No.

MINISTRY OF HOUSING
AND CONSTRUCTION
THE SYRIAN ARAB REPUBLIC

THE STUDY ON
SEWERAGE SYSTEM DEVELOPMENT
IN THE SYRIAN ARAB REPUBLIC

FINAL REPORT
[Volume I : Summary Report]

MARCH 2008

JAPAN INTERNATIONAL COOPERATION AGENCY

NJS CONSULTANTS CO.,LTD.
and
TOKYO ENGINEERING CONSULTANTS CO.,LTD.

GE
JR
08-006

< Structure of Report >

Volume I
Summary Report

Volume II
Main Report
(Master Plan and Feasibility Study)

Volume III
Supporting Report
(Master Plan and Feasibility Study)

1 USD = 52.61 SP
1 USD = 118.32 Yen
1 Euro = 72.820 SP
1 USD = 0.71 JD
1 USD = 1.45 TD

(As of November 2007)

PREFACE

In response to a request from the Government of Syrian Arab Republic, the Government of Japan decided to conduct a study on “The Study on Sewerage System Development in Syrian Arab Republic” and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Hirofumi Sano of NJS CONSULTANTS CO., LTD. and consisted of experts from NJS CONSULTANTS CO., LTD. and TOKYO ENGINEERING CONSULTANTS CO., LTD. between November 2006 and December 2007. In addition, JICA set up an advisory committee supported by Mr. Atsuo Furuyama, Chief Engineer, Agriculture and Forestry Division, Ninohe City Government (former JICA expert regarding Syrian Arab Republic) and Ms. Hiroko Kamata, Senior Advisor, Institute for International Cooperation, JICA, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Syrian Arab Republic and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Syrian Arab Republic for their close cooperation extended to the study.

March 2008

Ariyuki Matsumoto
Vice-President
Japan International Cooperation Agency

March 2008

Mr. Ariyuki Matsumoto
Vice-President
Japan International Cooperation Agency

Letter of Transmittal

Dear Sir,

We are pleased to submit to you this Final Report on the Study on Sewerage System Development in the Syrian Arab Republic. This report incorporates the views and suggestions of the authorities concerned of the Government of Japan, including your Agency. It also includes the comments made on the Draft Final Report by the Ministry of Housing and Construction of the Syrian Arab Republic and other government agencies concerned of the Syrian Arab Republic.

The Final Report comprises a total of three volumes as listed below.

Volume I	: Executive Summary (English, Arabic and Japanese)
Volume II	: Main Report (English, Arabic and Japanese)
Volume III	: Supporting Report (English and Arabic)

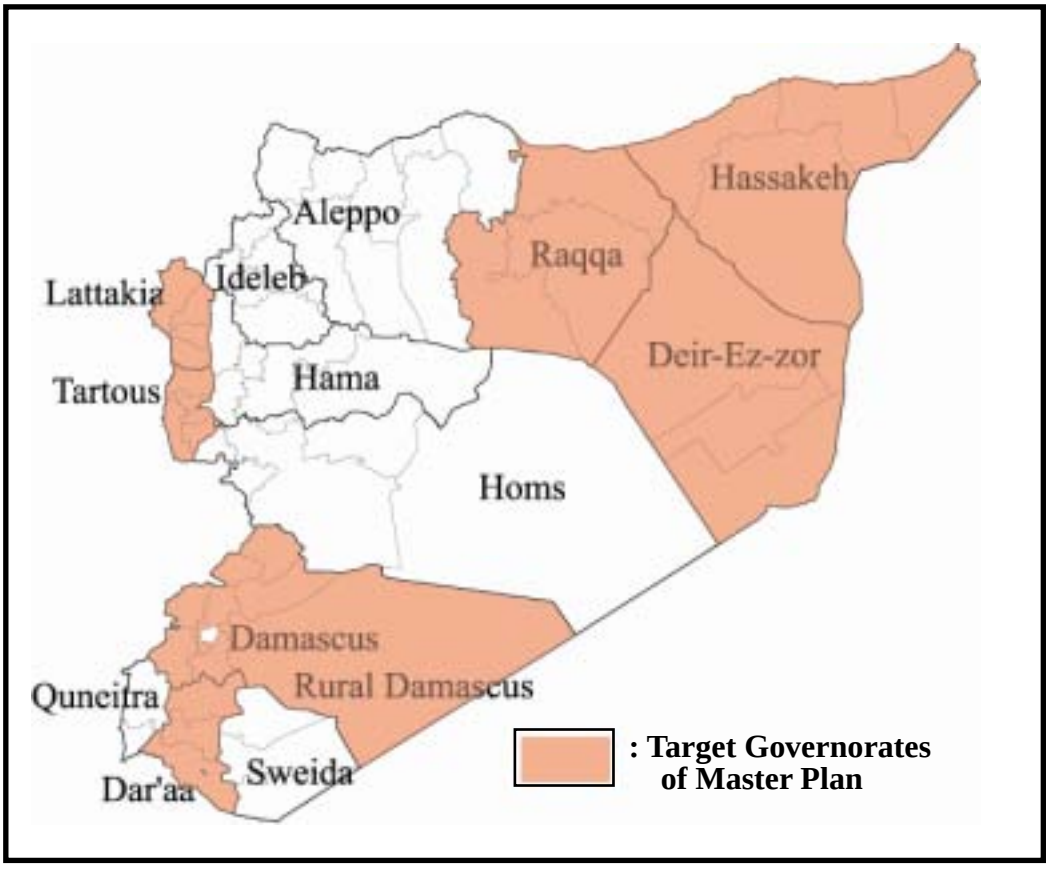
This report contains the Study Team's findings, conclusions and recommendations derived from the three phases of the Study. The main objective of the Phase I was to review of existing development plans in national sewerage sectors. That of Phase II was to formulate the Governorate Master Plan for seven Governorates, and that of the Phase III was to undertake the Feasibility Study of the priority project which had previously been identified in the Master Plan during the course of the Phase II.

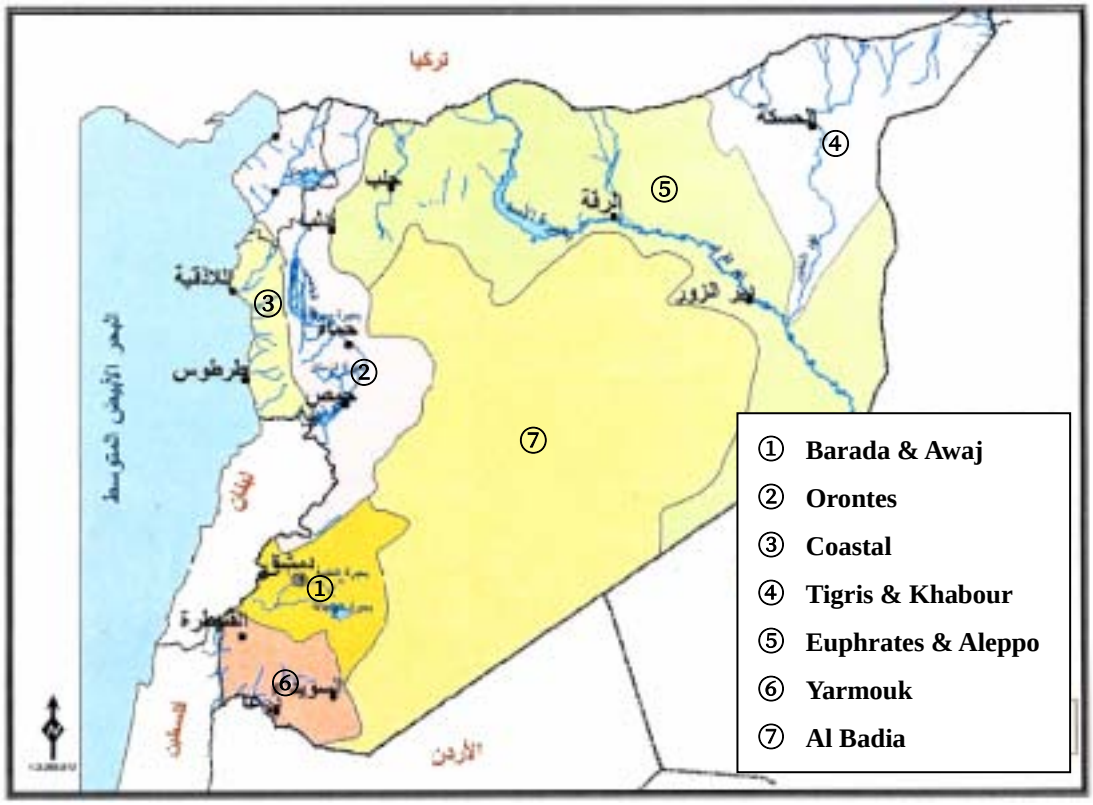
We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Land, Infrastructure, Transport and Tourism of the Government of Japan for their valuable advice and suggestions. We would also like to express our deep appreciation to the relevant officers of the Ministry of Housing and Construction of the Government of the Syrian Arab Republic for their close cooperation and assistance extended to us throughout our Study.

Very truly yours,

Hirofumi Sano
Team Leader
Study on Sewerage System Development
in the Syrian Arab Republic

Location Map of Study Area





Hydrological Basins in Syria

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF HOUSING AND CONSTRUCTION
THE SYRIAN ARAB REPUBLIC

THE STUDY
ON
SEWERAGE SYSTEM DEVELOPMENT
IN
THE SYRIAN ARAB REPUBLIC

<FINAL REPORT>

Volume I: Summary Report

TABLE OF CONTENTS

PART II: FEASIBILITY STUDY

CHAPTER 8 Recommendations to the Syrian Water Sector

List of Abbreviation

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
Company	Sewerage Company
Council	Council for the Protection of the Environment
DAWSSA	Damasucus Water Supply & Sewerage Authority
DFEA	Directorate for Environmental Affairs
DS	Dry Solid
DSDC	Damasucus Sanitary Drainage Company
EC	European Community
EIA	Environment Impact Assessment
EIB	European Investment Bank
EIRR	Economic Internal Rate of Return
Establishment	General Establishment of Potable Water and Sewerage (GEPWS)
EU	European Union
FAO	Food and Agriculture Organization
FIRR	Finacial Internal Rate of Return
F/S	Feasibility Study
GCEA	General Commission for Environmental Affairs
GCEC	General Company for Engineering Studies and Consulting
GDF	Government Debt Fund
GES	General Establishment System
GIS	Geographic Information System
GORS	General Organization of Remote Sensing
GOS	The government of Syrian Arab Republic
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IEE	Initial Environment Examination
IMF	Internatinal Monetary Fund
JD	Jordan Dinar
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
L/A	Loan agreement
LBS	Land-Based Sources
LCD	Liter per capita per day
ℓ/s	Liter per second

MAP	Mediterranean Action Plan
MED POL	Program for the Assessment and Control of Phase Ⅲ Pollution in the Mediterranean Region
MHC	Ministry of Housing and Construction
MLAE	Ministry of Local Administration and Environment
MLSS	Mixed Liquor Suspended Solids
M/M	Minutes of Meetings
MOF	Ministry of Finance
MOI	Ministry of Irrigation
M/P	Master Plan
MPN	Most Probable Number
m^3/d	Cubic meter per day
NEAP	National Environmental Action Plan
O&M	Operation and Maintenance
PS	Pumping Station
PVC	Polyvinyl Chloride Pipe
RDAWSSA	Rural Damasucus Water Supply & Sewerage Authority
SAP	Strategic Action Program
SASMO	Syrian Arab Standards Measurement Organization
SPC	State Planning Commission
SS	Suspended Solids
STP	Sewage Treatment Plant
S/W	Scope of Work
SP	Syrian pounds
SV	Sludge Volume
TD	Tunisian Dinar
TDS	Total Dissolved Solids
10^{th} FYP	10^{th} Five-Year Plan
T-N	Total Nitrogen
T-P	Total Phosphorus
TS	Total Solids
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
WB	World Bank

WHO	World Health Organization
WRIC	Water Resource Information Center

Executive Summary

1 Study Area

Among 14 Governorates in Syria, seven Governorates were selected as prioritized ones for sewerage development plan establishment. Refer to Table **ES-1**.

Table ES-1 Study Area

Name of Governorate	Basins belong to
Tartous, Lattakia	Mediterranean Sea basin
Deir-Ez-zor, Raqqa	Euphrates River basin
Hassakeh	Tigris and Khabour River basin
Dar'aa	Yarmouk River basin
Rural Damascus	Barada/ Awaji River basin

2 Establishment of Sewerage Development Master Plan

Upon establishment of sewerage development master plan, the work was executed through two stages, namely "Macro Plan" and "Master Plan". Refer to **Table ES-2** for their outline:

Table ES-2 Outline of Macro Plan and Master Plan

Plans	Outline of the Plan
Macro Plan	Prepare long-term goal of sewerage development plan such as , sewerage service area, served population, number of proposed STP, basic policy on re-use of treated sewage and sludge treatment and O&M plan. In Macro Plan, regional sewerage plan including not only target core-cities for M/P but also their surrounding cities, towns and villages is carried out to grasp the possibility in integrated or decentralized sewage collection and treatment. Results are utilized to establish more feasible Master Plan.
Master Plan	Further detailed sewerage service area delineation in target core city is conducted to allocate the optimum sewerage system options, namely Centralized Sewerage System, Decentralized Sewerage System and On-site System.

Outline of proposed centralized sewerage system based on established sewerage development master plan for seven cities in designated seven Governorates is shown in **Table ES-3** :

Table ES-3 Outline of Facilities planned in Master Plan

Name of Cities / Governorates	Target Year/ Design Service Population	Design Incoming Sewage Flow	Sewage Treatment Plant	Project Cost (10^3SP)
Slunfeh/ Lattakia	2025 2,800	1,833 m^3/day	Submerged Attach Method ×3 STPs	177,427
Banias/ Tartous	2025 85,600	19,556 m^3/day	Oxidation Ditch Method ×1 STP	1,060,688

Table ES-3 Outline of Facilities planned in Master Plan

Name of Cities / Governorates	Target Year/ Design Service Population	Design Incoming Sewage Flow	Sewage Treatment Plant	Project Cost (10^3SP)
Mayadin/ Deir-Ez-zor	2025 100,400	15,300 m^3/day	Oxidation Ditch Method ×1 STP	529,824
Malkieh/ Hassakeh	2025 34,500	4,518 m^3/day	Oxidation Ditch Method ×1 STP	192,018
Thawra/ Raqqa	2025 115,600	17,889 m^3/day	Constructed Wet-Land Method ×1 STP	315,550
Muzerib/ Dar'aa	2025 30,500	3,994 m^3/day	Constructed Wet-Land Method ×1 STP	198,789
Zabadani/ Rural Damascus	2025 53,500	22,201 m^3/day	Oxidation Ditch Method ×1 STP	781,026

3 Feasibility Study on Sewerage Faciities

Out of seven areas prioritized for Master Plan, the Study Team selected Zabadani of Rural Damascus Governorate as target area for Feasibility Study owing to the following reasons:

- As Zabadani is located upstream of Ain Fijeh Spring, the most important water source of Damascus Governorate, there is possibility of spring water contamination by discharged raw sewage. Affected population was estimated as 1.5 million.
- Though Zabadani is extremely famous tourism spot, its tourism resource has been affected by remarkable water contamination of Barada river caused by raw sewage discharge.
- There are numerous farmers in Zabadani who are utilizing said raw sewage for irrigation use. Such raw sewage re-use not comply with irrigation water quality standard have serious influence to agricultural products and soil.

As urgency in sewerage system development in Zabadani was confirmed, Zabadani was selected as target area for Feasibility Study.

Outline of project for Feasibility Study is shown in **Table ES-4**:

Table ES-4 Outline of Project for Feasibility Study

Items	Unit	Project for Feasibility Study
Target Year		2015
Design Service Population	Person	48,300
Design Incoming Sewage Flow（Daily Average）	m^3/day	18,250
Sewage Treatment Plant/ Sewage Treatment Method		Oxidation Ditch Method
Project Cost	10^3SP	770,978

Along with the proposal on institutional and organizational framework restructure, economic and financial analysis and initial environmental examination was carried out to confirm the feasibility of the project.

PART I : MASTER PLAN

SUMMARY

CHAPTER 1 BACKGROUND OF THE STUDY

A large percentage of the land of Syrian Arab Republic is comprised of desert plateaus with elevation ranging from 200 m to 1,000 m and due to the small precipitation, water resources in the country are scarce. Because of the rapid population inflow from rural areas and industrialization, urban areas have been suffered from water shortage.

The sewerage system development has just been launched and only the four major cities with large population, Damascus, Aleppo, Homs and Hama, have sewage treatment facilities. Even sewer networks are served, many of cities are not equipped with sewage treatment facilities. This causes aggravation of living, sanitary and environmental conditions, deterioration of groundwater and dam water for water supply, resulting in closing of wells and suspension of intake from the dam water. Further, raw industrial wastewater generated in facilities such as Olive Oil Factories is discharged to the rivers nearby, contributing to the water quality deterioration. Such absence of sewerage systems and sewage treatment facilities result in further acceleration of the water source shortage.

Syrian Government is tackling water environmental problems mainly led by the Ministry of Housing and Construction (MHC) and the Ministry of Local Administration and Environment (MLAE). With achievement of nearly 100% of water supply service ratio, the Government is planning to develop sewerage systems and sewage treatment facilities aiming to water pollution control, effective utilization of water sources and cost recovery in sewerage works. Although the MHC requires review and renewal of existing Governorate Master Plan, owing to the capacity shortage of Governorate offices and the MHC headquater, these planning works are quite severe for them. Considering these circumstances, the Syrian Government requested the technical support from the Japanese Government. In response to this request, JICA dispatched the Preliminary Study Team in October 2005. M/M was signed on 19 October 2005 and S/W was also signed on 15 March 2006 for the implementation of this study.

CHAPTER 2 OBJECTIVES OF THE STUDY AND STUDY AREA

2.1 Objectives of the Study

The main objectives are enumerated as follows:

1) Review of existing development plans in national sewerage sectors
2) Formulate Governorate Master Plan for prioritized area aiming at water pollution control and public hygiene improvement

3) Conduct the Feasibility Study in Rural Damascus Governorate in cooperation with Syrian counterpart officers
4) Execute the Technical Transfer to Syrian counterpart officers in course of the study

2.2 Study Area

As described below, the study is divided into three Phases and each target study area is shown in **Table MS2.2.1** and **Figure MS2.2.1**.

Table MS2.2.1 Study Contents and Study Areas

Phase	Study Contents and Study Area
Phase-1	Examination on the current status of sewerage sector and preparation of improvement plan for the entire area of Syria
Phase-II	Establishment of Master Plan for prioritized areas (7 Governorates in 4 areas named Rural Damascus, Dar'aa, Tartous, Lattakia, Raqqa, Deir-Ez-zor, Hassakeh) Refer to the following Location Map.
Phase-III	Undertake the Feasibility Study as a Pilot Project for training purpose in Rural Damascus Governorate

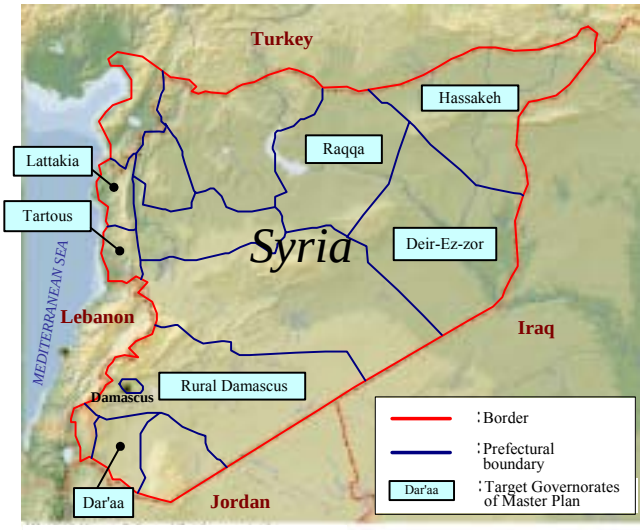


Figure MS2.2.1 Location Map of the Study Area

2.3 Description of the Study Area

2.3.1 Natural Conditions

The daily differences between the maximum and minimum temperature are generally quite high all through the land. The difference sometime reaches approximately 20℃ as shown **Table MS2.3.1**. December, January and February are the coldest months of the year, while from June to September are the hottest season. In winter, the temperature frequently falls under 0℃ at mountain area, while in summer it may rise frequently up to 48℃.

Table MS2.3.1 Average Temperature in Syria (1996 – 2005)

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum Average	13.2	15.1	19.6	24.9	31.2	35.1	38.4	37.5	34.0	28.6	21.0	15.1
Minimum Average	0.9	1.6	4.2	7.6	11.8	15.4	18.6	17.9	14.4	10.2	4.6	2.3

Source: Meteorological Office in Damascus

Coastal and mountain areas have the most rains, followed by the north areas (Aleppo, Kamishly and Malkia in Hassakeh) where atmospheric depressions coming from Mediterranean Sea meet the mountains. On the other hand, in the eastern, southern and desert places, precipitation is low. **Table MS2.3.2** presents the average rainfall data from 1996 to 2005.

