Ministry of Water Resources and Irrigation
The Arab Republic of Egypt

OUTLINE DESIGN STUDY REPORT
ON
THE PROJECT
FOR
ESTABLISHING THE COMPLEX OF WATER QUALITY IMPROVEMENT FOR IRRIGATION
IN
THE CENTRAL NILE DELTA
IN
THE ARAB REPUBLIC OF EGYPT

June 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

SANYU CONSULTANTS INC.

RDD
JR
10-027

PREFACE

In response to a request from the Government of the Arab Republic of Egypt, the Government of Japan decided to conduct an outline design study on the Project for Establishing the Complex of Water Quality Improvement for Irrigation in The Central Nile Delta and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Egypt a study team from September 27th, 2009 to October 27th, 2009 and from December 2nd, 2009 to January 23rd, 2010 and from March 4th, 2010 to March 13th, 2010.

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

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

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

June 2010

Motofumi KOHARA
Director General,
Rural Development Department,
Japan International Cooperation Agency

SUMMARY

(1) Outline of the Arab Republic of Egypt

The Arab Republic of Egypt (hereinafter referred to as "Egypt") is located at the northeast end of the African Continent. North of the country is the Mediterranean Sea and to the East is the Red Sea. The population was 83,000,000 in 2008 and the country's area is 995,000 km^2. 96% of the land is desert. Inhabitable and cultivatable areas are concentrated in the Nile Valley and Nile Delta areas. The Nile River flows from the south to the north. Terrace and plain of alluvial soil are formed, and out of those are vast desert.

After the incidents of September 11th, 2001 in the U.S., economical conditions of Egypt decreased due to lack of tourism revenue. Reformation for stabilizing the macro economy started in the 2000s and has gradually created the present results. Foreign currency revenue increased in late 2004 as a result of the recovery of tourism revenue, the increment of traffic through the Suez Canal, and the commencement of exporting natural gas to Europe. This prevented any devaluing of the Egyptian pound. However, Egypt has problems such as a high jobless rate (reaching nearly 10%), the latescence of the poor people, a low self-sufficient ratio for food, an underdeveloped export industry, and a trade deficit. Therefore, many challenges to be addressed remain.

(2) Background, Proceedings and Contents of the Project

In July 2009, Egypt made a request for a Program Grant Aid for Environment and Climate Change of the Project for Establishing the Complex of Water Quality Improvement for Irrigation in the Central Nile Delta (hereinafter referred to as "the Project") to the Government of Japan (hereinafter referred to as "the GOJ"). The contents of the Project are as follows:

Objective: One of the most important issues in Egypt is to meet the increasing demand of food production under the rapid population growth. Global Climate Change has been influencing the stability of discharge of the Nile River that is a main water source in Egypt, and it is an anxiety for Egypt that the countries situated in the Nile Basin may control the Nile water more tightly for irrigation in their countries in the future. It has been recognized that Egypt has to take measures for mitigation and adaptation for Climate Change (Global Warming) and urgently requires technologies to secure the supply of quality irrigation water, which includes a system of sewage water treatment and waste disposal for re-using/recycling drainage water. The Project aims at establishing a new complex system for water quality management in the rural communities. In reference to the untreated rural wastewater and pollution issues, the Project provides improvement of irrigation water quality based on the re-use policy of agricultural drainage water. The Project is to contribute to enhancing a drainage water re-using/recycling system, thereby improving the environmental conditions in the Project region.

Contents: The following are the main components of the Project requested by Egypt:

(a) Drainage water re-use system: Pump-gate facility
(b) Agricultural waste disposal system: Composting and bio-energy facility
(c) Rural wastewater treatment system: In-stream treatment facility and sewage treatment facility

Target sites: Bahr El Nour and the Kafr El Sheikh Governorate

(3) Outline of Study Results

JICA sent a study team to Egypt from September 27th, 2009 to October 27th, 2009; from December 2nd, 2009 to January 23rd, 2010; and from March 4th, 2010 to March 13th, 2010. The team held discussions with the Ministry of Water Resources and Irrigation, the Government of Egypt and other concerned parties and conducted a field study at the study area.

Water sources in Egypt depend of the Nile River thoroughly. Based on the agreement with Sudan in 1959, Egypt can use 55,500 MCM per year as a possible water source from the Nile River. The main issue of the water resources sector in Egypt is how to effectively utilize the limited water resource. The Ministry of Water Resources and Irrigation (hereinafter referred to as "MWRI") took the initiative to develop the National Water Resources Plan (hereinafter referred to as "NWRP") with the objective of describing how Egypt will safeguard its water resources in the future, both with respect to the quality and the quantity, and how it will best use these resources from both socio-economic and environmental perspectives.

The NWRP strategy is to improve the performance of the water resources system, making more water available for the various uses and also improving water quality. Under the circumstances, 11,026,000 feddan (approx. 4.52 million hectares) of land reclamation from desert areas will be developed by 2017 for irrigation, which represents an increase from the 7,985,000 feddan (approx. 3.28 million hectares) that was reclaimed in 1997, in order to increase food production. To meet the increasing demand of water by reclamation, recycling of drainage water has been considered as a great opportunity for obtaining additional water sources.

The project site is in the Bahr El Nour area and its neighbor in the Kafr El Sheikh Governorate. The Kafr El Sheikh governorate is located at the north coast area in the Nile delta, and its population had approx. 2,739,000 inhabitants in 2009. The main industry is agriculture, including cotton-processing factories, rice and fishing, with 30 % of the rice in Egypt being produced in this governorate. The Bahr El Nour area is located beside Biyala city, about 30km northeast of Kafr El Seikh City, the capital of the Governorate. The Bahr El Nour area surrounding the main drainage canal No.4 (hereinafter referred to as "Drain No.4") and the Biyala drainage canal (hereinafter referred to as "Biyala drain") is in an agricultural zone and has an irrigation area of 4,200 feddan (approx. 1,720 hectares). Its main products are rice, wheat, pasture grass, beat, and cotton.

The Water Management Improvement Project (WMIP) was conducted in the Bahr El Nour area by the Japan Technical Cooperation Project from 2000 to 2007. The Water Users Associations was established in each Mesqa and an irrigation system was organized by pipelines and irrigation pumps set along the Bahr El Nour irrigation canal. The Second Phase of WMIP (WMIP-2) is ongoing at present (June 2008 - March 2012), with the support of the capacity development for Branch Canal Water Users Association. There are three villages along the Bahr El Nour irrigation canal and the Biyala drain. These three villages have about ninety households in total.

According to the site reconnaissance during October - December 2009 (when the Nile River is in its low discharge season) by the Study Team of the Project, the Bahr El Nour irrigation canal may be polluted by inflowing domestic wastewater from villages along the canals. The Biyala drain is also polluted by inflowing domestic wastewater from Biyala city upstream. These water quality issues may not be fit, according to the domestic law on water quality (Law-48 regarding the Protection of the Nile River and Waterways from Pollution, refer to Appendix 13), to utilize as irrigation water. On the other hand, households in the villages have a septic tank for treating domestic wastewater but almost all septic tanks are not functional. There domestic wastewater flows into irrigation canals directly. In addition to this, agricultural waste disposal stored along the canals in every place drops into the canals. This may cause pollution of the canals.

The Study Team collected water quality data around the Project site. One of data results is from the Bahr Tera main irrigation canal and Gharbia main drain canal in 2007. The following table shows the comparison to DLWQ, Article 65 which gives the standards of drainage water re-use as follows:

Comparison between Water Quality in Main Canal and Law-48

Parameters	Law -48 Article 65	Bahr Tera 2007 (Average)	Gharbia Drain 2007 (Average)	Standard of Water Quality for Agriculture in
Absorbed biotic oxygen	≦10	**20**	**25**	
Chemically consumed oxygen	≦15	**26**	**31**	
Dissolved oxygen	＞5	**3.07**	**1.49**	≧5
Hydrogen exponent	7～8.5	7.37	7.30	6～7.5
Total solid substances	≦500	476	**881**	≦100
Nitrates	≦45	3.04	4.58	
Ammonia	≦0.05	**0.92**	**1.40**	
Copper	＜1	0.03	0.09	
Iron	＜1	0.79	0.87	
Manganese	＜1.5	0.15	0.61	
Zinc	≦1	0.02	0.02	≦0.5
T-N	-	3.99	6.00	≦1

Note; Law-48 Article 65 shows standard of drainage re-use water quality in Egypt

The table above shows that the water quality values of BOD, COD, DO and NH3 at the main canals are above DLWQ, Article 65. TDS in the irrigation canal is below the standards, but the drain canal is above. The heavy metals, such as Cu, Fe, Mn, and Zn, are below DLWQ, Article 65.

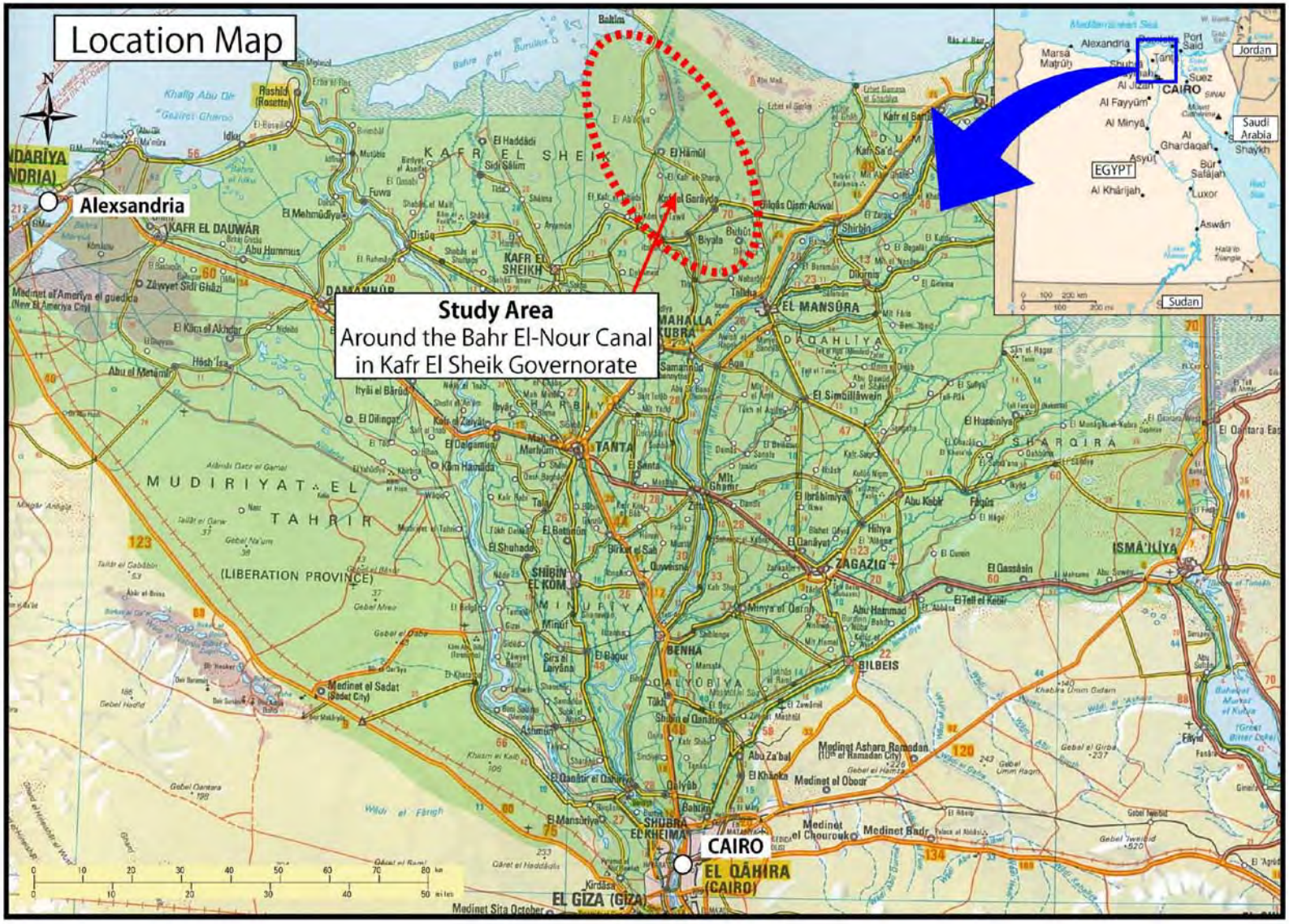
The following points became clear through the field survey:

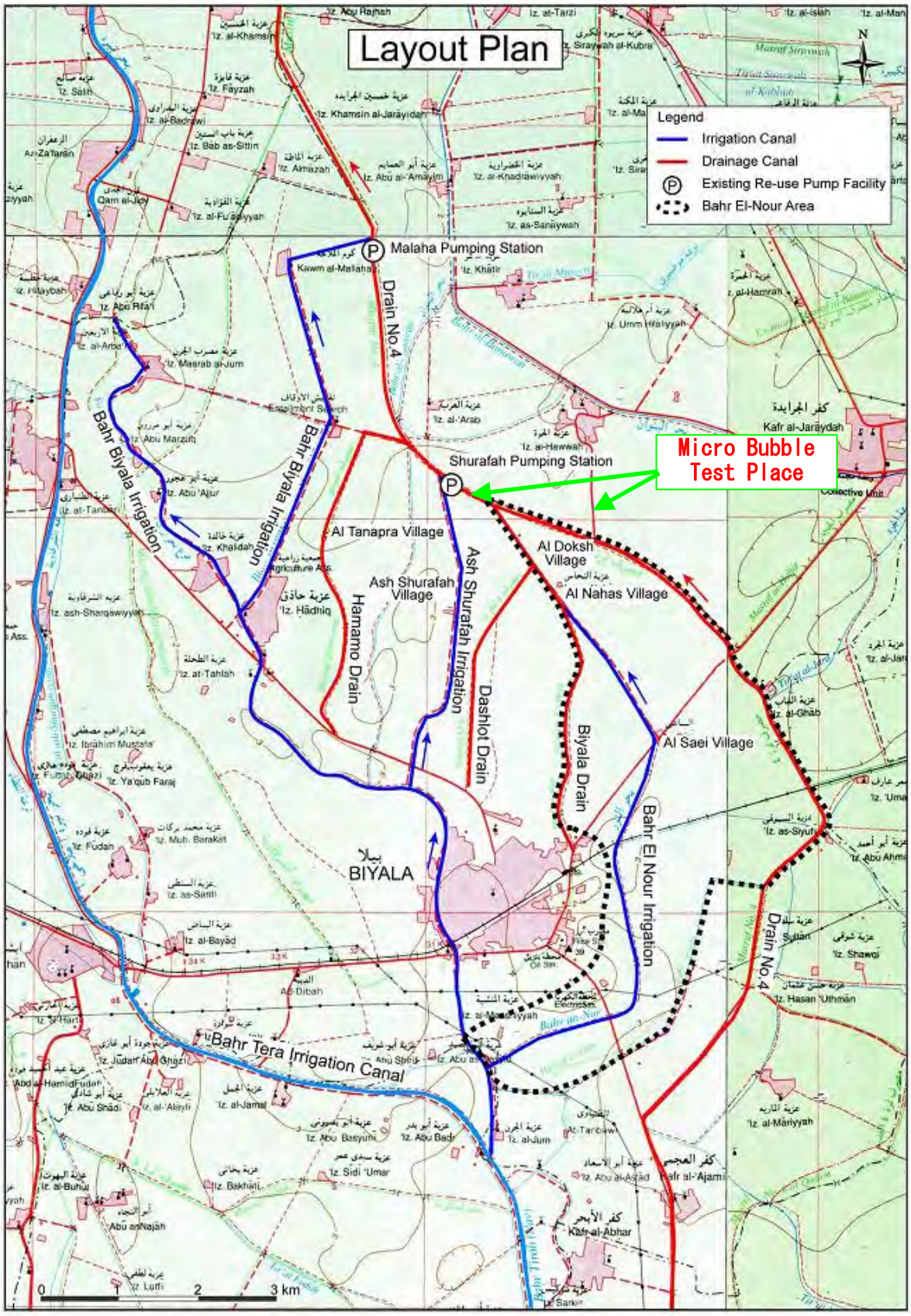
- Drainage water re-use is an effective measure from the water resources point of view in Egypt, where water resources are limited. However, the water quality of the canals in the Nile delta is totally polluted. Improvement of water quality in drainage canals is essential in order to secure water resources effectively. The contents of the Project coincide with this purpose.
- The purpose of an in-stream treatment facility, one of the proposed systems, is to purify the drainage water, an important pre-requisite for re-using the drainage water. A drainage water re-use facility is also essential for securing irrigation water.
- With respect to the pump-type for drainage water re-use facility, the Egyptian pump is enough to use from the O&M point of view. It is unnecessary to use a pump-gate type, which is proposed.
- Because of the pollution of the irrigation canal presently, it is essential to implement a sewage treatment facility and composting facility for improving the water quality of the irrigation canal. On the other hand, the bio-energy for the composting facility is premature to plan in the project.
- With respect to implementation agencies, obtaining lands and the O&M system for the facility were not confirmed during the Filed Survey-1 and need more study. It is especially necessary for the O&M system of the sewage treatment facility and composting facility to enlighten the beneficiary and to establish the O&M system.

For the implementation of this project, it is important to choose the target area. Also there are many challenges to be addressed, such as: analyzing the water's quality in the dry season, addressing water quality improvement in the target area, conforming to a sewage improvement plan, and establishing an O&M system for the project facilities, as well as other issues.

CONTENTS

[Appendices]


Location Map
Alexsandria
Study Area
Around the Bahr El-Nour Canal
in Kafr El Sheik Governorate
CAIRO
EL QÂHIRA
(CAIRO)
EGYPT
Jordan
Saudi
Arabia
Sudan
Alexandria
Port
Said
Suez
Al Fayyûm
Al Minyâ
Asyût
Al Khârijah
Luxor
Aswân
KAFR EL SHEIK
KAFR EL DAUWÂR
EL MANSÛRA
DAQAHLÎYA
SHARQIRA
TANTA
MUDIRIYAT EL TAHRIR
(LIBERATION PROVINCE)
MINUFIYA
ZAGAZIG
ISMÂ'ILÎYA
BILBEIS
BENHA
QALYÛBIYA
SHUBRA
EL KHEIMA
EL GIZA (GIZA)
Rashîd
(Rosetta)
Idkû
Abu Hummus
Damanhûr
Shibîn
El Kôm
Medinet el Sadat
(Sadat City)
Medinet Ashara Ramadan
(Medinet el Ramadan City)
Medinet el Obour
Medinet
el Chourouk
Medinet Badr
Medinet Sitta October


Layout Plan
Legend
Irrigation Canal
Drainage Canal
Existing Re-use Pump Facility
Bahr El-Nour Area
Malaha Pumping Station
Shurafah Pumping Station
Micro Bubble Test Place
Drain No.4
Bahr Biyala Irrigation
Al Tanapra Village
Ash Shurafah Village
Hamamo Drain
Ash Shurafah Irrigation
Dashlot Drain
Al Doksh Village
Al Nahas Village
Biyala Drain
Al Saei Village
Bahr El Nour Irrigation
BIYALA
Bahr Tera Irrigation Canal
Kafr al-Jaraydah
Kafr al-Ajami
Kafr al-Abhar
0
1
2
3 km

LIST OF FIGURES AND TABLES

List of Figures

List of Tables

ABBREVIATIONS

AES	: Agriculture Extension Sector
BOD	: Biochemical Oxygen Demand
CFU	: Colony Forming Unit
COD	: Chemical Oxygen Demand
CODcr	: Chemical Oxygen Demand (Chromium)
CODmn	: Chemical Oxygen Demand (Manganese)
CO_2	: Carbon Dioxide
Cu	: Copper
DLWQ	: Domestic Law on Water Quality
DO	: Dissolved Oxygen
EC	: Electric Conductivity
ECRI	: Environment and Climate Research Institute
EEAA	:
EIA	: Environmental Impact Assessment
EPADP	: Egyptian Public Authority for Drainage Project
F	: Fluorine
GET	: Growth Effectiveness Test
GOJ	: Government of Japan
HCWW	: Holding Company for Water & Wastewater
ID	: Irrigation Department in MWRI
IS	: Irrigation Sector
JARUS	: Japan Association of Rural Resource Recycling Solutions
JICA	: Japan International Cooperation Agency
JPY	: Japanese Yen
kW	: Kilo watt
LE	: Egyptian pound
MALR	: Ministry of Agriculture and Land Reclamation
MBD	: Micro Bubble Device
MCM	: Million cubic meters
m^3/day	: Cubic meters per day
MED	: Mechanical and Electrical Department in MWRI
m^3/s	: Cubic meters per second
mg/l	: Milligrams per liter
Mn	: Manganese
MWRI	: Ministry of Water Resources and Irrigation
mV	: mill-volts
N_2	: Nitrogen
NH_3	: Ammonium
NH_3-N, NH_4-N	: Ammonia Nitrogen
NO_2	: Nitrous Acid
NO_2-N	: Nitrite Nitrogen

NO_3	: Nitric Acid
NO_3-N	: Nitrate Nitrogen
NWRP	: National Water Resources Plan
O&M	: Operation and Maintenance
O/D	: Outline Design
ORP	: Oxidation Reduction Potential
pH	: Hydrogen Ion Exponent
SAR	: Sodium Adsorption Ratio
SPAD	: Soil & Plant Analyzer Development
SS	: Suspended Solids
TDS	* Total Dissolved Solid
T-N	: Total Nitrogen
TOC	: Total Organic Carbon
WMIP	: Water Management Improvement Project
WQU	: Water Quality Unit in MWRI
WUA(s)	: Water Users Association(s)
Zn	: Zinc
μS/cm	: Micro Siemens per centimeter

Currency

J. Yen	Japanese Yen
USD	US Dollar
EGP	Egypt Pond

Exchange Rate (October 2009)

USD= 89.98 J.Yen EGP= 16.492 J. Yen

CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1-1 Object of the Study

In July 2009, the Government of the Arab Republic of Egypt (hereinafter referred to as “Egypt”) made a request for a Program Grant Aid for Environment and Climate Change of the Project for Establishing the Complex of Water Quality Improvement for Irrigation in the Central Nile Delta (hereinafter referred to as “the Project”) to the Government of Japan (hereinafter referred to as “the GOJ”). The contents of the Project are as follows;

Objective: One of the most important issues in Egypt is to meet the increasing demand of food production under the rapid population growth. Global Climate Change has been influencing the stability of discharge of the Nile River that is a main water source in Egypt and it is an anxiety for Egypt that the countries situated in the Nile Basin may control the Nile water more tightly for irrigation in their countries in the future. It has been recognized that Egypt has to take measures for mitigation and adaptation for Climate Change (Global Warming) and urgently requires technologies to secure the supply of quality irrigation water, which includes a system of sewage water treatment and waste disposal for re-using/recycling drainage water. The Project aims at establishing a new complex system for water quality management in the rural communities. In reference to the untreated rural wastewater and pollution issues, the Project provides improvement of irrigation water quality based on the re-use policy of agricultural drainage water. The Project is to contribute to enhancing a drainage water re-using/recycling system, thereby improving the environmental conditions in the Project region.

Contents: The followings are the main components of the Project requested by Egypt;

(a) Drainage water re-use system: Pump-gate facility
(b) Agricultural waste disposal system: Composting and bio-energy facility
(c) Rural wastewater treatment system: In-stream treatment facility and sewage treatment facility

Target sites: Bahr El Nour in Kafr El Sheikh governorate

1-2 Present Condition and Issues of Water Resources Sector

Water sources in Egypt depend of the Nile River thoroughly. Based on the agreement with Sudan in 1959, Egypt can use 55,500 MCM per year as the possible water source from the Nile River. The main issue of the water resources sector in Egypt is how to utilize effectively the limited water resource.

The Ministry of Water Resources and Irrigation (MWRI) took the initiative to develop the

National Water Resources Plan (NWRP) with the objective of describing how Egypt will safeguard its water resources in the future, both with respect to the quality and the quantity, and how it will best use these resources from both socio-economic and environmental perspectives. The NWRP strategy is to improve the performance of the water resources system, making more water available for the various uses and also improving water quality. Under the circumstances, 11,026,000 feddan (approx. 4.52millom hectors) of land reclamation from desert areas will be developed by 2017 for irrigation, which represents an increase from the 7,985,000 feddan (approx. 3.28millom hectors) that was reclaimed in 1997, in order to increase food production. To meet the increasing demand of water by reclamation, recycling of drainage water has been considered as a great opportunity for obtaining additional water sources. Recycling of the drainage water in the NWRP was planned as shown in Table 1-1below:

Table 1-1 Recycling Plan of Drainage Water in NWRP (until 2017)

Area	in 1997 (MCM/year)	In 2017 (MCM/year)	Increasing (MCM/year)	2017／1997 (%)
East-Delta	1,774	3,639	1,865	205%
Central -Delta	808	3,159	2,351	391%
West-Delta	637	1.670	1,033	262%
Fayoum	241	396	155	164%
Total	3,460	8,864	5,404	256%

Based on the NWRP, the water resources sector made a plan in the 6th Social-Economic Development Plan (August 2007 – December 2011) that a farmland of 9,250,000 feddan (approx. 3.8 million hectors) is planned to be developed. Commencing with the development of the north Sinai project, the water resources sector has a plan to improve drainage canal networks of 1,560,000 feddan (approx. 64 million hectors).

1-3 Project Site

1-3-1 Outline of the Site

The project site is at Bahr El Nour area and its neighboring in Kafr El Sheikh governorate.

The Kafr El Sheikh governorate is located at the north coast area in the Nile delta, and its population had approx. 2,739,000 inhabitants (2009). The main industry is agriculture, including cotton-processing factories, rice and fishing, with 30 % of the rice in Egypt being produced in this governorate.

The Bahr El Nour area is located beside Biyala city, about 30km northeast of Kafr El Seikh City, the capital of the Governorate. The Bahr El Nour area surrounding main drainage canal No.4 (Drain No.4) and the Biyala drainage canal (Biyala drain) is an agricultural zone and has an irrigation area of 4,200 feddan (approx. 1,720 hectors). Main productions are rice, wheat, pasture grass, beat, and cotton.

Irrigation facilities in the Bahr El Nour area are the Bahr El Nour irrigation canal located in the center of the area, Drain No.4 on the east side and the Biyala drain on the west side. The Bahr El Nour irrigation canal, the secondary irrigation canal, branches off of the Bahr Biyala branch irrigation canal, which branches off of the Bahr Tera main irrigation canal south of Biyala city. The Bahr El Nour area is irrigated by end canals (Mesqa) with water pumped up from the Bahr El Nour irrigation canal. The end of the Bahr El Nour irrigation canal banks off and connects with Mesqa by gravity and with the Biyala drain by an overflow pipe. The Biyala drain flows, taking in domestic wastewater of Biyala city at the upstream and taking in over flow water of the Bahr El Nour irrigation canal at the middle-stream, flowing together with the Dashlot drain at the downstream and flowing into Drain No.4 at the end. There are 2 existing drainage water re-use pumping stations west of the area and along Drain No.4. One is the Shurafah re-use pumping station providing water for the Ash Shurafah irrigation canal and the other is the Malaha re-use pumping station providing water for the Bahr Biyala irrigation canal. There are 3 villages along the Bahr El Nour irrigation canal and the Biyala drain. These 3 villages have about 90 households in total. (Refer to “Layout Plan” on the first page).

The Water Management Improvement Project (WMIP) was conducted in the Bahr El Nour area by the Japan Technical Cooperation Project from 2000 to 2007. The Water Users Associations (WUA) was established in each Mesqa and an irrigation system was organized by pipelines and irrigation pumps set along the Bahr El Nour irrigation canal. The Second Phase of WMIP (WMIP-2) is ongoing at present (June 2008 - March 2012), with the support of the capacity development for Branch Canal Water Users Association.

1-3-2 Water Quality

According to the site reconnaissance during October - December 2009 (the Nile River is in low discharge season) by the Study Team of the Project, the Bahr El Nour irrigation canal may be polluted by inflowing domestic wastewater from villages along the canals. The Biyala drain is also polluted by inflowing domestic wastewater from Biyala city upstream. These water quality issues may not be fit, according to the domestic law on water quality (Law-48 regarding the Protection of the Nile River and Waterways from Pollution, refer to Appendix 13), to utilize as irrigation water. On the other hand, households in the villages have a septic tank for treating domestic wastewater but almost all septic tanks are not functional. There domestic wastewater flows into irrigation canals directly. In addition to this, agricultural waste disposal storing along the canals in every place drops into canals. This may cause pollution of the canals.

Then, water quality on the Project site was tested at the laboratory by a sub-contractor and by the potable test kit of the Study Team. Detailed data from the laboratory test is shown in Appendix-8, and the water quality at the Project site is summarized as follows:

(1) Main Canals around the Project Site

The Study Team collected water quality data around the Project site. One of data results is from

the Bahr Tera main irrigation canal and Gharbia main drain canal in 2007. Table 1-2 shows the comparison to DLWQ, Article 65 which gives the standards of drainage water re-use as follows:

Table 1-2 Comparison between Water Quality in Main Canal and Law-48

Parameters	Law -48 Article 65	Bahr Tera 2007 (Average)	Gharbia Drain 2007 (Average)	Standard of Water Quality for Agriculture in
Absorbed biotic oxygen	≦10	**20**	**25**	
Chemically consumed oxygen	≦15	**26**	**31**	
Dissolved oxygen	＞5	**3.07**	**1.49**	≧5
Hydrogen exponent	7～8.5	7.37	7.30	6～7.5
Total solid substances	≦500	476	**881**	≦100
Nitrates	≦45	3.04	4.58	
Ammonia	≦0.05	**0.92**	**1.40**	
Copper	＜1	0.03	0.09	
Iron	＜1	0.79	0.87	
Manganese	＜1.5	0.15	0.61	
Zinc	≦1	0.02	0.02	≦0.5
T-N	-	3.99	6.00	≦1

Note; Law-48 Article 65 shows standard of drainage re-use water quality in Egypt

The table above shows that the water quality values of BOD, COD, DO and NH_3 at the main canals are above DLWQ, Article 65. TDS in the irrigation canal is below the standards but the drain canal is above. The heavy metals, such as Cu, F, Mn, and Zn, are below DLWQ, Article 65. Theses parameters are changing by season.

(2) Canals in the Project Site

The water quality of irrigation and drainage canals in the project site were tested in the Field Survey-1 (September - October, 2009) and detail of its result is shown in Appendix-8. On the other hands, the test result by the potable test kit of the Study Team is shown in the table below.

Table 1-3 Water Quality Test Result

No.	Canal	Village	Point	Pack Test COD mg/L	Pack Test NH4-N mg/L	Pack Test Cl mg/L	Pack Test pH	Water Quality Meter pH	Water Quality Meter DO mg/L	Water Quality Meter EC S/m	Water Quality Meter TURB NTU	Water Quality Meter TEMP ℃
①	Bahr El Nour Canal	Al Saei	Bridge	12	0.8	≦200		7.7	4.34	0.039	21.6	25.6
②	Bahr El Nour Canal	Al Saei	Ditch	90	≧10							
③	Bahr El Nour Drain	Al Nahas	Drain	70	0.7	210	7.5					
④	Drain No.4 (Main Drain)		Shurafah Pump	30	8	270	7.5	7.5	0.02	0.152	44.1	25.2
⑤	Drain from Biyala		Drain	30	3	≦200	7.5					
⑥	Irrigation Canal to Drain No.4	Al Tanapra	Canal	12	0.8	≦200	7.5					
⑦	Irrigation Canal to Drain No.4	Ash Shurafah	Canal	18	0.7	≦200	7.5					
⑧	Intake of Bahr El Nour Canal		Gate	4	0.3	≦200	7.5					
⑨	Branch Canal to Bahr El Nour Drain		Irrigation	18	0.2	270	7.5					
⑩	Branch Canal to Bahr El Nour Drain		Drain	13	0.2	250	7.5					
⑪	Drain No.4 (Main Drain)		Shurafah Pump					7.44	0.03	0.127	41.8	25.5
⑫	Drain No.4 (Main Drain)		Nahas Bridge					7.47	0.18	0.116	35.8	26.2
Standard of Water Quality for Paddy Field				6	(0.5)	(250)	6～7.5	6～7.5	5	0.03	–	–
Law 48 for the year 1982				6	–	–	7～8.5	7～8.5	5	–	–	5℃

Note; COD: COD (Mn)

Lines highlighted by color in Table 1-3 show the irrigation canal, while the others are drainage canals. Point ② in the table is the small canal around Al Saei village. Point ④ and ⑪ are the same place but measured on different dates.

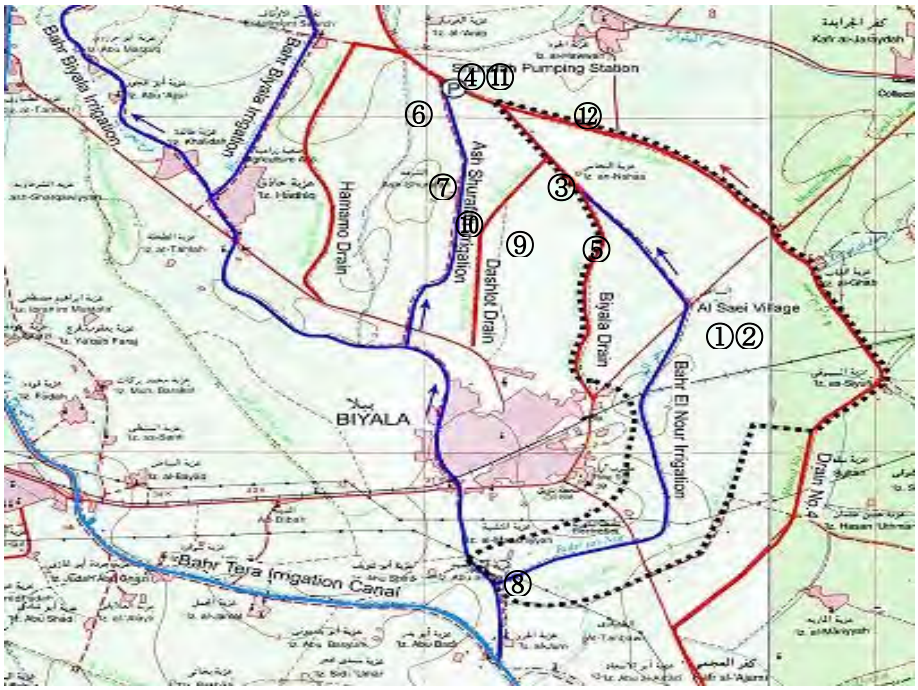


Figure 1-1 Location of Water Quality Teat Points

The heavy metals of the water quality result at the canals in the Project site are the same result as the sub-section “Main Canals around the Project Site” above and are below the DLWQ Article 65. Other parameters, such as, COD, DO, and one of BOD are above the DLWQ, Article 65.

(3) Quality of the Domestic Wastewater from Villages

Quality of the domestic wastewater flowing from four villages was tested by the sub-contractor during 1 week. The results are shown in the table below and details are shown in Appendix-8.

Table1-4 Quality of Domestic Water from the Villages

Parameters	Al Saei	El Nahas	Al Doksh	Al Shurafah
SS(mg/l)	966～5,266	1,206～4,159	615～6,146	401～6,457
T-N(mg/l)	16.8～39.2	9.8～98	2.8～154	2.8～57.4
T-P(mg/l)	0.5～1.8	0.6～2.1	0.2～2.6	0.08～1.9
TOC(mg/l)	39.25～225.01	29.47～184.61	2.42～376.11	5.42～369.81
COD(mg/l)	319～2,197	247～2,301	32～2,306	40～2,188
BOD(mg/l)	100～1,200	60～1,300	4～1,300	18～1,100
Coliform CFU/100ml	8.0E＋04 ～1.13E+08	1.05E+04 ～9.00E+07	1.60E+04 ～1.40E+08	2.20E+01 ～5.00E+07
EC(ms)	1.38～2.06	0.99～3.25	0.66～4.21	0.6～2.16
pH	6.93～7.5	7.0～7.84	7.43～8.26	7.1～8.8
DO(mg/l)	0.09～0.90	0.1～4.5	0.3～3.2	0.1～2.6
Temp(℃)	20.5～28.6	21.0～30.3	21.3～29.3	21.8～29.1
Salinity(g/l)	0.6～1.0	0.4～1.1	0.2～2.2	0.2～1.1

It was confirmed that water quality widely varied daily and temporally among villages. As the domestic wastewater is kept in the box at the outlet of the septic tank, it is changing according to depositing time and at the time to be flowed out. It cannot find a common trend of weekly or timely variation.

(4) Issue of Present Water Quality

Water quality data obtained in the Field Survey-1 include that of a whole season at the main canals around the Project site, and test results in October and in December (refer to Appendix-8) are actual ones.

The water quality at the Project site summarized that parameters and figures shown in the table below are issues of the Project. However, discharge of the Nile River in October and December is about 40 ~ 60% of that in May - August, which is the largest discharge season of the Nile River.

Table 1-5 Issue Parameters of Water Quality

Canal	BOD	CODcr	CODmn	DO	T-N
Main Drain near Site	11～40	14～46	－	0.70～2.80	3.68～7.55
Main Irrigation near Site	11～31	13～43	－	1.40～5.62	1.09～6.55
Drain in the Site	11～40	12～58	13～70	0.03～1.8	3.68～19.6
Irrigation in the Site	12～80	20～87	12～18	0.07～3.5	4.2～9.8

1-4 Organization of Implementation Agency

Agencies related to the Project are the Ministry of Water Resources and Irrigation (MWRI) in Cairo and the Kafr El Sheikh Central Directorate in the Kafr El Sheikh Governorate which has jurisdiction over the project site.

Table 1 -6 Department of MWRI in Cairo

Department	Main Duty
Irrigation Department（ID）	Presiding over all departments in the MWRI. The Vice Minister is the head of the department.
Egyption Public Authority for Drainage Projects （EPADP）	Organization of constructing and maintaining drainage canals. Responsibility of implementation agency for in-stream treatment facility and proposed structures inside canals Monitoring and publishing discharge and water quality of drainage canals in the country by DRI*
Central Department for Irrigation Advisory Services（CDIAS）	Organizing and guiding WUAs. Counterpart of WMIP-2 and also coordinating WUAs.
Water Quality Unit （WQU）	Dealing with water quality in MWRI and coordinating other donor projects related to water quality. Implemented a pilot project of sewage treatment facility (CLEM* analysis of water quality) in the country.
Planning sector（PS）	Coordinating plans in the MWR and donors.
Mechanical and Electrical Department（MED）	Operating and maintaining pumps in the main irrigation canals.

Table 1 -7 Kafr El Sheikh Governorate

Department	Main Duty
Under MWRI	
Under Secretary of States （USOS）	Branch office of USOS directly under control of Vice Minister. Presiding over all departments of MWRI in Kafr El Sheikh
Irrigation Sector（IS）	There are 2 departments, East Kafr El Shikh IS and West Kafr El Shikh IS. The Bahr El Nour area belongs to East Kafr Ek Shikh IS. Operating and maintaining existing re-use pumps (Shrafa PS, Malaha PS) in East Kafr Ek Shikh IS
Central Department for Irrigation Advisory Services （CDIAS）	There is a branch office of Central Delta in Kafr El Sheikh. Counterpart of WMIP-2.
Drainage Sector (DS)	There are 2 departments, East Kafr El Shikh DS and West Kafr El Shikh DS. The Bahr El Nour area belongs to East Kafr Ek Shikh DS. Operation and maintenance of in-stream treatment facility will be done by East Kafr Ek Shikh DS.
Mechanical and Electrical Department（MED）	Operating and maintaining pumps in main irrigation and drainage canals.
Local Council	
Kafr El Sheikh Governorate	Presiding over all cities and towns including Biyala city in the governorate.
Biyala City（City Council）	Will be an owner of public land proposing the sewage treatment facility and the composting facility.
Community Organizations	
Water Users Association （WUA）	Operating and maintaining re-use pumps of Mesqa in the project site.

＊ CLEM: Central Laboratory for Environmental Quality Monitoring (National Water Research Center) , DRI: Drain Research Institute,

Organization chart of MWRI is shown in below;

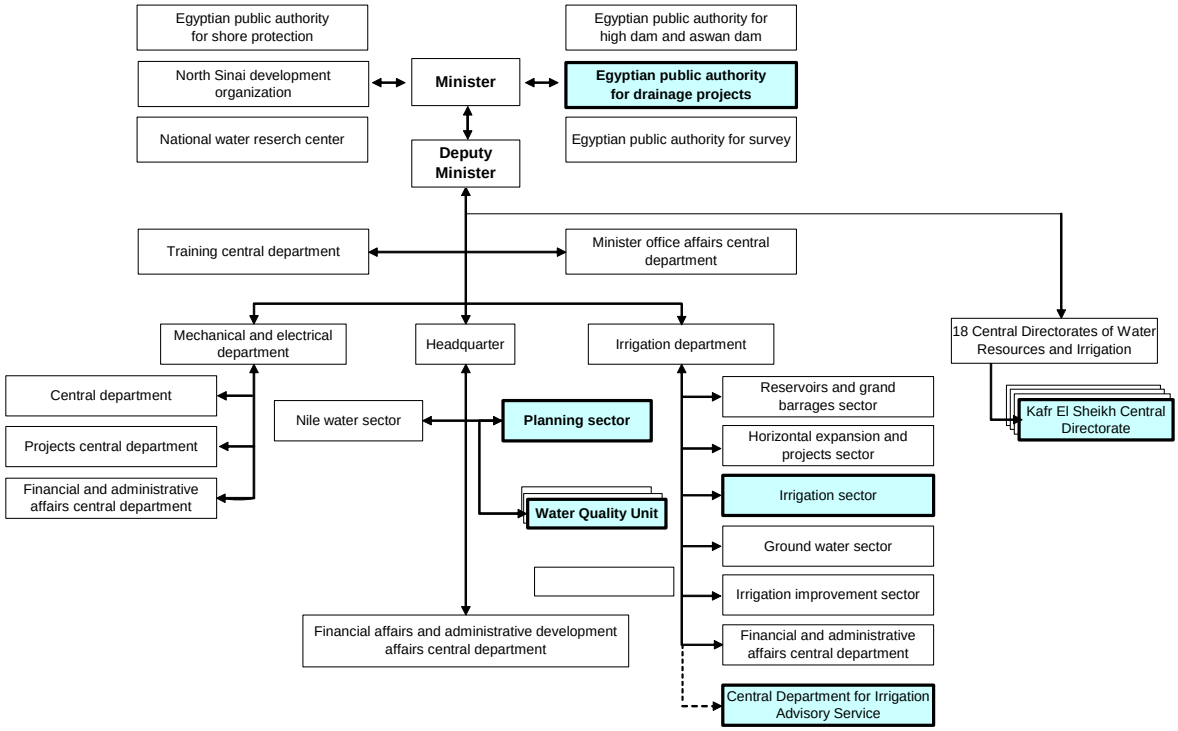


Figure 1-2 Organization Chart of MWRI

1-5 Other Donors

1-5-1 Bahr El Nour and its vicinity

There are no donors working in the Bahr El Nour area and its vicinity. The GOJ has the project WMIP-2.

1-5-2 Similar Project

The Water Quality Unit (WQU) had a pilot project of rural sewage treatment facility in the Fayoum Governorate donated by the Netherlands. The objective of the project contributes to the improvement of drainage water quality under a low cost of operation and maintenance (O&M) in a rural area.

The rural sewage treatment facility of anaerobic baffled reactor system was constructed to service a population of 2000 inhabitants (200 households). Enlightenment activity to the beneficiary was started in 2004 and the beneficiary presented land for the treatment facility after discussions among the Local Council, the Fayoum Governorate and the Water Board. Operation of the facility was started in June 2007. The facility was transferred to the Local Council in December 2008 under the

Agreement among the MWRI, the Local Council, and the Water Board of the Governorate. The Local Council has property rights over the facility and collected a sewage charge from the beneficiary. The Local Council operates and maintains the facility at present. O&M cost (electricity, salary for two operators: LE.200 each) is approx. LE.500 per month. The sewage charge per household per month is LE 10 which is cheaper than one by honey wagon.

The Study Team investigated the facility during the Field Survey-1 and confirmed that the capacity of the facility might be insufficient against the service population. The duty of the WQU in MWRI is to present the pilot project of the rural sewage treatment system to the Holding Company of Water and Wastewater (HCWW) under the Ministry of Housing or the Local Council.

CHAPTER 2 RESULT OF FIELD SURVEY

CHAPTER 2 RESULT OF FIELD SURVEY

2-1 Field Survey Plan

2-1-1 Objective of Field Survey

The Project is to study the validity of the Japanese Grant Aid Program for Environment and Climate Change (Water related Technology) for "Establishing the Complex of Water Quality Improvement for Irrigation in the Central Nile Delta" as requested by the Ministry of Water Resources and Irrigation (MWRI), Egypt. The Project aims to establish a new complex system for water quality management in the rural areas. In reference to the untreated rural wastewater and pollution issues, the Project provides improvement of irrigation water quality based on the re-use policy of agricultural drainage water. The Project is to contribute to enhancing a drainage water re-using/recycling system, thereby improving the environmental conditions in the Project region.

The following are the main components of the Project requested by Egypt:

(a) Drainage water re-use system: Pump-gate facility,
(b) Agricultural waste disposal system: Composting and bio-energy facility, and
(c) Rural wastewater treatment system: In-stream treatment facility and sewage treatment facility.

The environmental improvement interventions are formulated and presented in terms of an in-stream treatment system, rural wastewater treatment technologies, and agricultural waste disposal management. It is requested to introduce Japanese technologies to establish the complex as mitigation measures to reduce the impact of pollution sources and secure the quality of re-used water for irrigation. The complex can serve as a showcase of a rural resource recycling system for irrigation water as well as to improve the living environmental condition of the villages.

2-1-2 Survey Plan

The field survey was planned to be divided into 2 phases. The Field Survey-1 is to start at the end of September 2009 to conduct a basis survey and collect data, and the result of the Field Survey-1 is analyzed in Japan. Then, the Field Survey-2 is to start from the beginning of December 2009 to design facilities, estimate the project implementation cost and prepare the tender documents for implementation.

2-1-3 Modification of Survey Plan

The Field Survey-1 was carried out from September 29 to October 27, 2009. The Study Team investigated the Project site and discussed the plan with MWRI, the implementation agency of the Project. The following points were confirmed at the meeting between the two parties on October 20, 2009 (refer to Appendix-4);

(a) Drainage water re-use system:
- Drainage water re-use facility is necessary but a normal kind of pump is enough depending on result of survey and condition,

(b) Agricultural waste disposal system:
- Composting facility is necessary and is made by a concrete slab and walls, and
- Bio-energy facility is not appropriate because it is not sustainable economically at present,

(c) Rural wastewater treatment system:
- Membrane method proposed by Egypt's side is so expensive and not applicable for rural wastewater treatment system,
- Micro Bubble Device is applicable as an in-stream treatment facility, but there are still unknown points to use in the field, and
- Sewage treatment facility is necessary but it needs more survey from the operation and maintenance point of view.

Under these situations it was planned to conduct a field test of the Micro Bubble Device (MBD) as an additional field survey before commencement of the Field Survey-2. The Additional Field Survey was started from December 2009 to March 2010. The Additional Field Survey aims to monitor the improvement of water quality by MBD and to confirm the effectiveness for crops by improved water of MBD.

2-2 Result of Field Survey-1

2-2-1 Validity of In-Stream Treatment Facility

(1) Water Quality and Quantity

Table 2-2-1 shows the comparison between the water quality of drainage canals in the Project site at present and domestic law on water quality (DLWQ) of re-use water (DLWQ, Article 65).

Water quality of drainage canals in the Project site is so much worse when compared with the DLWQ. DLWQ shall be the target value for designing facilities, but it is supposed to be

expensive to maintain DLWQ' value. However, the design value of the in-stream treatment facility shall comply with DLWQ.

Table 2-2-1 Water Quality at Present and DLWQ

Canal Name	BOD	CODcr	CODmn	DO	T-N
Drain No.4	11～40	12～62	30	0.03～1.80	3.68～21
Biyala Drain	14～20	49～55	30～70	0.19～0.97	5.6～19.6
National Standards	≦10mg/l	≦15mg/l	≦6mg/l	≧5mg/l	≦1mg/l

The table below shows the estimated flow of drainage canal in the Project site.

Table 2-2-2 Discharge Drainage Canal

Location	Drain No.4 (Shurafah)	Drain No.4 (Mahala)	Biyala Drain
Station	Sta. 17.0km	Sta. 15.0km	Near Al Nahas Village
Flow	6.8 m^3/s	12.2 m^3/s	0.75～2.25 m^3/s

It needs a design flow, a target water quality and a present water quality of the proposed canals to study and design the in-stream treatment facility. However, water quality at present was measured in October and December, that season of the flow which is low in the Nile River compared with that of May to September. The design value of the present water quality and flow shall be studied based on the full data from the year.

(2) Treatment Method

As mentioned in "Appendix-6, the Study of the Rural Wastewater Treatment System", MBD is more recommendable compared to the aeration method of the in-stream treatment facility as the main system for ease of operation and maintenance. In addition to this, use of aquatic plant or attached growth treatment process by gravels is planned as a supplementary measure.

