THE HASHEMITE KINGDOM OF JORDAN
MINISTRY OF WATER AND IRRIGATION (MWI)
WATER AUTHORITY OF JORDAN (WAJ)
YARMOUK WATER COMPANY (YWC)

THE PROJECT FOR THE STUDY ON WATER SECTOR FOR THE HOST COMMUNITIES OF SYRIAN REFUGEES IN NORTHERN GOVERNORATES IN THE HASHEMITE KINGDOM OF JORDAN

MASTER PLAN
SEWERAGE

FINAL REPORT

JANUARY 2015

JAPAN INTERNATIONAL COOPERATION AGENCY

TEC INTERNATIONAL CO., LTD.
YACHIYO ENGINEERING CO., LTD.
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Currency Exchange Rates (JICA, September, 2014)

1 JD = 147.004 JPY = 1.4166 US$
1 US$ = 103.77 JPY
1 US$ =0.7059 JD

EXECUTIVE SUMMARY

1. Since the armed conflict in Syria in 2011 the influx of Syrian refugees has brought about large stress on the wastewater management facilities which cause overflows of wastewater and ceptage and insufficient wastewater treatment in the northern governorates in Jordan. In order to improve the sewerage service in northern governorates, the study has been initiated.

2. The Study is undertaken to formulate a master plan for sewerage system in order to identify the required improvements for the sewerage services in the Study area (Irbid, Ramtha, and Mafraq, refer to Figure 1.2 and 1.3 for locations), where the Syrian refugees are largely settled in the largest urban areas in the northern governorates. The Master Plan presents a sewerage development plan meeting the wastewater generation of 2035 Jordanian population, considering current level of Syrian refugees.

3. Even before the influx of Syrian Refugees, Water Authority of Jordan (WAJ) has developed and improved sewerage facilities to collect, convey and treat the wastewater generated in the Study area. At the Central Irbid wastewater treatment plant (WWTP) and Mafraq WWTP, the wastewater treatment process are modified enable to use the effluents for irrigation purposes and the construction work are underway.

4. Planning basis set for six sewerage district (SWD) are as shown below.

Table 1 Planning Basis for Six SWDs

Item	Central Irbid SWD	Wadi Al-Arab SWD	Shallala SWD	Wadi Hassan SWD	Ramtha SWD	Mafraq SWD
1) Service Area (ha) in 2035	696	4,613	6,523	1,453	2,483	3,770
2) Service Population in 2035	118,200	328,900	307,300	35,400	201,200	156,200
3) Design Flows						
Average Daily (m^3/d)	10,880	28,430	22,520	2,490	17,270	14,360
Maximum Daily (m^3/d)	12,720	33,260	26,360	2,920	20210	16,800
4) Design Influent Quality						
BOD_5 conc. (mg/L)	706	752	887	924	757	707
SS conc. (mg/L)	652	694	819	853	699	653
5) Design Effluent Quality						
BOD_5 conc.(mg/L)	30	30	30	30	30	60
SS conc.(mg/L)	30	30	30	30	30	60
NH_4^+-N conc.(mg/L)	2.5	2.5	2.5	2.5	15	-
NO_3-N conc. (mg/L)	30	30	30	30	25	70
T-N conc. (mg/L)	45	45	45	45	45	80

5. Based on the assessment results on capacity of the existing trunk sewers, lift pump station and WWTP, the required improvements are identified and the facility plan is prepared to achieve the design bases.

Table 2 Sewerage Improvement Plans for Six SWDs

Item	Central Irbid SWD	Wadi Al-Arab SWD	Shallala SWD	Wadi Hassan SWD	Ramtha SWD	Mafraq SWD
1) Branch Sewer	No need	200mm CP, 316 km	200mm CP, 257 km	200mm CP, 61 km	200mm CP, 216 km	200mm CP, 442km
2) Trunk Sewer	No need	No need	200mm CP 3.3km long, 400mm CP 4.6km long	No need	300mm CP, 4.3 km long, 150mm DIP, 2.4km long 200 mm DIP, 4.7km long, 200mm DIP, dual installation, 5.25km long, 200mm DIP, triple installation, 5.16km long	300mm CP, 19km, 200mm DIP, 23 km, 250mm DIP 4km
3) Lift Station	No need	Hakama LS increase capacity of 2.32 m^3/min	Maghayer Manhole Pump and Al Hoson LS, capacity increase 1.42 m^3/min.	(Al Hoson LS is to be shifted to Shallala SWD)	4 manhole pumps	Mansha LS, capacity of 3.25 m^3/min, Mafraq LS, capacity of 2.14 m^3/min
4) WWTP	Sludge De-hydrator	three sets of aeration tank and final sedimentation tank, capacity 3,500 m^3/d each	one primary sedimentation tank, two oxidation ditches, and one final sedimentation tank, to cover the design flow increase of 8,520 m^3/d.	20 sludge drying beds. capacity is 1,200 m^3/d.	two sets of aeration tank and final sedimentation tank and sludge de-hydrator, Capacity 4,400 m^3/d each.	Two lines of treatment facilities, capacity 3,600 m^3/d each

6. Facility construction plan by three phases are proposed considering the priorities of new sewerage service area. The service population is assumed to set connection rate to identify the timing of expansion of treatment capacity at the respective WWTP. The project cost is estimated for each phases for six SWDs.

Table 3 Implementation Schedule and Cost Estimates

Phase	Central Irbid SWD	Wadi Al-Arab SWD	Shallala SWD	Wadi Hassan SWD	Ramtha SWD	Mafraq SWD
Phase-1 (Y2017-21)	1) Sludge de-hydrator	1)Br. sewer 168km, 2)Hakama LS 2.32 m^3/min, 3)WWTP: one set of aeration tank and final sedimentation tank, capacity 3,500 m^3/d	1)Br. Sewer 90km, 2)Trunk sewer 3.3km, 3)Maghayer Manhole Pump	No plan	1)Br. Sewer 66km 2) Trunk Sewer 4.3 km (300CP) 3)One set of aeration tank and final sedimentation tank, capacity 4,400 m^3/d and sludge de-hydrator	1)Br. Sewer 122km 2)Trunk Sewer, 15km(300CP), 3km (200DIP) 3) Mansha LS, capacity of 3.25 m^3/min 4)One line of facilities, capacity 3,600 m^3/d
Direct Cost (Million JD)	1.200	24.024	11.397	0	14.192	22.962
Indirect Cost (Million JD)	0.535	11.069	5.080	0	6.325	10.235

Phase	Central Irbid SWD	Wadi Al-Arab SWD	Shallala SWD	Wadi Hassan SWD	Ramtha SWD	Mafraq SWD
Phase-1 Project Cost (Million JD)	1.735	35.093	16.477	0	20.517	33.197
Phase-2 (Y2022-26)	No plan	1)Br. Sewer 88km 2)WWTP: one set of aeration tank and final sedimentation tank, capacity 3,500 m^3/d	1)Br. Sewer 39km 2) Trunk Sewer 4.6km (400 CP) 3) Al Hoson LS is shifted from Wadi Hasan SWD, with capacity increase 1.42 m^3/min	1)Br. Sewer 18km 2)WWTP: 20 sludge drying beds	1)Br. Sewer 53km	1)Br. Sewer 164km 2)Trunk Sewer, 4 km(300CP) 3) Mafraq LS, capacity of 2.14 m^3/min 4)One line of facilities, capacity 3,600 m^3/d
Direct Cost (Million JD)	-	13.700	5.965	2.403	6.355	25.691
Indirect Cost (Million JD)	-	6.413	2.660	1.070	2.833	11.451
Phase-2 Project Cost (Million JD)	-	20.113	8.625	3.473	9.188	37.142
Phase-3 (Y2027-32)	No plan	1)Br. Sewer 61km 2)WWTP: one set of aeration tank and final sedimentation tank, capacity 3,500 m^3/d	1)Br. Sewer 129km 2) one primary sedimentation tank, two oxidation ditches, and one final sedimentation tank, to cover the design flow increase of 8,520 m^3/d.	1) Br. Sewer 43km	1)Br. Sewer 97km 2)Trunk Sewer 150-200mm DIP 3) 4 manhole pumps 4)One set of aeration tank and final sedimentation tank	1)Br. Sewer 156km 2)Trunk Sewer, 4km (250DIP)
Direct Cost (Million JD)	-	10.549	24.967	5.137	19.616	19.584
Indirect Cost (Million JD)	-	5.008	11.128	2.289	8.742	8.728
Phase-3 Project Cost (Million JD)	-	15.557	36.095	7.426	28.358	28.312
Total Project Cost (Million JD)	1.735	70.763	61.197	10.899	58.063	98.651
Grand Total Project Cost (Million JD)						301.308

7. The economic evaluation is carried out based on the benefits and costs. The evaluation reveals that the EIRR of the project results in 18.6% as a whole, which exceed 10% of the opportunity cost of capital though the EIRRs vary from SWD to SWD. Therefore, the project is judged to be economically feasible.

8. The financial evaluation is carried out based on the revenues and costs. The evaluation reveals the

FIRRs of every SWD do not exceed 6% of the opportunity cost of capital. And the project results in -11.6% as a whole. It is apparent that the low level of present sewerage tariff and the huge project costs are the major reasons for the negative FIRR. Therefore the increase of sewerage tariff and the government grant to a part of the project cost are recommended to make the project financially feasible. Meanwhile, even though tariff increase and grants, the project net cash flow will be negative until the end of the phase-3. For this, the WAJ subsidies are required until the phase-3 to sustain the project financially.

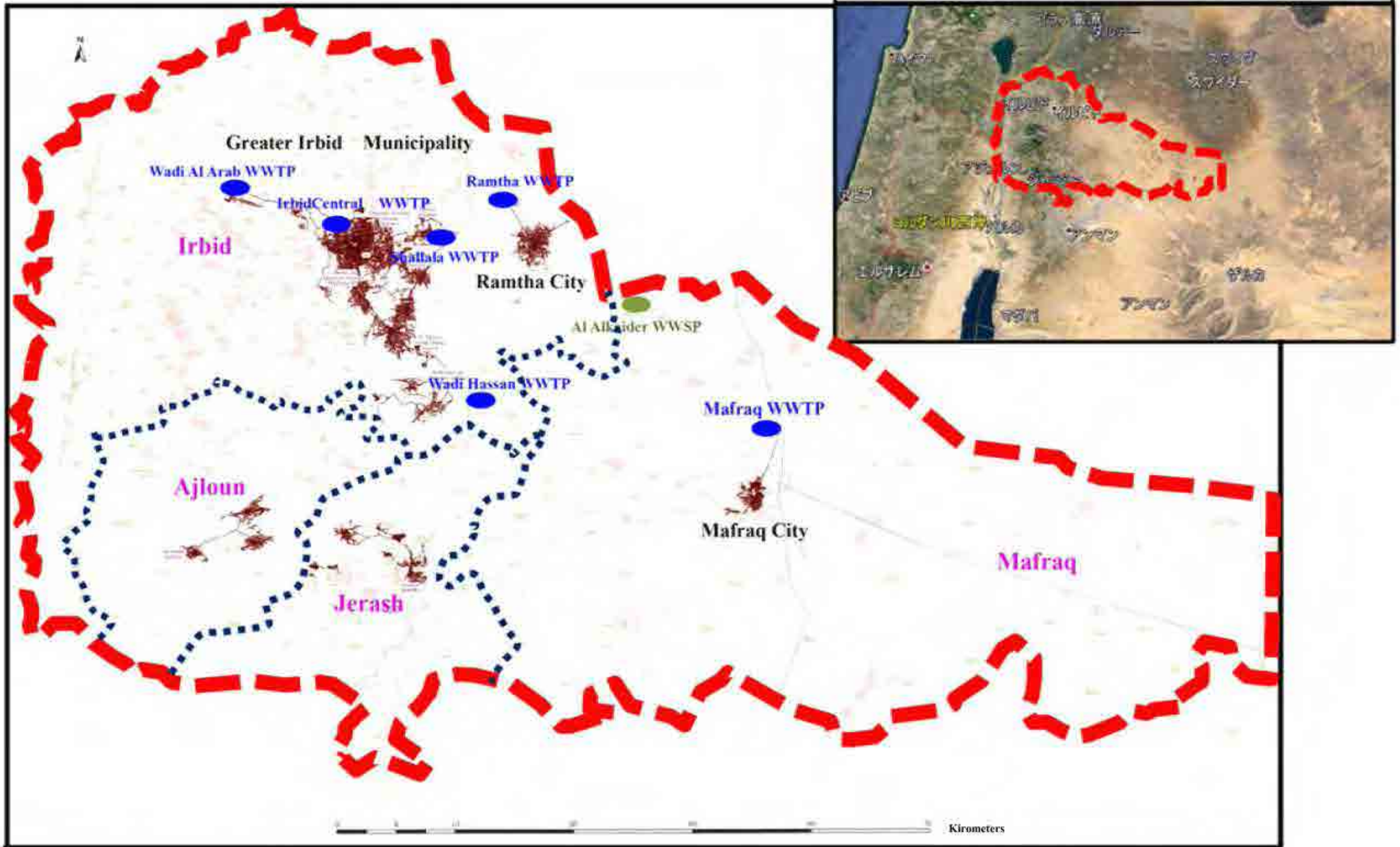
10. The phase-1 project of Central Irbid SWD is recommended to implement as soon as possible, because the proposed sludge dewatering facilities for Central Irbid SWD are essential to treat and dispose of properly.

11. To suggest implementation priorities to the proposed phase-1 projects of four SWD, these projects are compared and evaluated with four parameters: increased number of beneficiaries, need to expand the sewerage services, increased population coverage ratio, and cost performance. The phase-1 project of Shallala SWD gets the first priority and that of Wadi Al-Arab SWD gets the second priority. Both projects may be easier to implement because of less financial burdens to WAJ and YWC, in which the existing WWTP facilities could be used efficiently without any investment (Shallala SWD) and with smaller investment (Wadi Al-Arab) compared with cases of Ramtha SWD and Mafraq SWD. Therefore, JICA Study Team recommends both phase-1 projects of Shallala SWD and Wadi Al-Arab SWD are implemented as priority projects.

12. Due to the huge costs, the phase-1 project of Mafraq SWD may be difficult to implement. The project of Mafraq SWD is expected to mitigate the Syrian refugees impacts to the wastewater management of community. However, from the financial viewpoints, the phase-1 project should be modified to smaller investment plan such as service area would be limited only to urban city center and to stop the service provision to Manshiyah Bani Hassan. To realize the sewerage service provision to the area of Manshiyah Bani Hassan, financial supports from WAJ and foreign donors are indispensable.

13. Environmental and social impacts are expected during construction period like noise, vibration, odor etc., and the negative impacts are not expected to be significant. These impacts can be mitigated by appropriate measures. For this, monitoring plan is proposed. One more concern is occurrence of antiquities during excavation for construction. If found, the consultation with the concerned agency is required.

Location of Study Area



Location of Study Area and Six Wastewater Treatment Plants

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ABBREVIATION

BGR	Bundesanstalt für Geowissenschaften und Rohstoffe
$BOD_{5,}$ BOD	Biological Oxygen Demand
CFU	Colony Forming Units
CODcr	Chemical Oxygen Demand
CODcr	Chemical Oxygen Demand, measured using potassium dichromate
CP	Concrete Pipe
DIP	Ductile Iron Pipe
DMA	District metered area
DO	Dissolved Oxygen
DOS	Department of Statistics
E/N	Exchange of Notes
EIA	Environmental Impact Assessment
EIB	European Investment Bank
FOG	Fat, Oil and Grease
G/A	Grant Agreement
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
GIM	Greater Irbid Municipality
GIS	Geographic Information System
GRDP	Gross Regional Domestic Product
HDPE	High Density Polyethylene Pipe
HRD	Human Resource Development
IBNET	International Benchmarking Network for Water and Sanitation Utilities
ICT	Information Communication Technology
IEC	Information, Education and Communication
IEE	Initial Environmental Examination
ISSP	Institutional Support and Strengthening Program
JD	Jordanian Dinar
KfW	Kreditanstalt für Wiederaufbau
km	Kilometer
LLC	Limited Liability Company
lpcd	Liters Per Capita Per Day
LS	Lifting Station (Pumping Station)
m.a.s.l	Meters above sea level
mg/l, mg/L	Milligram Per Litter
m^3/d	Cubic Meter Per Day
m^3/min	Cubic Meter Per Minute
mm	Millimeter
MP	Manhole Pump
MCM	Million Cubic Meters
MOE	Ministry of Environment
MOI	Ministry of Interior
MOMA	Ministry of Municipal Affairs
MOTA	Ministry of Tourism and Antiquities
MPWH	Ministry of Public Works and Housing
MPN	Most Provable Number
MWI	Ministry of Water and Irrigation
NGWA	Northern Governorates Water Administration
NH_4-N	Ammonium Nitrogen
NO_3-N	Nitrate Nitrogen
OD	Oxygen Ditch
O&M	Operation & Maintenance
OJT	On-the-Job Training

PF	Peaking Factor
pH	potential of hydrogen
PIs	Performance Indicators
PMU	Project Management Unit
pph	persons per hectare
RFP	Request for the Proposal
ROU	Regional Operating Units
RSCN	Royal Society for the Conservation of Nature
SCADA	Supervisory Control and Data Acquisition
SOP	Standard Operating Procedure
SS	Suspended Solids
SWD	Sewerage District
SWMP	Strategic Wastewater Mater Plan
TDS	Total Dissolved Solids
TOR	Terms of Reference
ToT	training of trainers
TSS	Total Suspended Solids
TSP	Total Suspended Particles
T-N	Total Nitrogen
UGA	Urban Growth Area
UN	United Nations
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children’s Fund
USAID	United State Agency for International Development
UV	Ultraviolet
WAJ	Water Authority of Jordan
WASH	Water, Sanitation and Hygiene
WWTP	Wastewater Treatment Plant
YWC	Yarmouk Water Company

CHAPTER 1 INTRODUCTION

1.1 Study Background

Jordan is one of the four most water scarce countries in the world, having an annual per capita water availability of only 145 m^3, far below the internationally recognized water scarcity level of 1000 m^3. The increase in population and resulting water demand is putting enormous pressure on the limited water resources and creating a serious chronical water supply and demand imbalance. Furthermore, the sudden influx of thousands of Syrian refugees since March 2011 has left the Jordanian government and particularly the local authorities in the northern governorates, struggling to keep up with the demand for its scarce water resources.

Wastewater management is also a challenge. In areas where on-site wastewater treatment facilities such as cesspits or other underground simple storage tanks are commonly used, poor facility structure and infrequent removal of accumulated solids causes overflow of wastewater and septage. While in areas with sewerage service, the coverage ratios in Irbid, Mafraq and Ajloun governorates are lower than those of the national average. This poor wastewater management practices pose a serious threat to public health and the surrounding environment.

Jordan needs international support to improve the water supply services and wastewater management in affected areas. As part of the international effort, JICA (Japan International Cooperation Agency) and the Water Authority of Jordan (WAJ) met a number of times and signed the document on "Minutes of Meetings" on 30th in October 2013. JICA will work with WAJ on "The Project for the Study on Water Sector for the Host Communities of Syrian Refugees in the Hashemite Kingdom of Jordan (hereinafter called the Project)" as stated in the Record of Discussions signed on 13th in November 2013.

1.2 Goal, Outputs and Objectives of the Project

- Goal of the Project

The Project would contribute to achieving sustainable development of the water and sanitation sector in the communities hosting Syrian refugees.

- Outputs of the Project

The Project would provide an assessment of the impact of Syrian refugees on the water supply and sewerage services in the northern governorates, formulate a comprehensive plan for the improvement of these services and put forward a set of sustainable solutions.

The outputs are listed in the Record of Discussions as follows:
Components A: Preparation of outline designs for the most prioritized projects
Components B: Preparation of water supply and wastewater management plan
Components C: Pilot activities

This document is for Component B and reports on the following 3 major undertakings towards achieving the objectives of Component B.

- Assessment of the impact of the influx of Syrian refugees on water supply and wastewater management services
- Formulation of a development plan for water supply and wastewater management in the affected areas
- Identification and priority setting for short- and mid- term projects

The short-term plan will be prepared with due consideration to the requirements for the water and sanitation sector for 2014-2016, as stated in the National Resilience Plan.

The priority projects will be unveiled in the mid-term plan. The mid-term plan aims to provide a strategic roadmap for the development of the sector in the coming three to five year period. The concerned authorities and organizations will share the comprehensive development policy and support the projects by aligning with the plan. Furthermore, both short and mid-term plans will be continuously revised according to the changes in circumstances with the Syrian refugee situation as well as those in the hosting communities in Jordan.

1.3 Sewerage Component

The steps taken in the formulation of the sewerage development plan are shown in Figure 1.1.

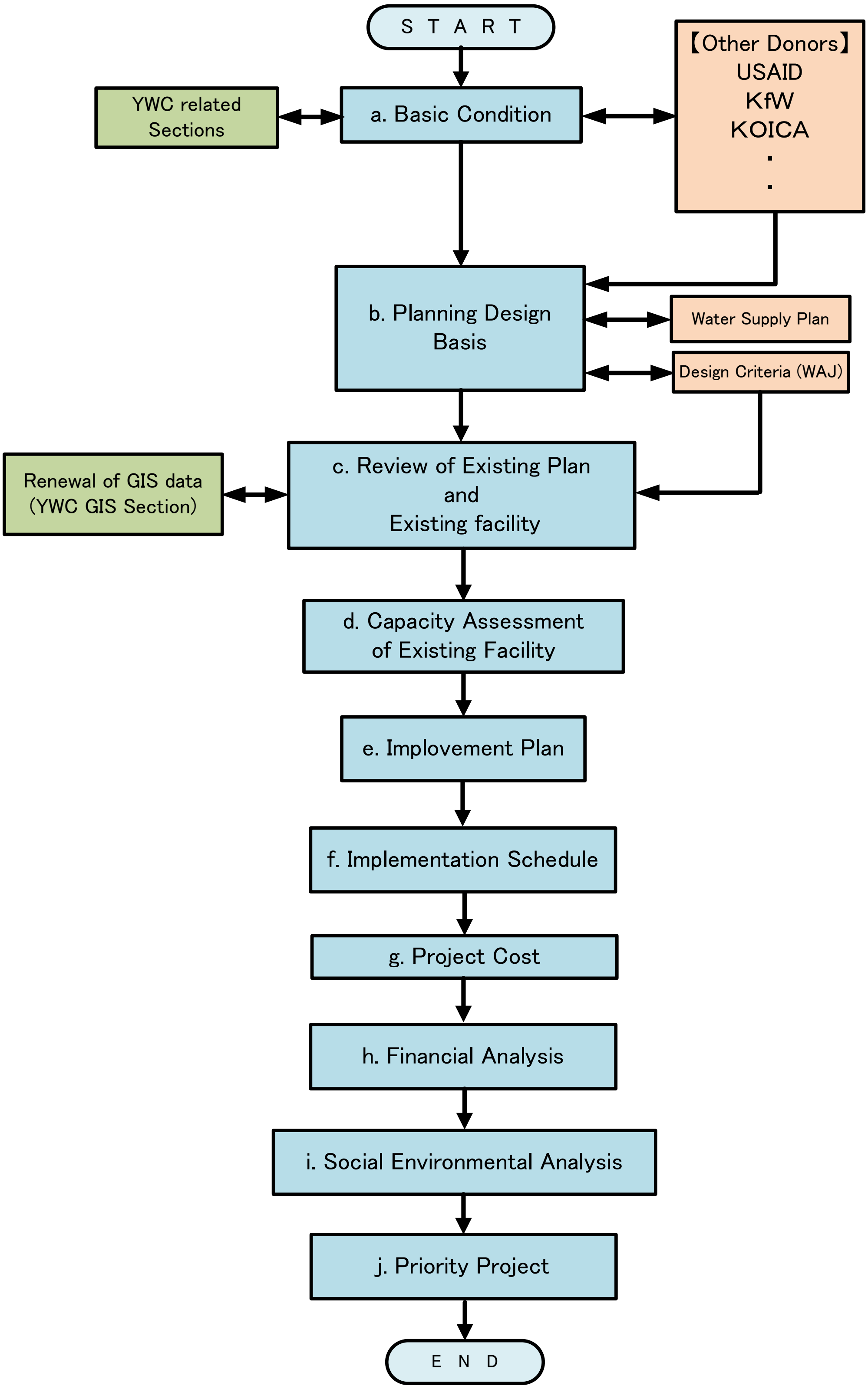


Figure 1.1 Process for Formulation of the Sewerage Development Plan

1.4 Study Area

The Study area is the northern governorates: Irbid, Ajloun, Jerash, and Mafraq. Maps of the northern governorates are shown in Figures 1.2 and 1.3.

Figure 1.2 Northern Governorates (1)

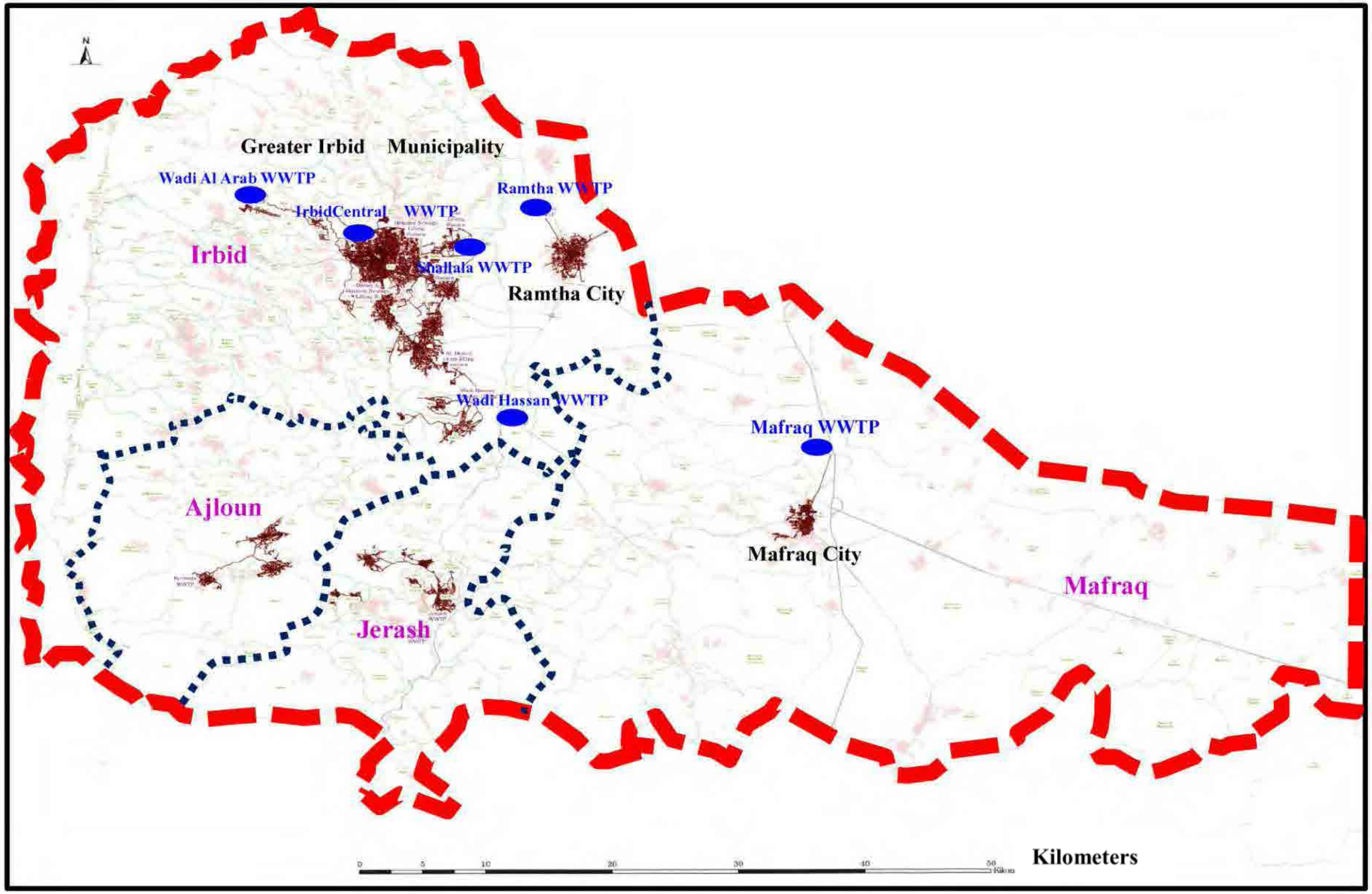


Figure 1.3 Northern Governorates (2)

1.5 Planning Horizon

The sewerage development plan is formulated looking 20 years ahead towards 2035, which matches the planning horizon used by WAJ. The capacity of the facilities, particularly the trunk sewers, are designed for this time frame.

1.6 Report Components

Chapter 1 is an introduction of the Study.

Chapter 2 explains the existing situation of the Study Area.

Chapter 3 presents the existing wastewater treatment facilities and the existing sewerage plans and projects to identify current issues and problems in the wastewater management in the Study Area.

Chapter 4 deals with sewerage service area, wastewater generation projection, design flow, and design wastewater quality.

Chapter 5 assesses the capacity of existing sewerage facilities for the design flows and pollutant loads, and prepares the sewerage development plan.

Chapter 6 deals with institutional development plan and capacity development plan, including operation and maintenance staff plan for the proposed sewerage facilities.

Chapter 7 proposes the implementation plan of the proposed sewerage facilities.

Chapter 8 estimates the project cost for the proposed sewerage development plan.

Chapter 9 conducts the economic and financial analysis for the proposed projects.

Chapter 10 describes the environmental and social considerations for the sewerage development plan.

Chapter 11 compares the proposed phase-1 projects and suggests implementation priorities for these projects.

Chapter 12 presents conclusions and recommendations.

CHAPTER 2　EXISTING CONDITIONS OF THE STUDY AREA

2.1 Socio-Economic Conditions

2.1.1Administrative Organization and Boundary

Jordan consists of 12 governorates (see Figure 1.1), and the Irbid Governorate is divided into 9 Liwas (see Figure 2.1). “Liwa” is an administrative unit under governorate. For statistical purposes by Department of Statistics (DOS), Liwa is almost the same as “District,” which has a hierarchy of Governorate – District – Sub-district – Locality. In addition, a large city has “Neighborhood” under Locality. In the Study, statistical classification is used for population distribution and water demand estimation because population data is available by this classification.

A municipality may be formed by combining several Liwas such as the Greater Irbid Municipality which consists of a part of the Qasabat (central) Irbid Liwa and all of the Bani Obaid Liwa; or it may be a part of a Liwa, such as, the Ramtha Liwa, which has two municipalities namely, the Ramtha Municipality and the Sahel Horan Municipality, as shown in Figure 2.1. The old Irbid Municipality was abolished and has become a part of the Greater Irbid Municipality since 2011. However, the old Irbid Municipality is often called Irbid city today. Following this custom, the old Irbid municipality is referred to as “Irbid city”.

In addition, another classification for Irbid municipal area for planning purpose according to the Ministry of Municipal Affairs is: urban growth area, rural growth area and rural settlement (see Figure 2.2). The population distribution in the Study Area uses this classification.

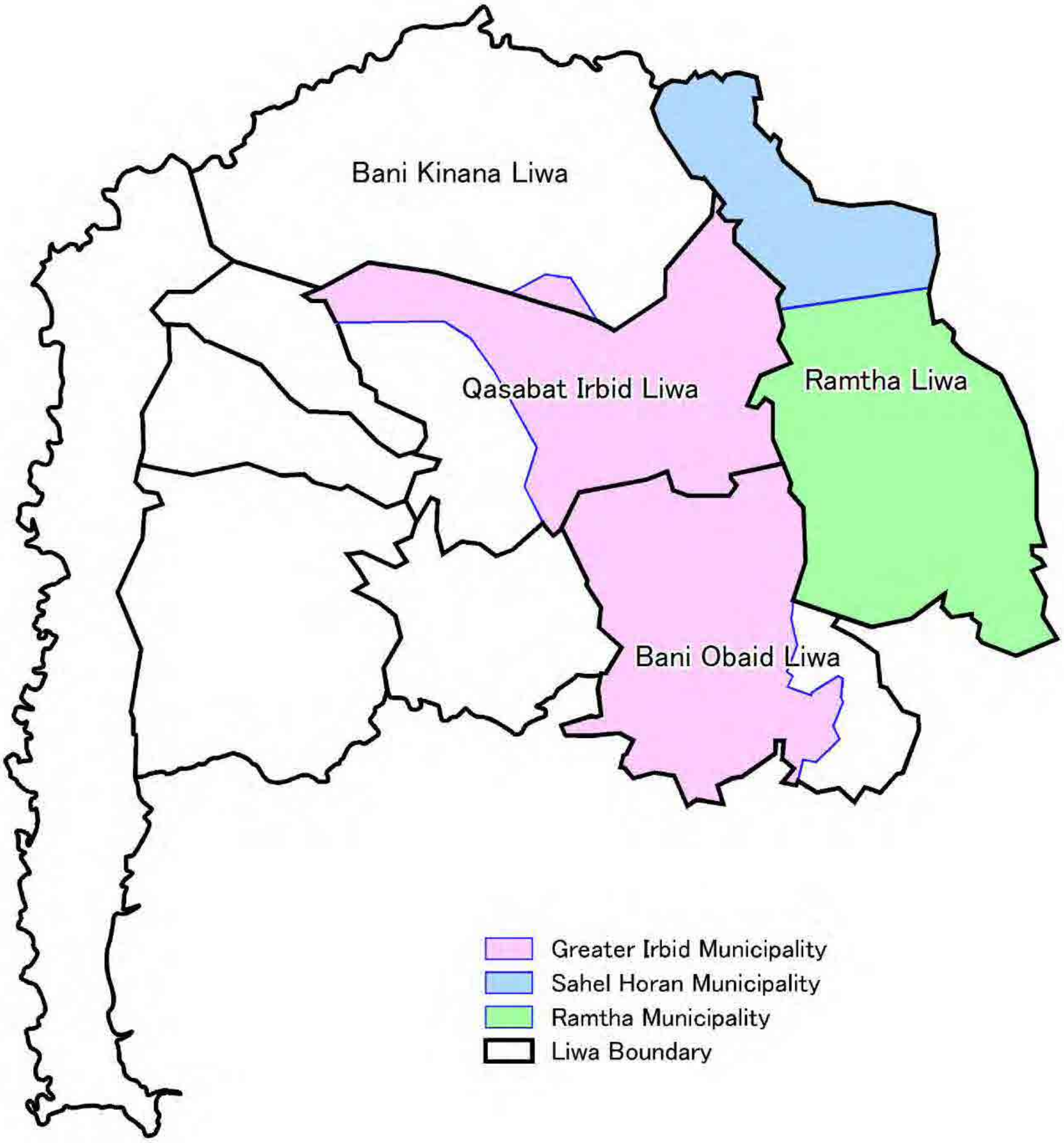
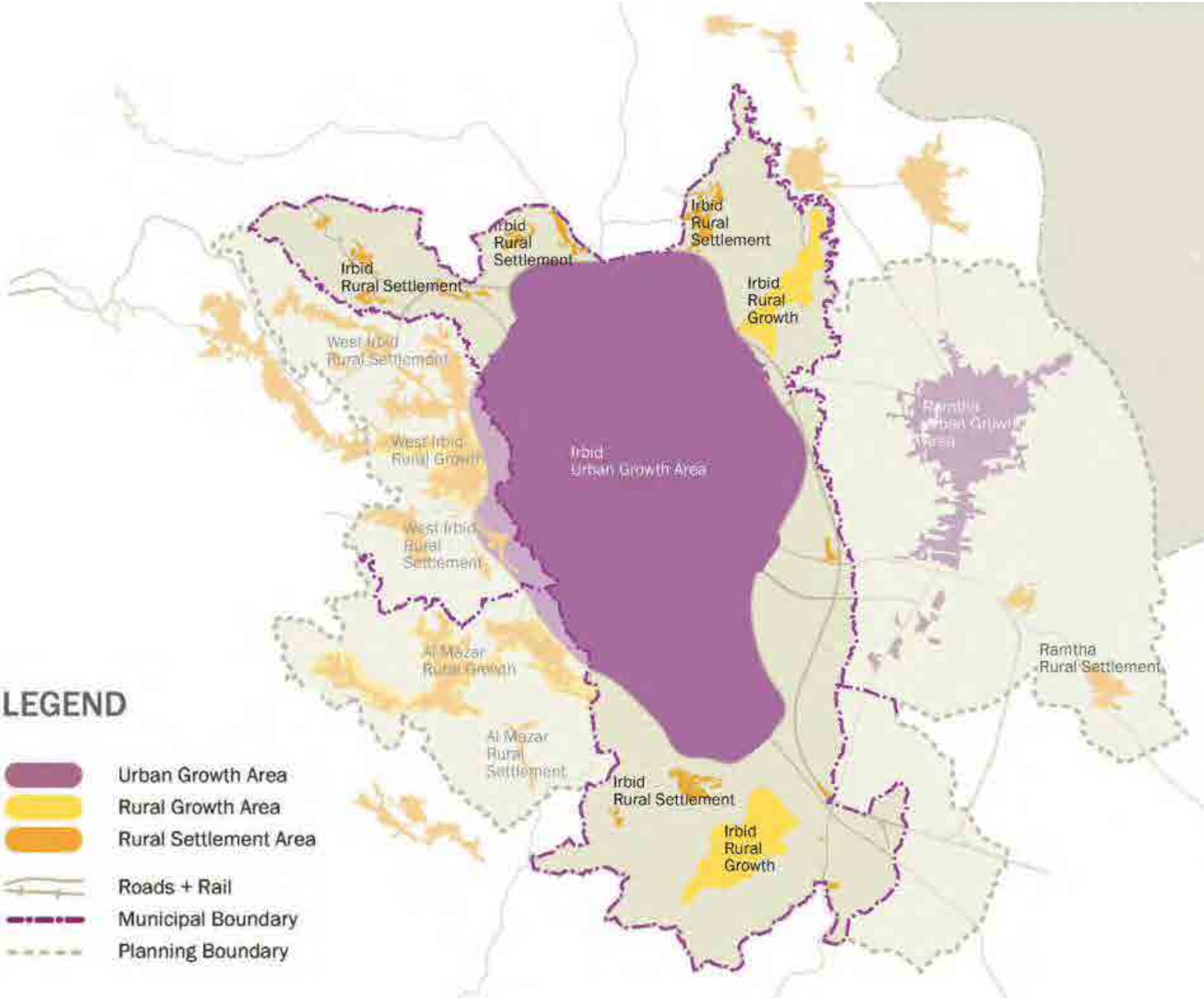


Figure 2.1 Liwa and Municipalities in Irbid Governorate



Source: Irbid 2030* Greater Irbid Area Plan, the Ministry of Municipal Affairs

Figure 2.2 Greater Irbid Municipality with Urban Growth Area

2.1.2 Economy

<u>Gross Domestic Product (GDP)</u>

Table 2.1 shows the Gross Domestic Product (GDP) of Jordan. The nominal GDP in 2012 is 22 billion JD (approximately 3 trillion Yen), and the GDP growth rate compared to the previous year is 7.3%. The GDP growth rate in 2008 was 29% due to the contribution of the mineral resource sector and the government sector. GDP growth rate still remains high although it has slowed down after 2009.

Tertiary industry accounts for approximately 70% of the whole industry in Jordan, 30% of which is contributed by the government sector, followed by the finance, transport, and wholesale and retail sectors. The contribution of the agriculture sector (3%) and the manufacturing sector (18%) to the whole industry has been growing year after year.

Table 2.1 GDP and its Growth Rate in Jordan

Item	2008	2009	2010	2011	2012
GDP (Nominal) (Billion JD)	15.6	16.9	18.8	20.5	22.0
Primary industry	1.2	1.0	-	-	-
Secondary industry	3.9	4.3	-	-	-
Tertiary industry	10.5	11.6	-	-	-
GDP growth rate (%)	29.3	7.7	11.2	9.0	7.3
Primary industry	89.0	-16.7	-	-	-
Secondary industry	26.3	9.9	-	-	-
Tertiary industry	24.8	10.8	-	-	-
Contribution by industry (%)					
Primary industry	7.8	6.0	-	-	-
Secondary industry	24.9	25.3	-	-	-
Tertiary industry	67.3	68.7	-	-	-

Note: 1) GDP by industry after 2010 is void because the data have not been obtained.
2) GRDP of the Northern governorates is not available.

Source: JICA Expert team based on Jordan Statistical Yearbook 2012 (2008-2009), Jordan in Figures, Department of Statistics (2010-2012)

The main economic sectors in Irbid are agriculture, real estate, transport and communication, electricity, water supply and public administration. The GDP of Greater Irbid has been estimated at 445 Million JD, with a GDP per capita of 978 JD in 2002 at current prices against 1,240 JD per capita for Jordan.[1]

2.1.3 Population

(1) Jordanian Population

Population growth rates in Jordan were high in the past: 4.8 % per annum (p.a.) during the period 1961–1979, 4.4 % p.a. between 1979 and 1994, 2.6 % p.a. between 1994 and 2004, and 2.2 % p.a. between 2004 and 2012. The high rates of growth were due to the influx from the West Bank in the late 1960s, the high rate of natural increase, and the return of Jordanians after the 1990 Gulf crisis and the 2003 Second Gulf War. On the other hand, fertility declines in Jordan have contributed to slowing down of the population growth rate from 3.2 % p.a. in the second half of the 1990s to 2.3 % p.a. in 2007 and 2.2 % p.a. in 2012[2].

Populations in the Irbid Governorates and Jordan are shown in Table 2.2. Populations in Irbid, Ramtha and Mafraq cities in 2012 are estimated at 307,024 and 87,499, respectively.

Table 2.2 Governorate Population

(Unit: persons)

Year/ Governorate	1994 Census (persons)	2004 Census (persons)	2012 Estimate (persons)
Irbid	751,634	927,892	1,137,100
Mafraq	178,634	244,188	300,300
Jerash	123,190	153,602	191,700
Ajloun	94,548	118,725	146,900
4 Governorates	1,148,006	1,444,407	1,776,000
Jordan	4,139,458	5,103,639	6,388,000

Source: Department of Statistics (DOS)

1 Meso-economic Analysis of the Greater Irbid, Jordan (2005)
2 Population and Family Health Survey 2012, Department of Statistics

(2) Population of Syrian Refugees

As is seen in Figure 2.3, the influx of Syrian refugees started in the first quarter of 2012 and the number of Syrian refugees has increased drastically during the first quarter of 2013, reaching to about 500,000. Then, the growth was slowed down in April 2013 and the number of Syrian refugees reached to about 600,000 in April 2014. As of October 2014, this number is about 619,000. Half of the total Syrian refugees in Jordan, about 322,000 persons stay in the northern governorates.

Table 2.3 Syrian Refugees Registered with UNHCR

(Unit: persons)

Northern Governorates		Other Governorates		Total
Mafraq	156,013	Amman	170,980	
Irbid	144,438	Zarqa	70,683	
Jerash	11,184	Balqa	19,695	
Ajloun	9,990	Other	25,610	
Sub-total	**321,625**	**Sub-total**	**286,968**	**608,593**

Source: UNHCR: Date is not clear, however, probably as of July 2014.

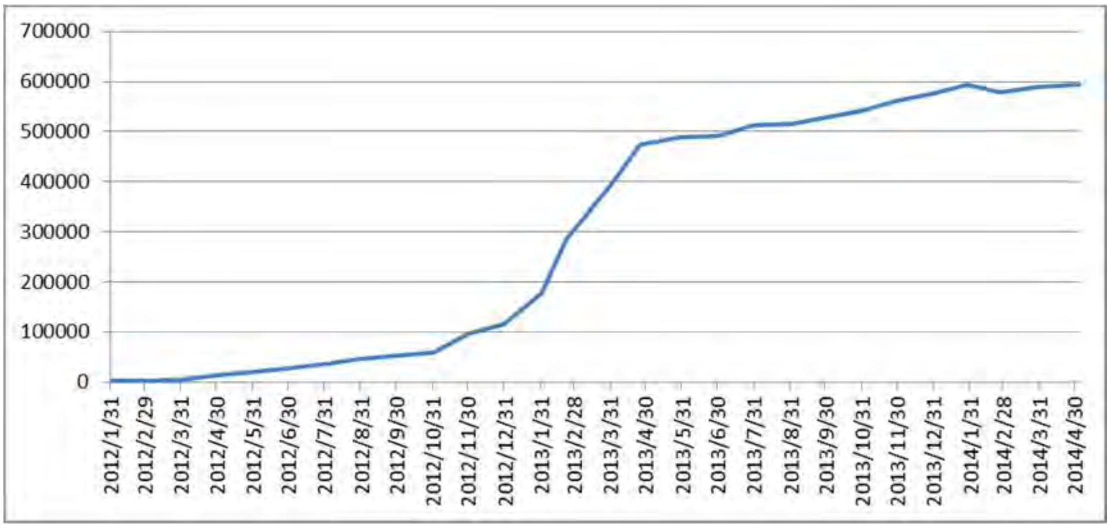


Figure 2.3 Syrian refugees Registered with UNHCR

The number of Syrian refugees in the northern governorates as of July 2013 was estimated separately by the Ministry of the Interior (MOI). This number is 394 thousands as shown in Table 2.4, which is larger than 322 thousands according to the UNHCR estimate. It seems MOI estimate includes un-registered persons, so the number is larger than that presented by the UNHCR. The total number of Syrian refugees including unregistered refugees is not known, but it is more than this figure.

Table 2.4 Syrian Refugees and Jordanian Population in the Northern Governorates

Governorate	Refugees Population in July 2013	Jordanian Population in 2012	Total
Irbid	239,750	1,137,100	1,376,850
Mafraq	134,900	300,300	435,200
Jerash	10,218	191,700	201,918
Ajloun	9,066	146,900	155,966
Total	393,934	1,776,000	2,169,934

Source: Ministry of Interior

In the Study, the MOI estimate for July 2013 is used as a fixed number for future refugee population because it may include un-registered persons also, and because the recent trend of change in the refugee population is relatively stable. The population estimated by the MOI is shown in Table 2.4 together with the Jordanian population in the northern governorates in 2012. The total population is approximately 2.2 million consisting of 1.8 million Jordanians and 0.4 million refugees. The refugee population accounts for 18 % of the total population.

Table 2.5 and Figure 2.4 show the projected Jordanian population and population of Syrian refugees. The sum of the current Jordanian population and refugee population is equivalent to the Jordanian population in 2022; the projected Jordanian population in 2035 is equivalent to the sum of the Jordanian population and the refugee population in 2028. If the number of refugees is counted in this master plan, the target year becomes 2028. In such a case, facilities need to be completed earlier than the planned implementation schedule. .

Table 2.5 Projected Jordanian Population and Syrian Refugees in the Northern Governorates

Year	Jordanian Population	Syrian Refugee Population	Population Including Refugees
2012	1,776,000	393,934	2,169,934
2015	1,890,248	393,934	2,284,182
2020	2,097,312	393,934	2,491,246
2022	2,185,447	393,934	2,579,381
2025	2,327,175	393,934	2,721,109
2026	2,375,590	393,934	2,769,524
2028	2,477,087	393,934	2,976,290
2030	2,582,356	393,934	2,976,290
2035	2,865,668	393,934	3,259,602

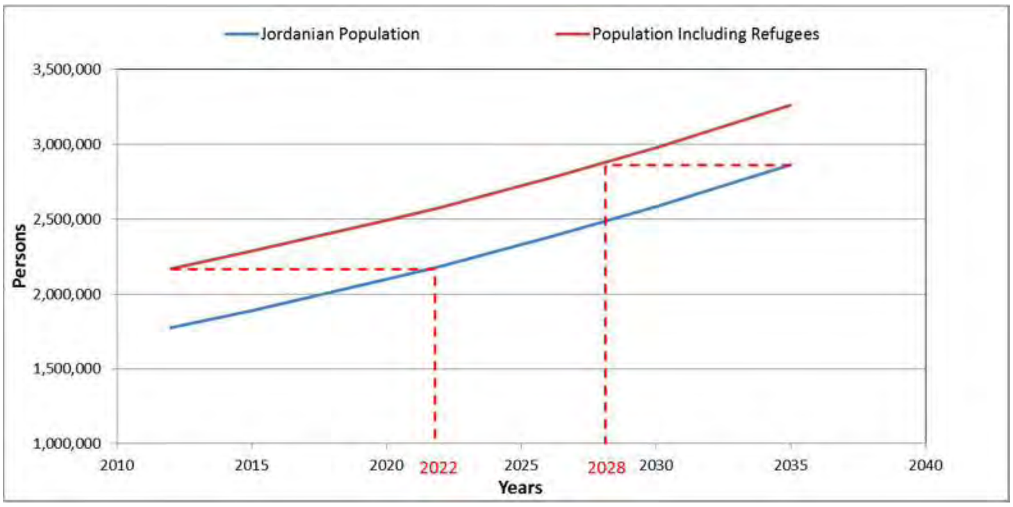


Figure 2.4 Projected Jordanian Population and Total Population including Syrian Refugees

2.1.4 Household Income and Expenditure

A main source of data for household income is the Household Expenditures and Income Survey in 2010 conducted by the DOS. The following table shows annual income from employment of the northern governorates, Amman, and the country average. It shows that the income of Irbid is lower than that of the country average.

Table 2.6 Average Household Income from Employment of Northern Governorates

(Unit: JD)

Governorate	Household Income from Employment	Total Household Income
Irbid	3442.2	7,877.2
Mafraq	3606.3	7,276.3
Jerash	3567.5	7,945.5
Ajloun	3342.0	7,470.9
Amman	4099.4	10,618.7
Country Average	3842.8	8823.9

Note: Total income includes employment, own account, rent, transfer and property.

Source: Household Expenditures & Income Survey 2010

Table 2.7 and Figure 2.5 show the results of expenditure survey for the northern governorates. In terms of the lowest expenditure decile, Ajloun and Irbid are less than 3,000 JD per year and Jerash is around 3,600 JD per year. The country average is less than 3,600 JD per year. These show that relatively low income people reside in the Study Area.

Table 2.7 Distribution of Households by Governorate and Household Expenditure Group

(Unit: %)

Household Expenditure Group (JD/year)	Irbid	Mafraq	Jerash	Ajloun	Amman	Average
<14,000	**11.8**	8.2	**12.1**	6.1	**24.7**	**16.0**
- 12,000	6.8	5.7	**14.8**	4.5	8.1	7.4
- 10,000	**10.3**	9.9	**17.8**	8.3	**11.3**	**10.6**
- 9,000	7.0	6.4	7.1	6.0	6.6	6.9
- 8,000	7.8	7.1	5.0	8.1	9.2	8.4
- 7,000	**10.1**	**12.7**	**11.3**	**13.7**	9.0	9.8
- 6,000	**12.0**	**10.2**	9.6	**13.4**	**10.1**	**11.1**
- 5,400	6.6	8.2	6.7	6.5	5.5	6.5
- 4,800	6.7	6.5	1.9	8.7	4.8	6.0
- 4,200	5.9	7.6	3.2	7.5	4.2	5.5
- 3,600	5.1	5.6	5.9	4.2	3.3	4.7
- 3,000	5.1	5.2	1.3	6.6	1.5	3.4
- 2,400	2.3	2.9	1.7	3.2	0.8	1.8
- 1,800	1.4	2.2	0.1	1.3	0.6	1.2
>1,800	1.0	1.6	1.4	1.8	0.2	0.8
	100.0	100.0	100.0	100.0	100.0	100.0

Source: Household Expenditure & Income Survey 2010, Department of Statistics

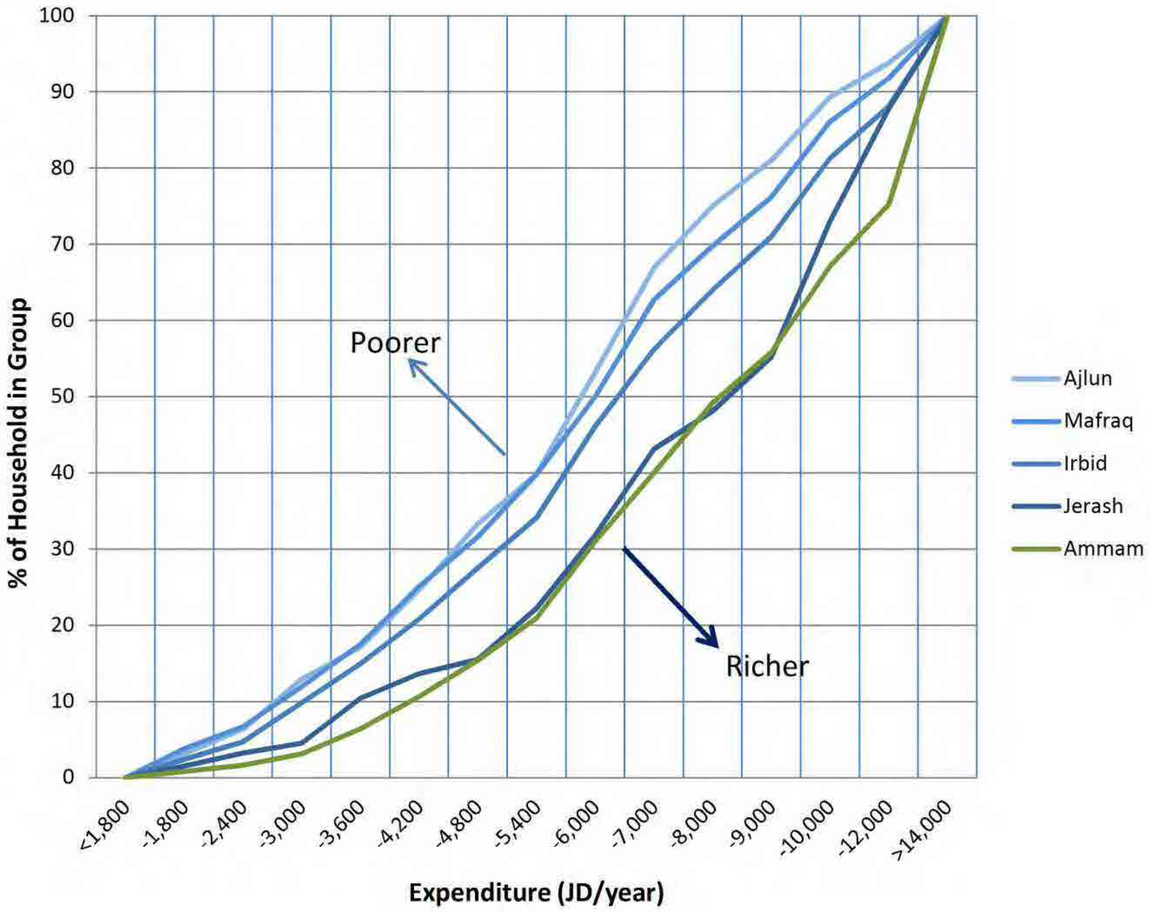


Figure 2.5 Household Expenditure Survey Results 2010

2.1.5 Health Status

The life expectancy of Jordan is 73.7 years - 72.1 years for males and 75.4 years for females in 2012 (World Bank). The table below shows the crude birth rate, crude death rate, and infant mortality rate of the Irbid Governorate from 2000 to 2009. The world median (2005-2010) and Jordan average (2012) are also shown in the same table.

Table 2.8 Birth and Mortality Rate of Irbid Governorate

(Per 1,000 persons)

Sr. No	Impact Indicators	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Jordan average 2012	World median 2005-2010
1	Crude Birth Rate	28.6	29.0	30.0	30.1	29.7	29.9	31.9	35.2	33.5	32.9	28.1	20.1
2	Crude Death Rate	2.8	3.3	3.2	3.2	3.1	3.2	3.4	3.5	3.1	3.3	7.0	8.1
3	Infant Mortality Rate	-	-	-	-	-	-	-	19.0	-	21.0	17.0	42.3

Source: KNOEMA.com, Web site, Development Statistics of Jordan, 2014
UN, World Population Prospects: The 2012 Revision

The crude death rate in Irbid Governorate is lower than the world median and Jordan average, but the crude birth rate is higher than the world median and Jordan average. It indicates that the population growth rate in Irbid governorate is higher than that of the country average and relatively high growth trend will continue. It also indicates that sanitary conditions including water supply surrounding infant is poor and need to be improved since the crude death rate in Irbid Governorate is lower but the infant mortality rate is higher than the Jordan average.

Table 2.9 Birth and Mortality Rate of Mafraq Governorate

(Per 1,000 persons)

Sr. No	Impact Indicators	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Jordan average 2012	World median 2005-2010
1	Crude Birth Rate	23.9	30.6	27.4	27.8	25.9	23.7	24.3	27.0	25.4	23.8	28.1	20.1
2	Crude Death Rate	2.3	3.1	2.7	2.6	2.4	2.3	2.7	2.5	2.3	2.2	7.0	8.1
3	Infant Mortality Rate	-	-	-	-	-	-	-	29.0	-	30.0	17.0	42.3

Source: KNOEMA.com, Web site, Development Statistics of Jordan, 2014
UN, World Population Prospects: The 2012 Revision

The crude death rate in Mafraq Governorate is also lower than the world median and Jordan average, but the crude birth rate is as same as the world median and Jordan average. It indicates that the population growth rate in Mafraq governorate is higher than that of the country average and relatively high growth trend tends to be continued. It also indicates that sanitary conditions including water supply surrounding infant is poor and need to be improved since the crude death rate in Marfraq Governorate is lower but the infant mortality rate is higher than the Jordan average.

2.2 Natural Conditions

2.2.1 Meteorology

The water demand fluctuates in the Study Area during a year according to climate; high water demand in dry and hot summer and low demand in rainy and cold winter.

(1) Climate

Irbid and Ramtha have a hot, summer Mediterranean climate with two seasons as listed below. It has an annual rainfall of 470 mm/year, average temperature of 17.5^{o}C, maximum mean temperature of 23.1^{o}C, and minimum mean temperature of 12.4^{o}C.

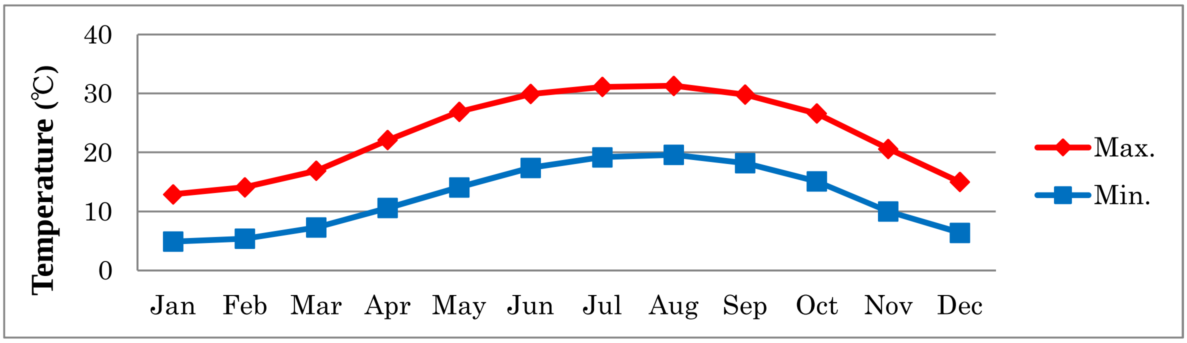
Summer season: April–October

Winter season: November–March

Mafraq is situated in the Northern Highlands Agro-Climatic Zone of Jordan, and is characterized as having a semiarid climate.

(2) Temperature

Figure 2.6 shows the mean maximum and minimum temperatures in Irbid City (30-year period). The difference between the monthly maximum and monthly minimum temperatures is about 10^{o}C.



Source: World Weather Information Service, Web site

Figure 2.6 Mean Maximum and Minimum Temperatures in Irbid City (30-year period)

Figure 2.7 shows the mean maximum and minimum temperatures in Irbid City (47-year period). The difference between the monthly maximum and monthly minimum temperatures is about 17°C.

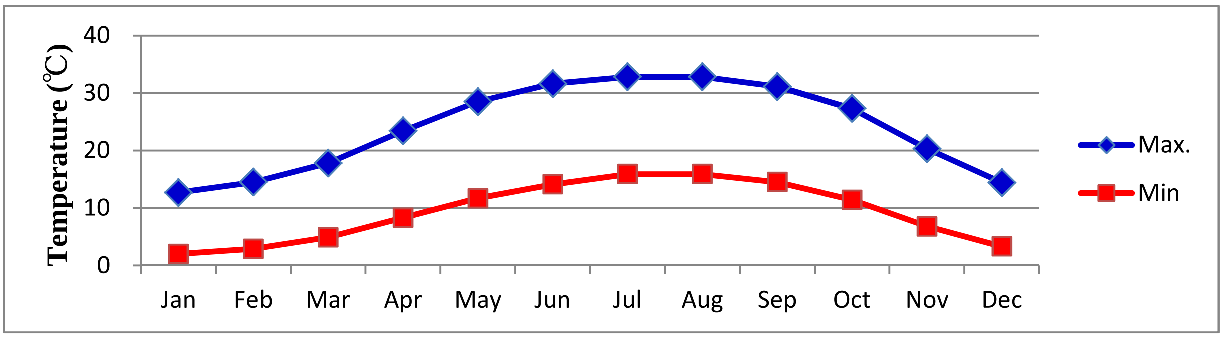
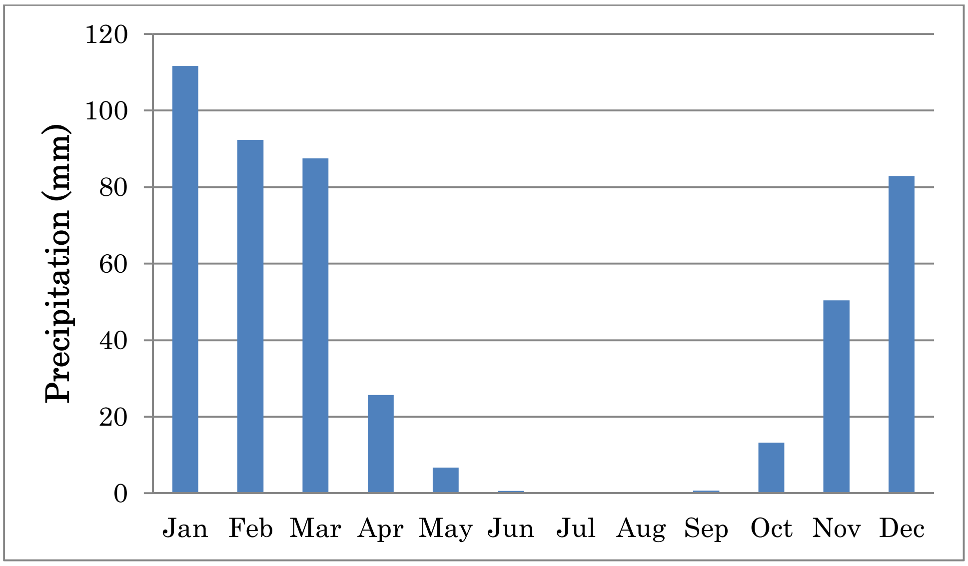


Figure 2.7 Mean Maximum and Minimum Temperatures in Mafraq City (47-year period)

(3) Rainfall

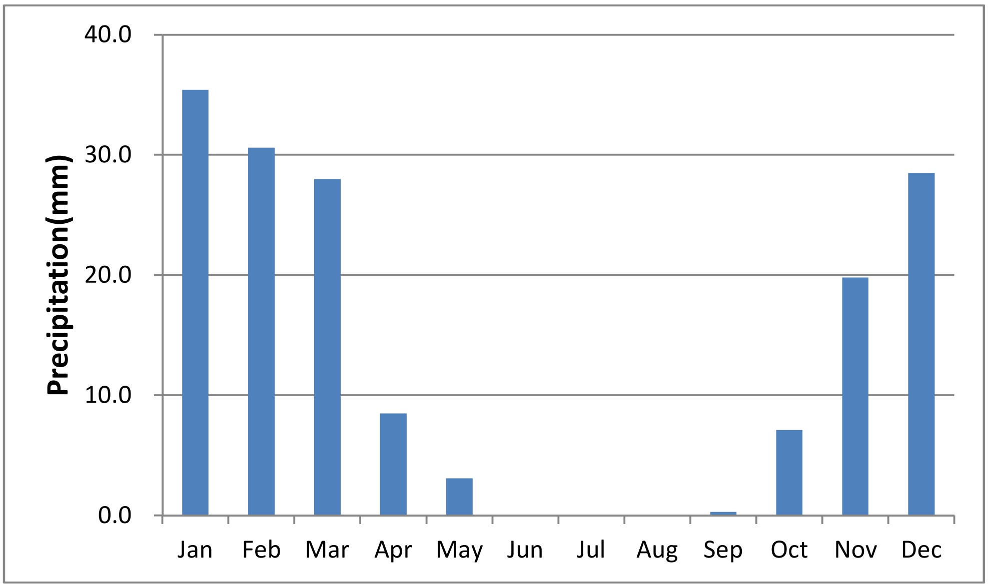
Figure 2.8 shows the monthly mean rainfall in Irbid. The annual mean rainfall is calculated at 470 mm. About 95% of the total rainfall throughout the year is from November to March.



Source: World Weather Information Service, Web site

Figure 2.8 Mean Monthly Rainfall in Irbid City (30-year period)

Figure 2.9 shows the monthly mean rainfall in Mafraq. The annual mean rainfall is calculated at 161 mm. About 88% of the total rainfall throughout the year is from November to March.



Source: World Weather Information Service, Web site

Figure 2.9 Mean Monthly Rainfall in Mafraq City (58-year period)

2.2.2 Topography

The undulated topography in the Study Area makes water supply pressure control difficult. Irbid is situated on a large plateau with ground elevation ranging from 250 m to 750 m. Ramtha is situated on a small hill with elevation ranging from 400 m to 600 m. Mafraq is situated on a small hill with elevation ranging from 600 m to 700 m.

2.2.3 Hydrogeology

The geological structure of the Study Area is attributed to a large plateau with ground elevation ranging from 400 m to 700 m. The geological formations in the Study Area are classified into two main periods based on the geological age (from old to new): (1) the Upper Cretaceous Period and (2) the Paleogene Tertiary Period. The plateau consists of limestone, dolomite and chalk.

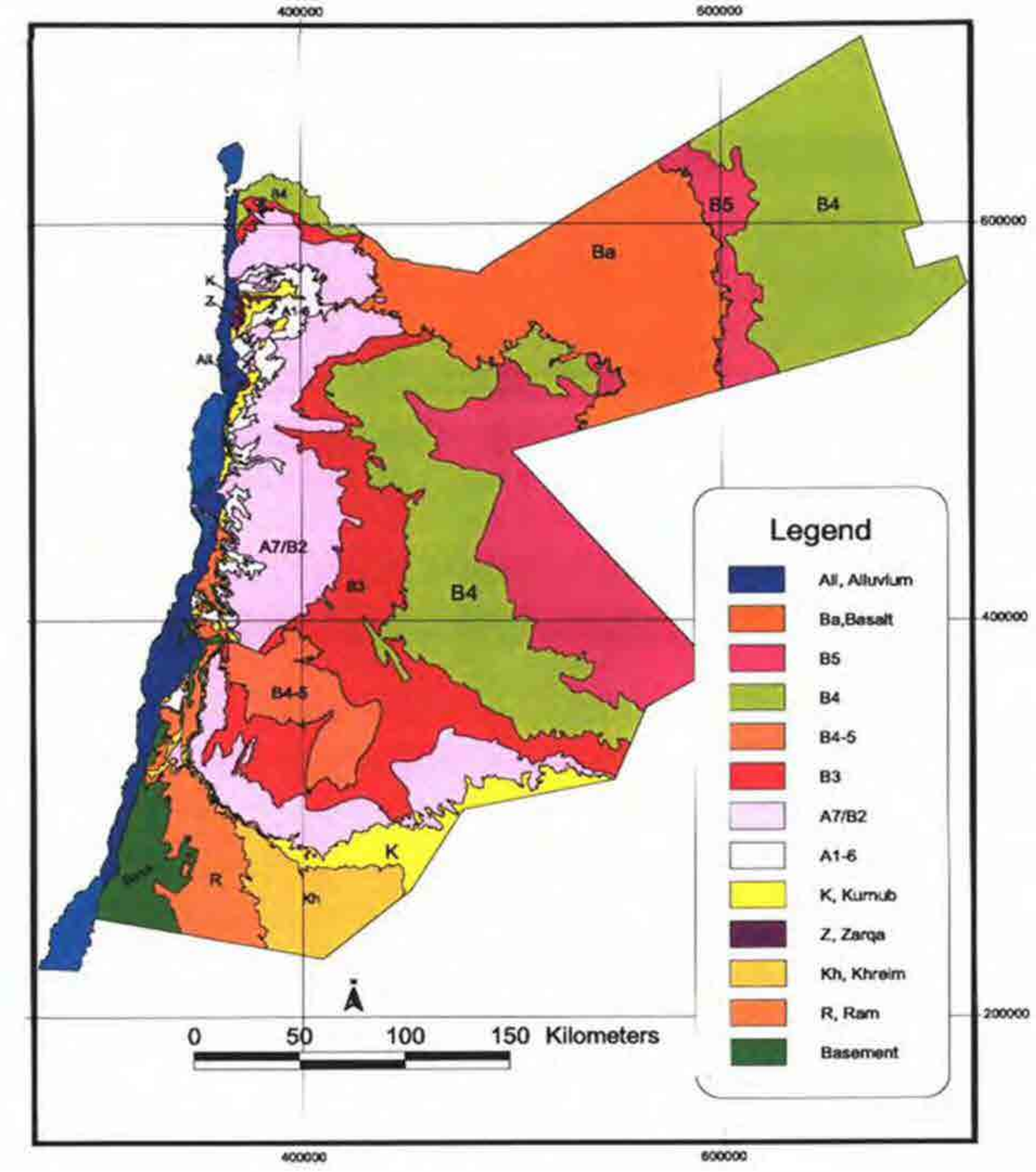
Table 2.10 Geological Formations

ERA	PERIOD		EPOCH	Group	Formation	Symbol	Lithology	Aquifer Characteristics	Aquifer Cond. (m/s)
CENOZOIC	Quarter-nary		Holocene	Alluvium	Fuviatile	Rc	Soil, sand, and gravel	Poor to Good (Aquifer)	Not Available
			Pleistocene	Diluvium	Laest and Eolian				
	Tertiary	Neogene	Pliocene	J. Valley	Jafer – Azraq	Ja-Az	Marl, clay, and evaporites conglomerate with siliceous sand, gravel, and basalt	Poor Fair	Not Available
			Miocene	Volcanics	Basalts	Ba	Basalt	Good (Aquifer)	4.0 E -04 *
		Paleogene	Oligocene	Volcanics	Basalts	Ba	Basalt		
			Eocene	Balqa	Wadi Shallah	B5	Limestone, chalk, and marl	Good (Aquifer)	5.0 E -05 *
			Paleocene		Rijam	B4	Chert, limestone, chalk, and marl	Good (Aquifer)	5.0 E -05 *
					Muwaqqar	B3	Marly limestone, and shale	Poor (Aquifer)	1.0 E -09 **
					Amman	B2	Chert, limestone, and phosphate	Good (Aquifer)	2.0 E -05 *
MESOZOIC	Cretaceous	Upper	Meastrichtian Campanian Santonian		Wadi Ghudran	B1	Chalk, marl, and marly limestone	Poor (Aquifer)	Not Available
			Taronian ?????	Ajlun	Wadi Sir	A7	Limestone, dolomite, and chert	Very Good (Aquifer)	2.0 E -05 *
					Shueib	A5, A6	Limestone, and marly limestone	Poor (Aquitard)	1.0 E -09 **
			Cenomanian		Hummar	A4	Dolomite, and dolomitic limestone	Fair to Good (Aquifer)	2.0 E -05 *
					Fuheis	A3	Marl, and marly limestone		1.0 E -09 **
					Naur	A1, A2	Limestone, and dolomitic limestone	Poor (Aquitard) Good (Aquifer)	1.0 E -05 **
		Lower	Albian	Kurnub	Subeihi	K2	Sand and shale	Fair to Good	3.0 E -05 *
			Aptian				Clay and sandy limestone	(Aquifer)	
			Neocomian						
			Berriasian		Aarda	K1	Sandstone, marl and shale		
	Jurassic	Malm	Tithonian						
			Kimmeridgian						
			Oxfordian						

(Source; Northern Governorates Water Transmission System Feasibility Study Final Report CDM International Inc. 2005, Modified from JICA 2001 and BGR 2001)

The main aquifer is following 6 aquifers from the surface and the salient features are shown in Table 2.10.

1) Basalt (BA, eruption in Oligocene Paleogene-Neogene Miocene)
2) Barqa group, Wadi Shallalah formation / Rijam formation (B5/B4, Paleogene Eocene/ Paleocene)
3) Barqa group, Wadi Amman formation / Ajloun group, Wadi Sir formation (B2/A7, Paleogene Paleocene/ Upper Cretaceous)
4) Ajloun group, Hummar formation (A4, Upper Cretaceous)
5) Ajloun group, Naur formation (A1, A2, Lower Cretaceous)
6) Kumub group, Subeihi formation, Aarda formation (K, Lower Cretaceous-Jurassic)



Source: Northern Governorates Water Transmission System Feasibility Study Final Report
CDM International Inc. 2005, Modified from JICA 2001 and BGR 2001

Figure 2.10 Geology of Jordan

Table 2.11 Main Aquifers from the Top

Symbol	Formation	Lithology	Formation Thickness (m)	Hydraulic Conductivity (m/s)	Specific Yield (m^3/h/m)
BA	Basalts	Basalt	10->500	4.0E-04	0.01
B4/B5	Shallalah/Rijam	Limestone , Chert	0-850	5.0E-05	0.05
B2/A7	Amman/Wadi as Sir	Limestone	80-650	2.0E-05	0.05
A4	Hummar	Limestone	30-100	2.0E-05	0.01
A1/2	Naur	Chert, Limestone	90-220	1.0E-05	0.01
K	Kurnub	Sand and Shale	120-350	3.0E-05	0.025

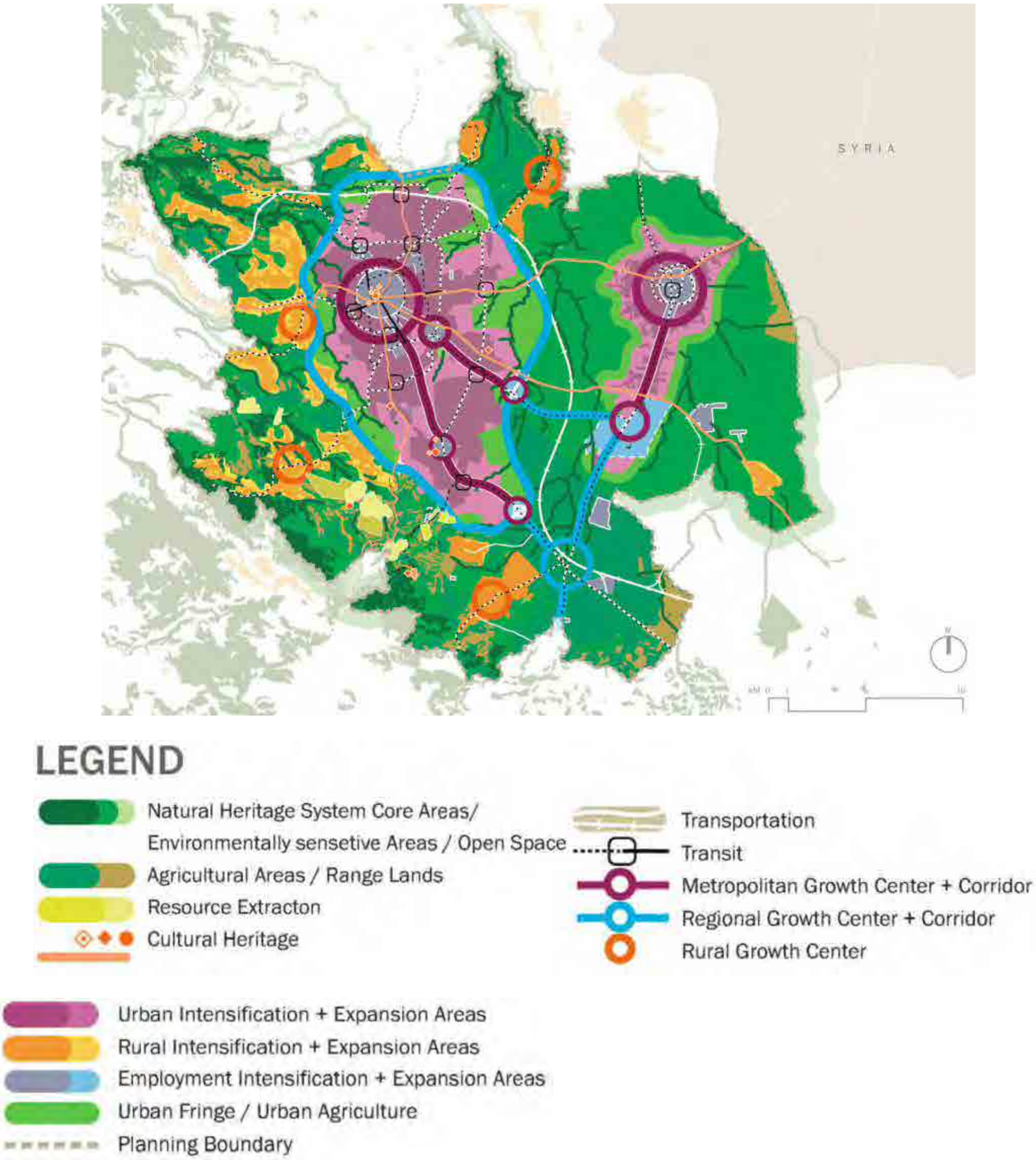
Many wells abstract water from the B2/A7 deep aquifer in the northern governorates. Some wells take water from the B4/B5 shallow aquifer in Ramtha and Badia. Some wells take water from the BA aquifer (Basalt) in Badia, Mafraq, and Za'atary. Deeper aquifers are utilized by some wells in Ramtha, North Shouna, Ajloun and Jerash. Groundwater is extracted from all "A" aquifers in part of Irbid, from "K" aquifer of the deepest part in almost half of Jerash, and from the "K" aquifer in part of Ajloun.

2.3 City Plans

2.3.1 Irbid and Suburbs

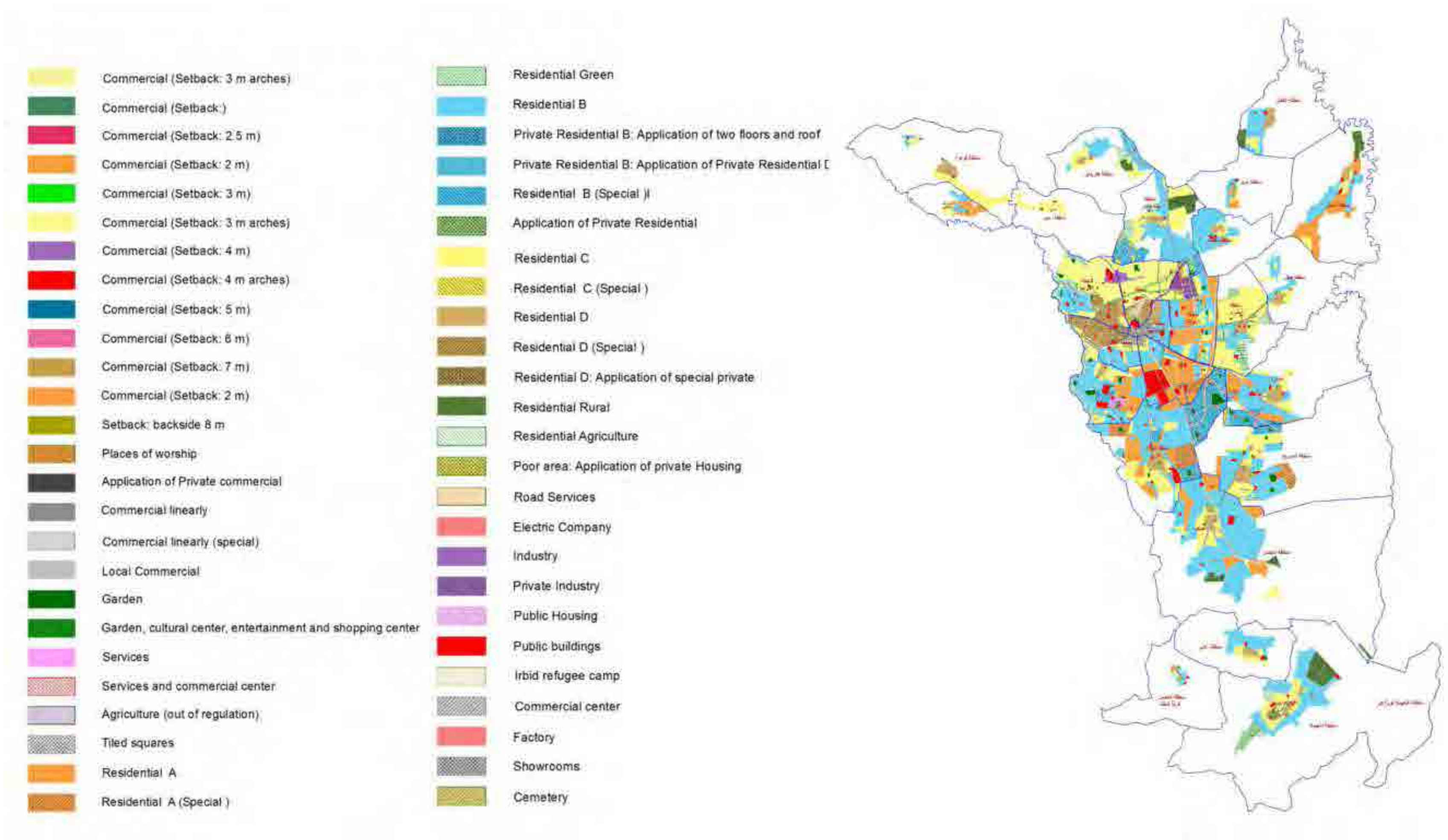
The existing municipal-level master plan is called "Irbid 2030: Greater Irbid Area Plan" (Ministry of Municipal Affairs: MOMA). The following are excerpts from the Plan related to the Study:

- Figure 2.11 shows the projected urban growth area for Irbid city and its suburbs. Appendix I shows the detailed maps
- Irbid and suburbs are classified as follows and are shown in Figure 2.11 as well.
  a) Residential Stable
  b) Residential Intensification
  c) Residential Expansion
- Development is to be encouraged in designated residential intensification areas taking advantage of existing infrastructure and services on first priority, to be followed by new expansion areas that will accommodate the population and promote employment growth to 2030.
- Residential stable area is also defined with recommendation to avoid accepting additional population in such areas so as to prevent severe congestion that may lead to an unhealthy environment.
- Planned population densities for sound living environment are 100 persons per hectare (pph) for Irbid city and 30-50 pph for the suburbs in the urban growth area. Projected population densities for Irbid and suburbs are as shown in Appendix I.
- Population of Irbid city is not projected; however, total population of the Greater Irbid Municipality is projected to almost double from 395,472 in 2004 to 741,276 by 2030.



Source: Irbid 2030: Greater Irbid Area Plan of MOMA

Figure 2.11 Residential Intensification and Expansion Areas in Irbid, Ramtha and its Suburbs



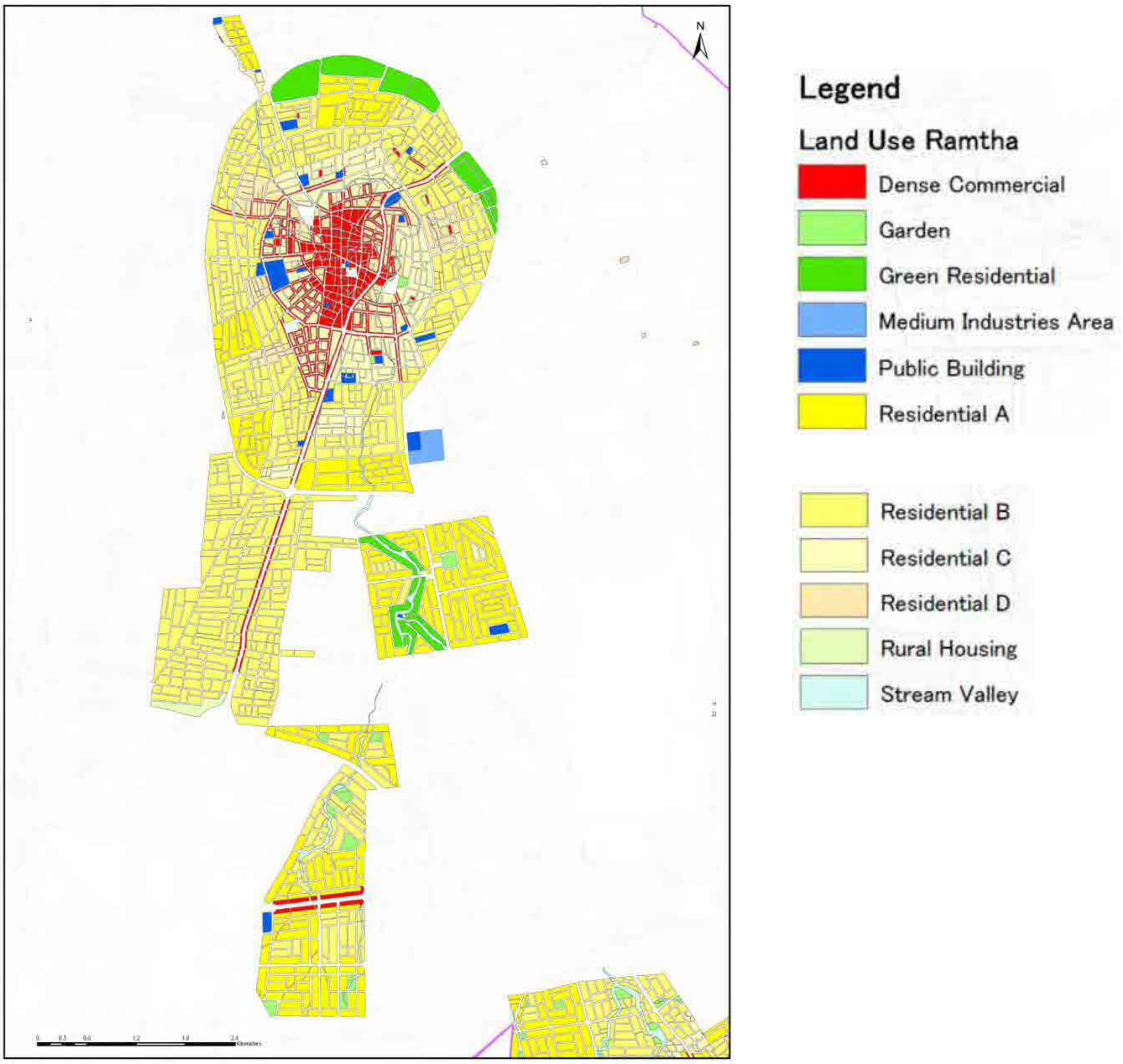
Source: Municipality of Greater Irbid

Figure 2.12 Land Use Plan in Irbid

2.3.2 Ramtha City

Urbanization in Ramtha is planned southwards according to the Growth Plan on Regional Scale in the "Irbid 2030: Greater Irbid Area Plan" of MOMA (Refer to Appendix 2B). Ramtha is divided into mainly four(4) areas, such as urban intensification, rural intensification, urban fringe and agricultural area. They are shown in Figure 2.13.

Figure 2.13 shows the land use plan of Ramtha prepared by the Ramtha municipality. The central part of Ramtha is mainly occupied by dense commercial buildings. Commercial blocks are surrounded by residential areas. Some stretches of green residential areas lie on the outskirts.



Source: Ramtha Municipality and JICA Study Team

Figure 2.13 Land Use Plan in Ramtha City

2.3.3 Mafraq City

There is no existing urban plan for Mafraq area. But the water supply plan prepared by KfW covers the future expansion area in southern area, then the service area of water supply plan is used to define the sewerage service area. The general water plan showing the gravity service area under the Project is shown in Figure 2.14.

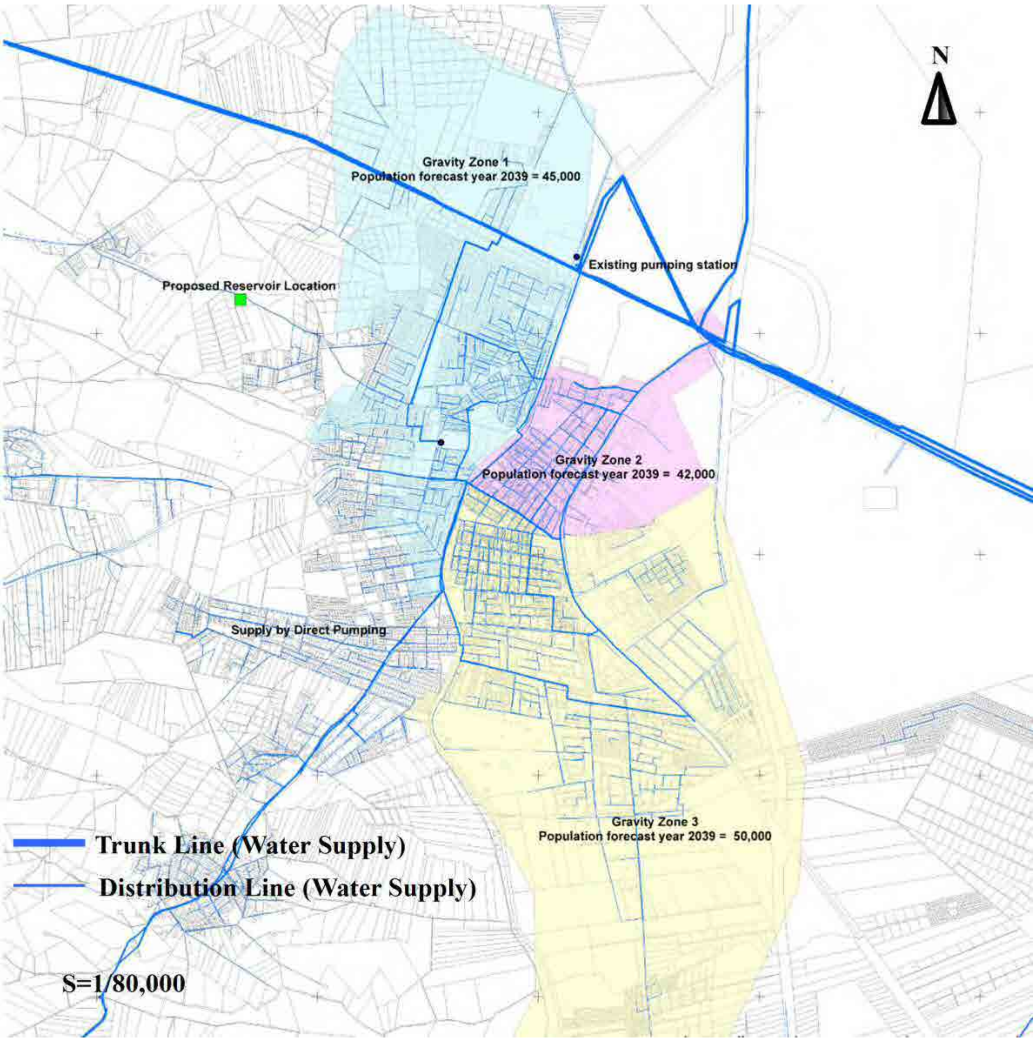


Figure 2.14 Water Supply Plan of Mafraq

2.4 Institution and Organization of Water Sector

2.4.1 Policies, Laws, and Regulations

A list of existing plans, strategies, policies, and legislations for the Water Sector of Jordan is given in the table below.

