWSS course.

G.1.2 Digital Planimeters

Digital planimeters are used to easily estimate area on maps. It is used for calculation of water shed area and irrigation area using a given map. Therefore the planned equipment is digital type and able to measure area and segment. In the present curriculum it is used for rural water supply facility design in RWSS and small scale irrigation system design in SSID.

G.1.3 Automatic Level

Automatic Levels are survey equipment used to easily check levelness and height difference between two points by automatic correction. It is quite common in level survey in Ethiopia and necessary for height estimation in the construction of facilities for water supply and irrigation, and for conducting level checks in pipe alignment. Specification is standard, and suitable for practical use in

the construction of water supply facilities in Ethiopia. In the present curriculum it is used for practical survey training in the RWSS and SSID courses, and for practical training of rural water supply facility design and construction management in the RWSS course.

G.1.4 Geological Compass

Geological Compasses measure the strike and dip of strata. It is a very basic tool for geological surveys, so the standard type is procured. In the present curriculum it is used for practical training of water resource investigation for rural water supply in RWSS, and small scale irrigation system design and water resource surveys in the SSID course.

G.1.5 Cylinder infiltration meter

Cylinder infiltration meters measure the rate of infiltration or absorption of water into soil, which are essential for determining the irrigation method and duration. It is also used for measurement of groundwater infiltration. In the present curriculum it is used in practical training of water resource investigation for rural water supply in RWSS, and for small scale irrigation system design and water resource surveys in the SSID course.

G.1.6 Permeability test kit

Permeability test kits are used for the measurement of soil permeability (saturated hydraulic conductivity) using undisturbed samples. The value of permeability measured by this equipment is an important factor in determining the irrigation method and duration. This type of kit is usable both indoors and outdoors, and includes a sample ring and soil sampler. In the present curriculum it is used in practical training of water resource investigation for rural water supply in the RWSS course, and small scale irrigation system design and water resource surveys in the SSID course.

G.1.7 Soil color chart

Standard color charts are used to objectively determine soil color. In order to be applicable to the varied soil types in Ethiopia, it should describe value of hue, brightness, and chromatic level. In the present curriculum it is used in practical training of water resource investigation for rural water supply, rural water supply facility design and facility construction management in RWSS course, and small scale irrigation system design and water resource survey in SSID course.

G.1.8 Pick hammer

Geological hammers are essential for observing and sampling rock in geological field surveys. Made of high strength metal in order to break rigid rock. In the present curriculum it is used for practical training of water resource investigation for rural water supply in the RWSS course, and small scale irrigation system design and water resource surveys in the SSID course.

G.1.9 Magnifying lens

Magnifying lens is a small hand glass with high magnification to observe rock composition mainly used in the field. Standard type of 10 and 20 power magnifications are to be used in the practical training of water resource investigation for rural water supply in the RWSS course, and small scale irrigation system design and water resource surveys in the SSID course.

G.1.10 Sieves

A standard sieve set contains several metal sieves with standard mesh size in order to test particle size distribution of sediment. They are necessary for understanding soil characteristics for irrigation purposes. In the present curriculum they are used for practical training of rural water supply facility design and construction management in the RWSS course, and small scale irrigation system design and water resource survey in the SSID course.

G.1.11 Conductivity meter

Conductivity meters measure the electrical conductivity of soil in the field. In the present curriculum they are used in the practical training of water resource investigation for rural water supply in the RWSS course, and small scale irrigation system design and water resource surveys in the SSID course.

G.1.12 pH meter

pH meters are used to easily measure pH of soil in the field. This equipment is essential for irrigation planning because pH is an important factor to determine the suitability of soil. In the present curriculum it is used in practical training of water resource investigation for rural water supply and rural water supply facility operation in the RWSS course, and small scale irrigation system design and water resource surveys in the SSID course.

G.1.13 Field bacteriological & physiochemical complete water analysis kit

This kit is portable and designed for simple water quality test of groundwater or surface water in the field. A kit capable of biological tests of coliform is needed. A small, simple spectrometer is included for analysis of chemicals in water, and minimum required parameters are pH, TDS, temperature, NO_2, NO_3, NH_4, F, Mn, Fe, SO_4, hardness. Enough test reagent is included for 200 tests (40 x 5 years) or more. In the present curriculum it is used in the practical training of water resource investigation for rural water supply and rural water supply facility operation in the RWSS course, and small scale irrigation system design and water resource survey in the SSID course.

G.1.14 Hand auger

A hand auger is used for simple drilling surveys and soil sampling surveys in the field. It is used for some soil tests, such as permeability measurements, in order to determine irrigation sites, and includes several types of blade edge applicable to any soil type (sandy, clayey, rigid, soft, etc). In the present curriculum it is used for the practical training of water resource investigation for rural water supply and rural water supply facility design in the RWSS course, and water resource survey and discharge system design in the SSID course.

G.1.15 Diesel generator

Diesel generators are the common power source for rural water supply. It is used for the practical training of generator maintenance. It is planned to procure the type of 5kVA output which is the smallest and most portable, because the structure of the generator is basically the same regardless of power scale. In the present curriculum it is used for practical training of operation and maintenance of diesel/gasoline discharge pump/engine, installation of generator set/pump, and operation and maintenance of pump in the EMT course.

G.1.16 Submersible pump

The submersible pump is the most common pump for rural groundwater supply. It is planned to procure a small portable type for practical training of maintenance, actual setting, and water pumping. In the present curriculum it is used for practical training in installation of generator set/pump, and operation and maintenance of pump in the EMT course.

G.1.17 Surface pump (electrical)

This is an electrical surface pump. It is used for practical training in installation of generator set/pump, and operation and maintenance of pump in the EMT course.

G.1.18 Arc welding machine

The welding machine is planned to be used in the practical training of equipment maintenance. An arc welder will be used with rated current of 300A or more. In the present curriculum it is used for practical training of rural water supply facility design and construction management in the RWSS course.

G.1.19 Dewatering pump (petrol)

A surface pump is set at ground-level and pumps up water with the attached hose. In the present curriculum it is used for practical training of operation and maintenance diesel/gasoline discharge pump/engine, installation of generator set/pump, and operation and maintenance of pumps in the EMT course.

G.1.20 Chain pipe vice

A chain pipe vice is used to fix pipes in an appropriate position for pipe work, allowing pipes to be quickly fixed and released using a chain. It is planned to use for the practical training of pipe alignment and is capable to fixing GS pipe (steel pipe) of 6” maximum diameter. In the present curriculum it is used in the practical training of rural water supply facility design and construction management in the RWSS course.

G.1.21 Chain wrench

Chain wrench tightens and loosens various shape and size of bolts by winding chain around the bolt. It is planned to be used in the practical training of pipe connection and capable to fixing GS pipe (steel pipe) of 6” maximum diameter. In the present curriculum it is used for practical training of rural water supply facility design and construction management in the RWSS course.

G.1.22 Pipe wrench set

This is a large wrench which holds a pipe directly in order to rotate it, and the diameter of its opening is adjustable. Its planned use is for the practical training of pipe connection and suitable for GS pipe of 2”, 2-1/2", 3"diameter that is generally used in rural water supply. In the present curriculum it is used for practical training of rural water supply facility design and construction management in the RWSS course.

G.1.23 Pipe threader

Pipe threaders are used for threading pipes or steel bars by using cutting parts called chasers. It is for the practical training of pipe connection and suitable for 2" or less diameter that is generally used in rural water supply. In the present curriculum it is also used in the practical training of rural water supply facility design and construction management in RWSS course.

G.1.24 Torque wrench set

A torque wrench screws up a nut using the appropriate amount of torque so as not to damage it. In the present curriculum it is planned for practical training in the maintenance of generators etc. and is presently used for practical training of operation and maintenance diesel/gasoline discharge pump/engine, generator/pump installation, and operation and maintenance of pump in the EMT course.

G.2 Transportation

G.2.1 Bus

At present, nine of the water technology departments in TVETC don't have any vehicles such as buses or pickups. According the common practical curriculum of these departments (Annex 3), the total training time required for the entire main course is 6,678.5 hours, and 2,330 hours of this is for practical field training (Table 10). Simply dividing this value by daily training hours (7 hours), it is calculated to be 330 days, or 35% of entire course (Table 10).

Table 10 Ratio of field training in TVETC water technology department (common in 9 schools)

	Entire main course (Total 3 grades)	Field practice (Total 3 grades)	Ratio
Total training hours planned in curriculum	6,678.5 hours	2,330 hours	35%
Gross days of training calculated using training hours *	954days	333days	—

*Gross days = Total training hours/ 7 hours (usual training hours a day)

In reality the field practice portion of the curriculum is mostly uncompleted in all departments because of limited transportation. In the case of field visits to project sites operated by a regional water resource bureau, TVETC borrows the regional water resource bureaus vehicles and only pays fuel costs. Otherwise trainees use a public bus or shared-taxi to get to the training sites individually, with their travel costs supplied by TVETC. Such makeshift measures are questionable, for example, borrowing cars places a burden on the bureau, and having to find their own way to training prevents trainees from participating, shown in the low percentage of attendance. Only three TVETC are located in same town as regional water resource bureaus; Awassa, Asossa and Bahir Dar. As for other TVETC trainees it is difficult to get any transport assistance from a regional water resource bureau. It is a major concern that TVETC cannot properly carry out field work due to a lack of vehicles, considering the fact that it is responsible for training members who will work for Woreda water supply offices, and whose future work will mostly be in the field.

When evaluating the training content of each course, field work is considered essential to understand the basic concepts.

Based on above discussions, the necessity of buses as a transport measure in the field is judged very high. A bus capacity of 50 was initially requested given that the usual class size is 40 students with some teachers accompanying. However, the expected travel is to rural areas when visiting zonal water offices, Woreda water offices or in their surrounding area, so the bus will mainly be driven on unpaved roads. The rainy season will make driving such a large bus difficult. Moreover, such buses will be unable to enter into some TVETC compounds. For these reasons, a 30 seat bus which has a smaller turning radius is considered more appropriate. When the field training is nearby, several trips can be made or trainees can be divided into groups, and the schedule for field trips will be arranged accordingly. Therefore it is planned to procure a 30 seat bus.

2-2-3 Implementation Plan

2-2-3-1 Procurement Policy

(1) Basic matters

This plan is to be carried out as per the implementation schedule.

- Exchange of Notes is concluded between the government of Ethiopia and Japan, through the Japanese cabinet approval.
- Based on the Exchange of Notes, the cooperative project proceeds to implementation stage. Implementing agencies controlled by the Ministry of Water Resources conclude a contract with a Japanese consulting firm for the implementation design and supervision of works in the project.

(2) Design of Implementation

- The contracted consultant works out the implementation design for equipment procurement through field surveys and prepares documents for tenders and contracts
- The consultant holds discussion and comes to an agreement with the Ethiopian side about the tender document prepared on the basis of the basic design study report and the equipment specification document.
- The period presumed for implementation design is about 4 and a half months.

(3) Tender

- The tender is implemented following equipment procurement guidelines for grant aid.
- General competitive bidding by businesses which satisfy the requirement of the guidelines is the usual procedure for equipment procurement. Bidding is limited to Japanese candidates.
- The consultant supervises implementation of the tender announcement, bidding, evaluation of tender proposal documents, and so on.
- The implementing agency prepares a tender evaluation report about the result of bidding and an evaluation of tender proposal documents with the assistance of the consultant, and signs a contract with the first bidder under an agreement with Japan International Cooperation Agency.

2-2-3-2 Implementation Conditions

① Clear work responsibility between Ethiopian side and Japanese side
Division of procurement responsibility between the Ethiopian side and Japanese side is shown in Table 11. In particular, preparation for utility of the provisions by the Ethiopian side should be completed before delivery of equipment to encourage the smooth commencement of operation.

② The equipment is to be delivered to existing schools where there are lessons, courses, and other educational activities. Therefore before installing equipment at the schools, an installation plan shall be prepared based on discussions with Ethiopian implementing agency, Japanese consultants, and suppliers in order to avoid disturbance to the educational activities. In addition, attention shall be paid to the safety of students during the installation of equipment, especially vehicles and heavy equipment.

③ As shown in Table 11, the final destination of equipment is each target area/school. The security conditions in Ethiopia will be taken into consideration and if necessary equipment shall be delivered to a more secure neighboring area. The installation plans for the equipment are to be sent to each target area/school at the time of the basic design study as future security is unpredictable.

2-2-3-3 Scope of Work

The below table summarizes the scope of works for division of procurement responsibility (Japanese grant aid) for both Japanese and Ethiopian sides.

Table 11 Division of Procurement Responsibility

Descriptions	Japanese side	Ethiopian side
1. Equipment		
• Equipment procurement	O	
• Transportation and installation of equipment to designated places	O	
• Securing of power source for equipment		O
2. Securing of equipment storage		O
3. Transportation and customs clearance of equipment		
• Transport of equipment to designated places	O	
• Customs clearance		O
• Tax exemption (custom duty, VAT, etc.)		O
• Acquisition of approval for importing equipment		O
4. Bank arrangement and issue of authority to pay (A/P)		O
• Implementation of bank arrangement		O
• Issue of authority to pay（A/P）		O
• Other miscellaneous expenses related to above bank service charge		O
5. VISA approval and arrangement for project members and their costs		O
6. Required approval to implementation of the project		O
7. Cost burden related to project activities (exclusive of grant aid)		O
8. Tender Support Service		
• Preparation of tender documents	O	
• Consulting service for tender and supervision of procurement	O	

Descriptions	Japanese side	Ethiopian side
9. Receiving inspection		
• Inspection of delivered equipment		O
• Inspection of delivered equipment in presence of consultant	O	

2-2-3-4 Consultant Supervision

(1) Basic Policy

Based on the Japanese government grant aid policy and the agreement with the consultant, the consultant shall provide technical assistance to Ethiopia in the implementation design and supervision of procurement under the concept of the basic design. In addition, the Consultant shall carry out the grant aid arrangements in Japan on behalf of the Ethiopian government and make efforts to smoothly achieve the goals of this plan.

(2) Points of Concern

The consultant shall provide proper support services for smooth procurement of equipment. Specifically these services shall include: preparation of tender documents in the implementation design phase; holding of tender under the name of the client; technical support to approve equipment drawings by the Ethiopian side during the procurement supervision phase; pre-shipment review, and dispatch of engineers to Ethiopia during the handover of equipment. In addition, the Consultant shall confirm if acceptance of equipment is done as is indicated in obligation of the recipient country, and give necessary advice in case of delay to ensure the smooth implementation of the equipment procurement plan.

2-2-3-5 Quality Control Plan

The consultant shall confirm in advance the equipment drawings of the items necessary to be produced for this plan. Also, the consultant shall check the necessary equipment at the factory prior to shipment. All equipment to be procured in Japan shall be tested by a third party before shipment.

When equipment is delivered to the planned destinations, the Ethiopian side shall conduct tests on the delivered items in the presence of the consultant.

2-2-3-6 Procurement Plan

(1) Method of Procurement

In Ethiopia, there are no manufacturers that produce equipment to be procured in this plan; therefore, procurement of the equipment in this plan shall include equipment made in Japan or other third countries. Regarding the equipment that is available at local agents in Ethiopia, in principal, equipment with after-service available through local agents shall be selected in the plan.

(2) Supplier and Route of Transportation

As stated above, equipment shall be made in Japan or other third countries. However the plan shall assume that the suppliers are from either Japan or Ethiopia. The equipment made in third counties shall be procured through agents in Ethiopia. The following items shall be procured in Japan: 1) items

manufactured in a third county by Japanese enterprises, and 2) items manufactured in a third county that are generally available in Japan.

Since Ethiopia is a landlocked country, the equipment procured in Japan shall arrive through Djibouti. After import inspection in Djibouti, it shall be cleared at customs in Addis Ababa and delivered to the planned destinations.

2-2-3-7 Operational Guidance Plan

(1) Adjustment/Trial Operation Plan

Of the equipment planed to be procured in this project, adjustment/trial operation will be implemented for the equipment shown in the table below.

Table 12 Items for adjustment and test operation plan

Organization	Item		Content
EWTEC	A-1	Electro-Magnetic Meter	Adjustment/trial operation/Japanese Engineer
EWTEC	A-2	Resistivity meter	Adjustment/trial operation/Japanese Engineer
EWTEC	A-3	Logging equipment	Adjustment/trial operation/Japanese Engineer
EWTEC	B-1	Service rig	Adjustment/trial operation/Japanese Engineer
EWTEC	B-2	Drilling rig	Adjustment/trial operation/Japanese Engineer
EWTEC	B-3	Air compressor	Adjustment/trial operation/Japanese Engineer
EWTEC	B-4-1	Air lifting compressor	Adjustment/trial operation/Japanese Engineer
EWTEC	B-4-2	Submersible motor pump	Adjustment/trial operation/Japanese Engineer
EWTEC	B-6-16	Engine ump	Adjustment/trial operation/Japanese Engineer
EWTEC	C-1-21	Jet washer	Adjustment/trial operation/Local Engineer
EWTEC	D-1-01	Experimental machine for DC motor & generator	Adjustment/trial operation/Local Engineer
EWTEC	D-1-02	Experimental machine for 3 phase induction motor and generator	Adjustment/trial operation/Local Engineer
EWTEC	D-1-03	Experimental machine for Synchronous motor & generator	Adjustment/trial operation/Local Engineer
EWTEC	D-1-04	Low voltage switch gear experimenter	Adjustment/trial operation/Local Engineer
EWTEC	D-1-05	Basic Circuit Trainer	Adjustment/trial operation/Local Engineer
EWTEC	D-1-06	Analog Trainer (OP-AMP experiment trainer)	Adjustment/trial operation/Local Engineer
EWTEC	D-1-07	Digital Trainer (Logic circuit trainer)	Adjustment/trial operation/Local Engineer
EWTEC	D-1-08	PLC trainer	Adjustment/trial operation/Local Engineer
EWTEC	D-1-09	Electric leakage breaker experiment unit	Adjustment/trial operation/Local Engineer
EWTEC	E-1-01	Pipe locator	Adjustment/trial operation/Local Engineer
EWTEC	E-1-02	Leak detector	Adjustment/trial operation/Local Engineer
EWTEC	E-2	Incubator and accessories	Adjustment/trial operation/Local Engineer
TVETC	G-1-13	Field bacteriological & physiochemical complete water	Adjustment/trial operation/Local Engineer

Organization	Item	Content
	analysis kit	
TVETC	G-1-15 Diesel generator	Adjustment/trial operation/Local Engineer
TVETC	G-1-16 Submersible pump	Adjustment/trial operation/Local Engineer
TVETC	G-1-17 Surface pump (electrical)	Adjustment/trial operation/Local Engineer
TVETC	G-1-18 Arc welding machine	Adjustment/trial operation/Local Engineer
TVETC	G-1-19 Dewatering pump (petrol)	Adjustment/trial operation/Local Engineer

As for the equipment relevant to drilling technology (Number A and B), a drilling engineer will be required to implement adjustment/trial operation. Therefore, it is planned that the professional drilling engineer is sent from drilling equipment supplier. Since they are common in Ethiopia and basic equipment for practical training, local engineers (electrical and mechanical engineers) are to be sent with regard to the equipment of number C, D, E, and G.

(2) Training for Initial Operation and General Operation Plan

Since the equipment to be procured in this project is used in education and training organizations in Ethiopia, instructors and teachers know how to use them very well. Therefore, in general, training is not required for initial operation or general operation. However, the operation of the equipment shown in the table below is different depending on the type, and so there is at risk of accidents occurring due to mishandling. Therefore, a drilling engineer will be sent from the drilling equipment supplier, and will implement training in the initial operation and the general operation of the equipment.

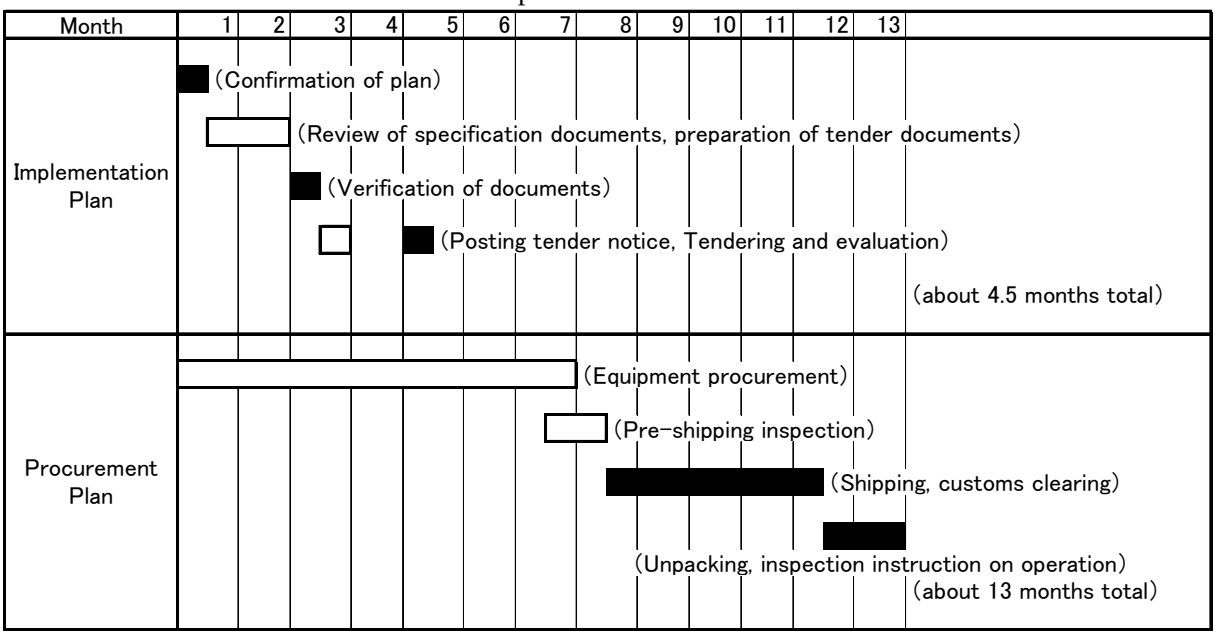
Table 13 Training for Initial Operation and General Operation

Organization	Item	Contents
EWTEC	B-1 Service rig	Training for Initial and General Operation
EWTEC	B-2 Drilling rig	Training for Initial and General Operation
EWTEC	B-3 Air compressor	Training for Initial and General Operation
EWTEC	B-4-1 Air lifting compressor	Training for Initial and General Operation

2-2-3-8 Implementation Schedule

The implementation schedule is given below including obligation of the Japanese side, such as design of implementation, tender and procurement service.