(3) Improvement of Water Quality

There is much refuse dumping and domestic wastewater flowing into the Biyala drain. It is necessary to improve the water quality of the Biyala drain in light of this refuse dumping, to treat domestic wastewater in Biyala city and to clean the canal regularly, such as removing the water hyacinth and dredging up sludge from the bottom of the Biyala drain.

The flow velocity of Drain No.4 was very slow during the Field Ssurvey-1 period and the self-purification capacity of Drain No.4 may be dropping because the DO value in Drain No.4 was very low. It is considered that Drain No4 will be improved to increase the DO value over the long term by the in-stream treatment system (such as MBD), and then it may recover its self-purification capacity. Values of other parameters of the COD, T-N and SS also may be improved by increasing the DO value.

(4) Procuring of Lands for Facilities

It is very difficult to procure private lands for proposed facilities in Egypt. However, it may be possible to procure lands inside the Drain No.4 where MWRI property exists and also where the necessary capacity of flow for Drain No.4 can be maintained and the bank can be protected by using blocks since the bank slope of Drain No.4 was fragile.

(5) Power Source

A solar panel option is being studied to be considered for the power source of the in-stream treatment facility.

Solar panels may be more effective in Egypt than in Japan because of amount of insolation and good power generation efficiency. It is considered that the solar panel has the effect of contributing to the prevention of global warming and to the deduction of the O&M cost.

However, there is much dust in Egypt, and this causes deterioration of solar panel capacity when lacking maintenance. Therefore, it is necessary to create an organization and to be trained in the O&M system during the implementation phase.

(6) Facility Plan for Drain No.4

As shown in Table 2-2-1, the water quality of Drain No.4 is 12 – 62 mg/l of CODcr value and 0.03 - 1.80 mg/l of DO value. There are two existing drainage water re-use pumping stations along Darin No.4 near the Project site, and drainage water is utilized by these pumps during irrigation season and non-irrigation season when it is necessary. Then, it is useful to plan an in-stream treatment facility for improving water quality of Drain No.4 in order to utilize these existing re-use pumps.

Self-purification in Drain No.4 may be difficult, as mentioned above, because of a gradual longitudinal slope, slow velocity and a low DO value of Drain No.4. It looks like the same condition as the polluted closed-pond. The same fish are inhabitable under low-oxygen conditions in the Drain No.4; even though it is a low value of oxygen, they respire near the surface of Drain No.4.

The concentration of saturated DO is 8.84 mg/l at 1.0 Pa and 20 ℃. Aerobic micro organisms are active, and normal fish can live in the condition of more than 2 mg/l of DO value. It is necessary to increase DO value, and then the decomposition of organic matter (removal of COD) and de-nitrification (removal of nitrogen) is expected. The self-purification capacity is also increased. The condition of Drain No.4 may change to an aerobic condition from an anaerobic one, and then phosphorous settled in the bottom of Drain No.4 may decrease the value because its elution will be little.

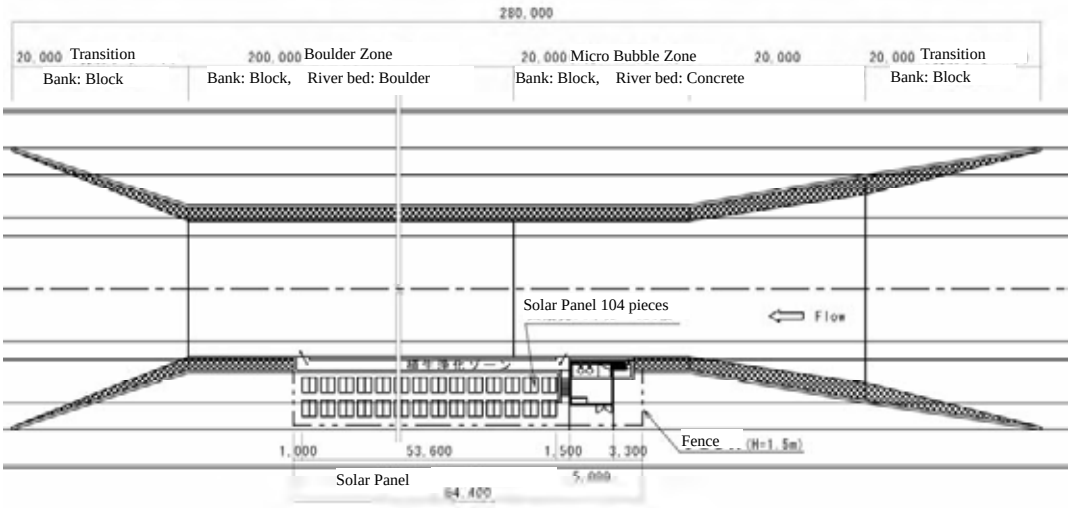
As shown in Table 2-2-1, the flow of Drain No.4 is 6.8m^3/s at the Shurafah pumping station

and 12.2m^3/s at the Mahala pumping station. The plan of the in-stream treatment facility is shown below:

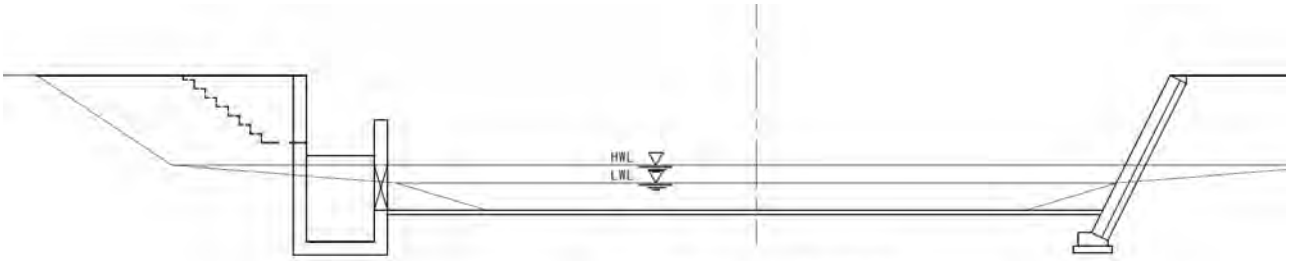
Table 2-2-3 Design Criteria of MBD in Drain No.4

Location	Shurafah	Mahala
Stagnation	17.0km	15.0km
Flow	6.8m^3/s	12.2m^3/s
MVD	11.0kw×2units	7.5kw×2units×2places
Capacity of Solar Panel	22.0kw	30.0kw
Number of Panels	104 pieces	142pieces

Based on the design criteria in Table 2-2-3, the layout plan of the in-stream facility for the Shurafah re-use pumping station is shown in the figure below.



Layout of Drain Improvement



Section of Plant Purification Zone

Figure 2-2-1 Plan and Section of In-stream Facility

As the plan and section of the in-stream treatment facility is shown in Figure 2-2-1, bank protection is made by blocks in order to maintain the site areas. Downstream from the facility, bank protection by the hydrophilic blocks and protection of the bottom by cobble stones will be planned.

A grit chamber will be planned before the position of the MBD to remove SS, if SS should be found to be sedimentary by the survey results.

(7) Future Prospects

Effects of the in-stream treatment facility by the MBD will be monitored by the WMIP after implementation. If it is successful, the in-stream treatment facility by the MBD is prospected to be used in other Nile delta areas and/or other African countries where available irrigation water sources are contaminated.

2-2-2 Validity of Sewage Treatment Facility

(1) Water Quality and Quantity

Target water quality for the sewage treatment facility is shown in the table below based on the DLWQ, Article 66.

Table 2-2-4 Water Quality Standards

Parameters	Egyptian Standards (mg/l)	JARUSstandards in Japan (mg/l)
BOD	60	20
CODcr	80	—
SS	50	50

The service population for the sewage treatment facility in the proposed sites will be 50 - 300 inhabitants. The facility is planned with a design discharge of 60 litters per capita per day with a projected population increase of one every 5 years.

(2) Sewage Treatment Method

As mentioned in “Appendix-6 Study of Rural Wastewater Treatment System”, the sewage treatment facility is recommendable as a “physical treatment by sedimentation + attached growth treatment process with aeration” in order to operate easily and reduce O&M cost. It is also recommendable to implement a catalyst carrier, which has been implemented in Japan recently. Back washing is unnecessary and bacteria are held more in the catalyst carrier than in other kinds of media. Treated wastewater will be better and more stable.

(3) Improvement of Water Quality

Domestic wastewater flowing from the villages and flow into irrigation canals directly

through small drain canals around the village or manure pits may be untreated .

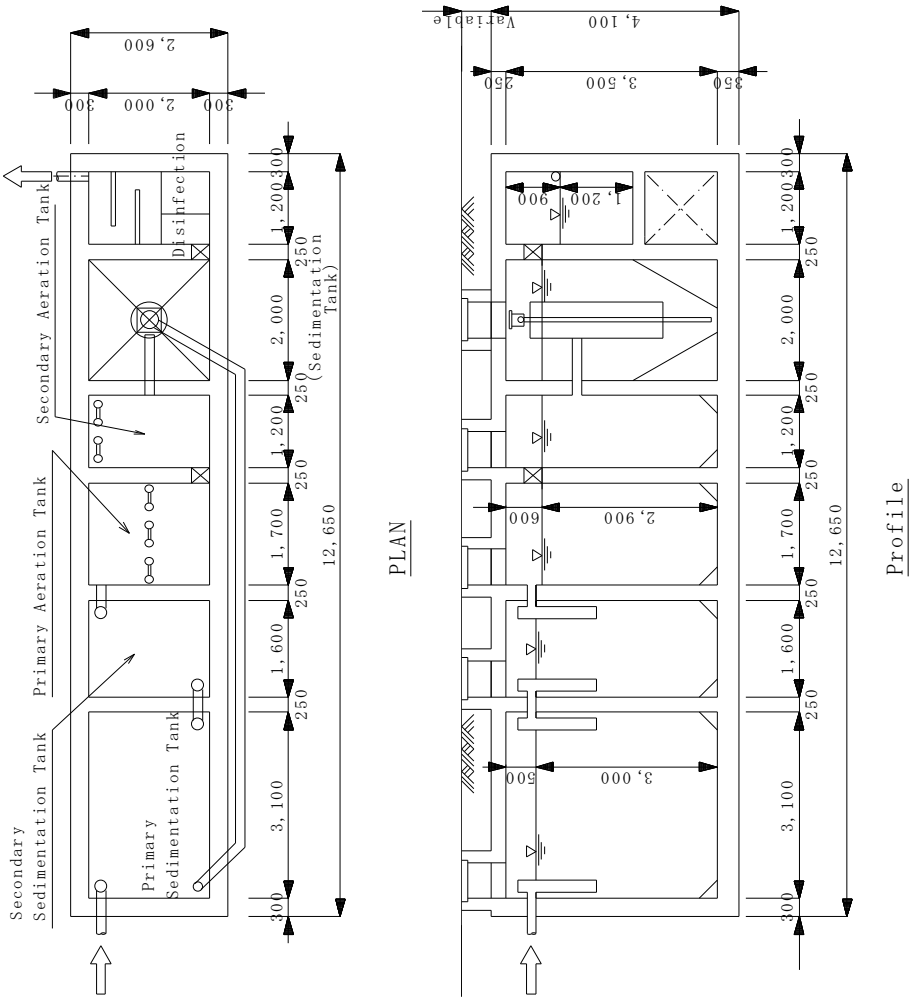
As small drain canals around the village are extremely polluted, it is necessary to improve the water quality of these small canals as well as the environmental living condition by constructing the sewage treatment facility. The improvement of irrigation water quality due to no inflow of domestic wastewater from the village is also expected. However, it will be essential to organize an association for O&M, including its cost, because the villagers may not be aware of the purpose of the sewage treatment facility.

(4) Procuring of Lands for Facilities

For the same reason mentioned in section “2-2-1, (4)” above, the sewage treatment facility is planned for the road/drainage canal or public lands.

(5) Facility Plan

A plan of the sewage treatment facility is shown in Figure 2-2-3. (Refer to “Appendix-7: Design of Sewage Treatment Facility.”)



2-2-3 Validity of Agricultural Waste Disposal System

(1) Composting Facility

There are many agricultural waste disposals, such as animal feces and urine, straw, etc., piling up around villages and along the road. They are very important materials as some of the fertilizers for farmers. Practice of collection and utilization of the agricultural waste disposals may be established among farmers. Farmers pile it up along road shoulders and along the canal for temporary use from the beginning of production to return it to the field because of limited space. However, the amount of agricultural waste disposals dropping into the canal may contribute slightly to the contamination of the canals, adversely affecting their water quality. It was confirmed during the discussions with the counterparts that it was necessary to plan an agricultural waste disposal system, and its facility shall be planned in the public yards, such as roads, banks, upper part of canals, compounds belong to the local council, and so on. As the lands have not been fixed yet, the agricultural waste disposal facility will be recommended and planned for the following places:

Table-2-2-5 Composting Facility

Kind of wastewater disposal	animal feces and urine, straw, etc
Collection system	Users collect by tractor or donkey
Lands	Public yards (road shoulder ~ waterside of canal)
Structure & dimension	Concrete made wall at the canal side and concrete slab to protect seepage into the canal (Width: 5m, height: 1.5m, Length: 100m) x 5 villages
Owner	Local Council
User	Farmers in the villages
Trustee	EPADP or WUA
O&M items	Repair of wall, bank protections by EPADP Repair of slab by WUA
O&M cost	LE. 100 ~ 1,000 per year
Obligations of O&M	EPADP: Repairing inside canals WUA: Minor repair

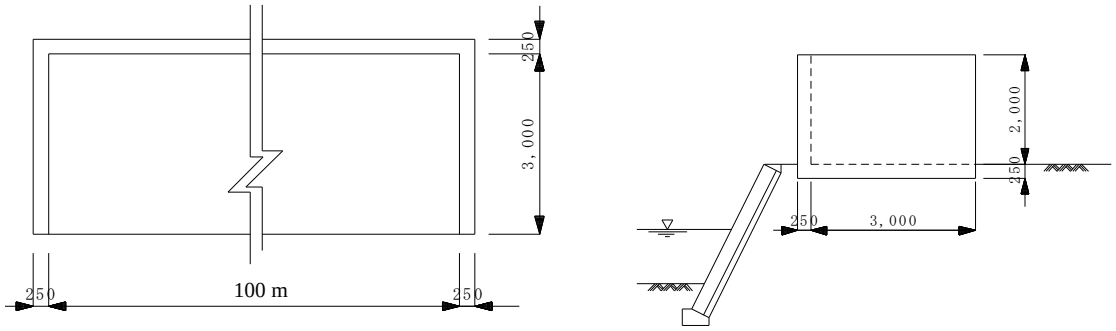


Figure 2-2-4 Plan of Composting Facility

(2) Bio-energy Facility

Raw materials for the bio-energy are cow-cakes for generating marsh gas and straws for generating ethanol. There is no such bio-energy facility in/around the Project site. It will be very difficult to maintain these facilities in the future even though Japan bears and constructs these facilities considering an ability of farmers and new technology in the village. Also, it will take much time to build up utilization of these produced bio-energies and to establish the marketing outlet system.

The effectiveness of the Japanese grant aid program is not clear at present, and also it is a disputable situation in the way of collecting produced energy at present. The Study Team confirmed that it is not applicable to plan it.

2-2-4 Validity of Drainage Water Re-use Facility

The Study Team examined the water shortage condition in the Bahr El Nour area based on the data from “The Master Plan Study for The Improvement of Irrigation Water Management and Environmental Conservation in The North-East Region of The Central Nile Delta (1998 - 1999)”, WMIP-2 of the JICA Technical Cooperation Project and MWRI. As a result of the estimation, water shortage occurs in the summer season (June - September) (refer to Appendix-10). It was proved that drainage water of the Biyala drain was necessary for irrigation water. It was also confirmed by interview to farmers that there was a bad harvest season because of a lack of irrigation water.

Figure 2-2-5 shows the layout of the Project site for the drainage water re-use facility.

The existing Bahr El Nour irrigation canal connects with the Biyala drain by an overflow pipe only, which is located at the end of the irrigation canal, and there is no connection from the Biyala drain. Irrigation water is supplied to Mesqa by one gravity system and by two existing irrigation pumps located in the Bahr El Nour irrigation canal during the irrigation season. It is stagnant in the non-irrigation season. The proposed site for the drainage water re-use facility is acquired beside the Bahr El Nour irrigation canal as shown in Figure 2-2-5, and there is enough space for it.

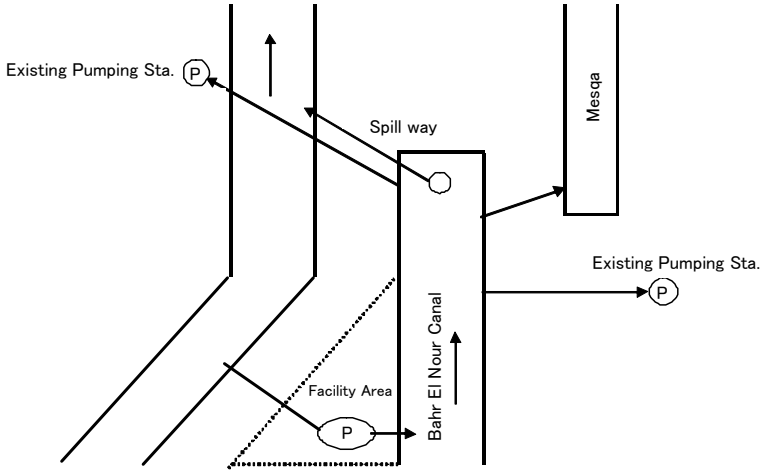


Figure 2-2-5 Layout of Drainage Water Re-use Facility

2-2-5 Project Plan

As the request from Egypt was not clearly mentioned in the details of the Project, the Study Team submitted the inception report to and discussed the project plan with MWRI, the counterpart of Egypt, before the official member arrived in Egypt. Then, the Study Team investigated the sites and had discussions with MWRI in order to make a feasible plan. The Project plan prepared by the Study Team is as follows:

As mentioned in section "1-3-1 Outline of the Site", the present condition in the Bahr El Nour area and its vicinity is that a lot of water pollutant, such as domestic wastewater from the villages and agricultural waste disposal of animal feces and urine, straw, etc., are stock-piling around villages, flowing into irrigation canals. In addition to this, as water quality of drainage canals is contaminated by the polluted water coming from upstream, it cannot be used for irrigation water. Under these circumstances, it is necessary to remove pollutants in the project area directly and to improve the water quality coming from upstream. Thus, the Study Team made the following project plan:

- Five sets of the sewage treatment facility and the composting facility in 5 villages each to protect pollution of the irrigation canal,
- One set of the in-stream treatment facility in Drain No.4 for improving water quality of Drain No.4 in order to utilize the existing drainage water re-use pump effectively with a solar panel being planned as the supply source of the in-stream treatment facility, and
- One drainage water re-use facility beside the Biyala drain to supply water to the Bahr El Nour irrigation canal. As water quality of the Biyala drain is improved by water hyacinth at present, there is no plan of the in-stream treatment facility in the Biyala drain.

The above facilities are planned in the following places where there exists no condemnation of lands, in consideration of the difficulty to use private lands in Egypt:

- Sewage treatment facility: inside public lands, such as, roads, drainage canals, etc.,
- Composting facility: bank shoulders, roads, properties of the local council,
- In-stream treatment facility: inside Drain No.4 belonging to MWRI property, and
- Drainage water re-use pumping station: Land is available.

The implementation agency of the Project is EPADP in MWRI. However, EPADP has jurisdiction only for an in-stream treatment facility inside Drain No.4 and the drainage water re-use facility. Other facilities, such as the sewage treatment facility and the composting facility, belong to the Ministry of Housing and the Ministry of Agriculture, respectively. As for the sewage treatment facility, the WQU has an experience in the Fayoum governorate. However, as coordination for the detail of the project contents have not been built up among other agencies (governorate, local council) and association (WUA) at present, a description shall be discussed among agencies concerned in the Field Survey-2.

Table-2-2-6 shows the rough implementation cost of the Project.

Table 2-2-6 Rough Estimate of the Project

Items	Unit cost	Q'ty	Amount	Remarks
Construction				Uit: x 1000 JYen.
In-stream	130,000	1	130,000	Upstream in Drain No.4
Drainage water re-use	32,000	1	32,000	BIyala Drain
Rehabilitation	5,000	2	10,000	
Sewage Treatment	18,000	5	90,000	In 5 villages
Composting	3,000	5	15,000	In 5 villages
Total			277,000	
Consulting Fee			28,000	
Agent Fee			30,000	
Grand Total			335,000	

Note） Main equipment are procured form Japan

2-2-6 Confirmation of Operation and Maintenance

(1) Agency and Ability

The Study Team discussed with authorities concerned about the main agency of O&M for the proposed facilities of the Project. As a result of the discussions, the table below shows agencies concerned for O&M, as follows:

Table 2-2-7 Basic Principle of Agencies for O&M

Facility	Lands	Property Right	O&M Agency	Defrayal Agency
In-stream Treatment	Inside drain canal	MWRI	EPADAP	EPADAP (East Kafr El Sheikh)
Sewage Treatment	Public land	Biyala City Council	Biyala City Council	Beneficiary
Composting	Public land	Biyala City Council	Biyala City Council	Beneficiary
S.W. Re-use	Public land/ Inside canal	MWRI	CDIOAS	CDIOAS (CD Kafr El Sheikh)

Note: WQU monitors in-stream facility and sewage treatment facility.

EPADP in MWRI has jurisdiction over the facilities constructed inside the drainage canal. Then, EPADP will be a main agency of O&M for the in-stream treatment facility and will absorb its maintenance cost. As for the drainage water re-use facility, EPADP is in charge of repair and maintenance of facilities installed inside the drainage canal, such as, the bar screen and suction chamber and so on, and the Irrigation Sector (IS) in the Central Directorate in Kafr El Sheikh has jurisdiction over the re-use pumps. IS will be a main agency of O&M for the drainage water re-use facility.

Concerning the sewage treatment facility and the composting facility, these facilities will be constructed outside the MWRI's jurisdiction. Then, other agencies, such as the Biyala City Council or the Water Users Association in Bahr El Nour, shall join the Project. The Local Council is recommendable because the land to be installed and the organization to be created shall be public. It is very difficult to procure private land for these facilities. Then, the land shall be public and the Local Council shall possess these public lands, except the area in the canal belong to MWRI.

As mentioned in section "1-5-2 Similar Project", the Local Council commits to using public lands for these facilities, so it is possible the same situation will be adopted.

Farmers recognize agricultural waste disposal as one of their fertilizers, but they do not understand that it is a pollutant of irrigation water. Therefore, it is necessary for the beneficiary to study not only enlightenment activities but also a maintenance free system.

(2) Payment ability to Sewage Treatment Facility

The present situation of payment for septic tank (sewage treatment facility) by users is shown in table below:

Table 2-2-8 Present Situation of Payment for Septic Tank

Canal along	Village	Households	Present Situation
Bahr El Nour Irrigation	Al Saei	24	There are septic tanks but wastewater flows into irrigation canal through small canals No honey wagon comes and removes it.
Biyala Drain	Al Nahas	51	Domestic wastewater flows into drainage canal. No honey wagon comes and removes it.
	Al Doksh	11	Domestic wastewater flows into drainage canal. No honey wagon comes and removes it.
Ash Shurafah Irrigation	Al Shurafah	39	Honey wagon comes and removes human excrement from a septic tank. Households pay LE. 10/time. Overflow from the septic tank may flow into drainage canal.
	Al Tanapra	9	Honey wagon comes and removes human excrement from a septic tank. Households pay LE. 10/time. Overflow from the septic tank may flow into drainage canal.

There are two villages along the Ash Shurafah irrigation canal paying sewage charges at present. Inhabitants in the Al Nahas village laid sewage pipes themselves 4 years ago. They collect domestic wastewater by pipes and keep it in a collection chamber. Sludge was removed once per year. There is no sewage charge in the Al Nahas village.

In these situations, discussions are necessary before installing sewage treatment facilities which incur charges by the beneficiary.

2-2-7 Effectiveness of Project Implementation

It is considered that the following points are effective for the project implementation of the proposed facilities (in-stream treatment facility, drainage water re-use facility, sewage treatment facility, composting facility):

- In-stream treatment facility installed upstream of the sewage re-use pumping station will improve drainage water, and irrigation water which conforms to the DLWQ will increase,
- Landscape around the drainage canals will be improved, and these areas will be more water-attracting after the installation of an in-stream treatment facility,
- Insufficient irrigation water will increase by installing a drainage water re-use facility, the insufficient water at the irrigation season will become more secure, crop production will increase, and finally farmers' income will also increase,
- Water quality of irrigation water will be improved by a sewage treatment facility,
- Living environment will be improved after constructing a sewage treatment facility and a composting facility.

The effectiveness of these facilities is dependent upon an O&M system from the Egyptian side. In this Project, as agencies for the O&M of the Project facility are different, all agencies

(MWRI, the Biyal City Council,) shall need cooperation from each other.

2-2-8 Confirmation of Environmental-Social Consideration

Main attention to the environmental-social consideration is a land expropriation for the facilities of the Project. Then, locations of the facilities are planned inside canals belonging to MWRI property or public lands belonging to City Council property.

The Study Team had discussions with the Environment and Climate Research Institute (ECRI) in charge of the environmental impact assessment in MWRI. According to ECRI's explanation, EIA will be necessary in case the Project has a large scale of construction, but the project plan explained by the Study Team may not be necessitate the involvement of EIA. ECRI will support the Project, making a report and submitting it to the EEAA for approval for when the Project could be carried out, a procedure of the environmental-social consideration. These matters are discussed again at the project implementation period.

2-2-9 Information collected from WMIP

The Bahr El Nour area is irrigated by the Bahr El Nour irrigation canal, as the branch irrigation canal is 4,200 feddan of irrigated areas and cultivated by 3,000 farmhouses. The JICA Technical Cooperation Project "Water Management Improvement Project Phase-2 (WMIP-2)" organized 70 WUAs at the same level as Mesqa (end canal). In Mesqa, the irrigation system was changed from gravity to pipelines pumped up from the Bahr El Nour irrigation canal. Intake pumps are operated by WUAs, and the O&M cost of the facility are covered by WUAs. A pipeline system has the following advantages:

- Continuity irrigation by the pipeline system mitigated anxiety of water shortage,
- Irrigation costs by using a corporative pump were reduced, and
- Crop production by improvement of irrigation efficiency increased.

However, water shortage still occurred downstream from the area. Especially, the irrigation method was changed to an intermittent irrigation this year. That was a pending issue for maintaining irrigation water recently. In addition to this, water quality of irrigation water is also one of the issues for the left bank of the Bahr El Nour irrigation canal.

2-2-10 Outcome to Action of Climate Change

The following points are considered as the outcome to actions of the climate change in the Project.

- In-stream treatment facility (by MBD and aquatic plants) improves water quality of

the canal and mitigates marsh gases arising from polluted canals,

- Water quality improvement methods by clean energy like a solar panel and aquatic plants is possible,
- A sewage treatment facility controls marsh gases caused by domestic wastewater,
- A recycling system of a composting facility is established, and decreased carbon dioxide caused by burnout of straw is mitigated,
- Greenhouse effect is diminished by greening of the desert using surplus (re-used) irrigation water

Indicators to evaluate these outcomes are (i) water purification value based on the changing water quality, (ii) reduction value of marsh gas by constructed sewage treatment facility, (iii) reduction value of carbon dioxide by compositing facility of straw, and (iv) areas of greening of the desert by re-used water.

2-2-11 Situation of Construction/Procurement

As the Project is the Japanese Grant Aid Program for Environment and Climate Change, the main supplier of the Project is a Japanese firm and the contractor(s) is a local construction firm(s).

The Project consists of many kinds of works, such as, civil works, mechanical and electrical works, river works, water treatment system, architecture, and so on. However, the construction schedule may be very tight and is very difficult to be extended.

(1) Local Contractor

There are many local contractors and building companies in Egypt. High and middle grade contractors have main offices in Cairo and branch offices in other towns. They have enough capacity and ability for several kinds of construction works. EPDAP, the implementation agency of the Project, has a list of local contractors having offices in the Kafr El Sheikh Governorate. They are middle or low grade contractors and have little experience except with normal civil works.

Considering the above mentioned circumstances, high or middle grade contractors are recommendable for the Project’s implementation in order to keep a schedule, control construction quality, and manage the safety of the Project.

(2) Labor Force

The construction works need many laborers, such as foremen, skilled labor, carpenters, masons, welders, plumbers, electricians, mechanics, and so on. These laborers are available not only in Cairo, but also in main cities near the Project site like Kafr El Sheikh city, El Mansura

city, and Tanta city.

(3) Materials for Civil Works

Materials for civil works, such as cement, aggregate, sand, reinforcing bar, timber, wooden forms, and so on, are available in Egypt. Construction machinery is also available in Egypt.

(4) Transportation to the Project Site

Main equipment and materials for the Project will be transported from Japan to the Alexandria port in Egypt. After disembarkation at the Alexandria port, inland transportation to Biyala city is approximately 150 km in distance. The national highway from Alexandria to Biyala city has an enough width and good pavement for heavy vehicles. However, roads from Biyala city to the Project site are 4 ~ 5m in width and have no pavement. As there are many pedestrians, bicycles, and horse carts in Biyala city, vehicles must be driven carefully during the implementation.

2-2-12 Major Equipment to be taken by Egypt

Major equipment and materials for the Project are shown in the table below. There is no major equipment to be taken by Egypt. However, the details shall be discussed during the Field Survey-2.

Table 2-2-9 Major Equipment List

Facility	Main Equipment and Materials	Egypt	Japan
In-stream Treatment (1 set)）	MBD		○
	Solar panel		○
	Gate, Screen		○
	Removal of sludge		○
Drainage Water Re-use (1 set）	Centrifugal pump		○
	Solar panel		○
Sewage Treatment （5 sets）	Blower		○
	Aeration		○
	Contact media		○
	Solar panel		○
Composting （5 sets）			○

2-2-13 Technical Assistance

Concerning utilization and the O&M of the proposed facilities, the following technical assistance shown in the table below may be necessary to ensure the effect of the Project:

Table 2-2-10 Technical Assistance

Facility	Main Items	O&M works	Agency of O&M	Assistance for O&M	Assistance for Enlightenment
Sewage Treatment	Aeration Solar panel	Check-on and repair, Cleaning	Check-on: WUA Maintenance: Supplier	Training for operators	Accounting, environment
Composting	None	Repairing mortar	EPADP, WUA	Training for users	Cleaning, environment
In-stream Treatment	Pump, MBD Solar panel	Check-on and repair, Cleaning	EPADP	Training for EPADP	Cleaning, environment
Drainage Water Re-use	Pump, Generator	Changing spare parts, Check-on	WUA	Training for EPADP / users	Cleaning, environment

It is also necessary for beneficiaries or users to improve their awareness against deterioration of water quality. Main issues of deterioration of water quality are as follows:

Table 2-2-11 Plan for Beneficiaries/Users for their Awareness

Issues of Water Quality	Countermeasures to Beneficiaries/Users
Stock-pile of agricultural waste disposal	Presentation of how to use the composting facility and actions for utilization of the facility
Dumping domestic waste disposal	Setting dumping location, address for environmental beautification and its campaign, and regular cleaning of the canals
Inflow of domestic wastewater from villages	Explanation of sewage treatment facility (purpose, benefit, position of the connection to sewage pipe, necessity of cleaning of the facility, and so on)
Eutrophication by water hyacinth	Utilization of the complex facilities for water quality

2-2-14 Result of Sub-Contract Works

The following sub-contact works were conducted in the Field Survey-1. However, the social condition survey was postponed to the Additional Field Survey because of the delay of permission for the works.

(1) Water Quality Analisys-1

The water quality analysis-1 consists of water quality analysis-I that is conducted in order to grasp the present water quality condition of the Project sites and water quality analysis-II which is done to collect data for designing the proposed facilities. The following parameters and sampling points were collected in the water quality analysis-1. The result of the water quality analysis-1 is shown in “Appendix-8 Water Quality Test Result”.

Table 2-2-12 Water Quality Analysis-1

Items	Description
a) Water Quality Analysis - I	29 parameters × 8 samples
- Parameters	EC, pH, DO, Temperature, Salinity, SS, TSS, T-P, T-N, Oil Grease, CODcr, BOD, Detergent, TOC, SAR, Chloride, Boron, Arsenic, Cadmium, Cobalt, Chromium, Copper, Iron, Manganese, Nickel, Lead, Zinc, Mercury, Total Coliform
- Sampling points	8 points of proposed facilities
b) Water Quality Analysis - II	11 parameters × 81 samples
- Parameters	BOD, CODcr, SS, T-N, T-P, pH, DO, Temperature, EC, TOC, Total Coliform
- Sampling points	5 points of proposed sewage treatment facility and 13 points of facilities related to the re-use pump
- Interval	12:00 noon during 1 week

(2) Geological Survey

A geological survey at eight points in the Project area was carried out during the Field Survey-1 for investigating and designing the foundation of the main facilities in the Project. The following table summarizes the result of boring:

Table 2-2-13 Result of Geological Survey

Boring Hole	N-Value	Groundwater Level GL(-)m	Depth of Foundation (m)
1	3～15	3.35	―
2	4～93	2.00	15
3	8～58	1.80	12
4	3～64	3.30	10
5	4～77	1.80	12
6	3～34	1.75	―
7	6～49	1.98	13
8	3～21	1.95	―

The soil property is soft ground and sandy soil consisting of clay and silt. The foundation with more than 30 of the N-Value appears in the deep level as shown on the table above. There is also a site where the foundation does not appear by the depth of 15m. There would be a case that would require a pile foundation according to the weight and formation of the structure upon construction. This should be taken into consideration in designing structures. It is considered that the permeability coefficient should be low due to clay soil, and therefore diversion work could be easily implemented.

(3) Surveying

The surveying was conducted for the purpose of obtaining detailed surveying data for the proposed facilities. The surveying items are shown in the table below.

Table 2-2-14 Surveying

Items	Description
a) Plane surveying	- Proposed sewage treatment facility and composting facility: 3.0 ha - Proposed in-stream facility: 1.0 ha - Proposed re-use pumping facility: 4.0 ha
b) Longitudinal surveying	- Proposed sewage treatment facility and composting facility: 250m - Proposed in-stream facility: 200m - Proposed re-use pumping facility: 150m
c) Cross-Sectional surveying	- Proposed sewage treatment facility and composting facility: 25 sections - Proposed in-stream facility: 20 sections - Proposed re-use pumping facility: 60 sections

(4) Social Condition Survey

A social condition survey in order to grasp the situation of irrigation water shortage and re-use of drainage water, living conditions of the village, and disposal of agricultural waste, as well as the capacity or willingness of the farmers to pay for the O&M cost of wastewater treatment system was planned to carry out in the Field Survey-1. However, it was postponed because of the long process of the permission. Finally, the social condition survey was conducted in the Additional Field Survey (refer to “2-3-5 Result of Sub-Contract Works”.

2-3 Result of Additional Field Survey

2-3-1 Micro Bubble Device (MBD) Test

(1) Test Plan

(a) Purpose

The purpose of the MBD test is to verify the effect of the MBD to increase a low Dissolved Oxygen (DO) value which may be a main cause of water pollution in the existing drainage canal.

(b) Test Site

The test site is Drain No. 4 as the main drainage water source in Bahr El Nour in the Kafr El Sheikh governorate (Refer to "Location Map" and "Layout Plan") and the Ash Shurafah irrigation canal connected with the Shurafah pumping station of an existing drainage water re-use pump along the left bank of Drain No.4.

(c) Test Condition

The following MBDs were prepared for the test;

- 21 mm of nozzle size×2 units ($Q \fallingdotseq 0.03\ m^3/s$ per one unit) and
- 15 mm of nozzle size×1 unit ($Q \fallingdotseq 0.03\ m^3/s$ per one unit)

(d) Parameters and Sampling Points/Stations

Water samples of the MBD tests with highlighted lines in Table 2-1 were taken at the points and intervals shown in Table 2-2, and 9 parameters of the water quality test shown in Table 2-3-2 were analyzed in the laboratory. The Dissolved Oxygen (DO) value of all tests was also measured at the sites by the potable water quality kit.

In addition to this, samples of the mud and bottom sedimentation were taken at the center of Drain No.4, and its depths are 50cm, 80cm and 120cm from the bottom of Drain No.4. The samples were analyzed in the same laboratory.

Table 2-3-1 Test Parameters and Sampling Points/Intervals

Test Parameters of Water Quality	Sampling
1) DO (Dissolved Oxygen) 2) COD (Chemical Oxygen Demand) 3) ORP (Oxidation Reduction Potential)	1) Location Station (meters) from MBD setting up point
4) SS (Suspended Solids) 5) pH (Hydrogen Ion Exponent) 6) T-N (Total Nitrogen) 7) NH_3-N (Ammonia Nitrogen) 8) NO_2-N (Nitrite Nitrogen) 9) NO_3-N (Nitrate Nitrogen)	2) Interval - before MBD operation - 30 minutes after MBD operation - 1 hour after MBD operation - 2 hours after MBD operation, and - 3 hours after MBD operation

(e) Water Quality Standards

Water quality standards in Egypt (WQS) regarding the protection of the Nile River and waterways from pollution are described in Law 48, Section 65. The main parameters of WQS relevant to this test are as follows;

- DO: not less than 5 mg/l
- COD: not exceeding 15 mg/l

(f) Micro Bubble Device Composition

The MBD consists of a nozzle for creating micro bubbles, a pump for supplying pressed water, an air pipe connected with the MBD and a stand supporting the MBD. The type of pump utilized for the MBD can be a submersible pump, a centrifugal pump, a potable engine pump, etc. A supplier of the MBD used in the test submits the specification of the MBD and total electrical capacity shown in Table 2-3-2.

Micro Bubble Device（MBD）

Table 2-3-2 Specification of MBD

Flow rate (m^3/day)	MBD		Pump		Total (sets)	Total (kW)	Cost (x1,000 JPY)
	Diameter	Units	kW/ unit	unit			
～ 5,000	21 mm	2	3.7	1	2	3.7	10,000
～ 10,000	21 mm	2	3.7	2	4	7.4	16,000
～ 50,000	15 mm	6	11.0	3	18	33.0	25,000
～ 100,000	32 mm	4	15.0	3	12	45.0	43,000
～ 500,000	32 mm	4	15.0	10	40	150.0	143,000
～ 1,000,000	32 mm	4	15.0	16	64	240.0	190,000
～ 1,500,000	32 mm	6	22.0	22	132	484.0	307,000

(2) Test for MBD

The following 8 tests shown in Table 2-3-3 below were carried out from December 25, 2009 to January 1, 2010. The purpose and detail of each test were described from the next sections below.

Table 2-3-3 List of Test

Type of Test		Date	Location of MBD	Flow rate	MBD (Nozzle dia.×unit)
Pre-test	Test-1	Dec. 25, 2009	in Drain No.4	7.000 m^3/s	21mm×2units,15mm×1unit
	Test-2	Dec. 26, 2009	in Temporary drain	0.015 m^3/s	21mm×2units
	Test-3	Dec. 27, 2009	in Temporary drain	0.008 m^3/s	21mm×1unit
Main test	Test-4	Dec. 28, 2009	in Temporary drain	0.015 m^3/s	21mm×2units
	Test-5	Dec. 28, 2009	in Temporary drain	0.008 m^3/s	21mm×1unit
	Test-6	Dec. 29, 2009	in Temporary drain	0.015 m^3/s	21mm×2units

Additional test	Test-7	Dec. 31, 2009	in Irrigation canal	1.000 m^3/s	21mm×2units,15mm×1unit
	Test-8	Jan. 1, 2010	in suction & discharge chamber of pumping station	0.000 m^3/s	21mm×1unit

(3) Pre-Test (Test-1 ~ Test-3 in "Table 2-3-3")

Pre-Tests were done to confirm a position of the MBD in Drain No.4 and a relation between the capacity (number of units) of the MBD and flow/water quality of Drain No.4.

Firstly, all MBDs were set at the planned position in Drain No4 (center of Drain No.4) and an effective capacity of the MBD against full flow/water quality of Drain No.4 was tested (Test-1). Then, the temporary drain of approximately 1 meter in width and 1 km in length by vinyl sheets was set at the left bank in Drain No.4, and the effective capacity of the MBD was verified by Test-2 and Test-3. Based on these tests, it was decided that the main tests were done at the temporary drain in Drain No.4 with 2 units of the MBD.

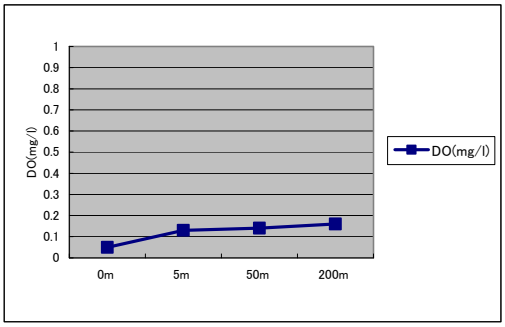
Table 2-3-4 Pre-Test of MBD

Test	Purpose	Test Result	Comments
Test-1	Confirmation of the capacity of 3 units of the MBD in Drain No.4 by DO value	DO value of Drain No.4 was 0.05mg/l before operating the MBD and was increased to 0.16mg/l at Sta. 100m after 1 hour of operation. MBD's capacity ($0.1m^3/s$) was deficient to flow of Drain No.4 ($7.0 m^3/s$).	It was difficult to use the MBD in Drain No.4 because MBD's capacity was too small against full flow of Drain No.4. The next test would be carried out in the temporary drain.
Test-2	Confirmation of the capacity of 2 units of the MBD in the temporary drain by DO value	DO value of temporary drain from Drain No.4 was 0.06mg/l before operating the MBD and was increased to 6.45mg/l at Sta. 5m、5.43mg/l at Sta. 50m and 2.35mg/l at Sta. 200m in the temporary drain after 1 hour of operation.	In case of 3 units of the MBD operation, water was overflowed from the temporary drain. Then, Test-2 would be applied by 2 units of the MBD. DO value by the operation of 2 units of the MBD was increased to more than 5mg/l of WQS, but it was getting decreasing towards downstream.
Test-3	Confirmation of the capacity of 1 unit of the MBD in the temporary drain by DO value	DO value was increased only up to 4.3mg/l in the temporary drain after 5 hours of operation.	DO value by 1 unit of the MBD operation was less than 5mg/l of WQS. Main test would be applied by 2 units of the MBD.

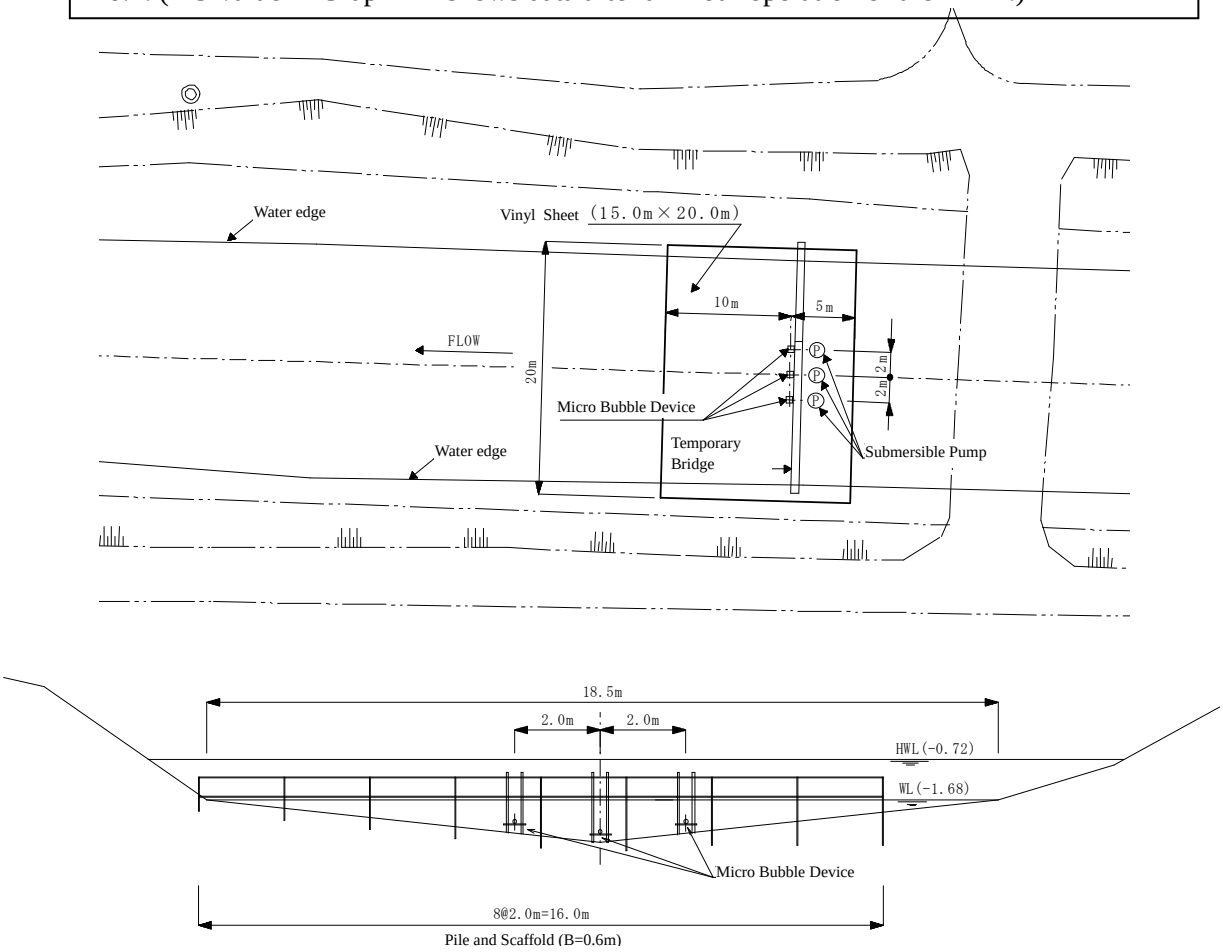
Graph 2-1 【Test-1】3 units Operation of the MBD in Drain No.4

No.	Test Place	Flow rate (m^3/s)	MBD (dia. × unit)
Test-1	Drain No.4	7.0	21mm×2units, 15mm×1unit

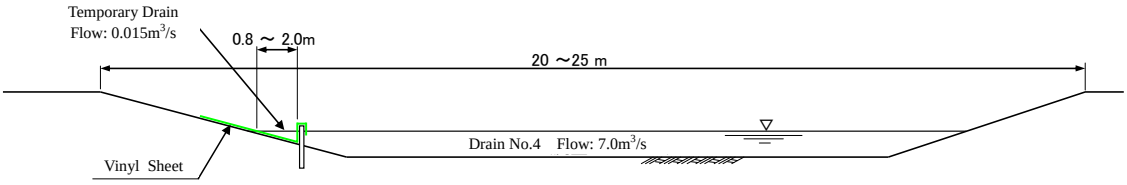
Distance	DO(mg/l)
0m	0.05
5m	0.13
50m	0.14
200m	0.16



As the capacity of the MBD was too small against the full flow/water quality of Drain No.4, the DO value was increased very slightly. The next test was at the temporary drain in Drain No.4. (DO value in Graph 2-1 shows data after a 1 hour operation of the MBD.)



Plan & Profile of the Test Place in Drain No.4



Profile of Temporary Drain set in Drain No.4

(4) Main Test (Test-4 ~ Test-7 in “Table 2-3-3”)

As confirmed during the Pre-test, 2 units of the MBD operated in the temporary drain had an effect on the improvement of water quality for Drain No.4. The main test of Test-4 was planned under the same condition. Samples of the water quality test were taken according to the stations and the intervals shown in Table 2-2 above. Then, Test-5 by 1 unit of the MBD operation was done in the temporary drain to confirm the DO value. In addition to this, Test-6 by 2 units of MBD operation was done in the temporary drain without a bottom vinyl sheet to confirm an effect on the improvement of water quality by the mud and bottom sedimentation.

These results are shown in Table 2-3-5. It was confirmed that the DO values were improved to above the WQS. However, the DO value increased by the MBD operation was decreasing towards downstream from the MBD’s position. This means that the Oxygen was consumed by a decline of pollutional load reflected in the COD value or by the nitrification of an ammonia element.