Table MS2.3.2 Average Rainfall Data by Governorate and Month (1996 – 2005)

(Unit: mm)

Governorate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Lattakia	141.4	85.2	76.6	48.7	8.3	7.9	0.4	3.5	18.9	68.7	79.2	171.1	709.9
Tartous	180.0	124.2	95.2	39.7	8.1	0.4	0.0	0.1	13.5	67.0	91.6	181.9	801.6
Deir-Ez-zor	30.0	24.8	20.0	13.3	7.3	0.1	2.3	0.0	0.2	4.0	21.4	25.4	148.8
Hassakeh	43.8	38.6	32.0	24.9	10.5	0.3	0.0	0.0	1.6	11.1	24.4	39.8	226.8
Raqqa	38.1	26.3	30.5	17.5	9.8	0.0	0.1	0.0	0.2	5.9	16.4	24.7	169.4
Dar'aa	52.9	46.5	37.6	9.7	3.0	1.6	0.0	0.0	0.4	7.6	16.5	38.6	214.5
Rural Damascus	31.8	20.4	11.4	2.6	3.7	0.0	0.0	0.0	0.0	3.5	15.3	22.5	111.1
Damascus	47.6	37.6	18.6	4.9	2.4	0.0	0.0	0.3	0.0	6.0	25.8	41.2	184.4

Source: Meteorological Office in Damascus

The total land area of Syria is 18,518 thousand hectares, 5,934 thousand hectares is cultivable lands and the rest is uncultivable lands and others. The steppes and deserts area are about 8,300 thousand hectares and they may be used for grazing when there is enough rainfall and good management. **Table MS2.3.3** shows the present land use conditions from 2003 to 2005.

Table MS2.3.3 Land Use (2003-2005)

(unit: thousand hector)

Year	Cultivable Lands				Uncultivable Lands				Steppes & deserts	Forests	Total lands area
	Irrigated	Non-irrigated	Fallow	Total	Buildings & roads	Water surface	Rock & sandy	Total			
2003	1,361	3,300	1,202	5,863	636	159	2,935	3,730	8,335	590	18,518
2004	1,439	3,290	1,181	5,910	651	161	2,924	3,736	8,279	593	18,518
2005	1,426	3,447	1,061	5,934	652	161	2,907	3,720	8,266	598	18,518

Source) Statistical Abstract 2006

2.3.2 Socio-Economic Conditions

Syrian society is characterized by being young. According to the 2006 Statistical Abstract, 39.5% of the population is below 15 years old, 57.2% is between 15-64 years old and 3.3% is over 65 years old. The percentage of males to females is 50.2% to 49.8%. This percentage is reflected on the economic factor. According to the 2006 Statistical Abstract, 39.2% of the total population of Syria lives in the city of Damascus, Rural Damascus and Aleppo governorates. **Table MS2.3.4** shows the distribution of population in the Syrian Governorates.

Table MS2.3.4 Distribution of Population

(unit: thousand person)

Governorate	Total Population	Females	Males	Percentage (%)
Lattakia	1,121	560	561	5.3
Tartous	874	433	441	4.2
Deir-Ez-zor	1,387	701	686	6.5
Hassakeh	1,349	679	670	6.3
Raqqa	839	427	412	3.9
Dar'aa	944	466	478	4.5
Rural Damascus	1,619	797	822	7.8
Aleppo	4,974	2,474	2,500	23.6
Hama	1,837	907	930	8.8
Homs	1,881	931	950	9.0
Idleb	1,744	861	883	8.3
Sweida	443	222	221	2.1
Quneitra	422	209	213	2.0
Damascus	1,627	812	815	7.7
Total	21,061	10,479	10,582	100.0

Source: Statistical Abstract 2006

24.3% of the total population works in economic activities. The distribution of this percentage is 40.8% for males and 7.5% for females. The economic activation of the population is distributed mainly in the service sector (44.4%), agriculture (6.9%), industry (16.2%), commerce (16.8%) and construction (15.7%), respectively.

Table MS2.3.5 shows the most important economic indicators in Syria, mainly the total local output, the agricultural and industrial output.

Table MS2.3.5 Economic Indicators in Syria between 1993 and 2006

Economic Indicators	1990	2006
Total local output (million Syrian Pounds)	925,377	1,947,029
Agricultural output (million Syrian Pounds)	207,034	391,532
Industrial output (million Syrian Pounds)	360,233	696,029

Source) Statistical Abstract 2006

The Government of Syria has prepared the 10th Five-Year Plan (10th FYP) for Economic and Social Development (2006-2010) in January 2006. This plan represents the supreme

development plan at the national level in Syria. The 10th FYP envisions transition to the "Social Market Economy" society, and it stresses the need for enhancement of the society's awareness supported by rights of individuals and groups. Their responsibilities for participation in the public affairs and conviction to achieve a high productivity society, giving numerical targets for the main macroeconomic, social and infrastructural indicators towards 2010 such as the economic growth rate, infant mortality rate, illiteracy rate, drinkable water availability rate, and so on.

CHAPTER 3 PRESENT CONDITION OF WATER POLLUTION CONTROL IN SYRIA

3.1 Institutional Framework

The responsibility for dealing with the main environmental issues in Syria lies within the Ministry of Local Administration and Environment (MLAE). However, as long as the water quality monitoring/control is concerned, its administration is the responsibility of several Ministries and organizations, which exert varying degrees of planning and controlling functions. MLAE is responsible for the protection of the environment by issuing the required standards and monitoring the quality of water for all uses. In addition, it has the task to plan and implement all governmental activities at the regional level.

The Ministry of Irrigation (MOI) is responsible for the water resources management and for the provision of all irrigation water in the country, including sewage effluent. For monitoring the water quality, MOI is also in charge of controlling and monitoring water quality through the Water Safety Committee.

The Ministry of Housing and Construction (MHC) is responsible for proposing, planning and executing the Government's program in the field of water supply and wastewater in all regions of Syria. However, the Public Establishments of Drinking Water and Sewerage (Establishments) under the auspices of MHC conduct drinking water quality testing in their laboratories.

3.2 Legislative Framework

The Syrian Government issued the environmental law as Law No. 50 for the year 2002. The law specified the objectives, tasks and formation of General Commission for Environmental Affairs (GCEA), tasks and formation of Environmental Protection Council, environmental protection and support fund, and responsibility and compensation.

As for regulations/standards, the following regulations/standards are currently issued in terms of water pollution control and wastewater management.

- The maximum limits of industrial polluters permitted to be discharged to the external

environment

- The maximum limits of industrial polluters permitted to be discharged to the sewer networks
- Regulations for treated water reuse for irrigation
- Regulations on the sludge use in agriculture

However, the JICA Study Team observes that actual enforcement is very weak because the specific instructions related to the main Law No. 50 have not been yet provided sufficiently. In fact, although the law stipulates the punishment against the violations related to the law, the application of punishment to the violated enterprises or entities would be almost impossible, because most of the wastewater discharged into the public waters from such enterprises and sewer systems in Syria is not treated and the water quality of the effluent does not meet the legal regulations.

In order for the Law No. 50 to be more enforceable, issuance of a by-law which defines/ stipulates in-depth clauses such as:

- detailed definition of the type and scale of industry to be regulated,
- obligation of reporting on treatment facilities and discharged wastewater quantity and quality from industrial wastewater dischargers,
- provision of temporary standards or moratorium periods for existing industries and
- restriction on new industries' locations (limiting them to the exclusive industrial zones, for example),

would be necessary.

3.3 Present Condition of Water Pollution in Public Waters

3.3.1 Water Resources

In the intake water volume for water supply by Governorate (2005), Aleppo uses the largest volume and its share is approximately 23% of the total amount of water supply in Syria, followed by Damascus with a share of 17% and Rural Damascus with 11%, respectively. The total intake volume for the water supply of these three Governorates exceeds 50% of the total volume in Syria, implying that population and industrial and commercial activities are concentrated in these Governorates.

With regard to the water resources type, Aleppo, Raqqa and Deir-Ez-zor heavily depend on the surface water with more than 90% of the total volume while Damascus and Rural Damascus have a high dependence on groundwater.

3.3.2 Water Quality of Public Water Bodies and Their Major Pollution Sources

In the Study Area, groundwater contamination of Barada and Awaj River basins and the river water pollution of Orontes River basin are remarkable. Both basins have large population and industrial activities. In addition to the above problems, especially Barada and Awaj River

basins receive limited precipitation and have a high ratio of water utilization for irrigation. Such features seem to accelerate water quality problems in Barada and Awaj River basin.

The water pollution problems and their main sources in each hydrological basin can be summarized as shown in **Table MS3.3.1**.

Table MS3.3.1 Estimated Main Pollution Sources of Water Quality Problems

Name of River Basin (Governorate)	Water pollution /contamination problems	Main Pollution Load Sources
Barada and Awaj River basin (Damascus and Rural Damascus)	Pollution of surface water for irrigation	• Domestic and commercial wastewater • Public factories which have large amount of pollution load
	Pollution of groundwater for water supply and irrigation	• Infiltration of polluted river water, which is polluted by domestic, commercial and industrial wastewater. • Infiltration of irrigated water, which is polluted by domestic, commercial and industrial wastewater. • Infiltration of irrigated water, which is treated water from sewerage treatment plant • Treatment facilities (on-site facilities with penetration type) of domestic wastewater
Orontes River basin (Homs, Hama and Idleb)	Pollution of surface water for irrigation	• Domestic and commercial wastewater (outlet of sewer pipe) • Public factories which have large amount of pollution load
Coastal basin (Tartous and Lattakia)	Pollution of water sources for Water supply	• Widely scattered small-scale olive oil pressing factories • Treatment facilities (on-site facilities with penetration type) of domestic wastewater and non-treated domestic wastewater
	Water pollution of sea area (bacteriological contamination)	• Domestic and commercial wastewater from sewer pipe without treatment.
Tigres and Khabour River basin (Hassakeh)	Pollution of water sources for irrigation	• Domestic and commercial wastewater (Outlet of sewer pipe) • Public factories which have large amount of pollution load
	Water pollution of living environment	
Euphrates River basin (Aleppo (Qweick River), Raqqa and Deir-Ez-zor)	Pollution of water sources for water supply	• Domestic and commercial wastewater (Outlet of sewer pipe) • Public factories which have large amount of pollution load
	Water pollution of living environment	
Yarmouk River basin (Dar'aa, Sweida and Qunetra)	Pollution of groundwater for water supply	• Domestic, commercial and industrial wastewater

CHAPTER 4 INSTITUTIONAL AND ORGANIZATIONAL FRAMEWORK OF SEWERAGE SECTOR

4.1 Institutional Framework

The present institution of sewerage sector in Syria is rather complex. In principle, the sewerage issues are governed by two central authorities, i.e. the Ministry of Housing and Construction (MHC) and the Ministry of Local Administration and Environment (MLAE), and local authorities.

MHC is responsible for water supply and wastewater issues in all regions of Syria. MHC has a Directorate of Sewerage which deals with wastewater issues. Main tasks of this directorate focus on design of sewage treatment plants and main sewer networks as well as approval the plans prepared by other organizations and supervision of construction projects.

MLAE also has a directorate working with sewer networks and treatment plants for small villages. Its role is to approve designs of pipelines, treatment plants and construction contracts.

The 14 Governorates, under auspices of MLAE and their municipalities have their own budgets and undertake investments in the field of wastewater and waste management, mainly for small sewer networks but they will be phasing out in the near future, transforming these tasks to the Public Establishment of Drinking Water and Sewerage (Establishment) in each Governorate. Its general task is to ensure adequate water supply and sanitation services in the Governorate. In particular, it is involved in planning, implementing and operating new projects as well as maintaining the existing facilities. The Sewerage Companies (Companies) under these Establishments have been set up in cities which have sewage treatment plants (STPs), for implementing O&M of their sewerage facilities, i.e. STPs and sewer networks. They are guided and controlled by MHC rather than by local authorities. Other institutions such as the General Company for Engineering and Consulting (GCEC) and the University of Damascus are related to the sewerage work. Planning and design of the sewerage systems are commissioned to these institutions by MHC.

4.2 Issues and Challenges in Water and Sewerage Sector

The 10th Five-Year Plan (FYP) envisions in the next 20 years to "Provide services that satisfy people's needs through highly efficient Establishments which manage and preserve water sources designated for drinking purposes in order to ensure all citizens' rights for safe drinking water and treated sewage".

In order to meet the requirements of the FYP, GTZ has been providing MHC with advisory services for the institutional reform from 2006, which will be continued until 2008. The

contents of the services include 1) Monitoring and evaluation, 2) Economic and financial management, 3) Management of strategic planning and communication, 4) Project development and management, and 5) Human resources development.

It is considered that most of the necessary institutional arrangement is fulfilled through the GTZ support, and therefore, this Study should rather focus on the organization and capacity building of the Executor for the sewerage projects, namely, the sewerage directorate of the Establishments and the Sewerage Company. When specific projects commence in each Governorate, they have to deal with the whole cycle of the projects including project preparation, tender, construction, operation and maintenance and so on. This Study will provide proposals and recommendations on the necessary organization structure and management plan for the executing agency in the target 7 Governorates, as well as on the necessary technical assistance scheme.

CHAPTER 5 PRESENT CONDITIONS OF EXISTING SEWERAGE SYSTEM

Sewerage service ratios were investigated in 14 Governorates. Sewerage service ratio here means "population ratio served by sewer network". However, sewage treatment facilities were not implemented in some Governorates. The results are stipulated in **Table MS5.1.1**.

Table MS5.1.1 Current Status of Existing Sewerage Facilities

No.	Governorate	Average Service Ratio	Current Status of existing Sewerage Facilities
1	Lattakia	61%	No STP was constructed and raw sewage is discharged to the Mediterranean Sea from 13 discharge points.
2	Tartous	58%	Though no large-scaled STP was constructed, plural STPs are under construction/study. There are two private STPs serving beach resort compounds. Raw sewage is discharged to the Mediterranean Sea from 60 discharge points.
3	Deir-Ez-zor	44%	Though no STP was constructed, design of Deir-Ez-zor STP was completed by GCEC. Raw sewage is discharged to Euphrates River from many discharge points.
4	Hassakeh	37%	One STP is currently operated but it shall be expanded. Design of Hassakeh STP is now on-going by GCEC. Most of raw sewage is discharged into Khabour River.
5	Raqqa	31%	Five STPs constructed by MLAE are operated and Governorate is now preparing Tender for Raqqa STP construction contract under the support of Spanish Government. Sewage generated in areas not connected to sewer network is discharged into Euphrates River or served by On-site facilities.
6	Dar'aa	45%	Two STPs are now under construction. This Governorate is well-known as granary and sewage has been fully utilized for irrigation use. High concentration of Nitrogen and Phosphorous was observed in groundwater.
7	Rural Damascus	71%	Two STPs are currently operated. 33% of sewage is pumped by Yarmouk PS and sent to Adraa STP. However, treated sewage quality is not adequate for irrigation use. Aside of these, 12 STPs were designed by Damascus Univ. and their civil works are now on-going.

Table MS5.1.1 Current Status of Existing Sewerage Facilities

No.	Governorate	Average Service Ratio	Current Status of existing Sewerage Facilities
8	Aleppo	82%	Aleppo STP adopted AL method is now operated but it has large seasonal frequency in treatment efficiency.
9	Hama	66%	Though one STP is now operated, it shall be expanded. Construction work of Hama STP is on-going and another STP is under study.
10	Homs	45%	Homs STP employed conventional activated sludge method is currently operated but treatment efficiency is unfavorable due to incoming industrial wastewater.
11	Idleb	69%	Idleb STP adopted stabilization pond method is now under construction and another STP is now under study.
12	Sweida	56%	Though no STP was constructed, Sweida STP has been studied through the support of Spanish Government.
13	Qunetra	53%	No STP was constructed and raw sewage is discharged to the water courses nearby.
14	Damascus	96%	Yarmouk PS and Adraa STP are operated but treated sewage quality is not appropriate for irrigation use.

Completed sewerage facilities are managed by Establishment and Company. Company is set up in cities where STP was constructed.

As sewer network has been developed focusing core areas of cities, service ratio in city center is generally high. However, when Governorate average was calculated dividing served population by the whole population inhabited, lower ratio was reckoned in some Governorates as shown in the **Table MS5.1.1**. National average ratio is 47%.

CHAPTER 6 INVESTMENT PROGRAM AND FINANCIAL STATUS OF SEWERAGE SECTOR

6.1 Investment for the Sewerage Sector in the Tenth (10th) Five-Year Plan

The Plan intends to make a fivefold investment from 2006 to 2010 amounting to SYP 37 billion. The investment plan includes three types of projects: (1) Started Projects, (2) New Decided Projects and (3) New Proposed Projects. The number of projects is 529 (Started Projects - 195, New Decided Projects - 77, and New Proposed Projects - 257, excluding Damascus. The Started Projects mean that they are being executed at present. For the New Decided Projects, it is already decided to implement in one or two years and most of them are put in the annual investment budget. The New Proposed Projects are still at the proposal stage expecting for the future implementation.

The planned investment for the New Proposed Projects is the largest among the three types of projects, amounting to SYP 21.9 billion, which occupies more than half (59.2%) of the total investment during the Plan period. The Started Projects follow them with SYP 9.1 billion investment, occupying 24.6% of the total. Investment of SYP 6 billion for the New Decided Projects occupies 16.2%.

6.2 Budgetary Arrangement for Sewerage Projects

Based on the "Five Years Plan", the annual investment budget is prepared by MHC and the Establishments and it includes the cost of the annual investments in water and wastewater projects executed by both parties and the estimated funds needed to cover these investments.

The investment budget for water and sewerage is composed of the National Budget and the budgets of 14 Public Establishments of Drinking Water and Sewerage (Establishments), each of which has responsibility to develop, operate and maintain the water and sewerage system under its jurisdiction. The National Budget for the development of water and sewerage is under the Ministry of Housing and Construction (MHC). The Ministry of Local Administration and Environment (MLAE) and 14 Governorates under the MLAE are responsible to carry out the works related to administration of the Central and local governments. The governorates and municipalities under them have their own budgets for sewerage and waste disposal, however, the sewerage issues are gradually being transferred to the Establishment (including the Sewerage Company) recently. Refer to **Chapter 6, 6.2**.

The investment amount for sewerage projects during 2007 planned in the Five-Year Plan is SYP 10,940 million, including SYP 6,774 million for the new decided and new proposed projects.

6.3 Financial Condition in Public Establishments

In Syria, a national unified tariff water and sewerage is applied to regional service providers. It was determined in 2000 and revised in August 2007. The present volumetric part of the tariff table is shown as **Table MS6.3.1**.

The sewerage tariff is determined by percentage in relation to the water tariff, but is not imposed on the customers who do not receive sewage treatment services. The present tariff in Syria is lower than in similar countries such as Jordan and Tunisia.

Table MS6.3.1 Water Tariff Table

Category	Tariff	Notes
Volume-based charges	SP/m^3	
Domestic 1 to 15 m^3	2.5	
Domestic 16 to 25 m^3	7	
Domestic 26 to 40m^3	15	
Domestic 41 to 60m^3	22	applied for the total volume consumed
Domestic 61 $m^3$and over	30	applied for the total volume consumed
Governmental institutions	14	
Industrial, commercial and tourism	30	
Fixed charges (per year)	SP	
Meters maintenance	240	
Network fee	250	

Note) Other fixed fees may apply, as for instance the water meters installment fee, a special surcharge of SP20 for the bills exceeding SP100 and so on.
Source) MHC

According to MHC, only four (out of 14) Establishments gained operating profit in 2004, which are Damascus, Aleppo, Lattakia and Rural Damascus. However, these data are not reliable since Syria does not adopt the international financial reporting standards.

CHAPTER 7 PLANNING FUNDAMENTALS

7.1 Basic Policy on Establishment of Sewerage Development Plan

Sewerage system development plan will be prepared by two stages, namely 1) Macro Plan and 2) Master Plan. "Macro Plan" means macroscopic picture for sewerage development covering priority areas of the target seven Governorates. For detail, refer to **8.3** of this Summary. Upon establishment of Macro Plan, fundamental framework comprises long-term objective of sewerage system development will be examined. They are served population, number of STP, sewage and sludge treatment, basic policy for O&M activities and priority order of projects. Further, one core city or area will be selected by each seven designated Governorates and Master Plan will be formulated for them.

The scale of sewerage system is determined by design sewage flow at target year. Design sewage flow is calculated by multiplying design service population to per capita sewage rate. Further, sewage quality shall be established to design the sewage treatment facilities. Such design criteria are estimated herein.

7.2 Population Projection

7.2.1 General

Design served population is the most fundamental criteria in determination on scale of sewerage development plan. Design served population is the future population in the target year. The future population is projected by past population data.

7.2.2 Population Data

Two kind of population data are available, namely National Census Data and Residential Registration Data. The JICA Study Team adopted the National Census Data to estimate the future population accounting the accuracy of data. For detail, refer to **Table 7.1.1** of Main Report.

7.2.3 Population Estimation Method

National population growth rate during 1981 to 1994 was approximately 3.3%, very high. While, that during 1994 to 2004 decreased to 2.66%. Population growth rate is seemed to display decreasing trend from now on. Population growth rates in every five years were

settled accounting the reduction rate examined based on the population transition in two periods, 1981 to 1994 and 1994 to 2004. Refer to **Table MS7.2.1**.

Table MS7.2.1 Population in Each Governorate

Governorates	Population in Syria (Person)			Increasing Ratio (%)		Ratio (%)	Planning Ratio per 5 year
	1981	1994	2004	1981 -1994	1994 -2004		
Lattakia	551,508	746,441	879,551	2.36	1.65	69.9	80.0
Tartous	443,167	587,514	701,395	2.19	1.79	81.7	90.0
Deir-Ez-zor	408,357	711,375	1,004,747	4.36	3.51	80.5	90.0
Hassakeh	669,614	1,022,940	1,275,118	3.31	2.23	67.4	80.0
Raqqa	349,848	553,395	793,514	3.59	3.67	102.2	100.0
Dar'aa	362,798	606,620	843,478	4.03	3.35	83.1	90.0
Rural Damascus	918,551	1,646,744	2,273,074	4.59	3.28	71.5	80.0
Aleppo	1,877,339	2,975,063	4,045,166	3.61	3.12	86.4	90.0
Hama	736,822	1,097,769	1,384,953	3.11	2.35	75.6	80.0
Homs	812,419	1,217,342	1,529,402	3.16	2.31	73.1	80.0
Idleb	580,440	905,483	1,258,427	3.48	3.35	96.3	100.0
Sweida	199,584	268,337	313,231	2.30	1.56	67.8	80.0
Qunetra	26,266	48,774	66,627	4.88	3.17	65.0	80.0
Damascus	1,109,431	1,394,322	1,552,161	1.77	1.08	61.0	70.0
Total	9,046,144	13,782,119	17,920,844	3.29	2.66	80.9	

Source) National Census

7.2.4 Population Projection

Based on the population in 2004, future population was calculated adopting each population growth rate. Refer to **Table MS7.2.2** as to population projection in target seven Governorates.