Table 14 Implementation Schedule



2-3 Obligations of Recipient Country

Envisaged obligation of recipient country is as follows.

Table 15 Obligation of Recipient Country

Items	Obligation	Cost (Birr)	Party responsible
Electric power	Secure power source to operate equipment	90,992	MoWR
Site	Secure storage for equipment	—	MoWR
Transportation and custom duty	• Customs clearance • Tax exemption (custom duty, VAT 15% etc) Approval of importing equipment	21,656,051	MoWR
Bank arrangement and issue of authority to pay (A/P)	• Implementation of bank arrangement • Issue of authority to pay (A/P) Other miscellaneous expenses related to above bank service charge	27,298	MoWR
Receiving inspection	Inspection of delivered equipment	—	MoWR
Others	• VISA approval and arrangement to project members and their costs Required approval for implementation of the project		
Total		21,774,341	

Ethiopian side shall cover 21,774,341 Birr of the total cost of this project. Among this, tax exemption for procured equipment (21,656,051 Birr) is earmarked as a special budget, and Ethiopian side (MoFED) has already accepted it. The responsible organization, MoWR, has dealt with the tax exemption for the past grant aid projects in the same manner as this project, and there haven't been any tax problems to date. Besides, the other amount of money that has to be covered by Ethiopian side (118,290 Birr) is only around 14 % of the total budget excluding the cost of employment. Therefore, MoWR will be able to take responsibility in this project.

2-4 Project Operation Plan

2-4-1 EWTEC

The equipment provided and used for training courses at EWTEC is operated and maintained in very good condition. It will not be a big problem even if the current storage space is used for the new equipment; however, in case space becomes limited in the future, the study team requested that enough space is secured to store the new equipment. Furthermore, currently EWTEC is making a facility expansion and improvement plan (threefold increase in the quota of trainees) by utilizing the KR2 Counterpart Fund. The fund application has already been submitted to MoFED.

At present, the equipment at EWTEC is strictly secured by a warehouseman. Operation and maintenance of individual equipment are carried out responsibly by coordinators and trainers. It is expected that same operation and maintenance system will be applied for the new equipment procured by this study. In addition, during the EWTEC project phase 3, which will start during 2008, operation and maintenance system of the equipment will be strengthened by the assistance of Japanese experts.

2-4-2 TVETC

Formerly, budgeting and technical assistance for TVTEC water technology departments were the responsibility of the TVETC team of Department of Rural Water Supply and Sanitation Service in MoWR. Training curriculum, teaching material, text, procurement, operation and maintenance of the equipment, and running costs (teacher salaries, student allowance, and fuel expenses, etc.) were covered by the TVETC team. However, recently, the transference of the above responsibilities from MoWR to TVETC agencies or TVET commissions in the regions, Regional Education Bureau, or Regional Water Resources Development Bureau was coordinated to start since July in 2008 in the earliest region. According to the person in charge of the TVETC team in MoWR, only one regional organization, a TVET agency in Oromia region, was transferred in July 2008. The control of the others is to be transferred after July, 2009.

On the other hand, the Oromia TVET agency, facing the earliest regional transference in July, 2008, has already submitted a request letter that they want to put the responsibilities such as procurement of equipment and training of teachers into the hands of the central government and MoWR. Considering this situation, relationship between the central and the regional authorities is judged much the same as when the study was requested. This matter was confirmed by the consultant who surveyed the TVETC in each region.

Consequently, as originally requested, the following content was summarized in the minutes of discussion (M/D); The liaison of the Ethiopian side for procurement of the equipment to TVETC is concentrated in MoWR; MoWR has ownership of the equipment and responsibility for its sustainable operation; Following the transference of authority, the TVET agency or commission in each regional

state, Regional Education Bureau, or Regional Water Resources Development Bureau, will appropriate the budget for operation and maintenance of the equipment to TVETC, which then covers its own operation and maintenance costs. A formal agreement paper from each region to secure the above contents has been already obtained from each region. Table 16 shows the current situation of responsibility for operating TVETC in each region.

Table 16 Responsibility for the operation of TVETC Water Technology Department

TVETC		Region	Responsibility for operation	
			Present	Remarks
1	Assela TVETC	Oromia	TVET Agency	Transferred to TVET Agency from MoWR in July 2008
2	Woliso TVETC	Oromia	TVET Agency	Transferred to TVET Agency from MoWR in July 2008
3	Bahir Dar TVETC	Amhara	MoWR	Planned to be transferred to TVET Agency in 2009
4	Komborcha TVETC	Amhara	MoWR	Planned to be transferred to TVET Agency in 2009
5	Maychew TVETC	Tigray	MoWR	Planned to be transferred to TVET commission in 2009
6	Awassa TVETC	SNNP	MoWR	Planned to be transferred to Regional Education Bureau in 2009
7	Merka TVETC	Afar	MoWR	Planned to be transferred to Regional Education Bureau in 2009
8	Jijiga TVETC	Somali	MoWR	Planned to be transferred to Regional Water Bureau in future
9	Asossa TVETC	Benishangul-Gumuz	MoWR	Planned to be transferred to Regional Education Bureau in 2009

Regarding operation and maintenance conditions of the equipment after procurement, MoWR is supposed to monitor the working status of the equipment through the regular reports submitted by the TVET agency (only transferred in Oromia region), TVET commission, Regional Education Bureau, or Regional Water Resources Development Bureau（Figure 6）.

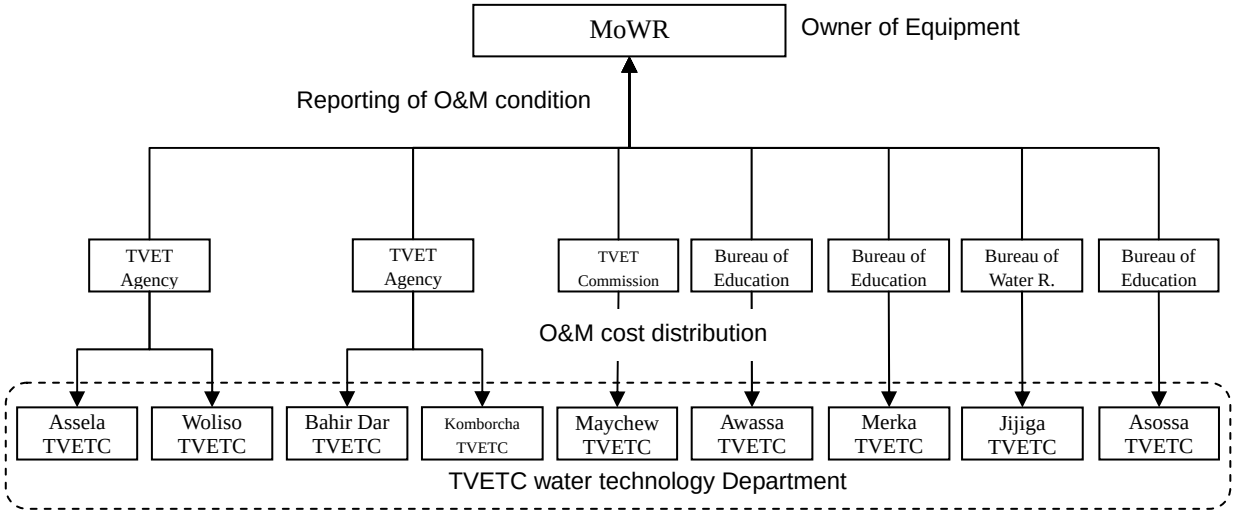
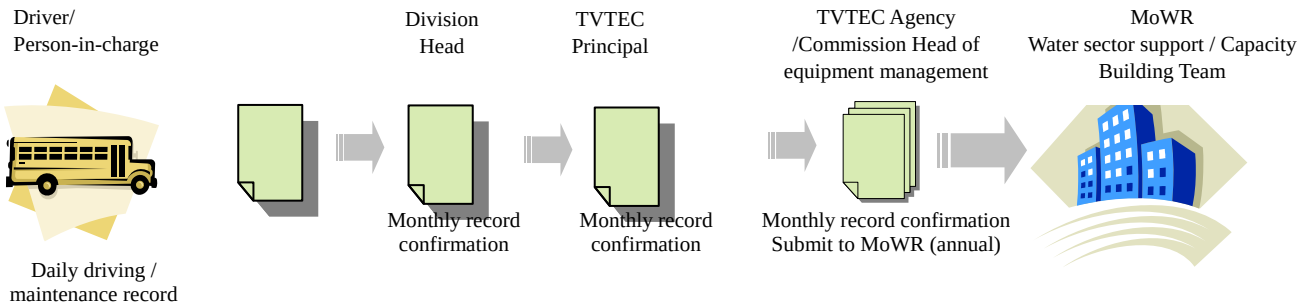


Figure 6 O&M and Monitoring structure for the equipment for TVETC

Monitoring policy of equipment provided to TVTEC will be implemented in the following ways. Monitoring will cover all of the equipment provided to TVTEC.

- The head of each agency must submit an annual Status of Use Report (including photos of vehicles) on the equipment they are using. Attachment 1 shows the record of monitoring. This monitoring will continue for at least 5 years.
- The monitoring record is split into three main sections: the rig; large and expensive equipment which need regular maintenance such as vehicles, generators, and other items with engines; field equipment that is easily maintained, and also relatively cheap tools that do not generally require maintenance.
- In the case of vehicles and generators, as the driver or person responsible for them is usually set, they can keep a record of maintenance and any troubles. Every month they should submit this record of operation to the head of their department for approval. The head of the agency verifies this (Appendix 5 (3)).
- In the case of electrical exploration equipment etc., the user makes a record after each use. The head of the department responsible checks this every month (Appendix 5 (3)).
- An inventory check of the condition of tools is undertaken bi-annually using a prepared itemized list.

Below is an outline of the monitoring reporting procedure of the provided equipment.



2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

This cost estimation is provisional and would be further examined by the Government of Japan for the approval of the Grant.

2-5-1-1 Ethiopian side cost obligation

The following cost shall be borne by the Government of Ethiopia.

Table 17 Ethiopian side cost obligation

Item	Cost (million yen)
Securing power source	1
Securing equipment storage space	—
Tax exemption measures	238
Banking・authorization to pay	0.3
Equipment inspection	—
Others	—
Total	239.3

2-5-1-2 Conditions of Cost Estimation

1) Time of Cost Estimation: September 2008
2) Exchange rate: 1USD = 106.18
3) Procurement Period: The detailed design and procurement period is as shown in the project implementation schedule.
4) Others: This project is carried out as Grant Aid from the Government of Japan.

2-5-2 Operation and Maintenance Cost

The planned equipment is basically selected considering the ease of operation and maintenance. The majority of equipment requires only electricity costs for running, except for drilling rigs and vehicles for which have higher maintenance and fuel costs. Below is a further description of necessary costs and how much the Ethiopian government is able to bear.

2-5-2-1 EWTEC

(1) Well Drilling Machine

Calculation of fuel expenses for drilling a 300m deep well is shown in Table 11.The following criteria was set up for the purpose of calculation.

- Working hours per well drilling is 8 hours
- Geological condition:

Depth 0-35m surface, weathered layer (soft rock)
Depth 35-250m hard volcanic rock (hard rock)
Depth 250-300m volcanic rock fractured zone, aquifer (middle-hard rock)

- Transportation fuel expenses are excluded

Table 18 Necessary days and fuel costs for drilling 1 well (*1, 2)

Work	Type A (6 inch casing well)		Type B (4 inch casing well)	
	Days	Fuel cost (Birr)	Days	Fuel cost (Birr)
1. Preparation	2.00		2.00	
2. Transportation	1.00		1.00	
3. Machine setup	6.00	2,970	6.00	2,970
4. Temporary work	1.00		1.00	
5. Drilling work	29.33	168,707	24.60	140,500
6. Logging	1.00		1.00	
7-1. Casing preparation	1.00		1.00	
7-2. Casing installation	1.00	1,238	1.00	1,238
8. Gravel packing	0.14		0.13	
9. Sealing work	0.28		0.26	
10. Cementing	0.18		0.13	
11. Finishing	3.00	2,828	3.00	2,828
12. Pumping test	9.00	839	9.00	839
Total	54.93	176,582	50.12	148,375

*1 Diesel cost 9.62ETB/L (5.10.2008)

*2 Reference

①National Water Well Association of Japan (2008)

②Japan construction mechanization Association (2008)

According to this, the cost of fuel alone to drill a 300m deep well is about 148～176 thousand Birr. Actually, about another 45 thousand Birr will be added as allowance for trainees and instructors; therefore drilling cost per well becomes 193～221 thousand Birr, excluding well materials such as casing and gravel. During the transition period from EWTEC project phase 2 to phase 3, all training was carried out by the Ethiopian side. Especially for practical training in drilling technology course, a well planed to be drilled by Oromia regional water resource development bureau was successfully constructed by EWTEC as OJT practice. For this, Oromia regional water resource development bureau covered all the costs of drilling, including allowances. Currently, demand for drilling wells is very high in Ethiopia, thus this system will go on in the future. In the same way, 300 m wells planned by MoWR, regional water bureau, and so on, are also drilled by EWTEC OJT training, with the organization which planned the well covering all costs of the training. In this manner training can be carried out.

(2) Vehicles

Based on the training schedule in the report of EWTEC project phase 2, and the draft schedule of EWTEC project phase 3 described in Figure 5, the fuel expense and O&M cost for bus and 4WD (long wheel base) were examined and the estimated result is summarized in Table 19.

Table 19 Fuel and maintenance cost for vehicles in EWTEC (Bus and 4WD (long wheel base))

	Driving distance (km)	Fuel cost (Birr)[*3]	Maintenance Cost (Birr)	Fuel+ Maintenance (Birr)
Bus (2 cars)[*4]	25,934[*1]	46,201	21,925	68,126
4WD (long wheel base) (4 cars)[*4]	48,310[*2]	70,415	41,369	111,784
Total	—	116,616	63,294	179,910

*1 Hino for 29 passengers (Liesse II) fuel consumption 8.90km/L
*2 Toyota Landcruiser fuel consumption 6.6km/L
*3 Diesel cost 9.62ETB/L (5.10.2008)
*4 A Bus and two 4WDs are already in EWTEC

According to this, annual O&M cost for two buses and a 4WD (long wheel base) is estimated at approximately 180,000Birr. Actually, the cost of vehicle operation and maintenance (fuel and oil) is covered by the budget of EWTEC (around 100,000Birr annually), and material compensation from MoWR. MoWR allocates fuel to all vehicles in the ministry. 50 litters and 70 litters of fuel per wagon・pickup and bus are allocated from storage of MoWR. In addition, they are maintained, such as by changing the engine oil and filter every 5,000 km. It seems this system will be continued in the future, and vehicles to be procured in this project can be maintained and refueled by MoWR, in the same manner as the existing vehicles. It has already been confirmed with the Ethiopian side that the budget of EWTEC is increasing with the increment of the number of cars, since the budget is earmarked depending on the number of cars.

Therefore, EWTEC (MoWR) can sufficiently afford to cover operation and maintenance cost for vehicles including fuel as it has up until now.

2-5-2-2 TVETC

Based on the training curriculum of TVETC water technology department attached in Annex 3, and taking into account field trip locations (relevant regional and district government agency, public enterprise, private firm, project site) and the distance from each TVETC, the fuel and maintenance cost for TVETC vehicles are estimated with the result is summarized in Table 20.

Table 20 Calculated fuel and maintenance cost for the bus operation in TVETC based on the existing curriculum

TVETC		Region	Fuel (Birr)	Maintenance Cost (Birr)	Total (Birr)
1	Assela TVETC	Oromia	35,830	27,065	62,895
2	Woliso TVETC	Oromia	32,509	24,741	57,250
3	Bahir Dar TVETC	Amhara	24,234	18,954	43,188
4	Komborcha TVETC	Amhara	31,216	23,825	55,041
5	Maychew TVETC	Tigray	34,450	26,105	60,555
6	Awassa TVETC	SNNPR	26,028	20,162	46,190
7	Merka TVETC	Afar	35,994	27,247	63,241
8	Jijiga TVETC	Somali	36,534	27,654	64,188
9	Asossa TVETC	Benishangul-Gumuz	27,347	21,103	48,450

Currently, water technology departments in each TVETC do not have any vehicles. Therefore, the cost for vehicle maintenance is very low and accounts for around only 1.2 to 1.5 % of total budget. This budget is used for fuel for vehicles borrowed from regional water resource development bureau, traffic expense for students to move to the field by bus and taxi and so on. Though it depends on the location of TVETC, the required cost for bus operation and maintenance with mileage calculated from the TVETC curriculum is expected around 43 to 64 thousand Birr. However, the budget related to vehicles is still only 2.3 to 3.8 % of the total budget. Therefore, the budget allocation can be adjusted. In addition, each TVETC has a category “Miscellaneous” in the budget and this can be used comparatively freely at its discretion. Normally, this budget is in emergencies and applied for unscheduled events and workshops. However, it has also been confirmed with the Ethiopian side that this budget can be allocated for vehicles.

The responsibility for operation of TVETC water technology department will be transferred to TVET agency, TVET commission, Bureau of Education, and so on by the regional government in the future. However, the budget allocation will be expected to be the same as or more than present.

Based on the reasons above, budget wise, it is considered possible to operate and maintain the vehicles for practical training procured in this project.

2-6 Other relevant Issues

① Customs, tax exemption, entry permit and residency

Procurement operation sometimes gets delayed due to problems of customs and tax exemption procedures in spite of that planned equipment has right to tax-exempt status. Care has to be taken to process these procedures promptly and not to affect this project.

Chapter 3 Project Evaluation and Recommendations

3-1 Project Effect

Expected effects by the implementation of the project are shown below.

Table 21 Effects by the implementation of the project

Current conditions and problems	Countermeasures through the implementation of the project	Direct effect and degree of improvement	Indirect effect and degree of improvement
■ Only approximately half of the posts requiring staffing in the water supply sector are filled at present for the achievement of UAP. Therefore, producing additional manpower and improving the capacity of existing manpower are urgent issues to develop water supply and operation and maintenance. ■ It is now necessary to replace some of the equipment that has gradually degraded over the past 10 years in EWTEC which is the center of human resources development on water supply to meet the needs of new and existing training. In addition, TVETC is also lacking equipment for practical training.	Procurement of equipment for practical training of water supply field.	■ Quality training with the procured equipment will be given to Engineers, technicians and TVETC students who are engaged in groundwater development and water supply activities in regions, zones, woredas, private, NGO, TVETC etc. (300 to 500 in EWTEC and about 1,350 in 9 TVETC) ■ Ratio of practical training in the training curriculum will improve from 10 - 30% to 70%.	■ Since EWTEC's training targets core engineers who are engaged in water supply activities and TVETC teachers, EWTEC graduates will transfer the technology and knowledge to other engineers, technicians and TVETC students who do not participate the training. ■ Ethiopian citizens will have better quality service compared to the previous conditions as a result of increase of trained engineers.

3-2 Recommendations

3-2-1 Issues to be solved by the recipient country and recommendations

① To secure constant budget for instructors

It is important to have sufficient number of EWTEC personnel (course coordinators and instructors) for sustainable operation and maintenance of the equipment and improvement of training quality. Assigning appropriate instructors is expected to be based on the human resources database, which is planned to be prepared during EWTEC project phase 3, starting from January 2009. It is also

important to strengthen the system to employ necessary instructors for short-term training, as guest lecturers from private and enterprises etc. and to secure enough budget for their employment.

② Utilization of equipment for EWTEC and its operation and maintenance

The equipment procured through the project shall be used during EWTEC project phase 3. After initial operation training, EWTEC personnel shall continue developing their skills through actual training courses with Japanese experts. Since EWETC is the center of technical training on water supply in Ethiopia, it plays an important role as a model of equipment utilization and its operation and maintenance. Therefore, MoWR shall make an effort to improve the skills of the course coordinators and instructors by sending them to seminars and workshops conducted by other donors and international organizations in addition to EWTEC project phase 3.

③ Establishment of monitoring system of operation and maintenance for TVETC equipment

It is important for MoWR to establish a monitoring system of the operation and maintenance of equipment for 9 TVETC, in order to use the equipment appropriately in cooperation with TVET agency, TVET commission, Education bureau, and water resources bureau.

④ To secure places for drilling for drilling technology training

It is important to collect information about drilling plans and schedules for the drilling training of 300m wells from regional water resources bureau, NGOs, and other donors which can cooperate with the EWTEC training. Strengthening the network among these organizations is necessary to secure places for drilling.

3-2-2 Technical Cooperation and Partnership with other Donors

It is essential to develop human resources for water supply in order to achieve UAP, which depends on the on-going WASH program donated by World Bank and AfDB. Donors are giving high attention to EWTEC and TVETC as the major organization to strengthen human resources for water supply. It is important for EWTEC to be actively involved in other related human resource development projects implemented in Ethiopia, so that it can implement activities with the whole water sector in mind.

The equipment procured in this project will be utilized in the existing and newly planned training courses with appropriate instruction by Japanese experts under the EWTEC project phase 3 starting from January 2009.

