THE PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

PALESTINIAN WATER AUTHORITY

THE PREPARATORY SURVEY REPORT ON THE JERICHO WASTEWATER COLLECTION, TREATMENT SYSTEM AND REUSE PROJECT IN THE PALESTINIAN INTERIM SELF-GOVERNMENT AUTHORITY

AUGUST 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

NJS CONSULTANTS CO., LTD.

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Preface

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey on the Jericho Wastewater Collection, Treatment System and Reuse Project and entrusted the survey to NJS Consultants Co., Ltd.

The survey team held a series of discussions with officials concerned of the Palestinian Interim Self-Government Authority, and conducted field investigations from 12 December 2010 to 7 January 2011, and from 31 January 2011 to 8 March 2011. After further studies in Japan, the draft preparatory survey report was completed and explained to the Palestinian side from 6 to 7 July 2011, and finalized the final report as shown herewith.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendship between us.

Finally, I wish to express my sincere appreciation to the officials concerned of the Palestinian Interim Self-Government Authority for their close cooperation extended to the survey team.

July, 2011

Shinya Ejima
Director General,
Global Environment Department
Japan International Cooperation Agency

Executive Summary

1．Background, Circumstances and Outline of the Requested Project

The Jericho Jordan Valley Area with a population of 89 thousand is located in the world-famous Great Rift Valley. Owing to the topographic conditions, wastewater generated in urban areas has no other discharging points, thus, it remains within the valley. Since there is no proper wastewater treatment facilities available in this area, the contamination of the groundwater vein, which is the sole water source for the water supply system of the Jericho Municipality, has been found in serious condition in January 2010.

The groundwater and soil contamination in this area also affects and causes disturbing concerns to Israel, thus, the establishment of an appropriate wastewater treatment system has become a major issue within the context of the Peace of Middle East. From a viewpoint of effective use of the limited water source, treated wastewater is expected to be used as a new water source. Agricultural activities have been prospected in this area and a construction of an “Agro-Industrial Park” is planned as a core project in the “Corridor for Peace and Prosperity” that is being promoted by the Government of Japan. Wastewater generated in the park is also planned to be treated and utilized.

Based on these circumstances, the Palestinian Interim Self-Government Authority requested the Jericho Wastewater Collection, Treatment System and Reuse Project (hereinafter referred to as ‘the Project’) in Jericho Municipality located in the Jordan River’s West Bank Area in August 2008 under the Japanese Grant Aid Assistance. In response to the request, the Government of Japan decided to conduct the Preparatory Survey to study the feasibility of the Project. JICA conducted the Preparatory Survey to examine the target facility construction sites and wastewater treatment methods. The outline of the request is as follows:

- Construction of a wastewater treatment plant (WWTP) that serves Jericho Municipality and the surrounding areas; namely, Nwaeima District, Duyuk District, Ain Sultan Camp and Aqbet Jaber Camp
- Installation of trunk and branch sewer lines

2. Summary of Study Results and Contents of the Project

The survey team was dispatched from 12 December 2010 to 7 January 2011 and from 31 January 2011 to 8 March 2011 for the basic design, and in July 2011 for the explanation of the Draft Final Report of the basic design.

In accordance with the contents of the request by the Palestinian Interim Self-Government Authority, the result of the preliminary study and meetings with relevant agencies, the following design policy was adopted as a basis of the survey:

1) The whole WWTP is planned to be constructed under this project. However, the sewer pipelines are decided to be included under this project to its maximum extent within the remained budget. Furthermore, Japanese technology is positively employed in planning and designing the project.

2) The design target year for the WWTP is set at 2020. Facilities were designed to cope with the increasing wastewater amount collected in accordance with sewer pipeline development. Applicable Palestinian Design Manuals are decided to be used.

3) Basic planning policy of the Waste Water Treatment System is as follows:

(1) Design wastewater amount and quality

Design wastewater amount and quality are planned for the target year of 2020 and for the ultimate plan (100 % connection in 2025) as shown in Table-1.

Table-1 Design Wastewater Amount and Quality

Items		Target Year		Amount Ratio	Application to facility design
		2020	Ultimate Plan		
Wastewater Amount (m^3/day)	Daily Average	6,600	9,900	1.0	Reactor during winter season and sludge drying bed
	Daily Maximum	9,800	14,400	1.5	Past record of other WWTP facilities
	Hourly Maximum	19,100	29,000	2.9	Sewer pipes and pipes in WWTP
Wastewater Quality (mg/L)	BOD	500	500	---	Mass balance, reactor capacity and air blower capacity
	TSS	500	500	---	
	T-N	75	75	---	

(2) WWTP

Design WWTP capacity and treated wastewater quality are planned as shown in Table-2:

Table-2 Design WWTP Capacity and Treated Wastewater Quality

Items	Wastewater Amount and Quality			Effluent Quality
	Daily Average	Daily Maximum	Hourly Maximum	
Wastewater Amount (m^3/day)	6,600	9,800	19,100	---
BOD (mg/L)	500			20
TSS (mg/L)	500			30
T-N (mg/L)	75			50

Upon planning of these design frame values, the following points are taken into account:

- Compared with Japan, water consumption is much less in the Middle East countries including Palestine, but the pollution loading is similar to that of Japan. This attributes to the lower level of incoming wastewater quality especially due to the high nitrogen (N) concentration as a result of high BOD. An advanced removal technology for nitrogen is needed for a stable WWTP operation. Accordingly, Advanced Oxidation Ditch (OD) method with high N removal rate is employed. However, due to the low level of incoming wastewater quality, treatment loading becomes high compared with the normal OD method. Therefore, this treatment method is considered to be an "Extended Aeration Method".
- Upon selection of agitation and aeration method, energy efficiency is examined. Horizontal shaft propelling agitator and hyper fine bubble aerator, which are developed in Japan are selected. This system has quite high energy efficiency and it has been employed recently in many WWTPs in Japan.
- The Ministry of Agriculture is positive in the reuse of the treated wastewater. However, this requires chlorine disinfection for the safe reuse of the treated wastewater. Thus, chlorine disinfection is planned even if it is not needed according to the current Palestinian effluent quality standard. Furthermore, irrigation water tanks are planned to be installed for the efficient reuse.
- As electricity cost is relatively high in Palestine, solar panels of 100 kW capacity that can generate the power required for the plant operation at the primary stage was in order, to the same O&M cost, and to express Japanese technology. Panels will be installed near the entrance gate so that visitors can easily recognize them. Generated power will be utilized for wastewater treatment during day time and the local grid power will be used during night time.
- Since the construction site has enough area, a Japanese style garden with trees, grass and brook will be established utilizing the treated wastewater to express the Japanese distinctive character.
- Since sludge-generation amount is relatively small, sludge-drying bed will be operated

without chemicals and electrical power. The wastewater sludge contains abundant nutrients such as nitrogen (N) and phosphorus (P). However, when it is directly applied to farmland, nutrients will be rapidly dissolved and this causes adverse effects to the crops. Therefore, dried sludge should be dumped within the plant site for one-year period for stabilization and it will be utilized as a fertilizer or soil improvement material.

(3) Sewer Pipelines

Sewer network is designed for present demand within the boundary of Jericho Municipality and for forecast wastewater amount for the surrounding areas in accordance with the design population. Sewer pipes which will be installed through the Project are basically trunk sewers which collect service areas exceeding 20 hectares (ha) and housings located along with trunk sewer routes were planned to be connected. To enhance the network development benefit, branch sewer installation with a total length of 16 km which will be covered by the Palestinian side is also planned. Two pipe-bridges crossing Wadi Qelt are designed.

(4) Project Implementation

Currently, residential housing areas are rapidly being developed in Jericho Municipality. Ready mix concrete plant, iron reinforcement bar factory and heavy construction machineries are readily available. Therefore, local contractors can be employed for the WWTP construction and sewer pipeline installation under this project.

(5) Materials and Equipment Procurement

Major civil and architectural materials are available in Palestine. Most of DCI pipes, mechanical and electrical equipment will be imported from Japan, unloaded at an Israeli port and they will be transported to Jericho Municipality by in-land transportation.

(6) Technical Cooperation

Since Jericho Municipality has no experience on sewerage system management, long-term technical cooperation is needed for O&M of the completed WWTP and sewer network, organizational and institutional strengthening, accounting and financial capacity building, and house connection to sewer main pipes.

3. Contents of Outline Design

1) Construction

Table-3 WWTP Facilities

Facilities	Specifications and Dimensions	Remarks
WWTP	Design Capacity 9,800m^3/day Civil Structures（RC） Waste Receiving Tank for Vacuum Trucks, Grit Chamber, Reactor, Final Clarifier, Sludge Thickener, Disinfection Tank, Irrigation Tank, Sludge-Drying Bed, In-plant Landscaping, In-plant Piping Architectural Structures（RC/Concrete Block） Administration Building, Substation Building, Workshop Building, Blower and Electric Room, Return-Sludge Pump House, Chlorine House, Thickened-Sludge Pump House, Japanese Garden Mechanical Equipment Equipment for Grit Chamber, Primary Clarifier, Reactor, Final Clarifier including Return-Sludge Pump House, Chlorine House, Sludge Thickener Electrical Equipment Equipment for Substation, Power Control Panel, SCADA Control Panel, Instrumentation Solar Panel（Output 100kW）	Newly Constructed
Sewer Pipes	Trunk Sewer（Dia. 200mm-700mm）25.4km Pipe Bridge（Wade Crossing; Steel Truss with DCIP）2 points 400m×124.5m 700m×88.0m	Newly Constructed
Effluent Pipe	Dia. 700mm×400m	Newly Constructed

2）Procurement

Table-4 Procurement

Category	Equipment Name
Procured Equipment	Water Quality Analysis Equipment (Portable pH・DO Meter, MLSS Meter, ORP Meter, Working Bench, Electric Balance, Incubator, Refrigerator, Vacuum Pump, Deionizer, Dehydrator, Colony Counter, BOD Incubation Bottle, Portable N/P Measurement Kit)

4. Project Implementation Schedule

The period for detailed design and bidding procedures is estimated to be 4.5 months compressing to the maximum extent. Further 2.5 months are needed for relevant procedures, and 24 months are needed for construction works including equipment procurement, resulting to the total project period of 31 months.

5. Verification of Project Appropriateness

The project is to construct a sewerage system in Jericho Municipality where no similar system has ever existed to improve the water environment of the river basin, including groundwater and the Dead Sea. It will promote the reuse of treated wastewater in the target areas where water source is quite tight. Further,

as nitrogen concentration is increasing in groundwater, which is the sole water source for municipality water supply system, a provision of an integrated wastewater treatment has become an emergency issue. Israel is also strongly requesting the water environment preservation in the area. Therefore, the urgency to implement the Project is recognized.

Year 2020 is set as the target year of the proposed sewerage system development plan. As to 53 thousand design service population, connection ratio of 80% is set for Jericho Municipality and 50% for its surrounding areas. WWTP facilities that can provide an advanced treatment to incoming wastewater will be constructed. Treated wastewater will be stored in an irrigation tank and it will be reused effectively through pumps and pipelines to be provided by the Palestinian side.

Through the project implementation, water environment pollution issues will be mitigated and the reuse of the treated wastewater will provide valuable water resource to the target area. Moreover, the sanitary environment of Jericho Municipality and its surrounding areas, which are considered as world-famous tourism spot, will be greatly remedied. Also, since Palestine's O&M and technology level in sewerage facilities is still at primary level, a Japanese technical cooperation project is needed to establish organization/management structure and to instruct the O&M methods of sewerage system.

The project is implemented utilizing Japanese grant aid and therefore, advanced Japanese technology is duly utilized. In the reactor, which is the core facility in the WWTP, energy-saving aerator developed in Japan is employed. Solar panels with significant output are also applied for the electric power needed in the plant operation during daytime. In addition, a Japanese-style garden utilizing the treated wastewater is planned to express Japanese identity.

Tariff collection is needed to manage the sewerage system. Even if sewerage tariff is set at the lowest level of supply water tariff and if actual connection rate is lower than the design connection rate, sewerage system of the Project is planned to be manageable.

The followings can be expected as the direct project benefits:

1) At present, all the wastewater generated by 40 thousand residents is penetrating underground, but in the target year of 2020, 68 % of wastewater generated by design service population of 53 thousand will be collected and treated through the system.
2) Design pollution removal rates are as high as 94 %, 86 % and 67 % for SS, BOD and Nitrogen, respectively.
3) Treated wastewater of 6,600 m^3/day, daily average amount, is to be reused as irrigation water. The supplying potable water in Jericho Municipality through which wastewater is generated contains less

soluble salinity compared with groundwater, therefore, the treated wastewater can be used in various purposes.

4) As a result, increase of nitrogen concentration in groundwater will be prevented.
5) At present, generated wastewater penetrates underground and finally discharged into the Dead Sea through the Jordan River. Although some pollutant removal is expected by soil absorption, a considerable rate of pollutants is discharged to the Dead Sea. Upon completion of the sewerage system, most of pollutants will be removed by the WWTP, and the amount of pollutants discharged into the Dead Sea will be decreased drastically.
6) Agro-Industrial Park is currently developed in Jericho City under Japanese assistance. The park is expected to generate considerable amount of wastewater with high pollutant concentration, therefore, it is basically needed for the park to have its own WWTP. If the wastewater from the park is sent to the proposed WWTP in this project, the construction of the park-owned WWTP is not needed. This will help save considerable costs in construction and O&M cost because per wastewater volume of O&M cost for small-scale WWTP is higher than large-scale ones.

Also, the following are anticipated as indirect project benefits:

1) According to the results of the survey conducted among the residents of Jericho Municipality, morbidity is quite high. Since high morbidity is caused by inferior sanitation condition, their hygiene status will be improved by the introduction of the sewerage service.
2) Currently, the sole potable water source is the spring water generated from the nearby mountains shared by residents and farmers. Considering the population growth, future water source capacity shortage is apparent. If some percentage of the spring water used for agriculture is replaced by the treated wastewater, the saved spring water volume can be used as potable water.
3) Increase in potable water volume will enhance commercial and industrial activities and reuse of the treated wastewater to irrigation purpose will increase agricultural products. In addition dried sludge can be used as fertilizer or soil improvement material for farm lands. This effect will invigorate the local economy.
4) Though the number of tourists has been increasing rapidly, most of them are single-day visitors and the number of overnight visitors is still small. The improvement of the sanitary environment will encourage more visitors to stay overnight, thus, there will be an increase in the number of overnight tourists bringing more revenues.

As aforementioned, many project benefits can be expected and this project will also contribute in upgrading the residents' Basic Human Needs (BHN). However, since the Jericho Municipality, the executing agency, lacks the technical know-how and experience in O&M activities for the sewerage system to be constructed under this project, the execution of a Japanese technical cooperation project is

strongly recommended.

In addition, the following items are required to be positively undertaken by the Palestinian side for the effective and smooth project implementation:

1) Securing of project budget for portions to be undertaken by Palestinian side
2) Securing of land acquisition for the facilities constructed by the Project
3) Acquisition of EIA approval from EQA
4) Mutual coordination between related Palestinian agencies for procedures needed for project implementation
5) Appointment of counterpart staff for technical cooperation project
6) Assignment of staff in participation to training and capacity building program
7) Preparation of mid-short term sewer network installation plan, budgetary arrangement and assured system development
8) Execution of measures needed in sewerage system management such as formulation of tariff structure, establishment of management organization, preparation of house connection promotion plan and so on
9) To formulate a concrete plan for the reuse of treated water

Jericho Wastewater Collection, Treatment and Reuse Project

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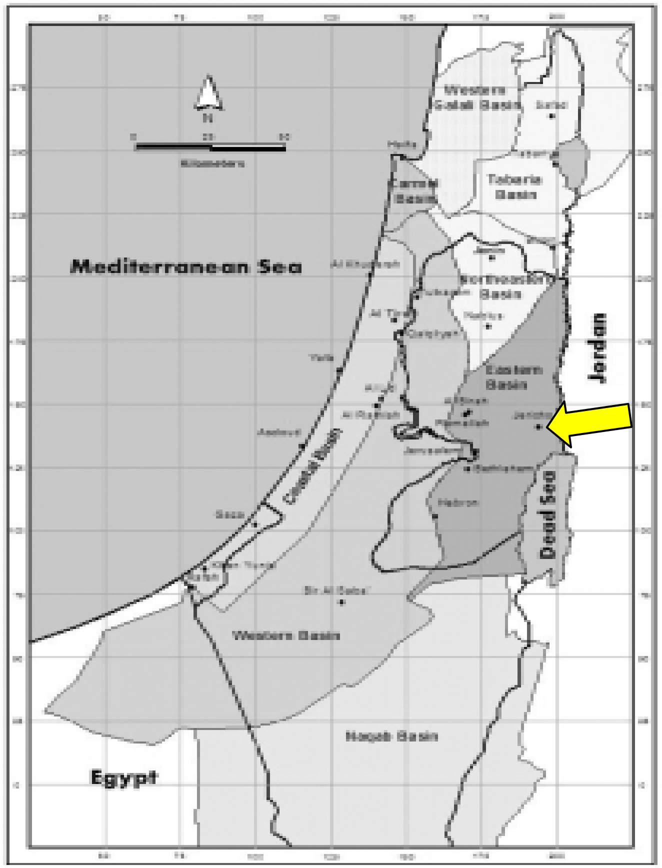
APPENDIX



Location Map of Proposed Sewerage System

Bird’s-eye View during Operation

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Abbreviations

AfD	Agency Francaise de Development (French Development Agency)
ARIJ	Applied Research Institute of Jerusalem
BOD	Bio-chemical Oxygen Demand
CAMP	Gaza Coastal Aquifer Management Program
CARE	Cooperative for Assistance and Relief Everywhere, Inc.
Cl^-	Chloride
COD	Chemical Oxygen Demand
CMWU	Coastal Municipality Water Utility
DFID	Department for International Development
ECHO	European Commission for Humanitarian Office
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EQA	Environmental Quality Authority
EU	European Union
ICT	Israeli Civil Administration
ICRC	International Committee of the Red Cross
IDB	Inslamic Development Bank
GTZ	German Technical Cooperation
JICA	Japan International Cooperation Agency
JWU	Jerusalem Water Undertakings
KfW	Kreditanstalt für Wiederaufbau
MCC	Mennonite Central Committee
MCM	Million Cubic Meter
MOA	Ministry of Agriculture
MOLG	Ministry of Local Government
MOTA	Ministry of Tourism and Antiquities
NEDA	Netherland Development Cooperation Agency
NORAD	Norwegian Development Cooperation Agency
NWC	National Water Council
NWU	National Water Utility
NGO	Non-governmental Organization
NH_3	Ammonia-Nitrogen
N-Kjd	Kjeldahl Nitrogen
NO_2	Nitrite
NO_3	Nitrate
OPEC	Organization of the Petroleum Exporting Countries
Oxfam	Oxford Committee for Famine Relief
O&V	Organic and Volatile matter
PAPP	Program of Assistance for the Palestinian People
pH	Negative Log of Hydrogen Ion Concentration
PECDAR	Palestinian Economic Council for Development and Relief
PHG	Palestinian Hydrologic Group
PNA	Palestinian National Authority
PO_4	Phosphate
PWA	Palestinian Water Authority
SIDA	Swedish Development Cooperation Agency
SO_4	Sulfate
SS	Suspended Solids
TDS	Total Dissolved Solids
TS	Total Solids
TSS	Total Suspended Solids

TVSS	Total Volatile Suspended Solids
UNDP	United Nations Development Programme
UNWRA	United Nation Works and Relief Agency
USAID	United States Agency for International Development
WB	World Bank
WBWD	West Bank Water Department
WSSA	Water Supply & Sewerage Authority (Bethlehem)
WWTP	Wastewater Treatment Plant

Chapter 1 Background of the Project

1-1 Background, Circumstances and Outline of the request for Grant Aid Assistance

1-1-1 Background and Circumstances

The Jericho Jordan Valley Area with a population of 89 thousand is located in world-famous Great Rift-Valley. Owing to the topographic conditions, wastewater generated in the urban area has no other discharging points, thus, it remains within the valley. Since there is no proper wastewater treatment facilities available in this area, contamination of the groundwater vein, which is the sole water source for the water supply system of Jericho Municipality, has been found in serious conditions in January 2010.

The groundwater and soil contamination in this area also affects and causes disturbing concerns to Israel, thus, the establishment of an appropriate wastewater treatment system has become a major issue within the context of the Peace of Middle East. From a viewpoint of effective use of the limited water source, treated wastewater is expected to be used as a new water source. Agricultural activities have been prospected in this area and a construction of an "Agro-Industrial Park" is planned as a core project in the "Corridor for Peace and Prosperity" that is being promoted by the Government of Japan. Wastewater generated in the park is also planned to be treated and utilized.

Based on these circumstances, the Palestinian Interim Self-Government Authority requested the Jericho Wastewater Collection, Treatment System and Reuse Project (hereinafter referred to as 'the Project') under the Japanese Grant Aid Assistance in Jericho Municipality located in the Jordan River's West Bank Area in August 2008. In response to the request, the Government of Japan decided to conduct the Preparatory Survey to study the feasibility of the project. Under the decision, JICA conducted the Assistance Feasibility Study on April and October of 2009 for data collection and arrangement. Then, JICA carried out the Preparatory Study from July to August of 2010 to examine the target facility construction sites and wastewater treatment method.

1-1-2 Outline of the Request

1) Facilities：Sewerage system to serve Jericho Municipality and its surrounding areas（Nwaeima District, Duyuk District, Ain Sultan Camp and Aqbet Jaber Camp）
{Wastewater Treatment Plant 15,400m^3/day, Trunk Sewer and Sewer Network will be decided based on the Survey}
2) Equipment：Water Quality Analysis Equipment

3) Technical Cooperation：Technical cooperation and soft component on organization and O&M structure strengthening

1-2 Natural Conditions

(1) Topography

The Palestinian Interim Self-Government Authority is surrounded by Israel and is divided by Gaza Area and Jordan River West Bank Area. While, Gaza Area has the border between Israel in the east and another border between Egypt in the south. Gaza is faced to the Mediterranean Sea in the west. Except for the border between Jordan in the east, Jordan River West Bank Area is surrounded by Israel.

Jericho Municipality where the project is planned to be implemented is located at the west bank of the Jordan River in Palestinian Areas. The municipality is renowned as one of the oldest cities in the world having the ruins of the ancient city dates back to 9000 B.C., appearing repeatedly in the Old Testament. It faces the Dead Sea which has elevation of minus 400 meters from sea level. The center district of the municipality is at an elevation of minus 250 meters from sea level which is the lowest elevation in the world where cities exist.

Including the Mount of Temptation where Jesus was said tempted by the Devil, rocky mountain exists in the west. Topographically, ground elevation has a slight slope towards Jordan River located in the east. Elevation is ranging from minus 150 m by mountain side to minus 250 m in municipality center and to minus 320 m at eastern municipality boundary. There are many springs in western area where ancient cities were once-flourishing, but eastern springs has low groundwater level of GL-15 m. Due to high salinity concentration, it is not applicable for drinking purpose.

Wadi Quelt running through mountain range penetrates the municipality area and other two lines of Wadi exist in the north and south. Once or twice a year, huge amount of muddy rainwater caused by concentrated rain flows though these Wadi(s).

The ground of municipality center and eastern area is composed of silt and clay. They are generated by mountain erosion and transported through Wadi and accumulated at aforementioned areas. Depth of the layer reaches several dozen meter and ground condition is solid. Though many plants and trees can be found, they are cultivated by man-made irrigation and a few natural bushes are found near Wadi.

(2) Soil Conditions

From the geological viewpoint, the soil condition of Jericho Municipality is different from that in Ramallah and Jerusalem where are characterized by noticeable rock outcrop. Except for rocky mountain and rock outcrop in western area, the area ranging from municipality center to Jordan River is composed of thick silt/clay layer. Few gravels and cobbles are found in these areas. Groundwater table is low, and soil humidity can be observed at a level below GL -10 m. The ground is relatively firm despite of silty/clayey layers, N value exceeds 30 at GL -10 m.

As to the WWTP construction site, since the N value exceeds 15 throughout the depth, the ground has a due supporting capacity for the foundation for tanks and buildings. However, ground with N value less than 10 is partially observed, where may be required to be replaced with firm soil or be compacted.

(3) Climate

Palestinian climate belongs to Mediterranean Sea climate having rainy winter time and hot summer time. Annual rainfall fluctuates depend on year or area ranging from 150 mm to 1,100 mm. Average annual rainy days are 25 to 55 days. Supposing from the locality of Jericho Municipality, surrounded by mountains with ground elevation of minus 300 m below sea level, it is hot in summer time with temperature exceeding 40^{o}C, on the other hand it is cold and comfortable with temperature down to 15 ^{o}C. Thanks to such a favorite locality, many tourists visit the area. Annual rainfall is 50 to 400 mm and most of rain falls concentrate during October to March. Because of the small precipitation, plants and vegetables cannot grow without artificial irrigation. A number of large Wadi (dried river) are found in the municipality, and bank erosions are observed caused by large amount of rain water during rainy season in winter time.

On the other hand, Jericho municipality is favored with spring water from the ancient time. The river-bed water generated by Ain Sultan spring serves as a stable potable water source of Jericho Municipality. Owing to this abundant water source, average unit water consumption in Jericho Municipality is larger than that in other cities.

1-3 Environmental and Social Considerations

1-3-1 Palestinian Environmental Law

The Palestinian Environmental Law was established in 1999 and defined the principle clauses on the environmental protection. The objectives of the law are as shown below.

- Protecting the environment from all sorts and types of pollution
- Protecting public health and social welfare
- Incorporating environmental resources protection in all social and economic development plans and promote sustainable development to protect the rights of future generations
- Conserving ecologically sensitive areas, protecting biodiversity, and rehabilitating environmentally damaged areas
- Setting inter-ministerial cooperation regulations and standards various environmental protection areas and jurisdictions
- Promoting environmental information collection and publication, public awareness, education and training

This law regulates various subjects on environmental aspects as follows.

- Management and protection of various resources. Issues covered are related to land environment, air environment, water resources and aquatic environment, and natural, archeological, and historical heritage protection
- Environmental Impact Assessment (EIA) and auditing, permitting of development projects, monitoring of environmental resources and their parameters
- Penalties to be applied in case of violation of any article presented under the law
- Other issues addressed by the legislation include emergency preparedness, public participation, research training and public education

In accordance with the environmental law, the policy of the EIA was established in 2000 aiming the goals as shown below.