Table 2.12 Existing Plans, Strategies, Policies, and Legislations

Year	Document Title	Type	Theme
1988	Water Authority Law No. 18 of 1988	Law	Institutional
1992	Ministry of Water and Irrigation By-law No. 54 of 1992	By-law	Institutional
1994	Wastewater Regulation No. 66 of 1994	Regulation	Wastewater
	Drinking Water Subscription Regulation No. 67 of 1994	Regulation	Drinking water
1997	**Water Strategy of Jordan 1997**	**Strategy**	**Water sector**
	Water Utility Policy of 1997	Policy	Water utility
1998	Ground Water Management Policy of 1998	Policy	Groundwater
	Irrigation Water Policy of 1998	Policy	Irrigation
	Wastewater Management Policy of 1998	Policy	Wastewater
2001	Jordan Valley Development Law No. 30 of 2001	Law	Institutional
2002	Underground Water Control By-Law No. 85 of 2002 and its amendments of 2003, 2004 and 2007	By-law	Groundwater
2003	JVA Strategy Plan for 2003 - 2008	Strategy	Water sector
2004	National Water Master Plan of 2004	Water master plan	Water sector
	Jordan's Water Strategy and Policies of 2004	Strategy and policy	Water, wastewater, and irrigation
2006	**National Agenda 2006-2015**	**Strategy**	**All sectors**
2008	Irrigation Equipment and System Design Policy of 2008	Policy	Irrigation
	Irrigation Water Allocation and Use Policy of 2008	Policy	Irrigation
	National Water Demand Management Policy of 2008	Policy	Water demand management
	Water Authority Strategic Plan 2008-2012	Strategy	Water sector
2009	**Jordan's Water Strategy 2008-2022: Water for Life**	**Strategy**	**Water sector**
2010	Water Reallocation Strategy between Governorates	Strategy	Water sector

The following major policy documents for the Water Sector in Jordan are described below:

- Jordan's Water Strategy and Policies adopted by the Council of Ministers, 1997;
- The National Agenda, 2006-2015;
- Water for Life: Jordan's Water Strategy, 2008-2022.

(1) Jordan's Water Strategy and Policies

Jordan's Water Strategy and Policies are strongly committed to:

1) Reducing groundwater extraction to renewable rates;
2) Ongoing monitoring effort to control groundwater withdrawals;
3) Careful planning and judicious withdrawals from fossil aquifers;
4) Quest for the highest possible efficiency in the conveyance, distribution, and use of water;
5) Integrated and temporally dynamic approach to the management of demand and supply;
6) Use of the most advanced technology to enhance resource management capabilities;
7) Keeping operation and maintenance costs as low as possible.

There was a commitment to increased co-operation and co-ordination among public and private entities involved in water development and management. The government promised to undertake periodic reviews of the existing institutional arrangements and legislation to assess the adequacy of the status quo in light of changed settings and circumstances. The government advocated frequent monitoring and scoring of the performance of water and wastewater systems.

The Ministry of Water and Irrigation (MWI) was directed to set municipal water and wastewater tariffs at levels that would cover the cost of operation and maintenance. The Ministry was also directed to launch a program to recover all or part of the capital costs of water infrastructure.

There was a rather modest commitment to cost recovery for operation and maintenance expenses for utilities. The recommendation was "capital cost recovery must be carefully approached," suggesting the political difficulties associated with this commitment. It is reported that the role of water tariffs should be considered to attract private investment in water projects.

With respect to groundwater, the government promoted irrigated agriculture in the arid southeast from 1984. The agriculture promoted by the government over two decades ago is now a threat to urban water supply. The report suggests that there will be a vigorous campaign focused on illegal drilling of tube wells—drilling will be stopped, rigs confiscated and legal action taken against violators. The Ministry is said to be implementing a program effective in gradually reducing groundwater withdrawals to the level of sustainability.

At the time of the report, the Ministry was providing wastewater collection and treatment services to 14 major populated areas. The Ministry was also reorganizing to become more effective in monitoring and enforcing wastewater regulations. The Ministry was directed by the Councils of Ministers to establish a unit responsible for planning, designing, constructing and managing sewerage system projects and for reusing treated effluent.

Wastewater was recognized as an essential component of renewable water resources and it was expected to become an integral part of the national water budget. Industries were encouraged to recycle part of their wastewater and to treat the remainder to meet specific standards. Priority was given to treated effluent for irrigation. Blending of treated wastewater with fresh water was encouraged where possible.

There is a commitment in this report to "institutional restructuring" in which proper legislation and effective law enforcement would form the basis of a new policy climate.

The MWI would play a central role in planning and development of the water sector, formulation of a coherent policy framework, and regulation of the sector. This new policy framework would have three general principles:

1) MWI would retain responsibility for sectoral governance. This would entail policy formulation, decision making, data collection, geo- referenced data systems, monitoring, and overall national planning;
2) The Water Authority of Jordan (WAJ) would separate its bulk water supply and retail functions shifting water delivery to the private sector. WAJ would monitor retail supply contracts, and would become a smaller organization. For those bulk supplies that are not privatized, WAJ would remain the purveyor of bulk supplies not privatized, and it would provide support to smaller retail distribution units not operated by the private sector;
3) The Jordan Valley Authority (JVA) has seen its programs in social infrastructure diminish in the recent past; so there was a call for the reassessment of its functions and programs. Jordan's Water Strategies and

Policies required the JVA to launch a new program to focus on tourism, industry, manufacturing, and advanced technologies. Law No. 19 of 1988 would remain a mandate of the water sector to the JVA. The private sector was expected to become more active in development and activities concerned with operation and maintenance.

(2) The National Agenda: 2006-2015

This document acknowledged the water sector as strategically important because water scarcity can significantly impede socio-economic growth. The document acknowledged that the water sector suffered from distribution inefficiencies, inadequate tariffs, limited wastewater treatment capabilities, and restricted private sector involvement in addition to the scarcity of renewable water resources and depletion of underground water.

Proposed initiatives pertinent to institutional assessment included:

1) Improvements in the efficiency of water distribution networks to decrease operational costs and non-revenue water;
2) Restructuring tariffs and gradual reductions in subsidies;
3) Development (and upgrading) of wastewater treatment facilities by using state-of-the-art technology and re-use of treated water for agriculture and industry; and
4) Greater involvement of the private sector in developing the water sector and creating an investment-friendly environment. The National Water Master Plan of 2004 reinforced the importance of these reforms.

(3) Water for Life: Jordan‘s Water Strategy, 2008-2022

The government of Jordan is committed to:

1) Providing adequate, safe and secure drinking water supply;
2) Promoting greater understanding and more effective management of groundwater and surface water;
3) Providing healthy aquatic ecosystems;
4) Sustainable use of water resources;
5) Fair, affordable and cost-reflective water charges; and
6) Timely adaptation to increased population growth and economic development across the water sector and water users.

The ISSP (Institutional Support and Strengthening Project, USAID) Report analyzed this strategy and admitted that the prevailing motivation for water “management” in Jordan was dominated by the flawed imperative to supply water rather than the more logical approach that focuses on justified water needs. As a result, groundwater levels had dramatically declined, and the imbalance between supplies and claimed “needs” had grown to unsustainable levels. Moreover, the quality of the nation’s water had declined significantly.

The Water for Life report calls for:

1) Efficient and effective institutional reforms;

2) More efficient use of water resources;
3) Dramatic reduction in the exploitation of groundwater;
4) Implementation of the Disi water conveyance and the Red-Dead conveyance projects
5) More attention to problems created by irrigated agriculture in the highlands; and
6) Appropriate water tariffs and water-conserving incentives.

2.4.2 Organization

The organizations responsible for water section are the Ministry of Water and Irrigation (MWI), Water Authority of Jordan (WAJ), and public operators namely, Miyahuna, the Aqaba Water Company and the Yarmouk Water Company (YWC). The organizational structure of the water sector is shown in the following figure:

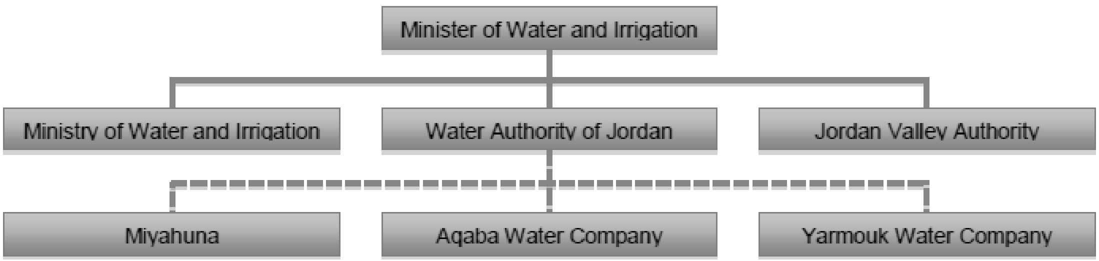


Figure 2.15 Organization of the Water Sector

The MWI, which is the main government agency entrusted with responsibility for water resources, drinking water supply and wastewater services, was formed in 1992 to manage the country's water resources. The MWI is responsible for formulating and implementing water and wastewater development programs and for recommending water sector policies and tariff revisions to the Council of Ministers for approval.

The WAJ established by the "Water Authority Law No.18 of 1988," is an autonomous entity with financial and administrative independence beholden to government and civil service regulations. The WAJ is governed by a Board of Directors chaired by the Minister for Water and Irrigation with representatives from the Ministries of Planning, Agriculture and Health, as well as the Secretary Generals of the WAJ and the JVA.

The WAJ is responsible for implementing policies related to the provision of water supply and wastewater disposal services. Its responsibilities include the design, construction, and operation of these services, as well as supervision and regulation of the construction of public and private wells, as well as licensing well drilling rigs and drillers, and issuing permits to engineers and licensed professionals to perform water and wastewater related activities.

The Yarmouk Water Company (YWC) was established in 2010, serves the four Northern Governorates of Jordan, namely Irbid, Jerash, Ajloun and Mafraq. The YWC is also a 100%-subsidiary of the WAJ and replaces the Northern Governorates Water Administration (NGWA).

CHAPTER 3 EXISTING WASTEWATER MANAGEMENT

3.1 Existing Wastewater Management in the Northern Governorates

3.1.1 On-site Wastewater Treatment Facilities and Management

(1) Present Conditions

On-site wastewater treatment facilities such as septic tanks, cesspits or other simple underground storage tanks are commonly used in the northern governorates. The report prepared by WASH in host communities in Jordan, "An interagency assessment, September-October 2013", points out that the septic tanks are really "improved pits" for the following reasons:

"*The devices commonly called "septic tanks" in host communities do not have any outlet pipes, but are not designed to retain sludge and scum. No maintenance is performed on such "septic tanks", except for sporadic emptying by wastewater trucks. These are allowing wastewater septage into the ground. Regular sludge removal from these on-site sanitation facilities is required. In several cases, these are in fact pits dug in the ground and covered by concrete slabs equipped with apertures for emptying."*

Based on site observations it is also reported that *"Most improved pits are private, i.e. they are used by one household only, although some are shared by several households. The size of improved pits vary, ranging from 9 m^3 to 70 m^3 for private ones and 10 m^3 to 80 m^3 for shared ones".*

To maintain the on-site system properly, de-sludging or empting the septage is essential. De-sludging services are provided by private companies using vacuum trucks. The average charge is about 4 JD/m^3. Average cesspit tank capacity for each house-holds is about 6 m^3, then about 24 JD is paid for each desludging service. The desludging service is required once monthly or bimonthly.

The collected sludge is delivered and treated at the Al Alkaider WWTP which has a pond system with a capacity of 4,000 m^3/d, specially designed for treating faecal sludge and septage[1].

In the rural area, separation of domestic wastewater at source is a wide spread practice[2]: black water from toilets is discharged to cesspools or septic tanks, while the grey water is discharged directly into the environment or used for irrigation without treatment.

(2) Impacts on host communities from the influx of Syrian refugees.

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[1] "Options for Wastewater Treatment in the Context of Syrian Refugees in North Jordan, Fact Finding Mission 2013", KfW

[2] "Onsite Greywater Treatment Using Septic Tank Followed by Intermittent Sand Filter – A Case Stud of Abu Al Farth Village in Jordan", July 2010, Vol. 1, No.1, International Journal of Chemical and Environmental Engineering.

The on-site sanitation facilities such as cesspits are overloaded.. Wastewater often overflows from cesspits or temporally excavated pits to nearby shallow wells. The need for de-sludging (vacuum) services run by private companies increased twice after the inflow of Syrian refugees. The more frequent maintenance of these on-site sanitation facilities would deplete the budget for household services and the overflows of wastewater are sometimes overlooked.

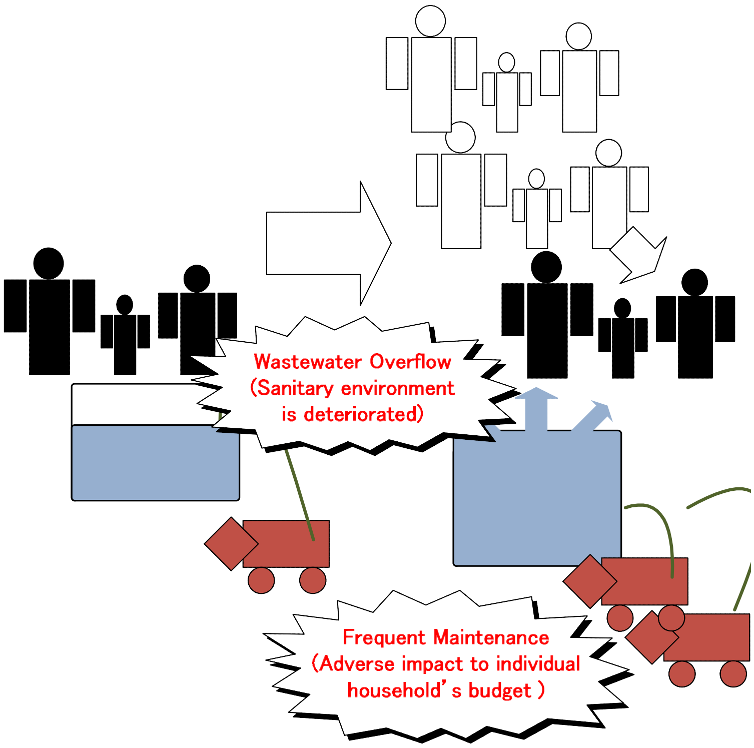


Figure 3.1 Issues for On-site Sanitation Management in the Host Communities

The improper practices of Syrian refugees when they use toilets have caused the following problems. Disposal of paper and garbage other than toilet tissues in toilets are more frequent. The per capita daily water consumption has been reduced because the water supply volume is limited and fixed. These situations cause more clogging and blocking of the sewers, resulting in more frequent overflows of wastewater from manholes.

3.1.2 Off-site Wastewater Treatment Facilities and Management

Table 3.1 summarizes the population with sewerage service in the four northern governorates, the capital of Amman, as well as nationally as of 2012.

Table 3.1 Sewerage Service Population in Four Northern Governorates, Amman and Jordan

Governorate	Totals by Governorate		Localities larger than 5,000people		Population Served with Wastewater Collection and Treatment Systems			
	No. of Localities	Total Governorate Population 【2012】	No of Localities	Total Population in Localities	No. of Localities Served	Total Population Served	% of Total Governorate Population . 【2012】	% of Total Population Residing in Localities larger than 5,000 people
Irbid	137	1,137,100	54	981,378	12	594,404	52%	61%
Mafraq	172	300,300	12	139,102	1	24,000	8%	17%
Jerash	55	191,700	10	131,808	16	113,031	69%	86%
Ajloun	55	146,900	10	117,172	4	61,700	42%	53%
Amman	157	2,473,400	32	2,345,764	25	2,080,112	84%	89%
Jordan	1,042	6,388,000	173	5,456,136	91	3,951,465	62%	72%

Source: SWMP (ISSP)

The population with sewerage service in Mafraq governorate is very low compared with other governorates, and even when compared with localities with more than 5,000 people. Jerash governorate has the highest served population among the four northern governorates, which is as high or closed to that of Amman governorate. But those of Irbid and Ajloun governorates are lower than Jordan.

The present status of sewerage services and the existing sewerage plans for Ajloun and Jerash Governorates are summarized based on the information provided in the Strategic Wastewater Master Plan (herein after referred as ”SWMP”) prepared by Institutional Support and Strengthening Program (herein after referred as “ISSP”). Existing services and plans for Irbid and Mafraq are described in Section 3.2, based on SWMP as well as field surveys, plus other data and information collected through WAJ, YWC and other related organizations.

(1) Sewerage Services in Ajloun Governorate

Sewerage services are provided to 61,700 people, which is about 42% of the total population of 146,900, in four localities in two districts in the Ajloun Governorate. There is one treatment plant called “Kufranjah” WWTP. Table 3.2 shows the present sewerage in Ajloun Governorate.

Table 3.2 Present Sewerage Services in Ajloun Governorate.

District	Localities	Population 【2012】	Estimated Served Population	System
Ajloun Qasabah	Anjarah	21,794	19,615	Ajloun sewer system
	Ain Janna	10,841	9,757	Ajloun sewer system
	Ajloun	9,018	8,116	Ajloun sewer system
Kufranjah	Kufranjah	26,891	24,202	Ajloun sewer system
Total Population Served		61,690		
Total Population in the above Localities		68,544		
% Served in the Localities		90%		
Total Governorate Population		146,900		
% Served in Ajloun Governorate		42%		

Source: SWMP (ISSP)

Two trunk sewers (the 400 mm line that collects wastewater from the Ajloun and Ain Janna localities and the 300 mm line that collects wastewater from Anjararah) are connected to the 500 mm line that collects wastewater from Kufranjah and conveys it to the Kufranjah WWTP. The capacity of the Kufranjah WWTP and inflow is summarized in Table 3.3. The existing sewerage system in Ajloun governorate is shown in Figure 3.2.

Table 3.3 Outline of the Kufranjah WWTP in Ajloun Governorate

Treatment Process	Design Capacity	Inflow to WWTP
Trickling filter process in operation since 1989.	1,900 m^3/d	about 2,763 m^3/d

Source: SWMP (ISSP)

The SWMP proposes to improve the sewerage service, including expanding the service area of the Sakhrah and Ebbien localities as a priority II project to be implemented by 2025. The location of the two population centers is shown in Figure 3.3.

Table 3.4 shows the target sewerage service coverage in 2035 compared to the current situation. It is reported that "WAJ is upgrading the Kufranjah WWTP to increase the treatment capacity to 9,000 m^3/d. The wastewater generated by the Sakhrah and Ebbien localities estimated at about 2,810 m^3/d by 2035 will be conveyed and treated at the Wadi Hassan WWTP in Irbid Governorate.

Table 3.4 SWMP Proposal on Sewerage Development for Ajloun Governorate

Localities	WWTP	Estimated Served Population 【2012】 (person)	% of total Governorate Population	Projected Population 【2035】 (person)	Projected Wastewater Flow 【2035】 ($m^{3/}$d)
Ajloun	Kufanjah	61,690	42%	101,151	8,092
Sakhrah	-	12,736	9%	20,883	1,671
Ebbien	-	8,686	6%	14,242	1,139

Source: SWMP (ISSP)

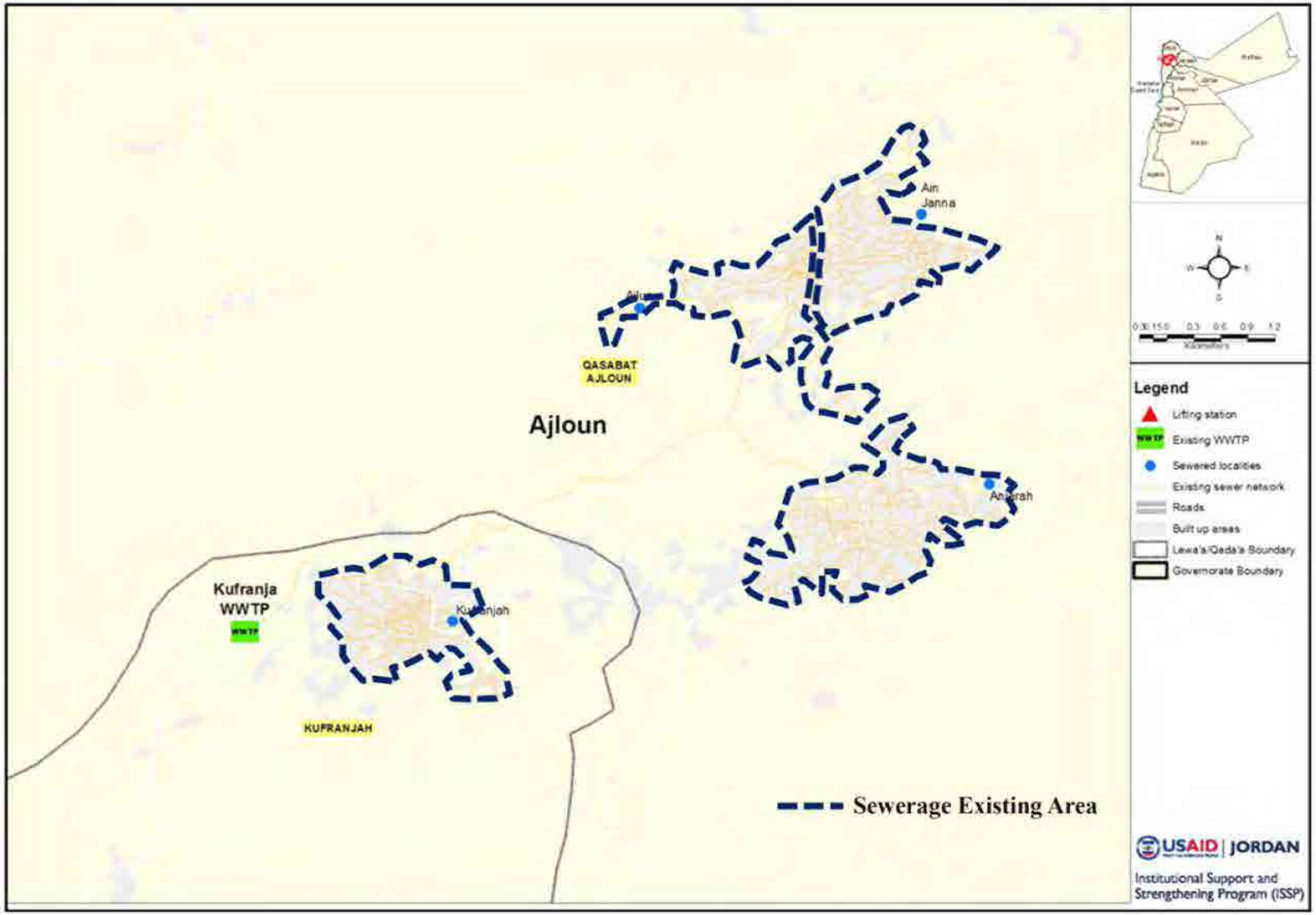


Figure 3.2 Existing Sewerage System in Ajloun Governorate (Source: SWMP (ISSP))

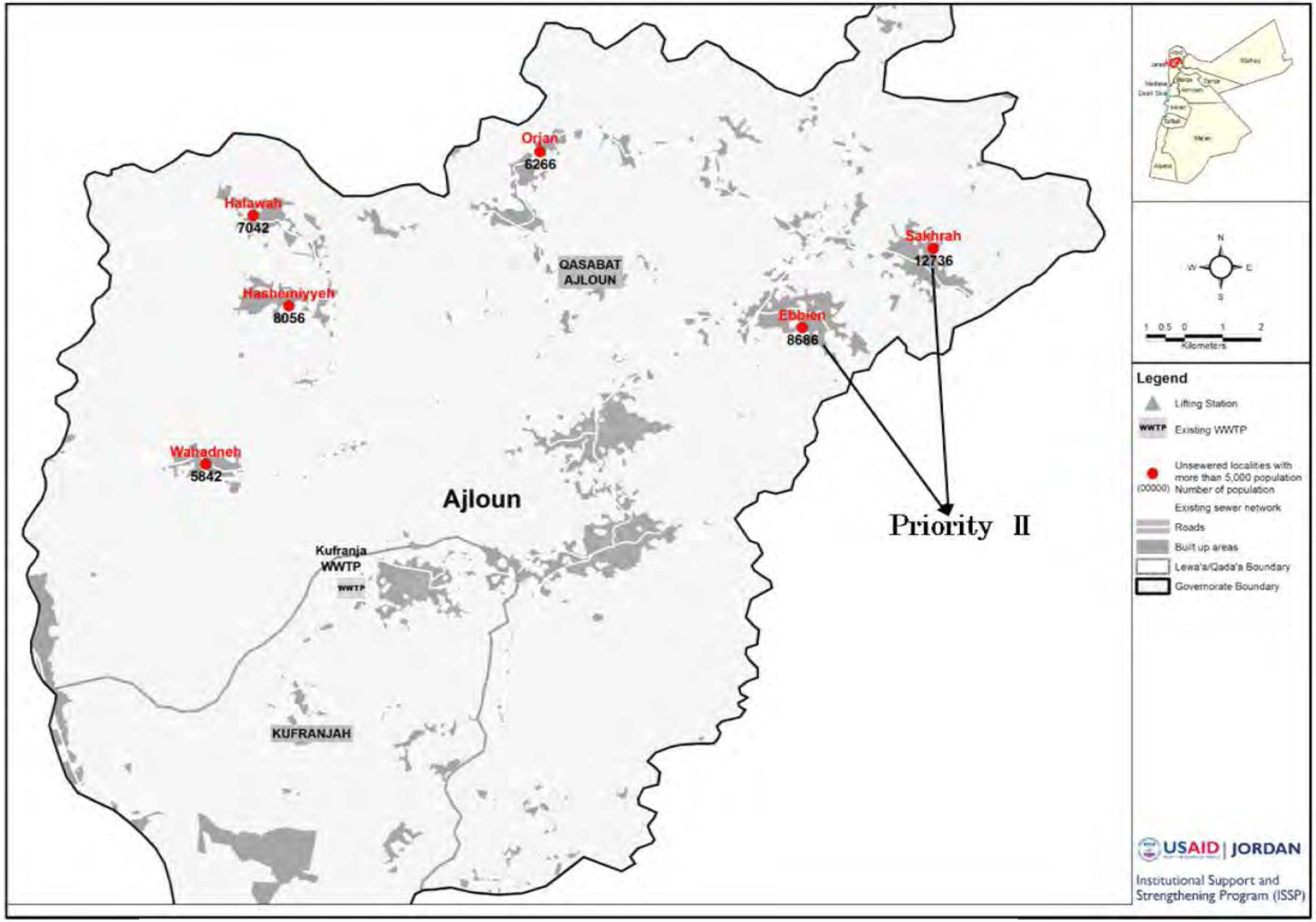


Figure 3.3 Localities where No Sewerage System and Two Localities Proposed as Priority II Project in SWMP (Source: SWMP (ISSP))

(2) Sewerage Services in Jerash Governorate

Table 3.5 summarizes the sewerage services currently provided to 16 localities (7 urban and 9 rural) in the Jerash Qasabah District, serving about 69% of the total population or about 132,200 people. There are two sewerage districts (SWD), the East SWD and the West SWD. Figure 3.4 shows the existing sewerage systems in Jerash Governorate.

Table 3.5 Present Sewerage Services in Jerash Governorate

District	Localities	Population 【2012】	System
Jerash Qasabah	Jarash	32,385	East
	Soof	14,574	East
	Mukhayyam Soof	13,299	East
	Dair Elliyyat	3,029	East
	Meqebleh	2,072	East
	Asfoor	961	East
	Nabi Hood	1,173	East
	Mukhayyam Ghazzeh	17,750	West
	Sakeb	12,771	West
	Raimoon	7,839	West
	Ketteh	7,294	West
	Dahr As-Srou	7,118	West
	Nahleh	3,926	West
	Hadadeh	2,776	West
	Mansheiat Hashem	2,947	West
	Ejbarat	2,229	West
Total Population Served		132,144	
Total Governorate Population		191,700	
%Served		69%	

Source: SWMP

About 67,500 people are served in the East SWD. The wastewater is conveyed to the East WWTP by the 'Line A' interceptor and the 'Soof' interceptor with pipe diameters ranging from 200 mm to 500 mm. The West SWD serves about 64,650 people. Wastewater is conveyed by 'Line A' and 'Line B' trunk sewers with pipe diameters ranging from 200 mm to 400 mm, and from 200 mm to 500 mm, respectively. Both trunk sewers are connected to 'Line T' with a diameter of 600 mm and a length of 2,380 m, before reaching the West WWTP. General information on the two WWTPs is summarized in Table 3.6.

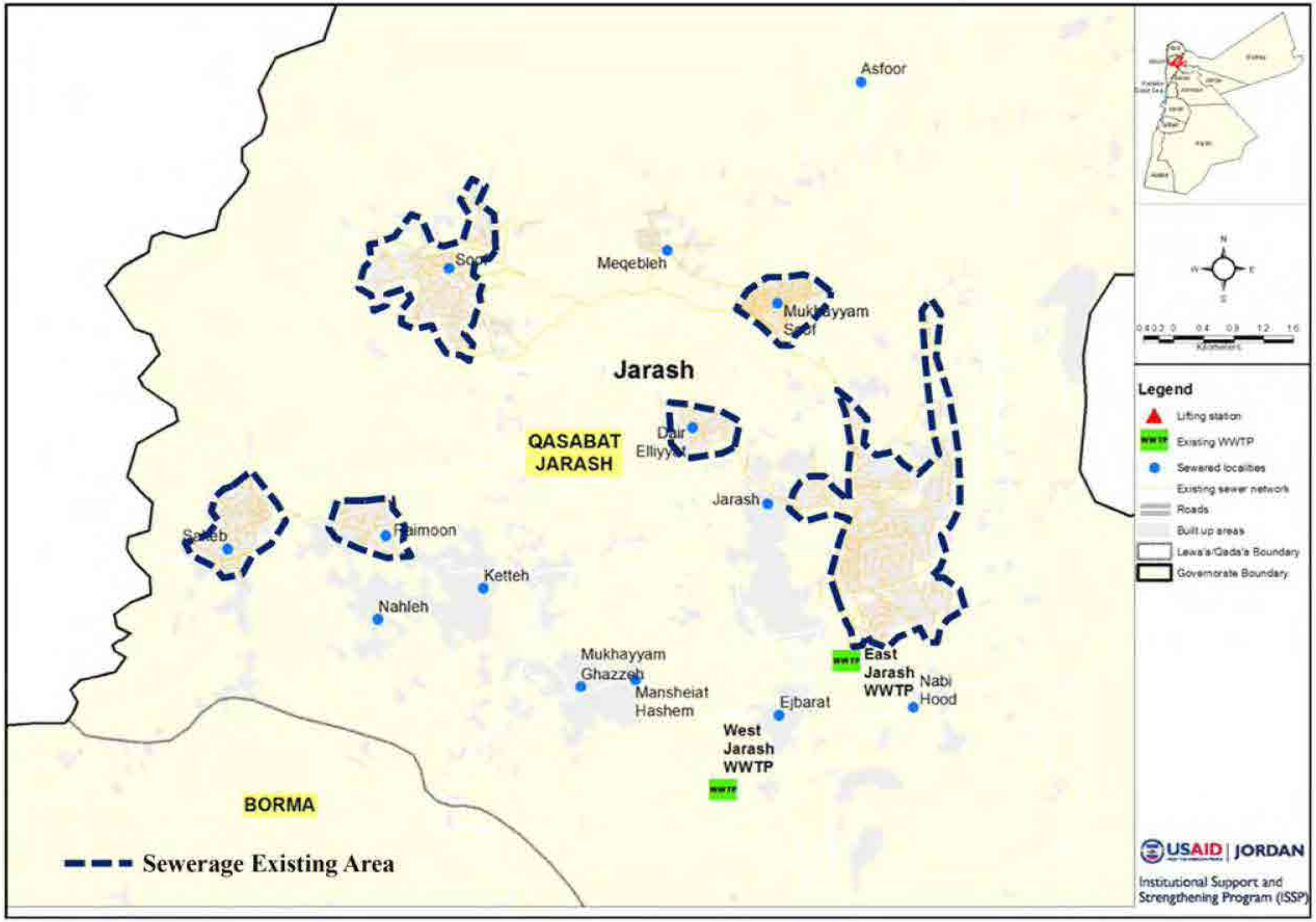


Figure 3.4 Existing Sewerage Systems in Jerash Governorate (Source: SWMP (ISSP))

Table 3.6 General Information on Existing WWTPs in Jerash Governorate

WWTP	Treatment Process	Design Capacity	Inflow to WWTP	Remarks
East	Activated sludge process upgraded with polishing ponds, in operation since 1993	3,750 m^3/d	Estimated at about 5,399 m^3/d	An extended aeration process having design capacity of 1,150 m^3/d, in operation since 1983
West	Oxidation ditch process, providing nitrogen and phosphorus removal, in operation since 2011	9,550 m^3/d, including 400 m^3/d for septage	Estimated at about 5,172 m^3/d	Sludge thickening and mechanical centrifugal dewatering equipment and sludge drying beds

Source: SWMP (ISSP)

Approximately 53 km of new sewers have been designed for the West SWD in 2010. About 53 km of new sewers ranging from 200 mm to 500 mm in diameter and three lift stations are proposed to be constructed. The present design capacity of 9,550 m^3/d at the West WWTP can cover the estimated wastewater generated in 2035 as shown in Table 3.7.

In addition, the SWMP proposes to expand the service area in Kofor Khall and Baliela localities in Jerash District as priority II project to be implemented by 2025. The East WWTP is to be expanded to a capacity of 8,000 m^3/d from the present capacity of 3,750 m^3/d by 2025 and to 10,800 m^3/d by 2035.

Table 3.7 SWMP Proposal on Sewerage Development for Jerash Governorate

SWD	WWTP	Status	Localities	Estimated Served Population【2012】(person)	% of total Governorate Population	Projected Population【2035】(person)	Projected Wastewater Flow【2035】(m^3/d)
East	East	Existing	East	67,494	35%	113,323	9,066
West	West	Existing	West	64,650	34%	105,876	8,470
		Proposed	KoforKhall	7,007	4%	11,623	930
			Baliela	6,195	3%	10,276	822

Source: SWMP (ISSP)

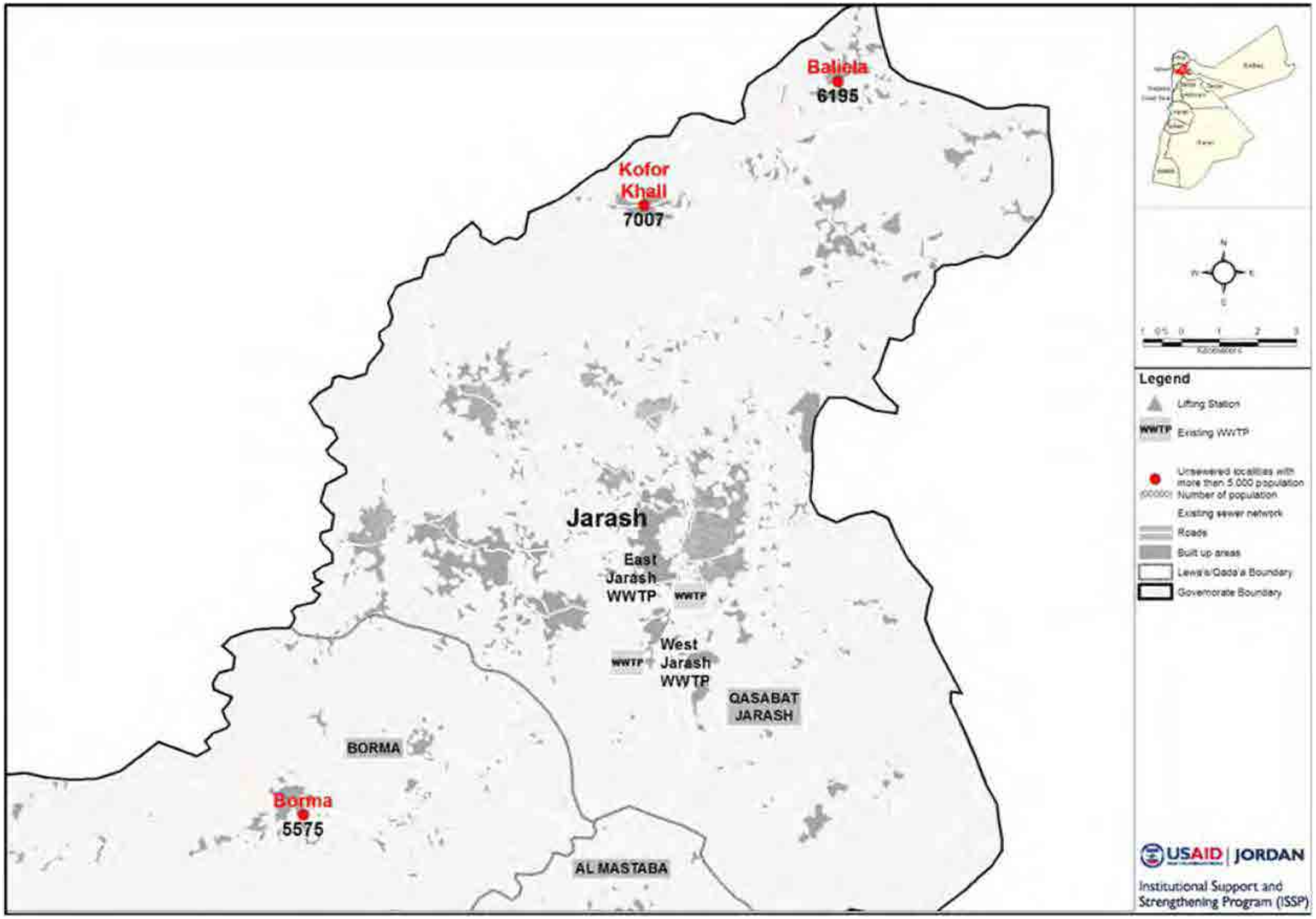


Figure 3.5 Localities of Baliela and Kofor Khall, Proposed as Priority II Project in SWMP (Source: SWMP (ISSP)

3.2 Existing Sewerage Facilities in Irbid, Ramtha and Mafraq Governorates

The current conditions of the sewerage system in Irbid city and its suburbs, Ramtha city and Mafraq city and any recent improvement plans and projects are explained in the following sub-sections.

3.2.1 Irbid City and its suburbs

(1) Sewers

The existing sewers in Irbid and its suburbs are about 1,408 km in total length, of which 6% or about 91 km are 300 mm or more in diameter. The rest are branch sewers of 200 mm in diameter. The lengths and diameters of the existing sewer pipes are shown in Table 3.8.

Table 3.8 Existing Sewers in Irbid and Suburbs Unit: km

District	Total	Branch Sewer	Trunk Sewer Length by pipe diameter (mm)							
		200	300	400	500	600	700	800	900	Sub Total
Irbid area	1,407.5	1,317.0	29.1	7.3	15.0	11.3	8.5	13.2	6.1	90.5
Wadi Al-Arab	477.3	440.1	9.9	2.2	8.0	5.0	4.6	2.7	4.8	37.1
Central Irbid	114.8	105.3	4.4	1.6	1.8	0.5	-	-	1.3	9.5
Shallala	646.2	613.2	10.4	2.2	5.2	5.8	3.9	5.4	-	33.0
Wadi Hassan	169.2	158.4	4.5	1.2	-	-	-	5.1	-	10.8

Source: JICA Study Team, based on the YWC data and information

(2) Lift Stations

There are six lift stations in Irbid and its suburban area. The general information on the six lift stations are summarized in Table 3.9. Their locations are shown in Figure 3.6.

Table 3.9 Outline of Existing Lift Stations in Irbid and its suburbs

Item	Dougrah LS	Hakama LS	Bushrah LS	Sal LS	Al-Huson Camp LS	Wadi Hassan LS
Sewerage District	Wadi Al-Arab	Wadi Al-Arab	Shallala	Shallala	Wadi Hassan	Wadi Hassan
Commissioning year	2008	2000	2012	2012	2005	2002
Pump Type	Submersible	Submersible	Submersible	Submersible	Horizontal Shaft	Horizontal Shaft
Capacity (m^3/min)	6.0	3.9	3.8	3.8	4.2	6.7
Head (m)	69.0	35.0	58.0	58.0	79.0	85.0
Power (kWh)	50.0	45.0-50.0	52.7	-	132.0	160.0
Number Total (Standby)	2 (1)	2 (1)	2 (1)	2 (1)	2 (1)	2 (1)

*The Capacity is for one pump. The second pump is stand-by.

Source: JICA Study Team

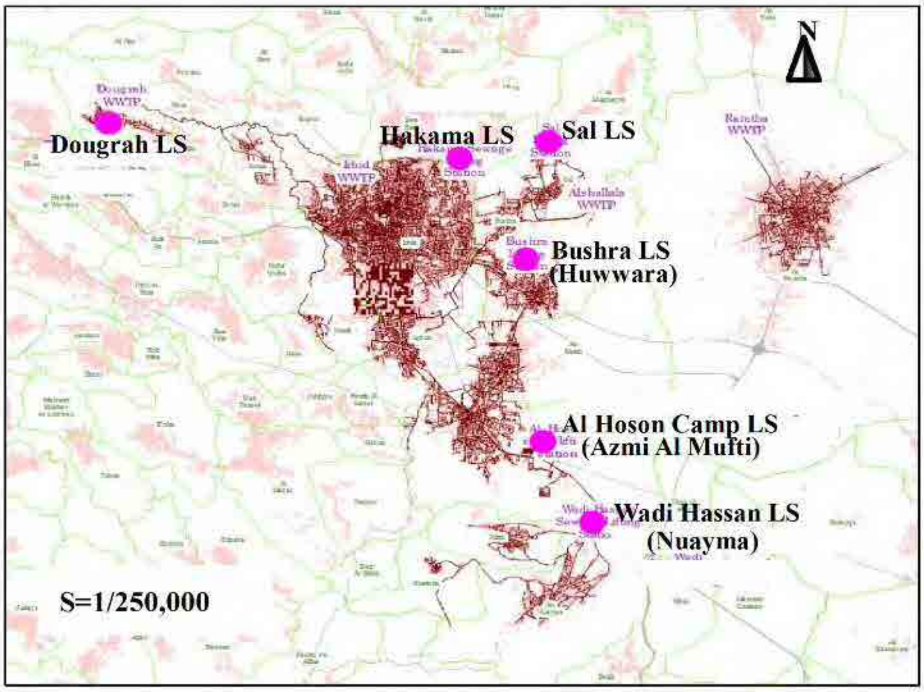


Figure 3.6 Location of Existing Lift Stations in Irbid and its Suburbs

(3) WWTP

There are four WWTPs in Irbid and its suburban areas. General information on the four WWTPs is summarized in Table 3.10 and their locations are shown in Figure 3.7.

The Central Irbid WWTP was the first to be constructed in Irbid City and has been operating for about 30 years since 1987. The Wadi Al-Arab WWTP at the bottom of the valley in the north western part of Irbid, has been in operation since 1999. The Wadi Hassan WWTP has been in operation since 2001 treating the wastewater generated in the “Al Huson” Palestinian refugee camp . The Shallala WWTP was put in operation in 2012 to cope with the further population increase and to reuse treated waste water more efficiently.

Table 3.10 Existing WWTPs in Irbid and its Suburbs

WWTP	Wastewater Treatment Method	Design Capacity	First Operation	Improvement Project	Improved Design Capacity
Central Irbid	Trickling Filter + Activated Sludge Process	6,000 m^3/d (assumed)	1987	Modify the treatment process to Oxidation Ditch Process, under construction	11,950 m^3/d (improved)
Wadi Al-Arab	Extended Aeration	20,800 m^3/d	1999	No improvement	20,800 m^3/d
Shallala	Oxidation Ditch	13,700 m^3/d	2012	Expansion (under construction)	13,700 m^3/d
Wadi Hassan	Oxidation Ditch	1,600 m^3/d	2001	No improvement	1,600 m^3/d

Source: JICA Study Team

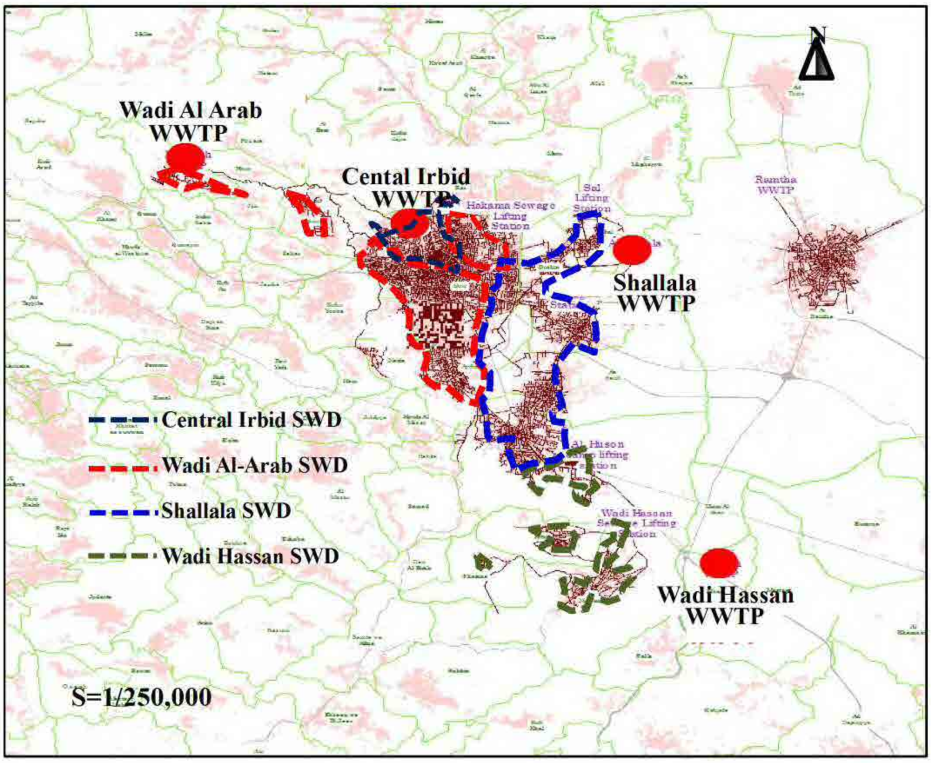


Figure 3.7 Locations of Existing WWTPs in Irbid

3.2.2 Ramtha

(1) Sewers

Total length of sewers in Ramtha is about 194 km. Table 3.11 shows the breakdown by pipe diameter. About 14 km or 7% of the total length have diameters of more than 300 mm. The remaining 93 % are made up of smaller pipes of 200 mm in diameter. All wastewater generated is conveyed by gravity.

Table 3.11 Existing Sewers in Ramtha

Branch Sewer	Trunk Sewer							Total
200 mm	300 mm	400 mm	500 mm	600 mm	700 mm	800 mm	Subtotal	
180.0 km	3.8 km	5.0 km	0.4 km	1.5 km	0.0 km	3.3 km	14.0 km	194.0 km

Source: JICA Study Team

(2) WWTP

The wastewater generated in Ramtha City is treated at the Ramtha WWTP located at the northern part of the city as shown in Figure 3.8. General information on the Ramtha WWTP is shown in Table 3.12.

Table 3.12 General Information on Ramtha WWTP

Wastewater Treatment Method	Design Capacity	First Operation	Improvement Project	Improved Design Capacity
Stabilization Pond	2,700 m^3/d (assumed)	1987	Modified to Activated Sludge Process in 2005	5,400 m^3/day

Source: JICA Study Team

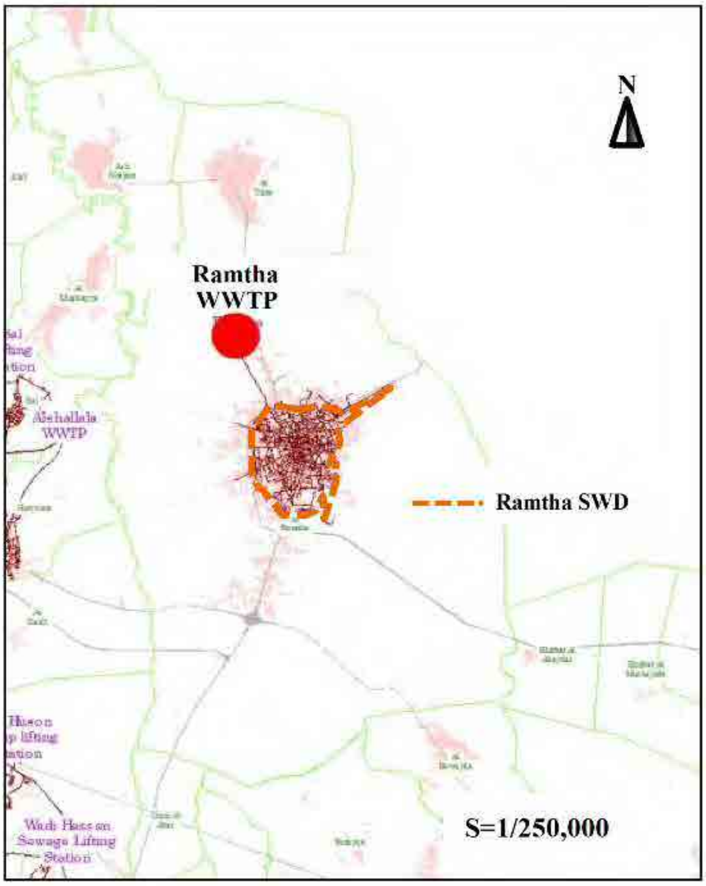


Figure 3.8 Location of the Ramtha WWTP

The Ramtha WWTP started its operation in 1987 at the same time as the Central Irbid WWTP. The treatment facilities were improved in 2005 to expand the sewerage services to meet the demands of the growing population and to distribute the treated wastewater for irrigation on the neighboring farm lands.

3.2.3 Mafraq

(1) Sewers
Table 3.13 shows the 152 km of sewers in Mafraq, of which 17 km (11%) are trunk sewers and the rest are 200 mm diameter branch sewers. All wastewater is conveyed by gravity.

Table 3.13 Existing Sewers in Mafraq

Branch Sewer	Trunk Sewer							Total
200 mm	300 mm	400 mm	500 mm	600 mm	700 mm	800 mm	Subtotal	
135.0 km	6.8 km	2.8 km	0.2 km	1.3 km	0.0 km	5.9 km	16.9 km	151.9 km

Source: JICA Study Team

(2) WWTP
Mafraq WWTP is located at the northern part of the city as shown in Figure 3.9. The outline of Mafraq WWTP is shown in Table 3.14.

The Mafraq WWTP was commissioned in 1988, one year after the commissioning of the Central Irbid WWTP and Ramtha WWTP. Improvements to the treatment facilities started in 2012 to expand the sewerage services and to promote the efficient reuse of treated wastewater for irrigation.

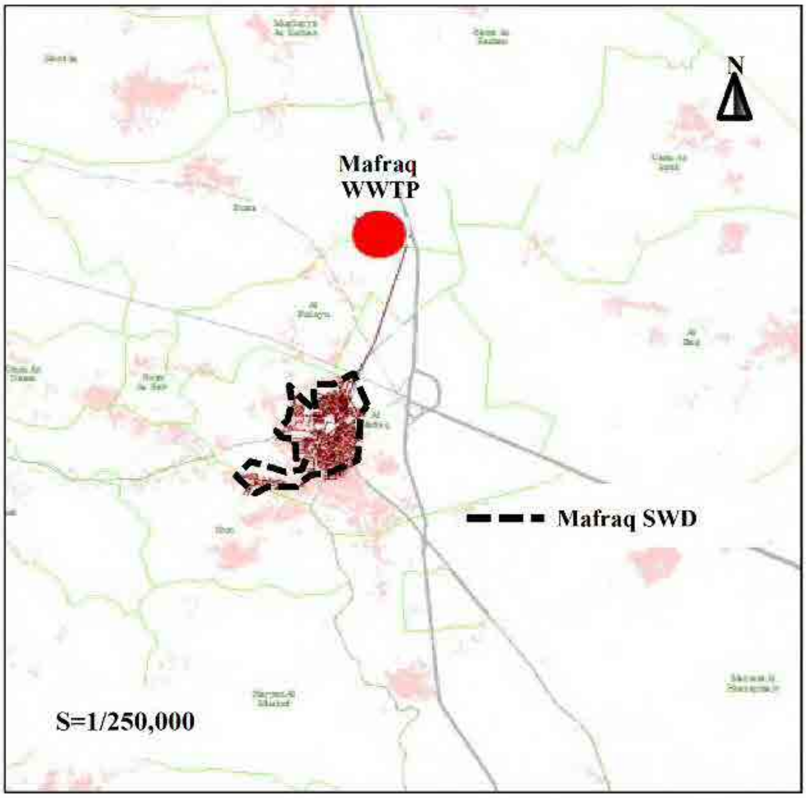


Figure 3.9 Location of the Mafraq WWTP

Table 3.14 Outline of the Mafraq WWTP

Wastewater Treatment Method	Original Design Capacity	First Operation	Improvement Project	Improved Design Capacity
Stabilization Pond	1,800 m^3/d	1988	Modify the treatment process to Activated Sludge Process and improve the treatment capacity. The project is on-going.	3,250 m^3/d, but after 2015 6,550 m^3/d

Source: JICA Study Team

3.3 Existing Plans and On-going Projects

3.3.1 Existing Plans

(1) Strategic Wastewater Master Plan, October 2013

The "Strategic Wastewater Master Plan (SWMP), October 2013" was prepared by Institutional Support and Strengthening Program (ISSP) supported by USAID at the request of the Minister of Water and Irrigation. SWWP identified localities having a population greater than five thousand, set three levels of priorities as summarized below and prepared the investment plan for the prioritized sewerage systems. The required investment for the implementation of the prioritized sewerage schemes are estimated by the unit cost for sewerage development per capita multiplied by the number of beneficiaries. The design of the sewerage facilities were not prepared under the SWMP.

Priority I Immediate: 2013 to 2015
- Existing sewers and WWTP that are overloaded, and need rehabilitation and expansion immediately.
- Localities with no sewer network and serious sanitation problems.

Priority II Short Term: 2016 to 2025
- Not overloaded but reaching design capacity of WWTP.
- The localities with no existing sewerage system to protect groundwater or water spring sources which are major drinking water sources in the area.

Priority III Long Term: 2026 to 2035
- Localities greater than 5,000 people with no sewerage system. (Non-sewered area but not categorized as Priority I and II)
- Expansion of WWTP needed to serve the future population beyond the 2025.

(2) National Resilience Plan 2014–2016, Final Draft

The National Resilience Plan (NRP) is a three year program of high priority investments by the Government of Jordan in response to the impact of the Syrian crisis on the Kingdom of Jordan. Now in its fourth year, the crisis in Syria continues to adversely impact Jordan in a variety of ways. The NRP represents an attempt by the GOJ to take initial stock of its consequences in the primary sectors, locations and communities most affected. In doing so the GOJ has reached out to its national, regional and international partners for assistance, both in the preparation, as well as in the financing and implementation of the NRP. This plan will help mitigate the potentially destabilizing political, demographic, social, economic, and fiscal effects of the crisis. The overall sector objective and specific objectives are shown below.

Overall Sector Objective:	To enhance the capacity of the Government of Jordan, particularly the host communities to meet the increase in demand in water and sanitation services.
Specific Objective 1:	Improving the quantity, quality and efficiency of safe drinking water and delivery of the same.
Specific Objective 2:	Expanding and improving sanitation services.
Specific Objective 3:	Addressing cross cutting water and sanitation issues.

The total cost of response interventions contained within the NRP is about US$2.48 billion. Critical investment area includes the Water & Sanitation (WASH) sector, with a cost of US$670.8 million. The complete budget breakdown of annual sector requirements is illustrated in Table 3.15 below. A list of the projects related to water supply in the northern governorates is presented in Table 3.15.

Table 3.15 Water and Sanitation Sector Projects in National Resilience Plan

(USD)

Water and Sanitation	2014	2015	2016	All Years
Specific Objective 1: To enhance the GOJ water and sanitation management and implementation capacity				
Project Summary 1.1: Establishment of YWC implementation capacity (IMU)	2,100,000	2,520,000	2,520,000	7,140,000
Project Summary 1.5: Performance-based contracting NRW reduction in Mafraq & Zarqa city	1,400,000	4,200,000	4,200,000	9,800,000
Specific Objective 2: Improving the quantity, quality and efficiency of water and its delivery				
Project Summary2.1: Rehabilitation of wells in different governorates (Irbid, Jerash, Ajloun, Mafraq, Amman, Zarqa, Madaba, Balqa)	8,400,000	8,400,000	-	16,800,000
Project Summary2.2: Restructuring the YWC main transmission/ distribution systems & network reinforcement (Irbid, Jerash, Ajloun, Mafraq, Balqa)	14,000,000	49,000,000	35,000,000	98,000,000
Project Summary 2.3: Water network rehabilitation & reinforcement in Mafraq city	5,000,000	7,000,000		12,000,000
Project Summary2.6: Supply of materials & equipment to YWC	8,568,000	-	-	8,568,000
Total	39,468,000	71,120,000	41,720,000	152,308,000

Note: Only projects related to water supply in the northern governorates is extracted from the original list.

(3) Sewerage Plans not yet implemented

Table 3.16 summarizes the list of plans have yet to be implemented as of May 2014.

Table 3.16 Sewerage Plans to be Implemented (as of May 2014)

Plan	The First Package: Sewerage Systems for the Manshyet Bani Hassan	The Second Package: Sewerage Systems for the Different Area in Mafraq	Sewerage Systems for the Bait-Ras
Governorate	Mafraq	Mafraq	Irbid
Project Cost	6.200 Mil. JD (about 8.8 Mil USD)	5.600 Mil. JD (about7.9 Mil. USD)	not available
Project Area	Bani Hassan, 5 km West of Mafraq City	South Western Part of Mafraq City	Bait-Ras area, northern part of Irbid city
Project Component	Lift station, trunk sewers, and branch sewers	Lift station, trunk sewers, and branch sewers	Branch sewers

Source: WAJ

3.3.2 On-going Projects

(1) On-going Projects

Table 3.17 shows the major on-going projects as of May 2014.

Table 3.17 Major On-going Sewerage Projects (as of May 2014)

Project	Shallala Wastewater Treatment Plant Construction	Mafraq Wastewater Treatment Plant Construction
Governorate	Irbid	Mafraq
Total Cost	51.340 Mil. JD	16.547 Mil JD
Financial Source	KfW Loan + Self Budget	USAID Loan + Self Budget
Project Place	South Eastern Part of Irbid City, Shallala WWTP	Mafraq WWTP
Project Component	1) Expansion of WWTP 2) Expansion of Trunk Sewers 3) Expansion of Branch Sewers to Hawara area	Expansion and Improvement of WWTP
Progress	1) WWTP: 100% 2) Trunk sewers: 100% 3) Branch sewers: 100% 4) Under completion procedures	WWTP: 65%

Source: WAJ

The treatment process at Mafraq WWTP is being upgraded using USAID funding, based on the plan "Upgrade of Mafraq Wastewater Treatment Plant, September 2012". The existing system (anaerobic pond, facultative pond and polishing pond) is being replaced by an advanced treatment system of nitrification and denitrification tank, aerated lagoon, facultative pond, sand filter, and reed bed. Half of the facilities at Mafraq WWTP have already been commissioned and the remaining half is under construction.

Constructed Primary Sedimentation Tank

Constructed Aerated Lagoon

Operating Aerated Lagoon

Constructing Aerated Lagoon (Excavating)

Figure 3.10 Upgraded and Constructing Facilities at Mafraq WWTP

(2) Other Improvement Projects for WWTPs

The on-going projects for improving the WWTPs are summarized as follows:

1) Central Irbid WWTP in Irbid Governorate

The existing wastewater treatment processes (trickling filter and conventional activated sludge process with aeration tank and final sedimentation tank) are not working effectively. They are being replaced with an oxidation ditch process using KfW financing.

Construction of Reactor for Oxidation Ditch

Construction of Sedimentation Tank

Figure3.11 Rehabilitation Financed by KfW at Central Irbid WWTP

2) Wadi Al-Arab WWTP in Irbid Governorate

KfW financing is used to install the sludge dewatering facilities and construct the building housing the facilities. The building construction is completed but the mechanical and electrical dewatering equipment has not been installed yet.

A study on the introduction of advanced treatment using sand filter and UV disinfection is just underway. The target water quality with the advanced treatment is not yet available.

3.4 Operation and Maintenance

3.4.1 YWC Organization

(1) Background

The “Al Yarmouk Water Company (YWC)” is the legal successor to the Northern Governorates Water Administration (NGWA), which is responsible for providing water supply and sewerage services in the Irbid, Jerash, Ajloun and Mafraq governorates. YWC is a limited liability company (LLC) registered in 1997. It is an independent government company fully owned by WAJ.

YWC provides water supply and sewerage services based on the assignment agreement between YWC and WAJ, by which the ownership of all assets was transferred from WAJ to YWC.

(2) Management by Contractor

1) Management contract

PMU of WAJ and YWC employed a service provider for providing management, operation and maintenance services related to the water and wastewater infrastructure through open competition in September 2010. PMU assigned Veolia Water MENA/ Aqua Treat to this task for five years starting September 2011.

2) Goals of the management contract

The major goals of the contract were as follows:

- To improve the water and wastewater services to customers in the northern governorates;
- To improve the financial position of YWC by realizing cost efficiency and by improving revenue management;
- To establish the foundation for sustainable operations, business effectiveness and efficiency for YWC; and
- To reduce the amount of water lost or unaccounted for by reducing leakage and unauthorized connections to the facilities.

The contract, however, was terminated in June 2013; hence the management provider was employed for less than 2 years. Organizational restructuring by the Veolia Water MENA/ Aqua Treat (the

Management Contractor) during the time of the Management Contract was deadlocked presumably due to sensitive labor relations, influence of the clan system, requests for early retirement, deposition and transfer, and strong labor union. Hence, organizational restructuring has become sensitive although the current organizational restructuring by the General Manager has made gradual progress.

(3) Organization Structure of the YWC

Since the termination of management contract, the operation and management of the waterworks of YWC have been taken over by General Manager of YWC.

1) Staffing

According to the cost center database, the total number of employees is 1,649 as of September 2014. This number indicates that the downsizing of employee made a progress from 1,740 in 2012. The current level of staffing for water and wastewater services is better than the 8.7 average of 3 utilities in Jordan, such as Aqaba Water Company, Water Authority Balqa and Zarqa, Madaba and Karak, Maan and Tafila, and Jordan Water Company Miyahuna. It is similar to other upper-middle income countries (5.2 – 6.2) according to IBNET database.

Forty-five (45) employees are directly hired by the YWC, and others are transferred from WAJ to YWC; they are entitled to government retirement benefits. Nearly one-fourth of the total staff members are engaged in customer service activities. Most of these staff members are operators at the Call Center and account for a relatively large part unlike the typical staff composition of a water and wastewater utility.

The number of employees as of October 2014 based on information from the Cost Center is shown in Table 3.18. Staffing productivity per connection is shown in Table 3.19.

Table3.18 Staff composition of YWC by Cost Center

Governorate	ROU or Area	Total	Water	Wastewater	Support Service	Customer Service
Irbid	Head Office	253			224	29
	Irbid	318	110	92	23	93
	Bani Obaid	93	21	25	11	36
	Bani Kinana	70	36		10	24
	Al Koura	55	26		11	16
	North Shouna	122	78		20	24
	Ramtha	101	28	32	19	22
	Wadi Shalala*	10		10		
	Za'atary*	15	15			
Ajloun	Ajloun	158	74	19	20	45
Jerash	Jerash	163	43	26	49	45
Mafraq	Mafraq	204	97	20	39	48
	North Badia	87	59		12	16
Total		1,649	587	224	438	398

Note: * They are not ROU but facility office.

Source: YWC

Table3.19　Staff Numbers and Staffing Productivity per Connection (2006-2014)

	2006	2007	2008	2012	2013	2014
Total staff	1,761	1,801	1,673	1,740	1,671	1,649
Staff number W&WW/ W&WW 1,000 conn.	7.3	7.2	6.4	6.6	6.1	6.0

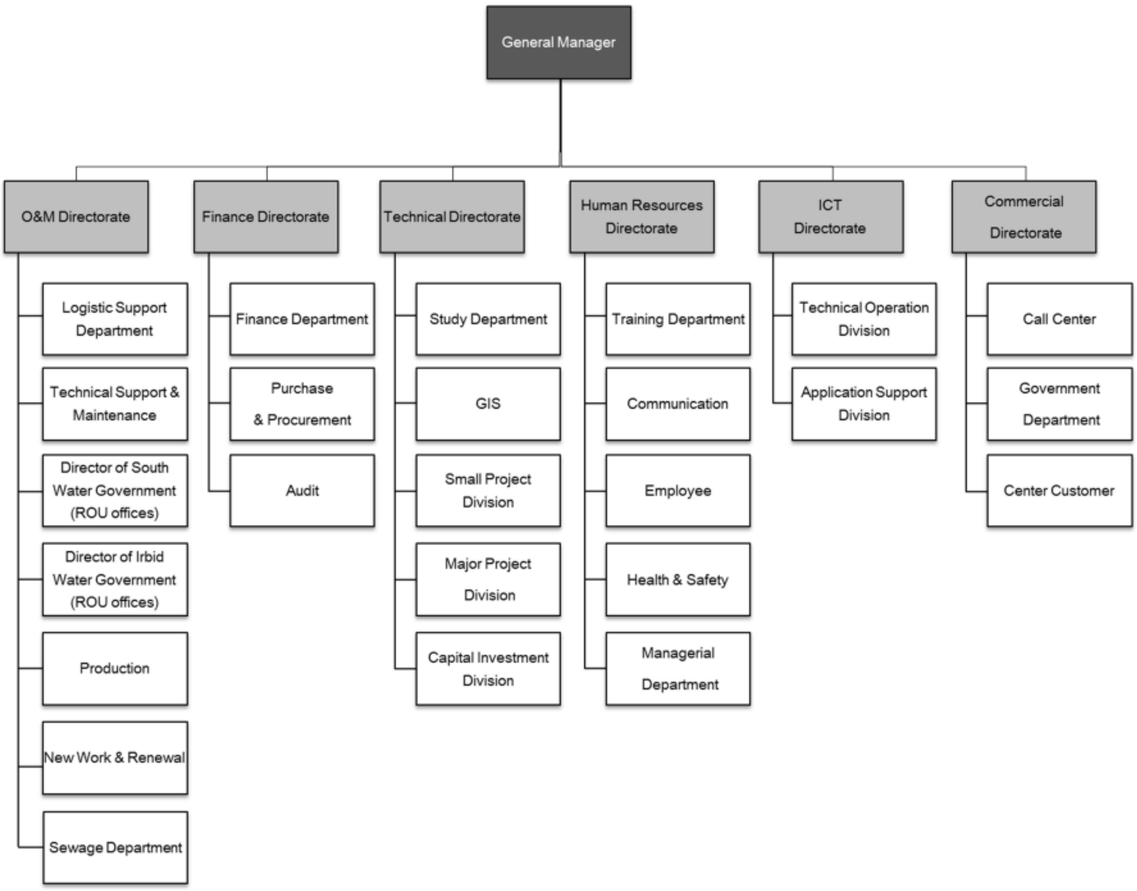
Note:
1. Data source: 2006-2008 Management Contract for YWC LLC, 2012-2014 YWC Technical Directorate
2. Data from 2009-2011 are not available
Source: JICA Study Team

2) Organization Chart

After the Management Contractor left, the organization structure was reviewed by the General Manager. The new organization structure, however, has not yet been finalized as of September 2014, presumably due to the sensitive labor issues. Hence, the current organization structure was envisaged by the JICA Study Team through interviews and observations, as shown in Figure 3.12. It should be noted that this organization structure is different from the aforementioned classification by the Cost Center, which aims for cost control.

3) Directorate and its Functions

The YWC encompasses six directorates: O&M, Finance, Technical, Human Resources, Information Communication Technology (ICT), and Commercial. The major functions of the various directorates of YWC are summarized in Table 3.20.



Source: JICA Study Team

Figure3.12　Organization Chart (YWC)

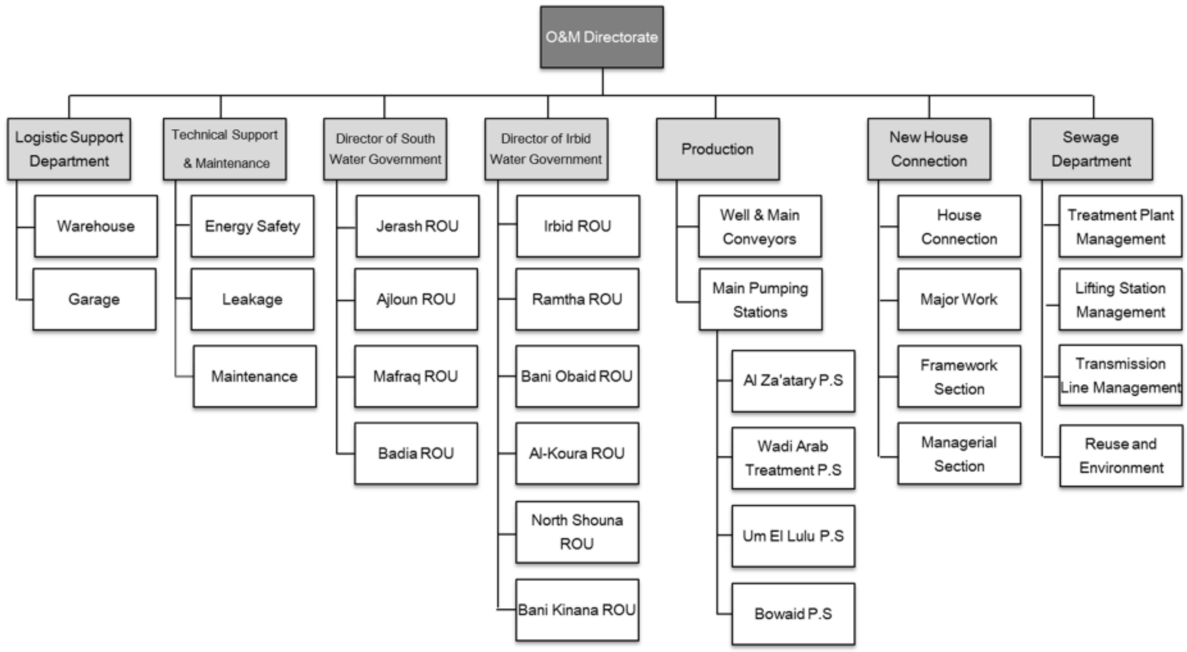
Table1 3.20 Activities of Directorates of the YWC

Directorate	Major activity
O&M Directorate	• O&M of plant, network pipeline, pumping station and other water and wastewater facilities ➢ Water production ➢ New connection ➢ Technical support service ➢ Logistic support and stock management
Finance Directorate	• Overall financial management (budget, income, expense, tax, salary, audit, etc.) • Planning and implementing cost reduction measures
Technical Directorate	• GIS database cleansing and updating • Management of capital investment • Preparation of contract and specification • Project planning and management
Human Resource Directorate	• Optimal human resource management • Management of payroll, staff allocation, personnel information, recruitment • Planning and implementing staff training
ICT Directorate	• Introduction and maintenance of ICT including both software and hardware
Commercial Directorate	• Billing and revenue collection management • Meter reading • Handling customer inquiries and complaints through the Call Center

Source: YWC

4) O&M Directorate

The O&M Directorate is one of the six directorates directly managed by the General Manager. It is a key directorate responsible for the daily operation and maintenance of water and wastewater facilities, such as intake wells, pumping station, water treatment plant, house connection, wastewater treatment plant, pumping station, pipeline and sewer networks, etc. Network operation and maintenance are under the responsibility of ROUs located in the ten regional areas of the northern governorates. The organization chart of O&M directorate is shown in Figure 3.13.



Source: JICA Study Team

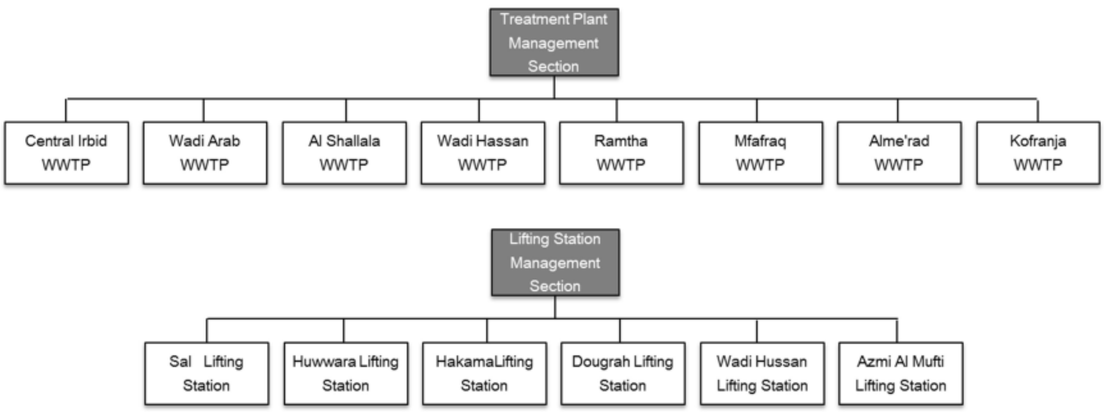
Figure 3.13 Organization Chart (O&M Directorate)

5) Sewerage Department

The Sewerage Department manages the wastewater facilities and consists of the following 4 sections.

- Treatment Plant Management
- Lift Station Management
- Transmission Line Management
- Reuse and Environment

The organization chart of the Treatment Plant Management Section and Lift Station Management Section are shown in the following figure.



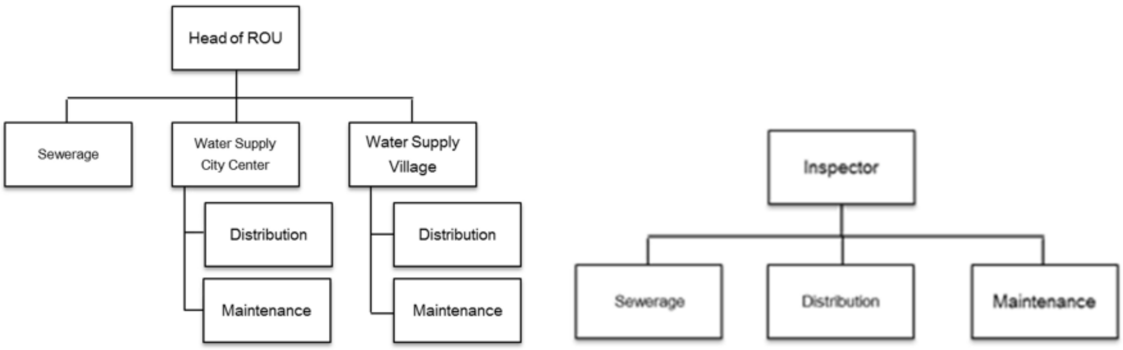
Source: JICA Study Team based on the information from YWC

Figure 3.14 Organization Charts - Treatment plant Management Section and Lift Station Management Section

6) Regional Operation Units (ROUs)

ROUs belong to the O&M Directorate, and are geographically divided into 2 groups: Irbid Water Governorate and South Water Governorates. The Irbid Water Governorate covers the Irbid center and the surrounding areas of the Irbid Governorate, and the South Water Governorates covers the remaining governorates of Jerash, Ajloun, Mafraq and Za'atary.

The organization structure of the ROU office can be categorized into two types: large scale and small scale. A large city such as Irbid City or Mafraq city has two separate sections for water supply: city center and village. There is no sewerage section if a sewerage system is not established in the area, such as Bani Kinana. The typical organization chart is shown in Figure 3.15.



Source: JICA Study Team based on the information from YWC

Figure 3.15 Typical Organization Chart (ROU) – Large Scale (Left), Small Scale (Right)

7) Sewerage Section

The sewerage section is in charge of sewer maintenance. These are established for each wastewater treatment area. For instance, Irbid ROU covers the northern area of Irbid city, and Beni Obeid ROU covers Sal, Bushra, Huwwara, a part of Zubda, Al Husn, Aydon, Al Sarih and East Irbid.

In the Irbid ROU, there are 6 cleaning teams for sewers and 1 cleaning and maintenance team for sewers and manholes. The cleaning teams are responsible for cleaning sewers to prevent sewer blockage and flooding, operates in 3 shifts on a 24 hours schedule. High pressure jet trucks are utilized for the cleaning. The maintenance team is responsible for finding the manholes which are paved over by road constructions, for leveling the manholes to the same level at pavement as well as cleaning.
The staff composition of the sewerage section for each ROU is shown as the following Table.

Table 3.21 Staff Composition of Sewerage Section in Irbid ROU

	Irbid ROU	Beni beid ROU	Ramtha ROU	Ajloun ROU	Jerash ROU	Mafraq ROU
Position	Number					
Head	1	1	1	1	1	1
Chief	1	1	1	1	1	1
Cleaning team of sewer (6 teams)						
Worker	12	4	4	2	2	4
Driver	6	2	2	1	1	2
Repair and cleaning team of sewer and manhole (1 team)						
Worker	2					
Driver	1					
Total	23	8	8	7	7	7

Source: JICA Survey Team based on the information from YWC

8) Management of Sewer Networks

The management of the sewer networks is primarily done by each ROU. The cleaning of sewer networks is implemented by using high pressure jet tank. The ROU also responds to residents' complaints on sewer blockages.

9) Management of WWTPs and Lifting Stations

The management system for WWTPs and lifting stations are shown in the following Table.

Table 3.22 The management system for WWTP and Lifting Stations (LS)

Governorate	WWTP/ Lifting Station	Staff Number	Management Type
Irbid	Central Irbid WWTP	22, 4 shifts	Residential
	Wadi Arab WWTP	21, 4 shifts	Residential
	Shallala WWTP	21, 4 shifts	Residential
	Wadi Hassan WWTP	12, 4 shifts	Residential
	Sal LS	14, 4 shifts	Residential
	Bushla LS	10, 4 shifts	Residential
	Hakama LS	4, 4 shifts	Residential
	Daugrah LS	4, 4 shifts	Residential
	Wadi Hassan LS	4, 4 shifts	Residential
	Al Hoson Camp LS	4, 4 shifts	Residential
Ramtha	Ramtha WWTP	15, 4 shifts	Residential
Mafraq	Mafraq WWTP	16, 4 shifts	Residential

Source: JICA Survey Team

The WWTPs are generally managed by a team of operators on a 24 hours-basis. The lift station is managed by one or two operator/s on a 24 hours-basis. Pumps are managed by an automated operation system sensitive to the wastewater level of the pump wells. The alarm is activated when a problem occurs.

10) Management of Wastewater Quality

The wastewater samples are taken by each WWTP and PS, and the wastewater quality tests are done by the laboratory at the Wadi Hassan WWTP. The results of both wastewater and water are collected and managed by the water quality section of the Central Irbid WWTP, which has one Section Head and 14 staff.

3.4.2 Financial Conditions

Water and wastewater services providers in Jordan were not financially independent organizations because of its public objective. However, the corporatization and privatization of the providers in recent years compelled them to adopt the corporate accounting system that conforms to international financial reporting standards. As a result, financial statements are now prepared by the providers, the so called “Water Company.”

(1) Water Tariff

The tariff structure is described in Table 3.23 and 3.24. Billing is quarterly, that is, four times a year.

Table3.23 Residential tariff structure

Consumption Block (m^3)	Water rate (JD)	Sewerage rate (JD)	Additional fixed charge (JD)
0-18	2.13 (fixed)	0.6 (fixed)	2.43
- 36	$0.145/m^3$	$0.040/m^3$	1.65
- 54	$0.500/m^3$	$0.250/m^3$	1.65
- 72	$0.935/m^3$	$0.495/m^3$	0.00
- 90	$1.150/m^3$	$0.690/m^3$	0.00
- 126	$1.610/m^3$	$0.805/m^3$	0.00
Above 126	$1.920/m^3$	$0.960/m^3$	0.00

The non-residential tariff structure is as follows.

Table 3.24 Non-residential tariff structure

Water rate (JD)	Sewerage rate (JD)	Additional fixed charge (JD)
$1.00/m^3$	$0.50/m^3$	2.00

(2) WAJ’s Financial Status

The WAJ prepares consolidated financial statements[3], which are consolidated statements of these four affiliated water companies. The consolidated financial statements of the WAJ indicate the severe financial situation of the WAJ.

1) Profit and Loss

Table 3.25 shows the consolidated profit and loss statement of the WAJ in 2011 and 2012. The

[3] Companies to be consolidated: Jordan Water Company – Miyahuna (JWCM), Aqaba Water Company (AWC), Yarmouk Water Company (YWC), Red Sea Water Company (RSWC).

operating revenues increased by 5%, but could not cover the total operating expenses. A huge loss was recorded because of the high non-operating expenses mostly composed of interest expenses for the loans. The operating expenses were 1.5 times more than the operating revenues; personnel expenses (20%), electricity expenses (28%) and depreciation expenses (31%) are the three major expenses and constitute 80% of the total expenses[4].

2) Assets, Liabilities and Equities

Table 3.26 presents the consolidated balance sheet of the WAJ. The total capital used in the year 2012 was 1.7 billion JD on average. The current ratio (current assets/current liabilities) was only 32%, which is extremely low, and indicates the tight short-term finances of the WAJ. On the other hand, the fixed assets ratio (fixed assets/net worth) was 230%, which reveals that the procurement of fixed assets largely depended on external finances such as foreign loans.

Most of the account receivables for the year 2012 were outstanding unpaid amounts of subscribers (70 million JD), which represents the amount after the write-off of long-term doubtful receivables (50 million JD).

The account payables turnover period is 155 days, which is too long a period compared to 90 days regarded as a sound period in general. Most of the account payables consisted of unpaid expenses, which soared in 2012.

The financial position of the WAJ is propped up by loans from international donors (8 donors, 14 to 40 years of loan period, 0.2% to 5.78% of interest rate), issue of corporate bonds (amortization in 2015, 4 to 8% of coupon rate) and MOF financial support.

[4] Water expenses in Japan：personnel 4.5%, electricity 3.3%, depreciation 9.4% (Japan Water Works Associations: Water Statistics Handbook, 2011)

Table3.25 Consolidated Profit and Loss Statement of WAJ (JD in thousands)

Account Items			2011	2012	2011-12 Average	2011-12 Constitution
Operating	Revenues	Water	112,618	115,177	113,898	66%
		Sewerage and Drainage	39,134	43,678	41,406	24%
		Other Revenues	18,005	18,579	18,292	10%
		Total	169,757	177,434	173,596	100%
	Expenses	Procurement of Water	15,572	20,422	17,998	7%
		Personnel	49,238	55,143	52,191	20%
		Electricity	62,293	81,800	72,047	28%
		Depreciation	78,663	80,013	79,338	31%
		Write-off of receivables	5,598	3,819	4,709	2%
		Other Expenses	29,001	29,767	29,385	11%
		Total	240,365	270,964	255,668	100%
	Operating Profit and Loss (-)		-70,608	-93,530	-82,072	-
Non-operating	Revenues	Foreign Exchange Gains	4,881	-	-	-
		Other Revenues	9,638	6,547	-	-
		Total	14,519	6,547	-	-
	Expenses	Financial Expenses	30,480	35,559	-	-
		Foreign Exchange Loss	-	3,527	-	-
		Other Expenses	3,622	8,092	-	-
		Total	34,102	47,178	-	-
	Non-operating Profit and Loss (-)		-19,583	-40,631	-	-
Profit and Loss (-) of the Year before Tax			-90,191	-134,161	-	-
Tax			318	186	-	-
Net Profit and Loss (1) of the Year			-90,509	-134,347	-	-

Table3.26 Consolidated Balance Sheet of WAJ (JD in thousands)

Account Items			2011	2012
Assets	Current Assets	Cash and the Equivalent	17,557	13,976
		Account Receivables	74,872	90,259
		Other Current Assets	68,879	51,556
		Total	161,308	155,791
	Net Fixed Assets		1,506,217	1,556,359
	Total		1,667,525	1,712,150
Liabilities	Current Liabilities	Account Payables	38,551	64,753
		MOF Advancing Support	-	129,942
		External Loans (Due within 1 year)	19,934	21,196
		Corporate Bonds (Due within 1 year)	138,500	248,980
		Bank Overdraft Account	41,356	70,114
		Other Current Liabilities	52,198	34,804
		Total	290,539	569,798
	Fixed Liabilities	External Loans	213,718	233,984
		Corporate Bonds	392,980	220,000
		Other Fixed Liabilities	47,703	47,216
		Total	654,401	501,200
	Total		844,940	1,070,998
Equities	Own Equity	Paid-in Capital	2,004,697	2,056,936
		Reserves	5,495	6,139
		Accumulated Profit & Loss(-)	-1,293,360	-1,427,895
		Total	716,832	635,180
	Minority Shareholders' Interests		5,753	6,026
	Total		722,585	641,206
Total of Liabilities and Equities			1,667,525	1,712,204

Source of both Tables: Summarized by the JICA Study Team based on the Statements of WAJ

3) Cash Flow

Table 3.27 shows the cash flow (CF) statement of the WAJ. The statement clearly reveals that the capital investment of the WAJ is not covered by the operating net CF but with the financial net CF such as paid-in capital, loans and MOF support. CF at the end of 2012 was 35 million JD, which was only 6% of the current liabilities. A company is generally regarded to be solvent if this percentage is greater than 100. In this sense, the solvency of the WAJ is considered extremely low.

Table3.27 Consolidated Cash Flow (CF) Statement of WAJ (JD in thousands)

CF Items		2011	2012
CF from Operating Activities	Net Profit	-90,071	-133,745
	Depreciation	78,663	80,013
	Others	-6,202	-608
	Net CF	-17,610	-54,340
CF from Investment Activities	Additional Assets	142,579	129,927
	Additional Investment to DWCP	5,084	2,558
	Net CF	147,663	132,485
CF from Financial Activities	Paid-in Capital	29,019	52,228
	MOF Advancing Support	-	129,942
	External Loans	5,278	18,001
	Corporate Bonds	95,500	-62,500
	Bank Overdraft Account, etc.	9,158	27,679
	Net CF	138,955	165,350
Net CF Changes of the year		-26,318	-21,475
CF at the beginning of the Year		83,039	56,721
CF at the end of the Year		56,721	35,245

Source: Summarized by the JICA Study Team based on the Statements of WAJ

3.4.3 YWC's Financial Status

The financial statements of the YWC also show the severe financial situation of the company.

(1) Profit and Loss

Table 3.28 presents the profit and loss statement of the YWC. The table shows that the operating revenues could not cover the operating expenses, and the YWC as well as the WAJ, recorded losses for three consecutive years. Therefore, adequate tariff setting and reduction in operating expenses are expected to be studied and analyzed. The operating expenses were 1.6 times more than the operating revenues; personnel expenses (26%), electricity expenses (33%) and depreciation expenses (10%) were the three major expenses and constituted 70% of total expenses. The unit cost of supplied water[5] is estimated as lying between 0.9 and 1.0 JD/m^3 in 2012, including indirect costs such as administrative and other miscellaneous costs.

(2) Assets, Liabilities and Equities

Table 3.29 shows the balance sheet of the YWC. The current ratio (current assets/current liabilities)

5 Water actually billed to the customers by the YWC.

was 110%, higher than 32% of the WAJ, but still lower than 200% which is generally regarded as a sound level. On the other hand, the ratio of fixed assets to long-term capital (fixed assets / (net worth + fixed liabilities)) was 97%, which is generally sound because fixed assets were appropriated mostly with long-term finances.

The account receivables in 2012 were 16 million JD as shown in Table 3.35. However, the total unpaid amount before the write-off was 29 million JD (amount unpaid over the half year was 20 million JD), which exceeded the operating revenue of 28 million JD in 2012. This stagnant amount of sales receivables compelled the YWC to raise loans of 10 million JD from the Housing Bank (5 years, 8.5% of interest) for securing working capital. The account payables turnover period was 205 days, which is greater than 155 days for the WAJ.