Table MS7.2.2 Population Projection in each Governorate

Governorates	Population in Syria				
	2004	2010	2015	2020	2025
Lattakia	879,551	983,300	1,060,700	1,127,800	1,185,300
Tartous	701,395	784,300	853,900	922,700	990,100
Deir-Ez-zor	1,004,747	1,239,800	1,433,400	1,618,200	1,793,700
Hassakeh	1,275,118	1,443,300	1,569,300	1,679,100	1,773,100
Raqqa	793,514	968,500	1,130,000	1,303,800	1,492,500
Dar'aa	843,478	1,020,500	1,171,700	1,321,100	1,468,500
Rural Damascus	2,273,074	2,855,400	3,358,900	3,909,000	4,500,700
Aleppo	4,045,166	4,864,000	5,586,900	6,330,300	7,085,600
Hama	1,384,953	1,592,100	1,747,500	1,882,600	1,998,300
Homs	1,529,402	1,754,000	1,922,400	2,068,900	2,193,900
Idleb	1,258,427	1,533,500	1,808,200	2,132,100	2,514,000
Sweida	313,231	313,231	343,700	365,700	384,400
Qunetra	66,627	80,300	91,000	100,600	109,000
Damascus	1,552,161	1,625,800	1,691,800	1,749,100	1,800,000
Total	17,920,844	21,058,031	23,769,400	26,511,000	29,289,100

Note)
a) Population projection was estimated based on population in 2004 and population growth rate
b) Population growth rate until 2010 was calculated by population in 1994 and 2004
c) Growth rate 2010 to 2025 was calculated applying reduction ratio ranging from 0.7 to 1.0 based on the population growth characteristics in each Governorate

Population estimation in cities contained in M/P target area is shown in **Table MS7.2.3**.

Table MS7.2.3 Population Projection of MP Target Cities

Governorate	District	Sub-district	City & Town	1994	2004	2010	2015	2020	2025	Annual Growth Rate (%)
Lattakia	Total				2,534	2,600	2,700	2,800	2,800	
	Al-Haffeh	Slunfeh	Slunfeh		1,847	1,900	2,000	2,100	2,100	0.78
			Biereen		687	700	700	700	700	0.78
Tartous	Total				43,647	54,300	64,200	74,700	85,600	
	Banias	Banias	Banias	28,623	41,632	52,100	61,700	71,900	82,500	3.82
			Tero	726	838	900	1,000	1,100	1,200	1.45
			Khabet Snasel		645	700	800	900	1,000	2.03
			Boston Al-Najor	266	532	600	700	800	900	2.03
Deir-Ez-zor	Total			39,121	60,175	80,400	95,400	107,600	117,100	
	Mayadin	Mayadin	Mayadin	26,151	44,028	60,200	72,400	82,400	90,300	5.35
			Taiba	7,432	6,061	7,600	8,700	9,500	10,100	3.76
			Makhan	5,538	10,086	12,600	14,300	15,700	16,700	3.76
Hassakeh	Malkieh	Malkieh	Malkieh	22,182	26,311	29,100	31,200	33,000	34,500	1.72
Raqqa	Thawra	Thawra	Thawra	54,473	69,425	80,300	90,700	102,400	115,600	2.46
Dar'aa	Total			23,844	30,536	35,600	39,600	43,100	46,200	
	Dar'aa	Dar'aa	Atman	5,942	8,929	11,400	13,200	14,600	15,700	4.16
	Muzerib	Muzerib	Muzerib	10,476	12,640	14,200	15,500	16,700	17,900	1.90
			Yaduda	7,426	8,967	10,000	10,900	11,800	12,600	1.90
Rural Damascus	Total			40,966	47,737	54,000	58,700	62,700	66,100	
	Zabadani	Zabadani	Zabadani	21,049	26,285	30,000	32,800	35,200	37,300	2.25
			Bloudan	4,685	3,101	3,300	3,400	3,500	3,600	1.00
			Rawdah	2,825	4,536	6,000	7,100	8,000	8,700	4.85
			Hosh Bajet	429	604	700	800	900	1,000	3.48
		Madaya	Madaya	8,649	9,371	9,800	10,100	10,400	10,600	0.80
			Bukein	1,746	1,866	1,900	2,000	2,000	2,000	0.67
		Serghaya	Ain Hour	1,583	1,974	2,300	2,500	2,700	2,900	2.23

7.3 Land Use Plan

Existing and future land use of Governorates are shown in **Table MS7.3.1**.

Table MS7.3.1 Future Land Use of Governorates

(Unit: km^2)

2025	Forests	Steppe and Pastures	Rocky and Sandy Land	Rivers and Lake	Building and Public Roads	Cultivated Land	Irrigated Land	Non-Irrigated Land	Fallow and others	Total
Lattakia	884	19	106	46	261	980	377	603	0	2,297
Tartous	324	29	19	31	260	1,232	273	960	0	1,896
Deir-Ez-zor	110	18,829	10,916	152	297	2,376	2,142	235	380	33,060
Hassakeh	1,635	5,890	653	334	720	12,172	7,030	5,142	1,928	23,334
Raqqa	221	9,462	309	892	726	5,161	2,902	2,260	2,845	19,616
Dar'aa	131	298	309	24	834	1,443	484	959	691	3,730
Rural Damascus	767	13,180	1,343	42	817	1,716	1,105	611	154	18,018
Aleppo	695	2,269	2,274	400	785	9,272	2,792	6,480	2,807	18,500
Qunetra	44	131	51	13	75	231	66	165	1,315	1,861
Damascus	11	0	0	0	100	7	7	0	0	118

Source) Statistical Abstract 2006

7.4 Wastewater Quantity and Quality

7.4.1 Wastewater Quantity

(1) Per Capita Sewage Rate

1) General

Since arrangement of relevant data on water supply is quite poor in Syria, accurate estimation of per capita sewage rate is also extremely difficult. Accordingly, it will be settled referring to the existing study reports and real status of residential life.

Generally, period of water supply is limited in Syria, namely from 6 AM to 3 PM. Therefore, every household is equipped with storage tank to secure water during water supply suspension hours. This tells about nationwide chronic water shortage in Syria. Owing to such circumstances, hourly water consumption curve shows one peak in the morning. As residents dully aware the current water supply status, per capita water consumption is assumed not to grow drastically in future.

2) Existing Studies

According to the Feasibility Study on Zabadani executed by EIB and the Feasibility Study on Barada & Ghouta implemented by WB, per capita sewage rate was created as shown in **Table MS7.4.1**. However, detailed bases for per capita sewage rate were not clarified in every study.

Table MS7.4.1 Per Capita Sewage Rate in Existing Studies

	Unit		Zabadani by EIB	Brada & Ghouta by WB
Domestic Water demand	L/capita/day	2005 2025	80 175	110 110
Non-domestic demand				10 % of domestic demand
Unaccounted for water				20 % of domestic demand
Wastewater Production	%		80	80
Max. day factor			$5/P^{1/6}$ P: (Population in 1000)	1.2
Peak hour factor				1.8

Source) Feasibility Study on Muzerib Sewerage System/GCEC
Pre-Feasibility Study Zabadani Water and Wastewater Project/EIB
Wastewater Strategic Plan and Priority Investment Study in Barada & Ghouta Gharbiyah/WB

While, DAWSSA established per capita water consumption as shown in **Table MS7.4.2** and reflected them to facility designing.

Table MS7.4.2 Per Capita Water Consumption by DAWSSA

Community Population	LCD
1-5000	75
5,000-10,000	100
10,000-25,000	125
25,000-50,000	150
50,000 or More	175

3) Per Capita Sewage Rate

Per capita domestic sewage rate was calculated as shown in **Table MS7.4.3** and **S7.4.4**:

Table MS7.4.3 Per Capita Domestic Sewage Rate (Non-domestic Ratio= 0.3)

(Unit : LCD)

Items	2004	2010	2015	2020	2025
Daily Average Flow (DAF)					
Domestic	100	105	110	115	120
Non-Domestic	30	32	33	35	36
Total	130	137	143	150	156
Conversion ratio			0.8		
Wastewater	104	109	114	120	125
Daily Maximum Flow (DMF) (DMF=1.2×DAF)					
	125	131	137	144	150
Peak Hour Flow (PHF) (PHF=1.8×DMF)					
	225	236	247	258	270
Unaccounted Flow (=DMF×20%)					
	25	26	27	29	30
Design Sewage Unit Flow					
Daily Average	129	135	142	148	155
Daily Maximum	150	157	165	172	180
Peak Hour	250	262	275	287	300

Table MS7.4.4 Per Capita Domestic Sewage Rate (Non-domestic Ratio= 0.1)

(Unit : LCD)

	2004	2010	2015	2020	2025
Daily Average Flow					
Domestic	100	105	110	115	120
Non-Domestic	10	11	11	12	12
Total	110	116	121	127	132
Conversion ratio			0.8		
Wastewater	88	92	97	101	106
Daily Maximum Flow (DMF) (DMF=1.2×DAF)					
	106	111	116	121	127
Peak Hour Flow (PHF) (PHF=1.8×DMF)					
	190	200	209	219	228
Unaccounted Flow (=DMF×20%)					
	21	22	23	24	25
Design Sewage Unit Flow					
Daily Average	109	115	120	125	131
Daily Maximum	127	133	139	146	152
Peak Hour	211	222	232	243	253

Note) Assumption:

- Daily Domestic Average Flow (Water Consumption) increases 1 LCD/Year owing to future living level upgrading
- Non-domestic ratio of 0.3 was adopted to Urbanized Area, while 0.1 was employed to Residential Area

7.4.2 Wastewater Quality

(1) Pollution Load

Referring to the sewage quality analysis data in Adraa STP, having the largest number of samples, the average pollution load of SS, T-N, T-P was settled as shown in **Table MS7.4.5**. Although T-P is little bit high, it is still lower than the largest value of 4 g/d/c adopted in USA

and no adverse influence is foreseen in planning.

Table MS7.4.5 Average Pollution Load for Water Pollution Analysis

Parameter	Pollution Load (g/d/c)	Calculation (g/d/c)
BOD	38	23+53.7/2＝38.4
SS	45	#1 38.4*242/205＝45.3
T-N	9	#2 38.4*62/255＝9.3
T-P	3	#3 38.4*20/255＝3.0

(2) Design Sewage Quality

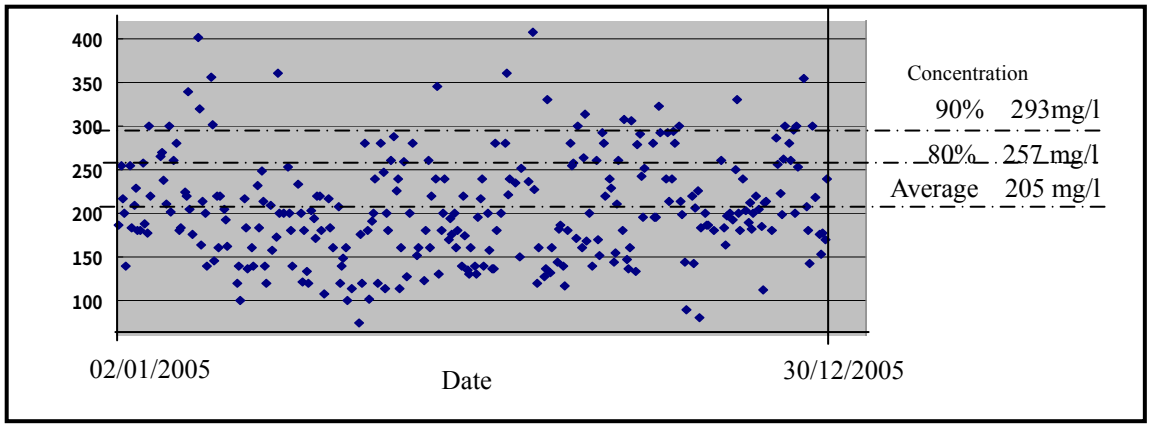
Based on the average pollution load, design sewage quality was established as shown in **Table MS7.4.6**:

Table MS7.4.6 Average Pollution Load and Design Sewage Quality

Parameter	Pollution load when average water consumption is 155LCD (g/d/c)	Design Sewage Quality (mg/ℓ)
BOD	38.4	310
SS	45.3	360
T-N	9.3	74
T-P	3.0	24

Distribution of BOD concentration of incoming sewage to Adraa STP is shown in **Figure MS7.4.1**. Laboratory of Adraa STP has abundant sewage quality data. Calculated BOD concentration of 307 mg/ ℓ locates at the upper portion of **Figure MS7.4.1** and this gives adequate allowance upon planning.

Compared with the results of sewage quality analysis conducted at Mayadin where domestic sewage is predominant, 307 mg/ℓ is exceeding the average BOD concentration. This also indicates that designed facilities will have appropriate allowance if 307 mg/ℓ is applied for facility designing.



Source) Adraa STP Laboratory Record

Figure MS7.4.1 BOD Concentration of Incoming Sewage(Adraa STP, 2006)

CHAPTER 8 RECOMMENDATION ON DEVELOPMENT STRATEGY

The development strategy recommended by the JICA Study Team includes that for water pollution control and for the sewerage sector itself, in order for the Syrian sewerage sector to be able to sustain the sewerage operation by themselves throughout the life cycle of sewerage management.

8.1 Impact of Sewerage Development and Industrial Load Reduction on Public Water Quality

(1) Impact of Sewerage Development on Public Water Quality

1) Euphrates River

It is expected that the development of the sewerage system will make the water quality in the Euphrates River satisfy the target of the (proposed) environmental standard for BOD (BOD: 2mg/l or less) on annual average. However, notable improvement on the river water quality is not expected due to the large load of industrial discharge.

2) Khabour, Barada/Awaj, Yarmouk River

For Khabour and Barada/Awaj Rivers, the sewerage system development will satisfy the target of the (proposed) environmental standard for BOD (BOD: 8mg/l or less) on annual average. However, the water quality in the Yarmouk River is not expected to satisfy the (proposed) standard according to this study, due to the very high present water quality, although improvement in the water quality is seen. It is apparent that the present BOD concentration of 33 mg/l is extremely unsuitable for the drinking water source. As the available water quality data were very few, accumulation of water quality monitoring data is desired.

3) Mediterranean

It is expected that the development of the sewerage system will make the water quality in Mediterranean Coastal Area satisfy the target of the (proposed) environmental standard of water quality (of fecal coliform concentration of 1,000 MPN/100ml).

(2) Impact of Sewerage Development on Groundwater Quality

For the groundwater quality improvement in Barada/Awaj basin, sewerage system development with a nitrogen removal method only can meet the proposed water quality standard (12mg/l as T-N), and almost meet the WHO standard (50mg/l as NO_3).

(3) Necessity of Industrial Load Reduction

In addition to the sewerage development, if all the industrial discharges meet the Syrian regulation, the run-off BOD loads will further be reduced to a level of 56-87%. Regulation of industrial discharges is especially effective for Euphrates and Coastal basins.

8.2 Strategy for Water Pollution Control

(1) Strategy for Sewerage System Development

Without the sewerage system development, the public water quality will be getting worse and worse. To cope with this anticipated situation, the sewerage system need to be developed as fast as possible, however, investments must be in an efficient manner. The JICA Study Team recommends that prioritization of sewerage investments should be based on the expected effectiveness of the water quality improvement in public waters. In other words, how much improvement in the public water quality is expected by developing the sewerage system. According to the result of study, water quality in public water bodies by developing sewerage system are expected to improve as shown in **Table MS8.2.1**.

Table MS8.2.1 Expected Improvement in Public Water Quality by Developing Sewerage System

Public water and pollution parameter	Year 2007	2025 without sewerage	2025 with sewerage
BOD in Euphrates river (mg/l)	1.8	2.6	1.8
BOD in Khabour river (mg/l)	6.1	8.5	3.8
BOD in Barada river (mg/l)	13.0	27.0	5.8
BOD in Yarmouk river (mg/l)	33.0	46.0	20.0
Fecal coliform in Mediterranean (MPN/100ml)	more than 1,000	more than 1,000	less than 1,000
T-N in groundwater of Rural Damascus (average; mg/l)	17.4	31.5	11.7

In this regard, the following prioritization is proposed:

A: Barada/Awaj basin (Rural Damascus)
B: Coastal basin, Yarmouk basin (Lattakia, Tartous, Dar'aa)
C: Euphrates basin, Khabour basin (Deir-Ez-zor, Raqqa, Hassakeh)

It should be noted that in developing the sewerage system for Rural Damascus, adoption of the treatment method with a nitrogen removal method is vital to prevent groundwater from contamination. In addition, the existing treatment system in Adraa STP needs to be upgraded to a system that can remove nitrogen.

Finally, consistency should be maintained between the investments for STPs and those for sewer networks.

(2) Recommendation of Countermeasures for Industrial Wastewater Control

The treatment method and strategies for countermeasures concerning industrial wastewater are mentioned below and recommended treatment methods for each type of factory are presented in **Chapter 8.5** in this Summary.

- Recommendation concerning the high polluted and contaminated wastewater/ sludge
  - Olive mill factory

Construction of treatment plant for olive mill wastewater (OMW) is needed. Lagoon with drying bed is applicable for OMW. OMW shall be conveyed to this treatment facility by tank lorry.

- Sugar factory

It is recommended that wastewater collection system is divided into flume wastewater and Steffen wastewater*1). Flume wastewater*2) is treated by sedimentation and oxidation pond method. The treatment methods for Steffen wastewater adopt a lagoon system with drying bed same as treatment method of olive mill wastewater.

Note) *1) As sugar extracted from Sugar Beet contains many impurities, it must be refined. Refinery method is called "Steffen Method". Wastewater generated through refinery process was called as "Steffen Wastewater".

*2) Sugar beet is washed first and conveyed to next process by this washed wastewater flowing in flume. "Flume Waste" means this wastewater used for washing and conveyance.

- Tannery factory

Pre-treatment method (screen, pH control, sedimentation, and coagulation method) for discharging to sewer networks and treatment method (screen, pH control, sedimentation, Biological treatment method and coagulation method) are recommended. It is also recommended that the small-scale factory is relocated to Industrial zone with tannery excusive area.

- Sludge containing a toxic substance

Planning and construction concerning disposal site (plant) for the sludge that contains hazardous substance is recommended.

➢ Recommended countermeasures for pollution control management of industrial wastewater
- Upgrading and expanding of "Cleaner Production"
- Introduction of "Industrial Pollution Control Manager (e.g.)" system
- Introduction of "Commendation for the excellent factory and for the excellent activates by citizen / citizens' organization" system

(3) Other Pollution Sources Issues

According to the information from Ministry of Agriculture, it is found that the livestock farm have no wastewater discharging system, and all the wastes are discharged to agricultural area such as solid. Therefore, it is judged that there is no serious influence to the water pollution problem by wastewater from the livestock barn in Syria.

8.3 Recommendation on Capacity Development of Sewerage Sector

(1) Strategy for Establishing Sewerage Development Plan

Prior to establishing M/Ps, the JICA Study Team proposed to draw a macroscopic picture for sewerage development (referred to as the "Macro Plan") covering priority areas of the target 7 Governorates, in order to ensure the efficient construction of sewerage infrastructure. The plan shall include:

- Long-term goal of sewerage coverage areas, served population, etc.
- Number of sewage treatment plants (STPs) to be constructed

- Basic plan for treated wastewater reuse and sludge treatment (e.g. irrigation areas, type of crops, cooperative sludge treatment)
- Basic plan for operation and maintenance of sewerage facilities (e.g. Standardization of facilities, cooperative O&M in order to establish an efficient O&M system)
- Basic plan for phased construction (e.g. effect of sewerage development in improvement of water quality in public waters and drinking water sources, prioritizing and time scheduling for sewerage construction programs in each of the areas)

In order to form M/P covers substantially wide areas, taking these procedures is essential to establish the optimal plan. The details of the planning methods and procedures for the Macro Plan will be presented in this Study Report as a technical transfer tool. Referring to these methods and procedures, the Syrian C/P side needs to prepare the plan by themselves for the areas other than the priority area to be prepared by the JICA Study Team.

(2) Strategy for Institutional and Financial Reform

As mentioned in Chapter 4, GTZ is currently providing technical support to MHC, and it seems that most of the legislative, institutional arrangement surrounding the water and sewerage sector would be fulfilled through their support.

Likewise, the financial and cost recovery issues are being dealt with by a component of this program, and most part of these aspects will be fulfilled as a result of these activities for improvement primarily of the water supply management.

This Study will examine and propose on various sewerage tariff levels including recovery of investment costs based on detailed surveys for capital and O&M cost estimation for the M/P priority projects in the target 7 Governorates. These results will be able to serve as a baseline for setting the appropriate levels of sewerage tariff and government subsidies as well as for building a government subsidy system for sewerage projects in the long-term perspective. Thus, the outcome obtained from such examinations shall be provided to MHC as recommendations from the JICA Study, for a basis of the cost recovery policy of sewerage sector.