資　料

目　次

1. 調査団員･氏名

1) 基本設計現地調査

現地滞在期間:2008年8月14日～2008年9月10日

No	氏名	担当分野	所属
1	丸尾　祐治	総括	JICA 国際協力専門員
2	望戸　昌観	計画管理	JICA 地球環境部 水資源・防災グループ 水資源第二課
3	鎌田　烈	業務主任/地下水開発計画	国際航業株式会社
4	池元　壮彦	給水人材育成機材計画 1	国際航業株式会社
5	酒井　和弘	給水人材育成機材計画 2	国際航業株式会社（日さく）
6	山崎　秀人	機材調達計画 1/積算	国際航業株式会社
7	三野　史朗	ベースライン調査/機材調達計画 2	国際航業株式会社

2) 基本設計概要説明

現地滞在期間:2008年12月15日～2009年12月23日

No	氏名	担当分野	所属
1	丸尾　祐治	総括	JICA 国際協力専門員
2	望戸　昌観	計画管理	JICA 地球環境部 水資源・防災グループ 水資源第二課
3	鎌田　烈	業務主任/地下水開発計画	国際航業株式会社
4	山崎　秀人	機材調達計画 1/積算	国際航業株式会社

2. 調査行程

1) 基本設計現地調査

本件基本設計調査団の現地調査日程は次のとおりである。

日数	日程	曜日	官団員		コンサルタント				
			総括 （丸尾）	計画管理 （望戸）	業務主任/地下水開発計画 (鎌田)	給水人材育成計画1 (池元)	給水人材育成計画2 (酒井)	ﾍﾞｰｽﾗｲﾝ調査/機材調達計画2 (三野)	機材調達計画1/積算 (山崎)
1	8/13	水			移動(日本→ﾄﾞﾊﾞｲ)				
2	8/14	木			移動(ﾄﾞﾊﾞｲ→ｱﾃﾞｨｽ)、JICA事務所打合せ				
3	8/15	金			水資源省関係部局およびEWTEC			ﾍﾞｰｽﾗｲﾝ調査 現地雇用管理	
4	8/16	土			資料整理				
5	8/17	日	移動(日本→ﾄﾞﾊﾞｲ)		資料整理				
6	8/18	月	移動（ﾄﾞﾊﾞｲ→ｱﾃﾞｨｽ）、JICA事務所打合せ		移動を除き左に同じ	EWTEC			
7	8/19	火	日本大使館表敬、水資源省表敬・協議、MoFED表敬			EWTEC			
8	8/20	水	教育省表敬 オロミア州（水資源開発局、BoFED、教育局）表敬			EWTEC	移動（ｱﾃﾞｨｽ→ｱﾜｻ）、TVETCｱﾜｻ校		
9	8/21	木	EWTEC視察・協議、移動（ｱﾃﾞｨｽ→オロミア州アセラ）			EWTEC	南部諸民族州水資源開発局、水道建設公社、TVTCｱﾜｻ校、移動（ｱﾜｻ→ﾒﾙｶ）		
10	8/22	金	TVTCアセラ校視察、移動（ｱｾﾗ→ｱﾃﾞｨｽ）			EWTEC	TVETCﾒﾙｶ校、移動（ﾒﾙｶ→ｱﾃﾞｨｽ）		
11	8/23	土	団内打合せ、資料整理						
12	8/24	日	M/D作成			資料整理			
13	8/25	月	M/D協議			EWTEC			
14	8/26	火	M/D協議・署名			EWTEC		移動（ｱﾃﾞｨｽ→ｺﾝﾎﾞﾙﾁｬ）	
15	8/27	水	JICA事務所、日本大使館報告 移動(アディス→ドバイ)		移動を除き左に同じ	移動（ｱﾃﾞｨｽ→ﾊﾊﾙﾀﾞｰﾙ）	EWTEC	TVTCｺﾝﾎﾞﾙﾁｬ校	
16	8/28	木	移動（ﾄﾞﾊﾞｲ→日本)		EWTEC	ｱﾑﾊﾗ州教育局、TVTCﾊﾊﾙﾀﾞｰﾙ校	EWTEC	移動（ｺﾝﾎﾞﾙﾁｬ→ﾏｲﾁｮｳ） TVTCﾏｲﾁｮｳ校	移動(日本→ﾄﾞﾊﾞｲ)
17	8/29	金			EWTEC	移動（ﾊﾊﾙﾀﾞｰﾙ→ｱﾃﾞｨｽ）	EWTEC	TVETCﾏｲﾁｮｳ校 移動ﾏｲﾁｮｳ→ﾒｹﾚ	移動(ﾄﾞﾊﾞｲ→ｱﾃﾞｨｽ)
18	8/30	土			資料整理	資料整理	資料整理	移動（ﾒｹﾚ→ｱﾃﾞｨｽ）	市場調査
19	8/31	日			移動（ｱﾃﾞｨｽ→ｱｿｻ）	資料整理	資料整理	移動（ｱﾃﾞｨｽ→ｱｿｻ）	資料整理
20	9/1	月			TVTCｱｿｻ校 州水資源開発局	EWTEC		TVTCｱｿｻ校 州水資源開発局	市場調査
21	9/2	火			移動（ｱｿｻ→ｱﾃﾞｨｽ）	市場調査	EWTEC	移動（ｱｿｻ→ｱﾃﾞｨｽ）	市場調査
22	9/3	水			EWTEC	市場調査	EWTEC	資料整理	市場調査
23	9/4	木			EWTEC	ｱﾃﾞｨｽｱﾍﾞﾊﾞ上下水道局	EWTEC	市場調査	市場調査
24	9/5	金			EWTEC	上水道設計・監理公社	EWTEC	市場調査	市場調査
25	9/6	土			資料整理				市場調査
26	9/7	日			資料整理				資料整理
27	9/8	月			EWTEC			移動（ｱﾃﾞｨｽ⇔ｳｫﾘｿ） TVTCｳｫﾘｿ校	
28	9/9	火			資料整理				
29	9/10	水			JICA事務所報告、移動(ｱﾃﾞｨｽ→ﾄﾞﾊﾞｲ)				
30	9/11	木			移動(ﾄﾞﾊﾞｲ→日本)				

2)　基本設計概要説明

本件基本設計概要説明団の調査日程は次のとおりである。

日数	日程	曜日	官団員		コンサルタント団員	
			総括 （丸尾）	計画管理 （望戸）	業務主任/ 地下水開発計画 (鎌田)	機材調達計画1 /積算 (山崎)
1	12/14	日	移動(日本→ﾄﾞﾊﾞｲ)			
2	12/15	月	移動(ﾄﾞﾊﾞｲ→ｱﾃﾞｨｽ)、JICA事務所打合せ			
3	12/16	火	日本大使館、水資源省関係部局およびEWTEC表敬・協議			
4	12/17	水	M/D作成・協議			
5	12/18	木	M/D作成・協議			
6	12/19	金	M/D作成・協議			
7	12/20	土	資料整理			
8	12/21	日	資料整理			
9	12/22	月	M/D協議、日本大使館報告		ｵﾛﾐｱ州TVETｴｰｼﾞｪﾝｼｰ、M/D協議、移動（ｱﾃﾞｨｽ→ﾄﾞﾊﾞｲ）	
10	12/23	火	JICA事務所、MoFED報告、移動（ｱﾃﾞｨｽ→ﾄﾞﾊﾞｲ）		移動(ﾄﾞﾊﾞｲ→日本)	
11	12/24	水	移動(ﾄﾞﾊﾞｲ→日本)			

3. 関係者（面会者）リスト

1) 在エチオピア国日本大使館

駒野　欽一　　大使
舛田　直樹　　書記官
竹中　一行　　書記官

2) JICA エチオピア事務所

佐々木　克宏　所長
安藤　直樹　　次長
二見　伸一郎　所員
薬師　弘幸　　所員
鈴木　桃子　　所員

3) 水資源省（Ministry of Water Resources）

＜本省＞

Mr. Asfaw Dingamo（Minister、大臣）
Mr.Adugna Jebessa（State Minister、次官）
Mr. Michael Abebe Haile（Acting Chief Engineer、技監代理）
Mr.Teferi Menkir（Head, RWSS Department、地方給水衛生局長）
Mr.Ketama W/Agegenu（Team Leader, Water Works Technical Vocational Training Program、チーム長）
Mr.Tasfaye Tadesse（EGRAP Cooridinator、EGRAPコーディネーター）
Mr.Zenaw Tessema（EGRAP Programme Manager、EGRAPプログラムマネージャー）

<エチオピアウオーターテクノロジーセンター：EWTEC（Ethiopia Water Technology Center）>

Mr.Markos Tefera（Head, EWTEC、所長）
Mr.Endris Mohamed（EWTEC Coordinator、コーディネーター）
Mr.Mulgeta Kinfu（EWTEC Cooirdinator、コーディネーター）
Mr.Shumet Kebede（EWTEC Cooirdinator、コーディネーター）
Mr.Mekkonen Aweke（Chief Driller、チーフドリラー）

4) 教育省（Ministry of Education）

Mr.Daniel G.K.（Expert, TVET System Reform、TVET専門家）

5)　アディスアベバ

アディスアベバ上下水道局（Addis Ababa Water Sewrage Authority, AAWSA）

瀧田　英生　シニアボランティア

Mr. Solomon Waltenigus（Acting Department Head of Water Production and Distribution、給水局長代理）

上水道設計監理公社（Water Works Design and Superisioin Enterprise, WWDSE）

Mr. Engida Zemedagegnehu（Manager, Hydrogeology and Geotechnic Department、水理地質局長）

6)　オロミア州

オロミア州財務経済開発局（Oromia Finance and Economic Development Bureau, OBoFED）

Mr. Alemayhu（Head、局長）

オロミア州水資源局（Oromia Water Resource Bureau, OWRB）

Mr. Fekadu Lebecha（Coordinator、コーディネーター）

Mr. Lemessa Mekonta（R WaSH Coordinator、コーディネーター）

Mr. Demie Abera（Socio-Economist）

オロミア州TVET Agency

Mr. Bizunech Adugna（Labour Market Manager、マネージャー）

Mr. Teshome Alemu（Curriculum Development & Technical Support Performer、マネージャー）

Mr.Tasew Belele（Head, Planning & Budgeting Dept.、計画予算担当課長）

オロミア州TVETC、Asela校

Mr. Magarssa Guluma（Dean、校長）

Mr. Ferede Lemi Debissa（Training Process Owner、訓練課長）

オロミア州TVETC、Woliso校

Mr. Getachew Mitike（Dean、校長）

Mr. Nagasa Bayissa（Vice Dean、副校長）

Mr. Masay Aklilu（Water Technology Department Head、水利学科長）

7)　アムハラ州

アムハラ州水資源局（Amhara Water Resource Bureau、AWRB）

Mr. Gizachew Beyene（Water Supply Core Process Owner）

アムハラ州TVET Agency

Mr. Tesfaye Yeshiwass（Process Owner）

アムハラ州TVETC、Bahir Dar校

Mr. Tekele Nega Tesema（Academic & Research Vice Dean、副校長）

Mr. Chalachew Gebeyehu（Administration & Development Vice Dean、副校長）

アムハラ州TVETC、Komborcha校

Mr. Ali Abate（Dean、校長）

Dr. Antena Mohammed（Academic & Research Vice Dean、副校長）

Mr. Ayenachew Getafun（RWSS Course Head、村落給水衛生コース長)

Mr. Eyoel Lulseged（SSID Course Head、小規模灌漑コース長）

Mr. Jemal Endris（EMT Course Head、電気機械コース長）

8)　ティグライ州

ティグライ州TVET Commission

Mr. Amanuel Gebretinsae Beyene（Commisioner、コミッショナー）

ティグライ州TVETC、Meychaw校

Mr. Muzein（Dean、校長）

Mr. Hailay Zenawi（RWSS Course Head、村落給水衛生コース長)

Mr. Tadesse Getahun（EMT Course Head、電気機械コース長）

9)　南部州

南部州水資源局（SNNPRS Water Resource Bureau、SNNPRSWRB）

Mr. Miteku（Bureau Head、局長）

南部州TVETC、Awassa校

Mr. Fiseha Hariso Burra（Dean、校長）

Mr. Girma Bafagado（Academic & Research Vice Dean、副校長）

Mr. Fikere Teshome (Water Technology Department Head、水利学科長)

10)　アファール州

アファール州TVETC、Melka校

Mr. Tamrat Fetene（Academic & Research Vice Dean、副校長）

11)　ソマリ州

ソマリ州TVETC、Jijiga校

Mr. Abdera Abude（Dean、校長）

Mr. Admasu（Finace Head、会計課長）

Mr. Lemma Kifaga（Water Technology Department Head、水利学科長）

(12)　ベニシャングル・グムス州

ベニシャングル・グムス州水資源局（Benishangul-Gumusu Water Resource Bureau、BGWRB）

Mr. Minilik Wube（Bureau Head、局長）

ベニシャングル・グムス州TVETC、Asossa校

Mr. Tafari Taka（Dean、校長）

Mr. Girma Tadele（Academic & Research Vice Dean、副校長）

4. 討議議事録(M/D)

(1) Minutes of Discussion 2008 年 8 月 26 日

MINUTES OF DISCUSSIONS
ON THE BASIC DESIGN STUDY ON THE PROJECT
FOR THE IMPROVEMENT OF THE EQUIPMENT FOR GROUNDWATER DEVELOPMENT
IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

In response to a request from the Government of the Federal Democratic Republic of Ethiopia (hereinafter referred to as "Ethiopia"), the Government of Japan decided to conduct the Basic Design Study on the Project for the Improvement of the Equipment for Groundwater Development (hereinafter referred to as "the Project") in Ethiopia and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Ethiopia the Basic Design Study Team (hereinafter referred to as "the Team"), which is headed by Dr. Yuji Maruo, Senior Advisor, JICA, and is scheduled to stay in the country from 14th August to 10th September.

The Team held discussions with the officials concerned of Ethiopia and conducted a field survey at the study area.

In the course of discussions and field survey, both parties confirmed the main items described on the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Addis Ababa, 26th August 2008

Dr. Yuji Maruo
Leader
Basic Design Study Team
Japan International Cooperation Agency
Japan

ABERA MEKONNEN
CHIEF ENGINEER

Ato. Abera MEKONNEN
Chief Engineer
Ministry of Water Resources
Federal Democratic Republic of Ethiopia

(Witness)

Ato. Hailmichael Kinfu
Head
Bilateral Cooperation Department
Ministry of Finance and Economic Development
Federal Democratic Republic of Ethiopia

ATTACHMENT

1. Title of the Project

The Title of the Project has been changed as follows;

- Initial Title in the Original Proposal: The Project for the Capacity Building for Human Resource Development
- New Title: The Project for the Improvement of the Equipment for Groundwater Development

2. Objective of the Project

The objective of the Project is to procure equipment necessary for conducting training programs in Ethiopia Water Technology Center (hereinafter referred to as "EWTEC") and for carrying out practical education in Technical and Vocational Education and Training Colleges (hereinafter referred to as "TVETC").

3. Project sites

The sites of the Project are located in the following ten (10) sites shown in Annex 1.

- EWTEC in Addis Ababa
- Nine (9) TVETCs
  - Assela and Woliso, Oromia Region
  - Bahir Dar and Kombolcha, Amhara Region
  - Maichew, Tigray Region
  - Awassa, SNNPRs Region
  - Melka, Afar Region
  - Jijiga, Somali Region
  - Asossa, Benishangul Gumuz Region

4. Responsible Organization and Implementing Agency

4-1. The Responsible Organization is the Ministry of Water Resources (MoWR).

4-2. The Implementing Agencies are EWTEC and nine (9) TVETCs.

The organization chart of MoWR and TVETCs are shown in Annex 2-1 and Annex 2-2 respectively and relations among MoWR, TVETC and related organizations are shown in Annex 3-1 and Annex 3-2 respectively. The responsible organizations on various procedures related to the Project are shown in Annex 4.

5. Japan's Grant Aid Scheme

5-1. Ethiopian side understands the Japan's Grant Aid Scheme explained by the Team, as described in Annex 6.

5-2. Ethiopian side will take the necessary measures, as described in Annex 7-2, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

1

6. Schedule of the Study

6-1. The consultants will proceed to further studies in Ethiopia until 10th September 2008.

6-2. JICA will prepare the draft basic design report in English and dispatch a mission in order to explain its contents around Mid December 2008.

6-3. In case that the contents of the report are accepted in principle by the Ethiopian side, JICA will complete the final report and send it to the Ethiopian side around February 2009.

6-4. The Ethiopian side understood that execution of the Basic Design Study did not necessarily imply the Japanese Government's commitment of the project implementation.

7. Items requested by the Government of Ethiopia

7-1. Revision of the Requested Items

Both side discussed requested items of the equipment and their quantities on following viewpoints, and small revisions were made and the items listed in Annex 5 were finally requested by the Government of Ethiopia.

- Necessity in the execution of training programs of EWTEC in the present and forthcoming JICA's Technical Cooperation Project "Ethiopia Water Technology Center Project Phase III"
- Necessity of the replacement for obsolete and damaged existing equipment in EWTEC
- Necessity of executing practical education in the TVETC
- Operation and maintenance capability of EWTEC and TVETC

Both sides confirmed that the appropriateness of the request shall be assessed in accordance with the further studies and analysis in Japan and the final components of the Project shall be decided by the Japanese side after the assessment.

7-2. Provision of Vehicles

The Ethiopian side strongly requested the procurement of vehicles, since they were facung severe shortage of transportation and it greatly hampered them from carrying out field training and excursion programs. The Ethiopian side added that therefore the vehicles were essential for the sustainable implementation of the EWTEC and nine (9) TVETCs programs.
The Team replied that they would examine this matter in detail during the course of the study and report the result to the Government of Japan.

8. Ownership and O/M Responsibility of Equipment

Both sides agreed that how to manage and control the equipment to be provided as mentioned below.

(1) MoWR is responsible to the ownership and sustainable use of all equipment including the ones allocated to each TVETC.

(2) However, operational and maintenance cost, and appropriate spaces and facilities to

accommodate the equipment will be provided by TVET Agency/Commission or Bureau of Education in each regions.

(3) TVET Agency/Commission or Bureau of Education in each region use the equipment appropriately, and report the conditions of them to MoWR.

(4) MoWR and each TVET Agency/Commission or Bureau of Education exchange official letters to confirm 8-(1), (2) and (3).

(5) Procurement of the equipment will be done on the condition that the letters mentioned in 8-(4) are exchanged.

9. Expansion of the EWTEC Capacity

A part of the present project is intended to provide the equipment necessary for executing the EWTEC Phase III Project and additional spaces are required in EWTEC to accommodate these equipment.

MoWR explained that EWTEC plans to expand the training capacity for it's future program by three times and the financial application has been already submitted to Ministry of Finance and Economic Development to apply a part of Counter Fund of Kennedy Round 2 Scheme of Japan's Grant Aid in the construction of EWTEC's expansion facilities.

10. Assignment of Additional Personnel

MoWR agreed to assign an appropriate number of capable instructors and coordinators for conducting or coordinating newly formulated training courses such as Various Geophysical Exploration Methods and Drilling Technology (2), and MoWR also agreed to fill immediately the vacancies in the following two training courses, namely Electro-Mechanical Maintenance Technology and Water Supply Engineering Courses.

11. Other relevant issues

The following issues were also discussed and confirmed by both sides.

11-1. Inception Report

The contents of Inception Report, which the Team explained to the Ethiopian side, was understood and accepted in principle by the Ethiopian side.

11-2. Arrangements for the Study

As a response to the request by the Team, the Ethiopian side agreed to arrange necessary number of counterpart personnel for the study and provide all the data and information relevant to the Project for the smooth implementation of the study.

11-3. Internal Transportation

The Team explained that the procured items of equipment are to be transported from the port of disembarkation to respective project site by the expense of the Project.

However, Jijiga TVETC, Somali region is concerned, the Japanese nationals are not allowed to go to the site according to the security code of Japanese side.

In this particular case, the procured items of equipment are to be transported to a certain nearest location at which Japanese nationals are allowed to get access and at which Japanese consultants conduct acceptance inspection on the equipment. Both sides agreed that the transportation of the equipment from the location of acceptance inspection to the Jijiga TVETC is to be carried out by the expense of MoWR.

11-4. Budgetary Arrangement for Taxation

The Team explained that Value Added Tax, customs duties and any other taxes and fiscal levy charges in Ethiopia arisen from the Project activities should be borne by beneficiary organizations as occasion arises.

MoWR understood that and it would make a commitment to secure necessary amount of budget for refunding of these taxes, if any.

11-5. Safety and Security

MoWR agreed to make necessary arrangements to secure the safety of the members of the Team.

11-6. Careful Handling of the Study Reports

The Team explained that certain information in both the draft and the final reports of the Study should be dealt with confidentially until the tendering is completed when the project proceeds to actual implementation stage, since disclosure of the information will affect fairness of tendering procedure.

The Ethiopian side understood the sensitivity in dealing with the study reports and agreed on careful handling of the reports for achieving fair tendering.