Table3.28 Profit and Loss Statement of YWC (JD in thousands)

Account Items		2010	2011	2012	2010-12	
					Average	Percentage
Revenues	Water Sales	13,127	19,745	20,284	17,719	73%
	Sewerage & Drainage Fees	1,196	2,170	2,213	1,860	8%
	Other Revenues	3,490	5,022	5,547	4,686	19%
	Total	17,813	26,937	28,044	24,265	100%
Expenses	Salary & Wages	7,773	9,882	11,766	9,807	26%
	Electricity	10,204	12,428	15,582	12,738	33%
	Fuels	1,424	1,407	1,210	1,347	4%
	Repair & maintenance	2,452	2,556	1,658	2,222	6%
	Water Purchase from Private Wells	1,476	2,961	3,408	2,615	6%
	Chemicals	227	312	252	264	1%
	Administration	675	762	704	714	2%
	Management Contract	-	909	1,451	787	2%
	Depreciation	3,288	3,392	4,842	3,841	10%
	Provision of Doubtful Receivables	-	2,228	2,820	1,683	4%
	Other Expenses	1,947	2,012	2,832	2,264	6%
	Total	29,466	38,849	46,525	38,282	100%
Profit & Loss (-) of the Year		-11,653	-11,912	-18,481	-	-

Source: Summarized by the JICA Study Team based on the Statements of YWC

(3) Cash Flow

Table 3.30 shows the cash flow of the YWC. The negative net operating CF as well as the capital investment was appropriated with bank loan and the WAJ credit for paid-in capital.

The CF at the end of 2012 was 3.9 million JD, which was only 20% of the current liabilities. In this sense, the solvency capacity of YWC as well as WAJ is considered extremely low.

Table3.29 Balance Sheet of YWC (JD in thousands)

Account Items			2010	2011	2012
Assets	Current Assets	Cash and the equivalent	3,776	1,126	3,984
		Account Receivables	10,767	14,156	16,337
		Inventories	2,215	3,087	3,083
		Total	16,758	18,369	23,404
	Fixed Assets	Net Fixed Assets	37,644	64,172	65,407
		Under Construction	33,244	17,534	18,224
		Total	70,888	81,706	83,631
	Total of Assets		87,646	100,075	107,035
Liabilities	Current Liabilities	Account Payables	4,546	17,906	19,443
		Short-term Loans	-		1,666
		Total	4,546	17,906	21,109
	Fixed Liabilities	WAJ Credit	145,591	156,547	95,594
		Long-term Loans	-	-	8,334
		Total	145,591	156,547	103,928
	Total of Liabilities		150,137	174,453	125,037
Equities	Paid-in Capital		0	25	25
	Accumulated Profit		-62,491	-74,403	-18,027
	Total of Equities		-62,491	-74,378	-18,002
Total of Liabilities and Equities			87,646	100,075	107,035

Source: Summarized by the JICA Study Team based on the Statements of YWC

Table3.30 Cash Flow Statement of YWC (JD in thousands)

CF Items		2010	2011	2012
CF from Operating Activities	Net Profit	-11,653	-11,912	-18,481
	Depreciation	3,288	3,392	4,842
	Others	-7,620	9,101	681
	Net CF	-15,985	581	-12,958
CF from Investment Activities	Additional Assets	8,064	7,939	5,128
	Additional Assets under Construction	5,772	6,273	2,507
	Net CF	13,836	14,212	7,635
CF from Financial Activities	Paid-in Capital	-	25	-
	WAJ Credit	31,949	10,956	13,451
	Loans	-	-	10,000
	Net CF	31,949	10,981	23,451
Net CF Changes of the year		2,128	-2,650	2,858
CF at the beginning of the Year		1,649	3,776	1,126
CF at the end of the Year		3,776	1,126	3,984

Source: Summarized by the JICA Study Team based on the Statements of YWC

3.5 Sewerage Improvement Plan

As shown in Table 3.1 and Table 2.3, all governorates except Jerash have a sewerage service coverage that is lower than the national average, and the governorates of Irbid and Mafrqa receive 95% of Syrian refugees. Based on the current sewerage service coverage and the Syrian refugees number in the four northern governorates, the governorates of Irbid and Mafraq are selected for further study and for preparing sewerage improvement plans.

CHAPTER 4 SEWERAGE PLANNING AND DESIGN BASIS

4.1 Planning and Design Basis

4.1.1 Service Area

The sewerage development plan has been prepared for the areas of Greater Irbid Municipality (GIM), Ramtha District, and Greater Mafraq Municipality. The service area is defined by reviewing the following information:

1) Existing sewerage service area
2) Priority area proposed in SWMP
3) Existing urban plan
4) Influx of Syrian Refugees

4.1.2 Service Population

The sewerage service population is set based on the future population in 2035 for each sewerage district.

4.1.3 Design Flows

Wastewater generation is calculated using the sewerage service population and per capita wastewater generation rate.

(1) Per Capita Water Consumption
According to the water supply plan in the JICA study, the per capita water consumption is set as follows:

Table 4.1 Per Capita Water Consumption used for Wastewater Generation

Item	Urban Area (lpcd)	Rural/Sub-urban areas (lpcd)
1. Basic Water	100.0	80.0
2. Commercial Water	3.0	2.4
3. Industrial Water	5.0	1.6
4. Tourism Water	3.0	0.0
5. Contingency	5.0	4.0
6. Per Capita Water Consumption	116.0	88.0
7. Peak Supply (Peak Factor 17%)	135.7	103.0

Source: JICA Study Team

The water consumption for the sub-urban areas in the sewerage service area is assumed to be the same as the rural areas.

(2) Per Capita Wastewater Generation

The wastewater generation rate is set at 80% of the per capita water consumption rate: that is 92.8 lpcd for the urban area and 70.4 lpcd for rural/sub-urban areas.

(3) Industrial Wastewater

The industrial wastewater is included in the above per capita wastewater generation. The planned industrial wastewater is generated from home industries or small scale industries. It is not planned to receive the wastewater generated from medium and large factories and treat at the municipal wastewater treatment plants, because the effluents of municipal wastewater treatment plant are used for irrigation and other purposes.

(4) Inflow and Infiltration of Groundwater

Groundwater infiltration and surface water inflow are not considered in the Study, because the groundwater level in the study area is low and there is little precipitation.

(5) Design Flows

The design flows for each sewerage district are estimated by multiplying the sewerage service population by the per capita wastewater generation rate.

The average daily flows are used for the management of the operation of the WWTP, including determining the O&M costs and user charge. Yearly, monthly or daily figures are applied for the calculations. The maximum daily flows are used for checking the treatment capacity of facilities such as aeration tanks. The design for pipes and channels at the wastewater treatment facilities is based on the maximum hourly flows. Although the sewers are designed based on maximum hourly flows, the Habit's coefficient is used for the calculation of the designed maximum hourly flows in Jordan.

The following peaking factors in Table 4.2 are used for calculating the design flows.

Table 4.2 Peaking Factors

Factor	Peaking	Remarks
Ratio between maximum daily flow and average daily flow	1.17	Calculated
Ratio between maximum hourly flow and maximum daily flow	1.50	Set
Ratio between maximum hourly flow and average daily flow	1.80	Calculated (1.756) from water supply data

4.1.4 Design Wastewater Quality

(1) Design Influent Quality

The influent qualities in terms of BOD_5 and SS for the design of WWTP are estimated using the unit load of 65 g/capita・day for BOD and 60 g/capita・day for SS. The unit loads cover the pollutant loads of domestic, commercial, industrial (house industry level) wastewater. The BOD unit load is based on the figure provided in the SWMP.

(2) Design Effluent Quality

The design effluent quality is usually set to meet the national or regional effluent quality standards that are specified by the central and/or local environmental agencies. These vary depending on the sensitivity of receiving water bodies or reuse purposes of the treated wastewater.

The effluent standards in Jordan are summarized as follows:

1) Policies and Standards for Wastewater Management in Jordan

Water resources are scarce in Jordan. The national wastewater strategy, in the ”Wastewater Management Policy of 1997” states that “the sewage should not be wasted, it should be used as one of the water resources.”

Under the policy, “Reclaimed Domestic Wastewater Standard No 893/2006” was established to promote the use of reclaimed water. The allowable limits in the standards are specified for the following discharge cases:

A: Discharge to streams, wadis, and reservoirs
Ba: Groundwater recharge
Bb: Irrigation purposes

The allowable limits for irrigation with treated effluent vary depending on the end use of the crop:
Bb-1 - vegetables that will be cooked, parks, playgrounds and side roads in populated areas;
Bb-2 - fruit trees, highway trees and green areas;
Bb-3 - feed crops, industrial crops and forest trees, and flowers.

Tables 4.3, 4.4 and 4.5 show the allowable limits for each type of discharge.

Table 4.3 Allowable Limits for Discharging to Streams, Wadis and Reservoirs (A)

Parameter	Allowable limit
BOD_5 (mg/l)	60
CODcr (mg/l)	150
DO (mg/l)	1
TSS (mg/l)	60
pH	6-9
NO_3-N (mg/l)	70
T-N (mg/l)	80
E. coli (MPN or CFU/100ml)	1,000
Intestinal Helminth Eggs (egg/1)	< or =1
Fat, Oil and Grease (FOG) (mg/1)	8.0

Table 4.4 Allowable Limits for Groundwater Recharge (Ba)

Parameter	Allowable limit
BOD_5 (mg/l)	15
CODcr (mg/l)	50
DO (mg/l)	>2
TSS (mg/l)	50
pH	6-9
Turbidity (NTU)	2
NO_3-N (mg/l)	30
NH_4-N (mg/l)	5
T-N (mg/l)	45
E. coli (MPN or CFU/100ml)	< 2.2
Intestinal Helminth Eggs (egg/1)	< or =1

Table 4.5 Allowable Limits for Irrigation Purposes (Bb)

Standards	Allowable concentration according to aspects of uses			Cut flower
	vegetables that will be cooked, parks, playgrounds and side roads in populated areas (Bb-1)*	Fruit trees, trees along highway and green areas (Bb-2)*	Feed crops, industrial crops and forest trees (Bb-3)*	
BOD_5 (mg/l)	30	200	300	15
CODcr (mg/l)	100	500	500	50
DO (mg/l)	> 2	-	-	＜2
TSS (mg/l)	30	200	300	15
pH	6-9	6-9	6-9	6-9
Turbidity (NTU)	10	-	-	5
NO_3-N (mg/l)	30	45	70	45
T-N (mg/l)	45	70	100	70
E. coli (MPN or CFU/100ml)	100	1,000	-	1.1
Intestinal Helminth Eggs (egg/1)	< or =1	< or =1	< or =1	1 <
FOG (mg/1)	8.0	8.0	8.0	2.0

The allowable limits of hazardous substances in the effluents are stipulated as shown in the Table 4.6.

Table 4.6 Allowable Limits of Hazardous Substances

Parameter	Streams, Valleys and Reservoirs (A)	Groundwater Recharge (Ba)	Irrigation Purposes	
			(Bb-1, -2 and -3)	Cut flower
Phenol (mg/l)	< 0.002	< 0.002	< 0.002	< 0.002
MBAS* (mg/l)	25	25	100	15
TDS** (mg/l)	1,500	1,500	1,500	1,500
Total PO_4 (mg/l)	15	15	30	30
Cl (mg/l)	350	350	400	400
SO_4 (mg/l)	300	300	500	500
HCO_3 (mg/l)	400	400	400	400
Na (mg/l)	200	200	230	230
Mg (mg/l)	60	60	100	100

Parameter	Streams, Valleys and Reservoirs (A)	Groundwater Recharge (Ba)	Irrigation Purposes	
			(Bb-1, -2 and -3)	Cut flower
Ca (mg/l)	200	200	230	230
SAR***	6.0	6.0	9.0	9.0
Al (mg/l)	2.0	2.0	5.0	5.0
As (mg/l)	0.05	0.05	0.1	0.1
Be (mg/l)	0.1	0.1	0.1	0.1
Cu (mg/l)	0.2	1.5	0.2	0.2
F (mg/l)	1.5	2.0	2.0	2.0
Fe (mg/l)	5.0	5.0	5.0	5.0
Li (mg/l)	2.5	2.5	2.5 (0.075)	0.075
Mn (mg/l)	0.2	0.2	0.2	0.2
Mo (mg/l)	0.01	0.01	0.01	0.01
Ni (mg/L)	0.2	0.2	0.2	0.2
Pb (mg/l)	0.2	0.2	0.2	0.2
Se (mg/l)	0.05	0.05	0.05	0.05
Cd (mg/l)	0.01	0.01	0.01	0.01
Zn (mg/L)	5.0	5.0	5.0	5.0
Cr (mg/l)	0.02	0.05	0.1	0.1
Hg (mg/l)	0.002	0.001	0.002	0.002
V (mg/l)	0.1	0.1	0.1	0.1
Co (mg/l)	0.05	0.05	0.05	0.05
B (mg/l)	1.0	1.0	1.0	1.0
CN (mg/l)	0.1	0.1	0.1	0.1

Note: *MBAS: Methylene Blue Active Substance, **TDS: Total Dissolved Solids, and ***SAR: Sodium Absorption Ratios
Figure in the (   ): for citrus crops

Almost all of hazardous substances cannot be removed by typical biochemical treatment methods that are generally applied for municipal wastewater treatment plants. Therefore, when the industrial wastewater is received by a sewerage system, the qualities are regulated by laws and quality standards. In Jordan the industrial wastewater is allowed to be discharged to the sewer networks when discharge conditions between the industry and the authority concerns are satisfied, as it is stated in “Reclaimed Domestic Wastewater Standard No. 893/2006”.

The design effluent quality is set based on the review of the uses of the treated wastewater for each WWTP. The result of the review for each treatment plant is explained in the following sections.

4.2 Greater Irbid Municipality

4.2.1 Service Area

(1) Existing sewerage service area
Four sewerage districts, Wadi Al-Arab, Central Irbid, Shallala, and Wadi Hassan, in the Greater Irbid Municipality, are shown in Figure 4.1. The boundary of Greater Irbid Municipality is presented in Figure 4.3. The sewerage service areas for each sewerage district are summarized in Table 4.7.

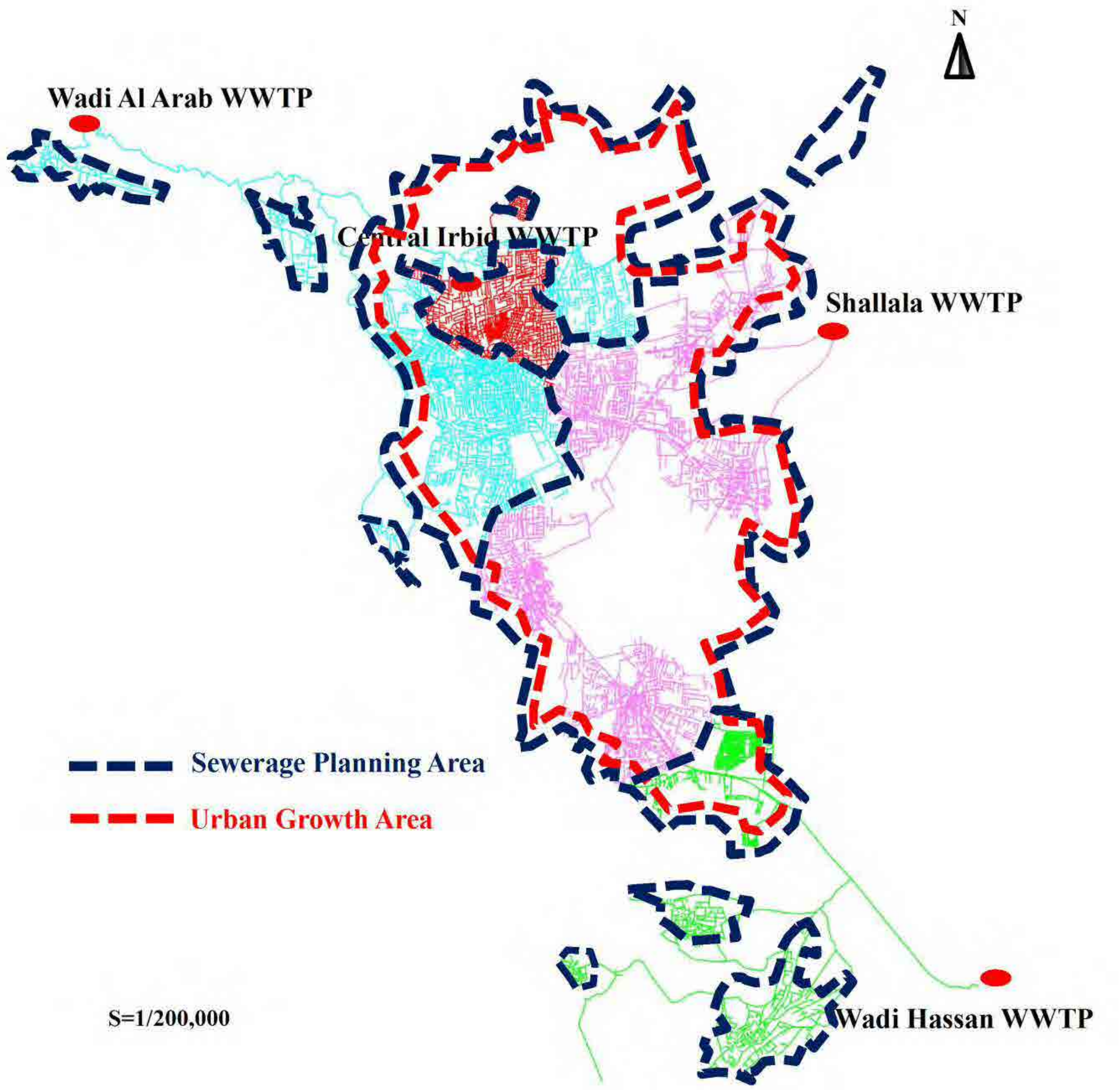


Figure 4.1 Existing Four Sewerage Districts in the Greater Irbid Municipality

Table 4.7 Present Sewerage Service Area in Each Sewerage District

Central Irbid	Wadi Al-Arab	Shallala	Wadi Hassan	Total
696 ha	2,409 ha	4,053 ha	1,124 ha	8,282 ha

Source: JICA Study Team

(2) Priority Areas in SWMP

Figure 4.2 shows the priority areas in Irbid proposed in the SWMP. Mughyyir, Bait Ras, and Hakama are categorized as Priority II area.

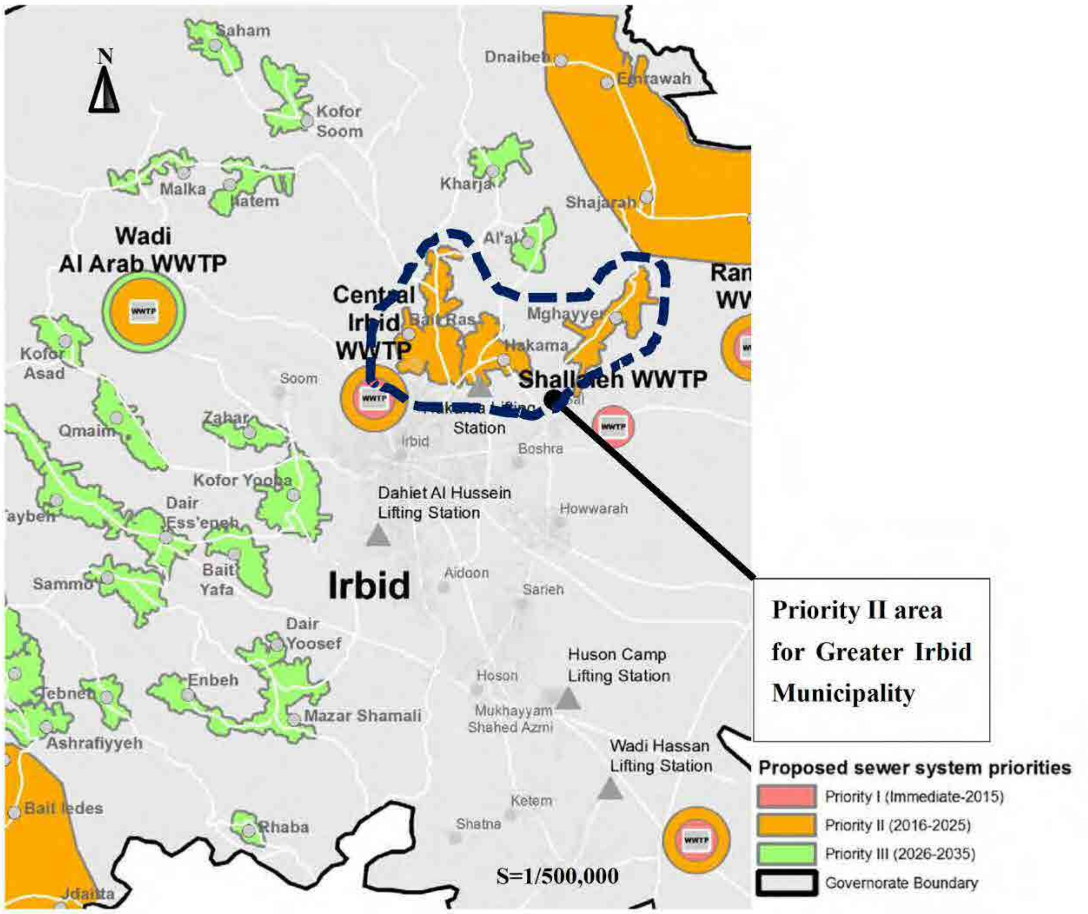


Figure 4.2 Priority II Area in the Greater Irbid Municipality as Proposed by SWMP

(3) Existing Urban Plan

Figure 4.3 shows the GIM (area in dark brown), the urban planning area (inside of broken white line) and the urban growth area (UGA) of the Greater Irbid Municipality. The UGA covering about 90% of the current population is expected to continue to grow.

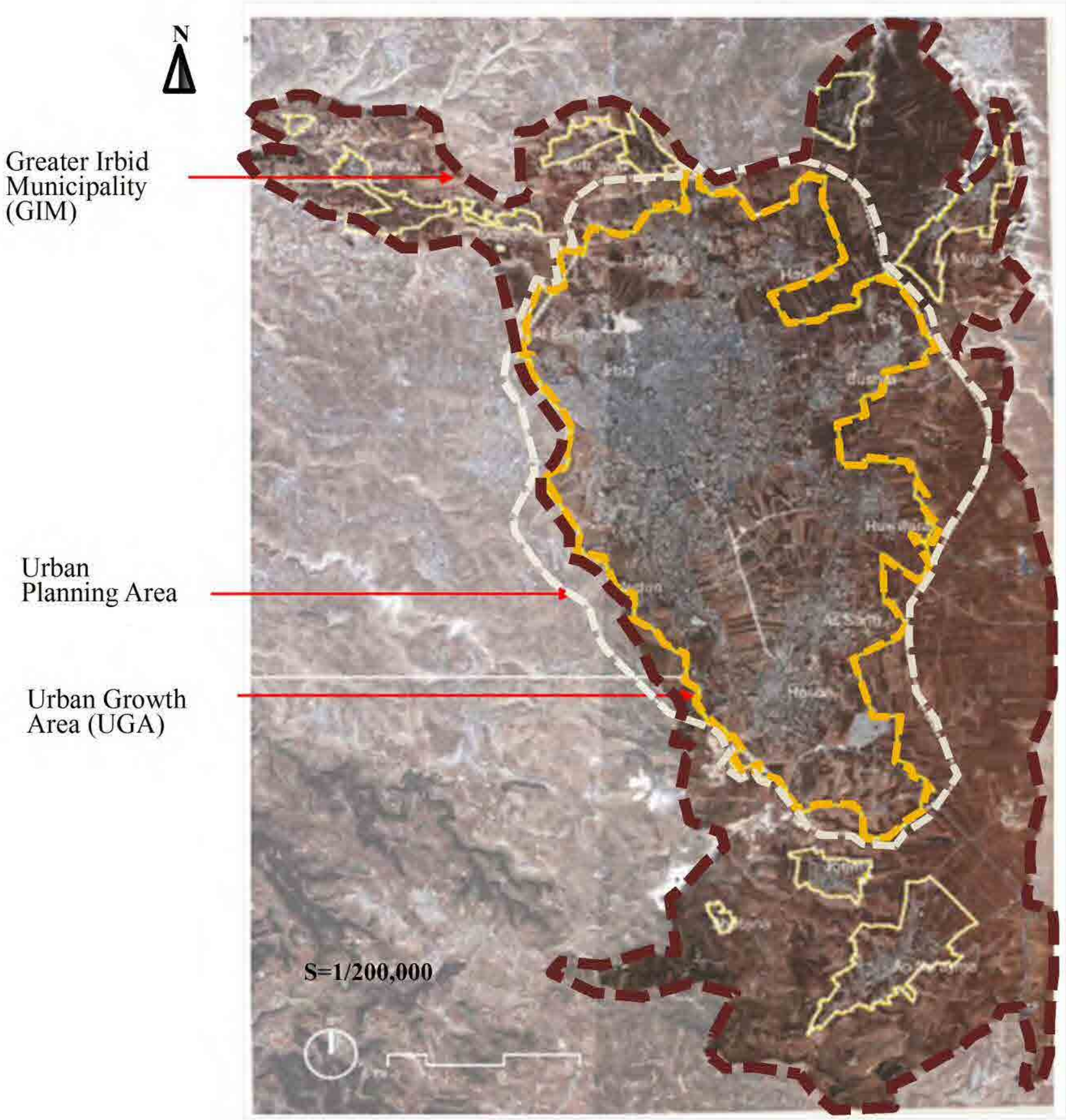


Figure 4.3 Urban Growth Area (UGA), the Urban Planning Area and the Greater Irbid Municipality (GIM)

The Urban Growth Area Plan to 2030, includes land use plan and the development of infrastructures such as roads. Table 4.8 shows that the UGA area currently includes about 90% of the population and housing units located in the Greater Irbid Municipality. This ratio is projected to be about the same in 2030.

Table 4.8 Existing and Projected Population and Housing Units in the UGA and GIM

Area	Existing【2004】				Urban Growth Area Plan【2030】			
	Population		Housing Units		Population		Housing Units	
	(person)	(%)	(unit)	(%)	(person)	(%)	(unit)	(%)
Greater Irbid Municipality	395,472	100.0	94,983	100.0	741,276	100.0	192,312	100.0
Urban Growth Area	355,363	89.9	85,731	90.3	671,165	90.5	175,579	91.3

Source: MOI

Bait Ras and Hakama are categorized as Priority II in the SWMP, and are located in the UGA.

(4) Influx of Syrian Refugees

According to the Ministry of the Interior (MOI), about 120,000 Syrian refugees are living in the GIM as of July 2013. Since the Jordanian population in the GIM is estimated at 514,395 in 2012, the ratio of Syrian refugees to Jordanians has reached about 23%.

Table 4.9 Distribution of Syrian refugees

Governorate	District		Municipality	Jordan Population【2012】(person)	Syrian Refugee【July 2013】(person.)	Syrian/Jordanian (%)
Irbid	Irbid Qasabah (+Bani Obeid)	①	Irbid Al-Kobra	514,395	120,000	23.0
		②	Gahrb Irbid	55,448	10,000	18.0
	Al-Mazar, Al-Shemli	③	Al-mazar Al-Jadida	54,100	6,000	11.0
	Bani Kenanah	④	Al-Yarmouk Al-Jadida	17,313	4,000	23.0
		⑤	Al-Sho'lah	11,507	4,000	35.0
		⑥	Al-Kafarat	28,668	8,000	28.0
		⑦	Al-Sarou	15,692	4,000	25.0
		⑧	Khaled Bin Al-Waleed	22,480	1,500	7.0

Source:MOI

Legend: more than 30% / more than 25% / more than 20% / more than 15%

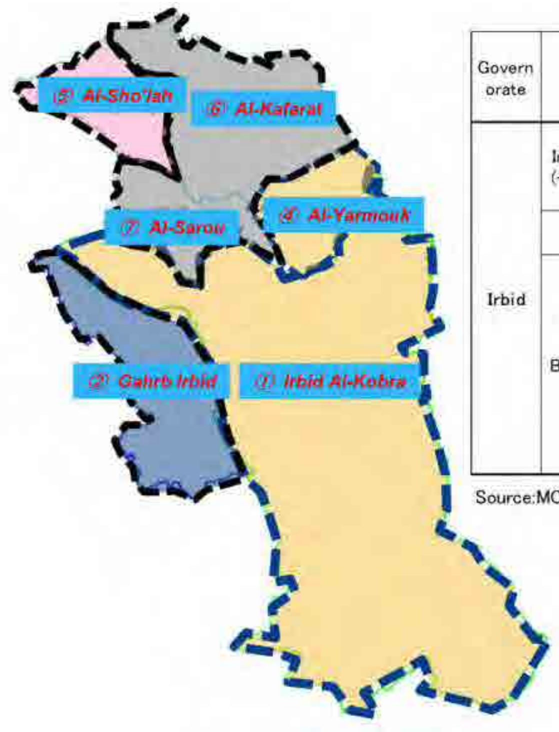


Figure 4.4 Syrian Refugees Distribution in Irbid

(5) Sewerage Service Area

The sewerage service area in the GIM is shown in Table 4.10 and Figure 4.5, covering the four sewerage districts, plus the UGA and Mughyyir proposed under this Study. The planning area covers the Priority II area in the SWMP. The UGA is densely populated and is receiving many Syrian refugees.

It should be noted that the Hoson Camp, currently covered by Wadi Hasan SWD, is planned to be covered by Shallala SWD in the future. Therefore, the area of 102 ha of Hoson Camp is included in the Shallala SWD in table below.

Table 4.10 Sewerage Service Area in Greater Irbid Municipality (GIM)

Sewerage District	Sewerage Service Area (ha)			Ratio (B/A) %
	Existing Area (A)	Planned Area (B)	Increased Area (B-A)	
Central Irbid	696	696	0	100
Wadi Al-Arab	2,409	4,613	2,204	191
Shallala	4,053	6,523	2,470	161
Wadi Hassan	1,124	1,453	329	129
Total	8,282	13,285	5,003	160

Source: JICA Study Team

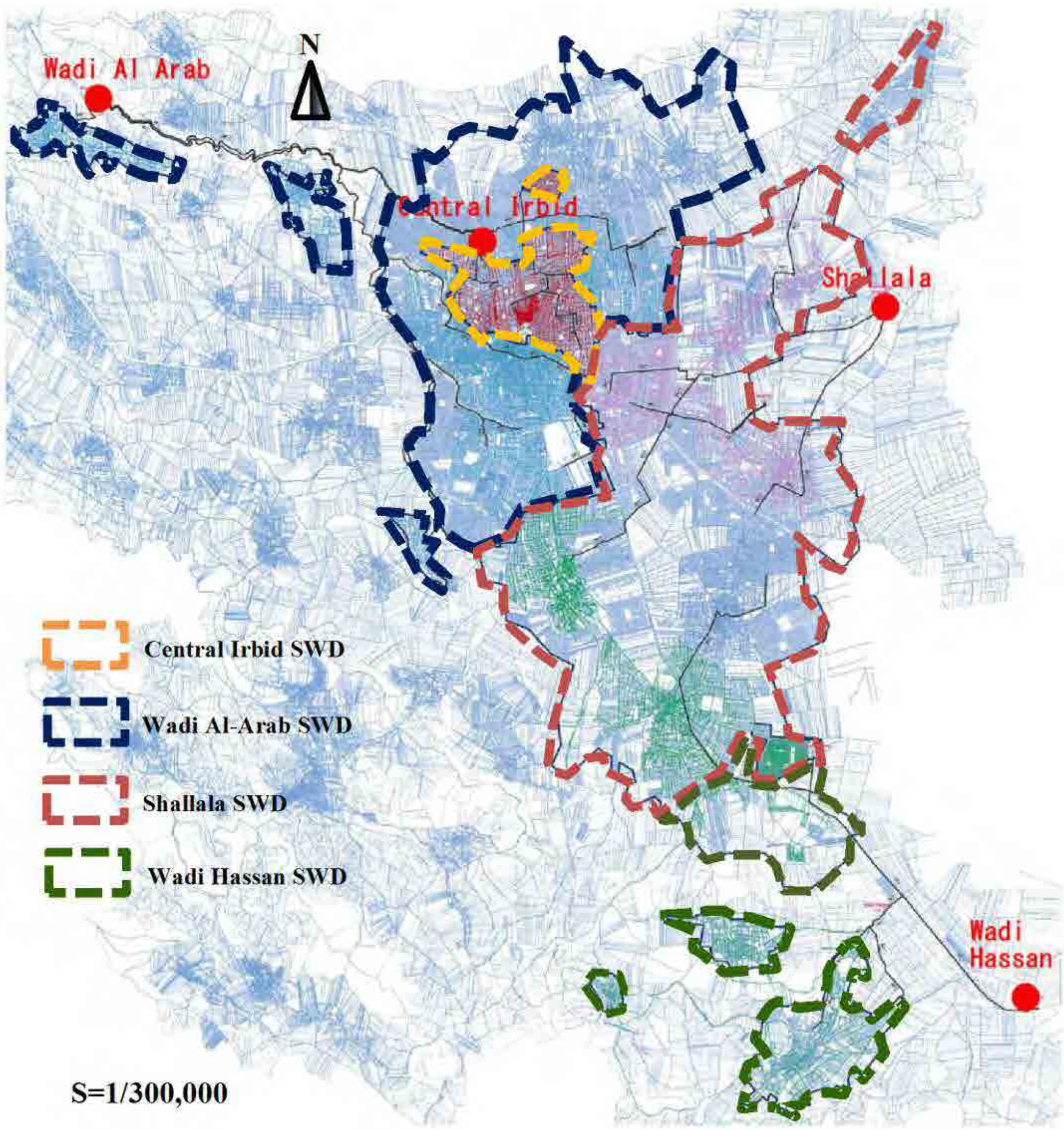
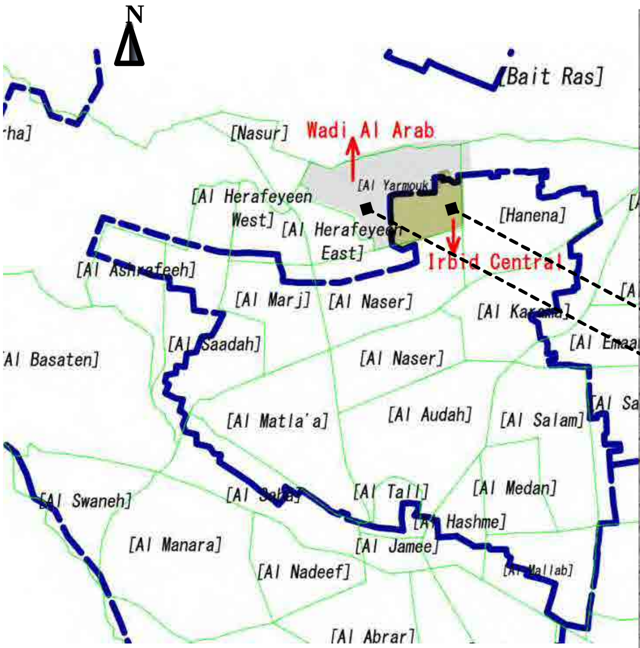


Figure 4.5 Planned Sewerage Service Area in GIM

4.2.2 Service Population

The population data for 2035 is available for each locality in the Greater Irbid Municipality and sub-locality in Irbid City. The population data is distributed into four sewerage districts, Wadi-Arab (A), Central Irbid (C), Shallala (S), and Wadi Hassan (H), based on the boundary of each locality or sub-locality and of each sewerage district. When an area or neighborhood is divided into two or more sewerage districts then the population attributed to each sewerage district is estimated based on the area.

Figure 4.6 shows sewerage service population for one neighborhood divided into two sewerage districts.



S=1/100,000

NameArea	Neighborhood	Service Population 【2035】	Population in SWD-A	Population in SWD-C	Population in SWD-S	Population in SWD-H
Al Roudah	Al Sena'a	2,174	2,174			
Al Barha	Al Basaten	11,768	11,768			
Al Manara	Al Manara	21,481	21,481			
Al Arabia	Al Ateba'a	11,868	11,868			
Al Nouzha	Al Jamiah	13,591	13,591			
Al Nouzha	Al Nouzha	6,896	6,896			
Al Arabia	As Surayj	4,992	4,992			
Al Arabia	Zebdat	10,561	10,561			
Al Arabia	Al Mohandisin	9,717	9,717			
Al Arabia	Al Afraah	11,917	11,917			
Al Roudah	Al Baqaa	6,340	6,340			
Al Roudah	Al Baiyda	2,943	2,943			
Al Nasur	Al Herafeyeen East	648	648			
Al Barha	Al Herafeyeen West	997	997			
Al Manara	Al Swaneh	7,201	7,201			
Al Manara	Al Nadeef	8,904	8,904			
Al Manara	Al Abrar	19,224	19,224			
Al Manara	Al Qasela	10,397	10,397			
Al Hashimia	Al Jamee	1,730	1,730			
Al Nasur		1,206	1,206			
Al Barha		12,453	12,453			
Al Nasur	Al Yarmouk	5,511	3,968	1,543		
Al Barha	Al Ashrafeeh	2,308	1,546	762		
Al Barha	Al Seha	13,147	9,466	3,681		
Al Roudah	Al Emaan	6,215	5,718	497		
Al Nouzha	Al Hekmah	7,562	3,554		4,008	
Al Roudah	Al Rouda	7,684	7,300		384	
Al Roudah	Al Sahel Green	8,011	5,688		2,323	
Al Hashimia	Al Salam	14,272		14,272		
Al Barha	Al Matla'a	12,990		12,990		
Al Hashimia	Al Medan	6,920		6,920		

Figure 4.6 Method of Population Distribution into Each Sewerage District in GIM

Table 4.11 shows the sewerage service population for 2035 for each sewerage district (SWD).

Total sewerage service population is about 790,000: 118,000 (15%) in Central Irbid SWD, 329,000 (42%) in Wadi-Arab SWD, 307,000 (39%) in Shallala SWD, and 36,000 (4%) in Wadi Hassan SWD.

The service population in Shalala SWD includes the population in Hoson Camp that is currently served by the sewerage system of Wadi Hassan SWD. WAJ plans to switch Hoson Camp from Wadi Hassan SWD to Shallala SWD.

Table 4.11 Sewerage Service Population for Four Sewerage Districts in GIM

NameArea	Neighborhood	Service Population 【2035】	Population in SWD-A	Population in SWD-C	Population in SWD-S	Population in SWD-H
Al Roudah	Al Sena'a	2,174	2,174			
Al Barha	Al Basaten	11,768	11,768			
Al Manara	Al Manara	21,481	21,481			
Al Arabia	Al Ateba'a	11,868	11,868			
Al Nouzha	Al Jamiah	13,591	13,591			
Al Nouzha	Al Nouzha	6,896	6,896			
Al Arabia	As Surayj	4,992	4,992			
Al Arabia	Zebdat	10,561	10,561			
Al Arabia	Al Mohandisin	9,717	9,717			
Al Arabia	Al Afraah	11,917	11,917			
Al Roudah	Al Baqaa	6,340	6,340			
Al Roudah	Al Baiyda	2,943	2,943			
Al Nasur	Al Herafeyeen East	648	648			
Al Barha	Al Herafeyeen West	997	997			
Al Manara	Al Swaneh	7,201	7,201			
Al Manara	Al Nadeef	8,904	8,904			
Al Manara	Al Abrar	19,224	19,224			
Al Manara	Al Qasela	10,397	10,397			
Al Hashimia	Al Jamee	1,730	1,730			
Al Nasur		1,206	1,206			
Al Barha		12,453	12,453			
Al Nasur	Al Yarmouk	5,511	3,968	1,543		
Al Barha	Al Ashrafeeh	2,308	1,546	762		
Al Barha	Al Seha	13,147	9,466	3,681		
Al Roudah	Al Emaan	6,215	5,718	497		
Al Nouzha	Al Hekmah	7,562	3,554		4,008	
Al Roudah	Al Rouda	7,684	7,300		384	
Al Roudah	Al Sahel Green	8,011	5,688		2,323	
Al Hashimia	Al Salam	14,272		14,272		
Al Barha	Al Matla'a	12,990		12,990		
Al Hashimia	Al Medan	6,920		6,920		
Al Nasur	Al Audah	32,581		32,581		
Al Nasur	Hanena	17,089	7,519	9,570		
Al Nasur	Al Karama	13,814	4,697	9,117		
Al Barha	Al Marj	2,687	242	2,445		
Al Barha	Al Saadah	8,446	3,547	4,899		
Al Hashimia	Al Mallab	4,512	1,128	3,384		
Al Hashimia	Al Tall	1,908	687	1,221		
Al Hashimia	Al Hashme	2,732	1,065	1,667		
Al Nasur	Al Naser	10,871	2,283	8,588		
Al Nouzha	Al Werud	14,292			14,292	
Al Roudah	Zahra	3,707			3,707	
Al Roudah	Zahra	5,385			5,385	
Al Roudah	Andalus	4,015			4,015	
Al Roudah	Andalus	5,643			5,643	
	【City Total】	**389,310**	235,416	114,137	39,757	
Bait Ras	Bait Ras	50,036	46,033	4,003		
Hakama	Hakama	14,404	14,404			
Maro	Maro	6,046	6,046			
Aliah	Aliah	5,197	5,197			
Howwarah	Howwarah	31,955			31,955	
Sal	Sal	24,699			24,699	
Boshra	Boshra	32,175			32,175	
Aidoon	Aidoon	48,819			48,819	
Sarieh	Sarieh	47,359			47,359	
Hoson	Hoson	65,633			41,349	
Hoson	Shahed Azmi				24,284	
Mghayyer	Mghayyer	16,831			16,831	
Shatana	Shatana	540				540
Ketem	Ketem	10,696				10,696
Soom		9,997	9,997			
No`ayymeh		24,141				24,141
Dougrah		9,154	9,154			
Natfeh		2,617	2,617			
	【Suburbs Total】	400,299	93,448	4,003	267,471	35,377
			328,864	**118,140**	**307,228**	**35,377**
			A	**C**	**S**	**H**
						789,609
						Total

【Sewerage District】

- A Wadi A-Arab
- C Central Irbid
- H Wadi Hassan
- S Shallaleh
- SWD Sewerage District

4.2.3 Design Flows

(1) Design Average Flow for Four Sewerage Districts in Greater Irbid Municipalities

Tables 4.12 to 4.15 show the design flows for each sewerage district. As explained in Section 4.1, the wastewater generation rate is calculated by multiplying the service population by per capita wastewater generation rate for urban and rural areas. The average flows are the same as the wastewater generation rate assuming no groundwater inflow and infiltration. The maximum daily and hourly flows are set using the peaking factor in Table 4.2.

Table 4.12 Calculation of Design Flows for Central Irbid SWD

NameArea	Locality Neighborhood	Population	Average Water Supply Volume	Wastewater Generation	Ground water I/I	Ave. Daily Flow	Max. Daily Flow	Max. Hourly Flow
		(pers.)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)
Al Nasur	Al Yarmouk	1,543	179	143	0	143	168	252
Al Barha	Al Ashrafeeh	762	88	70	0	70	83	125
Al Barha	Al Seha	3,681	427	342	0	342	400	600
Al Roudah	Al Emaan	497	58	46	0	46	54	81
Al Hashimia	Al Salam	14,272	1,656	1,325	0	1,325	1,549	2,324
Al Barha	Al Matla'a	12,990	1,507	1,206	0	1,206	1,410	2,115
Al Hashimia	Al Medan	6,920	803	642	0	642	751	1,127
Al Nasur	Al Audah	32,581	3,779	3,023	0	3,023	3,537	5,306
Al Nasur	Hanena	9,570	1,110	888	0	888	1,039	1,559
Al Nasur	Al Karama	9,117	1,058	846	0	846	990	1,485
Al Barha	Al Marj	2,445	284	227	0	227	265	398
Al Barha	Al Saadah	4,899	568	454	0	454	532	798
Al Hashimia	Al Mallab	3,384	393	314	0	314	367	551
Al Hashimia	Al Tall	1,221	142	114	0	114	133	200
Al Hashimia	Al Hashme	1,667	193	154	0	154	181	272
Al Nasur	Al Naser	8,588	996	797	0	797	932	1,398
	City Total	114,137	13,241	10,591	0	10,591	12,391	18,591
Bait Ras	Bait Ras	4,003	352	282	0	282	330	495
	Suburbse Total	4,003	352	282	0	282	330	495
	Total	**118,140**	13,593	10,873	0	10,873	12,721	19,086

Table 4.13 Calculation of Design Flows for Wadi Al-Arab SWD

NameArea	Locality Neighborhood	Population	Average Water Supply Volume	Wastewater Generation	Ground water I/I	Ave. Daily Flow	Max. Daily Flow	Max. Hourly Flow
		(pers).	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)
Al Roudah	Al Sena'a	2,174	252	202	0	202	236	354
Al Barha	Al Basaten	11,768	1,365	1,092	0	1,092	1,278	1,917
Al Manara	Al Manara	21,481	2,492	1,994	0	1,994	2,332	3,498
Al Arabia	Al Ateba'a	11,868	1,377	1,102	0	1,102	1,288	1,932
Al Nouzha	Al Jamiah	13,591	1,577	1,262	0	1,262	1,475	2,213
Al Nouzha	Al Nouzha	6,896	800	640	0	640	749	1,124
Al Arabia	As Surayj	4,992	579	463	0	463	542	813
Al Arabia	Zebdat	10,561	1,225	980	0	980	1,147	1,721
Al Arabia	Al Mohandisin	9,717	1,127	902	0	902	1,055	1,583
Al Arabia	Al Afraah	11,917	1,382	1,106	0	1,106	1,294	1,941
Al Roudah	Al Baqaa	6,340	735	588	0	588	688	1,032
Al Roudah	Al Baiyda	2,943	341	273	0	273	319	479
Al Nasur	Al Herafeyeen East	648	75	60	0	60	70	105
Al Barha	Al Herafeyeen West	997	116	93	0	93	108	162
Al Manara	Al Swaneh	7,201	835	668	0	668	782	1,173
Al Manara	Al Nadeef	8,904	1,033	826	0	826	967	1,451
Al Manara	Al Abrar	19,224	2,230	1,784	0	1,784	2,087	3,131
Al Manara	Al Qasela	10,397	1,206	965	0	965	1,129	1,694
Al Hashimia	Al Jamee	1,730	201	161	0	161	188	282
Al Nasur		1,206	140	112	0	112	131	197
Al Barha		12,453	1,445	1,156	0	1,156	1,352	2,028
Al Nasur	Al Yarmouk	3,968	460	368	0	368	431	647
Al Barha	Al Ashrafeeh	1,546	179	143	0	143	168	252
Al Barha	Al Seha	9,466	1,098	878	0	878	1,028	1,542
Al Roudah	Al Emaan	5,718	663	530	0	530	621	932
Al Nouzha	Al Hekmah	3,554	412	330	0	330	386	579
Al Roudah	Al Rouda	7,300	847	678	0	678	792	1,188
Al Roudah	Al Sahel Green	5,688	660	528	0	528	617	926
Al Nasur	Hanena	7,519	872	698	0	698	816	1,224
Al Nasur	Al Karama	4,697	545	436	0	436	510	765
Al Barha	Al Marj	242	28	22	0	22	26	39
Al Barha	Al Saadah	3,547	411	329	0	329	385	578
Al Hashimia	Al Mallab	1,128	131	105	0	105	122	183
Al Hashimia	Al Tall	687	80	64	0	64	75	113
Al Hashimia	Al Hashme	1,065	124	99	0	99	116	174
Al Nasur	Al Naser	2,283	265	212	0	212	248	372
	City Total	235,416	27,308	21,849	0	21,849	25,558	38,344
Bait Ras	Bait Ras	46,033	4,051	3,241	0	3,241	3,793	5,690
Hakama	Hakama	14,404	1,268	1,014	0	1,014	1,187	1,781
Maro	Maro	6,046	532	426	0	426	498	747
Aliah	Aliah	5,197	457	366	0	366	428	642
Soom	soom	9,997	880	704	0	704	824	1,236
Dougrah	Dougrah	9154	806	645	0	645	754	1,131
Natfeh	Natfeh	2617	230	184	0	184	216	324
	Suburbse Total	93,448	8,224	6,580	0	6,580	7,700	11,551
	Total	328,864	35,532	28,429	0	28,429	33,258	49,895

Table 4.14 Calculation of Design Flows for Shallala SWD

NameArea	Locality Neighborhood	Population (pers.)	Average Water Supply Volume (m^3/day)	Wastewater Generation (m^3/day)	Ground water I/I (m^3/day)	Ave. Daily Flow (m^3/day)	Max. Daily Flow (m^3/day)	Max. Hourly Flow (m^3/day)
Al Nouzha	Al Hekmah	4,008	465	372	0	372	435	653
Al Roudah	Al Rouda	384	45	36	0	36	42	63
Al Roudah	Al Sahel Green	2,323	269	215	0	215	252	378
Al Nouzha	Al Werud	14,292	1,658	1,326	0	1,326	1,552	2,328
Al Roudah	Zahra	3,707	430	344	0	344	402	603
Al Roudah	Zahra	5,385	625	500	0	500	585	878
Al Roudah	Andalus	4,015	466	373	0	373	436	654
Al Roudah	Andalus	5,643	655	524	0	524	613	920
	City Total	39,757	4,613	3,690	0	3,690	4,317	6,477
Howwarah	Howwarah	31,955	2,812	2,250	0	2,250	2,633	3,950
Sal	Sal	24,699	2,173	1,738	0	1,738	2,035	3,053
Boshra	Boshra	32,175	2,831	2,265	0	2,265	2,651	3,977
Aidoon	Aidoon	48,819	4,296	3,437	0	3,437	4,023	6,035
Sarieh	Sarieh	47,359	4,168	3,334	0	3,334	3,902	5,853
Hoson	Hoson	41,349	3,639	2,911	0	2,911	3,407	5,111
Hoson	Shahed Azmi	24,284	2,137	1,710	0	1,710	2,001	3,002
Mghayyer	Mghayyer	16,831	1,481	1,185	0	1,185	1,387	2,081
	Suburbse Total	267,471	23,537	18,830	0	18,830	22,039	33,062
	Total	**307,228**	28,150	22,520	0	22,520	26,356	39,539

Table 4.15 Calculation of Design Flows for Wadi Hassan SWD

NameArea	Locality Neighborhood	Population (pers.)	Average Water Supply Volume (m^3/day)	Wastewater Generation (m^3/day)	Ground water I/I (m^3/day)	Ave. Daily Flow (m^3/day)	Max. Daily Flow (m^3/day)	Max. Hourly Flow (m^3/day)
Shatana	Shatana	540	48	38	0	38	44	66
Ketem	Ketem	10,696	941	753	0	753	881	1,322
No`ayymeh		24,141	2,124	1,699	0	1,699	1,989	2,984
	Suburbse Total	35,377	3,113	2,490	0	2,490	2,914	4,372
	Total	**35,377**	3,113	2,490	0	2,490	2,914	4,372

4.2.4 Design Wastewater Quality

(1) Design Influent Quality

Design influent BOD_5 and SS for the four WWTP are set as shown in Table 4.16.

Table 4.16 Design Influent Quality for Four Sewerage Districts in GIM

Sewerage District	Population 【2035】	Ave. Daily Flow	BOD Loads	SS Loads	Influent BOD Conc.	Influent SS Conc.
	(pers.)	(m^3/day)	(kg/day)	(kg/day)	(mg/ℓ)	(mg/ℓ)
Wadi-Arab	328,864	28,429	21,376	19,732	752	694
Central Irbid	118,140	10,873	7,679	7,088	706	652
Shallala	307,228	22,520	19,970	18,434	887	819
Wadi Hassan	35,377	2,490	2,300	2,123	924	853

Unit Pollution Load		
BOD	65	(g/capita/day)
SS	60	(g/capita/day)

The BOD_5 concentrations are more than 700 mg/L for all districts. These values are very high; more than 2.3 to 3.5 times the typical BOD_5 concentrations in Japan which are in the range of 200 to 300 mg/L. The water supply volume is around 240 to 300 lpcd in Japan, which is about 3 times higher than Jordan, thus making the BOD_5 loading more comparable.

(2) Design Effluent Qualities

1) Current Use of Treated Effluent at the Existing WWTPs

The current use of treated effluent for the four WWTPs and allowable limits specified in the Jordanian Standards (No. 893/2006) are summarized in Table 4.17.

Table 4.17 Current Use of Treated Effluent and Allowable Limits for Four WWTPs

SWD	Central Irbid	Wadi Al-Arab	Shallala	Wadi Hassan
Category of Use	A*	A*	A*	Bb-2*
Purpose or Place	Jordan River	Jordan River	Jordan River	Jordan university farmland
BOD_5 (mg/l)	60	60	60	200
CODcr (mg/L)	150	150	150	500
TSS (mg/l)	60	60	60	200
T-N (mg/l)	80	80	80	70
NO_3-N (mg/l)	70	70	70	45

Note: Category A: Discharge to streams, wadis and reservoirs, Category Bb-2: Irrigation for fruit trees, trees along highways and green areas. (Refer to Table 4.3 and Table 4.5, respectively.)

2) Treated Wastewater Use in Future Plan

The design qualities of treated wastewater in the plan prepared by KfW are shown in Table 4.18.

Table 4.18 Planned Design Treated Wastewater Quality for Two WWTPs

Item	Wadi Al-Arab	Wadi Hassan
Category of Use	Bb-1*	Bb-1*
Discharge	Jordan River	Jordan university farmland
BOD_5 (mg/l)	30	30
CODcr (mg/l)	100	100
TSS (mg/l)	30	30
NO_3-N (mg/l)	-	-
NH_4-N (mg/l)	2.5	2.5
T-N (mg/l)	-	-

Note: Category Bb-1: Irrigation of vegetables which will be cooked, parks, playgrounds and roadsides in populated areas (Refer to Table 4.5)

Source: Wadi Al-Arab and Wadi Hassan are based on KfW plan

The KfW plan does not specify the concentrations of T-N and NO_3-N, but the design quality of T-N and NO_3-N for Wadi Al-Arab and Wadi Hassan would follow the allowable limits for Bb-1irrigation purposes: (Jordanian Standard No. 893/2006), because those parameters are the same as BOD_5, CODcr and TSS in the Standards. (Refer to Table 4.5).

The design effluent quality based on the treated effluent uses, shown in Table 4.19, are applied in the design of the WWTP. The design effluent quality of Wadi Al-Arab and Wadi Hassa WWTPs are used also for Central Irbid and Shallala WWTPs because they have the same treated effluent use.

Table 4.19 Applied Design Effluent Quality for Four WWTPs

Item	Central Irbid	Wadi Al-Arab	Shallala	Wadi Hassan
Category of Use	Bb-1*	Bb-1*	Bb-1*	Bb-1*
Discharge	Jordan River	Jordan River	Jordan River	Jordan university farmland
BOD_5 (mg/l)	30	30	30	30
CODcr (mg/l)	100	100	100	100
TSS (mg/l)	30	30	30	30
NO_3-N (mg/l)	30	30	30	30
NH_4-N (mg/l)	**2.5	**2.5	**2.5	**2.5
T-N (mg/l)	45	45	45	45

Note: * Category Bb-1: Irrigation, Cooked vegetables, parks, playgrounds and roadsides in populated area (Refer to Table 4.5), ** Value applied by KfW Projects is also applied for other WWTPs.

Source: Wadi Al-Arab and Wadi Hassan are based on KfW plan

4.3 Ramtha District

4.3.1 Service Area

(1) Existing sewerage service area

In Ramtha City, only parts of the central area, about 1,271 ha, are served by a conventional sewerage system as shown in Figure 4.7.

(2) Priority Areas in SWMP

Dnaibeh, Emrawah, Shajarah, and Torrah in the northern area shown in Figure 4.8 are selected as the Priority II area in the SWMP. .

(3) Existing Urban Plan

The existing urban plan is used to define the sewerage plan area. The urban plan area is shown in Figure 4.9.

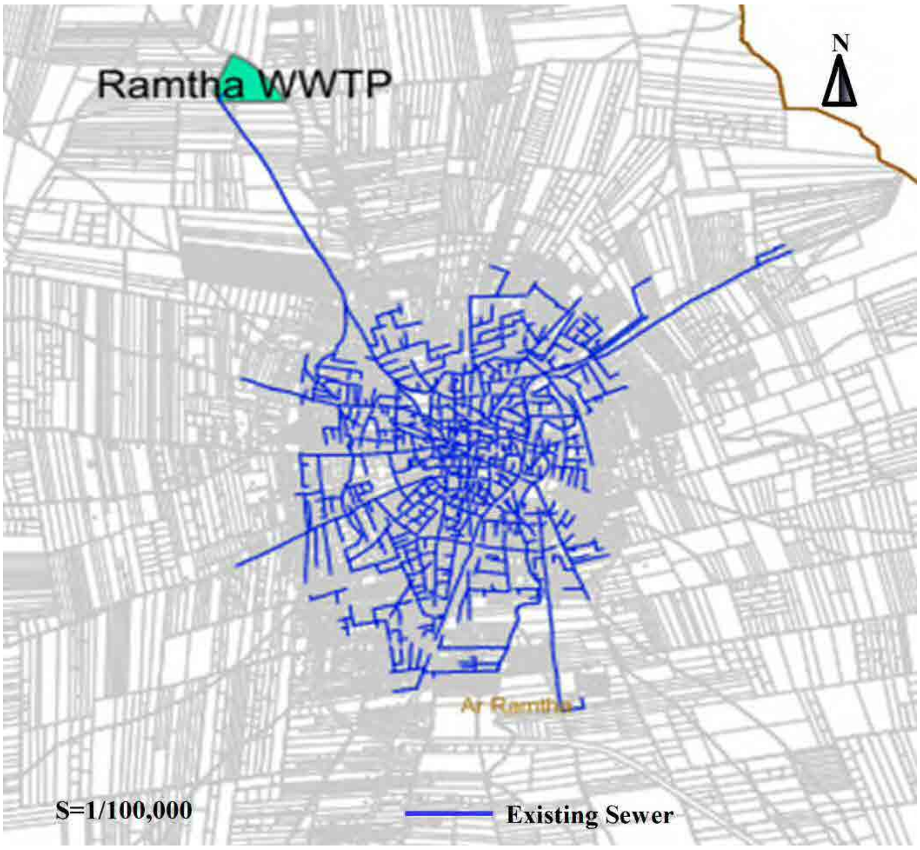


Figure 4.7 Existing Sewerage Service Area in Ramtha City

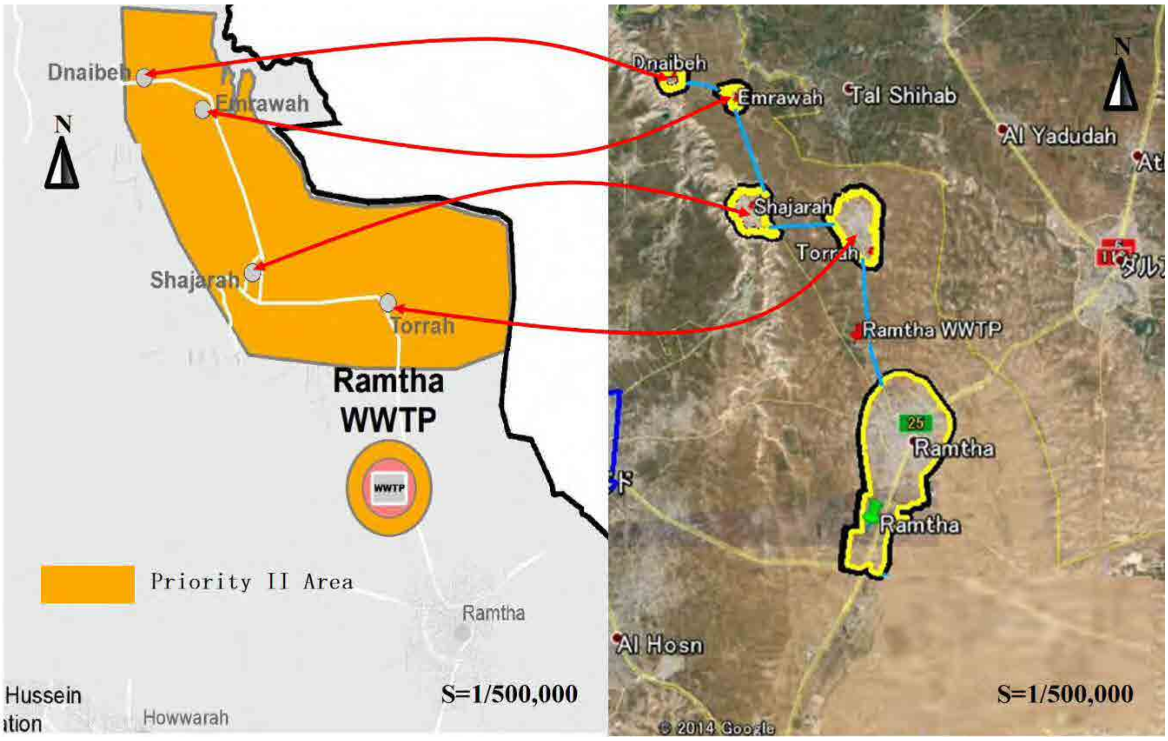


Figure 4.8 Priority II Area in Ramtha District Proposed by SWMP

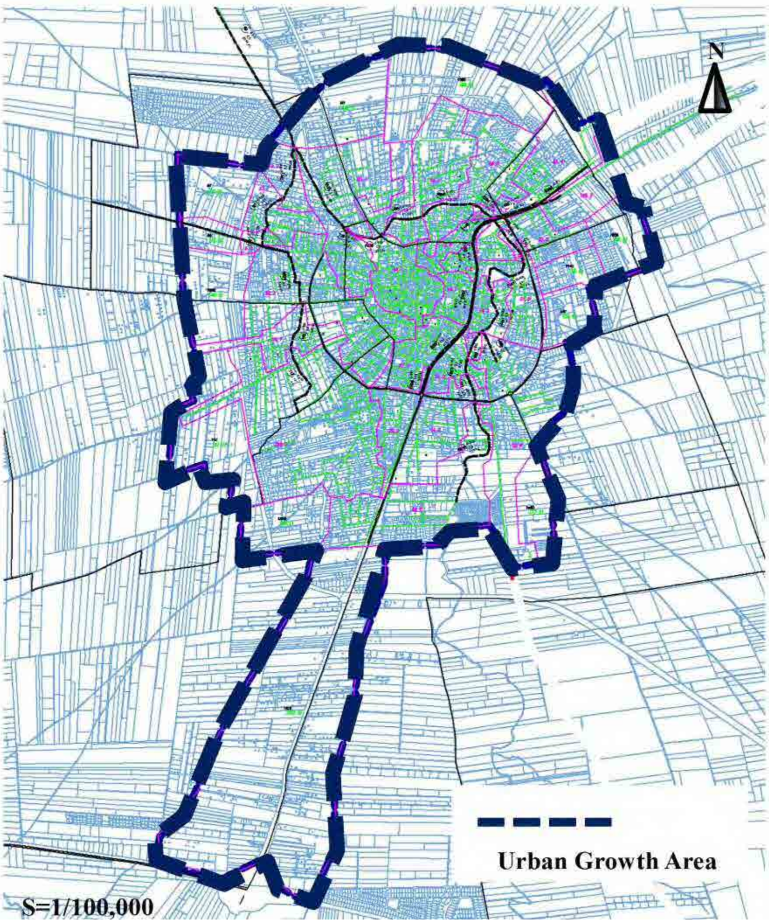


Figure 4.9 Urban Growth Area in the Urban Plan of Ramtha District

(4) Influx of Syrian Refugees

Ramtha City and the four localities of Suhoul Horan, with the influx of Syrian refugees now making up 40% of the Al-Ramtha district's population (see Table 4.20), requires the urgent development of the sewerage system. The cesspits commonly used in these areas are overflowing and are causing serious deterioration to the environment.[1]

Table 4.20 Syrian Refugee Numbers in Ramtha District

<table>
<tr><th>Governorate</th><th>District</th><th>Municipality</th><th>Locality</th><th>Jordanian Population 【2012】</th><th>Syrian Refugees 【July 2013】</th><th>Syrian/ Jordanian (%)</th></tr>
<tr><td rowspan="3">Irbid</td><td rowspan="3">Al-Ramtha</td><td>Al-Ramtha Al-Jadida</td><td>・Al-Buwayda</td><td>96,269</td><td>40,000</td><td>42</td></tr>
<tr><td>Suhoul Horan</td><td>・Dnaibeh
・Emrawah
・Shajarah
・Torrah</td><td>40,391</td><td>15,000</td><td>37</td></tr>
<tr><td colspan="2">Total</td><td>136,660</td><td>55,000</td><td>40</td></tr>
</table>

Source: MOI

(5) Sewerage Service Area

The area where sewerage development is being planned in the Ramtha District is in the Priority II area in the SWMP and the existing urban plan area with many Syrian refugees.

Table 4.21 and Figure 4.10 show the Sewerage Service area in Ramtha District.

Table 4.21 Sewerage Service Area in Ramtha District

Locality	Sewerage Service Area (ha)		Increase: B-A (ha)	B/A (%)
	Existing (A)	Planned (B)		
Ramtha City	1,021	1,846	825	181
Dnaibeh	-	74	74	-
Emrawah	-	41	41	-
Shajarah	-	205	205	-
Torrah	-	317	317	-
Total	1,021	2,483	1,462	243

[1] WASH in Hosting Communities in Jordan

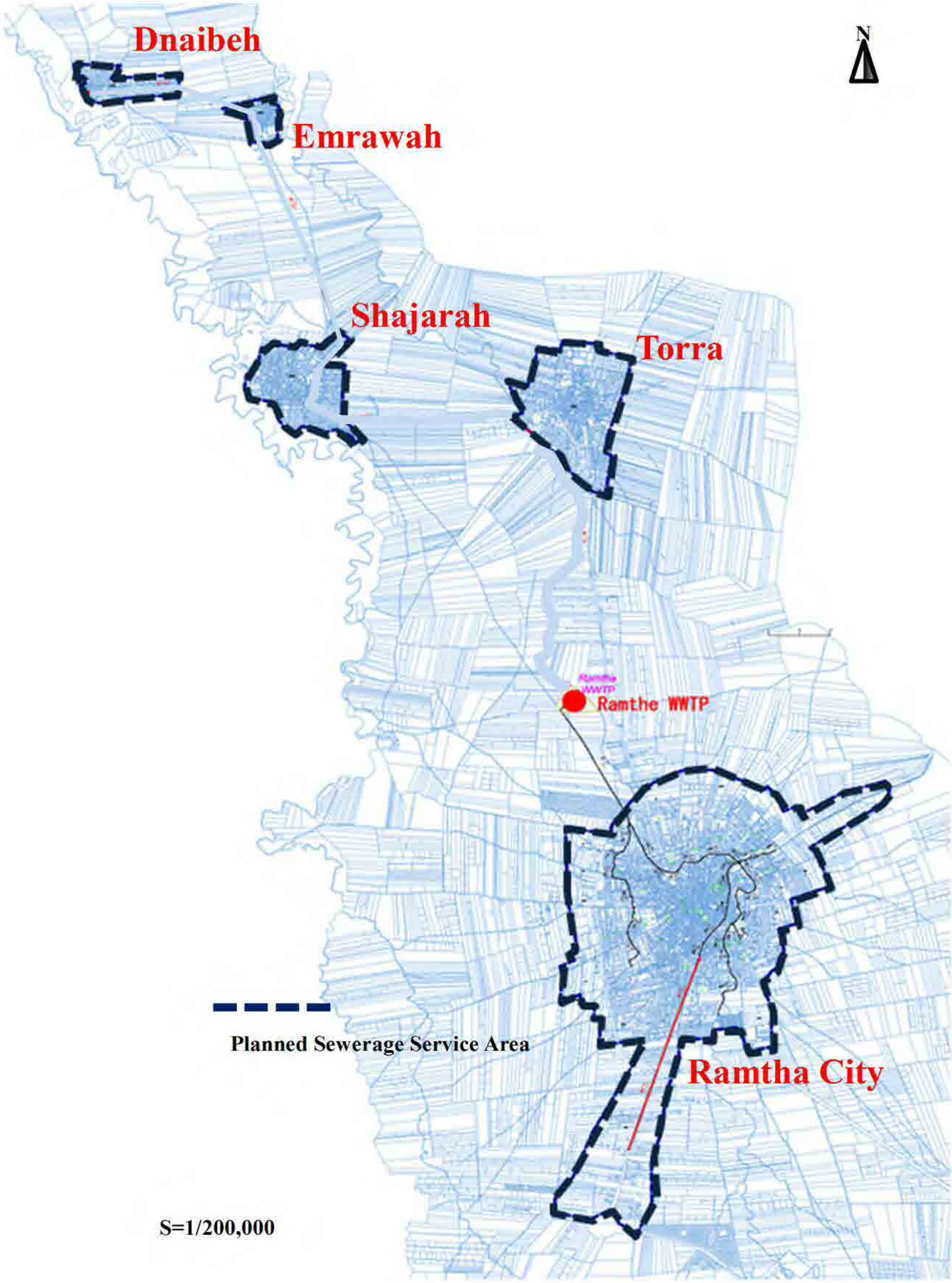


Figure 4.10 Planned Sewerage Service Area in Ramtha District

4.3.2 Service Population

The projected sewerage service population for Ramtha District is shown in Table 4.22, representing a sewerage coverage ratio of 100% in Ramtha City and the northern four localities. This planned sewerage service population of about 201,200 in 2035 includes about 62,600 in Dnaibeh, Emrawah, Shajarah and Torrah.

Table 4.22 Sewerage Service Population for Ramtha District

Ramtha City (person)	Northern Four (4) Localities (person)					Total Population (person)
	Dnaibeh	Emrawah	Shajarah	Torrah	Sub-total	
138,605	4,109	7,322	22,359	28,803	62,593	201,198

Source: JICA Study Team

4.3.3 Design Flows

Table 4.23 summarizes the design flows for Ramtha SWD.

Table 4.23 Calculation of Design Flows for Ramtha SWD

City and Locality	Population	Average Water Supply Volume	Wastewater Generation	Ground-water I/I	Ave. Daily Flow	Max. Daily Flow	Max. Hourly Flow
	(pers.)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)
Ramtha City	138,605	16,078	12,862	0	12,862	15,047	22,571
Dnaibeh	4,109	362	290	0	290	339	509
Emrawah	7,322	644	515	0	515	603	905
Shajarah	22,359	1,968	1,574	0	1,574	1,842	2,763
Torrah	28,803	2,535	2,028	0	2,028	2,373	3,560
Total	201,198	21,587	17,269	0	17,269	20,204	30,308

4.3.4 Design Wastewater Quality

(1) Design Influent Quality

Design influent BOD_5 and SS for the Ramtha WWTP are set as shown in Table 4.24.

Table 4.24　Design Influent Quality for the Ramtha WWTP

Wasetwater Treatment District	Population【2035】	Ave. Daily Flow	BOD Loads	SS Loads	Influent BOD Conc.	Influent SS Conc.
	(pers.)	(m^3/day)	(kg/day)	(kg/day)	(mg/ℓ)	(mg/ℓ)
Ramtha	201,198	17,269	13,078	12,072	757	699

Unit Pollution Load		
BOD	65	(g/capita/day)
SS	60	(g/capita/day)

(2) Design Effluent Quality

1) Current Use of Treated Effluent at the Existing WWTPs

The current use of treated effluent at Ramtha WWTP and allowable limits specified in the Jordanian Standards (No. 893/2006) are summarized in Table 4.25.

Table 4.25　Current Use of Treated Effluent at Ramtha WWTP and Allowable Limits in Treated Effluent

Category of Use	Bb-3*
Purpose or Place	Feed Crop
BOD_5 (mg/l)	300
CODcr (mg/l)	500
TSS (mg/l)	300
T-N (mg/l)	100
NO_3-N (mg/l)	70

Note: * Category Bb-3: Irrigation, Feed crops, industrial crops and forest trees (Refer to Table 4.5)

2) Design Effluent Quality

The design treated effluent quality for Ramtha WWTP by the OTV[2] project is shown in Table 4.26. This is used to determine the effluent quality for the expansion of the treatment facilities at Ramtha WWTP.

Table 4.26　Design Effluent Quality for Ramtha WWTP

Category of Use	Closed to Bb-1*
Discharge	Wadi and farmlands nearby
BOD_5 (mg/l)	30
CODcr (mg/l)	100
TSS (mg/l)	30
NO_3-N (mg/l)	25
NH_4-N (mg/l)	15
T-N (mg/l)	45

Note: * Category Bb-1: Irrigation, Cooked vegetables, parks, playgrounds and roadsides in populated area (Refer to Table 4.5)
Source: OTV Report

[2] OTV is the associated company of Veolia Water Solutions & Technologies for engineering services

4.4 Greater Mafraq Municipality

4.4.1 Service Area

(1) Existing sewerage service area

The sewerage system is developed in parts of Mafraq as shown in Figure 4.11. The expansion of sewers and facilities at the WWTP have been implemented during 2011 and 2014 by USAID. The service area is about 879 ha.

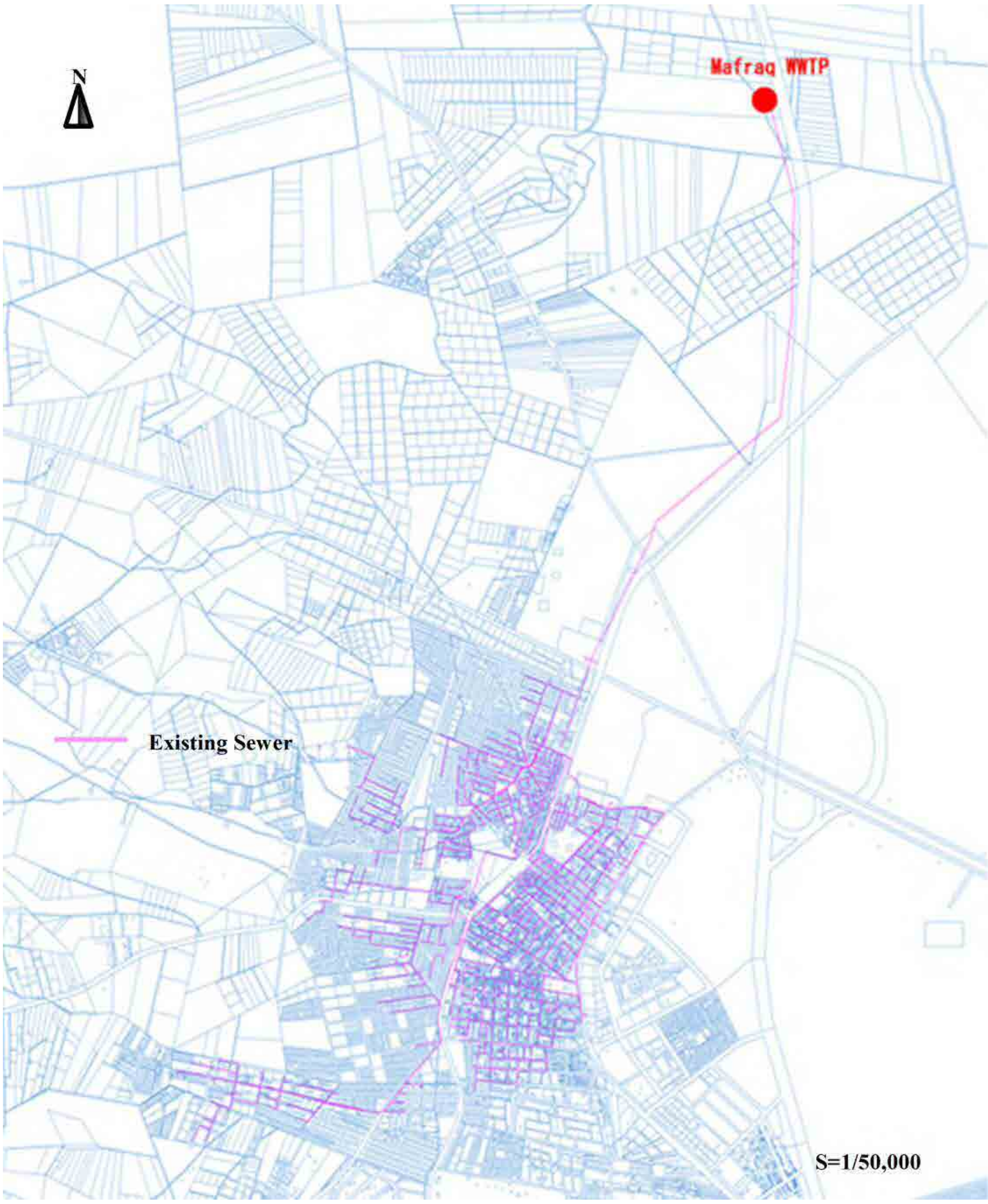


Figure 4.11 Existing Sewerage Service Area in Mafraq

(2) Priority Areas in SWMP

The Priority II areas for Mafraq defined in the SWMP are shown in Figure 4.12. Manshiyet Bani Hassan is close to Mafraq WWTP, but the southern three localities of Balama, Khaldiyah and Mabrookah are far from Mafraq WWTP but close to As Samra WWTP. The topographic features are advantageous for connecting these three localities to the As Samra WWTP.

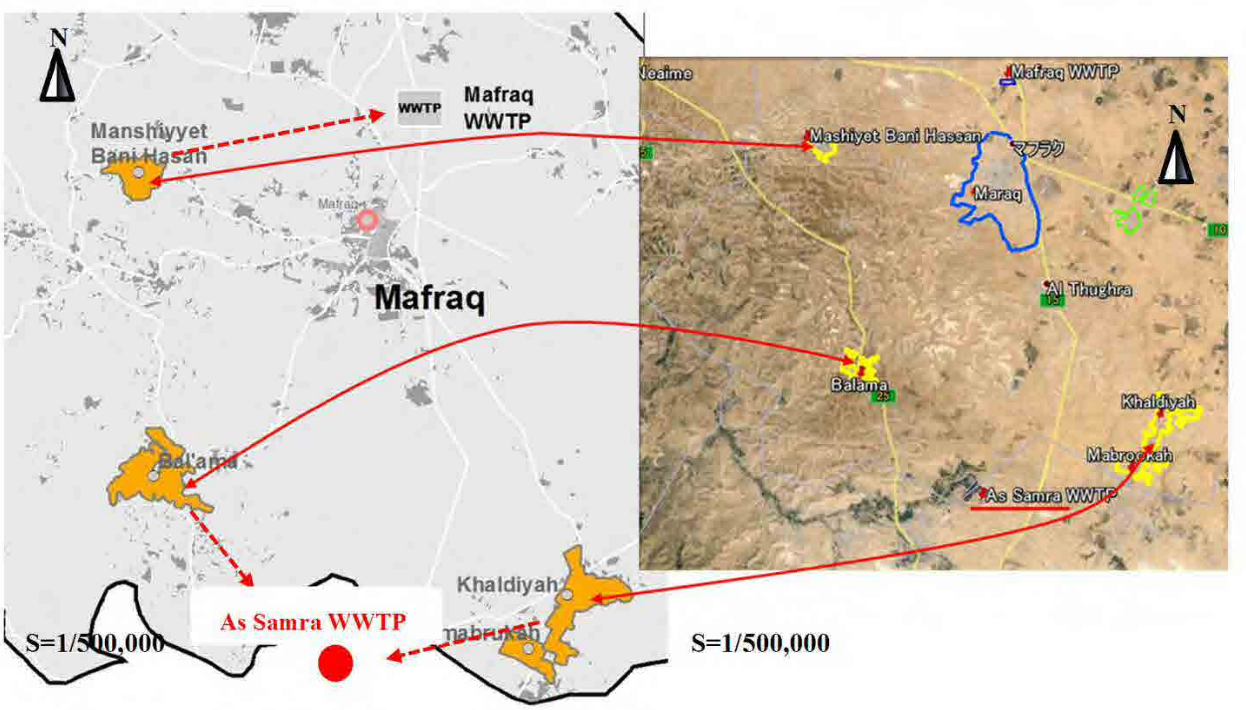


Figure 4.12 Priority II Area in Mafraq Proposed by SWMP

(3) Existing Urban Plan

As explained in Chapter 2, there is no urban plan for Mafraq area, but the water supply plan prepared by KfW covers the future (2039) expansion area.

The northern, southern and eastern boundaries of the water supply plan are used to define the sewerage plan. The western boundary follows the boundary of Mafraq City.

(4) Influx of Syrian Refugees

Figure 4.13 shows the influx of Syrian refugees to urban areas in Jordan. About 33% of Syrian refugees are living in Mafraq[3].

[3] High level conference on Jordan's Water Crisis

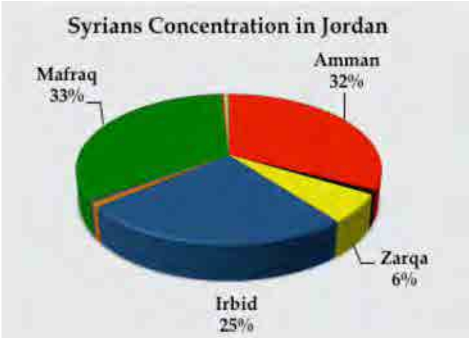


Figure 4.13 Syrian Refugees as Percentage of Total Population

Table 4.27 shows the number of Syrian refugees in the municipalities in Mafraq Oasabah District. The total of Jordanian population and number of Syrian refugees as of 2013 are compared with the projected Jordanian population in 2035. In the Mafraq Al-Koba municipality, the 90,000 Syrian refugees exceed the Jordanian population of 70,000, and the current Jordanian population and Syrian refugees exceed the projected Jordanian population for 2035.

Table 4.27 Syrian Refugees in Mafraq Oasabah District

District	Municipality	Jordanian Population 【2012】 (pers.)	Syrian Refugees 【July 2013】 (pers.)	Syrian/ Jordanian (%)	A: Jordanian+ Refugees (pers.)	B: Jordanian Population 【2035】 (pers.)	A/B (%)
Mafraq Oasabah	Mafraq Al-Kobra	70,050	90,000	128	160,050	113,546	141
	Ba'ama Al-Jadida	25,570	7,500	29	33,070	41,447	80
	Irhab Al-Jadida	20,370	5,000	25	25,370	33,018	77
	Manshiyah Bani Hassan	9,090	2,500	28	11,590	14,734	79
	Total	125,080	105,000	-	230,080	202,745	-

Source: "Needs Assessment Review of the Impact Syrian Refugees on Jordan"

(5) Sewerage Service Area

Figure 4.14 shows the planned service area for Greater Mafraq Municipality. The service area is 3,770 ha in total, an increase of 349%, with 2,931 ha to be developed.

Bani Hassan located at the western part of the city is included in the sewerage service area, as a Priority II area in the SWMP and the KfW water supply area.

Table 4.28 Sewerage Service Area in Mafraq

City/Locality	Sewerage Service Area (ha)		Increase B-A (ha)	B/A (%)
	Existing (A)	Planned (B)		
Mafraq City	839	3,409	2,570	406
Manhiyah Bani Hassan	-	240	240	-
Aidoon	-	121	121	-
Total	839	3,770	2,931	449

Source:JICA Study Team

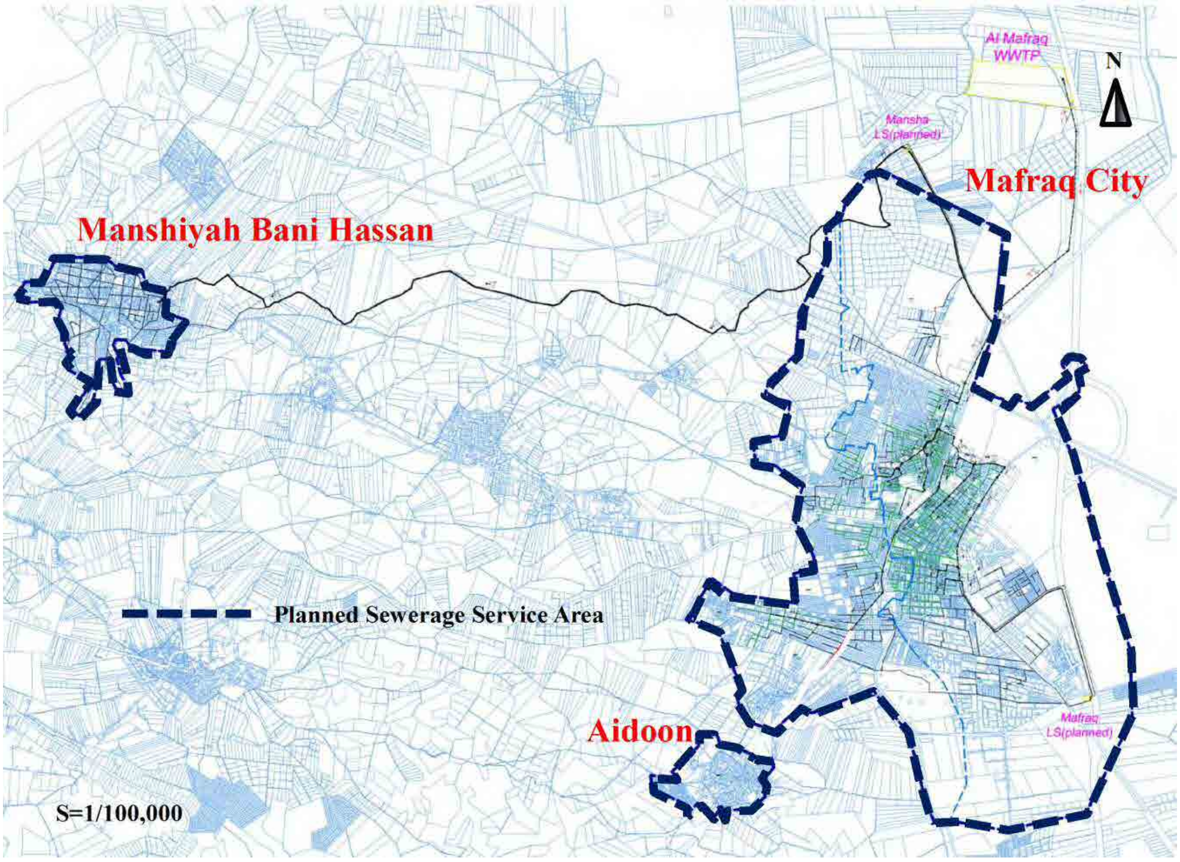


Figure 4.14 Planned Sewerage Service Area in Greater Mafraq Municipality

4.4.2 Service Population

Table 4.29 (a) shows the present population and refugee number in each locality and Figure 4.15 shows the geographical locations.

The 2012 population in the Mafraq-sub District is 70,050. About 90,000 Syrian refugees fled to Mafraq city and suburbs, bringing the total population to 160,050.

Mashiyet Bani Hassan has a total population of 10,854, with a local population of 8,354 and 2,500 refugees.

The population projection by DOS for 2035 for Mafraq-sub district is 113,546, lower than the present total population of 160,050. The projected population of 13,541 in Mashiyet Bani Hassan is higher than the present total population of 10,854.

The following adjustment is made to the projected population in Mafraq sub-district.

The total population of Mafraq sub-district in 2035 including refugees is fixed at 160,050. The number of refugees remaining in 2035 is estimated to be 46,505 which is the balance between the total population and the projected population of 113,545. These population projections are shown in Table 4.29 (b).

Based on the population set for the Mafraq area, the sewerage service population is 156,137, composed of the population of Mafraq City, Aidoon and Mashiyet Bani Hassan.

Table 4.29 (a) Present Population in Greater Mafraq Municipality

	City and Locality	【2012】 Population	Refugee No.	Total
①	Mafraq City	58,736	79,980	138,716
②	Aidoon	2,608	3,551	6,159
③	Um Enna'am Sharqiyyeh	1,591	2,166	3,757
④	Um Enna'am Gharbiyyeh	1,436	1,955	3,391
⑤	Bwaidhet El-Hawamdeh	1,724	2,348	4,072
	Sub-total	66,095	90,000	156,095
⑥	Hayyan El-Meshref	1,172	-	1,172
⑦	Mazzeh	1,091	-	1,091
⑧	Ghadier Abyadh	726	-	726
⑨	Teeb Isem	500	-	500
⑩	Rojom Essabi'e El-Shamali	466	-	466
	Total above	70,050	90,000	160,050
	Mafraq Sub-district	70,050	90,000	160,050
⑪	Mashiyet Bani Hassan	8,354	2,500	10,854

Table 4.29 (b) Population in 2035 in Greater Mafraq Municipality

	City and Locality	【2035】 Population	Refugee No.	Total	Sewerage Plannig Population
①	Mafraq City	95,207	41,327	136,534	136,534
②	Aidoon	4,227	1,835	6,062	6062
③	Um Enna'am Sharqiyyeh	2,579	1,119	3,698	
④	Um Enna'am Gharbiyyeh	2,328	1,011	3,339	
⑤	Bwaidhet El-Hawamdeh	2,794	1,213	4,007	
	Sub-total	107,135	46,505	153,640	
⑥	Hayyan El-Meshref	1,900	-	1,900	
⑦	Mazzeh	1,768	-	1,768	
⑧	Ghadier Abyadh	1,177	-	1,177	
⑨	Teeb Isem	810	-	810	
⑩	Rojom Essabi'e El-Shamali	755	-	755	
	Total above	113,545	46,505	160,050	
	Mafraq Sub-district	113,546		160,050	
⑪	Mashiyet Bani Hassan	13,541	0	13,541	13,541
					156,137

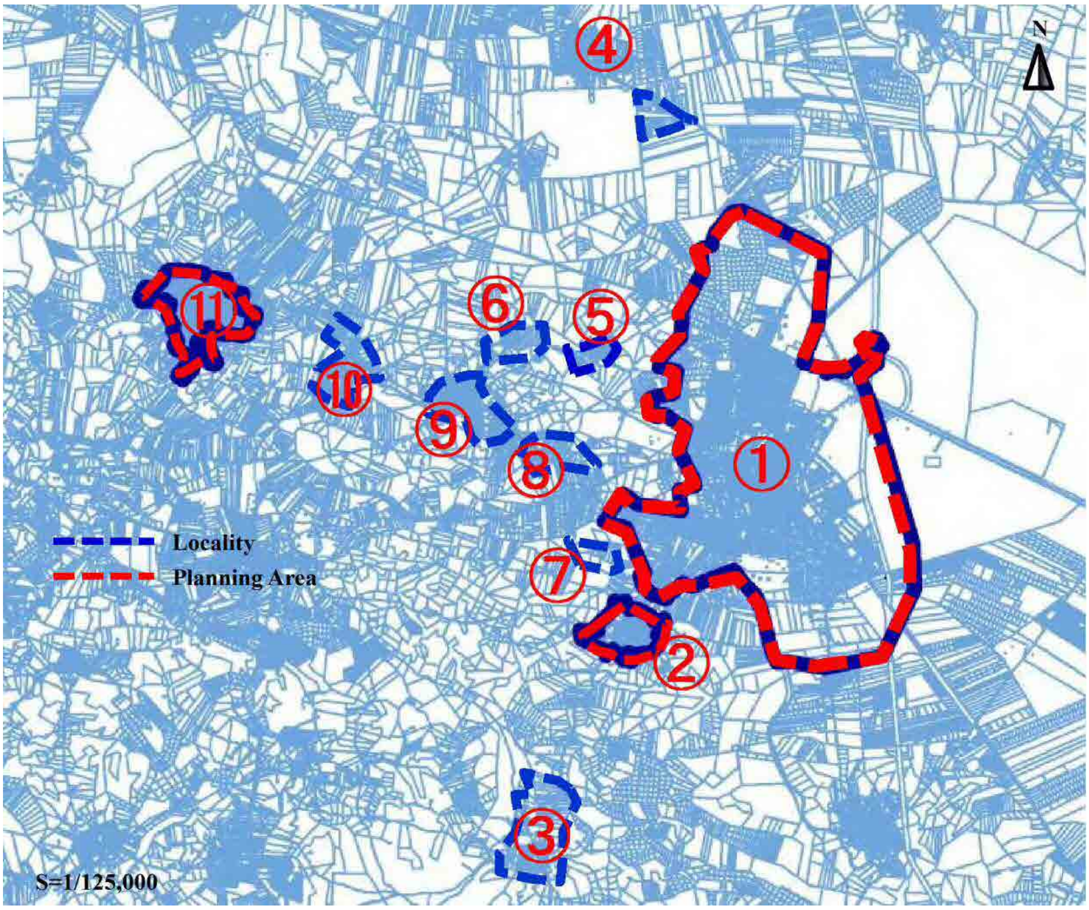


Figure 4.15 .Localities in Greater Mafraq Municipality

4.4.3 Design Flows

Table 4.30 summarizes the design flows for Mafraq SWD.