(3) Strategy for Organizational Strengthening

The JICA Study Team considers that capacity uplift for project implementation and O&M is the most important technical issues for the Syrian sewerage sector to sustain their work. Therefore, this Study will focus on the organization and capacity building of the Executor for the sewerage projects, namely, the sewerage directorate of the Establishments and the Sewerage Company. When specific projects commence in each Governorate, they have to deal with the whole cycle of the projects including project preparation, tender, construction, operation and maintenance and so on. This Study will provide proposals and recommendations on the necessary organization structure and management plan for the executing agency in the target 7 Governorates, as well as on the necessary technical assistance scheme.

8.4 Recommendation on Other Countermeasures

In this section, countermeasures for industrial and agricultural wastewater pollution control are discussed.

(1) Countermeasures concerning Agricultural Wastewater (wastewater of livestock barn)

On the basis of information from Ministry of Agriculture and results of the field survey, it is judged that there is no serious influence on the water pollution problem by wastewater from the livestock barn in the Syria.

The following description is not the countermeasure for agricultural wastewater, and is recommendation for a problem of irrigation water in Rural Damascus. It is said that an adverse affect for farm products is occurred by irrigation water in Adraa and Ghouta areas of the Rural Damascus. However, it is not clarified about the actual condition and cause in the both areas. Therefore, investigation for the actual condition of the problem and its causation by Ministry of Agriculture are required as high priority.

(2) Countermeasures concerning Industrial Wastewater

Industrial wastewater is the biggest pollution load next to domestic wastewater. Untreated effluent from factories may contain hazardous substance. Highly polluted effluents or industrial effluents with high level of contamination may cause water pollution or contamination in public water bodies.

Problems concerning industrial wastewater and countermeasures under present enforcement are shown in **Table MS8.4.1**.

Table MS8.4.1 Problems concerning Industrial Wastewater and Countermeasures under Present Enforcement

Items		Contents
Problems concerning industrial wastewater	Monitoring system and data management	Before carrying out the Capacity Development of Environmental Monitoring at Directorates for Environmental Affaires in Governorates by JICA, periodical water quality surveillance for industrial wastewater was not carried out. The following investigations were conducted. **Ministry of Irrigation:** In order to investigate the cause of pollution /contamination of river, the water quality analysis of industrial wastewater was carried out. **Ministry of Local Administration and Environment:** The water quality analysis of industrial wastewater was mainly conducted by residents' complaint. **Ministry of Industry:** Irregular investigation was conducted for factories that have problems in wastewater quality. In addition to the above situations, results of the investigation were managed by each enforcement organization.

Table MS8.4.1 Problems concerning Industrial Wastewater and Countermeasures under Present Enforcement

Items		Contents
Problems concerning industrial wastewater	Administrative guidance	Sufficient effect of administrative guidance is not acquired. Based on the results of the water quality survey for industrial wastewater, it has become clear that wastewater quality in many factories do not satisfy effluent standards.
	Olive mill wastewater	Many olive mill factories are a small scale and seasonal operation. In addition, treatment processing in a factory is not easy because of its high concentration. In the present condition, number of wastewater disposal site is insufficient and these mills have become one of the water pollution sources.
	Tannery wastewater	Usually, wastewater contains high concentration of suspended substances (organic and inorganic) and chromium. Many small-scale factories discharge wastewater into river or sewer networks without treatment.
	Sludge that contained hazardous substances	At present, disposal of sludge containing a hazardous substance is not managed. It seems that the sludge containing a hazardous substance is disposed of with normal sludge.
Countermeasures under present enforcement	Monitoring system and data management	Ministry of Local Administration and Environment is establishing the water quality monitoring system containing industrial wastewater. Furthermore, the data management system containing the results of water quality survey by other organizations is also established.
	Planning and Construction of industrial zone (Including an exclusive tannery factory area)	At present, four industrial zones in Aleppo, Homs, Rural Damascus and Deir-Ez-zor are planning or under construction. Adraa industrial zone in Rural Damascus has an exclusive tannery factory area, and relocation of tannery factory is possible. Furthermore, the Adraa industrial zone has three treatment plants, first is industrial wastewater in the whole area and second is tannery wastewater treatment unit. The third is treatment plant for industrial water. Treated effluent from the Adraa STP is purified in this plant, and supplied to factories in this industrial zone. Not only tannery factory but also relocation of other factories is recommended. Moreover, establishment of new factory in industrial zone is also recommended.
	Aid fund and subsidy system for construction costs of treatment facilities and exemption of tax	Based on the information of Ministry of Local Administration and Environment, including exemption of the tax for import of pollution control facilities is under consideration as ministerial decree.

In addition to the above countermeasures, following countermeasures are recommended as promotional incentive schemes for the industrial wastewater treatment and reduction of pollution load. (See **Table MS8.4.2**)

Table MS8.4.2 Countermeasures concerning Industrial Wastewater

Items	Countermeasures	Responsible Administrative organization
Olive mill factory	Construction of treatment plant for olive mill wastewater (OMW) is recommended. Lagoon with drying bed as OMW treatment method and conveyance system of OMW by tank lorry to the treatment plant are proposed. 1)	Ministry of Industry (Chamber of Industry)
Tannery factory	Relocation of small-scale tannery factory and electroplating factory to industrial zone, and construction of treatment facilities. Not only the above-mentioned factory, but also for other factories, relocation to the industrial zone is recommended.	Ministry of Industry
The sludge that contains hazardous substance	Planning and construction concerning disposal site (plant) for the sludge that contains hazardous substance is recommended.	Ministry of Housing and Construction
Strengthening of regulations	According to the results of water quality monitoring for industrial wastewater, control for illegal factory that dose not observe the effluent standard regulation is strengthened.	Ministry of Local Administration and Environment
Strengthening of administrative guidance	According to the results of water quality monitoring for industrial wastewater, administrative guidance for illegal factory is strengthened.	Ministry of Industry
Introduction of "Industrial Pollution Control Manager (e.g.)"	Introduction of Industrial Pollution Control Manager (e.g.) 3) is recommended as a measure for advancing administrative guidance effectively and promptly.	Ministry of Industry
Upgrading and expanding of "Cleaner Production" 2)	Implementation of "Cleaner production" at site of production factories under instruction of " Industrial Pollution Control Manager (e.g.)" can expect large advantages in terms of the industrial wastewater pollution load reduction.	Ministry of Industry
Introduction of "Commendation for the excellent factory and for the excellent activities by citizen / citizens' organization" system	In order to achieve a good output from the factory manager responsible for carrying out activities concerning a positive environmental countermeasure, the system of incentives are required to be established. For this purpose, it is recommended that social evaluation and name recognition be awarded to a factory manager by the "commendation for the excellent factory". Similarly, establishment of "commendation for the excellent activities by citizen / citizens' organization" system is also recommended, and it is expected that social acknowledgement of activities for environment would lead to the improvement in consciousness towards environment.	Ministry of Local Administration and Environment & Ministry of Industry

Note) 1) The treatment method is described to Chapter 8.5.
2) "Cleaner production" is described to Chapter 8.5.
3) Outline of "Industrial Pollution Control Manager (e.g.)" is shown below:

< Outline of "Industrial Pollution Control Manager (e.g.)">

- As one of countermeasure for preservation of the water environment, appropriate wastewater treatment and management in factory are required. In Japan, in factory where pollution is expected to occur due to its effluent, the factory manager has to assign "person" as legal obligation at the factory to control pollution. The person is "manager in charge of pollution control in factory", and he takes charge of the following activities as his assignment in factory. Also in the Syria, it seems that assignment of "Industrial Pollution Control Manager" in factory can expect a

significant effect on promotion of environmental administration. Surveillance of operation / operation method of production facilities
- Implementation of "Cleaner Production"
- Measurement and recording (condition of water use and wastewater)
- Action in emergency
- Operation and maintenance of treatment facilities
- Supervision of working method
- Reception and explanation to neighboring residents
- Report to administrative agency

8.5 Recommendation of Treatment Method for Problematic Industrial Wastewaters

(1) Water Quality Survey for Industrial Wastewater

Based on the water quality analysis survey for industrial wastewater, the main findings concerning the characteristics of wastewater are described below:

- Especially, high-level of organic pollution (as BOD) is observed in effluent from olive mill and beer factory, and the level of BOD in effluents in this case is around 10,000 mg/l or more. Also, the level of BOD exceeds 2,000 mg/l in effluents from paper, meat processing (including slaughterhouse) and yeast factories. In addition, the industries that discharge wastewater into sewer networks with BOD level exceeding the criteria (800 mg/l as BOD) include tannery, milk processing & dairy and cooking oil refinery factories.
- High-concentration of Ammonia Nitrogen (as NH_4-N) is detected in effluent from olive mill, tannery and yeast factory, and the wastewater from these factories is observed to include more than 200 mg/l of NH_4-N. In addition, factories that have wastewater with NH_4-N exceeding the criteria of discharging into sewer networks (100 mg/l as NH_4-N) are textile, cooking oil refinery and aluminum factories.
- From the results of questionnaire survey, the rate of installation of treatment facilities in the targeted factory for investigation was 44% as average, and it can judge that the rate of installation of treatment facilities is insufficient.

(2) Recommended Treatment Method for Industrial Wastewater with Special Conditions and Problems

Based on the information and knowledge from the field survey and wastewater quality survey, treatment method and system are described. (refer to **Table MS8.5.1**)

Table MS8.5.1 Recommendation of Treatment Method for Industrial Wastewater with Special Conditions and Problems

Type of Industry	Special conditions and problems	Recommendation of treatment method and system
Olive mill	• Small scale factory • Seasonal operation • High concentration wastewater • Small wastewater volume	Lagoon with drying bed as OMW treatment method and conveyance system of OMW by tank lorry to the treatment plant are recommended. Construction of communal treatment plant is proposed.
Sugar	• Large scale factory • Seasonal operation • Two kinds of wastewater (Flume wastewater and Steffen wastewater)	Wastewater collection system is divided into flume wastewater and Steffen wastewater. Flume wastewater is treated by sedimentation and oxidation pond method. The treatment methods for Steffen wastewater adopt a lagoon system with drying bed same as treatment method of olive mill wastewater. (Steffen wastewater is high concentration organic wastewater from sugar refining process.)

Table MS8.5.1 Recommendation of Treatment Method for Industrial Wastewater with Special Conditions and Problems

Type of Industry	Special conditions and problems	Recommendation of treatment method and system
Tannery	• Small scale factory • Wastewater contains many organic /inorganic SS and chromium salt.	Recommendation of treatment processes is screen, pH control, sedimentation, biological treatment method and coagulation. If necessary, filtration method is added. It is recommended that small-scale factories be relocated to industrial zone. Consideration is required for disposal of the sludge containing chromium.
Electroplating	• Wastewater contains hazardous substance	Recommendation of treatment method is coagulation and filtration method. If necessity, chelating resin or ion exchange resin adsorption process will be added. It is necessary to classify electroplating wastewater for every kind of plating and process. It is recommended that small-scale factories be relocated to industrial zone.

(3) Cleaner Production (Reduction of Industrial Wastewater Pollution Load)

As introduction of cleaner production, the following three items are very effective in reduction of industrial wastewater pollution load.

- Negative flow sheet: Wastewater quality and volume at every production process are grasped.
- Separation of thin and thick wastewater /separation for contained substance: Based on the negative flow sheet, suitable wastewater collection system and the treatment method are selected.
- Devised washing methods: Devised washing methods have the possibility of mitigation of wastewater volume and pollution load.

The contents and the example of "cleaner production" are explained below. (See **Table MS8.5.2**)

Table MS8.5.2 Outline of Cleaner Production

Creation of Negative flow sheet	Amount of wastewater and pollution load from each process are illustrated according to the flow of manufacturing process. The ratio of the amount of pollutant and contribution ratio in each process could be calculated from this figure. The process, which has the highest contribution ratio, is a considerable production process in treatment system, and this process has high priority.
Change of raw materials	Reduction of wastewater and simplified treatment facilities by change of raw materials - Change to low impurities - Change to low hazardous materials - Change to high biodegradation - Change to low organic pollution /low pollutant
Management, improvement, and change of equipment and instrument	- Dividing drain system according to concentration/ pollutant - Improvement of washing method (wiping, spray-washing, steam-washing, multistage washing) - Prevention of liquid dropping onto the floor
Change of production process	Based on the negative flow sheet, production process is improved with the viewpoint of reduction of wastewater.
Recycle	Examination of re-use of low concentration wastewater and recovery of raw material and valuables from concentrated wastewater

Table MS8.5.2 Outline of Cleaner Production

Other treatment method without effluent	Application of the following processing methods is considered. - Drying - Incineration of thick wastewater - Wet-oxidation

CHAPTER 9 ESTABLISHMENT OF SEWERAGE DEVELOPMENT MASTER PLAN

9.1 Proposed Sewerage Facilities

The JICA Study Team proposed sewerage facilities for seven designated M/P areas based on careful investigation on the existing sewerage facilities, topographic condition, availability of STP construction land and locally available O&M skill. The outline of proposed sewerage facilities are shown in **Table MS9.1.1**. Trunk sewer covers from existing discharge points to STP.

Table MS9.1.1 Proposed Sewerage Facilities in seven designated Areas

MP Areas	Items	Facilities	Quantity	Remarks
Slunfeh/ Lattakia	Population		2,800	In 2025
	Wastewater		1,833	Daily Average (m^3/day)
	Pipe	D 250	2,700 m	No.1DP – No.1 STP
		D 250	1,600 m	No.3DP – No.2 STP
		D 250	3,600 m	No.6DP – No.3 STP
		Total	7,900 m	
		D 100	500 m	No.5 DP
		D 100	500 m	No.8 DP
		Total	1,000 m	
	Pumping Station	0.5 m^3/min	2	No.5,8 DP
	STP	Incoming Flow	610 m^3/day×3	3 STPs
		Treatment Method	Submerged attached method	
		Site Area	0.1 ha×3	3 STPs
Banias/ Tartous	Population		82,500	In 2025
	Wastewater		19,556	Daily Average (m^3/day)
	Pipe First phase	D 250	1,800 m	From Tero
		D 250	1,300 m	From Kharbet Snasel
		D 250	1,600 m	From Al-Najor
		D 300	580 m	Gravity
		D 250	140 m	Pressure
		D 300	550 m	Pressure
		D 400	770 m	Pressure
		D 500	1,820 m	Pressure
		D 600	2,310 m	Pressure
	Second phase	D 250	140 m	Pressure
		D 300	550 m	Pressure
		D 400	770 m	Pressure
		D 500	1,820 m	Pressure
		D 600	2,310 m	Pressure
	Manhole Pump	3.0 m^3/min	4×2	(First phase, Second phase)
		1.0 m^3/min	5×2	(First phase, Second phase)
	STP	Incoming Flow	19,556 m^3/day	

Table MS9.1.1 Proposed Sewerage Facilities in seven designated Areas

MP Areas	Items	Facilities	Quantity	Remarks
		Treatment Method	Oxidation Ditch	
		Site Area	5.1 ha	
Mayadin/ Deir-Ez-zor	Population		117,100	In 2025
	Wastewater		15,300	Daily Average (m^3/day)
	Pipe	D 400	3,500m	
		D 800	1,000m	
	STP	Incoming Flow	15,300 m^3/day	
		Treatment Method	Oxidation Ditch	
		Site Area	5.9 ha	
Malkieh/ Hassakeh	Population		34,500	In 2025
	Wastewater		4,518	Daily Average (m^3/day)
	Pipe	D 500	100 m	diversion device –STP
	STP	Incoming Flow	4,518 m^3/day	
		Treatment Method	Oxidation Ditch	
		Site Area	2.6 ha	
Thawra/ Raqqa	Population		115,600	In 2025
	Wastewater		17,889	Daily Average (m^3/day)
	Pipe	D 500	100 m	No.3 – STP
		D 600	1,300 m	No.2, 3 – STP
	STP	Incoming Flow	17,889 m^3/day	
		Treatment Method	Constructed Wet Land	
		Site Area	2.4 ha	
Muzerib/ Dar'aa	Population		30,500	In 2025
	Wastewater		3,994	Daily Average (m^3/day)
	Pipe	D 400	5,800 m	
		D 500	4,000 m	
	STP	Incoming Flow	3,994 m^3/day	
		Treatment Method	Constructed Wet Land	
		Site Area	4.9 ha	
Zabadani/ Rural Damascus	Population		53,500	In 2025
	Wastewater		22,201	Daily Average (m^3/day)
	Pipe	D 800	100 m	diversion device –STP
	STP	Incoming Flow	22,201 m^3/day	
		Treatment Method	Oxidation Ditch	
		Site Area	5.5 ha	

Note) D : Diameter (mm), DP : Discharge point

9.2 Proposed Treatment Methods and Major Effluent Regulations

Table MS9.2.1 shows the proposed sewage and sludge treatment methods employed in each STP in seven target areas. Syrian effluent standards according to the types of receiving water bodies and to the usage of treated sewage are also described.

Table MS9.2.1 Proposed Treatment Methods and Major Effluent Regulations

MP Area	Situations of STP site and Sewage Treatment Method	Sludge Treatment Method	Maximum Allowed Limits of effluent standard in Syria (mg/l)			
			BOD	SS	NH_3-N	No_3-N
Slunfeh/ Lattakia	Three STP lands are allocated in mountainous tourist spot. Each plant capacity is 500 m^3/d. As proposed plant capacity is small, Submerged Attached Growth Method generally adopted to on-site facility in Japan was proposed as this facility needs no daily O&M. Weekly O&M is sufficient to maintain treatment function. Treated wastewater discharged to valley reaches to two dams located 20 to 28 km away. Dam water has not been polluted.	Small amount of sludge peeled from bio-film shall be conveyed to Lattakia STP by tanker.	Discharge to River			
			40	30	5	50
Banias/ Tartous	As proposed STP construction site is supposed to be urban area in the future, OD requires easy O&M and no primary settling tank generates offensive odor, was proposed.	As stated, offensive odor must be minimized. Mechanical sludge dewatering unit was proposed.	Discharge to Sea			
			60	60	10	50
Mayadin/ Deir-Ez-zor	STP was planned in the midst of public owned farmland. Receiving water body has big environment capacity. OD needs easier O&M was proposed.	Proposed STP site has enough area but sludge can not be thickened by gravity. Mechanical Thickening and Drying Bed was proposed.	Discharge to River			
			40	30	5	50
Malkieh/ Hassakeh	All methods are applicable as proposed STP construction site has vast area. OD was proposed to satisfy the effluent standard, to preserve water resources. Easiness in O&M was another reason of adoption.	Proposed STP site has enough area but sludge can not be thickened by gravity. Mechanical Thickening and Drying Bed was proposed.	Discharge to River / Irrigation for cotton			
			40	30	5	50
Thawra/ Raqqa	There is well performed reed beds spread about 2 km's long. Wet-land was proposed to optimize the existing facility. To cope with future population growth, pre-treatment facility - primary settling tank- supporting the existing reed beds shall be installed.	Though generated sludge is not digested, Sludge Drying Bed was proposed due to the economical efficiency.	Discharge to River			
			40	30	5	50
Muzerib/ Dar'aa	STP was planned in private farm land. As pollution in water resource (well), has not been reported, Wet-land was proposed in terms of improvement of water environment of water body and lowering of financial burden.	Ditto	Discharge to River			
			40	30	5	50
Zabadani/ Rural Damascus	STP was proposed in public land of 5.5ha in the midst of farm land. OD was proposed in terms of mitigation of nitrogen contained in water within Barada river basin, efficient and safe irrigation purpose use and easiness in O&M.	Considering the odor issue, proposed site area is not enough for drying bed. Mechanical Dewatering were proposed.	Irrigation/ Discharge to River			
			30	30	3	20

9.3 Design Criteria and Major Facilities

Table MS9.3.1 indicates design criteria, structural dimension of major facilities and specifications of major equipment.

Table MS9.3.1 Design Criteria and Major Facilities

	Slunfeh	Banias	Mayadin	Malkieh	Thawra	Muzerib	Zabadani
Average flow (m^3/d)	1,833	19,556	15,300	4,518	17,889	3,994	22,201
Hourly max (m^3/d)	3,548	37,851	29,610	8,744	34,625	7,730	42,970
Sludge kgDS/d	224	4,401	3,787	1,119	2,361	527	5,495
Sludge m^3/d	2.7	22.0	9.5	2.8	5.9	1.3	27.5
Moisture content %	92	80	60	60	60	60	80
No. of STP	3	1	1	1	1	1	1
Treatment method	Submerged attached growth	OD (Oxidation Ditch)	OD (Oxidation Ditch)	OD (Oxidation Ditch)	Wet-land	Wet-land	OD (Oxidation Ditch)
Grit chamber (No.-w×L)	Each 1-1×1m	2-1.5×7m	2-1.4×6m	1-1.3×4.0m	2-1.3×7.5m	1-0.9×5m	2-1.6×8m
Main Pump (No.-D×power)	-	-	5-φ200mm ×11kw	3-φ150mm ×3.7kw	5-φ250mm ×11kw	3-φ150mm ×5.5kw	5-φ250mm ×15kw
Primary settling tank					4-φ10	2-φ6.5m	
Reed Bed						24-21m×37m	
Reactor (No.-W×L×H)	Each 2-5.5×12 ×5m	12-4.5 ×140× 3.0m/ high rate	8-4.5 ×140×3.0m/high rate	4-4.5 ×140×3.0m			10-5.5 ×150 ×5m
Final sedimentation tank	Each 2-5.5×3m	8-φ18m	8-φ15m	4-φ11m			8-φ18m
Disinfection channel (No.-W×L×H)	Each 1-φ0.9m	2-2×24×2.1m	2-2×21×1.9m	1-0.9×3.5×0.8 m (UV)			3-1.5×3.5×0. 8m (UV)
Gravity Thickener (No-kg/d)		2-5.0×5.0					2-6.0×6.0
Mechanical Thickener (No-kg/d)			2-1,893	1-1,119			
Mechanical Dewatering (No-kg/d)		2-2,201					2-2,747
Drying Bed (No.-W×L)			24-15×43m	8-15×38m	20-15×32m	8-12×22m	
Required land area （ha）	Each 0.1	5.1	5.9	2.6	2.4	4.9	5.5
Land Owner	Public/Private	Private	Public	Public	Public	Private	Public

Source) Japanese Sewerage System Standard as to sludge moisture content

CHAPTER 10 PRELIMINARY COST ESTIMATES AND IMPLEMENTATION PLAN

10.1 Cost Estimates Related to the Projects

(1) Project Cost

The Project financial cost comprises the following cost items.