Annex 1: Project Sites
Annex 2-1: Organization Chart of MoWR
Annex 2-2: Organization Chart of TVETC
Annex 3-1: Relations among MoWR, TVETC and related Organizations (Case 1)
Annex 3-2: Relations among MoWR, TVETC and related Organizations (Case 2)
Annex 4: Responsibilities Sharing by Various Organizations
Annex 5: Items requested by the Government of Ethiopia
Annex 6: Japan's Grant Aid
Annex 7-1: Flowchart of Japan's Grant Aid Procedures
Annex 7-2: Major Undertakings to be taken by Each Government

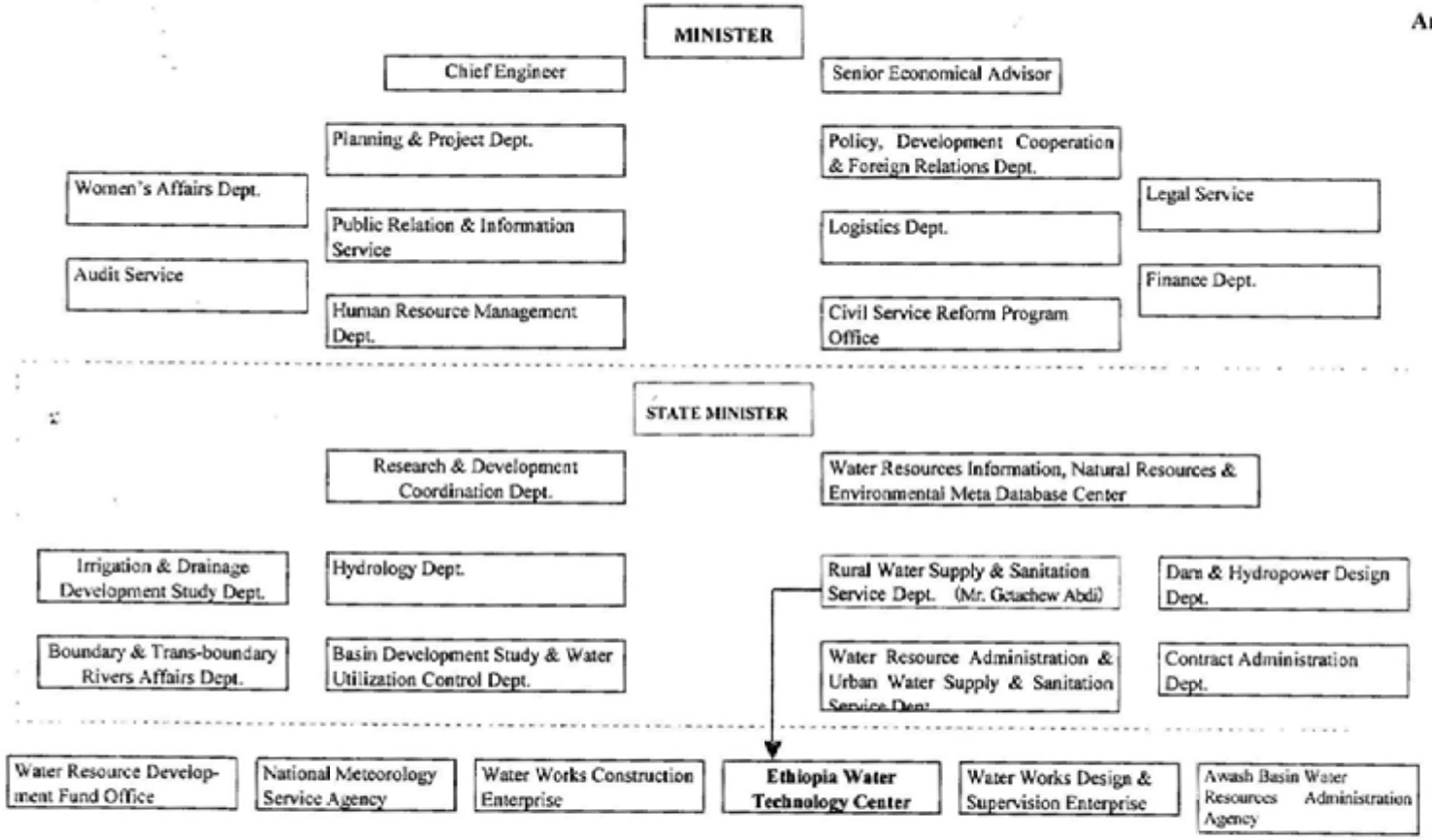
Annex 1

Project Sites

LOCATION MAP OF THE STUDY AREA

5

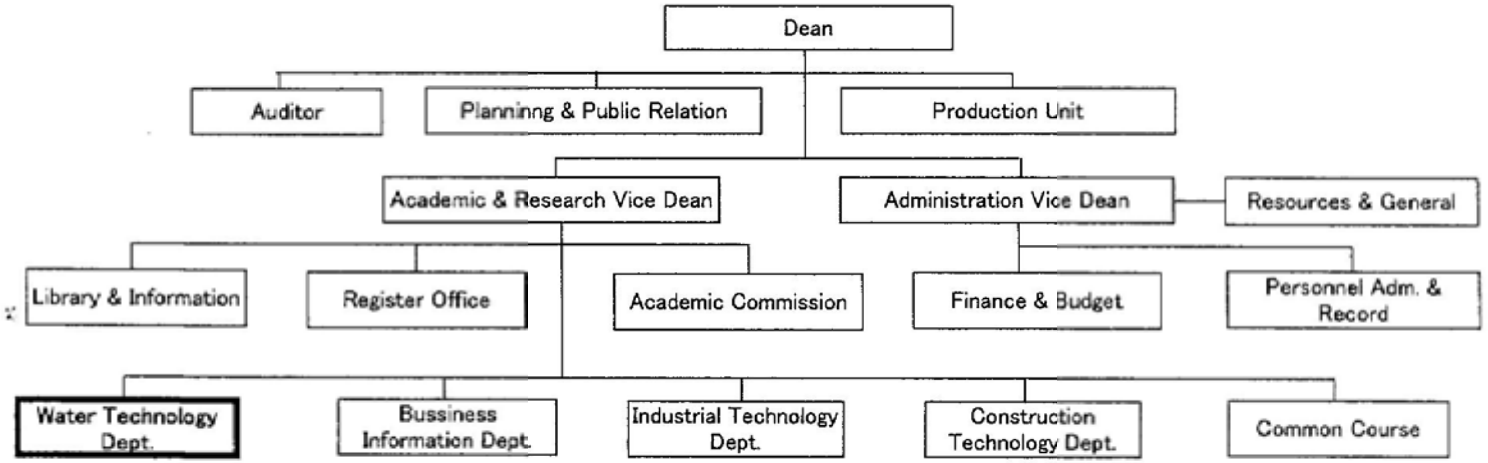
Annex 2-1



Organization Chart of MoWR

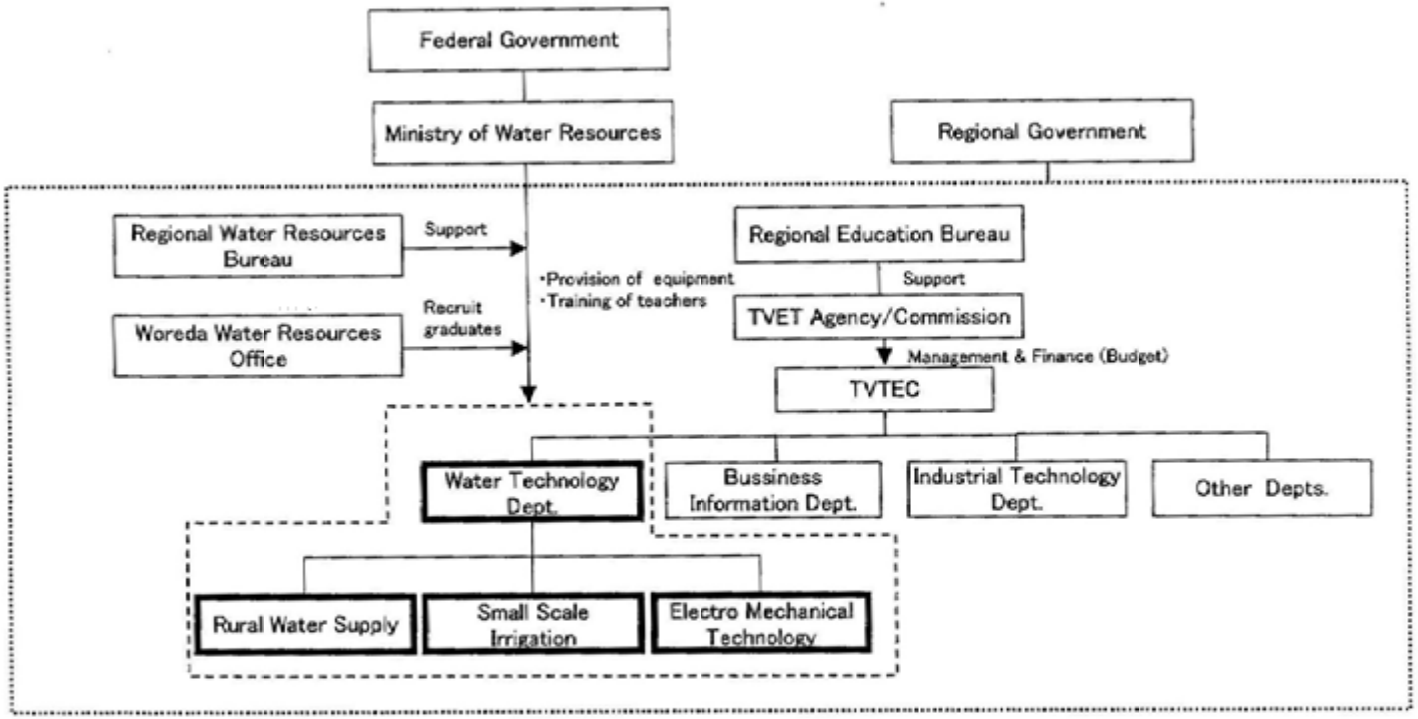
Remark: New organizational structure of the MoWR is under process and the position of the EWTEC will be graded up to the level of department.

6

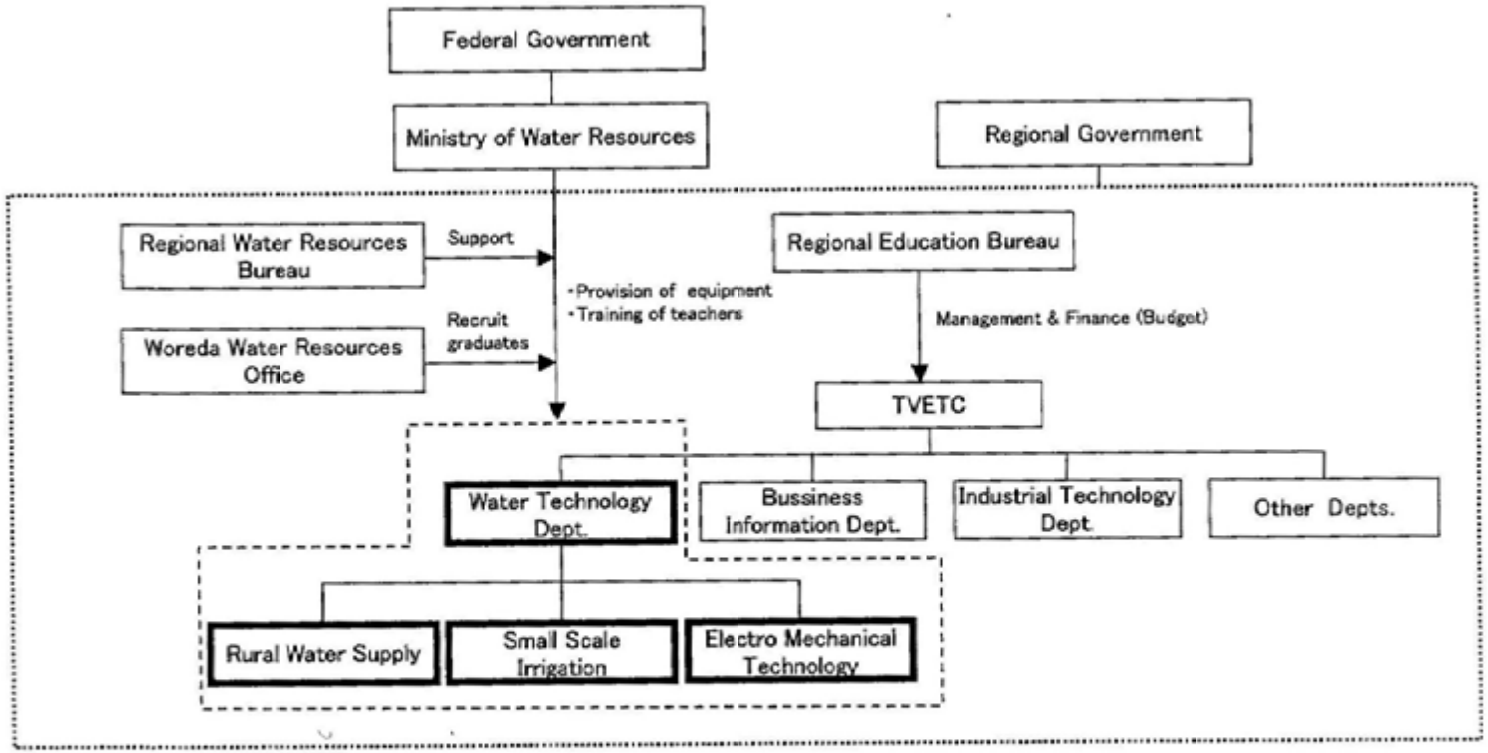


Organization Chart of TVETC

7



Relations among MoWR, TVETC and related Organizations (Case 1)



Relations among MoWR, TVETC and related Organizations (Case 2)

Annex 4

Responsibilities Sharing by Various Organizations

Organization \ Items		Recruitment of Teachers	Training of Teachers	Expenditure for Teachers and Students	Development of Text and Teaching Material	Owner and Management of Building Facilities	Owner of Equipment Procured by Japanese Grant	Operation & Maintenance Cost of Equipment Procured by Japanese Grant	Implementation of Training using Procured Equipment and Safe Custody of the Equipment	Provision of Other Ordinary Equipment
Central	MoWR		x	x**	x**		x			x
Region	Regional Educational Bureau	x*	x*	x*	x*	x*		x*		
	TVET Agency or Commission	x*	x*	x*	x*	x*		x*		
	Regional Water Bureau									x
	TVETC	x						x	x	

* For the regions where there is a TVET agency or a TVET commission already established, either of them is the organization responsible for each item. Otherwise Regional Educational Bureau is responsible for each item.

** Only Oromia Region covers TVETC expenses from Ethiopian fiscal year 2001(2008.7-2009.6).
And other regions cover the expenses starting from Ethiopian fiscal year 2002.

Annex 5

Items requested by the Government of Ethiopia

Target Organization	Category		Name of equipment	Requested Qty	Revised Qty	New/ Renewal	Original Request/ Additional	Current Situation	Purpose	Purpose of training	Priority	Remarks
1 EWTEC	A Groundwater investigation	1	TDEM	-	1	New	Additional	N/A	Geophysical survey course	Aquifer investigation by using electromagnetic wave	A	
		2	FDEM	-	1	Renewal	Additional	Old/damaged	Ditto	Aquifer investigation by using electromagnetic wave	B	Check if it can be repaired
		3	Magnetometer	4	1	New	Original	N/A	Ditto	Investigation for geological structure	B	
		4	Resistivity meter	4	1	Renewal	Original	Old/damaged	Geophysical survey course, Groundwater investigation course	Aquifer investigation by using resistivity	A	Check if logger and software can be exchanged
		5	Logging equipment	-	1	Renewal	Additional	Old/damaged	Drilling technology course, Geophysical survey course	Training for determining aquifers in a borehole	A	Check if the current equipments can be repaired. 300 m depth applicable
		6	Groundwater analysis software	1set	1set	New	Original	N/A	Ground water investigation course	Training for groundwater analysis	A	
		7	GIS software	-	1set	New	Additional	N/A	GIS course	Training for GIS operation	B	Check the availability of free software
	B Drilling Tools and Accessories	1	Service Rig	1set	1set	New	Original	N/A	Well rehabilitation course	Training for Well rehabilitation	A	
		2	300m Drilling Rig (Rotory type, including DTH and tools)	1set	1set	New	Original	N/A	Drilling technology course	Training for 300m deep well drilling	A	
		3	High pressure compressor for DTH (Truck mounted)	1set	1set	New	Original	N/A	Ditto	Ditto	A	
		4	Generator, Pumping test kit, Welding machine and some other equipments	1set	1set	New	Original	N/A	Ditto	Ditto	A	
		5	Crane truck	1	1	New	Original	N/A	Ditto	Ditto (for transportation of equipments)	A	Transportation of pipes and so on
		6	Truck	1	1	New	Original	N/A	Ditto	Ditto	A	Transportation of materials
		7	Pick up truck	1	1	New	Original	N/A	Ditto	Ditto	B	Ditto
		8	Accessories for 150m depth drilling Rig	1	1	Renewal	Original	Good	Ditto	Training for 150m deep well drilling	A	
	C Drilling Machinery	1	Measuring and maintenance equipment and tools	1set	1set	New	Original	N/A	Drilling machinery maintenance technology course	Training for operation and maintenance of machines with measuring equipments	A	
		2	Cut models	1set	1set	Renewal	Original	Too old	Ditto	Training for mechanisms of variety of machines	A	Shortage of variety
	D Electro Mechanical Maintenance Equipments	1	Electrical/electronics mainer and measuring equipment	1set	1set	New	Original	N/A	Electro mechanical maintenance course	Training for basic theory on electricity and operation and maintenance of electric/electronic machines in water supply facilities	A	Analog equipment is too old to use.
		2	Cut models	1set	1set	Renewal	Original	Too old	Ditto	Training for mechanisms of variety of electric machines	A	
		3	Electrical/electronics components and accessories and tools	1set	1set	New	Original	N/A	Ditto	Ditto	A	
	E Water Supply Equipments	1	Equipments for survey	1set	1set	New	Original	N/A	Water supply engineering course	Training for survey of water supply facilities	A	
		2	Water quality analysis equipments	1set	1set	New	Original	N/A	Ditto	Training for water quality analysis	A	
		3	Softwares	1set	1set	New	Original	N/A	Ditto	Training for designing of water supply facilities	B	Check the availability of free software
	F General Equipments	1	Printer	1	5	Renewal	Original	Out of order	All courses	To print out the training textbooks	A	
		2	Photocopier	-	2	Renewal	Additional	Out of order	Ditto	To photocopy the training textbooks	A	
		3	Projector	1	2	New	Original	Need more	Ditto	To give lectures	A	
	G Vehicles	1	Bus (for 30 seats)	2	1	Renewal	Original	Too old	All courses	Field training transportation for trainees	A	
		2	4x4 Wagon Long Wheel Base	-	2	New	Additional	N/A	All courses	Ditto	A	

Target Organization	Category		Name of equipment	Requested Qty	Revised Qty	New/ Renewal	Original Request/ Additional	Current Situation	Purpose	Purpose of training	Priority	Remarks
II TVTC	A Water Supply Technology Equipments	1	Survey Equipment	1set	1set	New	Original	N/A	Water technology department	Survey training for water supply facilities and channels	A	MoWR administers three courses in water technology department (RWSS, EMT, and SSID)
		2	Field water quality analysis equipments	1set	1set	New	Original	N/A	Ditto	Training for simple water quality analysis in the field	A	
		3	Soil test equipments	1set	1set	New	Original	N/A	Ditto	Soil sampling and test for soil property in the field	A	
		4	Pumping test equipments	1set	1set	New	Original	N/A	Ditto	Training for pumping test	A	
		5	Switch board, generator	1set	1set	New	Original	N/A	Electro mechanical technology department	Training for operation and maintenance of electric machines for water supply facilities	A	
		6	Handpumps and tools for the maintenance	-	1set	New	Additional	N/A	Water technology department	Training for operation and maintenance of water supply facilities inside and in the field	B	
	B Vehicles	1	Bus (for 50 seats)	18	9	New	Original	N/A	All departments	Transportation for teachers and students for field study	A	
		2	Pick up track	10	9	New	Original	N/A	Ditto	Transportation of equipments for the field training	B	

Annex 6

JAPAN'S GRANT AID

I Japan's Grant Aid Scheme

The Grant Aid scheme provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

(1) Grant Aid Procedures

Japan's Grant Aid Program is executed through the following procedures:

• Application	(Request made by a recipient county)
• Study	(Basic Design Study conducted by JICA)
• Appraisal & Approval	(Appraisal by the Government of Japan and Approval by Cabinet)
• Determination of Implementation	(The Notes exchanged between the Governments of Japan and the recipient country)

Firstly, the application or a request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for the Grand Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using (a) Japanese consulting firm(s).

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Scheme, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes (E/N) signed by the Governments of Japan and the recipient country.

Finally, for the smooth implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

(2) Basic Design Study

1) Contents of the Study

The aim of the Basic Design Study (hereafter referred to as "the Study") conducted by JICA on a requested project (hereafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows:

i) Confirmation of the background, objectives, and benefits of the requested Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation.
ii) Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view.
iii) Confirmation of items agreed upon by both parties concerning the basic concept of the Project.
iv) Preparation of a Basic Design of the Project,
v) Estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure it's self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

2) Selection of Consultants

For smooth implementation of the Study, JICA uses (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms. The firm(s) selected carry(ies) out a Basic Design Study and write(s) a report, based upon terms of reference set by JICA.

The consulting firm(s) used for the Study is (are) recommended by JICA to the recipient country to also work on the Project's implementation after the Exchange of Notes, in order to maintain technical consistency.

(3) Japan's Grant Aid Scheme

1) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

2) "The period of the Grant Aid" means the one fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consulting firm(s) and (a) contractor(s) and final payment to them must be completed.

However in case of delays in delivery, installation or construction due to unforeseen factors such as natural disaster, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

3) Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However the prime contractors, namely, consulting, constructing and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

4) Necessity of the "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

5) Undertakings required to the Government of the Recipient Country

In the implementation of the Grant Aid project, the recipient country is required to undertake such necessary measures as the following:

i) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction.
ii) To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites.
iii) To secure buildings prior to the procurement in case the installation of the equipment.
iv) To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid.
v) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts.
vi) To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the Verified contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

6) "Proper Use"

The recipient country is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

7) "Re-export"

The products purchased under the Grant Aid should not be re-exported from the recipient country.

8) Banking Arrangement (B/A)

a) The Government of the recipient country or it's designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.
b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to Pay (A/P) issued by the Government of the recipient country or it's designated authority.

9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions to the Bank.

2 Grant Aid Procedures

(1) Flowchart of Japan's Grant Aid Procedures
Refer to Figure.