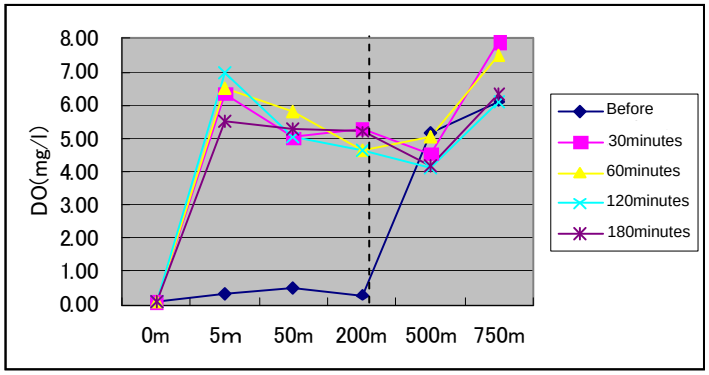
Table 2-3-5 Main Test of MBD

Test	Purpose	Test Result	Comments
Test-4	Test by 2 units of MBD operation in the temporary drain. (Sampling for laboratory test)	DO value of temporary drain from Drain No.4 was 0.09mg/l before operating the MBD and was increased to 6.49mg/l at Sta. 5m、5.81mg/l at Sta. 50m、4.64mg/l at Sta. 200m and 5.03mg/l at Sta. 500m in the temporary drain after 1 hour of operation. COD value of temporary drain from Drain No.4 was 50mg/l before operating the MBD and was decreased to 39mg/l at Sta. 50m、42mg/l at Sta. 200m and 20mg/l at Sta. 500m in the temporary drain after 1 hour of operation.	DO value after MBD operation increased to more than 5mg/l of WQS. As both DO and COD values were decreased, the DO supplied by the MBD might be used for decomposing COD. Other parameters of water quality were not significantly changed.
Test-5	Test by 1 unit of MBD operation in the temporary drain	DO value of temporary drain from Drain No.4 was 0.19mg/l before operating the MBD and was increased to 3.26mg/l at Sta. 5m after 30 minute of operation.	Increasing rate of DO value was one half against that of the Test-4 case. Therefore 2 units of MBD operation were appropriate.
Test-6	Same test of Test-4 except for removal of bottom vinyl sheet for influence of mud and bottom sedimentation. (Sampling for laboratory test)	DO value of temporary drain from Drain No.4 was 0.07mg/l before operating the MBD and was increased to 6.16mg/l at Sta. 5m、5.15mg/l at Sta. 50m、and 1.12mg/l at Sta. 200m in the temporary drain without bottom sheet after a 1 hour operation of the MBD.	Decreasing rate of the DO value was larger than that of the Test-4 case. It might be influenced by the mud and bottom sedimentation.

Graph 2-2 【Test-4】2units Operation of the MBD in Temporary Drain set in Drain No.4

No.	Test Place	Flow rate (m^3/s)	MBD (dia. × unit)
Test-4	Temporary Drain	0.015	21mm×2unit

Distance / Time	0	30	60	120	180
0m	0.10	0.08	0.09	0.08	0.08
5m	0.35	6.36	6.49	6.96	5.50
50m	0.49	5.02	5.81	5.02	5.29
200m	0.30	5.30	4.64	4.63	5.20
500m	5.17	4.54	5.03	4.12	4.16
750m	6.12	7.91	7.49	6.10	6.35

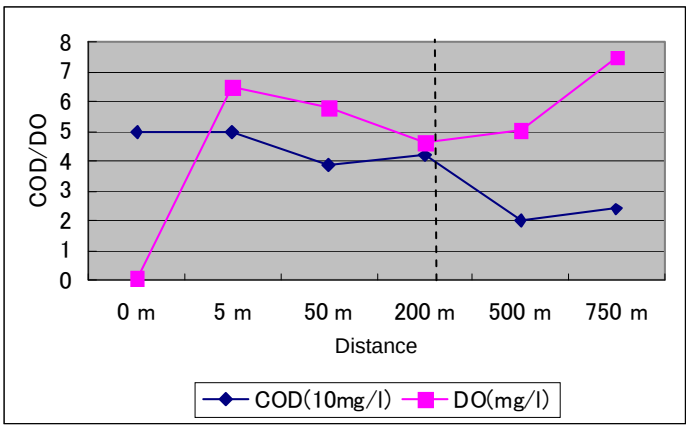


It was tested by 2 units of MBD operation in the temporary drain. Result in the graph shows DO value reached above 5 mg/l of the WQS.

DO value of the right side from the dotted line in the graph that is Sta. 500m and more was higher than the left side of the dotted line. It means that Oxygen might be supplied from the stream surface, not by MBD operation.

Graph 2-3 【Test-4】Decrease of DO & COD after 1 hour Operation of the MBD

Pumping	Distance	DO mg/l	COD mg/l
1 hour after pumping	0 m	0.09	—
	5 m	6.49	50
	50 m	5.81	39
	200 m	4.64	42
	500 m	5.03	20
	750 m	7.49	24



It was tested by 2 units of MBD operation in the temporary drain. The result in the graph shows the DO value was decreasing towards downstream after it reached above 5 mg/l of the WQS at Sta. 5 m.

The COD value was also decreasing with the same trend. This means that Oxygen supplied by MBD operation was consumed for decomposing COD.

The DO value of the right side from the dotted line in the graph is Sta. 500m, and more was higher than the left side of the dotted line. This means that Oxygen might be supplied from the stream surface, not by MBD operation.

According to the result of Test-4, it took a 200m distance to decrease the COD value from 50mg/l to 40 mg/l, and its time of flow was approximately 10 minutes. It is considered that the

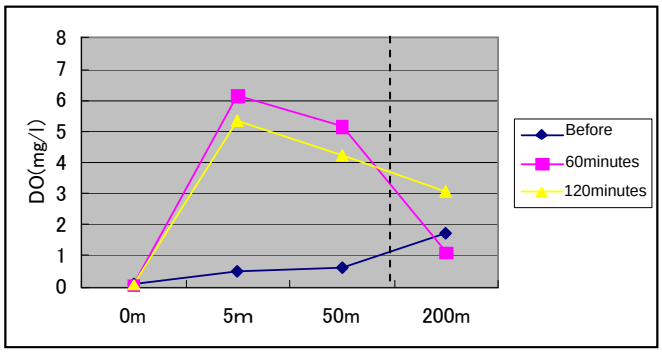
more time for reaction might be necessary to improve the COD value by aeration. In case of Drain No.4 in the test site, 0.5 ~ 1.0 hour of MBD operation may be necessary to reduce COD from the present value in Drain No.4 to15mg/l (WQS).

For the detailed study, it is essential to finalize the raw water quality and design water quality together, studying their theoretical value.

Graph 2-4 【Test-6】2units Operation of the MBD in Temporary Drain set in Drain No.4 without Bottom Sheet (Experimentation on the Influence of Mud and Bottom Sedimentation)

No.	Test Place	Flow rate (m^3/s)	MBD (dia. × unit)
Test- 6	Temporary Drain (without bottom sheet)	0.015	21mm×2unit

Distance / Time	0	60	120
0m	0.08	0.07	0.07
5m	0.49	6.16	5.33
50m	0.61	5.15	4.25
200m	1.72	1.12	3.08



It was tested by 2 sets of MBD operation in the temporary drain without bottom vinyl sheets to confirm the influence of the mud and bottom sedimentation.

Decreasing rate of the DO value by time and distance from the MBD setting point was higher than that of Test-4 with the vinyl sheet. It seems that the Oxygen was consumed by the anaerobic mud and bottom sedimentation. (It is considered that there was no influence of MBD operation at the right side of dotted line in the graph that is 200m and more.)

(5) Examination of Nitrogen

Based on the main tests (Test-4 ~ Test-6 in "Table 2-3-3"), Nitrogen (N_2) is examined as follows:

(a) Decomposition related with the Ammonia

Ammonium Nitrogen (NH_3) dissolved in water is decomposed to Nitrous Acid (NO_2) and then NO_2 changes to Nitric Acid (NO_3) because of increased Oxygen. In case of limited Oxygen, NO_3 is deoxidized to NO_2 and then changes to N_2.

In case of increased Oxygen: $NH_3 \rightarrow NO_2 \rightarrow NO_3$ (Nitrification, Oxygen reaction)

In case of limited Oxygen: $NO_3 \rightarrow NO_2 \rightarrow N_2$ (De-nitrification, Deoxidization reaction)

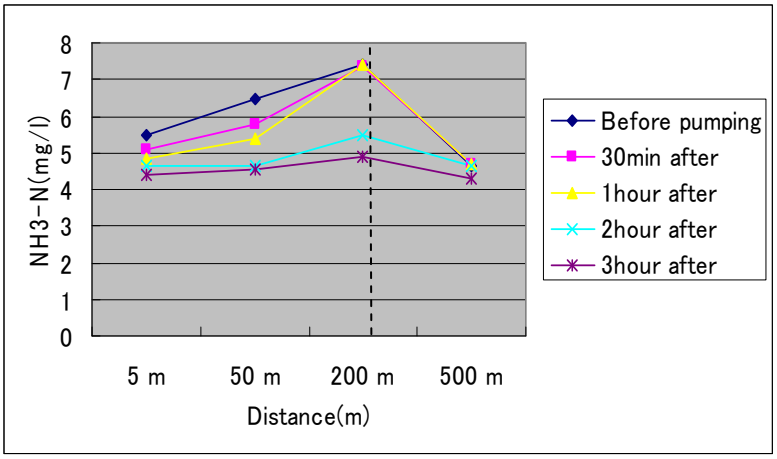
A sewage treatment system places an aerobic tank and an anaerobic tank alternately to cause a reaction in the above process artificially (Nitrification - De-nitrification process). In the case of the natural river, Nitrification reacts in a place of high velocity by aeration and De-nitrification reacts in a place of low velocity or limited Oxygen.

(b) Trend of Nitrogen Element in the Temporary Drain (Test-4)

NH_3-N made up 98% of the total Nitrogen (T-N) in the temporary drain. This means that T-N depends on NH_3-N. The Nitrogen trend (NH_3-N, NO_3-N) during MBD operation in the temporary drain by Test-4 is shown in Graph 2-5 and Graph 2-6 below;

Although the NH_3-N values in the temporary drain varied at each station before MBD operation, these values decreased depending on the time that had passed, such as after 30 minutes, 1 hour, 2 hours and 3 hours of MBD operation. It seems that NH_3-N changed to NO_3-N by increasing Oxygen in the MBD operation. Oxygen may be supplied from the canal surface also.

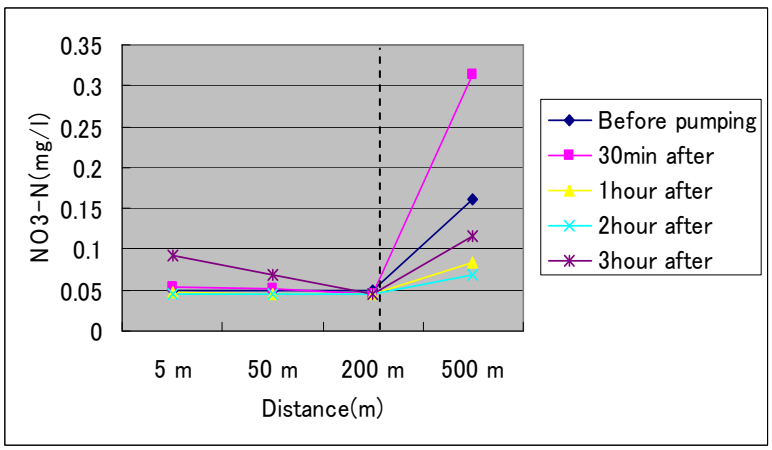
Graph 2-5 【Test-4】Decrease of Ammoniac Nitrogen in Temporary Drain



The NH_3-N value decreased depending on the lapse after MBD operation. It seems that Oxygen supplied by the MBD operation was consumed in the process of Nitrification.

(It is considered that there was no influence of the MBD operation at the right side of the dotted line that was 500m and more in the graph.)

Graph 2-6 【Test-4】Increase of Nitric Nitrogen in Temporary Drain



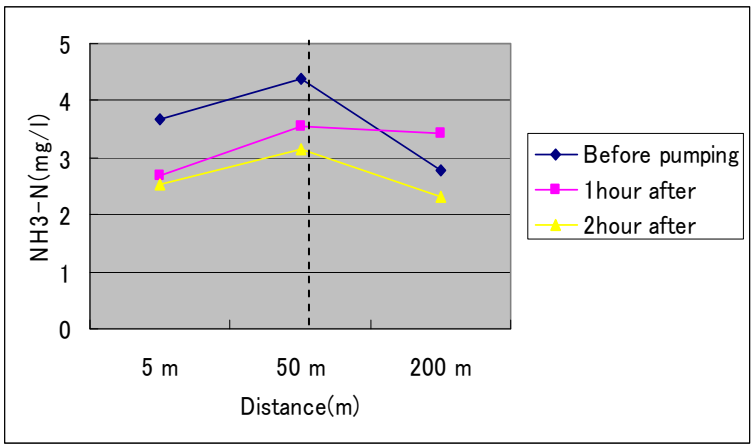
The NO_3-N value increased depending on the lapse after MBD operation. It seems that Oxygen supplied by the MBD operation was consumed in the process of Nitrification.

(It is considered that there was no influence of the MBD operation at the right side of the dotted line that was 500m and more in the graph.)

(b) Trend of Nitrogen Element in the Temporary Drain without Bottom Sheet (Test-6)

Graph 2-7 and Graph 2-8 show the trend of the Nitrogen element in the temporary drain without a bottom vinyl sheet. The same result occurred as well in the temporary drain with the bottom vinyl sheet of Test-4, and the NH_3-N value decreased depending on time elapsed from before MBD operation to after 1 hour and 2 hours of MBD operation. On the other hand, the NO_3-N value increased. This means that NH_3-N changed to NO_3-N in the process of Nitrification by supplying Oxygen during MBD operation. Particularly, the NO_3-N value increased more than that before removing the bottom vinyl sheet in the temporary drain. The reason may be that water improved by MBD operation the day before this test (measurement) was performed and the Oxidization/Nitrification had been already processed.

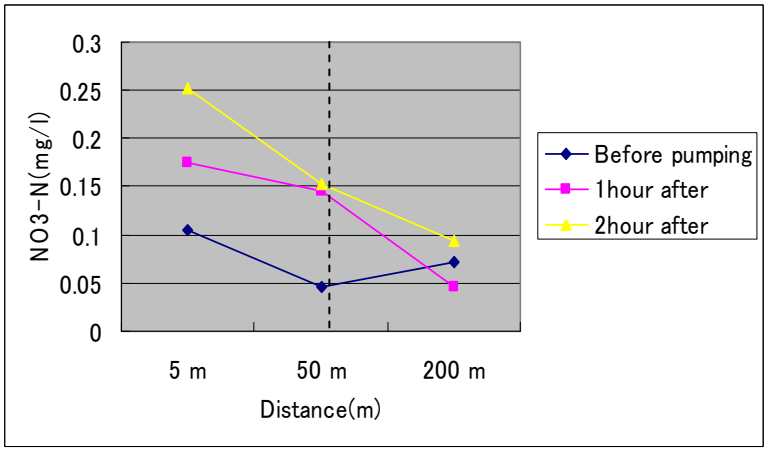
Graph 2-7 【Test-6】Decrease of Ammoniac Nitrogen in Temporary Drain without Bottom Sheets (Experimentation on the Influence of Mud and Bottom Sedimentation)



NH_3-N value increased depending on the lapse after MBD operation. It seems that Oxygen supplied by the MBD operation was consumed for the process of Nitrification also for mud and bottom sedimentation.

(It is considered that there was no influence of the MBD operation at the right side of the dotted line that was 200m and more in the graph.)

Graph 2-8 【Test-6】Increase of Nitric Nitrogen in Temporary Drain without Bottom Sheets (Experimentation on the Influence of Mud and Bottom Sedimentation)



NO_3-N value increased depending on the lapse after MBD operation. It seems that Oxygen supplied by MBD operation was consumed for the process of Nitrification also for mud and bottom sedimentation.

(It is considered that there was no influence of the MBD operation at the right side of the dotted line on the graph that was 200m and more.)

(6) Additional Test (Test-7 in “Table 2-3-3”)

The effect of MBD operation was tested by the re-use pump at the Shurafah pumping station installing the existing drainage re-use pump. The existing re-use pump in the Shurafah pumping station was operated for lifting up drainage water in Drain No. 4 to an irrigation canal, and 3 units of the MBD were operated in the irrigation canal. Samples for water quality analysis in the irrigation canal were taken and analyzed to confirm the variation of water quality.

The result is shown in Table 2-3-6, and it was confirmed that the DO value was improved by aeration operated by the re-use pump, and it could be improved by the potable pump at the tertiary canal.

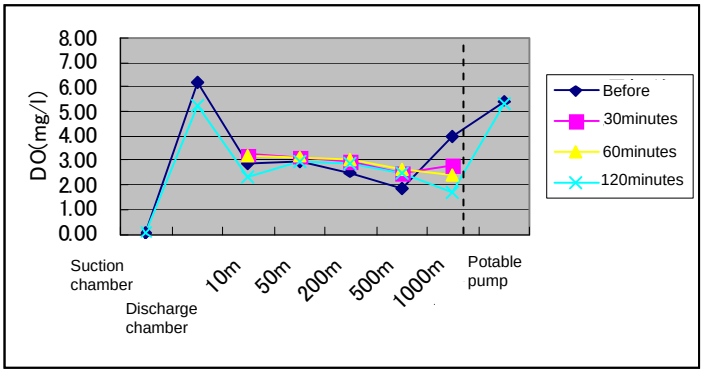
Table 2-3-6 Additional Test (Test-7)

Test	Purpose	Test Result	Comments
Test-7	Confirmation of water quality improvement. Existing re-use pump in the Shurafah pumping station was operated, and 3 units of the MBD were set in irrigation canal.	DO value of Drain No.4 (0.06mg/l) in the discharge chamber was improved to 5.31mg/l. DO values in the irrigation canal were changed to 2.90mg/l at Sta.10m and the value at the tertiary canal after pumping up by potable pump was increased to 5.44mg/l. In addition to that, by operating the MBD, the DO value was improved to 3.0mg/l at Sta. 10m -200m (after 60 minutes of operation).	DO values were improved at the discharge chamber by air mixing of re-use pump operation and at the tertiary canal by air mixing from potable pump operation. Air may be mixed by pump operation. As MBD’s capacity ($0.1m^3/s$) was deficient to flow of pump capacity ($1.0\ m^3/s$), the DO value in the irrigation canal was not increasing sufficiently (less than 5mg/l of the DO value).

Graph 2-10 【Test-7】3 units Operation of the MBD in Irrigation Canal

Type of Test	No.	Date	Test Place	Flow rate	MBD (dia. × unit)
Drain reuse pump	Test 7	Dec. 31, 2009	Shurafah Pump station & Irrigation canal	1.000 m^3/s	21mm×2unit, 15mm×1unit

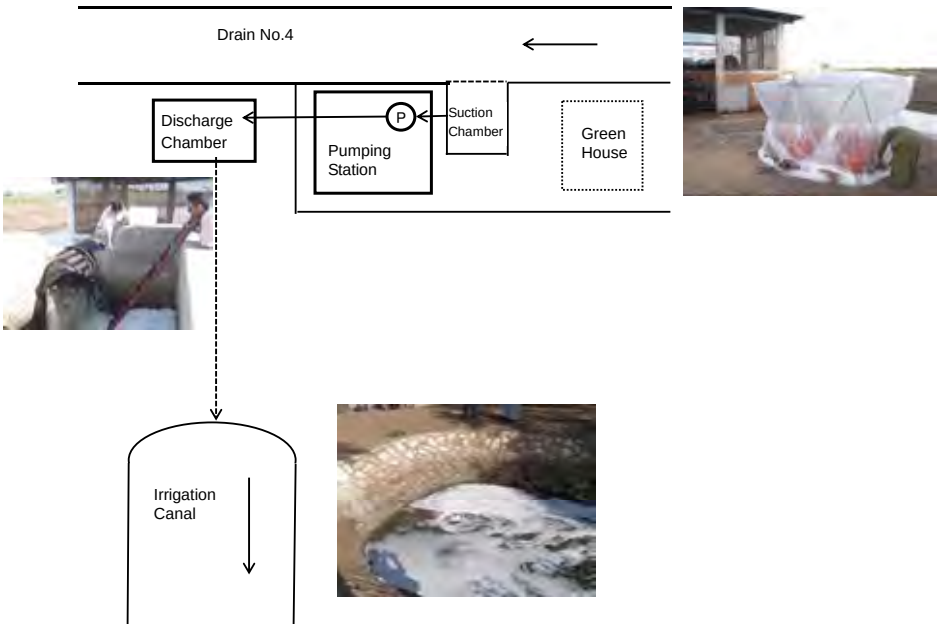
Distance / Time	0	30	60	120
Suction chamber	0.06			0.07
Discharge chamber	6.22			5.22
10m	2.90	3.24	3.20	2.32
50m	2.96	3.14	3.15	2.95
200m	2.52	2.97	3.03	2.89
500m	1.85	2.50	2.65	2.50
1000m	3.97	2.79	2.39	1.71
Potable pump	5.44			5.30

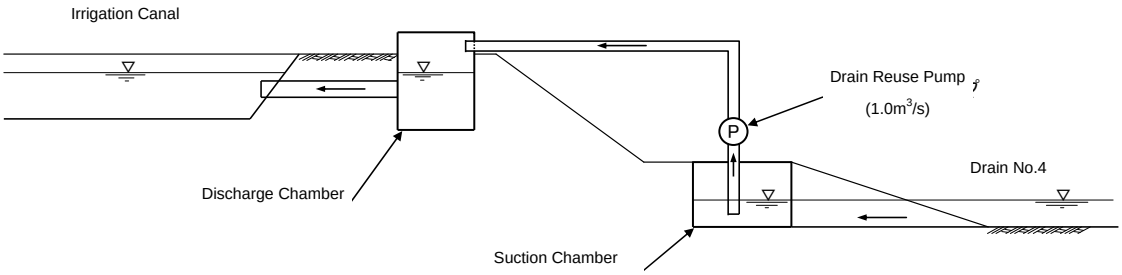


A DO value of less than 0.1 mg/l in the suction chamber rose to more that 5 mg/l in the discharge chamber by the re-use pump operation. It changed to less than 3.0mg/l in the irrigation canal at 10m-500m by attenuation with the raw water in the irrigation. However, it rose again to more than 5 mg/l by potable pump operation lifted from the irrigation canal.

There is no significant influence by MBD operation in the irrigation canal because of the small capacity of the MBD.

It is considered that there is no influence of MBD operation at the right side of dotted line in the graph that is at Sta.1000m, but the CO value rose by air mixing from the potable pump operation.





Layout of Shurafah Pumping Station

The DO value is increased by lifting water with a small pump to the tertiary

(7) Additional Test (Test-8 in “Table 2-3-3”)

The test was done for reference in order to confirm the improvement of the DO value in the closed water area. The MBD was installed and operated in the suction chamber and in the discharge chamber respectively at the Shurafah pumping station. Increasing the DO value in the chamber was recorded. The DO values of both chambers were increased to 5.0 mg/l within 50 minutes in the suction chamber and 10 minutes in the discharge chamber as shown in Table 2-3-7.

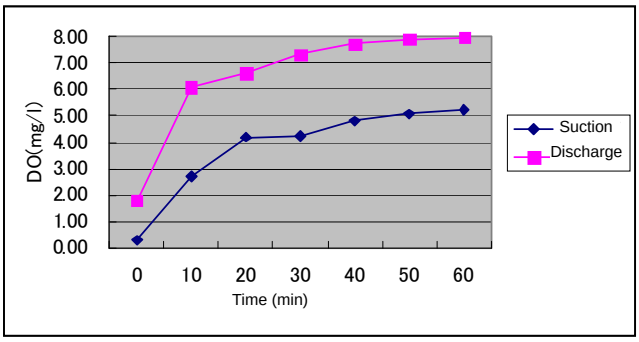
Table 2-3-7 Additional Test (Test-8)

Test	Purpose	Test Result	Comments
Test-8	Confirmation of increasing time of DO value in the two chambers at the Shurafah pumping station.	It took 50 min. in the suction chamber to increase from 0.3mg/l to 5mg/l, and 10 min. in the discharge chamber from 1.80mg/l to more than 5mg/l.	It took much time to improve the DO value in the suction chamber because raw water in the suction chamber may contain mud and bottom sedimentation. However, that in the discharge chamber may contain some air due to operation of the re-use pump.

Graph 2-6 【Test-8】DO-Rise in Suction & Discharge Chamber of Pumping Station

Type of Test	No.	Date	Test Place	Flow rate	MBD (dia. × unit)
Specification check	Test-8	Jan. 1, 2010	Suction and discharge chamber	None	21mm×1unit

Time (min)	Suction	Discharge
0	0.30	1.80
10	2.70	6.08
20	4.20	6.60
30	4.25	7.33
40	4.80	7.72
50	5.07	7.90
60	5.25	7.96



MBD Operation in Suction Chamber

Table 2-3-8 Dimension of Discharge Chamber in Shurafah Pumping Station

Length (inside)	205 cm (Concrete thickness : 50cm)
Width (inside)	309 cm (Concrete thickness : 50cm)
Depth (inside)	285 cm (Overflow pipe is set at 100cm from the top)
Effective Capacity	11.72m^3 (Volume under the overflow pipe)

(8) Result of Water Quality (Other Parameters)

Variation of DO value, COD value and T-N are described in the above sections. Other parameters analyzed in the laboratory are examined below.

(a) Temperature

Range of temperature resulted as 15℃~ 18℃, and it is increasing downstream. However, it is judged that this has no effect on water quality improvement. The WQS of the temperature is more than 5℃.

(b) pH

Variation of pH value was slight. It ranges from 7.12 to 9.62. It is considered that pH decreases by the CO2 produced by the decomposition of COD. However, there was no significant downslide in the tests and it was within 7 ~ 8.5 of the WQS except 2 data.

(c) EC and Salinity

EC and Salinity showed no significant variations in the test. The range of EC resulted in 1,537 ~ 2,380 μS/cm and that of Salinity resulted in 0.7 ~ 1.2 mg/l. These results are reasonable because the parameters are not relative to Oxygen concentration. However, there was an increasing trend toward downstream at Test-6 of the temporary drain without bottom vinyl sheets. It seems that the salinity deposited at the slope of the bank was melted in the temporary drain. There is no parameter of EC in the WQS.

(d) SS

The SS value showed no change among the stations. The range of SS resulted in 3 ~ 91 mg/l. Variation of SS depended on the velocity of water in the temporary drain. All data were not exceeding 500 mg/l of the WQS.

(e) Heavy Metal

Heavy metals, such as Arsenic, Cadmium, Cobalt, Chromium, Copper, Iron, Manganese, Nickel, Lead, Zinc, and Mercury, were tested at the stage of Field Survey-1. All parameters except Cobalt and Nickel, which have no parameters in the WQS, were below the stais ndard value.

(f) Coliform Group Count

Coliform group count was tested at the stage of Field Survey-1. Its range resulted in 10 ~ 90×10^5CFU. It was over 5,000 CFU of the WQS at the project site.

(g) ORP

Oxidation Reduction Potential (ORP) is a measure of the tendency of a chemical species to acquire elections (oxidation) and thereby be reduced (reduction).

A measure figure in the sewage processing is 100 ~ 150 mV at aerating tank in the activated sludge method and -200 mV at the anaerobic tank. Also, ORP figure is 400 ~ 500

mV at drinking water and approximately 180 mV at pure water generally.

In the nature it is 350 mV of ORP figure in the seawater and minus mV in the sand under the sea. ORP figure increases at the shallow depth of a river or a pond because photosynthesis influences water surface.

ORP figures collected in the test as shown in the table below are ones of the raw water and of the bottom sedimentation in the Drain No.4 (refer to the table below).

Table 2-3-9 Result of ORP in Drain No.4

Raw Water in Drain No.4（Dec. 28）					Bottom Sedimentation （Dec. 30）		
Time after MBD operation					Depth from the bottom		
0 min.	30 min.	1 hour	2 hours	3 hours	0.5m	0.8m	1.2m
90.0	102.7	154.1	174.5	141.5	75.5	73.9	81.2

Above table shows that ORP figures of the raw water are increasing according to passage of time by the effect of sunlight and these figures are higher than one of the bottom sedimentation.

ORP figures of the bottom sedimentation are around 80 mV irrespective of depth from the bottom of Drain No.4. It is considered that the same reduction state exists until 1.2 m depth from the bottom. Also, according to the test result, it is not considered that DO deoxidizes flow of Drain No.4 because of showing positive figure of ORP.

2-3-2 Growth Effectiveness Test for Crops

(1) Contents of Test

The objective of the test is to confirm the growth effectiveness of crops irrigated by improved water due to MBD operation. Test crops are rice, spinach and cabbage. Details are shown in Table 2-3-10 below:

Table 2-3-10 Growth Effectiveness Test

Date	Contents	Remarks
Dec. 17, 2009	Start of 1st germination test	Indoor test
Dec. 22, 2009	Start of 1st growth effectiveness test (GET)	Cultivation in the pot at the site by tap water. Seeded approx. 30 grains in total per one pot. Rice: each 4 pots by 2 kinds of soil (sand and soil in the filed), Spinach and cabbage: each 4 pots by soil in the filed Chemical fertilizer as a basal application was put uniformly.
Dec. 28, 2009	Finish of 1st germination test	Ratio of 1st germination test Rice: 100%, spinach: 52% and cabbage: 87%
Dec. 29, 2009	Start of 2nd germination test	Indoor test
Dec. 31, 2009	1st GET	All pots of the rice were covered by vinyl sheets.
Jan. 1, 2010	1st GET	A half of pots of all crops were irrigated by water of Drain No.4 and remaining pots were by improved water by MBD. Rice was watered everyday and vegetables once per 4 days.
Jan. 7, 2010	Finish of 2nd germination test	Ratio of 2nd germination test Rice: 97%, spinach: 18% and cabbage: 86%
Jan. 8, 2010	Start of 3rd germination test	Indoor test
Jan. 13, 2010	Start of 2nd GET	A half of pots of all crops were measured a number of growth crops and its total weight. At the same time, 5 rice seedling of 2nd germination test were planted in 4 pots.
Jan. 17, 2010	Finish of 3rd germination test	Ratio of 3rd germination test Rice: 99%, spinach: 19% and cabbage: 91%
Jan. 18, 2010	Verification-1 by Japanese Doctor of Agriculture	All seedlings of 1st GET were taken out. GET needs continuously.
Jan. 19, 2010	2nd GET	Five rice seedling of 3rd germination test were planted in 4 pots, as the same as one dated on Jan.13.
Mar. 10, 2010	Verification-2 by Japanese Doctor of Agriculture	It was found that the improved water by MBD operation was more efficient for rice than for vegetable.

(2) Result of Germination Test

The germination tests were conducted 3 times. The indoor temperature of the test was more than 20℃. The results of the test are shown in Table 2-3-11 below. Although the germination ratio of spinach was lower than that of others, spinach seed itself is no problem.

Table 2-3-11 Result of Germination Test

	Date	Rice	Spinach	Cabbage	Remarks	Date	Rice	Spinach	Cabbage	Remarks	Date	Rice	Spinach	Cabbage	Remarks
	Dec. 17	1st Seeding				Dec. 29	2nd Seeding				Jan. 8	3rd Seeding			
Day 1	Dec. 18					Dec. 30	0%	0%	6%	20.7 ℃	Jan. 9	0%	0%	74%	20.7 ℃
Day 2	Dec. 19					Dec. 31					Jan. 10	0%	0%	80%	
Day 3	Dec. 20					Jan. 1	0%	4%	79%		Jan. 11	38%	3%	89%	
Day 4	Dec. 21	39%	10%	87%		Jan. 2	38%	7%	80%		Jan. 12	93%	8%	91%	
Day 5	Dec. 22	50%	14%	87%		Jan. 3	76%	9%	83%		Jan. 13	99%	16%	91%	
Day 6	Dec. 23	77%	21%	87%	22.0 ℃	Jan. 4	96%	13%	85%		Jan. 14	99%	18%	91%	
Day 7	Dec. 24	95%	36%	87%	21.2 ℃	Jan. 5	97%	17%	86%		Jan. 15	99%	18%	91%	
Day 8	Dec. 25	98%	49%	87%	21.2 ℃	Jan. 6	97%	18%	86%		Jan. 16	99%	19%	91%	
Day 9	Dec. 26					Jan. 7	97%	18%	86%		Jan. 17	99%	19%	91%	
Day10	Dec. 27					Jan. 8					Jan. 18				
Day11	Dec. 28	100%	52%	87%	20.7 ℃	Jan. 9					Jan. 19				

(3) Result of First Growth Effectiveness Test (GET-1)

Approximately 30 seeds of rice, spinach and cabbage each were sown in one pot on December 22, 2009. Vegetables had 4 pots each and rice had 8 pots; namely, 2 kinds of soil (sand and soil in the field) and 4 pots each. There were 16 pots in total for the first growth effectiveness test (GET-1). Irrigation water was changed from tap water to re-usable drainage water from Drain No4 (D-water) or improved drainage water of Drain No.4 by MBD operation (M-water) on January 1, 2010. Maximum plant length of GET-1 up to January 13, 2010 is shown in Table 2-3-12. Table 2-3-13 shows the seeding growth condition (number, weight, etc.) on January 13.

Table 2-3-12 Maximum Plant Length

Pot No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Crops	Rice								Spinach				Cabbage			
Watering	M-Water				D-Water				M-Water		D-Water		M-Water		D-Water	
Soil	Soil		Sand		Soil		Sand		Soil				Soil			
Date	Maximum Plant Length (cm)															
Jan. 1, 2010	0	0	0	0	0	0	0	0	0	2	4	4	3	3	3	3
Jan. 2, 2010	0	0	0	0	0	0	0	0	3	2	4	4	3	3	3	3
Jan. 3, 2010	0	0	0	0	0	0	0	0	3	3	4	4	3	3	3	3
Jan. 4, 2010	0	0	0	0	0	0	0	0	4	3	5	5	3	3	3	3
Jan. 5, 2010	0	0	0	0	0	0	0	0	5	4	6	6	4	3	3	3
Jan. 6, 2010	0	0	0.5	0.5	0	0	0.5	0.5	6	5	7	7	4	3	4	4
Jan. 7, 2010	0	0	1	1	0	0	1	1	7	5	8	7	5	3	5	4
Jan. 8, 2010	-	-	-	-	-	-	-	-	7	7	8	7	6	4	5	5
Jan. 9, 2010	-	-	-	-	-	-	-	-	7	7	8	8	6	5	5	5
Jan.10, 2010	-	-	-	-	-	-	-	-	7	7	8	9	6	5	8	6
Jan.11, 2010	0	2	3	3	3	3	2	2	7	8	9	9	6	6	8	6
Jan.12, 2010	3	3	4	4	3	4	4	3	7	8	9	9	6	6	9	6
Jan.13, 2010	3	3	4	4	3	4	4	3	7	8	9	10	7	7	9	7

Table 2-3-13 Seeding Growth Condition by GET-1

Pot No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Crops	Rice								Spinach				Cabbage			
Watering	M-Water				D-Water				M-Water		D-Water		M-Water		D-Water	
Soil	Soil		Sand		Soil		Sand		Soil				Soil			
Max. Plant Length (cm)	3.0	0.0	4.1	4.0	3.0	4.0	4.0	3.0	7.4	8.0	9.2	10.1	6.9	7.0	9.2	7.0
Number of Seeding	7	0	11	6	6	4	10	6	5	7	13	17	8	9	14	12
Weight of Root (g)	1≧	-	1≧	-	1≧	-	1≧	-	1≧	-	1≧	-	1≧	-	1≧	-
Weight of Shoot (g)	1≧	-	1≧	-	1≧	-	1≧	-	1	-	7	-	4	-	9	-
Weight per Seeding (g)	1≧	-	1≧	-	1≧	-	1≧	-	0.2	-	0.5	-	0.5	-	0.6	-
Growth Condition of Root	Tad	-	Tad	-	Tad	-	Tad	-	Tad	-	Tad	-	Tad	-	Tad	-

As a result of GET-1 by the Japanese Doctor of Agriculture (Katsuyoshi Shimizu, Assistant Professor of Tsukuba University), he suggested that it was necessary to irrigate crops by March in order to assess the growth effectiveness of crops though the root condition of crops by M-water, which was better than that of D-water.

(4) Result of Second Growth Effective Test (GET-2)

Five seedlings each of rice sown at the second germination test were planted in 4 pots for GET-2 on January 13, 2010. As regarding spinach and cabbage, five seeds each were sown in one pot on February 5, 2010. The irrigation water was the same as the GET-1. The result is shown in Table-2-3-14.

Table 2-3-14 Result of GET-2

Crops	Watering	Plant length (cm)	Foliar age	SPAD	Root length (cm)	Fresh weight (g)
Rice	D-water	20.2 ± 5.9	4.1 ± 2.9	26.3 ± 3.6	6.8 ± 2.5	0.6 ± 0.2
	M- water	29.2 ± 3.0	6.8 ± 0.5	35.0 ± 3.1	6.8 ± 1.6	1.3 ± 0.4
Spinach	D-water	8.3 ± 0.5	5.0 ± 1.1	38.1 ± 1.7	5.1 ± 2.3	1.4 ± 1.0
	M- water	4.6 ± 1.7	6.0 ± 0.0	29.8 ± 1.3	2.6 ± 0.7	0.4 ± 0.2
Cabbage	D-water	16.4 ± 2.4	5.7 ± 0.8	48.0 ± 4.7	4.9 ± 0.4	7.1 ± 3.3
	M- water	11.4 ± 1.5	4.8 ± 0.4	38.7 ± 2.1	5.9 ± 1.1	4.8 ± 1.2

Note） SPAD (Soil & Plant Analyzer Development): Index of chlorophyll contents of leaves

All crops were gathered on March 10, 2010 for assessing the growth condition.

Rice irrigated by M-water had a better growth condition than that by D-water, such as higher plant length and 2 times the fresh weight. Root length of both watering types was nearly the same, but the roots which were irrigated by M-water were more luxuriant than those irrigated by D-water. Meanwhile, spinach and cabbage irrigated by D-water had a better growth condition than that by D-water, such as a higher SPAD value.

2-3-3 Rural Sewage Treatment Facility

During Field Survey-1, those who are responsible for the O&M of the proposed facilities were questioned in the course of the discussions with MWRI because the facilities to be installed outside the canals are out of the responsibility of MWRI unlike the in-stream treatment facilities or drainage water re-use pumps. MWRI instructed that the involvement of entities like the Water Users Association (WUA) and Local Unit should be preconditioned, when the components such as a sewage treatment system and composting system, which are installed outside the canal, are considered. It has been confirmed that the study and discussions on the responsibilities of the other entities aside from MWRI should be pursued in Field Survey-2.

The Study Team surveyed the Biyala City Council (Local Unit) and WUA in Bahr El Nour as the possible responsible entities for O&M of the facilities. Also, the Study Team made interviews to the Holding Company for Water & Wastewater (HCWW) concerning the rural sewage treatment system and the Ministry of Agriculture and Land Reclamation (MALR), Agriculture Extension Sector (AES) and the Biyala Agriculture Office, concerning the composting facilities.

The following is the information received from HCWW concerning the rural sewage treatment system:

(1) Strategy of HCWW for Rural Sewage Treatment System Development

HCWW has prepared a master plan in each governorate for the extension of the wastewater treatment system. The minimum size of the facility in their strategy is set at from 2,000-5,000 m^3/day for a population of at least 8,000. They do not have a policy to construct a small wastewater treatment unit, which would cover villages with a population of around 100 to 500.

The strategy of HCWW for rural sewage treatment system development is defined as clustering, namely grouping villages into a cluster to network them with pipelines into the treatment facility, for which HCWW will be responsible. The clusters have been prioritized for implementation in their master plans.

HCWW considers that the cost for installing many small treatment units in small villages (hamlets) would be higher than networking the villages with pipelines into the large-scale treatment system, since collecting sludge from many units by using a honey wagon would cost much more than the O&M cost of the pipeline system, albeit the pipeline system requires a considerable initial investment cost.

According to the interview with the office of HCWW in the Kafr El Sheikh Governorate, the master plan of the governorate covering the project area of this Study and Biyala city has been formulated with the target year of 2037. However, the small villages (hamlets) situated

around the Bahr El Nour area are not covered by the master plan, thus it has been confirmed that constructing a small rural sewage treatment unit in the small villages would not be consistent with the policy and strategy of HCWW.

Conversely, a project for the construction of a septic tank in the Fayoum governorate implemented by WQU of MWRI has provided a model of O&M of the facility by making an agreement between WQU and the Local Unit, which takes responsibility for the O&M of the facility, and the role of HCWW in Fayoum is defined in this agreement as for providing technical training to the users of the facility. It could be expected that HCWW would be able to provide such technical assistance to the operation of the rural sewage treatment system.

(2) Outline of the Wastewater Treatment System of HCWW

A generally activated sludge method has been applied for the minimum scale of a wastewater treatment system of HCWW. The sludge is disposed of by dry yard. Major items of the O&M cost are labor force and electricity for aeration and the operation cost is estimated at from LE.0.5 to LE.0.6/m^3 excluding repair cost.

The cost for the wastewater treatment is included in the charge of water supply. HCWW has a workforce to collect the charge from users. The average charge of water supply is from LE.0.25 to LE.0.4/m^3. The charge for wastewater treatment is added to the charge of the water supply at a rate of 35% of it, e.g. if the charge of the water supply is LE.0.4/m^3, the charge of the water supply and wastewater treatment is calculated as LE.0.4 x 135% = LE.0.54/m^3 (charge of the wastewater treatment is LE. 0.14/m^3).

HCWW has not been fully privatized but is receiving subsidy from the Government to run the operation. The amount of the subsidy, which HCWW receives from the Government, is said to be twice to three times the amount of the charge collection. As mentioned above, this subsidy ratio can be verified from the required O&M cost and the charge of wastewater treatment to the users.

(3) Basic Strategy for Planning O&M of Rural Sewage Treatment System (Simple Septic Tank)

In the villages which are not connected to the wastewater treatment facility, sludge is collected from individual small septic tanks by private companies, which costs from LE.5 to LE.10/month. Collecting sludge by a honey wagon seems more costly than the pipeline network due to its less efficient operation. If the villages were connected with a pipeline in the future, the cost for sludge disposal would be less, but for the villages without the plan of a pipeline, networking the target O&M cost for introducing a rural sewage treatment system should be around LE.5/month per household or less.

As discussed above, it is unlikely that HCWW would be the entity responsible for the O&M of the rural sewage treatment system. Therefore, it would be practical for O&M of the

system to apply the model developed in the Fayoum governorate by WQU of MWRI, namely making an agreement among the stakeholders, such as the Ministry, HCWW, Local Unit, etc., that the Local Unit is the owner and responsible for the O&M of the system.

2-3-4 Composting Facility

The following is the information obtained from AES of MALR about the composting facility:

- It is a good idea to construct a composting facility along the drainage canal. MARL has never constructed such a facility that the Study Team is proposing (concrete wall along the drainage canal). However, if such a facility was constructed, AES could cooperate in organizing farmers to utilize the facility and train them on how to make compost as the duty of the Sector.
- The Sector cannot be responsible for the O&M of the facility (it is difficult to source the cost for repair, etc.), and if the facility were constructed within the land where the drain is, EPADP or a farmer organization should be responsible for the facility. WUA is responsible for the maintenance of the canal so that the existing WUA could be the responsible organization for the O&M of the facility rather than establishing a new farmer organization, even in consideration of the size of the facility and simple technology.
- There will be no preconditions or regulation from MALR as far as using the land owned by MWRI to construct the composting facility along the drainage canal. In case the land in question belongs to MALR, permission from the Land Protection Sector of MALR will be required.

It would therefore be possible to get technical cooperation from MALR for operating the composting system. The ownership of the facility would depend on the owner of the land for the facility. If the facility were constructed within the drainage canal area, MWRI would be the owner of the facility, and if the land belonged to public land, the owner would be the Local Unit. In case of constructing the facility on the land of the drainage canal, MWRI could construct such a facility for the purpose of the canal protection (wall to protect the canal slope), and MWRI would be the responsible agency for the O&M of the facility.

Practically, the O&M set-up would be established so that the WUA is an operator of the facility and MWRI is a supervisor, since the maintenance cost of the planned structure would be almost nil unless the structure collapses due to change of land form.

2-3-5 Drainage Water Re-use Pumping Station

A drainage water re-use pumping station is planned at the place where the drain and the irrigation canal are close to each other. The Study Team carried out a reconnaissance survey on

the candidate sites of constructing a drainage water re-use pump station as per the reference to the future planning. The Study Team visited a site around the Bahr El Nour area and three sites in the Central Delta, which were requested by MWRI for a Japanese grant aid project in July 2008.

Table 2-3-15 Surveyed Candidate Sites for Constructing Drainage Water Re-use PS

No.	Drain	Irrigation Canal	Remark
1	Old Khadra	Sidi Gaber	Requested for grant in 2008
2	Farsh El Ganayen	Mar El Gamel	Requested for grant in 2008
3	Naser	Al Mansor	Requested for grant in 2008
4	Drain No.4	Gard El Agami	

The No.4 site is located southeast of the Bahr El Nour area, and the candidate drain is Drain No.4, the same one of the Project. This site is located upstream from the Project area, and the water quality is considered more or less the same as that of the Project area. The other candidate sites are located in the coastal area of the Mediterranean Sea, and therefore the salinity concentration in the water needs to be confirmed for applying it to drainage water re-use for irrigation.

2-3-6 Result of Sub-Contract Works

The following sub-contact works were conducted in the Additional Field Survey-2, including the social condition survey, which has not been carried out in the Field Survey-1 because of the delay of permission for the works.

(1) Water Quality Analysis-2

The water quality test-2 consists of water quality analysis and sedimentation analysis of the following parameters and sampling points. The result of the water quality test-2 is shown in “Appendix-8 Water Quality Result”.

Table 2-3-16 Water Quality Analysis-2

Items	Description
1) Water Quality Analysis	29 parameters × 74 samples
- Parameters	DO、CODcr、ORP、SS、ｐH、T-N、NH_3-N、NO_2-N、NO_3-N
- Sampling points	0m、10m、50m、200m and 500m from MBD
- Interval	① Before operation of MBD ② At the operation of MBD ③ 1 hour after the operation of MBD ④ 2 hours after the operation of MBD ⑤ 3 hours after the operation of MBD
- Others	Sample ⑤ is tested after 24 hours.
2) Sedimentation Analysis	8 parameters × 3 samples
- Parameters	Ignition loss、T-N、T-P、NO_2-N、NO_3-N、CODcr、$SO4_2$-、ORP
- Sampling points	0.5m、0.8m and 1.2m in depth from the bottom

(2) Social Condition Survey

A social condition survey was carried out to grasp the situation of irrigation water shortage and re-use of drainage water, living conditions of the village, and disposal of agricultural waste, as well as the capacity or willingness of the farmers to pay for O&M cost of wastewater treatment system if it were constructed. The survey was conducted with a prepared questionnaire.

The villages surveyed were five villages with 134 households: Al Saei, Al Nahas and Al Doksh, located along the Bahr El Nour irrigation canal and the Biyala drain, and Ash Shurafah and Al Tanapra, located along the Ash Shurafah irrigation canal. Farmers in the latter two villages are re-using drainage water from Drain No.4. The number of the sample household in each target village was shown in the following table. The samples cover almost all the households in the target villages. The average family size of the samples is 5.5 persons per household.

As the survey result shows, it was confirmed that the farmers in all the five villages have suffered from irrigation water shortage and required drainage water re-use. Also, the farmers feel that water quality in the drain is deteriorating and they think the discharge of sewage into the canal is a cause of worsening water quality.

Among the five villages, sewage/wastewater has been directly discharged into the drain in the Al Nahas and Al Doksh villages, and in the other three villages, sewage/wastewater has been collected from an individual septic tank by honey wagon. The average cost of disposing sewage/wastewater is LE15 per month per household in Al Saei, LE19 in Ash Shurafah, and LE29 in Al Tanapra. The mode for the disposing cost in the three villages is LE10 per month per household. The majority of farmers feel that the cost is expensive, and some say that the cost should be free of charge.

It was found that farmers in the five villages are all tenants with a share-cropping system (dividing the produce between land owner and tenant by half). The average farming area of the sample farmers is 2.82feddan (1.18ha). The small-scale farming and share-cropping tenancy make the farm income low. It is estimated that the average annual farm income (income from crop production) is LE.3,583 per household. Because the valid answers about income from animal husbandry and other sources were not obtained, farmers may have another additional income rather than farm income. Also the value of home consumption is not included in the farm income.

The ratio of disposing cost of sewage/wastewater to the average farm income is estimated at 5.7% in case of applying the average cost of sewage/wastewater disposal, for which the sample farmers are actually paying. In case of applying the mode of disposing cost for sewage/wastewater, the ratio of the cost to the average farm income is calculated at 3% to 4% in

each village. This amount would not be cheap for the farmers, but they are actually paying this amount for the disposal. Therefore, it could be said that if a sewage treatment facility were constructed, it should be designed with its O&M cost less than or around LE.10 per month per household, as the users of the facility would be able to pay for the O&M cost if the fee were set at such a range.