- Construction Cost
- Land Acquisition (and Compensation) Cost
- Engineering Services Cost
- Government's Administration Cost
- Organizational Development Cost

- Physical Contingency
- Price Contingency

(2) Operation and Maintenance Cost

Annual O&M cost is estimated about the following items.

- Running Cost of STP and PS
- Running Cost of Pipes
- Data Base
- Other Costs

(3) Implementation Schedule

A setup of the implementation and investment schedule for each project is based on the following assumption.

Project period :	2008 ~ 2025
Pre-Construction Stage :	2009 ~ 2010
Construction Stage :	2011 ~ 2013 (based on the project scale)
O&M stage :	2014 ~ 2025

A summary of the cost estimate for each project is shown below in **Table MS10.1.1 - Table MS10.1.7**.

(1) Lattakia (Slunfeh)

Project components

STP: 3 places (Q=610 m^3/day per place, Total Q=1,830 m^3/day)
(Submerged Attached Growth Method)

PS: 2 places (Q=0.5 m^3/min)

Pipes: Dia. 250mm 7,900 m
Dia. 100mm 1,000 m

Table MS10.1.1 Project Cost for Slunfeh

Cost Item	Cost (10^3SP)
Construction Cost	
1) STP	84,504
2) PS	25,700
3) Pipes	1,340
Total of Construction Cost	**111,544**
Land Acquisition Cost	1,000
Engineering Cost	11,154
Government's Administration Cost	5,577
Organizational Development Cost	3,347
Physical Contingency	11,154
Sub Total	**32,232**
Price Contingency	33,651
Total (Excluding Price Contingency)	**143,776**
Total	**177,427**

(2) Tartous (Banias)

Project components

STP: Q=19,560 m^3/day (Oxidation Ditch Method), 1 place

PS: 8 places (Q=3.0 m^3/min)
10 places (Q=1.0 m^3/min)

Pipes: Dia. 600mm 4,620 m
Dia. 500mm 3,640 m
Dia. 400mm 1,540 m
Dia. 300mm 1,680 m
Dia. 250mm 4,980 m

Table MS10.1.2 Project Cost for Banias

Cost Item	Cost (10^3SP)
Construction Cost	
1) STP	462,954
2) PS	14,700
3) Pipes	86,550
Total of Construction Cost	**564,204**
Land Acquisition Cost	127,500
Engineering Cost	56,420
Government's Administration Cost	28,210
Organizational Development Cost	16,927
Physical Contingency	56,420
Sub Total	**285,477**
Price Contingency	211,007
Total (Excluding Price Contingency)	**849,681**
Total	**1,060,688**

(3) Deir-Ez-zor (Mayadin)

Project components

STP: Q=15,300 m^3/day (Oxidation Ditch Method), 1 place

PS: 2 places (Q=3.0 m^3/min)

Pipes: Dia. 800mm 1,000 m

Dia. 400mm 3,500 m

Table MS10.1.3 Project Cost for Mayadin

Cost Item	Cost (10^3SP)
Construction Cost	
1) STP	295,200
2) PS	2,000
3) Pipes	28,250
Total of Construction Cost	**325,450**
Land Acquisition Cost	-
Engineering Cost	32,545
Government's Administration Cost	16,273
Organizational Development Cost	9,763
Physical Contingency	32,545
Sub Total	**91,126**
Price Contingency	113,248
Total (Excluding Price Contingency)	**416,576**
Total	**529,824**

(4) Hassakeh (Malkieh)

Project components

STP: Q=4,520 m^3/day (Oxidation Ditch Method), 1 place

Pipes: Dia. 500mm 100 m

Table MS10.1.4 Project Cost for Malkieh

Cost Item	Cost (10^3SP)
Construction Cost	
1) STP	117,330
2) PS	-
3) Pipes	600
Total of Construction Cost	**117,930**
Land Acquisition Cost	-
Engineering Cost	11,793
Government's Administration Cost	5,897
Organizational Development Cost	3,537
Physical Contingency	11,793
Sub Total	**33,020**
Price Contingency	41,068
Total (Excluding Price Contingency)	**150,950**
Total	**192,018**

(5) Raqqa (Thawra)

Project components

STP: Q=17,890 m^3/day (Wet-land Method), 1 place

Pipes: Dia. 600mm 1,300 m

Dia. 500mm 100 m

Table MS10.1.5 Project Cost for Thawra

Cost Item	Cost (10^3SP)
Construction Cost	
1) STP	182,485
2) PS	-
3) Pipes	11,000
Total of Construction Cost	**193,485**
Land Acquisition Cost	-
Engineering Cost	19,348
Government's Administration Cost	9,674
Organizational Development Cost	5,806
Physical Contingency	19,348
Sub Total	**54,176**
Price Contingency	67,889
Total (Excluding Price Contingency)	**247,661**
Total	**315,550**

(6) Dar'aa (Muzerib)

Project components

STP: Q=3,990 m^3/day (Wet-land Method), 1 place

Pipes: Dia. 500mm 4,000 m

Dia. 400mm 5,800 m

Table 10.1.6 Project Cost for Muzerib

Cost Item	Cost (10^3SP)
Construction Cost	
1) STP	58,636
2) PS	-
3) Pipes	50,100
Total of Construction Cost	**108,736**
Land Acquisition Cost	24,500
Engineering Cost	10,874
Government's Administration Cost	5,437
Organizational Development Cost	3,263
Physical Contingency	10,874
Sub Total	**54,946**
Price Contingency	35,107
Total (Excluding Price Contingency)	**163,682**
Total	**198,789**

(7) Rural Damascus (Zabadani)

Project components

STP: Q=22,200 m^3/day (Oxidation Ditch Method), 1 place

Pipes: Dia. 800mm 100 m

Table MS10.1.7 Project Cost for Zabadani

Cost Item	Cost (10^3SP)
Construction Cost	
1) STP *1	509,300
2) PS	-
3) Pipes	1,250
Total of Construction Cost	**510,550**
Land Acquisition Cost	-
Engineering Cost	51,055
Government's Administration Cost	25,527
Organizational Development Cost	15,316
Physical Contingency	51,055
Sub Total	**142,953**
Price Contingency	127,523
Total (Excluding Price Contingency)	**653,503**
Total	**781,026**

*1) Not including removal cost of existing facilities and ground leveling cost.

10.2 Organization Structure for Implementation and O&M of Sewerage System

The life of a sewerage project can be divided into the following phases.

- Project formation phase
- Project implementation phase (including project preparation stage, pre-construction stage and construction stage)
- Operation and maintenance phase

The JICA Study Team recommends that these all phases of sewerage projects be controlled by one Ministry, i.e. MHC, and the central Ministry should concentrate on supervising the performance of the sector and on the project formation through establishing the national priority. The project implementation and the operation and maintenance should be managed by the Establishment and the Company, respectively, in accordance with the Minister Decree No. 14/1984.

In summary, an outline of the proposed organization structure for implementation and O&M of sewerage system is illustrated as shown in **Figure MS10.1.1**. Proposed member of Steering Committee is MHC, MLAE, MOI, SPC, Governorates, City Council and GCEC. As Sewerage Company was only established in Lattakia Governorate so far, it shall be formulated in the remaining six Governorates.

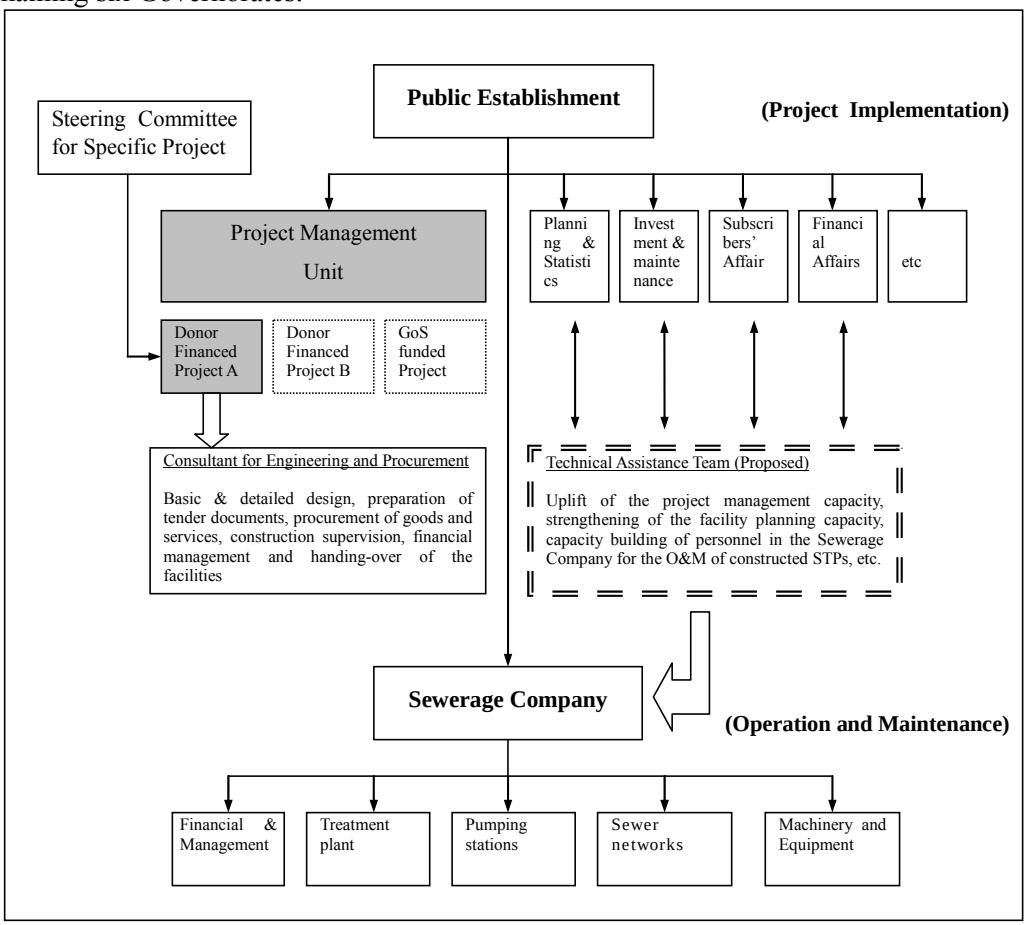


Figure MS10.1.1 Proposed Organization Structure for Sewerage Project Implementation and O&M

CHAPTER 11 ECONOMIC AND FINANCIAL ANALYSIS

11.1 Methodology of Economic Analysis

The Master Plan sewerage system development project is designed to contribute to the public welfare and therefore profitability can hardly be considered as the major mission of this project. Therefore, the Economic Internal Rate of Return (EIRR) approach was used for the project justification.

The project capital costs (excluding taxes) and O&M costs throughout the project life represent the economic costs for the EIRR calculation. The following economic benefits were taken into account in the economic analysis: (i) tourism development economic benefits; (ii) health economic benefits, consisting of the reduction of productive time and reduction of medical expenditures relating to waterborne and water-related diseases; (iii) economic benefits of using the treated wastewater; and (iv) economic benefits of using sludge as fertilizer. A number of other economic benefits were left not quantified.

11.2 Results of Economic Analysis of Master Plan

Results of analysis show that the M/P project as a whole is feasible from the economic point of view. The NPV of the M/P is positive (SP 764.6 million) and the average EIRR is 15.0%. In particular, the calculated EIRR for the Damascus Rural priority area is 18.0%, which is above the M/P average figure.

11.3 Outline of the Financial Plan of the Master Plan Sewerage Project

Whereas a detailed financial plan will be prepared at the Feasibility Study stage for the Rural Damascus priority area, main ideas of this financial plan are outlined in this report.

The capital costs of the M/P project could be financed from different sources, such as for instance the Public Debt Fund, i.e. as a subsidy of the Syrian Government, by taking a soft loan, by grants of international donor agencies, and so on. The concrete sources could be determined at a later stage of the project development cycle.

Recovery of capital costs of sewerage projects through user charges occurs very rare in the international practice and is not on agenda of the Government of Syria. Requirement for the full cost recovery would require a drastic increase of tariffs, which would be not viable. Therefore, in preparation of the financial plan it was assumed that the capital costs of the project would be eventually contributed to the respective establishments as a subsidy.

On the contrary, following the best international practice, at least the O&M costs of the

sewerage system upon the project completion should be financed from the revenue generated, i.e. from the sewerage fees. Accordingly, the 100% recovery of the O&M cost was assumed in the financial plan, which would represent a very important, but at the same time an attainable target for financial sustainability of the sewerage system throughout the project life.

CHAPTER 12 FORMULATION OF SEWERAGE DATABASE FOR SMALL CITIES AND RURAL AREAS

The utilization of GIS (GIS; Geographical Information System) system is very effective for data collection, storage and management. The GIS system is a computer tool for adequate decision-making and management for sewerage system works. In this project, the formulated system consists of graphical data, which includes the information on sewerage facilities and networks, such as trunk sewers, pumping stations, water resources and industrial plans.

The Ministry of Housing and Construction has not yet prepared any database for the facilities of sewerage system, water supply and water environment. Therefore, the water pollution control programs and the operation and maintenance of sewerage system have not been conducted by using GIS effectively due to lack of data on locations, alignment and other information on these facilities.

12.1 Existing GIS in Syria

The list of organizations, which are using GIS is shown in the **Table MS12.1**. There is no cooperation and sharing of the information among these organizations.

Table MS12.1.1 The List of Organizations Using GIS tool

Organization	Condition
Regional Planning Sector, Ministry of Housing and Construction	This sector has the basic digital map in seven (7) governorates. Especially, the organization plans have been held by only this sector.
Directorate of Information and System, Ministry of Local Administration and Environmental Affairs	This directorate has been conducting the project, namely "Comprehensive Disaster Reduction Programme". In this project, "Geomedia has been utilized as GIS software."
Water Resource Information Center (WRIC)	WRIC conducted the project, namely "Water Resources Management Barada – Awaj Basin & Coastal Basin". In this project, this center formulated the GIS database in Barada basin, Awaj basin and coast area basin.
General Organization of Remote Sensing (GORS)	GORS has been conducting several projects relevant to GIS database at requests of the other organizations. JICA Study Team obtained the GIS database in Tartous and Lattakia from GORS.
Damascus Water Supply & Sewerage Authority (DAWSSA)	DAWSSA has the basic digital map in Damascus city and formulates GIS database for facilities of water supply and sewerage system.
General Establishment System (GES)	GES creates the basic digital map of whole of Syria with 1: 50,000 scales.

12.2 Formulation of Sewerage Database for Small City and Rural Area

JICA Study Team decided to utilize "ArcGIS" as GIS tool considering the factors such as operational performance, condition of distributor for GIS software, status of utilization of GIS software in each organization, trend for utilization of GIS software in the future and format of the obtained basic digital map data.

The data for basic digital map was provided by regional planning sector in the Ministry of Housing and Construction.

JICA Study Team conducted the formulation work of sewerage database for small city and rural area as sub-contract. This work consists of collection of the position data and attribute data regarding sewerage facilities, water resources and water pollution sources, and combination of graphical data, which describes object geometry (for example sewer lines), and numerical data, which relates to graphical data (for example diameter of sewer pipelines).

The field survey was carried out in one hundred thirty seven (137) locations in seven governorates.

In Syria, STM (Syria transverse mercator projection) has been utilized for the projection. However, this information has not been published in general due to the military rules and nature of data. Therefore, in this project, "GCS_WGS_84" and "WGS_1984_UTM_Zone_37N" are applied to projection of GIS map data.

JICA Study Team conducted the training course on GIS in parallel with procurement of GIS software.

12.3 Possible Application of GIS for Sewerage System Management

Using GIS tool can be helpful to carry out the following main works related to sewerage system management. GIS provides the ideal means of describing sewer infrastructure facilities, identifying problems and recommending solutions, scheduling and recording maintenance activities, and supporting technical analysis of the facilities.

- Information management for specifications of sewerage facilities and the conditions of operation and maintenance
- Simulation of pollution load in public water bodies
- Establishment of monitoring system for water quality
- Hydrological and hydraulic evaluation for sewerage system
- Efficient construction works of sewer pipeline
- Improvement of sewerage service and accountability

12.4 Recommendations

(1) Continuance of the Formulation for Sewerage System Database

The formulation for sewerage system database was carried out as a pilot project. The number of target facilities is from fifteen (15) to twenty seven (27) locations in each governorate, one hundred thirty seven (137) in total of seven (7) governorates. However, it is necessary to input information of all facilities, such as sewerage facilities (sewerage treatment plant, pumping station and trunk sewer), point source of water pollution (industrial plant and live stock) and water sources (well, intake point of river and spring) for improvement of sewerage planning and sewerage service. Updating of GIS database shall be continued by MHC as shown in **Table MS12.4.1**.

Table MS12.4.1 Required Works for Formulating and Upgrading of GIS Database

Required Works for Formulating and Upgrading of GIS database	Target Items and Method of Formulating and Upgrading for GIS database
Upgrading of the GIS database formulated by JICA Study Team	➢ The target items; upgrading of collected data (137 points) and collection of the remaining target facilities regarding sewerage system in the target seven (7) governorates ➢ Method; MHC and each governorate carry out field survey by using GPS and questionnaire
Formulation of the sewerage database for remaining seven (7) governorates	➢ The target items; collection of the remaining target facilities regarding sewerage system in the target seven (7) governorates ➢ Method; MHC and each governorate carry out field survey by using GPS and questionnaire
Establishment of the GIS sector in MHC and each governorates	➢ Target organization; MHC, Sewerage company and General establishment of water and sewerage ➢ Method; Structure of GIS sector, Staffing GIS engineers and Allocation of budget

According to the draft training program proposed by MHC, they will establish "GIS Section" (temporally named) in MHC headquarter and seven Governorates (Establishments). Assigned staff to GIS section will conduct GIS database formation work exclusively. MHC created three levels namely, Elementary Level, Intermediate Level and Advanced Level. Each level lasts about one month followed by one month of practicing. Upon accomplishment of three levels, the trainees can take GPS course for two weeks.

Considering the effective methods for updating, the Ministry of Housing and Construction shall establish the future plan for GIS data collection. The future plan consists of the procurement plan of GIS software and GPS (Global Positioning System), implementation plan and cost estimation. Based on the future plan, the Ministry of Housing and Construction shall make close relationship with person in charge of GIS in seven (7) governorates and implement the GIS data collection.

(2) Sharing of GIS Database

Several organizations have formulated GIS database as a part of different activities. However, the sharing system for GIS database has not been established in Syria. As a consequence, each organization have wasted time and cost for the activities, such as studies and construction.

Considering efficient and effective works, it is necessary to improve the effectiveness of GIS database by sharing the information on infrastructure development including water supply system, gas and electricity, and future planning. The integrated GIS is useful system for sharing database and is cross-section system which all users in a network can apply to GIS database. However, it is required to complete to collect the current data in each organization before the installation of the integrated GIS system.

(3) Management of Software License for GIS

As a result of the economic sanction of United States, JICA Study Team legally procured "ArcEditor 8.3" and "ArcView 8.3" with the hardware key as GIS software. (The latest version is "9.1".) For starting GIS software, it is necessary to put the hardware key to computer for the prevention of usage of the illegally-copied software. Therefore, it is recommended that the Ministry of Housing and Construction should carry out proper management of software license for prevention of illegal use.

Considering the proper management of software license, the Ministry of Housing and Construction shall select GIS engineer. The selected person shall have consciousness and moral for property right and copyright management of files relevant to GIS, application software and satellite image. The hardware key for GIS software shall be stored in the locked space.

(4) Management of Information Security

The information such as GIS database has the overwhelming potential to increase efficiency of works. Meanwhile, there is concern for divulgation or loss of prepared and compiled information, destruction or deterioration of the function for information management, unauthorized access and security damages.

Considering the security for GIS database, it is recommended that a specialized section of GIS shall be established for enhancement of security of all database management. GIS engineer shall be assigned in this section and the required equipments, such as GPS, computer, scanning machine, GIS software and security software shall be procured. These equipments shall be stored in the locked space and managed by the authorized GIS engineer.

CHAPTER 13 SOCIAL CONSIDERATIONS AND INITIAL ENVIRONMENTAL EXAMINATION

13.1 Environmental and Social Consideration

On the occasion of holding the stakeholder meeting, the widest possible range of stakeholders is

selected ten (10) categories based on the consultation with the Ministry of Housing and Construction. During the stakeholder meetings, an active discussion and consultation are conducted. The details of 1st Stakeholder Meeting and 2nd Stakeholder Meeting are summarized in **Table MS13.1.1**.