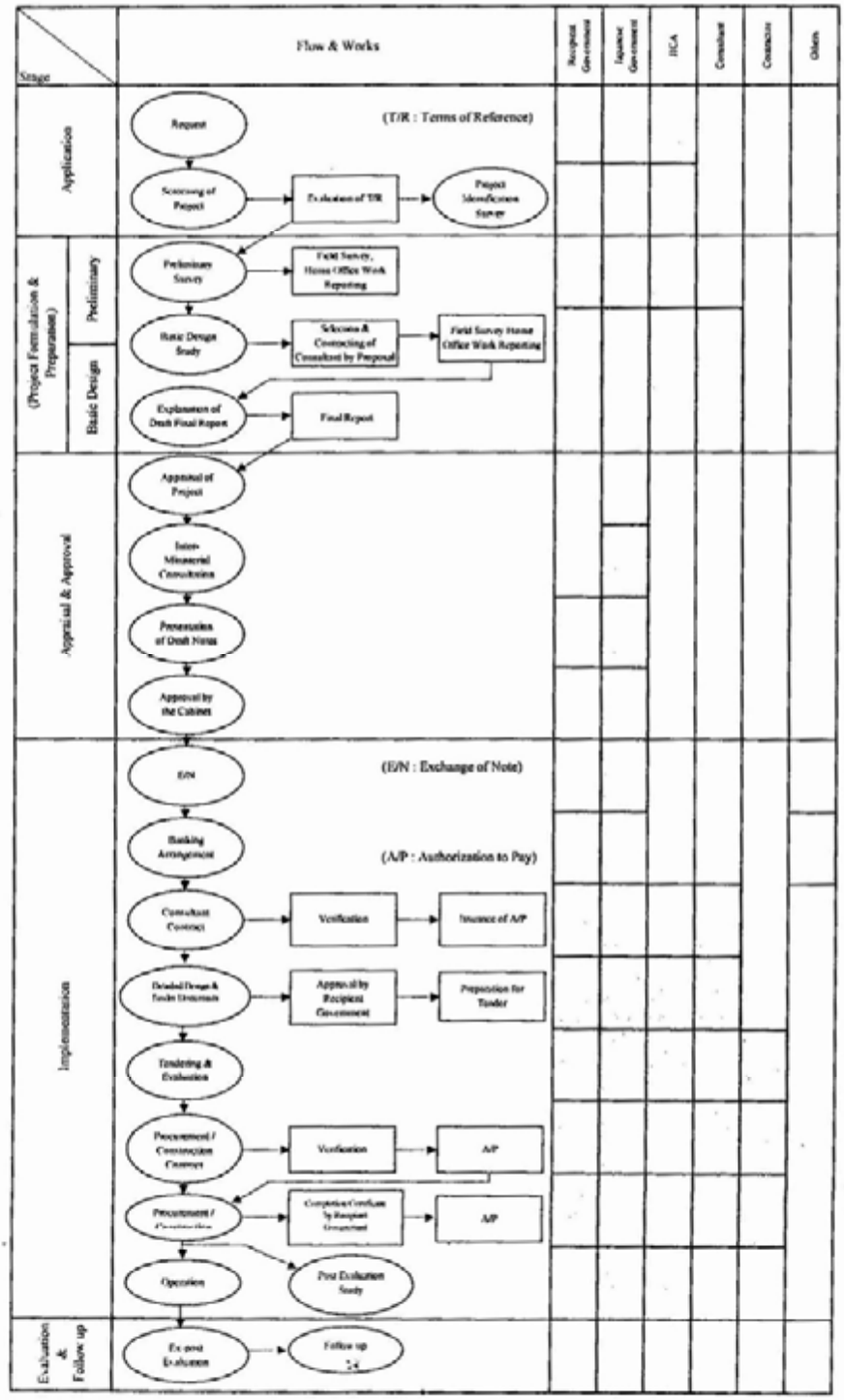
(2) Major Undertaking to be taken by Each Government

Refer to Table.

15

Annex 7-1

Flowchart of Japan's Grant Aid Procedures



16

Annex 7-2

Major Undertakings to be taken by Each Government

NO	Items	To be covered by Grant Aid	To be covered by Recipient side
1	To bear the following commissions to a bank of Japan for the banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
2	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country		
	1) Marine(Air) transportation of the products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	(●)	(●)
3	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
4	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract		●
5	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid		●
6	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for the transportation and installation of the equipment		●

17

(2) Minutes of Discussion 2008 年 12 月 22 日

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY ON
THE PROJECT FOR THE IMPROVEMENT OF THE EQUIPMENT FOR
GROUNDWATER DEVELOPMENT
IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

(Explanation on Draft Final Report)

In August 2008, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Basic Design Study Team on the Project for Improvement of the Equipment for Groundwater (hereinafter referred to as "the Project") to the Federal Democratic Republic of Ethiopia (hereinafter referred to as "Ethiopia"), and through discussion, field survey, and technical examination of the results of the survey in Japan, JICA prepared a Draft Final Report of the Basic Design study.

In order to explain and to consult with the concerned officials of the Government of Ethiopia on the components of the Draft Final Report, JICA sent to Ethiopia the Draft Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Dr. Yuji MARUO, Senior Advisor, JICA, from December 15 to 23, 2008.

As a result of discussions, both sides confirmed the main items described on the attached sheets.

Addis Ababa, December 22, 2008

丸尾祐治

Dr. Yuji MARUO
Leader,
Draft Final Report Explanation Team,
Japan International Cooperation Agency (JICA)

Ato. Abera MEKONNEN
Chief Engineer
Ministry of Water Resources
Federal Democratic Republic of Ethiopia

(Witnessed by)

Ato. Hailmichael Kinfu
Head
Bilateral Cooperation Department
Ministry of Finance and Economic Development
Federal Democratic Republic of Ethiopia

ATTACHMENT

1. Components of the Draft Report

The Ministry of Water Resources (MoWR; and hereinafter referred to as "the MoWR") agreed and accepted in principle the components of the Draft Final Report explained by the Team.

2. Japan's Grant Aid scheme

The MoWR 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 project is implemented basically through the Grant Aid Scheme and necessary measures, which were described in the Annex 6 and 7 of the Minutes of Discussions signed by both sides on August 26, 2008 (hereinafter refereed to as "the Previous M/D"). The previous M/D is attached to the Draft Final Report of the Basic Design Study of the Project. However, new measures like Grant Agreement (G/A) etc will be added on the above mentioned Grant Aid Scheme procedure.

3. Schedule of the Study

JICA will complete the final report in accordance with the confirmed items and send it to the MoWR by the end of February 2009.

4. Other Relevant Issues

(1) Items of Equipment to Be Procured

The Team explained the items of equipment to be procured which is listed in Annex 1. The MoWR requested to add nine sets of the diesel generator, submersible pump and field bacteriological & physiochemical water analysis kit, which were not provided to Technical Vocational Education and Training College (hereinafter refereed to as "the TVETC") by MoWR in 2008. The Team replied that there is no sufficient time to discuss about the increment of equipment with relevant authorities, because the components of the Project must be finalized by the end of next week in order to acquire the cabinet approval in February 2009. The MoWR understood the above mentioned situation.

(2) Project Cost Estimate

The Team presented to the MoWR the estimated project cost to be born by the Japanese

side as attached in Annex 2. Both sides acknowledged that this estimated cost is provisional and would be examined further by the Government of Japan for its final approval.

Both sides also confirmed that this estimated project cost should never be duplicated in any form nor disclosed to any other party(s) until the relevant contracts are awarded by MoWR. This confinement of the estimated project cost is necessary for securing fairness of tender procedure.

The Team explained the estimated project cost to be born by the MoWR as attached in Annex 2, and requested the MoWR to secure necessary budget in time for the smooth implementation of the Project. The MoWR assured to secure the necessary amount of budget on time.

(3) Ownership, and Operation and Maintenance (O/M) Responsibility of Equipment

As earlier agreed in the previous M/D the Team requested the MoWR to secure TVETC's letter of consent regarding the ownership and O/M responsibility of the equipment. The MoWR informed that an official letter to remind the TVETC to issue the letter of consent has already sent to the respective TVETC. The MoWR confirmed that it would secure the letters of consent from TVTC's by the end of second week of January 2009.

(4) Monitoring of Equipment Utilization and Maintenance

The Team requested the MoWR to monitor proper utilization, maintenance and condition of vehicles and equipment to be procured for TVETC by means of submission of the annual operation and maintenance records by TVETC to MoWR using the forms attached in Annex 3 and 4. The record shall be sent from the respective TVETC to the MoWR as well as to JICA Ethiopia Office as carbon copy once a year at least for 5 years time. The MoWR agreed to the monitoring procedure described in item 4-2-3 of the DRAFT FINAL REPORT, which is also attached in the Annex 5.

(5) Final Components of the Project

The Team explained that the Government of Japan would examine the contents of the Final Report of the Basic Design Study of the Project and the final components of the Project would be decided by the Government of Japan.

The MoWR understood and agreed to the above explanation made by the Team.

(6)Undertakings of the MoWR

Both sides confirmed again the undertakings of the MoWR, which were described in

Annex 7-2 of the Attachment of the Previous M/D which is attached in Annex 6.

End

Annex 1: LIST OF EQUIPMENT
Annex 2: PROJECT COST ESTIMATION (CONFIDENTIAL)
Annex 3: VEHICLE OPERATION AND MAINTENANCE RECORD
Annex 4: EQUIPMENT CONDITION RECORD
Annex 5: ITEM 4-2-3 OF THE DRAFT FINAL REPORT
Annex 6: PREVIOUS M/D

Annex 1 List of equipment

No.	List of equipment	Specification	Q'ty	
A. Groundwater Investigation				
A-1	Electro-Magnetic Meter	Time domain, Measuring depth 300m	1	uni
A-2	Resistivity meter	2D profiling, Measuring depth 200m	1	uni
A-3	Logging equipment	Measuring depth 300m	1	uni
B. Drilling Technology				
1. Service Rig				
B-1	Service Rig	For 6" and 8" well, max well depth 200m, 4x4 or 6x4 truck, high pressure pump Tools for bailing (flat valve bailer) Tools for brushing (brushing body and brush) Tools for jetting (high pressure pump: delivery 500l/min, pressure 2MP)	1	set
2. 300m Drilling Rig (Rotary type, including DTH and tools)				
	Drilling Rig and Tools	Following Items	1	set
	300m Drilling Rig	Rotary type, drill pipe OD 4-3/4" Mud pump delivery 1,500l/min or more, pressure 20kg/cm2 or more Truck 6x4, PTO	1	set
	Drive head sub	3-1/2 (Box)×3-1/2 (pin)	2	pcs
	Drill pipe	4-3/4" OD x 6m, 3-1/2"IF box x pin, wrench recess on both ends, hard thread protectors	70	pcs
	Drill pipe	4-3/4" OD x 3m, 3-1/2"IF box x pin, wrench recess on both ends, hard thread protectors	2	pc
	Drill pipe	4-3/4" OD x 1.5m, 3-1/2"IF box x pin, wrench recess on both ends, hard thread protectors	1	pc
	Crossover sub	3-1/2" IF box x 4-1/2" IF pin	2	pc
	Drill collar	6-1/2" OD x 3m, 4-1/2"IF box x pin, wrench recess on both ends & hard thread protectors -Drill collars should be fitted with non-return valves, which are replaceable	6	pcs
	Bit stabilizer	9-7/8" OD x 2m, 4-1/2" IF box x pin, wrench recess on both ends & thread protectors	2	pc
	Bit stabilizer	8-1/2" OD x 2m, 4-1/2" IF box x pin, wrench recess on both ends & thread protectors	2	pc
	Bit sub	4-1/2" IF box x 6-5/8" REG box	2	pc
	Bit sub	4-1/2" IF box x 4-1/2" REG box	2	pc
	Tricone bit (tooth type)	14-3/4" x 6-5/8" REG pin, soft formation (S type)	1	pc
	Tricone bit (tooth type)	14-3/4" x 6-5/8" REG pin, hard formation (H type)	1	pc
	Tricone bit (tooth type)	12-1/4" x 6-5/8" REG pin, soft formation (S type)	1	pc
	Tricone bit (tooth type)	9-7/8" x 6-5/8" REG pin, medium to hard formation (MH type)	2	pc
	Tricone bit (insert type)	12-1/4" x 6-5/8" REG pin, hard formation Tungsten carbide inserted	2	pc
	Tricone bit (insert type)	9-7/8" x 6-5/8" REG pin, hard formation Tungsten carbide inserted	2	pc
	Tricone bit (insert type)	8-1/2" x 4-1/2" REG pin, hard formation Tungsten carbide inserted	2	pc
	Hammer Sub	4-1/2" IF box x 4-1/2" REG box	2	pc
	DTH hammer body	7-1/8 OD or more	2	pc
	DTH hammer bit	Button bit 9-7/8"	5	pc
	DTH hammer bit	Button bit 8-1/2"	5	pc
	Shock absorber		2	pc
	Dissembling Tools for DTH hammer		1	sets
	Bit grinder for DTH hammer		1	pc
	Grinding wheel		3	pcs
	Clay bit	14-3/4" x 6-5/8" REG pin	1	pc
	Clay bit	12-1/4" x 6-5/8" REG pin	1	pc
	Clay bit	9-7/8" x 6-5/8" REG pin	1	pc
	Hoisting swivel	3-1/2" IF pin	1	pc
	Hoisting plug	4-1/2" IF pin	1	pc
	Backup Wrench	For drill pipe 4-3/4"	1	pc
	Backup Wrench	For drill collar 6-3/4"	1	pc
B-2	Breakout wrench	For drill pipe 4-3/4"	1	pc
	Breakout wrench	For drill collar 6-3/4"	1	pc
	Bit breaker	for 14-3/4" tricone bit	1	pc

Annex 1 List of equipment

No.	List of equipment	Specification	Q'ty	
	Bit breaker	for 12-1/4" tricone bit	1	pc
	Bit breaker	for 9-7/8" tricone bit	1	pc
	Bit breaker	for 8-1/2" tricone bit	1	pc
	Work casing	12" x 5.5m	7	pcs
	Work casing	10" x 5.5m	7	pcs
	Casing elevator	6"	1	pc
	Casing elevator	4"	1	pc
	Casing band	12"	2	pcs
	Casing band	10"	2	pcs
	Casing band	6"	2	pcs
	Casing band	4"	2	pcs
	Wire sling	16mm×6m×4, 12mm×6m×2, 9mm×6m×2, 9mm×3m×2	1	set
	Suction hose for mud pump	with foot valve	1	pc
	Mud mixer	750liter	1	pc
	Sand pump	2.2kw, 3phase, 200V, 2" hose (Crystal) x 20m	1	pc
	Mud hopper	Hose 1-1/2-2" x 10m, High pressure 50kg/cm2	1	pc
	Dewatering pump	2" outlet, Suction hose with foot valve x 10m, Delivery hose 2" x20m	1	pc
	Mud balance	Standard	1	pc
	Desconsit meter	Standard	1	pc
	Switch panel	Swtch Panel (60mA, 30mA, 200V×3) Main cabtyre (22mm2)×10m	1	set
	Collapsible water tanker	2m3	1	set
	Collapsible water tanker	4m3	1	set
	Hand pump for fuel	Standard	1	pc
	Tool box	Standard,	1	pc
	Pipe wrench set	1200mm, 900mm, 600mm, 450mm	2	sets
	Driver set	Standard	1	set
	Box wrench set	Standard	1	set
	Adjustable wrench set	Standard	1	set
	Socket wrench set	Standard	1	set
	Chain tong	12", 10", 8"	2	sets
	Sledge hammer	5kg, 1kg	1	set
	Level gauge	Standard	1	pc
	Welding Generator,	300A class, accessories	1	pc
	Gas Welding/Cutting Machine		1	pc
	Disk Grinder	100mm (100V), Disck 100mm, for grinding:50, cutting:20	1	pc
	Drilling form	Powder	300	kg
	Inside tap	max 4-1/2"	1	pc
	Outside tap	max 10-7/8"	1	pc
3. High pressure compressor for DTH (Truck mounted)				
B-3	Air Compressor	Truck mounted 6x4 or 4x4 Air delivery 25m3/min, Rated pressure 2.0MPa-2.41MPa	1	pc
4. Air lifting and pumping test equipment				
B-4-01	Air lifting compressor	Air compressor for air lifting Air delivery8.5m3/min Rated pressure 10kgf/cm2 (1.0MPa) Air hose 3/4"×20m Air pipe 3/4" 4.0m x 60 pcs Water pipe 3" 300m Other accessories	1	pc
B-4-02	Submersible motor pump	400l/min discharge at 200m head Cable 240m Riser pipe 2-1/2"x5.5m (galvanized) 230m Control box	1	pc
B-4-03	Weir Pumping test form	max 800l/min or more	1	pc
B-4-04	Water level meter	300m	1	pc

Annex 1 List of equipment

No.	List of equipment	Specification	Q'ty	
5. Crane truck				
B-5	Crane truck	3 ton crane 4x4or6x4 cargo length 6.5m or more	2	uni
6. Accessories for existing drilling Rig				
B-6	Mud pump suction hose	With foot valve 4" size x 9m	1	pc
	DTH hammer body	6-5/8" OD, 4-1/2" REG pin	1	pc
	Hammer sub	4-1/2" REG box x 3-1/2" IF box	1	pc
	Clay bit	12-1/4" x 6-5/8" REG pin	2	pcs
	Clay bit	9-5/8" x 6-5/8" REG pin	2	pcs
	Clay bit	8-1/2" x 6-5/8" REG pin	2	pcs
	Chain tong set	ST-3x2pcs, ST-2x2pcs, ST3 spare chainx1pc	1	set
	Pipe wrench set	1200mm×1 900mm×1 600mm×1 450mm×2 300mm×2	1	set
	Wire sling	16mm×6m×4, 12mm×6m×2, 9mm×6m×2, 9mm×3m×2	1	set
	Water level meter	200m	1	pc
	Bentonite		10	t
	CMC		500	kg
	Polyphosphates		500	kg
	First Aid Kit with relevant accessories		1	pc
	Submersible pump	with all accessories (150m head & 10 ℓ/s discharge), outlet size 2-1/2", for 6" well	1	pc
	Dewatering pump	with suction & delivery hose, suction hose 50mm×9m, delivery hose 50mm×20m	1	pc
	Hoisting plug	4-1/2"IF box	1	pc
C. Drilling Machinery Maintenance				
1. Mensuring and maintenance equipment and tools				
C-1-01	Diesel tacho tester	Measuring range: 0 - 6000rpm	1	unit
C-1-02	Nozzle tester	Mounted on the bench, manually operated	1	unit
C-1-03	Diesel compression gauge set	0 - 7MPa, with different adapters	1	unit
C-1-04	Valve spring tool	Standard	1	unit
C-1-05	Valve lifter & compressor	Opening range: 50-180mm Applicable valve type: Overhead valve	1	unit
C-1-06	Valve lapper	Air valve lapper: Required air pressure: More than 0.6MPa With hand valve lapper and valve compound	1	set
C-1-07	Piston ring compressors	Diameter 50-175mm	1	unit
C-1-08	Piston ring tool	Diameter 50-135mm	1	unit
C-1-09	Torque wrench with angle scale	Angle scale: 360 degrees,Graduation: 40-280Nm	1	unit
C-1-10	Socket for engine head bolt	Different sizes	1	set
C-1-11	Cylinder gauge	Measuring range: 50-150mm	1	unit
C-1-12	Connecting rod aligner	Measuring range: 150-400mm	1	unit
C-1-13	Camber caster-king pin inclination gauge	Large vehicle	1	unit
C-1-14	Brake bleeder wrench set	Wrench: 8, 10	1	set
C-1-15	Braking spring pliers	For large size vehicle	1	unit
C-1-16	Brake lining riveter	For large size vehicle	1	unit
C-1-17	Brake drum gauge	Capacity: approx. 350 to 600 mm	1	unit
C-1-18	Portable brake booster tester	Gauge: 20, 10, 1MPa, 76cmHg	1	unit
C-1-19	Diesel smoke meter	Filter type, with necessary accessories	1	unit
C-1-20	Arc welding machine	Rated current 300A or more	2	units
C-1-21	Jet washer	Enough for washing for truck engene	1	unit
2. Cut models				
C-2-1	Cutaway model of fuel injection pump	PT pump type	1	unit
C-2-2	Cutaway model of manual transmission	General vehicle, more than 5 gears	1	unit
C-2-3	Cutaway model of steering gear assembly	General vehicle	1	unit
C-2-4	Cutaway model of brake valve	General vehicle	1	unit
C-2-5	Cutaway model of disc brake	General vehicle	1	unit
C-2-6	Cutaway model of drum brake	General vehicle	1	unit
C-2-7	Cutaway model of torque converter	General vehicle	1	unit
C-2-8	Cutaway model of diaphragm cylinder	General vehicle, for break booster	1	unit