- Ensuring an adequate standard of life in all its aspects, and not negatively affecting the basic needs, and the social, cultural and historical values of people as a result of development activities
- Preserving the capacity of the natural environment to clean and sustain it
- Conserving biodiversity, landscapes and the sustainable use of natural resources

- Avoiding irreversible environmental damage, and minimizing reversible environmental damage caused by development activities

To meet the goals, the process of EIA is established by the Environmental Quality Authority (EQA), which is the main body of this issue, as shown in Figure 1-1. In the policy the facility of sewerage treatment system with trunk sewer pipelines is defined as a project subject to the EIA among the 14 categories of facilities like power plant and so on. The procedures such as site survey, public hearing, screening, scoping and preparation of EIA (draft) are the similar procedures employed in Japan.

However, uniquely EIA is to be explained and approved by stakeholders composed of 11 agencies such as Ministry of Agriculture (MOA), Ministry of Tourism and Antiquities (MOTA), Ministry of Local Government (MOLG), EQA, Palestinian Water Authority (PWA), and others. After obtaining the approval from these agents, the final EIA will be submitted to the EQA for the final approval. It will take for about six months to complete all the procedures and get the final approval from the EQA.

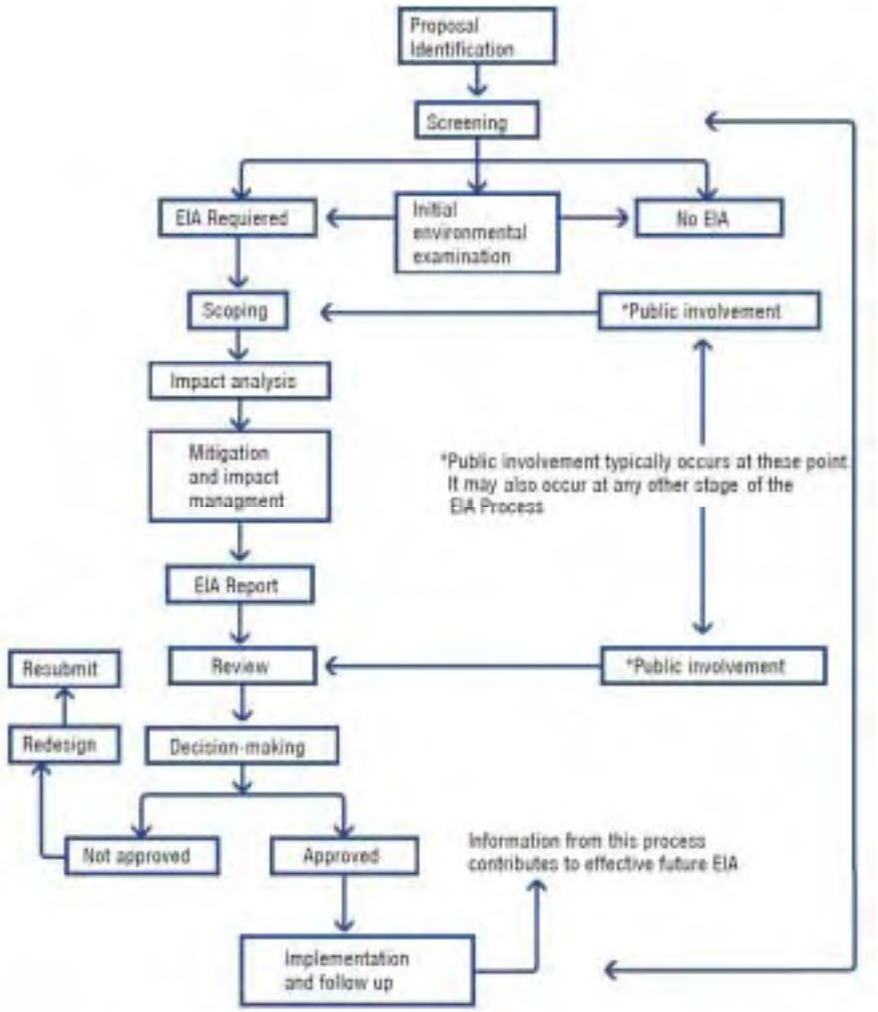

Figure 1-1 Flow Chart of EIA Procedures

1-3-2 Applied Regulations on Environmental Contamination

In Palestine the regulations for the environmental contamination are currently established only for atmospheric conditions and noise nuisance affected by the quality of effluent water, emission gas, and machine operations by a project. As for vibration and odor, no Palestinian own regulations are established yet.

In this project, there is no any combustion equipment to be installed and no negative effects for atmospheric conditions are expected to occur. Noise regulations are established as shown in Table 1-1.

Table 1-1 Noise Regulations by Districts

Districts/Regulations	Daytime(db) 7am-8pm	Night(db) 8pm-7am
Local residence, hospital・school	＜40	＜30
Urban residence	＜50	＜40
Commercial/residential	＜55	＜45
Commercial	＜65	＜50
Industrial	＜75	＜65
Public plaza	＜85	＜75

As any definite district/regulation is defined to be applied for the site of this kind of project, the regulation for the industrial district will be to apply for this Project which is the second lowest strict regulation next to the public plaza.

The effluent water is regulated by the Palestinian regulation and also by the more strict regulation agreed with Israel. The latter regulation is divided into two stages. In the first stage, it regulates as BOD ＜20mg/L、TSS＜30mg/L、T-N＜25mg/L (actually this figure is applied as T-N＜50mg/L as mutual agreed between PWA and Israel) The regulations for the second stages are as shown in Table1-2 and Table 1-3, which are quite strict regulations.

Table 1-2 Effluent Water Regulations

End Usage	Grade	Treatment Method	Applied to
Irrigation in aquatically most sensitive area	1	Activated sludge method、denitrification, high quality treatment such as added sand filtration or disinfection	Any crops, park, garden、athletic field, and others applicable
Irrigation in aquatically medium sensitive area	2	Activated sludge method then disinfection	Olive, peanuts, fruits, cooking vegetable, for canned fruits, plants
Irrigation for crops of non-edible use	3	Anaerobic pond, aeration pond, or aerated lagoon	Cotton, sugar beet, park garden, athletic field, and others applicable
Discharge to Wadi or river	4*	Activated sludge method、denitrification, high quality treatment such as added sand filtration or disinfection	Any crops, park, garden、athletic field, and others applicable

*Note: From January 1st, 2008 the grade 4 is applicable for the discharge to Wadi or river.

Table 1-3 Effluent Regulations by Grades

Items	Unit	Grade 1		Grade 2 and 3		Grade 4*		Japan (reference)
		Average	Max.	Average	Max.	Average	Max.	
BOD	mg/l	10	15	20	40	10	15	20
TSS	mg/l	10	15	30	60	10	15	70
COD	mg/l	70	100	100	150	70	100	20
Electric conductivity	ds/m	1.4	-	1.4	-	-	-	-
pH	mg/l	6.5-7.5	7.5-7.5	6.5-8.5	-	7-8.5	7-8.5	5.8-8.6
Chlorine ion	mg/l	250	-	250	-	400	-	-
Boron	mg/l	0.4	-	0.4	-	-	-	10
Na	mg/l	150	-	150	-	200	-	-
SAR	mg/l	5	-	5	-	-	-	-
Fecal coliform number	MPN /100 ml	10	100	10	-	200	100	300,000*
T-N	mg/l	25	40	25	40	10	15	120
Silver(Ag)	mg/l	0.05	-	0.05	-	0.05	-	-
Arsenic(As)	m/l	0.1	-	0.1	-	0.1	-	0.1
Cadmium(Cd)	mg/l	0.01	-	0.01	-	0.005	-	0.01
Chromium(Cr)	mg/l	0.1	-	0.1	-	0.05	-	2
Cobalt(Co)	mg/l	0.05	-	0.05	-	-	-	-
Copper(Cu)	mg/l	0.2	-	0.2	-	0.02	-	3.0
Fluorine(Fl)	mg/l	2.0	-	2.0	-		-	8.0
Ion(Fe)	mg/l	2	-	2	-	-	-	10.0
Mercury(Hg)	mg/l	0.002	-	0.002	-	0.0005	-	0.005
Lithium(Li)	mg/l	2.5	-	2.5	-	-	-	-
Manganese(Mn)	mg/l	0.2	-	0.2	-	-	-	10.0
Molybdenum(Mo)	mg/l	0.01	-	0.01	-	-	-	-
Nickel(Ni)	mg/l	0.2	-	0.2	-	0-.05	-	-
Lead(Pb)	mg/l	0.1	-	0.1	-	0.008	--	0.1
Selenium(Se)	mg/l	0.02	-	0.02	-	-	-	0.1
Vanadium(V)	mg/l	0.1	-	0.1	-	0.1	-	-
Aluminum(Al)	mg/l	5	-	5	-	-	-	-
Zinc(Zn)	mg/l	2	-	2	-	0.2	-	2.0

*Note : The number shown in Japan shows the number of coliform number and not the fecal coliform number.

1-3-3 Environmental Condition of Project Site and its Surrounding Areas

Figure 1-2 shows the land usage of Jericho Municipality. Commercial areas and public office buildings are concentrated at the center of the municipality and surrounded by residential areas and farmlands. Further toward the east at lower lands are fields for agricultural products and date palms. There are refugee camps. Residential areas are being newly developed toward the outer skirt of the municipality. Some of the residential houses may be the second summer houses to pass the winter time enjoying the mild climate of this area. The west part of the municipality toward the mountain range is rich with springs and many ruins dating back to 8,000 B.C. are archeologically excavated. Some historical monuments of Christian/Islamic temples also locate in this region.

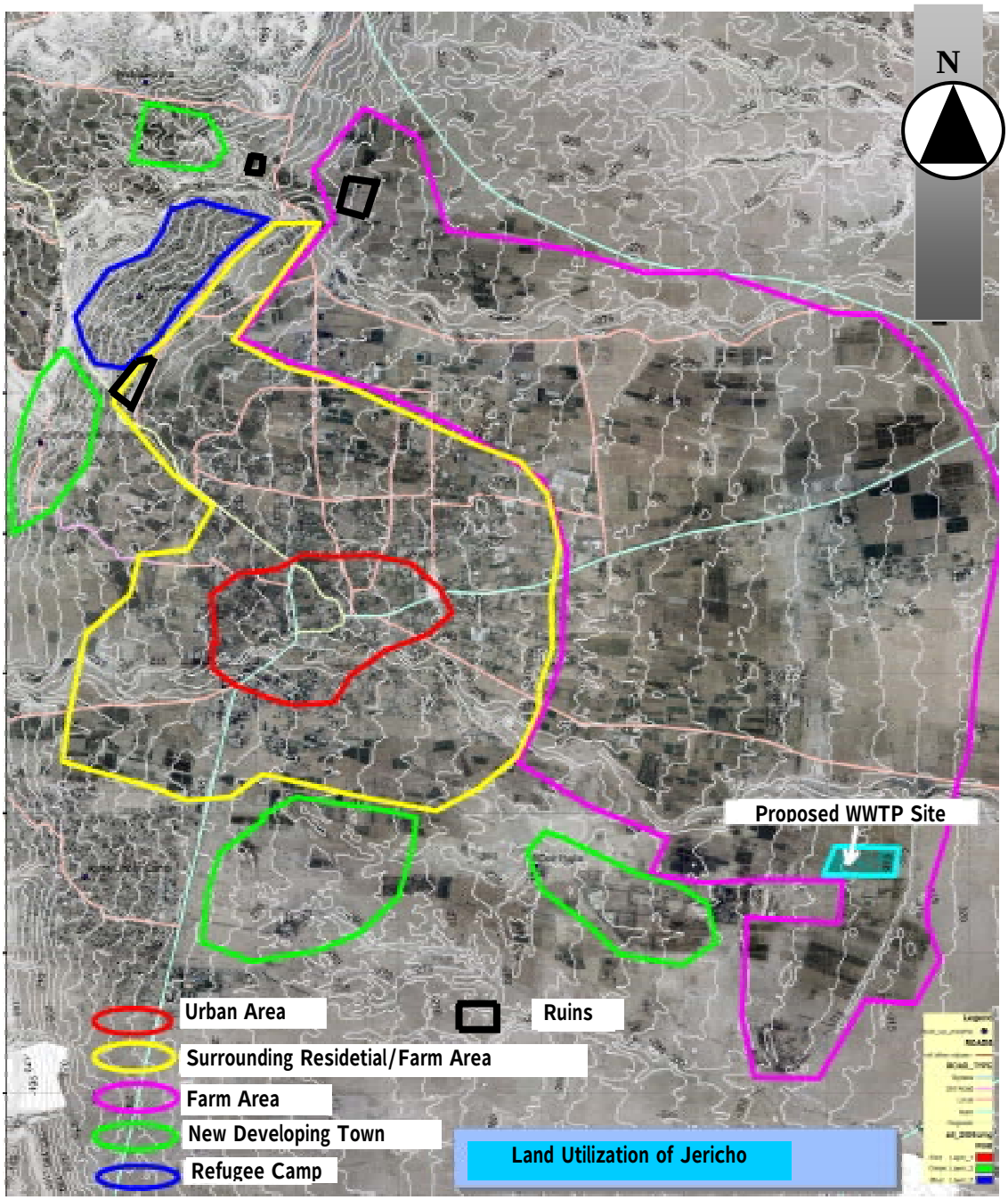

Figure 1-2 Land Use of Jericho Municipality

The site where the Wastewater Treatment Plant (WWTP) is proposed to be constructed is owned by the government under the management of the Ministry of Religious Affairs. A part of the site is utilized for agriculture farm. The surrounding lands of the proposed site are also the farm land but no residential houses are observed. A horse riding club and cemetery are spotted in this area. As for the farm land in this region, crops cannot be expected without watering systems due to scarce rainfalls. Polyethylene pipes are provided for sprinkling by using the underground water as water resources.

There are no water surfaces at all in the vicinity. There are dried stream traces of water called 'Wadi' which become water streams when enough precipitation falls in winter time only once or twice annually. This means only the water resources for irrigation in this region are from the underground water. The salt content of the underground water in this area is high and not suitable for drinking purpose.

1-3-4 Screening

This Project, construction of a Wastewater Treatment System, is defined to be the category "B" based on the JICA Guidelines for Environmental and Social Considerations (2004 version). Any particular serious environmental and social impacts will not be observed as detailed below.

1) As the proposed site for the WWTP belongs to the national property and is not for the residential area and is used for agricultural purpose partly. Any relocation of residents is not necessary. In addition, any big socio-impact will not be observed because no residential houses exist in the vicinity of the proposed site of the WWTP.
2) There will be no adverse effects on natural environment in the proposed site since only a part of the areas is used for farm and the rest is left not used. Although there are the ruins date back to several thousand years B.C in the Jericho Municipality, the location of the ruins are limited in the area in the west of the municipality, where a plenty of springs had been found. There is no such ruin in the proposed site due to lack of such water resource. Therefore, the issues about encounter of ruins in the proposed site of the WWTP will not be necessary to consider.
3) Since the treated wastewater by the WWTP is basically reused for irrigation, there will be no possibility of wastewater contamination to the farmland. However, a part of the surplus treated water will be discharged to Wadi and infiltrate into the river bed nourishing the underground water and may flow in the Jordan River and to the Dead Sea incidentally. Compared with the current conditions which directly discharges the not-treated wastewater to Wadi and let it infiltrate into underground causing contamination of the underground water resources, the proposed wastewater treatment system mitigates the present underground water contamination and reduces inflowing pollutants to the Dead Sea.

1-3-5 Scoping

Environmental and Social impacts by this project are analyzed in two phases, namely "Construction Stage" and "Operation Stage"

(1) Issues on Construction Stage

1) During Installation of Sewer Pipelines

i) Noise, vibration and dust generation may cause nuisances to surrounding areas during excavation and transportation of excavated soil for pipe installation work. These are temporary problems and can be alleviated by the proper selection of construction methods and restriction of working hours.

ii) Traffic congestion may be caused because some roads in the municipality will be excavated and soil will be transported away. This is also a temporary problem and can be solved by a proper selection/indication of the detours and assignment of persons for traffic control.

iii) Harmful effects, such as possible inclination of house may be necessary to study during the roads excavation. However, major problems will not be expected to occur because the soil of Jericho is stable enough for excavation and groundwater level which affects the stability of excavated slope of ground is very low and not harmful.

iv) Historical ruins during excavation. When pipes are being installed at "Old Jericho", there may be ruins/relics found especially at this area. In this case, the ruins/relics shall be preserved and informed/consulted to the relevant Palestinian Authority in charge, and if required route changing of sewer pipelines will be studied for alternative routes.

2) During Construction of the WWTP

i) Since there are no houses in the vicinity of the proposed construction site for the WWTP, the issues of noise and vibration will not be considered as big issues, but dust problems will be caused by construction vehicles because of dust arising from clayish soil of the site especially during dried weather seasons. In order to cope with this issue, pavement or gravelling of the roads and sprinkling by water trucks can be adopted.

ii) For the construction of the WWTP, traffic congestion, including noise, vibration and dust caused by heavy construction vehicles transporting a huge amount of the materials and disposal soils should be considered. Since there is little population living in the surrounding areas of the WWTP site, these issues can be solved by selecting proper access routes to and from the construction site, and restricting of hours of traffic for construction transportation.

iii) The problem in handling of a huge amount of construction wastes, such as packages of construction materials and equipment and disposal soils, and domestic waste of the employees/labors during construction will take place. In order to cope with these, a "Solid Waste Management Plan" will be formulated and implemented. In this plan, reuse of construction waste materials such as metals, plastics, cardboard, and timber shall be encouraged. Since the problem

of proper management of domestic waste disposed by concentrated labor force during the construction is rather serious. This issue shall be properly incorporated in the current waste treatment management system of Jericho Municipality.

iv) Since there are no endangered species, or valuable historical heritage in the proposed site of the WWTP, no particular countermeasures against these issues are required. In addition, the landscape of the Jordan Valley looked down from the vicinity of the proposed site of the WWTP is excellent at present. This view will not be hindered by the construction of the WWTP as the height of the facilities is limited and the plant site is surrounded by plenty of planted trees irrigated by the treated wastewater from the plant.

(2) Issues in the Operation Stage of the Wastewater Treatment System

The sewer pipelines themselves in the operation will not cause any environmental/ social issues. While, in the operation of the WWTP, issues of noise/vibration, and odor due to the plant operation, and problems by traffic to and from the plant are to be discussed in this section. In rare case, the treated excess water from the reuse for irrigation may be discharged to Wadi. Consideration on this issue is also given.

1) Noise/vibration and odor

i) Nuisance of noise/vibration to surrounding area mainly caused by blower operation

Since the blower room will be located far from the site boundary and housed in a concrete structure covered by noise absorption materials with muffler for inhaling/exhausting air, the noise level at the site boundary will be kept less than 50db, which is permissible level for the surrounding areas of the WWTP site even if houses are to be constructed in the future.

ii) Odor

ii)-1 Odor from wastewater receiving tank and grit chamber

Since the odor generated from the wastewater receiving tank and grit chamber, where raw wastewater inflow, cannot entirely be prevented, people can smell it from the range of several dozen of meters depend on wind directions. However, there are no houses expected to be built as the adjacent land located near such facilities is owned by government. Further, the odor will be absorbed and minimized by trees planted surrounding the channel.

ii)-2 Odor from sludge treatment facilities

In this WWTP, the sludge to be treated is the excess sludge from activated sludge process, which generates weak and inoffensive odor. Therefore, there will be no nuisance as long as the sludge is fresh. Since the sludge becomes rotten and then generates offensive odor when the sludge is stored over one day, the excess sludge shall be continuously withdrawn from the clarifier. After several hours of thickening, the sludge shall be filled in the sludge drying bed. Procedures of the above processing will prevent sludge treatment system from generating of the odor.

2) Issues by Traffic for the Plant Operation

In the operation of the WWTP, delivery of chemicals to (once per one or two weeks) and taking out of the dried/stabilized sludge from, which are used as fertilizer and soil improvement agents, (three ton/day) are required. The number of vehicles used for this purpose is very small and causes no negative impacts such as noise, vibration and traffic hazards to the surrounding areas.

3) Quality of Treated Wastewater Discharged to Wadi

The requirements for quality of treated wastewater are: BOD <20mg/L, TSS <30mg/l and T-N <50mg/L (the design value is specified to be less than 25mg/L). The surplus treated water from the reuse for irrigation may be discharged to wadi and infiltrates into underground alongside and may not reach as far as to the Jordan River. In the current situation, only human waste is flowed in “Cess-pit” (concrete-made chamber without bottom slab), and other gray water is discharged directly to wadi. The wastewaters infiltrates into underground without having any treatment. The stored wastewater in the Cess-pit is collected by vacuum vehicles and discharged to wadi and finally penetrates into underground.

Compared with the present situation, after the completion of the WWTP the degree of possible water contamination which may be caused by occasional drain of treated wastewater into wadi will be negligibly small.

(3) Summary of Scoping

According to the above scoping to environmental and social impacts, almost no negative impacts will be observed in the operation stage. Only the issues during sewer pipes installation and construction of the WWTP requires some countermeasures to mitigate the negative impacts as described below.

1) The countermeasures for the issues of noise/vibration nuisance and traffic congestion during installation of sewer pipelines are needed to be prepared
2) The countermeasures are needed to be prepared if ruin/relic is found during installation of sewer pipelines
3) The countermeasures for the nuisance of dust generation by vehicles during WWTP construction are needed to be prepared
4) Prior to the commencement of construction of the WWTP, "The Solid Waste Management Plan" is needed to be formulated taking especially the reuse of waste materials into consideration.

1-3-6 Monitoring Plan

At present, locally hired environment specialists are conducting a site survey for EIA for PWA as a part of the assistant program.

As the project proposed site is owned by the government, and any relocation of people or acquisition of private lands is not necessary. Consequently any big social issues are not expected and therefore no particular monitoring for the progress of local negotiations will be required.

However, after commencement of construction, during construction, and in the operation stage, the monitoring for various issues will be required. All the necessary items, contents and timing to be considered for the monitoring are summarized in Table 1-4. As shown in the table, it is essential to grasp the present environmental/social situations during implementation of the EIA. In addition, mitigation countermeasures for various negative impacts to environmental/social conditions shall be prepared and be included in the Construction Plan. As for Monitoring, these mitigation methods should be evaluated and modified as required.

During construction, various items of monitoring are conducted in the course of the construction observing the conditions before commencement of the construction and proper mitigation methods. In the operation stage of the Plant, even though serious environmental/social problems will not be expected, the required monitoring will be continuously executed as listed in the table based on the EIA.

Table 1-4 Monitoring Items, the Execution Agencies, Frequency, and Timing

Division	Items	Contents	Agency	Frequency	Timing
Grasping of Present Condition	Along the Sewer-pipes	・Facilities required paying special attention; such as hospitals and schools	PWA	At preliminary survey in EIA	EIA
		・Traffic density and noise by the hour			
		・Situation of Traffic congestion generation			
		・Locations and kinds of historical heritage			
	Surrounding conditions of WWTP	・Land utilization conditions			
		・Facilities in surrounding areas			
		・Surrounding housings and others			
		・Dust generation situation by wind			
		・Landscape			
	Effluent Water	・Condition of effluent point			
		・Groundwater quality （Survey of Wells）			
		・Water quality of Dead Sea			
	Solid Waste	・Collection and disposal methods for domestic solid waste in municipality			
	Management	・Collection and disposal methods for industrial solid waste in municipality			
		・Reusing ways for dried sludge from WWTP			
Mitigation Countermeasures and check	Installation of Sewer-pipes	・Countermeasure for noise/vibration	Prepared by the Contractor and reviewed by Consultant/PWA	The Contractor shall prepare as “Environment Protection plan” in the planning of Construction Plan	Formulation of Construction Plan
		・Traffic countermeasures including detour			
		・Historical ruins and procedures of handling when			
		・Construction time scheduling			
	Construction of WWTP	・Countermeasure for noise/vibration			
		・Traffic countermeasures			
		・Countermeasures to facilities requiring paying attention			
		・Prevention measure for dust			
		・Consideration to landscape			
	Treated Water	・Treated water quality, quality of groundwater, influence to quality of Dead sea			EIA
	Solid Waste Management	・Solid Waste Management Plan (Recycling, Disposal of domestic waste and industrial waste)			Formulation
		・Treatment and disposal/reuse of dried sludge and screenings in operation phase			of Construction
Monitoring during Construction	Installation of Sewer-pipes	・Noise/vibration during construction(working points and nearby facilities requiring paying attention	Prepared by construction contractor and reviewed by Consultants/PWA	Daily	During Construction
		・Generation of traffic congestion by construction and effect by countermeasures		Daily	
		・Finding ruin/relic and handling procedures when		Daily	
	Construction of WWTP	・Nuisance by Noise/vibration and influence to surrounding		Daily	
		・Generation of traffic congestion by vehicles for		Daily	
		・Generation condition of dust and effect of mitigation		Daily	
	Solid Waste Management	・Observance situation of Solid Waste Management Plan		Weekly	
		・Disposal methods and quantities of domestic/industrial		Weekly	
		・Recycling methods and quantities		Weekly	
Monitoring in Commissioning Operations	WWTP	・Detection of odor by monitor	Conducted by construction contractor and	As required	During Test Operations
		・Measurement of Noise/Vibration		Moring,Evening, Night	
		・Quality tests of wastewater and treated water		Weekly	
		・Water content and odor measurement for dried sludge		Every Disposal	
Monitoring in operation phase	Sewer-pipe	・Occurrence of odor nuisance and clogging	Conducted by Jericho Municipality and reviewed by EQA	As required	Operation Phase
		・Generation of caving–in		As required	
	WWTP	・Complaint for odor/noise/vibration		As required	
		・Regular analysis for treated water		Monthly	
		・Quantity/purpose of reused treated water, complaint by		As required	
		・Quantity/purpose of reused dried sludge, complaint by		As required	

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

In Palestine, the National Water Policy was enacted on 1995 to clarify the responsibility sharing of water government with related agencies, and regarded the water sources as the public property owing to its importance in sustainable application.

Further, the Water Resource Management Strategy was enacted in 1998 to specify the strategy in execution of the said Policy, for the purpose to prepare a comprehensive framework in sustainable water management and to establish coordination in improving and supporting relevant agencies. In this connection, PWA established a powerful organization to provide public service for water supply and sewerage treatment including solid wastes. This is stipulated in the Water Act.

This project aims the construction of sewerage system in Jericho Municipality where no similar system has ever been available. The project improves sanitary conditions and mitigates groundwater contamination which is incurred by wastewater penetration into the ground. The treated wastewater is aimed to be reused as valuable irrigation water. Table 2-1 shows the outline of the sewerage facilities to be constructed under this project.

Execution of Soft Component for sewerage technology is requested as well. Palestine, where the similar system is not experienced, requires such technical cooperation. This will be covered by the Japanese technical cooperation project.