Table 2-3-17 Outline of the Social Condition Survey Result

Irrigation Canal	Bahr El Nour			Ash Shurafah		Total
Drain	Biyala Drain			No.4 Drain		
Name of Village	Al Saei	Al Nahas	Al Doksh	Ash Shurafah	Al Tanapra	(Ave.)
No. of Sample	24	51	11	39	9	134
Ave. Family Size	5	5	4	7	5	5.5
Period of water shortage						
Summer (%)	8.3	0.0	18.2	43.6	22.2	17.2
Summer + Winter (%)	91.7	100.0	81.8	56.4	77.8	82.8
Period of re-use						
Summer (%)	4.2	86.3	18.2	11.1	0.0	39.2
Winter (%)	4.2	0.0	0.0	0.0	0.0	0.80
Summer + Winter(%)	91.6	13.7	81.8	88.9	100.0	60.0
Disposal of sewage						
Drain (%)	0.0	100.0	100.0	2.6	0.0	47.0
Honey wagon (%)	100.0	0.0	0.0	97.4	100.0	53.0
Cost of Disposal						
Ave. (LE/month)	15	-	-	19	29	18.9
Mode (LE/month)	10	-	-	10	20	10
Willingness (LE/m)	0	-	-	7	0	
Ave. farming area (fed) ( ) = ha	2.25 (0.95)	2.36 (0.99)	2.64 (1.11)	3.71 (1.56)	3.28 (1.38)	2.82 (1.18)
Ave. farm income (LE/yr)	3,012	3,070	3,117	4,744	3,553	3,583
Ave. disposing cost (LE/yr)	180	-	-	228	348	227
Ratio to farm income (%) (*)	5.98	-	-	4.80	9.79	5.65
Ratio to farm income: In case disposing cost is LE120/yr (%)	*3.98*	*3.91*	*3.85*	*2.53*	*3.38*	*3.35*

(*) Average is of Al Saei, Ash Shurafah and Al Tanapra

CHAPTER 3 RECOMMENDATION

CHAPTER 3 RECOMMENDATION

3-1 Field Survey-1

The Project is important for Egypt to be able to use its limited water resources to the full extent, since the available resources are being adversely affected by climate change. The Project focuses not only on increasing the volume of the water resources but also to improve the water quality, which may have decreased as the resource has been affected.

Water from the irrigation canal in the Nile delta is very important for farmers to use to irrigate the fields and also for inhabitants to utilize as a domestic water source. If this domestic wastewater flows discharged into drainage canal downstream without treatment, it cannot be used for irrigation and domestic water downstream. These issues happen not only in the Nile delta but also anywhere else.

The study site of the Project is at Bahr El Nour and its neighboring in Kafr El Sheikh Governorate located in the northern coastal area of the Nile Delta. The Bahr El Nour area is irrigated by the Bahr El Nour irrigation water flowing in the center of the area, but the irrigation water is insufficient during the irrigation period. Then, the drainage water of the Biyala drain is used for irrigation water during the irrigation period. However, the water quality of the Biyala drain collecting the domestic wastewater of Biyala city upstream is extremely bad and does not satisfy the national water quality standards (NWQS). There are two existing pumping stations for re-using drainage water along Drain No.4, which is a main drainage canal on the northern side of the Bahr El Nour area. Drainage water of Drain No.4 is important for the two existing pumping stations, as they irrigate the western site of the Bahr El Nour area through the Ash Shurafah irrigation canal and the Bahr Biyala irrigation canal. According to the Field Survey-1, the water quality of Drain No.4, such as DO and COD, is also bad and below the NWQS. In addition to this, the domestic wastewater of villages in Bahr El Nour and its neighboring area flows into the irrigation canal without treatment, and agricultural waste disposal stock-piling around the villages also causes bad water quality in the irrigation canal.

Under these present conditions, it was clarified during the Field Survey-1 that:

- Drainage water re-use is an effective measure from the water resources point of view in Egypt, where water resources are limited. However, the water quality of the canals in the Nile delta is totally polluted. Improvement of water quality in drainage canals is essential in order to secure water resources effectively. The contents of the Project coincide with this purpose.
- The purpose of an in-stream treatment facility, one of the proposed systems, is to purify the drainage water, an important pre-requisite for re-using the drainage water. A drainage water re-use facility is also essential for securing irrigation water.

- With respect to the pump-type for drainage water re-use facility, the Egyptian pump is enough to use from the O&M point of view. It is unnecessary to use a pump-gate type, which is proposed.
- Because of the present pollution of the irrigation canal, it is essential to implement a sewage treatment facility and composting facility for improving the water quality of the irrigation canal. On the other hand, the bio-energy for the composting facility is premature to be planned in the project.
- With respect to implementation agencies, obtaining lands and the O&M system for the facility were not confirmed during the Filed Survey-1 and more study is required. It is especially necessary for the O&M system of the sewage treatment facility and composting facility to enlighten the beneficiary and to establish the O&M system.

3-2 Additional Filed Survey

Water quality improved with the MBD, which uses advanced Japanese technology, and was validated during the Additional Filed Survey. Also, the advantage of a micro-bubble in the stream or canal created by MBD operation was confirmed though the MBD test and is commonly used in closed water areas in Japan. Raw water flow in the tests was arranged by installing the temporary drain in order to fit the capacity (number of units) of the MBD. Some positive results were achieved by the tests implemented while simulating many problems and various constraints.

Through the specification check in order to confirm the genuine effect of the MBD, the expected effect of water quality improvement was observed in securing the condition of closed water areas. However, it would not be economical to clear the NWQS of drainage re-use water by using the MBD alone under the condition of very bad rates of DO and COD values and considering the actual volume of re-use water during an irrigation period. As it is judged that only MBD is not enough to improve water quality, further study scheduled for detailed design and cost estimation of the Project was cancelled. Yet it has been reconfirmed that supplying Oxygen has an effect to decrease COD and Nitrogen value even in the flowing water. At the moment the MBD could be utilized just as a model to demonstrate its effect of improving water quality.

On the other hand, mixing air by re-use pump operation had a good effect on increasing DO value. In addition to this, it was also confirmed that potable pumps installed along branch/tertiary canals connected with farm fields also had an effect. These systems (mixing air by pumps) will be studied as future countermeasures of water quality conservation.

Regarding the growth effectiveness of crops irrigated by improved drainage water of Drain No.4 by the MBD operation, it was found that improved water by the MBD operation was more

efficient for rice than for vegetables (spinach and cabbage) and that the water quality improvement is not only implemented based on the legal regulations but also understood from the aspect of the practical advantage for farmers. In order to make results of the growth effectiveness test more effective, it is necessary to continue the test also during the irrigating period.

Originally, countermeasures for water quality conservation is comprehensive and each measure should be taken simultaneously after an overall picture of water utilization and pollution are understood/recognized and the countermeasures are discussed among those concerned, as the causes for water pollution and the purposes for utilizing water are various. The measures from the aspect of agriculture are limited to those against causes in rural areas and to in-stream treatment such as a treatment applying the MBD. And it is not fair that only those who utilize the water in rural areas bear the cost for applying the measures.

Therefore it is necessary to share immediately basic understanding to discuss comprehensive countermeasures through the discussion on the following:

i) The water pollution is originated from the water quality of mainstream Nile River water or is caused by pollutants in urban areas.
ii) The position and responsibility of those who benefit from the improvement of water quality.
iii) The policy to apply the countermeasures and to levy for pollutants.
iv) Others.

The first approach is to collect and analyze all data kept by Ministries concerned in Egypt, to grasp the present situation of water quality and to make an outline of comprehensive countermeasures. It will be essential and an effective way based on Japanese experience of environmental pollution and its countermeasure. After such an approach is undertaken, it is recommended to utilize the results of this O/D Study.

3-3 Recommendation for Future Study

This Report was to be prepared for the implementation of Japanese Grant Aid Program. However, it was confirmed that the in-stream treatment facility only by MBD mainly applying Japanese technology, was not feasible and economically inefficient to comply with NWQS.

Issues raised during the field survey are arranged herein for the purpose of continuing the Project in the future, as follows;

- The field survey was conducted during a non-irrigation period (from October to January of the following year) when the discharge of Nile River is low. The discharge of this season is approximately 50% of the irrigation period (from May to September) when the

discharge of Nile River is high. The water quality also varies between the irrigation period and the non-irrigation period. Good water quality during the irrigation period is essential and shall be measured for designing the in-stream treatment facility because more drainage water is utilized for the irrigation water during the irrigation period.

- According to the survey result, the main issues of pollution in the proposed Project site are (i) bad water quality deriving from the upstream of the Project areas and (ii) untreated water quality deriving from wastewater flowing from within the Project sites, such as, domestic wastewater of the villages, agricultural waste disposal (animal feces and urine, straw, etc.) and illegal dumping of refuse.

  In case of (i) above, the problems shall be discussed among the agencies concerned in the country constructively. One of the measures for re-using drainage water to be taken in the Project site is to make the plan for water quality improvement not for all volume in the drainage canal, but for the minimum flow for re-using the drainage water to improve the necessary volume. As for (ii) above, the measures must be discussed and taken in the Project site.
- The program for sewerage in Egypt is implemented mainly in the urban areas and there is no plan in the Project site. However, as the domestic wastewater of the villages in the Project site is one of main causes of the pollution for the irrigation water, it is urgently necessary to make a plan of the sewage treatment facility in order to improve water quality of the irrigation canal in the Project site.
- It is ideal for conserving water quality to carry out all countermeasures to be considered simultaneously. However, considering the necessity of equal expense for the cost of countermeasures by all concerned with water quality control and of encouraging their participation, total volume of pollutants and ratio of each pollutant, the cost for countermeasures, the target of water quality improvement and its prospect are to be proposed.
- It should be avoided that the sense of inequality among farmers, which is raised by unsuccessful water quality improvement resulted from the actions taken only by farmers, cause the hindrance to necessary activities for achieving the abovementioned target. It is important that the government shall make measures and policies with their quantitative indicators for the conservation of water quality.
- With respect to the sewage treatment facility and the composting facility, the implementing agency would be different from MWRI, the counterpart organization of the Project. Therefore, it is necessary to secure lands for the facilities and to clarify the organization for O&M in the future before planning. It is important to coordinate with the authorities concerned and local councils.
- It is confirmed that the sewage treatment facility and the composting facility are essential but it is also important to enlighten the awareness of the inhabitants and to organize the O&M system, taking in consideration the future O&M.

Appendices

Appendix-1 Member List of the Study Team

1-1 Member of Field Survey-1 Study Team

	Name	Job title	Occupation
1.	Yoshiyuki GOYA	Team Leader	Executive Technical Advisor to the Director General, Rural Development Department, JICA
2.	Yuka SEO	Planning Management	Field Crop Based Farming Area Division 2, Field Crop Based Farming Group, Rural Development Department, JICA
3.	Toshiyuki OMOTO	Procurement Management	First Construction Management Division, First Management Department, JICS
4.	Noriyasu KIMATA	Chief Engineer/ Wastewater Treatment System	Technical Advisor, Project Operation Division, International Department, Sanyu Consultants Inc. (SCI)
5.	Toru TAKAHASHI	Agricultural Waste Treatment / Bio-energy Generation	Manager, Project Operation Division, International Department, SCI
6.	Tuneyoshi OGISO	Rural Infrastructure / Rural Sewage Treatment System	General Manager, Project Operation Division No.2, Domestic Department, SCI
7.	Toshinori KUDO	Construction Plan / Cost Estimate / Tender Document Preparation	Senior Engineer, Project Operation Division, International Department, SCI
8.	Akihiko HATA	Operation & Maintenance / Financial Analysis / Environmental & Social Consideration-2	Agro-economist, Project Planning & Promotion Division, International Department, SCI
9.	Sachiko HIRANO	Coordinator	Technical Assistant / Administrator, Project Operation Division No.2, International Department, SCI

1-2 Member of Additional Field Survey Study Team

	Name	Job title	Occupation
1.	Yoshiyuki GOYA	Team Leader	Executive Technical Advisor to the Director General, Rural Development Department, JICA
2.	Nobuyuki KOBAYASHI	Cooperation Planning	Field Crop Based Farming Area Division 2, Field Crop Based Farming Group, Rural Development Department, JICA
3.	Noriyasu KIMATA	Chief Engineer/ Wastewater Treatment System	Technical Advisor, Project Operation Division, International Department, Sanyu Consultants Inc. (SCI)
4.	Toru TAKAHASHI	Agricultural Waste Treatment / Bio-energy Generation	Manager, Project Operation Division, International Department, SCI
5.	Tuneyoshi OGISO	Rural Infrastructure / Rural Sewage Treatment System	General Manager, Project Operation Division No.2, Domestic Department, SCI
6.	Akihiko HATA	Operation & Maintenance / Financial Analysis / Environmental & Social Consideration-2	Agro-economist, Project Planning & Promotion Division, International Department, SCI
7.	Sachiko HIRANO	Coordinator	Technical Assistant / Administrator, Project Operation Division No.2, International Department, SCI

1-3 Member of Supervision of Cultural Test

	Name	Job title	Occupation
1.	Katsuyoshi SIMIZU	Advisor of Cultural Test	Associate Professor, Graduate School of Life and Environmental Sciences, Tsukuba University
2.	Toru TAKAHASHI	Agricultural Waste Treatment / Bio-energy Generation	Manager, Project Operation Division, International Department, SCI

Appendix-2 Study Schedule

2-1 Field Survey-1

No.	Date	Day	Official members	Consultant members					
				Chief Engineer/Wastewater Treatment System	Agricultural Waste Treatment / Bio-energy Generation	Rural Infrastructure / Rural Sewage Treatment System	Construction Plan / Cost Estimate / Tender Document Preparation	Operation & Maintenance / Financial Analysis / Environmental & Social Consideration-2	Coordinator
1	Sep.27	Sun		Trip (Kansai→Dubai)	Trip (Haneda→Dubai)	Trip (Kansai→Dubai)			Trip (Haneda→Dubai)
2	Sep.28	Mon		Trip (Dubai→Cairo)					Trip (Dubai→Cairo)
3	Sep.29	Tue		Courtesy call to JICA Cairo Office, MWRI, Explanation on Ic/R and Questionnaire, Arrangement for sub-contract survey					same as others
4	Sep.30	Wed		Meeting at Kafr El Sheikh Drainage office and Irrigation Advisory Service, Site selection					same as others
5	Oct.1	Thu		Site investigation at Bahr El-Nour Canal Area					same as others
6	Oct.2	Fri		Site investigation at Bahr El-Nour canal, Biyala Drain and Drain No.4	Site investigation at Bahr El-Nour canal, Biyala Drain and Drain No.4	Site investigation at Bahr El-Nour canal, Biyala Drain and Drain No.4			Preparation of sub-contract survey
7	Oct.3	Sat		Site investigation at Bahr El-Nour Canal Area					ditto
8	Oct.4	Sun		Meeting at Irrigation Advisory Service at Kafr El-Sheikh Meerting at MWRI			Trip (Haneda→Dubai)		ditto
9	Oct.5	Mon		Meeting at Irrigation Advisory Service at Kafr El-Sheikh, Site survey			Trip (Dubai→Cairo)		ditto
10	Oct.6	Tue		Analysis of collected data					data analysis support
11	Oct.7	Wed		Site survey for existing projects	Preparation of sub-contract survey	Site survey for existing projects	Meeting at MWRI		Preparation of sub-contract survey
12	Oct.8	Thu		Data Collection at EPADP, Meeting at JICA, Preparation of sub-contract survey		Analysis of collected data	Data Collection at EPADP, Meeting at JICA, Preparation of sub-contract survey		Data collection at EPADP, Meeting with JICA, Preparatiion of sub-contract survey
13	Oct.9	Fri		Analysis of collected data					same as others
14	Oct.10	Sat		Analysis of collected data			ditto		ditto
15	Oct.11	Sun		Meeting at Kafr El Sheikh Drainage office and Irrigation Advisory Service	Supervision of sub-contractor				
16	Oct.12	Mon		Data collection at WQU and EPADP, Meeting at WWRI	ditto	〃	Collecting quatations	Hearing from Farmers at the site	Data analysis support
17	Oct.13	Tue		Meeting at MWRI	ditto	〃	Collecting quatations	Data collection/analysis	Preparation of sub-contract survey
18	Oct.14	Wed	Meeting at JICA and Courtesy call to Embassy of Japan		Meeting at JICA, Data collection at EPADP			Meeting at JICA and Courtesy call to Embassy of Japan, preparation of sub-contract survey	
19	Oct.15	Thu	Courtesy call to MWRI and related agencies, Internal meeting		Internal Meeting, Data collection at EPADP			MCourtesy call to MWRI and related agencies, Internal meeting	
20	Oct.16	Fri	Preparaton for MM	Analysis of collected data					
21	Oct.17	Sat	Site Survey				Data collection/analysis	Site Survey	
22	Oct.18	Sun	Meeting at JICA, courtesy call to Embassy of Japan	Meeting at JICA	Data collection/analysis	Data collection/analysis	Data collection at EPADP	Meeting at JICA	
23	Oct.19	Mon	Discussion with MWRI about M/D		Data collection at EPADP, Ministry of Agriculture and Cairo University		Discussion with MWRI about M/D		
24	Oct.20	Tue	Discussion with MWRI		Data collection at Kafl El Sheikh	Data collection/analysis	Cost Estimate collection at EPADP	Discussion with MWRI	Discussion with MWRI
25	Oct.21	Wed	Singing M/M Trip (Cairo→Tokyo)	Singing M/M	Data collection/analysis	ditto	ditto	Singing M/M	
26	Oct.22	Thu	Trip (Cairo→Tokyo)	Data collection at MWRI	Preparation of a report of the survey result		ditto	Data collection/analysis	data analysis support
27	Oct.23	Fri		Preparation of a report of the survey result	Trip (Cairo→Dubai)		Preparation of a report of the survey result		Preparation of a report of the survey result
28	Oct.24	Sat		ditto	Trip (Dubai→Haneda)	Trip (Dubai→Kansai)	ditto		ditto
29	Oct.25	Sun		Meeting at JICA and Embassy of Japan about survey result			Meeting at JICA about survey result		Meeting at JICA about survey result
30	Oct.26	Mon		Preparation of a report of the survey result Trip (Cairo →Dubai)			Preparation of a report of the survey result Trip (Cairo →Dubai)		Preparation of a report of the survey result Trip (Cairo →Dubai)
31	Oct.27	Tue		Trip (Dubai →Haneda)			Trip (Dubai →Haneda)		Trip (Dubai →Haneda)

2-2 Additional Field Survey

No.	Date	Day	Official members	Consultant members				
				Chief Engineer/Wastewater Treatment System	Agricultural Waste Treatment / Bio-energy Generation	Rural Infrastructure / Rural Sewage Treatment System	Operation & Maintenance / Financial Analysis / Environmental & Social Consideration-2	Coordinator
1	Dec. 7	Mon			Trip (Haneda→Dubai)	Trip (Kansai→Dubai)		Trip (Haneda→Dubai)
2	Dec. 8	Tue			Trip(Dubai→Cairo), Courtesy call to JICA			Trip(Dubai→Cairo), Courtesy call to JICA
3	Dec. 9	Wed			Courtesy call to MWRI, EPADP and JICA exoerts			Courtesy call to MWRI, EPADP and JICA exoerts
4	Dec. 10	Thu			Explanation of MBD test to IAS and EPADP in Kafl El Sheikh			Preparation of sub-contract survey
5	Dec. 11	Fri			Internal meeting, preparation of sub-contract survey			Internal meeting, preparation of sub-contract survey
6	Dec. 12	Sat			Preparation of sub-contract survey	Preparation of sub-contract survey		Preparation of sub-contract survey
7	Dec. 13	Sun			Discussion with contractor of temporary works, Preparation of cultivation test			Discussion with contractor of temporary works, Preparation of cultivation test
8	Dec. 14	Mon			Preparation of sub-contract survey, data collection	Supervision of sub-contractor at site, Hearing from farmers of Bahr El-Nour Area		Supervision of sub-contractor at site, Hearing from farmers of Bahr El-Nour Area
9	Dec. 15	Tue			ditto	Explanation of MBD test to WQU and EPADP, Preparation of cultivation test		Explanation of MBD test to WQU and EPADP, Preparation of cultivation test
10	Dec. 16	Wed			ditto	Explanation of MBD test to EPADP at Kafl El Sheikh, Supervision of Temporary works		Explanation of MBD test to EPADP at Kafl El Sheikh, Supervision of Temporary works
11	Dec. 17	Thu			ditto	Supervision of temporary works, Preparation of cultivation test		Preparation of sub-contract survey, Meeting with MWRI about permission of MBT
12	Dec. 18	Fri			ditto	ditto		Preparation of sub-contract survey
13	Dec. 19	Sat			ditto	ditto		Preparation of sub-contract survey, data collection
14	Dec. 20	Sun			ditto	ditto		Preparation of sub-contract survey, Hearing at Ministry of Agriculture about composting facilities
15	Dec. 21	Mon			Preparation of sub-contract survey, Meeting at EPADP	ditto	Inspection of MBD test site	Preparation of sub-contract survey, Meeting with EPADP about MBT Test
16	Dec. 22	Tue			Report of progress of MBD test to IAS and EPADP in Kafl El Sheikh	ditto	Discussion with MWRI about progress of MBD test	
17	Dec. 23	Wed			Supervision of temporary works at the site	ditto	Survey on Operation and Maintenance	Field survey support
18	Dec. 24	Thu			ditto	ditto	ditto	ditto
19	Dec. 25	Fri			ditto	ditto	ditto	ditto
20	Dec. 26	Sat			ditto	ditto	ditto	ditto
21	Dec. 27	Sun			ditto	Discussion with MWRI about progress of MBD test		Supervision of sub-contract survey
22	Dec. 28	Mon			MBD test in Drain No.4		Supervision of sub-contract survey	MBD test in Drain No.4
23	Dec. 29	Tue			ditto		Survey on Operation and Maintenance	ditto
24	Dec. 30	Wed			MBD test in Shurafar Pump Station		ditto	MBD test in Shurafar Pump Station
25	Dec. 31	Thu			ditto		Supervision of sub-contract	ditto
26	Jan. 1	Fri			Additional MBD test, internal meeting	Analysis of MBD test result, Internal meeting	Data collection/analysis, Internal meeting	
27	Jan. 2	Sat		Trip (Kansai→Dubai)	Supervision of cultivaation test at the site			Data analysis support
28	Jan. 3	Sun		Trip (Dubai→Cairo)	Analysis of MBD test result	Analysis of MBD test result		ditto
29	Jan. 4	Mon		Courtesy call to MWRI and EPADP		Courtesy call to MWRI Trip (Cairo→Dubai)		Courtesy call to MWRI Trip (Cairo→Dubai)
30	Jan. 5	Tue		Report of MBD test result to IAS and EPADP in Kafl El Sheikh		Trip (Dubai→Kansai)		Trip (Dubai →Haneda)
31	Jan. 6	Wed		Site survey for other proposed site at Nile delta				
32	Jan. 7	Thu		ditto				
33	Jan. 8	Fri		ditto				
34	Jan. 9	Sat		Meeting at EPADP				
35	Jan. 10	Sun		Analysis of water quality survey result				
36	Jan. 11	Mon		ditto				
37	Jan. 12	Tue		Analysis of MBD test result				
38	Jan. 13	Wed		ditto				
39	Jan. 14	Thu		Internal meeting	Internal meeting Trip (Caito →Dubai)			
40	Jan. 15	Fri		Analysis of MBD test result	Trip (Dubai→Haneda)			
41	Jan. 16	Sat	Trip (Narita→Singapore)	ditto				
42	Jan. 17	Sun	Trip (Singapore→Cairo) Meeting at JICA	Meeting at JICA				
43	Jan. 18	Mon	Field Survey					
44	Jan. 19	Tue	Meeing at JICA					
45	Jan. 20	Wed	Discussion with MWRI					
46	Jan. 21	Thu	Report of MBD test result to Embassy of Japan					
47	Jan. 22	Fri	Analysis of MBD test result	Trip (Cairo→Dubai)				
48	Jan. 23	Sat	ditto	Trip (Dubai→Kansai)				
49	Jan. 24	Sun	Trip (Cairo→Singapore)					
50	Jan. 25	Mon	Trip (Singapore→Narita)					

2-3 Supervision of Cultural Test

No.	Date	Day	Official members	Consultant members					
				Chief Engineer/Wastewater Treatment System	Agricultural Waste Treatment / Bio-energy Generation	Rural Infrastructure / Rural Sewage Treatment System	Construction Plan / Cost Estimate / Tender Document Preparation	Operation & Maintenance / Financial Analysis / Environmental & Social Consideration-2	Coordinator
1	Mar.4	Thu			Trip (Tokyo – Dubai)				
2	Mar.5	Fri			Trip (Dubai – Cairo)				
3	Mar.6	Sat			Contract & Payment				
4	Mar.7	Sun			Meeting at JICA, MWRI				
5	Mar.8	Mon			Supervision of Cultural Test				
6	Mar.9	Tue			ditto				
7	Mar.10	Wed	Inspection of Cultural Test		ditto				
8	Mar.11	Thu			Site Clearance				
9	Mar.12	Fri			Trip (Cairo – Dubai)				
10	Mar.13	Sat			Trip (Dubai – Tokyo)				

Appendix-3 List of Parties Concerned in The Arab Republic of Egypt

No.	Name	Position
MINISTRY OF WATER RESOURCES AND IRRIGATION		
Irrigation Department		
1.	Dr. Hussein I. El-Atfy	Senior Undersecretary / Head of Department
2.	Ms. Nabila Bahaa El-Dein M	Irrigation Inspector, Technical Office for Chiarman
Central Directorate for Irrigation Advisory Services (CD-IAS)		
1.	Mr. Atef El Kashef	Head
Plannning Sector		
1.	Dr. Mohamed Abdel Motaleb	Head
2.	Dr. Koji KITAMURA	Policy Adviser for Agriculture and National Water Resources Management, JICA Expert
Water Quality Unit		
1.	Dr. Ms. Manar El-Beshry	Head
2.	Dr. Hatem M. M. Ali	Deputy Director
3.	Mr. Hussein El Gammal	Resercher of WQMU
4.	Mr. Mohsen Shaki	Engineer
Seculity		
1.	Mr. Ibrahim Salam	Director General of Security
Egyptian Public Authority for Drainag Projects (EPADP)		
1.	Eng. Mr. E. Abrahim Harhash	Chiarman
2.	Eng. Abdel Fatah Salman	Fist U/S, Vice Chairman
3.	Ms. Samia Samy Kamal	U/S for Information Center
4.	Mr. George Mishriky	U/S for M&E of Drainage Maintenance Group
5.	Ms. Fatma Hassan Hasan	General Director of MIS
6.	Mr. Ali Said Mohamed	Irrigation Engineer
7.	Mr. Emad Mohamed	Civil Engineer
8.	Eng. Omayma Shaheen	G.D for planning and follow up
9.	Eng. Wedad Khalaf	U/S Studies and Design
10.	Ms. Amal Mohammad	Engineer
Kafr El Sheikh Drainage Office		
1.	Mr. Ebraheem El Sabagh	Drainage Genral Director of East Kafr El-Sheikh
2.	Mr. Magdy Mohamed Mahmoud	Irrigation Engineer
Irrigation Advisory Service (IAS)		
1.	Mr. Mohammed Beltagy	Chiarman, USOS of Kafr El-Sheikh Governerate
2.	Eng. Mohamed Ezzat El-Shafey	General Director, Irrigation Department, General Department of IAS for Middle Delta
3.	Mr. Mohamed Bakr	Deputy Director of DMDIAS in Kahr El Sheikh
4.	Mr. Ibrahim M Bakh	Engineer in Kahr El Sheikh
5.	Mr. Mohamed El Lhiat	Engineer in Kahr El Sheikh
East Irrigation Office in Kahr El Sheikh		
1.	Mr. Ahmed Abl El Bari	Deputy Manager
Biela City Council		
1.	Mr. Abdel Baset	Secretary General of City Council, Biela
Ministry of Agriculture		
1.	Eng. Mohamed Salah El Din M. Moustafa	Director General, General Department for Grants&Technical Cooperation
Embassy of Japan		
1.	Mr. Yasuaki Nakamura	First Secretary
JICA Cairo Office		
1.	Mr. Nobuhiro Ikuro	Chief Representative
2.	Mr. Masakatsu Komori	Deputy Resident Representative （at the time of Outline Design Study）
3.	Mr. Shigeru Omori	Deputy Resident Representative （at the time of Additional Outline Design Study）
4.	Mr. Osamu Tanaka	Representative, JICA Egypt Office
5.	Mr. Sherif Yousri	Senior Program Officer of JICA
JICA Expert		
1.	Mr. Soji Shindo	Chief Advisor/Institutional Development for Water Management Improvement Project II
2.	Eng. Koichi Yamamoto	Water User's Organization/Coordinator for Water Management Improvement Project II
3.	Eng. Yasuo Watanabe	Water Resource Management for Water Management Improvement Project II

Minutes of Discussions
on the Preparatory Survey for Outline Design Study
on the Project
"The Complex of Water Quality Improvement for Irrigation in the Central Nile Delta"
in Arab Republic of Egypt

The Government of Japan (hereinafter referred to as "GoJ") has established Cool Earth Partnership as a new financial mechanism. Through this, GoJ is cooperating actively with developing countries' efforts to reduce greenhouse gasses emissions, such as efforts to promote clean energy. A new scheme of grant aid, "Program Grant Aid for Environment and Climate Change", was also created by GoJ as a component of this financial mechanism. According to the initiative of Cool Earth Partnership, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), in consultation with GoJ, decided to conduct the Preparatory Survey (hereinafter referred to as "the Survey") for Outline Design Study on the Project for "The Complex of Water Quality Improvement for Irrigation in the Central Nile Delta" (hereinafter referred to as "the Project") in Arab Republic of Egypt (hereinafter referred to as "Egypt").

JICA has sent to Egypt the Preparatory Survey Team (hereinafter referred to as "the Team"), headed by Mr. Yoshiyuki GOYA, Executive Technical Advisor to the Director General, Rural Development Department, JICA , and the Team is scheduled to stay in the country from 28th of September to 26th of October 2009 for Phase1 of the Survey.

The Team held discussions with the concerned officials of the Government of the Republic of Egypt and conducted a field survey.

In the course of discussions both sides confirmed the result of survey as attachment.

Cairo, 20th of October, 2009

Mr. Yoshiyuki GOYA
Leader
Preparatory Survey Team
Japan International Cooperation Agency
JAPAN

Dr. Hussein El-Atfy
Deputy Minister
Chairman of Irrigation Department
Ministry of Water Resources and Irrigation
Arab Republic of Egypt

Witness

Mr. Nabil Abdel Hamid
First Undersecretary of State
Ministry of International Cooperation
Arab Republic of Egypt

ATTACHMENT

1. Current Situation

Based on the official request from the Government of Egypt, the Preparatory Survey Team conducts the field study for the Field Survey Phase 1 in Egypt in order to create outline design of the Project.

If the GoJ approves the implementation of 2nd Phase of the Survey based on the results of 1st phase of the Survey, JICA will proceed to the 2nd Phase.

2. Objective of the Project

The objective of the Project is to improve the quantity and quality of irrigation water in the project area from the view point of Climate Change.

3. Organization Responsible and Implementing Agency

The organization responsible, which bears overall responsibility for the administration and implementation of the Survey and the Project, is the Ministry of Water Resources and Irrigation (hereinafter referred to as "MWRI") (The organization chart of MWRI is shown in Annex-1.)

The implementing agency is the Egyptian Public Authority for Drainage Projects (hereinafter referred to as "EPADP") (The organization chart of EPADP is shown in Annex-2.) . Water Quality Unit (hereinafter referred to as "WQU") and Planning Sector (hereinafter referred to as "PS") will be the coordinators.

4. Items Requested by the Government of Egypt

4-1. The following items were requested by the Egyptian side.

(1) Gate with Pump
(2) Compost Facility
(3) Bio-energy Facility
(4) Rural Waste Water Treatment System (In-stream treatment methodology and sewage treatment facility)

4-2. Project site is as shown in Annex-3

4-3. The Egyptian side explained that there is no duplication between the contents of the Project and any other project implemented or planned to be implemented by the other donors or the Egyptian side.

4-4. The Team assess the appropriateness of the request and will report the findings to JICA Headquarters and the GoJ according to the result of the survey. The Egyptian side has understood that the final components and the design of the Project shall be decided (confirmed) after further survey.

4-5. According to the result of the survey, the Team confirmed the appropriateness of each items as follows.

(1) Gate with Pump

Water Re-use Facility is necessary but normal kind of the facility depends on result of survey and condition.

(2) Compost Facility

Appropriate.

(3) Bio-energy Facility

Not appropriate.

(4) Rural Waste Water Treatment System (In-stream treatment methodology and sewage treatment facility)

Appropriate.

And all related works.

5. Japan's Program Grant Aid for Environment and Climate Change

The Egyptian side understood the Japan's Program Grant Aid for Environment and Climate Change scheme explained by the Team as described in Annex-4, 5 and 6.

6. Schedule of the Survey

(1) If the necessity of implementing the 2nd Phase of the Survey in Egypt is accepted by GoJ, the timing of the 2nd Phase will be expected from December, 2009 to January, 2010.

(2) After the 2nd Phase of the Survey, JICA will prepare the final report and reference document to discuss them with the Government of Egypt. The time for the completion of the report, which is informed to the Egyptian side by the end of the 2nd Phase, will be tentatively the end of May 2010.

7. Other Relevant Issues

7-1. Coordination with Related Organizations

The Implementing Agency shall be the focal point of the Project and responsible for the coordination and assistance such as securing land with related organizations and acquire the commitment of Water Users Association and Local Unit.

7-2. Procurement of Equipment and Materials

The Team explained that, in accordance with the policy of GoJ, products of Japan shall be procured for major equipment in the Project. The Egyptian side agreed with the policy of GoJ.

7-3. Major Undertakings to be taken by the Government of Egypt

The Egyptian side confirmed that major undertakings as shown in Annex-7 as a basic rule of the Grand Aid Scheme is general and will be finalized according to the 2nd survey result. In

addition, the Egyptian side should be responsible for following issues.

(1) Securing necessary land

(2) Temporary stockyard during installation of the equipment and materials

(3) Vehicles for Operation and Maintenance

(4) Furniture and equipment necessary

7-4. Application of the Related Laws and Regulations

The Implementing Agency of the Project shall be responsible for the application of related laws and regulations for the operation of the system before commissioning of the Project.

7-5. Property of Equipment and Materials

The Implementing Agency of the Project shall own the equipment and materials provided during and after implementation of the Project.

7-6. Environmental and Social Considerations

The Team explained the outline of JICA Environmental and Social Considerations Guideline (hereinafter referred to as "the JICA Guideline") to the Egyptian side. The Egyptian side took the JICA Guideline into consideration, and shall complete the necessary procedures.

7-7. Operation and Maintenance

The Egyptian side agreed to secure the necessary budget and personnel for the Operation and Maintenance of the complex of water quality improvement system procured and installed under the Project.

7-8. Customs and Tax exemption

The Egyptian side agreed that the Egyptian side shall be responsible for the exemption of all customs, tax, levies and duties incurred in Egypt for implementation of the Project.

7-9. The Egyptian side shall ensure the security of all concerned Japanese nationals working for the Project, if deemed necessary.

7-10. The Egyptian side shall provide necessary numbers of counterpart personnel to the Team during the period of their survey in Egypt.

7-11. The Egyptian side shall submit all the answers to the Questionnaire, which the Team handed to the Egyptian side, by October 26, 2009.

7-12. Egyptian side made the following comments for the further survey.

(1) First Priority of the project is reuse of drainage water and the locations of treatment system to be planned will be discussed by both sides.

(2) Some technologies that could be applied for drainage water treatment for irrigation

should be proposed from Japanese side.

(3) Monitoring and evaluation system of the Project should be established at the beginning of the Project in order to secure the smooth implementation and sustainability at the beginning of Project .

<List of Annex>

Annex-1 Organization Chart of Ministry of Water Resources and Irrigation

Annex-2 Organization Chart of Ministry of Egyptian Public Authority for Drainage Projects

Annex-3 Project site map

Annex-4 Japan's Environment Program Grant Aid Scheme

Annex-5 Flow of Funds for Project Implementation

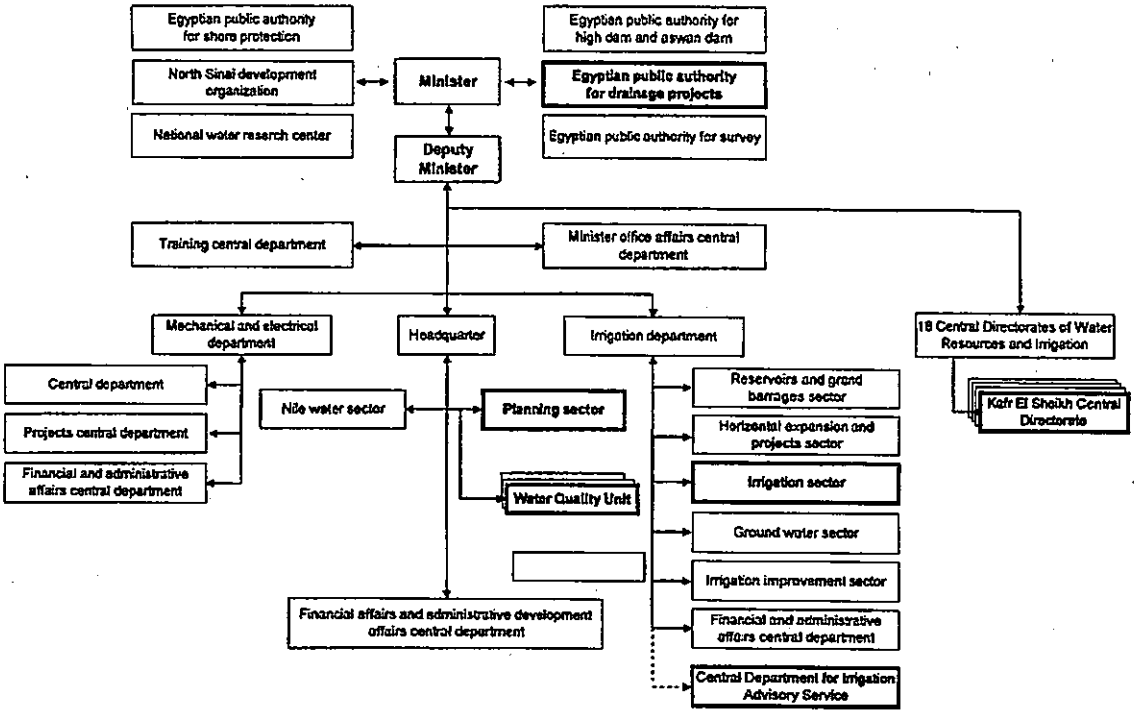
Annex-6 Project Implementation System

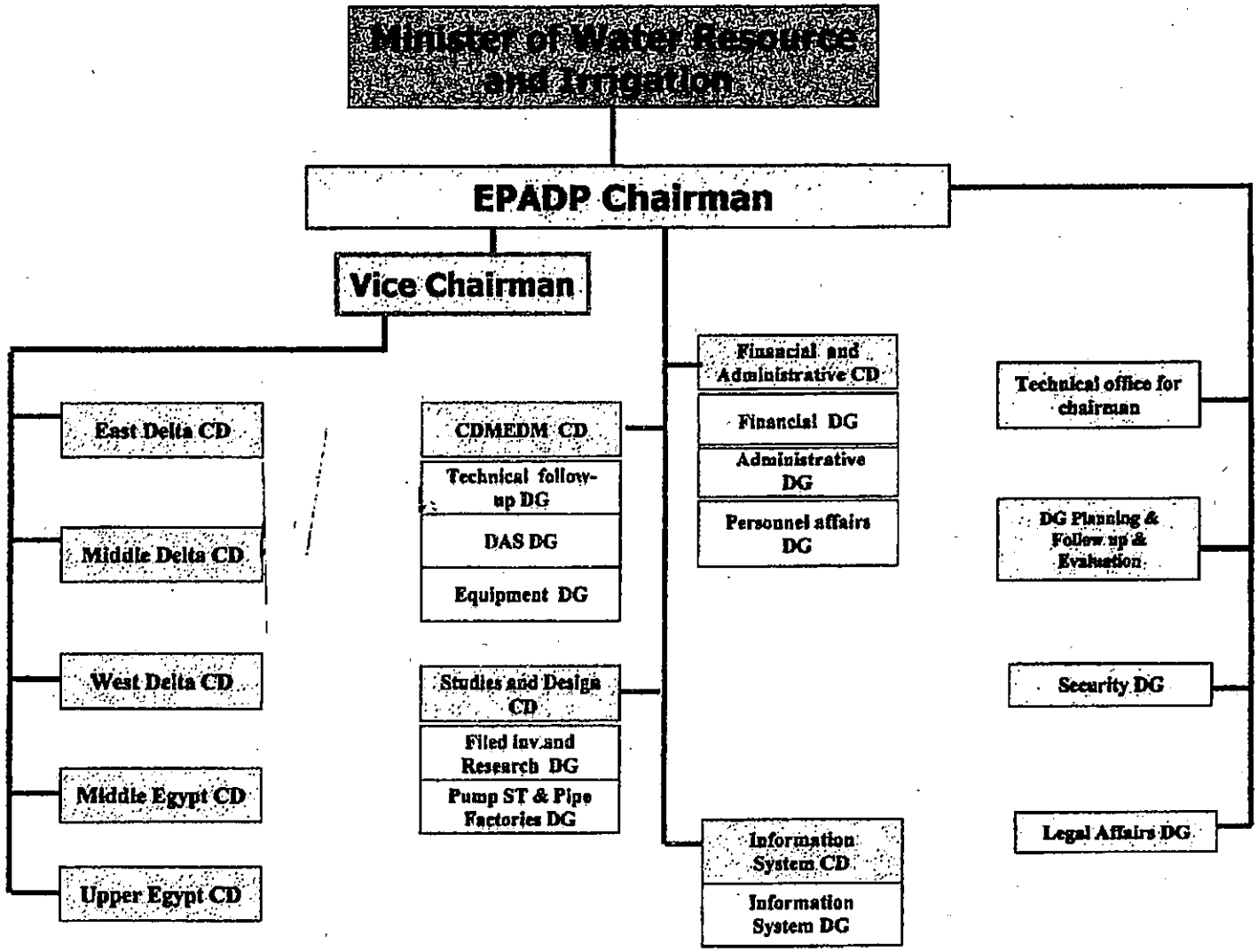
Annex-7 Major Undertakings to be taken by Each Government

Annex-8 Terms of Reference of the Consultative Committee (Provisional)

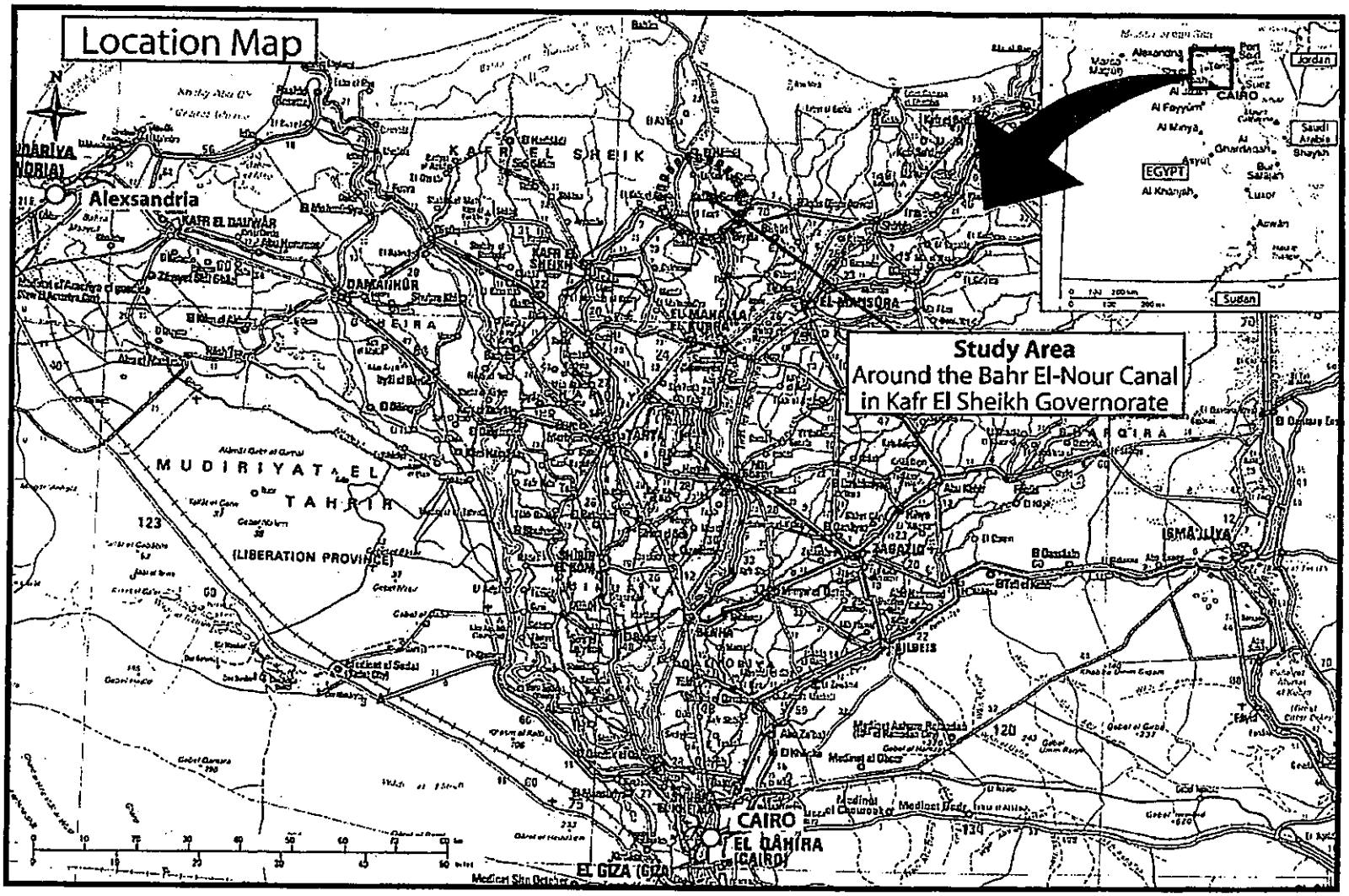
Annex1

Organization Chart of the Ministry of Water Resources and Irrigation (MWRI)

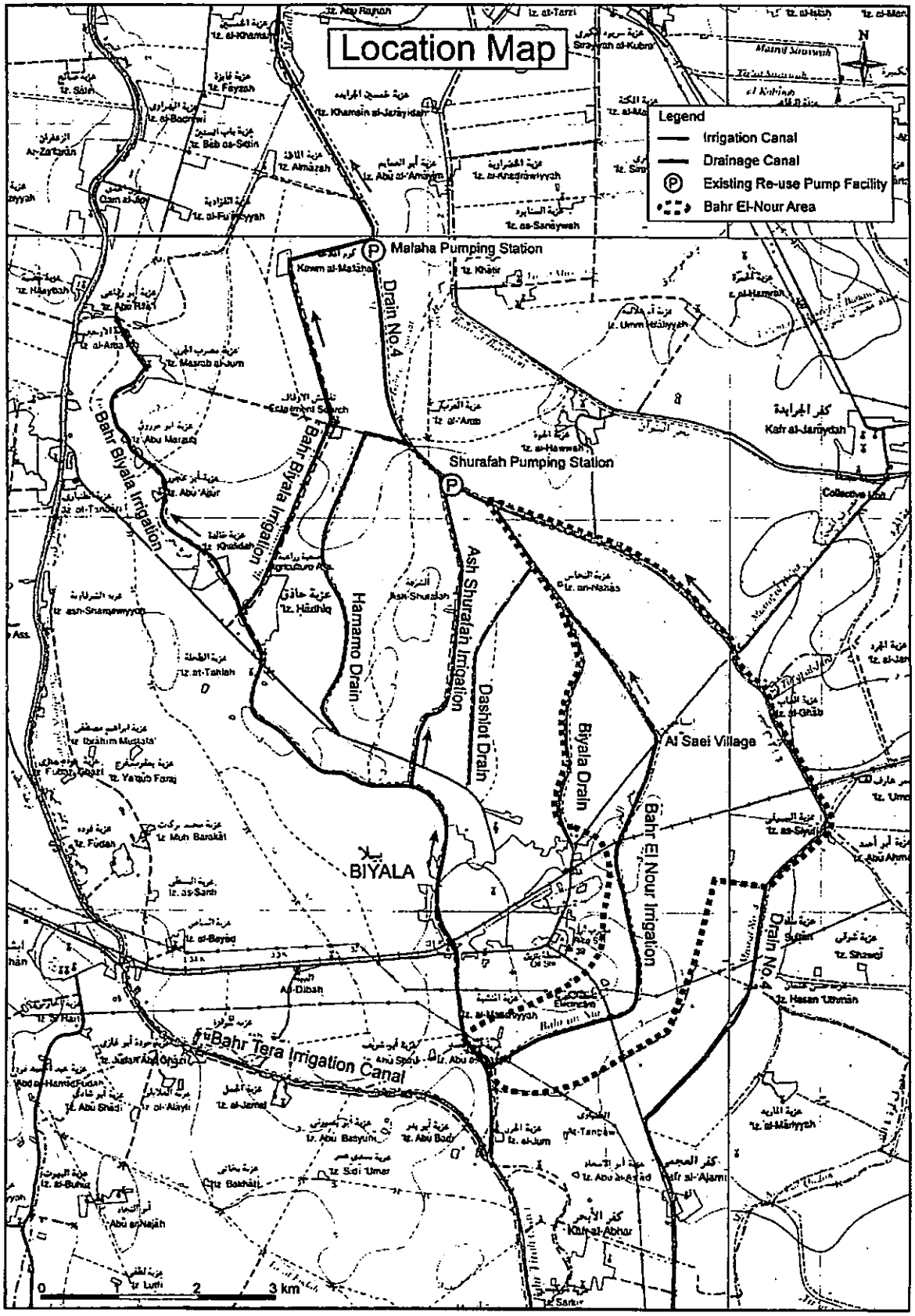




EPADP Organization


Location Map
Alexsandria
KAFR EL SHEIK
DAMANHUR
EL MAHALLA EL KUBRA
EL MANSURA
MUDIRIYAT EL TAHRIR
(LIBERATION PROVINCE)
ISMAILIYA
ZAGAZIG
BILBEIS
CAIRO
EL QAHIRA (CAIRO)
EL GIZA (GIZA)
EGYPT
Jordan
Saudi Arabia
Sudan
Study Area
Around the Bahr El-Nour Canal
in Kafr El Sheikh Governorate

A4-9


Location Map
Legend
Irrigation Canal
Drainage Canal
Existing Re-use Pump Facility
Bahr El-Nour Area
Malaha Pumping Station
Shurafah Pumping Station
Drain No.4
Bahr Biyala Irrigation
Ash Shurafah Irrigation
Hamamo Drain
Dashlot Drain
Biyala Drain
Bahr El Nour Irrigation
Drain No.5
Bahr Tera Irrigation Canal
Al Saei Village
BIYALA
Kafr al-Jamydah
Kafr al-Ajami
Kafr al-Abhar
0 1 2 3 km

Program Grant Aid for Environment and Climate Change of the Government of Japan

The Grant Aid provides a recipient country (hereafter referred to as "the Recipient") 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.