Annex 1 **List of equipment**

No.	List of equipment	Specification	Q'ty	
C-2-9	Differential with mechanical lock	Hypoid gearing type with mechanical lock	1	unit
C-2-10	Cutaway model of exhaust turbocharger	Geneanl vehicle, diesel engine	1	unit
C-2-11	Cutaway model of diesel fuel feed pump	Double acting, for diesel engine	1	unit
D. Electro Mechanical Maintenance				
1. Electrical/electronics trainer and measuring equipment				
D-1-01	Experimental machine for DC motor & generator	DC motor: DC100V, 2.2kW DC generator: DC100V, 2kW	1	unit
D-1-02	Experimental machine for 3 phase induction motor and generator	AC motor 3phase, 380V, 2.2kW DC generator 100V	1	unit
D-1-03	Experimental machine for Synchronous motor & generator	Syncronous motor: 3phase, 380V, 2.2kW Syncronous generator: 3phase, 380V, 2.0kVA	1	unit
D-1-04	Low voltage switch gear experimenter	Desktop type relay sequence	1	unit
D-1-05	Basic Circuit Trainer		3	pcs
D-1-06	Analog Trainer (OP-AMP experiment trainer)	OP AMP basic circuit	3	pcs
D-1-07	Digital Trainer (Logic circuit trainer)	Logic circuit :AND, NOT, NAND, NOR, Exclusive OR	3	pcs
D-1-08	PLC trainer		3	units
D-1-09	Electric leakage breaker experiment unit		1	unit
D-1-10	Frequency counters	Frequency range: 1mHz-2GHz	2	pcs
D-1-11	AC/DC power supply	AC power : single phase 1000VA, AC1-270V, DC power: out put 0—40V	4	pcs
D-1-12	Soldering iron desoldering pump & soldering lead set	50W or more	5	pcs
D-1-13	Variable resistor		1	pc
D-1-14	Variable capacitor		1	pc
D-1-15	Variable inductor		1	pc
D-1-16	Digital multimeter	Standard	10	pcs
D-1-17	Oscilloscope	Band range: 100MHz	4	pcs
D-1-18	Signal generator	Frequency range: 100kHz-150MHz or more	4	pcs
D-1-19	Logic probe	Pen type	4	pcs
D-1-20	Wattmeter	Standard	3	pcs
D-1-21	Galvanometer	Standard	5	pcs
D-1-22	Electrical hand drill	Greater than 500W	5	pcs
D-1-23	Circular saw (electrical)	Greater than 1kW	2	pcs
2. Cut models				
D-2-01	Cut model DC motor	Approx.400W	1	unit
D-2-02	Cut model AC motor	Approx.400W	1	unit
E. Water Supply Engineering				
1. Equipments for survey				
E-1-01	Pipe locator	Electromagnetic induction	1	unit
E-1-02	Leak detector	Sound collecting type	1	unit
2. Water quality analysis equipments				
E-2	Incubator and accessories	Incubator, autoclave	1	set
F. Vehicles				
F-1	Bus	For 30 seats	1	unit
F-2	Long Wheel Base 4x4 Wagon	4x4	2	units

Annex 1 **List of equipment**

No.	List of equipment	Specification	Q'ty	
G. Equipment for 9 TVETC				
1. Water Supply Technology Equipments				
G-1-01	Total Station	Prism reflector, Tripod, Level staff, Measuring tape 100m	9	se
G-1-02	Digital Planimeters		9	pc
G-1-03	Automatic Level	Tripod, Level staff	9	set
G-1-04	Geological Compass	Stainless type Accessories: mirror, hand level	9	pc
G-1-05	Cylinder infiltrometer	Double ring Hammer	9	pa
G-1-06	Permeability test kit	Undisturbed soil sampler Sampling tube Stop watch	9	set
G-1-07	Soil color chart	Standard	9	pes
G-1-08	Geological hammer	Steel handle with nylon grip Not less than 700g Leather cover	9	pes
G-1-09	Magnifying lens	For observation of rock minerals, field type, 10x and 20x	9	pcs
G-1-10	Sieve	Different opening sizes	9	sets
G-1-11	Conductivity		9	pcs
G-1-12	pH meter		9	pcs
G-1-13	Field bacteriological & physiochemical complete water analysis kit	Potable incubator, colorimeter/photometer (pH, TDS, temperature, NO2, NO3, NH4, F, Mn, Fe, SO4, Hardness) with necessary reagents for more than 200 tests	9	sets
G-1-14	Hand auger	With different augers for various type of soil	9	pcs
G-1-15	Diesel generator	5kVA or more	9	pcs
G-1-16	Submersible pump	Q=20l/min, H=25m, 4" well With control panel	9	pcs
G-1-17	Surface pump (electrical)	Q=30l/min, H=20m	9	pcs
G-1-18	Arc welding machine	300A	9	pcs
G-1-19	Dewatering pump (petrol)	Standard	9	pcs
G-1-20	Chain pipe vice	With tripod stand 2" to 6"	9	pcs
G-1-21	Chain wrench	1" to 6"	9	pcs
G-1-22	Pipe wrench set	2", 2-1/2", 3"	9	sets
G-1-23	Pipe threader	Cutting wheel: 1/2-2" Hand operated	9	pcs
G-1-24	Torque wrench set	20-140N·m	9	pcs
2. Vehicles				
G-2-01	Bus	30 seats	9	units

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Annex 2 Project Cost Estimation

Japanese side cost obligation

Table 1 Japanese side cost obligation

Item	Cost (million yen)
(1) Equipment procurement	532
a. equipment	(476)
b. transportation	(34)
c. installation	(2)
d. procurement management	(4)
e. general management	(16)
(2) Design administration	24
Total	556 (USD 5.24 million)

Ethiopian side cost obligation

Table 2 Ethiopian side cost obligation

Item	Cost (million yen)
Securing power source	1
Securing equipment storage space	—
Tax exemption measures	238
Banking・authorization to pay	0.3
Equipment inspection	—
Others	—
Total	239.3 (USD 2.25 million)

*Note:

(1) Time of Cost Estimation: September 2008

(2) Exchange rate: 1USD = 106.18JPY

Annex 3

1 of 2

VEHICLE OPERATION AND MAINTENANCE RECORD

Name of TVETC _____ **Vehicle Number** _____

Year: _____

Jan. / Feb. / Mar. / Apr. / May / Jun. / Jul. / Aug. /Sept. /Oct. / Nov. / Dec.

Driving Record

End Mileage (km)	Total travel distance of this month(km)	

Date	Purpose of Use	Destination	Trevel Distance(km)

Maintenance record

Type of Maintenance	Date	Remarks
Regular · Repair		
Regular · Repair		
Regular · Repair		
Regular · Repair		
Regular · Repair		
Regular · Repair		
Regular · Repair		

	Date	Name	Signature
Recorded by driver			
Checked by head of office			
Authorized by TVETC principle			
Authorized by TVET Agency/ Committee			

VEHICLE OPERATION AND MAINTENANCE RECORD (For Photo Frame)

**Please attach photos to show the current condition*

Date:
OBLIQUE FRONT VIEW
OBLIQUE REAR VIEW

Annex 4

<Anual Record Format>

EQUIPMENT CONDITION RECORD

Name of TVETC : _____

Date: _____

ID Number	Item	Condition			Remarks
		Good	Workable	Out of order	
	Total Station				
	Digital Planimeters				
	Automatic Level				
	Geological Compass				
	Cylinder infiltrometer				
	Permeability test kit				
	Soil color chart				
	Geological hammer				
	Magnifying lens				
	Sieve				
	Conductivity				
	pH meter				
	Field bacteriological & physiochemical complete water				
	Hand auger				
	Diesel generator				
	Submersible pump				
	Surface pump (electrical)				
	Arc welding machine				
	Dewatering pump (petrol)				
	Chain pipe vice				
	Chain wrench				
	Pipe wrench set				
	Pipe threader				
	Torque wrench set				

	Date	Name	Signature
Recorded by store keeper			
Checked by head of office			
Authorized by TVETC principle			
Authorized by TVET Agency/ Commission			

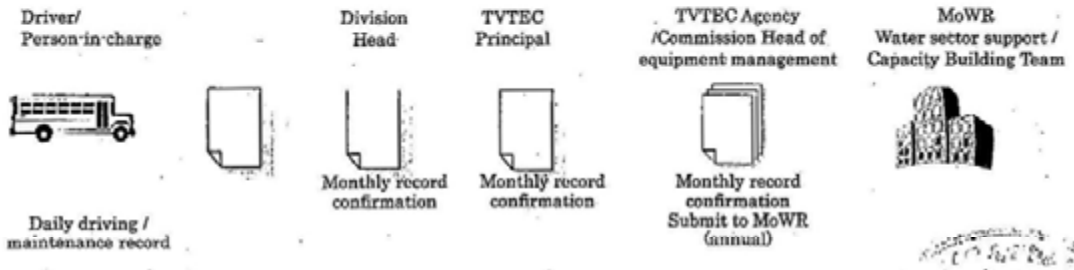
Annex 5 Item 4-2-3 of the draft final report

4-2-3 Monitoring Policy

Monitoring policy of equipment provided to TVTEC will be implemented in the following ways. Monitoring will cover all of the equipment provided to TVTEC.

- The head of each agency must submit an annual Status of Use Report (including photos for vehicles) on the equipment they are using. Attachment 1 shows the record of monitoring. This monitoring will continue for at least 5 years.
- The monitoring record is split into three main sections: the rig; large, expensive equipment which need regular maintenance, such as vehicles, generators, and other items with engines; field equipment that is easily maintained and also relatively cheap tools that do not generally require maintenance.
- In the case of vehicles and generators, as the driver or person responsible for them is usually set, they can keep a record of maintenance and any troubles. Every month they should submit this record of operation to the head of their department for approval. The head of the agency verifies this. Please see Annex 4-1.
- In the case of electrical exploration equipment etc., the user makes a record after each use. The head of the department responsible checks this every month. Please see Annex 4-2.
- An inventory check of the condition of tools is undertaken bi-annually using a prepared itemized list.

Below is an outline of the monitoring reporting procedure of the provided equipment.



5. 事業事前計画表

1.案件名

エチオピア国地下水開発機材整備計画

2.要請の背景（協力の必要性・位置付け）

「エ」国における安全な水へのアクセス率の現状は全国で約22%（2004年UNDP）と、サブサハラ平均の56%（2004年UNDP）と比較しても極めて低い数値にとどまっており、人口の85%が居住する村落部の住民は、生活用水の確保に多大な時間と労力を費やさざるを得ず、貧困を助長する一因となっている。「エ」国政府は2005年に国家給水衛生向上計画Universal Access Program (UAP)を提唱し、2012年までに農村部で98%、都市部で100%の給水率を達成するという目標を揚げている。この目標を達成するためには建設資金のほかに、給水事業に携わる人材が村落給水分野、都市給水分野の両分野合わせて約50,000人必要とされている。

かかる状況のもと、我が国は1998年1月から2008年3月まで、技術協力プロジェクト「地下水開発・水供給訓練計画プロジェクト」（フェーズ1、フォローアップ、フェーズ2）を実施し、エチオピアウォーターテクノロジーセンター（EWTEC）の新設、各州の行政機関の給水関連人材を対象とした掘削技術・維持管理等の訓練コース、水資源開発に資する各種調査や適正技術の普及活動を支援してきた。「エ」国は、給水人材育成のための中核機関と位置付けられたEWTECを既存給水人材育成の場として活用し、更に、将来の給水人材のための技能教育の場として全国9箇所にある職業訓練校（TVETC）も活用して、UAP達成に必要な人材の確保、質の向上図ることとしている。しかし、EWTECにおける既存の機材は約10年が経過し老朽化が進んでおり、中核機関として既存及び新規ニーズに適切に対応出来る機材・設備を整え機能強化を行う必要性が生じている。

さらに「エ」国からの強い要望により、わが国は2009年から5年間の予定でEWTECプロジェクトフェーズ３を開始予定である。このプロジェクトでは、訓練対象者を民間やNGOまで広げ、既存訓練コースに新たないくつかの訓練プログラムを加えることが計画されている(全20訓練コース)。これら新たに開始される訓練プログラムを実施するために、新規の訓練機材を導入する必要がある。

3.プロジェクト全体計画概要

(1) プロジェクト全体計画の目標（裨益対象の範囲及び規模）

「エ」国において、持続的な給水開発および維持管理を行うために必要な実務的な給水人材育成を行うための環境が整備される（直接裨益：EWTECで年間約300～500名の訓練終了生、TVETC9校で年間約1,350名の訓練卒業生を輩出）。

(2) プロジェクト全体計画の成果

ア. エチオピア給水技術センター（EWTEC）で実務的な訓練を行うための機材が整備される。

イ. 全国９カ所の職業訓練校（TVETC）で実務的な訓練を行うための機材が整備される。

(3) プロジェクト全体計画の主要活動

ア. 機材を調達する

イ. 機材を用いて研修を行う

(4) 投入（インプット）

ア. 日本側

(ア) 本案件：無償資金協力 5.56億円

(イ) 技術協力プロジェクト：EWTECフェーズ３

イ. 「エ」国側

(ア) 機材運転用の動力源の確保

(イ) 機材維持管理費の負担

(ウ) 機材設置・保管場所の確保

(5) **実施体制**

主管官庁： 「エ」国水資源省

実施機関： エチオピアウオーターテクノロジーセンター（Ethiopia Water Technology Center：EWTEC）

職業訓練校（Technical Vocational Education and Training College：TVETC）

4.無償資金協力案件の内容

(1) サイト

①EWTEC（アディスアベバ市）

②地方TVETC全9校（オロミア州アセラ市及びウォリソ市、アムハラ州バハルダール市及びコンボルチャ市、ティグライ州マイチョウ市、南部諸民族州アワサ市、アファール州メルカ市、ソマリ州ジジガ市、ベニシャングル・グムス州アソサ市）

(2) 概要

ア. EWTECにおける地下水開発及び給水事業に係る訓練用機材の調達

イ. 全国9校のTVETC水利学科における訓練用機材の調達

(3) 相手国側負担事項

ア. 機材運転用の動力源の確保

イ. 機材設置・保管場所の確保

(4) 概算事業費

概算事業費7.95億円（無償資金協力5.56億円、「エ」国側負担2.39億円）

(5) 工期

詳細設計・入札期間を含めて約13ヶ月（予定）

(6) 貧困、ジェンダー、環境及び社会面の配慮

なし

5.外部要因リスク

経済的な混乱がない。

6.過去の類似案件からの教訓の活用

なし

7.プロジェクト全体計画の事後評価に係る提案

(1) プロジェクト全体計画の目標達成を示す成果指標

成果指標	現状 （2008年）	計画値 （2011年以降）
訓練生人数	EWTECで年間約300～500名 TVETC9校で年間約1,350名	
訓練カリキュラムにおいて実習が占める割合	10～30%	70%

(2) その他の成果指標

なし

(3) 評価のタイミング

2011年以降（機材稼動開始1年以降）

6. 参考資料・入手資料リスト

番号	名　　称	形態 図書・ビデオ 地図・写真等	ｵﾘｼﾞﾅﾙ・ ｺﾋﾟｰ	発行機関	発行年
1	Groundwater Development and Water Supply Training Project, Drilling Technology Textbook	図書	ｺﾋﾟｰ	Ministry of Water Resource	-
2	Groundwater Development and Water Supply Training Project, Groundwater Investigation Course, Water Well Management	図書	ｺﾋﾟｰ	Ministry of Water Resource	2002
3	Groundwater Development and Water Supply Training Project, Groundwater Investigation Course, Geology of Ethiopia (For the Course on the Hydrogeology of Ethiopia)	図書	ｺﾋﾟｰ	Ministry of Water Resource	-
4	Groundwater Development and Water Supply Training Project, Groundwater Investigation Course, Groundwater Volume I	図書	ｺﾋﾟｰ	Ministry of Water Resource	-
5	Groundwater Development and Water Supply Training Project, Groundwater Investigation Course, Groundwater Volume II	図書	ｺﾋﾟｰ	Ministry of Water Resource	-
6	Groundwater Development and Water Supply Training Project, Groundwater Investigation Course, 6th Training Course Textbook, Hydrogeology of Ethiopia	図書	ｺﾋﾟｰ	Ministry of Water Resource	2001
7	Groundwater Development and Water Supply Training Project, Groundwater Investigation Course, Contract Administration	図書	ｺﾋﾟｰ	Ministry of Water Resource	2002
8	水資源省 1999 年度年報 （アムハラ語）	図書	ｵﾘｼﾞﾅﾙ	Ministry of Water Resource	2007
9	19th - Drilling Machinery Maintenace Technology Training Course, Course Guide	図書	ｵﾘｼﾞﾅﾙ	EWTEC	2008
10	18th Training Course in Drilling Technology Course, Course Guide	図書	ｵﾘｼﾞﾅﾙ	EWTEC	2008
11	17th Groundwater Investigation Course, Course Guide	図書	ｺﾋﾟｰ	EWTEC	2007
12	Groundwater Development and Water Supply Training Project, Groundwater Investigation Course, Pumping Test	図書	ｺﾋﾟｰ	EWTEC	-
13	Implementation report on 18th Driling Machinery Maintenance Technology Course	図書	ｵﾘｼﾞﾅﾙ	EWTEC	2008
14	18th Groundwater Investigation Training Course Accomplishment Report	図書	ｺﾋﾟｰ	EWTEC	2008
15	Woreda Water Offices Situation and Training Needs Survey Conducted in Forteen Woredas of Oromia and Afar Regions	図書	ｺﾋﾟｰ	JICA	2008
16	Survey on the Situation and Training Needs of TVETC, Public Enterprises and private Firms/ Companies	図書	ｺﾋﾟｰ	JICA	2008

7. その他の資料･情報

(1) EWTEC 基礎コースカリキュラム

1. 地下水管理コース（Groundwater Investigation）

	ﾓｼﾞｭｰﾙ名	内 容	時間配分	備 考
1	Occurrence and Groundwater Movement (Groundwater Hydrology)	1 Occurrence of Groundwater movement 2 Groundwater movement at different geological frameworks	8	
2	Groundwater Investigation Methods	1 Information and Data Acquisition 2 Remote Sensing and Fracture Trace 3 Geological and Hydrogeological methods of investigation 4 Geophysical Survey 4.1 Electric Resistivity Survey 4.2 Electromagnetic Survey 4.3 Data Analysis	44	
		Practical training in the field. The followings are contents: 1 Data collection 2 Observation of Morphology 3 Geological and Hydrogeological Investigation 4 Geophysical Survey (Vertical Electrical Sounding) 5 Geophysical Survey (Vertical Electrical Sounding) 6 Horizontal Profiling 7 Electro Magnetic Survey 8 Demobilization 9 Interpretation of Field data (In the EWTEC lecture)	9日 (72時間)	掘削技術コースの掘削実習に先立ち、物理探査手法を用いて掘削場所の選定。
3	Drilling Technology and water well management	1 Drilling methods and type of drilling machines 2 Contract administration 3 Water wells management 4 Water well design and well rehabilitation	20	
		Practical training: Supervision of well drilling.		5日(40時間)
4	Geophysical Logging Test	1 Lecture of Geophysical Logging Test 2 Field Test 3 Data Analysis and Interpretation	8	
5	Pumping Test	1 Theory of Pumping Test 2 Method of Pumping Test Interpretation	20	
		Field work: Pumping test practice in the field and analysis the data	2日 (16時間)	現場での揚水試験実習。
6	Water Chemistry	1 Typical characteristics of Water 2 Purpose of Water quality Analysis & Required parameters 3 Sampling and Analysis 4 Ground water pollution and Groundwater treatment	8	
7	Geology and Hydrogeology of Ethiopia	1 Geology of Ethiopia 2 Hydrogeology of Ethiopia 3 Case Study	20	
		Practical training: Case study at Dire Dawa, Harar and around these towns	5日 (40時間)	地方州への現場実習（ハラル、ディレダワ等）
8	Groundwater modeling and GIS	1 Introduction to Groundwater Modeling 2 Software utilization 3 Introduction to GIS 4 Producing map using GIS software	20	

2. 掘削技術コース（Drilling Technology）

	ﾓｼﾞｭｰﾙ名	内 容	時間配分	備 考
1	Introduction to Geology and Hydrogeology	1. Introduction to geology & hydrogeology 2. Hydrologic cycle and groundwater movement 3. Occurrence of GW in different geology 4. Types of well logging 5. Well logging interpretation 6. Introduction of pumping test 7. Data collection & report preparation	26	岩盤の種類、地層の構成、水文学上のサイクル、地下水の存在、探査の方法および揚水試験などについて学ぶ。また、掘削日報のつけ方なども学ぶ。
2	Drilling Administrative Techniques	1. Drilling Administrative Techniques	12	掘削時の安全確保の仕方について学ぶ。さらに、掘削計画のたて方や掘削チームの管理方法、および作業員の選定方法などについても学ぶ。
3	Units of Measurement and their application	1. Unit of Measurements	8	掘削時にはさまざまな測定機器が必要になる。また、たくさんのアクセサリーも付随してくる。それらの基本的な使用方法について学ぶ。
4	Drilling Machines and Tools	1. Types of Drilling Machines 2. Types of bits and drilling accessories	24	掘削機それ自身や、ビット、ツールス、および付随装備について学ぶ。
5	Drilling Technology	1. Drilling Technology (cable tools) 2. Drilling Technology (mud rotary system) 3. Drilling Technology (DTH system) 4. Cementing Techniques 5. Drilling Fluid Technology 6. Important Points in Drilling Operation 7. Drilling Supporting Techniques 8. Field visit (Oromia Afar, SNNP, WWDE)	54	ロータリーリグ、DTH、およびパーカッションリグおよびそれに付随する技術について学ぶ。
6	Functions of the Drilling Machine and equipment	1. Air compressor and its function 2. Fundamental knowledge on hydraulic system 3. Principles of electrical systems of rigs & compressors 4. Circuit diagram and Electric maintenance of pumps and generators 5. Principles of mud pump construction and function	44	掘削機器の詳細な操作方法やセットアップ等について学ぶ。また、コンプレッサーや発電機などについてもその操作や機能を学ぶ。
7	Recovery of Drilling Problems (Trouble Shooting)	1. Drilling Trouble Shoot	8	掘削時によく起こる問題、およびその対処方法について学ぶ。
8	Practical Training	1. Introduction of the machine and the accessories 2. Greasing the machine 3. Rigging up and down practice 4. Mud rotary drilling and surface casing installation 5. DTH/Mud Rotary drilling 6. Trip out of drilling tools 7. Geophysical logging and casing arrangement 8. Casing installation, gravel packing & development. 9. Pump installation and provisional test 10. Continuous Pumping test & data collection	132	掘削機を用いて実際にボアホールを掘削する。