Table 4.30 Calculation of Design Flows for Mafraq SWD

City and Locality	Population, (include refugees)	Average Water Supply Volume	Wastewater Generation	Ground-water I/I	Ave. Daily Flow	Max. Daily Flow	Max. Hourly Flow
	(pers.)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)
Mafraq City	136,534	15,838	12,670	0	12,670	14,822	22,233
Aidoon	6,062	533	426	0	426	500	750
Mashiyet Bani Hassan	13,541	1,571	1,257	0	1,257	1,470	2,205
Total	156,137	17,942	14,353	0	14,353	16,792	25,190

Source: JICA Study Team

4.4.4 Design Wastewater Quality

(1) Design Influent Quality

Design influent BOD_5 and SS for the Ramtha WWTP are set as shown in Table 4.31.

Table 4.31 Design Influent Quality for the Mafraq WWTP

Wasetwater Treatment District	Population 【2035】	Ave. Daily Flow	BOD Loads	SS Loads	Influent BOD Conc.	Influent SS Conc.
	(pers.)	(m^3/day)	(kg/day)	(kg/day)	(mg/ℓ)	(mg/ℓ)
Mafraq	156,137	14,353	10,149	9,368	707	653

Unit Pollution Load		
BOD	65	(g/capita/day)
SS	60	(g/capita/day)

(2) Design Effluent Quality

1) Current Use of Treated Effluent at the Mafraq WWTP

The current use of treated effluent and allowable limits specified in the Jordanian Standards (No. 893/2006) for Mafraq WWTP are summarized in Table 4.32.

Table 4.32 Current Use of Treated Effluent at Mafraq WWTP and Allowable Limits

Category of Use	Bb-3*
Discharge Place	Wadi and farmlands nearby
BOD_5 (mg/l)	300
CODcr (mg/l)	500
TSS (mg/l)	300
T-N (mg/l)	100
NO_3-N (mg/l)	70

Note: * * Category Bb-3: Irrigation, Feed crops, industrial crops and forest trees (Refer to Table 4.5)

Source: JICA Study Tea,

2) Design Effluent Quality.

The design effluent quality for Mafraq WWTP (USAID project) is shown in Table 4.33. This is used for the design effluent quality for the expansion of treatment facilities at Mafraq WWTP.

Table 4.33 Design Treated Effluent Quality for Mafraq WWTP

Category of Use	A*
Purpose or Place	Discharge to Wadi
BOD_5 (mg/l)	60
CODcr (mg/l)	150
TSS (mg/l)	60
NO_3-N (mg/l)	70
NH_4-N (mg/l)	-
T-N (mg/l)	80

Note: * Discharged to streams, wadis and reservoirs (Refer to Table 4.3)

Source: USAID report

CHAPTER 5　SEWERAGE DEVELOPMENT PLAN

5.1 Existing Capacity of Sewerage Facilities

5.1.1　Assessment of Trunk Sewers

(1)　Methodology

The design flow is compared with the present capacity following the process outlined in Figure 5.1.

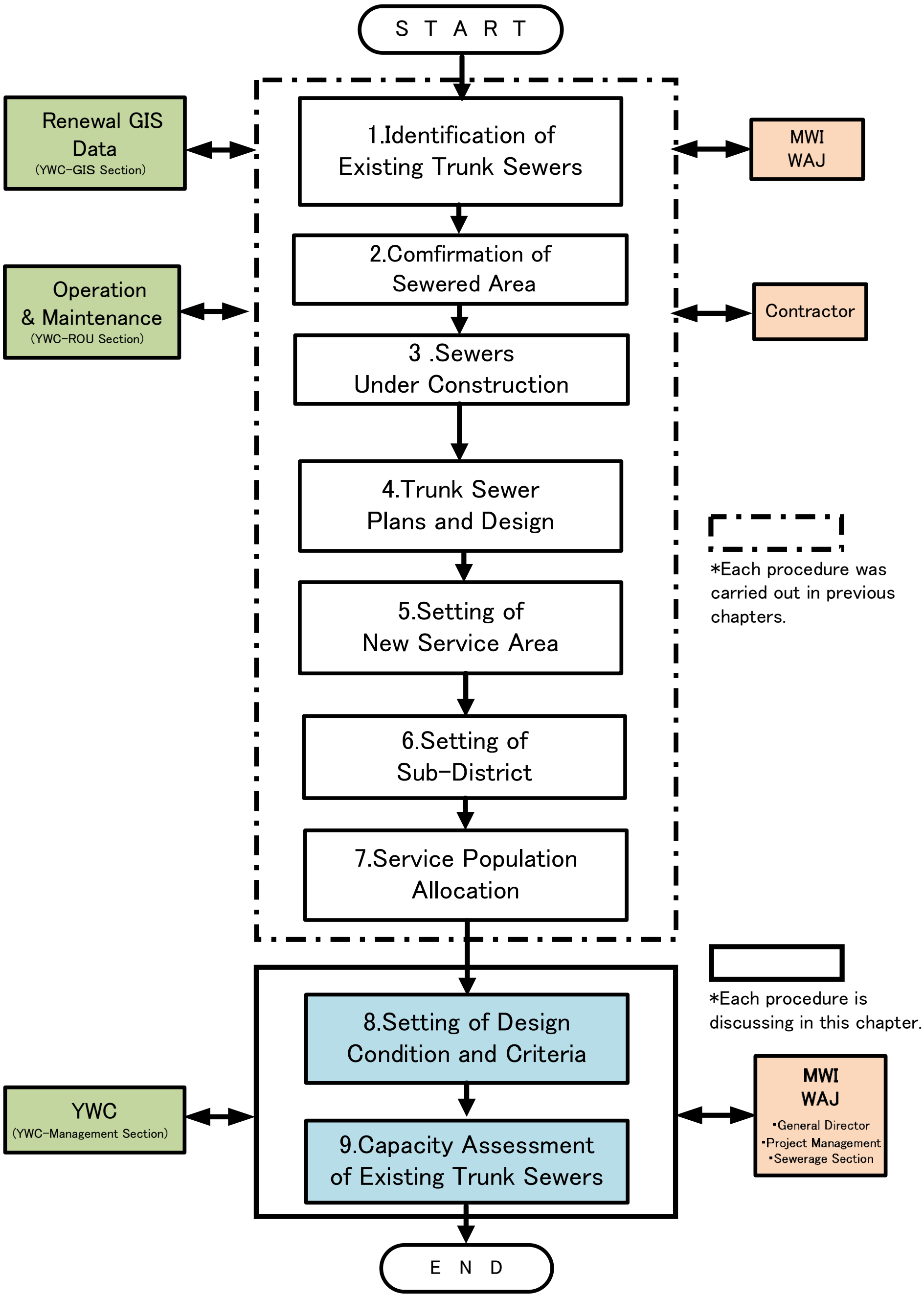


Figure 5.1 Capacity Assessment Process for Trunk Sewers

(2) Assessment

The sewerage plan for each sewerage district described in Chapter 3 is further studied to determine the design flows in the existing sewers. The detailed capacity assessment is explained in the following sub.sections.

The capacity of sewers is assessed based on the design standards of sewers prepared by WAJ. The main design criteria are as follows:

1) Peaking Factor

The Peaking Factor (PF) is determined based on the size of the service population:

For a service population of less than 80,000: Babbit's Peaking Factor is calculated using the following equation:

$$PF = 5/(P/1000)^{(1/6)}$$

Where, P: Planning Population.   The PF value should be less than 4.5 (PF<4.5).

For a service population of more than or equal to 80,000: Babbit's Peaking Factor is calculated using the following equation:

$$PF=\{18+(P/1,000)^{0.5}\}/\{4+(P+1,000)^{0.5}\}$$

The PF value should be less than 2.5 (PF<2.5).

2) Flow Velocity Equation

Manning's formula is used for calculating the flow velocity.

$$V=(1/n)\times R^{2/3}\times S$$

Where, V: flow velocity (m/s), R: wetted perimeter (m), S: slope (m/m), n: roughness coefficient

3) Minimum Diameter

The minimum diameter of sewers is 200 mm.

4) Minimum and Maximum Flows

Table 5.1 shows the minimum and maximum velocity set for pressured and free surface flow..

Table 5.1 Minimum and Maximum Velocity

Item	Pressured flow	Free surface flow
Minimum Velocity	0.8 m/s	4.0 m/s
Maximum Velocity	0.9 m/s	4.5 m/s

5) Minimum and Maximum Slope

The minimum and maximum slopes for concrete pipes of different diameters with the roughness coefficient of 0.013, under pressured flow are shown in Table 5.2.

Table 5.2 Minimum and Maximum Slope

Pipe Diameter (mm)	Minimum Slope (m/km)	Maximum Slope (m/km)
200	10.0	194.8
300	5.8	114.0
400	3.9	77.0
500	2.9	57.3
600	2.3	45.0
700	1.9	37.0
800	1.6	30.8
900	1.3	26.3
1,000	1.2	22.8
1,200	1.0	17.8

6) Roughness Coefficient

The roughness coefficient for calculating flow velocity using the Manning formula varies depending on the pipe material (see Table 5.3).

Table 5.3 Roughness Coefficients

Pipe Material	Roughness Coefficient
Concrete pipe	0.013
Plastic pipe or Inner coating with epoxy resin	0.012
Ductile Cast Iron pipe	0.012
PVC (polyvinyl chloride) pipe	0.010

7) Pipe Sizing and Design Allowance for Sewers Flowing Partly Full

In general sewers are designed to flow full only under maximum conditions. For optimum performance sewers are designed to flow partially full at design flows. For design purposes the ratio between design flow (q) and the maximum full pipe flow (Q) is usually taken as 0.75 or less. This (q/Q) ratio is equivalent to a depth of flow to the diameter ratio (h/D) of 0.67. The relationships between depth and flow for partly full and full pies are shown schematically in Figure 5.2 for a circular pipe.

The existing sewers are evaluated based on the ratio of depth to diameter h/D. When the ratio exceeds 0.67, the sewer does not have enough capacity.

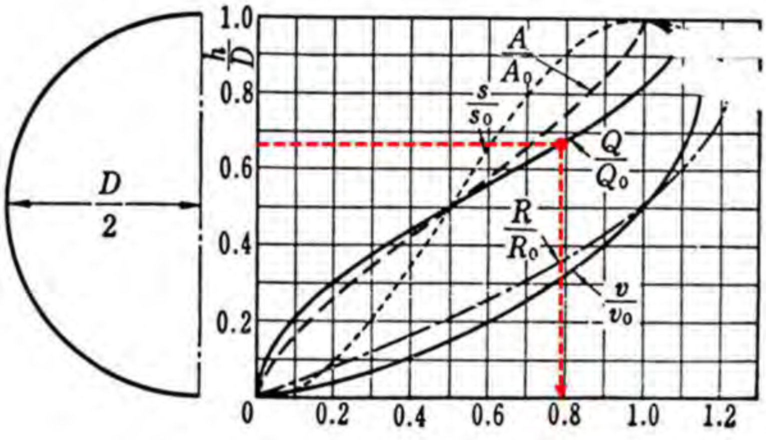
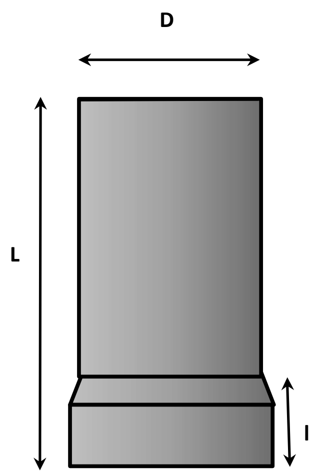


Figure 5.2 Hydraulic Elements for Circular Pipes and Allowance for Pipe Design

8) Concrete Pipe used in Jordan

The standards for concrete pipe commercially available in Jordan are as shown in Table 5.4 and Figure 5.3.

Table 5.4 Standards for Concrete and Reinforced Concrete Pipes in Jordan



Concrete Pipes

Diameter: D (mm)	Effective length: L (mm)	Pipe thickness (mm)	Ring thickness (mm)	Cut depth: l (mm)	Standard weight (kg)
100	1,000	24	12	56	30
150	1,000	40	12	65	72
200	1,000	40	12	68	90
250	1,000	40	14	63	92
300	1,000	44	16	68	102
400	1,000	50	16	97	195
500	1,000	60	15	105	245

Reinforced Pipes

Diameter: D (mm)	Effective length: L (mm)	Pipe thickness (mm)	Ring thickness (mm)	Cut depth: l (mm)	Standard weight (kg)
300	2,000	45	16	95	255
400	2,000	55	16	95	412
500	2,000	60	15	95	554
600	2,000	75	18	110	716
800	2,000	102	18	110	1,227
900	2,000	110	22	125	1,706
1,000	2,000	110	22	125	1,998
1,200	2,000	120	22	125	2,886

Source: Institution for Standard & Metrology

Figure 5.3 Concrete Pipes used in Jordan

(3) Assessment of the Existing Trunk Sewers

The topographic feature of hills and “Wadis” provides adequate slope such that almost all of the existing trunk sewers have enough capacity to handle the future wastewater flows. The ratio of water depth (h/D) is less than 0.67 for all trunk sewers in the Central Irbid Sewerage District (see Table 5.5), Wadi-Arab Sewerage District (see Table 5.6), Shallala Sewerage District (see Table 5.7), Wadi-Hassan Sewerage District (see Table 5.8). Therefore, the trunk sewers in these districts are judged to have enough capacity to meet the design flow.

The ratio of water depth is less than 0.67 for most of the trunk sewers in Ramtha Sewerage District, except for line no. 1990 which has the h/D value of 0.71 (see Table 5.9). This difference is too small to be of significance. Therefore, the sewers in Ramtha should have enough capacity to handle the planned flow.

Tables 5.10 and 5.11 show the assessment of trunk sewers in the Mafraq Sewerage District.

In Case-1 shown in Table 5.10, the wastewater is pumped by the proposed lift station at the south western part of Mafraq and conveyed to the trunk sewer (node no. 694). Wastewater collected in Aidoon is conveyed to node no. 1267 by new sewers. Several trunk sewers do not have enough capacity for the design flows.

Case-2 (Table 5.11) shows the changes to the locations of connections. Wastewater is pumped by the lift station to the trunk sewer (node no. 703), and the wastewater from Aidoon is conveyed to the trunk sewer (node no. 1319). The trunk sewer is diverted to the new trunk sewer line (NAH-1 and NAH-2) and then connected to the existing trunk sewer line (node no. 168). The new connections can provide an h/D that is less than 0.67, and the sewers thus has enough capacity for the design flow.

Table 5.5 Capacity Assessment of the Existing Trunk Sewers in Central Irbid SWD

Urban 92.80ℓpcd   Rurul 70.40ℓpcd

Line Name	From		To		Pipe Diameter	Pipe Material	Pipe Length	Pipe Slope	Population 【2035】		Peak Factor	Pipe Flow Data						Assessment 【d/D<0.67】
	M.H. No.	Invert Level	M.H. No.	Invert Level					Each	integrated Value		Total Flow	Flow Full	Flow Vel.	Ratio q-part	Actual Vel.	Ratio depth	
	-	[m]	-	[m]	[φmm]	[rial]	[m]	[1/1000]	[pers.]		-	[ℓ/sec]	[ℓ/sec]	[m/sec]	[/q-full]	[m/sec]	[d/D]	-
779	779	-	523	-	300	CP	772.02	12.30	7,351	7,351	3.59	28.32	109.09	1.54	0.2595	1.30	0.34	OK
523	523	-	559	-	300	CP	540.52	28.60	13,297	20,648	3.02	66.96	166.33	2.35	0.4026	2.24	0.44	OK
559	559	-	1069	-	400	CP	339.79	8.90	4,071	24,720	2.93	77.80	198.80	1.58	0.3913	1.49	0.43	OK
1069	1069	-	685	-	400	CP	328.08	54.80	19,314	44,034	2.66	125.87	493.09	3.92	0.2553	3.30	0.34	OK
	flow into 685																	OK
851	851	-	685	-	300	CP	714.88	8.70	16,011	16,011	3.15	54.17	91.75	1.30	0.5904	1.34	0.56	OK
685	685	-	476	-	400	CP	413.35	17.10	634	60,679	2.52	164.43	275.53	2.19	0.5968	2.26	0.56	OK
	flow into 476																	OK
740	740	-	476	-	400	CP	478.34	39.50	3,527	3,527	4.05	15.35	418.68	3.33	0.0367	1.63	0.13	OK
476	476	-	471	-	500	CP	253.48	27.30	160	64,366	2.50	172.72	627.77	3.20	0.2751	2.75	0.35	OK
471	471	-	1394	-	600	CP	455.40	25.50	19,054	83,420	1.05	93.88	981.56	3.47	0.0956	2.22	0.21	OK
	flow into 1394																	OK
1776	1776	-	1762	-	300	CP	1004.00	16.40	4,003	4,003	3.97	12.94	125.97	1.78	0.1028	1.16	0.21	OK
1762	1762	-	1394	-	300	CP	754.25	11.30	1,543	5,546	3.76	22.39	104.57	1.48	0.2141	1.18	0.31	OK
1394	1394	-	463	-	900	CP	698.19	1.50	4,397	93,363	1.05	104.81	692.73	1.09	0.1513	0.79	0.26	OK
463	463	-	WWTP	-	900	CP	624.69	4.60	869	94,232	1.05	105.77	1212.96	1.91	0.0872	1.20	0.20	OK
	flow into Irbid Central WWTP																	
2736	2736	-	2292	-	300	CP	575.05	3.80	10,168	10,168	3.40	37.11	60.65	0.86	0.6119	0.89	0.57	OK
	flow into 2292																	
2765	2765	-	2292	-	500	CP	941.55	12.20	12,024	12,024	3.30	42.67	419.73	2.14	0.1017	1.39	0.21	OK
2292	2292	-	WWTP	-	500	CP	607.38	27.00	1,716	23,908	2.95	75.66	624.31	3.18	0.1212	2.19	0.23	OK
	flow into Irbid Central WWTP						9500.97	Total	118,140	118,140								
					CP:Concrete Pipe													
					DIP:Ductile Iron Pipe													

Table 5.6 Capacity Assessment of the Existing Trunk Sewers in Wadi Al-Arab SWD

Urban 92.80ℓpcd   Rurul 70.40ℓpcd

Line Name	From M.H. No.	From Invert Level	To M.H. No.	To Invert Level	Pipe Diameter	Pipe Material	Pipe Length	Pipe Slope	Population 【2035】 Each	Population 【2035】 integrated Value	Peak Factor	Pipe Flow Data: Total Flow	Flow Full	Flow Vel.	Ratio q-part	Actual Vel.	Ratio depth	Assessment 【d/D<0.67】
	-	[m]	-	[m]	[φmm]	[rial]	[m]	[1/1000]	[pers.]		-	[ℓ/sec]	[ℓ/sec]	[m/sec]	[/q-full]	[m/sec]	[d/D]	-
4280	-	-	-	-	300	CP	756.80	25.10	6,664	6,664	3.65	26.09	155.82	2.20	0.1674	1.65	0.27	OK
2855	-	-	-	-	300	CP	772.80	12.20	5,705	12,369	3.29	43.69	108.65	1.54	0.4021	1.46	0.44	OK
726	-	-	-	-	300	CP	962.10	14.40	2,718	15,087	3.18	51.55	118.04	1.67	0.4367	1.60	0.46	OK
1560	-	-	-	-	500	CP	849.20	6.90	5,440	20,527	3.02	66.63	315.68	1.61	0.2111	1.29	0.31	OK
6322	-	-	-	-	500	CP	443.50	32.70	10,370	30,897	2.82	93.69	687.02	3.50	0.1364	2.48	0.25	OK
6788	-	-	-	-	500	CP	841.60	25.30	30,187	61,084	2.52	165.35	604.35	3.08	0.2736	2.65	0.35	OK
2951	-	-	-	-	500	CP	125.40	26.50	9,153	70,237	2.46	185.75	618.50	3.15	0.3003	2.77	0.37	OK
4336	-	-	-	-	600	CP	512.80	9.00	9,647	79,884	2.41	206.78	583.26	2.06	0.3545	1.90	0.41	OK
4519	-	-	-	-	600	CP	432.60	20.50	6,723	86,608	1.05	97.39	880.13	3.11	0.1107	2.09	0.22	OK
700	-	-	-	-	600	CP	774.40	53.90	7,161	93,769	1.05	105.26	1426.72	5.05	0.0738	3.03	0.18	OK
2413	-	-	-	-	600	CP	951.90	47.70	9,166	102,935	1.04	115.32	1342.22	4.75	0.0859	2.94	0.19	OK
3401	-	-	-	-	600	CP	845.10	37.70	6,701	109,636	1.04	122.68	1193.35	4.22	0.1028	2.74	0.21	OK
	flows into 6349																	
2170	-	-	-	-	500	CP	831.20	44.20	8,739	8,739	3.48	32.71	798.67	4.07	0.0410	2.03	0.13	OK
	flows into 2097																	
3090	-	-	-	-	300	CP	517.70	71.00	7,004	7,004	3.62	27.20	262.00	3.71	0.1038	2.41	0.21	OK
2097	-	-	-	-	500	CP	1122.06	30.10	18,910	34,653	2.77	103.09	659.16	3.36	0.1564	2.48	0.26	OK
6334	-	-	-	-	500	CP	745.60	47.60	4,900	39,553	2.71	115.10	828.80	4.22	0.1389	3.00	0.25	OK
	flows into 2574																	
5641	-	-	-	-	300	CP	815.40	26.00	8,507	8,507	3.50	31.98	158.59	2.24	0.2017	1.77	0.30	OK
5653	-	-	-	-	300	CP	933.90	23.60	2,617	11,124	3.35	39.99	151.10	2.14	0.2647	1.82	0.35	OK
4156	-	-	-	-	300	CP	1642.90	22.10	0	11,124	3.35	39.99	146.22	2.07	0.2735	1.78	0.35	OK
2195	-	-	-	-	300	CP	1049.80	25.00	8,739	19,864	3.04	64.83	155.51	2.20	0.4169	2.09	0.45	OK
2574	-	-	-	-	500	CP	496.40	18.50	5,877	65,294	2.49	174.79	516.82	2.63	0.3382	2.37	0.39	OK
2111	-	-	-	-	500	CP	1062.80	25.70	6,204	71,497	2.45	188.52	609.10	3.10	0.3095	2.73	0.37	OK
1929	-	-	-	-	500	CP	1356.40	21.20	2,253	73,750	2.44	193.46	553.24	2.82	0.3497	2.56	0.40	OK
6349	-	-	-	-	800	CP	2683.60	22.20	0	183,386	1.03	203.35	1954.11	3.89	0.1041	2.53	0.21	OK
	flows into 3097																	
6772	-	-	-	-	300	CP	920.30	15.20	2,492	2,492	4.29	11.49	121.27	1.72	0.0948	1.10	0.20	OK
1213	-	-	-	-	400	CP	446.80	7.50	15,320	17,811	3.09	59.20	182.50	1.45	0.3244	1.29	0.39	OK
4799	-	-	-	-	500	CP	86.40	9.70	13,452	31,263	2.82	94.62	374.28	1.91	0.2528	1.60	0.34	OK
5259	-	-	-	-	600	CP	288.30	6.20	3,609	34,872	2.77	78.62	484.13	1.71	0.1624	1.27	0.27	OK
	flows into Hakama LS																	
5047	-	-	-	-	400	DCIP	1784.10	-	0	34,872	2.77	103.64	Pressure	1.00	【6.218m³/min】			OK
1109	-	-	-	-	600	CP	688.80	36.50	44,121	78,994	2.41	155.41	1174.22	4.15	0.1324	2.91	0.24	OK
1376	-	-	-	-	600	CP	437.20	20.10	12,057	91,051	1.05	77.59	871.51	3.08	0.0890	1.94	0.20	OK
4644	-	-	-	-	600	CP	109.70	27.10	2,823	93,874	1.05	79.94	1011.87	3.58	0.0790	2.18	0.19	OK
762	-	-	-	-	700	CP	655.20	18.80	22,134	116,008	1.04	98.37	1265.29	3.29	0.0777	2.01	0.19	OK
3376	-	-	-	-	700	CP	3892.80	44.20	10,324	126,332	1.04	106.95	1939.59	5.04	0.0551	2.77	0.16	OK
3097	-	-	-	-	900	CP	276.00	43.40	0	309,718	1.02	258.67	3723.74	5.85	0.0695	3.45	0.18	OK
6351	-	-	-	-	900	CP	276.00	50.00	9,997	319,715	1.02	266.91	3996.63	6.28	0.0668	3.64	0.17	OK
6354	-	-	-	-	900	CP	2122.30	51.60	0	319,715	1.02	266.91	4060.02	6.38	0.0657	3.70	0.17	OK
2790	-	-	-	-	900	CP	2122.30	41.80	0	319,715	1.02	266.91	3654.51	5.74	0.0730	3.45	0.18	OK
	flows into Wadi Arab WWTP																	
2240	-	-	-	-	300	CP	1505.30	172.50	9,154	9,154	3.46	36.63	408.23	5.78	0.0897	3.64	0.20	OK
	flows into Wadi Arab WWTP						37137.46	Total	328,869	328,869								

CP:Concrete Pipe

DIP:Ductile Iron Pipe

Table 5.7 Capacity Assessment of the Existing Trunk Sewers in Shallala SWD

Urban 92.80ℓpcd　　Rurul 70.40ℓpcd

Line Name	From M.H. No.	From Invert Level	To M.H. No.	To Invert Level	Pipe Diameter	Pipe Material	Pipe Length	Pipe Slope	Population 【2035】 Each	Population 【2035】 integrated Value	Peak Factor	Pipe Flow Data: Total Flow	Flow Full	Flow Vel.	Ratio q-part	Actual Vel.	Ratio depth	Assessment 【d/D<0.67】
	-	[m]	-	[m]	[φmm]	[rial]	[m]	[1/1000]	[pers.]		-	[ℓ/sec]	[ℓ/sec]	[m/sec]	[/q-full]	[m/sec]	[d/D]	-
5884	-	-	-	-	300	CP	4554.70	6.00	13,416	13,416	3.24	35.46	76.20	1.08	0.4654	1.06	0.48	OK
	flows into 17877-1																	
AZMI-1	-	-	-	-	400	CP		6.00	24,284	24,284	2.94	58.15	163.23	1.30	0.3562	1.20	0.41	OK
5034	-	-	-	-	300	CP	300.00	16.00	9,382	9,382	3.44	26.32	124.42	1.76	0.2116	1.41	0.31	OK
17877-1	-	-	-	-	600	CP	1580.00	2.30	28,889	75,970	2.43	150.44	294.90	1.04	0.5101	1.04	0.51	OK
17877-2	-	-	-	-	600	CP	1000.00	2.30	13,148	89,118	1.05	75.98	294.90	1.04	0.2576	0.88	0.34	OK
17877-3	-	-	-	-	700	CP	850.00	1.90	11,957	101,075	1.04	85.94	402.37	1.05	0.2136	0.84	0.31	OK
17877-4	-	-	-	-	700	CP	1950.00	1.90	11,957	113,033	1.04	95.89	402.37	1.05	0.2383	0.86	0.32	OK
3524	-	-	-	-	700	CP	1130.00	1.90	2,312	115,344	1.04	97.81	402.37	1.05	0.2431	0.87	0.33	OK
3569	-	-	-	-	800	CP	276.20	1.60	474	115,819	1.04	98.21	524.82	1.04	0.1871	0.80	0.29	OK
3011	-	-	-	-	800	CP	960.00	1.60	13,143	128,962	1.04	109.13	524.82	1.04	0.2079	0.82	0.30	OK
3058	-	-	-	-	800	CP	1130.00	1.60	7,681	136,643	1.04	115.51	524.82	1.04	0.2201	0.85	0.32	OK
3030	-	-	-	-	800	CP	2640.00	1.60	0	136,643	1.04	115.51	524.82	1.04	0.2201	0.85	0.32	OK
	flows into 7478-2																	
3011	-	-	-	-	400	CP	1690.00	6.00	36,317	36,317	2.75	81.33	163.23	1.30	0.4982	1.30	0.49	OK
2091	-	-	-	-	500	CP	1530.00	2.90	8,212	44,529	2.66	96.38	204.68	1.04	0.4709	1.03	0.48	OK
15879	-	-	-	-	500	CP	820.00	2.90	4,249	48,778	2.62	103.99	204.68	1.04	0.5081	1.04	0.50	OK
2158	-	-	-	-	500	CP	560.00	2.90	1,924	50,702	2.60	141.57	204.68	1.04	0.6917	1.10	0.62	OK
	flows into 1562																	
1605	-	-	-	-	300	CP	417.00	19.10	12,029	12,029	3.30	42.68	135.94	1.92	0.3140	1.71	0.38	OK
	flows into 1562																	
7470	-	-	-	-	300	CP	940.00	6.00	9,013	9,013	3.47	33.56	76.20	1.08	0.4404	1.05	0.46	OK
7471	-	-	-	-	300	DCIP	2400.00	-	0	9,013	3.47	33.56	Pressure	-	【1.801m³/min】			OK
1562	-	-	-	-	600	CP	940.00	2.30	6,358	78,103	2.42	202.93	294.90	1.04	0.6881	1.11	0.61	OK
	flows into 1553																	
450	-	-	-	-	300	CP	220.90	24.80	6,392	6,392	3.67	25.20	154.89	2.19	0.1627	1.62	0.27	OK
521	-	-	-	-	300	CP	324.50	6.00	7,852	14,244	3.21	49.14	76.20	1.08	0.6449	1.13	0.59	OK
511	-	-	-	-	400	CP	446.20	5.80	5,865	20,109	3.03	65.50	160.49	1.28	0.4081	1.21	0.44	OK
521	-	-	-	-	500	CP	938.80	6.70	5,916	26,024	2.91	81.20	311.08	1.58	0.2610	1.35	0.35	OK
1553	-	-	-	-	500	CP	400.40	23.10	1,730	105,857	1.04	118.53	577.48	2.94	0.2053	2.32	0.30	OK
7427	-	-	-	-	500	CP	938.80	20.60	6,964	112,821	1.04	126.17	545.36	2.78	0.2314	2.28	0.32	OK
7476	-	-	-	-	600	CP	251.10	6.20	12,416	125,237	1.04	139.78	484.13	1.71	0.2887	1.47	0.36	OK
	flows into 7478-2																	
MHG-1	-	-	-	-	200	DIP	3300.00	-	16,831	16,831	3.12	42.84	Pressure	-	【2.570m³/min】			OK
1257-1	-	-	-	-	300	CP	30.00	18.00	9,703	26,534	2.90	62.61	131.96	1.87	0.4744	1.85	0.48	OK
1257	-	-	-	-	150	DIP	2237.50	-	0	26,534	2.90	62.61	Pressure	-	【3.929m³/min】			OK
1135	-	-	-	-	300	CP	145.90	54.20	7,052	33,587	2.78	76.20	228.93	3.24	0.3328	2.91	0.39	OK
1413	-	-	-	-	300	CP	507.60	50.00	7,972	41,559	2.69	91.00	219.89	3.11	0.4138	2.96	0.45	OK
7401	-	-	-	-	300	CP	398.50	50.00	3,239	44,798	2.65	96.87	219.89	3.11	0.4405	3.02	0.46	OK
1422	-	-	-	-	300	CP	190.90	51.70	551	45,349	2.65	97.86	223.60	3.16	0.4377	3.04	0.46	OK
7478-1	-	-	-	-	600	CP	2020.00	2.30	0	170,585	1.03	143.66	294.90	1.04	0.4872	1.03	0.49	OK
7478-2	-	-	-	-	800	CP	430.00	1.60	0	307,228	1.03	256.61	524.82	1.04	0.4890	1.03	0.49	OK
	flows into Shallala WWTP						38449.00		307,228									
					CP:Concrete Pipe													
					DIP:Ductile Iron Pipe													

Table 5.8 Capacity Assessment of the Existing Trunk Sewers in Wadi-Hassan SWD

Urban	92.80ℓpcd	Rurul	70.40ℓpcd

Line Name	From M.H. No.	From Invert Level	To M.H. No.	To Invert Level	Pipe Diameter	Pipe Material	Pipe Length	Pipe Slope	Population 【2012】 Each	Population 【2012】 Total integrated Value	Peak Flow Factor	Pipe Flow Data: Flow Flow	Pipe Flow Data: Ratio Full	Pipe Flow Data: Actual Vel.	Pipe Flow Data: Ratio q-part	Pipe Flow Data: Vel.	Pipe Flow Data: depth	Assessment 【d/D<0.67】
	-	[m]	-	[m]	[φmm]	[rial]	[m]	[1/1000]	[pers.]		-	[ℓ/sec]	[ℓ/sec]	[m/sec]	[/q-full]	[m/sec]	[d/D]	-
1653	1653	-	1860	-	300	CP	1411.99	17.50	10,582	10,582	3.38	29.10	130.12	1.84	0.2236	1.49	0.32	OK
1860	1860	-	1800	-	300	CP	629.60	14.30	4,242	14,824	3.19	38.54	117.63	1.66	0.3276	1.48	0.39	OK
1800	1800	-	1795	-	400	CP	304.20	15.90	0	14,824	3.19	38.54	265.69	2.11	0.1451	1.52	0.25	OK
1795	1795	-	1772	-	400	CP	435.20	15.40	10,696	25,520	2.91	60.61	261.48	2.08	0.2318	1.71	0.32	OK
	flows into 1772																	
1105	1105	-	1089	-	300	CP	877.70	13.40	9,107	9,107	3.46	25.68	113.87	1.61	0.2255	1.30	0.32	OK
1089	1089	-	1772	-	300	CP	1026.10	18.40	750	9,857	3.42	27.43	133.42	1.89	0.2056	1.49	0.30	OK
1772	1772	-	LS	-	400	CP	505.50	11.70	0	35,377	2.76	79.57	227.92	1.81	0.3491	1.65	0.40	OK
	flows into Wadi hassan LS																	
1075	1075	-	1076-2	-	300	DIP	526.60	-	0	35,377	2.76	79.57	Pressure	1.50	【4.785m³/min】			OK
1076-2	1076-2	-	WWTP	-	800	CP	4145.20	1.60	0	35,377	2.76	79.57	524.82	1.04	0.1516	0.76	0.26	OK
	flows into Wadi Hassan WWTP						10833.59	Total	35,377									
					CP:Concrete Pipe													
					DIP:Ductile Iron Pipe													

Table 5.9 Capacity Assessment of the Existing Trunk Sewers in Ramtha SWD

Urban 92.80ℓpcd   Rurul 70.40ℓpcd

Line Name	From M.H. No.	From Invert Level	To M.H. No.	To Invert Level	Pipe Diameter	Pipe Material	Pipe Length	Pipe Slope	Population【2035】 Each	Population【2035】 integrated Value	Peak Factor	Pipe Flow Data: Total Flow	Flow Full	Flow Vel.	Ratio q-part	Actual Vel.	Ratio depth	Assessment【d/D<0.67】
	-	[m]	-	[m]	[φmm]	[rial]	[m]	[1/1000]	[pers.]		-	[ℓ/sec]	[ℓ/sec]	[m/sec]	[/q-full]	[m/sec]	[d/D]	-
1828	1828	-	751	-	300	CP	1217.20	3.20	4,885	4,885	3.84	15.28	55.65	0.79	0.2746	0.68	0.35	OK
751	751	-	1967	-	300	CP	328.70	2.80	3,290	8,175	3.52	23.47	52.06	0.74	0.4508	0.71	0.47	OK
1967	1967	-	1188	-	300	CP	97.90	5.10	1,489	9,664	3.43	26.98	70.26	0.99	0.3840	0.92	0.43	OK
1188	1188	-	544	-	300	CP	285.05	7.60	370	10,034	3.41	27.84	85.76	1.21	0.3246	1.08	0.39	OK
	flows intto 544																	
1460	1460	-	544	-	300	CP	322.95	8.70	9,884	9,884	3.41	27.49	91.75	1.30	0.2996	1.13	0.37	OK
544	544	-	547	-	400	CP	431.85	4.50	1,629	21,546	3.00	52.63	141.37	1.12	0.3723	1.05	0.42	OK
547	547	-	110	-	400	CP	627.85	4.60	4,191	25,738	2.91	61.04	142.93	1.14	0.4270	1.09	0.45	OK
110	110	-	1193	-	400	CP	389.70	4.10	300	26,038	2.90	61.63	134.94	1.07	0.4567	1.04	0.47	OK
1193	1193	-	2204	-	500	CP	113.20	2.00	3,953	29,990	2.84	69.33	169.98	0.87	0.4079	0.82	0.44	OK
	flows into 2204																	
1966	1966	-	489	-	300	CP	306.50	6.60	2,927	2,927	4.18	9.97	79.92	1.13	0.1248	0.78	0.23	OK
489	489	-	2204	-	400	CP	447.40	1.70	3,806	6,733	3.64	19.96	86.90	0.69	0.2298	0.56	0.32	OK
	flows into 2204																	
SEB-1	SEB-1	-	SEB-2	-	300	CP	2160.00	6.00	12,402	12,402	3.29	33.22	76.20	1.08	0.4359	1.03	0.46	OK
SEB-2	SEB-2	-	2206	-	300	CP	2160.00	6.00	5,820	18,222	3.08	45.77	76.20	1.08	0.6007	1.12	0.56	OK
2206	2206	-	2207	-	300	CP	280.05	14.90	2,425	20,647	3.02	50.80	120.07	1.70	0.4231	1.63	0.45	OK
2207	2207	-	1990	-	300	CP	479.65	21.10	4,227	24,874	2.93	59.33	142.87	2.02	0.4152	1.92	0.45	OK
1990	1990	-	1565	-	300	CP	475.90	6.40	2,368	27,242	2.88	64.00	78.70	1.11	0.8132	1.20	0.71	(Acceptable)
1565	1565	-	1565	-	400	CP	407.25	4.90	1,160	28,401	2.86	66.26	147.52	1.17	0.4492	1.14	0.46	OK
1149	1149	-	2204	-	400	CP	304.60	20.00	1,577	29,978	2.84	69.31	297.97	2.37	0.2326	1.94	0.32	OK
2204	2204	-	1696	-	500	CP	276.75	5.90	151	66,853	2.48	135.23	291.92	1.49	0.4633	1.46	0.48	OK
1696	1696	-	251	-	600	CP	535.95	2.70	9,670	76,523	2.43	151.35	319.51	1.13	0.4737	1.12	0.48	OK
251	251	-	1226	-	600	CP	673.90	2.30	3,654	80,177	1.05	68.51	294.90	1.04	0.2323	0.86	0.32	OK
1226	1226	-	119	-	600	CP	287.60	2.10	7,288	87,465	1.05	74.60	281.79	1.00	0.2647	0.85	0.35	OK
119	119	-	1613	-	800	CP	98.61	2.40	48	87,514	1.05	74.64	642.74	1.28	0.1161	0.87	0.23	OK
1613	1613	-	90	-	800	CP	883.45	2.00	0	87,514	1.05	74.64	586.75	1.17	0.1272	0.81	0.24	OK
	flows into 90																	
112	112	-	190	-	400	CP	100.00	5.00	20,303	20,303	3.03	50.09	149.01	1.19	0.3361	1.07	0.39	OK
190	190	-	1625	-	400	CP	495.50	7.60	2,498	22,801	2.97	55.17	183.71	1.46	0.3003	1.29	0.37	OK
1625	1625	-	99	-	400	CP	785.05	8.20	15,989	38,789	2.72	85.91	190.82	1.52	0.4502	1.47	0.47	OK
99	99	-	97	-	400	CP	175.00	16.50	698	39,487	2.71	87.20	270.65	2.15	0.3222	1.92	0.39	OK
97	97	-	104	-	400	CP	354.90	10.80	3,634	43,121	2.67	93.84	218.98	1.74	0.4285	1.67	0.45	OK
104	104	-	90	-	400	CP	504.50	5.30	1,519	44,640	2.66	96.58	153.42	1.22	0.6296	1.27	0.58	OK
90	90	-	WWTP	-	800	CP	2347.10	2.00	6,451	138,605	1.04	117.14	586.75	1.17	0.1996	0.91	0.30	OK
	flows into Ramtha WWTP																	
DN-1	DN-1	-	EM-1	-	150	DIP×1	2400.00	-	4,109	4,109	3.95	13.23	Pressure	1.50	【0.794m^3/min】			OK
EM-1	EM-1	-	SH-1	-	200	DIP×1	4680.00	-	7,322	11,431	3.33	31.03	Pressure	1.50	【1.862m^3/min】			OK
SH-1	SH-1	-	TOR-1	-	200	DIP×2	5250.00	-	22,359	33,790	2.78	76.58	Pressure	1.50	【4.595m^3/min】			OK
TOR-1	TOR-1	-	WWTP	-	200	DIP×3	5160.00	-	28,803	62,593	2.51	128.01	Pressure	1.50	【7.681m^3/min】			OK
	flows into Ramtha WWTP						14034.06	Total	201,198	201,198								
					CP:Concrete Pipe													
					DIP:Ductile Iron Pipe													

Table 5.10 Capacity Assessment of the Existing Trunk Sewers in Mafraq SWD (1)

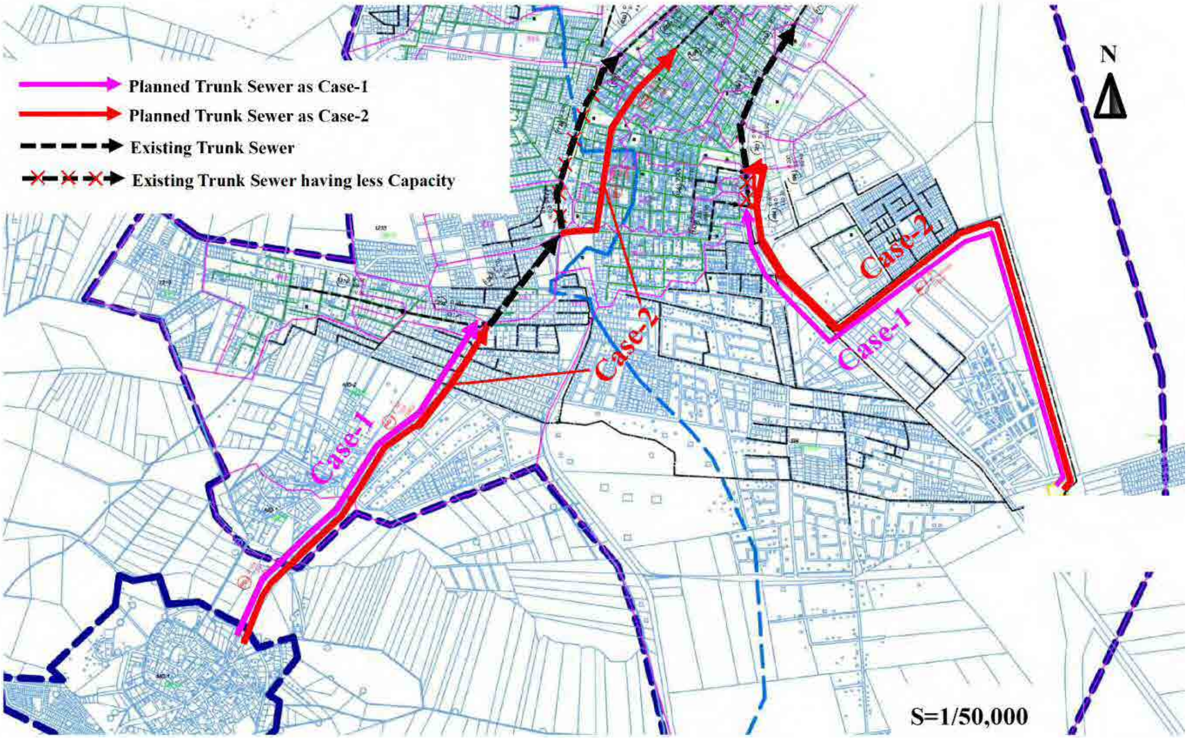
Urban 92.80ℓpcd   Rurul 70.40ℓpcd

Line Name	From M.H. No.	From Invert Level	To M.H. No.	To Invert Level	Pipe Diameter	Pipe Material	Pipe Length	Pipe Slope	Population 【2035】 Each	Population 【2035】 integrated Value	Peak Factor	Pipe Flow Data: Total Flow	Flow Full	Flow Vel.	Ratio q-part	Actual Vel.	Ratio depth	Assessment 【d/D<0.67】
	-	[m]	-	[m]	[φmm]	[rial]	[m]	[1/1000]	[pers.]		-	[ℓ/sec]	[ℓ/sec]	[m/sec]	[/q-full]	[m/sec]	[d/D]	-
1873	1873	-	694	-	300	CP	369.90	3.50	7,190	7,190	3.60	21.09	58.20	0.82	0.3623	0.76	0.41	OK
MAF-1	MAF-1	-	694	-	300	CP	3750.00	-	16,611	23,802	2.95	57.19	Pressure Line					OK
694	694	-	698	-	300	CP	185.25	4.00	524	24,325	2.94	58.23	62.22	0.88	0.9359	0.93	0.83	NG!
698	698	-	703	-	300	CP	93.10	7.50	291	24,616	2.93	58.81	85.19	1.21	0.6903	1.28	0.62	OK
	flows into 703																	
1045	1045	-	703	-	300	CP	657.60	6.70	5,687	5,687	3.74	17.34	80.52	1.14	0.2154	0.91	0.31	OK
703	703	-	706	-	400	CP	322.90	5.40	2,837	33,140	2.79	75.35	154.86	1.23	0.4866	1.22	0.49	OK
706	706	-	710	-	400	CP	415.40	5.00	1,404	34,544	2.77	78.00	149.01	1.19	0.5235	1.20	0.51	OK
710	710	-	1712	-	400	CP	227.80	9.00	276	34,820	2.77	78.52	199.91	1.59	0.3928	1.50	0.43	OK
1712	1712	-	1733	-	400	CP	414.90	8.80	2,306	37,127	2.74	82.83	197.68	1.57	0.4190	1.49	0.45	OK
1733	1733	-	1906	-	500	CP	177.45	3.60	66	37,193	2.74	82.96	228.04	1.16	0.3638	1.07	0.41	OK
1906	1906	-	1826	-	600	CP	450.40	1.40	1,278	38,471	2.72	85.33	230.08	0.81	0.3708	0.76	0.42	OK
	flows into 1826																	
168	168	-	509	-	300	CP	364.30	12.10	6,871	6,871	3.63	20.31	108.20	1.53	0.1877	1.18	0.29	OK
509	509	-	475	-	400	CP	67.20	14.40	427	7,298	3.59	21.35	252.85	2.01	0.0844	1.25	0.19	OK
475	475	-	193	-	400	CP	226.00	14.20	1,184	8,482	3.50	24.20	251.09	2.00	0.0964	1.30	0.21	OK
193	193	-	1826	-	400	CP	226.00	13.50	1,320	9,803	3.42	27.30	244.82	1.95	0.1115	1.31	0.22	OK
1826	1826	-	494	-	600	CP	212.30	2.20	132	48,406	2.62	103.33	288.42	1.02	0.3583	0.94	0.41	OK
	flows into 494																	
AID-1	AID-1	-	AID-2	-	300	CP	1100.00	10.00	10,376	10,376	3.39	28.63	98.37	1.39	0.2910	1.21	0.37	OK
AID-2	AID-2	-	1319	-	300	CP	1280.00	10.00	386	10,762	3.37	29.51	98.37	1.39	0.3000	1.22	0.37	OK
1319	1319	-	1235	-	300	CP	719.95	8.00	3,282	14,044	3.22	36.84	87.99	1.24	0.4187	1.18	0.45	OK
1235	1235	-	1267	-	300	CP	491.40	7.30	2,323	16,368	3.14	41.86	84.05	1.19	0.4980	1.19	0.49	OK
1267	1267	-	1130	-	300	CP	697.50	7.80	1,535	17,903	3.09	45.10	86.88	1.23	0.5192	1.23	0.51	OK
1130	1130	-	1138	-	300	CP	100.00	7.00	1,696	19,599	3.05	48.64	82.31	1.16	0.5909	1.20	0.56	OK
1138	1138	-	251	-	300	CP	100.00	7.00	13,188	32,787	2.80	74.68	82.31	1.16	0.9074	1.25	0.79	NG!
251	251	-	253	-	300	CP	246.85	3.10	388	33,175	2.79	75.42	54.78	0.77	1.3768	0.00	0.00	NG!
253	253	-	1568	-	300	CP	450.25	11.50	1,106	34,282	2.77	77.51	105.49	1.49	0.7348	1.60	0.65	OK
1568	1568	-	1312	-	300	CP	482.45	10.40	356	34,638	2.77	78.18	100.32	1.42	0.7793	1.52	0.68	NG!
1312	1312	-	494	-	300	CP	337.08	13.10	805	35,444	2.76	79.69	112.58	1.59	0.7078	1.69	0.63	OK
494	494	-	639	-	600	CP	366.35	3.00	0	83,849	1.05	71.58	336.79	1.19	0.2125	0.95	0.31	OK
639	639	-	638	-	600	CP	239.60	11.60	586	84,435	1.05	72.07	662.14	2.34	0.1088	1.55	0.22	OK
	flows into 688																	
935	935	-	20	-	300	CP	100.00	7.00	7,758	7,758	3.55	22.47	82.31	1.16	0.2730	1.00	0.35	OK
20	20	-	1565	-	300	CP	482.45	12.50	3,308	11,066	3.35	30.21	109.98	1.56	0.2747	1.34	0.35	OK
1565	1565	-	84	-	300	CP	188.55	9.70	265	11,331	3.34	30.81	96.88	1.37	0.3180	1.22	0.38	OK
84	84	-	1107	-	400	CP	305.50	8.00	5,404	16,735	3.13	42.64	188.48	1.50	0.2262	1.21	0.32	OK
	flows into 1107																	
108	108	-	153	-	300	CP	348.10	11.60	2,293	2,293	4.35	8.14	105.95	1.50	0.0768	0.90	0.18	OK
	flows into 153																	
110	110	-	153	-	300	CP	309.25	9.50	11,924	11,924	3.31	32.15	95.88	1.36	0.3353	1.22	0.39	OK
153	153	-	149	-	300	CP	83.10	36.50	294	14,512	3.20	37.86	187.89	2.66	0.2015	2.10	0.30	OK
149	149	-	743	-	400	CP	142.70	8.20	2,188	16,699	3.13	42.56	190.82	1.52	0.2231	1.23	0.32	OK
743	743	-	802	-	400	CP	356.00	6.90	7,041	23,740	2.95	57.06	175.05	1.39	0.3260	1.24	0.39	OK
802	802	-	1107	-	400	CP	211.75	7.10	7,812	31,552	2.81	72.33	177.56	1.41	0.4073	1.34	0.44	OK
1107	1107	-	688	-	400	CP	15.20	25.70	0	48,286	2.62	103.12	337.75	2.69	0.3053	2.37	0.37	OK
638	638	-	1865	-	800	CP	554.30	1.70	652	133,373	1.04	112.80	540.97	1.08	0.2085	0.85	0.30	OK
1865	1865	-	674	-	800	CP	800.00	2.00	5,844	139,217	1.04	117.65	586.75	1.17	0.2005	0.92	0.30	OK
674	674	-	100-1	-	800	CP	303.30	2.00	3,378	142,595	1.04	120.45	586.75	1.17	0.2053	0.92	0.30	OK
100-1	100-1	-	100-2	-	800	CP	1000.00	2.00	0	142,595	1.04	120.45	586.75	1.17	0.2053	0.92	0.30	OK
	flows into 100-2																	
BH-1	BH-1	-	BH-2	-	300	CP	2000.00	6.00	13,541	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
BH-2	BH-2	-	BH-3	-	300	CP	1800.00	6.00	0	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
BH-3	BH-3	-	BH-4	-	300	CP	2900.00	6.00	0	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
BH-4	BH-4	-	BH-5	-	300	CP	2900.00	6.00	0	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
BH-5	BH-5	-	BH-6	-	300	CP	3500.00	6.00	0	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
BH-6	BH-6	-	MNS-1	-	300	CP	1500.00	6.00	0	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
MNS-1	MNS-1	-	100-2	-	300	DIP	2800.00	-	0	13,541	3.24	35.74	Pressure Line					OK
100-2	100-2	-	100-3	-	800	CP	264.60	2.00	0	156,136	1.04	131.68	586.75	1.17	0.2244	0.95	0.32	OK
100-3	100-3	-	100-4	-	800	CP	1283.90	2.00	0	156,136	1.04	131.68	586.75	1.17	0.2244	0.95	0.32	OK
100-4	100-4	-	100-5	-	800	CP	918.70	2.00	-	156,136	1.04	131.68	586.75	1.17	0.2244	0.95	0.32	OK
100-5	100-5	-	WWTP	-	800	CP	768.60	2.00	0	156,136	1.04	131.68	586.75	1.17	0.2244	0.95	0.32	OK
	flows into Mafraq WWTP							Total	156,136									
					CP:Concrete Pipe													
					DIP:Ductile Iron Pipe													

Table 5.11 Capacity Assessment of the Existing Trunk Sewers in Mafraq SWD (2)

Urban 92.80ℓpcd   Rurul 70.40ℓpcd

Line Name	From M.H. No.	From Invert Level	To M.H. No.	To Invert Level	Pipe Diameter	Pipe Material	Pipe Length	Pipe Slope	Population【2035】 Each	Population【2035】 integrated Value	Peak Factor	Pipe Flow Data: Total Flow	Flow Full	Flow Vel.	Ratio q-part	Actual Vel.	Ratio depth	Assessment【d/D<0.67】
	-	[m]	-	[m]	[φmm]	[rial]	[m]	[1/1000]	[pers.]		-	[ℓ/sec]	[ℓ/sec]	[m/sec]	[/q-full]	[m/sec]	[d/D]	-
1873	1873	-	694	-	300	CP	369.90	3.50	7,190	7,190	3.60	21.09	58.20	0.82	0.3623	0.76	0.41	OK
694	694	-	698	-	300	CP	185.25	4.00	524	7,714	3.56	22.36	62.22	0.88	0.3594	0.81	0.41	OK
698	698	-	703	-	300	CP	93.10	7.50	291	8,005	3.54	23.06	85.19	1.21	0.2707	1.04	0.35	OK
	flows into 703																	
1045	1045	-	703	-	300	CP	657.60	6.70	5,687	5,687	3.74	17.34	80.52	1.14	0.2154	0.91	0.31	OK
MAF-1	MAF-1	-	694	-	250	DIP	3750.00	-	16,611	22,298	2.98	54.16	Pressure	【3.250m³/min】				OK
703	703	-	706	-	400	CP	322.90	5.40	2,837	33,140	2.79	75.35	154.86	1.23	0.4866	1.22	0.49	OK
706	706	-	710	-	400	CP	415.40	5.00	1,404	34,544	2.77	78.00	149.01	1.19	0.5235	1.20	0.51	OK
710	710	-	1712	-	400	CP	227.80	9.00	276	34,820	2.77	78.52	199.91	1.59	0.3928	1.50	0.43	OK
1712	1712	-	1733	-	400	CP	414.90	8.80	2,306	37,127	2.74	82.83	197.68	1.57	0.4190	1.49	0.45	OK
1733	1733	-	1906	-	500	CP	177.45	3.60	66	37,193	2.74	82.96	228.04	1.16	0.3638	1.07	0.41	OK
1906	1906	-	1826	-	600	CP	450.40	1.40	1,278	38,471	2.72	85.33	230.08	0.81	0.3708	0.76	0.42	OK
	flows into 1826																	
AID-1	AID-1	-	AID-2	-	300	CP	1100.00	10.00	10,376	10,376	3.39	28.63	98.37	1.39	0.2910	1.21	0.37	OK
AID-2	AID-2	-	1319	-	300	CP	1280.00	10.00	386	10,762	3.37	29.51	98.37	1.39	0.3000	1.22	0.37	OK
1319	1319	-	1235	-	300	CP	719.95	8.00	3,282	14,044	3.22	36.84	87.99	1.24	0.4187	1.18	0.45	OK
1235	1235	-	1267	-	300	CP	491.40	7.30	2,323	16,368	3.14	41.86	84.05	1.19	0.4980	1.19	0.49	OK
1267	1267	-	1130	-	300	CP	697.50	7.80	1,535	17,903	3.09	45.10	86.88	1.23	0.5192	1.23	0.51	OK
NAH-1	AID-1	-	AID-2	-	300	CP	1100.00	10.00	0	17,903	3.09	45.10	98.37	1.39	0.4585	1.35	0.47	OK
NAH-2	AID-2	-	1319	-	300	CP	1280.00	10.00	0	17,903	3.09	45.10	98.37	1.39	0.4585	1.35	0.47	OK
168	168	-	509	-	300	CP	364.30	12.10	6,871	24,774	2.93	59.13	108.20	1.53	0.5464	1.56	0.53	OK
509	509	-	475	-	400	CP	67.20	14.40	427	25,201	2.92	59.98	252.85	2.01	0.2372	1.65	0.32	OK
475	475	-	193	-	400	CP	226.00	14.20	1,184	26,386	2.90	62.32	251.09	2.00	0.2482	1.66	0.33	OK
193	193	-	1826	-	400	CP	226.00	13.50	1,320	27,706	2.87	64.90	244.82	1.95	0.2651	1.66	0.35	OK
1826	1826	-	494	-	600	CP	212.30	2.20	132	66,309	2.49	134.32	288.42	1.02	0.4657	1.00	0.48	OK
	flows into 494																	
1130	1130	-	1138	-	300	CP	100.00	7.00	1,696	1,696	4.58	6.33	82.31	1.16	0.0769	0.70	0.18	OK
1138	1138	-	251	-	300	CP	100.00	7.00	13,188	14,884	3.19	38.67	82.31	1.16	0.4698	1.14	0.48	OK
251	251	-	253	-	300	CP	246.85	3.10	388	15,272	3.17	39.51	54.78	0.77	0.7213	0.83	0.64	OK
253	253	-	1568	-	300	CP	450.25	11.50	1,106	16,379	3.14	41.88	105.49	1.49	0.3970	1.40	0.43	OK
1568	1568	-	1312	-	300	CP	482.45	10.40	356	16,735	3.13	42.64	100.32	1.42	0.4250	1.36	0.45	OK
1312	1312	-	494	-	300	CP	337.08	13.10	805	17,540	3.10	44.34	112.58	1.59	0.3939	1.50	0.43	OK
494	494	-	639	-	600	CP	366.35	3.00	0	83,849	1.05	71.58	336.79	1.19	0.2125	0.95	0.31	OK
639	639	-	638	-	600	CP	239.60	11.60	586	84,435	1.05	72.07	662.14	2.34	0.1088	1.55	0.22	OK
	flows into 688																	
935	935	-	20	-	300	CP	100.00	7.00	7,758	7,758	3.55	22.47	82.31	1.16	0.2730	1.00	0.35	OK
20	20	-	1565	-	300	CP	482.45	12.50	3,308	11,066	3.35	30.21	109.98	1.56	0.2747	1.34	0.35	OK
1565	1565	-	84	-	300	CP	188.55	9.70	265	11,331	3.34	30.81	96.88	1.37	0.3180	1.22	0.38	OK
84	84	-	1107	-	400	CP	305.50	8.00	5,404	16,735	3.13	42.64	188.48	1.50	0.2262	1.21	0.32	OK
	flows into 1107																	
108	108	-	153	-	300	CP	348.10	11.60	2,293	2,293	4.35	8.14	105.95	1.50	0.0768	0.90	0.18	OK
	flows into 153																	
110	110	-	153	-	300	CP	309.25	9.50	11,924	11,924	3.31	32.15	95.88	1.36	0.3353	1.22	0.39	OK
153	153	-	149	-	300	CP	83.10	36.50	294	14,512	3.20	37.86	187.89	2.66	0.2015	2.10	0.30	OK
149	149	-	743	-	400	CP	142.70	8.20	2,188	16,699	3.13	42.56	190.82	1.52	0.2231	1.23	0.32	OK
743	743	-	802	-	400	CP	356.00	6.90	7,041	23,740	2.95	57.06	175.05	1.39	0.3260	1.24	0.39	OK
802	802	-	1107	-	400	CP	211.75	7.10	7,812	31,552	2.81	72.33	177.56	1.41	0.4073	1.34	0.44	OK
1107	1107	-	688	-	400	CP	15.20	25.70	0	48,286	2.62	103.12	337.75	2.69	0.3053	2.37	0.37	OK
638	638	-	1865	-	800	CP	554.30	1.70	652	133,374	1.04	112.80	540.97	1.08	0.2085	0.85	0.30	OK
1865	1865	-	674	-	800	CP	800.00	2.00	5,844	139,217	1.04	117.65	586.75	1.17	0.2005	0.92	0.30	OK
674	674	-	100-1	-	800	CP	303.30	2.00	3,378	142,595	1.04	120.45	586.75	1.17	0.2053	0.92	0.30	OK
100-1	100-1	-	100-2	-	800	CP	1000.00	2.00	0	142,595	1.04	120.45	586.75	1.17	0.2053	0.92	0.30	OK
	flows into 100-2																	
BH-1	BH-1	-	BH-2	-	300	CP	2000.00	6.00	13,541	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
BH-2	BH-2	-	BH-3	-	300	CP	1800.00	6.00	0	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
BH-3	BH-3	-	BH-4	-	300	CP	2900.00	6.00	0	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
BH-4	BH-4	-	BH-5	-	300	CP	2900.00	6.00	0	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
BH-5	BH-5	-	BH-6	-	300	CP	3500.00	6.00	0	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
BH-6	BH-6	-	MNS-1	-	300	CP	1500.00	6.00	0	13,541	3.24	35.74	76.20	1.08	0.4690	1.06	0.48	OK
MNS-1	MNS-1	-	100-2	-	200	DIP	2800.00	-	0	13,541	3.24	35.74	Pressure	【2.144m³/min】				OK
100-2	100-2	-	100-3	-	800	CP	264.60	2.00	0	156,136	1.04	131.68	586.75	1.17	0.2244	0.95	0.32	OK
100-3	100-3	-	100-4	-	800	CP	1283.90	2.00	0	156,136	1.04	131.68	586.75	1.17	0.2244	0.95	0.32	OK
100-4	100-4	-	100-5	-	800	CP	918.70	2.00	0	156,136	1.04	131.68	586.75	1.17	0.2244	0.95	0.32	OK
100-5	100-5	-	WWTP	-	800	CP	768.60	2.00	0	156,136	1.04	131.68	586.75	1.17	0.2244	0.95	0.32	OK
	flows into Mafraq WWTP							Total	156,136									
					CP:Concrete Pipe													
					DIP:Ductile Iron Pipe													



Note: "x" in red-color shows the route of trunk sewers having insufficient capacity; bold red lines show the new trunk sewers required.

Figure 5.4 Connection Alternatives for Capacity Assessment of Trunk Sewers in Mafraq SWD

5.1.2 Assessment of Lift Stations and WWTPs

There are six LSs and six WWTPs in the sewerage service area, their locations are shown in Figure 5.5.

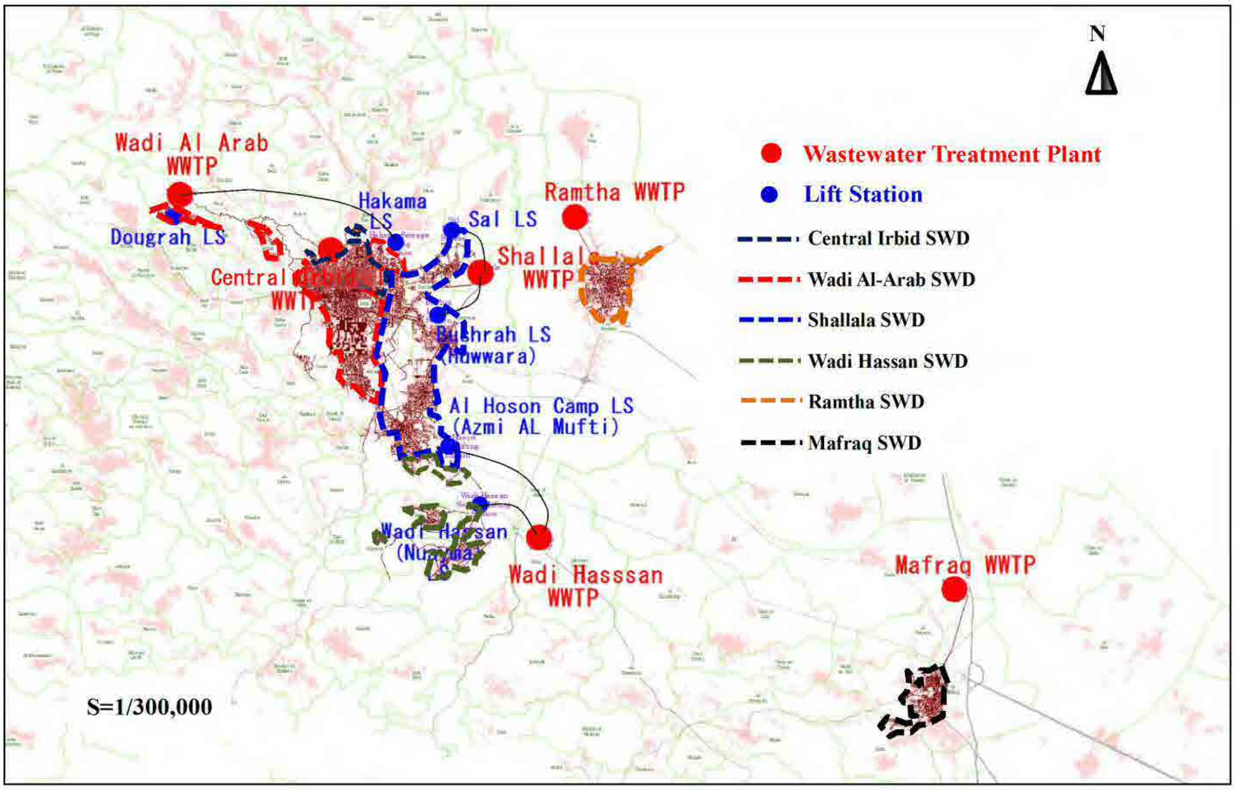


Figure 5.5 Location of Existing LSs and WWTPs

(1) Capacity of Lift Stations and the Design Flows

Table 5.12 summarizes the capacity of each lift station and the design flow required in the improvement plan.

Table 5.12 Present Pump Capacity and the Design Flows for Each Lift Station

Sewerage District	Lift Station (LS)	Capacity (m^3/min)			Remarks
		Existing	Design	Expansion required	
Wadi Al-Arab	Hakama	3.90	6.22	2.32	Need to Improve
	Dougrah	6.00	2.20	-	
Shallala	Sal	3.80	3.93	-	To be managed by operating the stand-by pump
	Bushra	3.80	1.80	-	
Wadi Hassan	Al Hoson Camp	4.20	5.62	1.42	Shift to Shallala SWD
	Wadi Hassan	6.70	4.79	-	

Source: JICA Study Team

(2) Present Treatment Capacity of WWTPs and Design Flows

Actual inflow and the present design capacity for the six existing WWTPs are shown in Table 5.13. In

Jordan the design capacity of WWTP is expressed as the average daily flow. The present design capacity (average daily flow) for each WWTP is compared with the design flows for 2035.

The design average daily flow in 2035 would exceed the capacity of all WWTPs except the Central Irbid WWTP, as indicated in red in Table 5.13.

Table 5.13 Present Treatment Capacity and Design Flows for Each WWTP Unit:m^3/d

Item \ WWTP	Central Irbid	Wadi Al-Arab	Shallala	Wadi Hassan	Ramtha	Mafraq
Actual Inflow (2013)	8,104	11,281	3,497	1,277	4,477	1,710
Present Design Capacity (Average Daily Flow)	12,000	20,800	13,700	1,600*	5,400	6,550
Average Daily Flow (2035)	10,900	28,500	22,500	2,500	17,300	14,400
Maximum Daily Flow (2035)	12,700	33,300	26,400	2,900	20,200	16,800
Maximum Hourly Flow (2035)	19,100	49,900	39,600	4,400	30,308	25,200

Note: * at the Wadi Hassan, the present wastewater treatment capacity is assessed to be 2,800 m^3/day, but the sludge treatment capacity is assessed to be only 1,600 m^3/day, then the treatment capacity of the Wadi Hassan WWTP is evaluated as 1,600 m^3/day.
Source: JICA Study Team

The treatment facilities that are currently under construction at the Mafraq WWTP (USAID financing) have a capacity of 3,275 m^3/day. The present capacity of 3,275 m^3/day will be doubled to 6,550 m^3/day by 2015 when the project is completed.

(3) Planned Effluent Quality and Present Treatment Condition

Actual (2013) and planned influent and effluent qualities for the six WWTPs are shown in Table 5.14. The influent and effluent quality data are not available for Shallala WWTP because it has just started its operation at the end of 2013.

Table 5.14 Actual and Design Influent and Effluent Quality for Each WWTP

Parameter \ WWTP	Central Irbid	Wadi Al Arab	Shallala	Wadi Hassan	Ramtha	Mafraq
Actual Influent BOD_5 (mg/L)	930	893	—	1,184	873	—
Design Influent BOD_5 (mg/L)	706	752	887	924	757	707
Actual Influent SS (mg/L)	758	518	—	781	386	(300)
Design Influent SS (mg/L)	652	694	819	853	699	653
Actual Effluent BOD_5 (mg/L)	65	22	—	7	15	209
Design Effluent BOD_5 (mg/L)	30	30	30	30	30	60
Actual Effluent SS (mg/L)	77	19	—	8	26	236
Design Effluent SS (mg/L)	30	30	30	30	30	60

Source: JICA Study Team

The treatment processes at the four WWTPs, (excluding Central Irbid WWTP and Mafraq WWTP), show good performance. At the Central Irbid and Mafraq WWTPs the BOD_5 and SS concentrations (shown in red) exceed the design effluent quality which was set to comply with the standards explained in Chapter 4.

Based on site inspection and data collection, the reasons for poor performance at the Central Irbid and Mafraq WWTPs are identified and summarized as follows:

1) Central Irbid WWTP

The wastewater at Central Irbid WWTP is treated by a series of primary sedimentation tanks, trickling filters, aeration tanks (conventional activated sludge method), and final sedimentation tanks. The treated wastewater (effluent) quality does not meet the design effluent quality because the performance of the trickling filters and aeration tanks is poor. The trickling filters are frequently blocked by a film of slime and solids.

The oxidation ditch process under construction to replace the trickling filter, aeration tank and final sedimentation tank, will be able to achieve the design effluent quality.

2) Mafraq WWTP

Wastewater at the Mafraq WWTP is treated by a system of anaerobic, facultative, and polishing ponds. The treated wastewater quality exceeds the design effluent quality and effluent quality standards.

The advanced treatment process under construction is comprised of nitrification and denitrification tanks, aerated lagoon, facultative pond, sand filter, and reed bed. Half of the existing facilities have been reconstructed and the new treatment process is in operation. The other half is still under construction. The design effluent quality will be achieved when all the facilities are in operation.

The capacity calculations for the existing and new facilities at each WWTP are presented in Appendix III-A of the Supporting Report.

5.2 Rationale for Sewer Improvement

5.2.1 Trunk Sewers

The need to improve trunk sewers is explained as follows:

i) The new service area is far from the existing service area. New trunk sewers are required in the expanded service area to connect to the existing trunk sewers pumping facilities and the WWTP.

ii) New trunk sewers are also needed in Mafraq to bring the capacity of the existing trunk sewers to the required level (as shown in Figure 5.4).

5.2.2 Branch Sewers

The need for new branch sewers is estimated in following manner:

- The length of branch sewer per unit area (m/ha) is calculated based on the existing branch sewer network.
- The length of new branch sewers for each SWD is calculated based on the expanded service area.

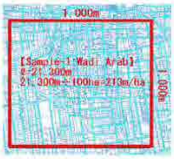
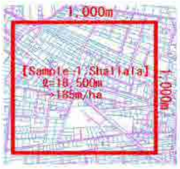
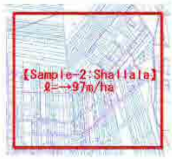
The specified minimum diameter for branch sewers is 200 mm.

The branch sewer length per unit area (m/ha) is estimated in the following manner:

The methodology for calculating the length per unit area is as follows. For each SWD the length of sewers in one square km is compiled for three types of areas: densely populated commercial, moderately populated urban residential, and sparsely populated sub-urban areas as shown in Table 5.15. Central Irbid SWD is excluded because there is no planned sewer expansion.

The average branch sewer length per unit area for all five SWD combined is 130.3 m/ha. The averages range from 108.7 m/ha for densely populated areas such as Wadi Hassan to 152.3 m/ha for sub-urban areas such as Ramtha. The highest average of 152.3 m/ha is used for estimating the branch sewer length for each SWD.

Table 5.15 Existing Branch Sewers Length Per Unit Service Area

Area	Condition.A 【Densely Populated】 Commercial Area (City Core)	Length (m/ha)	Condition.B 【Moderately Popurated】 Residential Area A (Downtown)	Length (m/ha)	Condition.C 【Sparsely Populated】 Residential Area B (Surburb)	Length (m/ha)	Average (m/ha)
Wadi Arab		213.0		115.0		81.0	136.3
Shallala		185.0		97.0		58.0	113.3
Wadi Hassan		208.0		72.0		46.0	108.7
Ramtha		278.0		101.0		78.0	152.3
Mafraq		198.0		143.0		82.0	141.0
Average	-	216.4	-	105.6	-	69.0	130.3

Source: JICA Study Team

5.2.3 House Connection

The branch sewers can collects the wastewater through house connections of the individual houses or buildings. When a branch sewer is constructed near a house or building, the owner of the house or building shall connect to the branch sewer by regulation. The house connections are constructed by the expenses of owner of individual houses or buildings. Therefore, construction plan of house connections are not prepared in the sewerage improvement plan and cost estimation.

5.3 Sewerage Improvement Plan in Central Irbid SWD

5.3.1 WWTP Improvement Plan

As discussed in the previous section, additional sewers, lift stations and wastewater treatment facilities are not required for the Central Irbid SWD.

The existing sludge drying beds at the Central Irbid WWTP are not operated because of odor problems for the residential areas near the WWTP. Digested and thickened sludge is disposed of at the solid waste landfill sites.

Sludge treatment facilities with mechanical dewatering facilities which would replace the sludge drying beds are required, as summarized in Table 5.18.

Table 5.16 Expansion Plan for Central Irbid WWTP

Component	Dimension (m)			Existing Number	Future Number	Remarks
	Width/ diameter	Length	Depth			
Coarse Screen				2	**2**	
Fine Screen				2	**2**	
Girt Chamber	2.2	10		2	**2**	Aerated
Primary Sedimentation Tank	6	36	3.2	2	**2**	
Lift Pump Station				1	**1**	
Trickling Filter	20		7.5	2		
Aeration Tank	15	30	3	2		
Final Sedimentation Tank	22		3.8	2		
Oxidation Ditch	20	60	4.5	2	**2**	
Final Sedimentation Tank	30		3.5	2	**2**	
Disinfection (Chlorine Contact)	1.5	102	3	2	**2**	
Dewatering Machine					**2**	
Sludge Thickener	18		3.5	1	**1**	
Anaerobic Digestion Tank	26		7	1	**1**	
Sludge Holding Tank	24		4.5	1	**1**	
Sludge Drying Bed				9		

Note: green: existing facilities to be used without any changes, yellow: existing facilities to be abandoned, pink : facilities under construction in 2014, orange: facilities planned by other donors, blue: facilities planned in this Study.

Source: JICA Study Team

Figure 5.6 is a proposed layout showing the mechanical sludge dewatering facilities in the present 7 ha site.

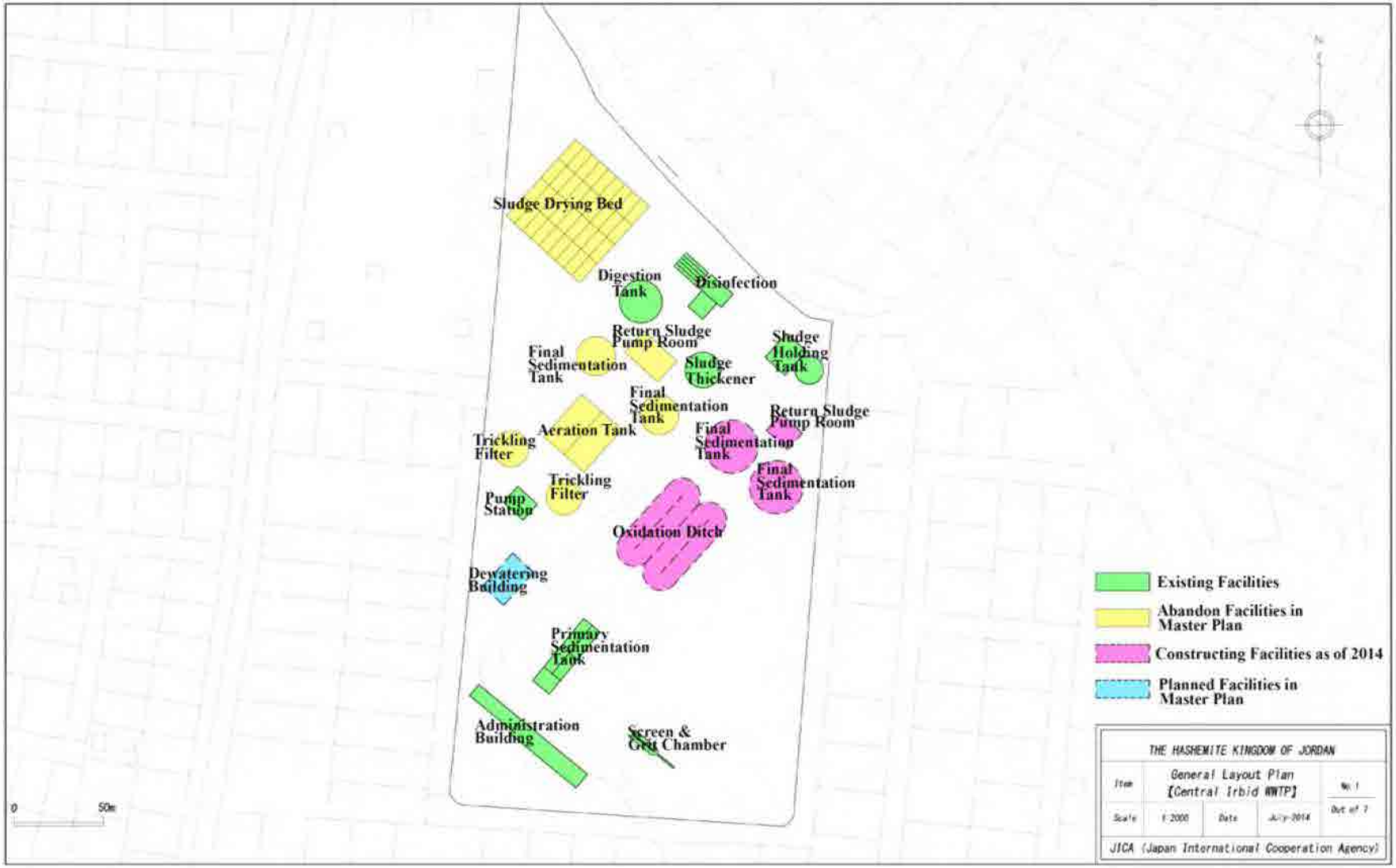


Figure 5.6 Layout of Central Irbid WWTP

5.4 Sewerage Improvement Plan for Wadi Al-Arab SWD

5.4.1 Trunk Sewers and Lift Stations

The existing trunk sewers can be used and no expansion is needed. The existing Hakama LS has to increase its capacity by 2.32 m^3/min, from 3.9 m^3/min to 6.22 m^3/min as shown in Table 5.12.

5.4.2 Branch Sewers

The required length of branch sewer per ha (calculated to be 152.3 m/ha) is multiplied by the net area in the expanded service area to estimate the total length of branch sewer to be installed. The net area requiring branch sewers in this case is 2,075.8 ha (total expansion area of 2,204 ha minus 128.2 ha which already have branch sewers installed although the house connections have not been made). Therefore, the additional branch sewer requirement is about 316 km.

5.4.3 Wadi Al-Arab WWTP

Table 5.17 shows the capacity calculations, identifying the treatment facilities required. The capacity calculations for each treatment process are shown in Appendix III-B of the Supporting Report. The capacity calculations are based on the average and maximum daily flows.

Table 5.17 Design Capacity of Wadi Al-Arab WWTP

Item	Design
Actual Average Flow in 2013	11,281 m^3/d
Present Design Capacity (One train capacity x train nos.)	21,000 m^3/d (3,500 m^3/d x 6)
Planned Average Daily Flow	28,429 m^3/d
Improved Design Capacity (One train capacity x train nos.)	31,500 m^3/d (3,500 m^3/d x 9)
Existing Sludge Treatment Capacity coverage	100 %

Source: JICA Study Team

Only three sets of aeration and final sedimentation tanks are required as shown in Table 5.18. The layout proposed in Figure 5.7, indicates that the additional facilities could be constructed on 27 ha.

Table 5.18 **Expansion Plan for Wadi Al-Arab WWTP**

Component	Dimension (m)			Existing Number	Future Number	Remarks
	Width/ diameter	Length	Depth			
Coarse Screen				2	**2**	
Fine Screen				2	**2**	
Girt Chamber	2.8	38	2	1	**1**	Aerated
Grease Chamber	2.85	33		1	**1**	
Aeration Tank	18	72	4.5	6	**9(+3)**	
Final Sedimentation Tank	21		3.4	6	**9(+3)**	
Sand Filter				2	**2**	Planning by KfW
UV disinfection				2	**2**	Planning by KfW
Disinfection (Chlorine Contact)	2.45	150	2	2	**2**	
Sludge Holding Tank	12			1	**1**	
Sludge Holding Tank	8			2		
Dewatering Machine				3	**3**	
Sludge Drying Bed	6	25-30		73		

Source: JICA Study Team

Figure 5.7 Layout of Wadi Al-Arab WWTP

5.5 Sewerage Improvement Plan for Shallala SWD

5.5.1 Sewer and Lift Station

A 200 mm diameter and 3,300 m long new concrete trunk sewer, “MHG-1g”, is required for the new service area of Mughayer, located at the north eastern part of Irbid urban area. A small manhole type pump is required to lift the wastewater at one point before the flow continues by gravity to the existing trunk sewers as shown in Figure 5.8. The existing Sal lift station can be used for the design flow as specified in Table 5.12.

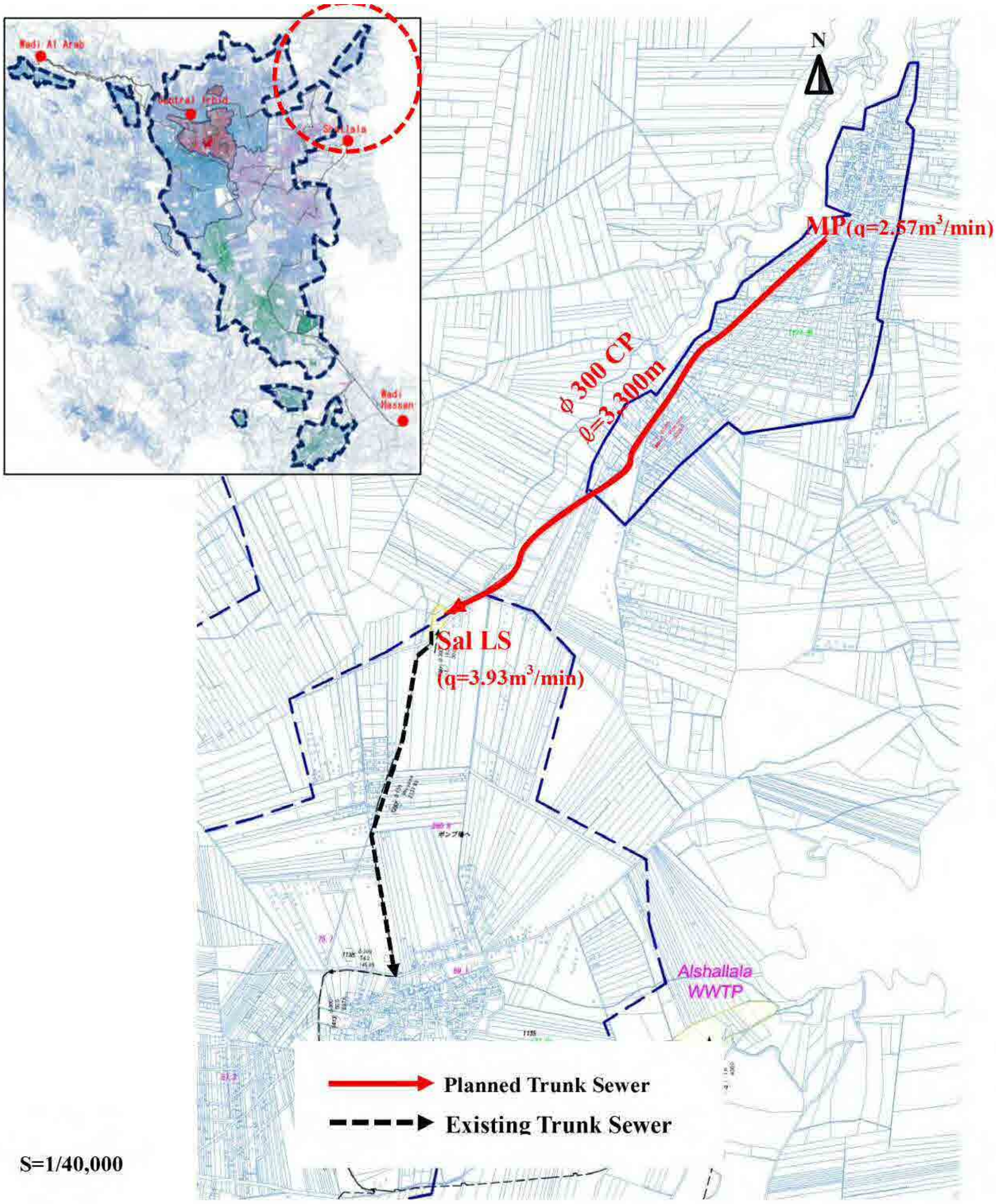


Figure 5.8 New Trunk Sewers in Shallala SWD (1)

New trunk sewer, “AZMI-1”. having 400 mm diameter and 4,550 m long, is required for conveying the wastewater generated in Hoson Camp where it is belong to Wadi Hassan SWD but planned to be changed to Shallala SWD by WAJ.