Based on "Cool Earth Partnership" initiative of the Government of Japan, the Program Grant Aid for Environment and Climate Change (hereafter referred to as "GAEC") aims to mitigate effects of global warming by reducing GHGs emission (mitigation; e.g. improvement of energy efficiency) and to take adaptive measures (adaptation; e.g. measures against disasters related to climate change, including disaster prevention such as enhancing disaster risk management).

1. Procedures for GAEC

GAEC is executed through the following procedures. It is decided by GoJ whether the process after the 2nd Phase of the Survey is implemented, based on the results of the 1st phase of the Survey. The procedures mentioned below could be changed accordingly.

Application	Request made by a recipient country
Preparatory Survey (Phase 1)	Preparatory Survey (Phase 1 for project identification) conducted by Japan International Cooperation Agency (JICA)
Appraisal & Approval (*)	Appraisal by the Government of Japan and Approval by the Cabinet
Preparatory Survey (Phase 2)	Preparatory Survey (Phase 2 for detailed design) conducted by JICA
Determination of Implementation	The Notes exchanged between the Government of Japan and the Recipient Country
Grant Agreement (hereinafter referred to as the "G/A")	Agreement concluded between JICA and the Recipient
Preparatory Survey (Phase 3)	Preparatory Survey (Phase 3 for inquiry of the opinion of the Recipient country for the report) conducted by JICA
Appraisal & Approval (*)	Appraisal by the Government of Japan and Approval by the Cabinet
Implementation	Procurement through the Procurement Agency by the Recipient

* Appraisal & Approval either after the Phase 1 or after the Phase 2 will be chosen by GoJ.

1. Preparatory Survey

1) Contents of the Survey

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

- Confirmation of background, objectives, and benefits of the Project and institutional

capacity of agencies and communities concerned of the Recipient necessary for project implementation.
- Evaluation of relevance of the Project to be implemented under the Grant Aid Scheme for Environment and Climate Change from a technical, social, and economic point of view.
- Confirmation of items agreed upon by both parties concerning the basic concept of the Project.
- Preparation of the detailed design of the Project and reference document for tender.
- Estimation of cost for the Project.

The contents of the original request will be modified, as found necessary, in the design of the Project according to the guidelines of Japan's Grant Aid scheme.

The Government of Japan requests the Government of the Recipient to take whatever measures necessary to ensure its responsibility in implementing the Project. Such measures must be guaranteed even if they may fall outside the jurisdiction of the implementing organization of the Recipient. This has been confirmed by all relevant organizations of the Recipient through the Minutes of Discussions.

2) Selection of consulting firms

For the smooth implementation of the Survey, JICA will conduct the Survey with registered consulting firms. JICA selects the firms based on proposals submitted by firms with interest in implementing the Survey. The firms selected will carry out the Preparatory Survey and prepare a report, based on the terms of reference set by JICA.

2. Implementation of GAEC after the E/N

1) Exchange of Notes (E/N)

The content of GAEC will be determined in accordance with the Notes exchanged by the two Governments concerned, in which items including, objectives of the project, period of execution, conditions and amount of the Grant Aid are confirmed.

2) Details of Procedures

Details of procedures on procurement and services under GAEC will be agreed between the authorities of the two governments concerned at the time of the signing of the G/A.

Essential points to be agreed are outlined as follows:

a) JICA will supervise the implementation of the Project.
b) Products and services will be procured and provided in accordance with JICA's "Procurement Guidelines for the Program Grant Aid for Environment and Climate Change."
c) The Recipient will conclude a contract with the Agent.
d) The Agent is the representative acting in the name of the Recipient concerning all transfers of funds to the Agent.

3) Focal points of "Procurement Guidelines for the Program Grant Aid for Environment and Climate Change"

a) The Agent

The Agent is the organization, which provides procurement of products and services on behalf of the Recipient according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by the Government of Japan and agreed between the two Governments in the A/M.

b) Agent Agreement

The Recipient will conclude the Agent Agreement, in principle, within two months after the

signing of the G/A, in accordance with the A/M. The scope of the Agent's services will be clearly specified in the Agent Agreement.

c) Approval of the Agent Agreement
The Agent Agreement is prepared as two identical documents and the copy of the Agent Agreement will be submitted to JICA by the Recipient through the Agent. JICA confirms whether the Agent Agreement is concluded in conformity with the E/N, A/M, and G/A and the Procurement Guidelines for the Program Grant Aid for Environment and Climate Change then approves the Agent Agreement.

The Agent Agreement concluded between the Recipient and the Agent will become effective after the approval by JICA in a written form.

d) Payment Methods
The Agent Agreement will stipulate that "Regarding all transfers of the fund to the Agent, the Recipient will designate the Agent to act on behalf of the Recipient and issue a Blanket Disbursement Authorization ("the BDA")to conduct the transfer of the fund (hereinafter referred to as "the Advances") to the Procurement Account from the Recipient Account.

The Agent Agreement will clearly state that the payment to the Agent will be made in Japanese yen from the Advances and that the final payment to the Agent will be made when the total remaining amount become less than three percent (3%) of the Grant and its accrued interests excluding the Agent's fees.

e) Products and Services Eligible for Procurement
Products and services to be procured will be selected from those defined in the G/A.

f) Selection of firms
In principle, firms of any nationality could be contracted as long as the firms satisfy the conditions specified in the tender documents.

The same applies for any individual consultants who will be involved in the project and provide services necessary for the training and guidance related to the Project. The consultants that will be employed to do detail design and supervise the work for the Project, however will be, in principle Japanese nationals recommended by JICA for the purpose of maintaining technical consistency with the Survey

g) Method of Procurement
When conducting the procurement, sufficient attention will be paid to transparency in selecting the firms and for this purpose, competitive tendering will be employed in principle.

h) Tender Documents
The tender documents should contain all information necessary to enable tenderers to prepare valid offers for the products and services to be procured by GAEC.

The rights and obligations of the Recipient, the Agent and the firms supplying products and services should be stipulated in the tender documents to be prepared by the Agent. Aside from this, the tender documents will be prepared in consultation with the Recipient.

i) Pre-qualification Examination of Tenderers
The Agent may conduct a pre-qualification examination of tenderers in advance of the tender so that the invitation to the tender can be extended only to eligible firms. The

pre-qualification examination should be performed only with respect to whether the prospective tenderers have the capability of concluding the contracts.

For this, the following points should be taken into consideration:
(1) Experience and past performance in contracts of similar kind
(2) Financial credibility (including assets such as real estate)
(3) Existence of offices and other items to be specified in the tender documents.
(4) Their potentialities to use necessary personnel and facilities.

j) Tender Evaluation
The tender evaluation should be implemented on the basis of the conditions specified in the tender documents.

Those tenderers which substantially conform to the technical specifications and other stipulations of the tender documents, will be judged in principle on the basis of the submitted price, and the tenderer who offers the lowest price will be designated as the successful tenderer.

The Agent will submit a detailed evaluation report of tenders to JICA for its information, while the notification of the results to the tenderers will not be premised on the confirmation by JICA.

k) Additional procurement
If there is any remaining balance after the competitive and/or selective tendering and/or direct negotiation for a contract, and if the Recipient would like to procure additional items, the Agent is allowed to conduct this additional procurement, following the points mentioned below:
(1) Procurement of same products and services
When the products and services to be additionally procured are identical with the initial tender and a competitive tendering is judged not efficient, additional procurement can be conducted by a negotiated contract with the successful tenderer of the initial tender.
(2) Other procurements
When products and services other than those mentioned above in (1) are to be procured, the procurement should be conducted through competitive tendering. In this case, the products and services for additional procurement will be selected from among those in accordance with the G/A.

l) Conclusion of the Contracts
In order to procure products and services in accordance with the guideline, the Agent will conclude contracts with firms selected by tendering or other methods.

m) Terms of Payment
The contract will clearly state the terms of payment. The Agent will make payment from the "advances," against the submission of the necessary documents from the firm on the basis of the conditions specified in the contract. When the services are the object of procurement, the Agent may pay certain portion of the contract amount in advance to the firms on the conditions that such firms submit the advance payment guarantee worth the amount of the advance payment to the Agent.

4) Undertakings required by the Government of the Recipient Country
In the implementation of the Grant Aid Project, the Recipient is required to undertake necessary measures as the following:
a) To secure land necessary for the sites of the Project and to clear, level and reclaim the land

prior to commencement of the Project.

b) To provide facilities for distributing electricity, water supply and drainage and other incidental facilities in and around the sites.

c) To ensure all the expense and prompt execution for unloading, customs clearing at the port of disembarkation and domestic transportation of products purchased under the Grant Aid,

d) To ensure that customs duty, internal taxes and other fiscal levies that may be imposed in the Recipient with respect to the purchase of the Components and the Agent's services will be exempted by the Government of the Recipient.

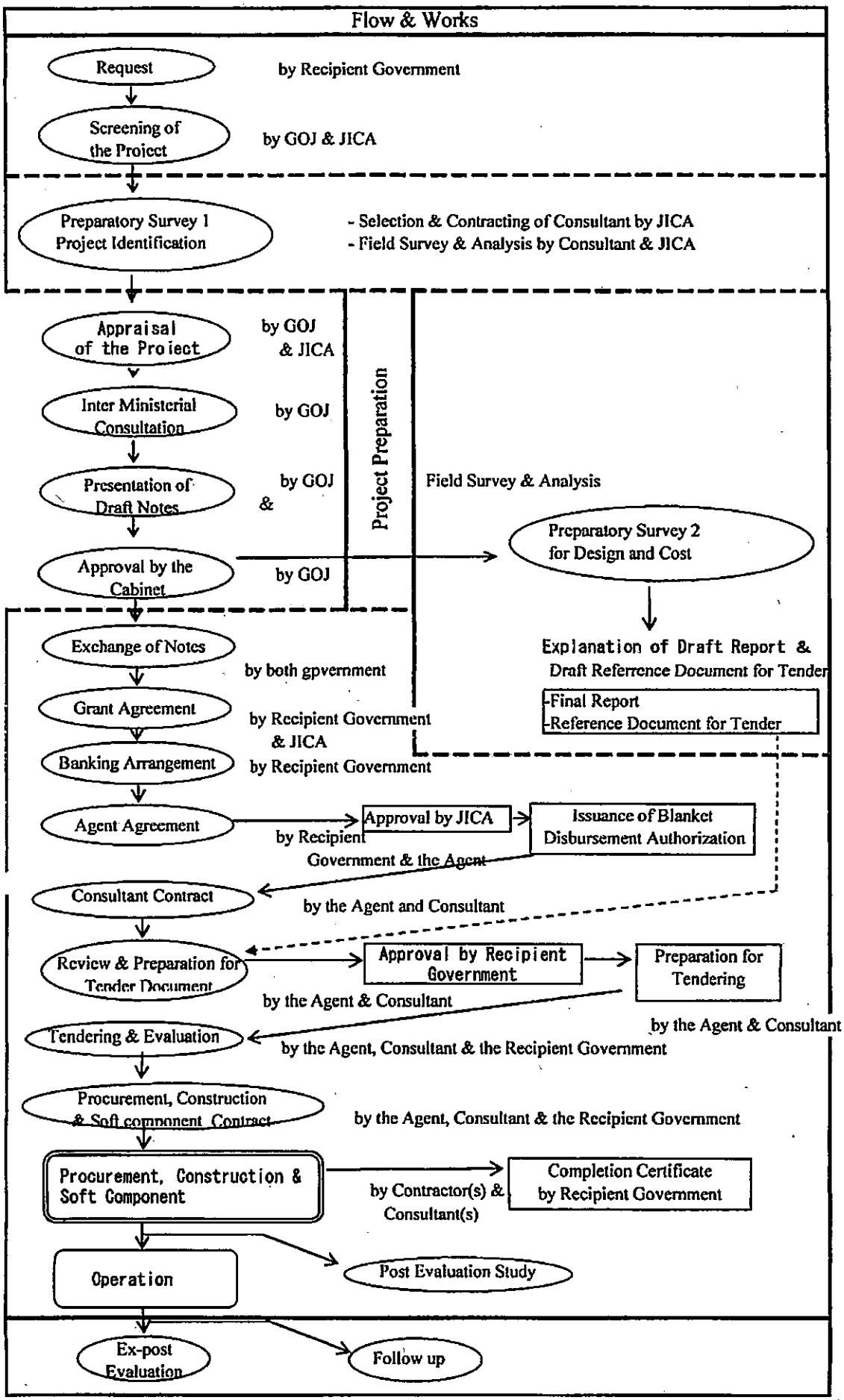
e) To accord all the concerned parties, whose services may be required in connection with supply of the products and services under the contracts, such facilities as may be necessary for their entry into the Recipient and stay therein for the performance of their work.

5) "Proper use of funds"

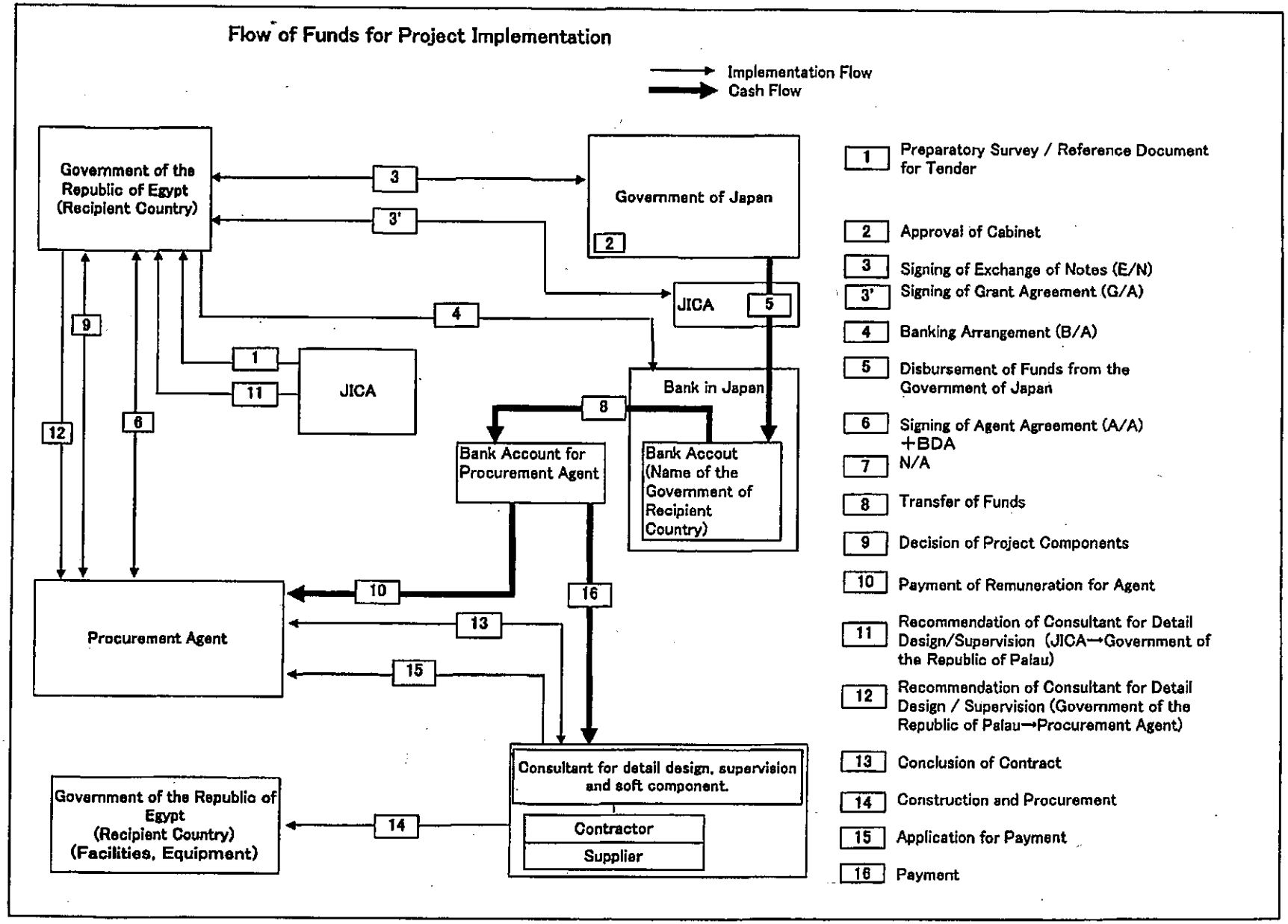
The Recipient is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign personnel necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

6) "Export and Re-export" of products

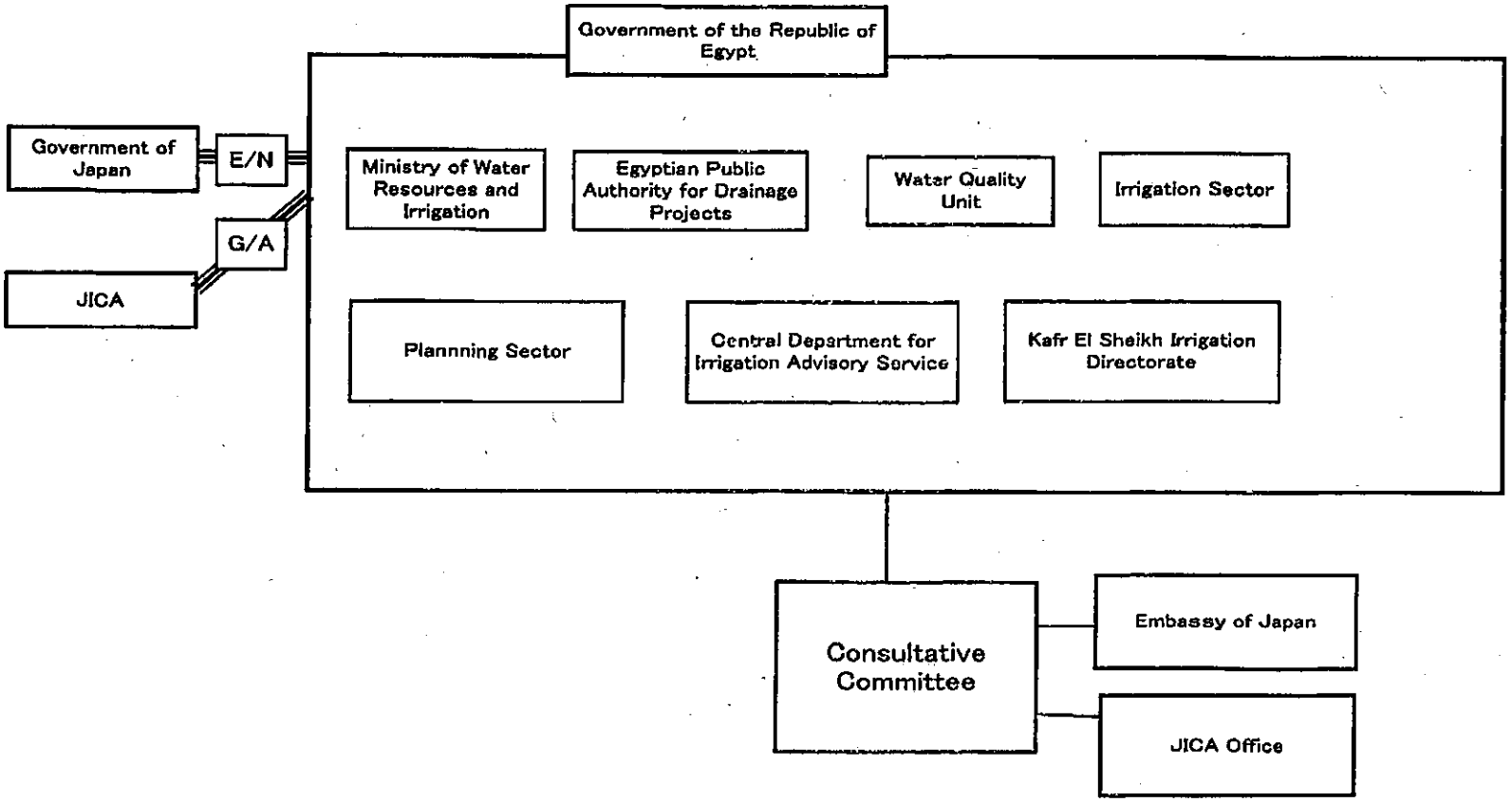
The products purchased under the Grant and its accrued interest will not be exported or re-exported from the Recipient.


Flow & Works
Request
by Recipient Government
Screening of the Project
by GOJ & JICA
Preparatory Survey 1
Project Identification
- Selection & Contracting of Consultant by JICA
- Field Survey & Analysis by Consultant & JICA
Appraisal of the Project
by GOJ & JICA
Inter Ministerial Consultation
by GOJ
Presentation of Draft Notes
by GOJ &
Approval by the Cabinet
by GOJ
Project Preparation
Field Survey & Analysis
Preparatory Survey 2 for Design and Cost
Explanation of Draft Report & Draft Referrence Document for Tender
-Final Report
-Reference Document for Tender
Exchange of Notes
by both gpvernment
Grant Agreement
by Recipient Government & JICA
Banking Arrangement
by Recipient Government
Agent Agreement
by Recipient Government & the Agent
Approval by JICA
Issuance of Blanket Disbursement Authorization
Consultant Contract
by the Agent and Consultant
Review & Preparation for Tender Document
by the Agent & Consultant
Approval by Recipient Government
Preparation for Tendering
by the Agent & Consultant
Tendering & Evaluation
by the Agent, Consultant & the Recipient Government
Procurement, Construction & Soft component Contract
by the Agent, Consultant & the Recipient Government
Procurement, Construction & Soft Component
by Contractor(s) & Consultant(s)
Completion Certificate by Recipient Government
Operation
Post Evaluation Study
Ex-post Evaluation
Follow up

Flow of Funds for Project Implementation



Project Implementation System



Annex-7

Major undertakings to be taken by each Government

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed urgently		●
3	To construct gates and fences in and around the site		●
4	To construct a parking lot if necessary		●
5	To construct roads		
	1) Within the site	●	
	2) Outside the site and Access road		●
6	To construct the facility and install the equipment	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities if necessary:		
	1)Electricity		
	a. The power distribution line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer for the site	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for conveying storm water, sewage, etc. from the site)		●
	b. The drainage system within the site (for sewage, ordinary waste, storm water, etc.)	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
8	To bear the following commissions applied by the bank in Japan for banking services based upon the Bank Arrangement (B/A):		
	1) Payment of bank commission		●
9	To ensure all the expense and prompt execution of unloading and customs clearance at the port of disembarkation in the recipient country		
	1) Marine or air transportation of the products from Japan or third countries to the recipient	●	
	2) To ensure all the expense and prompt execution of unloading, tax exemption and customs clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
10	To accord Japanese nationals and / or nationals of third countries, including persons employed by the agent whose services may be required in connection with the Components such facilities as may be necessary for their entry into recipient country and stay therein for the performance of their work.		●
11	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the Components and to the employment of the Agent will be exempted by the Government of recipient country		●
12	To maintain and use properly and effectively the facilities that are constructed and the equipment that is provided under the Grant.		●
13	To bear all the expenses, other than those covered by the Grant and its accrued interest, necessary for the purchase of the Components as well as for the agent's fees.		●
14	To ensure environmental and social consideration for the Programme.		●

Annex- 8

Terms of Reference of the Consultative Committee (Provisional)

1. To confirm an implementation schedule of the Programme for the speedy and effective utilization of the Grant and its accrued interest.

2. To discuss the modifications of the Programme, including modification of the design of the facility.

3. To exchange views on allocations of the Grant and its accrued interest as well as on interest potential end-users.

4. To identify problems which may delay the utilization of the Grant and its accrued, and to explore solutions to such problems.

5. To exchange views on publicity related to the utilization of the Grant and its accrued interest.

6. To discuss any other matters that may arise from or in connection with the G/A.

Appendix-5. Photos of Field Survey

5-1 Outline Design Study

Waste material on the bank at Ash Shurafah Village

Household effluent at Al Nafas Village

Removed water hyacinth at Drain No.4

Machine dredging work by EPADP

Cow manure on the bank at Al Tanapra village

Carrying cow dung and composting

Drain reuse pump station at drain No.4

Main pump of Shurafah reuse pump station

	
Bahar El Nour irrigation canal at Al Saei village	End point of Bahar El Nour irrigation canal
	
Biyala drain in Biyala City	Biyala drain (downstream)

5-2 Additional Outline Design Study

(1) Micro Bubble Device (MBD) Test

1. MBD Test site at Drain No. 4

2. Temporary Bridge

3. MBD set point

4. Plastic sheet setting

5. Pier for water sampling

6. Temporary drain

7. MBD nozzle

8. MBD operation (in the air)

	
9. MBD operation	10. Jet bubble injected by MBD
	
11. Trash in drain flow	12. MBD operation in temporary drain
	
13.Sampling tool for Mud and sedimentation	14. Mud sampling
	
15. Discharge tank of Shurafah reuse pump station	16. MBD operation at end of irrigation canal

(2) Cultivation Test

1.Germination Test (indoor)

2. Green house

3. Rice Cultivation

4. Growth of Rice (right: MB water)

5. Cabbage Cultivation

6.Growth of Cabbage (right: MB water)

7. Growth of Spinach (right: MB water)

8. Chlorophyll Measurement

Appendix-6 Dirty Water Treatment Facilities

The in-stream treatment facility and sewage treatment facility, as the rural wastewater treatment facilities, are examined herein:

1. In-stream treatment facility

1-1 Treatment method

Treatment facilities for the purpose of improving water quality in canals can be constructed in river channels or major bed areas which are under the control of MWRI. Based on the "Guideline for In-stream Treatment" issued by the Japan Institute of Construction Engineering on March 31, 1997, a comparative chart of general treatment facilities is shown on the next page, and the applicable method for this project is shown on Table 1-1.

According to the comparative chart on the next page, possible treatment methods that can be constructed in river channels or major bed areas with easy maintenance of sludge disposal once a year are:

- Aeration
- Contact process using gravel
- Contact aeration process using gravel
- Use of aquatic plants

As a result of the site survey, the flow velocity in the No.4 Drain is very slow and is in an anaerobic condition. The DO value in this drain is less than 1 mg/l, and the Micro Bubble Device (MBD) is effective for improvement of the DO value. Supplement facilities such as the contact oxidation process is also effective as a supplementary treatment for high water contamination. The following combination is considered for the reusing of drainage water:

- Aeration : Micro Bubble Device as a new technology
- Use of aquatic plants : Chinese spinach as an edible plant for treatment
- Supplementary method : Contact process using gravel

Basis		Method	Location			Necessity of aeration	Applied range of raw water			Efficiency		Treated water BOD Concentration ( ): Influent BOD	Applied water quality ◎:more than 75%, ○:50～70%, △:25～50%, －:less than 25%					Required facility square for 1m^3/s treratment (m^2)	Cost for 1m^3/s treatment		Sludge treatment method /frequency		Design Basis
			River area	Dike	River side		BOD (mg/L)	SS (mg/L)	DO (mg/L)	BOD (%)	SS (%)		Coliforms	NH3-N	T-N	T-P	Others		Construction cost (million	O&M cost (JPY/m^3)	Sludge treatment method	Sludge treatment frequency	
Physical	Filtration	Vertical well	－	○	○	－	less than 10	less than 10	5～6	80～95	90～95	1～2 (2～10)	◎	◎	◎	◎	－	18,600m^2 (Water collection part)	－	－	Plowing and changing of suuface soil	3～4 times/year	Contact velocity
		filtration with long-fiber-filter	－	－	○	－	less than 20	less than 50		30～60	60～80	4～12 (5～20)	△	－	－	－	－	120	－	－	Vacuume disposal of backwash water	Backwash 3～12 times/day	Filtration rate 800 m^3/m^2・day
		Sand filter			○		less than 20	less than 50		30～60	80～95	4～12 (5～20)	○	△				1,000	1,800		Vacuume disposal of backwash water	Backwash 3～12 times/day	Filtration rate 120 m^3/m^2・day
		Microstrainer	－	－	○	－	less than 20	less than 50		30～60	60～80	4～12 (5～20)	△	－	－	－	－	120	－	－	Vacuume disposal of backwash water	Backwash 3～12 times/day	Filtration rate 100 m^3/m^2・day
	Aeration	Aeration	○	－	－	○	－	－	－	less than 10	less than 10	－	－	－	－	－	－	－	－	－	No need	No need	Depend on raw water quality
Physical + Biological	Sedimentation +Bacteria	Contact oxidation through interspaces of gravels	○	○	○	－	less than 20	less than 30		60～80	75～90	2～7 (5～20)	◎	－	－	－	－	6,000～12,000 (Water depth 2～4m)	1000	0.1～0.2	Desludging through aeration	2 times/year	Detention time 1.3 hours
																					Digging	1 time/5 year	
		Contact Oxidation through interspaces of Plastics	○	○	○	－	less than 20	less than 30	more than 5～6	50～70	65～85	3～10 (5～20)	○	－	－	－	－	4,000～8,000 (Water depth 2～4m)	1,500	0.3～1.2	Desluding with submersible pump	1～4 times/month	Detention time 2～3 hours
		Granular crushed stone method	△	○	○	－	less than 20	less than 30		50～70	70～85	3～10 (5～20)	○	－	－	－	－	2,500～5,000 (Water depth 2～4m)	900	0.1～0.2	Desludging through aeration	2 times/year	Detention time 0.5 hour
	Filtration +Organism	Charcoal purification method	－	－	○	－	less than 20	less than 30		50～70	70～85	3～10 (5～20)	○	－	－	－	－	3,000	600	0.6	Desludging through aeration	more than 2 times/year	Passage time 1 cm/minute
Biological	Bacteria	Aeration + Contact Oxidation through interspaces of Gravels	－	○	○	○	20～80	20～50		80～90	85～95	4～15 (20～80)	◎	◎	－	－	◎	9,000～18,000 (Water depth 2～4m)	2,000	1.3	Desludging through aeration	2 times/year	Detention time 2～4 hours
																					Gravel replace	1 time/5 year	
		Contact Aeration with Plastics	－	○	○	○	20～80	20～50	－	75～85	75～85	5～20 (20～80)	○	○	－	－	◎	5,000～10,000 (Water depth 2～4m)	2,400	1.8	Desluding with submersible pump	1～4 times/month	Detention time 2～4 hours
		Aeration Pond	－	○	○	－	less than 50	less than 50		40～50	40～60	6～30 (10～50)	○	○	△	△	－	15,000 (Water depth 5m)	2,500		Removal of phytoplankton	1 time/year	Detention time 5 days
		Aeration + Granular Crushed Stone method	－	○	○	○	20～80	20～50		75～85	75～85	5～20 (20～80)	○	○	－	－	◎	9,000～18,000 (Water depth 2～4m)	1,800	1.3	Desludging through aeration	2 times/year	Detention time 2～4 hours
		Oxidation Ditch	－	－	○	○	20～200	20～200		75～85	65～80	5～50 (20～200)	◎	○	○	－	－	10,000 (Water depth 1m)	－	－	Desluding with submersible pump and disposal	2～6 times/month	Detention time 16 hours
		Laminar Flow Treatment	○	－	－	－	less than 20	10～30		10～30	10～30	4～18 (5～20)	－	－	－	－	－	Length 1km Water depth 0.1m	－	－	Removal of the sand on the starting of operation	every time	Detention time 2 hours
	Use of Plants	Reed bed	－	○	－	－	10～30	10～30	more than 5～6	30～50	70～80	7～20 (10～30)	○	○	○	○	－	150,000 (Water depth 0.1m)	900	5.8	Mowing and cleaning	1 time/year	Detention time 5 hours
		Water Hyacinth	○	○	－	－	10～100	10～100		30～50	30～40	7～70 (10～100)	△	－	－	－	－	1,700,000 (Water depth 1m)	－	－	Removal of the plant	1 time/year	Detention time 20 days
Physical+ Chemical+ Biological	Adsorptive Filtration +Bacteria	High-speed Soil Treatment	－	○	○	－	less than 10	less than 10		80～95	90～95	1～2 (2～10)	◎	◎	△	◎	◎ (Color)	20,000m^2	2,600	1.5	Plowing and changing of suuface soil	3～4 times/year 1 time/5 year	Filtration rate 1～5 m^3/m^2・day (1～5 m/day)

Sorce: Handbook of River Purification (March 31, 1997) (Japan Institute of Construction Engineering)

Table1-1　Treatment method for river water

Basis of Purification		Treatment Method	Applicable place		Efficiency		Necessary Sludge Disposal
			River-area	River-side	BOD (%)	SS (%)	
Physical	Filtration	Vertical Well	×	○	80～95	90～95	3-4 / year
	Aeration	Aeration	○	△	10≧	10≧	No need
Physical+ Biological	Sedimentation +Bacteria	Contact process by Gravels	○	○	60～80	75～90	1 / 5years
		Contact Oxidation through interspaces of Plastics	○	○	50～70	65～85	1-4 / year
		Granular Crushed Stone method	△	○	50～70	70～85	2 / year
Biological	Bacteria	Contact Aeration Process using Gravel	×	○	80～90	85～95	1 / 5years
		Contact Aeration with Plastics	×	○	75～85	75～85	1-4 / year
		Aeration Pond	×	○	40～50	40～60	12 / year
		Aeration + Granular Crushed Stone method	×	○	75～85	75～85	2 / year
		Laminar Flow Treatment	○	×	10～30	10～30	Flush by flood
	Use of Aquatic Plants	Reed bed	×	○	30～50	70～80	1 / year
		Water Hyacinth	○	○	30～50	30～40	1 / year
Physical+ Chemical+ Biological	Adsorptive Filtration +Bacteria	High-speed Soil Treatment	×	○	80～95	90～95	3-4 / year

○ : Applicable　　△ : Applicable depending on the conditions　　× : inapplicable

1-2 Micro Bubble Device (MBD)

(1) Characteristics of the MBD

The MBD is a piece of aeration equipment that uses new technology to raise the oxygen value in wastewater and boost the activation of micro-organisms. It is necessary for improving water quality. The diameter of the micro-bubble is less than 50μm, and nano-bubble is smaller than the micro bubble.

Micro Bubble Device

The MBD was developed in 1995 using Japanese original technology. It has been used in Japan for ten years.

The following lists its application/ adaptation for the Project:

① Advantages of effectiveness and efficiency compared to existing aeration methods, considering the following points:

- As the diameter of the bubble is small, it retains itself in the water 400 times compared to that of the existing aeration method,
- As the oxygen dissolve efficiency is 3 times the existing one, it is possible to increase DO concentration promptly,
- It is expected that crushing the micro-bubble assists degradation of chemical and organic matter by physical and chemical treatment,
- It is expected that the surfacing separation of SS is effective by using the micro-bubble device, and
- As an additional effect, increasing the single yield point, shortening the growth period, and an improvement of quality are all expected.

② Share of MBD made in Japan: MBD was developed in Japan and its share is almost 100% in the world, even though there are similar devices in China

(2) Comparison between MBD and a Normal aeration device

(a) Ability of holding bubbles in the water

MBD and the normal aeration device used in sewage treatment facility, as well as the diffused aeration device (DAD), are compared in the table below:

Table1-2　Comparison between MBD and DAD

	MBD	DAD
Diameter of Bubble	Less than 50μm	Average1 ㎜(1,000μm)
Holding Time in the water	400	1
Dissolved Efficiency of Oxygen	51%	16%

In Table 1-2 above:

① Diameter of Bubble

Bubble diameter of DAD is approximately 1～5 ㎜ even though it is different by type and that of the MBD is less than 50μm.

② Holding time in the water

Rising speed of the bubble was estimated based on the theoretical formula of Stoke. Rising speed is in proportion to the duplicate ratio of the bubble's diameter. Then, the holding time of the micro-bubble in the water is 400 times longer than that of the DAD.

$$V=(1/18 \times g d^2)/\Gamma$$

where

V : Rising speed (m/s)

g : Gravitational constant (m/s^2)

d : Diameter of bubble (m)

Γ : Coefficient of kinematic viscosity (m^2/s)

③ Dissolved Efficiency of Oxygen

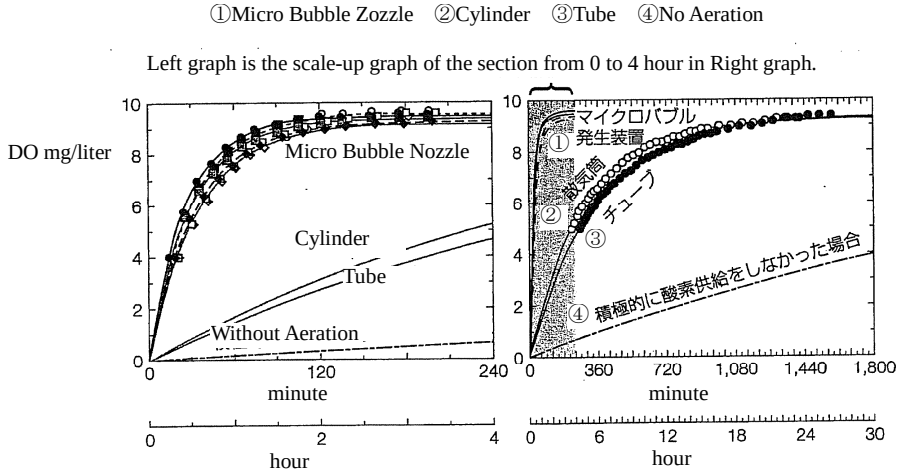
Data of the DAD shows a design value of 5 m depth for designing a sewage treatment facility while the data of the MBD is based on the supplier.

As mentioned above, the efficiency is varying according to the water temperature, installation condition, amount of turning on air, etc. However, the dissolved efficiency of the MBD is better than that of the DAD. In addition to this, it shows that the dissolved efficiency of the MBD is higher than that of the DAD because the air bubble produced by the DAD bursts at the surface after rising in the water, but the bubble created by the MBD bursts in the water.

As the rising speed of the bubble will be different in the free flow, the dissolved efficiency of the MBD will be higher than that of the DAD.

(b) Supplying Effect of Oxygen

The direct effect of the MBD was an increasing of the DO value in the water. The DO value is an important index to consider for fish and plant life and for micro-organisms to be able to take an active part in the water treatment. As shown in the following figure, the DO value increases rapidly by supplying bubbles in the water.



DO Value by Type of Aeration Device

Time varying of the DO value between the DAD and the MBD is shown in the above figure. As shown in the figure, it was confirmed that the DO concentration of the MBD is 8 times higher than that of the DAD after 1 hour of operation. Air bubbles caused by the DAD burst at the surface after rising in the water, but bubbles made by the MBD burst in the water. For this reason, the DO value of the MBD is higher than that of the DAD. It has been confirmed that the higher the DO value is, the more developed the soil environment is, and irrigation water improved by the MBD has an effect on the growth of crops and overall quality improvement.

Root: Aeration by Bubble Device (Right)
Without Bubble Device (Left)

Corolla: Aeration by Bubble Device (Left)
Without Bubble Device (Right)

Difference of Growing Condition

(c) Other Incidental effects

According to the reference books, the following agricultural effects are expected, resulting from improved water by the MBD:

- the increasing of the single yield point,

- shortening growth period, and
- improvement of quality

(3) Case Example of MBD in a Canal

There are many case examples of MBD operation in closed water bodies, such as a lake, pond or bay, because it is certain to increase the DO value in the water by improving the effect of the MBD operation.

There are a few case examples in a river in Japan. The reason is that flow velocity in Japan is high and the design flow for the MBD is bigger. As a result, it is disadvantageous for cost effectiveness to plan a large sized sewage treatment facility.

It is considered that the MBD is a new technology that has been put into practical use for 10 years and has adapted to closed water bodies.

The table below shows the case examples in the river, not closed water bodies:

Table1-3 Case Examples in the River

	Name of River	Location	Improving Effect
①	ONGA river	Fukuoka Prefecture	Prevention of Algae Reduction of odor source in water
②	SAKISHIMA canal	Osaka City	Prevention of Algae Improvement of Ecosystem
③	KYUSHIBA river	Saitama Prefecture	Improvement of DO value from 4.7 to 32mg/liter

Case ① and ② are similar to closed water bodies, since there is a slow flow.

The conditions of rivers/canals in Japan in comparison with those of Egypt are: narrower width, steeper river gradient, and higher velocity flow in general. It is considered that oxygen sullies into water from the river's surface by jumbling during on-flow, and then self purification is preceded by supplying oxygen. However, issues in Japan are: domestic wastewater and other pollutant flows into rivers by increasing population in the area, and water pollution occurs faster than the capacity for self purification.

Treatment methods in rivers are: physical treatment process (sedimentation, filtration and aeration) and a biological treatment process. Aeration has the effect of treatment in all treatment processes except sedimentation and filtration.

The COD value of the drainage canal in the Project site is high. It is considered that water quality will be improved by the MBD.

(4) Micro Bubble (Nano Bubble) as the advance wastewater treatment technology

As the definition of a wastewater system, the advance wastewater treatment is the process for the purpose of getting better water quality than the secondary treatment process that reduces the organic matters. The following 3 points are reasons for adoption:

① Achievement/sustainment of water quality standards in receiving water,
② Re-use of treated water, and
③ Correspondence of water utilization in receiving water

The membrane process is adopted for the requirement for the water quality of the drinking water in case of ② above. However, there are only 10 places to use the membrane process as the wastewater treatment in Japan, and these capacities are small-scale. The main reasons that restrict its wider application are that the construction cost and O&M cost are expensive and the cost for treatment is several hundred yen per m3.

The membrane process is a higher treatment performance than the one by the MBD. However, it is unrealistic to utilize drainage water re-use for irrigation because of high water quality and expensive treatment cost.

The following are the characteristics of water treated by the MBD:

① Increasing DO value
→ Enhancing biological process by shifting from anaerobic condition to aerobic condition; increasing aquatic organisms

②Crush by MBD
→ Degradation of chemical materials and organic matters by the physical and chemical process

③Surfacing separation by bubble
→ SS attaches to bubble and separates to surface

As mentioned above, the MBD is better than other aeration system used in normal wastewater treatment, and a physical treatment and chemical treatment process as the incidental effect is expected.

1-3 Use of Aquatic Plants

The fundamental principle for using aquatic plants is summarized as follows:

① Settling and absorption of granular nutrients and inactivation process of phosphorus
② De-nitrification process of nitrate nitrogen, and nitrite nitrogen by de-nitrifier living in the bottom
③ Mineralization process of organic matter by heterotrophic living flowing water, bottom surface, front face of the aquatic plants

By this treatment process, suspended solids (SS) will be settled and piled up on the soil's surface by the contact-sedimentation work of the aquatic plants. When SS with a load of organic materials are deposited in high quantities, sometimes foul odors will be produced from root rot and the anaerobic conditions of the aquatic plants. Removal of sediments would thus be necessary. The growing season of aquatic plants is from spring to fall, and they die down in winter. Withered plants will be decomposed by soil bacteria and elutes nitrogen and phosphorus. Plants thus should be mowed down once a year.

Water hyacinth is commonly used, and they are also often seen in the local drainage canals. Further review however would be necessary based on the result of the water quality study to choose the most suitable plant to be adopted by the project. In the meantime, the plan will be designed on the assumption that Chinese water spinach is used.

Chinese water spinach is edible and can be cultivated throughout the year. It has less impact on the ecosystem by having a high removal performance of BOD, nitrogen, and phosphorus. For this reason, Chinese water spinach has been widely used in Japan in recent years for water quality management purposes. The plant is widely grown in Asia, but it is also used in restaurants in Egypt.

Chinese water spinach

The nitrogen removal rate of Chinese water spinach is 0.51g/m^2/d and its phosphorus removal rate is 0.55g/m2/d. As roots of Chinese water spinach would grow inside a water channel and could capture suspended solids, the removal effects of SS can be expected. To enhance the capture efficiency of these roots, concrete water channels will be installed within the drainage canals, and float type aquatic plant treatment will be designed as shown in the picture.

Float type aquatic plant treatment facility

1-4 Contact oxidation in interspaces of gravels

River pollutants will be deposited on and absorbed in river beds, or they will be absorbed or decomposed by bio-film which is formed by the living organisms in river beds. Consequently, river pollutants will be purified. The gravel contact oxidation method is a method which artificially enhances this self-purification effect found in rivers.

The purification mechanisms of the gravel contact oxidation method are: 1) contact sedimentation (sedimentation is accelerated after suspended solids in water make contact with gravel); and 2) oxidation decomposition by the living organisms (organic materials in water will be absorbed and biodegraded by microorganisms on the surface of gravel). The treatment effect of SS and SS dominated BOD is high when using the contact sedimentation process.

To prevent deterioration of the treatment function of the gravel contact oxidation method, the following conditions should be met when applying it to the target areas:

(1) BOD in target river is under 20-30 mg/l

(2) DO confirmed in the water of target rivers

(3) No inflow of waste materials

In order to utilize DO in river water, the gravel contact oxidation method can only be used for water with certain BOD concentration. With the gravel contact oxidation method of aeration however, the DO will constantly be supplied from the bottom of the tank to the gravel contact oxidation tank by aeration. Oxidation decomposition by living organisms will then be further enhanced. As a result, with the aeration, water with BOD concentration below 80mg/l could also become treatable.

2. Rural sewerage treatment facility

2-1 Treatment methods

The main treatment methods and their features in the sewage treatment facilities in local communities in Japan will be explained below. A simple flow chart is illustrated in Figure 2-1 and a comparison table is shown in Table 2-1.

(1) Septic Tank Method

- Sewage flows into a putrefactive tank, where solids are settled and separated from liquids. It is a treatment method which involves some anaerobic decomposition. Treated water will flow out of the tank to an underground soil treatment system or it will further be disinfected and drained.
- Since the system only allows the settling and anaerobic decomposition of SS-dominated BOD, the treatment capacity is low.
- Although it is no longer used in Japan because of its low treatment capacity, the method is widely used in the small-scale wastewater treatment facilities in Egypt.
- Sludge in a putrefactive tank will be removed by a truck equipped with a vacuum hose.
- Removal of sludge is the only maintenance required.

(2) Sedimentation＋Contact Oxidation Method

- Sewage flows into a sedimentation tank, where solids are settled and separated from liquids. It is then sent to aerobic treatment in a contact oxidation tank followed by a sedimentation tank in the rear section where second sedimentation takes place. Treated water is then sent to a disinfection tank before it is discharged out of the system.
- Sludge will be transported from the second sedimentation tank to the first sedimentation tank. It will then be removed by a truck equipped with a vacuum hose.
- BOD removal rate of approximately 90% can be expected.
- Maintenance involves removal of sludge and backwashing of a contact oxidation tank.

(3) Anaerobic Filtration Bed ＋Contact Oxidation Method

- Sewage flows into an anaerobic filtration bed, where solids are settled and separated from liquids and anaerobic decomposition takes place. It is then sent to aerobic treatment in a contact oxidation tank followed by a sedimentation process in the sedimentation tank. Treated water is then sent to a disinfection tank before it is discharged out of the system.
- Sludge will be transported from a sedimentation tank and an anaerobic filtration tank to a sludge thickening tank. It will be removed by a truck equipped with a vacuum hose.
- BOD removal rate of approximately 90% can be expected.
- Maintenance involves removal of sludge and backwashing of a contact oxidation tank and an anaerobic filtration bed.