Table MS13.1.1 Details of Stakeholder Meetings

Contents	1st Stakeholder Meeting	2nd Stakeholder Meeting
Timing	Feb.-Mar. 2007 (Phase I)	Sep. 2007 (Phase II)
Place	Damascus: (for Rural Damascus and Dar'aa Governorates) Lattakia: (for Lattakia and Tartous Governorates) Deir-Ez-zor: (for Deir-Ez-zor, Raqqa and Hassakeh Governorates)	
Attendants	Relevant government agencies (MHC, GCEA, governorates, DFEAs etc.) and local stakeholders (residents, private sectors, international organizations/donors, university and research institutes, NGOs and media etc.) Total: 43 to 99 persons	
Contents of Presentation	1)The outline and progress of the M/P study 2)Explanation of JICA and Syrian guidelines for environmental and social considerations 3)Scoping of IEE level study	1) The results of the M/P study 2) The results of IEE level study

13.2 The Results of Initial Environmental Examination (IEE) Level Study

Based on the results of consultation with stakeholders at 1st Stakeholder Meeting for scoping of IEE level study, the IEE level study on the M/P studies for 7 target areas are carried out in August. The results of IEE level study are summarized in **Table MS13.2.1**.

Table MS13.2.1 Results of the IEE Level Study on the M/P Studies for 7 Target Areas

Environmental Items	Slunfeh	Banias	Mayadin	Malkieh	Thawra	Muzerib	Zabadani
Involuntary resettlement	D	D	D	D	D	D	D
Local economy/land ownership	C	C	D	C	D	C	D
Traffic	C	C	D	D	D	C	C
Cultural heritage	D	D	D	D	D	D	D
Water usage and rights	D	D	D	D	D	D	D
Water pollution	D	D	D	D	D	D	D
Soil pollution	C	C	C	C	C	C	C
Waste	D	D	D	D	D	D	D
Noise and Vibration	D	D	D	D	D	D	D
Offensive odor	C	C	C	C	C	C	C

Note) A: Serious impact B: Some impact
C: Light impact D: Negligible impact

Through the IEE level study, no serious impacts of the proposed projects on environment are identified, except some items having light impacts. In order to mitigate these negative impacts, some countermeasures and recommendations from an environmental viewpoint are proposed.

CHAPTER 14 EVALUATION OF THE MASTER PLAN

14.1 Technical Aspects

The water quality of sea water, river water and groundwater are expected to improve after the proposed sewerage system is introduced and/or adequate on-site and decentralized facilities are provided. And decreased overflow from the existing pit latrine and gray water from houses will improve residential amenity.

The activated sludge treatment system and the natural treatment system are the proposed sewage treatment methods for the Study Area. These systems are expected to be adequate in light of the present technical and institutional capacity of Syria. The existing sewage collection facilities will also be improved by the proposed sewer cleaning equipment.

The reuse of treated effluent from the STP for agriculture and watering gardens will conserve water supply resources. The reuse of the dewatered sludge from the STP for agriculture and/or as garden fertilizer will conserve natural and chemical resources. Consequently, implementation of the project will contribute to eco-system preservation.

14.2 Economic and Financial Aspects

The Master Plan sewerage system development project is designed to contribute to the public welfare and therefore the Economic Internal Rate of Return (EIRR) approach was primarily used for the project justification, rather than its financial profitability.

Results of analysis show that the M/P project as a whole is feasible from the economic point of view. The NPV of the M/P is positive (SP 764.6 million) and the average EIRR is 15.0%. In particular, the calculated EIRR for the Damascus Rural priority area is 18.0%, which is above the M/P average figure.

The economic benefits associated with the tourism development, reduction of the productive time lost and medical expenditures, as well as the economic value of the treated wastewater are the most significant for the entire Master Plan. However, the situation differs from one priority area to another, depending on the concrete circumstances.

Since a detailed financial plan will be prepared at the Feasibility Study stage for the Rural Damascus priority area, only an outline of the financial evaluation could be provided for the Master Plan taken as a whole.

The capital costs of the Master Plan project could be financed from different sources, such as

for instance the Public Debt Fund, soft loans, grants of international donor agencies, and so on. The concrete sources could be determined at a later stage of the project development cycle. Recovery of capital costs of sewerage projects through user charges is rare in the international practice and is not on agenda of the Government of Syria. Full cost recovery would require a drastic increase of tariffs, which would be not viable. Therefore, it was assumed that the capital costs of the project would be contributed to the respective establishments as a subsidy.

On the contrary, following the best international practice, the O&M costs of the sewerage system upon the project completion should be financed from the revenue generated, i.e. from the sewerage fees. It would represent a very important, but at the same time an attainable target for financial sustainability of the sewerage system throughout the project life.

14.3 Environmental Aspects

Based on the results of consultation with stakeholders at 1st Stakeholder Meeting for scoping of IEE level study, the IEE level study on the M/P studies for 7 target areas are carried out in August. Through the IEE level study, no serious impacts of the proposed projects on environment are identified, except some items having light impacts. In order to mitigate these negative impacts, some countermeasures and recommendations from an environmental viewpoint are proposed.

14.4 Selection of Pilot Project for the Feasibility Study

The Feasibility Study site will be extracted from Rural Damascus Governorate based on the signed M/M and S/W between two governments. And Zabadani Area is selected from Rural Damascus Governorate based on the discussion with the Ministry of Housing and Construction.

The feature of Zabadani Area is located just upstream of Ain Fejeh Spring, which is the largest and most important water source of Damascus. Ain Fejeh is also facing to Barada River. As Zabadani is also well-known as tourist spot, currently status that raw sewage is directly discharges into Barada River have been fiercely damaging the value of Zabadani as tourist resource.

PART II : FEASIBILITY STUDY

SUMMARY

CHAPTER 1 FEASIBILITY STUDY ON SEWERAGE FACILITIES

1.1 General Conditions for Feasibility Study

1.1.1 Target Area and Target Year

Zabadani the target area of F/S is located in Rural Damascus Governorate. There are four cities called Zabadani, Bloudan, Bukein and Madaya. As the elevation of Zabadani is exceeding 1,000m, numerous tourists visit here for comfortable environment during summer season. Therefore, the amount of wastewater in summer increases more than two times of that in winter.

The followings are the basic concept on this Feasibility Study:

- The target year of M/P is 2025. The target year of F/S was set by 2015 as intermediate year to M/P, considering phased project implementation.
- Design and construction of STP is supposed to take about three years. Further, some more years shall be accounted for related arrangements necessary. So until actual STP commission around seven years will be needed from now. Thus the JICA Study Team established F/S target year as 2015 and design plant capacity was also set by wastewater amount estimated to be generated in 2015.

1.1.2 Wastewater Collection System

The general wastewater collection system in Syria is combined system collects wastewater and storm water in one pipe. The existing wastewater collection system in Zabadani is also combined one. In all section, concrete pipe were adopted. However, the quality of domestic concrete pipe is inferior. Some of them are not even reinforced by steel bar. Further, as pipe connection structure is not manufactured precisely, pipe connection cannot be water-tight. Age of some sewer pipes is exceeding 50 years and they have been already deteriorated. Owing to these conditions, there is great possibility of wastewater leakage from sewer pipe and pipe breakage. The pipe repair or replacement works have been executed in each city.

The wastewater generated in household flows into connected sewer pipe and collected wastewater is discharged to the Barada River through trunk sewer without any treatment. Sewer pipe has been developed in almost whole urbanized areas. Areas not served by sewer network are served by Pit Latrine and stored sludge is periodically withdrawn by vacuum tanker and sludge is dumped into waterway or manhole of sewer network nearby. Thus, this collected sludge is also contributing to public water contamination as another pollution source. As geographical feature of this area has moderate slope, the sewer pipe was installed relatively shallow.

1.1.3 Per Capita Wastewater Flow and Pollution Load

(1) Per Capita Wastewater Flow

The amount of wastewater was calculated by multiply the per capita wastewater flow to design service population. Total amount of wastewater is comprised domestic wastewater and others. Wastewater generated in store, office, school and factory is contained in "others". Per capita domestic water supply in 2004 was presumed as 100 LCD, referring to the existing study. Per capita domestic water supply is assumed to be increased along with living standard improvement in future. Annual increment is estimated as 1 LCD.

The ratio of non-domestic water consumption against domestic water consumption increases according to urbanization degree. So, this ratio becomes low value at small-scale residential area. Since Zabadani is large-scaled city, 30% was adapted. As to other three core cities, namely Bloudan, Bukein and Madaya are middle-scaled cities, the ratio was set be 10%.

Some portion of consumed water converts to wastewater and this ratio is called as wastewater conversion rate. According to existing study, 80% was adapted.

Daily maximum wastewater flow means the maximum amount of wastewater generated through a year. The ratio to daily average wastewater flow was set by 1.2 according to WB Study. Hourly maximum wastewater flow is the hourly peak wastewater within a day. The ratio to daily maximum wastewater flow was set by 1.8 based on WB study.

As stated earlier, target area has moderate slope and therefore, sewer pipes were installed shallow assumed to be located above the groundwater Table. So, groundwater intrusion to sewer pipe was neglected.

Zabadani area is well-known tourist resort attracts many tourists including foreigners by its temperate climate during summer season. Therefore, compared with winter, much larger amount of wastewater is generated as tourist wastewater flow in summer. Based on EIB Study, its ratio to domestic wastewater flow was set as shown in **Table FS1.1.1**:

Table FS1.1.1 The Ratio of Tourist Wastewater Flow

City Name	Tourist Wastewater (%)	Domestic Wastewater (%)	Total (%)
Zabadani	200	100	300
Bloudan	300	100	400
Madaya	50	100	150
Bukein	250	100	350

Per capita wastewater flow calculated by the above-mentioned assumptions is shown in **Table FS1.1.2** and **FS1.1.3**:

Table FS1.1.2 Per Capita Wastewater Flow (Non-domestic Ratio= 0.3)

(Unit：LCD)

Items	2004	2010	2015	2020	2025
Daily Average Flow (DAF)					
Domestic	100	105	110	115	120
Non-Domestic	30	32	33	35	36
Total	130	137	143	150	156
Conversion ratio			0.8		
Wastewater	104	109	114	120	125
Daily Maximum Flow (DMF) (DMF=1.2×DAF)					
	125	131	137	144	150
Peak Hour Flow (PHF) (PHF=1.8×DMF)					
	225	236	247	258	270
Unaccounted Flow (=DMF×20%)					
	25	26	27	29	30
Design Sewage Unit Flow					
Daily Average	129	135	142	148	155
Daily Maximum	150	157	165	172	180
Peak Hour	250	262	275	287	300

Table FS1.1.3 Per Capita Domestic Wastewater Rate (Non-domestic Ratio= 0.1)

(Unit：LCD)

Items	2004	2010	2015	2020	2025
Daily Average Flow					
Domestic	100	105	110	115	120
Non-Domestic	10	11	11	12	12
Total	110	116	121	127	132
Conversion ratio			0.8		
Wastewater	88	92	97	101	106
Daily Maximum Flow (DMF) (DMF=1.2×DAF)					
	106	111	116	121	127
Peak Hour Flow (PHF) (PHF=1.8×DMF)					
	190	200	209	219	228
Unaccounted Flow (=DMF×20%)					
	21	22	23	24	25
Design Sewage Unit Flow					
Daily Average	109	115	120	125	131
Daily Maximum	127	133	139	146	152
Peak Hour	211	222	232	243	253

(2) Pollution Load

Per capita pollution load was set as **Table FS1.1.4**, referring to the inflow wastewater quality in Adraa STP.

Table FS1.1.4 Average Pollution Load and Design Wastewater Quality

Indices	Average Pollution Load (g/capita/day)	Design Wastewater Quality (mg/l)
BOD	38.4	310
SS	45.3	360
T-N	9.3	74
T-P	3.0	24

Note) BOD loading was assumed based on data in abroad and others were estimated based on actual analysis data in Adraa STP

1.1.4 Facilities Designed in F/S Stage

Sewer network has already been developed in these four core cities. Now, wastewater flows through closed conduit and open channel, then discharged into Barada River. In order to mitigate the odor emitted from this open channel section, this portion will be converted to closed conduit by each City. Closed conduit was planned to be constructed in abandoned railroad line situated along with this open channel. So, no additional trunk sewer shall be designed through this F/S.

Since Zabadani area is hilly area with moderate ground slope, all generated wastewater can be collected by gravity. So, no pumping station is needed.
As existing sewer is combined system, storm water and wastewater are collected by same sewer and flow into trunk sewer. In dry weather, since no storm water is contained, whole wastewater shall be treated by STP. While in wet weather, as large volume of storm water is contained in wastewater, treatment of whole wastewater is not applicable. Some portion of wet weather wastewater shall be treated by STP and the rest shall be discharged to Barada River without treatment. To separate wet weather wastewater, diversion facility was proposed in F/S. STP with design capacity can cope with the generated wastewater flow in 2015 was planned as well.

1.1.5 Summary of Design Fundamentals on Sewerage System Development Plan

The population, wastewater flow and other design fundamentals are summarized in **Table FS1.1.5**.

Table FS1.1.5 Summary of Design Fundamentals

Items	Unit	F/S		M/P	
Target year		2015		2025	
Service Population	person	48,300		53,500	
Daily Average Wastewater Fow	m^3/day	18,250		22,201	
Reaction Tank	No	9		10	
Treatment Method		Oxidation Ditch Method		Oxidation Ditch Method	
Discharge Pint		Barada River via Conduit		Barada River via Conduit	
Wastewater Quality		Incoming	Effluent	Incoming	Effluent
BOD	mg/l	310	30	310	30
SS	mg/l	360	30	360	30

1.2 Design of Sewerage Facilities

1.2.1 Population and Wastewater Flow Projection

(1) Population Projection

National census was utilized for population projection as it is most reliable population data available. Although national census was performed on the year of 1981, 1994 and 2004, population data classified into administrative units such as City, Town, Village and Municipality

is only available in the investigation conducted on 1994 and 2004. Based on these two population data, average population growth rate was calculated.

Compared the population growth ratio calculated by total Governorate population between two time periods, namely 1981-1994 and 1994-2004, the later has lower ratio. There is restriction on population growth.

As excessive population was calculated by constant population growth rate, the JICA Study Team applied reduction ratio to population growth rate in order to attain proper future population. Based on the said two section population data, reduction ratio was set by 80% per five years. The population projection of each city is shown in **Table FS1.2.1**.

Table FS1.2.1 Population Projection

(Unit : Person)

District	Sub -district	City & Town	1994	2004	2010	2015	2020	2025	Annual Growth Rate (%)
Zabadani	Zabadani	Zabadani	21,049	26,285	30,000	32,800	35,200	37,300	2.25
		Bloudan	4,685	3,101	3,300	3,400	3,500	3,600	1.00
	Madaya	Bukein	1,746	1,866	1,900	2,000	2,000	2,000	0.67
		Madaya	8,649	9,371	9,800	10,100	10,400	10,600	0.80
Total			36,129	40,623	45,000	48,300	51,100	53,500	

(2) Wastewater Flow Projection

As aforementioned, numerous tourists visit Zabadani during summer season, wastewater flow increases remarkably in this season. Based on EIB Study, the JICA Study Team set the rate of anticipated tourist wastewater flow against domestic wastewater flow as indicated in **Table FS1.1.1**. Projected wastewater flow is shown in **Table FS1.2.1**. Per capita wastewater rate-1 was calculated by "non-domestic ratio" of 0.3, while per capita wastewater rate-2 was reckoned by "non-domestic ratio" of 0.1.

Table FS1.2.2 Projection of Wastewater Flow

City	Item		Unit	2004	2010	2015	2020	2025
Zabadani	Population		per.	26,285	30,000	32,800	35,200	37,300
	per capita wastewater rate-1	Average	LCD	129	135	142	148	155
		Daily max		150	157	165	172	180
		Hourly max		250	262	275	287	300
	Tourist		%	200	200	200	200	200
	Generated wastewater (pcwr-1)	Average	m^3/day	10,169	12,187	13,959	15,661	17,317
		Daily max		11,809	14,152	16,210	18,187	20,110
		Hourly max		19,682	23,587	27,017	30,311	33,516
	per capita wastewater rate-2	Average	LCD	109	115	120	125	131
		Daily max		127	133	139	146	152
		Hourly max		211	222	232	243	253
Bloudan	Population		per.	3,101	3,300	3,400	3,500	3,600
	Tourist		%	300	300	300	300	300
	Generated wastewater (pcwr-2)	Average	m^3/day	1,354	1,512	1,632	1,757	1,886
		Daily max		1,572	1,756	1,896	2,040	2,190
		Hourly max		2,620	2,927	3,160	3,400	3,650
Bukein		Population	per.	1,866	1,900	2,000	2,000	2,000

Table FS1.2.2 Projection of Wastewater Flow

City	Item		Unit	2004	2010	2015	2020	2025
	Tourist		%	250	250	250	250	250
	Generated wastewater (pcwr-2)	Average	m^3/day	713	762	840	878	917
		Daily max		828	885	976	1,020	1,064
		Hourly max		1,379	1,475	1,626	1,700	1,774
Madaya		Population	per.	9,371	9,800	10,100	10,400	10,600
	Tourist		%	50	50	50	50	50
	Generated wastewater (pcwr-2)	Average	m^3/day	1,534	1,684	1,818	1,958	2,082
		Daily max		1,781	1,956	2,112	2,273	2,418
		Hourly max		2,969	3,260	3,520	3,789	4,030
Total		Population	per.	40,623	45,000	48,300	51,100	53,500
	Generated wastewater	Average	m^3/day	13,769	16,145	18,250	20,254	22,201
		Daily max		15,990	18,749	21,193	23,520	25,782
		Hourly max		26,650	31,249	35,322	39,201	42,970

Note) (pcwr-1) means "per capita Wastewater rate-1", while (pcwr-2) means "per capita Wastewater rate-2"

1.2.2 Sewage Collection System

As sewer network has already been developed and though odor mitigation is on-going, trunk sewer has been completed, only remaining collection system to be designed by F/S is diversion facility and truck sewer to transfer the diverted wastewater to STP. This facility converts whole dry weather wastewater to STP and separates some portion of wet weather wastewater to STP. Refer to **Figure FS1.2.1**.

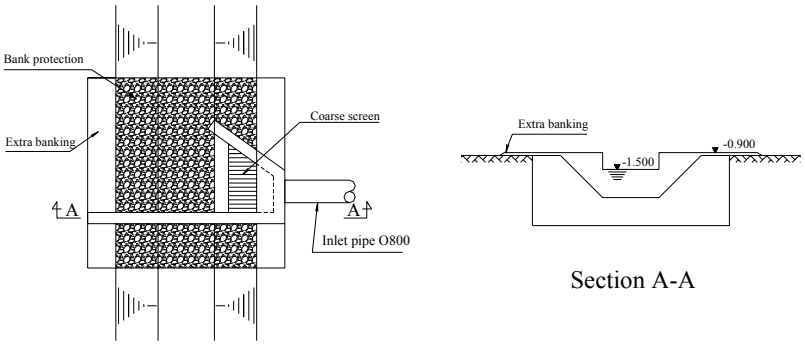


Figure FS1.2.1 Outline of Diversion Facility

In case of wet weather, some portion of wastewater is overflows the weir and discharged to the channel. However, pollution load contained in this overflowed wastewater is quite small compared that contained in dry weather wastewater and natural purification action of the channel and Barada River which this channel confluents is also expected. Stop log is planned to control this overflow wastewater volume.

Wastewater is converted by the weir to pit and then transferred to STP by inlet trunk. Refer to **Figure FS1.2.2**.

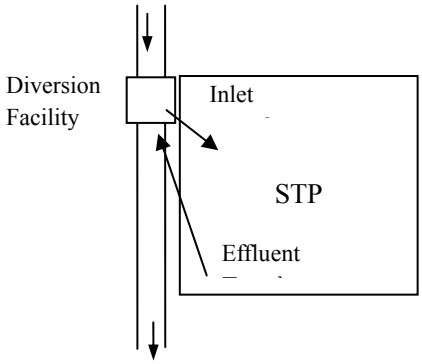


Figure FS1.2.2 Layout of Diversion Facility and STP

As incoming volume of storm water is unknown at this moment. In detailed storm water analysis, its effluent volume is calculated based on collection area by each section of sewer pipes according to rainfall intensity formula and storm water flow formula. Due to the study period restriction, the JICA Study Team couldn't afford such detailed analysis. As stated earlier, treatment of whole wet weather wastewater is not applicable, as its volume is expected to be huge. So some "portion" of wet weather wastewater shall be treated in STP. The Team proposed that volume ratio of wet weather wastewater to be treated is two times of dry weather wastewater. **Table FS1.2.3** shows the specification of proposed trunk sewer:

Table FS1.2.3 Specification of Proposed Trunk Sewer

Wastewater Flow		Proposed Capacity	Diameter	Slope	Velocity	Pipe Capacity
m^3/day	m^3/s	m^3/s	mm	‰	m/s	m^3/s
42,970	0.497	0.994	800	3.4	1.99	1.002
Dry Weather Flow		$2Q_{DWF}$				$2.1Q_{DWF}$

Treated wastewater was planned to send to just downstream of diversion facility to secure constant flow in the channel.

1.2.3 Sewage Treatment Plant

(1) Basic Conditions for the Design of Sewage Treatment Facilities

1) Basic data from M/P

The basic conditions for the design of sewage treatment facilities are presented in **Table FS1.2.4**.

Table FS1.2.4 Basic Conditions for the Design of Zabadani STP

Items	unit	M/P	Stage 1
Target year		2025	2015
Design flow Q_1(Daily Average) for main treatment facilities	m^3/d	22,201	18,250
Design flow Q_2 (Hourly Max) for Pump and UV	m^3/d	42,970	35,322
Available land area	m^2	62,400	
Wastewater quality		BOD	SS
Incoming	mg/l	310	360
Effluent	mg/l	30	30

Note) UV = Ultra Violet Radiation Equipment

2) Verification of Basic Conditions

Regarding to design flow, the JICA Study Team visited the site several times and observed the followings:

- As Zabadani is well-known tourist spot, there must be seasonal fluctuation in wastewater flow.
- As abundant flow with enough velocity was observed in open channel and outlet pipes every time, no sediment in trunk sewer is expected.