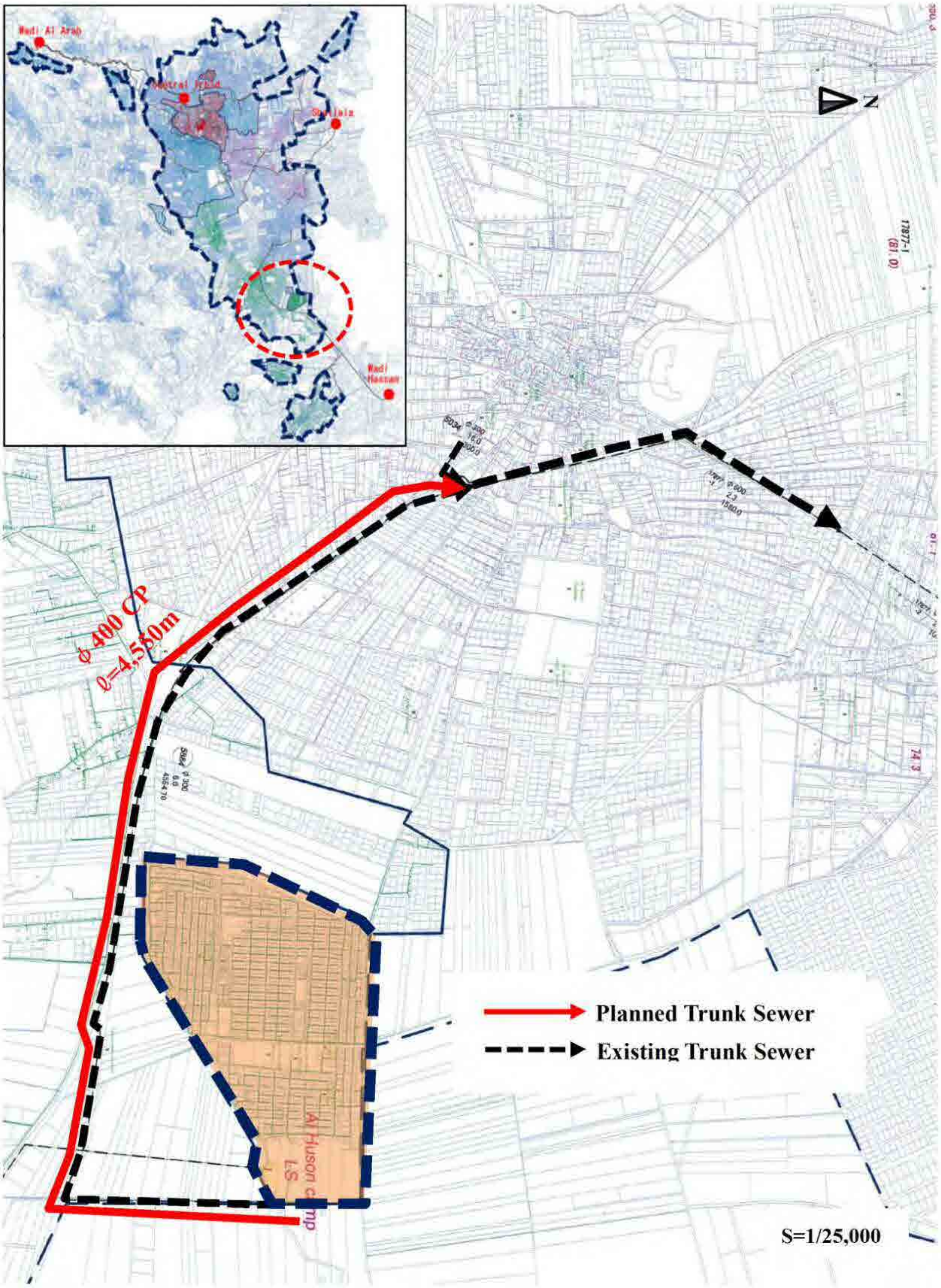


Figure 5.9 New Trunk Sewer in Shallala SWD (2)

The capacity of Al Hoson LS is required to increase by 1.42 m^3/min, from 4.20 m^3/min to 5.62 m^3/min as shown in Table 5.12.

5.5.2 Branch Sewers

The required length of branch sewer per ha (calculated to be 152.3 m/ha) is multiplied by the net area in the expanded service area to estimate the total length of branch sewer to be installed. The net area in this case is 1,686.5 ha (total expansion area of 2,368 ha minus 681.5 ha which already have branch sewers installed although the house connections have not been made). The additional branch sewer requirement is about 257 km.

5.5.3 Shallala WWTP

Table 5.19 shows the capacity calculations, identifying the treatment facilities. The capacity calculations of each treatment process are shown in Appendix III-B of the Supporting Report. The capacity calculations are based on the average and maximum daily flows.

Table 5.19 Design Capacity of Shallala WWTP

Item	Design
Actual Average Flow in 2013	3,497 m^3/d
Present Design Capacity (One train capacity x train nos.)	14,000 m^3/d (7,000 m^3/d x 2)
Planned Average Daily Flow	22,520 m^3/d
Improved Design Capacity (One train capacity x train nos.)	21,000 m^3/d (7,000 m^3/d x 3)
Existing Sludge Treatment Capacity coverage	100 %

Note: * Nominal capacity, but facilities can cover the design flow.   Source: JICA Study Team

As shown in Table 5.20, one primary sedimentation tank, two oxidation ditches, and one final sedimentation tank are required for the expansion of Shallala WWTP. Figure 5.10 is the proposed layout, showing the additional facilities to be constructed on the current site of 7ha.

Table 5.20 Expansion Plan for Shallala WWTP

Component	Dimension (m)			Existing Number	Future Number	Remarks
	Width/ diameter	Length	Depth			
Coarse Screen				2	**2**	
Fine Screen				2	**2**	
Girt Chamber	3	30	4	2	**2**	Aerated
Grease Chamber	2	30		2	**2**	
Equalization Tank	10	72	5	5	**5**	
Primary Sedimentation Tank	7	32		2	**3(+1)**	
Oxidation Ditch	20	58	4.5	2	**4(+2)**	
Final Sedimentation Tank	42		3	2	**3(+1)**	
Disinfection (Chlorine Contact)				1	**1**	
Sludge Thickener	10		4	3	**3**	
First Digestion Tank	18		13	2	**2**	
Second Digestion Tank	12		10	1	**1**	
Belt Thickener				2	**2**	
Centrifugal Dehydrator				2	**2**	

Source: JICA Study Team

Figure 5.10 Layout of Shallala WWTP

5.6 Sewerage Improvement Plan for Wadi Hassan SWD

5.6.1 Sewer and Lift Station

The existing trunk sewers can be used and no expansion is required. The Wadi Hassan LS is not required to improve the capacity. Al Hoson Camp LS is planned to change to Shallala SWD.

5.6.2 Branch Sewers

The required length of branch sewer per ha (calculated to be152.3 m/ha) is multiplied by the net area in the expansion area. The net area in this case is 400.3 ha (total expansion area of 430 ha minus 29.7 ha which already have branch sewers installed although the house connections have not been made). The additional branch sewer requirement is about 61 km.

5.6.3 Wadi Hassan WWTP

Table 5.21 shows the capacity calculations, identifying additional treatment facilities are not required. The capacity calculations of each treatment process are reported in Appendix III-B of the Supporting Report. The capacity calculations are based on the average and maximum daily flows.

Table 5.21 Design Capacity of Wadi Hassan WWTP

Item	Design
Actual Average Flow in 2013	1,277 m^3/d
Present Design Capacity (One train capacity x train nos.)	2,800 m^3/d (1,400 m^3/d x 2)
Planned Average Daily Flow	2,490 m^3/d
Existing Sludge Treatment Capacity coverage	44 %

Source: JICA Study Team

It is proposed that 20 sludge drying beds for the design flow of 1,200 m^3/d will be constructed in Phase-2 to increase the sludge treatment capacity of Wadi Hassan WWTP from 1,600 m^3/d to 2,800 m^3/d.

Table 5.22 Expansion Plan for Wadi Hassan WWTP

Component	Dimension (m)			Existing Number	Future Number	Remarks
	Width/ diameter	Length	Depth			
Coarse Screen				2	**2**	one for bypass
Fine Screen				1	**1**	
Girt Chamber	2	20	3	1	**1**	Aerated
Grease Chamber				1	**1**	
Oxidation Ditch	14	60	3	2	**2**	
Final Sedimentation Tank	15		3.8	2	**2**	
Polishing Pond	60	88	1.8	4	**4**	
Disinfection (Chlorine Contact)				1	**1**	
Sludge Holding Tank	11.2		10.2	1	**1**	
Sludge Drying Bed	6	30		16	**36(+20)**	

Source: JICA Study Team

Figure 5.11 Layout of Wadi Hassan WWTP

5.7 Sewerage Improvement Plan in Ramtha SWD

5.7.1 Trunk Sewer and Manhole Pump

To convey the wastewater generated in the four locations at the north western areas of Ramtha City, new trunk sewers, DN-1, EM-1, SH-1, TOR-1 and four small pumping facilities (manhole type) are required as shown in Figure 5.12.

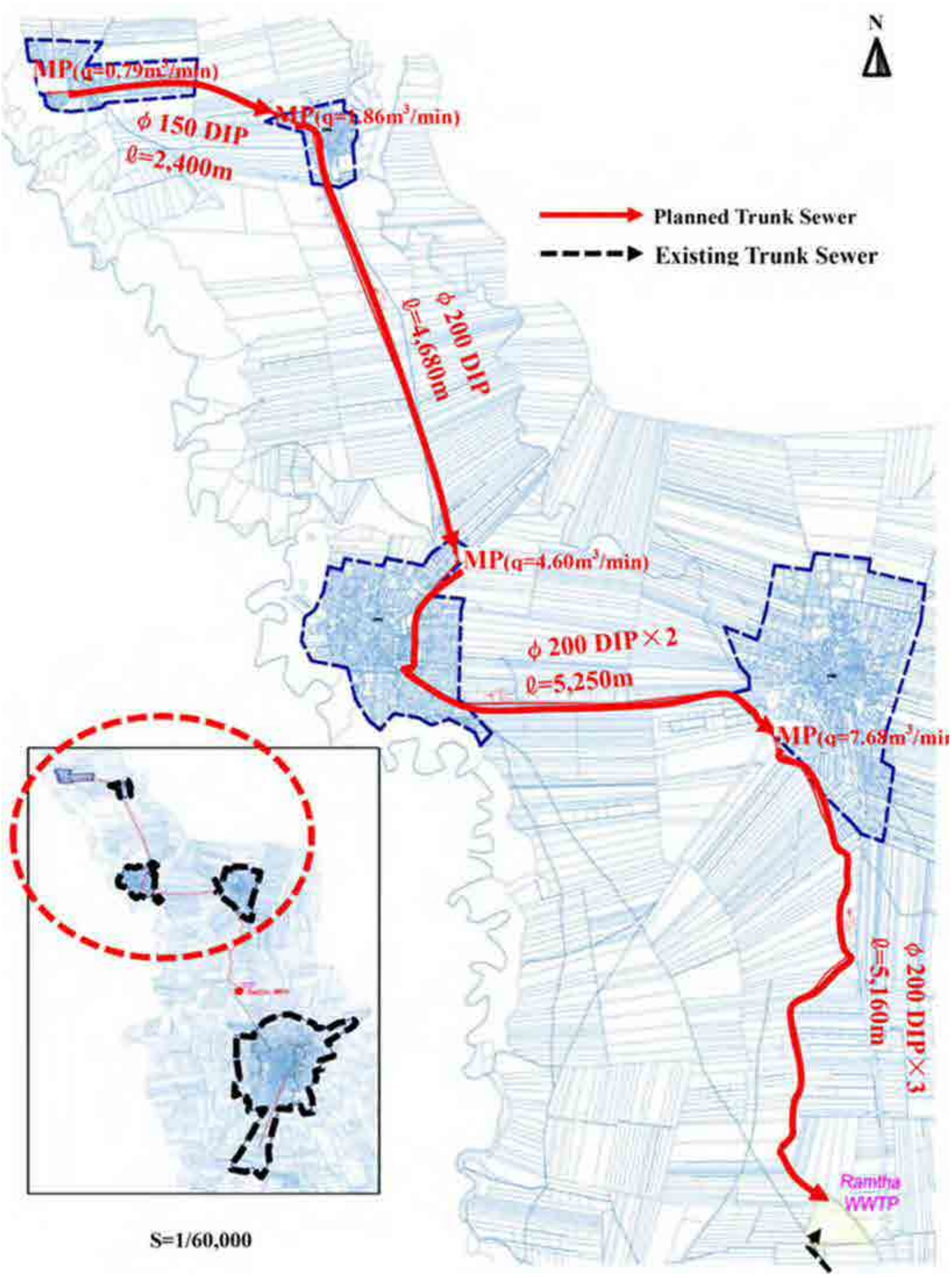


Figure 5.12 New Trunk Sewers in Ramtha SWD (1)

To convey the wastewater generated in the south western area of Ramtha City, new trunk sewers, SEB-1 and SEB-2, are required as shown in Figure 5.13.

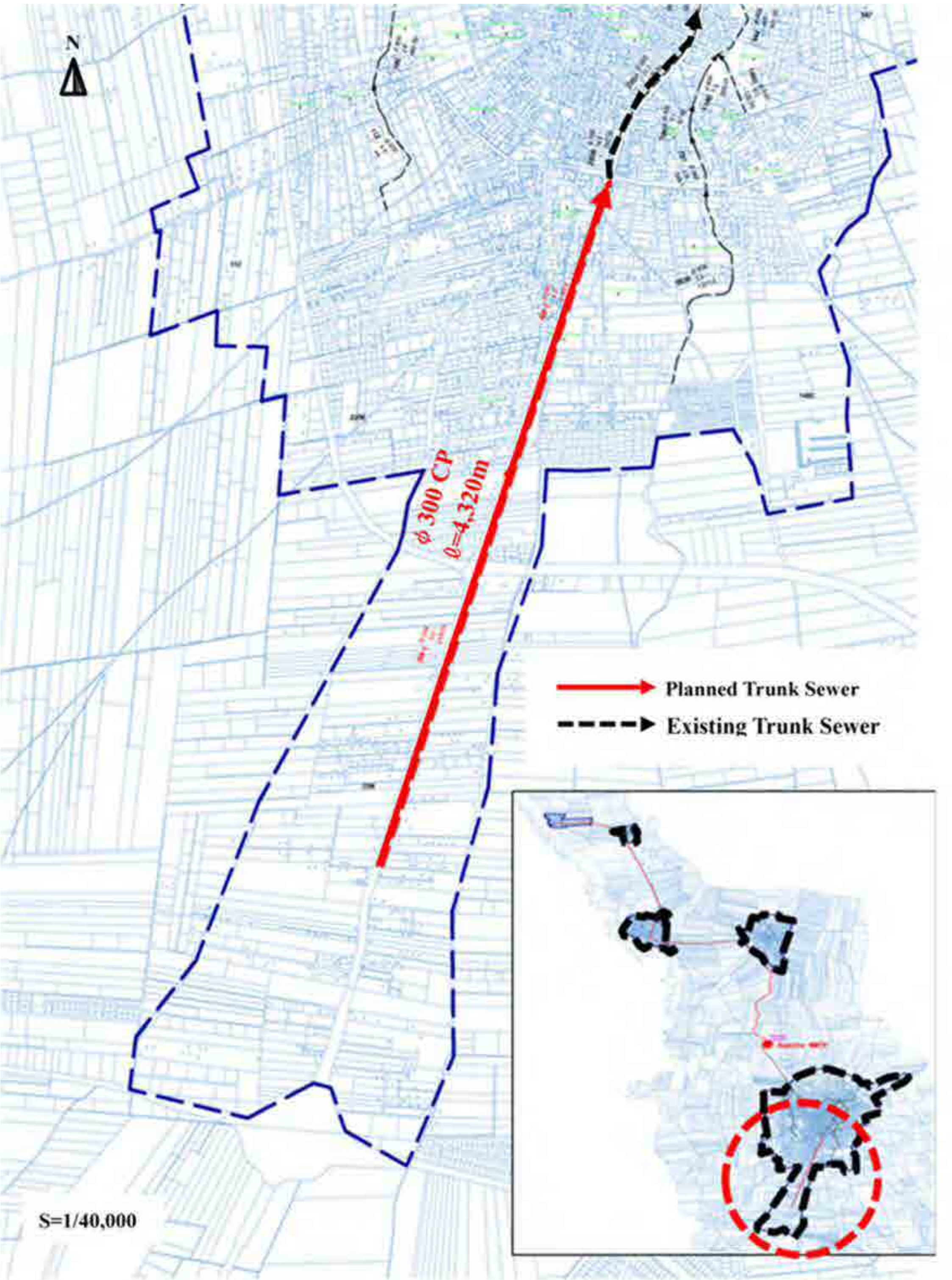


Figure 5.13 New Trunk Sewers in Ramtha SWD (2)

5.7.2 Branch Sewer

The required length of branch sewer per ha (calculated to be 152.3 m/ha) is multiplied by the net area to estimate the total length of branch sewer to be installed. The net area requiring new branch sewers in this case is 1,415.5 ha (total expansion area of 1,462 ha minus 46.5 ha which already have branch sewers installed although the house connections have not been made). The additional branch sewer requirement is about 216 km.

5.7.3 Ramtha WWTP

Table 5.23 shows the capacity calculations, identifying the treatment facilities required. The capacity calculations of each treatment process are shown in Appendix III-B of the Supporting Report. The capacity calculations are based on the average and maximum daily flows.

Table 5.23 Design Capacity of Ramtha WWTP

Item	Design
Actual Average Flow in 2013	4,477 m^3/d
Present Design Capacity (One train capacity x train nos.)	8,800 m^3/d (4,400 m^3/d x 2)
Planned Average Daily Flow	17,269 m^3/d
Improved Design Capacity (One train capacity x train nos.)	17,600 m^3/d (4,400 m^3/d x 4)
Existing Sludge Treatment Capacity coverage	50 %

Source: JICA Study Team

Two lines of aeration tanks and final sedimentation tanks and mechanical sludge drying facilities are required as shown in Table 5.24. It is difficult to expand the existing sludge drying beds within the present 18 ha site. These will be demolished and replaced by mechanical sludge drying facilities as shown in the proposed layout in Figure 5.14.

Table 5.24 Expansion Plan for Ramtha WWTP

Component	Dimension (m)			Existing Number	Future Number	Remarks
	Width/ diameter	Length	Depth			
Coarse Screen				1	**1**	
Fine Screen				3	**3**	
Girt Chamber	5		3	2	**2**	
Equalization Ponds	25	70	3	2	**2**	
Lifting Station				1	**1**	4 pumps
Aeration Tank	33.4	50.1	4.5	2	**4(+2)**	
Final Sedimentation Tank	22		3	2	**4(+2)**	
Polishing Pond	30-36	70-94	2	10	**10**	
Disinfection (Chlorine Contact)	1.4	52.5	3.5	2	**2**	
Sludge Thickener	9		4	2	**2**	
Sludge Drying Bed	6	25		100		
Sludge Dewatering Machine					**2**	
Irrigation Reservoir	43	63.2	3.5	1	**1**	

Source: JICA Study Team

Figure 5.14 Layout of Ramtha WWTP

5.8 Sewerage Improvement Plan for Mafraq SWD

5.8.1 Sewer and Lift Station

To convey the wastewater generated in the western area “Bani Hassan” of Mafraq City, new trunk sewers, BH-1 to BH-6 and MNS-1, are required as shown in Figure 5.15.

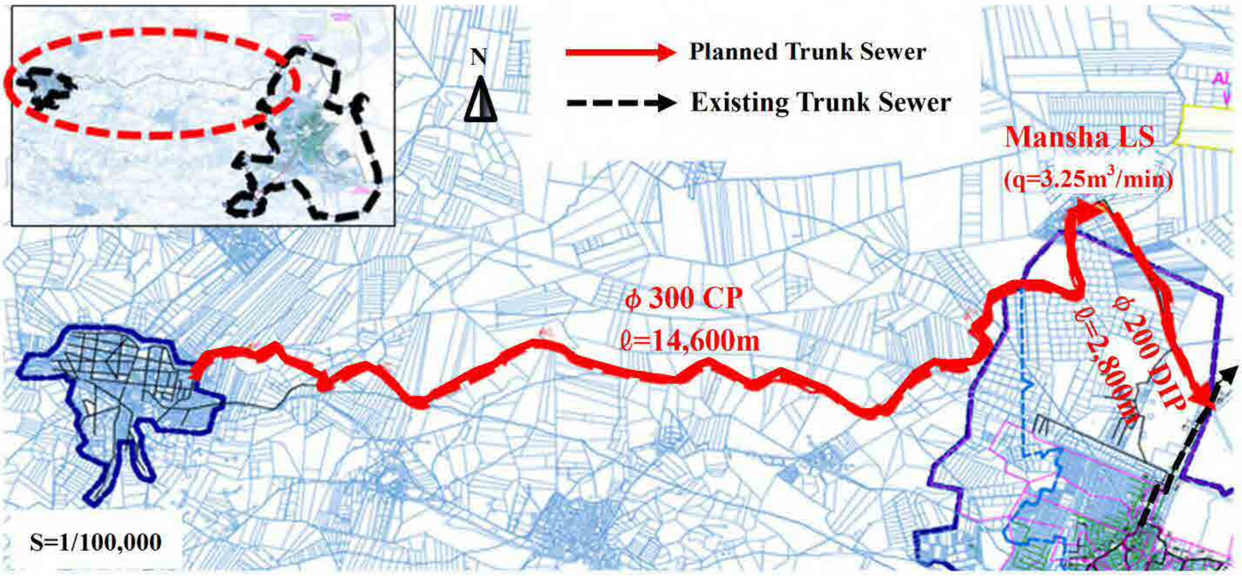


Figure 5.15 New Trunk Sewers in Mafraq (1)

To convey the wastewater generated in the south western area of “Aidoon” in Mafraq City, new trunk sewers, AID-1 and AID-2, are required as shown in Figure 5.15. In addition, to convey the wastewater generated in the south eastern part of Mafraq City, a new pumping station, and new trunk sewer, MNS-1, are required as shown in Figure 5.16.

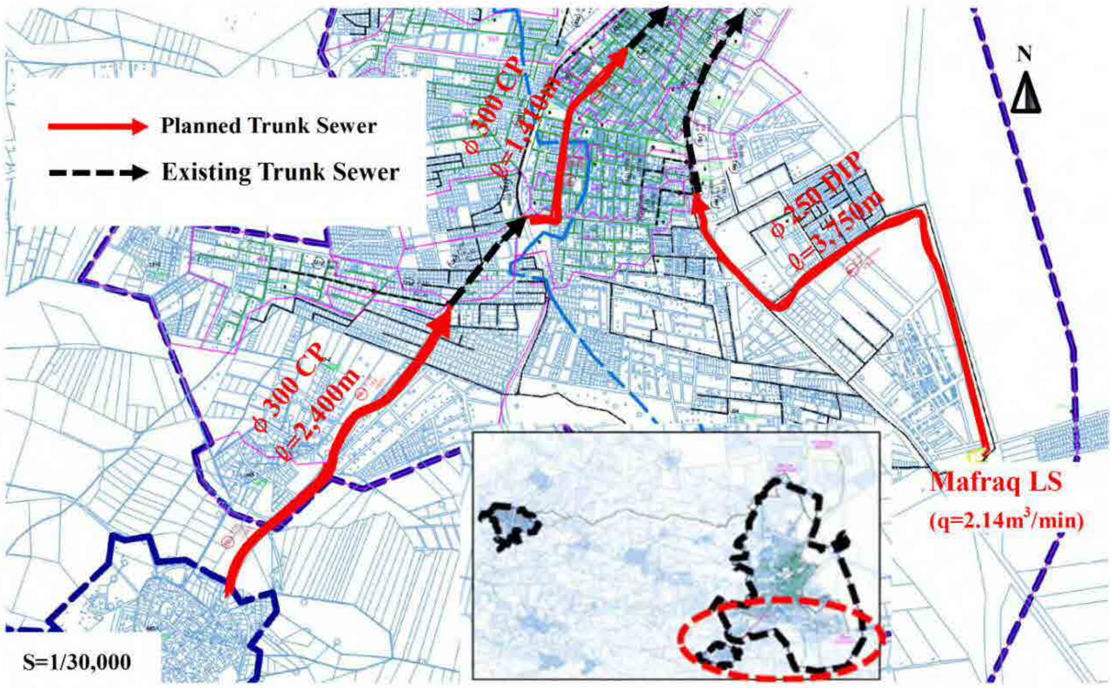


Figure 5.16 New Trunk Sewers in Mafraq (2)

5.8.2 Branch Sewer

The required length of branch sewer per ha (calculated to be 152.3 m/ha) is multiplied by the net area in the expansion area. The net area in this case is 2,901.2 ha (the expansion area of 2,931 ha minus 29.8 ha which already have branch sewers installed, although the house connections have not been made). The additional branch sewer requirement is about 442 km.

5.8.3 Mafraq WWTP

Table 5.25 shows the capacity calculations, identifying the treatment facilities required. The capacity calculations of each treatment process are shown in Appendix III-B of the Supporting Report. The capacity calculations are based on the average and maximum daily flows.

Table 5.25 Design Capacity of Mafraq WWTP

Item	Design
Actual Average Flow in 2013	1,710 m^3/d
Present Design Capacity (One train capacity x train nos.)	7,200 m^3/d (3,600 m^3/d x 2)
Planned Average Daily Flow	14,353 m^3/d
Improved Design Capacity (One train capacity x train nos.)	14,400 m^3/d (3,600 m^3/d x 4)
Existing Sludge Treatment Capacity coverage	50 %

Source: JICA Study Team

Two options for the expansion of Mafraq WWTP are prepared based on the availability of additional land.

1) Case-1 (additional land is available)

The treatment process as shown in Table 5.26 would require an additional 13.2 ha of land adjacent to the present site. Figure 5.17 shows the proposed layout with the additional treatment facilities constructed on the adjacent land (minimum required area for the expansion is 6.5 ha). WAJ owns the land where the WWTP is located as well as 90 ha in the surrounding area.

Table 5.26 Case 1 Expansion Plan for Mafraq WWTP

Component	Dimension (m)			Existing Number	Future Number	Remarks
	Width/ diameter	Length	Depth			
Coarse Screen				1	**2(+1)**	for bypass
Fine Screen				2	**4(+2)**	
Wet Weather Storage Lagoon	62	62	5	1	**1**	
Oil & Grease Removal	5.9			2	**4(+2)**	
Sedimentation /Thickening Tank	4.3	8.3	6.75	2	**4(+2)**	
Denitrification Basins	15	26	3.5	2	**4(+2)**	
Aeration Stabilization Basins	88.4	35.5	3.5	10(+5)	**20(+10)**	
High Rate Nitrification Basin	14	20	3.5	2(+1)	**4(+2)**	
Facultative Lagoon	37	73	3.5	2(+1)	**4(+2)**	
Sand Filter	45	80		3	**6(+3)**	
Reed Bed	30	50		2	**3(+1)**	
Chlorine Disinfection	2	51	1.8	1	**1(+1)**	
Sludge Storage/Stabilization Lagoon	15	15	3	2	**6(+4)**	
Sludge Drying Bed	12	35		26	**52(+26)**	
Window Compositing				1	**1**	

Source: JICA Study Team

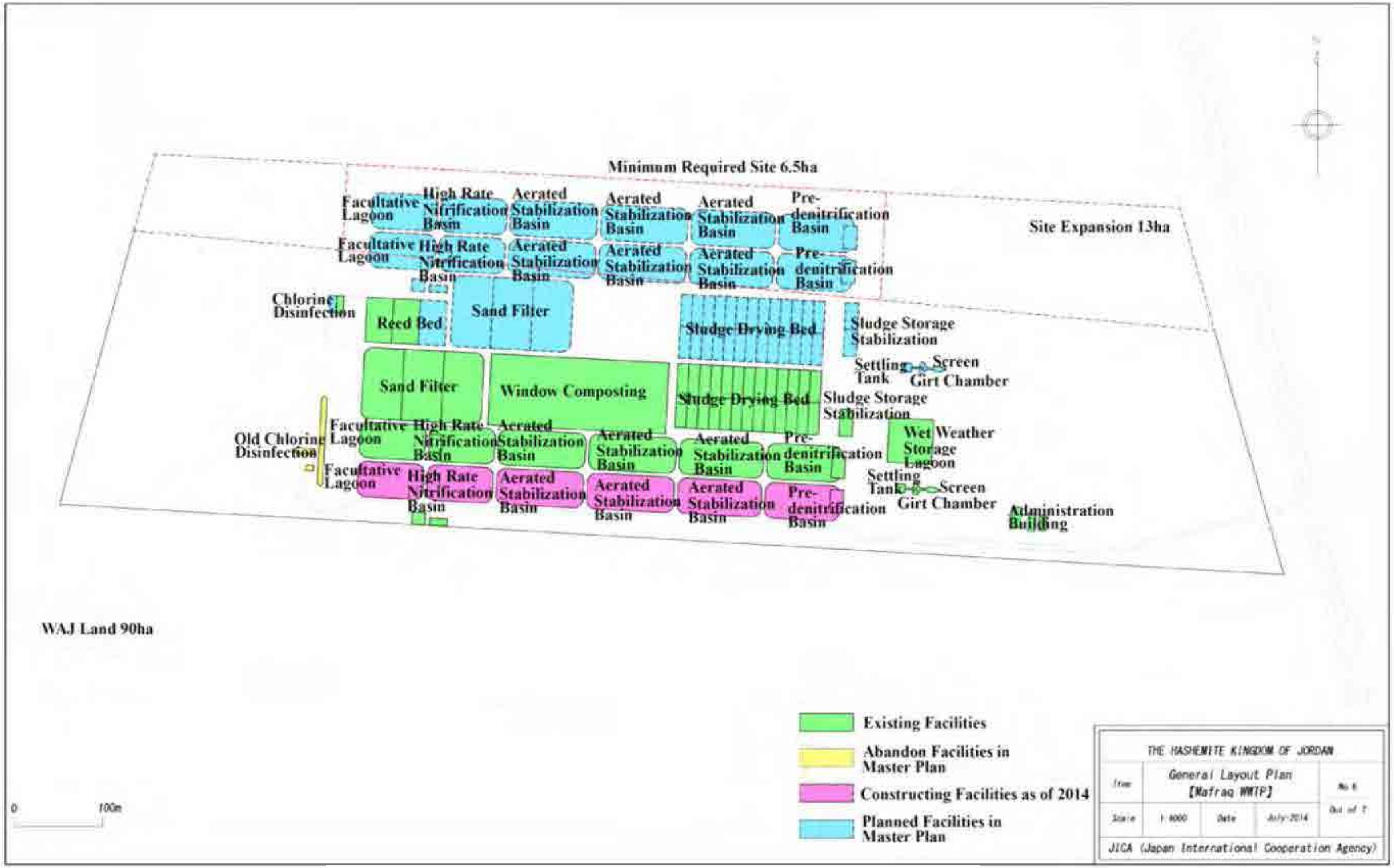


Figure 5.17 Case-1 Layout of Mafraq WWTP

2) Case-2 (no additional land is available)

If no additional land is available, the wastewater treatment process using "nitrification and denitrification tank, aerated lagoon, facultative pond, sand filter, and reed bed" would be replaced by a "three step feed nitrification-denitrification reactor, sedimentation tank, sand filter, and reed bed". Table 5.27 shows the expansion plan and Figure 5.18 the layout for Case-2.

Table 5.27 Case 2 Expansion Plan for Mafraq WWTP

Component	Dimension (m)			Existing Number	Future Number	Remarks
	Width/ diameter	Length	Depth			
Coarse Screen				1	**2(+1)**	for bypass
Fine Screen				2	**4(+2)**	
Wet Weather Storage Lagoon	62	62	5	1	**1**	
Oil & Grease Removal	5.9			2	**4(+2)**	
Sedimentation /Thickening Tank	4.3	8.3	6.75	2	**4(+2)**	
Denitrification Basins	15	26	3.5	2	2	
Aeration Stabilization Basins	88.4	35.5	3.5	10(+5)	10	
High Rate Nitrification Basin	14	20	3.5	2(+1)	2	
Facultative Lagoon	37	73	3.5	2(+1)	2	
3 Steps Feed Ntirification-Denitrificaion Reactor	9.5	70	4.5		**4**	
Final Sedimentation Tank	17		3.4		**4**	
Sand Filter	45	80		3	**6(+3)**	
Reed Bed	30	50		2	**3(+1)**	
Chlorine Disinfection	2	51	1.8	1	**1(+1)**	
Sludge Storage/Stabilization Lagoon	15	15	3	2	**6(+6)**	
Sludge Drying Bed	12	35		26	**60(+34)**	
Window Compositing				1	**1**	

Source: JICA Study Team

Since additional land will likely be available, the Case 1 expansion plan will be discussed in the following Chapters.

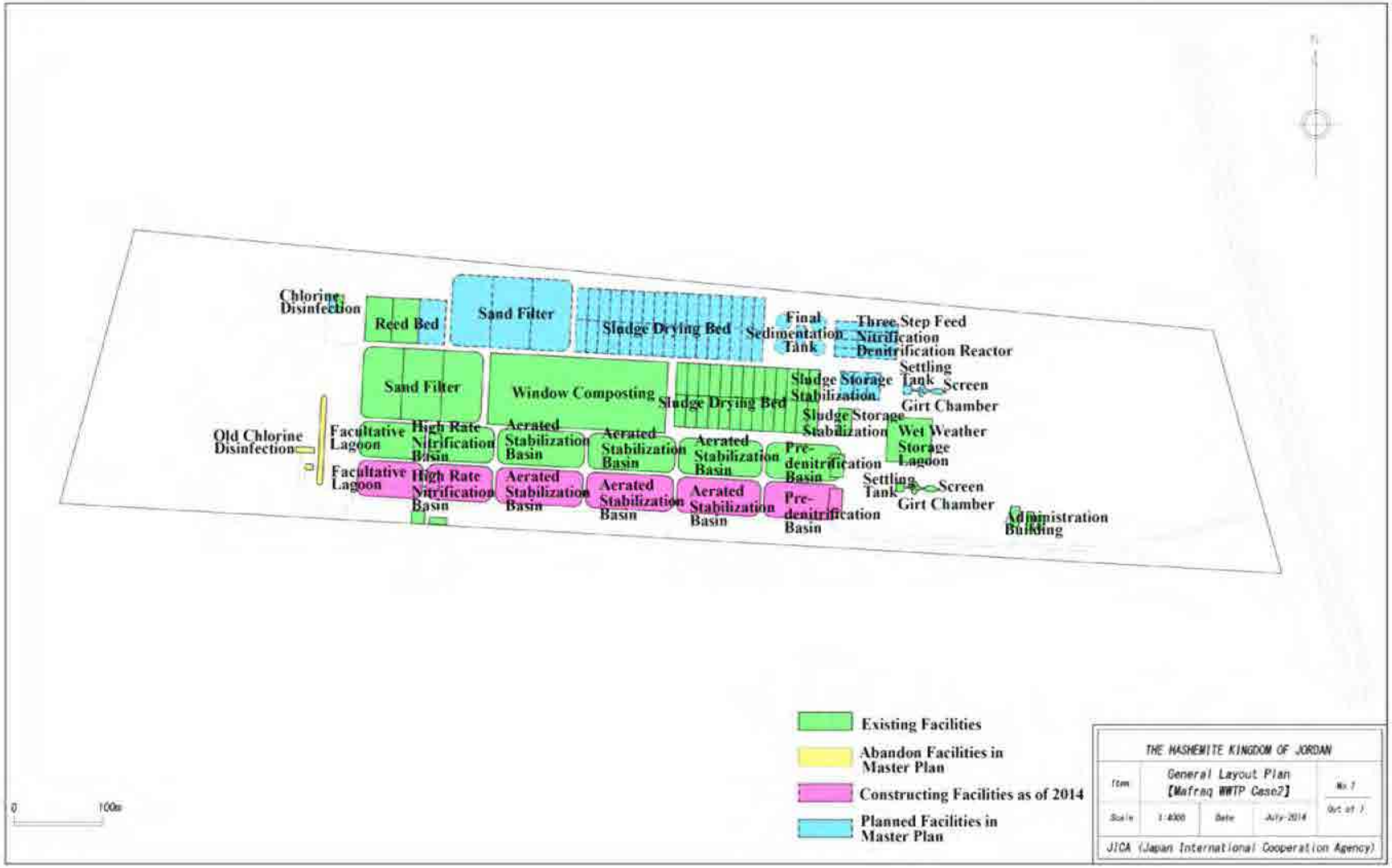


Figure 5.18 Case 2 Layout of Mafraq WWTP

CHAPTER 6 INSTITUTIONAL DEVELOPMENT PLAN AND CAPACITY DEVELOPMENT PLAN

6.1 Institutional Development Plan

6.1.1 Organizational Arrangement

The Study Team proposes the following arrangement of YWC organization structure in view of the incremental responsibilities and workload arising from the additional facilities in the Master Plan and considering the optimization of the structure as a water and wastewater utility.

(1) Business Management and Quality Management Section
This section is suggested to be newly established directly under the General Manager to ensure its independent function. The main functions shall be 1) to prepare high level policies, plans and strategies, and to manage investment considering urgency, priority, weakness and development goals, 2) to regularly monitor the business performance of waterworks and wastewater works as a whole by using Performance Indicators (PIs), and 3) to initiate and enhance continuous improvement in the quality of services as a whole and, to increase customer satisfaction as a service provider.

The consistency among the corporate plan, operational plan and development plan will be secured by initiative taken by this section. Furthermore, this section will enhance the inter-directorate decision-making from the aspects of not only public services but also business activities. Hence, sustainability view point will be expected to be nurtured by this institutional arrangement.

YWC has been engaged with various donor-funded projects for many years since it was NGWA. These projects sometime tend to be patchworks without the consideration of a comprehensive planning and a middle- and long-term goal for development. Thus the function of this section for keeping its consistency shall be strengthened.

In addition, quality management system does not exist in YWC currently and the awareness on this concept is scarcely shared among the employees. Initially, an understanding of the concept needs to be promoted and awareness on the concept should be shared by all employees. Presumably the next step may be to obtain and translate ISO9001 and ISO24512, related to the management of drinking water utilities and for the assessment of drinking water services, and bring into practice in stages.

(2) Technical Planning Division
This section is suggested to be newly established under the Technical Directorate. The expected functions of the section are 1) to develop, lead and coordinate the engineering plan and the design of sewerage facilities, mechanical and electrical equipment, water engineering, and 2) to monitor and assess wastewater demands and technical functionality of overall existing sewerage system and development projects. This section is also responsible for overall management of sewer network and

its planning and planning coordination.

(3) Maintenance Section of Technical Support and Maintenance Division

Maintenance section in Technical Support and Maintenance Division needs to be strengthened by increasing the number of staffs and by providing more advanced training.

Only 3 persons consisting of the section head, mechanical engineer and electrical engineer exists in the section and cover technical service and maintenance for all pumping stations and treatment plants except for pipeline. Preventive maintenance was possible to be done under the YWC operation by the private contractor, however it seems to become not sufficiently functioning due to the reduction of staffs and availability of only one vehicle after the contractor left.

Since maintenance activities are very crucial to extend the lifetime of machine and electrical equipment and to contribute to sustainable utility's management by delaying rehabilitation and replacement investments, additional 3 engineers and at least one vehicle should be allocated. Current staff's motivation to learn advanced technique and technology should also be respected.

(4) ROU Sewerage Section

There are no remedial measures to immediately reduce sewer blockage and sewer flooding, which is considered to be mainly caused by residential people's behavior. The development of trunk lines and sewer network will be assumed in all four Governorates up to 2035. Hence, sewerage section of each ROU needs to be strengthened by increasing additional 21 staffs in accordance with the deployment of high power vacuum trucks (Table 6.1).

Table 6.1 Staffing for ROU Sewerage Section

Governorate	ROU	Current Staff (Sep. 2014)	Additional Staff	Total (by 2035)
Irbid	Irbid sewerage section	21	8	29
	Bani Obaid sewerage section	5		5
	Ramtha sewerage section	7	4	11
Mafraq	Mafraq sewerage section	3	3	6
Ajloun	Ajloun sewerage section	3	3	6
Jerash	Jerash sewerage section	3	3	6
Total		42	21	63

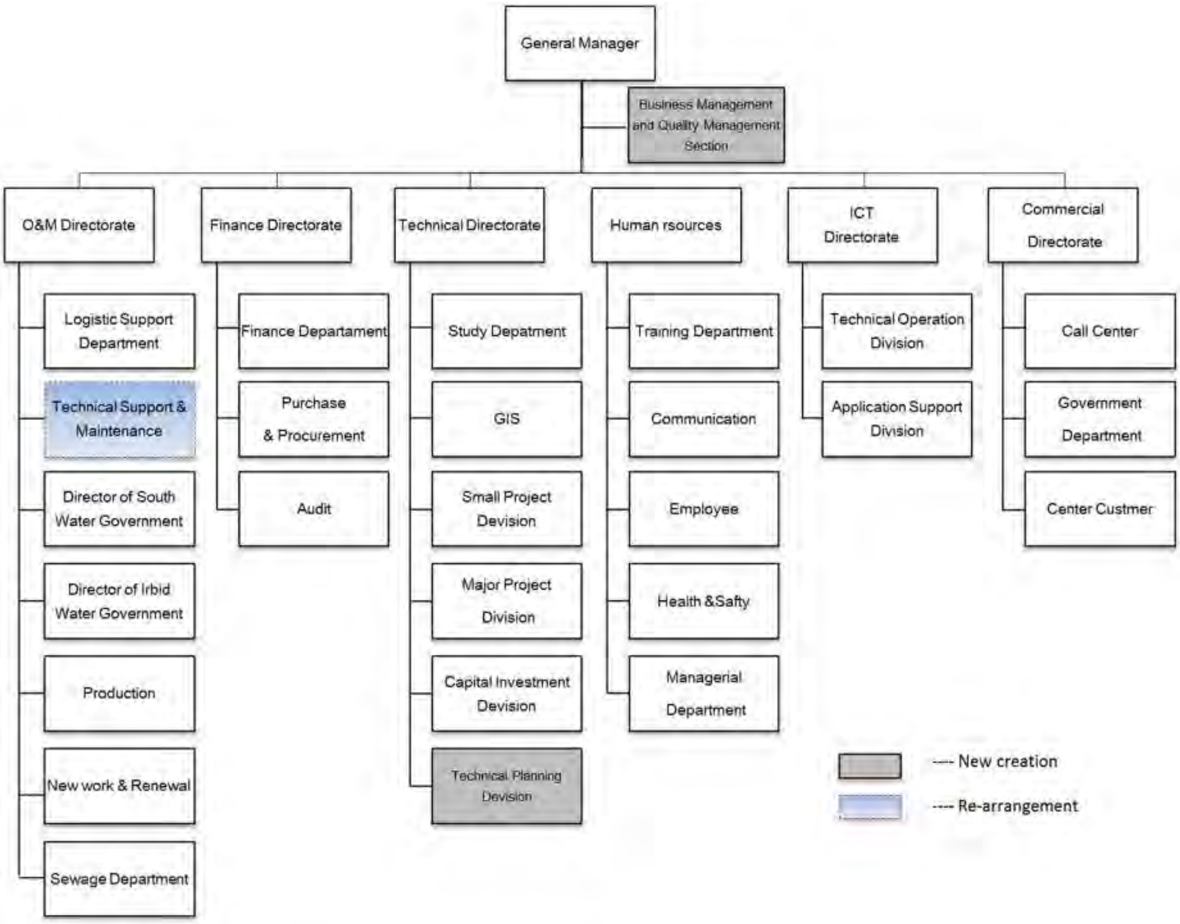
Source: JICA Study Team

(5) Commercial Directorate

A Call Center in the head office receives customer's phone call on 24 hour basis. The customer complaints are categorized into mainly 11 areas and are statistically recorded. These customer complaints and inquiries are transferred and handled by each ROUs. Monitoring, tracking and providing feed-back on received complaints are not sufficiently practiced. A more functional system and an overall organizational capacity leading to substantial resolution need to be established between ROU Sewerage Section and Commercial Directorate. With regard to sewer blockage and sewer flooding, it is pointed out that a proactive approach of promoting IEC activities for the residents is essential. This issue is described in the Section 6.1.2.

(6) Proposed Organization Structure

Proposed organization structure of YWC overall and O&M Directorate are presented in the following figures (Figure 6.1, and 6.2).



Source: JICA Study Team

Figure 6.1 Proposed Organization Structure (YWC Overall)

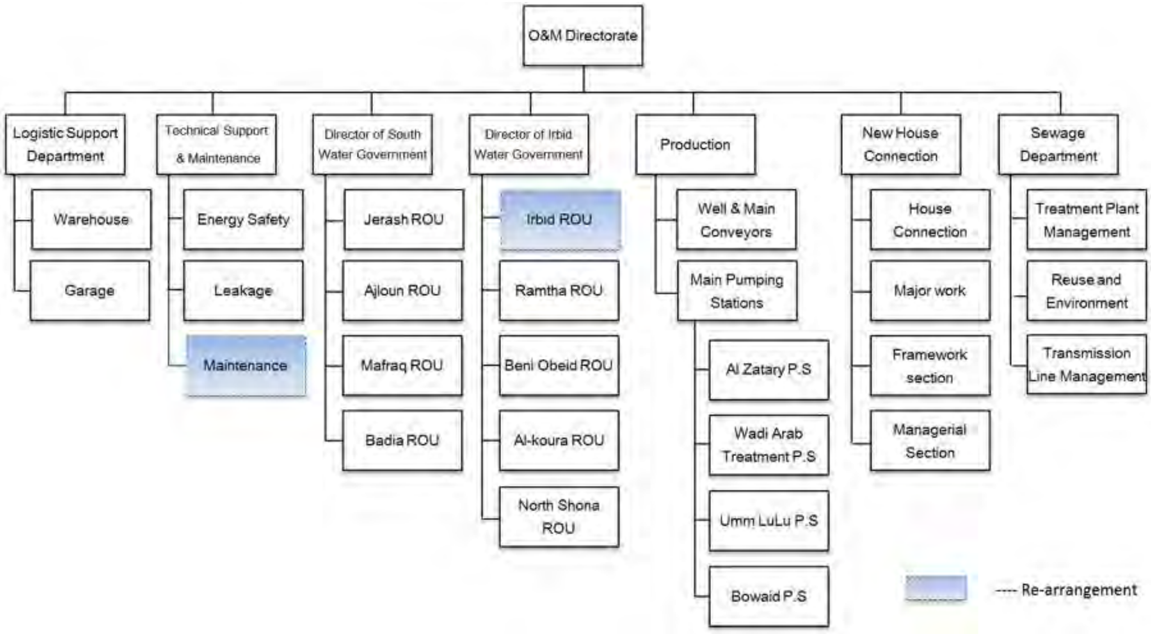


Figure 6.2 Proposed Organization Structure (O&M Directorate)

6.1.2 Key Issues for Institutional Development

(1) Cultural Change toward Service Provider with Business Awareness

- It is important to nurture corporate culture with business awareness and customer focus as a service provider from governmental institutions.
- Change to an administrative organization with technical specialization is required. The first step for this change could be started from the change of employee's mind and awareness at the individual level. In order to do that, strong leadership needs to be taken by the upper management class. The Sewerage Division is not the exception. YWCneeds to pay more attention to the cost recovery of sewerage service for their sustainability.

(2) Efficient Usage of Performance Indicators (PIs)

- Performance indicators for wastewater services should be effectively utilized in the business operation of sewerage facilities. PIs are an effective tool for evaluation of performance quantitatively. It enables to compare the utility's performance of the past, present and future periodically, and also to set up quantitative targets for future improvement. The state of existing business operation and target achievement status of sewerage service should be always monitored. It makes current management situation and achievement visible. Although key data is collected and some performance indicators are currently compiled by YWC, some parameters such as E-coliform, PO^4, COD and BOD sometimes do not meet the standards and the countermeasure is not taken in such cases. Effective analysis should be carried out to clarify issues and improvement points to be undertaken should be suggested for reflecting the results on development of strategy and plan.

(3) Setting Targets for Sewerage Works

- Performance targets and achievement standards of sewerage service should be clearly established. Business Management and Planning Division should set up the key performance indicators and the achievement targets, and do their best for achievement of these targets. Then the performance results need to be reviewed and the results should be made best use for feedback to the development of strategy setting and target setting.

(4) Clear Job Description and Standard Operating Procedures

- Limited job description and Standard Operating Procedure (SOP) is observed. In order to raise the level of staff's performance, job description and SOP need to be defined and delegation of responsibility should be clearly established in each section. Authority should be delegated to the lower level in the hierarchy. Thereby self-awareness and self-reliance of employees is encouraged more than ever before.

(5) Building Up the Human Resource Management System

- YWC should clearly understand internal human resources by establishing human resource management system which enables efficient use of human resources and their proper appointment. Evaluation standards need to be set up so as to objectively evaluate the performance of the employees. Incentive mechanism and promotion system needs to be formulated and employee's motivation should be enhanced.

(6) Enhancement of People's Awareness through IEC Activities

- Although commercial department is responsible for IEC activities, however its activities are limited due to lack of budget. Also they are basically busy in providing responses to customer's claim rather than IEC activities on water saving, leakage reduction and garbage disposal. Hence, establishment of IEC activity programs, its implementation and development of IEC materials in cooperation with outside institutions and experts need to be strengthened. People's education and awareness-raising by using media, publications and primary schools should be also proactively promoted. The intensive training for the department staffs needs to be carried out to implement the programs appropriately.

6.1.3 Staffing Plan

The appropriate number of YWC staffs by job type for the Master Plan up to Year 2035 is estimated. These are described in the following sections.

The estimation of specific number of O&M staff in water and wastewater sectors is based upon the current operation, the planned new facilities, the intended shift arrangement and the workload anticipated. It should be noted that the necessary staff number depends upon the quality of maintenance and the operational performance of the facilities.

(1) O&M for Wastewater Sector

1) Central Irbid WWTP

Additional 4 operators will be necessary to be stationed when rehabilitation and expansion works are finished by KfW project which is currently ongoing (Table 6.2). The new facilities such as effluent filters, UV disinfection system, sludge stabilization and dewatering system, new odor control facilities will be constructed and the existing facilities will be partly upgraded. Hence, it is proposed that the total staff number be increased from 22 to 26 by 2035.

Table 6.2 Staffing for Central Irbid WWTP

	Current Staff (Sep. 2014)	Additional Staff	Total (by 2035)
Plant manager	1		1
Engineer	1		1
Laboratory analyst	1		1
Plumber	1		1
Labor	2		2
Driver	1		1
Operator head	4		4
Operator	8	4	12
Other	3		3
Total	22	4	26

Source: JICA Study Team

2) Wadi Al-Arab WWTP

Additional 4 operators will be necessary when incremental three units of facilities such as aeration tanks and sedimentation tanks are constructed (Table 6.3). One operator will be allocated to each of 4 shift teams respectively.

SCADA system was already installed in 2008 and it is currently available, so that operation of the new aeration tank and sedimentation tank can be integrated into the comprehensive system. Hence, it is proposed that the total staff number be increased from 21 to 25 by 2035.

Table 6.3 Staffing for Wadi Al-Arab WWTP

	Current Staff (Sep. 2014)	Additional Staff	Total (by 2035)
Plant manager	1		1
Engineer	2		2
Laboratory analyst	1		1
Plumber			
Labor			
Driver			
Operator head	4		4
Operator	6	4	10
Other	7		7
Total	21	4	25

Source: JICA Study Team

3) Shallala WWTP

Additional 2 operators will be necessary when incremental one unit of facilities such as oxidation ditch, and primary and final sedimentation tanks are constructed (Table 6.4).

Shallala WWTP was newly established in 2013 and the operation was just started in January 2014. SCADA system is available, so that operation of the new oxidation ditch, and primary and final sedimentation tanks can be integrated into the comprehensive system. Hence it is proposed that the total staff number be increased from 21 to 23 by 2035.

Table 6.4 Staffing for Shallala WWTP

	Current Staff (Sep. 2014)	Additional Staff	Total (by 2035)
Plant manager	1		1
Engineer	2		2
Laboratory analyst	2		2
Plumber			
Labor	5		5
Driver	2		2
Operator head	5		5
Operator	4	2	6
Other			
Total	21	2	23

Source: JICA Study Team

4) Wadi Hassan WWTP

Additional 2 operators will be necessary when incremental one unit of facilities such as oxidation ditch, final sedimentation tank, and sludge drying bed are constructed (Table 6.5).

SCADA system was already installed, however it is currently out of order. Hence, operation of the new oxidation ditch, final sedimentation tank, and sludge drying bed may need to be done manually, unless a new plan of the SCADA system either through repair or installation comes up and it becomes functional. Hence, it is proposed that the total staff number be increased from 12 to 14 by 2035.

Table 6.5 Staffing for Wadi Hassan WWTP

	Current Staff (Sep. 2014)	Additional Staff	Total (by 2035)
Plant manager	1		1
Engineer			
Laboratory analyst	1		1
Plumber			
Labor			
Driver			
Operator head	4		4
Operator	4		4
Other	2		2
Total	12	0	12

Source: JICA Study Team

5) Ramtha WWTP

Additional 4 operators will be necessary when incremental two units of aeration tanks and final sedimentation tanks, and sludge dewatering machine are constructed (Table 6.6). One engineer will be necessary when the MP is installed for the four remote areas for regular inspection and for emergency cases. SCADA system was available and functional, so that the operation of new facilities can be also integrated into the system. Hence, it is proposed that the total staff number be increased from 15 to 20 by 2035.

Table 6.6 Staffing for Ramtha WWTP

	Current Staff (Sep. 2014)	Additional Staff	Total (by 2035)
Plant manager	1		1
Engineer		1	1
Laboratory analyst			
Plumber			
Labor	1		1
Driver	2		2
Operator head	5		5
Operator	4	4	8
Other	2		2
Total	15	5	20

Source: JICA Study Team

6) Mafraq WWTP

Mafraq WWTP has been rehabilitated and upgraded under the USAID project. The first phase of the project was completed and the second phase will be finished in March 2015. Two (2) new operators was already allocated and partially trained, so that there are 16 staffs in total at present. Additional 4 operators will be necessary to be stationed when the second phase of the construction of treatment facilities is completed (Table 6.7).

Manual operations have been done since 1987, the commencement of WWTP, however the installation of SCADA system is underway by the project. Hence it is proposed that the total staff number be increased from 16 to 20 by 2035.

Table 6.7 Staffing for Mafraq WWTP

	Current Staff (Sep. 2014)	Additional Staff	Total (by 2035)
Plant manager	1		1
Engineer			
Laboratory analyst			
Plumber	2		2
Labor	3		3
Driver	1		1
Operator head	4		4
Operator	4	4	8
Other	1		1
Total	16	4	20

Source: JICA Study Team

7) ROU office

New trunk line is suggested to be constructed for Irbid Center, Waji Arab, Shalala, Waji Hassan, Ramtha and Mafraq areas in the M/P up to Year 2035. Generally, the new trunk line itself may not need particular maintenance, however sewer blockage may occur in the densely populated city areas sometime even in case of new line. Hence the following number of maintenance staffs is assumed to be necessary: Irbid Center 9, Ramtha 3, Mafraq 3. It is proposed that the total staff number be raised to 37 in Irbid ROU, 13 in Ramtha ROU and 13 in Mafraq ROU by 2035.

The summary of staffing plan by ROU office is shown in Table 6.8.

Table 6.8 Staff for Sewer Maintenance by the ROU Office

ROU	Current Maintenance Staff (Sep. 2014)				Proposed Maintenance Staff by 2035			
	Chief	Worker	Driver	Total	Chief	Worker	Driver	Total
Irbid	1	12	6	19	**1**	**18**	**9**	**28**
						6	**3**	**9**
Ramtha	1	4	2	7	**1**	**6**	**3**	**10**
						2	**1**	**3**
Mafraq	1	4	2	7	**1**	**6**	**1**	**10**
						2	**1**	**3**

Note: Additional staff numbers are shown in red color., Source: JICA Study Team

8) Lift Station

Table 6.9 summarizes the staff required for the existing and new lift stations. For Mughyeer MP and 4 MP the operation will be regularly inspected by the engineers of Shallala WWTP and Ramtha WWTP respectively. For Mafraq LS and Mansha LS, 4 staffs will need to be newly appointed for the operation.

Table 6.9 Staff required for Lift Stations

SWD	LS/MP	Status	Current Operator (Sep. 2014)	Proposal	Remarks
Wadi Al-Arab	Hakama LS	Exp.	4 no., 4 shifts	no change	
Shallala	Mughyeer MP	New		Regular inspection by 2 engineers at Shallala WWTP	no staff increase
Shallala (Wadi Hassan)	Al Hoson Camp LS	Exp.	4 no., 4 shifts	no change	it is planned to shift to the Shallala SWD
Ramtha	4 MP	New		Regular inspection by an engineer at Ramtha WWTP	
Mafraq	Mafraq LS	New	-	**4** nos. by 4 shifts	
	Mansha LS	New	-	**4** nos., 4 shifts	

Source: JICA Study Team

(2) Overall

1) Current Staffing Level

The progress of downsizing staffs can be seen after the recent peak number of 1740 in 2012 (Table 6.10). The current number of staffs in 2014 is counted as 1,649 according to the information from YWC cost center. The staffing level per water and wastewater 1,000 connections of YWC in 2014 indicates even better performance than the average of available 3 utilities in Jordan (Table 6.11). In comparison to the level of other upper-middle income countries, the staff productivity of YWC is nearly similar to their performances except in case of Azerbaijan and Kazakhstan.

Table 6.10 Staff Numbers and Staffing Productivity per Connection (2006-2014)

	2006	2007	2008		2012	2013	2014
Total staff number	1,761	1,801	1,673	---	1,740	1,671	1,649
Staff number W&WW/ W&WW 1,000 conn.	7.3	7.2	6.4	---	6.6	6.1	6.0

[Note]

1. Data source: 2006-2008 Management Contract for YWC LLC, 2012-2014 YWC Technical Directorate
2. Data during 2009-2011 is not yet obtained by the Study Team

Table 6.11 Staff Productivity of Jordan and Other Upper-Middle Income Countries

IBNET Performance Indicators	Jordan					Albania	Azerbaijan	Bosnia & Herzegovina	Kazakh stan	Macedonia
	YWC	Jordan Average of 3 Utilities	Aqaba Water Company, W.L.L.	Water Authority Balqa and Zarqa, Madaba and Karak, Maan and Tafila	Jordan Water Company (waters) Miyahuna					
12.2 Staff W&WW/1000 W&WW conn (#/1000 W&WW conn)	6.0	8.7	13.0	9.8	3.4	6.2	2.8	5.2	318.9	5.3
12.4 Staff W&WW/1000 W&WW Pop Served (#/1000 W&WW pop served)	0.7	0.9	1.3	1.2	0.2	1.7	0.7	1.3	2.1	1.0

Source: JICA Study Team

[Note]

1. Data source: IBNET Database
2. Average of Jordan is calculated by using available results of 12.2 and 12.4v

2) Target of Staffing Level

In this M/P, JICA Study Team proposes "gradual reform" rather than "radical reform" considering local historical and cultural context, nature of employees and past experience. The appropriate target of the staffing level shall be proposed to be 4.5 staffs per 1,000 connections in Year 2035 (Table 6.12). If the number of subscribers for water and wastewater increase according to population growth of four northern governorates, it is estimated that the appropriate staffing level of YWC reaches to 2,345 staffs in Year 2035.

The projection and the estimation condition are shown as follows.

Table 6.12 Projection of Appropriate Staffing Level

	2014	2020	2025	2030	2035
Number of Subscribers (connection) - Water supply	275,362	320,579	379,020	445,759	521,031
Number of Subscribers (connection) - Sewerage	180,590	215,469	238,084	262,226	286,737
Number of Subscriber - Total	420,326	536,048	617,105	707,985	807,768
Staff W&WW/1000 W&WW conn (#/1000 W&WW conn)	6.0	5.6	5.2	4.9	4.5
Number of Staffs (persons)	1,649	1,786	1,976	2,165	2,345

Source: JICA Study Team

[Note]
1. Data source: Year 2014 – YWC
2. Data source: Year 2020, 2025, 2030, 2035 – Estimation by JICA Study Team
3. Population for Northern 4 governorates: 2.87 million in 2035, Coverage ratio: 98% for water supply

Meanwhile it is important to keep in mind that “number of staffs per 1,000 connections” and “number of staffs per 1,000 population served” are benchmarking indicators, not standards. The staffing level should be flexible and appropriate for the actual management of waterworks and wastewater works. Also, staff productivity should not be utilized for the purpose of downsizing workforce without considering the local context, but should be balanced with the purpose of nurturing proactive workforce with high motivation and high skill. The arrangement of job description and terms of conditions of works could contribute to build up harmonious relations with employees.

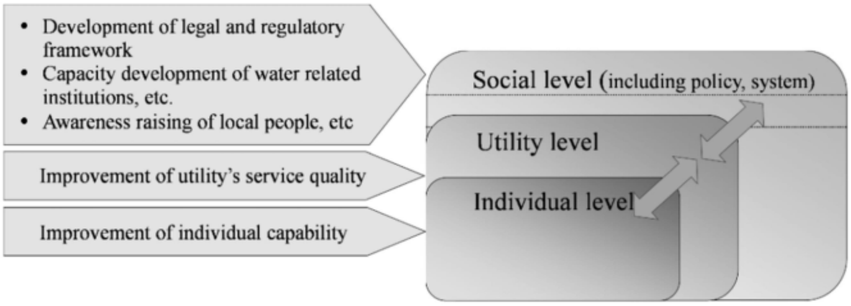
6.2 Capacity Development Plan

6.2.1 Outline of Capacity Development

(1) Concept of Capacity Development

Capacity development is defined as “the process by which individuals, organizations, institutions, and societies develop abilities to perform functions, solve problems and set and achieve objectives” by JICA. Capacity development not only in technical aspects but also in overall organizational aspects including management and financial issues is essential for water and sewerage utilities to operate their organization and infrastructure facilities in sustainable manner. In order to support this, capacity development at individual and social level also plays a crucial role.

Capacity development cannot be achieved without human resources. Any utility needs to address that human resources are the greatest assets of the utility and are the most valuable element of capacity development.



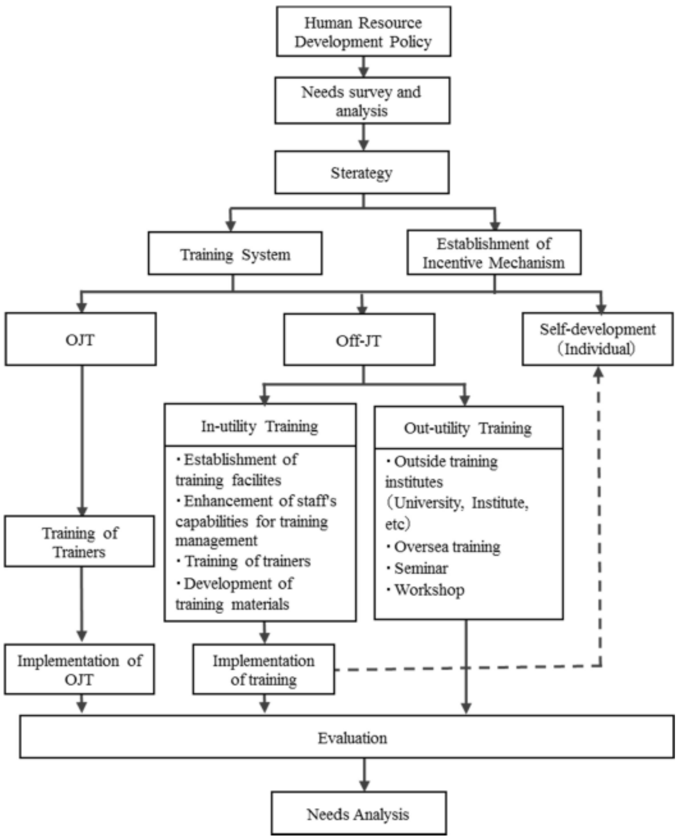
Source: JICA (2008) Capacity Assessment Handbook

Figure 6.3 Concept of Capacity Development

(2) Capacity Development Methods

Training mechanism and capacity development methods are indicated in following figure. Capacity development should follow a utility's basic policy for human resource development and should be planned based on the result of needs assessment. Main methods of capacity development are the following three: (1) OJT, (2) Off-JT, (3) self-development.

OJT enhances capacity in terms of necessary technology and capability through a form of training on practical works and trial and error in normal working situation. Off-JT is a form of training through external lectures or education either inside or outside of utility. Self-development is a form of training to develop own capability by individual learning.



Source: JICA (2008) Capacity Assessment Handbook

Figure 6.4 Capacity Development Mechanism and Methods

For effective capacity development of YWC, combination of all training methods for capacity development such as OJT, Off-JT and self-training are essential. The training subjects of YWC in 2012 were varied from the areas of technical, management, information technology, health and safety and customer service partially funded by the USAID. One of weakness of the training system by YWC can be that most of training courses are contracted out to outside service providers. It naturally requires a large training budget amount. Alternatively the adoption of training of trainers (ToT) system could be a solution.

From the long-term view, it is expected to nourish resource persons effectively, and that they teach obtained knowledge and experiences to the next middle or young staff members. At the same time, creation of incentive mechanism and awareness-raising, and development of surrounding environment where the obtained lessons learnt by training are effectively utilized are necessary.
At the initial stage, it is considered that the assistance of dispatch of external experts by aid agencies etc. and a technical cooperation project are useful for entire capacity development.

(3) Capacity Assessment

1) Capacity Assessment by JICA's Tool
A capacity assessment of YWC is conducted in accordance with the JICA Capacity Assessment Handbook. The key items to be checked are selected in overall items since the number of check items in the list is many in various fields.
Assessment fields are categorized into the following three areas; (1) technical capacity, (2) core capacity (non-technical) capacity, (3) enabling environment.
The summary of the assessment is shown below (Table 6.13).

Table 6.13 Summary of Capacity Assessment

Category (large)	Category (middle)	Category (small)	Results
Technical capacity	Sewer network	Technology and skill for maintenance	• Maintenance unit exist under O&M directorate • Response to sewer flooding reported by customer is supportive • Knowledge, equipment and facilities for reduction of sewer blockage are not sufficient • No future plan on sewer blockage reduction • Most of high pressure jet truck are aged • No vacuum truck is owned
	Water quality management	Operation of waterworks and wastewater works facilities	• Operation records are basically reported on regular-basis. • Some of discharge water quality from WWTP cannot be complied with the Jordanian standards, particularly in the WWTP of Fourah, Jerash, Mafraq, Akaider
		Water quality analysis	• Chemical, microbiological and biochemical sampling and analysis are done

Category (large)	Category (middle)	Category (small)	Results
Core capacity (Non-technical aspects)	Financial strength	Financial stability	• No tariff setting guideline • The trend of financial balance of current account of YWC has been in deficit • The deficit amount has generally been subsidized by WAJ • Revenue covers only about 50% of operating costs • A concerned issue is a rapid growth of expenditure during 5 years, equivalent to 60%
		Procurement of funds	• Fund sources for capital investment are generated fund by YWC, WAJ, international agencies
		Accounting	• Double-entry bookkeeping accounting system has been adopted • Not financially autonomous
		Tariff	• Metered rate is applied • Increasing Block Tariff is applied for WS and SW • In overall the tariff rate level presumably remain at low level
		Revenue and subsidies	• YWC has the authority to levy, collect and retain revenue • Subsidies are provided by WAJ if revenue cannot cover the expenses
Core capacity (Non-technical aspects)		Meter reading, billing and collection	• Monthly reading and billing are done • Average collection ratio is 77% (2013), relatively low • Regional disparity exists, the collection ratio (Mafraq, Badia) is around 50%
	Governance/ management/ personnel affairs	Organizational function and performance	• Organization restructuring has been reconsidered by Director, not yet clearly concluded • Division of role and responsibility is partially defined, but very limited • Some key information on PIs is collected but seems not sufficient and effectively utilized
		Employment/ transfer/ turnover	• Personnel management is done by Human Resource Development Dept. • Recruitment criteria is established • Progress of staff transfer from WAJ to YWC is very slow, more than 95% still belongs to WAJ
		Personnel management and incentives	• No commendation system • Promotion criteria is not clear, it mostly depend upon personal connections • Performance evaluation system does not exist
		Communication	• Regular meetings are held for management class • Communication between manager and lower staffs are not sufficient in general

Category (large)	Category (middle)	Category (small)	Results
	Training	Plan and Budget	• Training is implemented every year, an annual training plan is developed • Budget amount is decreasing during the recent 3 years • Budget largely depends upon outside donor funding, very limited budget in 2014
		Training program	• Engineering training is done mostly by outside provider − Materials: supplied by providers − Trainer: outside service providers • Effectiveness of training program is not sufficiently reviewed
		OJT	• Rarely implemented
		Training system	• Training system exists
		Knowledge sharing and culture	• There is a potential if systemized
		Staff's motivation	• No regular evaluation system, no incentive mechanism for capacity development • Training achievement appears to be not considered in the promotion stage
Enabling environment	External influence	Governance and political influences	• Independent utility as limited liability company, but owned by WAJ • Influence on tariff setting is unknown
		Regulatory bodies	• No regulatory agency
		Procurement	• No function for reduction of corruption
		Cooperation with donors, other water utilities	• Cooperation by aid agencies both in WS and SW sectors • Cooperation relations with WAJ can be seen in maintenance works
	Law, regulations and guidelines	Laws and regulatory framework	• National strategy and policy are established by WAJ
		Regulation and standards	Licensing system of house connection works for contractor exists in water sector
	Others	Public awareness and IEC	• Little or no IEC activities by YWC

Source: JICA Study Team

(4) Current Situation of Human Resource Development

1) Department of Human Resource Development (HRD)

Dept. of HRD was upgraded from one section to the department after Veolia Water company commenced their operation based upon the management contract for YWC with WAJ in 2012. The director was newly recruited from outside YWC, so that it is assumed that a dramatic change was expected.

2) Training Policy

Training policy was established in April 2012 and it states its objectives and training management process which include strategy, training plan, training implementation, evaluation, reporting and so on. Transportation provision and internal trainer's bonus according to their working years were also mentioned.

The following training objectives were defined in the policy.

- Developing staff competencies
- Improving staff performance in accordance with the Training Needs Assessment as defined by each line manager
- Developing staff attitude as required by each job, and in parallel with the Corporate Culture of the company

3) Training Budget

The training budget was accounted for 189,000 JD in 2012, however it has been reducing since 2012. The budget for 2014 allocated is 50,000 JD as less than one-third of the peak and the downward trend remarkably appeared after the completion of donor funding by USAID and the Contractor's left. The training budget for 2014 accounts for only 0.1% of the total expenditure of YWC in 2013.

4) Training Achievements

Based upon the needs assessment initiated by department of HRD, the training areas were divided into the following six: Technical, Safety, Management, ICT, Customer Service, Miscellaneous.

The main types of trainings in YWC are internal session and workshop, while outside course organized by external training institutions are very limited. The number of trainees and the training hours in 2012 was doubled in comparison to the past yearly achievement during 2009-2011. In the aspect of training hours, internal sessions shares most of training hours as 93%. These training achievements will be dramatically declined in 2014 according to the manager of training division.

The number of persons trained and the training hours in the past 5 years are shown as below (Figure 6.5).

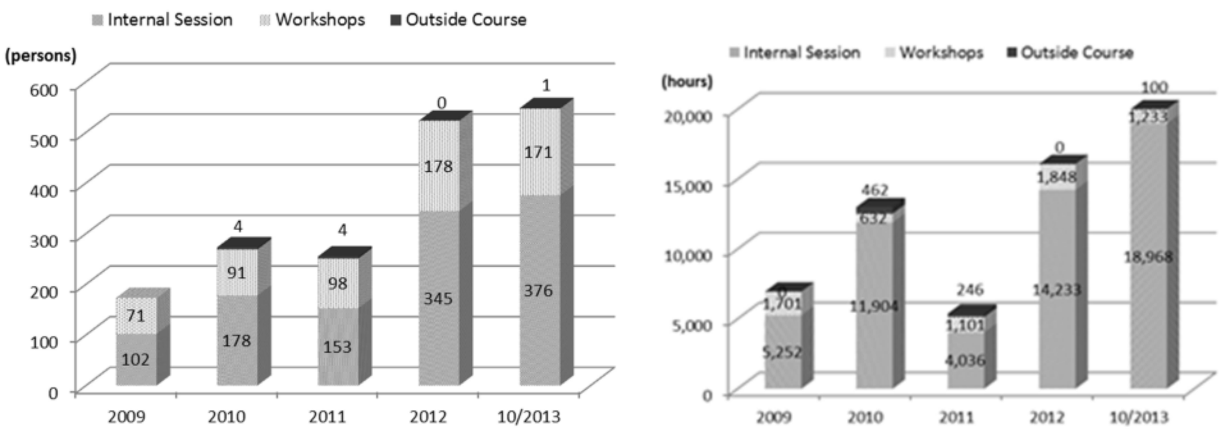


Figure 6.5 Number of Persons Trained (Left) and Training Hours (Right)

5) Training Institutions

Most of training courses aforementioned have been implemented by external service providers, even in the internal training case according to Training Department. The lecturers are mostly asked and dispatched from external service providers arranged by department of HRD.

6) Challenges

Major challenges of training are observed as follows.

- Internal budget for training department has been decreasing since the termination of Contractor due to severe financial situation of YWC
- Training budget largely depends upon external funding, mostly from development agencies, but the funding is lacked at present
- Most training courses are rely on outside providers, thereby the training costs becomes high
- Training of trainers (ToT) and OJT need to be enhanced by effectively using internal resource persons
- A strategic training plan with prioritization should be prepared to substantially improve staff competence considering current urgent needs of YWC

(5) Capacity Development Plan

The necessary areas for capacity development of YWC in water supply and wastewater sectors in the short- and middle-term up to 2025 are summarized in the following Table 6.14. Priority is given in the range of high and low. High priority means that the training is urgently necessary within 3 years. While, low priority indicates that the training for the area need to be done up to 2025 and the degree of urgency is not high, and it does not mean that the training needs are low.

Table 6.14 Training Areas for Capacity Development of YWC

Category		Necessary areas for capacity development	Priority		
			3y high	5y	～2025 low
Technical capacity	Plan and Design	1. Wastewater Sector Policy	●		
		2. Development Plan			●
		3. Design of Wastewater System and Facilities		●	
		4. Strategic Business Plan	●		
		5. Human Resource Management Plan	●		
		6. Budgetary Planning	●		
	Civil works	7. Plumbing Works for New Sewer Connection	●		
	O&M	8. Operation Manual			●
		9. O&M Recording and Reporting			●
		10. Operation - WWTP	●		
		11. Operation - PS & Reservoir		●	
		12. Maintenance - Mechanical Corrective Maintenance	●		●
		13 Maintenance - Mechanical Preventive Maintenance		●	
		14. Maintenance - Electrical Corrective Maintenance	●		

Category		Necessary areas for capacity development	Priority 3y (high)	5y	～2025 (low)
		15. Maintenance - Electrical Preventive Maintenance		●	
		16. SCADA System Monitoring and Evaluation	●		
		17. Programmable Logical Control	●		
	Water quality	18 Sampling Plan and Skill			●
		19. Skill and Knowledge for Water Quality Test			●
		20. Technique for Quality Analysis and Data Analysis		●	
		21. Monitoring and Advanced Water Quality Analysis (Trace contaminant, Biological analysis)		●	
	Sewer	22. Sewer Flooding Reduction Plan	●		
		23. Basics for Sewer Network	●		
		24. Maintenance - Sewer Cleaning	●		
Core capacity (Non-technical capacity)	Organization	25. Corporate Culture and Business Mind	●		
		26. KAIZEN Method	●		
		27 Division of Role and Duty	●		
		28 Time Management		●	
		29 Personnel Management	●		
		30 Good Governance and Prevention Measure for Corruption		●	
	Management	31 Sustainable Waterworks/Wastewater Works Management (ISO24512)		●	
		32 Performance Indicators (PIs) and Management Tools	●		
		33 Performance Monitoring and Evaluation		●	
		34 Quality Management (ISO9001, ISO14001)	●		
		35 Management Information System (MIS)			●
		36 Public Procurement Management and Supervision			●
		37 Occupational Health and Safety Management	●		
		38 Computerization and Data Processing and Editing		●	
		39 Computer Literacy and Skill (MS Word, Excel, PPT)		●	
		40 Advanced Computer Skill (Oracle, Unix, etc.)		●	
Core capacity (Non-technical capacity)	Finance	41 Cost Recovery/ Water Tariff Setting	●		
		42 Financial Analysis/ Financial Projection		●	
		43 Asset Management		●	
		44 Effective Billing and Collection	●		
	Public/Society	45 Customer Relation/ Customer Satisfaction	●		
		44 Public Awareness and Education for People	●		
		47 Social Responsibility and Accountability for People		●	
		48 People's Participation and Public Involvement		●	
		49 Environmental Impact Assessment		●	
Enabling Environment	Regulatory framework	50 Water & Wastewater Sector Policy/ Regulatory Framework		●	
		51 Water Quality Standards/ Effluent Standards		●	
		52 Other relevant legislation (Road, Building, Land etc.)			●

Source: JICA Study Team

(6) Priority Areas for Capacity Development

1) Technical Capacity

The daily operation practice of some WWTPs such as Fourah and Mafraq should be enhanced through training in order to meet its discharge water quality of the Jordanian standards. The demand of corrective maintenances for mechanical and electrical matters is large in YWC, thus the competence level of YWC staffs still needs to be developed. In Irbid city many sewer blockages and flooding are occurred, so that a series of training in this area from planning to practice at the field level is necessary. At the same time, supervising capacity of YWC's staffs on new sewer connection and its system has to be strengthened.

2) Core Capacity

The first priority should be given to an organizational area such as corporate culture and business mind, role and duty and continuous improvement, for instance through the KAIZEN method. In addition, an understanding and a practice of utility management by PIs and quality management in the managerial area are essential for an efficient management by using tangible indicators. To reduce sewer blockages and flooding, the nurturing public awareness by campaign and media and the education could be required as well as physical cleaning. In financial management area, the disparity of collection ratio should be improved, since it will contribute to decrease commercial loss of non-revenue water significantly. The awareness on cost recovery of YWC staffs is weak at present, because the deficit is compensated by the central government. Hence it should be enhanced toward a self-sustainable financial management of YWC.

CHAPTER 7 IMPLEMENTATION PLAN

7.1 General Implementation Schedule

Sewerage improvements are proposed to be implemented in three phases according to the following schedule .

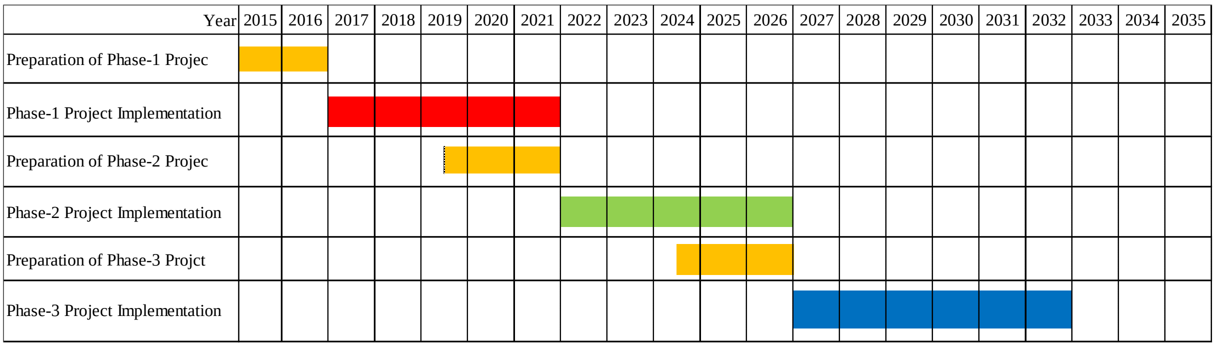


Figure 7.1 General Implementation Schedule

Each phase would take two to two and half years for the preparation of financing arrangements, selection of consultants and detailed design of the sewerage facilities. The construction of the sewerage facilities in each phase will take 5 to 6 years.

The proposed implementation schedule is applied to each SWD for comparison. The actual schedule for each SWD would be changed depending on financing arrangements.

7.2 Sewerage Facility Development Plan

7.2.1 General

(1) Service Area Expansion

The priority for sewerage development is determined in consultation with WAJ. The following facts are noted in the preparation of the development plan:

1) The service area will be expanded from the city center to the urban area.
2) Priority II areas are proposed by the SWMP.
3) Detailed Plans including detailed design report are readily available.
4) Some donors will assist with the expansion of the service area.

The details of prioritized areas are explained for the each of the SWD.

(2) House Connection

The branch sewers can collects the wastewater through house connections of the individual houses or buildings, that is, the actual influent flow rates to a WWTP depend on the number of house connections to the branch sewers. The predicted influent flow rates to each WWTP are used as basic data for calculations of revenue of sewerage service, O&M costs such as power and chemicals, and for preparation of phased improvement plan of treatment capacity.

To predict the influent flow rates, the growth in sewerage service population are estimated by the growth in house connections multiplied by the average number of person per household. in the following manners.

The installation of branch sewers are planned to completed by 2032, and the house connections are assumed to be completed by the target year of 2035.

7.2.2 Central Irbid SWD

(1) Service Area Expansion
The service area is not planned as explained in Chapter 4.

(2) House Connection Ratio
House Connection Ratio will be slightly increased to 100% by target year as shown Table 7.1.

Table 7.1 House Connection Ratio for Central Irbid SWD

Item	2013	2035
Population Planned (pers.)	104,440	118,140
Population Connected (pers.)	88,043	118,140
House Connection (units)	16,185	21,717
House Connection Ratio (%)	84.3	100.0

Note: Number of persons living in household : 5.44 persons/unit
Source: JICA Study Team

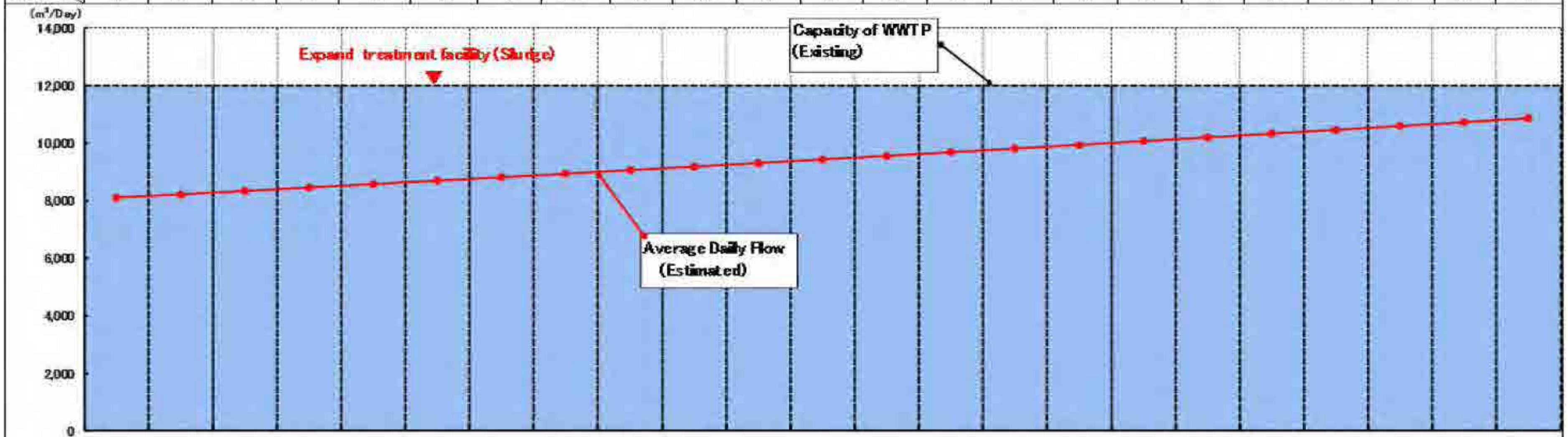
(3) Branch Sewers
Because the service area is not planned, new branch sewers are not planned.

(4) Trunk Sewers
The existing trunk sewers can be used for the design flow for 2035.

(5) Lift Stations
There are no lift stations.

(6) WWTP
The service population is estimated based on the connection rate and the wastewater flow to the Central Irbid WWTP as shown in Figure 7.2.

In Phase-1 mechanical dewatering equipment will be installed at the treatment plant and the building housing the equipment will be constructed.



Item \ Year		2013	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Event	Branch		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trunk		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WWTP					Sludge Treatment (Comm'd)	Sludge Treatment (Comp)																	
Population Planned		104,440	105,063	105,685	106,308	106,931	107,554	108,176	108,799	109,422	110,045	110,667	111,290	111,913	112,535	113,158	113,781	114,404	115,026	115,649	116,272	116,895	117,517	118,140
	Pers	0	623	1,245	1,868	2,491	3,114	3,736	4,359	4,982	5,605	6,227	6,850	7,473	8,095	8,718	9,341	9,964	10,586	11,209	11,832	12,455	13,077	13,700
Population Connected		88,043	89,316	90,601	91,894	93,195	94,505	95,825	97,153	98,490	99,835	101,190	102,554	103,926	105,308	106,698	108,097	109,505	110,922	112,348	113,783	115,226	116,679	118,140
	Pers	0	1,275	2,558	3,851	5,152	6,463	7,782	9,110	10,447	11,792	13,147	14,511	15,880	17,265	18,655	20,054	21,462	22,879	24,305	25,740	27,183	28,636	30,097
Connection Ratio (%)		84.3	85.0	85.7	86.4	87.2	87.9	88.6	89.3	90.0	90.7	91.4	92.2	92.9	93.6	94.3	95.0	95.7	96.4	97.1	97.9	98.6	99.3	100.0
ADF (m³/d)		8,104	8,217	8,335	8,454	8,574	8,694	8,816	8,938	9,061	9,185	9,309	9,435	9,561	9,688	9,816	9,945	10,074	10,205	10,336	10,468	10,601	10,734	10,873
Capacity (as ADF)		12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
MDF (m³/d)		9,077	9,205	9,336	9,469	9,603	9,738	9,874	10,011	10,148	10,287	10,427	10,567	10,709	10,851	10,994	11,138	11,283	11,429	11,576	11,724	11,873	12,023	12,178

Figure 7.2 Estimated Service Population and Inflow to the Central Irbid WWTP

7.2.3 Wadi Al-Arab SWD

(1) Service Area Expansion

Figure 7.3 shows the locations where the sewerage services will be provided by the proposed projects in Wadi Al-Arab SWD.

At Bait Ras the sewerage service will be expanded in Phase-1. The area is proposed as a Priority II area in the SWMP. The population density is as high as 60 person/ha. KfW plans to assist with the construction of branch sewers.

The sewerage service at Hakama will be expanded in Phase-2. This area is also proposed as a Priority II area in the SWMP. The population density is as high as 60 person/ha. Gulf Cooperation Council (GCC) is interested in assisting with the construction of branch sewers.

The sewerage services in the remaining areas of Zebdah, Ariah and Basaten, Al Barha will be expanded from the urban area to sub-urban areas in Phase-3 .

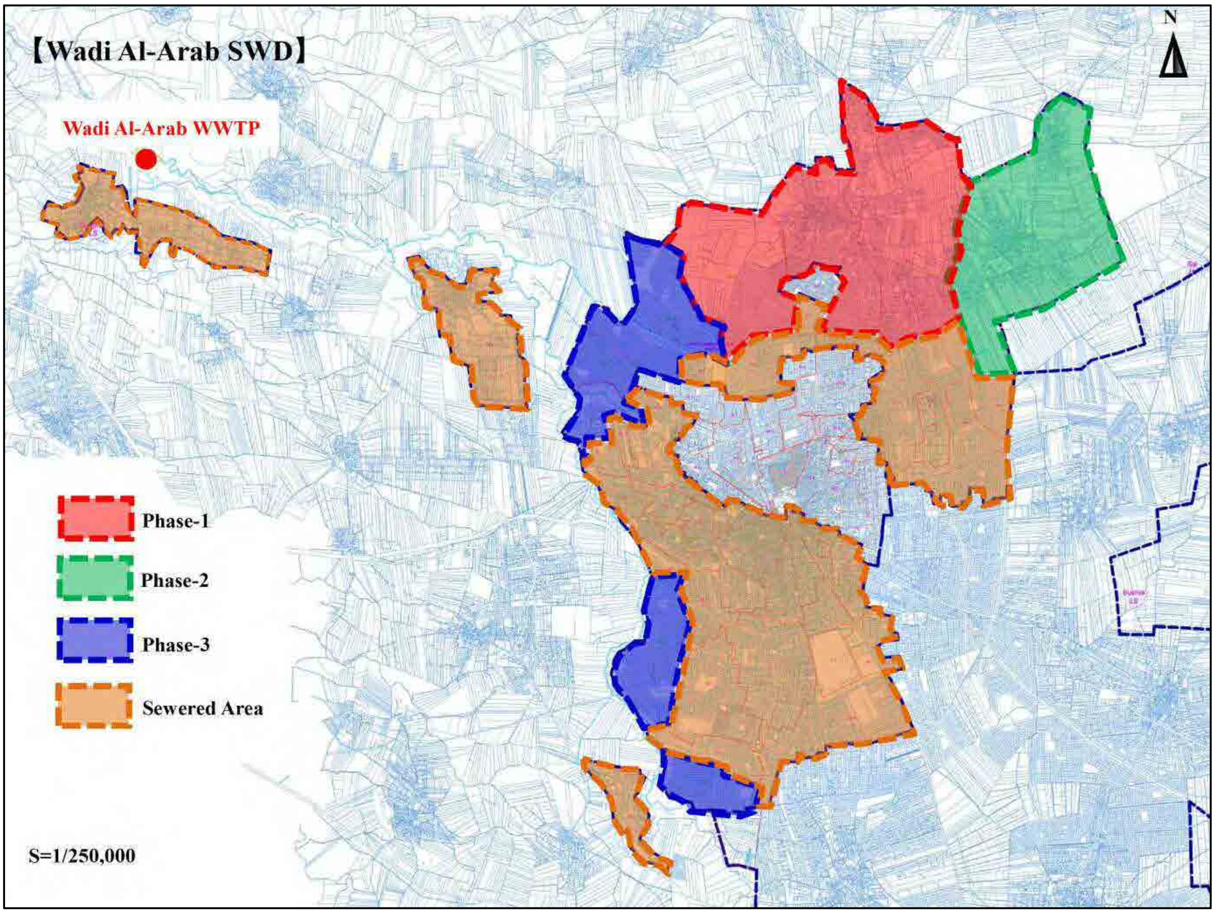


Figure 7.3 Locations Where New Sewerage Services Will Be Provided in Wadi Al-Arab SWD

(2) House Connection Ratio

House Connection Ratio will be slightly increased to 100% by target year, the ratio in each phases is as shown Table 7.2.

Table 7.2 House Connection Ratio for Wadi Al-Arab SWD

Item	Phase-1	Phase-2	Phase-3
Population Planned (pers.)	279,677	308,588	328,864
Population Connected (pers.)	224,660	283,564	328,864
House Connection (units)	41,298	52,126	60,453
House Connection Ratio (%)	80.3	91.9	100.0

Note: Number of persons living in household : 5.44 persons/unit
Source: JICA Study Team

(3) Branch Sewers

The required branch sewers for each phase are shown in following table.