Table 2-1 Outline of the proposed Sewerage Facilities

Facilities	Dimensions and Contents	Remarks
WWTP	WWTP 9,800m^3/day（RC） Wastewater Receiving Tank for Vacuum Tanker Truck, Screen Channel, Grit Chamber, Distribution Chamber, Reactor, Clarifier, Sludge Thickener, Wastewater Tank, Flow Measurement Tank, Pump Room, Chlorine Disinfection Tank, Sludge Drying Bed, Administration Building, Power Receiving Building, Workshop and Storage Building, Blower and Electric Building, Return Sludge Room, Thickened Sludge Pump Room, Solar Panel（Output 100kW）	Newly Built
Irrigation System	Irrigation Tank	Newly Built
Effluent Pipe	Dia. 700mm×0.35km	Newly Built
Sewer Network	Trunk Sewer（Dia. 700-200mm）25.4km Branch Sewer（Dia. 200mm）16km（Installed by Pallestine side）	Newly Built
Equipment	Water Quality Analysis Equipment (Portable pH・DO Meter, MLSS Meter, ORP Meter, Work Bench, Electro Balance, Incubator, Refrigerator, Deionizer, Dryer, Colony Counter, Vacuum pump, BODIncubation Bottle, N・P Measurement Kit）	

2-2 Basic Design of the Project

2-2-1 Design Policy

(1) Basic Design Policy

Design target year is set at 2020 and designed to cope with the increasing wastewater amount by sewer network expansion within Jericho Municipality and its surrounding areas including refugee camps. For facility design, some parts of Palestinian Design Manuals, mainly sewer pipe portions are referred. For the design of the WWTP, Japanese design manuals are referred.

(2) Consideration on Natural Conditions

Jericho Municipality is regarded as an area with the least precipitation in Palestine. Rainy period is concentrated between December to February, and during dry season between June to August, no rain is anticipated. Even during rainy season, only weak rain falls in short period. Therefore, construction work efficiency will not be significantly influenced by the weather during the execution of the Project.

(3) Policy on Socio-Ecumenical Conditions

Holidays in Palestinian public offices are only on Fridays and office hour is between 8:00 to 14:30. While, in case of private companies, Fridays are holidays but office hour is basically for 8 hours. As there are no regulations on limit of work period, the work period varies by companies and workers are paid according to their worked hours. Since the most of the people are Muslims, they visit Mosque with ardor, and even if they can not visit the Mosque, they pray several times a day. This should be respected and considered in planning not to be affected for working efficiency. Further, the period of the fast and holidays after the fast are to be considered in planning the construction scheduling.

(4) Policy on Laws, Institutions and Regulations

In the sewerage system construction, the Environmental Impact Assessment (EIA) is required to be approved from the Environmental Quality Authority (EQA), for which PWA already submitted and is waiting the comments and/or approval. Though no special rules and regulations as to sewer network installation and WWTP construction, an environmental management plan during construction/operation period of this project is needed to comply with EIA requirement. JICA guideline requests various procedures such as stakeholder meetings.

In case of public structure installation, such as sewer lines, in the private land, the Palestinian laws

require land owners to approve the work without compensation charge, but actually such approval is hardly available. In this project, crossing of private land is not necessary in the sewer installation routes.

During the WWTP operation, effluent standard and noise regulation set by area must be observed. These legal observations are included in the abovementioned environmental management plan.

(5) Policy on Application of Local Contractor and Local Materials

Only a few Grant Aid Assistances have been rendered to Palestine and these project scales are small. However, many construction works are now on-going in Jericho Municipality where many heavy construction machinery are being operated. Reinforced iron bar factory and ready mixed concrete plant are also available. According to the results of construction condition survey, local contractors have capacity for the construction of the proposed sewerage system and the major construction materials are also available except mechanical/electrical equipment.

(6) Policy on O&M Capacity of Project Executing Agency

Currently the staff number of Jericho Municipality is 270. They are managing water supply service also. Water tariff collection is covered by the financial division while system management is undertaken by the service division. However, staff assigned in water supply service is only 6 and their capacity is quite limited. Construction of the proposed sewerage system is to be undertaken by the technical division but their capacity is also regarded weak. In addition, though sewer network system is available in many cities in Palestine, advanced WWTP applying modern technologies such as Activated Sludge Method is only available in Al-Bireh which was constructed by the assistance of German Government. Almost no sewerage related technologies have been accumulated in Palestine. They have scarce experiences in sewerage project management including tariff collection and O&M.

Accordingly, comprehensive training and instruction are needed for not only technology, but also for system management and business operation. Therefore, an introduction of long-term training through Japanese technical cooperation project is judged appropriate. Al-Bireh which is the WWTP managed satisfactorily by German assistance is recommended to be included in the scope of the said cooperation project.

(7) Policy on Facility and Equipment Grade Setting

Needless to say, the treated wastewater quality must comply with the Palestinian effluent standards, and it must meet the more stringent effluent quality accord agreed with Israel. As this accord describes

1st phase and 2nd phase regulations, the treated wastewater quality must comply with the 1st phase regulation at the moment. However, the WWTP shall be designed to cope with quite stringent 2nd phase regulation in future. The 2nd phase regulation stipulates the treated wastewater indices of less than 10 mg/L for BOD, SS and T-N, respectively. The WWTP equipment shall be manufactured based on the universally recognized standards namely ISO. JIS or IEC and civil/architectural structures shall be designed based on British Standard (BS).

(8) Policy on Construction Method, Material/Equipment Procurement and Construction Schedule

Based on the aforementioned natural and socio-economical conditions, a construction schedule shall be prepared considering sufficient available working parties. Quality control and safety plan in construction shall be established as well.

2-2-2 Basic Plan

Figure 2-1 shows the location of the proposed sewerage system.

The WWTP is planned to be constructed at an agricultural land located south-east of Jericho Municipality, which has the lowest elevation in the City. The land belongs to A Zone area within Palestinian dominion located next to C Zone, buffer zone to Israel and under Israeli dominion. Only trunk sewers are to be installed under this project with collection areas along with their route, where are expected to be connected directly to the wastewater lines. There are two main trunk lines: the first is the one Crossing Wadi Qelt which runs through the municipality from west to east collecting wastewater from major urban area located in the north, and the second one collecting wastewater from Agro-Industrial Park and residential area located in the south.

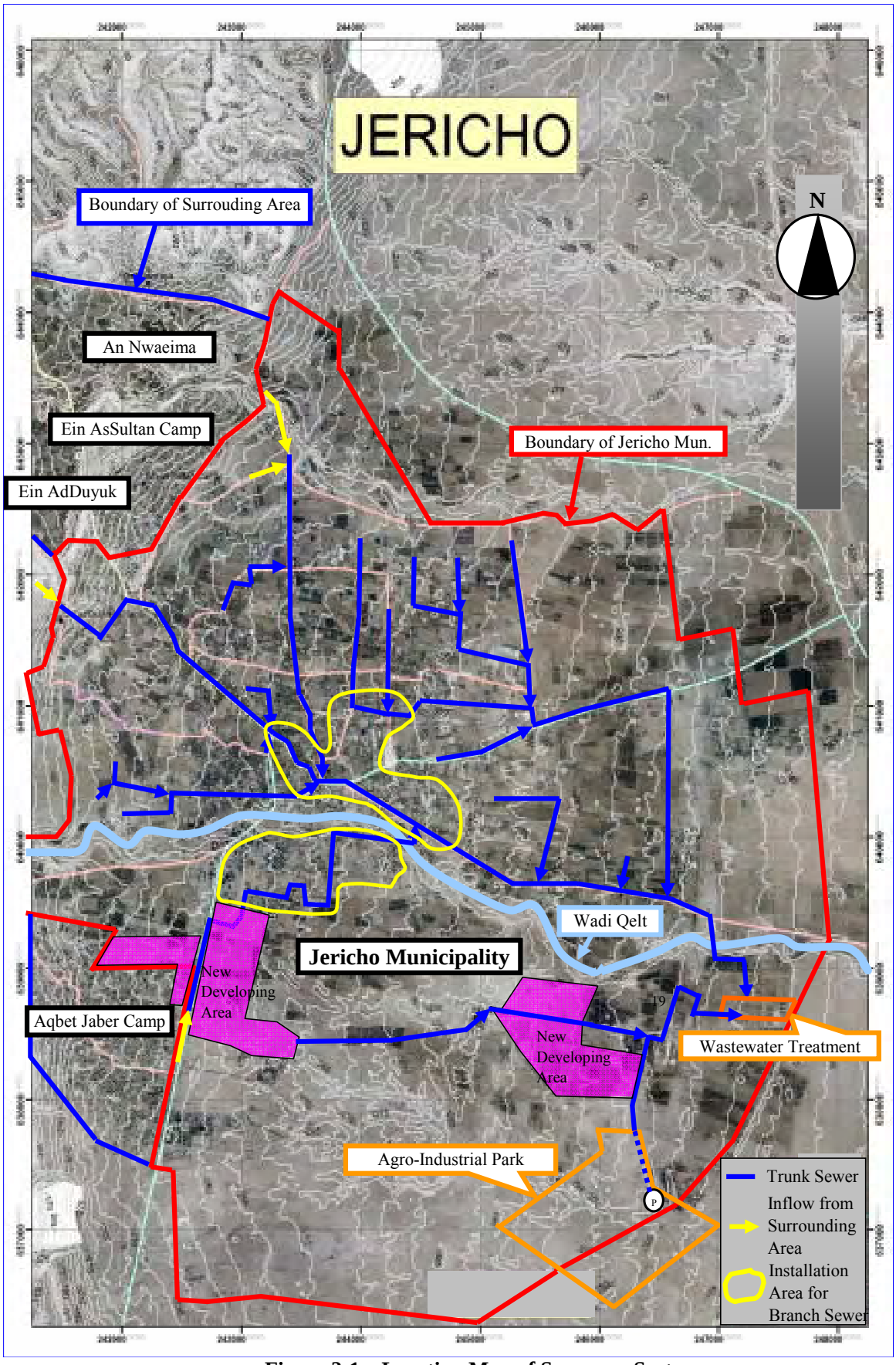

Figure 2-1 Location Map of Sewerage System

2-2-2-1 Basic Items

(1) Design Service Area

The design areas cover Jericho Municipality and its surrounding areas; namely, Nwaeima District, Duyuk District, Ain Sultan Camp and Aqbet Jaber Camp. However, under this project only the Jericho Municipality is considered. As for the sewer line only the main trunk lines with high priority are included under the Grant Aide Scheme. The recipient side is requested to develop with own budget the branch lines which make the system effective. The applied trunk lines and the required branch lines are shown in Figure 2-1

(2) Design Service Area

Population per capita unit water consumption is projected up to 2025 based on the data offered by PWA and wastewater amount and quality are calculated by setting connection ratio by areas. PWA requested to set the design target year at 2025, but it is finally set to 2020 for the following reasons:

- "A target year of 15 years after the request" seems too long according to the purpose of the Grant Aid Assistance
- As sewerage facilities can not be easily expanded, they must be designed in proper scale
- Design target year of sewerage plan formulated by Israel and Palestine is also 2020

Ultimate plan is set for the projected population of 2025 roundup to hundred digits with the connection ratio of 100%.

Connection ratio in Jericho Municipality is set as 50% in 2015, 1 year after the WWTP completion and at 80% at the target year. Relatively high ratio of connection is set for area within the municipality. The sewer network development in the surrounding areas is not included in the scope of work but assuming that the sewer network development will be promoted by own budget, the ratio is set as 50%. The wastewater to be generated in Agro-Industrial Park being planned under Japanese assistance will also be collected.

Commuting population from surrounding areas to Jericho Municipality during daytime is estimated to be 6,000 as follows, and 1% of annual growth rate of it is set.

- Water supply amount for commuting population : 1,200 m^3/day (2007 data)

- Per capita unit water consumption : 200 lcd (80% of 250 lcd set for Residents)

- Commuting Population : 1,200 m^3/day÷200 lcd = 6,000 (2007)

Unit pollution load of BOD, SS and T-N are set as 80% of those for residents. The Summary is shown in Table 2-2 and Table 2-3. The design wastewater amount in target year of 2020 is calculated as 6,600 m^3/day.

Table 2-2 Calculation Results of Design Wastewater Amount and Quality

Area Name/Year			2010	2015	2020	2025	Ultimate	Note
Nwaeima District	Population		1,400	1,704	2,073	2,522	2,600	
	LCD		120	130	140	150	150	
	Water Consumtion(m^3/d)		168	222	290	378	390	
	Discharge Rate(%)		70	70	70	70	70	
	C. Ratio(%)		0	0	50	70	100	
	WW Volume(m^3/d)		0	0	102	185	273	
	Load(kg/d)	BOD	0	0	62	106	156	60g/cap./d
		TSS	0	0	73	124	182	70g/cap./d
		T-N	0	0	12	21	31	12g/cap./d
Duyuk District	Population		907	1,073	1,268	1,498	1,500	
	LCD		120	130	140	150	150	
	Water Consumtion(m^3/d)		109	139	178	225	225	
	Discharge Rate(%)		70	70	70	70	70	
	C. Ratio(%)		0	0	50	70	100	
	WW Volume(m^3/d)		0	0	62	110	158	
	Load(kg/d)	BOD	0	0	38	63	90	60g/cap./d
		TSS	0	0	44	73	105	70g/cap./d
		T-N	0	0	8	13	18	12g/cap./d
Ain Sultan Camp	Population		3,538	4,263	4,943	5,674	5,700	
	LCD		150	160	170	180	180	
	Water Consumtion(m^3/d)		531	682	840	1,021	1,026	
	Discharge Rate(%)		70	70	70	70	70	
	C. Ratio(%)		0	0	50	70	100	
	WW Volume(m^3/d)		0	0	294	500	718	
	Load(kg/d)	BOD	0	0	148	238	342	60g/cap./d
		TSS	0	0	173	278	399	70g/cap./d
		T-N	0	0	30	48	68	12g/cap./d
Jericho Municipality (Residents)	Population		19,589	22,164	25,076	28,371	28,400	
	LCD		250	250	250	250	250	
	Water Consumtion(m^3/d)		4,897	5,541	6,269	7,093	7,100	
	Discharge Rate(%)		70	70	70	70	70	
	C. Ratio(%)		0	50	80	90	100	
	WW Volume(m^3/d)		0	1,939	3,511	4,468	4,970	
	Load(kg/d)	BOD	0	665	1,204	1,532	1,704	60g/cap./d
		TSS	0	776	1,404	1,787	1,988	70g/cap./d
		T-N	0	133	241	306	341	12g/cap./d
Jericho Municipality (commuters)	Population		6,306	6,628	6,966	7,321	7,400	
	LCD		200	200	200	200	200	
	Water Consumtion(m^3/d)		1,261	1,326	1,393	1,464	1,480	
	Discharge Rate(%)		70	70	70	70	70	
	C. Ratio(%)		0	50	80	90	100	
	WW Volume(m^3/d)		0	464	780	922	1,036	
	Load(kg/d)	BOD	0	119	201	237	266	36g/cap./d
		TSS	0	139	234	277	311	42g/cap./d
		T-N	0	24	40	47	53	7.2g/cap./d
Aqbet Jaber Camp	Population		8,243	10,223	12,438	14,772	14,800	
	LCD		120	130	140	150	150	
	Water Consumtion(m^3/d)		989	1,329	1,741	2,216	2,220	
	Discharge Rate(%)		0	50	70	70	70	
	C. Ratio(%)		0	0	50	70	100	
	WW Volume(m^3/d)		0	0	609	1,086	1,554	
	Load(kg/d)	BOD	0	0	373	620	888	60g/cap./d
		TSS	0	0	435	724	1,036	70g/cap./d
		T-N	0	0	75	124	178	12g/cap./d
Agro-Industrial Park	WW Volume(m^3/d)			243	1,180	1,180	1,180	
	Load(kg/d)	BOD		122	590	590	590	500mg/L
		TSS		122	590	590	590	500mg/L
		T-N		12	59	59	59	50mg/L
Total	Population (P)	Municipality	25,895	28,792	32,042	35,692	35,800	
		C.in Municipality	0	14,396	25,634	32,123	35,800	
		Whole Area	39,983	46,055	52,764	60,158	60,400	
		C. in Whole Area	0	14,396	35,995	49,249	60,400	
	Water Consumtion(m^3/d)		7,955	9,239	10,712	12,397	12,441	
	WW Volume(m^3/d)		0	2,646	6,538	8,453	9,889	
	Load(kg/d)	BOD	0	906	2,616	3,387	4,036	
		TSS	0	1,036	2,954	3,853	4,611	
		T-N	0	169	464	618	748	
	Concentra-tion(mg/L)	BOD		342	400	401	408	
		TSS		392	452	456	466	
		T-N		64	71	73	76	

LCD: Litter/capita/day, C: Connected, WW: Wastewater, P: Persons

Table 2-3 Summary of Design Wastewater Amount and Quality

Areas/Year		2010	2015	2020	2025	Ultimate
Jericho Municipality	Population (P)	25,895	28,792	32,042	35,692	35,800
	C. Population (P)	0	14,396	25,634	32,123	35,800
	C. Ratio (%)	0	50	80	90	100
	WW Volume(m^3/d)	0	2,403	4,291	5,391	6,006
Surrounding Areas	Population (P)	14,088	17,263	20,722	24,466	24,600
	C. Population (P)	0	0	10,361	17,126	24,600
	C. Ratio (%)	0	0	50	70	100
	WW Volume(m^3/d)	0	0	1,067	1,882	2,703
Agro-Industrial Park	Inflow Ratio(%)	0	0.23	100	100	100
	WW Volume(m^3/d)	0	270	1,180	1,180	1,180
Total	Population(P)	39,983	46,055	52,764	60,158	60,400
	C. Population(P)	0	14,396	35,995	49,249	60,400
	WW Volume(m^3/d)	0	2,673	6,538	8,453	9,889
Average Concentration (mg/L)	BOD	---	342	400	401	408
	TSS	---	392	452	456	466
	T-N	---	64	71	73	76

Note) WW = Wastewater, C. Ratio = Connection Ratio, P = Persons

As to Agro-Industrial Park to be constructed in the south of Jericho Municipality, design wastewater amount is planned as shown in Table 2-4:

Table 2-4 Wastewater Amount generated in Agro-Industrial Park（m^3/day）

WW Amount/Stage	Stage I	Stage II	Stage I+II
Daily Average WW Amount	270	920	1,180
Daily Maximum WW Amount	470	1,650	2,120
Hourly Maximum WW Amount	620	2,150	2,760

The daily average wastewater amount is set as shown in Table 2-3. It is required to be converted to the daily maximum wastewater amount and the hourly maximum wastewater amount which become the basis of capacity calculations of the WWTP facilities. According to the results of consultation with PWA held during this preparatory survey, the peak factor, daily maximum/daily average is set as 1.4, and that of hourly maximum/daily average is set as 3.0 for areas of residents, shops and factories, excluding Agro-Industrial Park.

The daily maximum wastewater amount fluctuation can be estimated by the potable water supply amount fluctuation in Jericho Municipality. By the fluctuation of annual potable water supply amount shown in Table 2-5 and that of monthly potable water intake amount from the Ain Sultan Spring, 1.2 times of increase during the summer time compared with the annual average as shown in Table 2-6. As for the daily fluctuation, daily maximum peak factor of 1.4 is deemed adequate. Though no data for hourly maximum peak factor is available, 2.14 times (=3.0/1.4) of daily maximum amount is assumed appropriate for this project, as a relatively small-scaled system design.

Table 2-5 Water Supply Amount Fluctuation in every 2 Months

Month	Jan.+Feb	Mar.+April	May+June	July+Aug.	Sep.+Oct.	Nov.+Dec.	Average
Monthly Amount	276,777	300,906	415,011	412,747	415,666	300,816	353,654
Daily Amount	4,691	4,933	6,803	6,657	6,814	4,931	5,805
Ratio	0.81	0.85	1.17	1.15	1.17	0.85	1.00

Table 2-6 Monthly Intake Water Amount Fluctuation at Ain Sultan Spring

Month	2007	2008	2009	Average	Ratio
January	158,500	183,100	195,700	179,100	0.81
February	141,400	153,400	170,500	155,100	0.70
March	188,200	224,200	184,000	198,800	0.89
April	199,100	227,800	245,200	224,033	1.01
May	242,300	223,200	262,900	242,800	1.09
June	243,500	249,300	260,800	251,200	1.13
July	270,600	253,500	275,900	266,667	1.20
August	265,900	245,900	266,200	259,333	1.17
September	252,200	240,600	236,800	243,200	1.09
October	249,300	223,800	249,100	240,733	1.08
November	211,800	201,300	226,200	213,100	0.96
December	197,400	198,300	191,500	195,733	0.88
Average	218,350	218,700	230,400	222,483	1.00

Based on these peak factors, the daily maximum and hourly maximum wastewater amount, the Design Wastewater Amount is summarized as shown in Table 2-7. As to Agro-Industrial Park, the amount shown in Table 2-4 is adopted. As a result, the daily maximum amount is 1.5 times of daily average amount, while hourly maximum amount is 2.9 times of daily average amount. Though the design wastewater quality is also shown in the same table, they are much more than those shown in Table 2-2 and 2-3. These are fixed in the consultation with PWA, considering the balance with design criteria employed in other WWTP.

Table 2-7 Design Wastewater Amount and Quality

Items		Target Year		Amount Ratio	Application to facility design
		2020	Ultimate Plan		
Wastewater Amount (m^3/day)	Daily Average	6,600	9,900	1.0	Reactor during winter season and sludge drying bed
	Daily maximum	9,800	14,400	1.5	Past record of other WWTP facilities
	Hourly Maximum	19,100	29,000	2.9	Sewer pipes and pipes in WWTP
Wastewater Quality (mg/L)	BOD	500	500	---	Mass balance, reactor capacity and air blower capacity
	TSS	500	500	---	
	T-N	75	75	---	

2-2-2-2 WWTP Facility Design

(1) Design Criteria

The following policies are adopted for the WWTP facility planning and design:

- Since no Palestinian WWTP design manuals are available, the facilities design will be executed based on Japanese design standard
- In Palestine, the water consumption is less than Japan but pollution loading is equivalent. This resulted in quite high pollutant concentration. In proportion with BOD concentration, the nitrogen concentration is also high, so, advanced nitrogen removal is needed for a stable wastewater treatment operation. An advanced treatment method of Oxidation Ditch Method (OD Method) with easy plant operation and stable nitrogen removal is employed. However, incoming wastewater concentration is higher than those adopted in general OD method. This method is classified as Extended Aeration Method.
- Horizontal shaft propellering agitator and hyper fine bubble aerator, which are operated in Japan with high energy efficiency, is employed. Recently this combination is applied in many WWTPs in Japan.
- In this case, an advanced nitrogen removal is needed. It can be achieved easily by intermittent operation controlled by timer-setting. To ensure the stable nitrogen removal, sufficient denitrification time during no oxidation operation will be secured. The oxidation time is planned for less than 12 hours/day.
- Though installation of a primary clarifier is examined as for power saving and reducing of the reactor capacity, this is not employed because only a small effect can be expected and an anaerobic sludge digestion tank is needed as odor measurement for generated raw sludge. This requires large increment in project cost and complicated operation. However a land for a future installation of this system is recommended to be acquired.
- The Ministry of Agriculture is positive in reuse of the treated wastewater and insisted the necessity of chlorine disinfection for the safety reuse. Thus chlorine disinfection is planned, although it is not needed in accordance with the current Palestinian effluent quality standard.
- Likewise, an installation of rapid sand filters is examined as for the treated wastewater reuse, but it is not employed due to large increase in project cost. In addition, direct application to irrigation use is justified by observing the treated wastewater of Al-Bireh WWTP, which is the sole plant being operated in Palestine with the similar treatment method. The treated wastewater from the Plant has high transparency and low color.
- Storage tank for irrigation is planned for the efficient reuse of treated water. Installation of pump facilities is to be covered by users.

- As the electricity rate is relatively high in Palestine, solar panels of 100 kW capacity which can generate the electricity for the plant operation power demand in the primary stage are introduced to save the O&M cost and to express the Japanese distinctive character. Panels will be located near the entrance gate so that visitors can easily see them. The generated power will be utilized for the wastewater treatment and other plant facilities during daytime. The city electricity is used for operation during nighttime.
- Since the construction site has enough area, garden with trees and grass and brook sprinkled with the treated wastewater are also planned to express the Japanese atmosphere.
- Since the sludge generation amount is relatively small, sludge drying beds by the sun are provided in order to save chemicals and power. The wastewater sludge contains abundant nutrients such as nitrogen and phosphorus. When it is directly applied for farmlands, nutrients will be rapidly dissolved and cause adverse effects to the crops. Therefore, the dried sludge should be stored in the plant site for one year period for stabilization, then be utilized as fertilizer or soil improvement material.

(2) Design Wastewater Amount and Treated Wastewater Quality

According to the MOU prepared between Palestine and Israel, the quality of the treated wastewater is regulated by the 1st phase and the 2nd phase as shown in Table 2-8. Target year of the 1st phase was set at 2020, but that of the 2nd phase with quite stringent effluent standard is not yet set.

Based on the MOU, target treated wastewater quality is set as shown in Table 2-8. As to T-N, the set figure is larger than that of Table 2-9. This was settled by PWA considering the city planning experiences and WWTP design criteria in other cities such as Nablus, through negotiation with Israel. Actual WWTP facility design is conducted based on T-N less than 25 mg/L.

Table 2-8 Treated Wastewater Quality described in MOU issued by Israel

Items	1st Phase	2nd Phase
BOD (mg/L)	20	10
TSS (mg/L)	30	10
T-N (mg/L)	25	10
Fecal Coliform Group (MPN/100mL)	--	10

Table 2-9 Design Wastewater Amount and Treated Wastewater Quality set for this Project

Items	Incoming Wastewater Amount, Quality			Effluent Quality
	Q_{DA}	Q_{DM}	Q_{HM}	
WW Amount (m^3/day)	6,600	9,800	19,100	---
BOD (mg/L)	500			20
TSS (mg/L)	500			30
T-N (mg//L)	75			50

If the wastewater contains high concentration of nitrogen, the following reaction occurs and cause interference in the wastewater treatment:

- In the reactor, NH_3 is converted into NO_3 by oxidation. This lowers wastewater pH to an extent not to meet the effluent standard
- In the clarifier, high NO_3 causes denitrification in the final clarifier and generates nitrogen gas, which attaches to the sludge and floats at clarifier's surface

Therefore, nitrogen is to be properly removed to maintain a stable wastewater treatment system.