Based on the wastewater flow and quality survey conducted by the JICA Study Team, BOD was 290 mg/l when flow was 16,000 m^3/day. Refer to **Table FS1.2.5.** When wastewater flow is exceeding design flow, sewage quality is less than design quality.

Table FS1.2.5 Wastewater Flow/Quality and Treatment Indicator

Items	Actual Measurement	Design flow		Remark
		Q_1	Q_2 $(2.2 \cdot Q_1)$	
Flow (m^3/d)	16,000	22,201	42,970	$Q_1=Q_{DA}$, $Q_2=Q_{HM}$
BOD (mg/l)	290	310	160	
SS (mg/l)	272	360	186	
BOD-SS Loading of OD (kg-BOD/kg-SS・D)	0.043	0.040	0.041	Japanese standard 0.03 to 0.05 Metcalf & Eddy 0.04 to 0.1
Retention Time of OD (hr)	38	44	20	

Note) Actual Measurement was conducted by the JICA Study Team from 10:00 to 12:00 on 11th Nov.2007

Providing that pollution loading is constant and hourly maximum flow $(2.2 \cdot Q_1)$ is constant, incoming BOD concentration was calculated as 144 mg/l and BOD-SS loading in Oxidation ditch was reckoned as 0.041 (kg-BOD/kg-SS・D) corresponding to the Japanese standard and American standard shown in the guideline issued by Metcalf & Eddy. This is why capacity of OD is determined by BOD pollution loading. Therefore, even incoming wastewater flow is fluctuated, STP will have stable treatment function. Thus, appropriateness of basic condition in **Table FS1.2.5** was verified.

3) Treatment of Combined Sewage

As aforementioned, no sediment at bottom of sewer pipe or open channel is expected due to abundant flow and sufficient velocity, when generated wastewater flow exceeds design flow, wastewater quality becomes lower than design quality. Therefore OD can treat $2.2 \cdot Q_1$. This also means that treatment performance will be stable against wet weather wastewater flow which was set by $2 \cdot Q_1$. However, further detailed quality and quantity survey on combined wastewater is favorable to attain more reliable STP design in detail design stage.

(2) STP Land Acquisition Status and Necessity of Odor Control

STP land is public land owned by Agriculture organization located in farm area. Proposed STP site is advantageous for the followings:

- As proposed STP site is adjoining to the existing trunk sewer, less length of additional trunk sewer to convey wastewater to STP is needed.
- As it is located in farming area, it convenient for re-use of treated wastewater in agricultural purpose.

For the sustainable development of Zabadani as tourist spot through the future, wastewater treatment is essential and as STP land is located in farm area, odor control is necessary. Refer to **Volume III, Supporting Report, Part II Feasibility Study, Appendix 1.1** as to the detail of odor control.

(3) Site Condition

Plane Table FSurvey was conducted to measure the land area and ground level of the proposed Zabadani STP construction site. As present ground elevation looks lower compared with road elevation, design STP ground elevation shall be set at +0.500m, 0.5m higher than road level± 0.000. Refer to **Table FS1.2.6** as to site conditions.

Table FS1.2.6 Conditions of proposed STP Construction Site

Items	Unit	Figure	Remarks
Land Area	m^2	60,000	
Present Ground Elevation	m	－1.000	
Road Elevation	m	± 0.000	Public road in front of STP
Wastewater Surface Elevation	m	－1.370	36m away from the public road
Design STP Ground Elevation	m	+0.500	

Note) “Elevation” means the height from the base point on front approach road.

(4) Proposed Facilities

The facilities are summarized in **Table FS1.2.7**.

Table FS1.2.7 Summary of Proposed Facilities

Items	M/P	F/S
Grit Chamber (No.-W×L)	2-1.6m×8m	2-1.6m×8m
Main Pump (No.-D×power)	5(1)-φ250mm×15kw	5(1)-φ250mm×15kw
Reactor (No.-W×L×H)	10-5.5m×150.0m×5m	9-5.5m×150.0m×5m
Final Sedimentation Tank	8-φ18m	7-φ18m
Disinfection Channel	3-1.5m×3.5m×0.8m	3-1.5m×3.5m×0.8m
Gravity Sludge Thickener	2-6.0m×6.0m	2-6.0m×6.0m
Mechanical Dewatering Unit	2-30m^3/hr	2-30m^3/hr

Note) W = Width, L = Length, D = Diameter, H = Height

CHAPTER 2 CONSTRUCTION PLAN AND PROCUREMENT PLAN

2.1 Construction Plan

(1) Construction components

Zabadani project is planned to be implemented two stages based on the design target years of 2015 (Stage-I) for the feasibility study (F/S), 2025 (Stage-II) for the Master Plan (M/P). Stage-I is an urgent and priority project, and is expected to start operation from 2013. Construction is carried out for facilities of Stage-I (F/S).

1) STP (Oxidation ditch method)

The contents of construction in a stage-I are shown in **Table FS2.1.1**.

Table FS2.1.1 Contents of Construction for STP

Facility	Stage-I [2015] (18,250 m^3/day)	Stage-II [2025] (22,200 m^3/day)
Pumping station Dia. 250mm	5/5 units	—
Oxidation ditch tank	9/10 basins	1/10 basins
Sedimentation tank	7/8 basins	1/8 basin
Disinfection Channel	1 unit	—
Sludge thickener	2/2 basins	—
Sludge dewatering	2/2 units	—
Generator	1 unit	—

2) Pipes (Trunk sewer)

Dia. 800mm (HDPE), L=100 m

(2) Construction schedule

Construction of STP and pipe for stage-I is carried out for about three years from 2010 to 2012. Construction schedule is shown in **Table FS2.1.2**.

Table FS2.1.2 Construction Schedule for Stage-I

	2008	2009	2010	2011	2012	2013	2014	2015
1. Pre-Construction Stage	←	———	→					
1). Preparation of project	▪▪▪▪▪							
2). Pre-Construction (D/D, PQ, Tender)		▪▪▪▪▪▪▪▪						
2. Construction Stage			←	———	———	→		
1). Civil and Building Works								
a. Preparation of Construction			▪▪					
b. Removal of Existing Facility			▪▪					
c. Structural Construction			▪▪▪▪▪▪▪▪▪▪▪					
d. Trunk Sewer					▪▪▪▪			
2). M&E Works								
a. As-build Drawing, Manufacturing				▪▪▪▪▪▪				
b. Installation					▪▪▪			
3). Commissioning, Turn-over					▪▪			
3. O&M Stage						———	———	→

2.2 Procurement Plan

(1) Land Acquisition Plan for Sewerage Treatment Plant

The site planned construction for STP is a public land owned by Ministry of Agriculture (Ministry of Defense is using it now). Since deliberations are already made among relevant ministries, land acquisition will not be difficult.

(2) Procurement Plan for Construction Materials and Equipment

The construction materials necessary for the project shall be procured in Syria to the greatest extent possible. However, construction materials that are not available in the country, cannot meet the quality or specifications of the design requirements, or cannot be reliably procured with regard to distribution volume, shall be procured from other countries.

Component division of foreign and local portion is shown in **Table FS2.2.1**.

Table FS2.2.1 Component Division of Foreign and Local Portion

Item	Material	Foreign Portion	Local Portion
(1) Civil Works	Labor		○
	Sand, Gravel		○
	Concrete		○
	Form		○
	Reinforcement Bar	○	
(2) Pipe	HDPE		○
(3) Mechanical & Erectrical Equipment	Pump, Aerator, Sludge Collector, Dewatering Machine, etc	○	
(4) Construction Machinery			○
(5) Building Works	Brick		○
	Indoor Materials		○

CHAPTER 3 OPERATION AND MAINTENANCE PLAN

3.1 Organizational Strengthening

3.1.1 Summary of the Current Organization

Currently, the Rural Damascus Water Supply and Sewerage Authority (RDAWSSA) is responsible for water supply and sanitation services in Rural Damascus Governorate. In particular, it is involved in planning, implementing and operating new projects, as well as maintaining the existing facilities. A new Rural Damascus Sewerage Company under RDAWSSA is under the process of its setting up.

3.1.2 Proposed Organization Structure

The proposed organization structure for the project implementation and for the subsequent O&M, is discussed summarized below:

(1) At the project implementation stage, Project Management Unit (PMU) is supposed to be established under RDAWSSA on the basis of several relevant Directorates, which would be responsible for execution of on-gong capital projects. The PMU should be assisted by the selected Consultants. A Steering Committee should be also established to facilitate the F/S project implementation.

(2) At the O&M stage, the new Sewerage Company will manage all matters relating to O&M of the sewerage system.

3.1.3 Details of the Proposed Organization Structure for O&M

It is proposed to establish in Zabadani a Sewerage Operations Center under the Sewerage Company, responsible for O&M of the project upon its completion.

The Sewerage Operations Center in Zabadani is proposed to consist of two main sections: the Sewage Treatment Plant (STP) Section and the Sewage Collection Section, and assisted by the GIS Section. This structure is expected to be expanded to cover other areas and therefore other Operations Centers are expected to be established under the Sewerage Company.

3.2 Capacity Development

3.2.1 Necessity of Capacity Development

The required reforms in the water supply and sewage sector are impossible without an adequate capacity of the staff. It is assumed that construction of the F/S project will be managed by the

PMU and that all the constructed facilities will be transferred to the Sewerage Company upon completion of the project. Most of the staff will be newly employed. To identify the gaps between the required and the existing skills of the future staff, conducting a full-scope Training Needs Assessment (TNA) will have to be conducted first.

Taking the capacity building requirements of a similar sewerage company that functions in Damascus City as a benchmark, an outline of the future capacity building program is proposed.

3.2.2 Proposed Capacity Building Program

The Capacity Building Program should contain the items which will be able to raise the capability of the staff of the future PMU and the relevant operations center of the Sewerage Company under RDAWSSA up to the level of satisfactory planning, O&M and management of the sewerage system in the F/S area. It should be completed by the end of construction.

Such methodologies as a TNA, classroom trainings (lectures, workshops), on the job training (OJT) by/with respective experts, and Monitoring & Evaluation are proposed.

The proposed Capacity Building Program should concentrate on such areas as (i) General Management Skills, (ii) Sewerage System Management, (iii) Sewerage System Operation, (iv) Database and GIS, (v) Environmental Management, and so on.

3.3 Operation and Maintenance Guideline

The objectives of sewerage cannot be achieved and the value of existence of sewerage may become dubious without adequate O&M. In order to carry out proper O&M, development of the indicator and standards about the O&M of sewerage facilities is indispensable. In the chapter 4.3, the point on the O&M of sewerage facilities is described, putting a viewpoint mainly on a technical aspect.
Figure FS3.3.1 and **FS3.3.2** show O&M flow of sewer system, pumping station, and treatment Plant.

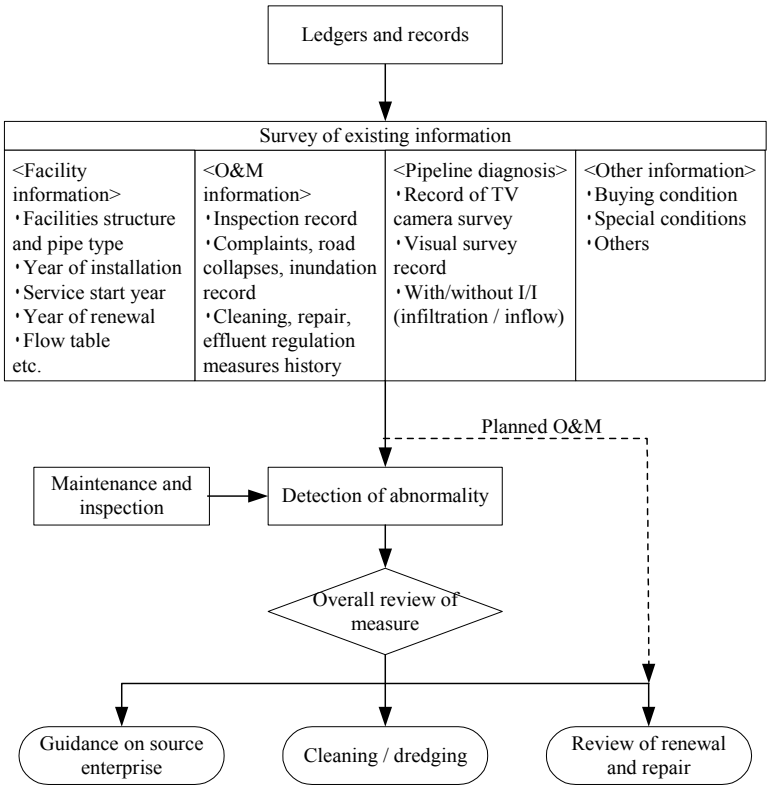


Figure FS3.3.1 O&M Flow of Sewer System

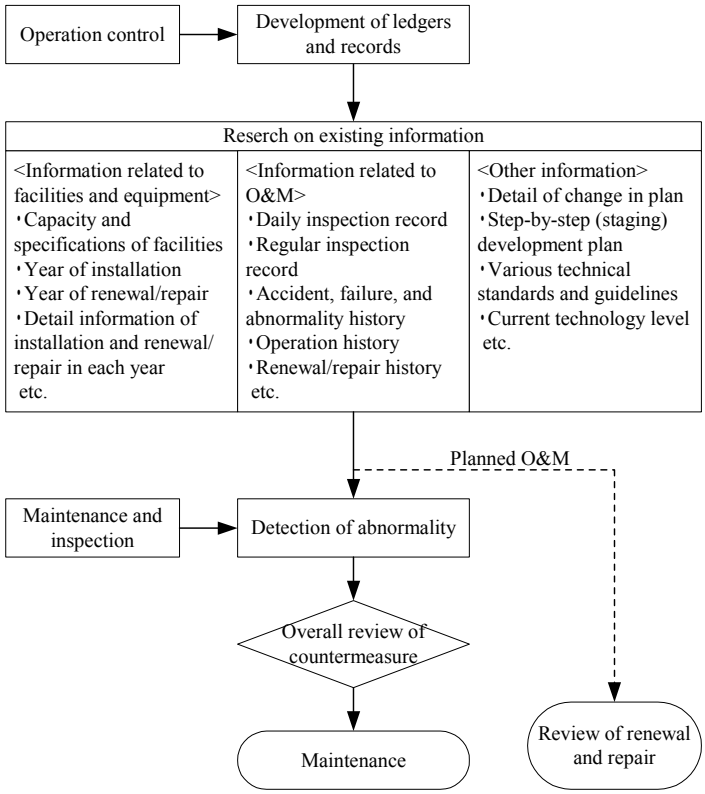


Figure FS3.3.2 O&M Flow of Pumping Station and Treatment Plant

3.4 Public Relations on Sewerage system

The Sewerage service must perform project management more than other public service, being based on a confidential relation with residents.

Public relation is regarded as necessary activity to gain the support to a sewerage project, asking residents for an understanding widely about "Role and effect of a sewerage", "Sewerage development plan", "Structure of sewerage finance", etc.

The example of the public relations plan in each stage of sewerage project is shown in **Table FS3.4.1**.

Table FS3.4.1 Examples of Public Relations Plan

Stage	Purpose	Objects	Examples of Activity	
			Method	Contents
Concept	To enhance opportunities for sewer development	・Citizens	・Publicity ・Inspection of advanced area ・Lecture ・Public relations magazine ・Homepage	・Understanding of the necessity for a sewerage, and public announcement which enhance opportunities for embodiment of a plan ・A explanation about increase of financial responsibility ・Public hearing about request of a sewerage
Plan	Complete understanding of a sewerage	・Citizens including children	・Publicity ・Inspection of advanced area ・Lecture ・Public relations magazine ・Homepage ・School lessons	And more above, ・Public announcement about effect of sewerage development
	Publicity of sewerage plan	・Citizens ・Related residents （Especially, to the residents who live near the STP site）	・Publicity ・Inspection of advanced area ・Briefing ・Lecture ・Public relations magazine ・Homepage ・Brochure	And more above, ・A explanation about economical efficiency of sewerage , and the reason for selection of STP site ・Public hearing about request for the sewerage plan
	Publicity of payment by beneficiary	・Citizens	・Publicity ・Briefing ・Lecture ・Canvass ・Public relations magazine ・Homepage ・Brochure	And more above, ・Public announcement about necessity for a payment by beneficiary based on the increase of environmental improvement, convenience and amenity accompanying development of sewerage, the increase in asset value etc. ・Public hearing about the situation of a prevention factor, and planning of a measure
Construction	Cooperation request to construction	・Residents near the construction site	・Public relations magazine ・briefing ・Homepage ・Brochure ・Signboard of construction	・Public announcement for aiming at smooth implementation of construction, and an understanding of the contents of construction (construction outline, processing organization for a complaint etc.) ・Publicity of schedule for start of operation, and an understanding to a sewerage ・Public hearing about the request for construction

Table FS3.4.1 Examples of Public Relations Plan

Stage	Purpose	Objects	Examples of Activity	
			Method	Contents
	Publicity of schedule for start of operation	・Residents and business establishment in the service area	・Publicity ・Briefing ・Public relations magazine ・Homepage ・Brochure	・Publicity of setting a house connection ・Recommendation on early house connection ・Public hearing about the situation of a prevention factor, and planning of a measure
Operation & Maintenance	Promotion of house connection	・Residents and business establishment in the service area	・Briefing ・Canvass ・Homepage ・Brochure	・Publicity of setting a house connection ・Recommendation on early house connection ・Public hearing about the situation of a prevention factor, and planning of a measure
	Publicity of right usage	・Residents including children and business establishment in the service area	・Publicity ・Visiting of STP (including for children) ・Public relations magazine ・Homepage ・Brochure	・Public announcement about right usage of sewerage (setting of pretreatment facility for discharge to sewerage system, prohibition of pouring oil from kitchen etc.)
	Rehabilitation	・Residents and business establishment in the service area	・Publicity ・Visiting of Facility ・Public relations magazine ・Homepage ・Brochure	・Public announcement about necessity for the renewal / repair to decrepit facilities

CHAPTER 4 COST ESTIMATION AND IMPLEMENTATION SCHEDULE

4.1 Project Cost for Stage-I (2015)

A summary of the project cost for Zabadani project (Stage-I :Target year 2015) is shown in **Table FS4.1.1**.

Project components

STP: Q=18,250 m^3/day (Oxidation Ditch Method)

Pipes: Dia. 800mm, L=100 m

Table FS4.1.1 Project Cost for Zabadani

Items	LC portion	FC portion	Total (10^3SP)
Construction Cost			
1) STP	234,208	270,735	504,944
2) Pipe		1,250	1,250
Total of Construction Cost	**234,208**	**271,985**	**506,194**
Land Acquisition Cost	-	-	
Engineering Cost	45,557	5,062	50,619
Government's Administration Cost	-	25,310	25,310
Organizational Development Cost	-	15,186	15,186
Physical Contingency	23,421	27,199	50,619
Sub Total	**68,978**	**72,756**	**141,734**

Items	LC portion	FC portion	Total (10^3SP)
Price Contingency	65,971	57,080	123,050
Total (Excluding Price Contingency)	**303,186**	**344,741**	**647,928**
Total	**369,157**	**401,821**	**770,978**

4.2 Implementation Schedule

Implementation schedule of Stage-I (Target year : 2015) is summarized to below.

Pre-construction Stage

2008 : Preparation of project (Financial arrangement, Selection of consultant)

2009 : Pre-construction (Detailed design, Bidding)

Construction Stage

2010-2012 : Construction (STP)

2012 : Construction (Trunk sewer)

Operation & Maintenance Stage

2013~ : Commencement of Operation

Table FS4.2.1 Implementation Schedule

	2008 1	2009 2	2010 3	2011 4	2012 5	2013 6	2014 7	2015 8	
Pre-Construction Stage	←	———	→						
Preparation of Project	■	(Financial Arrangement, Selection of Consultant)							
Pre-Construction		■	(Detailed Design, P/Q and Tender)						
Construction Stage			←	———	→				
STP			■	■	■				
Pipes					■				
Operation & Maintenance Stage						←	———	→	

CHAPTER 5 ECONOMIC AND FINANCIAL EVALUATION

5.1 Economic Evaluation

5.1.1 Methodology of Economic Evaluation

The F/S sewerage system development project was designed to contribute to the public welfare. It brings various social and economic benefits to the society and financial profitability can

hardly be considered as its major mission. Therefore, the Economic Internal Rate of Return (EIRR) approach was primarily used for the project justification.

5.1.2 Economic Costs

The project's economic costs are comprised of (i) the capital costs of the F/S project, but excluding the tax; and (ii) incremental O&M costs throughout the project life.

5.1.3 Economic Benefits

Efforts were made to estimate a number of economic benefits. The following economic benefits were taken into consideration: (i) tourism development, (ii) health benefits relating to reduction of the productive time lost, (iii) health benefits relating to reduction of medical expenditures; (iv) use of treated wastewater; and (v) use of sludge as fertilizer. Many potential economic benefits however were not readily quantifiable, especially in economic terms.

5.1.4 Results of EIRR Calculation

The EIRR calculated for the F/S project is 12.9%. Therefore, the F/S project is feasible from the economic point of view.

5.2 Financial Evaluation

5.2.1 Purpose and General Assumptions of Financial Evaluation

The main purpose of any project's financial evaluation is to ensure financial viability of the proposed project. A financial plan is supposed to determine the amount of funds required to finance the project, as well as the possible sources for these funds.