Table 7.3 Branch Sewers for Wadi Al-Arab SWD

Phase-1		Phase-2		Phase-3	
Expanded Area (ha)	Required Length (km)	Expanded Area (ha)	Required Length (km)	Expanded Area (ha)	Required Length (km)
1098.90	167.36	574.20	87.45	402.70	61.33

Note: Unit required length of sewers per area is 152.3 m/ha.
Source: JICA Study Team

(4) Trunk Sewers

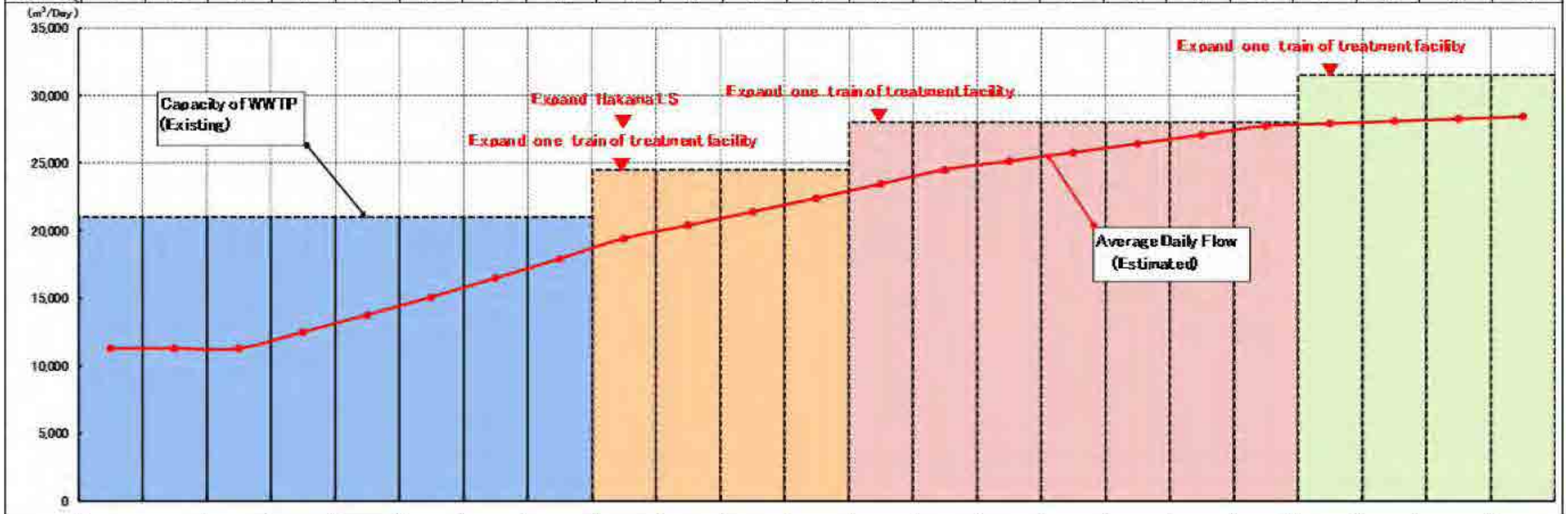
New trunk sewers are not required.

(5) Lift Stations

The pump capacity at the Hakama LS will be increased from 3.90 m^3/min to 6.22 m^3/min in Phase-1.

(6) WWTP

The inflow of wastewater from the expansion area and the increase in service population are estimated as shown in the following Figure. The treatment facilities plan is prepared based on the inflow estimates. One line of aeration and final sedimentation tanks are proposed to be constructed in each phase to meet the design daily average flow of 3,500 m^3/d.



Item \ Year		20## 13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Event	Branch					Unit 4 (Comme)	→	→	→	Unit 4 (Comp)	Unit 3 (Comme)	→	→	→	Unit 3 (Comp)	Unit 1+2 (Comme)	→	→	→	→	Unit1+2 (Comp)			
	Trunk		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS								Hakama (Comme)	Hakama (Comp)														
	WWTP								Expand 1train (Comm e)	Expand 1train (Comp)			Expand 1train (Comme)	Expand 1train (Comp)						Expand 1train (Comme)	Expand 1train (Comp)			
Population Planned		224 347	224 347	224 347	233 569	242 790	252 012	261 234	270 456	279 677	285 459	291 241	297 024	302 806	308 588	311 967	315 347	318 726	322 105	325 485	326 329	327 174	328 019	328 864
(Pers.)		0	0	0	9 222	9 222	9 222	9 222	9 222	55 330	61 112	66 894	72 677	78 459	84 241	87 620	91 000	94 379	97 758	101 138	101 982	102 827	103 672	104 517
Population Connected		130 570	130 570	130 570	144 551	159 212	174 554	190 576	207 278	224 660	235 906	247 419	259 200	271 249	283 564	290 886	298 299	305 803	313 399	321 086	323 061	325 043	327 030	328 864
(Pers.)		0	0	0	13 981	28 642	43 984	60 006	76 708	94 090	105 336	116 849	128 630	140 679	152 994	160 316	167 729	175 233	182 829	190 516	192 491	194 473	196 460	196 294
Additional Connected Area (ha)		0.0	0.0	0.0	183.2	366.3	549.5	732.6	915.8	1098.9	1213.7	1328.6	1443.4	1558.3	1673.1	1740.2	1807.3	1874.5	1941.6	2008.7	2075.8	2075.8	2075.8	2075.8
Connection Ratio (%)		58.2	58.2	58.2	61.9	65.6	69.3	73.0	76.6	80.3	82.6	85.0	87.3	88.6	91.9	93.2	94.6	95.9	97.3	98.6	99.0	99.3	99.7	100.0
ADF (m³/d)		11 289	11 289	11 289	12 496	13 764	15 090	16 475	17 919	19 422	20 394	21 389	22 408	23 449	24 514	25 147	25 788	26 437	27 093	27 758	27 929	28 100	28 272	28 430
Capacity (as ADF)		21 000	21 000	21 000	21 000	21 000	21 000	21 000	21 000	24 500	24 500	24 500	24 500	28 000	28 000	28 000	28 000	28 000	28 000	28 000	31 500	31 500	31 500	31 500
MDF (m³/d)		12 644	12 644	12 644	13 996	15 416	16 901	18 452	20 069	21 752	22 841	23 956	25 097	26 263	27 456	28 165	28 882	29 609	30 345	31 089	31 280	31 472	31 664	31 842

Figure 7.4 Estimated Service Population and Inflow to the WWTP and Design Capacity Improvements of Wadi Al-Arab WWTP

7.2.4 Shallala SWD

(1) Service Area Expansion

Figure 7.5 shows the locations where the sewerage services will be provided in Shallala SWD.

The services in Mughayeri and Howwarah will be expanded in Phase-1. Mughayeri is proposed as a Priority II area in the SWMP. It has a population density of 60 person/ha which is expected to increase to 95 person/ha. GCC is interested in assisting with the construction of branch sewers in Mughayeri. Lots of new housing is being developed in Howwarah. The population density of about 22 person/ha is expected to increase to 45 person/ha by 2035.

The sewerage services in Boshra and Sal will be developed in Phase-2. These areas are close to the urban center and the Shallala WWTP. The population densities in Boshra and Sal are about 11 and 20 person/ha and expected to increase to 31 and 47 person/ha by 2035. It is also proposed that the Hoson Camp will be switched from Wadi Hasan SWD to Shallala SWD after implementation of additional trunk sewer installation and Al Hoson Camp LS improvement work in the phase-2 project.

The sewerage services at Hoson, Aidoon, and Sarie are proposed to be developed in Phase-3. The population densities in Hoson, Aidoon, and Sarie are about 17 to 21 person/ha and expected to increase to 38 to 49 person/ha by 2035.

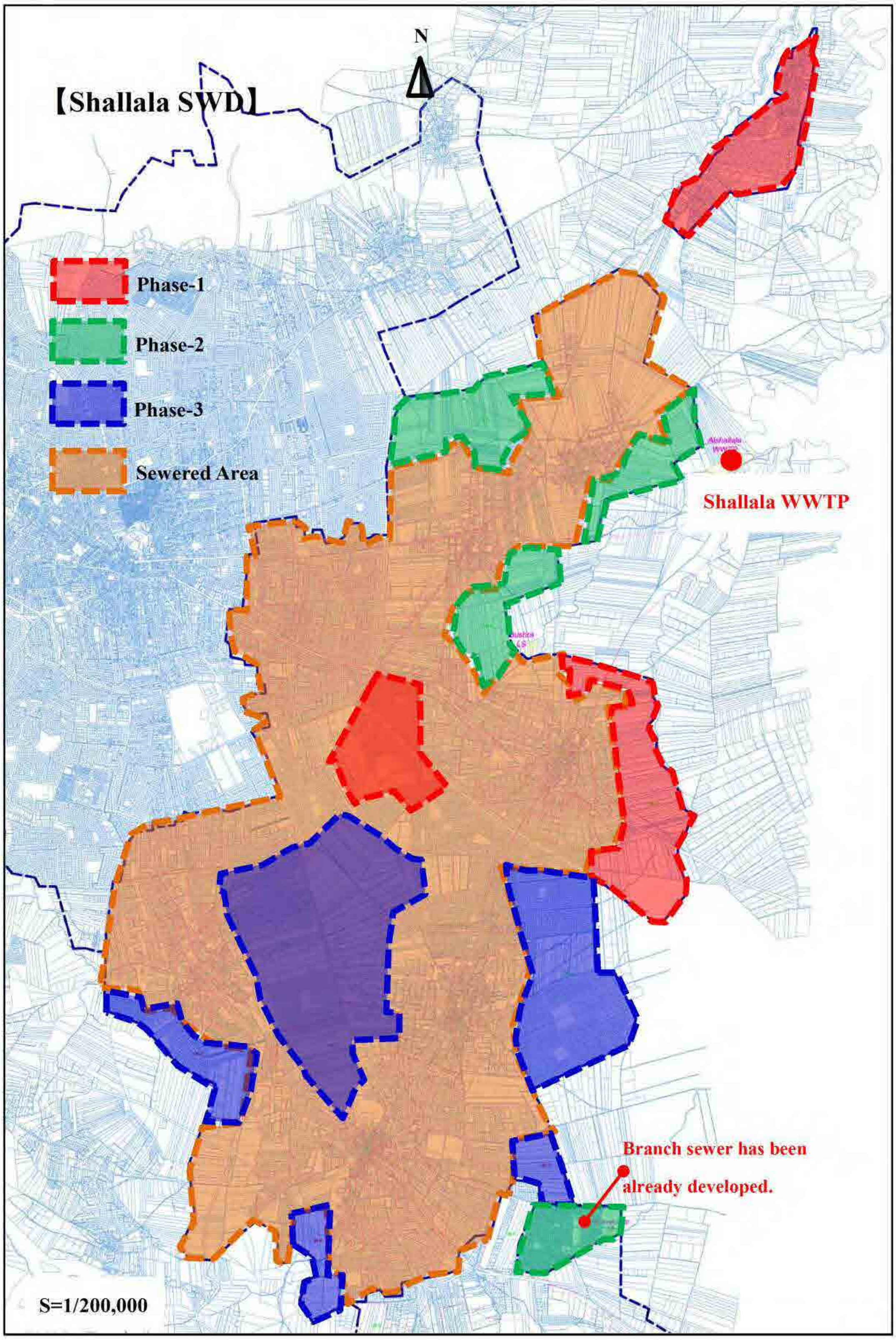


Figure 7.5 Locations Where New Sewerage Services Will Be Provided in Shallala SWD

(2) House Connection Ratio

House Connection Ratio will be slightly increased to 100% by target year, the ratio in each phases is as shown Table 7.4.

Table 7.4 House Connection Ratio for Shallala SWD

Item	Phase-1	Phase-2	Phase-3
Population Planned (pers.)	187,080	221,430	307,228
Population Connected (pers.)	82,143	132,735	307,228
House Connection (units)	15,100	24,400	54,476
House Connection Ratio (%)	43.9	60.0	100.0

Note: Number of persons living in household : 5.44 persons/unit
Source: JICA Study Team

(3) Branch Sewers

The required branch sewers for each phase are shown in the following table.

Table 7.5 Branch Sewers for Shallala SWD

Phase-1		Phase-2		Phase-3	
Expanded Area (ha)	Required Length (km)	Expanded Area (ha)	Required Length (km)	Expanded Area (ha)	Required Length (km)
586.80	89.37	255.20	38.87	844.50	128.62

Note: Unit required length of sewers per area is 152.3 m/ha..
Source: JICA Study Team

(4) Trunk Sewers

The required trunk sewers for each phase are shown in following table.

Table 7.6 Trunk Sewers for Shallala SWD

Pipe	Length (km)			Total (km)
	Phase-1	Phase-2	Phase-3	
200mm CP	3.30	-	-	3.30
400mm CP	-	4.55	-	4.55

Source: JICA Study Team

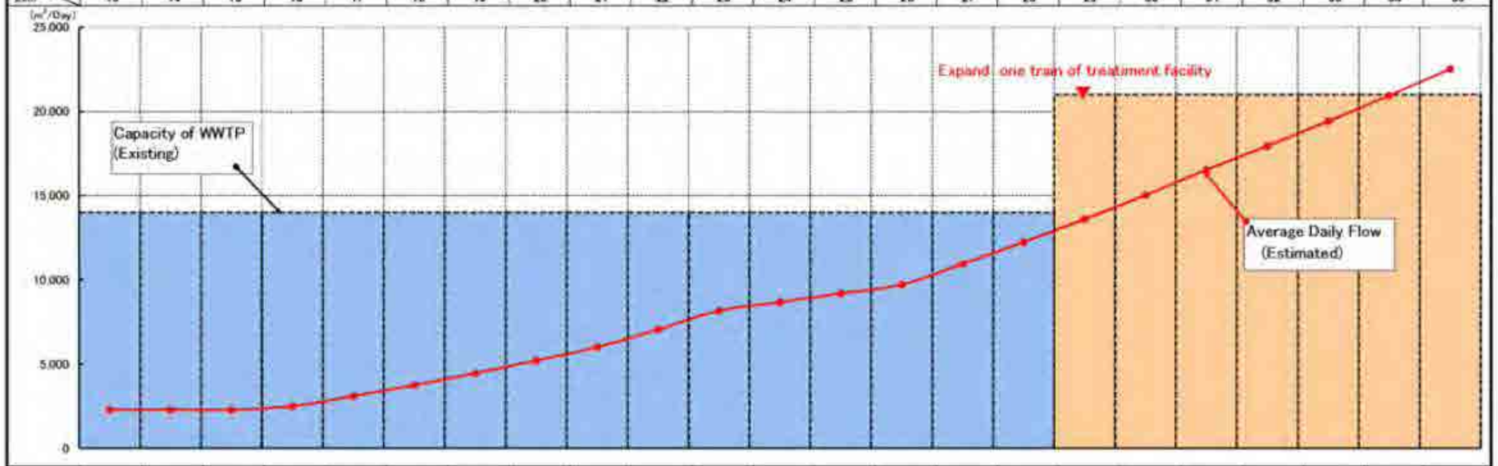
(5) Lift Station

A small manhole type pump station, Mughyeer MP, will be constructed in Phase-1. The capacity of the Al Hoson Camp LS will be increased from 4.20 m^3/min to 5.62 m^3/min in Phase-2.

(6) WWTP

The inflow of wastewater from the expansion area and the increase in service population are estimated as shown in the following Figure. The plan for the treatment facilities is prepared based on the inflow estimates.

One primary sedimentation tank, two oxidation ditches and one final sedimentation tank will be constructed additionally in Phase-3 to meet the design daily average flow of 22,520 m^3/d in total.



Item \ Year		2008 13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Event	Branch					Unit3+5 (Comme)	→	→	→	Unit3+5 (Comp)	Unit4 (Comme)	→	→	→	Unit4 (Comp)	Unit1+2 (Comme)	→	→	→	→	Unit1+2 (Comp)			
	Trunk					MGH-1 (Comme)	MGH-1 (Comp)				AZMI-1 (Comme)	AZMI-1 (Comp)												
	LS								Al Hasan Camp LS (Comme)	Al Hasan Camp LS (Comp)														
	WWTP																Expand 1train (Comme)	Expand 1train (Comp)						
Population Planned (Pers.)		135,442	135,442	135,442	144,048	152,655	161,261	169,868	178,474	187,080	197,518	207,955	212,447	216,938	221,430	232,047	242,663	253,280	263,896	274,513	282,692	290,870	299,049	307,228
		0	0	0	8,606	17,213	25,819	34,426	43,032	51,638	62,076	72,513	77,005	81,496	85,988	96,605	107,221	117,838	128,454	139,071	147,250	155,428	163,607	171,786
Population Connected (Pers.)		26,818	26,818	26,818	34,309	42,493	51,368	60,935	71,193	82,143	96,351	111,576	118,440	125,493	132,735	149,426	167,063	185,644	205,171	225,643	244,947	264,979	285,740	307,228
		0	0	0	7,492	15,675	24,551	34,117	44,376	55,326	69,533	84,758	91,623	98,676	105,917	122,609	140,245	158,827	178,354	198,825	218,129	238,162	258,922	280,410
As Additional Connected Area (ha)		0.0	0.0	0.0	97.8	195.6	293.4	391.2	489.0	588.6	637.8	688.9	739.9	791.0	842.0	962.6	1,083.3	1,203.9	1,324.6	1,445.2	1,686.5	1,686.5	1,686.5	1,686.5
Connection Ratio (%)		19.8	19.8	19.8	23.8	27.8	31.9	35.9	39.9	43.9	48.8	53.7	55.8	57.8	59.9	64.4	68.8	73.3	77.7	82.2	86.6	91.1	95.5	100.0
Average Daily Flow (m³/day)		2,307	2,307	2,307	2,515	3,115	3,765	4,467	5,218	6,021	7,063	8,178	8,682	9,199	9,729	10,953	12,246	13,608	15,039	16,540	17,955	19,423	20,945	22,520
Capacity of Facility* (as ADF) (m³/day)		14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000
Maximum Daily Flow (m³/day)		2,584	2,584	2,584	2,817	3,489	4,217	5,003	5,845	6,744	7,910	9,160	9,723	10,303	10,897	12,267	13,715	15,241	16,844	18,524	20,109	21,754	23,458	25,222

Figure 7.6 Estimated Service Population and Inflow to the WWTP and Design Capacity Improvements of Shallala WWTP Figure

7.2.5 Wadi Hassan SWD

(1) Service Area Expansion

Figure 7.7 shows the locations where the sewerage services will be provided in Wadi Hassan SWD.

No sewerage service expansion will take place in Phase-1. The sewerage service in Noayemeh will be developed in Phase-2. The area is quickly becoming urbanized and the population currently at 26 person/ha is expected to increase to 41 person/ha by 2035.

The sewerage services in Hoson-A and Hoson-B are proposed to be developed in Phase-3. The population density is about 17 person/ha at present.

As stated in Shallala SWD, WAJ plans Hoson Camp to shift to the Shallala Shallala SWD, after completion of additional trunk sewers installation and Al Hoson LS improvement work, which are scheduled in Phase-2.

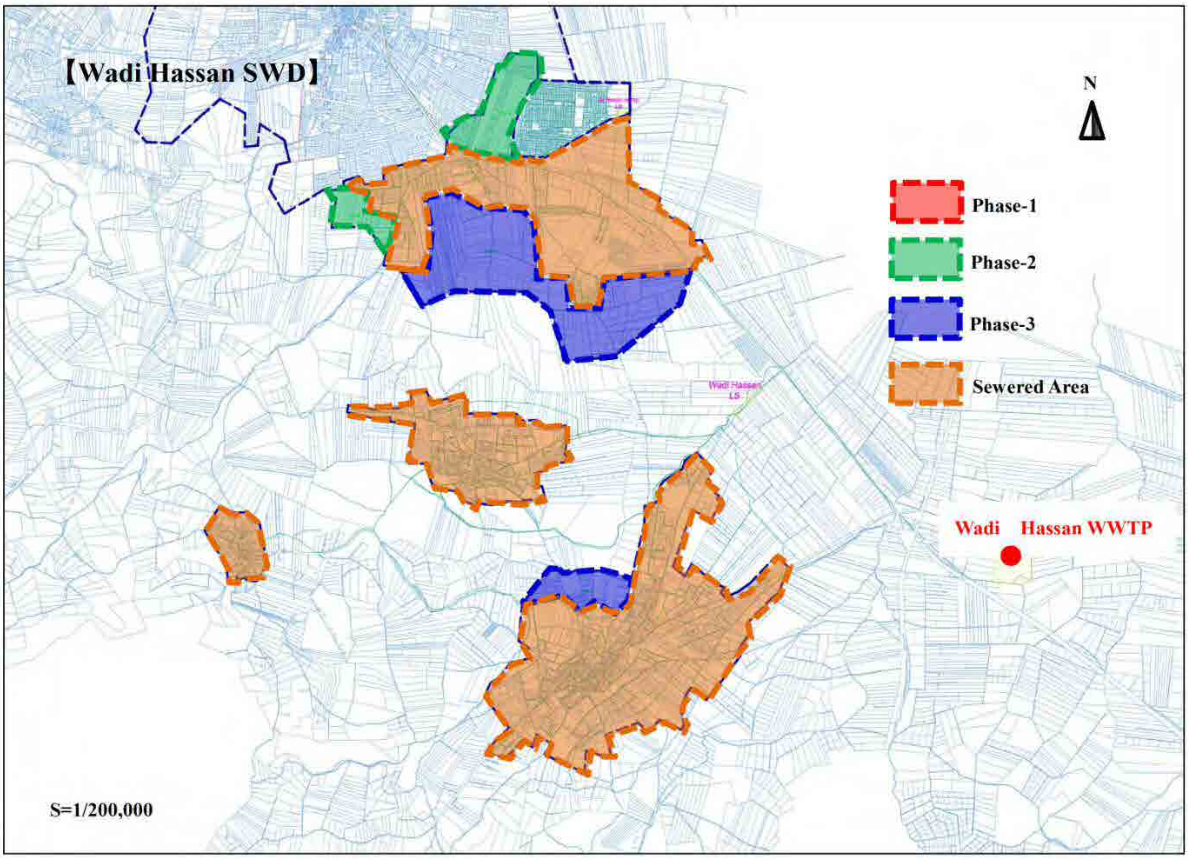


Figure 7.7 Locations Where New Sewerage Services Will Be Provided in Wadi Hassan SWD

(2) House Connection Ratio

House Connection Ratio will be increased to 100% by target year, the ratio in each phases is as shown Table 7.7.

Table 7.7 House Connection Ratio for Wadi Hassan SWD

Item	Phase-1	Phase-2	Phase-3
Population Planned (pers.)	17,345	10,213	35,377
Population Connected (pers.)	15,205	8,455	35,377
House Connection (units)	2,795	1554	6,503
House Connection Ratio (%)	87.7	82.8	100.0

Note: Number of persons living in household : 5.44 persons/unit
Source: JICA Study Team

(3) Branch Sewers

The required branch sewers for each phase are shown in the following table.

Table 7.8 Branch Sewers for Wadi Hassan SWD

Phase-1		Phase-2		Phase-3	
Expanded Area (ha)	Required Length (km)	Expanded Area (ha)	Required Length (km)	Expanded Area (ha)	Required Length (km)
-	-	120.70	18.38	279.60	42.58

Note: Unit required length of sewers per area is 152.3 m/ha..
Source: JICA Study Team

(4) Trunk Sewers

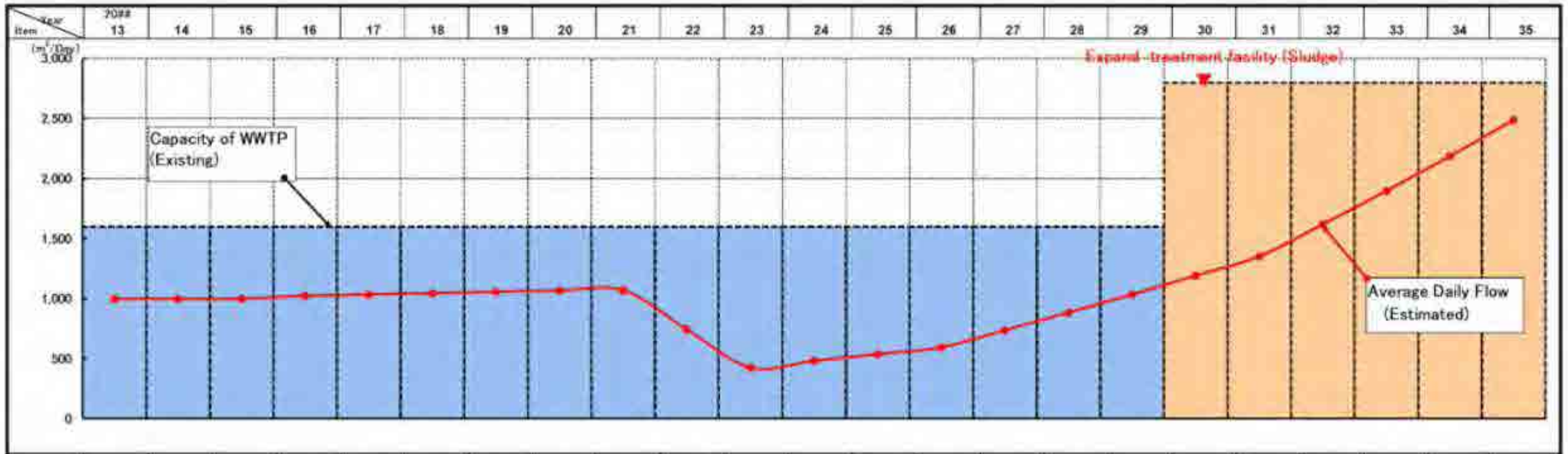
New trunk sewers are not required.

(5) WWTP

The inflow of wastewater from the expansion area and the increase in service population are shown in the following Figure. The plan for the treatment facilities is prepared based on the inflow estimates.

In Phase-2, when the Hoson Camp is shifted from Wadi Hassan SWD to Shallala SWD, the inflow of wastewater will be decreased as shown in Figure 7.8.

20 sludge drying beds for the design flow of 1,200 m^3/d will be constructed in Phase-2 to increase the sludge treatment capacity of Wadi Hassan WWTP from 1,600 m^3/d to 2,800 m^3/d. While the existing wastewater treatment facilities have the capacity of 2,800 m^3/d, based on the results of capacity calculation of Wadi Hassan WWTP in Appendix-IIIA.



Item		13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Event	Branch										Unit1+2+3 (Comme)	→	→	→	Unit1+2+3 (Comp)	Unit4 (Comme)	→	→	→	→	Unit4 (Comp)			
	Trunk	-	-	-	-	-	-	-	-	-	AZMI-I (Comme)	AZMI-I (Comp)	-	-	-	-	-	-	-	-	-	-	-	-
	LS								Al Hassan Camp (Comme)	Al Hassan Camp (Comp)														
	WWTP																		Sludge Treatment (Comme and Comp)					
Population Planned		16,377	16,377	16,377	16,679	16,840	17,002	17,163	17,324	17,345	12,545	7,503	8,407	9,311	10,213	12,425	14,637	16,848	19,060	21,272	24,798	28,324	31,851	35,377
	(Pers.)	0	0	0	302	463	625	786	947	968	-3,832	-8,874	-7,970	-7,066	-6,164	-3,952	-1,740	471	2,683	4,895	8,421	11,947	15,474	19,000
Population Connected		14,248	14,248	14,248	14,545	14,704	14,864	15,024	15,185	15,205	10,585	6,072	6,856	7,651	8,455	10,474	12,560	14,712	16,932	19,219	23,003	26,958	31,082	35,377
	(Pers.)	0	0	0	297	456	616	776	937	957	-3,663	-8,176	-7,392	-6,597	-5,793	-3,774	-1,688	464	2,684	4,971	8,755	12,710	16,834	21,129
As Additional Connected Area (ha)		0.0	0.0	0.0	8.4	9.8	13.2	16.6	20.0	20.4	44.5	63.6	82.6	101.7	120.7	167.3	213.9	260.5	307.1	353.7	400.3	400.3	400.3	400.3
Connection Ratio (%)		87.0	87.0	87.0	87.2	87.3	87.4	87.5	87.6	87.7	84.4	80.9	81.5	82.2	82.8	84.3	85.8	87.3	88.8	90.3	92.8	95.2	97.6	100.0
Average Daily Flow (m³/day)		1,000	1,000	1,000	1,024	1,035	1,046	1,058	1,069	1,070	745	427	483	539	595	737	884	1,036	1,192	1,353	1,619	1,898	2,188	2,490
Capacity of Facility* (as ADF) (m³/day)		1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	2,800	2,800	2,800	2,800	2,800	2,800
Maximum Daily Flow (m³/day)		1,120	1,120	1,120	1,147	1,159	1,172	1,185	1,197	1,199	835	479	541	603	667	826	990	1,160	1,335	1,515	1,814	2,126	2,451	4,915

Figure 7.8 Estimated Service Population and Inflow to the WWTP and Design Capacity Improvements of Wadi Hassan WWTP

7.2.6 Ramtha SWD

(1) Service Area Expansion

Figure 7.9 shows the locations where sewerage service will be provided. The Ramtha city boundary areas will be developed in Phase-1. The current population density in these areas is about 31 to 58 person/ha. The remaining southern area of Ramtha city will be developed in Phase-2.

The remaining northern four localities of Torra, Sharjarah, Emrawah, and Dnaibeh are identified as Priority II areas in the SWMP. The current population densities in these areas are as high as 35 to 89 person/ha. This study proposes the sewerage services to be provided to the four localities in Phase-3. The boundary and surrounding areas of Ramtha city can be developed with a smaller investment. The construction costs required for sewers and lift stations in the areas in Ramtha city under Phases-1 and 2 are much lower than those required for sewers and lift stations in the four localities to be developed under Phase-3, as shown in Table 8.26.

(2) House Connection Ratio

House Connection Ratio will be increased to 100% by target year, the ratio in each phases is as shown Table 7.9.

Table 7.9 House Connection Ratio for Ramtha SWD

Item	Phase-1	Phase-2	Phase-3
Population Planned (pers.)	156,402	172,168	201,198
Population Connected (pers.)	89,312	124,308	201,198
House Connection (units)	16,418	22,851	36,985
House Connection Ratio (%)	57.1	72.2	100.0

Note: Number of persons living in household : 5.44 persons/unit

Source: JICA Study Team

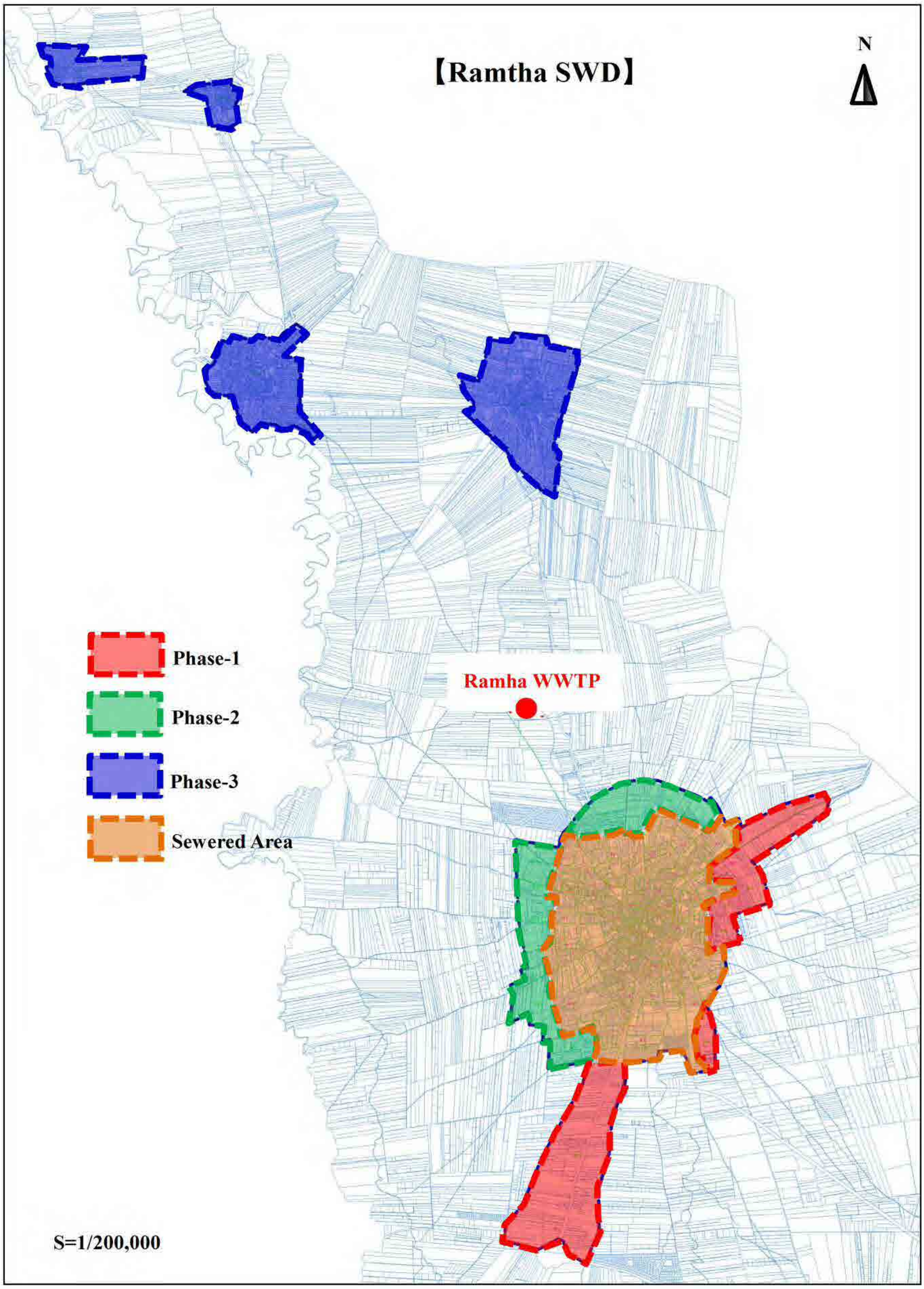


Figure 7.9 Locations Where New Sewerage Services Will be Provided in Ramtha SWD

(3) Branch Sewers

The required branch sewers for each phase are shown in following table.

Table 7.10 Branch Sewers for Ramtha SWD

Phase-1		Phase-2		Phase-3	
Expanded Area (ha)	Required Length (km)	Expanded Area (ha)	Required Length (km)	Expanded Area (ha)	Required Length (km)
433.00	65.95	345.80	52.67	636.69	96.97

Note: Unit required length of sewers per area is 152.3 m/ha..
Source: JICA Study Team

(4) Trunk Sewers

The required trunk sewers for each phase are shown in following table.

Table 7.11 Trunk Sewers for Ramtha SWD

Pipe	Length (km)			Total(km)
	Phase-1	Phase-2	Phase-3	
300mm CP	4.32	-	-	4.32
150mm DIP	-	-	2.40	2.40
200mm DIP	-	-	15.09	15.09

Source: JICA Study Team

(5) Lift Stations

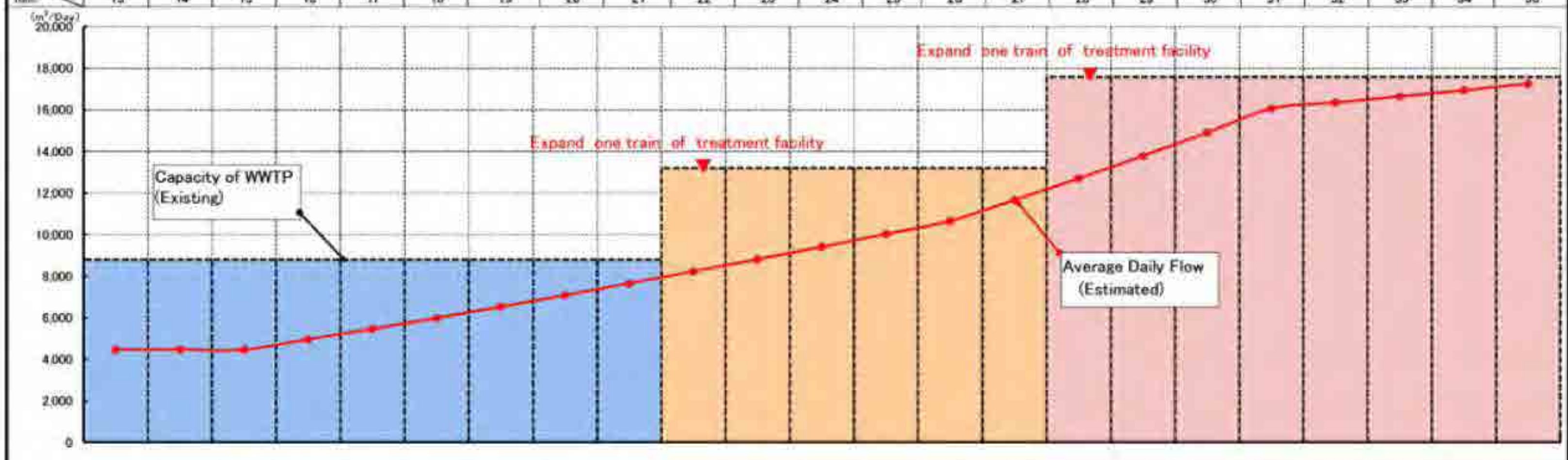
Four small manhole type pumps stations, at the localities of Dnaibeh, Emrawah, Shajarah and Torrah will be constructed in Phase-3.

(6) WWTP

The inflow of wastewater from the expansion area and the increase in service population are estimated as shown in the following Figure. The plan for treatment facilities is prepared based on the inflow estimates.

One aeration tank and final sedimentation tank to meet the design daily average flow of 4,400 m^3/d and mechanical sludge de-watering equipment with a building will be constructed in Phase-1.

Another aeration tank and final sedimentation tank to meet the design daily average flow of 4,400 m^3/d will be constructed in Phase-3.



Item \ Year (20##)		13	14	15	16	17	18	19	20	21	22	23	24
Event	Branch					Unit 1,4,5 (Comme)	→	→	→	Unit 1,4,5 (Comp)	Unit 2,3,6,7 (Comme)	→	→
	Trunk					Seb2 (Comme)	→	Seb2 (Comp)			Seb1 (Comme)	→	Seb1 (Comp)
	LS(MP)												
	WWTP								Expand 1train (Comme)	→	Expand 1train (Comp)		
Population Planned		136,860	136,860	136,860	139,950	143,241	146,531	149,821	153,111	156,402	159,555	162,708	165,861
	(Pers)	0	0	0	3,290	6,581	9,871	13,161	16,451	19,742	22,695	26,048	29,201
Population Connected		52,204	52,204	52,204	57,870	63,744	69,825	76,113	82,609	89,312	95,930	102,739	109,738
	(Pers)	0	0	0	5,666	11,540	17,621	23,909	30,405	37,108	43,726	50,535	57,534
As Additional Connected Area (ha)		0.0	0.0	0.0	72.2	144.3	216.5	288.7	360.8	433.0	502.2	571.3	640.5
Connection Ratio (%)		38.2	38.2	38.2	41.4	44.5	47.7	50.8	54.0	57.1	60.1	63.1	66.2
Average Daily Flow (m³/Day)		4,477	4,477	4,477	4,965	5,469	5,991	6,531	7,088	7,663	8,231	8,815	9,416
Capacity of Facility* (as ADF) (m³/Day)		8,800	8,800	8,800	8,800	8,800	8,800	8,800	8,800	8,800	13,200	13,200	13,200
Maximum Daily Flow (m³/Day)		5,014	5,014	5,014	5,561	6,126	6,710	7,314	7,938	8,583	9,219	9,873	10,545

Item \ Year (20##)		25	26	27	28	29	30	31	32	33	34	35
Event	Branch	→	Unit 2,3,6,7 (Comp)	Unit 8+9+10+11 (Comme)	→	→	→	→	Unit 8+9+10+11 (Comp)			
	Trunk			[illegible] (Comme)	→	→	→	→	[illegible] (Comp)			
	LS(MP)			MP1～4 (Comme)	→	→	MP1～4 (Comp)					
	WWTP			Expand 1train (Comme)	Expand 1train (Comp)							
Population Planned		169,015	172,168	177,006	181,844	186,682	191,520	196,358	197,568	198,778	199,988	201,198
	(Pers)	32,355	35,508	40,346	45,184	50,022	54,860	59,698	60,908	62,118	63,328	63,328
Population Connected		116,928	124,308	136,001	148,143	160,733	173,772	187,258	190,684	194,138	197,620	201,198
	(Pers)	64,724	72,104	83,797	95,939	108,529	121,568	135,054	138,480	141,934	145,415	145,415
As Additional Connected Area (ha)		709.6	778.6	884.9	991.0	1,097.1	1,203.3	1,309.4	1,415.5	1,415.5	1,415.5	1,415.5
Connection Ratio (%)		69.2	72.2	76.8	81.5	86.1	90.7	95.4	96.5	97.7	98.8	100.0
Average Daily Flow (m³/Day)		10,032	10,666	11,869	12,711	13,791	14,910	16,067	16,361	16,657	16,956	17,263
Capacity of Facility* (as ADF) (m³/Day)		13,200	13,200	13,200	17,600	17,600	17,600	17,600	17,600	17,600	17,600	17,600
Maximum Daily Flow (m³/Day)		11,236	11,945	13,069	14,236	15,446	16,699	17,995	18,324	18,656	18,990	18,990

Figure 7.10 Estimated Service Population and Inflow to the WWTP and Design Capacity Improvements of Ramtha WWTP

7.2.7 Mafraq SWD

(1) Service Area Expansion

Figure 7.11 shows the locations where the sewerage services will be developed in Mafraq SWD.

The southern part of Mafraq city and Bani Hassan are proposed to be developed in Phase-1. The southern part of Mafraq city is a residential area and a part of the urban center. Bani Hassan is proposed as a Priority II area in the SWMP. Bani Hassan experiences frequent wastewater overflows and the associated sanitation problems. Therefore there is the strong need for sewerage development. It is also worth noting that the water supply system in Bani Hassan has been rehabilitated recently.

Aidoon and the northern part of Mafraq city will be developed in Phase-2. These areas are still developing. The remaining eastern part of the city,will be developed in Phase-3 after the water supply system is put in place.

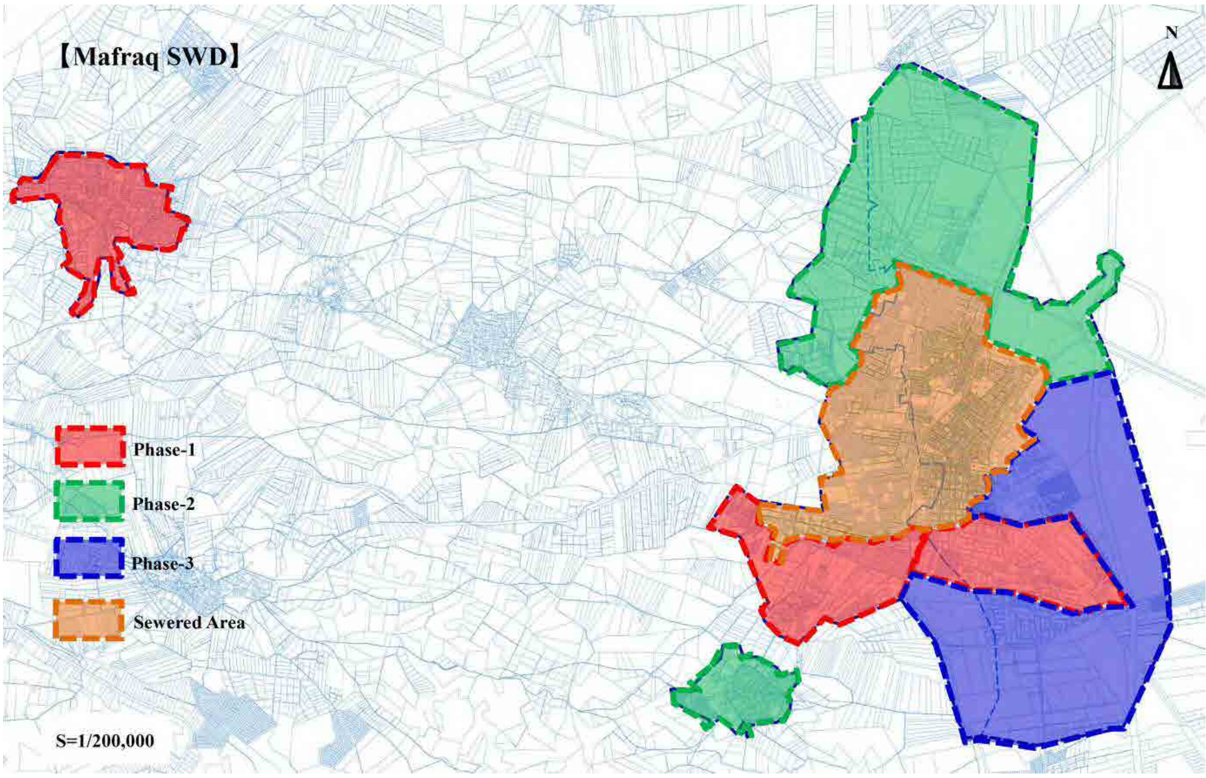


Figure 7.11 Locations Where New Sewerage Services Will be Provided in Mafraq SWD

(2) House Connection Ratio

House Connection Ratio will be increased to 100% by target year, the ratio in each phases is as shown Table 7.12.

Table 7.12 House Connection Ratio for Mafraq SWD

Item	Phase-1	Phase-2	Phase-3
Population Planned (pers.)	155,842	155,933	156,137
Population Connected (pers.)	72,874	115,527	156,137
House Connection (units)	13,396	21,237	28,702
House Connection Ratio (%)	46.8	74.1	100.0

Note: Number of persons living in household : 5.44 persons/unit, Source: JICA Study Team

(2) Branch Sewers

The required branch sewers for each phase are shown in following table.

Table 7.13 Branch Sewers for Mafraq SWD

Phase-1		Phase-2		Phase-3	
Expanded Area (ha)	Required Length (km)	Expanded Area (ha)	Required Length (km)	Expanded Area (ha)	Required Length (km)
800.60	121.93	1078.60	164.27	1022.00	155.65

Note: Unit required length of sewers per area is 152.3 m/ha..
Source: JICA Study Team

(3) Trunk Sewers

The required trunk sewers for each phase are shown in following table.

Table 7.14 Trunk Sewers for Mafraq SWD

Pipe	Length (km)			Total(km)
	Phase-1	Phase-2	Phase-3	
300mm CP	14.60	3.81	-	18.41
200mm DIP	2.80	-	-	2.80
250mm DIP	-	-	3.75	3.75

Source: JICA Study Team

(4) Lift Stations

Two new lift stations are required.

Mansha LS with a design capacity of 3.25 m^3/min will be constructed in Phase-1 to convey the wastewater collected from Bani Hassan.

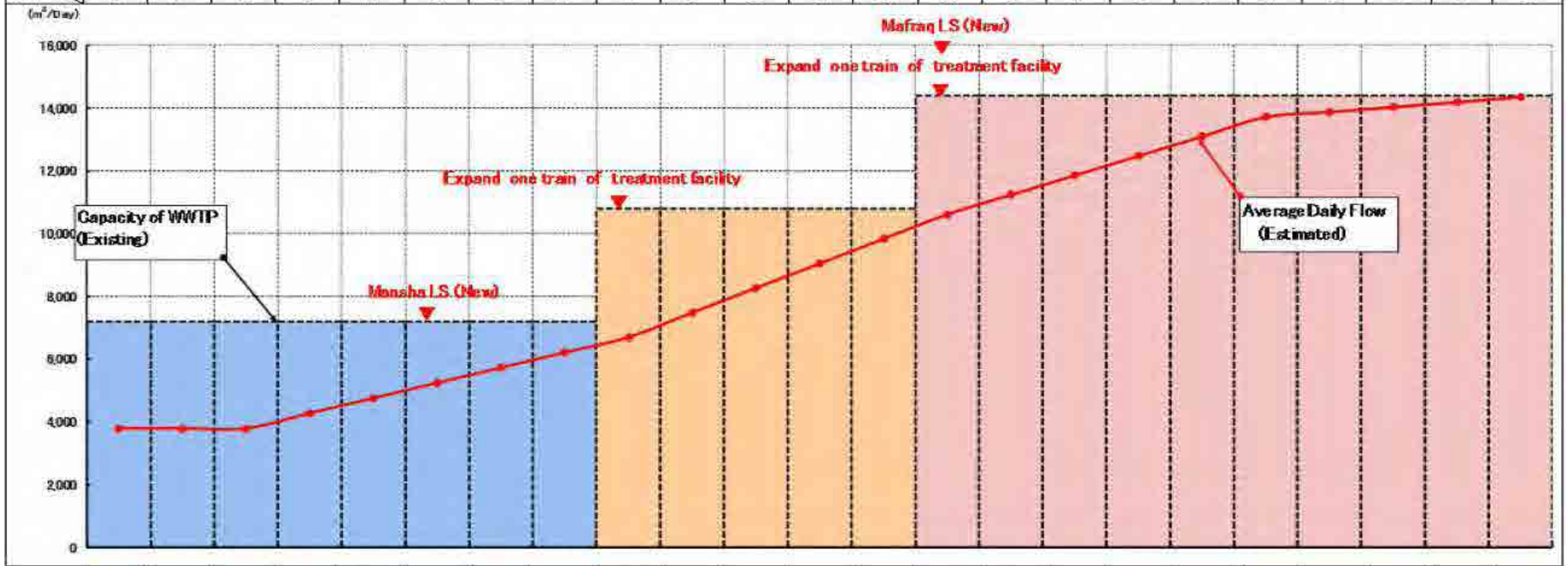
Mafraq LS with a design capacity of 2.14 m^3/min will be constructed in Phase-2 to convey the wastewater collected from the southern part of Mafraq city.

(5) WWTP

The inflow of wastewater from the expansion area and the increase in service population are estimated as shown in the following Figure. The treatment facilities plan is prepared based on the inflow estimates.

One line of wastewater treatment facilities with the design capacity of 3,600 m^3/d will be constructed in Phase-1.

A second line of wastewater treatment facilities with the design capacity of 3,600 m^3/d will be constructed in Phase-2.



Item \ Year		20## 13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Event	Branch					Unit2+3+6 (Comme)	→	→	→	Unit2+3+6 (Comp)	Unit1+4 (Comme)	→	→	→	Unit1+4 (Comp)	Unit3 (Comme)	→	→	→	→	Unit3 (Comme)			
	Trunk					BH-1 (Comme)	BH-1 (Comp)				AD1~3 (Comme)	AD1~3 (Comp)				MAF-1 (Comme)	MAF-1 (Comp)							
	LS					Mansha (Comme)	Mansha (Comp)							Mafraq (Comme)	Mafraq (Comp)									
	WWTP								Expand 1train (Comme)	Expand 1train (Comp)				Expand 1train (Comme)	Expand 1train (Comp)									
Population Planned		155,729	155,729	155,729	155,748	155,767	155,785	155,804	155,823	155,842	155,872	155,902	155,933	155,963	155,993	156,017	156,041	156,065	156,089	156,113	156,119	156,125	156,131	156,137
	(Pers.)	0	0	0	19	38	56	75	94	113	143	173	204	234	264	288	312	336	360	384	390	396	402	408
Population Connected		41,258	41,263	41,268	46,533	51,798	57,065	62,334	67,603	72,874	81,398	89,925	98,456	106,990	115,527	122,270	129,015	135,763	142,512	149,264	150,982	152,700	154,419	156,137
	(Pers.)	0	0	0	5,264	10,530	15,797	21,065	26,335	31,606	40,130	48,657	57,187	65,721	74,259	81,002	87,747	94,495	101,244	107,996	109,714	111,432	113,150	114,869
Additional Connected Area (ha)		0.0	0.0	0.0	133.4	266.9	400.3	533.7	667.2	800.6	1,016.3	1,232.0	1,447.8	1,663.5	1,879.2	2,049.5	2,219.9	2,390.2	2,560.5	2,730.9	2,901.2	2,901.2	2,901.2	2,901.2
Connection Ratio		26.5	26.5	26.5	29.9	33.3	36.6	40.0	43.4	46.8	52.2	57.7	63.1	68.6	74.1	78.4	82.7	87.0	91.3	95.6	96.7	97.8	98.9	100.0
ADF (m³/d)		3,790	3,793	3,793	4,276	4,760	5,244	5,728	6,213	6,697	7,480	8,264	9,048	9,832	10,617	11,237	11,857	12,477	13,097	13,717	13,875	14,033	14,191	14,353
Capacity (as ADF)		7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	10,800	10,800	10,800	10,800	10,800	14,400	14,400	14,400	14,400	14,400	14,400	14,400	14,400	14,400	14,400
MDF (m³/d)		4,248	4,248	4,248	4,790	5,332	5,874	6,416	6,958	7,501	8,378	9,256	10,134	11,012	11,891	12,585	13,279	13,974	14,669	15,363	15,540	15,717	15,894	16,075

Figure 7.12 Estimated Service Population and Inflow to the WWTP and Design Capacity Improvements of Mafraq WWTP

7.3 Construction Schedule for Sewerage Facilities

7.3.1 General

The following construction periods including procurement of equipment are proposed:

1) Branch Sewers: 4 or 5 years
2) Trunk Sewers: depending on the work required
3) Lift Stations: Two years, except for one manhole type pump which would only require one year
4) WWTPs: Two years generally, because only expansion of existing facilities is involved

7.3.2 Construction Schedule

Figure 7.13 summarizes the proposed 3-phase construction plan for the sewerage facilities for each SWD.

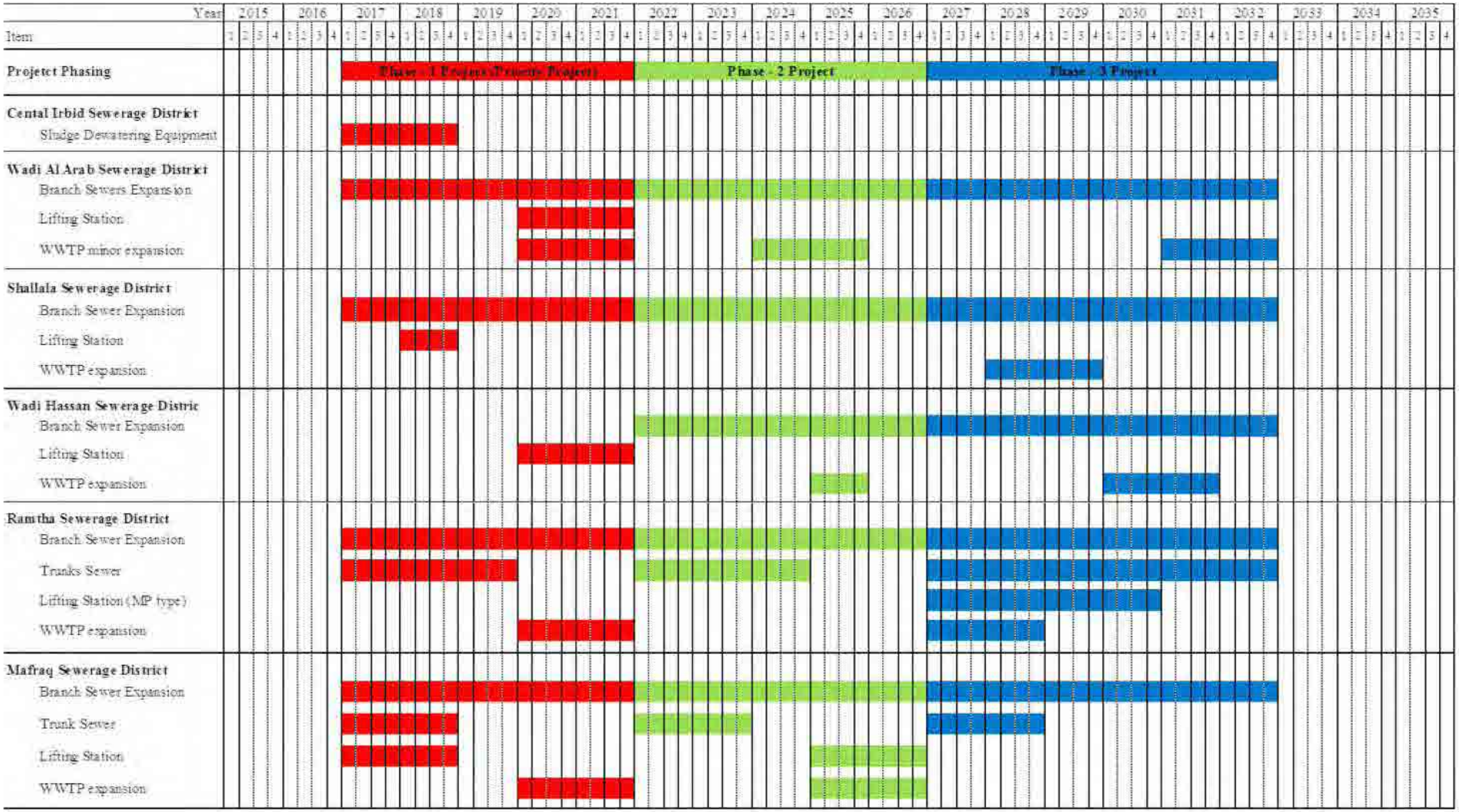


Figure 7.13 General Construction Schedule for Sewerage Facilities For Each SWD

CHAPTER 8   PROJECT COST ESTIMATE

8.1 Basis of Cost Estimate

8.1.1 General

The total project cost is the sum of the direct and indirect costs shown below:

1) Direct Costs
   Construction of Sewers, Lift Stations (LS) and Wastewater Treatment Plants (WWTPs)
2) Indirect Costs
   Engineering Services
   Land Acquisition
   Project Administration
   Physical Contingency
   Value Added Tax (VAT)

8.1.2 Basis of Cost Estimate

The project cost is estimated based on the following conditions.

(1) Price Level

Prices are estimated based on the average exchange rate as of September 2014 in accordance with the official announcement by JICA:

1 US Dollar (USD) = 0.7059 Jordanian Dinar (JD)
= 103.8 Japanese Yen (JPY)

(2) Foreign and Local Currency Portions

The project cost includes a foreign currency (F.C.) portion in US Dollar (USD) and a local currency (L.C.) portion in Jordanian Dinar (JD). The estimates for imported goods and services are allocated in the F.C. portion. Costs are allocated to the F.C. or L.C. portions according to their assumed share in each work item.

8.1.3   Direct Costs

(1) Sewers

Pipe materials used in the construction of trunk and branch sewers are locally available.   The pipes are installed by the open-cut method. The construction cost can be allocated in the L.C. portion.

Construction cost is estimated by unit cost or cost curves. The unit cost and cost curves are prepared by studying the data available in previous studies or sewerage projects and from information provided by Jordanian consultants.

The cost curves for sewer construction are prepared based on two references: one is the SWMP and the other is the latest detailed designs (2014) provided by Jordanian consultants.

1) SWMP (Strategic Wastewater Master Plan prepared by USAID/ISSP)

The SWMP proposes three phased investments for the sewerage sector in Jordan. The unit cost in SWMP is based on "Water/Wastewater Infrastructure Project/Tafileh Water Master Plan, February 2013". The unit cost is prepared using the construction costs of 25 cities, including Amman and Jerash city. It could serve as an average unit cost in Jordan. The unit costs of sewer (concrete pipe: CP) construction by diameter including 30% overhead are shown in Table 8.1.

Table 8.1 Unit Construction Cost of Concrete Pipe in SWMP

Diameter (mm)	Unit Construction Cost (JD/m)		
	Construction Cost (a+b)	Direct Cost (a)	Overhead (b)
150	130	91	39
200	140	98	42
300	160	112	48
400	170	119	51
500	200	140	60
600	210	147	63
700	240	168	72
800	290	203	87
900	330	231	99
1,000	380	266	114
1,200	460	322	138
1,500	640	448	192
1,800	910	637	273
2,000	1,100	770	330

Source: SWMP (ISSP)

2) Detailed Design in 2014

The unit cost for sewer construction is also obtained from a Jordanian consultant, who prepared the cost data while working on some detailed designs in 2014. The cost data reflect the most up to date cost information. The unit cost for sewer construction by pipe diameter is presented in Table 8.2, including 30% overhead.

The unit cost for this study is established by taking the average of the above two reference data. The cost curve is calculated by the least-square method as shown in Figure 8.1. The formula for the cost curve is shown in Equation 8.1.

Table 8.2 Unit Construction Cost of Sewers based on 2014 Detailed Design

Sewers Dia. (mm)	Unit Cost (JD/m)		
	Total Cost (a+b)	Direct Cost (a)	Overhead (b)
150 CP	59	45	14
200 CP	124	95	29
300 CP	169	130	39
400 CP	195	150	45
500 CP	260	200	60
150 DIP	85	65	20
200 DIP	165	115	50

Note: Asphalt Pavement, DIP Pipe Cost: 150mm about 52JD, 200mm about 70 JD

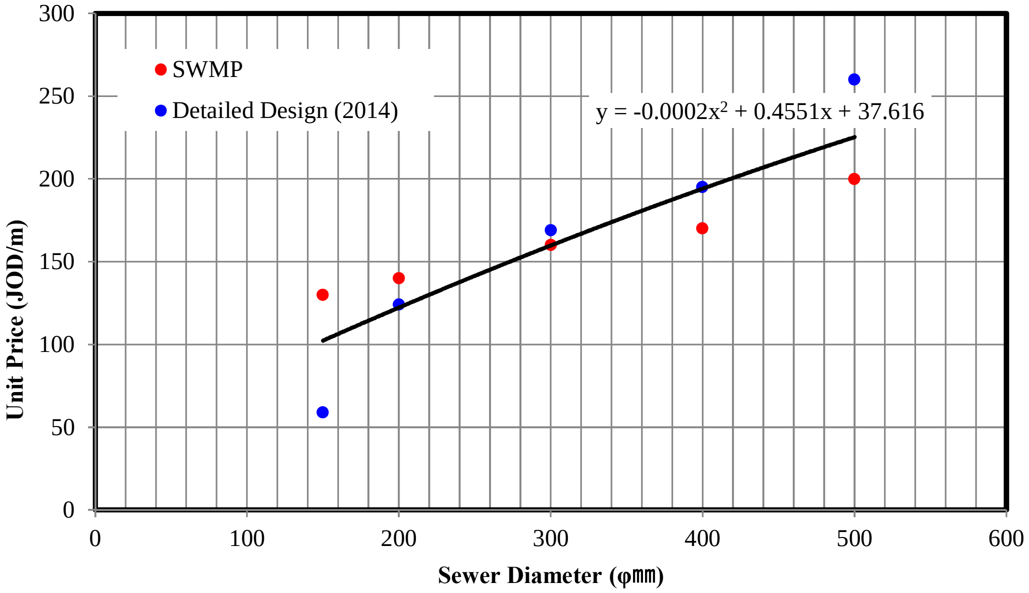


Figure 8.1 Cost Curve of Sewer Construction

$$y = -0.0002X^2 + 0.4551X + 37.616 \quad \text{--------------- Equation 8.1}$$

where, X (mm) is Sewer Diameter

The unit construction costs (JD/m) of CP for trunk and branch sewers are summarized in Table 8.3 using equation 8.1. Table 8.4 shows those of DIP for trunk sewers, based on the data shown in Table 8.2.

Table 8.3 Unit Construction Cost of Concrete Pipe for Trunk and Branch Sewers

CP Diameter	150 mm	200 mm	250 mm	300 mm	400 mm
Unit Cost	101.38 JD/m	120.64 JD/m	138.89 JD/m	156.15 JD/m	187.66 JD/m

Source: JICA Study Team

Table 8.4 Unit Construction Cost of Ductile Iron Pipe for Trunk Sewers

DIP Diameter	150 mm		200 mm		250 mm	
Unit Cost	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
	74 USD/m (52 JD/m)	33 JD/m	99 USD/m (70 JD/m)	80 JD/m	163 USD/m (115 JD/m)	100 JD/m

Source: JICA Study Team

(2) Wastewater Treatment Plant (WWTP)

1) Wastewater Treatment Facilities

The following cost data and information is used to set the unit construction cost.

a) Construction cost information (without breakdowns) of the two most recently developed WWTPs using extended aeration process, is provided by a Jordanian consultant:
   - Design capacity of 7,500 m^3/d: 13,367,800 JD (1,782 JD/m^3)
   - Design capacity of 10,000 m^3/d: 16,241,600 JD (1,624 JD/m^3)

b) Design Report[1] prepared by the USAID project, on Mafraq WWTP using the advanced aerated lagoon system: design capacity of 6,550 m^3/d: 10,227,372 JD (1,561 JD/m^3) (2012 price)

Based on the cost information of the two most recently developed WWTPs, the unit cost of WWTP using extended aeration and oxidation ditch process is set at 1,800 JD/m^3, considering inflation rate of 5%[2] to the average: (1,782 +1,624) / 2 x 1.05 = 1,788 JD/m3 => 1,800 JD/m^3 (2014 unit price).

However, since the proposed wastewater treatment processes, shown in the following, will be added to the existing facilities, the above unit cost cannot be applied directly.
- Wadi Al-Arab WWTP: Aeration tank and final sedimentation tank
- Shallala WWTP: Primary sedimentation tank, oxidation ditch, and final sedimentation tank
- Wadi Hassan WWTP: Oxidation ditch and final sedimentation tank
- Ramtha WWTP: Aeration tank and final sedimentation tank

Based on Japanese experience, the construction cost of primary and secondary unit processes is about 40% of the total construction cost of the treatment plant, as shown in Table 8.5. Considering miscellaneous costs, the unit construction cost for upgrades to existing wastewater treatment facilities is set at 900 JD/m^3, assuming 50% of the unit cost of a new WWTP.

Table 8.5 Share of Construction Cost among Facility Components

Component	Pump Station and Pretreatment	Wastewater Treatment Facilities	Sludge Treatment Facilities	Other Facilities (Administration)	Total
Share	15%	40%	35%	10%	100%

Source: JICA Study Team

The construction of wastewater treatment facilities can be divided into civil/architectural and mechanical/electrical components. The cost ratios of 40% and 60% are used for civil/architectural and mechanical/electrical components, respectively. The installation cost is 20% of the mechanical and electrical component. The costs of the civil/architectural component and installation of equipment are counted in the L.C. portion. The mechanical/electrical costs which involved mostly imported

[1] "Upgrade of Mafraq Wastewater Treatment Plant, Final Design Report", September 2012.
[2] 5% is the average of cost of living index of 4.4 (2011), 4.8 (2012) and (5.6) 2013 in Jordan, "General Government Finance Bulletin, Vol.16-No.9, October 2014"

equipment are counted in the F.C. portion.

The applied unit cost for wastewater treatment facilities for extended aeration and OD processes is summarized in the following table.

Table 8.6 Unit Construction Cost Used for Extended Aeration and Oxidation Ditch Processes

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Unit Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	450 JD/m^3 (50%)	-	450 JD/m^3 (637.5 USD/m^3)
L.C. Portion	360 JD/m^3 (40%)		90 JD/m^3 (10%)	450 JD/m^3

Note: Exchange rate 1.00 USD = 0.7059 JD
Source: JICA Study Team

At Mafrqa WWTP, one full line of treatment facilities are constructed, the cost information in the design report is used directly with the inflation rate of 5%[3].

The total cost for the capacity of 6,550 m^3/d is estimated to be 9,500,000 JD, as shown in the following table.

Table 8.7 Expansion Cost of Mafraq WWTP (Design Capacity of 6,550 m^3/d)

Component		2012 Price (USD)	2014 Price (USD)	Expansion Cost (USD)
1	Drying Beds	918,010	1,012,106	1,012,106
2	Head Works	401,700	442,874	442,874
3	Wet Weather Storage	363,785	401,073	0
4	Chambers	108,530	119,654	119,654
5	Primary Settling Tank	553,716	610,472	610,472
6	Pre-denitrification Tank	1,137,810	1,254,436	1,254,436
7	Nitrification Tank	1,517,245	1,672,763	1,672,763
8	Disinfection Basin	46,200	50,936	50,936
9	Sludge Digester	399,800	440,780	440,780
10	Retaining Walls	36,000	39,690	39,690
11	Composting	414,000	456,435	456,435
12	Sand Filter	306,523	337,942	337,942
13	Reed Beds	148,000	163,170	163,170
14	Recirculating Pumping Station	288,000	317,520	317,520
15	Buildings	636,000	701,190	0
16	900mm inlet trunk	80,000	88,200	88,200
17	Ponds	1,668,100	1,839,080	1,839,080
18	Site Works	122,000	134,505	134,505
19	Miscellaneous	2,100,000	2,315,250	2,315,250
20	Electrical Works	1,896,000	2,090,340	2,090,340

[3] 5% is the average of cost of living index of 4.4 (2011), 4.8 (2012) and (5.6) 2013 in Jordan, “General Government Finance Bulletin, Vol.16-No.9, October 2014”

Component		2012 Price (USD)	2014 Price (USD)	Expansion Cost (USD)
	Total (USD)	13,141,419	14,488,414	13,386,151
	Total (JD)	9,276,528	10,227,372	9,449,284 => **9,500,000**

Note: The construction cost of wet weather storage and buildings are excluded.
Source: USAID Report

2) Sludge Treatment Facilities
Mechanical sludge de-watering facilities are planned for Central Irbid WWTP and Ramtha WWTP, and sludge drying beds are planned for Wadi Hassan WWTP and Mafraq WWTP.

Since no information is available on the local cost of mechanical sludge de-watering facilities, the following is assumed: screw type dewatering machine (capacity 20 m^3/hour) USD 168,000 for one unit, plus installation cost of USD 28,000. The equipment cost is USD 140,000.

The construction cost of sludge drying beds is estimated using the cost estimates in the design of Mafraq WWTP by the USAID project: 1,012,106 JD / 6,550 m^3/d = 155 JD/m^3. This unit cost is used to estimate the construction cost of sludge drying beds at Wadi Hassan WWTP.

(3) Lift Station

The unit construction cost of a new lifting station is set as follows:

a) the unit construction cost of a WWTP excluding a lift station is 1,800 JD/$m^{3...}$
b) the pumping facilities (including a building) at the WWTP represents is 15% of the total cost as shown in Table 8.5.
c) the unit construction cost of a new lift station is estimated to be 300 JD/m^3 (=1,800 JD/m^3 /0.85 x 0.15 = 317 JD/m^3 => 300 JD/m^3).

The construction of a lift station can be divided into civil/architectural and mechanical/electrical components. The cost ratios of 40% and 60% are applied for the civil/architectural and mechanical/electrical components, respectively. The installation cost is 20% of the mechanical and electrical cost. The costs of civil/architectural component and installation of equipment are counted in the L.C. portion. The mechanical/electrical costs which covers mostly imported equipment are counted in the F.C. portion.

The unit construction cost used for a new lift station is shown in following tables.

Table 8.8 Unit Construction Cost for New Lift Station

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Unit Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	150 JD/m^3 (50%)	-	150 JD/m^3 (212.5 USD/m^3)
L.C. Portion	120 JD/m^3 (40%)		30 JD/m^3 (10%)	150 JD/m^3

Note: Exchange rate 1.00 USD = 0.7059 JD
Source: JICA Study Team

In case of expansion of the existing LS, the construction component is increased by 50%. The unit cost is shown in the following table.

Table 8.9 Unit Construction Cost for Expansion of Existing Lift Station

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Unit Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	150 JD/m^3 (42%)	-	150 JD/m^3 (212.5 USD/m^3)
L.C. Portion	180 JD/m^3 (50%)		30 JD/m^3 (8%)	210 JD/m^3

Note: Exchange rate 1.00 USD = 0.7059 JD
Source: JICA Study Team

For a small lifting station (manhole type pump facilities), the following unit costs are used:

F.C. portion: USD 118,000 (JD 83,000)

L.C. portion: JD 17,000

The unit cost is set as follows:

- The total cost of 140,000 JD (about 20 million JPY, based on Japanese cost estimation) is used as a base cost for one manhole type pump facility. About three quarter of the total cost is the cost of equipment and installation, and assuming about 80% of Japanese price, then the cost of equipment and installation (F.C. portion) are: 14,000 x 3/4 x 0.8 = 84,000 JD (=> adjusted to JD 83,000).
- The remaining one quarter of the total cost is construction cost and assuming about 50% of Japanese price, this cost (L.C. portion) is: 14,000 x 1/4 x 0.5 =18,000 JD (=> adjusted to JD 17,000).
- The total cost is JD 102,000, rounded to JD 100,000. The F.C. and L.C. portions are allocated as shown above.

8.1.4 Indirect Costs

The costs for engineering services, land acquisition, project administration and value added tax (VAT) are included in the indirect costs.

(1) Engineering Services

The engineering services cost includes the cost for detailed design, surveys, tender assistance and construction supervision services. The cost of engineering services is estimated to be 10% of the total direct cost.

(2) Land Acquisition Cost

The land acquisition cost for the expansion of WWTP or lift station should be calculated based on land price. This cost is not considered in this project cost estimation because land acquisition is not required.

(3) Project Administration Cost

The administration costs necessary for establishing the PIU (Project Implementation Unit) and other organizations required for project management are assumed to be 3.0 % of the sum of the direct cost, the engineering services cost and physical contingency.

(4) Physical Contingency

Physical contingency is estimated to be 10% of the total direct cost and the engineering services cost.

(5) Value Added Tax (VAT)

Value added tax is assumed to be 16 % of the total cost of the direct cost and the engineering services cost.

8.1.4 Operation and Maintenance Cost

The O&M costs are estimated as the expenditure needed for personnel, power supply and other costs.

(1) Personnel cost

The personnel cost is estimated based on the staff requirement to operate and maintain the completed branch sewers, trunk sewers, LS and WWTP. The annual personnel cost is calculated by multiplying the incremental staff number by the average staff salary of 8,040 JD/year.

(2) Power cost

Power is required to operate the mechanical equipment at the LSs and the WWTPs. The amount of power required depends on the volume of wastewater pumped and treated. The power cost is estimated by multiplying the unit power cost (0.08 JD/kWh) by the power requirements (0.7 kWh/m^3).

(3) Other costs

Other costs are estimated to be about 10% of the power cost. These include: chemicals, sludge disposal, routine equipment repair and inspection, cleaning and repair. The chemical cost include chlorination of secondary effluent, mechanical sludge dewatering, and water quality measurement. The sludge disposal cost include the loading of sludge at the WWTP, and transportation to the disposal site. Mechanical and electrical equipment needs routine maintenance and repair, including the purchase and installation of spare parts. Sewers must be inspected and cleaned on a regular basis.

8.2 Project Cost by Sewerage District

The estimated project cost is presented for the three development phases for each sewerage district. The operation and maintenance cost will be shown in the disbursement schedule.

8.2.1 Project Cost of Central Irbid SWD

Introduction of mechanical dewatering equipment and building construction are proposed for the Central Irbid WWTP in Phase-1. The cost is estimated as follows:

Equipment capacity: 30 m^3/hour, the equipment cost for one unit is USD 140,000 x 30/20 = USD 210,000.

Other facilities for sludge treatment such as sludge receiving tanks with agitators, sludge pumps, hopper, and electrical equipment are needed and will be installed in buildings. The total sludge facilities cost is estimated to be double the equipment cost: the installation cost is about 20% and building construction about 80% of the total sludge facilities cost.

Total sludge facilities cost: 210,000 USD/unit x 2 units x 2.0 = 840,000 USD => 600,000 JD
Installation cost: 600,000 JD x 0.2 =120,000 JD
Building construction cost: 600,000 JD x 0.80 = 480,000 JD

Table 8.10 Construction Cost of Sludge Treatment Facilities at Central Irbid WWTP

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	600,000 JD (50%)	-	600,000 JD (840,000 USD)
L.C. Portion	480,000 JD (40%)	-	120,000 JD (10%)	600,000 JD

Note: Exchange rate 1.00 USD = 0.7059 JD
Source: JICA Study Team

Based on the construction plan, the project cost for the Central Irbid SWD is estimated as shown in the following table.

Table 8.11 Project Cost by Phase for Central Irbid SWD

Component	Phase-1		Phase-2		Phase-3		Total	
	FC	LC	FC	LC	FC	LC	FC	LC
	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD
Branch Sewer	0	0	0	0	0	0	0	0
Trunk Sewer	0	0	0	0	0	0	0	0
Lifting Station	0	0	0	0	0	0	0	0
Wastewater Treatment Plant	850	600	0	0	0	0	850	600
Total Construction Cost	**850**	**600**	**0**	**0**	**0**	**0**	**850**	**600**
Engineering Service	85	60	0	0	0	0	85	60
Administration	0	44	0	0	0	0	0	44
Physical Contingency	94	66	0	0	0	0	94	66
VAT	165	123	0	0	0	0	165	123
Total of Indirect Cost	**344**	**293**	**0**	**0**	**0**	**0**	**344**	**293**
Total Cost	**1,194**	**893**	**0**	**0**	**0**	**0**	**1,194**	**893**

Source: JICA Study Team

8.2.2 Project Cost of Wadi Al-Arab SWD

(1) Direct Costs

1) Trunk and Branch Sewers

The required trunk and branch sewers for each phase are shown in following table.

Table 8.12 Sewer Construction Cost by Phase for Wadi Al-Arab SWD

Pipe	Phase-1			Phase-2			Phase-3		
	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)
200mm CP	167.36	120.64	20,190	87.45	120.64	10,550	61.33	120.64	7,399

Source: JICA Study Team

2) Lift Station

The capacity of the Hakama LS will be improved from 3.90 m^3/min to 6.22 m^3/min. The construction cost is estimated to be USD 404,000 for the F.C. portion and JD 399,000 for the L.C. portion in the Phase-1.

The cost is estimated as follows:

The improved capacity is 2.32 m^3/min as maximum hourly flow. The average flow is calculated to be about 1,900 m^3/d, using the peaking factor of 1.756.

Table 8.13 Construction Cost for Expansion of Hakama LS

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	150 x 1,900 = 285,000	-	JD 285,000 (USD 404,000)
L.C. Portion	180 x 1,900 = 342,000	-	30 x 1,900 = 57,000	JD 399,000

Note: Exchange rate 1.00 USD = 0.7059 JD

Source: JICA Study Team

3) WWTP

One line of aeration tank and final sedimentation tank with the design daily average flow of 3,500 m^3/d will be constructed in each phase. The construction cost is estimated to be USD 2,231,000 for the F.C. portion and JD 1,575,000 for the L.C. portion for each phase, as shown in the following figure.

Table 8.14 Construction Cost of Wastewater Treatment Facilities at Wadi Al-Arab WWTP

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	450 x 3,500 =1,575,000	-	JD 1,575,000 (USD 2,231,000)
L.C. Portion	360 x 3,500 =1,260,000	-	90 x 3,500 =315,000	JD 1,575,000

Note: Exchange rate 1.00 USD = 0.7059 JD

Source: JICA Study Team

4) Indirect costs

The indirect costs are estimated according to the method stated in the section 8.1.4.

5) Project Cost

Based on the direct and indirect costs, the Project cost is summarized in the following table.

Table 8.15 Project Cost by Phase for Wadi Al-Arab SWD

Component	Phase-1		Phase-2		Phase-3		Total	
	FC	LC	FC	LC	FC	LC	FC	LC
	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD
Branch Sewer	0	20,190	0	10,550	0	7,399	0	38,139
Trunk Sewer	0	0	0	0	0	0	0	0
Lift Station	404	399	0	0	0	0	404	399
Wastewater Treatment Plant	2,231	1,575	2,231	1,575	2,231	1,575	6,693	4,725
Total Construction Cost	**2,635**	**22,164**	**2,231**	**12,125**	**2,231**	**8,974**	**7,097**	**43,263**
Engineering Service	264	2,216	223	1,213	223	897	710	4,326
Administration	0	872	0	497	0	383	0	1,752
Physical Contingency	290	2,438	245	1,334	245	987	780	4,759
Taxes	510	4,430	432	2,427	432	1,799	1,374	8,656
Total of Indirect Cost	**1,064**	**9,956**	**900**	**5,471**	**900**	**4,066**	**2,864**	**19,493**
Total Cost	**3,699**	**32,120**	**3,131**	**17,596**	**3,131**	**13,040**	**9,961**	**62,756**

Source: JICA Study Team

8.2.3 Project Cost of Shallala SWD

(1) Direct Costs

1) Trunk and Branch Sewers

The required trunk and branch sewers for each phase are shown in following table.

Table 8.16 Sewer Construction Cost by Phase for Shallala SWD

Pipe	Phase-1			Phase-2			Phase-3		
	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)
200mm CP	89.37	120.64	10,782	38.87	120.64	4,689	128.62	120.64	15,517
300mm CP	3.30	156.15	515	-	-	-	-	-	-
400mm CP	-	-	-	4.55	187.66	854	-	-	-
Total	-	-	11,297	-	-	5,543	-	-	15,517

Source: JICA Study Team

2) Lift Station

A small manhole type pump, at Mughyeer, Mughyeer MP, will be constructed in Phase-1. The construction cost is estimated to be USD 118,000 for the F.C. portion and JD 17,000 for the L.C. portion.

The design capacity of the Al Hoson Camp LS will be increased from 4.20 m^3/min to 5.62 m^3/min in Phase-2. The construction cost is estimated to be USD 249,000 for the F.C. portion and JD 246,000 for the L.C. portion.

The improved capacity is 1.42 m^3/min as maximum hourly flow. The average flow is calculated to be about 1,170 m^3/d, using the peaking factor of 1.756 that is the value (rounded 1.80) shown in Table 4.2.

Table 8.17 Construction Cost for Expansion of Al Hoson Camp LS

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	150 x 1,170 = 175,500	-	JD 176,000 (USD 249,000)
L.C. Portion	180 x 1,170 = 210,600	-	30 x 1,170 =35,100	JD 245,700 => JD 246,000

Note: Exchange rate 1.00 USD = 0.7059 JD

Source: JICA Study Team

3) WWTP

One primary sedimentation tank, two oxidation ditches and one final sedimentation tank with the design daily average flow of 7,000 m^3/d will be constructed in Phase-3. The construction cost is estimated to be USD 6,693,000 for the F.C. portion and JD 4,725,000 for the L.C. portion, as shown in the following table.

Table 8.18 Construction Cost of Wastewater Treatment Facilities at Shallala WWTP

Component	Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Construction Cost
		Construction Cost	Equipment Cost	Installation Cost	
One line of PSD, OD, and FSD	F.C. Portion	-	450 x 7,000 =3,150,000	-	JD 3,150,000 (USD 4,462,000)
	L.C. Portion	360 x 7,000 =2,520,000	-	90 x 7,000 =630,000	JD 3,150,000
One OD	F.C. Portion	-	225 x 7,000 =1,575,000	-	JD 1,575,000 (USD 2,231,000)
	L.C. Portion	180 x 7,000 =1,260,000	-	45 x 7,000 =315,000	JD 1,575,000
Total	F.C. Portion	-	4,725,000	-	JD 4,725,000 (USD 6,693,000)
	L.C. Portion	3,780,000	-	945,000	JD 4,725,000

Note: Exchange rate 1.00 USD = 0.7059 JD
Source: JICA Study Team

4) Indirect costs
The indirect costs are estimated according to the method stated in the section 8.1.4.

5) Project Cost
Based on the direct and indirect costs, the Project cost is summarized in the following table.

Table 8.19 Project Cost by Phase for Shallala SWD

Component	Phase-1		Phase-2		Phase-3		Total	
	FC	LC	FC	LC	FC	LC	FC	LC
	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD
Branch Sewer	0	10,782	0	4,689	0	15,517	0	30,988
Trunk Sewer	0	515	0	854	0	0	0	1,369
Lift Station	118	17	249	246	0	0	367	263
Wastewater Treatment Plant	0	0	0	0	6,693	4,725	6,693	4,725
Total Construction Cost	**118**	**11,314**	**249**	**5,789**	**6,693**	**20,242**	**7,060**	**37,345**
Engineering Service	12	1,131	25	579	669	2,024	706	3,734
Administration	0	414	0	217	0	906	0	1,537
Physical Contingency	13	1,245	27	637	736	2,227	776	4,109
Taxes	23	2,257	48	1,156	1,296	4,064	1,367	7,477
Total of Indirect Cost	**48**	**5,047**	**100**	**2,589**	**2,701**	**9,221**	**2,849**	**16,857**
Total Cost	**166**	**16,361**	**349**	**8,378**	**9,394**	**29,463**	**9,909**	**54,202**

Source: JICA Study Team

8.2.4 Project Cost of Wadi Hassan SWD

(1) Direct Costs

1) Trunk and Branch Sewers
The required trunk and branch sewers for each phase are shown in following table.

Table 8.20 Sewer Construction Cost by Phase for Wadi Hassan SWD

Pipe	Phase-1			Phase-2			Phase-3		
	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)
200mm CP	-	-	-	18.38	120.64	2,217	42.58	120.64	5,137

Source: JICA Study Team

2) Lift Station

It is not required to expand the capacity of Wadi Hassan LS as specified in Table 5.12.

3) WWTP

The existing treatment capacity of Wadi Hassan is evaluated to have the capacity of 1,600 m^3/d equivalent to the wastewater treatment, due to lack of sludge treatment capacity. Additional 20 sludge drying beds with the design flow of 1,200 m^3/d equivalent will be constructed in Phase-2. Then, the capacity of WWTP is increased to 2,800 m^3/d covering the design average flow of 2,490 m^3/d.

The construction cost of 20 sludge drying beds is estimated to be JD 186,000 (=155 JD/m^3 x 1,200 m^3) for the L.C. portion only.

4) Indirect costs

The indirect costs are estimated according to the method stated in the section 8.1.4.

5) Project Cost

Based on the direct and indirect costs, the Project cost is summarized in the following table.

Table 8.21 Project Cost by Phase for Wadi Hassan SWD

Component	Phase-1		Phase-2		Phase-3		Total	
	FC	LC	FC	LC	FC	LC	FC	LC
	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD
Branch Sewer	0	0	0	2,217	0	5,137	0	7,354
Trunk Sewer	0	0	0	0	0	0	0	0
Lift Station	0	0	0	0	0	0	0	0
Wastewater Treatment Plant	0	0	0	186	0	0	0	186
Total Construction Cost	**0**	**0**	**0**	**2,403**	**0**	**5,137**	**0**	**7,540**
Engineering Service	0	0	0	240	0	514	0	754
Administration	0	0	0	87	0	186	0	273
Physical Contingency	0	0	0	264	0	565	0	829
Taxes	0	0	0	479	0	1,024	0	1,503
Total of Indirect Cost	**0**	**0**	**0**	**1,070**	**0**	**2,289**	**0**	**3,359**
Total Cost	**0**	**0**	**0**	**3,473**	**0**	**7,426**	**0**	**10,899**

Source: JICA Study Team

8.2.5 Project Cost of Ramtha SWD

(1) Direct Costs

1) Trunk and Branch Sewers

The required trunk and branch (200mm CP) sewers for each phase are shown in following table.

Table 8.22 Sewer Construction Cost by Phasing for Ramtha SWD

Sewer Pipe	Phase-1			Phase-2			Phase-3				
	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)	Length (km)	Unit Cost (JD/m)	Cost (x1000 JD)	Length (km)	Unit Cost F.C. USD/m	Unit Cost L.C. (JD/m)	Cost F.C. (x1000USD)	Cost L.C. (x1000 JD)
200mm CP	65.95	120.64	7,957	52.67	120.64	6,355	96.97	-	120.64	-	11,698
300mm CP	4.32	156.15	675	-	-	-	-	-	-	-	- -
150mmDIP	-	-	-	-	-	-	2.40	74	33	178	79
200mmDIP	-	-	-	-	-	-	4.68	99	80	463	374
200mmDIP (Dual)	-	-	-	-	-	-	5.25	198	80	1,040	420
200mmDIP (Triple)	-	-	-	-	-	-	5.16	297	80	1,532	413
Total	-	-	8,632	-	-	6,355	-	-	-	3,213	12,984

Source: JICA Study Team

2) Lift Station

Four small manhole type pumps, at the localities of Dnaibeh, Emrawah, Shajarah and Torrah, will be constructed in Phase-3. The total construction cost is estimated to be USD 472,000 for the F.C. portion and JD 68,000 for the L.C. portion.

3) WWTP

One line of aeration tank and final sedimentation tank with the design daily average flow of 4,400 m^3/d and mechanical sludge de-watering equipment with a building will be constructed in Phase-1. The construction cost is estimated to be USD 3,938,000 for the F.C. portion and JD 2,780,000 for the L.C. portion.

In addition, one line of aeration tank and final sedimentation tank with the design daily average flow of 4,400 m^3/d will be constructed in Phase-3. The construction cost is estimated to be USD 2,805,000 for the F.C. portion and JD 1,980,000 for the L.C. portion.

The construction costs are estimated as shown in the table below.

Table 8.23 Construction Costs of Wastewater Treatment Facilities at Ramtha WWTP

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	450 x 4,400 =1,980,000	-	JD 1,980,000 (USD 2,805,000)
L.C. Portion	360 x 4,400 =1,584,000	-	90 x 4,400 =396,000	JD 1,980,000

Note: Exchange rate 1.00 USD = 0.7059 JD

Source: JICA Study Team

Mechanical dewatering equipment and the building construction are proposed for Phase-1. The cost is estimated as follows:

Equipment capacity: 40 m^3/hour. Equipment cost is USD 140,000 x 40/20 = USD 280,000 for one unit.

Other facilities for sludge treatment such as sludge receiving tanks with agitators, sludge pumps, hopper, and electrical equipment are needed and will be installed in the buildings. Therefore, the total sludge facilities cost is estimated to be double the equipment cost: with the installation cost about 20% and building construction about 80% of the total sludge facilities cost.

Total sludge facilities cost: 280,000 USD/unit x 2 units x 2.0 = 1,120,000 USD => 800,000 JD
Installation cost: 800,000 JD x 0.2 =160,000 JD
Building construction cost: 800,000 JD x 0.80 = 640,000 JD

Table 8.24 Construction Cost of Sludge Treatment Facilities at Ramtha WWTP

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	JD 800,000 (50%)	-	JD 800,000 (USD 1,133,000)
L.C. Portion	JD 640,000 (40%)		JD 160,000 (10%)	JD 800,000

Note: Exchange rate 1.00 USD = 0.7059 JD
Source: JICA Study Team

4) Indirect Costs
The indirect costs are estimated according to the method stated in the section 8.1.4.

5) Project Cost
Based on the direct and indirect cost, the Project cost is summarized in the following table.