3. 掘削機械整備コース（Drilling Machinery Maintenance Technology）

	ﾓｼﾞｭｰﾙ名	内 容	時間配分	備 考
1	Basic knowledge	1 Introduction of drilling machines 2 Measuring tools 3 Lubricants 4 Unit 5 Machine component 6 Mechanical drawing 7 Arc Welding	64	
		Practical training: Visiting the factory around Akaki etc.	22	マシンのパーツ、潤滑油、オイル交換などの実習は、Akaki近辺の工場で行う。
2	Truck	1 Tracing mechanical power train on the actual truck (ISUZU) 2 Demonstrate the important 3 Practice on braking adjustment.	14	
		Practical training of breaking adjustment	4	
3	Top Head Drive type drilling machines	1 Hydraulic pumps 2 Hydraulic control valves 3 Actuators 4 Reading hydraulic circuit diagram of actual machines	31	
		Practical training at the drilling sites on the following drilling machines:- 1 INGERSOLL RAND 2 SCHRAMM, 3 SOILMEC 4 TONE, & KOKEN 5 MASSENZA	45	
4	Diesel engine and Injection pump	1 Making clear understanding on four strokes cycle engine, two strokes cycle engine and their firing order. 2 Making clear understanding on valve timing of four-strokes cycle engine. 3 Introduction “items of technical specification” on the four- strokes cycle engine. 4 Making clear understanding on all systems of diesel engine, combustion, lubricating, cooling, fuel, starting etc. 5 Making clear understanding on construction and functions of Injection pump and Injector.	16	
		Practical training on the following points: 1 Confirming component of diesel engine including turbo charger by using the cut model. 2 Overhauling fuel feed pump, fuel injector and the nozzle. 3 Explanation on injection system in inline type injection pump by using actual plunger and barrel.	7	
5	Down The Hole Air hammer	1 Making clear understanding on construction and function of the Air Hammer, especially how the piston operates by high-pressure air. 2 Took the actual hammer to a piece for recognition of the construction and function . 3 Making clear understanding on the purpose of usage of rock oil. 4 Guidance trouble shooting and maintenance points	4	
		Practical training on operation, assembling and disassembling etc.	2	

	モジュール名	内 容	時間配分	備 考
6	Air compressor	1 Making clear understanding on construction and function of the air compressors in trailer type. 2 Making clear understanding on sequence of high pressure air in the system, (no-load, load and Un-load conditions). 3 Making clear understanding on the usage of Air compressor oil and it's flow in the system 4 Making clear understanding on the oil separation system. 5 Guidance trouble shooting and periodical maintenance points on the Air compressor	14	
		Practical training on the following points: 1 Clarified construction and function of the entire component on actual air compressor, Belgium made ATLAS COPCO XRHS385 Md. 2 The sequence of pressurized air was shown in the air flow diagram systematically and also confirmed by the actual Air compressor. 3 The oil separation method was shown in the oil flow diagram. And using the actual parts involved in the system 4 To be understood firmly the systems with referring to actual diagrams of XRHS385 Md, XRVS 450 Dd, XRV 9 (Belgium made) respectively.	2	
7	Percussion type drilling machine	Making clear understanding on construction and function of power train, especially lines of bull reel, casing, sand reel and mast raising and lowering	12	
		Practical training at Awassa SNNPRS Enterprise on the following points: 1 Practice on operation of the actual machine on SNNP water works construction Enterprise drilling rig. 2 Guidance trouble shooting and maintenance points.	4	南部州での実習。
8	Electrical devices on Diesel engine	1 Making clear understanding what is electricity (DC and AV). 2 Making clear understanding on construction and function of lead battery. 3 Guided how to maintain the lead battery 4 Introducing starting circuit and charging circuit.	11	
		Practical training on the following points: 1 Measure current and voltage in AC and DC by using multi meter 2 Measure resistance in DC current by multi meter. 3 Confirming construction of lead battery by using the cut model. 4 Measure specific gravity of electrolyte and voltage of actual battery. 5 Overhauling actual Starter motor. 6 Explanation on construction and function of Alternator and Voltage Regulator by using the cut model and real one. 7 Measure output voltage at alternator and regulated voltage in battery charging system	7	

4. 電気機械整備コース（Electrical Mechanic Maintenance Technology） ※

	ﾓｼﾞｭｰﾙ名	内 容	時間配分	備 考
1	Fundamentals of Electricity and Measurements	1. Fundamentals of electricity 1.1 Safety precautions 1.2 Electrical symbols 1.3 Nature of electricity 1.3 Direct current theory 1.4 Alternating current theory 2. Electrical measuring instruments and measuring 2.1 Construction of electrical measuring instruments 2.2 Usages of electrical measuring instruments	19	
2	Submersible Pump	1. Introduction 1.1 General information 1.2 The head of the pump and its measurement 1.3 Pumping theory 2. Pump classification 2.1 Pump performance 2.2 Dismantling and assembling Submersible pump & Electrical motor 2.3 Submersible pumps installation 2.4 Polyphase motors 2.5 Three phase system 3. Cables 3.1 Cables 3.2 Soldering 3.3 Selecting Cable	20	
3	Sequence Control	1 Electrical devices and Logic 1.1 Control and Protective devices 1.2 Relay logic 1.3 Digital logic 2 Circuit design, development and analysis 3 Basic circuit diagram for machine, tools and machinery	24	
4	Diesel engines	1 Course introduction 2 General safety guide lines 3 How diesel engine works 4 Engine components 5 Starting system 6 Air intake/Exhaust system and tests 7 Lubricant system and tests 8 Cooling system and tests 9 Fuel system and test 10 Managing fluids and filters 11 Gathering data	16	
5	Electrical Devices on Diesel Engines	1 Direct current (DC) & Alternating current (AC) 2 Battery 3 Starting system 4 Charging system 5 Introduction of a tester	8	
6	Electric Motors and Generators	1 Basics of Electro Machine 2 Fundamental Concepts on Motors 3 Fundamentals Concepts on Generators	20	

※4日間のField Work有り

5. 給水技術コース（Water Supply Engineering）

	ﾓｼﾞｭｰﾙ名	内 容	時間配分	備 考
1	Introduction of Water Supply Engineering	Introduce the basic water supply components and operation & maintenance of water supply schemes	5	
		Practical training: Discuss with participants the general problem in water supply schemes of Ethiopia & their respective regions	2	
2	Planning of water supply	1 Introduce planning process and Review population forecast methods 2 Introduce water demand analysis & reservoir capacity determination methods	4	
		Practical training on the following points: 1 Case Study 2 Exercise	8	
3	Water source	1 Introduce the water Occurrence & Hydrology 2 Introduce the types & selection of water sources 3 Introduce the ground water investigation & pumping test methods & well design methods 4 Introduce the selection of water source site methods	8	
		Practical training on the following points: 1 Conduct site selection by the use of global map method 2 Conduct site selection at Akaki area 3 Conduct practical pumping test analysis in the compound of the training center 4 Conduct site visit at Akaki well field	8	
4	Contamination of water bodies/Pollution and sanitation facilities	1 Introduce the cause of water contamination 2 Introduce the sanitation facilities	4	
		Practical training on the following points: 1 Discus the sanitation of the country with participants 2 Field observation at waste water treatment facilities	4	
5	Water Quality Management & Control	1 Introduce water quality management & control 2 Introduce disinfection methods & Water Chemicals	4	
		Practical training on the following point: 1 Demonstrate water quality instruments	4	
6	Purification facilities	1 Introduce the types of purification facilities and operation & maintenance of treatment process 2 Introduce the types of purification facilities and operation & maintenance of treatment process	4	
		Practical training on the following points: 1 Case study on purification facilities 2 Exercise on purification facilities 3 Field observation on SSF 4 Field observation on old RSF 5 Field observation on new RSF	36	

	モジュール名	内 容	時間配分	備 考
7	Basic design criteria of water supply facilities and tender document preparations	1 Introduce basic design criteria of water supply facilities 2 Introduce Bid document preparations /civil & supply of pipes & fittings	4	
8	Mechanical & Electrical Facilities	1 Introduce the Electro-Mechanical equipments and its design, installation & operation methods 2 Introduce the power system & control, maintenance tools and instruments 3 Introduce the types and characteristics of a pumps & pump selection methods	6	
		Practical training on the following points: 1 Demonstrate electro-mechanical equipments in the center 2 Execute a hydraulic calculation for a pump specification 3 Exercise or case study	6	
9	Transmission & Distribution Facilities	1 Introduce the concept and basic elements of transmission & distribution systems 2 Introduce the design criteria for components and materials for water supply systems	4	
		Practical training on the following points: 1 Introduce software programs (EPANET/WATER CAD) 2 Practice with programs for linear and network systems 3 Practice with programs : Case study 1: Linear system for rural community a. Single period analysis b. Extended period analysis 7 Practice with programs: Case study 2: Urban network systems including system planning 8 Urban system continued	12	
10	Structure Analysis & Construction of water works	1 Introduction of basic knowledge and factors of structural engineering 2 Experiments of assembling model structural members 3 Introduction of concrete structure and design a. Limit state design 4 Finite element method	8	
		Practical training on the following points: 1 Practice with software (SAP) 2 Practice with software (SAP) Architectural 3 Practice with software (SAP) Civil 4 Field observation for water supply system and civil works Analysis of the observations in the field study: 1 Analysis of civil works 2 Analysis of water transmission/distribution system	16	
11	Group discussion	Give internal evaluation forms to all participants	1	
		Practical training on the following point: Discus with them about the general course process	1	

(2) TVETC 水利学科カリキュラム

1. EMT コース

学年	コースタイトル	内容	総時間（時間）	授業実施場所	備考
1	Electrical System Installation	Duty 1 Installing Electrical Wires (70hours) Duty 2 Installing Distribution Board & Connecting Final Sub-Circuits (28) Duty 3 Terminating Wires to Fittings (32) Duty 4 Testing and Trouble Shooting Electrical Installation (20)	150	学校内	
		Project Work： Preparing installation drawing of Woreda water supply office (Individual basis)	40	学校内（個人作業）	与えられたワレダ水利事務所の図面から、学生は電源、ブレーカーなどの電気システムの配置とサイズを決める。
		Apprenticeship： Working at Line departments & enterprises on water works, or Private enterprises on installing electrical system. Perform the actual wiring in an organization	78	-Line departments & enterprises on water works -Private enterprises on installing electrical system	左記より 1 箇所選ぶ。訪問先で電気系統据付図面を読んで理解し、実際に作業を行う。
1	Repairing Measuring Instruments & Control Panel Devices	Duty 1 Maintaining electrical measuring instruments (50) Duty 2 Maintaining control panel device (35)	85	学校内	
		Project Work： 1. Principle of operation of analog AVO meters, multimeter, wattmeters 2. Principle of operation of digital AVO meters 3. Measuring instruments repairing	40	学校内	1,2 に関しては、各計測器の操作方法、精度などの原理を知り、テストできるようになる。
		Apprenticeship： Exercise measuring unit in an organization	78	水サービス関係のユニットやオフィス	配属先にて、計測器と制御盤における実務を学ぶ。
2	Electric Motor and Generator maintenance	Duty 1　Identifying DC Generators & Motors(52) Duty 2　Identifying AC Generators & Motors(62) Duty 3　Maintaining Electric Motors (40) Duty 4　Maintaining Generators (45) Duty 5　Rewinding Armature Coils of Motors (180)	379	学校内	
		Project Work： Rewinding armature coils of motors	40	学校内、又は近くの給水オフィス	
		Apprenticeship： Electric motor and Generator maintenance activities	20	学校内、又は近くの給水オフィス	配属先にて、電気モーターと発電機における実務を学ぶ。
2	Water Pump Operation & Maintenance	Duty 1 Operating Water Pumps (18) Duty 2 Maintaining Surface Water Pumps (96) Duty 3 Maintaining Submersible Pumps (86) Duty 4 Maintaining Hand Pumps (36)	258	学校内	

学年	コースタイトル	内容	総時間（時間）	授業実施場所	備考
		Duty 5 Maintaining Hydraulic Ram Pumps (22)			
		Project Work： 1 Maintaining Surface Water Pumps 2 Maintaining Submersible Pumps 3 Maintaining Hand Pumps	70	学校内、又は施設がある場所であればどこでも OK。（個人又はグループ作業）	左記 3 プロジェクトより 1 つを選んで作業を行う。それぞれ、解体―スペアパーツの選定―組立、までを行うものである。
		Apprenticeship： To practice on the operation and maintenance of different water pumps in any water supply scheme	130	ゾーナル又はワレダ水利事務所。	様々な型のポンプの操作・修理を練習する。
3	Diesel & Dewatering Pump Gasoline Engine Operation & Maintenance	Duty 1　Operating Diesel Engine (16) Duty 2　Maintaining Engine Crank Mechanism (64) Duty 3　Maintaining Valve Mechanism (75) Duty 4　Maintaining Air Intake and Exhaust (23) Duty 5　Maintaining Cooling System (57) Duty 6　Maintaining lubricating System (60) Duty 7　Maintaining Fuel System (71) Duty 8　Maintaining Electrical System (35) Duty 9　Maintaining Gasoline Engine of Dewatering　Pumps (28)	429	学校内	
		Project Work： 1 Maintaining Crank Mechanism of Internal Construction Engine 2 Maintaining Valve Mechanism of Internal Construction Engine 3 Maintaining of cooling System 4 Maintaining Lubricants System 5 Maintaining Fuel System of diesel Engine	70	学校内、又は施設がある場所であればどこでも OK。（個人又はグループ作業）	左記 5 プロジェクトより 1 つを選んで行う。作業内容はそれぞれ対象機材の、解体、メカニズム確認、組立が主である。
		Apprenticeship： To practice on the operation and maintenance activities of diesel and dewatering pump gasoline engine in any water supply scheme	130	ゾーナル又はワレダ水利事務所	
3	Generator Set & Water Pump Installation	Duty 1　Installing Generator Set (21) Duty 2　Installing Surface Pumps (40) Duty 3　Installing Submersible Pumps (30) Duty 4　Installing Hand Pumps ()	91	学校内	
		Project Work： 1 Installing Generator Set, 2 Installing Surface Water Pumps, 3 Installing Submersible Pumps	70	学校内、又は施設がある場所であればどこでも OK。（個人又はグループ作業）	左記 3 プロジェクトより 1 つを選んで行う。それぞれ機材の据付を行い、試験まで行う。
		Apprenticeship To practice on installation works related to generator set and water pump of different kinds in any water supply scheme	156	ゾーナル又はワレダ水利事務所	

2. SSID コース

学年	コースタイトル	内容	総時間(時間)	授業実施場所	備考
2	Resources Investigation	Duty 1 Investigating Soils (40) Duty 2 Investigating Surface Water Resource (28) Duty 3 Assessing Ground Water Potential (21) Duty 4 Surveying Socio-Economic Conditions (26) Duty 5 Investigating Agronomic Aspects (40) Duty 6 Evaluating Land Resources(22) Duty 7 Analyzing Water Demand and Quality (96) Duty 8 Conducting Geotechnical Investigation (90)	363	学校内	
		Project Work (70)： 1 A preliminary study on nearby river for small scale irrigation development. 2 Appraisal of different feasibility studies	70	学校内、又は施設がある場所であればどこでも OK。（グループ作業）	
		Apprenticeship： To do an interpretation produce a brief report about what has he/she gained at the training center and work closely with experienced professionals.	156	Regional irrigation development authority, ESRDF, Regional commission for sustainable agriculture and environmental protection, Private consulting enterprises on irrigation development, Line departments and enterprises on water works	配属先で何をしたかを、専門家から何を得たのか等の報告書を提出する必要がある。
2	Small Scale Irrigation System Design	Duty 1 Designing Diversion Head Work (65) Duty 2 Designing Water Harvesting Structures (45) Duty 3 Designing Pumped Irrigation System (40) Duty 4 Designing Ground Water Source For Irrigation (30) Duty 5 Designing Channels and Farm Roads (25) Duty 6 Designing Channel Structures (55) Duty 7 Designing of Surface Irrigation System (40) Duty 8 Designing Pressurized Irrigation System (30) Duty 9 Preparing Specification & Bill of Quantities (10)	340		
		Project Work ： 1 Prepare the detailed design work for specific irrigation area 2 Prepare the specification and bill of quantities for the above mentioned design by the same group	70	学校内（5 人 1 組）	対象灌漑地域の詳細設計である。設計、積算、仕様書作成までを行う。
		Apprenticeship ：	156	Regional irrigation	灌漑にかかる構造物の設

学年	コースタイトル	内容	総時間(時間)	授業実施場所	備考
		designing of head works, irrigation structures, water harvesting structures, pumped irrigation system, ground water irrigation system, channels and roads, surface & pressurized irrigation system, and preparing specification and bill of quantities.		development authority, Commission for sustainable environmental and agricultural development, Line departments of and enterprises of water works, ESRDF NGOs	計、仕様書作成、積算。
3	Drainage System Design	Duty 1 Over viewing drainage (8) Duty 2 Over viewing salinity in irrigated agriculture (18) Duty 3 Describing and estimating drainage systems design basic data (22) Duty 4 Conducting hydraulic conductivity tests (75) Duty 5 Investigating drainage conditions (71) Duty 6 Designing surface drainage systems (65) Duty 7 Designing subsurface drainage systems (60)	319		
		Project Work ： 1 Preparation of detailed surface drainage systems design for an irrigated land. 2 Preparation of detailed subsurface drainage systems design for an irrigated land.	60	学校内で可能（記載なし）	地形図、排水、水路、配管関係の図面作成、積算、仕様書作成。
		Apprenticeship： -Topographical, water and soil investigations for drainage -Surface drainage systems design -Subsurface drainage systems design -Preparation specifications and bill of quantities.	156	Regional Irrigation Development Authority or Commission for Sustainable Environmental and Agricultural Development or line departments and enterprises of water, ESRDF, NGOs	小規模灌漑にかかる地形図、排水システムの設計、仕様書作成、積算の実務を学ぶ。
3	Small Scale Irrigation and Drainage Systems Operation and Maintenance	Duty 1 Planning Irrigation Operation (54) Duty 2 Distributing Irrigation Water & Monitoring It (42) Duty 3 Monitoring Soil & Water Quality (54) Duty 4 Planning Maintenance (62) Duty 5 Guiding implementing maintenance (62)	290	学校内	
		Project Work ： 1 Planning operation of the scheme 2 Planning maintenance of the scheme	50	学校近くの灌漑プロジェクトエリア	プロジェクトの水源、水供給量、積算、工程など、一連の流れを学ぶ。
		Apprenticeship： 1. To plan operation of this irrigation scheme 2. To plan maintenance of this irrigation	70	近くの Irrigation Development Authority。そこから現場へ配属。	上記の実務を学ぶ。
3	Small Scale Irrigation and Drainage Construction Supervision	Duty 1 Managing Construction (31) Duty 2 Guiding Construction of Micro dam (32) Duty 3 Guiding the Construction of River Diversion (37)	290	学校内	

学年	コースタイトル	内容	総時間(時間)	授業実施場所	備考
		Duty 4 Controlling the Construction of River Bank Intake (18) Duty 5 Guiding Construction of Ponds (20) Duty 6 Guiding the Construction of Hand Dug Well (15) Duty 7 Construction of Generator/Pump/House (28) Duty 8 Inspecting Construction of Spring Tapping (54) Duty 9 Constructing Conveyance Canal (21) Duty 10 Constructing Conveyance Canal Structures (34)			
		Project Work： Small scale irrigation development structures prototype production a) Prototype for diversion weir b) Prototype for embankment intake c) Prototype for flume d) Prototype for inverted siphon e) Prototype for micro dam f) Prototype for conveyance canal	50	学校内（グループ作業）	小規模灌漑開発に必要な構造物のプロトタイプを作る。
		Apprenticeship： a) process & bureaucracy of material supply b) process & bureaucracy of financial supply c) material quality d) design layout process e) indicate means for increasing construction efficiency f) delineate the conventional construction process from what is studied g) foundation treatment during construction	100	Irrigation farms in the awash valley, Irrigation farms Braile Agriculture Development Enterprise, Government institution working on Irrigation Development	小規模灌漑建設の、特に管理面を含めた一連の流れを学ぶ。

RWSS コース

学年	コースタイトル	内容	総時間(時間)	授業実施場所	備考
2	Rural Water Supply Source Investigation	Duty 1 Carrying out water demand assessment (16) Duty 2 Assessing ground water sources (54) Duty 3 Assessing surface water sources (65) Duty 4 Conducting water quality analyses (80)	215	学校内	
		Project Work： a) Ground Water Sources Investigation b) Surface Water Sources Investigation c) Water Quality Analyses	50	サイトおよび学校内（グループ作業）	学校周辺において、地下水源および表流水源を探す。その水の水質解析を校内の解析室にて行う（現段階では不可能）
		Apprenticeship： To participate in each and every steps of site selection starting from the office work	150	学校付近で、水源探しを行っているワレダ、ゾーン、ケベレの水利事務所であればどこでもOK。	サイトセレクション（水源）の一連の流れを学ぶ。
2	Rural Water Supply Scheme Design	Duty 1 Determining units of water supply schemes (6.5) Duty 2 Designing spring tapping (15) Duty 3 Designing hand dug well (15) Duty 4 Designing infiltration galleries (17) Duty 5 Designing drilled well head (7) Duty 6 Designing rain water harvesting? (16) Duty 7 Designing diversion head work (65) Duty 8 Designing run off water harvesting structures (45) Duty 9 Designing pipe lines (17) Duty 10 Designing masonry stand for steel reservoir (10) Duty 11 Designing Ferro-cement reservoir (24) Duty 12 Designing masonry wall reservoir (22) Duty 13 Designing reinforced concrete reservoir (31) Duty 14 Designing a slow sand filter (18)	308.5	学校内	
		Project Work： 1 Designing of surface water structures 2 Designing of ground water source structures	30	学校周辺および学校内（グループ又は個人作業）	1,2 とも、学校周辺で水源を見つけ、それを供給するための構造物を設計し、積算、仕様書まで仕上げる。
		Apprenticeship： Working at　Water bureaus, Water departments, Water works design and supervision enterprise, Water well drilling enterprise etc	150	水資源局、公社など	上記の実務を学ぶ
3		Duty 1 Managing construction (31) Duty 2 Guiding the construction of hand dug wells (12)	284	学校内	