(3) Treatment Flow

The wastewater treatment flow of the WWTP is shown in Figure 2-2. The wastewater flows into the WWTP from the municipality area through trunk sewer lines crossing the Wadi Qelt and also from trunk sewer line from the Agro-Industrial Park located in the right bank of Wadi Qelt. In addition, the wastewater collected from cess-pits or septic tanks is carried by vacuum tanker trucks. The wastewater flows into receiving tank, and sand is removed by grit chamber, then flows into reactor together with wastewater carried by the trunk sewers.

The treated water flows in the chlorine disinfection tank and stored in irrigation tank. Most of the stored treated wastewater is reused for irrigation but some may be discharged to Wadi. Horizontal shaft propellering agitators and hyper fine bubble diffusers are employed in the reactor. This type of aeration technology is developed in Japan having the highest energy efficiency.

The sludge removed from clarifier is thickened by the sludge thickener and hauled to sludge drying beds. The sludge depth is about 30 cm and will be dried for two weeks. The dried sludge will be stored for one year in an open area on the drying beds for stabilization, and then, supplied to users as fertilizer.

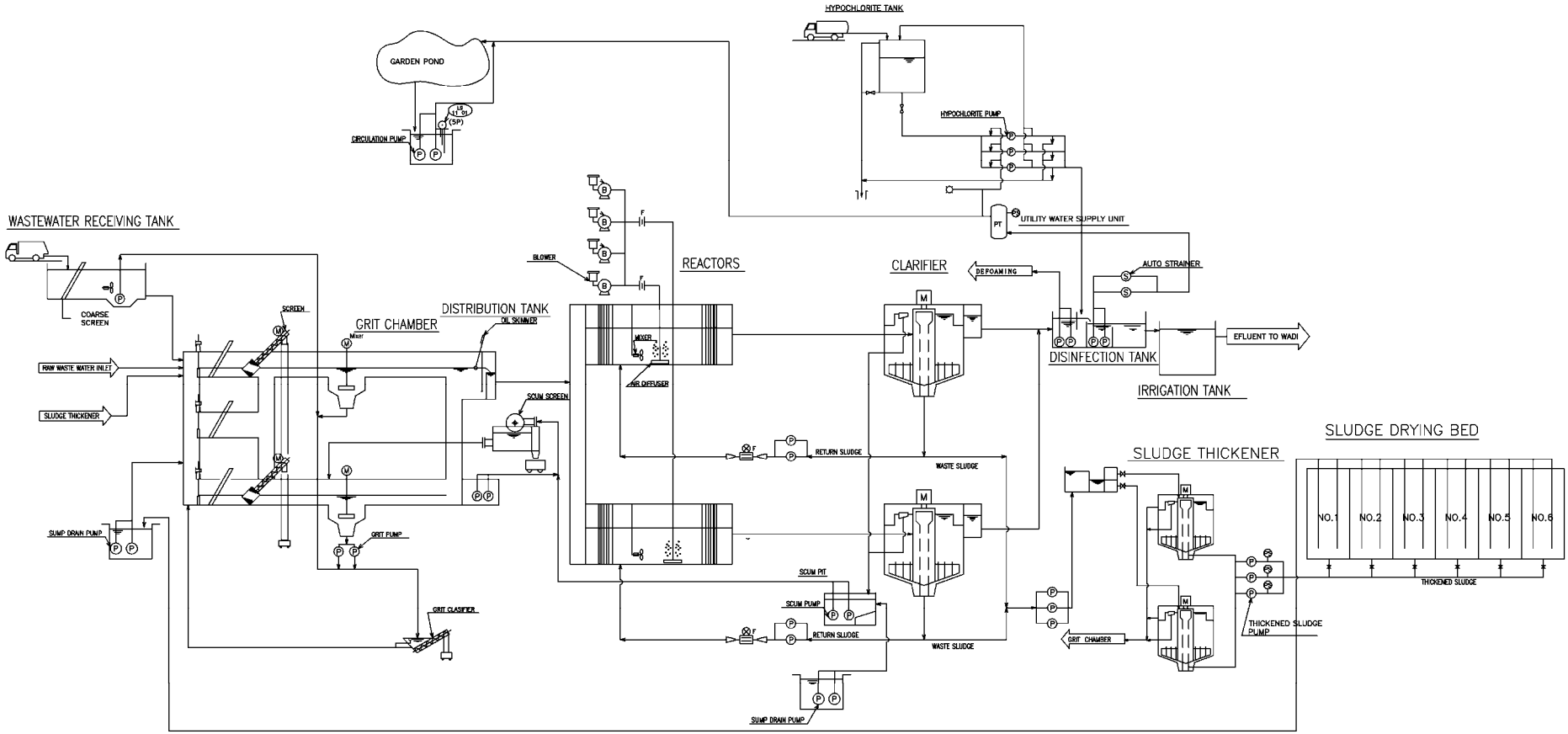

Figure 2-2 WWTP Treatment Flow Sheet

(4) Design of the WWTP Facilities

Basic design concept of the WWTP facilities is shown in Table 2-10.

Table 2-10 WWTP Facilities Design Concept

Facilities and Equipment	Contents
Receiving Tank for Vacuum Tanker Truck	To receive wastewater collected by vacuum tanker trucks and remove solid wastes and sand. It comprised of screen channel and grit chamber. The retention time of grit chamber is 1 hour. An agitator to avoid waste settling and sand pump to remove settled sand are provided.
Grit Chamber	It is composed of inlet channels, two screen channels and two trains (one for stand-by) of grit collector and a distribution chamber. Manual and auto screens are provided in the screen channel. Sand pumps and a sand separator is equipped on the slave of structure. The settled sand in the receiving tank for vacuum tanker truck is transmitted and also treated by this sand separator. A scum skimmer and weir-type flow meter are installed in the distribution chamber.
Reactor, Clarifier	Pollutants contained in wastewater is dissolved and removed. Two trains of the reactor tank with shape of OD tank have retention time exceeding 1 day of daily maximum wastewater amount. Two trains of the circular clarifier have surface load less than 12 m^3/m^2/day. Oxygen is supplied by hyper fine bubble diffusers and the agitation is executed by horizontal shaft propellering agitators. Nitrification and denitrification is carried out by an intermittent aeration. A center-pole type sludge collector is installed to the clarifier.
Chlorine Disinfection Tank	Equipped with the deforming pump, utility pump and weir-type flow meter. Sodium hypochlorite is applied for disinfection and the injection rate is 2 to 4 mg/L. The Retention time shall be more than 15 minutes.
Gravity Sludge Thickener	The thickened sludge of surplus sludge is transferred to sludge drying beds. The solid loading shall be less than 60kgDS/m^2/day and the sludge density is 0.6% at inlet and 1.3% at outlet.
Sludge Drying Bed	Dries thickened surplus sludge. Sludge depth is 30cm and hauled outside of beds after 14 days. Half of planned beds is to be constructed by this project.
Electrical Equipment	Power is received from Jerusalem District Electricity Company (JDECO). The major equipment can be operated by engine-driven generator and by a solar panel with capacity of 100 kW. Return surplus power to power grid. The operation supervision is carried out by monitoring screen connected to computer installed in administration building but basically the facilities shall be manually operated at site.

1) Wastewater Receiving Tank for Vacuum Tanker Truck

Private contractors in Jericho Municipality own 4 units of vacuum tanker truck with capacity of 10 m^3. If these 4 units of tankers collect and transfer wastewater to the WWTP within one hour, incoming

wastewater amount is 40 m^3/hr. The wastewater flows into the screen channel, the grit removal tank with an agitator to prevent waste settling and is transferred to inlet channel of the WWTP. The grit collector retention time is one hour amount of the said incoming amount. The grit removal tank is equipped with a sand pump to remove settled sand and transfer it to sand separator provided at the grit chamber.

2) Grit Chamber

The inflowing wastewater including those conveyed by vacuum tankers flows into screen channel, and screened wastes are removed by two trains of manual and auto screens. A by-pass screen channel with a manual screen is also installed. After the screening, sand is removed in two trains of grit collector. Vortex type grit collectors which is also employed at Al-Bireh WWTP is to be applied for its compactness and easy operation. Though two trains of grit collector are planned, as one train is stand-by unit, the capacity calculation is done for one train. The distribution chamber is installed at the downstream of grit collector. A scum skimmer, weir-type flow meter, sand pump and sand separator are provided.

3) Reactor and Clarifier

The capacity of reactor is designed based on the BOD loading and nitrification rate. According to Japanese design manual, surface loading of clarifier shall be less than 12 m^3/m^2/day, considering that OD method is ranging 8 to 12 m^3/m^2/day. Calculating by diameter of 24 m, the actual loading is reckoned as 10.8 m^3/m^2/day. Based on the wastewater temperature of 13°C during winter and peak factor ratio of 1.95 (hourly maximum/daily average), MLSS concentration in the reactor is calculated as follows:

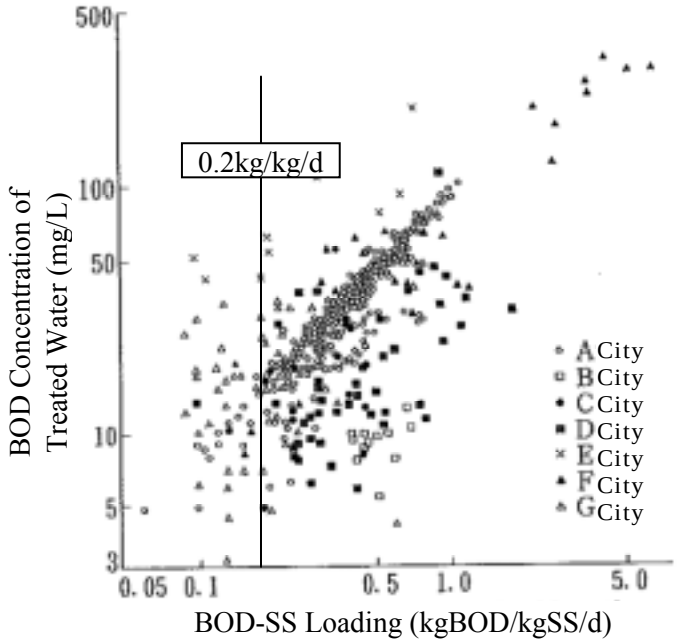

Figure 2-3 BOD-SS Loading and treated Wastewater Quality

$$X_A = [4.90 / r \times 10^6 \times T^{0.95} \times (SVI)^{-0.77} / S]^{(1/1.35)} \quad = 2{,}798 mg/L \rightarrow 2{,}500 mg/L$$

Where:

r: Flow Fluctuation Rate＝1.95(=19100/9800)

Temperature: 13°C

SVI：Sludge Volume Index＝200mL/g

S：Surface Loading of Clarifier＝10.8 m^3/m^2/day

The BOD loading shall be less than 0.20 BOD g / MLSS g/day and nitrification rate is set as 0.036N g / MLSS g/day during winter time.

According to Figure 2-3, BOD loading of 0.20 kg/kg/day will not affect the stable treatment.

As to the nitrification rate, 0.036 to 0.072 gN/gMLSS at wastewater temperature of 13 to 25°C is described in the Japanese Advanced Treatment Manual.

The reactors capacity is calculated based on the daily maximum wastewater amount and the nitrification rate are reckoned based on generated wastewater amount in winter time.

The daily maximum wastewater amount in winter time is estimated referring to Table 2-5:

9800 m^3/day×1/1.2＝8,200 m^3/day

As the denitrification is also needed for nitrogen removal process, the reactor capacity shall be secured for that. Therefore, two times of the capacity needed for nitrification is secured as the total reactor capacity. Provided 75% of incoming, NH_3 is to be nitrified.

Reactor capacity is calculated as follows:

By BOD loading: 9,800 m^3/day×500 mg.L/2500g/m^3/0.2＝9,800 m^3

By Nitrogen loading: 8,200 m^3/day×75 mg/L×0.75/2500 mg/L/0.036×2＝10,250 m^3

Therefore, reactor capacity shall be larger than 10,250 m^3.

The wastewater treated in reactor is agitated by horizontal propellering agitators to cause round flow, and oxygen is supplied by hyper fine bubble diffusers. Limiting oxidation time to less than 12 hours/day, sufficient anaerobic condition is secured, and even during oxidation terminated period, round flow is caused by agitator.

A center-pole type sludge collector with a scum skimmer is installed in the clarifier.

4) Chlorine Disinfection Tank

At the inlet of chlorine disinfection tank, deforming pumps and a weir-type flow measurement facility are installed, and sodium hypochlorite is injected at downstream of weir. Chlorine injection rate is 2 to 4 mg/L, and retention time shall be more than 15 minute. The disinfection tank with the retention time of 15 minutes is located at the downstream of the injection point. Above the tank, a disinfection room for chlorine disinfection facilities is built.

5) Irrigation Tank

After disinfection, the treated wastewater is stored in an irrigation tank. The treated wastewater is planned to be used for irrigation. Providing storage time of 2.5 hours, the tank capacity shall be more than 1,000 m^3. Crossing the overflowing weir, the surplus treated wastewater is discharged to Wadi through the effluent pipe with a length of 350 m.

6) Sludge Thickener

The surplus sludge generated from clarifier is thickened in this tank and transferred to sludge drying beds. Providing that inlet sludge concentration is assumed to be 0.6 % and outlet sludge concentration is assumed to be 1.3 %, the surface area is calculated based on the solid loading of 60 $kg/m^2/day$.

7) Sludge Drying Beds

These dries thickened sludge. 50 % of planned beds are to be constructed by this project. The sludge depth is 0.3 m and drying period is for two weeks. The beds are composed of earth embankment and sand bed with a depth of 20 cm. If the generated sludge amount will be increased, necessary number of drying beds shall be constructed accordingly. Drain water is sent back to sand sedimentation pond through drain pipe.

(5) Electric Facilities

1) Power Receiving Building

Power receiving capacity of the WWTP shall be decided by the demand in ultimate phase (Year 2025 with 100% of connection ratio). They are: One(1) unit of 500 kVA transformer to operate the treatment equipment, one(1) unit of 200 kVA diesel engine driven for an emergency generator, a power conditioner panel for 100kW solar panel, remote I/O (RIO) panels and motor control center for receiving tank for vacuum tanker truck and grit chamber in Power Receiving Building.

While, motor control center and RIO panel for reactor, clarifier, sludge thickener equipment is installed at electrical room in the blower building. Figure 2-4 shows electrical single wire diagram and outline of power receiving equipment including incoming power line from JDECO, solar panel and generator.

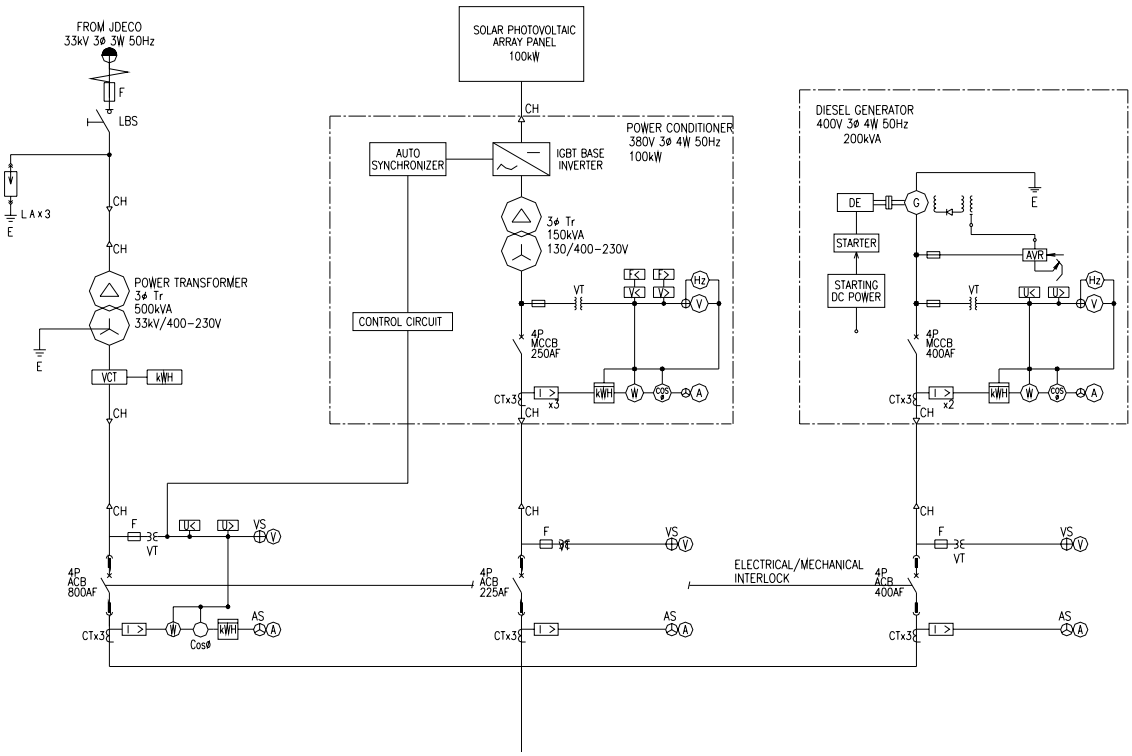

Figure 2-4 Electrical Single Wire Diagram

2) Transformer

The transformer is oil-immersed type and power is received from JDECO through 33 kV underground cable. Over current relay, high temperature relay and alarm are equipped to transformer by protection purpose. Necessary power for the WWTP operation is 320 kVA in first phase (2020) and 500 kVA in ultimate phase (2025). Since there is no significant cost difference between transformers with capacity of 400kVA and 500 kVA, the one with the larger capacity needed in ultimate phase is introduced from the beginning.

3) Solar Panels

The solar generation panels with a capacity of 100 kW are employed to save power expense in the plant O&M cost and to reduce exhaust CO_2, a cause of the global warming. The power generated by the solar panel is connected to the JDECO power supply grid to mitigate power receiving from JDECO.

A combination method synchronized to JDECO grid is applied as the panel operation method due to its simple system structure and high power efficiency. The solar generation unit is composed of

solar battery module, panel stand, connection box, power conditioner including synchronism and protection equipment, instrumentation and indicating equipment.

4) Instrumentation Equipment

As for the instrumentation equipment, Level switches for pump agitator operation, ultra-sonic water level detectors at weir-type flow meter in grit chamber and chlorine disinfection tank, ultra-sonic flow meters for air blower, electromagnetic flow meter at return sludge pump are installed. As the DO control in reactor is quite important, DO meter is employed for the DO monitoring. A voltmeter switch in water supply unit is installed as well.

5) Supervisory Control System

SCADA（Supervisory Control and Data Acquisition) is introduced as the supervising control system. The WWTP operation can be supervised by a monitor panel of computer installed in control room in administration building and the WWTP operation can also be explained to visitors by a wide screen. Since all measurements and signals are collected by the system, the plant can be properly monitored and data can be printed out by the printer.

Though the remote control through SCADA is possible, as the plant operation without the site confirmation is dangerous, the facilities shall in principal be operated and controlled at the site.

(6) Outline of the WWTP Facilities

Outline of the WWTP facilities is as shown in Table 2-11:

Table 2-11 Specifications and Dimensions of WWTP Facilities

Name of Facilities	Contents/Dimensions	Remarks
Civil/Architectural Structures		
1. Wastewater Receiving Tank for Vacuum Tanker Truck	Receiving Channel Width 1.0m×Length 10.5m×Depth 0.75-1.5mm x 2 units Grit Collector 5.0mx5.0m×D 1.3-3.5m×1 unit（V=53.3m^3, RT：1.3hr）	Q=40m^3/h Embankment H = 1.8m
2. Inflow Chamber (RC)	W 6.4m×L 3.2m×D 3.0m×1 unit（V=36.33m^3、RT：1.8min）	Q＝29,000m^3/d
3. Screen Channel (RC)	W 1.4m×L 6.1m×D 0.9m×2 units W 1.2m×L 6.1m×D 0.9m×1 unit	Q＝29,000m^3/d
4. Grit Chamber (RC)	Dia. 3.0m×D 1.0m×2(1) units（A=7.06m^2, S-Load: 4,107m^3/m^2/d<5,000, 7.06m^3, RT:21sec>15）	Q＝29,000m^3/d Vortex Type
5. Distribution Chamber (RC)	W 4.3m×L 3.5m×D 3.5m ×1 unit (V=40.3m^3, RT:2min)	Q＝29,000m^3/d Scum Skimmer, Weir Type
6. Reactor (RC)	W 8.0m×D 5.5×L 124m (Straight Channel 98m+Semicircle Channel 26m)×2 units（V=10,850m^3＞10,250m^3, RT：1.09d）	Q=9,800m^3/d Ellipse infinite channel
7. Clarifier (RC)	Dia. 24m×D 3.5m×2 units（A=904.8m^2, S-Load =10.8m^3/m^2/d <12, V=3177.3m^3, RT:7.8hr）	Q=9,800m^3/d
8. Chlorine Disinfection Tank (RC)	Deforming Pump Room：W 2.5m x L 2.0m x D 3.1m（V=15.5m^3, RT:38min）	Q=9,800m^3/d Deforming water ＝0.4m^3/min Water supply unit =0.5m^3/min
	Flow Measurement Chamber: W 2.5m x L 4.0m x D 2.7m （V=27m^3, RT=4min）	
	Water Supply Pump Room：W 2.0m x L 6.5m x D 2.6m （V=33.8m^3, RT：5.0min）	
	Disinfection Tank：W 1.75m x L 26.0m x D 2.5m（V=113.75m^3, RT:16.7min）	
9. Irrigation Tank (RC)	W 14.0m×L 18.0m×D 4.0m×1 unit (V=1008m^3, RT：2.5hr))	Q=9,800m^3/d Store irrigation water
10. Sludge Thickener	Dia. 7.0m×D 3.5m×2 units（A=77.0m^2, S-Load：49.3 kgDS/m^2, V=269.4m^3, RT: 10.2hr）	Surplus sludge Q＝633m^3/d DS：3,795kg/d
11.Sludge Drying Bed	W 32.0m×L 45m×D 0.3m×6 units (1,440m^2)、 Sand is spread at bottom	Thickened sludge Q=363m^3/d DS：3,416kg/d
12. Administration Building (RC and concrete block)	W 6.04m×L 19.0m (2 storied) 1F：6.0mx19m, 2F：6mx16.5m（Total A = 213m^2） Plant Chief Room: 3×4.5m Office: 4.5×5.0m Laboratory: 4.0×6.0m Rest Room: 4.0×6.0m Training Room: 6.0×7.0m Control Room: 6.0×6.5m	
13. Workshop (RC and concrete block)	W 6.0×L 8.0m＝48m^2	
14. Blower and Electrical Room (RC and concrete block)	Whole: W 8.4×L 20m＝168m^2 Blower Room: W 8.4×L 15.0m Electrical Room: W 8.4×L 5.0m	
15. Return Sludge Pump Room (RC and concrete block)	W 6.0×L 15.0m＝90m^2	

Name of Facilities	Contents/Dimensions	Remarks
16. Chlorine Disinfection Room (RC and concrete block)	W 4.5×L 10.2m＝45.9m^2 Includes dike	
17. Power Receiving Building (RC and concrete block)	Whole: W 9.0×L 12.0m＝108m^2	
	Generator Room: W 5.0×L 9.0m Power Receiving Panel Room: W 5.0×L 7.0m Transformer Room: W4.0×L 4.0m Warehouse: W 3.0×L 4.0m	
18. In-plant Piping	Dia. 700～80mm, Pipe Materials: HP,DIP,VP	
19. Japanese Style Garden	A=3,400m^2, Water System utilizing treated wastewater（Lake, Brooks and Circulation Pump）, Turf, Parade, Trees and Arbor	
20. Landscaping	Ground Grading, Planting, Pavement and Drainage Channel	
21. Effluent Pipe	Dia. 600 HP L=350m	
22. Miscellaneous	1 set of miscellaneous work	
Mechanical Equipment		
Grit Chamber Equipment		
1. Grit Chamber Inlet Gate	Manually Operated Cast Iron Gate W500 mm x H 750 mm x 3 units	Equipped with Container
2. Coerce Screen	Manually Operated Bar Screen W 1400mm x H 1400mm x Opening 100mm x 2 units	
3. Mechanical Fine Screen	Automatic Drum Screen (Channel Installation Type) Dia 1200mm×OP. 5mm×2.2kW x 2 units	Equipped with Container
4. Bypass Screen	Manually Operated Bar Screen W 1200mm×H 1400mm× OP. 16mm x 1unit	
5. Grit Collector	Vortex Type Dia 1600mm×0.75kW×2 units	
6. Grit Removal Pump	Centrifugal Sludge Pump 0.5m^3/min×2.2kW×2 units	
7. Floor Drain Pump	Submersible Sludge Pump 0.3m^3/min×1.5kW×2 units (1 of 2 is Standby)	Equipped with Container
8. Grit Separator	Screw Conveyor Type 0.5m^3/min×0.75kW×1 unit	
9. Oil Skimmer	Manually Operated Skimmer Dia 200mm×2,000mmL×2 units	
10. Oil Discharge Pump	Submersible Sludge Pump 0.2m^3/min×0.75kW×2units (1 of 2 is Standby)	Equipped with Container
11. Scum Screen	Automatic Drum Screen 0.4m^3/min×OP 2mm×0.4kW×1 unit	Equipped with Container
12. Screen Conveyor	Screw Conveyor (Shaft less) Dia 200mm×5,500mmL×2.2kW×1 unit	
13. Mixer	Submersible Type 1.5kW×2 units (1 of 2 is Standby)	
14. Grit Removal Pump	Submersible Sludge Pump 0.5m^3/min×3.7kW×2 units (1 of 2 is Standby)	
15. Coarse Screen	Manually Operated Bar Screen W 1400mm x H 1400mm x OP 16mm x 1 unit	Near to mechanical equipment outdoor of Sand Pump Room
16. Pipes and Valves	1 set	
Reactor Equipment		
1. Inlet Distribution Weir	Adjustable Weir, Cast Iron W 800mm x S.t.500mm x 2 units	
2. Air Diffuser	Membrane Type 67m^3/min x 2 units	
3. Reactor Tank Mixer	Submersible Propeller Mixer Dia 2.5m×2.3kW×8 units	
4. Outlet Gate	Manually Operated Cast Iron Gate W600 mm x H 600 mm x 2 units	