Table 8.25 Project Cost by Phase for Ramtha SWD

Component	Phase-1		Phase-2		Phase-3		Total	
	FC	LC	FC	LC	FC	LC	FC	LC
	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD
Branch Sewer	0	7,957	0	6,355	0	11,698	0	26,010
Trunk Sewer	0	675	0	0	3,217	1,286	3,217	1,961
Lift Station	0	0	0	0	472	68	472	68
Wastewater Treatment Plant	3,938	2,780	0	0	2,805	1,980	6,743	4,760
Total Construction Cost	**3,938**	**11,412**	**0**	**6,355**	**6,494**	**15,032**	**10,432**	**32,799**
Engineering Service	394	1,141	0	636	649	1,503	1,043	3,280
Administration	0	515	0	231	0	712	0	1,458
Physical Contingency	433	1,255	0	699	714	1,654	1,147	3,608
Taxes	762	2,292	0	1,267	1,257	3,024	2,019	6,583
Total of Indirect Cost	**1,589**	**5,203**	**0**	**2,833**	**2,620**	**6,893**	**4,209**	**14,929**
Total Cost	**5,527**	**16,615**	**0**	**9,188**	**9,114**	**21,925**	**14,641**	**47,728**

Source: JICA Study Team

8.2.6 Project Cost of Mafraq SWD

(1) Direct Costs

1) Trunk and Branch Sewers
The required trunk and branch sewers for each phase are shown in following table.

Table 8.26 Sewer Construction Cost by Phase for Mafraq SWD

Sewer Pipe	Phase-1					Phase-2			Phase-3				
	Length (km)	Unit Cost F.C. (USD/m)	Unit Cost L.C. (JD/m)	Cost F.C. (x1000 USD)	Cost L.C. (x1000 JD)	Length (km)	Unit Cost L.C. (JD/m)	Cost L.C. (x1000 JD)	Length (km)	Unit Cost F.C. (USD/m)	Unit Cost L.C. (JD/m)	Cost F.C. (x1000 USD)	Cost L.C. (x1000 JD)
200mm CP	121.93	-	120.64	-	14,710	164.27	120.64	19,818	155.65	-	120.64	-	18,778
300mm CP	14.60	-	156.15	-	2,280	3.81	156.15	595	-	-	-	-	-
200mm DIP	2.80	99	80	277	224	-	-	-	-	-	-	-	-
250mm DIP	-	-	-	-	-	-	-	-	3.75	163	100	611	375
Total	-	-	-	277	17,214	-	-	20,413	-	-	-	611	19,153

Source: JICA Study Team

2) Lift Station

Mansha LS with the design capacity of 3.25 m^3/min will be constructed in Phase-1. The construction cost is estimated to be USD 568,000 for the F.C. portion and JD 401,000 for the L.C. portion.

Mafraq LS with the design capacity of 2.14 m^3/min will be constructed in Phase-2. The construction cost is estimated to be USD 374,000 for the F.C. portion and JD 264,000 for the L.C. portion.

The capacity is expressed as the maximum hourly flow. Using the peaking factor of 1.756, the design capacity of 3.25 m^3/min and 2.14 m^3/min are converted into the average flow 2,670 m^3/d and 1,760 m^3/d, respectively. The construction of the new LSs are calculated in table below.

Table 8.27 Construction Cost of New Mansha LS

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	150 x 2,670 = 400,500	-	JD 400,500 => JD 401,000 (US 568,000)
L.C. Portion	120 x 2,670 = 320,400	-	30 x 2,670 = 80,100	JD 400,500 => JD 410,000

Note: Exchange rate 1.00 USD = 0.7059 JD

Source: JICA Study Team

Table 8.28 Construction Cost of New Mafraq LS

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	150 x 1,760 = 264,000	-	JD 264,000 (USD 374,000)
L.C. Portion	120 x 1,760 = 211,200	-	30 x 1,760 =52,800	JD 264,000

Note: Exchange rate 1.00 USD = 0.7059 JD

Source: JICA Study Team

3) WWTP

The construction cost of Mafraq WWTP is JD 9,500,000 for the design capacity of 6,550 m^3/d. But JICA Study team judged the facility have the capacity of 7,200 m^3/d.

The design capacity of the phase-1 and the phase-2 projects will be 3,600 m^3/d each and the estimated cost for each phase is JD 4,750,000.

The construction of the wastewater treatment facilities can be divided into civil/architectural and mechanical/electrical components. The cost ratios of 40% and 60% are used for the civil/architectural and mechanical/electrical components respectively. The installation cost is 20% of the mechanical and electrical component. The costs of construction and installation of equipment are accounted in the L.C. portion. The imported equipment is accounted in the mechanical/electrical component in the F.C. portion.

One line of wastewater treatment facilities with the design capacity of 3,600 m^3/d will be constructed in Phase-1 and a second line in Phase-2. The construction cost for each phase is estimated to be USD 3,365,000 for the F.C. portion and JD 2,375,000 for the L.C. portion, as shown in the following table.

Table 8.29 Construction Cost for One Series of Treatment Facilities at Mafraq WWTP

Currency Portion	Civil & Architect Works	Mechanical & Electrical Works		Construction Cost
	Construction Cost	Equipment Cost	Installation Cost	
F.C. Portion	-	JD 2,375,000 (50%)	-	JD 2,375,000 (USD 3,365,000)
L.C. Portion	JD 1,900,000 JD (40%)	-	JD 475,000 (10%)	JD 2,375,000

Note: Exchange rate 1.00 USD = 0.7059 JD

Source: JICA Study Team

4) Indirect Costs

The indirect costs are estimated according to the method stated in the section 8.1.4.

5) Project Cost

Based on the direct and indirect costs, the Project cost is summarized in the following table.

Table 8.30 Project Cost by Phase for Mafraq SWD

Component	Phase-1		Phase-2		Phase-3		Total	
	FC	LC	FC	LC	FC	LC	FC	LC
	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD	x1000 USD	x1000 JD
Branch Sewer	0	14,710	0	19,818	0	18,778	0	53,306
Trunk Sewer	278	2,504	0	595	611	375	889	3,474
Lift Station	568	401	374	264	0	0	942	665
Wastewater Treatment Plant	3,365	2,375	3,365	2,375	0	0	6,730	4,750
Total Construction Cost	**4,211**	**19,990**	**3,739**	**23,052**	**611**	**19,153**	**8,561**	**62,195**
Engineering Service	421	1,999	374	2,305	61	1,915	856	6,219
Administration	0	834	0	933	0	711	0	2,478
Physical Contingency	463	2,199	411	2,536	67	2,107	941	6,842
Taxes	815	4,004	724	4,612	118	3,822	1,657	12,438
Total of Indirect Cost	**1,699**	**9,036**	**1,509**	**10,386**	**246**	**8,555**	**3,454**	**27,977**
Total Cost	**5,910**	**29,026**	**5,248**	**33,438**	**857**	**27,708**	**12,015**	**90,172**

Source: JICA Study Team

8.3 Disbursement Schedule by Sewerage District

The annual project cost and annual O&M cost for Central Irbid SWD are presented in Table 8.31 and Table 8.32, respectively.

The annual project cost and annual O&M cost for Wadi Al-Arab SWD are presented in Table 8.33 and Table 8.34, respectively.

The annual project cost and annual O&M cost for Shallala SWD are presented in Table 8.35 and Table 8.36, respectively.

The annual project cost and annual O&M cost for Wadi Hassan SWD are presented in Table 8.37 and Table 8.38, respectively.

The annual project cost and annual O&M cost for Ramtha SWD are presented in Table 8.39 and Table 8.40, respectively.

The annual project cost and annual O&M cost for Ramtha SWD are presented in Table 8.41 and Table 8.42, respectively.

Table 8.31 Disbursement Schedule of Phase -1 Project for Central Irbid SWD

Phase-1 FC: x1000 USD, LC: x1000 JD

Component	2015		2016		2017		2018		2019		2020		2021				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer																	0	0
Trunk Sewer																	0	0
Lifting Station																	0	0
Wastewater Treatment Plant					340	360	510	240									850	600
Total Construction Cost	0	0	0	0	340	360	510	240	0	0	0	0	0	0	0	0	850	600
Engineering Service			43	30	21	15	21	15									85	60
Administration		7		15		11		11									0	44
Physical Contingency	0	0	4	3	37	37	53	26									94	66
Taxes	0	1	8	8	64	67	93	47									165	123
Total of Indirect Cost	0	8	55	56	122	130	167	99	0	0	0	0	0	0	0	0	344	293
Total Cost	0	8	55	56	462	490	677	339	0	0	0	0	0	0	0	0	1,194	893

Source: JICA Study Team

Table 8.32 Annual O&M Cost for Central Irbid SWD

Unit: x1000JD

Annual O&M Cost	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Personnel Cost		0	32	32	32	32	32	32	32	32
Power Cost	10	12	15	17	20	22	25	27	30	32
Other Cost	1	1	1	2	2	2	2	3	3	3
Total O&M Cost	11	13	48	51	54	56	59	62	65	68

Annual O&M Cost	2027	2028	2029	2030	2031	2032	2033	2034	2035
Personnel Cost	32	32	32	32	32	32	32	32	32
Power Cost	35	38	40	43	46	48	51	54	57
Other Cost	3	4	4	4	5	5	5	5	6
Total O&M Cost	71	74	76	79	82	85	88	91	94

Source: JICA Study Team

Table 8.33 Disbursement Schedule for Wadi Al-Arab SWD

Phase-1 FC: x1000 USD, LC: x1000 JD

Component	2015		2016		2017		2018		2019		2020		2021				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						4,038		4,038		4,038		4,038		4,038			0	20,190
Trunk Sewer																	0	0
Lifting Station											162	239	242	160			404	399
Wastewater Treatment Plant											892	945	1339	630			2,231	1,575
Total Construction Cost	0	0	0	0	0	4,038	0	4,038	0	4,038	1,054	5,222	1,581	4,828	0	0	2,635	22,164
Engineering Service			106	665	26	310	26	310	26	310	40	310	40	310			264	2,216
Administration	0	130	0	217	0	105	0	105	0	105	0	105	0	105			0	872
Physical Contingency	0	0	11	67	3	435	3	435	3	435	109	553	161	514			290	2,438
Taxes	0	21	19	152	5	782	5	782	5	782	193	990	285	921			510	4,430
Total of Indirect Cost	0	151	136	1,101	34	1,632	34	1,632	34	1,632	342	1,958	486	1,850	0	0	1,064	9,956
Total Cost	0	151	136	1,101	34	5,670	34	5,670	34	5,670	1,396	7,180	2,067	6,678	0	0	3,699	32,120

Phase-2 FC: x1000 USD, LC: x1000 JD

Component	2020		2021		2022		2023		2024		2025		2026				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						2,110		2,110		2,110		2,110		2,110			0	10,550
Trunk Sewer																	0	0
Lifting Station																	0	0
Wastewater Treatment Plant									892	945	1339	630					2,231	1,575
Total Construction Cost	0	0	0	0	0	2,110	0	2,110	892	3,055	1,339	2,740	0	2,110	0	0	2,231	12,125
Engineering Service			89	364	22	170	22	170	33	170	33	170	22	170			223	1,213
Administration	0	75	0	123	0	60	0	60	0	60	0	60	0	60			0	497
Physical Contingency	0	0	9	36	2	228	2	228	93	323	137	291	2	228			245	1,334
Taxes	0	12	16	83	4	411	4	411	163	577	241	522	4	411			432	2,427
Total of Indirect Cost	0	87	114	606	28	869	28	869	289	1,130	411	1,043	28	869	0	0	900	5,471
Total Cost	0	87	114	606	28	2,979	28	2,979	1,181	4,185	1,750	3,783	28	2,979	0	0	3,131	17,596

Phase-3 FC: x1000 USD, LC: x1000 JD

Component	2025		2026		2027		2028		2029		2030		2031		2032		Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						1,233		1,233		1,233		1,233		1,233		1,233	0	7,399
Trunk Sewer																	0	0
Lifting Station																	0	0
Wastewater Treatment Plant													892	945	1339	630	2,231	1,575
Total Construction Cost	0	0	0	0	0	1,233	0	1,233	0	1,233	0	1,233	892	2,178	1,339	1,863	2,231	8,974
Engineering Service			89	269	17	108	17	108	17	108	17	108	33	99	33	99	223	897
Administration	0	57	0	95	0	38	0	38	0	38	0	38	0	38	0	38	0	383
Physical Contingency	0	0	9	26	2	134	2	134	2	134	2	134	92	228	136	196	245	987
Taxes	0	9	16	61	3	242	3	242	3	242	3	242	163	407	241	351	432	1,799
Total of Indirect Cost	0	66	114	451	22	522	22	522	22	522	22	522	288	772	410	684	900	4,066
Total Cost	0	66	114	451	22	1,755	22	1,755	22	1,755	22	1,755	1,180	2,950	1,749	2,547	3,131	13,040

Source: JICA Study Team

Table 8.34 Annual O&M Cost for Wadi Al-Arab SWD

Unit: x1000JD

Annual O&M Cost	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Personnel Cost		0	0	0	0	16	16	16	40	56
Power Cost	51	78	106	136	166	186	206	227	249	270
Other Cost	5	8	11	14	17	19	21	23	25	27
Total O&M Cost	56	85	117	149	183	221	243	266	314	354

Annual O&M Cost	2027	2028	2029	2030	2031	2032	2033	2034	2035
Personnel Cost	56	56	56	56	56	56	56	56	56
Power Cost	283	296	310	323	337	340	344	347	350
Other Cost	28	30	31	32	34	34	34	35	35
Total O&M Cost	368	382	397	412	427	430	434	438	442

Source: JICA Study Team

Table 8.35 Disbursement Schedule for Shallala SWD

Phase-1 FC: x1000 USD, LC: x1000 JD

Component	2015		2016		2017		2018		2019		2020		2021				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						2,156		2,156		2,156		2,157		2,157			0	10,782
Trunk Sewer						258		257									0	515
Lift Station							118	17									118	17
Wastewater Treatment Plant																	0	0
Total Construction Cost	0	0	0	0	0	2,414	118	2,430	0	2,156	0	2,157	0	2,157	0	0	118	11,314
Engineering Service			0	339	3	158	9	158	0	158	0	159	0	159			12	1,131
Administration	0	61	0	103	0	50	0	50	0	50	0	50	0	50			0	414
Physical Contingency	0	0	0	34	0	257	13	258	0	232	0	232	0	232			13	1,245
Taxes	0	10	0	76	0	461	23	463	0	415	0	416	0	416			23	2,257
Total of Indirect Cost	0	71	0	552	3	926	45	929	0	855	0	857	0	857	0	0	48	5,047
Total Cost	0	71	0	552	3	3,340	163	3,359	0	3,011	0	3,014	0	3,014	0	0	166	16,361

Phase-2 FC: x1000 USD, LC: x1000 JD

Component	2020		2021		2022		2023		2024		2025		2026				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						938		938		938		938		937			0	4,689
Trunk Sewer						427		427									0	854
Lift Station					100	148	149	98									249	246
Wastewater Treatment Plant																	0	0
Total Construction Cost	0	0	0	0	100	1,513	149	1,463	0	938	0	938	0	937	0	0	249	5,789
Engineering Service			8	174	9	81	8	81	0	81	0	81	0	81			25	579
Administration	0	33	0	54	0	26	0	26	0	26	0	26	0	26			0	217
Physical Contingency	0	0	1	17	11	159	15	154	0	102	0	102	0	103			27	637
Taxes	0	5	1	39	19	285	28	275	0	184	0	184	0	184			48	1,156
Total of Indirect Cost	0	38	10	284	39	551	51	536	0	393	0	393	0	394	0	0	100	2,589
Total Cost	0	38	10	284	139	2,064	200	1,999	0	1,331	0	1,331	0	1,331	0	0	349	8,378

Phase-3 FC: x1000 USD, LC: x1000 JD

Component	2025		2026		2027		2028		2029		2030		2031		2032		Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						2,586		2,586		2,586		2,586		2,586		2,587	0	15,517
Trunk Sewer																	0	0
Lift Station																	0	0
Wastewater Treatment Plant							2,677	2,835	4,016	1,890							6,693	4,725
Total Construction Cost	0	0	0	0	0	2,586	2,677	5,421	4,016	4,476	0	2,586	0	2,586	0	2,587	6,693	20,242
Engineering Service			268	607	50	243	100	243	100	243	50	243	50	223	51	222	669	2,024
Administration	0	135	0	226	0	90	0	91	0	91	0	91	0	91	0	91	0	906
Physical Contingency	0	0	27	61	5	283	278	566	411	472	5	283	5	281	5	281	736	2,227
Taxes	0	22	47	143	9	512	489	1,011	724	845	9	513	9	509	9	509	1,296	4,064
Total of Indirect Cost	0	157	342	1,037	64	1,128	867	1,911	1,235	1,651	64	1,130	64	1,104	65	1,103	2,701	9,221
Total Cost	0	157	342	1,037	64	3,714	3,544	7,332	5,251	6,127	64	3,716	64	3,690	65	3,690	9,394	29,463

Source: JICA Study Team

Table 8.36 Annual O&M Cost for Shallala SWD

Unit: x1000JD

Annual O&M Cost	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Personnel Cost	0	0	0	0	0	0	0	16	40	40
Power Cost	17	30	44	60	76	97	120	130	141	152
Other Cost	2	3	4	6	8	10	12	13	14	15
Total O&M Cost	18	33	49	65	84	107	132	159	195	207

Annual O&M Cost	2027	2028	2029	2030	2031	2032	2033	2034	2035
Personnel Cost	40	40	40	56	56	56	56	56	56
Power Cost	177	203	231	260	291	320	350	381	413
Other Cost	18	20	23	26	29	32	35	38	41
Total O&M Cost	235	264	294	343	376	408	441	475	511

Source: JICA Study Team

Table 8.37 Disbursement Schedule of for Wadi Hassan SWD

Phase-1 FC: x1000 USD, LC: x1000 JD

Component	2015		2016		2017		2018		2019		2020		2021				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer																	0	0
Trunk Sewer																	0	0
Lift Station																	0	0
Wastewater Treatment Plant																	0	0
Total Construction Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Engineering Service																	0	0
Administration																	0	0
Physical Contingency																	0	0
Taxes																	0	0
Total of Indirect Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Phase-2 FC: x1000 USD, LC: x1000 JD

Component	2020		2021		2022		2023		2024		2025		2026				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						443		443		443		444		444			0	2,217
Trunk Sewer																	0	0
Lift Station																	0	0
Wastewater Treatment Plant											0	186					0	186
Total Construction Cost	0	0	0	0	0	443	0	443	0	443	0	630	0	444	0	0	0	2,403
Engineering Service	0	0	0	72	0	34	0	33	0	33	0	34	0	34			0	240
Administration	0	12	0	21	0	11	0	11	0	11	0	11	0	10			0	87
Physical Contingency	0	0	0	7	0	48	0	48	0	48	0	65	0	48			0	264
Taxes	0	2	0	16	0	86	0	86	0	86	0	117	0	86			0	479
Total of Indirect Cost	0	14	0	116	0	179	0	178	0	178	0	227	0	178	0	0	0	1,070
Total Cost	0	14	0	116	0	622	0	621	0	621	0	857	0	622	0	0	0	3,473

Phase-3 FC: x1000 USD, LC: x1000 JD

Component	2025		2026		2027		2028		2029		2030		2031		2032		Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						856		856		856		856		856		857	0	5,137
Trunk Sewer																	0	0
Lift Station																	0	0
Wastewater Treatment Plant																	0	0
Total Construction Cost	0	0	0	0	0	856	0	856	0	856	0	856	0	856	0	857	0	5,137
Engineering Service	0		0	144	0	62	0	62	0	62	0	62	0	61	0	61	0	514
Administration	0	27	0	45	0	19	0	19	0	19	0	19	0	19	0	19	0	186
Physical Contingency	0	0	0	14	0	92	0	92	0	92	0	92	0	91	0	92	0	565
Taxes	0	4	0	32	0	165	0	165	0	165	0	164	0	164	0	165	0	1,024
Total of Indirect Cost	0	31	0	235	0	338	0	338	0	338	0	337	0	335	0	337	0	2,289
Total Cost	0	31	0	235	0	1,194	0	1,194	0	1,194	0	1,193	0	1,191	0	1,194	0	7,426

Source: JICA Study Team

Table 8.38 Annual O&M Cost for Wadi Hassan SWD

Unit: x1000JD

Annual O&M Cost	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Personnel Cost	0	0	0	0	0	0	0	0	0	0
Power Cost	0	0	0	0	0	0	0	1	2	3
Other Cost	0	0	0	0	0	0	0	0	0	0
Total O&M Cost	0	0	0	0	0	0	0	1	2	3

Annual O&M Cost	2027	2028	2029	2030	2031	2032	2033	2034	2035
Personnel Cost	24	24	24	24	24	24	24	24	24
Power Cost	6	9	12	16	19	24	30	36	42
Other Cost	1	1	1	2	2	2	3	4	4
Total O&M Cost	31	34	38	41	45	51	57	64	70

Source: JICA Study Team

Table 8.39 Disbursement Schedule of for Ramtha SWD

Phase-1 FC: x1000 USD, LC: x1000 JD

Component	2015		2016		2017		2018		2019		2020		2021				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						1,591		1,591		1,591		1,592		1,592			0	7,957
Trunk Sewer						225		225		225							0	675
Lift Station																	0	0
Wastewater Treatment Plant											1,575	1,668	2,363	1,112			3,938	2,780
Total Construction Cost	0	0	0	0	0	1,816	0	1,816	0	1,816	1,575	3,260	2,363	2,704	0	0	3,938	11,412
Engineering Service			158	342	40	160	39	160	39	160	59	160	59	159			394	1,141
Administration	0	77	0	128	0	62	0	62	0	62	0	62	0	62			0	515
Physical Contingency	0	0	16	34	4	198	4	198	4	198	163	342	242	285			433	1,255
Taxes	0	12	27	80	7	358	7	358	7	358	288	612	426	514			762	2,292
Total of Indirect Cost	0	89	201	584	51	778	50	778	50	778	510	1,176	727	1,020	0	0	1,589	5,203
Total Cost	0	89	201	584	51	2,594	50	2,594	50	2,594	2,085	4,436	3,090	3,724	0	0	5,527	16,615

Phase-2 FC: x1000 USD, LC: x1000 JD

Component	2020		2021		2022		2023		2024		2025		2026				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						1,271		1,271		1,271		1,271		1,271			0	6,355
Trunk Sewer																	0	0
Lift Station																	0	0
Wastewater Treatment Plant																	0	0
Total Construction Cost	0	0	0	0	0	1,271	0	1,271	0	1,271	0	1,271	0	1,271	0	0	0	6,355
Engineering Service			0	191	0	89	0	89	0	89	0	89	0	89			0	636
Administration	0	34	0	57	0	28	0	28	0	28	0	28	0	28			0	231
Physical Contingency	0	0	0	19	0	136	0	136	0	136	0	136	0	136			0	699
Taxes	0	5	0	43	0	244	0	244	0	244	0	244	0	243			0	1,267
Total of Indirect Cost	0	39	0	310	0	497	0	497	0	497	0	497	0	496	0	0	0	2,833
Total Cost	0	39	0	310	0	1,768	0	1,768	0	1,768	0	1,768	0	1,767	0	0	0	9,188

Phase-3 FC: x1000 USD, LC: x1000 JD

Component	2025		2026		2027		2028		2029		2030		2031		2032		Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						1,950		1,950		1,950		1,950		1,949		1,949	0	11,698
Trunk Sewer					536	214	536	214	536	214	536	214	536	215	537	215	3,217	1,286
Lift Station					118	17	118	17	118	17	118	17					472	68
Wastewater Treatment Plant					1,122	1,188	1,683	792									2,805	1,980
Total Construction Cost	0	0	0	0	1,776	3,369	2,337	2,973	654	2,181	654	2,181	536	2,164	537	2,164	6,494	15,032
Engineering Service			195	451	84	225	84	225	78	150	78	150	65	151	65	151	649	1,503
Administration	0	108	0	179	0	71	0	71	0	71	0	71	0	71	0	70	0	712
Physical Contingency	0	0	20	45	186	359	242	320	73	233	73	233	60	232	60	232	714	1,654
Taxes	0	17	34	108	327	644	426	574	129	422	129	422	106	419	106	419	1,257	3,025
Total of Indirect Cost	0	125	249	783	597	1,299	752	1,190	280	876	280	876	231	873	231	872	2,620	6,894
Total Cost	0	125	249	783	2,373	4,668	3,089	4,163	934	3,057	934	3,057	767	3,037	768	3,036	9,114	21,926

Source: JICA Study Team

Table 8.40 Annual O&M Cost for Ramtha SWD

Unit: x1000JD

Annual O&M Cost	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Personnel Cost	0	0	0	0	0	16	16	16	40	40
Power Cost	21	32	44	55	68	79	90	102	114	126
Other Cost	2	3	4	6	7	8	9	10	11	13
Total O&M Cost	23	35	48	61	74	103	115	128	166	179

Annual O&M Cost	2027	2028	2029	2030	2031	2032	2033	2034	2035
Personnel Cost	40	48	64	64	64	64	64	64	64
Power Cost	147	168	190	213	237	243	249	255	261
Other Cost	15	17	19	21	24	24	25	26	26
Total O&M Cost	202	233	274	299	325	332	338	345	352

Source: JICA Study Team

Table 8.41 Disbursement Schedule of for Mafraq SWD

Phase-1 FC: x1000 USD, LC: x1000 JD

Component	2015		2016		2017		2018		2019		2020		2021				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						2,942		2,942		2,942		2,942		2,942			0	14,710
Trunk Sewer					139	1,252	139	1,252									278	2,504
Lifting Station					227	241	341	160									568	401
Wastewater Treatment Plant											1,346	1,425	2,019	950			3,365	2,375
Total Construction Cost	0	0	0	0	366	4,435	480	4,354	0	2,942	1,346	4,367	2,019	3,892	0	0	4,211	19,990
Engineering Service			168	600	42	280	42	280	42	280	63	280	63	280			421	1,999
Administration	0	126	0	210	0	100	0	100	0	100	0	100	0	100			0	834
Physical Contingency	0	0	17	60	41	472	52	463	4	322	141	465	207	416			463	2,199
Taxes	0	20	30	140	72	846	93	832	7	583	248	834	366	749			815	4,004
Total of Indirect Cost	0	146	215	1,010	155	1,698	187	1,675	53	1,285	452	1,679	636	1,545	0	0	1,699	9,036
Total Cost	0	146	215	1,010	521	6,133	667	6,029	53	4,227	1,798	6,046	2,655	5,437	0	0	5,910	29,026

Phase-2 FC: x1000 USD, LC: x1000 JD

Component	2020		2021		2022		2023		2024		2025		2026				Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						3,964		3,964		3,964		3,964		3,964			0	19,818
Trunk Sewer						298		298									0	595
Lifting Station											150	158	224	106			374	264
Wastewater Treatment Plant											1,346	1,425	2,019	950			3,365	2,375
Total Construction Cost	0	0	0	0	0	4,261	0	4,261	0	3,964	1,496	5,547	2,243	5,020	0	0	3,739	23,052
Engineering Service			150	692	37	323	37	323	37	323	56	323	56	323			374	2,305
Administration	0	140	0	232	0	112	0	112	0	112	0	112	0	112			0	933
Physical Contingency	0	0	15	69	4	458	4	458	4	429	154	587	230	534			411	2,536
Taxes	0	22	26	159	7	825	7	825	7	772	273	1,051	405	958			724	4,612
Total of Indirect Cost	0	162	191	1,152	48	1,718	48	1,718	48	1,636	483	2,073	691	1,927	0	0	1,509	10,386
Total Cost	0	162	191	1,152	48	5,979	48	5,979	48	5,600	1,979	7,620	2,934	6,947	0	0	5,248	33,438

Phase-3 FC: x1000 USD, LC: x1000 JD

Component	2025		2026		2027		2028		2029		2030		2031		2032		Total	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
Branch Sewer						3,130		3,130		3,130		3,130		3,130		3,130	0	18,778
Trunk Sewer					306	188	306	188									611	375
Lifting Station																	0	0
Wastewater Treatment Plant																	0	0
Total Construction Cost	0	0	0	0	306	3,317	306	3,317	0	3,130	0	3,130	0	3,130	0	3,130	611	19,153
Engineering Service			18	575	9	287	9	287	6	192	6	192	6	192	6	192	61	1,915
Administration	0	108	0	179	0	71	0	71	0	71	0	71	0	71	0	71	0	711
Physical Contingency	0	0	2	57	31	360	31	360	1	332	1	332	1	332	1	332	67	2,107
Taxes	0	17	3	130	56	647	56	647	1	596	1	596	1	596	1	596	118	3,822
Total of Indirect Cost	0	125	23	941	96	1,365	96	1,365	8	1,191	8	1,191	8	1,191	8	1,191	246	8,555
Total Cost	0	125	23	941	402	4,682	402	4,682	8	4,321	8	4,321	8	4,321	8	4,321	857	27,708

Source: JICA Study Team

Table 8.42 Annual O&M Cost for Mafraq SWD

Unit: x1000JD

Annual O&M Cost	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Personnel Cost		32	32	32	32	48	48	48	72	72
Power Cost	20	30	40	49	59	75	91	107	123	139
Other Cost	2	3	4	5	6	8	9	11	12	14
Total O&M Cost	22	65	76	87	97	131	149	166	208	226

Annual O&M Cost	2027	2028	2029	2030	2031	2032	2033	2034	2035
Personnel Cost	121	121	121	121	121	121	121	121	121
Power Cost	152	165	178	190	203	206	209	213	216
Other Cost	15	16	18	19	20	21	21	21	22
Total O&M Cost	288	302	316	330	344	347	351	354	358

Source: JICA Study Team

CHAPTER 9 ECONOMIC AND FINANCIAL EVALUATION

9.1 Economic Evaluation

9.1.1 Specifications for Economic Evaluation

An economic evaluation on the project proposed in the Chapter 5 is carried out in this chapter based on the specifications as presented in Table 9.1.

Table 9.1 Specifications for Economic Evaluation

Project	Project Cost	Project Benefit
6 SWDs: 1) Central Irbid, 2) Wadi Al-Arab, 3) Shallala, 4) Wadi Hassan, 5) Ramtha, 6) Mafraq	1. Construction and procurement 2. Incremental operation and maintenance	Reduction of current sewage disposal expenditures by the project

<Concept and Assumptions>	
1.Evaluation Measure	Economic Internal Rate of Return (EIRR)
2.Opportunity Cost of Capital	10% (Referring to Water Resources Management Master Plan of the Hashemite Kingdom of Jordan, JICA, 2001)
3.Evaluation Period	30 years from the operation start year of the project
4.Economic Life of Facilities & Equipment	30 years from the construction/installation year
5.Replacement Costs	Disregarded due to the above 3 and 4
6.Economic Conversion Factor	0.9 (estimated by the JICA Study Team based on the external trade of the country, DOS)

Source: JICA Study Team

9.1.2 Project Benefits

Currently the cesspits are utilized broadly in the project areas,. The project will make them of disuse anymore. Apparently the sewage disposal expenditures of the cesspits are not necessary anymore on completion of the project. Therefore the project benefit is defined as "the reduction of current sewage disposal expenditures by the project" as presented in Table 9.1. The sewage disposal expenditures are estimated on the basis of manners as presented in Table 9.2.

Table 9.2 Manners to estimate Sewage Disposal Expenditures

Items	Estimates	Note
1. Capacity of cesspit	6 m^3	Average of residential houses in Irbid
2. Frequency of vacuuming the cesspit	Once/month	Once or twice a month are common in Irbid
3. Vacuuming service charges	4 JD/m^3	Market price commonly charged in Irbid
4. Household expenditures for vacuuming	24 JD/month	-

Source: JICA Study Team based on the interview in the Irbid suburbs

9.1.3 Project Costs

The project costs comprise two items 1) construction and procurement costs (herein after referred to as investment costs), and 2) operation and maintenance costs (herein after referred to as "O&M costs).

In the economic evaluation, the project cost is classified as an "economic cost". The economic cost is calculated by subtracting taxes from the ordinary project costs (namely, financial costs) and multiplying the local portion costs by the economic conversion factor (0.9 for this project as given in Table 9.1). Price escalation due to inflation is disregarded. The item-by-item economic costs are shown below.

(1) Investment Costs

Table 9.3 shows the investment costs of the project.

Table 9.3 Investment Costs (JD million)

Project	Cost	Phase-1	Phase-2	Phase-3	Total
		2016-2021	2022-2026	2027-2032	
Overall Project	Economic cost	83.3	61.0	90.3	234.6
	(Ref: Financial cost)	106.7	77.2	115.4	300.3
1.Central Irbid	Economic cost	1.4	0.0	0.0	1.4
	(Ref: Financial cost)	1.7	0.0	0.0	1.7
2.Wadi Al-Arab	Economic cost	27.1	15.5	11.9	54.5
	(Ref: Financial cost)	34.7	19.8	15.3	69.8
3.Shallala	Economic cost	12.7	6.7	28.3	47.7
	(Ref: Financial cost)	16.6	8.6	36.0	61.2
4.Wadi Hassan	Economic cost	0.0	2.7	5.8	8.5
	(Ref: Financial cost)	0.0	3.5	7.4	10.9
5.Ramtha	Economic cost	16.1	7.1	22.3	45.5
	(Ref: Financial cost)	20.5	9.2	28.4	58.1
6.Mafraq	Economic cost	26.0	29.0	22.0	77.0
	(Ref: Financial cost)	33.2	37.1	28.3	98.6

Note: The financial cost includes taxes.
Source: JICA Study Team

(2) O&M Costs

The economic O&M costs comprise three items as discussed in the Chapter 8: 1) personnel costs, 2) electricity costs, and 3) other miscellaneous costs such as repair/maintenance and chemical. Table 9.4 summarizes the O&M costs of the project.

Table 9.4 O&M Costs (JD million)

Project	Costs	Phase-1	Phase-2	Phase-3	2033-2047	Total
		2016-2021	2022-2026	2027-2032		
Overall Project	Economic cost	1.4	3.7	7.8	22.9	35.8
	(Ref: Financial cost)	1.7	4.1	8.6	25.4	39.8
1.Central Irbid	Economic cost	0.2	0.3	0.4	1.1	2.0
	(Ref: Financial cost)	0.2	0.3	0.5	1.3	2.3
2.Wadi Al-Arab	Economic cost	0.5	1.3	2.2	5.6	9.6
	(Ref: Financial cost)	0.6	1.4	2.4	6.2	10.6
3.Shallala	Economic cost	0.2	0.7	1.7	6.4	9.0
	(Ref: Financial cost)	0.3	0.8	1.9	7.0	10.0
4.Wadi Hassan	Economic cost	0.0	0.0	0.2	0.9	1.1
	(Ref: Financial cost)	0.0	0.0	0.2	1.0	1.2
5.Ramtha	Economic cost	0.2	0.6	1.6	4.4	6.8
	(Ref: Financial cost)	0.2	0.7	1.7	4.9	7.5
6.Mafraq	Economic cost	0.3	0.8	1.7	4.5	7.3
	(Ref: Financial cost)	0.4	0.9	1.9	5.0	8.2

Source: JICA Study Team

9.1.4 Results of Economic Evaluation

The economic evaluation is carried out based on the above benefits and costs. The evaluation reveals that the EIRR of the project results in 18.8% as a whole, which exceed 10% of the opportunity cost of capital (see Table 9.1) though the EIRRs vary from SWD to SWD. Therefore, the project is judged to be economically feasible.

Table 9.5 Results of Economic Evaluation

Project	EIRR
Overall Project	18.6%
1.Central Irbid	50.2%
2.Wadi Al-Arab	24.6%
3.Shallala	32.6%
4.Wadi Hassan	11.9%
5.Ramtha	18.3%
6.Mafraq	6.3%

Source: JICA Study Team

< Sensitivity analysis >

Table 9.6 shows the results of sensitivity analysis on the project as a whole (note: the results of 6 SWDs are attached in Appendix IV respectively.). It must be remarked that the EIRR of the base case 1 maintains a relevant value of 15.1% even if the costs increase by 20%.

Table 9.6 Sensitivity Analysis of Overall Project

Items		Benefits				
		+20%	+10%	**base case 1**	-10%	-20%
Investment costs	-20%	31.9%	28.0%	24.5%	21.3%	18.3%
	-10%	27.0%	23.9%	21.1%	18.5%	16.0%
	base case 2	23.4%	20.9%	**18.6%**	16.4%	14.3%
	+10%	20.8%	18.6%	16.6%	14.7%	13.0%
	+20%	13.7%	16.9%	15.1%	13.5%	11.9%

Source: JICA Study Team

< Qualitative analysis >

Obviously the above economic evaluation is figured out only from the monetarily measurable aspects. However, it must be noted that the above project will bring forth many invaluable effects described below, which are difficult to estimate monetarily.

- Improvement of public hygiene that decreases the incidences of diseases and protects the citizens' health and welfare
- Preservation of natural environment by decreasing the pollutant materials
- Provision of re-usable treated wastewater especially for agriculture
- Improvement of citizens' living environment by exclusion of filthy water
- Improvement of land use, which elevates the land value as a result

Therefore, when considering the foreseeable growing urbanization of the northern governorates, conducting the feasibility study of the above projects is worthy.

9.2 Financial Evaluation

A financial evaluation of the project proposed in the Chapter 5 is carried out in this chapter based on the specifications presented in Table 9.7.

Table 9.7 Specifications for Financial Evaluation

Project Component	Costs	Revenues
6 Sewerage plans as presented in Chapter 9-1	1. Investment 2. Incremental operation and maintenance	Incremental revenues generated by the project (1) Sewerage tariff revenues (2) Sewerage tax revenues

< Concept and Assumptions>	
1.Evaluation Measure	Financial Internal Rate of Return (FIRR)
2.Opportunity Cost of Capital	6%: real interest rate as of September 2014 = 9% of long-term interest rate (-) 3% of CPI
3.Evaluation Period	30 years from the operation start year of the project
4.Economic Life of Facilities & Equipment	30 years from the construction/installation year
5.Replacement Costs	Disregarded due to the above 3 and 4

Source: JICA Study Team

9.2.1 Incremental Revenues

The incremental revenues are estimated below.

(1) Increase of Revenues from Sewerage Tariffs

Revenues = Incremental treated wastewater flows of the project (X) Present sewerage tariff (JD/m^3)

The YWC issues the bill and collects the fees from the customers quarterly. The bill is a combination of 3 categories of tariffs: 1) fixed tariff, 2) variable tariff of water and 3) variable tariff of sewage. So, the total sewerage tariff is unclear because the fixed tariff contains both water and sewerage tariffs. For this, the total sewerage tariff is estimated by the JICA Study Team on the basis of the 2013 financial statement of the YWC as follows. (Incidentally, the YWC will make an accounting of the water and sewerage tariff more clearly from the 2014 financial statement.)

Combined YWC tariff of 2013	: 0.578 JD/m^3
-Water	: 0.524 (90%)
-Sewerage	: 0.054 (10%)

Thus, a tariff of 0.054 JD/m^3 is applied for this financial evaluation (for reference: this tariff is likely to cover only 10% of the entire sewerage cost including the indirect costs such as administration, according to the examination by the JICA Study Team.)

(2) Increase of Revenues from Sewerage Tax

The city and municipality levy the subscribers a tax on their properties by 3% and contribute the collected tax to the YWC. The contribution is estimated at 20 JD/subscriber a year on the basis of the 2013 financial statements and the number of subscribers.

9.2.2 Financial Costs

The financial costs of the project are already presented in the Chapter 9.1.3. Incidentally, it should be carefully noted that the financial cost contains only the incremental costs generated by these project.

9.2.3 Results of Financial Evaluation

The financial evaluation is carried out based on the above revenues and costs. The evaluation reveals the FIRRs of every SWD do not exceed 6% of the opportunity cost of capital as presented in Table 9.8. And the project results in -11.6% as a whole. Therefore the benefit-to-cost ratios (B/C ratio) are computed for reference and shown in the table. If the B/C ratio is more than 1.0, a project is judged to be feasible. However, the ratios of the projects are extremely lower than 1.0. It is apparent that the low level of present sewerage tariff is a major reason for the negative FIRR and the low B/C ratios.

Table 9.8 Results of Financial Evaluation

Project	FIRR	B/C Ratio
Overall Project	-11.6	0.18
1.Central Irbid	0.1	0.67
2.Wadi Al-Arab	-9.7	0.24
3.Shallala	-8.5	0.26
4.Wadi Hassan	-14.9	0.12
5.Ramtha	-12.1	0.17
6.Mafraq	n/a 1)	0.10

Note: 1) Not applicable due to the consecutive negative cash flows of the project through all over the years
Source: JICA Study Team

< Sensitivity analysis >

Table 9.9 summarizes the results of sensitivity analysis by applying the conditions that lift the FIRR of the project more than 6%.

- Case 1: tariff increase
  The FIRR of the project reaches to higher than 6% as a whole if the tariff increases 14.1 times as much as the current tariff. However, the tariff after increase will be far beyond the affordable level of 0.309 JD/m^3 (estimated based on the affordability-to-pay for sewerage service, which is 1% of household income a month, 500 JD, and water consumption/capita).
- Case 2: grant to the investment costs
  The FIRR of the project will exceed 6% as a whole without any increase of tariff if the investment costs are granted as much as 89%.
- Case 3: combination of tariff increase and government grant
  Table 9-9 shows that the FIRR of the project exceed 6% as a whole if the combination is applied: the tariff increases by 5.7 times and the grant to the investment costs up to 60%. The tariff after the increase will be 0.308 JD/m^3, which goes into the affordable level.

Basically, a financial analysis of the project is carried out applying the own funds such as incremental revenues generated by the project. As a result, the FIRR indicates negative as a whole (see Table 9.8). Meanwhile, as discussed in the above sensitive analysis, the tariff increase and/or the government grant to the investment costs will lift the FIRR of the project to the feasible level of 6%. However, the substantial increase of the tariffs may be hardly put in effect[1]. Therefore, the government grants as a part of the investment costs, that is case 2, are considered as the most desirable measures to make the project viable.

Table 9.9 Results of Sensitivity Analysis

Project	(a) Increase of tariff		(b) Grant		FIRR
	Multiples	JD/m^3	% of Inv. Costs	JD million	
Case 1: Increase of tariff (note: affordable tariff is estimated at: 0.309)					
Overall Project	14.2	0.77	-	-	6.1%
1.Central Irbid	2.8	0.15	-	-	6.1%
2.Wadi Al-Arab	11.2	0.61	-	-	6.1%
3.Shallala	9.7	0.53	-	-	6.1%
4.Wadi Hassan	22.8	1.24	-	-	6.0%
5.Ramtha	13.9	0.76	-	-	6.0%
6.Mafraq	29.0	1.58	-	-	6.0%
Case 2: Grant to investment costs					
Overall Project	-	-	89%	267.0	6.3%
1.Central Irbid	-	-	65%	1.1	6.4%
2.Wadi Al-Arab	-	-	86%	60.0	6.3%
3.Shallala	-	-	80%	49.6	6.2%
4.Wadi Hassan	-	-	92%	10.0	6.1%
5.Ramtha	-	-	89%	51.7	6.2%
6.Mafraq	-	-	96%	94.6	6.3%
Case 3: Combination of tariff increase and grant					
Overall Project	5.7	0.308	58%	176.1	6.2%
1.Central Irbid	2.8 1)	0.15 2)	-	-	6.1%
2.Wadi Al-Arab	5.7	0. 308	47%	32.8	6.1%
3.Shallala	5.7	0. 308	38%	23.3	6.1%
4.Wadi Hassan	5.7	0. 308	74%	8.0	6.0%
5.Ramtha	5.7	0. 308	57%	33.1	6.1%
6.Mafraq	5.7	0. 308	80%	78.9	6.2%

Note: 1) and 2) - same as the case 1 because of less than affordable level
Source: JICA Study Team

< Cash flow analysis >

Table 9.10 presents the phase-by-phase net cash flow of the above case 2 over the project evaluation period. The net cash flow will continue to be negative until the end of the phase-3 mainly due to the remaining burden of the investment costs, but turn out to be continuously positive from 2030 after completion of the construction and also to be black cumulatively from 2037. The accumulated negative net cash flow will reach to 12.2 million JD by the end of phase-3. This amount averages 0.76 million JD per annum, which is estimated at less than 10% of the annual average WAJ subsidies contributed to the YWC from 2011 and 2013. If the said negative amount is covered with the similar

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1 According to the YWC top management, the water and sewerage tariff change is the political issues in the country. The cabinet committee under the prime ministry will decide the tariff un-periodically. The water companies inclusive the WAJ can hardly intervene in it. The sewerage tariff of the YWC increases only by 15%, meter reading basis from October 2014 and billing basis from January 2015: however, no water tariff change is instructed in this year.

subsidies, the project could be financially sustained during the period in the red.

(For reference: in terms of covering the incremental O&M cost only, the current tariff may sufficiently cover it from the phase-1: see Table 9.10.)

Table 9.10 Net Cash Flow (JD million)

Case	Account Items	Phase-1	Phase-2	Phase-3	ACOC	Total
		2016-2021	2022-2026	2027-2032	2033-2047	2016-2047
Case 2 of Table 9-9 (Overall Project)	Incremental costs	13.5	12.4	21.0	27.0	73.9
	Incremental revenues	4.4	10.0	20.3	67.4	102.1
	Net cash flow (CF)	-9.1	-2.4	-0.7	40.4	28.2
	Accumulated CF	-9.1	-11.5	-12.2	28.2	-
Reference: if to cover incremental O&M costs only						
Base Case: current tariff	Net CF	2.7	6.0	11.7	40.7	61.1

Note: ACOC = after completion of construction
Source: JICA Study Team

9.2.4 Financing Consideration for Investment Costs

(1) Government Budget

Table 9.11 presents the budget of the Government from 2013 to 2016. The budget of 2014 totals up to 8,100 million JD; that is 6,800 million JD for current expenditures and 1,300 billion JD for capital expenditures (herein after referred to as Capex). Meanwhile, the Capex budget allocated to the MWI is 65 million JD, 5% of the Jordanian Government Capex budget. Only a small amount, 2 or 3 million JD, of the Capex of the MWI will be allocated to subsidize to the WAJ from 2014.

Table 9.11 Expenditure Budget of Government (million JD)

Organizations	Expenditures	2013	2014	2015	2016
		Re-estimate	Budget	Indicative	Indicative
Jordanian Government (JG)		6,155	6,828	7,168	7,515
	Capital	1,021	1,268	1,333	1,401
	Total	7,176	8,096	8,501	8,916
- Allocated/to be allocated to MWI	Current	2	2	2	2
	Capital	63	65	55	33
	Total	65	67	57	35
Capital Budget of MWI to JG (%)		6%	5%	4%	2%

Note: The figures of the Jordanian Government are inclusive of the MWI.
Source: General Budget Department, Ministry of Economy and Finance

(2) Budget of WAJ

Table 9.12 shows the expenditure budget of the WAJ. The Capex of the WAJ amounts to 260 million JD in 2014, 75% of total expenditure budget. The YWC budget is not presented because almost all Capex for the development project are financed by the Government including that of the WAJ.

Table 9.12 Expenditure Budget of WAJ (million JD)

Expenditures	2013	2014	2015	2016
	Re-estimate	Budget	Indicative	Indicative
Current	85	86	79	79
Capital	168	260	270	270
Total	253	346	349	349

Source: General Budget Department, Ministry of Economy and Finance

(3) Capex Budget of MWI and WAJ for Water and Sewerage

Table 9.13 illustrates the sector-wise Capex budget by organization (the MWI and the WAJ) and reveals that around 40% goes to the sewerage sector. The annual average Capex for the sewerage sector over the 4-year period from 2013 up to 2016 is estimated at 102 million JD.

Table 9.13 Capital Budget of MWI and WAJ by Sector (million JD)

Sectors	Organizations	2013	2014	2015	2016	Average of 4 years
		Re-estimate	Budget	Indicative	Indicative	
Water	MWI	48	48	35	9	
	WAJ	84	156	165	162	
	Total	132	204	200	171	176.7
Sewerage	MWI	15	17	20	24	
	WAJ	72	87	88	87	
	Total	87	104	108	111	102.1
Total	MWI	63	65	55	33	
	WAJ	155	243	252	249	
	Total	218	308	307	282	278.8
% by Sector	Water	61%	66%	65%	61%	63%
	Sewerage	39%	34%	35%	39%	37%

Note: The difference between this table and Table 9-8 and -9 is the indirect Capex such as administration.
Source: General Budget Department, Ministry of Economy and Finance

(4) Financial Appropriation for Investment Costs

Table 9.14 is a summary of the phase-wise annual average investment costs calculated based on Table 9.3. The annual required costs for the 3 phases are 17.8 million JD, 15.6 million JD and 19.2 million JD, respectively.

Table 9.14 Annual Average Project Investment Costs by Phase (million JD)

Project	Phase-1 2016-2021		Phase-2 2022-2026		Phase-3 2027-2032		Total 2016-2032	
	Entire Phase	Year Average	Entire Phase	Year Average	Entire Phase	Year Average	Entire Phase	Year Average
Overall Project	106.6	17.8	78.2	15.6	115.5	19.2	300.3	17.6
1.Central Irbid	1.7	0.3	-	-	-	-	1.7	0.1
2.Wadi Al-Arab	34.7	5.8	19.8	4.0	15.3	2.6	69.8	4.1
3.Shallala	16.5	2.7	8.6	1.7	36.1	6.0	61.2	3.6
4.Wadi Hassan	0.0	0.0	3.5	0.7	7.4	1.2	10.9	0.6
5.Ramtha	20.5	3.4	9.2	1.8	28.4	4.7	58.1	3.1
6.Mafraq	33.2	5.5	37.1	7.4	28.3	4.7	98.6	5.8

Source: JICA Study Team

Table 9.15 shows the sources of funds for the sewerage sector Capex. It reveals that large part of funds for the entire Jordanian sewerage project is derived from the WAJ domestic funding including the own revenues, debts, and the foreign grants. Also the foreign loans play an important role in the sewerage sector. Apparently, the Government guaranty enables and secures the WAJ to raise funds from the internal and external loans including bond issues.

Table 9.15 Sources of Funds for Jordanian Sewerage Sector Capex (million JD)

Sources of Funds	2013	2014	2015	2016	Average	
	Re-estimate	Budget	Indicative	Indicative	of 4years	%
1.Government Budget	15	16	20	24	19	19%
2. WAJ	65	87	88	87	81	81%
1) Domestic Funding	24	26	32	33	28	28%
2) Foreign Loans	10	25	25	24	21	21%
3) Foreign Grants	31	36	31	30	32	32%
Total	80	103	108	111	100	100%

Note: The difference form Table 9-10 is the government subsidies to the WAJ which is disregarded because it is already contained in the Government budget.

Source: General Budget Department, Ministry of Economy and Finance

For financing the project, 3 sources of funds are expected as shown in Table 9.16: 20% from the government budget, 30% from the WAJ own funds and 50% from international donors' funds, assuming he current financing situation of Table 9.13 would continue.

The annual burden of the WAJ will be 5.3 million JD that equal to 18.9% of the WAJ own funds. Up to 10% is empirically assumed to be an affordable level for one project. To reduce the burden of the WAJ and cover these excessive costs, it is proposed a supplementary government budget appropriation and additional international donors' funds.

Table 9.16 Expected Source of Funds for the Project (million JD)

Items		Phase-1	Phase-2	Phase-3
		2016-2021	2021-2026	2027-2032
		6 years	5 years	6 years
1. Annual Average Investment Costs (see Table 9-14)		17.8	15.6	19.2
2.Expected Source of Funds based on current financing (see Table 9-14)		17.8	15.6	19.2
1) Government Budget:	20%	3.6	3.1	3.8
2) WAJ own Funds:	30%	5.3	4.7	5.8
3) International Donors' Funds	50%	8.9	7.8	9.6
3.Annual burden of WAJ (average of 17 years)		5.3 (equal to18.9% of WAJ own funds)		

Source: JICA Study Team

CHAPTER10 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

10.1 Environmental and Social Considerations

The purpose of the Environmental and Social Considerations is to ensure that sewerage improvement plans are environmentally and socially sound and sustainable and that the environmental consequences of the project are recognized early and taken into account in the project design.The procedures should follow the Jordanian Laws and JICA's Guidelines for Environmental and Social Considerations are also taken into account.

10.1.1 Outline of the Sewerage Improvement Plan

Components of the sewerage improvement plan subject to Environmental and Social Considerations are shown in and Table 10.2.

Table 10.1 Components of the Sewerage Improvement Plans subject to Environmental and Social Considerations (1) - Sewerage Planning Bases and Sewers and Lifting Stations -

Item	Sewerage District (SWD)	Central Irbid	Wadi Al-Arab	Shallala	Wadi Hassan	Ramtha	Mafraq
1. Service Planning Area (ha)							
	Existing(A)	696	2,409	4,053	1,124	1,021	839
	Planning(B)	696	4,613	6,523	1,453	2,483	3,770
	Increase(B-A)	0	2,204	2,470	329	1,462	2,931
	【B/A×100-100(%)】	0	91	61	29	143	349
2. Service Population (person)							
	Population 【2012】	104,440	202,796	135,442	37,928	127,013	155,729
	Population Projected 【2035】	118,200	328,900	307,200	25,400	201,200	156,200
3. Flow (m^3/day)							
	Actual Flow 【2013】	8,104	11,281	3,497	1,277	4,477	1,710
	Ave. Daily Flow【2035】	10,900	28,500	22,500	2,500	17,300	14,400
4. Design Capacity(m^3/day)							
	Existing (A)	12,000 (6,000×2)	21,000 (3,500×6)	14,000 (7,000×2)	2,800 (1,400×2)	8,800 (4400×2)	7,200 (3,600×2)
	Planning (B)	12,000 (6,000×2)	31,500 (3,500×9)	21,000 (7,000×3)	-	17,600 (4,400×2)	14,400 (3,600×4)
5. Lifting Station Capacity (m^3/min)							
	Existing(A)	-	Hakama q=3.90	Sal q=3.80	Al Hoson Camp q=4.20	-	-
	Planning(B)	-	Hakama q=6.22	Sal q=3.93 Al Hoson Camp q=5.62	-	-	Mafraq q=2.14 Mansha q=3.25
6.Trunk Sewer Planned		-	-	ϕ 200DIP L=3.30 km ϕ 300CP L=4.55 km	-	ϕ 150DIP L=2.40 km, ϕ 200DIP, L=15.09 km, ϕ 300CP, L=4.32 km	ϕ 200DIP, L=2.80 km ϕ 250DIP, L=3.75 km ϕ 300CP, L=18.41 km
7.Branch Sewer Planned(km)		-	316.14	256.85	60.97	215.58	441.85

Source: JICA Study Team

Table 10.2 Components of the Sewerage Improvement Plans subject to Environmental and Social Considerations (2)

- Proposed plans of wastewater treatment facilities in the respective WWTP-

	WWTP Name / Item	1	2	3	4	5
		Irbid Central	Wadi Al-Arab	Shallala	Wadi Hassan	Ramtha
1	Coarse Screen	(2)	(2)	(2)	(2)	(1)
2	Fine Screen	(2)	(2)	(2)	(1)	(3)
3	Grit Chamber	(2)	(1)	(2)	(1)	(2)
4	Grease Chamber		(1)	(2)	(1)	
5	Equalization Pond					(2)
6	Equalization Tank		(1)	(5)		
7	Primary Sedimentation Tank	(2)		(2)+1		
8	Lifting Station					(1)
9	Lift Pump Station	(1)				
10	Trickling Filter					
11	Aeration Tank		(6)+3			(2)+2
12	Oxidation Ditch	(2)*		(2)+1	(2)+1	
13	Final Sedimentation Tank	(2)*	(6)+3	(2)+1	(2)+1	(2)+2
14	Polishing Pond				(4)	(10)
15	Sand filter		(2)*			
16	UV disinfection		(2)*			
17	Disinfection (Chlorine Contact)	+2	2	(1)	(1)	(2)
18	Sludge Thickener	1		(3)		(2)
19	Dewatering Machine	+2	3			+2
20	First Digestion Tank			(2)		
21	Second Digestion Tank			(1)		
22	Belt Thickener			(2)		
23	Centrifugal Dehydrator			(2)		
24	Anaerobic Digestion Tank	1				
25	Sludge Holding Tank	1	1		(1)	
26	Sludge Drying Bed				(16)+44	
27	Irrigation Reservoir					(1)

Note; ( ): Existing, ( )*: Under construction, +: Proposed new construction in the Study

Source: JICA Study Team

Item		WWTP Name 6-1 Mafraq
1	Coarse Screen	(1)+1
2	Fine Screen	(2)+2
3	Wet Weather Storage Lagoon	(1)
4	Oil & Grease Removal	(2)+2
5	Sedimentation/ Thickening Tank	(2)+2
6	Denitrification Basins	(2)+2
7	Aeration Stabilization Basins	(10)+10
8	High Rate Nitrification Basin	(2)+2
9	Facultative Lagoon	(2)+2
10	3 Steps Fed Nitrification-Denitrification Reactor	
11	Final Sedimentation Tank	
12	Sand Filter	(3)+3
13	Reed Bed	(2)+1
14	Chlorine Disinfection	(1)+1
15	Sludge Storage/Stabilization Lagoon	(2)+4
16	Sludge Drying Bed	(26)+26
17	Window Compositing	(1)

Note; ( ): Existing, ( )*: Under construction, +: Proposed new construction in the Study
Source: JICA Study Team

10.1.2 Current Status of Environment and Society

(1) Land Use

Project area is shown in satellite picture, google map (Figure 10.1). Land use of each sub project is described below.

Surrounding area of target WWTP

The WWTPs are i) Central Irbid WWTP, ii) Wadi Al-Arab WWTP, iii) Wadi Shallala WWTP, iv) Wadi Hassan WWTP, v) Ramtha WWPT, vi) Mafraq WWTP. These WWTPs, except for Central Irbid WWTP, are located in farmland, wasteland or on both side of Wadi, and at least a few km apart from residential area. But the Central Irbid WWTP is located in the northwestern of Irbid city area, and is surrounded by many of stone processing plants, slaughterhouse, and general housing.

2) Trunk Sewer

The target new trunk sewers are planned in i) Shallala SWD, ii) Ramtha SWD and iii) Mafraq SWD. The sewers will be installed along the existing roads running the local cities or small towns.

3) Branch Sewer

Branch sewers are planned to collect the wastewater generated in the new sewerage service area in the i) Wadi Al Arab WSD, ii) Wadi Shallala SWD, iii) Wadi Hassan SWD, iv) Ramtha SWD, and v) Mafraq SWD. These are local cities and small towns.

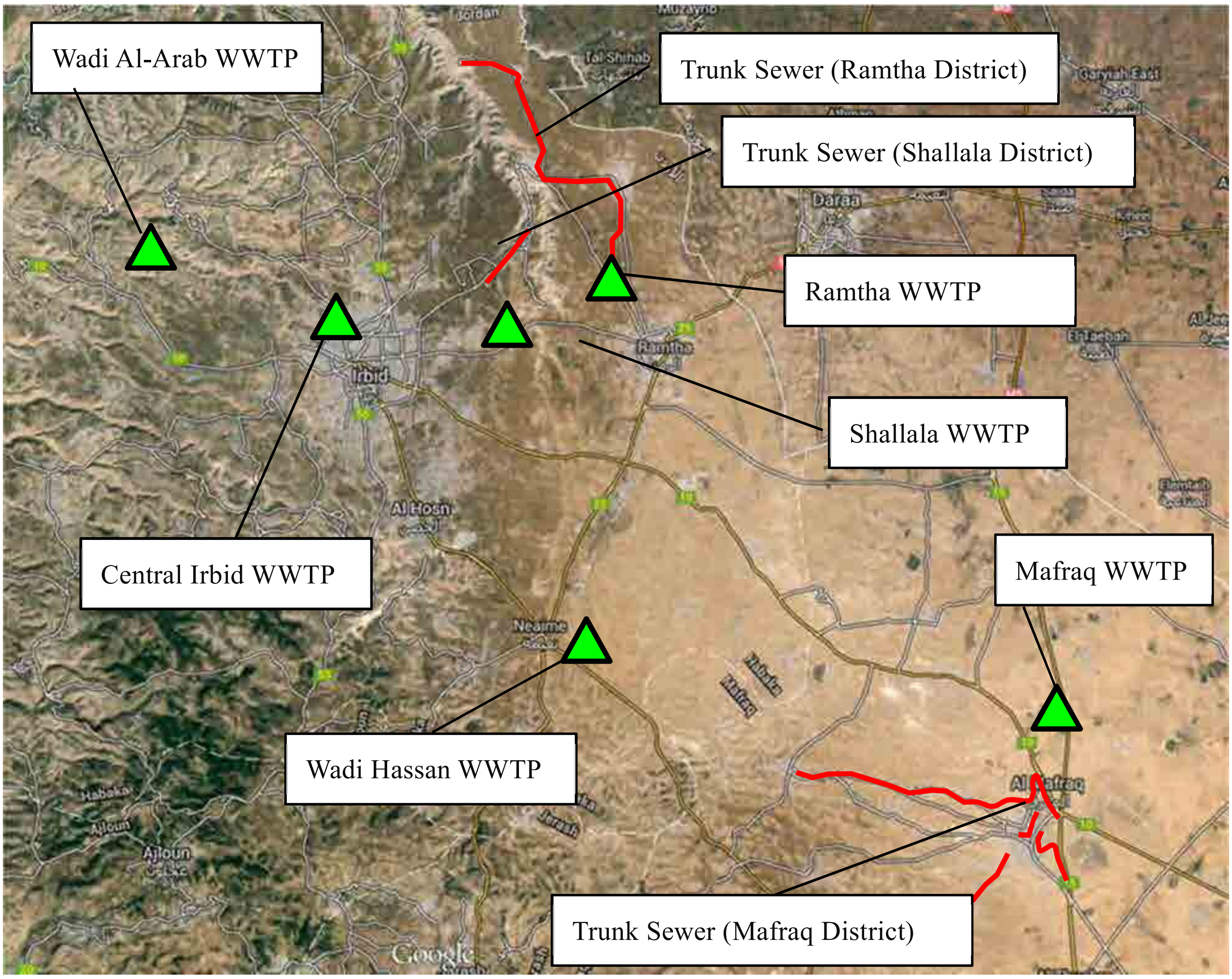


Figure 10.1 Locations of Main Sewerage Facilities

(2) Natural Environment

1) Reserve Area

Nature reserve areas in the northern 4 governorates are shown in and Figure 10.2. Nature reserves are located very far from target areas of the sewerage MP at a distance of more than 10 km. Hence, the implementation of the proposed sewerage components could not have any adverse impacts for these nature reserves.

Table 10.3 Natural Conservation Area in the Northern 4 Governorates

Name of Reserve	Ajloun Forest Reserve	Dibeen Forest Reserve	Yarmouk Nature Reserve
Year of the establishment	1988	2004	2010
Management organization	RSCN	RSCN	RSCN
Purpose of establishment	Forest conservation, evergreen oak forest	Forest conservation, pine-oak forest	Natural Conservation
Relevant laws	National parks and natural reserves regulation No.29, 2005	National parks and natural reserves regulation No.29, 2005	Proposed by RSCN, unspecified
Relevant Ministry	Ministry of Environment (MOE)	Ministry of Environment (MOE)	—

Name of Reserve	Ajloun Forest Reserve	Dibeen Forest Reserve	Yarmouk Nature Reserve
Area	13 km^2	8.5 km^2	20 km^2
Distance from the target area	19 km	23km	11 km

Note) RSCN: Royal Society for the Conservation of Nature
Source: JICA Study Team

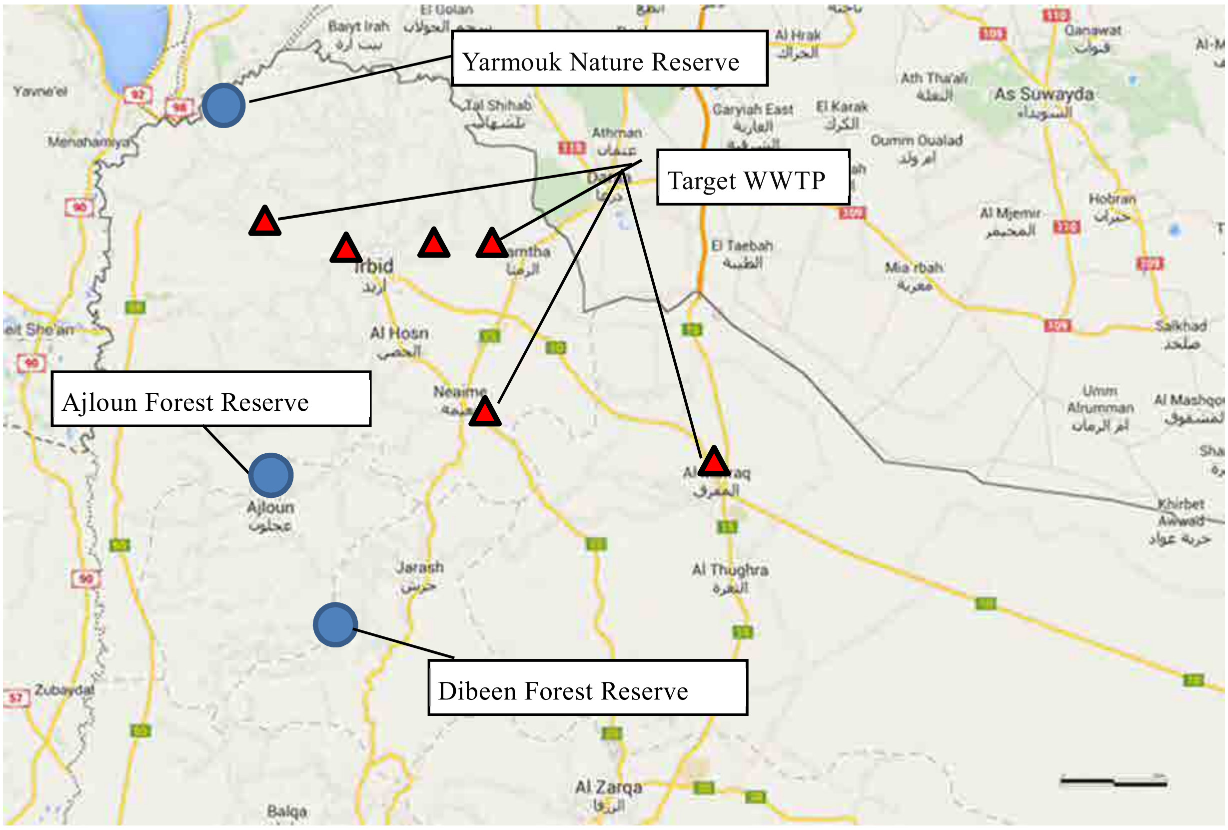


Figure 10.2 Site Map of Project and Nature Reserve Area

2) Conservation of River Basin

The watershed exists on the eastern side near the center of Irbid urban area. Wadi Al- Arab Basin is located on the western side. Wadi Shallala Basin in Yarmouk River system lies on the eastern side. Wadi Al-Arab basin with well-field area is not designated specifically as a conservation area.

(3) Historical and Cultural Heritage Area

The sites around the Project area where remains and relics have been found are shown in Table 10.4 and Figure 10.3. According to Antiquities Law No. 23, 2004 (Antiquities Law No.12, 1987 revised), Department of Antiquities in Ministry of Tourism and Antiquities is responsible for excavation and investigation of remains and relics. Remains and relics are excavated following the Old Stone Age around the proposed sewerage areas. The sites where remains and relics have been found are located along the old highway from Palestine to Damascus and Baghdad.

The sites of remains and relics related to the proposed sewerage areas are mainly in Irbid, surrounding Hawwara, Bait Ras, Sal, Al Yasielah and Al Turra. In Hawwara, the site of remains is

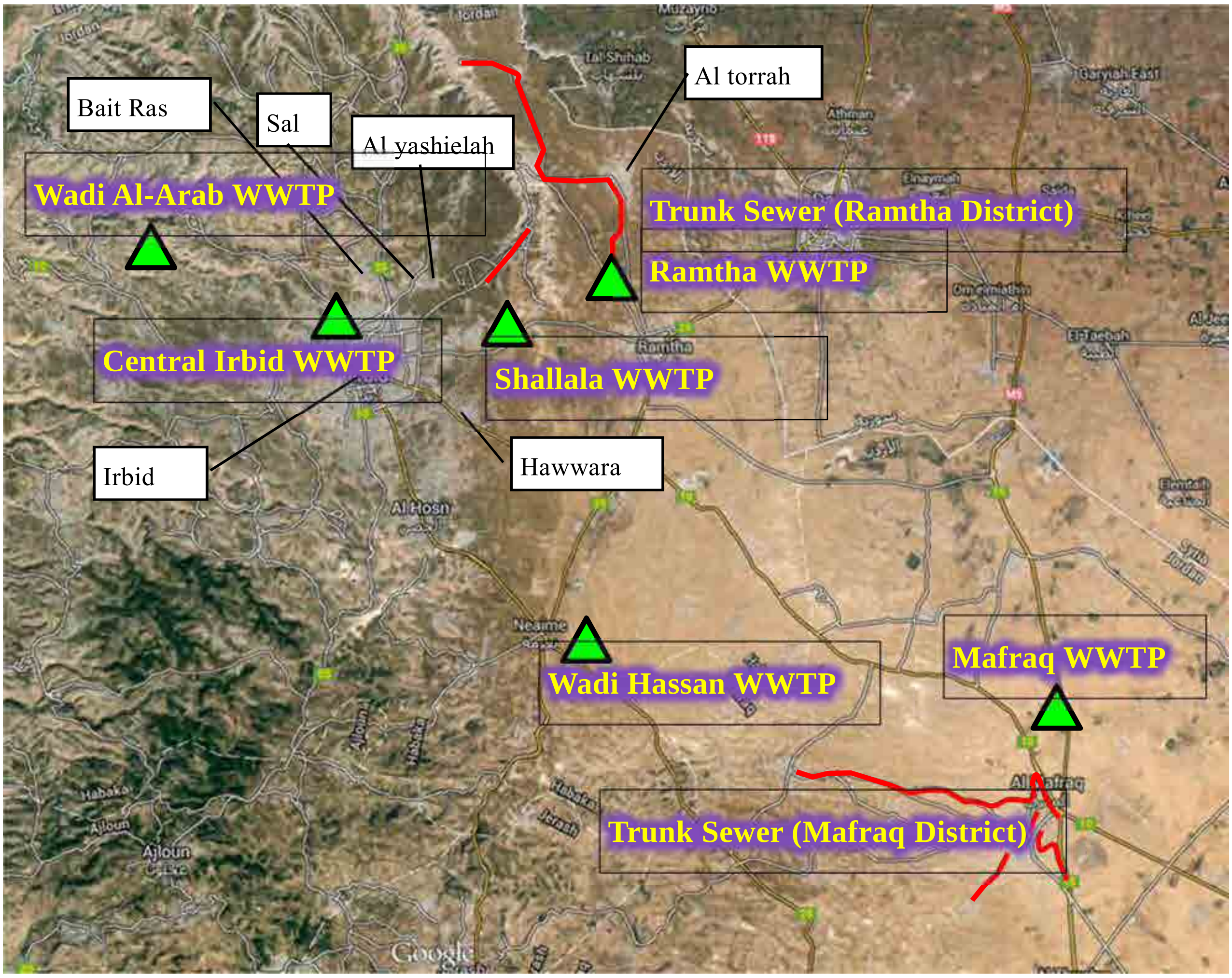
Ayyubid/Mamluk as listed in Table 10.4. In the past, Roman grave and ceramics were found and investigated during the installation of pipeline in Hawwara.(Ismael Melhem and other, Three Buriaks from Roman era at Hawwara/ Irbid, ANNUAL OF THE DEPARTMENT OF ANTIQUITIES OF JORDAN, Volume 55, 2011).

Table 10.4 Sites around the Project Area where remains have been found in past

Era	Irbid	Hawwara	Bait Ras	Sal	Al Yasielah	Al Turra
Umayyad	○	○	○	○	○	○
Abbasid	–	○	○	○	○	○
Ayyubid/Mamluk	○	○	○	○	○	○
Ottoman	○	–	○	○	○	○
Hellenistic	–	–	–	–	–	–
Roman	○	–	○	○	–	○
Late Byzantine	○	–	○	–	–	–
Middle Byzantine	○	–	–	○	–	–
Early Byzantine	○	–	–	○	–	–
Iron Age	○	–	–	○	–	○
Late Bronze	–	–	–	–	–	–
Middle Bronze	–	–	–	–	–	–
Early Bronze	–	–	–	–	–	–
Chalcolithic	–	–	–	–	–	–
Neolithic	–	–	–	–	–	–
Epi-Paleolithic	–	–	–	–	–	–
Paleolithic	–	–	–	–	–	–

○ Sites where Remains and relic have been found in past (Source: Dar As-Saraya Museum Guide, 2007, Department of Antiquities)

Source: JICA Study Team



*Exact locations of sites where remains and relics have been found are not shown
Source: JICA Study Team

Figure 10.3 Antique Sites in and around the Project Areas

10.1.3 Laws and organization of Environmental and Social Considerations

(1) Laws and regulations related to Environmental and Social Considerations

The Environmental Impact Assessment (EIA) is mainly enforced by the following Law and Regulation in Jordan.

- Environmental Protection Law No. 52 of 2006
- Environmental Impact Assessment Regulations No. 37 of 2005

Projects subject to the EIA are designated in Annex 2 (for comprehensive EIA) and Annex 3 (for Initial Environmental Examination (IEE)) of EIA Regulations No. 37 of 2005 as shown in Table 10.5. According to the EIA Regulations, the proposed projects are subject to the IEE as described in the item 6 of Annex 3, "Infrastructure projects including housing projects". In the examination of the Master Plan (M/P), Environmental and Social Considerations at IEE level was conducted in accordance with the EIA Regulations and the JICA's Guideline for Environmental and Social Considerations.

Table 10.5 Projects Subject to EIA and IEE

	Projects subject to EIA	Projects subject to IEE
Items	1. Raw petroleum Refining 2. Electricity generating plants 3. An establishments designed as permanent stores or as landfills for the irradiant nuclear wastes 4. Iron and steel factories 5. Establishments for extracting, treatment, conversion the asbestos and the substances which asbestos part of its structure 6. Integrated chemical industries such as: − Petrochemicals − Fertilizers, pesticides and peroxides industries − Chemical products, petrochemicals and petroleum storage facilities 7. Roads, airports and rails constructing projects 8. Hazardous wastes treatment plants and disposal from these wastes. 9. Establishing the industrial cities 10. Extraction industries: - The excavating processes for water and the geo- thermal digging except the digging for investigating the soil - Mining processes and relevant industries - Natural fortunes extraction 11. Generating energy industries - The industrial establishments which producing electricity, vapor, hot water - The industrial establishments which conveying gas, vapor, hot water and electrical energy - Natural gas surface storage - Flammable gases storage underground surface - Fossil fuels surface storage 12. Tanning (leathers) factories 13. Sugar factories 14. Yeast factories 15. Building up Marine ports 16. Establishing ships and boats for industrial and recreational purposes 17. Sea dumping for using the land in industrial and recreational uses 18. Glass factories 19. Establishing slaughterhouses (abattoirs)	1. Agriculture Projects: - Poultry Farms if the capacity exceed 30.000 birds - Caws Farms if the capacity exceed 50.000 caws - Sheep Farms Caws Farms if the capacity exceed 1.000 sheep 2.Minerals treatment projects: − Iron and steel works including galvanizing, varnish factories − Establishments producing non-irony minerals including production, purification (washing), liquefying, demonetizing (pulling) and galvanizing processes − Compressing Bullions − Treatment of minerals surfaces and covering (coating) − Boilers, cisterns, tanks, industrialized from minerals plates − Establishments for felting and scorching (roasting) raw minerals − Complexes industry and aligning (collecting). 3.Food Industries: - Oils, animal and vegetarian fats. - Bottling, Packaging the animal and vegetarian products - Milk products industry 4.Fabric, leather, wood, papers and tissues industries 5.Rubber industry 6.Infrastructure projects including housing projects 7.Other projects: - Municipal landfills - Landfill for disposal from junk. - Sports activities centers. - Junk storage establishments. 8.Any additions, amendments on the projects that mentioned in this annex.
Legal basis	Annex 2, EIA Regulations No. 37 of 2005	Annex 3, EIA Regulations No. 37 of 2005

Source: MOE

EIA is enforced by the following procedures in Jordan.

i) Project implementation organization submits the project overview document for examination to Directorate of Licensing & Guidance in MOE.

ii) MOE calls the meeting of central license committee. If necessary the committee will confirm current status of construction site. Based on the review by the committee, it will be decided to implement the Comprehensive EIA (Holding of Public Hearings), IEE (No Holding of Public Hearings), or no EIA. The result is noticed by the MOE to the Project implementation organization within 45 days of the submission of the document.

iii) Based on the result of decision in the committee, if needed, Project implementation organization implements EIA and submits the result to MOE. The committee meeting is held and the authorization or modified instructions is given as applicable.

iv) After approval of EIA (for the Projects that require EIA), construction or project is permitted.

v) MOE implements the monitoring for checking the parameters included in EIA during the construction period

Flow of EIA procedures is shown in Figure 10.4.

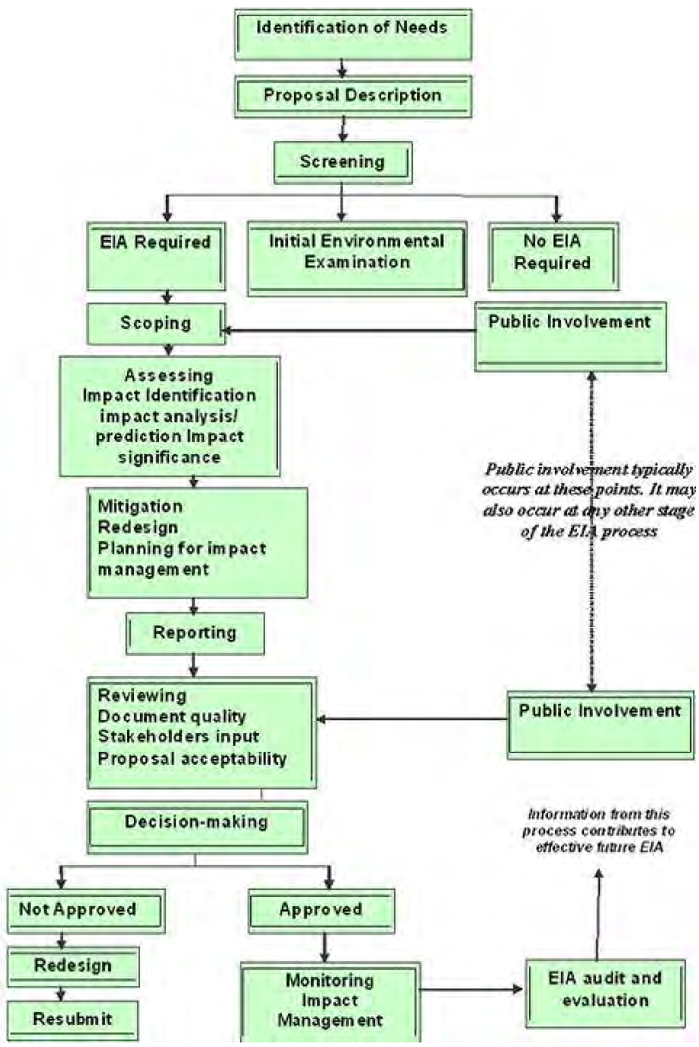


Figure 10.4 Flow of EIA Procedures

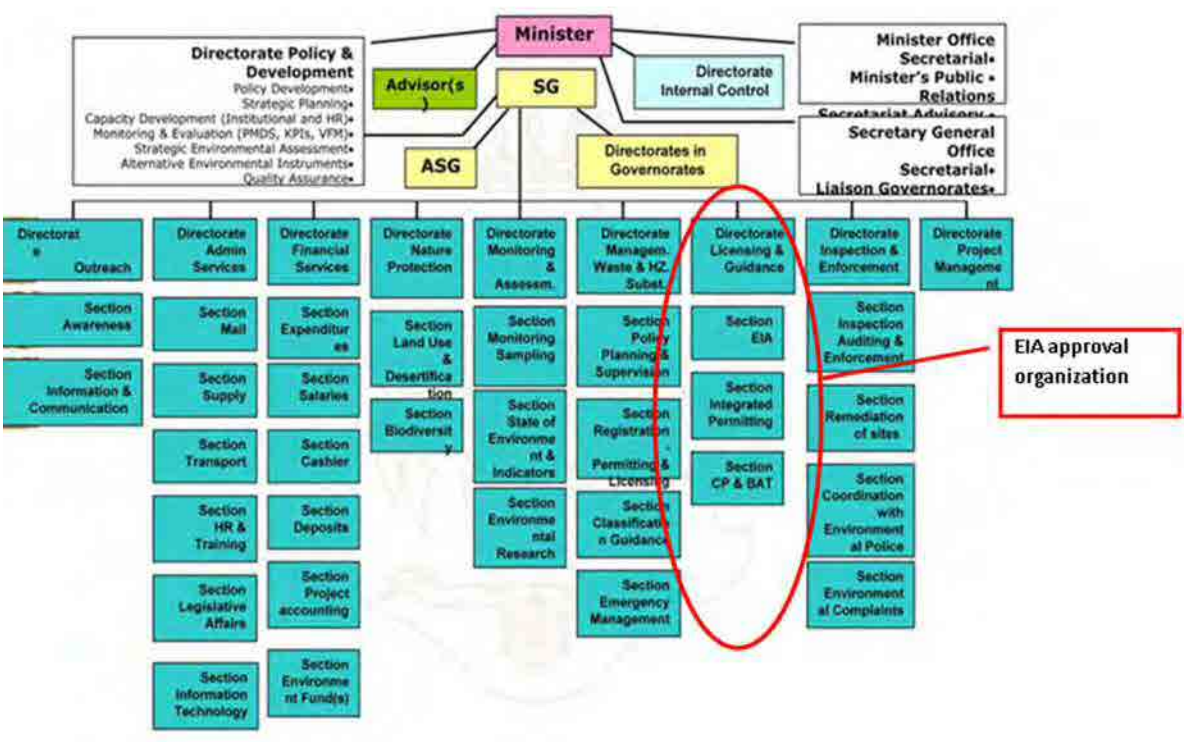
Regarding the contents of Project documents to be submitted for the examination, Directorate Licensing & Guidance in MOE and WAJ (Water Authority of Jordan) in charge of environment explained that there is no standard form and explained to submit project outline, planning and drawing for confirmation of project site, specifications and catalog of main installation equipment, document for Environmental evaluation.

(2) Relevant organization

1) MOE

Organization chart of MOE is shown in Figure 10.5.

The department responsible for supervision and EIA approval is Directorate of Licensing & Guidance under MOE.

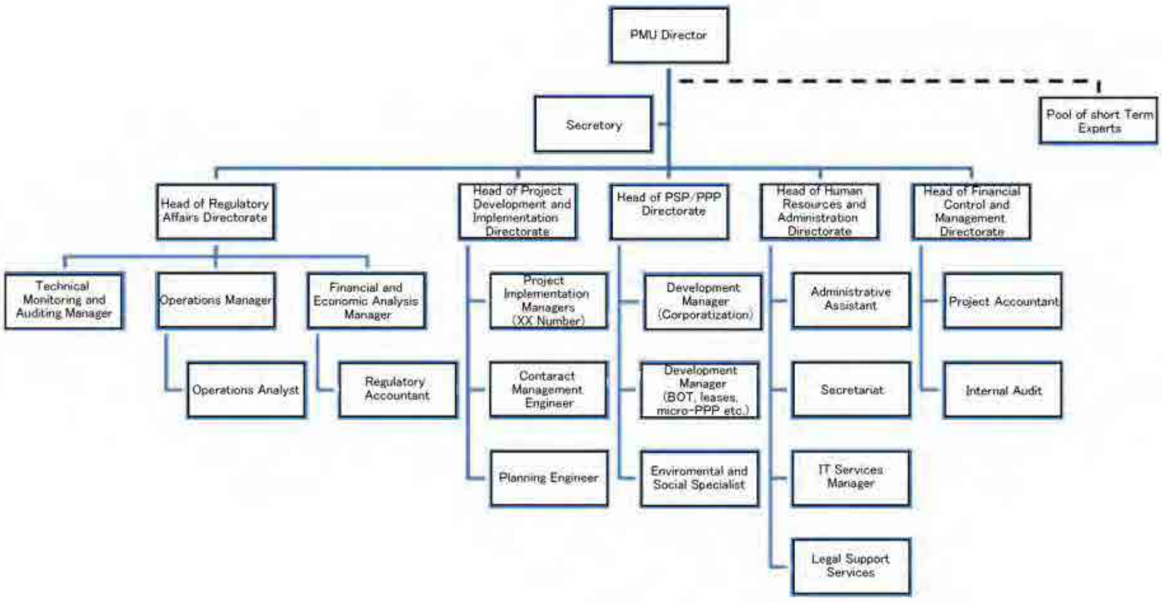


Source: MOE

Figure 10.5 Organization of MOE and EIA Approval Organization

2) WAJ

The division responsible for EIA management in WAJ is PMU: Project Management Unit. For this purpose, in PMU there is technical monitoring, Department of inspection, and Environmental and Social expert. Organization chart of WAJ PMU is shown in Figure 10.6.



Source: WAJ

Figure 10.6 Organization of WAJ PMU

10.1.4 Examination of Development Alternatives

(1)Examination of Development Alternatives at Concept Level

Development alternatives at concept level were not examined in the sewerage improvement plan but in the M/P for water supply, because the M/P for wastewater management should be elaborated according to the prospected increase of water consumption proposed in the M/P for water supply.

(2) Examination of Development Alternatives at Component Level

As well as the M/P for water supply, the components of the sewerage plans are mainly the improvement of existing facilities and network. There were two development alternatives: a new WWTP construction in consideration of gravity discharge system without LS, or expansion of existing WWTP in line with new construction of LS in Ramtha north area. As shown in Table 10.6, considering the scale of land acquisition, improvement of existing WWTP and necessary new construction of LS are recommended in the proposed sewerage improvement plan.

Table 10.6 Development Alternatives

	Development Alternatives		
	Without Sewerage Improvement Plan	Option	Proposed Sewerage Improvement Plan
Contents	N/A	- Expansion of existing WWTP in YWC land area - Expansion of trunk sewer and branch sewer	
		- In Ramtha north area, a new WWTP construction in consideration of gravity discharge system without LS	-Expansion of existing WWTP in YWC's land areas. - New construction of LS in Ramtha north area

	Development Alternatives		
	Without Sewerage Improvement Plan	Option	Proposed Sewerage Improvement Plan
Anticipated impact	<-> Over flow of wastewater in residents' areas <-> Serious deterioration of wastewater treatment capacity	<+> Improvement of wastewater management condition <-> Temporary inconvenience related to construction	
		<-> Land acquisition for a new WWTP	<-> Land acquisition for a new LS
		>>>New construction of LS is considered to have less negative impact than new WWTP construction in view of environmental consideration.	

Source: JICA Study Team

10.1.5 Scoping and Terms of Reference of Environmental and Social Considerations

Scoping of Environmental Item and Reason of evaluation in this Project (Component B) is shown in Table 10.7.

Table 10.7 Scoping (the Master Plan for Wastewater)

Category	No.	Item	Evaluation		Reason of evaluation
			Before and during construction	Operation	
Environmental consideration- pollution control	1	Air quality	B-	D	Construction Stage: Temporary deterioration in air quality is expected by construction activity. Operation Stage: Negative impact is not expected.
	2	Water quality	B-	D	Construction Stage: Water pollution by discharge from construction site, Operation Stage: Negative impact is not expected assuming that the proper processing of discharge and sludge is conducted.
	3	Wastes	D	D	Construction Stage: Small amount of wastes such as packing materials for construction materials, etc. Operation Stage: Negative impact is not expected.
	4	Soil pollution	B-	D	Construction Stage: Possibility of the soil pollution by oil from construction machines and vehicles. Operation Stage: Negative impact is not expected.
	5	Noise and vibration	B-	D	Construction Stage: Noise is expected from construction machines and vehicles. Operation Stage: Negative impact is not expected.
	6	Land subsidence	D	D	Land subsidence is not expected.
	7	Offensive odor	B-	B-	Construction Stage: There is a possibility that a bad smell occurs temporarily at the time of joining new house connection pipe to

Category	No.	Item	Evaluation		Reason of evaluation
			Before and during construction	Operation	
					branch sewer. Operation Stage: Offensive odor might affect on residential area (e.g. Irbid central WWTP)
	8	Substratum	D	D	The work that modifies on substratum is not included.
Environmental consideration-natural environment	9	Reserve area	D	D	Reserve Area does not exist in and around the target site of the sewerage improvement plans.
	10	Ecosystem	D	D	Project area is urban and its suburbs where people are living. The area does not include any protected animals and plants. No negative influence on ecosystem is expected.
	11	Hydrology	D	D	Alteration of Hydrology is not expected.
	12	Topography, geological feature	D	D	Alteration of Topography, geological feature is not expected from expansion of existing WWTP, construction of trunk sewers, and expansion of branch sewer along existing roads.
Social consideration	13	Resettlement	D	D	No resettlement due to the Project is expected.
	14	Poor classes	D	B+	Construction Stage: No negative impact on poor class is expected. Operation Stage: Residents including the poor can enjoy the improvement of wastewater management
	15	Ethnic minorities and indigenous peoples	D	D	Ethnic Minorities and Indigenous Peoples do not inhabit in the project area.
	16	Refugees	D	B+	Construction Stage: No negative impact is expected. Operation Stage: Residents including refugees can enjoy the improvement of wastewater management
	17	Local economy	B-	D	Construction Stage: Construction might temporarily affect on offices/shops close to construction site Operation Stage: No negative impact is expected.
	18	Land use and local resource use	D	D	No negative impact on land use and local resource use is expected.
	19	Water use	D	D	No negative impact on water use is expected.
	20	Existing social infrastructure and social	B-	B+	Construction Stage: In the case that the measures for sewage leakage are insufficient, there is a

Category	No.	Item	Evaluation		Reason of evaluation
			Before and during construction	Operation	
		service			possibility of water source contamination. During the construction, some inconveniences such as temporary interruption of sewage services and traffic regulation may occur. Operation Stage: Positive impacts such as the improvement of wastewater management are expected.
	21	Social capital and social organizations	D	D	No negative impact on social capital and social organizations is expected.
	22	Imbalance of profit and damage	D	D	No negative impact on the balance of profit and damage is expected.
	23	Local conflict	D	D	No conflict in local community due to the Project is expected.
	24	Cultural heritage	C-	D	Construction Stage: There is possibility to find remains and relics during the excavation. Operation Stage: Negative impact on cultural heritage is not expected.
	25	Landscape	D	D	No negative impact on landscape is expected.
	26	Gender	D	D	No negative impact on gender is expected.
	27	Rights of the child	D	D	No negative impact on the rights of the child is expected.
	28	Infectious diseases such as HIV/AIDS	C-	D	Construction Stage: There is a possibility to spread infectious diseases due to the inflow of labor if there is no appropriate health and hygiene instruction. Operation Stage: Negative impact is not expected.
	29	Work Environment	B-	D	Construction Stage: Working environment of labor is expected to deteriorate temporarily by aggravation of the air quality, noise, vibration. Operation Stage: Negative impact is not expected.
Others	30	accident	B-	D	Construction Stage: The consideration for the accidents such as traffic accidents is necessary. Operation Stage: T Negative impact is not expected if safety measures are appropriately taken.