(4) Batch Activated Sludge Method

- After passing through a flow equalization tank, sewage will intermittently flow into a batch tank according to the time schedule. It will be treated in a batch tank by the processes of inflow, oxidation, stirring, and discharge. It will then be treated in a disinfection tank and discharged.
- After completing the sedimentation process in a batch tank, sludge will be transported to a sludge thickening tank. It will then be removed by a truck equipped with a vacuum hose.
- BOD removal rate of approximately 90% can be expected, but depending on operation performances, better treatment can also be expected.
- Maintenance involves sequential controls. Time schedule control of batch tanks will be necessary. Sludge density in a batch tank which varies depending on the concentration of inflowing wastewater needs to be controlled by the MLSS analyzer, so that sludge removal volume can be regulated. Also, aeration volume needs to be controlled using a DO analyzer installed in a batch tank to regulate DO concentration. When sequential control does not function properly, treatment capacity will dramatically decline.

(5) Continuous Inflow - Intermittent Aeration Method

- After passing through an aeration tank, sewage will continuously flow into a sedimentation tank. After the separation of solids and liquids is completed, treated water will go through a disinfection tank and be discharged.
- Sludge will be transported from a sedimentation tank to a sludge thickening tank. It will then be removed by a truck equipped with a vacuum hose.
- BOD removal rate of approximately 90% can be expected, but depending on operation performances, better treatment can also be expected.
- For maintenance, sludge density in a batch tank which varies depending on the concentration of inflowing wastewater need to be controlled by the MLSS analyzer, so that return sludge volume from a sedimentation tank can be regulated. Also, aeration volume needs to be controlled using the DO analyzer installed in a batch tank to regulate DO concentration. When sequential control does not function properly, treatment capacity will dramatically decline.

(6) Membrane Separation Activated Sludge Method

- After passing through a de-nitrification tank, sewage will be pumped to a nitrification tank. Active sludge in a nitrification tank will be returned to a de-nitrification tank by the gravity flow. MF membrane will be placed in a nitrification tank. Treated water will be pumped by a suction pump to a disinfection tank and discharged.
- Sludge in a de-nitrification tank will be transported to a sludge thickening tank. It will then be removed by a truck equipped with a vacuum hose.
- BOD removal rate is 98%, removal effect of nitrogen and phosphorus is also high.

- For maintenance, the removal volume of sludge from a de-nitrification tank needs to be controlled. Quality of membranes also needs to be maintained. Treatment ability is lost when membranes are damaged or when clogging occurs.

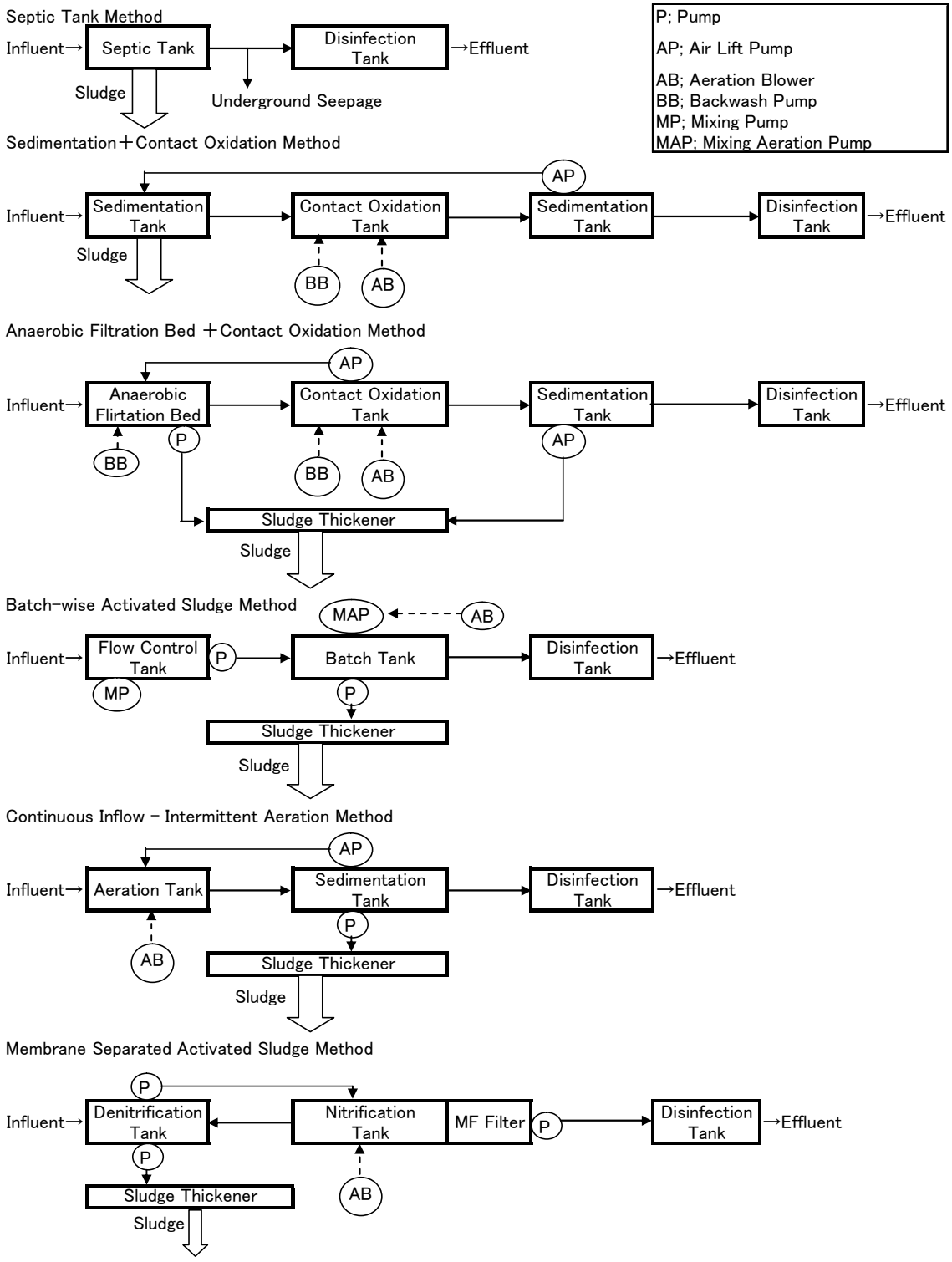


Figure 2-1 Flow of Rural Sewerage System

Table2-1　Rural Sewerage Systems

Treatment Type	Sedimentation Method	Bio-film Method		Suspended Bacteria Method		
	Septic Tank	Sedimentation ＋Contact Oxidation	Anaerobic Filtration Bed ＋Contact Oxidation	Batch-wise Activated Sludge	Continuous Inflow - Intermittent Aeration Method	Membrane Separation Activated Sludge
Feature of the structure	・ Treatment process is sedimentation only. ・ Treated water seeps underground or effluents to the stream.	・ Sedimentation Tank ・ Contact Oxidation Tank ・ Sedimentation Tank	・ Flow Control Tank ・ Anaerobic Filtration Bed ・ Contact Oxidation Tank ・ Sedimentation Tank	・ Oxidation and sedimentation process are carried out in the same tank. ・ Separate tanks are required for batch treatment	・ Oxidation tank + Sedimentation tank ・ Timer for Intermittent Aeration is incorporated.	・ De-nitrification tank + Nitrification Tank ・ Sludge separation by MF filter ・ Simple structure
Sludge Return	Not required	Not required	Not required	Not required	Not required	Not required
Purification Performance	Not Good	Depend on the capacity of the structure	Depend on the capacity of the structure	Depend on the operational condition	Depend on the operational condition	・ Depend on the operational condition ・ High performance
Sludge Volume	25～35％ of removed BOD	25～35％ of removed BOD	20～25％ of removed BOD	40～60％ of removed BOD	40～60％ of removed BOD	50％ of removed BOD
Required Land Area	Small	Middle	Middle	Small	Small	Small
Experience using	No experience in Japan	Many (small scale)	Many (small scale)	Many	Many	Few
Construction Cost	◎	◎（small scale）	○（small scale）	○	○	△
Maintenance frequency	Once a month	Once a month	Once every 2 weeks	Once a week	Once a week	Once a week
Easiness of O&M	◎	◎	◎	○	○	○
Total	○ Water quality does not improve very much because of low purification performance.	◎ Treated water quality is stable. There is no special equipment.	◎ Treated water quality is stable. There is no special equipment.	○ High level O&M is required such as blower control, selection of the treatment process and MLSS control.	○ High level O&M is required such as blower control, selection of the treatment process and MLSS control.	△ While Treated water quality is excellent, exchange cost of the membrane filter is quite expensive. High level O&M is required.

2-2 Rural sewage system applicable for the project

As shown in Table 2-1, the suspended bacteria method has more proven track records of adoption compared to that of the bio-film method. A small site area required for the suspended bacteria method can also be appreciated as a useful advantage. However, because the method requires intensive maintenance with high maintenance cost of the equipment to ensure water quality, it would not be suitable for the project area. Similarly, although septic tanks are widely used in small communities in Egypt as a wastewater treatment system, they have low treatment capacity, and effective improvement of water quality cannot be expected. When taking into account the future water quality of the entire water resources, adoption of septic tanks would not be desirable. Consequently, the bio-film method will be adopted for the community wastewater treatment facilities.

The bio-film method can be classified into the following types:

- Sedimentation + Contact oxidation
- Anaerobic filtration bed + Contact oxidation

Both processes require backwashing of contact media to prevent the growth of bio-film. Lack of backwashing will enlarge bio-film, and it will damage contact media or cause clogging to occur, decreasing the treatment capacity of the processes.

The project will adopt the “Sedimentation + Contact oxidation” method. With this method, some of the maintenance process can be reduced. The carrier that has been widely used recently in Japan will be adopted as a filter material in contact oxidation tanks. This enables the omission of the backwashing process, and because the retention effect of bio-film on carriers will be higher than that in average aeration tanks, stability of the treated water will be relatively high. Annual removal of sludge and inspection of two blowers are the only maintenance needed.

The treatment methods adopted by the Egyptian water and sewage corporation (holding company), the future plans, and the maintenance and operation framework will be reviewed before ultimately deciding on the most appropriate method.

Appendix-7 Design of Sewage Treatment Facility

The capacity of the sewage treatment facility is calculated based on the "Septic Tank Structural Standard" in Japan. Ten (10) liters/capita/day are added to the flushed toilet wastewater treatment tank unit requirement for Japan (fifty [50] liters/capita/day) as gray water, and the unit requirement of the amount of sewage is assumed to be sixty (60) liters/capita/day. For a detailed design, it is necessary to examine it closely, investigating the water quality and the volume of water in detail.

1. Design Parameter
   - ① Project population: 500 people (conversion: 100 Japanese people)
   - ② Pollutant load: 60 liters/capita/day (Japan: 300 liters/capita/day)
   - ③ Processing model: Physical treatment by sedimentation + attached growth treatment process with aeration (catalyst carrier use type)
   - ④ Average daily flow: 0.06 m^3/capita/day ×500 people =30m^3/day

     where, (from "the Septic Tank Structural Standard" in Japan) ;

     n=Processing population

     q=Unit requirement of the amount of sewage.

2. Sedimentation Tank

   Necessary capacity: V=5＋0.25（n—10）＝5＋0.25（100—10）= 27.5m^3

   Effective depth: 1.5m or more → 3.0m

2-1 Primary Sedimentation Tank

   Necessary capacity: 2/3 or more of necessary total capacity

   V1＝27.5×2/3＝18.34m^3

   Size of tank: width 2.0m, length 3.1m, depth 3.0m

   Effective volume: 2.0×3.1×3.0＝18.6m^3 ＞ 18.34m^3

2.2 Secondary Sedimentation Tank

   Necessary capacity: 1/3 or more of necessary total capacity

   V2＝27.5×1/3＝9.17m^3

   Size of tank: width 2.0m, length 1.6m, depth 3.0m

   Effective volume: 2.0×1.6×3.0＝9.60m^3 ＞ 9.17m^3

3. Aeration Tank

   Necessary capacity: V=2＋0.16（n—10）＝2＋0.16（100—10）= 16.4m^3

   Effective depth: 1.5m or more → 3.0m

3-1 Primary Aeration Tank

Necessary capacity: 3/5 or more of necessary total capacity

$V1 = 16.4 \times 3/5 = 9.84m^3$

Size of tank: width 2.0m, length 1.7m, depth 2.9m

Effective volume: $2.0 \times 1.7 \times 2.9 = 9.86m^3 > 9.84m^3$

Contact media requirement (filling rate 55%): $9.86m^3 \times 0.55 = 5.43m^3$

3-2 Secondary Aeration Tank

Necessary capacity: 2/5 or more of necessary total capacity

$V1 = 16.4 \times 2/5 = 6.56m^3$

Size of tank: width 2.0m, length 1.2m, depth 2.9m

Effective volume: $2.0 \times 1.2 \times 2.9 = 6.96m^3 > 6.56m^3$

Contact media requirement (filling rate 55%): $6.96m^3 \times 0.55 = 3.83m^3$

4. Sedimentation Tank

Necessary capacity: $V=0.7+0.04\times(n-10) = 0.7+0.04\times(100-10) = 4.3m^3$

(1/2 of the height of the hopper is not included in the net depth.)

Effective depth: 1.0m or more

60 degrees or more in angle of hopper

Surface loading: $8m^3/m^2$ or less

Necessary area: $30m^3 \div 8m^3/m^2 = 3.75m^2$

Size of tank: width 2.0m, length 2.0m, depth 2.9m (Net depth 2.2m)

Effective volume: $2.0 \times 2.0 \times 1.5 = 6.0m^3 > 4.3m^3$

Net Surface loading: $2.0m \times 2.0m = 4.0m^2 > 3.75m^2$

* It is assumed that the outflow of the scum is allowed and sets up neither the overflow weir nor the scum skimmer.

5. Disinfection Tank

Necessary capacity: $V = q \times n \times 1/24 \times 1/4 = 0.06 \times 500 \times 1/24 \times 1/4 = 0.32m^3$

Size of tank: width 1.2m, length 1.2m, depth 1.2m

Effective volume: $V = 1.2 \times 1.2 \times 1.2 = 1.72m^3 > 0.32m^3$

6. Blower ability calculation

6-1 Aeration Blower

Amount of necessary aeration: Q = 4＋0.25（n—10）＝ 4＋0.25（100—10）

= 26.5m^3/hour ＝0.45m^3/min

Aeration Blower

0.45m^3×3,500mmAq

φ32mm×1.5kw

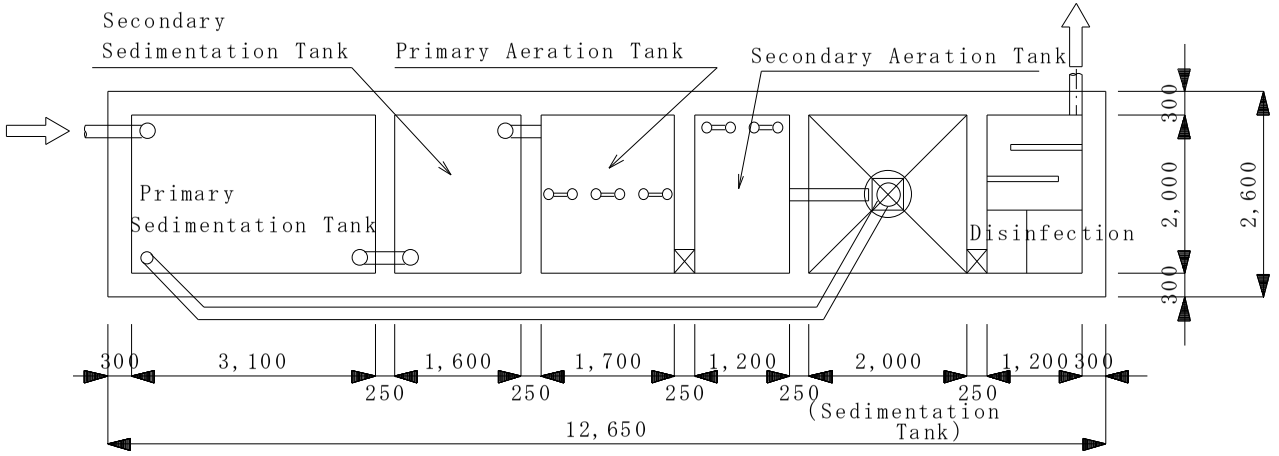
6-2 Air Lift Blower

0.15m^3×3,500mmAq

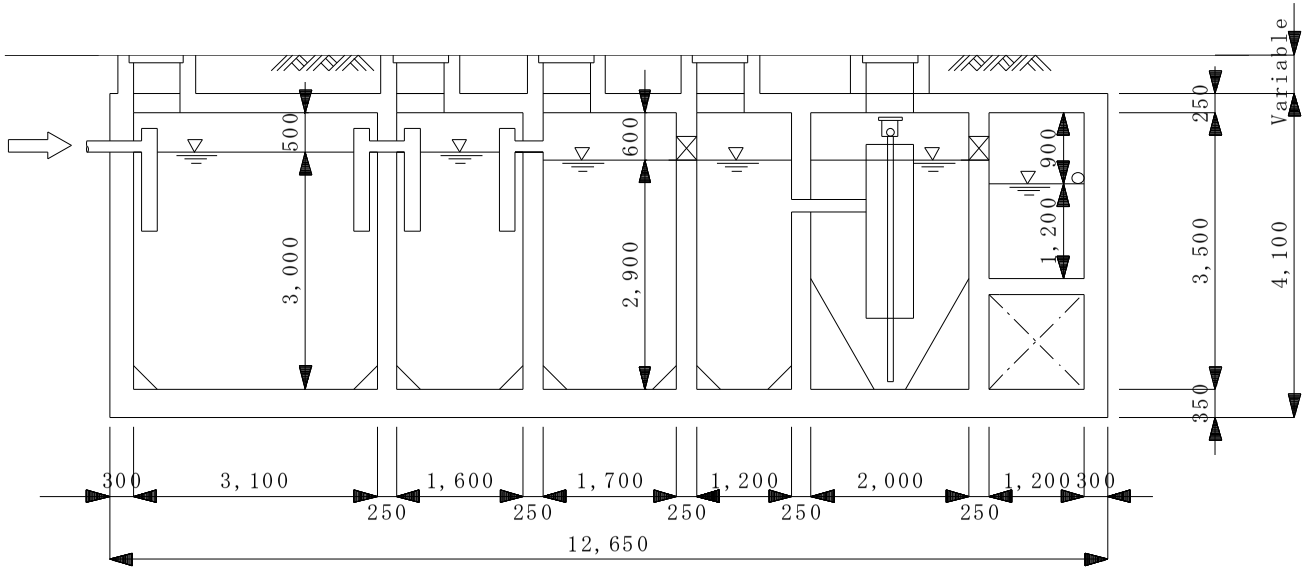
φ25mm×0.75kw

7. Main Equipment List

Facility	Standard	Amount
Aeration Blower	φ32mm×1.5kw×0.45m^3/min	1set
Air lift blower	φ25mm×0.75kw×0.15m^3/min	1set
Preliminary blower	φ32mm×1.5kw×0.45m^3/min	1set
Disinfection facility	50kg Solid chlorine filling type	1set
Advection pipe	PVC φ200×φ150	3set
Center well	φ600×2,200L SUS	1set
Air lift pump	φ150×3,100L PVC	1set
Ball valve	φ40mm、PVC	11piece
Aeration equipment	φ25mm×2 piece applying	5set
Manhole lid	φ600 DCI	22set
Air pipe	φ40mm、φ50mm SUS	1set
Sending back pipe	φ50mm SUS	1set
Contact media	Catalyst carrier（Primary；5.43m^3、Secondary；3.83m^3）	1set
Treat water infiltration inlet	φ1,200 Liner plate L＝15m	1set



PLAN



Profile

Appendix-8　Water Quality Test Result

Water quality data and water quality test result are shown below.

8-1：Domestic Law on Water Quality（Law-48）

8-2：Water Quality of Main Canal around the Project Site in 2007

8-3：Water Quality Test Result on Irrigation and Drainage Canal (Field Survey I)

8-4：Water Quality Test Result on the domestic water from the villages

8-5：Water Quality Test Result on MBD Verification Test

8-6：Water Quality Test Result by Simple Equipment (Additional Field Survey)

8-1：Domestic Law on Water Quality（Law-48）

Statement	Article 60	Article 61	Article 62	Article 65	Article 66
	Standards	by MOH	by MOI	Drain Water	Sewage Water
Color	＜ 100 degrees	Free from colored substances		＜ 100 unit	
Total soluble solid substances	500	800	1000	500	1000
Temperature	5 above the average	35℃		5℃	35℃
Odour	-			Free from colored substances	Free from colored substances
Dissolved oxygen	＞ 5			＞ 5	＞ 4
Hydrogen exponent	7 ～ 8.5	6 ～ 9		7 ～ 8.5	
Absorbed biotic oxygen	＜ 6	20	30	＜ 10	60
Chemically consumed oxygen	＜10	30	40	(Dichromate) ＜ 15	80
		10	15	(Permanganate) ＜ 6	40
Suspended substances		30	30		50
Organic nitrogen	＜ 1			-	
Ammonia	＜ 0.5			＜ 0.05	
Grease and oils	＜ 0.01	5	10	＜ 1	10
Total Alkalines	20 ～ 150			50 ～ 200	
Sulfates	＜ 200	1		-	1
Mercury compounds	＜ 0.001	0.001		＜ 0.001	
Iron	＜ 1	1		＜ 1	
Manganese	＜ 0.5	0.5		＜ 1.5	
Copper	＜ 1	1		＜ 1	
Zinc	＜ 1	1		＜ 1	
Detergents	＜ 0.5	0.05		＜ 0.5	
Nitrates	＜ 45	30	30	＜ 45	50
Fluorides	＜ 0.5	0.5		＜ 0.5	
Phenol	＜ 0.02	0.001	0.002	＜ 0.02	
Arsenic	＜ 0.05	0.05		＜ 0.05	
Cadmium	＜ 0.01	0.01		＜ 0.01	
Chromium	＜ 0.05	0.05		＜ 0.01	
Cyanide	＜ 0.1			＜ 0.1	
Lead	＜ 0.05	0.05		-	
Selenium	＜ 0.01			-	
Tannin and lignite	-			＜ 0.5	
Phosphate	-	1		＜ 1	
Carbon-chloroform abstracts	-			＜ 1.5	
Potential number of the colonic group in 100 cm^3	-	2500		5000	5000

Note;

Article 60 ; Fresh waterways into which processed liquid industrial wastes are licensed to drain

Article 61; The standards concerning licensing for draining the processed liquid industrial wastes into freshwater bodies and groundwater reservoirs as determined by the Ministry of Health

Article 62; The amount of processed liquid industrial wastes drained into freshwater bodies are less than one hundred cubic meter per day

Article 65; The drains water before being pumped into freshwater bodies

Article 66; The sewage water and liquid industrial wastes licensed to be drained into saline water bodies

8-2：Water Quality of Main Canal around the Project Site in 2007

Month	BOD	COD	DO	pH	TDS	NO3	NH4	Cu	Fe	Mn	Zn	Mg	T-P	T-N
Bahr Tira （Irrigation Canal）														
Jan.	28	32	2.30	7.41	733	5.00	1.50	0.000	1.000		0.000	2.06	0.61	6.55
Feb.	20	22	1.40	7.67	769	4.32	1.40	0.020	0.655		0.013	2.30	0.55	5.67
Mar.														
Apr.	30	42	2.90	7.72	402	1.70	0.51		0.655		0.013	1.48	0.31	2.25
May	16	24	3.20	7.63	373	3.45	1.04	0.020	0.655			1.23	0.27	4.54
Jun.	19	26	1.90	7.50	508	1.40	0.42	0.017	1.180	0.152	0.059	1.89	0.37	1.86
Jul.	20	27	2.00	7.44	437	3.20	0.96	0.020	0.655			1.65	0.20	4.20
Aug.	31	43	4.60	6.87	242	3.56	1.07	0.008	0.958		0.019	1.40	0.10	4.68
Sep.	18	22	4.00	6.88	356	0.80	0.24	0.027	0.775		0.029	1.32	0.14	1.09
Oct.	17	20	3.50	6.89	441	3.78	1.13	0.071	0.730		0.009	1.48	0.34	4.95
Nov.	11	13	2.40	7.63	532	2.20	0.66	0.071	0.730		0.009	0.99	0.20	2.90
Dec.	13	15	5.62	7.44	443	4.00	1.20	0.046	0.661		0.015	0.99	0.34	5.24
Ave.	20	26	3.07	7.37	476	3.04	0.92	0.03	0.79	0.15	0.020	1.53	0.31	3.99
Gharbia drain PS No.4 （Drainage Canal）														
Jan.	40	46	2.80	7.45	758	4.60	1.38	0.000	2.000		0.000	1.73	0.91	6.03
Feb.	28	30	0.90	7.48	1,110	5.43	1.90	0.066	0.511		0.007	2.30	0.96	7.11
Mar.														
Apr.	24	33	1.30	7.41	853	5.34	1.60		0.511		0.007	2.63	0.59	6.98
May	22	29	0.90	7.56	812	4.70	1.41	0.066	0.511			1.97	0.57	6.16
Jun.	27	34	0.70	7.70	709	5.78	1.73	0.590	1.690	0.611	0.007	2.14	0.35	7.55
Jul.	29	35	0.70	7.29	773	2.80	0.84	0.066	0.511			2.55	0.28	3.68
Aug.	25	35	1.60	6.89	669	4.40	1.32	0.000	0.418		0.000	1.89	0.30	5.77
Sep.	28	33	2.30	6.90	639	5.34	1.60	0.017	0.843		0.012	2.30	0.24	6.99
Oct.	11	14	1.80	6.88	870	4.00	1.20	0.042	0.743		0.035	2.63	0.49	5.24
Nov.	19	23	2.15	7.35	1,177	3.00	0.90	0.042	0.743		0.350	2.14	0.32	3.94
Dec.	22	24	1.23	7.38	1,321	5.00	1.50	0.044	1.070		0.033	2.22	0.49	6.54
Ave.	25	31	1.49	7.30	881	4.58	1.40	0.09	0.87	0.61	0.020	2.23	0.50	6.00

8-3 : Water Quality Test Result on Irrigation and Drainage Canal (Field Survey I)

Water Quality Data of Irrigation and Drainage Canal of the Study Area (1)

Location	Date	Season	EC mS	pH	DO mg/L	TEMP ℃	Salinity g/L	SS mg/L	TDS mg/L	TSS mg/L	T-P mg/L	T-N mg/L	NO3 mg/L	NH4-N mg/L	Oil ・ Grease mg/L	COD-Cr mg/L	COD-Mn mg/L	BOD mg/L	Deter-gent mg/L	TOC mg/L	SAR
Measured Value																					
X1 intake for upstream of Bahr El Nour Canal	2009.10.20	non irrigation season	1.23	7.48	0.07	28.3	0.6	92	–	992	0.927	9.8	–	–	< 1	87	–	80	0.04	10.1	3.96
X2 Proposed Drainage water re-use facilities site on downstream of Bahr El Nour Canal	2009.10.20	non irrigation season	1.29	6.95	2.69	26.3	0.6	34	–	876	0.07	5.6	–	–	< 1	51	–	12	0.03	6.35	4.62
X3 Proposed Drainage water re-use facilities site on Midstream of Biyala Drainage Canal	2009.10.20	non irrigation season	2.47	7.29	0.97	27	1.3	33	–	1652	0.53	19.6	–	–	< 1	55	–	20	0.03	6.91	6.49
X4 Suburban area of Biyala City on Upstream of Biyala Drainage Canal	2009.10.20	non irrigation season	2.12	7.23	0.19	25.9	1.1	19	–	919	0.42	5.6	–	–	< 1	49	–	14	0.03	5.86	3.78
X5 Downstream of Al Doksh Village on Downstream of Bilaya Drainage Canal	2009.10.20	non irrigation season	3.75	7.4	0.8	25.0	2.0	25	–	2067	0.7	8.4	–	–	< 1	54	–	20	0.03	6.25	9.97
X6 Downstream of Nafas Bridge on Upstream in the study area of Drain No.4	2009.10.20	non irrigation season	1.4	7.53	0.81	26.3	0.7	35	–	971	0.408	21	–	–	< 1	58	–	33	6.13	0.03	4.43
X7 Shurafah Pump Station on Midstream in the study area of Drain No.4	2009.10.20	non irrigation season	1.47	7.59	0.34	25.4	0.7	42	–	1009	0.6	4.2	–	–	< 1	62	–	40	7.43	0.03	4.64
X8 Bridge at downstream of Phurafah Pump Station on Downstream in the study area of Drain No.4	2009.10.20	non irrigation season	1.47	7.54	0.03	26.3	0.7	41	–	977	0.531	7	–	–	< 1	59	–	28	6.42	0.02	4.69
X6 Downstream of Nafas Bridge Upstream in the study area of Drain No.4	2009.12.28	non irrigation season	1.75	9.62	0.1	15.1	0.8	14		1158		5.1	0.05	5.0		12					
Collected Data																					
Bahr Tira Canal	2007.10	non irrigation season	–	6.89	3.5	–	–	–	441	–	0.34	4.95	3.78	1.13	–	20	–	17	–	–	–
Bahr Tira Canal	2007.7	irrigation season	–	7.44	2.0	–	–	–	437	–	0.20	4.2	3.20	0.96	–	27	–	20	–	–	–
Drainage Pump Station on Downstream of Drain No.4, outsite of the study area	2007.10	non irrigation season	–	6.88	1.80	–	–	–	870	–	0.49	5.24	4.0	1.20	–	14	–	11	–	–	–
Drainage Pump Station on Upstream of Drain No.4, outsite of the study area	2007.7	irrigation season	–	7.29	0.70				773	–	0.28	3.68	2.80	0.84	–	35	–	29	–	–	–
Water Quality Standard in Egypt																					
Irrigation Water Quality Standard on Low No.48 Article 62	(1982)	–	–	–	–	–	–	< 30	–	< 1000	–	–	< 30	–	< 10	< 40	< 15	< 30	–	–	–
Re-use Drainage Water Quality Standard on Low No.48 Article 65	(1982)			7.0～8.5	> 5					< 500			< 45	< 0.05	< 1	< 15	< 6	< 10	< 0.5		
Drainage Water Quality Standard on Low No.48 Article 66	(1982)	-	–	6 ～ 9	> 4	–	–	< 50	–	< 1000	–	–	< 50	–	< 10	< 80	< 40	< 60	–	–	–
Japanese Water Quality Standard by Ministry of Agriculture, Forestry and Fisheries of Japan	(1971.10.4)	–	0.3	6.0～7.5	> 5	–	–	100	–	–	–	1	–	1	–	–	6	–	–	–	–

Note; blue column: irrigation canal green colum: drainage canal

Red value means over the water quality standard in Egypt

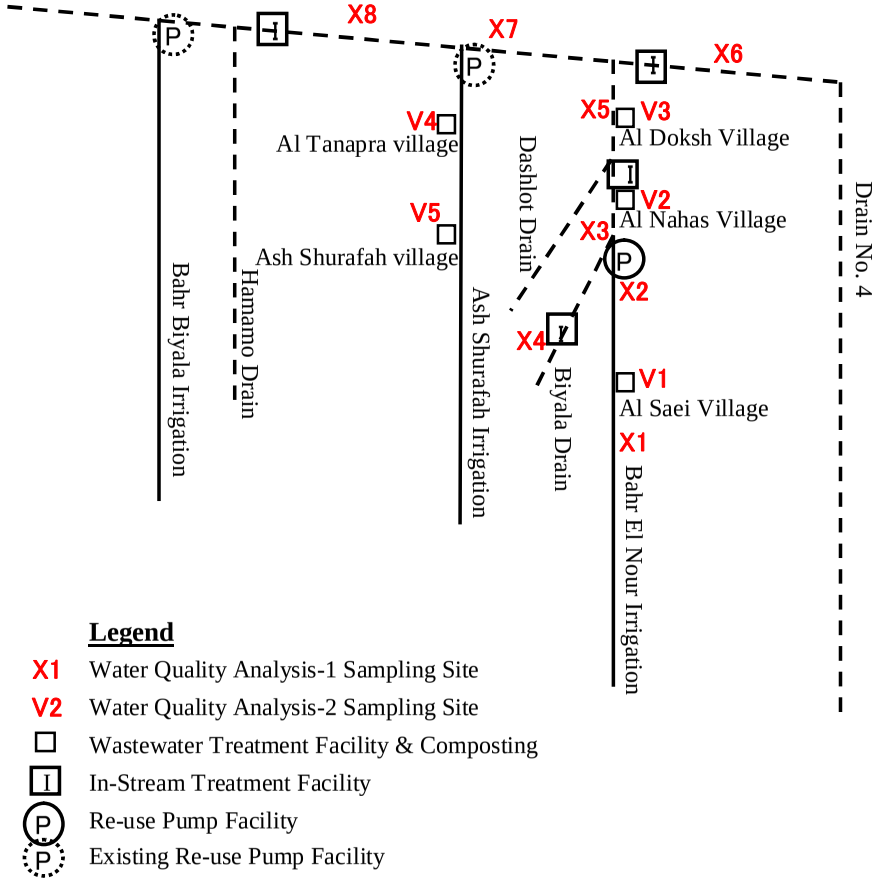
Water Quality Data of Irrigation and Drainage Canal of the Study Area (1)

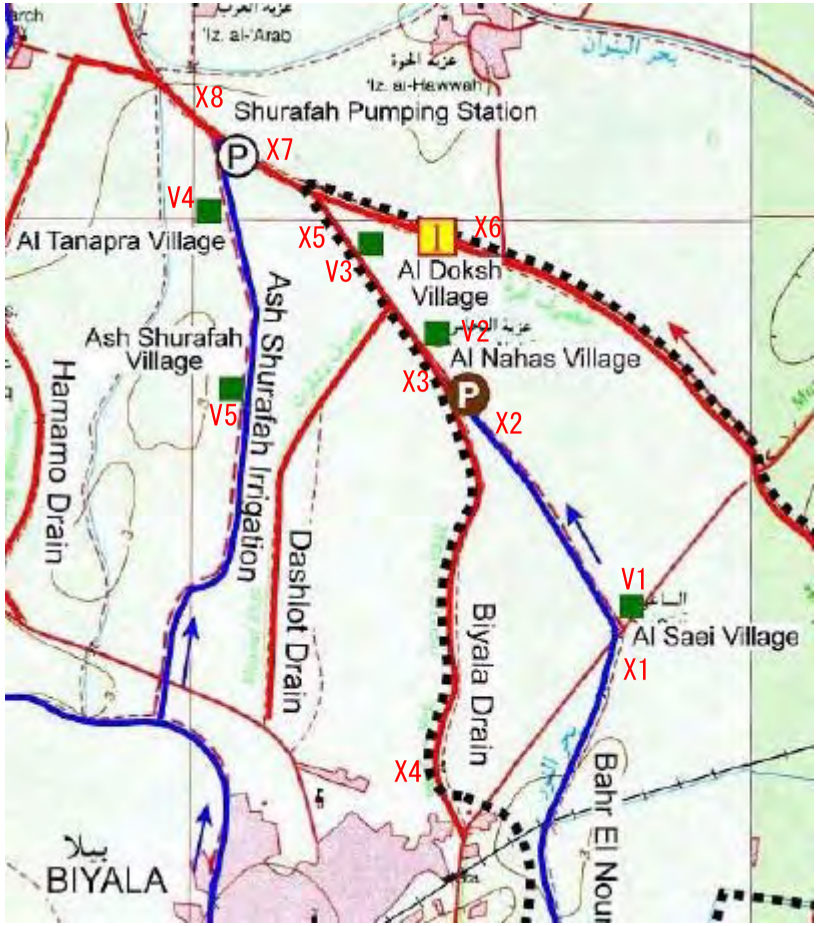
Location	Chloride mg/L	Boron mg/L	Arsenic mg/L	Cadmium mg/L	Cobalt mg/L	Chrom-ium mg/L	Copper mg/L	Iron mg/L	Mangan-ese mg/L	Nikel mg/L	Lead mg/L	Zinc mg/L	Mercury μg/L	Total Coliforms CFU /100mL
Measured Value														
X1 intake for upstream of Bahr El Nour Canal	180	0.32	< 0.001	< 0.001	< 0.005	0.07	0.061	0.108	0.289	0.01	< 0.001	0.01	< 0.08	48×10^5
X2 Proposed Drainage water re-use facilities site on downstream of Bahr El Nour Canal	210	0.23	< 0.001	< 0.001	< 0.005	0.04	0.028	< 0.02	0.076	0.005	< 0.001	0.006	< 0.08	46×10^3
X3 Proposed Drainage water re-use facilities site on Midstream of Biyala Drainage Canal	600	0.18	< 0.001	< 0.001	< 0.005	0.05	0.028	0.122	0.13	0.005	< 0.001	0.064	< 0.08	25×10^3
X4 Suburban area of Biyala City on Upstream of Biyala Drainage Canal	260	0.17	< 0.001	< 0.001	< 0.005	0.04	0.027	< 0.02	0.035	0.002	< 0.001	0.053	< 0.08	54×10^3
X5 Downstream of Al Doksh Village on Downstream of Bilaya Drainage Canal	900	0.32	< 0.001	< 0.001	< 0.005	0.04	0.028	< 0.02	0.445	0.007	< 0.001	0.075	< 0.08	36×10^3
X6 Downstream of Nafas Bridge on Upstream in the study area of Drain No.4	290	0.27	< 0.001	< 0.001	< 0.005	0.03	0.023	< 0.02	0.173	< 0.001	< 0.001	0.022	< 0.08	10×10^5
X7 Shurafah Pump Station on Midstream in the study area of Drain No.4	356	0.14	< 0.001	< 0.001	< 0.005	0.02	0.015	< 0.02	0.304	< 0.001	< 0.001	0.027	< 0.08	90×10^5
X8 Bridge at downstream of Phurafah Pump Station on Downstream in the study area of Drain No.4	340	0.21	< 0.001	< 0.001	< 0.005	0.02	0.037	< 0.02	0.139	< 0.001	< 0.001	0.024	< 0.08	70×10^5
X6 Downstream of Nafas Bridge Upstream in the study area of Drain No.4														
Collected Data														
Bahr Tira Canal	–	–	–	–	–	–	0.071	0.73	1.48	–	–	0.009	–	–
Bahr Tira Canal	–	–	–	–	–	–	0.020	0.655	1.65	–	–	–	–	–
Drainage Pump Station on Downstream of Drain No.4, outsite of the study area	–	–	–	–	–	–	0.042	0.743	2.63	–	–	0.035	–	–
Drainage Pump Station on Upstream of Drain No.4, outsite of the study area	–	–	–	–	–	–	0.066	0.511	2.55	–	–	–	–	–
Water Quality Standard in Egypt														
Irrigation Water Quality Standard on Low No.48 Article 62	–	–	–	–	–	–	–	–	–	0.1	0.05	–	–	–
Re-use Drainage Water Quality Standard on Low No.48 Article 65	–	–	< 0.05	< 0.01	–	< 0.01	< 1	< 1	< 1.5	–	–	< 1	< 0.001	< 5000
Drainage Water Quality Standard on Low No.48 Article 66	–	–	–	–	–	–	–	–	–	–	–	–	–	< 5000
Japanese Water Quality Standard by Ministry of Agriculture, Forestry and Fisheries of Japan	–	–	0.05	–	–	–	0.02	–	–	–	–	0.5	–	–

Note; blue column : irrigation canal green colum : drainage canal

Red value means over the water quality standard in Egypt

Location Map of Water Quality Test as of Field survey





X: Water quality of Drainage Canal

V: Water quality of Domestic water from villages including septic tank

8-4 : Water Quality Test Result on the Domestic Water from the villages

Water Quality Test Result on Filed Survey-1(Test-2)

Parameters	Date	Time	Al Saei Village			El Nahas Village			Al Doksh Village			Al Tanapra Village		Al Shurafah Village			
			V1			V2			V3			V4		V5			
			Up	V1	Down	Up	V2	Down	Up	V3	Down	Up	Down	Up	Front	Back	Down
SS (mg/l)	12/10	–		1384			4159			689					645	964	
	13/10	–		1634			2588			872					363	198	
	14/10	6am		3784			1206			4634					1139	2015	
		12pm	759	1310	616	1160	1456	1149	1380	1227	1301	1533	1575	1409	511	856	1331
		6pm		5266			1349			615					1390	1361	
	15/10	–		1354			2176			1379					1032	1450	
	16/10	–		1202			2261			1842					1377	1422	
	17/10	6am		1319			2876			5871					3625	2458	
		12pm	864	966	840	3020	1839	2070	2151	2353	2136	7154	3521	1019	6457	1598	1458
		6pm		1731			2825			4160					3845	1475	
	18/10	–		2733			3336			6140					401	1517	
T-N (mg/l)	12/10	–		35			22.4			11.2					8.4	22.4	
	13/10	–		30.8			98			11.2					2.8	98	
	14/10	6am		23.8			25.2			61.6					16.8	60.2	
		12pm	5.6	33.6	4.2	14	16.8	2.8	4.2	2.8	7	12.6	9.8	7	4.2	15.4	21
		6pm		105			16.8			9.8					19.6	4.2	
	15/10	–		23.8			22.4			49					8.4	4.2	
	16/10	–		16.8			9.8			5.6					7	4.2	
	17/10	6am		28			22.4			93.8					23.8	9.8	
		12pm	2.8	18.2	<2	75.6	95.2	9.8	16.8	116.2	12.6	5.6	5.6	9.8	43.4	4.2	21
		6pm		25.2			9.8			8.4					57.4	5.6	
	18/10	–		39.2			43.4			154					5.6	2.8	
T-P (mg/l)	12/10	–		1.24			1.39			0.97					0.412	1.16	
	13/10	–		0.803			0.806			0.669					0.083	1.84	
	14/10	6am		1.9			1.11			1.45					0.875	1.72	
		12pm	0.359	0.5	1.04	0.4	0.6	0.273	0.3	0.33	0.07	1.185	0.642	0.391	1.29	1.18	1.36
		6pm		1.76			1.209			0.22					1.08	1.55	
	15/10	–		0.6			0.9			0.173					0.327	0.239	
	16/10	–		1.23			1.4			0.76					0.55	0.269	
	17/10	6am		1.3			1.2			2.3					1.9	0.3	
		12pm	0.166	1.65	0.447	1.71	2.086	1.58	1.33	2.6	1.3	1.74	1.176	1.43	1.87	0.295	0.532
		6pm		1.3			1.1			0.7					0.86	0.346	
	18/10	–		1.8			1.5			2.4					0.111	0.7	

Water Quality Test Result on Filed Survey-1(Test-2)

Parameters	Date	Time	Al Saei Village			El Nahas Village			Al Doksh Village			Al Tanapra Village		Al Shurafah Village			
			V1			V2			V3			V4		V5			
			Up	V1	Down	Up	V2	Down	Up	V3	Down	Up	Down	Up	Front	Back	Down
TOC (mg/l)	12/10	–		199.32			184.61			35.25					100.27	61.25	
	13/10	–		216.27			383.1			64.21					29.56	369.81	
	14/10	6am		70.44			57.03			332.19					47.24	64.46	
		12pm	4.64	39.25	3.01	10.69	70.784	3.91	3.46	2.42	1.85	2.43	2.73	0.98	7.63	29.46	3.21
		6pm		63.76			52.94			32.12					70.86	5.42	
	15/10	–		65.39			63.18			108.01					62.4	14.78	
	16/10	–		53.35			29.47			14.63					9.97	18.08	
	17/10	6am		56.01			70.56			247.92					96.21	27.16	
		12pm	6.45	43.62	7.46	265.36	100.83	4.72	15.83	203.81	15.01	11.83	13.16	9.81	6.09	15.94	8.63
		6pm		41.28			30.01			28.14					111.58	14.95	
	18/10	–		225.01			80.14			376.11					39.26	24.63	
COD (mg/l)	12/10	–		1318			1154			302					956	688	
	13/10	–		1247			2301			614					264	2188	
	14/10	6am		684			560			2209					441	660	
		12pm	42	319	21	96	687	31	41	32	28	21	23	8	54	241	29
		6pm		587			478			281					668	40	
	15/10	–		625			586			931					562	196	
	16/10	–		461			338			185					178	191	
	17/10	6am		528			640			1751					800	228	
		12pm	186	376	233	1842	900	188	207	1320	206	196	249	254	541	228	227
		6pm		369			247			223					874	200	
	18/10	–		2197			1213			2306					188	222	
BOD (mg/l)	12/10	–		660			460			50					270	250	
	13/10	–		660			1300			210					150	1100	
	14/10	6am		540			350			1300					270	420	
		12pm	15	250	10	70	340	10	10	4	5	10	10	5	40	220	20
		6pm		360			220			200					280	20	
	15/10	–		240			280			340					180	30	
	16/10	–		140			60			30					18	35	
	17/10	6am		300			400			1300					600	100	
		12pm	20	100	25	1080	660	55	40	820	45	25	40	35	520	100	30
		6pm		200			80			200					500	35	
	18/10	–		1200			210			1300					160	100	

Water Quality Test Result on Filed Survey-1(Test-2)

Parameters	Date	Time	Al Saei Village			El Nahas Village			Al Doksh Village			Al Tanapra Village		Al Shurafah Village			
			V1			V2			V3			V4		V5			
			Up	V1	Down	Up	V2	Down	Up	V3	Down	Up	Down	Up	Front	Back	Down
Coliform CFU/100ml	12/10	–		1.13E+08			3.93E+07			3.55E+06					8.70E+05	3.90E+06	
	13/10	–		4.35E+07			3.95E+07			4.53E+06					9.60E+05	2.07E+07	
	14/10	6am		5.40E+07			3.40E+06			7.70E+06					1.65E+07	5.00E+07	
		12pm	7.60E+03	7.00E+07	3.20E+04	5.00E+06	1.00E+07	8.00E+04	2.60E+03	1.60E+04	1.60E+04	1.10E+04	1.96E+04	6.80E+03	9.80E+04	2.20E+07	6.00E+04
		6pm		2.80E+07			6.00E+07			5.00E+07					8.70E+06	2.00E+05	
	15/10	–		1.00E+08			3.90E+07			2.50E+07					1.20E+07	3.20E+05	
	16/10	–		1.10E+08			6.00E+05			1.50E+05					1.50E+04	4.00E+05	
	17/10	6am		2.50E+07			2.30E+06			1.40E+08					5.00E+07	4.00E+05	
		12pm	4.60E+04	8.00E+04	2.60E+05	2.00E+08	1.05E+04	4.40E+04	9.50E+04	5.00E+02	6.80E+04	2.80E+04	1.70E+04	1.30E+06	2.20E+01	2.85E+04	6.00E+04
		6pm		5.00E+06			1.10E+05			5.00E+04					1.00E+06	2.35E+05	
	18/10	–		3.74E+07			9.00E+07			1.20E+08					4.08E+05	8.70E+04	
EC (mS)	12/10	–		1.692			2.32			0.661					0.665	1.009	
	13/10	–		1.59			1.422			0.741					0.61	2.75	
	14/10	6am		2.06			1.197			4.21					0.965	1.975	
		12pm	1.143	1.794	1.094	1.684	1.098	1.74	1.997	1.85	1.874	2.12	2.18	2.04	0.667	1.004	1.892
		6pm		1.83			0.999			1.8					0.712	1.011	
	15/10	–		1.65			1.63			1.625					1.14	1.95	
	16/10	–		1.433			2.92			2.67					1.489	2	
	17/10	6am		1.8			2.71			2.35					1.08	2.13	
		12pm	1.31	1.38	1.24	1.89	2.52	3.1	2.32	1.91	2.63	2.34	2.21	1.394	0.802	2.15	2.1
		6pm		1.781			3.25			3.15					0.688	2.14	
	18/10	–		1.434			1.849			3.68					0.6	2.16	
pH	12/10	–		6.93			7.237			7.92					7.749	7.619	
	13/10	–		7.05			7.126			8.127					7.758	7.08	
	14/10	6am		7.323			7.84			8.262					7.868	7.39	
		12pm	7.531	7.24	7.58	7.53	7.61	7.6	7.7	7.68	7.03	8.25	8.38	8.339	7.9	7.408	7.59
		6pm		7.2			7.7			7.51					7.78	7.5	
	15/10	–		7.166			7.009			8.128					8.08	7.39	
	16/10	–		7.27			7.6			7.86					7.96	7.6	
	17/10	6am		7.12			7.4			8.211					8.801	7.8	
		12pm	7.7	7.24	7.8	8.08	7.47	8.23	7.94	8.01	7.45	8.4	8.37	8.5	7.81	7.8	8
		6pm		7.5			7.83			7.43					7.8	7.53	
	18/10	–		6.97			7.4			8.1					8.2	7.56	

Water Quality Test Result on Filed Survey-1(Test-2)

Parameters	Date	Time	Al Saei Village			El Nahas Village			Al Doksh Village			Al Tanapra Village		Al Shurafah Village			
			V1			V2			V3			V4		V5			
			Up	V1	Down	Up	V2	Down	Up	V3	Down	Up	Down	Up	Front	Back	Down
DO (mg/l)	12/10	–		0.46			0.62			0.55					0.42	0.49	
	13/10	–		0.23			0.1			0.25					0.23	0.17	
	14/10	6am		0.44			0.31			0.37					0.3	0.4	
		12pm	2.2	0.38	2.9	0.37	2.05	1.77	1.52	1.03	1.83	6.63	6.27	3.44	2.36	2.4	0.97
		6pm		0.73			1.47			1.17					2.14	2.53	
	15/10	–		0.24			2.33			3.16					0.19	0.63	
	16/10	–		0.5			4.5			0.87					1.5	0.51	
	17/10	6am		0.23			2.55			1.7					1.92	1.42	
		12pm	4.45	0.9	0.93	2.18	1.43	3.11	1.44	1.56	1.7	4.16	8.3	8.5	0.75	0.18	1.55
		6pm		0.62			0.51			0.38					0.13	0.91	
	18/10	–		0.09			1.14			0.5					2.6	1.8	
Temp (℃)	12/10	–		28.6			26.7			27.4					25.9	26.8	
	13/10	–		26.4			30.3			27.1					25.9	27.6	
	14/10	6am		20.6			24.1			23.1					23.5	23.4	
		12pm	28.6	25.4	28.8	25.3	26.5	24.7	22.8	22.4	22.3	27.2	28.2	26.3	25.5	25.7	25.7
		6pm		20.5			21			21.3					22.3	21.8	
	15/10	–		25.8			27.9			28.8					28.7	29.3	
	16/10	–		25.7			28.3			26.6					27	26.9	
	17/10	6am		22.5			23.9			27.4					26.3	29.3	
		12pm	28.2	25.7	29.6	27.2	29.9	28.4	25.5	28.9	29.8	26.5	30.8	31.7	26.4	29.1	30.2
		6pm		29			26.3			24.1					26.6	28.8	
	18/10	–		27.4			28.6			29.3					27.4	30.4	
Salinity (g/l)	12/10	–		0.8			1.1			0.2					0.2	0.4	
	13/10	–		0.8			0.7			0.3					0.2	1.4	
	14/10	6am		1			0.5			2.2					0.4	1	
		12pm	0.5	0.9	0.4	0.8	0.5	0.8	1	0.9	0.9	1.1	1.1	1.1	0.3	0.4	0.9
		6pm		0.9			0.4			0.9					0.3	0.4	
	15/10	–		0.8			0.8			0.8					0.4	1	
	16/10	–		0.7			1.5			1.4					1	1	
	17/10	6am		0.9			1.4			1.2					0.5	1.1	
		12pm	0.6	0.6	0.6	0.9	1.3	1.6	1.6	1	1.5	1.2	1.1	0.7	0.3	1.1	1.1
		6pm		0.9			1.7			1.7					0.3	1.1	
	18/10	–		0.7			0.9			2					0.2	1.1	

8-5：Water Quality Test Result on MBD Verification Test

(1) Items of Water Quality Analysis and Sampling Points

The purpose of the MBD test is to verify the effect of the MBD to increase a low Dissolved Oxygen (DO) value which may be a main cause of water pollution in the existing drainage canal. MBD were set in Drain No.4 and items of water quality analysis and sampling points are shown below.