A financial model was developed for financial evaluation of the F/S project under different scenarios.

5.2.2 Affordability to Pay Assessment

Affordability of the water and sewerage charges in the F/S area was assessed based on the Social Survey results and the latest (November 2007) tariff table.

The theoretically estimated water and sewerage charges account for only 0.56% of the average household income in the F/S area. It means that the existing tariffs are affordable, considering the 4% - 5% threshold. Moreover, there is a significant leeway for possible tariffs increase.

5.2.3 Willingness to Pay

Willingness to pay for sewerage services was analyzed based on the results of the above-mentioned Social Survey. The vast majority of respondents believe that the sewerage system in the F/S area needs to be improved. There is also apparent flexibility in raising the existing sewerage tariffs from the willingness to pay point of view.

5.2.4 Results of Financial Evaluation under Different Scenarios

The financial model was run under four different scenarios of setting the tariffs:

1) Baseline Scenario
2) O&M Cost Recovery Scenario
3) 50% Capital Cost Recovery Scenario
4) Financial Feasibility Scenario

Having considered them, the O&M Cost Recovery Scenario was recommended. This scenario requires only a moderate increase of the tariff. Target tariff level was roughly estimated as 2.4 SP/m^3.

5.2.5 Outline of the Proposed Financial Plan of the F/S Project

The proposed financial plan for the F/S project assumes that all capital costs and possible interest charges should be provided to RDAWSSA/ Sewerage Company as a grant. At the same time, sound financial management of the F/S sewerage project requires that the revenue generated by the project (sewerage charges) should cover all O&M costs of the project. For this purpose, the current sewerage tariffs should be raised upfront to a level that would reflect the project O&M costs. 2.4 SP/m^3 was roughly estimated as target tariff level. Refer to **5.2.4 (2)** of F/S Report.

CHAPTER 6 SOCIAL CONSIDERATIONS AND ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Environmental and Social Consideration

On the occasion of holding the 3rd Stakeholder Meeting, the widest possible range of stakeholders is selected based on the consultation with the Ministry of Housing and Construction. During the 3rd Stakeholder Meeting, an active discussion and consultation are conducted. The details of the 3rd Stakeholder Meeting are summarized in **Table FS6.1.1**.

Table FS6.1.1 Details of the 3rd Stakeholder Meeting

Item	Contents
Timing	20th November 2007
Place	Bloudan Grand Hotel, Bloudan City, Rural Damascus Governorate
Attendants	Relevant government agencies (MHC, GCEA, governorates, DFEAs etc.) and local stakeholders (residents, private sectors, international organizations/donors, university and research institutes, NGOs and media etc.) Total: 61 persons
Contents of Presentation	1)Outline of F/S on Zabadani Sewerage System 2)Explanation of the Results of Pre-EIA Level Study
Major Questions and Comments	1) Population estimation (population increasing during summer season) 2) Location of the proposed STP 3) Details about wastewater treatement and sludge treatment method 4) Odor impact of the STP

6.2 The Results of Pre-Environmental Impact Assessment (EIA) Level Study

Based on the results of the IEE level study, the pre-EIA level study (only part of study items are same as EIA level study) on the F/S for Zabadani sewerage system is carried out during November 2007 in accordance with the request of MHC. The major negative impacts of the Project are summarized in **Table FS6.2.1**.

Table FS6.2.1 Results of the Pre-EIA Level Study on the F/S of Zabadani Sewerage System

Environmental Items	Evaluation	Results
Traffic	C	Existing traffic flow of the road near the STP is low (100 cars/hr) and the period of impacts will be short. In addition, some measures will be taken during construction period.
Soil pollution	C	The results (see **Volume III, Supporting Report, Part II Feasibility Study, Appendix for Chapter 6**) of heavy metals analysis indicate that the concentrations heavy metals in the sludge of existing STP and soil at Zabadani area are lower than Syrian sludge disposal standards and soil environmental standards. Therefore, it is proposed to reuse dewatering sludge from the STP for agriculture. However, a monitoring system will be necessary to check the impacts of heavy metals in the sludge on the soil in operation stage.
Noise and Vibration	C	Noise and vibration may be generated by construction equipment and vehicles during construction stage. According to the results of field noise survey, the noise levels at the nearest houses are 45 dB(A) and 69 dB(A) respectively. It is estimated that during construction stage of the STP, the noise levels at the nearest houses may be increased to be 62 dB(A) and 72 dB(A) respectively (see **Appendix for Chapter 6**). Therefore, some countermeasures may be necessary. However, the period of the impact is short and no residential area around proposed STP site.
Offensive odor	C	Odor may be emitted from wastewater and sludge treatment facilities. However, following countermeasures are considered. 1) During planning stage, OD method and mechanical dewatering system are selected to reduce odor level. 2) Tree belt and buffer zone are proposed to mitigate odor. 3) A monitoring system is proposed to check odor during operation of the STP. If it is necessary in future, additional deodorization methodes can be applied. In addition, The concentrated residential area is more than 2 km away from the STP site, and the distance between the STP and the nearest houses (4 houses) is about 100 m. Moreover, raw sewage also emits odor. Considering these factors, the impact of odor is considered to be light.

Note) A: Serious impact B: Some impact
C: Light impact D: Negligible impact

Through the Pre-EIA level study, no serious impacts of the proposed project on environment are identified, except some items having light impacts. In order to mitigate these negative impacts, some countermeasures and recommendations from an environmental viewpoint are proposed. Finally, a monitoring plan is also proposed. If these countermeasures are taken into consideration, the impacts of the proposed project on the environmental will be minimum level.

CHAPTER 7 FORMULATIONS OF PROJECT IMPLEMENTATION PLAN

7.1 General Budgetary Allocation Procedure for Sewerage Projects

The general procedure applicable for budgetary arrangements for sewerage projects can be divided into the following stages: (1) Technical Departments of MHC estimate their needs and prepare initial plans that are forwarded to the Directorate of Planning in MHC; (2) The Directorate of Planning revises the plans and consolidates in an annual Ministry Plan, which is sent to the State Planning Commission (SPC) for approval; (3) SPC revises the Ministry Plan and sends the approved Plan to the Higher Council for Planning; (4) The Higher Council for Planning reviews the Plan and approves it. The finally decided Plan is sent back to MHC for implementation.

7.2 Procuring External Finance (Grants & Loans) for Projects in Syria

When external funds are expected to be procured, the following procedure is usually followed: (1) SPC addresses MHC for determining the projects proposed for external funding. In turn, MHC informs SPC about the available priority projects; (2) SPC informs the prospective funding institutions about availability of projects entitled for funding (by grants or/and loans); (3) The interested funding institutions visit MHC for discussions over these projects; (4) The funding institutions select the project(s) and send a letter to SPC expressing desire, consent and readiness to finance. (5) MHC provides the interested funding institutions with all details about the prospective projects including the target and concept, general information, strategy and policy of the Government of Syria, technical details, and financial information. (6) SPC negotiates with the selected funding institution the terms of the loan. (7) The loan agreement is authenticated and signed by the People's Council, and issued as per a decree of the President of Syria.

7.3 Tender Evaluation

Once the necessary funds are allocated by SPC, the project details are announced. The applying body (Ministry) forms the Envelopes Opening Committee, the Technical Committee, and the Financial Committee that carry out the tender evaluation based on technical and financial

criteria and determine the winning offer.

The total time expected for a foreign-funded project development starting from its financing phase till launching its execution is at least one year.

CHAPTER 8 RECOMMENDATIONS TO THE SYRIAN WATER SECTOR

8.1 Sewerage System

8.1.1 Improvement and Replacement of Existing Facilities

Numerous sewerage facilities have been constructed mainly in urban areas. However, there are numerous problems as well.

First, concrete pipe has been employed in most service areas but as its quality is inferior, sewage leakage has been detected in many places. Most of them don't have adequate connection structures and some pipes are not even reinforced by steel bar. Further, pipe bedding is also inappropriate and this caused pipe breakage. Some pipes have been already deteriorated and pipe breakage owing to this caused road sinking. Such deteriorated pipes shall be replaced based on the priority order and as other pipe materials are available in Syria, they shall be utilized in stead of concrete pipe. They are Poly-vinyl Chloride Pipe (PVC Pipe) and Poly-ethylene Pipe (PE Pipe). Compared with concrete pipe, they are quite light and ease in installation. Their pipe connection is easy and has high water-tightness. Pipe material cost is little bit higher than concrete pipe but it is negligible when future replacement cost is considered.

Second, some STPs are not functioning efficiently, namely Adraa STP in Damascus Governorate, Debse Afnan STP, Al Mansourah STP and Ma'dan STP in Raqqa Governorate, Homs STP in Homs Governorate. **Table FS8.1.1** shows the proposed remedial countermeasures for them:

Table FS8.1.1 Proposed remedial Countermeasures for the Existing STPs

Name of STP	Countermeasures
Adraa STP/ Damascus Governorate	As aeration time is insufficient in aeration tank, it resulted in inefficient treatment function. To compensate this, construction of additional aeration tank or installation of high-efficiency aeration devise was proposed. Highly concentrated return supernatant from sludge treatment method has been obstructing proper biological sewage treatment. This owes to the inefficient function in anaerobic sludge digestion tank. As primary sludge is too much concentrated, this might attribute to improper sludge mixing in digestion tank. Rehabilitation of sludge digestion tank is needed. In future, incoming sewage flow will increase and generated sludge volume will also be increased. This will cause capacity shortage in sludge drying beds. Therefore, introduction of sludge dewatering system shall be examined. When such system is employed, area occupied by drying bed can be utilized for facilities to be constructed in future. Tertiary treatment facility is also needed to upgrade treated sewage quality.
Debse Afnan, Al Mansourah, Ma'dan STP/ Raqqa Governorate	There are five STPs constructed by turn-key contract between private company in this Governorate. STPs were funded by MLAE. After the completion of STPs some O&M engineers were supposed to be assigned to each STP to learn O&M activities by working with operators of private company but no one was assigned and therefore plant operation of these three STPs was suspended. Raw sewage is discharged into irrigation canals near by. To optimize the completed STPs, proper O&M engineers shall be assigned immediately. Along with this, human resource development program shall be planned and implemented as soon as possible. It is inevitable as many STPs are expected to be constructed in near future.
Homs STP/ Homs Governorate	Homs STP is operated since 1998. Plant capacity is 133,900 m^3/day, employed Conventional Activated Sludge Method. There are two lines, called Sugar Line for sugar industrial wastewater and Regular Line for domestic wastewater. "The maximum limits of industrial polluters permitted to be discharged to the sewer network" is indicated in **Table 3.3.2** in Master Plan Report. According to this, the maximum limit of COD is 1,600 mg/l. According to the incoming wastewater quality analysis in Sugar Line described in **Figure 5.2.3** in Master Plan Report, further concentrated COD was observed. As sugar industries are apparently violating the regulation, they shall be legally obliged to install pre-treatment facility. Legal enforcement on illegal industrial development is stipulated in Responsibilities and Compensation in Low No.50 enacted in the year of 2002.

Third, some pumping stations are left over without installation of mechanical and electrical equipment. This is due to the difficulty in equipment procurement from overseas supplier. As reliable equipment is not available in domestic supplier, it must be imported but such import used to be quite difficult due to political/institutional restrictions. Nowadays, such restrictions are released gradually and equipment installation work can contracted out to international contractor. So, equipment installation work for the said PS shall be contracted out to international contractor to relieve stagnant project implementation caused by this.

8.1.2 Management and Utilization of Asset Data and O&M Records

As current data management on sewerage projects is quite insufficient, it led sewerage project implementation inefficient. Since MHC has not been managed asset data, information on existing sewerage facilities such as STP, PS and sewer network systematically, they cannot prepare cost and time-saving sewerage development plan. If they don't have precise and detailed data on the existing facilities, they cannot work properly and promptly even in case of accident. Along with institutional frame-work restructure in MHC, drastic data management system renewal is indispensable for future project execution and operation and maintenance of the constructed facilities.

As stated earlier, all information shall be integrated in "GIS System". The JICA Study Team proposed detailed information to be input in this system as described in **Volume II, Main Report, Part II Feasibility Study Table 8.1.2**. Adding to this, O&M record shall be included to attain efficient O&M activities.

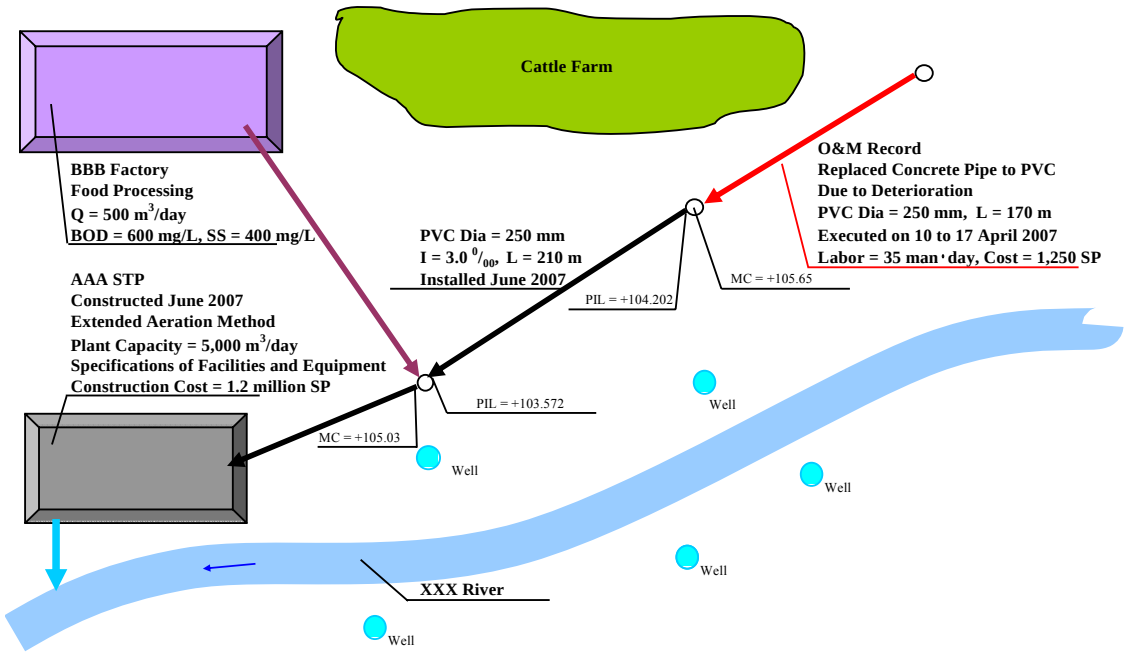


Figure FS8.1.1 Proposed Image of GIS Map as Sewerage System Detabase

If these data is fully input in GIS Map, it is quite useful from viewpoint of selection of priority area for sewerage system to be developed because locations of the existing facilities are clearly indicated. As deteriorated or aged facilities are also apparently located and their age is also stated in the Map, it facilitates prompt and efficient repair and replacement planning. **Figure FS8.1.1** shows the proposed image of GIS Map as sewerage system database.

Further, MHC shall prepare periodical O&M activity plan for the existing sewerage facilities not only for old ones but also for newly constructed ones as it will act as Preventive

Maintenance. Such O&M activities including repair works shall be summarized as "Monthly O&M Report" by each Establishment and shall be submitted to MHC headquarter at the end of every month by digital file. MHC headquarter shall prepare the report format by digital file and distribute it to all Establishments. The report shall include the record of O&M activities executed and the total amount of cost, materials, labor and equipment spent for the activities. MHC headquarter can evaluate the efficiency of O&M activities in each Governorate based on this report.

MHC shall construct and spreads this GIS Map Information System and Monthly O&M Report practice all over the Land for appropriate, time-saving and cost-efficient project execution and sustainable O&M activities.

8.1.3 Environmental and Water Quality Monitoring

As stated so frequently, current fragment and over-wrapped task assignment among several related ministries made execution of sewerage project quite ineffective.

Along with the progress of "The Capacity Development of Environmental Monitoring" supported by JICA, laboratories have been installed in 14 General Commission of Environmental Affairs (GCEA) under MLAE. Just like jurisdiction arrangement for MHC in sewerage system development project implementation, the role of environmental and water quality monitoring shall be concentrated to MLAE.

MHC shall share the GIS Map Information Database with MLAE since it quite useful in water quality monitoring. MLAE can prepare periodical water quality monitoring plan based on this GIS Map illustrating location of existing sewerage facilities and potential pollution sources such as factories. MLAE can input the monitoring results on the Map. MHC can also monitor the function of sewerage facilities based on the water quality monitoring results. **Table FS8.1.2** shows the summary of projects proposed for MLAE in 10th Five Year Plan.

Table FS8.1.2 Projects proposed for MLAE in 10th Five Year Plan (Summary)

No.	Proposed Projects	Budget	Year of Execution
10	The information system	72 mil SP	2007 to 2010
14	Maps Rehabilitation for the Use of GIS and Satellite Images	60 mil SP	2007 to 2010

In total, 15 projects were proposed in FYP of which No. 10 and 14 are seemed to be quite useful in sewerage system planning and therefore MLAE shall share these valuable outputs with MHC.

According to the interview to the Director of Survey Department of MLAE, they are planning to establish "Web-GIS Data Center" which manages spatial data all over Syria according to project

No.10 "The Information System". The data is accessible through web-site.

Such inter-Ministry cooperation and mutual exchange and shearing of available data is indispensable for the smooth and efficient project implementation.

Japanese Technical Assistance Program can also assist to formulate the efficient data management circumstances.

8.1.4 Introduction of Appropriate Technology

There are 13 major public STPs in Syria adopting several kinds of treatment methods. Comparing their treatment efficiencies, most of general biological treatment applying mechanical units, such as Extended Aeration Method or Activated Sludge Method has inferior performance. This owes to several factors, namely highly concentrated incoming wastewater, biological treatment performance largely affected by low temperature and so on.

However, the largest factor is lack of appropriate and sustainable O&M activities. Once STP is constructed, proper O&M is indispensable to maintain its sound treatment function. Current technology level of MHC cannot afford treatment methods which require complicated O&M skill. Therefore, treatment method can be operated and maintained by current technology level shall be adopted.

Two "Wet Land Systems" have been operated quite well. Wet Land System requires no complicated O&M skill and its construction cost is remarkably low compared with that of general biological treatment applying mechanical units. Treatment performance is satisfactory as well. Wet Land System has excellent cost performance.

Aside from Mediterranean Coastal Area, precipitation is generally scarce in Syria and therefore, farmers have high demand towards treated wastewater as irrigation water source. Upon planning treated wastewater re-use, wastewater shall be treated in the nearest point to its generating area. In short, STP shall be planned near to the target service area. Plant scale will be "small" as it only serves the nearest service area to supply treated wastewater to their farm. Call this system as "Small Sewerage System", hereinafter. Compared with large-scaled Centralized System, Small Sewerage System can be constructed in much shorter time period and by much lower budget. It is quite convenient in terms of treated wastewater re-use because it is available near to their farm. Small Sewerage System will be one solution for areas requiring proper wastewater treatment and re-use of treated wastewater.

As Wet Land System requires no complicated O&M skill and its construction cost is remarkably low, this treatment method is applicable in those areas.

MHC engaged a contract between GTZ that construct small-scaled treatment facility applying Wet land System by Debt Swap Loan System. Construction of 20 facilities was proposed mainly in in-land Government where demand toward re-use of treated wastewater is quite high.

The JICA Study Team had several meeting with stakeholders and Ministry and Governorate officers and their biggest concern was "Odor" and "Treated Wastewater Re-use". The later can be solved by introduction of Small Sewerage System. Although they insisted odor problem, as far as wastewater is dully oxidized, its odor is not so intensive. Stakeholders also have strong interest for odor problem but very few of them have actually visited STP. They only have negative image against STP.

To relieve such negative image, educational campaign will be most effective. Wastewater is generated by themselves. MHC must show them how public water bodies might be contaminated if generated wastewater is not properly treated. MHC must inform them the important role of sewerage system protecting their sanitary environment and preserving surrounding aquatic system.

STP visiting is also quite convincing for them. As Wet Land System is supposed as the most applicable treatment method in Syria for the time being, MHC can plan STP visiting to the existing two facilities in Rural Damascus Governorate and Raqqa Governorate.

Stakeholders' awareness toward the importance of sewerage facilities will be improved drastically through this campaign. This will contribute to smooth project execution including STP site acquisition.

8.2 Institutional Development

Summarizing results of analysis of institutional aspects of the O&M Plan the Syrian side is recommended:

- Establish a PMU under the structure of RDAWSSA to implement the F/S project.
- Take practical measures to set up Sewerage Company under RDAWSSA with an Operations Center in Zabadani for O&M of the sewerage system upon the F/S project completion.
- Include the Organizational Development as a component of the F/S project to enhance capacity of the PMU and RDAWSSA / Sewerage Company staff, starting from a Training Need Assessment of the relevant staff. Use all other means of the staff capacity building, including various technical assistance programs.

8.3 Financial Management

The following recommendations can be suggested:

- A modern financial management system should be implemented.
- The capital costs for the F/S project, along with the related financing costs, should be granted by the Government of Syria or other donors.
- Recovery of the sewerage O&M costs through sewerage charges should be set as a target
- In order to achieve the 100% recovery of the O&M, it was roughly estimated that the existing domestic sewerage charges should be raised in the current prices to approximately 2.4 SP/m^3, including fixed fees.
- Regionalization of sewerage tariffs is advisable due to different conditions in different areas
- Once the 100% recovery of the O&M costs is achieved, the next level target will have to be set.
- The tariffs should be regularly adjusted for inflation.
- The practice of using cross-subsidies from non-domestic domestic customers should be continued. Using of cross-subsidies from the water supply revenue to the sewerage system could be also considered in the future.