Name of Facilities	Contents/Dimensions	Remarks
5. Isolation Gate	Manually Operated Cast Iron Gate W600 mm x H600 mm x 1 unit	
6. Aeration Blower	Rotary Piston (Roots) Blower 34m^3/min×55kW×4 units	
7. Discharge Valve	Motorized Butterfly Valve Dia 200mm×0.2kW×2 units	
8. Hoist Block for Blower	Geared Trolley Chain Block 2ton×1 unit	Near to piping pit of Blower Room
9. Pipes and Valves	1 set	
Clarifier Equipment		
1. Sludge Collector	Center Driven Column Type Dia 24m×0.75kW×2unit	
2. Return Sludge Pump	Centrifugal Screw Type 5.4m^3/min×15kW×4 units (2 of 4 are Standby)	
3. Waste Sludge Pump	Centrifuged Non-clog Type 1.0m^3/min×5.5kW×3 units (1 of 3 is Standby)	
4. Hoist Block for Blower	Geared Trolley Chain Block 1ton×1unit	
5. Floor Drain Pump	Submersible Sludge Pump 0.3m^3/min×1.5kW×2 units (1 of 2 is standby)	
6. Scum Pump	Submersible Sludge Pump 0.5m^3/min×3.7kW×2 units (1 of 2 is standby)	Near to mechanical equipment outside of Sludge Pump Room
7. Pipes and Valves	1 set	
Disinfection Equipment		
1. Hypochlorite Tank	FRP or PE Tank 5m^3×1unit	
2. Hypochlorite Pump	Diaphragm Pump 0.05-0.15m^3/min×0.2kW×3units （1 of 3 is standby）	
3. Utility Water Supply Unit	Submersible Pump ×2 + Pressure Tank 0.5m^3/min×7.4kW×1unit	
4. Auto Strainer	Automatic Washing System 0.5m^3/min×Mesh 0.4mm ×0.1kW×2 units（1 of 2 is standby）	
5. Deforming Pump	Submersible Turbine Type 0.4m^3/min×3.7kW×2 units（1 of 2 is standby）	Near to mechanical equipment outside of Disinfection Tank
6. Pipes and Valves	1 set	
Sludge Thickener Equipment		
1. Sludge Thickener	Central Driven Type Dia 6.5m×0.4kW×2 units	
2. Thickened Sludge Pump	Centrifugal Non-clog Pump 0.95m^3/min×5.5kW×3 units（1 of 3 is standby）	
3. Waste Sludge Measuring Tank	Tank with Adjustable Weir W 1,500mm x L 1,800mm x H 1,000mmH x 1 unit	
4. Hoist Block for Sludge Pumps	Geared Trolley Chain Block 1ton×1 unit	Near to mechanical equipment outside of Sludge Pump Room
5. Pipes and Valves	1 set	
Garden Equipment		
1. Circular Pump	Non Blocking Pump 1.0m^3/min×3.7kW×2 units（1 of 2 is standby）	
Electrical Equipment		
1. Power Transformer	33kV/400V, 500kVA, Oil-immersed Type	
2. Solar Panel Equipment	400V, 100kW, Silicon Multi-crystal Solar Panel, Irradiance Meter, Module Temperature Meter, Temperature Meter, Wind Speed Meter, others	
3. Incoming Panel	Steel Plate made, Indoor, Self-standing Type ACB 800AF/400AF/225AF	
4. Low Voltage Feeder Panel	Steel Plate made, Indoor, Self-standing Type MCCB 225AF/100AF/50AF	

Name of Facilities	Contents/Dimensions	Remarks
5. Power Control Panel	Steel Plate made, Indoor, Self-standing Type MCC Type	
6. UPS	3kVA 230V, 30 minutes Back Up	
7. PLC Panel	Steel Plate made, Indoor, Self-standing Type 720 Points Digital Input, 45 Points Analog Input	
8. RIO(Remote Input/ Output) Panel	Steel Plate made, Indoor, Self-standing Type 170 Points Digital Input + 35 Points Analog Input 550 Points Digital Input + 10 Points Analog Input	
9. Site Control Panel	Indoor/Outdoor Stand Type	
10. Inflow Flow Meter	Weir + ultrasonic Water Level Meter（Convert overflowing water depth to flow）	
11. Effluent Flow Meter	Weir + ultrasonic Water Level Meter	
12. DO Meter	Polar-gragh Type	
13. Blower Flow Meter	Ultrasonic Type	
14. Retune Sludge Flow Meter	Electro-magnetic Type, Dia 250mm×2 units	
14. Voltmeter Switch	Diaphragm Type	
15. Level Switch	Electrode Type	
16. Operator Station	Work Station	
17. Wide Screen	LCD	

2-2-2-3 Sewer Network Plan

(1) Pipeline Design Conditions

1) Design Wastewater Amount

The design sewer collection area is Jericho Municipality and surrounding areas including the following areas and the Agro-industrial Park located in the south of the municipality. The design for this park is now on-going under the assistance of Japanese Government and is scheduled to be commissioned in 2012.

- Nwaeima District
- Duyuk District
- Ain Sultan Refugee Camp
- Aqbet Jaber Refugee Camp

Assuming that wastewater is to be collected from the whole design sewer collection areas in the future, sewer pipes are designed based on the ultimate design wastewater amount (Design Hourly Maximum Wastewater Amount.)

Design hourly maximum wastewater amount generated in Jericho Municipality, surrounding areas and Agro-industrial Park is as shown in Table 2-12.

Table 2-12 Design Hourly Maximum Wastewater Amount in Ultimate Plan (2025)

Districts		Waste Water Amount Hourly Maximum (m^3/day)
Jericho Municipality		18,018
Surrounding Area	Nwaeima District	819
	Duyuk District	474
	Ain Sultan Refugee Camp	2,154
	Aqbet Jaber Refugee Camp	4,662
Agro-industrial Park		2,760
Total		28,887

As to urban areas like Jericho Municipality, the incoming wastewater amount collected by sewer pipes is reckoned based on the following formula:

$Q=q\times A$

where:
Q：Design Hourly Maximum Wastewater Amount（m^3/sec）
q：Unit Wastewater Amount per ha (m^3/sec/ha)
A：Collection Area (ha)

To calculate the above unit wastewater amount, a map of water supply areas called “Neighborhood” and a List of connection by Neighborhood was povided from the Jericho Municipality water supply department. Counting sewer pipes contained in each Neighborhood, the wastewater amount is calculated in proprtion to connection number. Figure 2-5 shows the Location Map of Neighborhood, and Table 2-13 shows the unit wastewater amount.

Table 2-13 Population and Population Density by Neighborhood

No.	Neighborhood	Connection No.	Area (ha)	Population (person)		WW Amount (m^3/d)	Population Density (person/ha)	
				2010	2025		2010	2025
1	Al Bayader	81	12.39	466	550	277	38	44
2	Shiekh Sabbah	320	56.24	1,841	2,172	1,093	33	39
3	Shiekh Sbeih	232	31.56	1,335	1,574	792	42	50
4	Om Tawabeen	70	17.40	403	475	239	23	27
5	Sabiha + Al Doeuk	415	311.43	2,388	2,816	1,417	8	9
6	Ein Sultan	557	184.13	3,205	4,430	2,230	17	24
7	Qasir Hisham	314	110.26	1,806	2,497	1,257	16	23
8	Kitf Al Wad	521	97.31	2,997	5,874	2,956	31	60
9	Al Dahiah	86	16.20	495	684	344	31	42
10	Al Maghtes	151	93.34	869	1,201	604	9	13
11	Palestine/Falasteen	477	179.44	2,744	3,794	1,909	15	21
12	Amman	388	240.98	2,232	3,086	1,553	9	13
13	Al Souq	225	9.38	1,294	1,527	768	138	163
14	Al Ma'moun	136	19.23	782	1,082	544	41	56
15	Al Rasheed	39	13.03	224	265	133	17	20
16	Al Quds	338	40.28	1,945	2,688	1,353	48	67
17	Yaffa	52	44.89	299	414	208	7	9
18	Al Jame	99	1.96	570	672	338	291	343
	Total	4,501	616.56	25,895	35,800	18,018	42.0	58.1

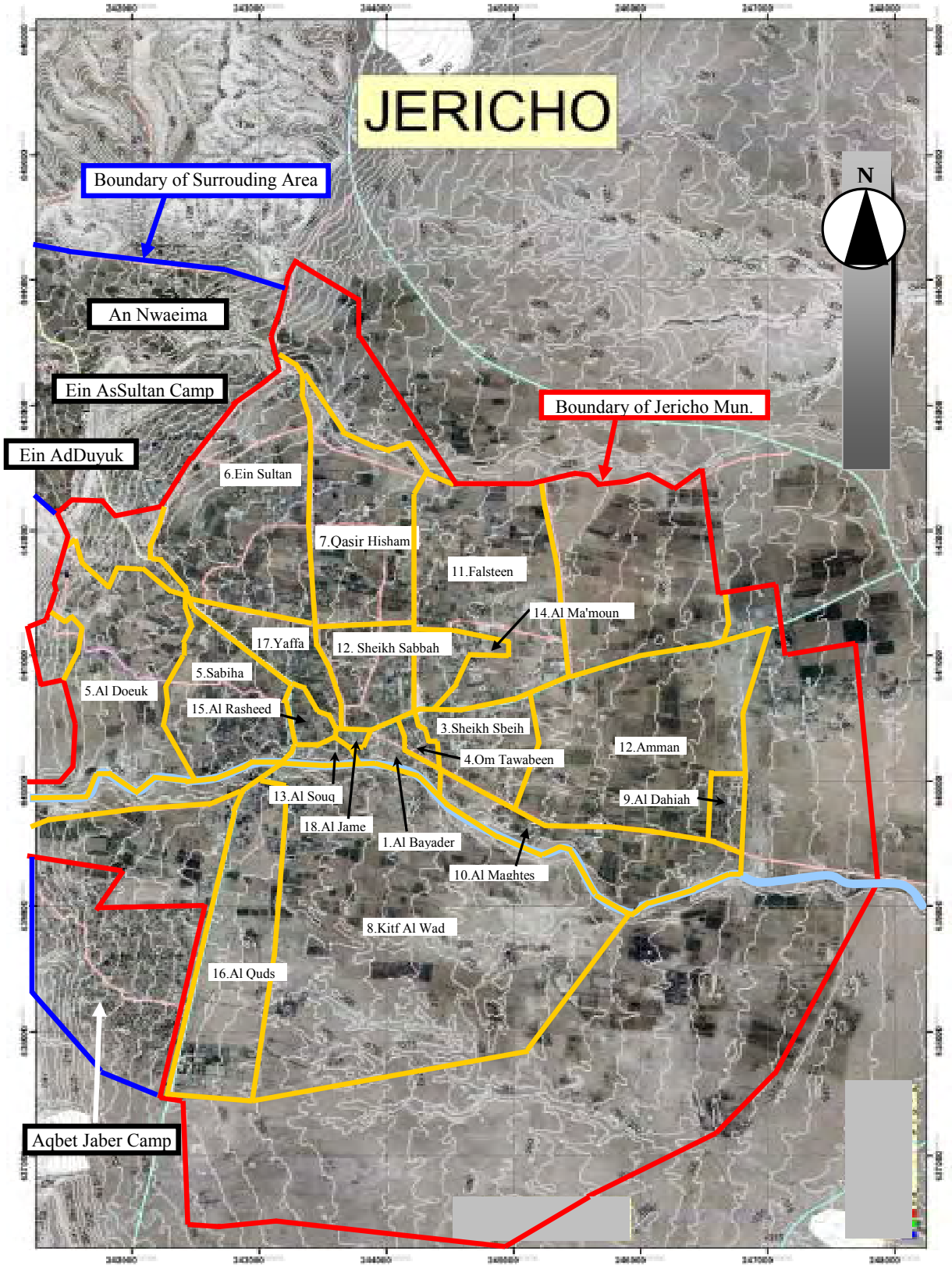

Figure 2-5 Neighborhood Location Map

Since the surrounding area is located outside of Jericho Municipality, these areas are out of scope of sewer development by this project. However, the wastewater amount to be generated in these areas is counted in the sewer pipe design as “Point Injection Amount”. The wastewater to be generated in Agro-industrial Park is scheduled to be conveyed through trunk sewer planned near by, and the wastewater amount is taken into acount in the sewer pipe design as well as other surrounding areas.

2) In-pipe Flow Velocity Formula and Effective Section

In Palestine, Polyvinyl Chloride (PVC) pipe is mainly applied due to its easy installation compared by Reinforced Concrete (RC) pipe, but PVC pipe with diameter larger than 250 mm is not manufactured. Thus, RC pipe is to be applied for sewer pipes with diameter larger than 250 mm.

The pipe diameter is to be determined comparing the pipe flow capacity and incoming wastewater amount. The following flow velocity formula shown in Table 2-14 is employed depending on pipe materials and flow types.

Table 2-14 Flow Velocity Formula

Flow Type	Pipe Material	Roughness Coefficient：n (Velocity Coefficient：C)	Flow Velocity Formula	Effective Pipe Section
Gravity Pipe	RC Pipe	0.010	Manning	Full
	PVC Pipe	0.013	Manning	Full
Force Pipe	Ductile Iron (DI) Pipe or PVC Pipe	(DIP110 and VP130)	Hazen-Williams	Full

Manning Formula $v = 1/n \cdot R^{2/3} \cdot I^{1/2}$
where:
v ： In-pipe Velocity（m/sec）
n ： Roughness Coefficient
R ： Pipe Radius
I ： Pipe Slope

Hazen-Williams Formula $v = 0.84935 \cdot C \cdot R^{0.63} \cdot I^{0.54}$
where:
v ： In-pipe Velocity（m/sec）
C ： Roughness Coefficient
R ： Pipe Radius
I ： Hydraulic Slope（h/L）
h ： Friction Loss (m) per length of L（m）

3) Sewer Pipe Capacity Allowance

Depends on pipe diameter and flow type, allowance shown in Table 2-15 is applied.

Table 2-15 Sewer Pipe Capacity Allowance

Flow Type	Pipe Diameter（㎜）	Allowance（%）
Gravity Flow Pipe	φ150 - φ600	100
	φ700 - φ1,500	50 - 100
	φ1,650 -	25 - 50
Forced Flow Pipe	No allowance applied	

4) Flow Velocity and Slope

The flow velocity of sewer pipes is within the range of 0.60 m/sec to 3.00 m/sec. Basically, the flow velocity in trunk sewers become gradually larger and pipe slope become gentler toward down stream. In Jericho Municipality, the natural ground slope is 2 % in west-east direction but the slope is much gentler in north-south direction. Therefore, the sewer profile designing based on the abovementioned policy generates uneconomical sewer design, for instance the pipes with too large earth cover and so on. Thus, to relieve such uneconomical sewer design, the design policy can be altered flexibly if it will not seriously affect the sewers located downstream.

In case of branch sewers, the pipe slope can be determined depends on the road slope, within a limit the sectional area of pipe will not be affected in the sewers located downstream.

5) Minimum Earth Cover

The design standard “Planning and Design Guidelines Construction and installation of pipes in water supply and sewerage trenches” issued by PWA described that “the minimum earth cover for pipes with diameter larger than 150 mm shall be 900 mm”. In the design, 0.9 m is adopted as the minimum earth cover.

6) Clearance between Underground Utilities

Since there are no regulations on the captioned as to water supply pipes, sewer pipes, irrigation pipes and channels, 0.3 m is applied as a practical value. As for some telecommunication and power cables installed underground, a clearance of 0.5m is taken as a prevention of accidental to avoid serious problems. Clearance for other underground utilities shall be 0.3 m, the same to water supply pipes.

Some Wadi crossing points are planned in this project. Wadi has several rainwater run-offs but normally no water is running.

7) Pipe Connection, Manhole Step and Manhole

Basically, the pipe connection at manholes shall be “Pipe Top Connection” and all the manhole steps shall be 2.0 cm.

Circular manholes shall be installed at sewer starting points, altering points in direction, slope and diameter, points with pipe level gaps, connection points with other sewers, and at necessary O&M points. Even a straight section, O&M manholes shall be installed with intervals depends on the pipe diameter as shown in table below. As Jericho Municipality has steep ground slope, the interval of manholes will become short and the maximum length shown in the table will not be applied. The minimum manhole interval is as follows:

Table 2-16 Allowable Manhole Interval by Pipe Diameter

Pipe Diameter（㎜）	Less than 300	Less than 600	Less than 1,000
Maximum Interval （m）	75	75	100

The design standard “Planning and Design Guidelines Construction and installation of pipes in water supply and sewerage trenches” issued by PWA describes that “the standard manhole interval shall be 70 m to 120 m. However, as to sewers with large diameters, 200 m is allowed if proper sewer cleaning equipment is available”.

8) House Connection

To collect the wastewater generated from residential houses, this project execution agency is required to install connection pits at the public-private border. Such installation work needs consultation with residents but it is quite difficult for foreign contractors. In this project, connection pits are planned in sideways in both sides of the road. Jericho Municipality will install the pits at public-private border and residents shall install in-house piping and connect it to connection pits. Since the existing cess-pits collect both toilet wastewater and gray water (such as kitchen/bath wastewater), in-house pipings are to be connected to the inlet pipe of cess-pits.

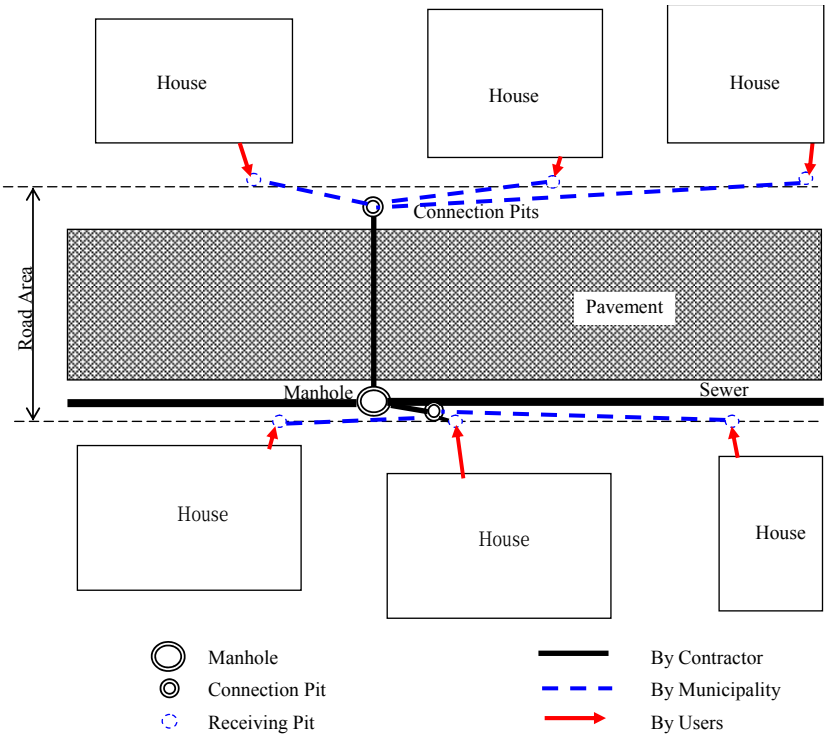

Figure 2-6 House Connection to Main Sewer Pipe

(2) Trunk Sewer Allocation

Due to budget restrictions, the service area shall be properly selected to generate the highest project benefit, namely to produce the maximum service ratio. A whole sewer network allocation plan was established based on the sewer network map prepared by F/S on sewerage system development in Jericho Municipality conducted in 1998. Developing residential areas and proposed residential areas are also included. Figure 2-7 shows the plan.

According to the road plan map collected during the study, one proposed residential area in the east has 500 lots and another developing residential area in the west also has 500 lots. As to the later, one-third of 500 lots has been already developed and residents have started dwelling.

Eastern residential area will be covered by Trunk No. 19 that also collects wastewater generated in Agro-industrial Park. Western residential area will be covered by two series of trunks, namely Trunk No. 1, 10 and Trunk No.20, 21.

Figure 2-7 Trunk Sewer Location Map in Jericho Municipality

(3) Sewers in the Scope of Work

Sewers shall be properly selected to collect the maximum service population by the limited budget. As the trunk sewer having collection area larger than 20 ha can cover the housings located along the trunk sewer route, sewer service ratio can be raised by development of trunk sewers only.

Owing to the request of PWA that trunk sewers shall be developed based on the priority, service ratio by trunk sewer development within municipality boundary is shown in Figure 2-7 and Figure 2-8.

As the results of the study, No. 1, 2, 3, 4, 7, 9, 10, 11, 13, 18, 19 were identified as the subject for construction in the Project. Table 2-17 shows the length of trunk sewer, its diameter and served population by each sewer.

Table 2-18 shows the project effect generated by branch sewer development. As shown in the table, project effect by development of branch sewer connected to Trunk No.10 is extremely high.

As aforementioned, service ratio cannot be largely raised only by trunk sewer development. Therefore, the Study Team would like to propose that some branch sewers shall be installed by Palestinian side for further service ratio increasing.

Table 2-17 Service Ratio by Sewer Network Development

Number	Pipe Length (m)	Pipe Dia.(mm)	Connected Population		Note
			2010	2025	
1	7,014	200 to 700	1,295	1,302	Included
2	178	195	17	23	Included
3	162	200 to 250	127	140	Included
4	1,627	200	374	539	Included
5	490	200	75	88	
6	111	200	12	16	
7	2,487	400	524	618	Included
8	808	200	172	198	
9	825	200	120	138	Included
10	3,146	400	1,868	2,078	Included
11	1,121	200	380	453	Included
12	120	200	208	239	
13	5,887	200 to 400	1,460	1,730	Included
14	477	195	131	146	
15	2,050	200 to 250	328	376	
16	306	200	130	150	
17	1,103	200	521	576	
18	988	200	304	420	Included
19	1,974	300 to 400	100	200	Included
20	1,251	250	30	300	
21	1,867	250	30	300	
Total	32,125		8,205	9,731	
Inclu. Area	25,409		6,569	7,642	
Branch	15,990	200	5,671	7,838	
Total Population in Municipality			25,900	35,800	
Ratio of Trunk Sewer coverage (%)			25.4	21.3	
Ratio covered by sewers including branch sewer (%)			47.38	43.2	

Table 2-18 Population served by Branch Sewers

Connecting Trunk No.	Collection Area (ha)	Served Population	Pipe Length(m)	Pipe Diameter (mm)
1	19.84	1,239	2,496	200
10	75.30	4,336	7,091	200
11	23.04	857	2,653	200
13	32.20	1,407	3,750	200
Total	150.38	7,839	15.990	–

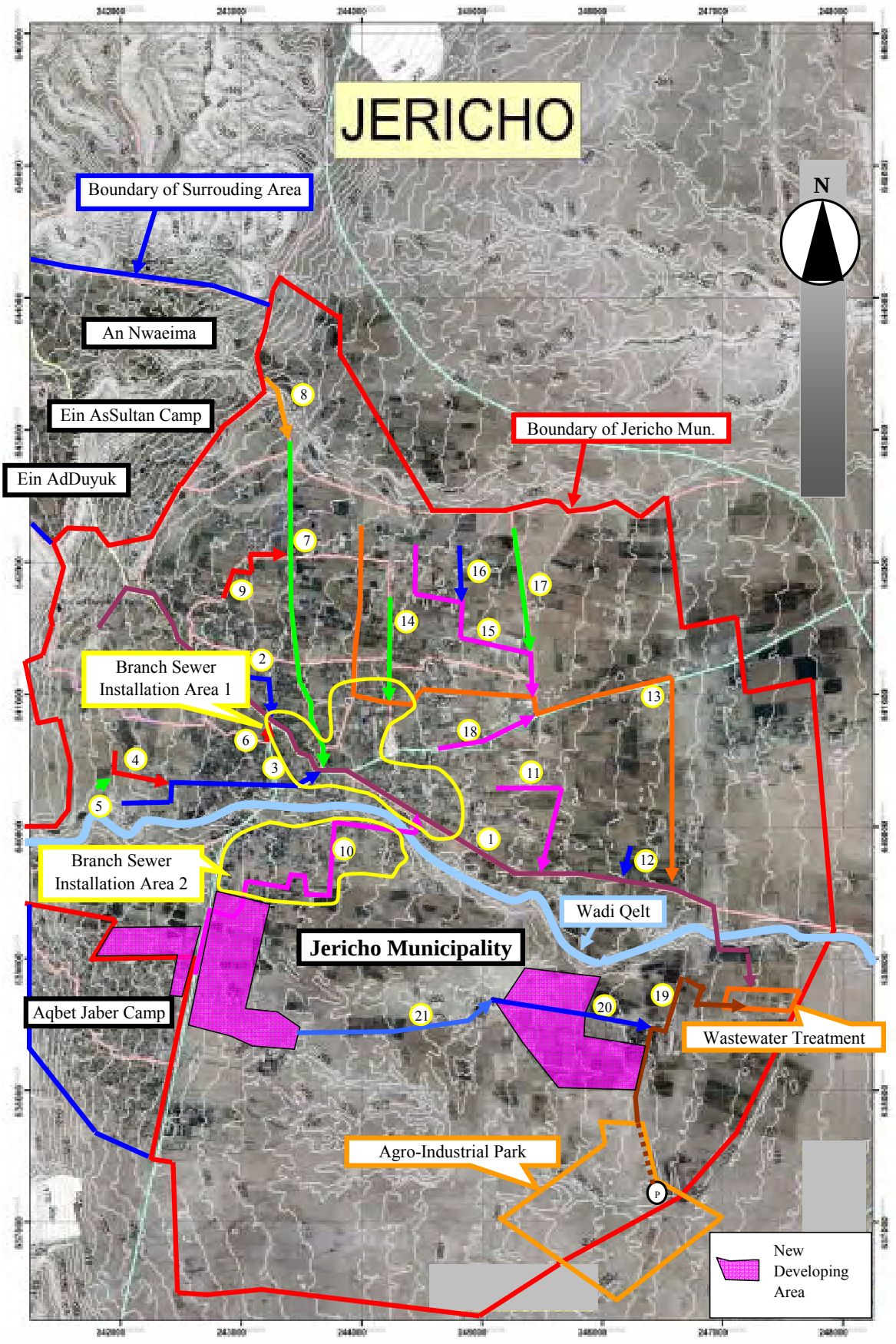

Figure 2-8 Sewerage System Location Map in Jericho Municipality

The areas with high population density should be covered with priority, and the Team suggested the branch sewer within a total length of around 16 km to be developed.

Area 1 and Area 2 shown in Figure 2-8 having high population density are selected as proposed branch development area. By branch sewer development in these areas, 22 % of service population will be added. Accordingly, the service ratio will be 43 % in 2025 and 47 % in 2010.

Here, the service ratio means service population ratio divided by total population, and service population means population within the areas where connection pits and connection pipe to the main sewers were already constructed. Installation of connection pits shall be covered by the Palestinian side.

(4) Crossing Wadi

As shown in Figure 2-7, the trunk sewer will cross Wadi at two points. In this case, thanks to the shallow earth cover at these points, pipes can be crossed by pipe bridges above the flood level of Wadi using ductile iron pipes. Siphon can be adopted as alternative for these crossing, but pipe bridge is much better because clogging of the pipe cannot be completely denied for siphon. While in the bridge method, there is no clog because bending is avoided. In addition, it can be easily constructed.