(a) Test-1：Water Quality Analysis（9 items × 78 samples）

Test Item	Details of Sampling
1) DO (Dissolved Oxygen) 2) COD (Chemical Oxygen Demand) 3) ORP (Oxidation Reduction Potential) 4) SS (Suspended Solids) 5) pH (Hydrogen Ion Exponent) 6) T-N (Total Nitrogen) 7) NH_3-N (Ammonia Nitrogen) 8) NO_2-N (Nitrite Nitrogen) 9) NO_3-N (Nitrate Nitrogen)	(1) Location of Sampling 15 points: (Longitudinal 5 points × Sectional 3points) Longitudinal 5 points: 1) 10 m from MBD installation point 2) 50 m from MBD installation point 3) 200 m from MBD installation point 4) 500 m from MBD installation point 5) 1,000 m from MBD installation point Sectional 3 points: 1) the right side of the flow of the Drain No.4 2) the center of the flow of the Drain No.4 3) the left side of the flow of the Drain No.4 (2) Number of the Sampling 5 times 1) Before MBD operation, 2) 30 minutes after the start of operation, 3) 1 hour after the start of operation, 4) 2 hours after the start of operation 5) 3 hours after the start of operation (3) Others 1 time - sample water after 3 hours from the start of MBD operation then leave it and check the water quality at the time that 24 hours have passed after sampling

(b) Mud and Sedimentation Analysis：Samples of the mud and sedimentation will be taken at the Drain No.4 to examine the condition of the bottom.

① Test items：7 items (Ignition loss, T-N, T-P, NO^{2}-N, NO^{3}-N, COD, $SO4^{2-}$)

② Test Points：3 points×1 time＝3 samples

Sampling of undisturbed soil at the 3 points for right bank, center and left bank at the upstream of MBD installation points

③ ORP test：1 point x 10 levels (depth)

Location: Sampling of undisturbed soil at the upstream of the MBD set points at the center of Drain No.4

Depth: 10cm , 20cm , 30cm, 40cm, 50cm, 60cm, 70cm, 80cm, 90cm, 100cm

(c) Flow Observation : Average flow at 3 points is measured at the MBD set points in Drain No.4 before MBD operation

The above test plan had to be changed and the comparison of proposed and actual test is summarized as shown in Table 8

- Though the test was planned to take 78 samples (3 samples ×5 sections ×5 times ＋3 samples (after 24 hours)) in Drain No.4 at first, 34 samples (1 samples ×6 sections ×5 times ＋4 samples) were taken actually in the temporary drain according to the result of the pre test of MBD. The reason of samples to be taken were reduced per 1 section is that 1 sample for 1 section would be enough for the temporary drain width with 0.8 to 2.0 m
- The location of samples has been changed but the number of samples has not been changed in irrigation canal
- Test in temporary drain has been changed to take 14 samples/section (1 sample ×4 section ×3 times ＋2 samples (after 24 hours)) with removed vinyl sheet to examine the influence by mud and bottom sedimentation because the samples were already taken not influenced by mud and bottom sedimentation.
- Mud and sedimentation test has not been changed
- ORP test has been changed to take 10 samples every 10 m to 3 samples every 30 m because it was difficult for the faculties of the laboratory to take samples every 10 m.

Table 8-1 Comparison of Water Quality Test

Item	Proposed Quantity	Revised Quantity
(a) Water Quality Analysis	Drain No.4：9 items×78 samples Irrigation Canal; ：9 items×26 samples Temporary Drainage Canal：9 items×25 samples Total 9 items×129 samples	Drain No.4：9 items×34 samples Irrigation Canal：9 items×26 samples Temporary Drainage Canal：9 items×14 samples Total 9 items×74 samples
(b) Mud and sedimentation analysis	Sedimentation test：7 items×3 samples ORP test ：1 item×10 samples	Sedimentation test：7 items×3 samples ORP test ：1 item×3 samples
(c) Flow Observation	3 points	3 points

(2) Water Quality Test Result

Water Quality Test Result on MBD Verification Test in the temporary drain (Dec 28, 2009)

MBD Operation	Distance	Temp ^{0}C	pH	Ec mS	Salinity g/l	DO mg/l	COD mg/l	SS mg/l	NH3-N mg/l	T-N mg/l	ORP mV	NO2-N mg/l	NO3-N mg/l
Before pumping by 2 MBDs	0 m	15.1	9.62	1752	0.8	0.1	12	1158	5.005	5.085	90.0	0.03	0.05
	5 m	15.1	8.6	1763	0.8	0.35	11	1128	5.49	5.57	102.4	0.03	0.05
	50 m	15.4	8.02	1752	0.8	0.49	13	1136	6.468	6.548	105.0	0.03	0.05
	200 m	16.2	7.12	1767	0.8	0.3	15	1138	7.4	7.48	125.0	0.03	0.05
	500 m	17.8	8.03	1848	0.9	5.17	2	1184	4.62	4.93	138.4	0.15	0.16
	750 m	16.3	8.2	1692	0.8	6.12	1	1081	3.927	4.945	158.0	0.42	0.598
30 minutes after pumping	0 m	15.2	7.54	1744	0.8	0.08	11	1129	5.09	5.373	102.7	0.03	0.253
	5 m	15.6	7.61	1756	0.8	6.36	8	1144	5.1	5.183	118.7	0.03	0.053
	50 m	15.8	7.69	1743	0.8	5.02	6	1140	5.8	5.881	138.1	0.03	0.051
	200 m	16.5	7.53	1762	0.8	5.3	7	1149	7.35	7.426	139.0	0.03	0.046
	500 m	18.5	7.72	1975	1.0	4.54	1	1275	4.7	5.076	113.8	0.063	0.313
	750 m	16.5	8.1	1699	0.8	7.91	1	1081	4.2	5.671	111.0	0.468	1.0028
1 hour after pumping	0 m	15.4	7.64	1715	0.8	0.09	11	1115	5.136	5.265	154.1	0.06	0.069
	5 m	15.5	7.5	1718	0.8	6.49	8	1112	4.859	4.967	130.0	0.06	0.048
	50 m	15.7	7.74	1728	0.8	5.81	5	1123	5.39	5.466	136.4	0.03	0.046
	200 m	16.4	7.5	1750	0.8	4.64	4	1138	7.392	7.468	140.7	0.03	0.046
	500 m	18.7	7.63	1820	0.9	5.03	1	1138	4.697	4.84	172.1	0.06	0.083
	750 m	17.6	7.93	1772	0.9	7.49	1	1146	3.773	4.174	166.5	0.24	0.161
2 hours after pumping	0 m	15.5	7.51	1695	0.8	0.08	10	1108	5.002	5.078	174.5	0.03	0.046
	5 m	15.6	7.45	1701	0.8	6.96	1	1114	4.65	5.14	107.8	0.03	0.46
	50 m	15.8	7.6	1707	0.8	5.02	2	1115	4.62	4.696	131.2	0.03	0.046
	200 m	16.6	7.62	1733	0.8	4.63	2	1126	5.467	5.543	126.0	0.03	0.046
	500 m	18.4	7.75	1790	0.9	4.12	1	1158	4.62	4.719	129.5	0.03	0.069
	750 m	17.7	7.91	1867	0.9	6.1	1	1204	3.465	3.822	136.8	0.15	0.207
3 hours after pumping	0 m	15.6	7.9	1681	0.8	0.08	10	1091	3.927	4.042	141.5	0.06	0.055
	5 m	15.8	7.81	1693	0.8	5.5	1	1095	4.39	4.575	137.0	0.093	0.092
	50 m	15.9	7.68	1696	0.8	5.29	1	1108	4.56	4.659	135.8	0.03	0.069
	200 m	16.4	7.65	1711	0.9	5.2	2	1109	4.9	4.976	142.8	0.03	0.046
	500 m	17.7	7.75	1782	0.9	4.16	1	1176	4.3	4.445	128.4	0.03	0.115
	750 m	17.2	7.88	1911	0.9	6.35	1	1232	3.1	3.643	131.9	0.06	0.483
Before pumping by 1 MBD	0 m	15.7	7.43	1661	0.8	0.19	7	1081	4.01	4.332	166.4	0.138	0.184
	5 m	15.8	7.49	1663	0.8	3.26	1	1085	4.3	5.386	146.6	0.12	0.966
	50 m	15.9	7.53	1683	0.8	3.7	2	1099	4.58	5.22	146.7	0.18	0.46
	200 m	16.4	7.56	1698	0.8	4.71	4	1108	4.98	5.104	144.1	0.03	0.094

Result on MBD Verification test in the temporary drain (Experimentation on the Influence of Mun and Bottom Sedimentation (Dec 28, 2009))

MBD Operation	Distance	Temp ^{0}C	pH	Ec mS	Salinity g/l	DO mg/l	COD mg/l	SS mg/l	NH3-N mg/l	T-N mg/l	ORP mV	NO2-N mg/l	NO3-N mg/l
Before pumping	0 m	16.0	7.55	1572	0.7	0.08	10	1024	3.619	3.822	117.2	0.12	0.0828
	5 m	15.9	7.38	1582	0.8	0.49	10	1021	3.665	3.892	131.7	0.123	0.104
	50 m	16.7	7.4	1584	0.8	0.61	12	1034	4.389	4.465	134.2	0.03	0.046
	200 m	18.6	7.49	2380	1.2	1.72	5	1531	2.772	2.903	126.1	0.06	0.071
1 hour after pumping	0 m	16.1	7.39	1572	0.7	0.07	10	1016	3.619	3.89	127.0	0.108	0.163
	5 m	16.2	7.7	1578	0.7	6.16	10	1031	2.695	3.020	143.2	0.15	0.1748
	50 m	16.3	7.5	1578	0.7	5.15	6	1039	3.56	3.873	137.6	0.168	0.1449
	200 m	17.5	7.46	2190	1.1	1.12	4	1397	3.412	3.488	141.5	0.03	0.046
2 hours after pumping	0 m	16.3	7.36	1582	0.8	0.07	11	1025	3.542	3.959	135.7	0.21	0.207
	5 m	16.4	7.44	1537	0.7	5.33	11	1039	2.54	2.973	122.1	0.18	0.253
	50 m	16.7	7.39	1600	0.8	4.25	7	1058	3.157	3.522	134.6	0.213	0.152
	200 m	17.6	7.54	1979	1.0	3.08	4	1296	2.313	2.467	131.0	0.06	0.0943
24 hours from Dec. 28		19.9	7.61	1695	0.8	3.5	37	1096	3.08	3.596	140.1	0.24	0.276
24 hours from Dec. 29		16.6	7.54	1577	0.7	4.7	51	1098	2.31	3.096	138.4	0.243	0.543

Water Quality Test Result on MBD Verification Test at Shurafah pump station and connected irrigation canal (Dec 31, 2009)

MBD Operation	Distance	Temp ^0C	pH	Ec mS	Salinity g/l	DO mg/l	COD mg/l	SS mg/l	NH3-N mg/l	T-N mg/l	ORP mV	NO2-N mg/l	NO3-N mg/l
Before pumping	Suction	17.0	7.46	1827	0.9	0.06	44	1205	4.697	4.967	80.0	0.03	0.24
	Discharge	17.1	7.53	1824	0.8	6.22	42	1190	5.39	5.53	90.0	0.06	0.08
	10 m	17.0	7.69	1822	0.8	2.9	39	1165	4.774	5.014	126.6	0.06	0.18
	50 m	17.0	7.79	1822	0.8	2.96	37	1154	5.467	5.737	80.0	0.06	0.21
	200 m	17.2	7.58	1824	0.8	2.52	37	1184	4.05	4.56	96.0	0.06	0.45
	500 m	17.2	7.5	1853	0.8	1.85	46	1205	5.467	5.557	109.6	0.03	0.06
	1 km	17.8	7.99	2200	1.1	3.97	32	1481	3.95	4.97	102.4	0.09	0.93
	Tertiary	17.2	7.58	1811	0.8	5.44	40	1192	4.62	4.77	96.7	0.06	0.09
30 minutes after	10 m	17.2	7.38	1802	0.8	3.24	38	1181	3.927	4.467	137.4	0.06	0.48
	50 m	17.3	7.43	1802	0.8	3.14	34	1184	4.312	4.54	121.1	0	0.228
	200 m	17.3	7.51	1806	0.8	2.97	33	1177	4.081	4.276	112.6	0.06	0.135
	500 m	17.3	7.5	1820	0.8	2.5	37	1181	4.158	4.518	125.4	0.06	0.3
	1 km	17.3	7.52	2000	1.0	2.79	32	1308	3.08	3.77	121.3	0.06	0.63
1 hour after	10 m	17.3	7.51	1791	0.8	3.2	38	1171	3.157	3.427	94.8	0.09	0.18
	50 m	17.3	7.54	1794	0.8	3.15	34	1165	4.466	4.736	98.6	0.06	0.21
	200 m	17.4	7.47	1793	0.8	3.03	34	1188	4.851	4.941	94.2	0.03	0.06
	500 m	17.4	7.53	1804	0.8	2.65	36	1184	4.466	4.616	99.7	0.03	0.12
	1 km	18.2	7.57	1840	0.8	2.39	33	1275	4.62	4.89	101.9	0.09	0.18
2 hours after	Section	17.4	7.35	1824	0.8	0.07	43	1192	4.774	4.864	52.0	0.03	0.06
	Discharge	17.4	7.34	1725	0.85	5.22	41	1190	4.63	4.78	97.9	0.03	0.12
	10 m	17.2	7.51	1701	0.8	2.32	38	753	4.543	4.813	92.9	0.06	0.21
	50 m	17.3	7.5	1813	0.8	2.95	32	753	4.62	4.98	108.3	0.06	0.3
	200 m	17.4	7.5	1801	0.8	2.89	31	755	4.081	4.369	132.6	0.15	0.138
	500 m	17.5	7.54	1797	0.8	2.5	33	752	4.62	6.27	110.0	0.39	1.26
	1 km	18.1	7.49	1876	0.8	1.71	33	751	3.85	4.09	108.7	0.06	0.18
	Tertiary	17.3	7.68	1813	0.8	5.3	33	1173	4.697	5.087	100.0	0.03	0.36

8-6 : Water Quality Test Result by Simple Equipment (Additional Field Survey)

Test day	Canal/Drain	Village/Place	Point	Conditions	Station	Date	Time	Temp ℃	MBD No.	Flow m3/min	Velocity m/min	Operation hour	DO mg/L	DO mg/L	DO mg/L	DO mg/L	DO mg/L	DO mg/L	DO mg/L	Transparency cm	COD mg/L	NH4+ mg/L	NO3- mg/L	NO2- mg/L
Test-1											3 MBD Operation													
Pretest	Drain No.4	Nafas Bridge	Drain No.4	Main Drain	Upside of MBD	2009.12.25	14:00	16.1	No.1,2,3	420	30	1 hour	0.05											
			Drain No.4	Main Drain	5m from MBD	2009.12.25	14:00	16.1	No.1,2,3	420	30	1 hour	0.13											
			Drain No.4	Main Drain	50m from MBD	2009.12.25	14:00	16.1	No.1,2,3	420	30	1 hour	0.14											
			Drain No.4	Main Drain	200m from MBD	2009.12.25	14:00	16.1	No.1,2,3	420	30	1 hour	0.16											
Test-2											2 MBD Operation													
Pretest	Drain No.4	Nafas Bridge	Drain No.4	Main Drain	Upside of MBD	2009.12.26	14:00	16.2	No.1,2	420	30	1 hour	0.06							13	40	≧10	15	≧1
			Temporary Drain	Flow on Sheet	5m from MBD	2009.12.26	14:00	16.2	No.1,2	0.4	10	1 hour	6.45							10	30	≧10	15	≧1
			Temporary Drain	Flow on Sheet	50m from MBD	2009.12.26	14:00	16.2	No.1,2	0.4	4	1 hour	5.43							11.5	30	≧10	10	≧1
			Temporary Drain	Flow on Sheet	200m from MBD	2009.12.26	14:00	16.2	No.1,2	0.4	3	1 hour	2.35							13	30	≧10	10	≧1
Test-3											1-2 MBD Operation													
Pretest	Drain No.4	Nafas Bridge	Temporary Drain	Flow on Sheet	5m from MBD	2009.12.27	14:00	16.2	No.1,2	0.4	10	5 hour	6.7											
			Temporary Drain	Flow on Sheet	5m from MBD	2009.12.27	14:00	16.2	No.1	0.2	10	5 hour	3.2											
			Temporary Drain	Flow on Sheet	5m from MBD	2009.12.27	14:00	16.2	No.2	0.2	10	5 hour	4.3											
Test-4							11:00-14:00				2 MBD Operation		before	0.5 hour	1 hour	2 hours	3 hours							
1st day	Drain No.4	Nafas Bridge	Drain No.4	Main Drain	Upside of MBD	2009.12.28		16.0		420	30		0.10	0.08	0.09	0.08	0.08							
			Temporary Drain	Flow on Sheet	5m from MBD	2009.12.28		16.0	No.1,2	0.9	10		0.35	6.36	6.49	6.96	5.50							
			Temporary Drain	Flow on Sheet	50m from MBD	2009.12.28		16.0	No.1,2	0.9	4		0.49	5.02	5.81	5.02	5.29							
			Temporary Drain	Flow on Sheet	200m from MBD	2009.12.28		16.0	No.1,2	0.9	3		0.30	5.30	4.64	4.63	5.20							
			Temporary Drain	Flow on Sheet	500m from MBD	2009.12.28		16.0	No.1,2	0.5	1		5.17	4.54	5.03	4.12	4.16							
			Temporary Drain	Flow on Sheet	750m from MBD	2009.12.28		16.0	No.1,2	0.5	0		6.12	7.91	7.49	6.10	6.35							
Test-5 (1)							14:00-14:30				1 MBD Operation		before	0.5 hour	1 hour	2 hours	3 hours							
1st day	Drain No.4	Nafas Bridge	Drain No.4	Main Drain	Upside of MBD	2009.12.28		17.0		420	30		0.08	0.19										
			Temporary Drain	Flow on Sheet	5m from MBD	2009.12.28		17.0	No.1	0.5	10		5.50	3.26										
			Temporary Drain	Flow on Sheet	50m from MBD	2009.12.28		17.0	No.1	0.5	4		5.29	3.27										
			Temporary Drain	Flow on Sheet	200m from MBD	2009.12.28		17.0	No.1	0.5	3		5.20	4.71										
Test-5 (2)											Before Operation		before	0.5 hour	1 hour	2 hours	3 hours							
2nd day	Drain No.4	Nafas Bridge	Drain No.4	Main Drain	Upside of MBD	2009.12.29	10:30	15.7		420	30		0.56											
			Temporary Drain	Flow on soil	5m from MBD	2009.12.29	10:30	16.0		0	0		0.11											
			Temporary Drain	Flow on soil	50m from MBD	2009.12.29	10:30	16.4		0	0		0.90											
			Temporary Drain	Flow on soil	200m from MBD	2009.12.29	10:30	17.9		0	0		2.72											
			Temporary Drain	Flow on Sheet	500m from MBD	2009.12.29	10:30	17.8		0	0		6.45											
			Temporary Drain	Flow on Sheet	750m from MBD	2009.12.29	10:30	18.0		0	0		3.65											
			Temporary Drain	Flow on Sheet	800m from MBD	2009.12.29	10:30	18.0		0	0		5.05											
			Temporary Drain	Flow on Sheet	900m from MBD	2009.12.29	10:30	18.0		0	0		7.03											
			Temporary Drain	Flow on Sheet	1000m from MBD	2009.12.29	10:30	18.7		0	0		9.80											
Test-6 (1)							12:00-14:00				2 MBD Operation		before	0.5 hour	1 hour	2 hours	3 hours							
2nd day	Drain No.4	Nafas Bridge	Drain No.4	Main Drain	Upside of MBD	2009.12.29		17.0		420	30		0.56			0.5								
			Temporary Drain	Flow on soil	5m from MBD	2009.12.29		17.0	No.1,2	0.9	10		0.11			6.3								
			Temporary Drain	Flow on soil	50m from MBD	2009.12.29		17.0	No.1,2	0.9	3		0.90			6.3								
			Temporary Drain	Flow on soil	200m from MBD	2009.12.29		17.0	No.1,2	0	0		2.72			2.0								
Test-6 (2)												No Operation	before	0.5 hour	1 hour	2 hours	3 hours							
3rd day	Drain No.4	Nafas Bridge	Drain No.4	Main Drain	Upside of MBD	2009.12.30	10:30	16.9		420	30		0.18											
			Temporary Drain	Flow on soil	5m from MBD	2009.12.30	10:30	16.9		0	0		0.18											
			Temporary Drain	Flow on soil	50m from MBD	2009.12.30	10:30	16.9		0	0		0.42											
			Temporary Drain	Flow on soil	200m from MBD	2009.12.30	10:30	16.9		0	0		1.44											
			Temporary Drain	Flow on Sheet	500m from MBD	2009.12.30	10:30	16.9		0	0		2.44											
			Temporary Drain	Flow on Sheet	750m from MBD	2009.12.30	10:30	16.9		0	0		2.00											
			Temporary Drain	Flow on Sheet	1000m from MBD	2009.12.30	10:30	16.9		0	0		6.46											
Test-7							12:30-14:30				Main Pump + 3 MBD Operation		before	0.5 hour	1 hour	2 hours	3 hours							
4th day	Canal	Shurafah PS	Suction	Main Pump	Suction of PS	2009.12.31		17.0		60	156		0.06			0.07								
			Discharge	Main Pump	Discharge of PS	2009.12.31		17.0		60	156		5.31			5.22								
			Canal	Main Pump + MBD	10m from MBD	2009.12.31		17.0	No.1,2,3	58.5	10.8		2.90	3.24	3.20	2.32								
			Canal	Main Pump + MBD	50m from MBD	2009.12.31		17.0	No.1,2,3	60.5	14.4		2.96	3.14	3.15	2.95								
			Canal	Main Pump + MBD	200m from MBD	2009.12.31		17.0	No.1,2,3	49.1	11.5		2.52	2.97	3.03	2.89								
			Canal	Main Pump + MBD	500m from MBD	2009.12.31		17.0	No.1,2,3	44.2	9.0		1.85	2.50	2.65	2.50								
			Canal	Main Pump + MBD	1000m from MBD	2009.12.31		17.0	No.1,2,3	0	0		3.97	2.79	2.39	1.71								
			Tertiary canal	Pump up from Canal	100m from MBD	2009.12.31		17.0	No.1,2,3	1	8		5.44			5.30								
Test-8 (1)							13:30-14:30				1 MBD Operation		before	10 minutes	20 minutes	30 minutes	40 minutes	50minutes	1 hour					
5th day	PS	Shurafah PS	Suction	MBD	Suction of PS	2010.1.1		17.0	No.1	0.5			0.30	2.70	4.20	4.25	4.80	5.07	5.25					
			Discharge	MBD	Discharge of PS	2010.1.1		16.3	No.2	0.4			1.80	6.08	6.60	7.33	7.72	7.90	7.96					
Test-8 (2)							13:00-13:30				1 MBD Operation		before	10 minutes	20 minutes	30 minutes	40 minutes	50minutes	1 hour					
6th day	PS	Shurafah PS	Suction	MBD	Suction of PS	2010.1.2		17.0	No.1	0.5			0.21			5.52								

Law 48 for the year 1982
Regarding the Protection of the Nile River and Waterways from Pollution

In the Name of the People

The President

The People's Assembly has adopted the following legislation and we have issued it as follows:
Article 1- In the application of the provisions of this law the following are considered waterways:

A) The freshwater bodies which include:
1- The Nile River, its tributaries and Akhwars.
2- Raiyahat, the canals with all its ranks and Gannabeyat.

B) The saline water bodies which include:
1- Drains with all its ranks.
2- Lakes.
3- Pools, enclosed water entities and Saiahats.

C) Groundwater Reservoirs.

Article 2 - It is prohibited to discharge or cast the solid, liquid or gas wastes discarded from real estate, shops, commercial, industrial and touristic facilities, or from sewage process in the waterways, either along the banks or over the surface unless after receiving license from the Ministry of Irrigation according to the regulations and standards stated in a resolution issued by the Minister of Irrigation based on a proposal by the Minister of Health. The license issued in this respect should include identification of the standards and specifications of each case separately.

Article 3 - The machinery of the Ministry of Health shall conduct a periodic analysis in its laboratories for samples of the processed liquid wastes taken from the facilities licensed to discharge in the waterways in the specified dates besides the analyses demanded by the Ministry of Irrigation in other than those periodic dates.

The machinery of the Ministry of Health shall be responsible for taking and analyzing the samples at the expense of the licensee, who must deposit a sum of money at the Ministry. The money shall be determined according to the quality of the wastes as a debit account of the costs of taking, transferring and analyzing the samples.

Both the Ministry of Irrigation and the licensee shall be informed with the result of the analysis. If the liquid wastes discharged in the waterways are violative of the standards and specifications stipulated in the license and do not constitute an instant danger, the licensee must within three months after being notified adopt a means of treating the wastes in order to be correspondent to the set specifications and standards. The process of treatment and testing should be performed during this period.

If the treatment is not finished by the end of the three-month period or is proved incompetent, the Ministry of Irrigation shall withdraw the given license and stop the discharge in the waterways in the administrative way.

If the result of the analysis shows that it violates the specifications and the standards specified in accordance with the provisions of this law in a way that shall constitute an instant danger to the pollution of the waterways, the licensee shall be notified to remove the causes of the damage immediately. Otherwise the Ministry of Irrigation shall undertake that task at the licensee's expenses or shall withdraw the granted license and stop the discharge done in the waterways in the administrative way.

Article 4 - It shall not be allowed to give permission to establish any facilities that would produce wastes disposed into the waterways.

However, the Ministry of Irrigation excluding any other authority may - if necessary and for the common good – give license to establish these facilities if the authorities using such facilities committed themselves to provide treatment units for these wastes in conformity with the specifications and standards set according to the provisions of this law. The operation of the treatment units should start upon the use of the facilities. The provisions of article 3 of this law shall apply to these facilities.

The existing facilities are to be given a one-year time limit starting from the date of putting this law into effect to provide a means for treating its wastes, otherwise the license shall be withdrawn. In such case the Ministry of Irrigation may take the measures necessary for stopping the discharge in the waterways in the administrative way without breaching the sanctions stated in this law.

Article 5 - The owners of the residential, tourist and other facilities floating in the Nile stream and its branches shall be committed to find a means for treating its wastes or combining them in certain places, draining and casting them in the sewage units. Draining any of its wastes in the Nile or the waterways shall not be allowed.

The irrigation engineers assigned with the application of this law, each in his area of jurisdiction, shall undertake the periodic inspection over these floating facilities. If it turns out that they violate the provisions of this article, the owner of the floating facility shall be given a time limit extending for three months to employ a means for treatment and removal of the causes of the damage. If this is not done by the end of the specified time, the license of the floating facility shall be cancelled.

Article 6 - The Ministry of Irrigation shall be responsible for issuing the licenses for establishing new floating facilities and renewing the licenses of the existing floating facilities, as well as authorizing the establishment of any facilities that would produce wastes to be discharged into the waterways.

Article 7- The movable river units used for transportation, tourism or any other purpose are prohibited to allow the leaking of the fuel used for its operation in the waterways.

The provisions of article 5 of this law shall apply to those units.

Article 8 - The Sanitation Utility shall undertake the task of setting more than one model for units for processing the liquid or adhesive wastes produced by factories, houses, other institutions, floating facilities and river units in a way that would conform to the specifications and standards set according to the provisions of this law.

Article 9 - The license pursuer shall be committed to submit evidence for providing a unit for processing the wastes as well as a certificate from the Sanitation Utility proving the examination of the processing unit and its competency.

Article 10- Upon choosing and using types of chemicals for controlling the plant diseases, the Ministry of Agriculture should maintain that they would not pollute waterways through what is leaked from these chemicals either in a direct way through the process of sprinkling or mixed with the agricultural drainage water or through washing the instruments and equipment used for sprinkling or the containers of pesticides in waterways according to the standards agreed upon among the ministries of Agriculture, Irrigation and Health.

Article 11- Upon choosing types of chemicals used for controlling the water weeds, the Ministry of Irrigation should maintain that they would

not result in polluting waterways, and should in all cases take the necessary precautions before, during and after the processing is done using chemicals, in order to prevent the use of processed water of the waterway until they are certain of the cessation of the effects of these substances on water quality and its usability for all purposes.

Article 12 - Reuse of Drains water shall not be allowed either directly or by mixing with fresh water for any purpose unless it is proven usable for that purpose. The Ministry of Irrigation , after consulting the Ministry of Health, shall take the actions necessary for processing the drains water that are to be reused.

Article 13 - The Nile Water Police Department shall supervise inspection patrols continuing along waterways and assist the competent authorities in controlling the wastes and in eliminating the causes of pollution and report any violations to the provisions of this law.

Article 14 - A special fund shall be instituted to comprise the revenues of charges, fines and costs resultant from the application of the provisions of this law. The money of that fund would be spent on the following cases:

- The costs of the administrative elimination of the violations.
- Monetary aids to the authorities that establish stations for processing the wastes before drainage.
- Conducting laboratory research and studies.
- Rewards for the officials who report and detect crimes violating the provisions of the law.

Article 15 - The Executive regulations for this law shall specify the charges that are due in implementation of the provisions of this law in a way that would not exceed the maximal limits stated in the enclosed table. The regulations shall also determine the expenses that are due in application of the provisions of this law and which may be collected via administrative confiscation.

Article 16 – Without prejudice to the provisions stated in the Penal Code, the punishment stated for violation of the provisions of articles 2, 3, 4, 5, 7 of this law shall be imprisonment for a period not exceeding one year in addition to a fine that shall not be less than five hundred pounds and shall not exceed two thousand pounds or one of these two penalties. If the violation reoccurs, the penalty shall be duplicated. The violator should eliminate or amend the violations at the date set by the Ministry of Irrigation. Unless the violator undertakes the elimination or the amendment of the violation at the specified date, the Ministry of Irrigation shall take the measures needed for the elimination or amendment by the administrative way and at the expense of the violator without breaching the right of the ministry to nullifying the license.

Article 17- The Minister of Irrigation shall issue the executive regulations of this law after consulting the other ministries concerned in three months from the date of issuing.

Article 18 - Irrigation engineers who, via a resolution from the Minister of Justice in agreement with the Minister of Irrigation, shall be designated as investigation officers in relation to the crimes stipulated in this legislation and which occur within their areas of jurisdiction.

Article 19 - This legislation is to be published in the official newspapers, and is to be in force within three months after the date of publication.

This legislation shall be stamped with the State Seal, and is to be implemented as one of its laws.

Issued at the Presidency on 21 June 1982.

Resolution no. 8 of the Minister of Irrigation for the year 1983 concerning the Executive Regulations of Law 48 for the year 1982 regarding the Protection of the Nile and Waterways from Pollution

Section 1
Definitions

Article 1- In the application of the provisions of law 48 for the year 1982, waterways mentioned are defined as follows:

1- The River Nile and its branches : the main stream of the Nile starting from the international boundaries with Sudan till the estuary of Demietta and Rashed branches in the Mediterranean.

2- Al-Akhwar : The side branches of the Nile Stream inside the islands

3-Al-Raiyahat: Large canals transferring water from the Delta Barrages supplying the network of canals in Lower Egypt.

4- Canals: Big and small canals with all its branches even field mesqas.

5- Gannabeyat: Distribution canals that pass parallel or adjacent to main canals transferring irrigation water.

6- Drains: Large and small drains with all its branches even the field drains and covered drains.

7- Lakes: Lakes connected with seas or springs.

8- Pools: Large enclosed water bodies into which waterways flow.

9- Closed water bodies: Lows filled with water and linked to waterways.

10- Saiahat: Low lands around the lakes into which drainage channels flow.

The source of the last three waterways is drainage water.

11- Groundwater reservoirs: Groundwater reservoirs within the Egyptian boundaries.

12- Solid Wastes : All the solid materials either resultant from garbage, sewage, dry wastes, stones, wastes from buildings or workshops, or any solid materials residual after individuals, residential, nonresidential buildings, either governmental or private, whether commercial, industrial, tourist or public as well as means of transportation.

13- Liquid wastes :

(1) Wastes emanating from industrial shops over which the standards regarding the liquid industrial wastes shall be applied.

(2) Human or animal wastes proceeding from the processes of sewage or its networks or from other properties or facilities such as public, commercial, industrial and tourist shops either movable, immovable or floating.

(3) Liquid animal wastes derived from the processes of slaughter, slaughter houses, abattoirs, poultry farms and barns.

14- The word "facility" refers to all the real estates, shops, commercial, industrial or tourist institutions whether governmental or nongovernmental.

Section 2
Licensing to Drain Processed Liquid Wastes in Waterways

Article 2- The banks of water bodies shall not be used - whatever their type - as places for collecting or disposal of solid wastes, transferring or storing volatile substances except for places for which a license is issued from the Ministry of Irrigation based on an application submitted by the party concerned.

Article 3- Storing or discharging chemicals or poisonous substances shall not be permitted at the banks of waterways except in places given prior license in relation to the existing licenses. The renewal of these licenses and issuance of new licenses shall be done by the Ministry of Irrigation.

Article 4- Liquid industrial wastes licensed to be discharged into waterways must not contain any pesticides or radiant substances or substances floating in the waterway... Or any substance that would constitute danger to man, animal, plant, fish, or bird, or would affect water usability for drinking, domestic, industrial, or agricultural uses.

Article 5- Licensing to drain human, animal wastes or sewage water into fresh water bodies, stated in article 1 from law 48 for the year 1982 referred to, or groundwater reservoirs shall not be granted. However the Minister of Irrigation may license draining wastes of movable floating facilities and river units into fresh waterways and groundwater after being processed according to the standards, conditions, and regulations stated as follows on the condition that the owner of floating facility or river unit should pay the charge stated in article 82 from the regulations.

Item	Standards and Specifications
Degree of Ionic Concentration of Hydrogen	7-8.5
Temperature	Five degrees above the average.
Color	Free from any colored substances.
Dissolved Oxygen	Not less than 2 milligrams/liter.
Absorbed biotic Oxygen	Not exceeding 20 milligrams/liter.
Chemically consumed oxygen (Permanganate Method)	Not exceeding 30 milligrams/liter.

Chemically consumed oxygen (Dicromate Method)	Not exceeding 60 milligram/liter.
Suspended Substances	Not Exceeding 20 milligram/liter.
Sulfides	Not Exceeding 0.5 milligram/liter.
Oils and greases	Not Exceeding 2 milligram/liter.
Nitrites	None.
Heavy metals group estimated	Not Exceeding 1.5 milligram/liter.
Lead of microscopic examination	Free from eggs of intestinal parasites
Potential number of colonic group	Not Exceeding 100/100 cm^3
Pesticides	None

1- The wastes must be sterilized after processing and before drainage into freshwater ways, Ozone is preferable.

In case of using chlorine or its derivatives, the chlorine left after 20 minutes after being added must not be less than 0.5 milligram/liter and must not exceed 1 milligram/liter.

2- Processing units for movable floating facilities should be designed in a way that provides points for taking samples before drainage. The draining of the slough resultant from processing into the waterway shall be

prohibited. Representatives of the Ministry of Health and Health Affairs Directorates are entitled to access these floating facilities and river units to confirm the operation of purification units and take the necessary samples.

3- The owner of the floating facility or river unit should submit to the Ministry of Health (the Public Department of Environmental Health) the detailed charts for the processing units accompanied with a study of competency and conformity with the specifications stated to get the preliminary approval before the issuance of the license.

4- The draining of processed and sterilized wastes shall take place only during the motion of the floating facility. Draining of processed or unprocessed wastes shall be prohibited during the halting of the floating facilities and river units at the anchorages or stopping in the waterway for any reason whatsoever.

5- Chemicals, oils, operation exhausts, or dry wastes must not be drained into a fresh waterway in any form whether the floating facility or river unit was movable or immovable.

6- Draining of processed or liquid wastes of the floating facilities into waterways should be stopped in case of extreme danger upon the decision of the Minister of Health.

Article 6- Drainage of all liquid industrial wastes or sewage water into fresh water bodies and groundwater reservoirs shall be prohibited. The Ministry of Irrigation may license drainage of liquid industrial wastes which were processed into groundwater reservoirs according to conditions, specifications and standards stated in the regulations.

Article 7- Licensing to discharge water produced through machinery cooling into waterways shall not be granted unless water is taken from the same stream in which it flows or from a similar source at least in terms of

water quality, provided that the cooling circuit should be closed and not mixed with wastes of any phase of the industrial operations. In such case it does not have to be compatible with specifications, and standards concerning discharge of industrial wastes into fresh or saline water bodies except for temperature, oil and grease standards.

Article 8- It is prohibited to discharge any water containing radiant materials in groundwater reservoirs.

Article 9- The pipe of discharging processed liquid wastes licensed to be drained into waterways must be located in an evident place above the water level of the water stream.

Article 10- In case of licensing to discharge processed liquid industrial wastes into waterways it is stipulated that the drainage pipe must be distanced at least 3 kilometers in front of drinking water intakes or one kilometer aback.

Article 11- Water used for washing the filters at drinking water purification stations should not be discharged into water bodies without being processed. The authorities concerned should provide suitable means of processing.

Article 12- The application for the license of discharging processed liquid wastes into waterways shall be submitted to the competent irrigation inspector of the Irrigation District in whose area of jurisdiction the facility is located, the application should be presented with the charge of stamp including the following data:

1. The name, location, and address of the facility.
2. The license issued to the facility or number and date of the license application as well as the approvals issued in its regard.
3. The name of owner of the facility.
4. The activity carried out by the facility.

5. The quality of the liquid wastes requiring a license to be discharged into the waterways.
6. The result of the analysis of a sample taken from these wastes for a period not exceeding three months in case of existing facilities.
7. The name of waterway adjacent to the facility and which may be used for drainage.
8. The charts demonstrating locations for draining the wastes into waterways or ground reservoirs as well as the proposed drainage technique and the necessary specifications.
9. Paying examination fees that amount to 20 Egyptian pounds.
10. Paying insurance fees at the account of the costs of sampling , transferring and analysis in the following categories :

	Type of wastes	Insurance rate
1	Sewage water	200 (two hundred pounds)
2	Liquid industrial wastes	
	(A) drained into fresh water bodies	500 (five hundred pounds)
	(B) drained into saline water bodies	400 (four hundred pounds)

Article 13 - The irrigation engineer in whose area of jurisdiction the facility is located shall undertake the necessary examination and the required technical studies.

Article 14 - The competent irrigation engineer should consult the Ministry of Health regarding the result of the analysis of a sample of liquid wastes requiring a license for drainage or concerning how identical the wastes proposed to discharge are in relation to the standards stated in the regulations.

Article 15 - The Ministry of Health shall undertake the process of taking one sample or more from processed liquid wastes in the scheduled times and shall inform the Ministry of Irrigation with the result of the analysis accompanied with the opinion of Health laboratories concerning the form referred to in article 26 of the regulations.

Article 16 - The license shall be issued by the General Director of the Public Department of Irrigation based on the technical examination and the result of the analysis.

Article 17 - The license issued in this regard shall include the following:

-The number of the license.
-The name and location of the facility.
-The name of the owner of the facility.
- The standards and specifications which should not be exceeded by the quality of the liquid wastes licensed to be drained.
- The name and location of the waterway in which liquid wastes are licensed to drain.
- The amount of liquid wastes licensed to drain into the waterway (m^3/day).
- The number and locations of the licensed drains.
- The duration of the effectiveness of the license.
- The charges that are due annually for the laboratory tests and analysis of samples.

Article 18 - The duration of the license should not exceed two years, and should be renewed at least two months before the expiry date. The license shall be abolished without renewal in case of expiry.

Article 19 - The following authorities shall be given a copy of the granted license:

1- The competent Irrigation Public Department.

2- The pursuer of the license.
3- The Public Department of Environmental Health of the Ministry of Health.
4- The Nile Water Police of the Ministry of Interior.

Article 20 - The Ministry of Irrigation, in case of disapproval of the license application, should inform the person concerned with a registered letter explaining the reasons of rejection within sixty days from the date of submitting the application. The owner of the facility has the right to complain in 15 days since the date of being notified with the rejection of the license.

Article 21- The complaint shall be submitted to the same authority to which the application of the license is presented. The same authority should examine and render a judgment regarding the application within thirty days from the date of receiving the complaint. The judgment shall be conclusive.

Article 22 - The sanctions stated in law 48 for the year 1982 referred to shall apply to any one who violates the conditions of the granted license.

Article 23 - In case of losing or damaging the license, the Irrigation Public Department issuing the license must be notified immediately in order to issue a substitutive license after paying the charges amounting to ten pounds.

Section 3
Monitoring Abidance by the Stipulations of the License

Article 24 - The Ministry of Health shall conduct in its laboratories at least once every three months a periodic analysis for samples of processed liquid wastes taken from the facilities licensed to drain in waterways stated in law 48 for the year 1982 referred to. The samples shall be taken at different times to determine the quality of the wastes in the required accuracy.

Article 25 - The Ministry of Irrigation shall have the right to request the Ministry of Health to take samples from the processed liquid wastes in the dates determined by the Ministry of Irrigation and in other than the periodic dates referred to in the above-mentioned article.

The Ministry of Health shall inform the facility requiring the license with the result of the analysis of these samples accompanied with the opinion of its laboratories.

Article 26 - The Ministry of Health shall apprise both the Ministry of Irrigation and the owner of the facility with the result of the analysis of the sample taken from the processed liquid wastes in a month from the date of taking the sample on a form including the following data:

1- The name and address of the facility.
2- The date and location of taking the samples
3- The hour of taking the sample.
4- The name and address of the laboratory following the Ministry of Health which performed the analysis.
5- The name and occupation of the official who took the sample.
6- The name and occupation of the laboratory official.
7- The result of the analysis in detail and comparing it with the stated standards.
8- The final opinion of the laboratory.

Article 27- If the result of the analysis of the samples turns out to be violating the standards and specifications stipulated in the license in a manner that represents an instant danger to the pollution of waterways, the Ministry of Irrigation shall notify the person concerned by any means possible to remove the causes of the danger of pollution immediately. Otherwise the Ministry of Irrigation shall undertake that task at the expenses of the person concerned.

In that case it is allowed to withdraw the license and stop the drainage in waterways in the administrative way and the police departments as well as the competent local government authorities shall be informed for implementation.

Article 28 - If the result of the analysis of samples taken from the processed liquid wastes turns out to be violating the standards and specifications stipulated in the license in a manner that would not represent an instant danger, the Ministry of Irrigation shall inform the person concerned with a registered letter to remove the causes of violation within three months from the date of notification.

The person concerned is considered aware of the notification since the date of receiving the notification or the date of receiving the result of the analysis of samples from the Ministry of Health.

Article 29 - The Ministry of Irrigation shall advise the Ministry of Health with the measures taken according to the above-mentioned article to assume the task of taking a new sample on the day following the end of the three-month period referred to in the preceding article for analysis and notifying the Ministry of Irrigation with the result of the analysis and the final opinion of the Ministry of Health in this respect according to the form referred to in article (26) in the regulations.

Article 30 - The Ministry of Irrigation shall withdraw the license and halt the drainage into waterways in the administrative way if the processing

does not occur within the three-month period referred to in article 28 or if the result of the reanalysis revealed the incompetence of the processing done by the party concerned.

Article 31 - The owners of permanent or temporary facilities that currently exist and produce wastes drained in waterways shall be committed to inform the Ministry of Irrigation within three months from the date of putting the regulations into effect with a statement including the following:

1- The name and address of the facility.
2- The name of the owner of the facility or the authority that it follows.
3- The activity practiced by the facility.
4- The granted license for establishing the facility.
5- The quality of the wastes that are discharged into the waterway.
6- The name of waterway into which the wastes are cast.
7- The license granted to the facility to discharge its wastes into the waterway.
8- The amount of liquid wastes authorized to be drained into the waterway.

The notification shall be done via a registered letter or by handing it with a receipt to the engineer of the irrigation district in whose area of jurisdiction the facility is located.

Article 32 - The Ministry of Irrigation shall create registers at the level of Irrigation Districts comprising data of the permanent or temporary facilities or the facilities licensed to be established under law 48 for the year 1982 referred to.

Article 33 - The Ministry of Irrigation shall revise the notifications submitted to it in accordance with article (31) by the facilities that currently exist, and the state of their drainage of their liquid wastes into waterways. The Ministry shall also perform the inspection necessary for

the process of draining liquid wastes produced by these facilities, demonstrate her observations regarding every location and send a copy of these data to the Ministry of Health for taking samples from the liquid wastes at the times scheduled by the ministry and conducting the analysis.

Article 34 - The Ministry of Health shall apprise the Irrigation Authority requiring the analysis and the owner of the facility with the result of the analysis of the samples accompanied with the final opinion of the Ministry of Health laboratories in their regard.

Article 35 - The owner of the facility should, within a year from the date of applying law 48 for the year 1982 referred to, provide a means for processing liquid wastes for removing the causes of violation to the stated standards and specifications.

Article 36- By the end of the duration referred to in the above-mentioned article, the Ministry of Health shall perform a new analysis of the samples of the processed liquid wastes from all the existing facilities previously informed with data according to article (33) from the regulations. The Ministry of Health shall apprise the Ministry of Irrigation and the owner of the facility with the result of the analysis and the opinion of the Ministry of Health laboratories in their regard.

Article 37- The Ministry of Irrigation shall withdraw the license and stop the drainage into waterways in the administrative way if the incompetency of the processing of the liquid wastes, conducted by the owner of the facility, is proven after the end of the duration referred to in article (35) from the regulations without prejudice to the sanctions stated in law 48 for the year 1982 referred to.

Article 38 - Starting from the date of the application of law 48 for the year 1982 referred to, the civil service and local government services shall not be allowed to authorize establishing facilities that would produce wastes to be drained in waterways. The Ministry of Irrigation

shall be exclusively responsible for giving the final license for instituting the facilities that would produce drainage wastes in waterways, after the owner of the facility receives approvals from the competent authorities and commits himself to provide units for processing liquid wastes in conformity with the standards and specifications stated in the regulations.