学年	コースタイトル	内容	総時間(時間)	授業実施場所	備考
	Rural Water Supply Construction Supervision	Duty 3 Guiding the construction of spring tapping (8) Duty 4 Controlling ling the construction of river bank intake (17) Duty 5 Guiding construction of ponds (14) Duty 6 Guiding construction of micro dams (17) Duty 7 Guiding construction intake weir (28) Duty 8 Guiding the construction of generator/pump (37) Duty 9 Guiding the construction of steel reservoir (25) Duty 10 Guiding the construction of Ferro-cement reservoir (9) Duty 11 Guiding the construction of masonry reservoir (19) Duty 12 Guiding the construction of reinforced concrete reservoir (19) Duty 13 Guiding the construction of a slow sand filter (13) Duty 14 Guiding/supervising the laying of transmission and distribution pipes. (20) Duty 15 Supervising Laying of Transmission and Distribution Pipelines (15)			
		Project Work： 1 Guiding and supervising hand dug well construction 2 Guiding and supervising pipe laying 3 Guiding and supervising water tight structures (masonry reservoir)	30	学校内又は外部	村落給水に関連する構造物の契約から設計・施工までの流れを学ぶ（主に契約書や図面などの書面）。
		Apprenticeship (150): Working at water works design enterprise, water works construction enterprise and water well drilling enterprise etc.	150	給水公社、建設公社など。	上記、施工管理の実務を学ぶ。
3	Rural Water Supply Scheme Operation	Duty 1 Guiding Operation of Surface Water Sources (41) Duty 2 Guiding Operation of Ground Water Schemes (18) Duty 3 Guiding Operation of Potable Water Treatment Plant (48) Duty 4 Guiding Operation of Pumping Stations (42) Duty 5 Guiding Operation Activities of Water Distribution Systems (57) Duty 6 Guiding Maintenance Civil Works (12)	218	学校内	
		Project Work： Water quality control	20	学校付近のプロジェクトサイト（個人又はグループ作業）	生水と処理水の水質解析を行う。
		Apprenticeship： Working at town water treatment units & water laboratory room	120	市内の水質解析室など	水質解析の実務。
3	Rural Sanitation	Duty 1 Developing human excreta disposal facilities (24)	59	学校内	

学年	コースタイトル	内容	総時間(時間)	授業実施場所	備考
		Duty 2 Guiding management of sludge water (35)			
		Project Work： Pit latrine design	10	学校内	ターゲットのコミュニティーの大きさを考慮したうえで、トイレの設計、仕様作成、積算までを行う。
		Apprenticeship： Working at organizations where design and construction of rural sanitation facilities are undergoing	30	トイレの設計と施工を現在行っている団体	上記の実務。

(3) 機材モニタリングシート

VEHICLE OPERATION AND MAINTENANCE RECORD			
Name of TVETC _____ Vehicle Number _____			
Year: _____			
Jan. / Feb. / Mar. / Apr. / May / Jun. / Jul. / Aug. /Sept. /Oct. / Nov. / Dec.			
Driving Record			
End Mileage (km)	Total travel distance of this month(km)		
Date	Purpose of Use	Destination	Trevel Distance(km)
Maintenance record			
Type of Maintenance	Date	Remarks	
Regular・Repair			
Regular・Repair			
Regular・Repair			
Regular・Repair			
Regular・Repair			
Regular・Repair			
Regular・Repair			
	Date	Name	Signature
Recorded by driver			
Checked by head of office			
Authorized by TVETC principle			
Authorized by TVET Agency/ Committee			

VEHICLE OPERATION AND MAINTENANCE RECORD (For Photo Frame)

**Please attach photos to show the current condition*

Month
OBLIQUE FRONT VIEW
OBLIQUE REAR VIEW

<Anual Record Format>

EQUIPMENT CONDITION RECORD

Name of TVETC : _____

Date: _____

ID Number	Item	Condition			Remarks
		Good	Workable	Out of order	
	Total Station				
	Digital Planimeters				
	Automatic Level				
	Geological Compass				
	Cylinder infiltrometer				
	Permeability test kit				
	Soil color chart				
	Geological hammer				
	Magnifying lens				
	Sieve				
	Conductivity				
	pH meter				
	Field bacteriological & physiochemical complete water				
	Hand auger				
	Diesel generator				
	Submersible pump				
	Surface pump (electrical)				
	Arc welding machine				
	Dewatering pump (petrol)				
	Chain pipe vice				
	Chain wrench				
	Pipe wrench set				
	Pipe threader				
	Torque wrench set				

	Date	Name	Signature
Recorded by store keeper			
Checked by head of office			
Authorized by TVETC principle			
Authorized by TVET Agency/ Commission			

(4) 計画機材概要

No.	機材名	仕様	数量
A. 地下水調査			
A-1	電磁探査機	時間領域、測定深度 300m	1 台
A-2	電気探査機	2 次元探査、測定深度 200m	1 台
A-3	孔内検層機	計測深度 300m	1 台
B. 掘削技術			
1. サービスリグ			
B-1	サービスリグ	井戸径 4", 6"、 8"、井戸深度 200m、 動水位 150m、4x4 or 6x4 トラック、高圧ポンプ搭載（流量 500L/min、圧力 2MP） ①ベーリング用アクセサリー（6、8 インチ用） ②ブラッシング用アクセサリー（6、8 インチ用） ③ジェッティング用アクセサリー（6、8 インチ用）	1 式
2. 300m 級掘削機及びツールス			
B-2	掘削機及び掘削ツール	以下の通り	1 式
	300m 級掘削機	Rotary type, drill pipe OD 4-3/4" 300m 以上 マッドポンプ仕様 送水量 1,500L/min 以上、送水圧 20kg/cm2 以上、トラック 6x4、PTO	1 式
	ドライブヘッドサブ	3-1/2 (Box)×3-1/2 (pin)	2 個
	ドリルパイプ	4-3/4" OD x 6m, 3-1/2"IF box x pin, wrench recess on both ends, hard thread protectors	70 個
	ドリルパイプ	4-3/4" OD x 3m, 3-1/2"IF box x pin, wrench recess on both ends, hard thread protectors	2 個
	ドリルパイプ	4-3/4" OD x 1.5m, 3-1/2"IF box x pin, wrench recess on both ends, hard thread protectors	1 個
	クロスオーバーサブ	3-1/2" IF box x 4-1/2" IF pin	2 個
	ドリルカラー	6-1/2" OD x 3m, 4-1/2"IF box x pin, wrench recess on both ends & hard thread protectors	6 個
	ビットスタビライザー	9-7/8" OD x 2m, 4-1/2" IF box x pin, wrench recess on both ends & thread protectors	2 個
	ビットスタビライザー	8-1/2" OD x 2m, 4-1/2" IF box x pin, wrench recess on both ends & thread protectors	2 個
	ビットサブ	4-1/2" IF box x 6-5/8" REG box	2 個
	ビットサブ	4-1/2" IF box x 4-1/2" REG box	2 個
	トリコンビット（トゥースタイプ）	14-3/4" x 6-5/8" REG pin, soft formation (S type)	1 個
	トリコンビット（トゥースタイプ）	14-3/4" x 6-5/8" REG pin, hard formation (H type)	1 個
	トリコンビット（トゥースタイプ）	12-1/4" x 6-5/8" REG pin, soft formation (S type)	1 個
	トリコンビット（トゥースタイプ）	9-7/8" x 6-5/8" REG pin, medium to hard formation（MH type)	2 個
	トリコンビット（インサートタイプ）	12-1/4" x 6-5/8" REG pin, hard formation Tungsten carbide inserted	2 個
	トリコンビット（インサートタイプ）	9-7/8" x 6-5/8" REG pin, hard formation Tungsten carbide inserted	2 個
	トリコンビット（インサートタイプ）	8-1/2" x 4-1/2" REG pin, hard formation Tungsten carbide inserted	2 個
	ハンマーサブ	4-1/2" IF box x 4-1/2" REG box	2 個
	DTH ハンマーボディ	7‐1/8 OD or more	2 個

No.	機材名	仕様	数量
	DTH ハンマービット	Button bit 9-7/8"	5 個
	DTH ハンマービット	Button bit 8-1/2"	5 個
	DTH ハンマー用ショックアブソーバー	上記ハンマーボディに適合すること	2 個
	DTH ハンマー分解用工具	上記ハンマーボディに適合すること	1 式
	DTH ハンマー用ビットグラインダー	標準タイプ	1 個
	グラインド歯	標準タイプ	3 個
	クレイビット	14-3/4" x 6-5/8" REG pin	1 個
	クレイビット	12-1/4" x 6-5/8" REG pin	1 個
	クレイビット	9-7/8" x 6-5/8" REG pin	1 個
	ホイスティングスイベル	3-1/2" IF pin	1 個
	ホイスティングプラグ	4-1/2" IF pin	1 個
	バックアップレンチ	For drill pipe 4-3/4"	1 個
	バックアップレンチ	For drill collar 6-3/4"	1 個
	ブレイクアウトレンチ	For drill pipe 4-3/4"	1 個
	ブレイクアウトレンチ	For drill collar 6-3/4"	1 個
	ビットブレーカー	for 14-3/4" tricone bit	1 個
	ビットブレーカー	for 12-1/4" tricone bit	1 個
	ビットブレーカー	for 9-7/8" tricone bit	1 個
	ビットブレーカー	for 8-1/2" tricone bit	1 個
	ワークケーシング	12" x 5.5m	7 個
	ワークケーシング	10" x 5.5m	7 個
	ケーシングエレベーター	6"	1 個
	ケーシングエレベーター	4"	1 個
	ケーシングバンド	12"	2 個
	ケーシングバンド	10"	2 個
	ケーシングバンド	6"	2 個
	ケーシングバンド	4"	2 個
	ワイヤースリング	16mm×6m×4, 12mm×6m×2, 9mm×6m×2, 9mm×3m×2 で 1 セット	1 式
	マッドポンプ用サクションホース	with foot valve	1 個
	泥水ミキサー	750liter	1 個
	サンドポンプ	2.2kw, 3phase, 200V, 2" hose (Crystal) x 20m	1 台
	マッドホッパー	Hose 1-1/2-2" x 10m, High pressure 50kg/cm2	1 台
	エンジンポンプ	2" outlet, Suction hose with foot valve x 10m, Delivery hose 2" x20m	1 台
	泥水比重測定器	標準タイプ	1 台
	粘度測定器	標準タイプ	1 台
	配電盤	配電盤(60mA、30mA、200V×3) メインキャップタイアー (22mm2)×10m	1 台
	折りたたみ式水タンク	2m3	1 台
	折りたたみ式水タンク	4m3	1 台
	ハンドポンプ(手動給油ポンプ)	標準タイプ	1 台
	工具箱	標準タイプ	1 台

No.	機材名	仕様	数量
	パイプレンチセット	1200mm, 900mm, 600mm, 450mm で 1 セット	2 式
	ドライバセット	各種	1 式
	ボックスレンチセット	各種	1 式
	スパナセット	各種	1 式
	メガネレンチセット	各種	1 式
	チェーントング	12", 10", 8" で 1 セット	2 式
	打撃ハンマー	5kg, 1kg	1 式
	水準器	標準タイプ	1 個
	エンジン溶接機	300A 以上	1 台
	ガス溶接機	酸素、アセチレン容器ほか一式	1 式
	ディスクグラインダー	100mm (100V), 上部ディスク 100mm、研磨用:50、切断用:20	1 台
	気泡材	粉末	300 kg
	インサイドタップ	max 4-1/2"	1 個
	アウトサイドタップ	max 10-7/8"	1 個
3. 高圧コンプレッサー			
B-3	高圧コンプレッサー	車載型 6x4 又は 4x4 トラック仕様は搭載する機材及び燃料の総重量を考慮して決めること。 空気量 25m3/min, 空気圧 2.0MPa～2.41MPa	1 台
4. エアリフト用及び揚水試験用機材			
B-4-01	エアリフト用コンプレッサー	エアーリフティング用 コンプレッサー 空気吐出量 8.5m3/min 以上 圧縮空気圧 10kgf/cm2（1.0MPa）以上 その他アクセサリー一式	1 台
B-4-02	水中モーターポンプ	**揚呈** 200m で 400ℓ/min ケーブル 240m 揚水管 2-1/2"x5.5m（亜鉛メッキ）230m 分 コントロールボックス	1 式
B-4-03	三角堰水量計測器	最大流量 800 リットル/分以上	1 台
B-4-04	水位計	300m	1 台
5. クレーントラック			
B-5	クレーントラック	3 トンクレーン 最大積載量約 12 トン 4x4or6x4 荷台長 6.5m 以上	2 台
6. 既存掘削機用ツールス			
B-6	マッドポンプ用サクションホース	フットバルブ付き、4" x 9m	1 個
	DTH ハンマーボディ	6-5/8" OD, 4-1/2" REG pin	1 個
	ハンマーサブ	4-1/2" REG box x 3-1/2" IF box	1 個
	クレイビット	12-1/4" x 6-5/8" REG pin	2 個
	クレイビット	9-5/8" x 6-5/8" REG pin	2 個
	クレイビット	8-1/2" x 6-5/8" REG pin	2 個
	チェートングセット	ST-3x2 本、ST-2x2 本、ST3 用スペアチェーン 1 本で 1 セット	1 式

No.	機材名	仕様	数量
	パイプレンチセット	1200mm×1　900mm×1　600mm×1　450mm×2 300mm×2 で 1 セット	1　式
	ワイヤースリング	16mm×6m×4, 12mm×6m×2,　9mm×6m×2, 9mm×3m×2 で 1 セット	1　式
	水位計	200m	1　個
	ベントナイト		10　t
	CMC		500　kg
	ポリプロピレン溶剤		500　kg
	救急箱	標準	1　個
	水中ポンプ	150m head & 10 ℓ/s discharge, 吐出口 2-1/2", 6"井戸用	1　台
	エンジンポンプ	サクションホース 50mm×9m, デリバリーホース 50mm×20m	1　台
	ホイスティングプラグ	4-1/2"IF box	1　個
C. 掘削機械整備			
1. 測定機器及び整備用機材・ツールス			
C-1-01	ディーゼルタコテスター	測定範囲: 0 - 6000rpm	1　台
C-1-02	ノズルテスター	卓上用手動タイプ	1　台
C-1-03	ディーゼルコンプレッションゲージ	0 - 7MPa	1　台
C-1-04	バルブスプリングツール	標準タイプ	1　台
C-1-05	バルブリフター及びコンプレッサー	開口範囲: 50-180mm 対応バルブタイプ: オーバーヘッドバルブ	1　台
C-1-06	バルブラッパー	エアバルブラッパー圧力: 0.6MPa 以上 ハンドバルブラッパー及び研磨剤付き	1　式
C-1-07	ピストンリングコンプレッサー	径 50-175mm 以上	1　台
C-1-08	ピストンリングツール	径 50-135mm 以上	1　台
C-1-09	アングルスケール付トルクレンチ	角度: 360 度, 目盛: 40-280Nm	1　台
C-1-10	エンジンヘッドボルト用ソケット	各種	1　台
C-1-11	シリンダーゲージ	計測範囲: 50-150mm	1　台
C-1-12	コネクションロッドアライナー	計測範囲: 150-400mm	1　台
C-1-13	キャンバーキャスターキングピン傾斜計	中・大型車両用	1　台
C-1-14	ブレーキブリーダーレンチセット	レンチサイズ: 8, 10	1　台
C-1-15	ブレーキスプリングプライヤー	中・大型車両用	1　台
C-1-16	ブレーキライニングリベッター	中・大型車両用	1　台
C-1-17	ブレーキドラムゲージ	約 350 - 600 mm	1　台
C-1-18	ブレーキブースターテスター	ゲージ: 20, 10, 1MPa, 76cmHg	1　台
C-1-19	ディーゼルスモークメーター	ろ紙反射式 With necessary accessories	1　台
C-1-20	アーク溶接機	低格電流 300A 以上	2　台
C-1-21	ジェットウォッシャー	エンジン洗浄用	1　台
2. カットモデル			
C-2-1	インジェクションポンプ－カットモデル	PT ポンプタイプ	1　台
C-2-2	マニュアルトランスミッション－カットモデル	一般車両、5 段以上	1　台
C-2-3	ステアリングギア－カットモデル	一般車両、ラックアンドピニオン式、ディスクブレーキ、ドラムブレーキ、フロントサスペンション付き	1　台

No.	機材名	仕様	数量
C-2-4	ブレーキバルブ－カットモデル	一般車両	1 台
C-2-5	ディスクブレーキ－カットモデル	一般車両	1 台
C-2-6	ドラムブレーキ－カットモデル	一般車両	1 台
C-2-7	トルクコンバーター－カットモデル	一般車両	1 台
C-2-8	ダイヤフラム型シリンダー－カットモデル	一般車両、ブレーキブースター用	1 台
C-2-9	メカニカルロック付ディファレンシャル－カットモデル	ハイポイドギヤタイプ、メカニカルロック付	1 台
C-2-10	排気ガスターボチャージャー－カットモデル	一般車両、圧力調整式、ディーゼル	1 台
C-2-11	ディーゼルフィードポンプ－カットモデル	複動タイプ、ディーゼルエンジン用	1 台
D. 電気機械整備			
1. 電気・電子訓練用機材及び測定用機材			
D-1-01	DC モーター/DC ジェネレーター実習装置	DC モーター：DC100V、2.2kW 以上 DC ジェネレーター：DC100V、2kW 以上	1 台
D-1-02	AC モーター/DC ジェネレーター実習装置	AC モーター三相、380V、2.2kW 以上 DC ジェネレーター100V	1 台
D-1-03	シンクロナスモーター実習装置	シンクロナスモーター3 相、380V、2.2kW 以上 シンクロナスジェネレーター：3 相、380V、2.0kVA 以上	1 台
D-1-04	低電圧スイッチギア実習装置	デスクトップタイプリレーシーケンス実験機	1 台
D-1-05	基礎電気回路トレーナー	ブロックタイプ	3 台
D-1-06	アナログトレーナー（OP-AMP 実験トレーナー）	オペアンプ基礎回路 4 回路以上	3 台
D-1-07	デジタルトレーナー（理論回路トレーナー）	理論回路：AND, NOT, NAND, NOR, Exclusive OR	3 台
D-1-08	PLC トレーナー	プログラム制御コントローラー	3 台
D-1-09	漏電ブレーカー実験器	供給電圧単相 220V、漏電ブレーカー	1 台
D-1-10	周波数カウンター	周波数範囲 1mHz-2GHz	2 台
D-1-11	AC/DC 電源	AC 電源：単相 1000VA, AC1-270V、DC 電源：出力電圧 0－40V	4 台
D-1-12	はんだ及びはんだ吸い取り機	消費電力 50W 以上	5 台
D-1-13	可変抵抗器		1 台
D-1-14	可変コンデンサ		1 台
D-1-15	可変インダクタ		1 台
D-1-16	デジタルマルチメーター	標準モデル	10 台
D-1-17	オシロスコープ	バンド幅：100MHz	4 台
D-1-18	信号発生器	周波数範囲：100kHz-150MHz 以上	4 台
D-1-19	ロジックプローブ	ペン型	4 台
D-1-20	電力計	標準モデル	3 台
D-1-21	検流計	標準モデル	5 台
D-1-22	電動ハンドドリル	500W 以上	5 台
D-1-23	円形のこぎり（電動）	1kW 以上	2 台
2. カットモデル			
D-2-01	DC モーター－カットモデル	約 400W のサイズ	1 台
D-2-02	AC モーター－カットモデル	約 400W のサイズ	1 台

No.	機材名	仕様	数量
E. 給水技術			
1. 調査用機材			
E-1-01	管位置探査装置	電磁誘導式	1 台
E-1-02	漏水探知機	音響集音式	1 台
2. 水質分析用機材			
E-2	微生物分析用機材	インキュベーター、オートクレーブ	1 式
F. 訓練実習用車両			
F-1	バス	30 人乗り	1 台
F-2	ロングホイールベース 4x4 ワゴン	4x4	2 台
G. TVETC 向け機材			
1. 技能教育関連機器			
G-1-01	トータルステーション	プリズム反射板、三脚、レベルスタッフ、メジャーテープ 100m	9 式
G-1-02	デジタルプラニメーター		9 台
G-1-03	オートレベル	三脚、レベルスタッフ	9 式
G-1-04	地質コンパス（クリノメーター）	ステンレス製、ミラー、ハンドレベル付き	9 台
G-1-05	シリンダー浸潤器	ダブルリング、ハンマー	9 台
G-1-06	透水テストキット	不撹乱土壌サンプラー、サンプリングチューブ、ストップウォッチ	9 式
G-1-07	土壌色表	標準タイプ	9 台
G-1-08	ピックハンマー	スチール柄、700g 以上、皮カバー付き	9 台
G-1-09	ルーペ	鉱物観察用、フィールド用、10x 及び 20x	9 台
G-1-10	ふるい	各サイズ	9 式
G-1-11	伝導度計	土壌用	9 台
G-1-12	pH メーター	土壌用	9 台
G-1-13	現場用水質分析キット	ポータブルインキュベーター、及び色彩計、光度計 (pH, TDS, 温度, NO2, NO3, NH4, F, Mn, Fe, SO4, 硬度)	9 式
G-1-14	ハンドオーガー	土壌タイプ別各種オーガー	9 式
G-1-15	ディーゼル発電機	5kVA 以上	9 台
G-1-16	水中ポンプ	Q=20l/min, H=25m, 4"井戸用、コントロールパネル	9 式
G-1-17	陸上ポンプ（電気）	Q=30l/min, H=20m	9 台
G-1-18	アーク溶接機	300A 以上	9 台
G-1-19	陸上ポンプ（ガソリン）	汎用タイプ	9 台
G-1-20	チェーンパイプバイス	2" to 6"	9 個
G-1-21	チェーンレンチ	1" to 6"	9 個
G-1-22	パイプレンチセット	2", 2-1/2", 3"	9 式
G-1-23	ねじ切り盤	カッティング歯径: 1/2-2", 手動タイプ	9 個
G-1-24	トルクレンチセット	20-140N・m	9 個
2. 訓練実習用車両			
G-2-01	バス	30 人乗り	9 台