The drawings of the crossings for sewer No.10, dia.400mm and sewer No.1, dia.700mm are shown in Figure 2-9. Truss bridges are adopted for the wide and deep points of Wadi, and steel beams are adopted for shallow parts of Wadi. For both cases ductile iron pipes will be installed on these steel structures.

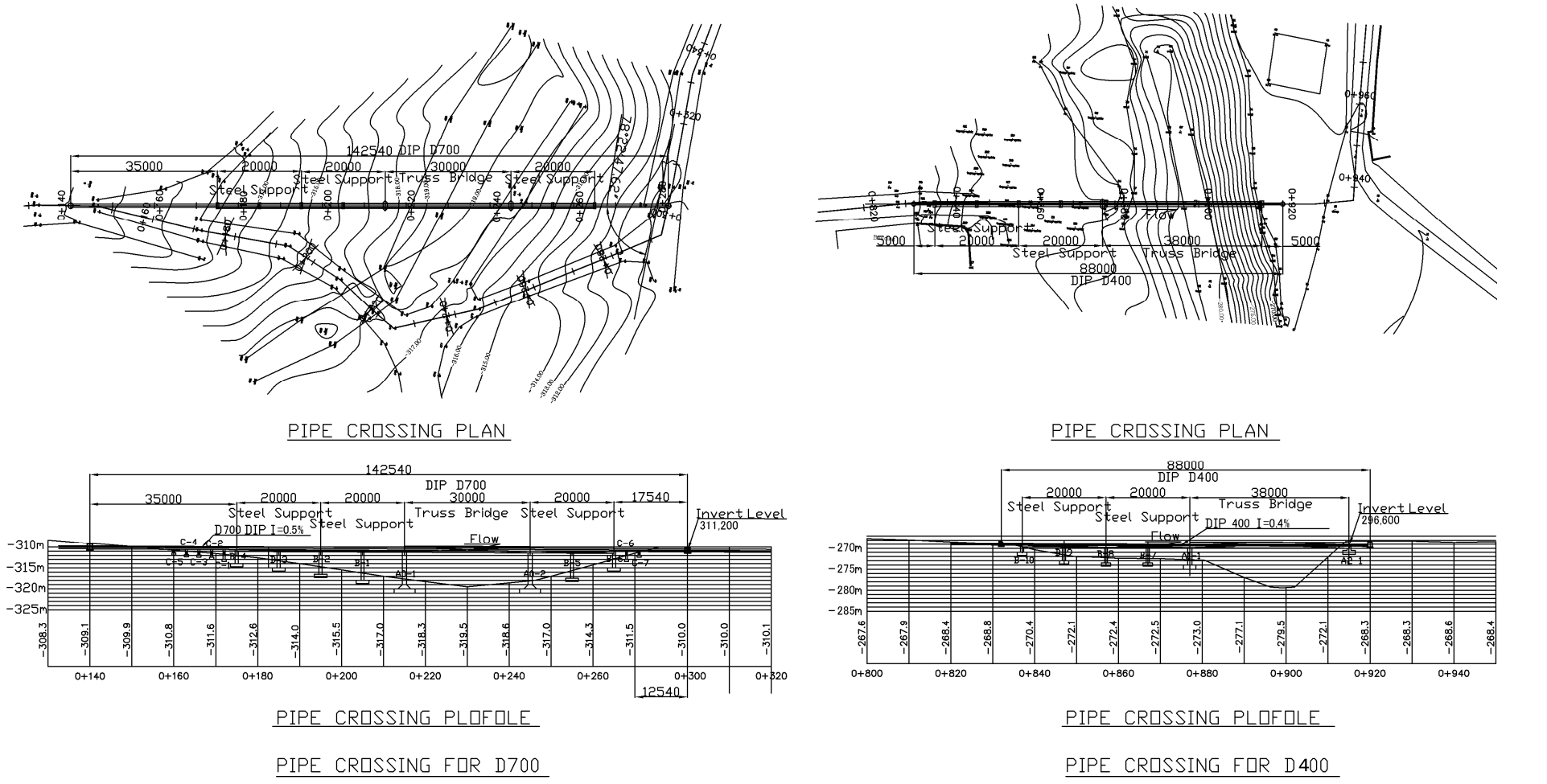

Figure 2-9 Structure of Wadi Crossing

2-2-2-4 Equipment Procurement Plan

The plan for procurement of the equipment requested by PWA is considered as follows;

(1) Water Quality Control Equipment and Operation and Maintenance Equipment

There is no Wastewater Treatment plant in Jericho now. Therefore, necessary water quality control equipment for water quality monitoring is procured in this project. Required water monitoring items for daily operation and administration in the wastewater treatment plant are shown Table 2-19. Equipment for monitoring items is shown on Table 2-20.

Table 2-19 Required Water quality monitoring and water quality test for operating in WWTP

Category	Item
Water quality	pH, BOD, COD, SS, T-N, Coliform
Water Condition	DO, MLSS, ORP, SV30, Water Temperature, Transparency , Moisture Contents of various Sludge, Microscopic Tests

For operating the water quality equipment, how to conduct water quality test and how to monitor the water quality analysis data will be supported in detail by the JICA, through technical cooperation project as explained in the later chapter.

Table 2-20 Water Quality Analysis Apparatus

Item	Contents
Procured Equipment	Water quality test equipment(portable pH meter, portable DO meter, portable MLSS meter, ORP meter, work table, electrical balance, incubator, refrigerator, Purify water equipment, dryer, Vacuum Pimp, colony counter, T-N/T-P testing kit, water quality test equipment, portable thermometer, perspective meter, chemical storage cabinet, oven, microscope etc)

2-2-2-5 Examination of Countermeasures for Climate Change

(1) Setting up of the Scenario

Since currently there are no sewerage system in Jericho Municipality and the surrounding areas, wastewater discharged from housing and various entities is temporarily stored in cess-pits, and then collected by private owned tankers with a charge, and majority of these are disposed of at nearby Wadi. Thus, since the wastewater is not treated in any style of treatment, the pollutants contained in wastewater generates methane, which is a kind of green house gas (GHG) with 21 times of green house effect to carbon dioxide (CO_2) due to methane fermentation. When a sewerage system will be constructed in the area and the wastewater will be collected and treated by the WWTP, the generation

of methane can be prevented. This is a help as a countermeasure to mitigate the climate change.

The reduction amount of GHG is calculated below;

(2) Reduction amount of CO_2

1) Treatment Condition

The wastewater treatment condition is assumed as shown in Table 2-21, and average inflow BOD and outflow BOD are assumed to be 80% and 50%, respectively.

Table 2-21 Design Quantity and Quality

item	Inflow Quantity and Quality			Outflow Quality
	Daily Ave.	Daily Max.	Hourly Max.	
Quantity (m^3/d)	6,600	9,800	19,100	---
BOD(mg/L)	500			20
TSS(mg/L)	500			30
T-N(mg//L)	75			50

2) Reduction Amount of CO_2

Without Case (Present)

Current untreated loading is assumed to be equivalent to the inflow loading for the WWTP at the target year of 2020.

i) Wastewater Treatment

$BE_{without} = B_0 \times MCF_p \times Q_{BOD,y} \times P_{BOD,y} = 289 (tCH_4/y)$

Therefore, 289 (tCH_4/y) x 21(t-CO_2/t-CH_4)

= 6,069 (tonCO_2/year)

Where,

B_0 = 0.60 ($kgCH_4$/kgBOD): maximum CH_4 generation ability

MCF_p = 0.5: CH_4 conversion coefficient

$Q_{BOD,y}$ = 6,600m^3/d×365d/y = 2,409,000 (m^3/y) : annual treatment amount of wastewater

$P_{BOD,y}$ = 400 (mg/l) : Average inflow BOD 500 x 0.8

With Case (After completion of project)

Treatment method of the project is the Aerobic Treatment + Drying Beds.

Employing the Extended Aeration Process with intermittent aeration (the figure of tank is OD), of

which the operation is easy and enable to operate stable and continuously.

$PE_{with} = PE_{with,w,} + PE_{with,e} + PE_{with,s}$

i) Wastewater treatment: Average treated BOD is 10mg/L

$PE_{with,w,} = B_0 \times MCF_p \times Q_{BOD,y} \times P_{BOD,y} = 7.2 \times 21 =$ 151 (t-CO_2/y)

ii) Power consumtion $PE_{with,e} = EC_{FC} \times EF_{FF}/1000 =$ 496 (t-CO_2/y)

Where,

EC_{FC} x＝886,400 (kWh/y): Annual power consumtion of WWTP

$EF_{FF=}$0.56 (kg-CO_2/kWh): Electricity/CO_2 Discharge coefficient

iii) Sludge Treatment

$PE_{with,s} = S\ y \times DOCy,s \times MCFys \times DOC_F \times F \times 16/12 \times GWP_{CH4} =$ 17 （t-CO_2/y）

where、

Sy ＝2,500 (t/y): Sludge Amount

DOCy,s = 0.05 : Rate of dissolving volatile materials

MCF_s = 0.4（CH_4 conversion coefficient, Unmanaged shallow solid waste disposal）

DOC_F = 0.5 (Rate of dissolving carbon to convert bio-gass)

F = 0.5 (CH_4 Contents rate)

GHG Discharge Reduction Amount

From above calculations, Reduction amount of GHG Emission Rate (ER) by introduction of Sewerage System is;

$ER = BE_{without} - PE_{with} = 6,069 - (151 + 496 + 17) =$ **5,405 （t-CO_2/y）**

2-2-2-6 Sewerage Projects assisted by other Donors

As mentioned previously, a modern WWTP was constructed under the aid of KfW in Al-Bireh in 2000 and the construction of a similar WWTP and sewer networks have been started in Nablus West under the aid of KfW. These WWTPs are compared with the WWTP planning in this Project as shown in Table 2-22.

Table 2-22 Comparison of WWTP between Jericho Project and Others

Donor country			Germany		Japan
Target LGU			Al-Bierh	Nablus West	Jericho
Design Population			50,000	150,000	42,500
Capacity(m^3/日)			5,750	14,860	9,800
Completion year （Plan）			2000	(2012)	(2014)
Inflow Water Quality			Actual ： BOD400-700mg/L, T-N90-120mg/L	Design：BOD560mg/L, T-N110mg/L	Design ： BOD500mg/L,SS500mg/L, T-N75mg/L
Treated Water Quality			BOD20mg/L, SS30mg/L, T-N50mg/L		
Treatment Facilities	Pre-treatment		Screen+Grit Chamber+ Regulation Tank	Screen+Grit Chamber+ Primary Clarifier	Screen+Grit Chamber
	Treatment Process		ＯＤ Process Reactor +Final Clarifier	Extended Aeration Reactor+Final Clarifier	Extended Aeration Reactor+Final Clarifier
	Measurement/Disinfection		ＵＶ Disinfection T+Measurement T	Measurement T	Chlorine Disinfection T+Measurement T
	Reuse Facility		Irrigation T	--	Irrigation T
	Sludge Treatment Facilities		Excess Sludge Gravity Thickener +Dewatering Machine	Raw/Excess/digested Sludge Gravity Thickener + Digester + Dewatering Machine+ Sludge Drying Beds +Sludge Storage yard	Excess Sludge Gravity Thickener +Sludge Drying Beds
Budget（mil.Yen）		Structure[*1]		1,660(10.7mil.€)	578
		Machines		1,047(6.7mil.€)	613
		Electrical Facilities		242(1.6mil.€)	575[*1]
		Total	856[*2](8 mil.＄)	2,949[*3](19 Mili.€)	1,766
O&M Costs, (NIS/m^3)		Power	0.40	1.07	0.20
		Human Expense	0.20	0.43	0.26
		Chemical	0.01	0.43	0.03
		Repair	0.04	0.64	0.11
		Others	0.04	0.43	0.00
		Total	0.69[*4]	3.00	0.60
Reactor Capacity（retention time）			V=13,846m^3（2.4day）	V=17,460m^3（1.17day）	V=10,700m^3（1.09day）
Final Clarifier Surface Load			A=904m^2（6.4m/d）	A=2,011m^2（7.4m/d）	A=904m^2（10.8m/d）

*1：Including pipe works、*2：2000year（Completion year）Calculated by ave.107Yen/$、
*3: 2008year (Study year) Calculated by ave.155Yen/€, *4: Recorded in 2007

2-2-3 Outline Design Drawings

Table 2-23 List of Drawings

No.	Name	Scale
1	SEWARAGE SYSTEM LOCATION	None
2	WWTP LAYOUT PLAN	1:100
3	WWTP FLOW SHEET	None
4	WWTP HYDRAULIC PROFILE	None
5	WWTP WASTE WATER RECEIVING TANK PLAN & SECTION	1:100
6	WWTP GRIT CHAMBER PLAN & SECTION	1:100
7	WWTP REACTOR TOP PLAN	1:100
8	WWTP REACTOR BELOW PLAN	1:100
9	WWTP CLARIFIER PLAN	1:100
10	WWTP REACTOR/CLARIFIER SECTION	1:100
11	WWTP DISINFECTION TANK/IRRIGATION TANK/SLUDGE THICKENER PLAN & SECTION	1:100
12	WWTP SLUDGE DRYING BED PLAN & SECTION	1:300
13	WWTP PIPE LAYOUT PLAN(1)	1:400
14	WWTP PIPE LAYOUT PLAN(2)	1:400
15	WWTP BUILDING PLAN & SECTION (1)	1:100
16	WWTP BUILDING PLAN & SECTION (2)	1:100
17	WWTP SINGLE LINE DIAGRAM	None
18	WWTP SCADA SYSTEM DIAGRAM	None
19	WWTP INSTRUMENTATION DIAGRAM(1/2)	None
20	WWTP INSTRUMENTATION DIAGRAM(2/2)	None
21	GENERAL PLAN for SEWER PIPES	1:15000
22	SEWER LAYING PLAN with COLLECTION AREA (NW, 1/4)	1:6000
23	SEWER LAYING PLAN with COLLECTION AREA (NE, 2/4)	1:6000
24	SEWER LAYING PLAN with COLLECTION AREA (SW, 3/4)	1:6000
25	SEWER LAYING PLAN with COLLECTION AREA (SE, 4/4)	1:6000
26	PROFILE for TRUNK SEWER (1/4)	1/200, 1/10000
27	PROFILE for TRUNK SEWER (2/4)	1/200, 1/10000
28	PROFILE for TRUNK SEWER (3/4)	1/200, 1/10000
29	PROFILE for TRUNK SEWER (4/4)	1/200, 1/10000
30	SEWER PIPE WADI CROSSING PLAN & SECTION	1:500

Above drawings are shown in attached “Appendix for drawing”

2-2-4 Construction Policy/ Procurement Policy

2-2-4-1 Construction Policy/ Procurement Policy

Palestine Water Authority (PWA) is the implementing agency for this project. The water supply project is managed by Jericho Municipality under PWA's administration. The project implementation structure is shown in Figure 2-10.

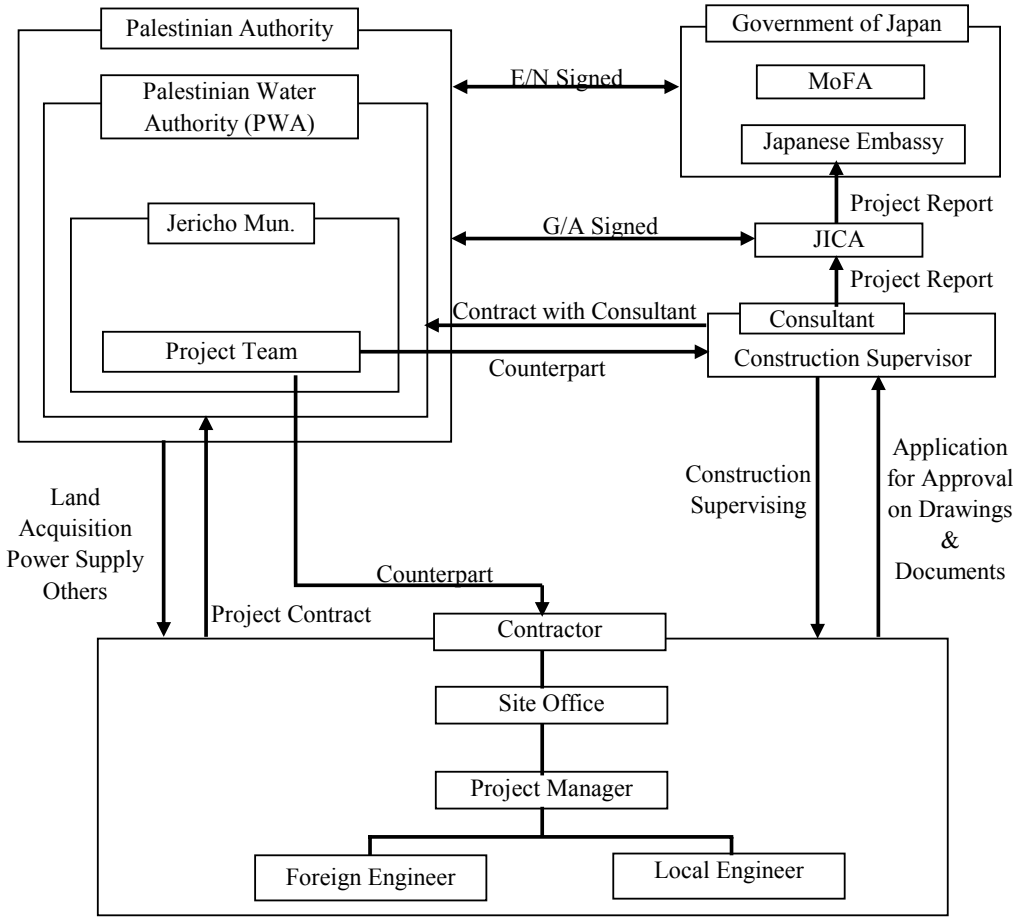

Figure 2-10 Project Implementation Structure

A project team organized in PWA and Jericho Municipality is in charge for the project from the detail design stage.

Roles for the project team are as shown below;

a. Manage and handle with PWA and Jericho Municipality in the Project
b. Contact and adjust with relevant departments in Palestine
c. Contact and adjust with relevant external departments in the Project

d. Coordinate for detail design and tender document in the Project
e. Coordinate for additional survey or test, if necessary.

For smooth implementation of this project, a Japanese Consultant team conducts the Detailed Design, Tender, and Construction Supervision. The work will be completed within the agreed period. For this reason, a Japanese resident engineer will station on the site and carry out the supervision for PWA as a representative during construction period. As to the progress of the construction work, each part of Japanese engineer such as civil, mechanical, electrical and pipeline will be dispatched for construction supervision.

Since civil/architectural work, pipeline installation and mechanical/electrical work are main parts of the Project, a Japanese general contractor who has similar construction experience will be selected by the Tender. For selecting a proper contractor, open bid shall be applied requiring certain qualifications, which is the basis of selection. These qualifications and conditions will be decided with PWA under the JICA guidelines during the tender preparation.

For implementation of the construction, the resident engineer dispatched from a Japanese contractor will manage and supervise the construction on the site. The construction industry in Palestine is developed especially in the Jericho areas, because there are many construction works implemented by local contractors. In this situation, hiring of local contractors as sub-contactors and procurement of construction materials are easily performed for the Project.

2-2-4-2 Remarks about Implementation and Procurement

Construction works are composed of construction of the WWTP and Sewer installation work. The contractor’s office and warehouse for construction materials can be located in the WWTP site where has large vacant space. The contractor shall negotiate with PWA and Jericho Municipality for the land usage.

Local contractors have abundant experiences for architectural structure works. However, since these experiences are much different from those used in the construction of the WWTP, contractors need to take care in material quality and finishing on the works. For example, they have limited construction work experience for water tank structures such as oxidation ditch, of which the wall thickness are as thick as 500mm with large diameter reinforce bars. Thus, it is necessary that Japanese Engineers carefully instruct how to carry out the works. In addition, as a lot of items of mechanical and electrical equipment are used for the WWTP, Japanese engineers are needed to instruct how to install and adjust for the equipment. Remarks on general matters and safety management are described below:

General Matters

a. To respect and take into consideration in the project execution that Fridays are public holidays. A number of holidays will be taken after Ramadan in accordance with the Muslims calendar. The national holidays are also to be respected and their dates are to be checked.

b. Jericho Municipality locates approximately 60km south-southeast away from Ramallah which is the capital city of Palestine Authority. The Remains of the oldest town in the world are uncovered and 'Mountain of Temptations', where the place for the myth that Jesus Christ was tempted by the devil, are in the municipality located near the "Dead Sea". Many tourists especially Christian from all over the world visit the municipality and the surrounding areas with a large number of tour buses and cars going through the municipality. These conditions shall be taken into consideration in hiring labors and transportation measures, and procuring of construction materials for the project.

c. Basically, construction materials are transported by vehicles in Palestine. There is no railway in Palestine.

d. The total annual rainfall amount is very small, which ranges averagely 50mm to 400mm in recent years. The climate in the municipality is divided into two; rainy season, which is from October to March, and dry season, which is from April to September. In the rainy season, it usually rains from evening to morning or from afternoon to evening. In the dry season there is no rain falls. Normally there will be no disturbance by rain falls in the construction works through the year. In implementing the construction, a decrease of efficiency on the work should be considered for days when precipitation more than 10mm/day occurs in the rainy season.

e. The location of the WWTP is away from the city center, but environmental protection from noise pollution, air pollution and etc should be considered for the neighbors. Especially, some water sprinkling for the un-pavement access road will be required.

f. According to the soil test survey, the bearing capacity of soil in the WWTP site is not even, some parts of it are considered not to have enough bearing capacity. Then replacement of soil and compaction should be carried out, if necessary.

g. For sewer pipes installation, pipes should be basically installed at road shoulder on the side of paved road, if possible. Installation on paved road will be carried when it is inevitable. The minimum width of excavation shall be applied for the pipe installation. The installation on private lands should be avoided as much as possible, except when it is necessary, PWA and

Jericho Municipality shall acquire the permission and deal with a necessary compensation for private lands.

h. Required pipe protection measures shall be provided on main road crossings in the municipality according to the regulations of Jericho Road Department.

i. For sewer pipes installation, some adequate installation plans shall be formulated taking into consideration of the minimum road blockage to avoid traffic jams. If a road blockage is required, an adequate detour shall be prepared as a countermeasure.

j. The soil in Jericho Municipality consists of silt and gravel. The soils are stable as the groundwater level is as low as 10 m in depth, therefore, the surface of excavated channel will be stable.

On the other hand, as the sewage flows by gravity in sewer pipes in the ground with slopes of up and down, in some parts the maximum excavation depth may reach to around 5m. If the excavation depth exceeds more than 2.5m, an earth retaining work such as sheet piling shall be applied for safety measure for earth corruption.

k. Jericho Municipality is known for the oldest city in the world, and the area called 'Old Jericho', located at western part of the municipality, remains uncovered with old historic remains, back to B.C 8 century. If any remains/relics are uncovered during the pipe installation in this area, the Contractor shall stop the work immediately and report to the relative authorities.

l. As the main roads in the municipality area are also residential road for the citizen, proper construction plan avoiding road blockage should be prepared. If the blockages are unavoidable, adequate detour should be prepared with proper sign.

m. There are some ready-mixed concrete factories in Jericho and surrounding areas. Basically, concrete for construction shall be procured from these factories. The quality of these concrete shall be checked to comply with the specifications.

n. For installation, adjustment and test operation for machines, such as rotating equipment including pumps and blowers, and electrical facilities including solar panel shall be carried out under the supervision of Japanese engineer on the site.

o. Value- added Tax (VAT) for imported items and import tax will be exempted with prescribed procedures. However, taxes on locally procured items should be applied for refund method in

principle.

p. The apprication for Approval of Environmental Impact Assessment (EIA) for implementing this project had been already submitted to EQA by PWA. It will be approved by EQA with some comments by August. The Project including construction of the WWTP is designated as 'category B' by JICA, which is applied adequate environmental and social consideration. Environmental Management plan and Solid Waste Management plan will be prepared and implemented in the construction. Especially, in construction stage environmental protection measures will be planed such as dust, noise pollution, turbid water treatment and solid waste disposal according to the relevant environmental laws in Palestine.

q. Since Jericho Municipality has many experiences in permissions for occupancy of roads, there is no problem to acquire ones for the Project. The construction plan should be prepared taking into consideration of environmental point of view.

r. Social infrastructures such as electricity in this municipality have no problem, but in case of power shortage, generators are to be provided.

r. Recent price escalation rate in Palestine market is considered. (West Bank 4.2%, Gaza 4.1% according to 2006 World Bank prediction)

Safety management item

Local safety information in Jericho Municipality and the surrounding area is collected from JICA Palestine Office and Embassy of Japan in Tel Aviv, and the safety measures in the construction stage are conducted as follows;

a. Generally, updated advice for safety and necessary precautions shall be given by local counterpart authorities.

b. Contact with other donors who work in Jericho Municipality and the surrounding areas closely. Safety information shall be shared each other.

c. In general, inside of Jericho Municipality and its surrounding areas are relatively safe, and there is no danger in working in the daytime. However, extra attention would be needed for safety on accommodation facility. Therefore, sufficiently guarded hotels or apartment is to be considered for accommodation, and detached houses are not recommended.

d. Construction cars shall be attached with stickers that explain this project is supported by Japan.

e. Government of Israel and a part of Palestine Authority are state of tension, now. It can be considered that there would happen any unexpected contingency in case of conflict between some factions. Evacuation routes and satellite phones should be considered during the construction. Basic Operating Guideline (BOG) should be publicized for construction workers for unexpected contingencies.

Others

a. Procurement of cement

- Cement for concrete mixing is distributed and easily purchased in the local market. The quality of the cement shall be confirmed for saline concentration, which may affect the long-term durability of the concrete.

b. Procurement of Re-bars

- There is a manufacturer of reinforce bars in Jericho Municipality. It is easy to get re-bars in this area.

c. Procurement of form work.

- It is also distributed and easily purchased in the local market in Palestine.

d. Procurement of aggregate and sand

- Aggregate is made by crushing stones collected at surrounding mountains in Palestine, and sand is collected from deserts of which the resource is abundant. Proper particle size of the aggregate shall be confirmed in accordance with the specifications.

e. Transportation cost

Palestine Authority shall bear in-land transportation cost in Palestine as shown in Table 2-23.

f. Fluctuating of exchange rate of New Israel shekel (NIS)

New Israel Shekel fluctuates at around 23 Japanese Yen per NIS averagely as of the beginning of 2011. It is stable recently. However, attention should be paid the trend of exchange rate in future.