Section 4
About The Floating Facilities and Movable River Units
Chapter 1
About The Floating Facilities

Article 39- In the application of the provisions of article (5) from law 48 for the year 1982, a floating facility means every motorized or non-motorized floating establishment … whether it was residential or touristic…

Article 40- Starting from the date of application of law 48 for the year 1982 referred to, the Ministry of Irrigation shall have the jurisdiction over issuing licenses for establishing the new floating facilities and renewal of licenses of the existing floating facilities after the owner receives approvals from the competent authorities.

Article 41- The application of the license for establishing the facility shall be presented by its owner to the President of the Irrigation Sector of the Ministry in Cairo. The application form must bear the necessary governmental stamps with the following documents enclosed:

1- The document of ownership of the facility.
2- A certificate from the Public Authority for River Transportation proving the usability of the facility and compatibility with the conditions stated by the Authority.
3- A certificate from the Irrigation Engineer in charge proving availability of a unit for processing the wastes resulting from using the facility, his examination of the facility and its competency.

4- Approvals of other competent authorities.
5- The commitment of the owner of the facility of preventing the leaking of the fuel used for operation of the facility into the waterways.
6- The name of the waterway used for operating or berthing the facility.
7- Paying the fees of examination which amount to twenty pounds…

Article 42- The license shall be issued by the competent Irrigation General Director or the Nile Inspector within a month from the date of presenting the application. The granted license should include the following:

- The name of the facility.
- The name of the owner of the facility.
- The activity practiced by the facility.
- The name of the waterway authorized for the use of the facility.
- Commitment of the owner of the facility of preventing the leaking of the fuel used for operation of the facility in the waterways.
- The duration of the effectiveness of the license granted to the facility, which shall be as follows:

1- Three years for the facilities used for residential purposes.
2- One year for the facilities used for touristic purposes.

Article 43 - The application of the renewal of the license shall be presented after applying the measures stated in article 41 from the regulations to the authority issuing the license in three months before the expiry of the existing license.

Article 44 - In case of loss or damage of the license, the Irrigation Public Department or the Nile Inspection issuing the license should be immediately informed and the owner should receive a substitutive license after paying the charges amounting to ten pounds.

Article 45 - The machinery of the Ministry of Irrigation should conduct periodic inspection at least once every three months and when

necessary over the floating facilities anchoring within the district – to confirm its abiding by the conditions of the granted license and providing a means for processing their wastes or collecting them in specific places, draining and casting them away in sewage. If the facilities violated that, the Ministry of Irrigation would inform the owner of the facility with a registered letter to remove the causes of the violation in three months since the date of receiving the notification.

Article 46 - The Irrigation Engineer or Nile Inspector should reexamine the facility by the end of the three-month period in the above-mentioned article. If the processing undertaken by the owner of the facility for removing the causes of the violation is proven to be incompetent, the license of the facility shall be cancelled.

Article 47- The Ministry of Irrigation shall create records at the level of the Irrigation Districts and Nile Inspections comprising all the data stated in the license granted for each facility that anchors or operates at the waterway situated within its boundaries.

Article 48- All the owners of the existing facilities should apprize the Ministry of Irrigation on the date of effectiveness of the regulations, whatever the use of the facility, with a statement including the following:

- The name of the facility.
- The name of the owner of the facility or the authority it follows.
- The activity practiced by the facility.
- The license granted for establishing the facility.

The name of the waterway authorized for use by the facility.

- The quality of the wastes resultant from the use of the facility and the method of disposal.
- The availability of units for processing the wastes before disposal.

- The license given to the facility for draining its wastes in the waterway.

This notification should be sent in a registered letter or is handed by receipt to the competent Engineer of the Irrigation District or the Nile Inspector in whose area of jurisdiction the facility is located within three months from the date of putting the regulations in effect.

Article 49- The Ministry of Irrigation shall revise the notifications submitted by the owners of the existing facilities at the time of applying law 48 for the year 1982 referred to and shall perform an examination of the facilities and methods of processing and drainage of its wastes and shall report its observations regarding every facility, and shall send a copy of all these data to the Ministry of Health and the Sanitation Utility to furnish the Engineer of the Irrigation District or the competent Nile Inspector with the opinion in its regard.

Chapter 2
About the River Units

Article 50- In the application of the provisions of article 7 of law 48 for the year 1982 referred to, the movable River Unit stands for every floating facility in which the machine is a means for its operation even if it consists of a propeller and a propelled device or a trailing and a trailed device whatever is the purpose of its use.

Article 51- The provisions of the articles from 39 to 49 from these regulations shall apply to the movable river units with the exception that the duration of the effectiveness of the license shall be three years.

Article 52- The Nile Water Police following the Ministry of Interior shall assume monitoring floating facilities and the river units which cast their wastes into waterways as well as those which leak the fuel, report the necessary records and notify the Engineer of the Irrigation

District or the Engineer of the Nile Inspection in whose area of jurisdiction the floating facility or the river unit is situated to take the necessary actions according to the provisions of law, carry out the periodic and sudden inspection when these floating facilities and river units are in the anchorages and adopt the necessary measures.

Article 53- The Ministry of Irrigation shall inform the Nile Water Police for detecting the violation, reporting the necessary record and notifying the competent authority in the Ministry of Irrigation for application of the provisions of the law.

Article 54- The Ministry of Irrigation shall inform the Ministry of Health for taking the samples from the liquid wastes that the facility drains into waterways, analyzing the samples and notifying the competent Authority of the Ministry of Irrigation with the result of the analysis accompanied with the opinion of the Ministry of Health laboratories in this regard.

Section 5
About Taking the Samples and Conducting the Analyses

Article 55- Representatives from the Ministries of Irrigation and Health and from the competent Sanitation Utility shall be entitled to access real estates, shops, touristic, industrial and commercial facilities and other institutions that drain their wastes into the water bodies for purposes of taking the samples, and conducting regular and irregular investigation for examining the technique of draining the liquid wastes and the processing units in order to confirm the effectiveness of operation or discovering the wastes.

The owner of the facility should offer the assistance and facilities needed for the completion of their task in the best way possible.

Article 56- The sample should not be less than two liters, the samples are to be put in bottles with sealed smooth glass covers. The containers and the covers should be cleaned well before use. If the samples are taken from liquid wastes treated with chlorine, sterilized containers should be used.

Article 57- The analysis shall take place at the Ministry of Health laboratories immediately after taking the samples. If that is difficult to maintain or if the determined tests are delayed for over three hours, the sample must be kept inside a fridge, with the container surrounded by a layer of ice till the sample reaches the laboratory with some ice left.

Article 58- The sample should be identical to the nature of the liquid wastes as much as possible, and should be taken from a suitable place at the end of the purification process or the final point of connection of the facility wastes or the purification process and from the place where it is drained into the waterways. If the facility has more than one exit for the wastes, the samples should be taken separately from each and every exit. The container should be full and well-plugged after taking the sample. No bubbles or unfilled space should be allowed between the water level inside the container and the plug. While taking the sample, the opening of the container should be placed counter to the current. The sample should neither be taken from the surface nor from the deep water. After filling the container, the opening should be covered by gauze and sealed with wax (or any similar substance) as well as with the signet of the official commissioned to take the sample.

Article 59- The official commissioned with taking the sample should accurately and legibly fill the form specified for that purpose and make the owner of the facility or his representative sign the form. He should send the form immediately with the sample to the Public

Department of the Central Laboratories at the Ministry of Health in Cairo or the provincial laboratories in other governorates.

Section Six
The Regulations, Standards and Specifications regarding the Draining of Processed Liquid Wastes into Waterways

First: Regarding Drainage in Freshwater Bodies:

Article 60- Fresh waterways into which processed liquid industrial wastes are licensed to drain should be kept within the following standards and specifications:

Statement	Standards and Specifications (milligram/liter unless otherwise mentioned)
Colour	Not exceeding 100 degrees
Total solid substances	500
Temperature	Five degrees above the average
Dissolved oxygen	Not less than 5
Hydrogen exponent	Not less than 7 and not exceeding 8.5
Absorbed biotic oxygen	Not exceeding 6
Chemically consumed oxygen	Not exceeding 10
Organic nitrogen	Not exceeding 1
Ammonia	Not exceeding 0.5
Grease and oils	Not exceeding .01
Total Alkalines	Not exceeding 150 and not less than 20
Sulfates	Not exceeding 200
Mercury compounds	Not exceeding 0.001

Iron	Not exceeding 1
Manganese	Not exceeding 0.5
Copper	Not exceeding 1
Zinc	Not exceeding 1
Detergents	Not exceeding 0.5
Nitrates	Not exceeding 45
Fluorides	Not exceeding 0.5
Phenol	Not exceeding 0.02
Arsenic	Not exceeding 0.05
Cadmium	Not exceeding 0.01
Chromium	Not exceeding 0.05
Cyanure	Not exceeding 0.1
Lead	Not exceeding 0.05
Selenium	Not exceeding 0.01

Article 61- The standards concerning licensing for draining the processed liquid industrial wastes into freshwater bodies and groundwater reservoirs as determined by the Ministry of Health are as follows:

(All the standards are milligram/liter unless otherwise mentioned)

Statement	Maximal standards of processed liquid industrial wastes that are drained in	
	The Nile river from the borders of South Egypt till the Delta Barrages	The Nile branch , Rayahat, Canals and Groundwater Reservoirs
Temperature	35	35
Hydrogen exponent	6-9	6-9
Color	Free from colored	Free from colored

	substances	substances
Absorbed biotic oxygen	30	20
Chemically consumed oxygen (Dicromate)	40	30
Chemically consumed oxygen (Permanganate)	15	10
Total soluble solid substances	1200	800
Ash of soluble solid substances	1100	700
Suspended substances	30	30
Ash of suspended substances	20	20
Sulfides	1	1
Oils, greases and resins	5	5
Phosphate (non-organic)	1	1
Nitrates	30	30
Phenol	0.001	0.001

Fluorides	0.5	0.5
Residual chlorine	1	1

Statement	Maximal standards of processed industrial liquid wastes that are drained in	
	The Nile river from the borders of South Egypt till the Delta Barrages	The Nile branch , Rayahat, Canals and Groundwater Reservoirs
Heavy metals group which includes (×)	1	1
× Mercury	0.001	0.001
× Lead	0.05	0.05
× Cadmium	0.01	0.01
× Arsenic	0.05	0.05
× Chromium	0.05	0.05
× Copper	1	1
× Nickel	0.1	0.1
× Iron	1	1
Manganese	0.5	0.5

Zinc	1	1
Silver	0.5	0.5
Detergents	0.05	0.05
Potential number of the colonic group in 100 cm^3	2500	2500

Article 62- The Ministry of Irrigation has the right to disregard some of the standards referred to in the above-mentioned article without prejudice to the provisions of the regulations. That may apply to the cases where the amount of processed liquid industrial wastes drained into freshwater bodies are less than one hundred cubic meter per day on condition that it does not exceed the measurements set in the following table:

Statement	Maximal standards of processed liquid industrial wastes that are drained in	
	The Nile river from the borders of South Egypt till the Delta Barrages	The Nile branch , Rayahat, Canals and Groundwater Reservoirs
Absorbed biotic oxygen	40	30
Chemically consumed oxygen (Diacromat)	60	40
Chemically consumed	20	15

oxygen (permanganate)		
Total solid substances	1500	1000
Ash of solid substances	1000	900
Suspended substances	40	30
Oils, greases and resins	10	10
Nitrates	40	30
Phenol	0.005	0.002

Article 63- The processed liquid industrial wastes licensed to be drained into freshwater bodies must not be mixed with human or animal wastes.

Article 64- In implementation of the provisions of law 48 for the year 1982 referred to, the legislations organizing the standards regarding radiations and radiant substances shall be applied to make sure that they are in conformity with the liquid industrial wastes before draining them into freshwater bodies.

Article 65- The drains water before being pumped into freshwater bodies should fulfill the following standards:

statement	Standards(milligram/liter unless otherwise mentioned)
Color	Not exceeding 100 unit
Total solid substances	500
Temperature	5 Celsius
Odor	Free from colored substances
Dissolved oxygen	Not less than 5
Hydrogen exponent	Not less than 7 and not exceeding 8.5
Absorbed biotic oxygen	Not exceeding 10
Chemically consumed oxygen (Dicromate)	Not exceeding 15
Chemically consumed oxygen (permanganate)	Not exceeding 6
Ammonia	Not exceeding 0.05
Oils or greases	Not exceeding 1
Alkalines	Not exceeding 200 and not less than 50
Mercury compounds	Not exceeding 0.001

Iron	Not exceeding 1
Manganese	Not exceeding 1.5
Copper	Not exceeding 1
Zink	Not exceeding 1
Detergents	Not exceeding 0.5
Nitrates	Not exceeding 45
Fluorides	Not exceeding 0.5
Phenol	Not exceeding 0.02
Arsenic	Not exceeding 0.05
Cadmium	Not exceeding 0.01
Chromium	Not exceeding 0.01
Cyanide	Not exceeding 0.1
Tannin and lignite	Not exceeding 0.5 milligram/liter
Phosphate	Not exceeding 1 milligram/liter
Carbon-chloroform abstracts	Not exceeding 1.50 gram/liter
Potential number of the colonic group 100 C^3	5000

Second: Regarding Draining into Saline Water Bodies:

Article 66: The sewage water and liquid industrial wastes licensed to be drained into saline water bodies should fulfill the following standards and specifications:

Statement	Maximal Standards and Specifications (milligram/liter unless otherwise mentioned)	
	Sewage water	Liquid industrial wastes
Temperature	35 Celsius	35 Celsius
Hydrogen exponent	6-9	6-9
Absorbed biotic oxygen	60	60
Chemically consumed oxygen(Dicromate)	80	100
Chemically consumed oxygen(Permanganate)	40	50
Dissolved oxygen	Not less than 4	-
Oils and greases	10	10
Dissolved substances	2000	2000
Suspended substances	50	60
Colored substances	Free from colored substances	Free from colored substances
Sulfides	1	1
Cyanide	-	0.1
Phosphate	-	10
Nitrates	50	40
Fluorides	-	0.5
Phenol	-	0.005
Total heavy metals	1	1

Pesticides Potential number of the colonic group 100 C^3	None 5000	None 5000

Article 67- In case of draining the sewage water or liquid industrial wastes mixed with sewage water into saline water bodies, based on a request by the competent Health Authority, drained water should be processed with chlorine for purification before drainage so that the chlorine remaining in it after twenty minutes from adding should not be less than 0.50 milligrams. The devices and materials used for purification should be available and ready for action continuously for performing the processing upon request.

Article 68- Saline water bodies into which liquid industrial wastes are licensed to drain should remain within the limits of the following standards and specifications:

Statement	Standards and specifications
Temperature	Not exceeding 5 Celsius above the average
Dissolved oxygen	Not less than 4 milligrams/liter at any time
Hydrogen exponent	Not less than 7 and not exceeding 8.5
Detergents	Not exceeding 0.5 milligram/liter
Phenol	Not exceeding 0.005 milligram/liter
Sediments	Not exceeding 50 units

Soluble solid substances	Not exceeding 650 milligram/liter
Potential number of the colonic group in 100 C3	Not exceeding 5000

Article 69- In case the liquid wastes are drained into the lakes – the number of the colonic bacteria in fish traps should not exceed (70) per 100 cm^3, and does not exceed (230) per 100 cm^3 in tenth of the samples taken from the lakes water at fishing season, for fish conservation and preventing the effects of draining that these wastes may have on fish traps.

Section 7
The Fund of the Revenue of Charges and Fines

Article 70- In application of the provisions of article 14 of law 48 for the year 1982 a special fund shall be created with a special account in the Egyptian Central Bank under the name" The fund of charges and fines of law 48 for the year 1982 regarding the protection of the Nile river and waterways from pollution".

Article 71- The revenue of the charges, fines and costs resultant from the implementation of the provisions of law 48 for the year 1982 referred to shall go to the above-mentioned fund.

Article 72- The board of directors of the fund shall be selected via a resolution by the Minister of Irrigation, and shall convene at least once every month.

Article 73- The board of directors shall undertake the responsibility of drawing the policy of the fund, follow-up of the actions, and formulating the systems and measures necessary for accomplishing those actions.

Article 74- The budget of the fund including the collected revenues and the expenditures shall be prepared and reviewed by the board of directors long enough before the beginning of the fiscal year and should be approved by the Minister of Irrigation.

At the end of the fiscal year the final account of the fund shall be prepared to be ratified by the board of directors in preparation of review for the Accounts Monitoring at the Central Auditing Organization.

Article 75- The board of directors shall formulate its own measures without being restricted by the governmental laws and regulations and shall be ratified by the Minister of Irrigation.

Article 76- The revenues of the fund shall comprise the following:

a) The charges of issuing the licenses and insurances regarding establishing any facilities that would produce wastes to be drained in waterways.
b) The charges of issuing the licenses and insurances regarding establishing new floating facilities and river units and renewal of the licenses of existing floating facilities and units.
c) The value of violations and fines stipulated in article 16 from law 48 for the year 1982 referred to.
d) Other revenues that shall be collected via application of law 48 for the year 1982 referred to.
e) Credits and monetary aids designated by the government as a subsidy for the fund's revenues.
f) The grants, donations and legacies that may be accepted by the Minister of Irrigation.

Article 77- The yields of the fund are spent according to the regulations formulated by the board of directors and shall include particularly the following:

a) The costs of the administrative removal of the wastes.
b) The monetary aids for the authorities establishing units for processing the wastes before drainage.
c) The costs of conducting laboratories analyses, researches and studies.
d) The rewards given to the workers who exert unusual efforts in the operations of detection and removal of the wastes.
e) The rewards given to the officials responsible for reporting and detecting the crimes violating the provisions of law 48 for the year 1982 referred to.
f) The wages of occasional workers whose services are needed in removing the wastes or any other tasks required for the implementation of law 48 for the year 1982 referred to.

Article 78- The Public Departments of the Irrigation Authority shall assume collecting those charges and dues, and depositing them in the Fund's account. The charges and due expenditures, in implementation of the provisions of this law may be levied by way of administrative confiscation.

Article 79- The board of directors shall specify the rewards for the officials responsible for reporting and detecting the crimes with a ratio of the value of the collected fine, as well as its minimal and maximal level, and the measures for spending.

Article 80- The holders of the licenses for draining the processed liquid wastes into waterways shall be informed annually in July with a

statement including the amounts due for charges, laboratory analyses, expenditures, fines and costs of removal done throughout the year.

Section 8
General Provisions

Article 81- The owners of the facilities licensed to drain their processed liquid wastes into waterways shall be committed to deposit insurance at the Irrigation Authority Fund as a guarantee of applying the provisions of article 16 of law 48 for the year 1982 referred to in accordance with the following:

a) One thousand pounds for every facility that employs a pipe whose diameter is not more than twenty centimeters or several pipes with the same amount of drainage for the purpose of draining its processed liquid wastes into waterways.
b) Two thousand pounds for every facility that employs a pipe whose diameter reaches or exceeds twenty centimeters for draining its processed liquid wastes into the waterways.

The value of the fine as well as the costs of the removal shall be deducted from the insurance upon violation if the violator did not pay the value of the fine and costs of removal. The owner of the facility shall be committed to complete the sum of the insurance in two months from the date of notification by discounting the determined value of the fine and the costs of removal.

The receipt of depositing the insurance money is considered one of the documents necessary for obtaining or renewing the license.

The insurance shall be paid back at the expiry of the license unless the licensee is indebted to the Irrigation Authority with any other money.

Article 82- For accessibility to waterways, one piaster is annually charged for every cubic meter of processed liquid wastes licensed to be drained into waterways. The revenues of that charge shall be deposited in the Irrigation Authority Fund in the Ministry of Public Works and Water Resources.

Article 83- This resolution shall be published in the Egyptian Official Gazette, and shall be effective starting from the date of publication.

Written on 17 January 1983.

The Minister of Irrigation
Engineer\Mohamed Abdel-Hady Samaha

Appendix-10 Social Condition Survey

1. Outline of Survey and Number of Sample

A social condition survey was carried out to grasp the situation of irrigation water shortage and re-use of drainage water, living conditions of the village, disposal of agricultural waste, as well as the capacity or willingness of the farmers to pay for O&M cost of wastewater treatment system if it were constructed. The survey was conducted with a prepared questionnaire. Following table summarizes the outline of the survey. The number of sample household was 134 in five target villages.

Table 1 Outline of Social Condition Survey

Item	Contents
Target	Farmers in and around Bahr El Nour area
Contents of the Survey	Family structure / cultivated area, crops / crop yield / income and expenditure / irrigation water shortage /practice of drainage water re-use / composting / farmer organization / willingness to pay for O&M
No. of sample	Assumed 250 households. However, it was found that the population of the target five villages was in total around 150 households. There were some households who are absent from home. As a result, total 134 households were surveyed by sub-contracted local consultant.

The villages surveyed were Al Saei, Al Nahas and Al Doksh located along the Bahr El Nour irrigation canal and Biyala drain, and Ash Shurafah and Al Tanapra located along the Ash Shurafah irrigation canal. Farmers in the latter two villages are re-using drainage water from No.4 Drain. The number of the sample household in each target village was shown in the following table. The samples cover almost all the households in the target villages. The largest village is Al Nahas with 51 households followed by Ash Shurafah with 39 households. The average family size of the samples is 5.5 persons per household.

Table 2 Number of Sample Household

Irrigation Canal	Bahr El Nour			Ash Shurafah		Total
Drainage Canal	Biyala Drain			No.4 Drain		
Name of Village	Al Saei	Al Nahas	Al Doksh	Ash Shurafah	Al Tanapra	(Ave.)
No. of Sample	24	51	11	39	9	134
Ave. Family Size	5	5	4	7	5	5.5

2. Irrigation Water Shortage

All the sample households in the five villages answered that they are facing irrigation water shortage. Among them 17.2% of sample answered that the period of water shortage in only summer and 82.8% answered in both summer and winter. As shown in Table 3, the villages along Bahr El Nour canal has more numbers of farmers who suffer from water shortage both in summer and winter. As for the degree of water shortage, farmers who answered such a degree as water shortage affects the growth of crops are 83.6% in summer crop and 32.8% in winter crop.

Table 3 Situation of Irrigation Water Shortage

Irrigation Canal	Bahr El Nour			Ash Shurafah		Total
Drainage Canal	Biyala Drain			No.4 Drain		
Name of Village	Al Saei	Al Nahas	Al Doksh	Ash Shurafah	Al Tanapra	(Ave.)
No. of Sample	24	51	11	39	9	134
Suffered from water shortage (%)	100	100	100	100	100	100
Period of Shortage						
Summer (%)	8.3	0.0	18.2	43.6	22.2	17.2
Summer + Winter (%)	91.7	100.0	81.8	56.4	77.8	82.8
Affect of water shortage to crop growth						
Summer (%)	50.0	98.0	100.0	79.5	88.9	83.6
Winter (%)	50.0	15.7	0.0	41.0	88.9	32.8

3. Drainage Water Re-use

97% of the sample farmers answered that they practice drainage water re-use. There are a few farmers along Ash Shurafah canal that they do not practice drainage water re-use. However, a pumping station has been installed at the tail of Ash Shurafah canal to lift drainage water from No.4 Drain into the canal and the station has been regularly operated. Therefore, all the farmers along the Ash Shurafah canal should be using drainage re-use water regardless their perception. It is hence considered 100% of the farmers in the surveyed area should be practicing drainage water re-use.

Most of the sample farmers say they practice drainage water re-use both in summer and winter, except 86.3% of the farmers in Al Nahas practice drainage water re-use only in summer. 98% of the sample farmers feel that the quality of drainage water is getting worse and they think the cause is the wastewater and sewage from houses.

Table 4 Situation of Drainage Water Re-use

Irrigation Canal	Bahr El Nour			Ash Shurafah		Total
Drainage Canal	Biyala Drain			No.4 Drain		
Name of Village	Al Saei	Al Nahas	Al Doksh	Ash Shurafah	Al Tanapra	(Ave.)
No. of Sample	24	51	11	39	9	134
Practice re-use (%)	100.0	100.0	100.0	92.3	88.9	97.0
Period of re-use						
Summer (%)	4.2	86.3	18.2	11.1	0.0	39.2
Winter (%)	4.2	0.0	0.0	0.0	0.0	0.80
Summer + Winter (%)	91.6	13.7	81.8	88.9	100.0	60.0

4. Sewage / Wastewater Treatment

It has been confirmed that sewage / wastewater in Al Nahas and Al Doksh is directly discharged into drain and in other three villages, sewage / wastewater is collected by honey wagon though some discharge of wastewater into canal was observed in Al Saei village. These three villages, in which sewage / wastewater is collected by honey wagon, people pay fee of LE18.9 per month on average for the disposal. The mode of the amount was LE10 per month but in Al Tanapra village, the mode of the amount was recorded at LE20 per month higher than other villages.

On a question to estimate the willingness to pay of the farmers for disposal of sewage / wastewater, average amount in Ash Shurafah was LE7 per month, while the farmers in other villages said the cost should be free. However, since at least farmers are paying the fee for the disposal of sewage / wastewater, it is likely that farmers would pay for the cost within the amount that they are currently paying.

Table 5 Situation of Sewage / wastewater Treatment

Irrigation Canal	Bahr El Nour			Ash Shurafah		Total
Drainage Canal	Biyala Drain			No.4 Drain		
Name of Village	Al Saei	Al Nahas	Al Doksh	Ash Shurafah	Al Tanapra	(Ave.)
No. of Sample	24	51	11	39	9	134
How to dispose						
Drain (%)	0.0	100.0	100.0	2.6	0.0	47.0
Honey wagon (%)	100.0	0.0	0.0	97.4	100.0	53.0
Cost of Disposal						
Ave. (LE/month)	15	-	-	19	29	18.9
Mode (LE/month)	10	-	-	10	20	10
Willingness (LE/m)	0	-	-	7	0	

5. Farmhouse Income

Income level of the sample farmhouses has been surveyed. Income source of the farmhouses would be from agriculture production, animal husbandry, off-farm work, remittance, etc., but the valid answers of income rather than agriculture production were not obtained from the survey. Therefore, analysis on income is discussed with only income from agriculture production.

In the survey a remarkable fact was found that all the farmhouses in the target villages are tenant farmers. Landowners are living in nearby Biyala city and its vicinity. Form of the tenancy is share-cropping, namely the produce of the farm is divided between land woner and the tenant by half. The average farming area of the total samples is 2.82feddan (1.18ha) and the average farming areas of Al Saei, Al Nahas, Al Doksh, Ash Shurafah, and Al Tanapra are 2.25feddan (0.95ha), 2.36feddan (0.99ha), 2.64feddan (1.1ha), 3.71feddan (1.56ha), and 3.28feddan (1.38ha) respectively. The average areas of farmhouses along Ash Shurafah canal are relatively larger than the one along Bahr El Nour canal.

The average annual farmhouse income (income from agriculture production) of the samples is estimated at LE3,583. This amount does not include the value of produce for home consumption. Share cropping gives high cost to the tenant farmers, which causes lower level of farm income. The average farmhouse income in Ash Shurafah is the highest with LE4,744 and the Al Saei is the lowest with LE3,012.

As for the ratio of the average cost of disposing sewage / wastewater in the three villages shown in Table 5 to the average farmhouse income, it is calculated at 6% in Al Saei, 5% in Ash Shurafah, and 10% in Al Tanapra. These numbers seem rather high to the income level of the sample farmhouses. Considering the mode of the disposing cost, namely LE10 per month (LE120 per year), the ratios of the disposing cost to the average farmhouse incomes in the three villages are calculated from 3% to 4%.

Table 6 Farmhouse Income Estimation

Irrigation Canal	Bahr El Nour			Ash Shurafah		Total (Ave.)
Drainage Canal	Biyala Drain			No.4 Drain		
Name of Village	Al Saei	Al Nahas	Al Doksh	Ash Shurafah	Al Tanapra	
No. of Sample	24	51	11	39	9	134
Ave. farming area (fed) ( ) = ha	2.25 (0.95)	2.36 (0.99)	2.64 (1.11)	3.71 (1.56)	3.28 (1.38)	2.82 (1.18)
Ave. farmhouse income (LE/yr)	3,012	3,070	3,117	4,744	3,553	3,583
Distribution of samples by income						
Less than 2000LE	6	21	3	5	0	35
2001-4000 LE	12	14	6	16	5	53
4001-8000 LE	6	14	2	15	4	41
More than 8000LE	0	2	0	3	0	5
Ave. disposing cost (LE/yr)	180	-	-	228	348	227
Ratio to farmhouse income (%) (*)	5.98	-	-	4.80	9.79	5.65
Ditto: In case disposing cost is LE120/yr (%)	*3.98*	*3.91*	*3.85*	*2.53*	*3.38*	*3.35*

(*) Average is of Al Saei, Ash Shurafah and Al Tanapra

6. Health and Amenity

In the survey, awareness of the farmers about the amenity of the villages relative to the drainage was also inquired. According to the field survey by the Study Team, villagers did not talk about their anxiety on deteriorating water quality very much. The reasons for that may be 1) the smell from animal yard inside the village would be more dominating than the smell from drain, and 2) piped water installation has been prevalent so that people can bath and wash inside the house and therefore the hygiene condition at home seems kept well. On the other hand, according to this survey, most of people in Al Saei and Al Nahas are aware of bad smell from the drain.

As for major diseases, skin disease was reported as the most popular disease in the villages. In Al Nahas village, incidence of diarrhea seems relatively higher than other villages. The average annual medical expense in Al Nahas is the lowest with LE42 and the expense in Ash Shurafah is

the highest with LE262. The average expense of all the samples is calculated at LE140 per year.

Table 7 Health and Amenity

Irrigation Canal	Bahr El Nour			Ash Shurafah		Total
Drainage Canal	Biyala Drain			No.4 Drain		
Name of Village	Al Saei	Al Nahas	Al Doksh	Ash Shurafah	Al Tanapra	(Ave.)
No. of Sample	24	51	11	39	9	134
Amenity (%)						
Drainage water / puddle	74	4	64	27	50	31
Smell of drain / ditch	78	100	27	46	38	70
Mosquito and flies	91	100	91	68	100	88
Major diseases (%)						
Diarrhea	13	96	36	20	22	49
Skin desease	92	96	45	92	100	90
Bilharzias	42	6	9	46	78	29
Ave. medical expenses (LE)	158	42	75	262	198	140

7. Disposal of Agricultural Waste and Domestic Garbage

About the disposal of agriculture waste, rice straw is used for composting, animal feed and spreading to animals in the yard. Few farmers burn the straw according to the survey result. Wheat straw is mainly used for spreading to animal yard. Animal manure is used for composting, as well according to the survey. However, animal manure is piled up along the canal, so that it drops into the canal and contaminates the water in the canal. Domestic garbage is mainly burnt and few sample farmers answered that they throw it to the canal.

Table 8 Situation of Disposal of Agriculture Waste and Garbage

Irrigation Canal	Bahr El Nour			Ash Shurafah		Total
Drainage Canal	Biyala Drain			No.4 Drain		
Name of Village	Al Saei	Al Nahas	Al Doksh	Ash Shurafah	Al Tanapra	(Ave.)
No. of Sample	24	51	11	39	9	134
Disposal of rice straw						
Burning (%)	0.0	0.0	0.0	2.6	0.0	0.7
Selling (%)	4.2	0.0	0.0	5.1	0.0	2.2
Composting (%)	29.2	84.3	27.3	5.1	0.0	41.0
Animal feed (%)	4.2	0.0	9.1	87.2	12.5	27.6
Spreading to animals (%)	62.5	15.7	63.6	2.6	87.5	28.4
Disposal of wheat straw						
Selling (%)	0.0	0.0	0.0	2.6	0.0	0.7
Composting (%)	0.0	0.0	0.0	2.6	0.0	0.7
Spreading to animals (%)	100.0	100.0	100.0	94.8	100.0	98.5
Domestic garbage						
Throw to drain (%)	0.0	0.0	0.0	7.7	11.1	3.0
Burning (%)	83.3	15.7	9.1	46.2	88.9	41.0
Vehicle transport (%)	16.7	0.0	9.1	46.2	0.00	17.2
Composting (%)	0.0	84.3	81.8	0.0	0.00	38.8

8. Summary

As the survey result shows, it was confirmed that the farmers in all the five villages have suffered from irrigation water shortage and required drainage water re-use. Also according to the survey result, the farmers feel that water quality in the drain is deteriorating and they think the discharge of sewage into can l as a cause of worsening water quality.

Among the five villages, sewage /wastewater has been directly discharged into drain in Al Nahas and Al Doksh villages and in other three villages sewage / wastewater has been collected from individual septic tank by honey wagon and the average cost of disposing sewage / wastewater is LE15 per month per household in Al Saei, LE19 in Ash Shurafah, and LE29 in Al Tanapra. The mode for the disposing cost in the three villages is LE10 per month per household. Majority of farmers feel that the cost is expensive and some say that the cost should be free of charge.

It was found that farmers in the five villages are all tenants with share cropping system (divide the produce between land owner and tenant by half). The average farming area of the sample farmers is 2.82feddan (1.18ha). Small farming scale and share cropping tenancy make the farm income low. It is estimated that the average annual farm income (income from crop production) is LE3,583 per household. Because the valid answers about income from animal husbandry and other sources were not obtained, farmers may have another additional income rather than farm income. Also the value of home consumption is not included in the farm income.

The ratio of disposing cost of sewage /wastewater to the average farm income is estimated at 5.7% in case of applying the average cost of sewage / wastewater disposal, for which the sample farmers are actually paying. In case of applying the mode of disposing cost for sewage

/wastewater, the ratio of the cost to the average farm income is calculated at 3% to 4% in each village. This amount would not be cheap for the farmers but they are actually paying this amount for the disposal. Therefore, it could be said that when a sewage treatment facility were constructed, it should be designed with its O&M cost less than or around LE10 per month per household, as the users of the facility would be able to pay for O&M cost if the fee were set in such range.

Appendix-11 Estimation of Water Balance in Bahr El Nour Area

(1) Gross Water Duties for Old Lands in Lower Egypt (Nile Delta) practiced by MWRI (cum/feddan)

Crop		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rice		0.00	0.00	0.00	0.00	716.60	1,593.30	1,693.85	1,494.14	1,093.92	450.00	0.00	0.00	7,041.81
Cotton		0.00	0.00	268.70	401.57	555.94	689.00	829.64	595.82	211.95	0.00	0.00	0.00	3,552.62
Maize		0.00	0.00	0.00	0.00	276.92	530.83	845.65	849.80	566.75	425.05	130.00	0.00	3,625.00
Vegetables (summer)		0.00	0.00	0.00	385.56	498.96	544.92	510.00	269.32	254.00	118.72	0.00	0.00	2,581.48
Wheat		256.78	310.54	542.09	543.46	43.32	0.00	0.00	0.00	0.00	0.00	251.17	205.17	2,152.53
Clover		311.82	363.51	116.66	0.00	0.00	0.00	0.00	0.00	131.09	644.36	337.61	296.21	2,201.26
Beat		258.32	335.83	615.35	932.06	1,195.49	603.60	0.00	0.00	0.00	0.00	0.00	135.51	4,076.16

(2) Estimation of Water Requirement and Balance for Bahr El Nour Command Area

Crop	Crop area	Water duties: Bahr Nour (4,200 fed)												Total
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Rice	3,767	0	0	0	0	2,699,719	6,002,598	6,381,410	5,629,023	4,121,234	1,695,330	0	0	26,529,315
Cotton	273	0	0	73,355	109,629	151,772	188,097	226,492	162,659	57,862	0	0	0	969,865
Maize	139	0	0	0	0	38,381	73,573	117,207	117,782	78,552	58,912	18,018	0	502,425
Vegetables (summer)	21	0	0	0	8,097	10,478	11,443	10,710	5,656	5,334	2,493	0	0	54,211
Wheat	1,995	512,276	619,527	1,081,470	1,084,203	86,423	0	0	0	0	0	501,084	409,314	4,294,297
Clover	1,495	466,233	543,520	174,430	0	0	0	0	0	196,006	963,447	504,794	442,893	3,291,324
Beat	630	162,742	211,573	387,671	587,198	753,159	380,268	0	0	0	0	0	85,371	2,567,981
Total requirement (m^3)		1,141,251	1,374,620	1,716,925	1,789,126	3,739,932	6,655,980	6,735,819	5,915,120	4,458,988	2,720,182	1,023,897	937,579	38,209,418
Total requirement (m^3/s)		0.44	0.53	0.66	0.69	1.44	2.57	2.60	2.28	1.72	1.05	0.40	0.36	1.23
Irrigation Efficieny		0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Water Required in the canal (m^3/s)		0.67	0.80	1.00	1.05	2.19	3.89	3.94	3.46	2.61	1.59	0.60	0.55	1.86
Bahr Nour Discharge (m^3/sec)		1.46	1.45	2	2.15	2.7	3.56	3.58	3.30	2.45	2.08	1.86	1.35	
Balance		0.79	0.65	1.00	1.10	0.51	-0.33	-0.36	-0.16	-0.16	0.49	1.26	0.80	

Source:

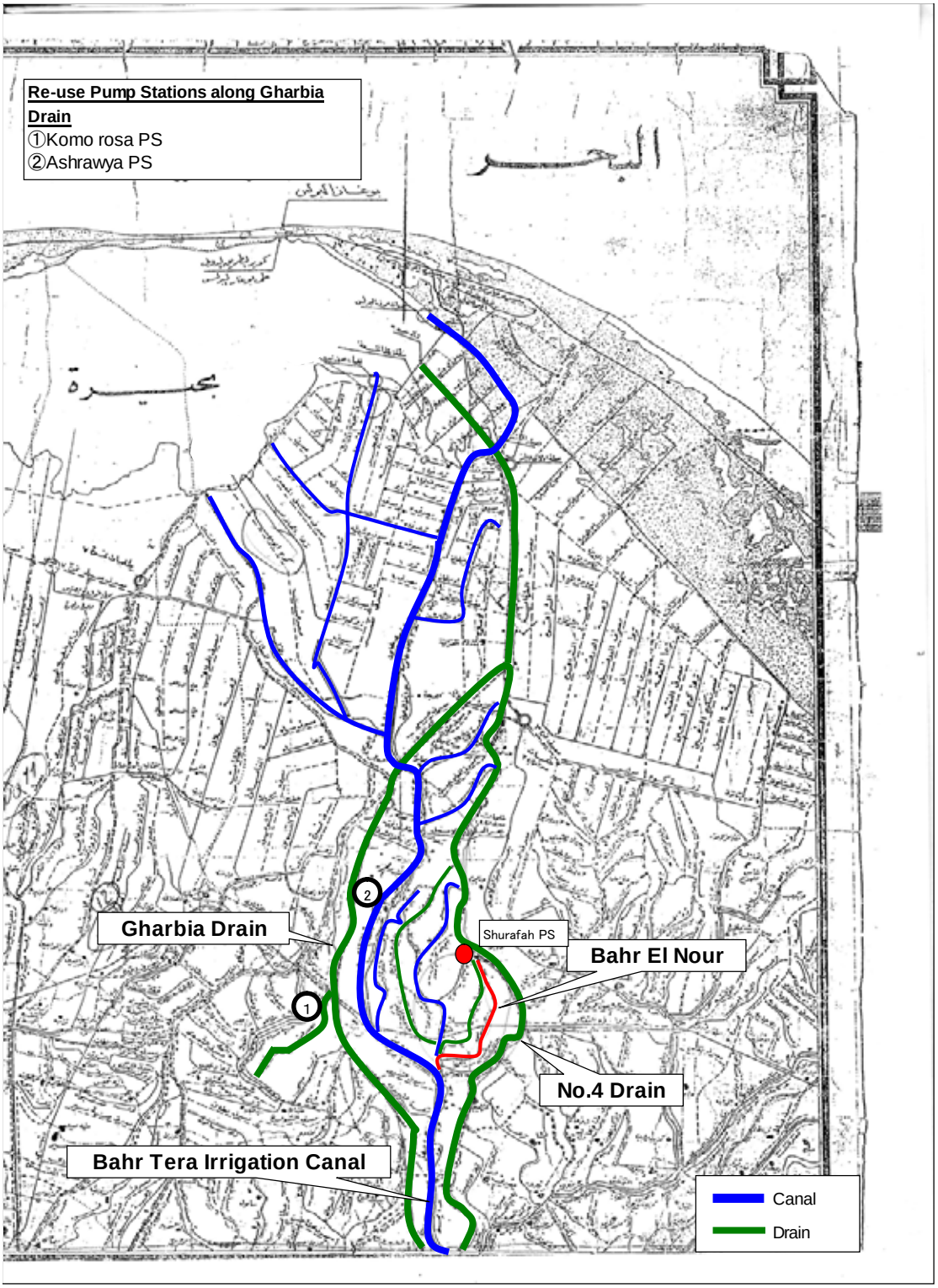
1. Water Duties: "The Master Plan Study for the Improvement of Irrigation Water Management and Environmental Conservation in the North-east Region of the Central Nile Delta, Appendix I Irrigation and Drainage" (JICA, Aug. 1999)
2. Crop and crop area: "Water Management Plan Feb 2007", "Water Management Improvement Project (Phase 1) (WMIP) JICA Technical Cooperation"
3. Irrigation Efficiency: 0.66 is applied, which is the pland efficiency on the above Master Plan Study. It is considered that the planed efficiency has been achieved through WMIP Phase 1.
4. Max. discharge of the Bahr El Nour canal is 3.58m3/sec. In-flow to Bahr El Nour canal by month was estimated comparing the monthly discharge trend of the Nile at Assiut (data from MWRI).

Ratio of discharge of the Nile at Assiut (Jan. = 1.00) (data from MWRI)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.00	0.99	1.37	1.48	1.85	2.44	2.46	2.27	1.68	1.43	1.28	0.92

Appendix-12 Result of the Survey on Re-use Pumping Stations

This survey was carried out to survey the outline of the existing re-use pumping stations with discharge chamber around the Bahr El Nour Area.



1. Re-use Pumping Station along No.4 Drain

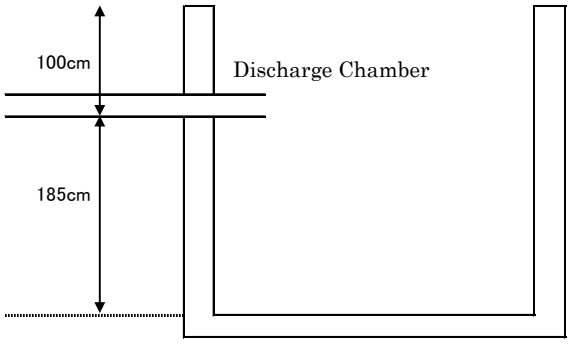
Shurafah Pumping Station

Basic Data of the Pump

Maker (Type)	ALLWEILER FARID PUMPS CO. (SAE) （SZ-60）
Manufactured year	2003
Capacity	1.0m^3/s
Total Head	6m
Power	121HP or 90kw
Pipe diameter (Inlet)	700 mm
Pipe diameter (Outlet)	600 mm

Size of Discharge Chamber (Inside)

Length	205 cm
Width	309 cm
Depth	285 cm (There is a spillway 100cm from the top of the chamber)
Volume	18.05 m^3 Effective volume (under the spillway): 11.72m^3)



2. Re-use Pumping Stations along Gharbia Drain

Komo rosa Pumping Station

Basic Data of the Pump

Maker (Type)	Motor: AVECO Pump: KSB GENIRFGAL(made in China)
Manufactured year	1997
Capacity	1.0m^3/s
Total Head	6m
Power	120HP

Size of Discharge Chamber (Inside)

Length	205cm
Width	303cm
Depth	345cm
Volume	21.43m^3

Ashrawya PS

Basic Data of the Pump

Maker (Type)	ALLWEILER FARID PUMPS CO. (SAE)
Manufactured year	2003
Capacity	$0.5m^3/s$
Total Head	6 m
Pump Power	45 kw

Size of Discharge Chamber (Inside)

Length	305cm
Width	505cm
Depth	500cm
Volume	$77.01m^3$

This pumping station ahs been operated for three to five months during the rice crop in summer. Operation time is 12 to 15 hours per day and three to four days per week. It has been broken due to absorption of mud for six months.

Appendix-13 Candidate Re-use Pump Stations

Region	Site No.	Drain	Irrigation Canal	Pump		Estimated Beneficiary Area			
						Command Area of the Irrigation Canal		Command Area of the Drain	
				Type	Discharge (m^3/s)	feddan	ha	feddan	ha
West Delta	1	El-Khairys	Lower Abo Diab	Submersible Pump	2.0	4,000	1,680	30,000	12,600
	2	Western Khandaq	Garrar Maanhah	Pump Gate	1.0	1,000	420	30,000	12,600
	3	Sidi Eisa	Amlak Irrigation Branch No.5	Pump Gate	1.0	*1,000*	420	15,000	6,300
	4	Shobrakheet	Mestnan Extention	Submersible Pump	1.0	1,000	420	35,000	14,700
	5	Sidi Eisa	Amlak Irrigation Branch No.3	Pump Gate	2.0	*7,400*	3,108	15,000	6,300
	6	Eitay / Shobrakheet	Trobmaba	Submersible Pump	2.0	2,000	840	15,000	6,300
	7	Sidi Eisa	Amlak Irrigation Branch No.2	Pump Gate	1.0	*1,000*	420	15,000	6,300
	8	Abd El-Hammed	Abd El-Hammed	Pump Gate	1.0	2,000	840	1,500	630
	9	Zahrah	Lower Abo Diab	Submersible Pump	2.0	*2,600*	1,092	2,500	1,050
	10	Eastern Gaparis	El - Rezqa	Pump Gate	1.0	1,000	420	3,000	1,260
			Sub-total			**23,000**	**9,660**	**162,000**	**68,040**
Central Delta	11	Old khadra	Sidi gaber	Submersible Pump	1.0	*1,000*	*420*	*700*	*294*
	12	Old abo chaba Bahary	Elroken	Pump Gate	1.0	*1,000*	*420*	*1,750*	*735*
	13	Farsh El ganayen	Mars EL Gamel	Submersible Pump	1.0	*1,000*	*420*	*12,000*	*5,040*
	14	Naser	Al Mansor	Submersible Pump	1.0	*1,000*	*420*	*44,000*	*18,480*
	15	Abo raia	El Khalig	Pump Gate	1.0	*1,000*	*420*	*10,000*	*4,200*
			Sub-total			***5,000***	***2,100***	***68,450***	***28,749***
East Delta	16	Belad El Ayed	Shapara	Submersible Pump	1.0	*1,000*	*420*	*5,900*	*2,478*
	17	Sandanhour(1.390)	Tahla Bardeen	Pump Gate	1.0	*1,000*	*420*	*61,850*	*25,977*
	18	Sandanhour(3.200)	El Tartoria	Submersible Pump	1.0	*1,000*	*420*		
	19	Sandanhour(18)	El Sahlia	Pump Gate	1.0	*1,000*	*420*		
	20	Abo El akhder	Sherweda	Pump Gate	1.0	*1,000*	*420*	*20,826*	*8,747*
			Sub-total			***5,000***	***2,100***	***88,576***	***37,202***
			Grand Total			***33,000***	***13,860***	***319,026***	***133,991***

Source: The request letters for Japan's Grant Aid submitted from MWRI and hearing from EPADP
The Project for Agricultural Intermediate Drainage Water Reuse in West Delta (June 2006)
The Project for Agricultural Intermediate Drainage Water Reuse in Nile Delta (July 2008)

Remark-1 The request letter in June 2006 shows the areas of each site with the Command Area of the irrigation canal, into which the drainage water is pumped, and the Command Area of the Drain, from which the re-use water is taken to the irrigation canal.

Remark-2 The inclined numbers in the table are estimation and other numbers are from the above request letters.

1) The command areas with inclined numbers are estimated based on the fact that the total area of the West Delta is 23,000 feddan and the relativeness between area and dishcarge in the other areas
2) The command areas with inclined numbers in the Central and East Delta are estimated comparing the command areas of the West Delta.

Appendix-14 List of Data Collected

Number	Title	Original/ Copy	Data Source	Year
1	Law 48 for the year 1982	Copy	Regarding the Protection of the Nile River and Water ways from Pollution	1982
2	Statistical Year Book	Original	Central Agency for Public Mobilization and Statistics	2009/9
3	Socio-economic Development Five-Year Plan	Original	Ministry of Economic Development	2007/3
4	Tender Law	Original	The Middle East Library for Economic Services	2009/1
5	Code 29D/1, Law No. 14 of the year 2009	Original	The Middle East Library for Economic Services	2009
6	Code 29D/2, Ministerial Decree No. 399/2009	Original	The Middle East Library for Economic Services	2009
7	The Executive Decrees of the Labour Law	Original	The Middle East Library for Economic Services	2009/2
8	The Law and the Executive Regulations of the Law on Environment	Original	The Middle East Library for Economic Services	2008/5
9	Code 54/A, Law No. 9 of the Year 2009 on the amendment of some provisions	Original	The Middle East Library for Economic Services	2009