2-2-4-3 Sharing Responsibilities in Construction/Procurement/Installation

Table 2-24 and Table 2-25 show the sharing of responsibilities in the implementation of this project between the government of Japan and the Palestinian Authority, which are based on the policy of “Grant Aid Program” of the government of Japan;

Table 2-24 Major Undertakings to be taken by Each Government（General Items）

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	to secure [a lot] /[lots] of land necessary for the implementation of the Project and to clear the [site]/[sites];		●
2	To construct the following facilities		
	1) The building	●	
	2) The gates and fences in and around the site		●
	3) The parking lot	●	
	4) The road within the site	●	
	5) The road outside the site		●
3	To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the [site]/[sites]		
	1) Electricity		
	a. The distributing power line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for storm sewer and others to the site)		●
	b. The drainage system (for toilet sewer, common waste, storm drainage and others) within the site	●	
	4) Gas Supply		
	The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
4	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products		
	1) Marine (Air) transportation of the Products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the Products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site		●
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services be exempted		●
6	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
7	To ensure that the Facilities be maintained and used properly and effectively for the implementation of the Project		●
8	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		●
9	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
10	To give due environmental and social consideration in the implementation of the Project.		●

(B/A : Banking Arrangement, A/P : Authorization to pay)

Table 2-25 Works to be undertaken by Each Government

Item	Type	Palestine	Government of Japan
Construction on WWTP and Sewer network	Procurement of Equipment and Materials		○
	Transportation in Palestinian Authority	○	
	Construction		○
	Installation		○
	Installation of Pipeline		○
	Land Acquisition	○	
	Installation of External Fence	○	
	Installation of Power Line and Water supply	○	
Common	Improvement of Access Road (on site)	○	
	Attaining required approvals	○	

2-2-4-4 Plans for Construction Supervising and Procurement

The Project will commence upon the signing of both governments on the "Exchange Notes(E/N)" for the Project on Grant Aid Program, through the Cabinet Approval of the Government of Japan.

1) Detailed Design

Based on the Exchange of Notes, PWA will hire the consultant for detailed design works for the Project. After the GOJ's verification of the detailed design contract, the consultants will perform detailed site survey and prepare the detailed design, cost estimates and tender documents in Japan.

2) Tendering

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

a. To allow one week for bidders to prepare an application for prequalification
b. To evaluate prequalification submitted from the bidders
c. To deliver the tender documents to pre-qualified bidders and allow one month to prepare bidding documents. The bidding documents will be opened at presence of the relevant organizations
d. To recommend the lowest qualified bidder for PWA as a successful bidder and assist PWA in contract negotiation and conclusion of the contract

3) Construction supervision

Construction works include civil works, plumbing works, and mechanical/electrical works. Besides a resident engineer, the consultants will dispatch civil engineers for plumbing and structures, as well as mechanical and electrical engineers to the construction site as needed, as construction works require. The consultants will hire local engineers to support their works.

The resident engineer of the consultants will maintain the close contact with PWA and the contractors throughout the project implementation period. The resident engineer will submit progress reports to PWA, MOLG, MOA, PIEFZA, the JICA Palestine Office and to the JICA headquarters at the agreed interval.

2-2-4-5 Quality Control Plan

Consultant shall instruct the Contractor to perform the analyses and tests etc. related to the facility construction works as shown in Table 2-26 and these shall reflect results on quality control.

Table 2-26 Test Methods on Quality Control

Work Items	Control Point	Method	Applicable Criteria
Pipe Material	-Strength/Dimension -Appearance/Dimension	Verification of Report of Shop Inspection & Tests Visual Inspection/Dimensional Measurement -Gauge	Criteria of Japan & ISO
Plumbing Constructions	-Torque -With or Without Water Leakage -Painting	-Torque Wrench -Hydrostatic Test -Film thickness meter/Visual Inspection	Criteria of Japan & ISO
Foundation	Ground Bearing Capacity	Plate Bearing Test	Criteria of Japan & ISO
Concrete	-Aggregate/Cement/Water -Ready Mixed Concrete -Concrete Strength	-Physical/Chemical Tests -Grain Size Analysis -Slumps/Air Content/Chloride Content -Compressive Strength Test	Criteria of BS
Reinforcing Steel Bar	Strength	-Tensile Strength -Bar Arrangement (scheduling) Inspection	Criteria of BS
Structural Output		Dimension Inspection	Criteria of Japan & ISO
Water proofing Works	-Material Quality -Coating Film/Adhesive Force -Coating Conditions -With or Without Water Leakage	-Verification on Certificate of Quality -Film thickness Test/Tension Test -Visual Inspection Water Leakage Test	Criteria of Japan & ISO
Solar Power Generator	-Installation Precision	Measurement on Installation Location	Criteria of Japan
	-Commissioning	Power、Performance Test	
Electrical/Mechanic Equipment	-Installation Precision -Capability	Measurement on Installation Location Loading Running Test	Criteria of Japan

2-2-4-6 Procurement Plan

(1) Procurement country

As to the procurement of construction materials and equipment, the countries eligible on the Grant Aid shall be the recipient country and/or Japan. Equipment and materials required for the Project shall be procured from the domestic market wherever possible. However, if equipment and materials cannot be procured from the domestic market, or if those available in the domestic market do not meet the quality specification, or provide stable prices or terms at the time of purchase, then procurement will be from Japan and/or a third country taking the cost-benefit performance, ease in O&M and self-sustainability. Third Countries mean southern Middle East countries and/or EU nations.

a. Civil works materials

Among the main civil engineering and building works, common construction materials such as cement, gravel, sand, brick, timber (squared timber & board), petrol and oil, etc. can be procured in Palestine. However, it is necessary to take appropriate measures for the stable procurement of the materials guaranteed in accordance with the specified quality

b. Sewer pipes and manholes

Since ductile iron pipes have not been produced in Palestine, these shall be procured from Japanese companies, even though some of them are produced in other courtiers under the quality control of these companies, with the conditions that the products are of high quality and secured in procurement. Since there are some manufacturers for reinforced concrete pipes, precast manholes and uPVC pipes in Palestine, these items are procured from local market in Palestine. However, some pipes with large diameter can not be produced in Palestine, then, these PVC pipes will be procured from Japan.

c. Mechanical and electrical equipment

Mechanical/electrical equipment is required by the Project. In addition, such equipment for the facilities of the new WWTP manufactured in the third country is of limited quantity. Therefore, merit of procurement from the third countries is not justifiable. Japanese mechanical/electrical equipment with higher reliability should be adopted.

d. Construction Machinery

Though there are some unknown factors regarding the failure and/or breakdown of construction machinery in the lease market in Palestine, general construction machinery will be available in Palestine.

Procurement plan for construction material is shown on Table 2-27.

Table 2-27 Procurement Plan

Construction Material/Equipment		Expected Country of Origin		
Classification	Item	Local	Japan	Third country
Material for civil work	Cement	○		
	Reinforcing Steel Bar	○		
	Form	○		
	Sand, Gravel, Brick	○		
	Diesel Oil and Petrol etc.	○		
Pipe for sewer network	Ductile Iron Pipe	○	○	○
	Steel Pipe	○	○	
	reinforced concrete pipe	○		
	uPVC/PVC pipe	○	○	
Mechanic/Electrical Equipment and Others	Pumps		○	
	Hyperfine Diffuser		○	
	Clarifier, Thickener		○	○
	Other Equipment		○	
	Solar Power Generation Device		○	
	Incoming Panel・Console Panel		○	
	Distribution Power Panel		○	
	Transformer		○	
	Other devices		○	
Construction Machinery （by Lease）	Construction Equipment	○		

2) Delivery/ storage area

Procured material is delivered at a temporary yard in the sewage treatment plant area. It is necessary to provide security guards. Delivering a lot of materials at one time is to be avoided in view of material control especially for sewer pipes.

2-2-4-7 Initial Operating Instruction Plan

The planned Sewerage system including a sewer network is a new construction; therefore, only the wastewaters from Ago-Industrial Park and that from cess-pit conveyed by vacuum cars are treated in the WWTP at the time of completion. The estimated sewage volume is approximately 300m^3/day maximum from Ago-Industrial Park, and 250m^3/day from vacuum tankers in April 2014, at the time of the

beginning of operation. The total amount will be only 550m^3/day max, which is around 6 percent of the planned volume of 9,800m^3/day. The WWTP can be operated with the small amount of inflow sewage. The Contractor shall instruct carefully how to cope with such small inflow. The flow rates will gradually increase and the manner of operation shall be changed along with increasing loads. The technical cooperation project should be formulated taking this situation into consideration.

Targets for operating facilities are 1) receiving tank, 2) grit chamber and screen, 3) reactor and clarifier, 4) Chlorination tank, 5) Sludge thickener and drying beds. The Contractor shall conduct commissioning for the facility with PWA and engineers assigned from Jericho Municipality. This commissioning is a part of operation instruction at the completion of the work, aimed for instruction on how to operate the facilities and how to solve the issues in operation.

The initial operation guideline is shown in Table 2-28.

Table 2-28 Initial Operation Guidance

Facility	Contents	Remarks
WWTP	Sludge receiving tank: confirming the function, On-Off test, Inspection method Grit chamber: confirming the function, On-Off test, how to operate and inspect and operate in emergency screen operation, sand pump, separator and scum separator. How to operate in emergency stop Reactor: how to operate and inspect Blower operation, air diffuser, mixer, DO meter and air flow meter. How to operate in emergency stop Clarifier: how to operate, inspect and operate in emergency stop sludge scraper, return and excess sludge pump. Chlorine disinfection tank: How to operate, inspect and operate in emergency stop chlorine injection tank, safety measure and flow meter operation Power receiving facility: how to operate, inspect and operate in emergency stop Solar Panel: how to operate, inspect and operate in emergency stop Diesel power generator: Function Confirmation, Operation and Inspection Method Control Panel and SCADA (monitoring system): confirming the function and how to operate and inspect monitors and panels.	Only for wastewater treatment
Cross section by Siphon	How to control gate operation, Inspection method and operation method in emergency	
Sewer	Inspection Method、Cleaning Method	

2-2-4-8 Necessary Preparation and Procedures for the Project

(1) Necessity of technical cooperation

With the progress and completion of the project, Jericho Municipality needs to establish organization and procedures for operation and management of the system, such as; securing operators at WWTP, and accountant for tariff collection and accounting; preparation and formulation of legislation

for sewer connection; institutional arrangement for sewerage department; designating qualified contractors for sewer connection; developing ideas for incentive to promote early connection to sewer network; preparation for reasonable tariff system; and so on. At present, due to insufficient personnel number in Jericho Municipality, it seems difficult for the municipality to implement variety tasks, plans and actions for launching the sewerage project except construction work.

This should be noted that sewage treatment engineering has not been taken root in Palestine. Under this project, WWTP and sewer network will be completed in April, 2014. However, only wastewater generated in Agro-Industrial Park and cess-pit wastewater collected and discharged by vacuum tankers will inflow to WWTP and total wastewater amount is estimated to be 200 to 400m^3/day for initial stage. Incoming wastewater amount will be increased gradually. Therefore, technical assistance is needed for the operation and maintenance (O&M) of WWTP to improve the abovementioned current technical/engineering situations.

Owing to current situation in Jericho Municipality, introduction of technical cooperation project is deemed adequate to assist initial stage of the project and to bottom-up of sewage treatment technology level. In addition, assistance to train and/or instruct for O&M of other WWTPs existing in Palestine or a capacity development for relevant entities' staff may be required, and therefore some additional assistant program for these requirement should be formulated.

Although there are some existing WWTPs in Palestine, only the modern WWTP in Al-Bireh, constructed by German grant-aid, has been operated properly with proper operation records. A new WWTP is constructing in the west part of Nablus by German grant-aid and the WWTP in Al-Bireh will be expanded within several years, and since GIZ will carries out technical assistance for O&M of these WWTPs, above assistance by the Project should cooperate with this activity.

PWA staff didn't show particular interest in the necessity for technical cooperation of other existing WWTPs due to the diminutive capacity and inadequate facilities, while they were positive to take a course of capacity development for technologies/methods such as design with the evaluation of sewerage system, and management of sewerage works and system. These courses and capacity building are important for PWA as they are useful to facilitate PWA roles to help especially Jericho Municipality and other municipality in general and to establish the organization and procedures for operation and management of the system and other issues. Therefore the assistance for capacity development by the experts dispatched for above assistance should be considered.

(2) Desirable assistance

Following points should be solved and established before the completion of the construction work under the projects are; securing the necessity personnel, implementing the system, confirmation of tariff structure and tariff collection method, launching the sewerage department, preparation of a setup for house connection construction work and incentive for house connection, etc. These preparatory works and required decision are difficult to be carried out only by the department in charge. The decision is necessary to be made between PWA, Jericho Municipality and other related parties such as audit organization from citizen through the meeting among parties. For this reason, two years of period is deemed appropriate for preparation of organization and implementation of the whole process.

The construction work will start in April, 2012. It is necessary for PWA and Jericho Municipality to proceed the preparation work for the sewerage project at that time. An assistance activity is desirable to start in April, 2012 at the timing of a contract signing for the construction work. On the other hand, even if above-mentioned activity is done, further assistance would be needed at the beginning of the operation stage for a year at least. Institution specialist, financial specialist, auditing specialist and sewer connection specialist will be necessary to have the project operation smoothly for three years in total from the start of the construction work.

For operation and maintenance of the WWTP and sewer network, technical assistance of the Contractor is needed at the time of commissioning. With regard to O&M of the WWTP, it will take three years to receive the planned quantity of sewage. Therefore, it is desirable to provide operators and workers appropriate training for this three years. During the training, additional assistance for capacity development for not only staff of Jericho Municipality but also relevant entities including PWA can be executed if necessary.

(3) Necessary work and output

1) Preparation work before completion of the system

The roles of dispatched experts are as follows;

① Participate and assist in establishing sewerage project preparatory committee
② Research Palestinian laws related to house connection and assist in enacting regulations suitable for Jericho Municipality
③ Set up temporary organization, calculation of operation cost including labor cost and assist in tariff schedule setting balancing revenue and expenditure
④ Assist in formulation of draft tariff system and tariff collection method, and assist in enacting them at Municipality Council.
⑤ Assist in formulation and decision of tariff billing system, tariff collection system and sewerage project audit system.

⑥ Assist in preparation of publication documents explaining the necessity of house connection, tariff schedule and tariff collection method.

⑦ Confirmation on personnel and their number needed in O&M of sewerage system by stages, assist preparation in organization structure plan and decision in the Municipality.

⑧ Carry out pilot project for house connection in designated area in the Municipality to confirm key points and needed procedures, skill upgrading in Municipality staff and designated contractors.

⑨ Assist in establishing contractors designated for house connection and preparation of tariff table.

⑩ Assist launching house connection advisory system and technical instruction to advisors.

⑪ Technical assistant in preparation of house connection manual.

⑫ Assist in examination of incentive making method and preparation of concrete measures for house connection and enacting them.

⑬ Formulate regulations for WWTP and sewer network O&M, prepare O&M report formats for daily, weekly, monthly and yearly basis.

⑭ Assist project management for established sewerage department in earlt stage.

2) Assistance before/after completion of the system

Contents of assistance are shown below;

① Check and correction order for mechanical/electrical equipment installation in final stage.

② Test operation of equipment and check operational conditions. Correction order, if needed.

③ Check equipment operation instructions by the Contractor and correct the contents if needed.

④ Confirm wastewater amount incoming from pilot project area, collected by vacuum tankers and sent from Agro-Industrial Park.

⑤ Instruct how to use water quality analysis equipment and how to reflect the analysis results to the plant operation.

⑥ Check initial plant operation condition and execute correction measures, if necessity.

⑦ Confirm wastewater flow in sewer network.

⑧ Technical instruction at early stage of house connection including those in pilot area.

⑨ Instruct house connection campaign implementation.

⑩ Prepare sewerage tariff collection bill distribution.

⑪ Confirmation on soft wares related to tariff calculation simulation

3) Assistance after WWTP commission

The contents of assistance works after WWTP commission and starting tariff collection are as follows. WWTP operation experts also execute capacity development for their special technologies to staff of relevant entities, if necessary.

① Instruct proper plant operation method to cope with increasing incoming wastewater amount.
② Instruct countermeasures for daily plant operation issues.
③ To formulate capacity development plan for staff of relevant entities, if necessary.
④ To execute seminars and site practices for above capacity development plan, if necessary.
⑤ Instruct the contents of house connection work to target households and designated contractors.
⑥ Instruct countermeasures for anticipated troubles during house connection works.
⑦ Instruct solutions expected at the beginning of sewerage tariff collection.
⑧ Instruct resolvents for issues might be occurred at the beginning of accountant works.
⑨ Instruct pipeline inspection method and remedial measures.
⑩ Monitor organizational management and propose correction measures, if necessary.
⑪ Instruction on sewerage system management
⑫ Evaluate the effects of incentive making method for house connection and propose remedial measures reflecting the evaluation results.

4) Necessary output

Noteworthy outputs are that personnel belong to sewerage department gains technical knowledge, Project is properly managed and completed facilities are smoothly operated. Accomplishments in document form are outputs for each target/task such as tariff tables and the reports.

2-2-4-9 Implementation Schedule

In implementation schedule, a period of 4.5 months for detailed design, 5.5 months for bidding/preparation work, 21 months for procurement and construction work. Further, a period of commissioning and turning over of the facility shall be added for implementation schedule, and total implementation schedule is approximately 31 months in total. Construction work of the WWTP takes a long term of 24 months at the shortest after implementing the construction work. Total length of the project implementation from detailed design stage to completion of the work, would be approximately 2.5 years. Implementation plan is as shown on Figure 2-11.

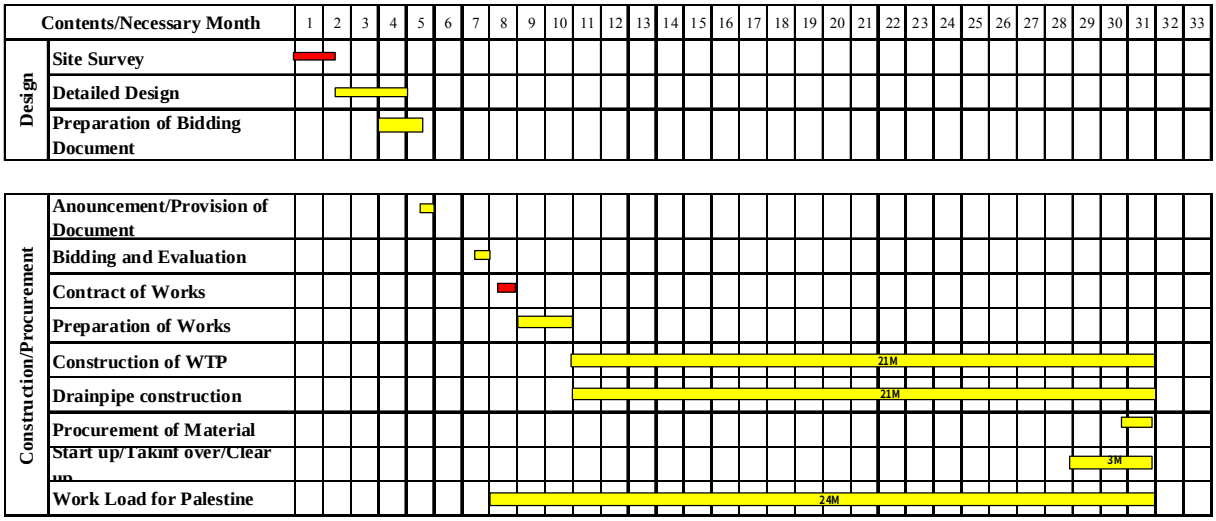

Figure 2-11 Implementation Schedule

2-3 Obligations of Recipient Country

The scopes by the Palestinian Interim Self-Government Authority and the Jericho Municipality in this project are described in "2-2-4-3 Sharing responsibilities in construction/procurement/installation". The followings are the concrete contents.

The proposed scopes are as follows:

a) Land Acquisition：Present 8.4ha, in Future 13ha

WWTP Site (Present 8.4 ha)：1 Lot of Land

As the proposed land is public land owned by the Ministry of Religion, land purchase is not needed but land lease fee, compensation fee for lending agricultural land and transplanting fee for existing plants shall be shouldered.

b) Fence for WWTP：Total length 1,710m

c) Access Road：Total length 1,380m

d) Power cable installation：Approx. 800m

e) Water supply pipe installation：Approx. 1,000m

f) Sewer pipe installation in priority areas：Approx. 16km

g) Installation of connection pit：for 2,000 households

h) Bank commissions

The whole cost of above works is estimated to be 273million JPY (refer to 2-5-2)

2-4 Project Operation Plan

2-4-1 Operation and Maintenance Plan

The existing water supply system is management by water supply department of Jericho Municipality, any sewerage system management department does not exist naturally. Currently, generated domestic wastewater is temporarily stored in private cess-pit and collected by vacuum tanker truck owned by private contractor by interval of once in several months. The collection is done by a fixed charge. Collected wastewater is discharged into Wadi. In some houses, the sanitary condition is worsened by overflowing of wastewater from cess-pit.

As Jericho Municipality is knows as area with the least precipitation in Palestine, no storm drainage pipe and sewer pipe exists. Therefore, new sewerage system management department is recommended to be established, and it shall be composed of administration and financial divisions. WWTP division and a proposed organization structure of the sewer network division with the WWTP is shown in Figure 2-13.

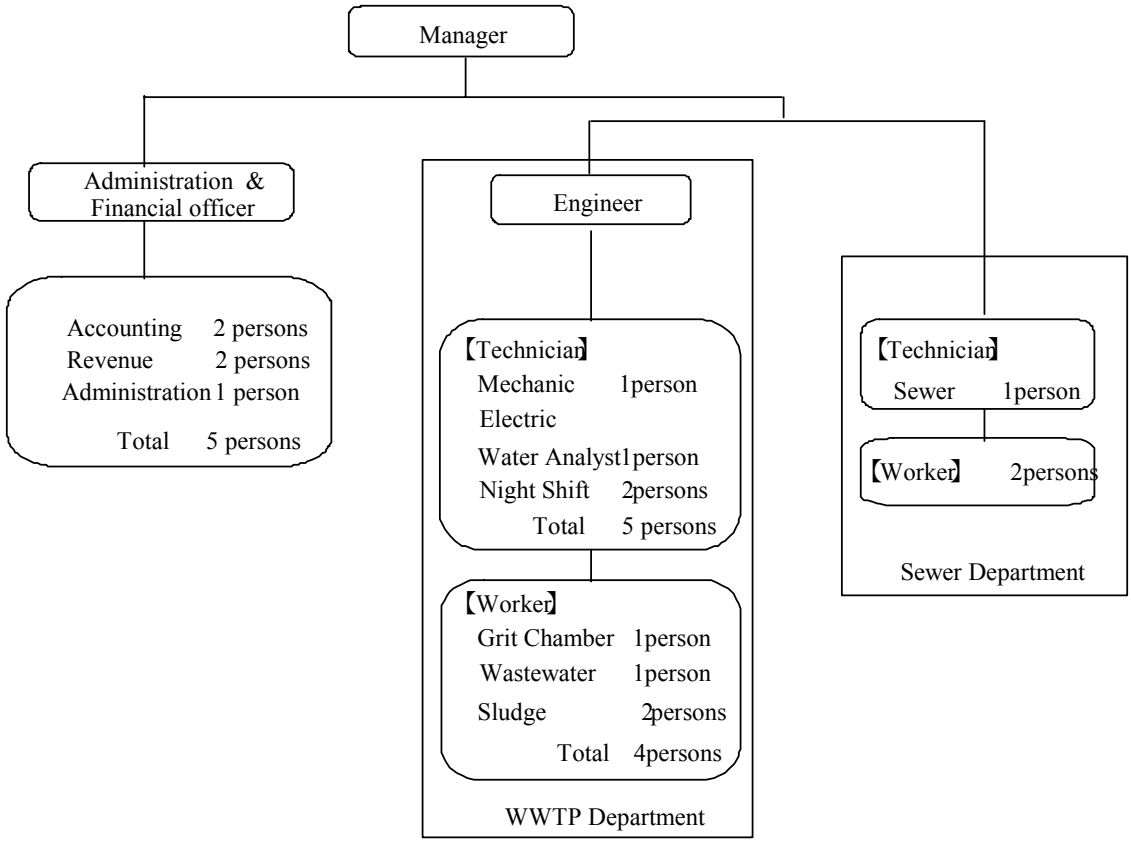

Figure 2-14 Organizational Structure in Target Year

Administration and financial divisions promote house connection to main sewer, tariff setting and tariff collection. The WWTP division and sewer network division undertake O&M activities for sewerage system. The organization structure is prepared referring to that of Al-Bireh WWTP and proposed one in Nablus. The Study Team proposed it to Jericho Municipality with comprehensive consultation with officers in charge. Staff should be increased along with incoming wastewater amount growth.

i) In initial stage, staff number will be minimum.

ii) As house connection work is time consuming, steady sewerage system O&M work will start one or two years after the system completion. As Jericho staff has no experiences in sewerage system management, technical cooperation project shall be conducted for institution, organization building for skill upgrading of the staff.

iii) Since the water tariff collection structure has already build-up, the sewerage tariff should be collected together with water tariff.

iv) The power/electricity tariff in Palestine is high and therefore the power expense occupies large part of the total WWTP operation cost. A solar generation system with capacity of 100 kW is planned to mitigate the power consumption during daytime and power-saving treatment facility is also introduced. Compared with those in Al-Bireh and Nablus WWTP, the proposed system can be operated by 50 % of power consumption.

In target year of 2020, staff number will be 20 and they should be properly increased towards ultimate year of 2025.

2-4-2 Operation and Maintenance Cost

(1) Calculation of Operationn and Maintenance Cost

Table 2-29 shows the operation and maintenance cost (O&M Cost) for the project in the target year of 2020 without depreciation cost, which was calculated as 2,215 thousands NIS/year, which is almost same to the calculated O&M cost.

The O&M cost is mainly composed of labor cost, disinfection chemical cost, power expense and maintenance/repair cost of mechanical/electrical equipment. Especially, the labor cost and power expense occupies large portion of the cost. To minimize the labor cost, sewerage tariff collection should be covered by water supply department staff but its percentage in O&M cost is still the largest. This owes to the following causes:

- Population scale of Jericho Municipality is relatively small
- Palestine does not have many sewerage systems and thus, private contractors who can undertake O&M of such system is not available
- Therefore, a large number of staff must undertake O&M works compared to the scale of the system

Though the solar generation panel and power-saving treatment system are introduced to mitigate power consumption, the power expense cost resulted in high, as power cost is expensive which is purchased from Jordan. The sludge disposal cost is ignored provided that dried and stored sludge will be used by farmers as fertilizer or soil improvement agent.

Based on Table 2-29 (refer to appendix 3-2), O&M costs in 2020 and 2025 are computed in two cases, namely with depreciation cost and without it. Table 2-30 shows the results. As described in footnote, Case 1 and 4 are supposed that house connection will be promoted as scheduled, while Case 2, 3, and 5 are supposed that HC (House Connection) will be delayed.

Table 2-29 Estimated O&M Cost for this Project (NIS/year)

Items	Computation	Total
Labor Cost	・Total 20 person (6,000×3 +3,000×11 +2,000×6)×12×1.8NIS/person ・ month ＝ 1,360,000 NIS/year	1,360,000
Chemical Cost	・Sodium Hypochlorite（Average injection rate：3 ppm counted as effective Cl） 1,120 NIS/m^3×0.2 m^3/day×365 day＝81,000 NIS/year	81,000
Power Expense	Power expense： 886,400 kWh/year×0.66 NIS/kWh＝585,000 NIS/year Saving by Solar Panel： 100 kW×8 h/day×0.6×0.66 NIS/kWh×365 day/year＝ -116,000 NIS/year	469,000
Sludge Disposal Cost	Basically disposal within WWTP site or used by farmers	0
Equipment Maintenance Cost	1% /year of mechanical/electrical equipment cost (Early stage of operation, and it will increase as the deterioration)	267,000
Total		2,177,000

Table2-30 Unit O&M Cost by Connection Ratio

Year	Case	Connection Ratio (%)			Wastewater Quantity (m^3/d)	Annual O&M Costs(1,000NIS/y)		Unit O&M Cost (NIS/m^3)	
		Municipality	Surrounding	Agro-industrial Park*2		Including	Excluding	Including	Excluding
2020	1*1	80	50	100	6,540	4,392	2,177	1.8	0.9
	2	60	30	50	4,470	4,196	1,981	2.6	1.2
	3	50	20	33	3,520	4,037	1,822	3.1	1.4
2025	4*1	90	70	100	8,450	4,523	2,308	1.5	0.7
	5	60	30	50	4,650	4,213	1,998	2.5	1.2

Note: including=including depreciation, excluding= excluding depreciation

*1: Original plan, *2: This case is discharge ratio to design discharge quantity

(2) Sewerage Tariff Assumption and Trial Balance Calculation

As shown in Table 2-31, when depreciation cost is included, the sewerage tariff has to be set higher than 2 NIS/m^3 but as this project is the grant aid project, depreciation cost is not necessarily considered.

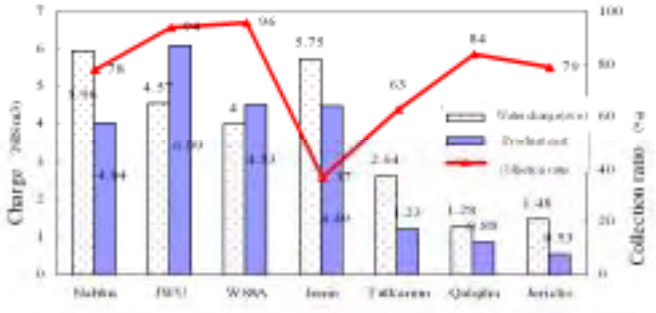

Figure 2-13 Palestinian Initial Water Supply Cost and Tariff

Source) Study of possibility of wastewater in Jericho, JICA Report, 2009

Current water tariff in the least consumption category is 1 NIS/m^3. As shown in Figure 2-14. The initial water cost and water tariff in Jericho municipality belong to one of the lowest levels in Palestine.

However, under current political situation, setting of water tariff for general household by higher than 1 NIS/m^3 seems to be quite difficult.

As examined in table 2-30 if sewerage tariff in all categories is set at 1 NIS/m^3, the sewerage system management will immediately run into red when house connection delayed. This is quite risky from viewpoint of the system management. It means that system replacement and repair in some extent mus be covered by own budget.

The tariff set for general housings is a progressive tariff, and for large amount consumers it becomes 5 times at maximum. However, introduction of progressive tariff in sewerage system is logically difficult. As water resource of piped water is utilizing limited water source, large consumers must pay surcharge because they are wasting such valuable resource. This makes a sense. However, in the case of sewage, since such consumers have already paid an additional charge, it is irrational to pay big amount again. In addition, the unit cost for wastewater treatment is decreased when inflow volume of the treatment plant is increased. If incoming wastewater amount is increased up to the WWTP capacity, the WWTP must be expanded with huge budget. In this sense, introduction of the progressive sewerage tariff is explicable. However, this is not applicable in this case, thus, fixed sewerage tariff of 1 NIS/m^3 is to be applicable.

According to water supply record, water consumption rate by general households and shops, excluding large consumers such as enterprises, hotels, governmental offices and schools is 85 %. The remaining 15 % is consumed by large consumers. Since some extent of surcharge is applicable for them to generate budget for depreciation cost, two cases of tariff are introduced. They are 1.5 NIS/m^3 and 2 NIS/m^3 and the balance calculation results are shown in Table 2-31. Case 2 and Case 3 falls in red even in target year of 2020.

Table 2-31 Balance Calculation by Cases

Year	Case	WW Amount (m^3/d)			O&M Cost (1,000 NIS/year)	Income (1,000 NIS/year)		Balance (1,000 NIS/year)	
		Total	General	Large Consumers		1.5*	2.0*	1.5*	2.0*
2020	1	6,540	3,910	2630	2,177	2,867	3,347	690	1,170
	2	4,470	3,300	1,170	1,981	1,845	2,059	-136	78
	3	3,520	2,670	850	1,822	1,440	1,595	-382	-227
2025	4	8,450	5,530	2920	2,308	3,617	4,150	1,309	1,842
	5	4,650	2,490	2,160	1,998	2,091	2,486	93	487

Above cases are same with Table 2-31, *: Tariff of sewage for large consumers (NIS/m^3)

(3) Replacement Period for Sewerage System

No durable years are described in Palestinian design standard but according to the Japanese standard, they are as follows:

- Concrete Structures：30 years
- Piping：30 years

・Mechanical/Electrical Equipment：10 years

2-4-3 Results of Residents' Awareness Survey

A Residents' awareness survey was carried out in January 2011 by contract-out to the local consultant. Targets were carefully selected for nonbiased survey; they are 170 general households, 4 hotels, 25 shops and 11 factories. As categorized information, major income source, diseased time and medical care cost of private household are shown in Table 2-32(1), hotel guest number is shown in Table 2-32(2), category breakdown of shops and factories is shown in Table 2-32(3), respectively.

Table 2-33 shows the summary of 210 samples.

Table 2-32(1) Survey Results of Private Households

Item		Value
Average income(NIS/m)		2,512
Average expenditure（NIS/m)		2,532
Frequency of sickness	Each house（time/house/y）	48.2
	Per capita（times/c/y)	8.6
Cause of sickness(%)	Water	11.2
	Food	5.3
	Sanitary system	4.7
	Others	78.8
Annual health care costs（NIS/y)		1093
Major source of income(%)	Agriculture	7.1
	Commercial	14.7
	Service	32.9
	Tourism	1.4
	Construction	43.5
	Others	0.6

Table 2-32(2) Survey Results of Hotels

Item		Average
Number of gust rooms		85.5
Gestnumber (person)	Annual	7,975
	daily	29

Table 2-32(3) Category Breakdown of Shops and Factories

Business Shop		Factory	
Selling Goods	Ratio(%)	Selling Goods	Ratio(%)
General trade	40	Food processing	36.4
Clothing	20	Plastic processing	9.1
Construction materials	4	Metal processing	9.1
Housing ware appliances	16	Wood processing	9.1
Others	20	Others	36.4

Table 2-33 Summary of Residents' Awareness Survey

Items			Residential House	Hotel	Shop	Factory
Sample Number			170	4	25	11
Number of Ave.Resident（Staff)			5.61	50	2.24	20.3
Av.Area(m^2)			125	8,314	53	3,081
Ave. Water Charge（NIS/Month)			101	12,643	46	1,472
Toilet	Location	Inside	97.6	100	68	100
		Outside	2.4		28	
		None			4	
	Type	Flushing	81.8	100	56	81.8
		Pit Latrine	18.2		12	18.2
Water Supply	Location of Faucet	Inside	78.2	100	68	63.6
		Outside	21.8		28	36.4
		None			4	
	Summer Consumption	Monthly(m^3)	43.34	584	26.7	272.5
		lpcd	258			
	Winter Consumption	Monthly(m^3)	21.32	351	17.4	183.1
		lpcd	127			
Cesspit	Gray water into cesspit	Whole	87.6	100	68	100
		Partly	11.8			
		None	0.6		32	
	Ownership of cesspit	Executive	31.8	100	4	63.6
		Sharing	68.2		64	36.4
		None			32	
	Frequency of Withdraw（times/year)		6.42	0.75	2.72	23.4
	Costs of Withdraw(NIS/time)		76.3	525	69.4	136.4
Cause of infection(%)	Oral		8.2		8	9
	Contact		4.1		4	
	Hygiene environment		84.1	100	88	91
	Others		3.5			
Willingness	Concerning to surrounding environment(%)		98.2	100	100	100
	also to surrounding water environment(%)		98.2	100	100	100
	Sewage connection is required to improve above(%)		98.8	100	100	100
	Approve to reuse of treated water and dried sludge(%)		70	100	92	90
	Approve to reuse of treated water for irrigation of farmland(%)		64.7	100	88	90
	Pay for water supply and sewage tariff(%)		85.9	50	96	100
	Upper limit of sewage tariff（NIS/month)		63	300	66	129
	Approve to construction of sewerage system(%)		97.1	100	100	100
	Use cesspit continuously after connection of sewer(%)		31.2	50	4	9.1
Priority of public project (Scale of 0-10）	Water supply		8.8	7	8	8.8
	Sewerage		8.6	8	9.1	8.6
	Road		7.3	7.5	4.5	5
	Education		8.3	5	4.4	5.3
	Communication		6.7	6.25	3	3.8
	Power supply		7.8	7	5.3	6.7
	Medical care		9	6	6.8	6.7
	Irrigation		7.9	6.25	5.5	5
	Garbage collection		8.4	9.25	7.2	7.5

According to the survey results, the following items are noteworthy for private households:

1) Water consumption during summer time is almost equivalent to design water supply amount but it falls to a half during winter time
2) Most of toilet is in-door/flush type and toilet/kitchen/bath wastewater is stored in cess-pit. Taking out from cess-pit is carried out once in two months.
3) Water tariff occupies 4 % of total income. Eight (8) diseased time during a year seemed to be quite high and the medical care cost is equivalent to water tariff.
4) Due to this high morbidity, residents' awareness toward sanitary environment is high and they also have high expectation on sewerage system.
5) Though 70 % of them agreed to the reuse of treated wastewater and dried sludge, the rate decreased to 65 % for the reuse in agricultural purpose.
6) Regarding to sewerage tariff, willing to pay rate is 85%. Affordable to pay amount is 100 NIS/m^3 for water and 60 NIS/m^3 for sewerage.
7) The problem is that 30% of them want to use the existing cess-pit continuously after connected to the sewer. In this case, pollutant penetration into ground can not be avoided.

The followings are observations for hotels, shops and factories:

1) The largest 2 hotels have their own wastewater treatment facility, and therefore they have no willingness to connect to the sewerage system
2) Sanitary conditions in shops are rather inferior compared with private households but they have higher willingness to pay
3) Factory owner have higher awareness than shop owners but affordable pay amount is only 10 % of water tariff

Chapter 3 Project Evaluation

3-1 Premises for Project Implementation

As the premises of project implementation, the Palestinian side shall undertake the followings:

① Execution of procedures needed for Japanese Grant Aid project and budget allocation for their undertakings and implementation
② As to sewer network development, the work will be only partially covered by the Project, therefore, continuous network development by Palestinian side is quite important
③ Since the JICA technical cooperation project is planned for smooth project implementation, Palestinian counterpart staff shall be properly allocated
④ To promote the effect of the project, progress of house connection is essential, thus, facilitation measurement should be prepared
⑤ A concrete plan for the treated wastewater reuse application should also be established including construction of necessary facilities for this purpose

3-2 Necessary Input by Palestinian Side

The followings are the proposed inputs by the Palestinian side.

3-2-1 Execution of Responsibilities by Palestinian Side

Upon implementation of the grant aid project, Palestinian side has to execute the following procedures and undertakings:

1) Execution of necessary procedures such as custom clearance, tax exemption, land renting, traffic and trespass licensing, EIA approval, construction work licensing and so on

2) Budget arrangement and execution of undertakings such as land acquisition, fence installation, water and power supply, access road construction, house connection and branch sewer installation

3-2-2 Expansion of Sewer Network

The target year of this project is set at 2020, and 80 % of municipality population, 50 % of surrounding area population and 2,000 m^3/day of wastewater generated in Agro-Industrial Park will be

covered through this project after the initial treatment in the park. One of the major targets of this project is to prevent the contamination of the groundwater, the sole water source for this area's portable water, and to prevent the pollution in river basin by discharge of untreated wastewater. Accordingly, sewer network is required to be developed as soon as possible to accomplish the said target. In addition, steady tariff income is indispensable for the financial stability of sewerage system management. Thus, a short-mid term sewer network development plan should be prepared. The network development should be facilitated not only through Palestinian budget but also through the assistance of Japanese government and other Donor Agencies.

As the first step, aforementioned branch sewers in densely inhabitant areas should be surely installed together with house connection.

3-2-3 Counterpart Staff Allocation

In this project, the sewerage system is composed of the WWTP and sewer network in Jericho Municipality as a project un-experienced in sewerage system management. During the preparatory stage, the following tasks are required namely; preparation and enactment of house-connection related regulation and institution, establishment of tariff structure and tariff collection method, organization set-up of sewerage department, designation of licensed contractors, incentive-making plan for house connection acceleration, preparation of concrete and due tariff table, and so on. Further, the O&M activities for the WWTP and sewer network which requires trouble shooting during project implementation and allocation of O&M staff and accounting staff should be started.

As the JICA's technical cooperation project will be executed to support these activities, counterpart staff should be properly allocated in Jericho Municipality through assistance of PWA. Even during preparatory stage, at least three counterpart staff is needed, namely staff for accountant/finance, organization/institution and house connection. During the final stage, staff for wastewater treatment technology, water analysis and mechanical/electrical equipment will be needed in addition. These counterpart staff will act as the core staff in commencement of the operation of the system.

3-2-4 Promotion of House Connection to Sewer Main

Along with the rapid expansion of sewer network, house connection (HC) should be accelerated as well. However, house connection is deemed to be difficult referring to the cases in Japan and other countries. Therefore, powerful propelling measure is needed. The Sample of HC promotion measures explained to Palestinian side is as follows:

1) Preferential treatment to users executed the house connection within a fixed time limit

2) Comprehensive and continuous publication on necessity of HC
3) Allocation of staff who can instruct efficient and economical HC methods to residents
4) Designate licensed contractors and prepare HC work cost table with them. These contractors may promote HC to residents.
5) Low interest rate for HC loan
6) Preparation of HC manual to be connected by users. Inspection method to confirm assured connection to sewer pipe shall also be described.
7) Execute the following stimulation measures:
   a) Preferential treatment for users with early HC
      : Subsidy for a part of HC cost
      : HC cost discount within a fixed period
      : Any tax exemption
   b) Actions to users not connecting before HC deadline
      : Continuous persuasion
      : Allocation of higher water tariff
      : Publication of users' name

3-2-5 Reuse of the Treated Wastewater

As Jericho Municipality and the surrounding areas have scarce rainfalls, no plants grow without irrigation. Poly-ethylene (PE) irrigation pipes are installed in all farmland and water source is pond water or groundwater. Jericho Municipality has one spring which has been utilized for several thousand years and spring water is used as potable water and irrigation water. Nowadays, percentage of irrigation water is decreasing. Spring water quality is excellent with low salinity concentration and therefore, treated wastewater has the least salinity. Compared with groundwater taken from many agricultural wells, the treated wastewater has more values as irrigation water.

An irrigation tank with capacity of 1,000 m^3 is planned in the WWTP for efficient reuse of treated wastewater, a concrete reuse plan should be established by Palestinian side and necessary pumps and pipeline should be installed. Further, since dried sludge stored for one year within the WWTP site is rich in fertilizer with effective elements such as nitrogen and phosphorus, they can be used as fertilizer and soil improvement agent.

3-3 External Conditions

External conditions that are needed in effective operation of this project are summarized as follows:

1) Jericho Municipality and surrounding areas are known as very peaceful and orderly place in Palestine and no major conflicts have been occurred. On the other hand, many residents have been transferred from these areas since the founding of Israel resulting in a severe economical depression. The areas shall be kept peaceful through out the future and the economical conditions shall be kept stable.

2) The proposed WWTP requires a lot of materials and equipment which are not manufactured in Palestine. Thus, Palestine shall be an externally open authority through where necessary materials and equipment are available as an international trading.

3) In the National Development Plan, Palestine intends to develop sewerage system aggressively. This project can be regarded as a forerunner of sewerage system development and might become successful sample if the Palestinian Interim Self-Government Authority continuously promotes the system development. Since the long-term system management needs huge man power, budget and materials, Authority's affirmative participation and leadership are essential for the stable system management.

3-4 Project Evaluation

3-4-1 Project Benefit

Anticipated project benefits from the project for residents of Jericho Municipality are as follows:

Table 3-1 Project Benefits

Current Status and Issues	Countermeasures proposed in this project	Project Effects
A：Direct Effects		
• Currently, no wastewater treatment is available in target areas • Groundwater contamination by raw wastewater penetration is on-going • Aqua environment of the Dead Sea is deteriorated • Water contamination is aggravating global environment • Groundwater is sole water source and the area is suffered by water shortage • Wastewater treatment is needed for Agro-Industrial Park	• In 2020, 68 % of total population is served by newly constructed WWTP and sewer network • High level pollutant removal is expected by advanced wastewater treatment method • Treated wastewater is utilized as irrigation water • Wastewater generated in Agro-Industrial Park is treated as well	• 68% of total population can enjoy the health and sanitary life • Progress of groundwater contamination is prevented • Incoming pollutant to the Dead Sea is ceases • Annual GHG emission is reduced by 5,400 tCO_2 • Amount of irrigation water covered by treated wastewater can be converted to urban potable water • 2000 m^3/d of wastewater used to discharged to Wadi is properly treated and reused
• Domestic wastewater is stored in Cess Pit, concrete tank without bottom for penetration to the ground, is removed by Vacuum Tanker Truck and discharged to Wadi • Jericho Municipality has no know-how and experiences in management and O&M of sewerage system • House connection might take long	• Wastewater is collected efficiently by sewer network and vacuum tanker wastewater receiving tank is also planned in WWTP • Finance/accountant, organization/institution, house connection and system O&M will be supported and instructed through Technical cooperation project • Prepare and execute incentive-making measures for house connection	• Cess pit wastewater is properly treated in WWTP • Jericho Municipality will be able to operate/manage the system, promote house connection • House connection will be accelerated
B：In-direct Effects		
• High morbidity caused by inferior aqua environment • Limited water source restricts economic development • Insufficient sanitary environment is suppressing the tourism	—	• No wastewater overflow occurs and residents'hygien condition is upgraded • Commercial/industrial development by increase of potable water amount, grow in agriculture products by augmentation of irrigation water • Development in tourism

3-4-2 Project Relevancy

According to the following benefits, the implementation of the project by Japanese Grant Aid Scheme is determined as adequate:

- Target service area is Jericho Municipality and surrounding areas with total population of 53,000 persons in the target year. Service population is large.
- Currently, no wastewater treatment is available except some hotels or army camp. Thus,

contamination in groundwater, which is the sole water source in the areas, is becoming serious. The project is the countermeasure for this contamination and is definitely needed. From the viewpoint of BHN, the project also has the urgency.

- Likewise, if no wastewater treatment is undertaken, incoming pollutant through the Jordan River to the Dead Sea belonging to Israel will not be stopped. Israel has strong request for wastewater treatment, and this project is the answer for it.
- Construction of Agro-Industrial Park is on-going under Japanese Assistance and the generated wastewater is scheduled to be sent and treated by the proposed WWTP. This arrangement is mutually effective for smooth project implementation.
- Japanese highly power efficienct wastewater treatment system is introduced
- Solar panel is employed in the WWTP to save power consumption
- Generation of the treated wastewater to be applied as irrigation water in areas where have been suffered by chronic water shortage will contribute local agricultural promotion, and spring water in excellent quality can be converted to potable water source.
- Since the proposed sewerage tariff is set to cover only the necessary O&M costs, thus, the project will not generate excessive profit
- In general, WWTP construction has large impacts to aqua environment in surrounding areas. The treated wastewater is scheduled to be reused for irrigation purpose, any negative impacts are observed
- The project contributes to target accomplishment of system development plan prepared by corresponding Palestinian sectors
- Smooth project implementation is expected through Japanese Grant Aid Scheme

3-4-3 Project Effectiveness

Through this project, a WWTP and trunk sewers are to be constructed. In addition, technical cooperation project is executed to support the establishment of a sewerage department in Jericho Municipality. Project effectiveness is evaluated in quantitative and qualitative manners.

(1) Quantitative Project Evaluation

As quantitative evaluation indices, pollutant load transition, pollutant load discharged to external environment, wastewater disposal of cess-pit, treatment of incoming wastewater are extracted. The most important index is pollutant load discharged to external environment. As shown in Table 3-2, the pollutant load will increase by 30 % but the discharged pollutant load will be largely decreased.

Table 3-2 Quantitative Project Evaluation

Category	Indices		Base Value 2010	Target Value 2020	Improvement Ratio
Transition	Target Population（person）		40,000	52,800	32 % up
	Pollution Load	Wastewater Amount(m^3/day)	5,570	7,500	35 % up
		BOD(kg/day)	2,249	3,000	33 % up
		SS(kg/day)	2,624	3,500	33 % up
		T-N(kg/day)	450	600	33 % up
Evaluation	Pollutant Load Discharged to the Environment	Raw WW Amount (m^3/day)	5,470	760	86 % improve
		BOD(kg/day)	2,114	504	76 % improve
		SS(kg/day)	2,466	353	86 % improve
		T-N(kg/day)	423	141	67 % improve
		GHG Emission（tCO_2/year）	4,600	664	86 % improve
	Cess-pit Wastewater Treatment	Service Population（person）	40,000	16,800	58 % improve
		Vacuum Tanker WW Amount (m^3/day)	100	200	100 % up
		WW Collection Rate (%)	10	70	60 % up
		Treatment Rate of collected WW (%)	60	100	40 % up
		WW Discharge Rate to Wadi (%)	40	0	Discharge Rate = 0
	Wastewater Treatment	Service Population（person）	0	36,000	Service Ratio = 68%
		Treatment Amount (m^3/day)	0	6,540	Treatment Ratio = 87%
		BOD Removal(mg/L)	--	500→20	Removal Rtio＝96%
		SS Removal(mg/L)	--	500→30	Removal Rtio＝94%
		T-N Removal(mg/L)	`--	75→25	Removal Rtio＝67%
	Reuse	Reuse Ratio (m^3/day)	0	6,540	Treatment Ratio = 87%

(2) Qualitative Project Evaluation

As to qualitative evaluation indices, local sanitary conditions, O&M capacity for sewerage system and effect to local economy are extracted. As shown in Table 3-2, many positive effects are anticipated.

Table 3-3 Qualitative Project Evaluation

Indices		Base Value (2010)	Target Value (2020)
Sanitary Condition	Residents' Awareness	Residents are worrying about water pollution near their households	Their sanitary conscious will be improved
	Medical Care Frequency	Average 9 times/year・person	Frequency will be decreased
	Cleanliness	Mainly single-day tourist	Overnight tourist will increase
O&M of Sewer Network	Technical Aspect	Scarce technical accumulation	Technical accumulation will be available in Jericho Municipality staff and it will be spreading to areas nearby
	Managerial Aspect	Scarce managerial accumulation	ditto
Economy	Agriculture	Restricted by water source limitation	Promotion is expected by irrigation water increase
	Tourism	Mainly single-day tourist	Overnight tourist will increase
	Employment	Biased to construction works	Increase in agriculture, agricultural product processing and tourism is anticipated

3-5 Issues and Recommendations

To accomplish the project target and to express the project effects at maximum, Palestinian side shall take care of the following issues affirmatively.

3-5-1 Issues to be taken care by Palestinian Side and Recommendations

(1) Before commencement of project implementation

- Arrangement of budget for undertakings by Palestinian side (WWTP land acquisition, fence installation, construction of access road, power and water supply, branch sewer installation in densely inhabitant areas and house connection, and so on) and disburse it according to the progress of the project
- Organization of the project team, staff and budget arrangement (the activity shall continue during project implementation and after completion of the project)
- Timely acquisition of necessary licenses related to construction works

(2) During project implementation

- Project team has to participate to detailed designing to comprehend the design and to acquire technology
- Allocate counterpart staff with necessary skills for JICA's technical cooperation project and carry out organization/institution, finance/accountant works needed for sewerage system management.
- Execution of scopes of Palestine side

(3) After completion of the project

- Allocate counterpart staff with system O&M skill to the technical cooperation project and let them participate to On the Job training rendered by the contractors to attain O&M technology.
- Sewer length to be covered by this project is 30 %（40/130 km）of the total length of necessary sewer network. Therefore, remaining sewer network has to be continuously designed and installed after this project completion. This is quite important for a stable sewerage system management.
- Even sewers are installed, no incoming wastewater to sewers and no sewerage tariff income are expected without house connection from users. Promote HC by designated licensed

contractors and by incentive-making treatments

- Collect sewerage tariff appropriately

3-5-2 Technical Cooperation and Coordination with other Donor Agencies

As aforementioned, technical cooperation project is needed for smooth project management. Only well-managed sewerage system including WWTP is available at Al-Bireh, and other existing WWTP are not properly maintained. As similar projects are expected to be implemented in Palestine, contents of technical cooperation project to be rendered to Jericho Municipality shall be properly arranged to be applied to other municipalities. PWA, the execution agency has to participate to the activities affirmatively.

3-6 Conclusion

As this project has potentials of remarkable benefits and contributes in residents' BHN fulfilling, the implementation of the project by Japanese grant aid scheme is justified to be valid.

As to O&M aspect of this project, though the current capacity of the counterpart agency seems to be quite insufficient in terms of technology, experiences, staff number and ability, the status can be upgraded by execution of technical cooperation project, with the efforts in staff and budget arrangement by Palestinian side.