Note) Evaluation A+/-: Significant positive / negative impact is expected.
Evaluation B+/-: Positive / negative impact is expected to some extent.
Evaluation C+/-: Positive / Negative impact is not clear. (Further examination is necessary, and level of impact becomes clear by the progress of the examination.)
Evaluation D: No impact is expected

Source: JICA Study Team

TOR of examination of Environmental and Social Considerations based on above Scoping is shown in Table 10.8.

Table 10.8 TOR of Examination of Environmental and Social Considerations

Environmental Item	Item of Examination	Means of Examination
Air Quality	1) Environmental standard (Jordan standard) 2) Impact during construction	1) Existing report 2) Contents of construction, method, period, and site 3) Confirmation of type of construction machine, number of machine, working site, working period
Water Quality	1) Environmental standard (Jordan standard) 2) Situation of water sources (Production wells) 3) Impact during construction	1) Existing report 2) Confirmation of water use and discharge condition during construction period
Soil Pollution	1) Preventive measures against oil leaks under construction	1) Confirmation of type of construction machine and vehicles, working area and working period
Noise and Vibration	1) Environmental standard (Jordan standard) 2) Impact during construction & operation	1) Existing report 2) Site investigation for confirmation
Offensive Odor	1) Environmental standard (Jordan standard) 2) Impact during construction & operation	1) Existing report 2) Site investigation for confirmation
Local economy	1) Situation of commercial activity in the project site 2) Impact during construction	1) Site investigation for confirmation 2) Procedure for traffic control and avoidance of traffic blocking for approach to commercial facilities
Existing Social Infrastructure and Social Service	1) Possibility of impact of water source contamination by sewage leakage 2) Duration of stop of sewage use and degree of traffic congestion	1) Examination of similar cases 2) Procedure for sewage leakage, shortening duration of interruption, and traffic congestion reduction 3) Site investigation for confirmation
Cultural Heritage	1) Existence of ruins and relics in the project site 2) Correspondence method before and during construction	1) Existing report 2) Inquiry to the related organization for confirmation of procedure during construction
Infectious Diseases such as HIV/AIDS	1) Guidance on health and hygiene for labor	1) Examination of similar cases 2) Site investigation for confirmation
Work Environment	1) Labor safety measures	1) Examination of similar cases 2) Confirmation of approach in the Similar example
Accident	1) Traffic safety measures during construction stage	1) Examination of similar cases 2) Site investigation for confirmation

Source: JICA Study Team

10.1.6 Result of the Survey on Environmental and Social Considerations

Result of examination of Environmental and Social Considerations based on Scoping is shown in Table 10.9.

Table 10.9 Result of Examination of Environmental and Social Considerations

Environmental Item	Result of examination
Air Quality	- According to Environmental standard of Air Quality in Jordan, the maximum emission levels are: • SO_2: 0.135 ppm (1 hour), 0.130 ppm (24 hours), 0.03 ppm (1 year), • CO: 26 ppm (1 hour), 9 ppm (8 hours), NO_2: 0.21 ppm (1 hour), 0.08 ppm (24 hours), 0.05 ppm (1 year), • Total suspended particles (TSP): 260 µg/m^3 (24 hours), 75 mg/m^3(1 year). (The Jordan Standard No.1140 for ambient air quality, 1996) - Air pollution is caused by exhaust gas from Construction machines and transportation vehicles, Air dust is caused by machine digging of ditch along road side for laying trunk sewers or sewer net. - Mitigation measures should be examined before construction, Monitoring and correspondences based on monitoring results will be required.
Water Quality	- Drinking Water Quality standard in Jordan is provided in Standard for Drinking Water No. 286, 2001 (Revised 2008). The quality of the water source is analyzed regularly by YWC and WAJ, and water quality management is carried out. - Well fields near the target area of the sewerage improvement plans are Hakama Well field and Bushra Well field. - The aquifer is the deep part of B2/A7. - Depth of Hakama Well field is 510-540 m and water table is 480-620 m. - Depth of Bushra Well field is 530 m and water table is 610 m. - There is possibility of water source contamination due to sewage leakage in case of insufficient measures for leakage at sewer net jointing work and detaching or left of old sewer pipes. - The discharges from sprinkling to restrain air dust and washing of equipment and vehicles are not in high amount. - It is expected that the influence on water source will be small. - Considering if there is a certain level influence to production well water quality, the measures or monitoring procedure will be examined.
Soil Pollution	- During construction period, leakage of small amount of oil may occur from Construction machines and vehicles that cause soil pollution. - Although, it is small amount, measures of oil spill prevention and collection of soil contaminated by spilled oil should be examined.
Noise and Vibration	- According to standard in Jordan, the maximum level of Noise is: • City township (daytime: 60 dB, night: 50dB), • Commercial area (daytime: 65 dB, night: 55 dB), • Education, hospital, mosque (daytime: 45 dB, night: 35 dB). (MOE, 1997) - Limitation of Load Vibration is: • Residential area (daytime: 65 dB, night: 60 dB), • Commercial, industrial area (daytime: 70 dB, night: 65 dB) (General rule of the Japanese local government) - Noise and Vibration occur due to transportation vehicles and machine excavation work for foundation of WWTP facilities, and trunk sewers and sewer net pipes buried construction. - Monitoring implementation and mitigation measures during construction are required. - In operation stage, many of WWTP facilities are located away from the residential areas; there are no effect of noise and vibration. - In Central Irbid WWTP which locates close to residential area, there may be a small influence of noise and vibration. - In buried construction of trunk sewers and sewer net in cities and suburbs, measures such as refraining from night work is necessary.
Offensive Odor	- In construction stage, bad smell occurs when new sewage pipes are connected to existing sewer net and old existing pipes are disconnected=

Environmental Item	Result of examination
	- In operation stage of WWTP facilities and process of sludge drying, offensive odor may occur Most of the WWTP is apart from the residential areas, there is no effect. - In the Central Irbid WWTP (under construction), after the completion of renovation, monitoring and, if necessary, deodorizing measures are required. - The dewatering facility planned is effective in reducing odor measures.
Local Economy	- During buried construction work of trunk sewers and sewer net in urban commercial area, traffic may be regulated, and some sort of interruption to approach to commercial facilities may occur. - Mitigation measures for blocking such as securement of small path should be examined.
Existing Social Infrastructure and Social Service	- There is a possibility of water sources contamination in the case of insufficient measures for sewage leakage during construction. It is common with the above mentioned in “Water quality”. - The temporary interruption of sewer service and traffic congestion due to traffic control occurs in the construction period. It is necessary to consider measures such as shortening of the construction period of each construction section.
Cultural Heritage	- If the remains and relic related to cultural heritage are located on ground, it can be avoided. - However, it is difficult to check if these are buried underground. - In Irbid, Bait ras, Hawwara, Sal, Al Yasielah, and Al Turra, there is possibility of occurrence of Roman remains and relic and attention is necessary during construction. - During construction, care should be taken during excavation and if any such remains or relics are observed, information should be sent to Department of Antiquities in Ministry of Tourism and Antiquities (MOTA) to get relevant expert assigned for further instruction about handling of such relics in order to continue excavation work.
Infectious Diseases such as HIV/AIDS	- Since there is a possibility that the workers fall ill with infection including the HIV/AIDS, the measures such as guidance of health management for workers should be examined.
Work Environment	- During machine excavation, air pollution may occur due to exhaust gas and dust, and noise and vibration may occur. - These factors may pose risk on workers’ health. - The measures that the impact can be mitigated such as use of the dust protective mask and noise reduction appliance should be examined.
Accident	- There is possibility of traffic jam and traffic accident due to regulated traffic and temporary interruption of traffic during construction. In the similar project, use of sign boards indicating construction works at sites and instruction by the traffic man are implemented.

Source: JICA Study Team

10.1.7 Evaluation of the Effect

Based on Result of examination of Environmental and Social Considerations, Result of Evaluation of impacts is shown in Table 10.10.

Table 10.10 Scoping Plan and Result of Examination

Category	No.	Environmental Item	Scoping Evaluation of Impact in Scoping		Evaluation of Impact based on examination result		Reason of evaluation
			Before &under constru c- tion	Opera- tion	Before & under constru c- tion	Opera- tion	
Pollution Control	1	Air Quality	B-	D	B-	N/A	- Air pollution occurs by dust from digging, and due to exhaust gas from construction machines and vehicles during construction.
	2	Water Quality	B-	D	B-	D	- There is possibility of water source contamination due to sewage leakage in case of insufficient measures during construction. - There is almost no impact, the water source contamination from discharge amount of watering and car wash because of small amount of discharge. - Water quality monitoring for water source will be conducted at the areas close to water source such as Hakama, Bushra, Al Turra, etc. during construction. - In operation stage, the sewer net pipes have been buried and improved sewage leakage so as not to cause. - In WWTPs Negative impact is not expected in the case of accrete reuse of discharge to agriculture and disposal of sludge to specified duping site.
	3	Wastes	D	D	D	N/A	- A small amount of waste such as packaging materials of construction materials is expected, but the problem does not occur by the transport to the specified disposal site. - In operation stage, the network pipes have been buried, waste does not occur.
	4	Soil pollution	B-	D	B-	N/A	- Soil pollution is expected due to leakage of small amount of oil from construction machines, vehicles during construction.
	5	Noise and Vibration	B-	C-	B-	C-	- In construction stage, noise and vibration is expected to occur from construction machine and vehicles. - The impact is limited to residential area. - Almost of WWTP facilities located far from residential area. - In operation stage, The impact of noise and vibration of WWTP facilities operation is a little.

Category	No.	Environmental Item	Scoping Evaluation of Impact in Scoping		Evaluation of Impact based on examination result		Reason of evaluation
			Before &under constru c- tion	Opera- tion	Before & under constru c- tion	Opera- tion	
							- Only, in Central Irbid WWTP, monitoring is necessary after completion of renovation, and if necessary, measures will be required.
	6	Subsidence	D	D	N/A	N/A	- Modification regarding subsidence is not carried out.
	7	Offensive odor	B-	B-	B-	C-	- In construction stage, there is possibility that bad smell occurs in accordance with connection work of new sewage pipes and existing sewer net. - In operation stage, the offensive odor occurs in operation of WWTP facilities. - Most of the WWTP is apart from the residential areas, there is no effect. - In the Central Irbid WWTP, after completion, confirmation by monitoring is necessary, and if necessary, the measures will be required.
	8	Substratum	D	D	N/A	N/A	- Modification regarding substratum is not carried out.
Natural Environment	9	Reserve Area	D	D	N/A	N/A	- Reserve areas are over 10km away from the target areas.
	10	Ecosystem	D	D	D	N/A	- In construction stage, modification regarding ecosystem is not conducted because of construction in existing operating WWTPs for WWTP facilities, and in residential areas of urban, suburban and along existing road with traffic for trunk sewers and sewer net. - In operation stage, no effect because the conduit is embedded in A.
	11	Hydrology	D	D	N/A	N/A	- Modification regarding hydrology is not carried out.
	12	Topography, geological feature	D	D	N/A	N/A	- Modification regarding topography and geological feature is not carried out.
Social Environment	13	Resettlement	D	D	N/A	N/A	- Resettlement does not occur.
	14	Poor classes	D	B+	N/A	B+	- Residents including the poor can enjoy the improvement of sewage service conditions
	15	Ethnic Minorities & Indigenous Peoples	D	D	N/A	N/A	- Ethnic minorities and indigenous peoples are not resident.
	16	Refugees	D	B+	N/A	B+	- Project activities will not have any

Category	No.	Environmental Item	Scoping Evaluation of Impact in Scoping		Evaluation of Impact based on examination result		Reason of evaluation
			Before &under construc- tion	Opera- tion	Before & under construc- tion	Opera- tion	
							discrimination against Refugee; rather sewage service is expected to improve for all.
	17	Local economy	B-	D	B-	N/A	- During construction, traffic may be regulated and traffic interruption may be caused, and approach to commercial places is expected to be limited. - In operation stage, the branch sewers have been buried, - There is no impact on the local economy.
	18	Land use & local resource use	D	D	D	D	- The construction is carried out in existing WWTP and along existing roads, change of land use and local resource use do not occur.
	19	Water use	D	D	D	N/A	- Construction Stage: Small amount of water is used for watering for dusting reduction and washing construction machines and vehicles.. - Operation Stage: Public supply water is not used without workers' daily life water.
	20	Existing social infrastructure & social service	B-	B+	B-	B+	- Construction Stage: There is possibility of water source contamination in the case of insufficient measures for sewage leakage. - Temporary stop of sewage service and inconvenience in traffic condition occur. - Operation Stage: Positive impacts such as the improvement of sewerage and sewer capacity is expected
	21	Social capital & social organizations	D	D	D	B+	- Construction Stage: No negative impact on social capital and social organizations is expected. - Operation Stage: Positive impacts such as the improvement of water supply system in which leakage is difficult to occur, are expected.
	22	Imbalance of profit & damage	D	D	N/A	N/A	- No negative impact on the balance of profit and damage is expected.
	23	Local conflict	D	D	N/A	N/A	- No conflict in local community due to the sewerage improvement plan is expected.
	24	Cultural Heritage	C-	D	C-	N/A	- There is possibility to find remains and relic during excavation work.
	25	Landscape	D	D	N/A	N/A	- No negative impact on landscape is

Category	No.	Environmental Item	Scoping Evaluation of Impact in Scoping		Evaluation of Impact based on examination result		Reason of evaluation
			Before &under constru c- tion	Opera- tion	Before & under constru c- tion	Opera- tion	
							expected
	26	Gender	D	D	N/A	N/A	- No negative impact on Gender is expected.
	27	Rights of the child	D	D	N/A	N/A	- No negative impact on the rights of the child is expected.
	28	Infectious diseases including HIV/AIDS	C-	D	C-	N/A	- Construction Stage: There is a possibility to spread infectious diseases due to the inflow of labor if there is no appropriate health and hygiene instruction. - Operation Stage: Negative impact is not expected
	29	Work Environment	B-	D	B-	N/A	- Construction activities are expected to have some negative impact on working environment of Labor in terms of air quality, noise, and vibration due to operation of construction machines.
Others	30	Accident	B-	D	B-	D	- Construction Stage: There is possibility of occurrence of traffic jam and traffic accident due to regulated and interrupted traffic. - Operation Stage: Negative impact is not expected assuming accurate sewerage and sewer operation.

Note: N/A: Not applicable

Source: JICA Study Team

10.1.8 Mitigation Measures and Cost

Mitigation measures and related cost on Environmental Items which is expected to have negative impact in this Project is shown inTable10.11. The Project activities are only expected to have negative impacts during construction, and not during operation.

Table 10.11 Mitigation Measures and Cost

No.	Environmental Item	Proposed Environmental management plan	Implement-ing Agency	Responsi-ble Agency	Cost (1,000 JD)
1	Air Quality	- To suppress the scattering of excavation dust occurring during construction, regular sprinkling of water is needed.	Contractor	YWC, WAJ	169.7
2	Water Quality	- In the case of construction in the vicinity of production well, the water quality of the production wells should be checked, and also, protection measures of sewage leakage and limit of discharge	Contractor	YWC, WAJ	19.2

No.	Environmental Item	Proposed Environmental management plan	Implement-ing Agency	Responsi-ble Agency	Cost (1,000 JD)
		should be carried out as much as possible.			
4	Soil pollution	- Construction machines and vehicles need to be checked regularly for any oil leakage and carry out repair if required. If leakage occurs, the soil containing leaked oil should be collected and disposed appropriately.	Contractor	YWC, WAJ	33.5
5	Noise and Vibration	- The construction section moves by week to 10 days, so the noise emitting period in each section is short, and the impact to daytime activity can be small. - Construction is planned such that noise during construction does not occur night. - In operation stage, the WWTP facilities operation noise in the WWTP and lift stations closed to resident area will affect sleep disorder. - Noise reduction measures are required. - The monitoring of Central Irbid WWTP (under rehabilitation) is necessary after renovation completion.	Contractor, Consultant for planning and design	YWC, WAJ	239.0
7	Offensive Odor	- In construction stage, there is possibility that bad smell occurs at joining or release of existing sewer net. The shortening procedure should be figured out. - In operation stage, offensive order occurs in WWTP facilities operation. - In Central Irbid WWPT, the monitoring and measures if necessary should be examined. - Other WWTPs are apart from residential area.	Contractor, Consultant for planning and design	YWC, WAJ	425.6
17	Local Economy	- During construction, to mitigate the impact on traffic and people daily life, approach side walk needs to be set appropriately and a traffic regulating person is needed to provide direction on site for safe and smooth traffic during construction works.	Contractor	YWC, WAJ	Same as 2.Water Quality
20	Existing social infrastructure and social service	- Common with “2 Water Quality” - In the case of construction in the vicinity of production well, the water quality of the production wells should be	Contractor	YWC, WAJ	Including in 30. Accident

No.	Environmental Item	Proposed Environmental management plan	Implement-ing Agency	Responsi-ble Agency	Cost (1,000 JD)
		checked, and also, protection measures of sewage leakage and limit of discharge should be carried out as much as possible.			
24	Cultural Heritage	- Construction plans should be submitted to MOTA in advance requesting assignment of a monitoring person for occurrence of any remains or relics. - If relics or remains are found during excavation, the instruction from monitoring person should be followed for continuing the excavation work.	MOTA	MOTA	-
28	Infectious diseases including HIV/AIDS	- For protection of infectious diseases including HIV/AIDS, contractor should distribute brochures and other documents and provide guidance to workers.	Contractor	YWC, WAJ	22.3
29	Work Environment	- Public and workers safety and sanitation measures should be taken during the construction period. - Safety management rules should be prepared and implemented on site. - Construction area indicator, protection fence, and provision of watchmen at construction sites should be provided to avoid occurrence of any accident. - For the workers, provision of mask against dust, and earmuffs or plugs against noise should be made. - Workers in construction site should wear Work clothes, helmet, safety jacket, and safety shoes.	Contractor	YWC, WAJ	90.5
30	Accident	- During construction period, it is necessary to isolate the construction sites, and implement traffic restriction. - For this purpose, it is important to install construction plan at site, indicate construction area, provide protection fence, watchmen, and especially at night provide lighting arrangements at construction site with appropriate traffic indicators in order to avoid accident.	Contractor	YWC, WAJ	1,492.5

Source: JICA Study Team

10.1.9 Monitoring Plan

Monitoring plan, which is mainly required for construction stage, is shown in Table 10.12.

Table10.12 Monitoring Plan

Environmental Item	Item	Place	Frequency	Responsible institution
Air Quality	Dust	Construction site and residential neighborhood	1 time /month	Contractor YWC, WAJ
Water Quality	Water quality analysis for general items, coliform and inorganic items	Production wells nearby construction section (before commencement, under construction, and after completion)	3 times/ construction section nearby water source	Contractor YWC, WAJ
Soil pollution	Checking of oil leakage from construction machines and vehicles, and status of repairing Situation of locations where soil is affected by oil leakage	Construction site, construction machinery, vehicle parking places	1 time /month	Contractor YWC, WAJ
Noise and Vibration	Noise and Vibration	Construction site and residential neighborhood, In operation stage, WWTP and Residential neighborhood	1 time /month	Contractor YWC, WAJ
Offensive Odor	Odor (Ammonia, methylmercaptan, hydrogen sulfide, methyl sulfide)	Construction site and residential neighborhood, In operation stage, WWTP and Residential neighborhood	1 time /month	Contractor YWC, WAJ
Local Economy	Condition of blocking, limited approach of commercial facilities	Surrounding Construction site	1 time /week	Contractor YWC, WAJ
Cultural Heritage	Existence of remains and relics	Construction site	MOTA coordination	Contractor MOTA
Infectious Diseases	Confirmation of implementation of worker education for health management	Field office, worker accommodation	4 times/ year	Contractor YWC, WAJ
Work Environment	Situation of wearing working clothes, safe shoes, masks, and other safety related accessories of Workers. Enforcement situation of the safety measures of neighboring inhabitants	Construction site surrounding construction site	1 time /week	Contractor YWC, WAJ
Accident	Enforcement situation of traffic safety measures. Traffic man work situation	Surrounding construction site	1 time /week	Contractor YWC, WAJ

Source: JICA Study Team

10.1.10 Stakeholder's Meeting

Stakeholder's meeting was held for the purpose of explaining the M/P for both water supply and sewerage under examination to participants and collecting wide range opinions on environmental and social issues from stakeholders. The detail is shown below.

Date and time: 16th September 2014, 10:00 - 11:00

Venue: WAJ PMU Meeting Room

Participating Organizations: Ministry of Environment, Ministry of Water and Irrigation, Organizations of EIA Technical Committee (Ministry of Agriculture, Ministry of Industry and Trade, Ministry of Hearth, Ministry of Municipality, Ministry of Energy and Mineral Resources), Water Authority of Jordan, Yarmouk Water Company, JICA Jordan Office, JICA Expert Team.

Table 10.13 Timetable and Agenda of the Stakeholder's Meeting

No.	Title	Main Contents	Presenter
1	Opening Remarks 1		WAJ PMU
2	Opening Remarks 2	Significance of SEA for M/P	MOE Directorate of Licensing & Guidance
3	Outline of draft master plan for water supply improvement & rehabilitation	1) Concept of M/P, 2) Population growth, 3) Unit of supply amount & water demand, 4) Water sources, 5) Water allocation, 6) 6) WS facilities improvement & rehabilitation	Water supply engineer of JICA Study Team
4	Outline of draft master plan for sewerage and sewer improvement & rehabilitation	1) Concept, 2) Unit discharge requirement & target sewerage service area, 3) Target effluent quality, 4) Sewerage facilities improvement plan	Team Leader of JICA Study Team
5	Pre-examination on environmental and social considerations for the M/P	1) Concept of SEA, 2) Examination of development alternatives in view of Environmental and Social Consideration, 3) Anticipated environmental impacts, 4) Anticipated social impacts	Environmental & social considerations expert of JICA Study Team
7	Discussion	1) Issues & opinion on environmental & social considerations	
8	Closing Remarks		JICA Jordan Office

Source: JICA Study Team

There were two major opinions and comments addressed in the discussion.
Firstly, a participant from the Ministry of Environment emphasized the importance of the consideration of risk for accident during construction. JICA Study Team answered that safety measures not only during construction but also during operation will be proposed in the M/P.
Secondly, a participant from the Ministry of Water and Irrigation asked JICA Study Team the measures for energy efficiency improvement and wastewater reuse. JICA Study Team answered to propose the gravity water supply system as wide as possible as the conversion from pumping system for energy saving, and to set treated wastewater quality to meet the standard for irrigation water in Jordan for wastewater reuse.

The meeting was concluded by the remark that all opinions and feedbacks of stakeholders will be considered and monitored during the project.

10.2 Land Acquisition and Resettlement

Since all of the components of the proposed sewerage plans are the improvement and expansion of existing WWTP facilities and pipelines under the right of way, land acquisition and resettlement due to the sewerage improvement plans are not anticipated.

As a reference, the legal overview of the land acquisition procedure in Jordan is shown in Appendix V-1.

10.3 Others

10.3.1 Draft Monitoring Form

Draft monitoring form is shown in Appendix V-2.

10.3.2 Checklist for Environmental and Social Considerations

Environmental check list is shown in Appendix V-3.

CHAPTER 11 PRIORITY PROJECT

11.1 Purpose

As described in Chapter 7, in four of six sewerage districts (SWD), phase-1 projects are required to expand the sewerage service area. In Central Irbid SWD, the sludge dewatering facilities are recommended to install as soon as possible, because the facilities are essential to treat the sludge properly before disposal. In Wadi Hassan SWD, the sewerage service is planned to expand from the second phase.

This chapter compares the phase-1 projects of four SWD: Wadi Al-Arab, Shallala, Ramtha, and Mafraq and suggests implementation priorities for these projects.

11.2 Evaluation Parameters

Table 11.1 summarizes the salient features of the phase-1 projects in four SWD and the key points are as follows:

- The project in Wadi Al-Arab SWD has the highest number of beneficiaries.
- The project in Shallala SWD has the highest service population per service area and that in Mafraq SWD has the lowest service population per service area.
- The projects in Wadi Al-Arab and Shallala SWDs can provide sewerage services to more people with a smaller per capita investment. The low investments of WWTP per capita, 33JD/capita for Wadi Al-Arab and 0 JD/capita for Shallala SWD, would contribute the high cost performance.
- The projects in Mafraq and Shallala SWDs have the highest need for increasing the coverage ratio.

To identify priorities among the phase-1 projects, evaluation is made considering the following parameters:

1) Number of beneficiaries (service population increased) by implementation of phase-1 project
2) Need to increase the service population coverage ratio
3) Increased population coverage ratio by implementation of phase-1 project
4) Cost performance based on the cost required to provide the sewerage service to one person

Table 11.1 Features of the Proposed Phase-1 Projects in Four SWDs

	Item	Wadi Al-Arab SWD	Shallala SWD	Ramtha SWD	Mafraq SWD
1.	Service Area expanded	Locality of Bait Ras, about 1,100 ha.	Localities of Mghayyer and Hawwara, about 590 ha.	Surrounded area of Ramtha city, about 440 ha.	Locality of Manshiyah Bani Hassan and the southern part of Mafraq city, about 800 ha.
2.	1) Service Population Increase by Project *	94,090	55,330	37,110	31,610
	2) 1) per service area	86 capita/ha	94 capita/ha	85 capita/ha	40 capita/ha
3.	1) Population Coverage Ratio in 2021	80 %	44 %	57 %	47 %
	2) Increase in Pop. Coverage between 2017 and 2021	15 % (14.7=80.3-65.6)	16 % (16.1=43.9-27.8)	13 % (12.6=57.1-44.5)	14 % (13.5=46.8-33.3)
4.	Proposed Sewerage Facilities	1) Branch Sewer: 168 km 2) Trunk Sewer: Not required 3) Hakama LS: increased capacity of 2.32 m^3/min, 4) WWTP: one line of aeration tank and final sedimentation tank, capacity of 3,500 m^3/d	1) Branch Sewer: 90 km 2) Trunk Sewer: 3.3 km (200mm CP) 3) New Mghayyer Manhole Pump, 4) WWTP: No expansion required	1) Branch Sewer: 66 km 2) Trunk Sewer: 4.3 km (300mm CP) 3) LS: not required, 4) WWTP: one line of aeration tank and final sedimentation tank, capacity of 4,400 m^3/d, and sludge de-hydrator.	1) Branch Sewer: 122km 2) Trunk Sewer: 14.6 km (300mm CP) and 2.8 km (200mm DIP), 3) New Mansha LS: capacity of 3.25 m^3/min, 4) WWTP: one line of waste- water treatment facilities, capacity of 3,600 m^3/d
5.	Direct Cost**	24.0 million JD	11.4 million JD	14.2 million JD	23.0 million JD
6.	Direct Cost per service population increase	255 JD/capita	206 JD/capita	382 JD/capita	726 JD/capita
		To improve sewerage service, all components of sewerage facilities except trunk sewers are required. About 87% of the direct cost or 222 JD/Capita is for construction of branch sewers and LS. While 33JD/capita is for construction of WWTP.	To expand sewerage service to Mghayyer, all components of sewers and lift pump facilities are required. But to expand the service to Howwala only branch sewers are required. The WWTP is not required to extend the capacity. The highest service population per service area and no need to expand the capacity of WWTP contribute to the lowest direct cost per service pop. increase.	To expand the sewerage service all components of sewerage facilities except lift pump are required. About 61% of the direct cost or 233 JD/Capita is for construction of branch and trunk sewers. 149 JD/capita is for construction of WWTP. The high investment cost for WWTP is disadvantage compared with that of Wadi Al-Arab SWD.	To expand the sewerage service all components of sewerage facilities are required with the longest trunk sewer construction among four SWD. The lowest service population per service area and need to expand the capacity of WWTP make for the highest direct cost per service pop. increase. (150 JD/capita for WWTP and 576 JD/capita for Sewers and LS)

Note: * Refer to Figure 7.4, Figure 7.6, Figure 7.10, Figure 7.12, respectively. ** Refer to Table 8.15, Table 8.19, Table 8.25, and Table 8.30, respectively.
Source: JICA Study Team

11.3 Implementation Priorities for Phase-1 Projects

The phase-1 projects of four SWD are assigned scores in terms of each evaluation parameter.

Table 11.2 shows the result of scores and priorities given to phase-1 projects of four SWD. The priorities are defined considering the total score.

Table 11.2 Priority of Projects Among the Proposed Phase-1 Projects

Evaluation Parameter		Wadi Al-Arab SWD	Shallala SWD	Ramtha SWD	Mafraq SWD
1.	Service Population (Beneficiaries)	94,090	55,330	37,110	31,610
	Score-1	4	3	2	2
2.	Needs to Increase the Population Coverage Ratio (100%-coverage ratio)	20 %	56 %	43 %	53 %
	Score-2	2	4	3	4
3.	Increase in population coverage ratio	15 %	16 %	13 %	14 %
	Score-3	2	2	2	2
4.	Cost Performance	255 JD/capita	206 JD/capita	382JD/capita	726 JD/capita
	Score-4	3	4	2	1
5.	**Total Score**	**11**	**13**	**9**	**9**
6.	**Priority based on the Score**	2nd	**1st**	3rd	3rd
7.	**JICA Study Team Suggestion**	Priority Project	Priority Project	Modify to smaller investment plan	Modify to smaller investment plan

Source: JICA Study Team

Based on the score of evaluated parameters, the phase-1 project of Shallala SWD gets the first priority and that of Wadi Al-Arab SWD gets the second priority. The phase-1 project of Shallala SWD receives the highest score in terms of the cost performance and with respect to the needs to increase the population coverage ratio. On the other hand, the phase-1 project of Wadi Al-Arab WSD scores the highest in terms of the service population increase and the second highest in terms of the cost performance.

The Phase-1 project of Mafraq SWD gets the third priority considering parameter scores; it is assigned the highest score in terms of the needs to increase the population coverage ratio but received the lowest score in terms of the cost performance. The Phase-1 project of Ramtha SWD also gets the third priority: the moderate scores in terms of all parameters.

JICA Study Team recommends both of the phase-1 projects of Shalla SWD and Wadi Al-Arab SWD are implemented as priority projects. Because the provision of sewerage service could be accomplished for the most densely populated area without expansion of WWTP in Shallala SWD. The sewerage service could be provided with much less per capita investment to WWTP in Wadi Al-Arab SWD. In other words, the service expansion could be accomplished by using the current WWTP capacity.

Due to the huge costs, the phase-1 project of Mafraq SWD may be difficult to implement. The project of Mafraq SWD is expected to increase the population service ratio and mitigate the Syrian refugees impacts to the wastewater management in community: worsen the public hygiene and the citizens' living environment due to frequent overflows of wastewater after the influx of Syrian refugees, where the current Syrian refugees are over the Jordanian population. But the service population density (service population per service area) is 40 capita/ha, which is the lowest among the four SWD and about 42% to 47% of other 3 SWD. The per capita investment required of 726 JD/ciapita is highest (worst) among four SWD, about 3.5 times of Shallala SWD, 2.8 times of Wadi Al-Arab and 1.9 times of Ramtha SWD. These disadvantages make the phase-1 project of Mafraq difficult to implement financially.

The phase-1 project of Mafraq SWD expand the service area, about 800 ha of Manshiyah Bani Hassan and the southern part of Mafraq city. From the financial viewpoints, the phase-1 project should be modified to smaller investment plan: service area is limited only to urban city center where the population density is relatively high and to stop the sewerage service provision to Manshiyah Bani Hassan, for which it is required to construct a long trunk sewers (15km, 300mmCP) and Mansha LS (3.25 m^3/min) because the area of Manshiyah Bani Hassan is located little bit far from the Mafraq city. To realize the sewerage service provision to the area of Manshiyah Bani Hassan, financial supports from WAJ and foreign donors are indispensable.

CHAPTER 12 CONCLUSION AND RECOMMENDATIONS

12.1 Conclusion

WAJ has developed the sewerage facilities in northern governorates. The sewerage systems are expected to contribute the improve public hygiene, preservation of natural environment, and provision of re-usable treated effluents for agriculture..

To manage the wastewater properly in the communities even though the impacts of influx of Syrian refugees, the sewerage facilities are planned to expand and improved, based on the capacity assessment of the existing main facilities such as trunk sewers, lift stations and wastewater treatment plants.

The project implementation plans have been prepared for six independent sewerage districts (SWD) in Irbid and Mafraq governorates, including the project cost estimates by each phase and disbursement schedule and annual O&M cost estimates. Total project cost required for six sewerage districts are about 302 million JD: 2 million JD for Central Irbid SWD, 71 million JD for Wadi Al-Arab SWD, 61 million JD for Shallala SWD, 11 million JD for Wadi Hassan SWD, 58 million Ramtha SWD, and 99 million JD for Mafraq SWD.

The projects are evaluated to be economically feasible. However, the project costs are huge. To realize the implementation of the projects , continuous financial assistance by WAJ and foreign donors is indispensable.

Among the phase-1 projects, that of Central SWD is proposed to implement immediately, because the equipment proposed are required for the existing facilities. To give implementation priorities, the phase-1 projects are evaluated by four evaluation parameters: increased number of beneficiaries, cost performance and need to expand the sewerage services. As a results, the phase-1 project of Shallala SWD gets the first priority and that of Wadi Al-Arab SWD gets the second priority, and those of Ramtha and Mafraq get the third priority.

JICA Study Team recommends both of the phase-1 projects of Shalla SWD and Wadi Al-Arab SWD are implemented as priority projects. Because the provision of sewerage service could be accomplished for the most densely populated area without expansion of WWTP in Shallala SWD. The sewerage service could be provided with much less per capita investment to WWTP in Wadi Al-Arab SWD. In other words, the service expansion could be accomplished by using the current WWTP capacity effectively.

Due to the huge costs, the phase-1 project of Mafraq SWD may be difficult to implement. The project of Mafraq SWD is expected to increase the population service ratio and mitigate the Syrian refugees impacts to the wastewater management in community. But the financial viewpoints, the phase-1 project should be modified to smaller investment plan: service area is limited only to urban city center and to stop the sewerage service provision to Manshiyah Bani Hassan. Especially to realize the sewerage service provision to the area of Manshiyah Bani Hassan, financial supports from WAJ and foreign donors are indispensable.

12.2 Recommendations

- ✓ This Report on Master Plan for Sewerage are expected to use as a basis for preparation of sewerage facility plan, identification of promising projects and implementation of sewerage projects.
- ✓ To implement the priority project and the phase-1 projects, funding of project need to be secured.
- ✓ The sludge de-hydrator for the Central Irbid SWD are required immediately installed to treat and disposal of the sludge properly.

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APPENDIX I ALLOCATION OF SERVICE POPULATION FOR EACH SEWERAGE SUB DISTRICT

Whole service population that allocated to each sewerage sub district are shown as follows.

1. Basis Idea for the Allocation

When an area of sub district belongs to both A and B, then the population for each sewerage sub district is estimated based on the area ratio of A and B.

2. Calculation for Central Irbid WWTP

Trunk Sewer	Locality/ Neighborhood	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑬	⑭	⑮	⑯	⑰	⑱	Remote ⑲	Total
		Al Mallab	Al Medan	Al Salam	Al Hashme	Al Tall	Al Audah	Al Emaan	Al Naser	Al Karama	Hanena	Al yarmouk	Al Marj	Al Ashrafeeh	Al Saadah	Al Matla'a	Al Seha	Bait Ras	
	Urban/Rulal	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	R	
	Population (pers.)	3,384	6,920	14,272	1,667	1,221	32,581	497	8,588	9,117	9,570	1,543	2,445	762	4,899	12,990	3,681	4,003	118,140
779	Area	32.78	21.32								54.10								
	Ratio	100%	57%								-								
	Population allocated	3,384	3,967																7,351
523	Area		15.87	42.84	13.19														71.90
	Ratio		43%	61%	100%														-
	Population allocated		2,953	8,677	1,667														13,297
559	Area			20.10															20.10
	Ratio			29%															-
	Population allocated			4,071															4,071
1069	Area			7.52		7.48	41.50												56.50
	Ratio			11%		100%	51%												-
	Population allocated			1,523		1,221	16,570												19,314
851	Area						40.10												40.10
	Ratio						49%												-
	Population allocated						16,011												16,011
685	Area								2.70	2.00									4.70
	Ratio								3%	4%									-
	Population allocated								262	372									634
740	Area							2.00		16.30							18.30		
	Ratio							100%		33%							-		
	Population allocated							497		3,030									3,527
476	Area							0.50	0.60							1.10			
	Ratio							1%	1%							-			
	Population allocated								49	112									160
471	Area							39.98	30.14	54.68							124.80		
	Ratio							45%	61%	100%							-		
	Population allocated								3,881	5,603	9,570								19,054
1776	Area							35.70	35.70										
	Ratio							100%	-										
	Population allocated																	4,003	4,003
1762	Area							20.60							20.60				
	Ratio							100%							-				
	Population allocated											1,543							1,543
1394	Area							45.30							45.30				
	Ratio							51%							-				
	Population allocated								4,397										4,397
463	Area												14.70						14.70
	Ratio												36%						-
	Population allocated												869						869
2765	Area														26.41	25.23	13.86		65.50
	Ratio														90%	30%	100%		-
	Population allocated														4,399	3,944	3,681		12,024
2736	Area							10.53		3.00	57.87			71.40					
	Ratio							25%		10%	70%			-					
	Population allocated												622		500	9,046			10,168
2292	Area							16.14	34.96					51.10					
	Ratio							39%	100%					-					
	Population allocated												954	762					1,716
Total	Area	**32.78**	**37.19**	**70.46**	**13.19**	**7.48**	**81.60**	**2.00**	**88.48**	**49.04**	**54.68**	**20.60**	**41.37**	**34.96**	**29.41**	**83.10**	**13.86**	**35.70**	**695.90**
	Ratio	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**-**
	Population allocated	**3,384**	**6,920**	**14,272**	**1,667**	**1,221**	**32,581**	**497**	**8,588**	**9,117**	**9,570**	**1,543**	**2,445**	**762**	**4,899**	**12,990**	**3,681**	**4,003**	**118,140**

3. Calculation for Wadi Al-Arab WWTP

Trunk Sewer	Locality/ Neighborhood	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	Total
																								Remote			Remote																	Remote		
		Al Mohandisin	Al Afaah	Al Jamiah	Al Tall	Al Hashme	Al Hekmah	Al Nouzhal	Al Mallab	Al Jamee	Al Abrar	Al Nedeef	Al Seha	Al Sadah	Al Ashrafeeh	Al Nasur	Al Burha	Al Manara	Al Swaneh	Al Basaten	Al Ateba'a	Al Qasela	Allah	Natfeh	Zebdat	As Surayj	Soom	Al Rouda	Al Sahel Green	Al Emaan	Al Baqaa	Al Sena's	Al Karama	AL Baiyda	Henena	Hakama	Maro	Bait Ras	Al Yarmouk	Al Naser	Al Herafeyee	Al Herafeyee	Al Marj	Dougrah	Unspecified (blank)	
	Urban/Rulal	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	R	U	U	R	U	U	U	U	U	U	U	U	R	R	R	U	U	U	U	U	R	R	
	Population (pers.)	9,717	11,917	13,591	687	1,065	3,554	6,896	1,128	1,730	19,224	8,904	9,466	3,547	1,546	1,206	12,453	21,481	7,201	11,768	11,868	10,397	5,197	2,617	10,561	4,992	9,997	7,300	5,688	5,718	6,340	2,174	4,697	2,948	7,519	14,404	6,046	46,033	3,968	2,283	648	997	242	9,154		328,869
4280	Area	95.61	90.00								135.61																																			
	Ratio	35%	28%																																											
	Population allocated	3,361	3,303								6,664																																			
2855	Area			17.22			31.88								49.10																															
	Ratio			21%			82%																																							
	Population allocated			2,805			2,900								5,705																															
726	Area		56.25				7.19								63.44																															
	Ratio		17%				18%																																							
	Population allocated		2,064				654								2,718																															
1560	Area					26.92	15.68								42.60																															
	Ratio					63%	100%								-																															
	Population allocated							4,312	1,128							5,440																														
6322	Area			34.53		1.00		16.13		12.14								63.80																												
	Ratio			41%		100%		37%		63%																																				
	Population allocated			5,624		1,065		2,584		1,097								10,370																												
6788	Area			31.69	7.56					7.00	77.79		18.00								142.04																									
	Ratio			38%	100%					37%	100%		47%																																	
	Population allocated			5,162	687					633	19,224		4,482								30,187																									
2951	Area					8.70	1.00								9.70																															
	Ratio					100%	3%								-																															
	Population allocated							3,904	249							9,153																														
4336	Area					32.6				37.89								70.50																												
	Ratio					26%				39%																																				
	Population allocated							5,626				4,021							9,647																											
4519	Area					2.00					30.50	5.25								37.75																										
	Ratio					5%					24%	13%								-																										
	Population allocated							498					5,262	963							6,723																									
700	Area					17.02	3.91						30.50								51.43																									
	Ratio					45%	18%						19%								-																									
	Population allocated							4,238	649						2,275							7,161																								
2413	Area					17.47	36.23		46.60			23.15								123.45																										
	Ratio					82%	100%		24%			15%								-																										
	Population allocated							2,898	1,546		2,995			1,727							9,166																									
3401	Area					15.00	10.00			71.90								96.90																												
	Ratio					58%	5%			46%								-																												
	Population allocated							595	543			5,364							6,701																											
5641	Area	94.17								105.83							200.00																													
	Ratio	34%								100%							-																													
	Population allocated	3,310								5,197							8,507																													
5653	Area					68.50								68.50																																
	Ratio					100%								-																																
	Population allocated							2,617							2,617																															
4156	Area					0.00																																								
	Ratio					-																																								
	Population allocated							0																																						
2195	Area		89.25								71.44	10.71							171.40																											
	Ratio		27%								36%	1%							-																											
	Population allocated		3,275								4,328	1,137							8,739																											
2170	Area		89.25								71.44	10.71							171.40																											
	Ratio		27%								36%	1%							-																											
	Population allocated		3,275								4,328	1,137							8,739																											
3090	Area	86.63								53.04				9.03							148.70																									
	Ratio	31%								27%				7%							-																									
	Population allocated	3,045								3,213				745							7,004																									
2097	Area					38.66			118.92	52.72								210.30																												
	Ratio					39%			93%	100%								-																												
	Population allocated							4,103			9,816	4,992							18,910																											
6634	Area					28.40								28.40																																
	Ratio					23%								-																																
	Population allocated							4,900							4,900																															
2574	Area					33.00	1.00								34.00																															
	Ratio					27%	3%								-																															
	Population allocated							5,693	183							5,877																														
2111	Area					33.00	2.00								35.00																															
	Ratio					84%	1%								-																															
	Population allocated							5,054	149							6,204																														
1929	Area					30.20								30.20																																
	Ratio					19%								-																																
	Population allocated							2,253							2,253																															
6349	Area					0.00																																								
	Ratio					-																																								
	Population allocated							0																																						
6772	Area					1.00	17.53		2.00	25.97								46.50																												
	Ratio					1%	24%		2%	43%								-																												
	Population allocated							84	1,339		142	926							2,492																											
1213	Area					26.00	40.70		35.00	30.00	27.00		17.00								175.70																									
	Ratio					35%	100%		57%	100%	45%		2%								-																									
	Population allocated							1,987	6,718		1,248	4,697	1,320		350							15,320																								
4799	Area					85.98	30.91		36.43			26.28								179.60																										
	Ratio					99%	42%		41%			44%								-																										
	Population allocated							7,216	2,362		2,588			1,285							13,452																									
5259 (to LS)	Area					50.80								50.80																																
	Ratio					57%								-																																
	Population allocated							3,609							3,609																															
5047 (from LS)	Area					0.00																																								
	Ratio					-																																								
	Population allocated																																													0
1109	Area																																	7.00	2.00	438.47	135.73	280.90								864.10
	Ratio																																	12%	7%	63%	100%	61%								-
	Population allocated																																	342	494	9,022	6,046	28,217								44,121
1376	Area																																		28.43	244.57										273.00
	Ratio																																		93%	35%										-
	Population allocated																																		7,025	5,032										12,057
4644	Area																																					28.10							28.10	56.20
	Ratio																																					6%							17%	-
	Population allocated																																					2,823							0	2,823
762 (to TP)	Area																																					149.26	48.35	15.00	24.15		2.00		136.20	374.96
	Ratio																																					33%	100%	100%	100%		100%		83%	-
	Population allocated																																					14,993	3,968	2,283	648		242		0	22,134
3376 (from TP)	Area															11.03	137.19																									23.40				171.62
	Ratio															42%	71%																									100%				-
	Population allocated															511	8,816																									997				10,324
3097	Area																																													0.00
	Ratio																																													-
	Population allocated																																													0
6351	Area																										195.20																			195.20
	Ratio																										100%																			-
	Population allocated																										9,997																			9,997
6354	Area																																													0.00
	Ratio																																													-
	Population allocated																																													0
2790 (to TP)	Area																																													0.00
	Ratio																																													-
	Population allocated																																													0
2240 (to TP)	Area																																											191.30		191.30
	Ratio																																											100%		-
	Population allocated																																											9,154		9,154
Total	Area	**276.41**	**324.75**	**83.44**	**7.56**	**1.00**	**39.07**	**43.05**	**15.68**	**19.14**	**77.79**	**8.70**	**38.02**	**21.38**	**36.23**	**26.03**	**193.79**	**124.51**	**39.25**	**157.75**	**195.92**	**97.97**	**105.83**	**68.50**	**127.95**	**52.72**	**195.20**	**86.98**	**74.44**	**40.70**	**89.23**	**60.97**	**30.00**	**60.28**	**30.43**	**700.04**	**135.73**	**458.26**	**48.35**	**15.00**	**24.15**	**23.40**	**2.00**	**191.30**	**164.30**	**4613.20**
	Ratio	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	-
	Population allocated	**9,717**	**11,917**	**13,591**	**687**	**1,065**	**3,554**	**6,896**	**1,128**	**1,730**	**19,224**	**8,904**	**9,466**	**3,547**	**1,546**	**1,206**	**12,453**	**21,481**	**7,201**	**11,768**	**11,868**	**10,397**	**5,197**	**2,617**	**10,561**	**4,992**	**9,997**	**7,300**	**5,688**	**5,718**	**6,340**	**2,174**	**4,697**	**2,948**	**7,519**	**14,404**	**6,046**	**46,033**	**3,968**	**2,283**	**648**	**997**	**242**	**9,154**	**0**	**328,869**

4. Calculation for Shallala WWTP

Trunk Sewer	Locality/ Neighborhood	1	2	2	3	4	5	6	7	8	9	10	11	12	Remote 13	14	Total
		Hoson	Hoson (Al Azmi)	Sarieh	Aidoon	Al Hekmah	Al Werud	Zahra	Andalus	Howwarah	Boshra	Al Rouda	Al Sahel Green	Sal	Mghayyer	Unspecified (blank)	
	Urban/Rulal	R	R	R	R	U	U	U	U	R	R	U	U	R	R	R	
	Population (pers.)	41,349	24,284	47,359	48,819	4,008	14,292	9,092	9,658	31,955	32,175	384	2,323	24,699	16,831		307,228
5884	Area	498.58														326.09	824.67
	Ratio	34%														42%	-
	Population allocated	13,887														0	13,887
Azmi-1 (from LS)	Area		101.50														101.50
	Ratio		100%														-
	Population allocated		24,284														24,284
5034	Area	365.70															365.70
	Ratio	25%															-
	Population allocated	10,186															10,186
17877-1	Area	590.44		63.98	32.28												686.70
	Ratio	40%		22%	2%												-
	Population allocated	16,445		10,296	934												27,675
17877-2	Area			81.70													81.70
	Ratio			28%													-
	Population allocated			13,148													13,148
17877-3	Area			74.30													74.30
	Ratio			25%													-
	Population allocated			11,957													11,957
17877-4	Area			74.30													74.30
	Ratio			25%													-
	Population allocated			11,957													11,957
3524	Area									43.88						102.12	146.00
	Ratio									7%						13%	-
	Population allocated									2,312						0	2,312
3569	Area									9.00							9.00
	Ratio									1%							-
	Population allocated									474							474
3011	Area									249.48						102.92	352.40
	Ratio									41%						13%	-
	Population allocated									13,143						0	13,143
3058	Area									145.80							145.80
	Ratio									24%							-
	Population allocated									7,681							7,681
3030	Area																0.00
	Ratio																-
	Population allocated																0
3011	Area	29.86			1224.64											156.30	1410.80
	Ratio	2%			73%											20%	-
	Population allocated	832			35,424											0	36,256
2091	Area				283.90												283.90
	Ratio				17%												-
	Population allocated				8,212												8,212
15879	Area				146.90												146.90
	Ratio				9%												-
	Population allocated				4,249												4,249
2158	Area						2.00			32.70							34.70
	Ratio						1%			5%							-
	Population allocated						201			1,723							1,924
7470 (to LS)	Area									125.70	42.30						168.00
	Ratio									21%	7%						-
	Population allocated									6,622	2,391						9,013
7471 (from LS)	Area																0.00
	Ratio																-
	Population allocated																0
1605	Area					1.00	117.80	1.00									119.80
	Ratio					2%	83%	1%									-
	Population allocated					84	11,865	80									12,029
1562	Area							32.80			65.80						98.60
	Ratio							29%			12%						-
	Population allocated							2,639			3,719						6,358
450	Area					46.90	22.10	3.00									72.00
	Ratio					98%	16%	3%									-
	Population allocated					3,924	2,226	241									6,392
521	Area							21.21	53.22				25.27				99.70
	Ratio							19%	41%				93%				-
	Population allocated							1,706	3,993				2,153				7,852
511	Area							31.50	37.00			5.00	2.00				75.50
	Ratio							28%	29%			100%	7%				-
	Population allocated							2,534	2,776			384	170				5,865
521	Area							23.50	38.50		20.10						82.10
	Ratio							21%	30%		4%						-
	Population allocated							1,891	2,889		1,136						5,916
1553	Area										30.60						30.60
	Ratio										5%						-
	Population allocated										1,730						1,730
7427	Area										123.20						123.20
	Ratio										22%						-
	Population allocated										6,964						6,964
7476	Area										214.90			5.00			219.90
	Ratio										38%			1%			-
	Population allocated										12,148			268			12,416
MGH-1 (to LS)	Area														177.90	20.01	197.91
	Ratio														100%	3%	-
	Population allocated														16,831	0	16,831
1257-1 (to LS)	Area													180.79		20.01	200.80
	Ratio													39%		3%	-
	Population allocated													9,703		0	9,703
1257 (from LS)	Area																0.00
	Ratio																-
	Population allocated																0
1135	Area													131.40		10.00	141.40
	Ratio													29%		1%	-
	Population allocated													7,052		0	7,052
1413	Area										10.00			138.00			148.00
	Ratio										2%			30%			-
	Population allocated										565			7,407			7,972
7401	Area										57.30						57.30
	Ratio										10%						-
	Population allocated										3,239						3,239
1422	Area										5.00			5.00		28.50	38.50
	Ratio										1%			1%		4%	-
	Population allocated										283			268		0	551
7478-1	Area															12.90	12.90
	Ratio															2%	-
	Population allocated															0	0
7478-2	Area																0.00
	Ratio																-
	Population allocated																0
Total	Area	1484.58	0.00	294.28	1687.72	47.90	141.90	113.01	128.72	606.56	569.20	5.00	27.27	460.19	177.90	778.85	6523.08
	Ratio	100%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	-
	Population allocated	41,349	0	47,359	48,819	4,008	14,292	9,092	9,658	31,955	32,175	384	2,323	24,699	16,831	0	307,228

5. Calculation for Wadi Hassan WWTP

Trunk Sewer	Locality/ Neighborhood	① No'ayymeh	② Ketem	③ Shatana	Total
	Urban/Rulal	R	R	R	
	Population (pers.)	24,141	10,696	540	35,377
3738 (from LS)	Area				0.00
	Ratio				-
	Population allocated				0
1076-1	Area				0.00
	Ratio				-
	Population allocated				0
1653	Area	386.80		43.00	429.80
	Ratio	38%		100%	-
	Population allocated	9,067		540	9,607
1860	Area	163.40			163.40
	Ratio	16%			-
	Population allocated	3,830			3,830
1800	Area				0.00
	Ratio				-
	Population allocated				0
1795	Area		379.80		379.80
	Ratio		100%		-
	Population allocated		10,696		10,696
1105	Area	450.80			450.80
	Ratio	44%			-
	Population allocated	10,567			10,567
1089	Area	28.90			28.90
	Ratio	3%			-
	Population allocated	677			677
1772 (to LS)	Area				0.00
	Ratio				-
	Population allocated				0
1075 (from LS)	Area				0.00
	Ratio				-
	Population allocated				0
1076-2 (to TP)	Area				0.00
	Ratio				-
	Population allocated				0
Total	Area	1029.90	379.80	43.00	1452.70
	Ratio	100%	100%	100%	-
	Population allocated	24,141	10,696	540	35,377

6. Calculation for Ramtha WWTP

Trunk Sewer	Locality/ Neighborhood	7 ① Sabea-B	6 ② Sades-B	6 ③ Sades-A	7 ④ Sabea-A	8 ⑤ Thamen	5 ⑥ Khames	2 ⑦ Aththani	4 ⑧ Arraba	1 ⑨ Aowl	3 ⑩ Aththalth	10 ⑪ Aasher	9 ⑫ Tesea-A	9 ⑬ Tesea-B	Remote ⑭ Torrah	Remote ⑮ Shajarah	Remote ⑯ Emrawah	Remote ⑰ Dnaibeh	⑱ Unspecified (blank)	Total
	Urban/Rulal	U	U	U	U	U	U	U	U	U	U	U	U	U	R	R	R	R	R	
	Population (pers.)	1,917	10,485	12,398	20,012	13,731	2,612	10,506	3,861	21,950	8,253	16,923	13,020	2,937	28,803	22,359	7,322	4,109		201,198
1828	Area			72.18						72.18										
	Ratio			39%						-										
	Population allocated			4,885						4,885										
751	Area			37.01				7.86							44.87					
	Ratio			20%				7%							-					
	Population allocated			2,505				785												3,290
1967	Area							14.90												14.90
	Ratio							14%												-
	Population allocated							1,489												1,489
1188	Area							3.70												3.70
	Ratio							4%												-
	Population allocated							370												370
1460	Area			74.00			30.53	22.66												127.19
	Ratio			40%			100%	22%												-
	Population allocated			5,008			2,612	2,264												9,884
544	Area							16.30												16.30
	Ratio							16%												-
	Population allocated							1,629												1,629
547	Area							27.45	26.75											54.20
	Ratio							26%	38%											-
	Population allocated							2,743	1,449											4,191
110	Area							3.00												3.00
	Ratio							3%												-
	Population allocated							300												300
1193	Area							9.28	27.06		15.23									51.57
	Ratio							9%	38%		19%									-
	Population allocated							927	1,466		1,560									3,953
1966	Area								17.48		19.33								97.36	134.17
	Ratio								25%		24%								87%	-
	Population allocated								947		1,980								0	2,927
489	Area										37.16								13.94	51.10
	Ratio										46%								13%	-
	Population allocated										3,806								0	3,806
SEB-1	Area	209.06	110.59																	319.65
	Ratio	100%	100%																	-
	Population allocated	1,917	10,485																	12,402
SEB-2	Area				62.22															62.22
	Ratio				29%															-
	Population allocated				5,820															5,820
2206	Area				24.20					1.00										25.20
	Ratio				11%					1%										-
	Population allocated				2,264					161										2,425
2207	Area				2.76					24.64										27.40
	Ratio				1%					18%										-
	Population allocated				258					3,969										4,227
1990	Area									14.70										14.70
	Ratio									11%										-
	Population allocated									2,368										2,368
1565	Area									7.20										7.20
	Ratio									5%										-
	Population allocated									1,160										1,160
1149	Area									6.80		7.00								13.80
	Ratio									5%		3%								-
	Population allocated									1,095		482								1,577
2204	Area											2.20								2.20
	Ratio											1%								-
	Population allocated											151								151
1696	Area										8.85	127.35								136.20
	Ratio										11%	52%								-
	Population allocated										907	8,764								9,670
251	Area											53.10								53.10
	Ratio											22%								-
	Population allocated											3,654								3,654
1226	Area									37.90		17.20								55.10
	Ratio									28%		7%								-
	Population allocated									6,104		1,184								7,288
119	Area									0.30										0.30
	Ratio									0.2%										-
	Population allocated									48										48
1613	Area																			0.00
	Ratio																			-
	Population allocated																			0
112	Area				98.05	132.37														230.42
	Ratio				46%	81%														-
	Population allocated				9,172	11,131														20,303
190	Area				26.70															26.70
	Ratio				12%															-
	Population allocated				2,498															2,498
1625	Area					30.92				43.74			29.63	33.37						137.66
	Ratio					19%				32%			42%	29%						-
	Population allocated					2,600				7,045			5,493	850						15,989
99	Area												1.00	20.10						21.10
	Ratio												1%	17%						-
	Population allocated												185	512						698
97	Area												13.07	47.53						60.60
	Ratio												19%	41%						-
	Population allocated												2,423	1,211						3,634
104	Area												6.55	11.95						18.50
	Ratio												9%	10%						-
	Population allocated												1,214	305						1,519
90	Area											39.07	19.98	2.30						61.35
	Ratio											16%	28%	2%						-
	Population allocated											2,689	3,704	59						6,451
DN-1	Area																	74.00		74.00
	Ratio																	100%		-
	Population allocated																	4,109		4,109
EM-1	Area																40.80			40.80
	Ratio																100%			-
	Population allocated																7,322			7,322
SH-1	Area															204.70				204.70
	Ratio															100%				-
	Population allocated															22,359				22,359
TOR-1	Area														317.19					317.19
	Ratio														100%					-
	Population allocated														28,803					28,803
Total	**Area**	**209.06**	**110.59**	**183.19**	**213.93**	**163.29**	**30.53**	**105.15**	**71.29**	**136.28**	**80.57**	**245.92**	**70.23**	**115.25**	**317.19**	**204.70**	**40.80**	**74.00**	**111.30**	**2483.27**
	Ratio	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**-**
	Population allocated	**1,917**	**10,485**	**12,398**	**20,012**	**13,731**	**2,612**	**10,506**	**3,861**	**21,950**	**8,253**	**16,923**	**13,020**	**2,937**	**28,803**	**22,359**	**7,322**	**4,109**	**0**	**201,198**

7. Calculation for Mafraq WWTP

Trunk Sewer	Locality/ Neighborhood	① Al-Malik Abdullah	② Gadeseyyah	③ Alshheed Wasfi	④ Nahadah	⑤ Zahoor	⑥ Al-Ameer -Hassan	Remote ⑦ Aidoon	⑧ Al-Ameer Hamzah	⑨ Shwaykah	⑩ Karamah	⑪ Hosban	⑫ Nuzhah	⑬ Al-Hussein	⑭ Fadeen	⑮ Nowwarah	⑯ Al-Ameer Ghazi	⑰ Al-Ameerah Alia	Remote ⑱ Bani Hassan	⑲ Unspecified (blank)	Total
	Urban/Rulal	U	U	U	U	U	U	R	U	U	U	U	U	U	U	U	U	U	R	R	
	Population (pers.)	15,348	4,448	3,172	25,483	164	8,956	6,062	2,156	12,288	731	12,462	5,682	7,814	10,809	7,064	12,499	7,457	13,541		156,136
1873	Area	10.57	16.02		6.06					2.56						35.21					
	Ratio	12%	89%		5%					1%						-					
	Population allocated	1,913	3,954		1,176					147											7,190
MAF-1 (from LS)	Area	74.25		176.68	2.34	12.54														1001.04	1266.85
	Ratio	88%		83%	2%	49%														50%	-
	Population allocated	13,435		2,641	454	80														0	16,611
694	Area		2.00	2.00																	4.00
	Ratio		11%	1%																	-
	Population allocated		494	30																	524
698	Area				1.50																1.50
	Ratio				1%																-
	Population allocated				291																291
1045	Area				29.30																29.30
	Ratio				22%																-
	Population allocated				5,687																5,687
703	Area			6.05	14.15																20.20
	Ratio			3%	11%																-
	Population allocated			90	2,746																2,837
706	Area			21.96	5.54																27.50
	Ratio			10%	4%																-
	Population allocated			328	1,075																1,404
710	Area			5.50	1.00																6.50
	Ratio			3%	1%																-
	Population allocated			82	194																276
1712	Area				9.16	13.01	3.37													2.00	27.54
	Ratio				7%	51%	5%													0%	-
	Population allocated				1,778	84	445													0	2,306
1733	Area						0.50													4.50	5.00
	Ratio						1%													0%	-
	Population allocated						66													0	66
1906	Area						9.68													55.45	65.13
	Ratio						14%													3%	-
	Population allocated						1,278													0	1,278
168	Area				35.40																35.40
	Ratio				27%																-
	Population allocated				6,871																6,871
509	Area				2.20																2.20
	Ratio				2%																-
	Population allocated				427																427
475	Area				1.00		7.50														8.50
	Ratio				1%		11%														-
	Population allocated				194		990														1,184
193	Area						10.00														10.00
	Ratio						15%														-
	Population allocated						1,320														1,320
1826	Area						1.00													5.60	6.60
	Ratio						1%													0%	-
	Population allocated						132													0	132
AID-1	Area							120.80	123.43	47.85										33.29	325.37
	Ratio							100%	72%	22%										2%	-
	Population allocated							6,062	1,563	2,752										0	10,376
AID-2	Area								30.50											33.29	63.79
	Ratio								18%											2%	-
	Population allocated								386											0	386
1319	Area								16.38	53.46										21.87	91.71
	Ratio								10%	25%										1%	-
	Population allocated								207	3,074										0	3,282
1235	Area									40.40											40.40
	Ratio									19%											-
	Population allocated									2,323											2,323
1267	Area									26.70											26.70
	Ratio									12%											-
	Population allocated									1,535											1,535
1130	Area				0.50					27.80											28.30
	Ratio				0%					13%											-
	Population allocated				97					1,599											1,696
1138	Area				15.44					14.90	9.00	57.42	10.93								107.69
	Ratio				12%					7%	100%	51%	39%								-
	Population allocated				2,997					857	731	6,394	2,209								13,188
251	Area				2.00																2.00
	Ratio				2%																-
	Population allocated				388																388
253	Area				5.70																5.70
	Ratio				4%																-
	Population allocated				1,106																1,106
1568	Area						2.70														2.70
	Ratio						4%														-
	Population allocated						356														356
1312	Area						6.10														6.10
	Ratio						9%														-
	Population allocated						805														805
494	Area																			4.10	4.10
	Ratio																			0%	-
	Population allocated																			0	0
639	Area																3.00			2.90	5.90
	Ratio																5%			0%	-
	Population allocated																586			0	586
935	Area											28.11	10.68		14.27						53.06
	Ratio											25%	38%		23%						-
	Population allocated											3,130	2,159		2,469						7,758
20	Area													5.00							5.00
	Ratio													42%							-
	Population allocated													3,308							3,308
1565	Area													0.40							0.40
	Ratio													3%							-
	Population allocated													265							265
84	Area													6.41			5.95				12.36
	Ratio													54%			9%				-
	Population allocated													4,241			1,163				5,404
110	Area											26.38			18.31	73.90				36.16	154.75
	Ratio											24%			29%	82%				2%	-
	Population allocated											2,938			3,168	5,818				0	11,924
108	Area												6.50		5.66						12.16
	Ratio												23%		9%						-
	Population allocated												1,314		979						2,293
153	Area														1.70						1.70
	Ratio														3%						-
	Population allocated														294						294
149	Area						3.78								9.76						13.54
	Ratio						6%								16%						-
	Population allocated						499								1,689						2,188
743	Area						22.20								12.77	11.82	4.96				51.75
	Ratio						33%								20%	13%	8%				-
	Population allocated						2,931								2,210	931	969				7,041
802	Area						1.00										38.91	1.22			41.13
	Ratio						1%										61%	1%			-
	Population allocated						132										7,603	77			7,812
1107	Area																				0.00
	Ratio																				-
	Population allocated																				0
638	Area																2.20	3.50			5.70
	Ratio																3%	3%			-
	Population allocated																430	222			652
1865	Area																7.45	69.26			76.71
	Ratio																12%	59%			-
	Population allocated																1,456	4,388			5,844
674	Area															4.00	1.50	43.72		790.98	840.20
	Ratio															4%	2%	37%		40%	-
	Population allocated															315	293	2,770		0	3,378
100-1	Area																				0.00
	Ratio																				-
	Population allocated																				0
BH-1	Area																		240.10		240.10
	Ratio																		100%		-
	Population allocated																		13,541		13,541
BH-2	Area																				0.00
	Ratio																				-
	Population allocated																				0
BH-3	Area																				0.00
	Ratio																				-
	Population allocated																				0
BH-4	Area																				0.00
	Ratio																				-
	Population allocated																				0
BH-5	Area																				0.00
	Ratio																				-
	Population allocated																				0
BH-6 (to LS)	Area																				0.00
	Ratio																				-
	Population allocated																				0
MNS-1 (from LS)	Area																				0.00
	Ratio																				-
	Population allocated																				0
100-2	Area																				0.00
	Ratio																				-
	Population allocated																				0
100-3	Area																				0.00
	Ratio																				-
	Population allocated																				0
100-4 (to TP)	Area																				0.00
	Ratio																				-
	Population allocated																				0
Total	**Area**	**84.82**	**18.02**	**212.19**	**131.29**	**25.55**	**67.83**	**120.80**	**170.31**	**213.67**	**9.00**	**111.91**	**28.11**	**11.81**	**62.47**	**89.72**	**63.97**	**117.70**	**240.10**	**1991.18**	**3770.45**
	Ratio	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	-
	Population allocated	**15,348**	**4,448**	**3,172**	**25,483**	**164**	**8,956**	**6,062**	**2,156**	**12,288**	**731**	**12,462**	**5,682**	**7,814**	**10,809**	**7,064**	**12,499**	**7,457**	**13,541**	**0**	**156,137**

APPENDIX II REQUIRED LENGTH AND COST OF BRANCH SEWER FOR EACH SEWERAGE DISTRICT

Required length and cost of branch sewer for each sewerage districts are shown in Table II--1.-

1. Length of Branch Sewer

The unit length of 152.3m/ha is used in this study.

2. Cost of Branch Sewer

The unit cost of 120.64 JD/m is used this study.

Table II-1 Direct Construction Cost for Branch Sewer by Each SWD

ℓ= 152.3m	C= 120.64JD/m

Item	District	Sub-District	Area (ha)	Length (km)	Cost (Million JD)
Contents	**Wadi Al-Arab**				
	【Unit-1:Zebdat,Aidoon】(Ⅲ)				
		1 (5641)	134.40	20.47	2.47
		2 (2097)	151.00	23.00	2.77
	【Unit-2:Al Basaten,Al Barha】(Ⅲ)				
		3 (3401)	57.70	8.79	1.06
		4 (2413)	59.60	9.08	1.10
	【Unit-3:Hakama】(Ⅱ)				
		5 (1109)	574.20	87.45	10.55
	【Unit-4: Bait Ras】(Ⅰ)				
		6 (1109)	289.90	44.15	5.33
		7 (1376)	273.00	41.58	5.02
		8 (762)	285.60	43.50	5.25
		9 (3376)	250.40	38.14	4.60
	Total		2075.80	316.14	38.14
	Mafraq				
	【Unit-1:Aidoon】(Ⅱ)				
		1 (AID-1)	120.80	18.40	2.22
	【Unit-2:Ameer Hmzaha,Shwaykah】(Ⅰ)				
		2 (AID-1)	30.50	4.65	0.56
		3 (AID-2)	205.60	31.31	3.78
		4 (1319)	44.70	6.81	0.82
		5 (1235)	26.70	4.07	0.49
	【Unit-3:South-West Area】(Ⅰ)				
		6 (MAF-1)	253.00	38.53	4.65
	【Unit-4:South-East Area】(Ⅲ)				
		7 (MAF-1)	1022.00	155.65	18.78
	【Unit-5:North Area】(Ⅱ)				
		8 (1906)	50.10	7.63	0.92
		9 (110)	66.50	10.13	1.22
		10 (MAN-1)	841.20	128.11	15.46
	【Unit-6:Bani Hassan】(Ⅰ)				
		11 (BH-1)	240.10	36.57	4.41
	Total		2901.20	441.85	53.30

Item	District	Sub-District	Area (ha)	Length (km)	Cost (Million JD)
Contents	**Shallala**				
	【Unit-1:Hoson】(Ⅲ)				
		1 (5034)	56.40	8.59	1.04
		2 (5034)	49.10	7.48	0.90
	【Unit-2:Aidoon,Sarie】(Ⅲ)				
		3 (3011)	120.10	18.29	2.21
		4 (17877-1)	81.00	12.34	1.49
		5 (3012)	240.40	36.61	4.42
		6 (17877-4)	297.50	45.31	5.47
	【Unit-3:Howwarah】(Ⅰ)				
		7 (15879)	146.90	22.37	2.70
		8 (3011)	262.00	39.90	4.81
	【Unit-4:Bushra,Sal】(Ⅱ)				
		9 (7427)	110.60	16.84	2.03
		10 (1135)	72.30	11.01	1.33
		11 (1413)	72.30	11.01	1.33
	【Unit-5:Mugheyerl】(Ⅰ)				
		12 (MGH-1)	177.90	27.09	3.27
	Total		1686.50	256.85	30.99

Item	District	Sub-District	Area (ha)	Length (km)	Cost (Million JD)
Contents	**Wadi Hassan**				
	【Unit-1:Noayemeh】(Ⅱ)				
		1 (1653)	40.40	6.15	0.74
	【Unit-2:Hoson-A】(Ⅱ)				
		2 (5884)	55.50	8.45	1.02
	【Unit-3:Hoson-B】(Ⅱ)				
		3 (5884)	24.80	3.78	0.46
	【Unit-4:Hoson-C】(Ⅲ)				
		4 (5884)	279.60	42.58	5.14
	Total		400.30	60.97	7.35
	Ramtha				
	【Unit-1:Sabea-A】(I)				
		1 (SEB-1)	330.60	50.35	6.07
	【Unit-2:Sabea-A】(II)				
		2 (SEB-2)	40.20	6.12	0.74
	【Unit-3:Thamen】(II)				
		3 (112)	67.20	10.23	1.23
	【Unit-4:Sades-A】(I)				
		4 (1460)	27.80	4.23	0.51
	【Unit-5:Arraba,Aththalth】(I)				
		5 (547)	22.60	3.44	0.42
		6 (1193)	18.20	2.77	0.33
		7 (1966)	33.80	5.15	0.62
	【Unit-6:Aasher】(II)				
		8 (1696)	80.90	12.32	1.49
		9 (90)	56.70	8.64	1.04
	【Unit-7:Tesea-B】(II)				
		10 (1652)	48.00	7.31	0.88
		11 (99)	15.30	2.33	0.28
		12 (97)	37.50	5.71	0.69
	【Unit-8:Torrah】(Ⅲ)				
		13 (TOR-1)	317.19	48.31	5.83
	【Unit-9:Shajarah】(Ⅲ)				
		14 (SH-1)	204.70	31.18	3.76
	【Unit-10:Emrawah】(Ⅲ)				
		15 (EM-1)	40.80	6.21	0.75
	【Unit-11:Dnaibeh】(Ⅲ)				
		16 (DN-1)	74.00	11.27	1.36
	Total		1415.49	215.58	26.01
Total		(Million JD)	8479.3	1,291.4	155.79
		(Million USD)			220.70

Planning Area	Priority I	Priority II	Priority III
Wadi Al-Arab	167.36	87.45	61.33
	1098.90	574.20	402.70
	20.19	10.55	7.40
	0.1523	0.1523	0.1523
Shallala	89.37	38.87	128.62
	586.8	255.2	844.50
	10.78	4.69	15.52
	0.1523	0.1523	0.1523
Wadi Hassan	0.00	18.38	42.58
	0.00	120.70	279.60
	0	2.22	5.14
	0	0.1523	0.1523
Ramtha	65.95	52.67	96.97
	433.00	345.80	636.69
	7.96	6.35	11.70
	0.1523	0.1523	0.1523
Mafraq	121.93	164.27	155.65
	800.60	1078.60	1022.00
	14.71	19.82	18.78
	0.1523	0.1523	0.1523

APPENDIX III-A CAPACITY CALCULATION FOR EXISTING AND CONSTRUCTING FACILITIES OF EACH WWTP

The capacity calculations on exiting and constructing facilities of each WWTP are shown as follows.

1. Basis of Capacity Calculation

The capacity calculation is based on design flow of existing plan and actual quality (or design quality if design quality is more concentrated than actual).

The WWTPs of Central Irbid and Mafraq are constructing new water treatment facilities on July in 2014. The capacity calculation is considered to these new facilities.

The dimensions of each tank are referred to the drawings, hearing and site investigations.

2. Capacity Calculation for Central Irbid WWTP

Design Flow						
Average Daily Flow (ADF)	=	11,950	m^3/day			
Maximum Daily Flow (MDF)	=	14,000	m^3/day			
Maximum Hourly Flow (MHF)	=	21,000	m^3/day			
Actual Influent Quality						
BOD	=	845	mg/l (Including return water =		930	mg/l)
SS	=	689	mg/l (Including return water =		758	mg/l)
Temperaure	15	～	28 ℃			
Removal Efficiency						
Primary Sedimentation Tank						
BOD	=	40.0%				
SS	=	50.0%				
Oxdation Ditch						
BOD	=	95.0%				
SS	=	95.0%				
Total Removal Efficiency						
BOD	=	97.0%				
SS	=	97.5%				
Treated Wastewater Quality						
After primary sedimentaiton tank						
BOD	=	557.7	mg/l			
SS	=	379.0	mg/l			
After trickling filter						
BOD	=	27.9	mg/l (<	30 mg/L)		
SS	=	18.9	mg/l (<	30 mg/L)		
Generated Sludge Amount						
Removal Solid Weight	=	757.9	mg/l ×	14,000	m^3/day ×	97.5%
	=	10.3	t/day			
Sludge Thickener						
Collection Rate	=	80.0%				
Tickenered Sludge Weight	=	8.3	t/day			
Solid Concentration	=	3.0%				
Dewatered Sludge Volume	=	275.9	m^3/day			
Digested Sludge						
Digestive Efficiency	=	50.0%				
Organic Matter Content Rate	=	85.0%				
Digested Sludge Solid Weight	=	4.8	t/day			
Solid Concentration	=	1.7%				
Dewatered Sludge Volume	=	275.9	m^3/day			

Sludge Holding Tank

Collection Rate	=	80.0%	
Tickenered Sludge Weight	=	3.8	t/day
Solid Concentration	=	2.5%	
Dewatered Sludge Volume	=	152.3	m^3/day

Pretreatment Facilities								
Coarse Screen	Manual							
Fine Screen	Automatical							
Grit Chamber	Aerated Grit Chamber with Grease Trap							
	L= 10	m, W= 2.2	m, D= 2	m, N= 2				
	Volume = 44 m^3 × 2 = 88 m^3							
	Retention Time = 6.03 mins							
Primary Sedimentation Tank	Rectanglar Tank							
	L= 36.0	m, W= 6.0	m, D= 3.2	m, N= 2				
	A= 216 m^2 × 2	=	432 m^2					
	Required Surface Load =	=	35	m^3/m^2/day				
	Actual Surface Load =	=	32.41	m^3/m^2/day				
Biocemical Facilities								
Aeration Tank	Oxidation Ditch							
	L= 60.0	m, W= 20.0	m, D= 4.5	m, N= 2				
	V= 5,014 m^3 × 2	=	10,027 m^3					
	MLSS	=	5,000	mg/l				
	MLVSS (MLSS *0.85)	=	4,250	mg/l				
	Design BOD/MLVSS Load	=	0.200	kgBOD/kgSS/d				
	Actual BOD/MLVSS Load	=	BOD * MDF / MLVSS / V					
		=	0.183	kgBOD/kgSS/d				
	Design Retention Time (θ)	=	BOD / MLVSS / Design Load					
		=	0.66	days				
	Actual Retention Time (θ)	=	0.72	days				
Sedimentation Tank	Circular Tank							
	Diameter = 30 m, D= 3.5 m, N= 2							
	A= 707 m^2 × 2	=	1,414 m^2					
	Maximum SVI	=	200					
	Required Surface Load =	=	10.79	m^3/m^2/day				
	(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))							
	Actual Surface Load =	=	9.90	m^3/m^2/day				
Disinfection Facilities	Chlorine Contact Basin							
	L= 102	m, W= 1.50	m, D= 3.00	m, N= 2				
	V= 459 m^3 × 2	=	918 m^3					
	Design Retention Time	=	20.0	minutes				
	Actual Retention Time	=	62.9	minutes				

Sludge Thickener	Diameter = 18.0 m, N= 1			
	Surface Area	=	254.5	m^2
	Design Surface Load	=	90.00	$kg/m^2/day$
	Actural Surface Load	=	40.65	$kg/m^2/day$
Sludge Digestion Tank	Diameter = 26.0 m, L= 7 m, N= 1			
	Tank Volume	=	3,717	m^3
	Design Surface Load	=	15.0	days
	Actural Retention Time	=	13.5	days
Sludge Holding Tank	Diameter = 8.0 m, N= 1			
	Surface Area	=	50.3	m^2
	Design Surface Load	=	90.00	$kg/m^2/day$
	Actural Surface Load	=	94.67	$kg/m^2/day$

3. Capacity Calculation for Wadi Al-Arab WWTP

Design Flow							
Average Daily Flow (ADF)	=	20,800	m^3/day				
Maximum Daily Flow (MDF)	=	24,300	m^3/day				
Maximum Hourly Flow (MHF)	=	36,500	m^3/day				
Actual Influent Quality							
BOD	=	811	mg/l (Including return water =			892	mg/l)
SS	=	471	mg/l (Including return water =			518	mg/l)
Temperaure	15 ～	28 ℃					
Removal Efficiency							
Biochemical Treatment							
BOD	=	95.0%					
SS	=	95.0%					
Sand Filter							
BOD	=	40.0%					
SS	=	60.0%					
Total Removal Efficiency							
BOD	=	97.0%					
SS	=	98.0%					
Treated Wastewater Quality							
After biochemical treatment							
BOD	=	44.6	mg/l (<	60 mg/L after Biocemical treatment)			
SS	=	25.9	mg/l (<	60 mg/L after Biocemical treatment)			
After sand filter							
BOD	=	26.8	mg/l (<	30 mg/L after sand filter)			
SS	=	10.4	mg/l (<	30 mg/L after sand filter)			
Generated Sludge Amount							
Removal Solid Weight	=	518.1	mg/l ×	24,300	m^3/day ×	98.0%	
	=	12.3	t/day				
Sludge Thickener							
Collection Rate	=	80.0%					
Tickenered Sludge Weight	=	9.9	t/day				
Solid Concentration	=	3.0%					
Dewatered Sludge Volume	=	329.0	m^3/day				
Mechanical Dewatering							
Collection Rate	=	95.0%					
Dewatered Sludge Weight	=	9.4	t/day				
Solid Concentration	=	20.0%					
Dewatered Sludge Volume	=	46.9	m^3/day				

Pretreatment Facilities								
Coarse Screen	Manual							
Fine Screen	Automatical							
Grit Chamber	Aerated Grit Chamber with Grease Trap							
	L=	38	m, W=	2.8	m, D=	2	m, N=	1
	Volume =	212.8	m^3 ×	1 =	212.8	m^3		
	Retention Time =	8.40	mins					
Biocemical Facilities								
Aeration Tank	Extended Aeration Activated Sludge							
	L=	72.0	m, W=	18.0	m, D=	4.5	m, N=	6
	V=	5,832	m^3 ×	6	=	34,992	m^3	
	MLSS			=	4,000	mg/l		
	MLVSS (MLSS *0.85)			=	3,400	mg/l		
	Design BOD/MLVSS Load			=	0.200	kgBOD/kgSS/d		
	Actual BOD/MLVSS Load			=	BOD * MDF / MLVSS / V			
				=	0.182	kgBOD/kgSS/d		
	Design Retention Time (θ)			=	BOD / MLVSS / Design Load			
				=	1.31	days		
	Actual Retention Time (θ)			=	1.44	days		
Sedimentation Tank	Circular Tank							
	Diameter =	21	m, D=	3.4	m, N=	9		
	A=	346	m^2 ×	9	=	3,117	m^2	
	Maximum SVI			=	200			
	Required Surface Load =			=	14.59	$m^3/m^2/day$		
	(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))							
	Actual Surface Load =			=	7.80	$m^3/m^2/day$		
Sand Filer	Filtration Rate			=	300	m/day		
	Required Filtration Area			=	81	m^2		
	L=	10	m, W=	6.00	m, N=	2		
	Design Area			=	120	m2		
Disinfection Facilities	Chlorine Contact Basin							
	L=	150	m, W=	2.45	m, D=	2.00	m, N=	2
	V=	735	m^3 ×	2	=	1,470	m^3	
	Design Retention Time			=	20.0	minutes		
	Actual Retention Time			=	58.0	minutes		
Sludge Thickener	Diameter =	12.0	m, N=	2				
	Surface Area			=	226.2	m^2		
	Design Surface Load			=	90.00	$kg/m^2/day$		
	Actural Surface Load			=	54.55	$kg/m^2/day$		
Dewatering Machine	Centrifugal Dewatering							
	Operation Time	(in a day)		=	8	hours/day		
		(in a week)		=	5.0	days/week		
	Required Capacity			=	58	m^3/hour		
	Design Machine Capacity			=	40	m^3/hour/machine		
	Design Machine Number			=	3			

4. Capacity Calculation for Shallala WWTP

Design Flow

Average Daily Flow (ADF)	=	13,700	m^3/day			
Maximum Daily Flow (MDF)	=	16,000	m^3/day			
Maximum Hourly Flow (MHF)	=	24,000	m^3/day			

Design Influent Quality (no actual data)

BOD	=	884	mg/l (Including return water =	972	mg/l)	
SS	=	816	mg/l (Including return water =	898	mg/l)	

Temperaure 15 ～ 28 ℃

Removal Efficiency

Primary Sedimentation Tank

BOD	=	50.0%
SS	=	60.0%

Oxidation Ditch

BOD	=	95.0%
SS	=	95.0%

Total Removal Efficiency

BOD	=	97.5%
SS	=	98.0%

Treated Wastewater Quality

After primary sedimentaiton tank

BOD	=	486.2	mg/l
SS	=	359.0	mg/l

After oxidation ditch

BOD	=	24.3	mg/l (< 30 mg/L)
SS	=	18.0	mg/l (< 30 mg/L)

Generated Sludge Amount

Primary Removal Solid Weight	=	897.6	mg/l ×	16,000	m^3/day ×	60.0%
	=	8.6	t/day			
Secondary Removal Solid Weight	=	359.0	mg/l ×	16,000	m^3/day ×	95.0%
	=	5.5	t/day			

Sludge Gravity Thickener

Collection Rate	=	80.0%	
Tickenered Sludge Weight	=	6.9	t/day
Solid Concentration	=	4.0%	
Dewatered Sludge Volume	=	172.3	m^3/day

Belt Thickener

Collection Rate	=	95.0%	
Tickenered Sludge Weight	=	5.2	t/day
Solid Concentration	=	4.0%	
Dewatered Sludge Volume	=	129.6	m^3/day

Digested Sludge (First Stage)

Digestive Efficiency	=	50.0%	
Organic Matter Content Rate	=	85.0%	
Digested Sludge Solid Weight	=	6.9	t/day
Solid Concentration	=	2.3%	
Dewatered Sludge Volume	=	302.0	m^3/day

Digested Sludge (second Stage)

Collection Rate	=	80.0%	
Tickenered Sludge Weight	=	5.6	t/day
Solid Concentration	=	3.0%	
Dewatered Sludge Volume	=	185.2	m^3/day

Sludge Dewatering

Collection Rate	=	95.0%	
Tickenered Sludge Weight	=	5.3	t/day
Solid Concentration	=	20.0%	
Dewatered Sludge Volume	=	26.4	m^3/day

Pretreatment Facilities

Coarse Screen	Manual							
Fine Screen	Automatical							
Grit Chamber	Aerated Grit Chamber with Grease Trap							
	L=	30	m, W=	3	m, D=	2	m, N=	2
	Volume =	180	m^3 ×	2 =	360	m^3		
	Retention Time =	21.60	mins					
Equalization Tank (for rain season)								
	L=	72.0	m, W=	10.0	m, D=	5	m, N=	5
	V=	3,493	m^3 ×	5	=	17,463	m^3	
	Retenciotn Time (at MHF)				=	17.5	hours	
Primary Sedimentation Tank	Rectanglar Tank							
	L=	32.0	m, W=	7.0	m, D=	3	m, N=	2
	A=	224	m^2 ×	2	=	448	m^2	
	Required Surface Load =				=	35	m^3/m^2/day	
	Actual Surface Load =				=	35.71	m^3/m^2/day	

Biocemical Facilities

Aeration Tank	Oxidation Tank							
	L=	58.0	m, W=	20.0	m, D=	4.5	m, N=	2
	V=	4,834	m^3 ×	2	=	9,667	m^3	
	MLSS				=	5,000	mg/l	
	MLVSS (MLSS *0.85)				=	4,250	mg/l	
	Design BOD/MLVSS Load				=	0.200	kgBOD/kgSS/d	
	Actual BOD/MLVSS Load				=	BOD * MDF / MLVSS / V		
					=	0.189	kgBOD/kgSS/d	
	Design Retention Time (θ)				=	BOD / MLVSS / Design Load		
					=	0.57	days	
	Actual Retention Time (θ)				=	0.60	days	
Sedimentation Tank	Circular Tank							
	Diameter =	42	m, D=	3	m, N=	2		
	A=	1,385	m^2 ×	2	=	2,771	m^2	
	Maximum SVI				=	200		
	Required Surface Load =				=	10.79	m^3/m^2/day	
	(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))							
	Actual Surface Load =				=	5.77	m^3/m^2/day	

Disinfection Facilities	Chlorine Contact Basin
	No Data

Sludge Gravity Thickener	Diameter = 10.0 m, N= 3			
	Surface Area	=	235.6	m^2
	Design Surface Load	=	90.00	$kg/m^2/day$
	Actural Surface Load	=	36.57	$kg/m^2/day$
Belt Thickener	Solid Weight	=	5.46	t/day
	Solid Concentration	=	0.80%	
	Required Capacity	=	682	m3/day
		=	28	m3/hour
	Actual Capacity	=	65	m3/hour × 2
		(45 - 90 m3/hour)		
Sludge Digestion Tank				
Fist Stage	Diameter 18.0 m, L= 13 m, N= 3			
	Tank Volume	=	9,924	m^3
	Design Surface Load	=	20.0	days
	Actural Retention Time	=	32.9	days
Second Stage	Diameter 12.0 m, L= 10 m, N= 1			
	Surface Area	=	113.1	m^2
	Design Surface Load	=	90.00	$kg/m^2/day$
	Actural Surface Load	=	60.95	$kg/m^2/day$
Dewatering Machine	Centrifugal Dewatering			
	Operation Time (in a day)	=	8	hours/day
	(in a week)	=	5.0	days/week
	Required Capacity	=	32.41	m^3/hour
	Design Machine Capacity	=	30	m^3/hour/machine
	Design Machine Number	=	2	(including sdand-by)

5. Capacity Calculation for Wadi Hassan WWTP

Design Flow

Average Daily Flow (ADF)	=	1,600	m^3/day	
Maximum Daily Flow (MDF)	=	1,900	m^3/day	
Maximum Hourly Flow (MHF)	=	2,800	m^3/day	

Actual Influent Quality

BOD	=	1076	mg/l (Including return water =	1,184	mg/l)
SS	=	710	mg/l (Including return water =	781	mg/l)

Temperaure 15 ～ 28 ℃

Removal Efficiency

Oxidation Ditch

BOD	=	95.0%
SS	=	95.0%

Polishing Pond

BOD	=	50.0%
SS	=	50.0%

Total Removal Efficiency

BOD	=	97.5%
SS	=	97.5%

Treated Wastewater Quality

After oxidation ditch

BOD	=	59.2	mg/l
SS	=	39.1	mg/l

After polishing pond

BOD	=	29.6	mg/l (< 30 mg/L)
SS	=	19.5	mg/l (< 30 mg/L)

Generated Sludge Amount

Removal Solid Weight	=	781	mg/l ×	1,900	m^3/day ×	95.0%
	=	1.4	t/day			

Sludge Gravity Thickener

Collection Rate	=	80.0%	
Tickenered Sludge Weight	=	1.1	t/day
Solid Concentration	=	3.0%	
Dewatered Sludge Volume	=	37.6	m^3/day

Sludge Drying Bed

Collection Rate	=	90.0%	
Tickenered Sludge Weight	=	1.0	t/day
Solid Concentration	=	50.0%	
Dewatered Sludge Volume	=	2.0	m^3/day

Pretreatment Facilities

Coarse Screen: Manual

Fine Screen: Automatical

Grit Chamber: Aerated Grit Chamber with Grease Trap
L= 20 m, W= 2 m, D= 1.6 m, N= 1
Volume = 64 m^3 × 1 = 64 m^3
Retention Time = 32.91 mins

Biocemical Facilities

Aeration Tank: Oxidation Tank
L= 60.0 m, W= 14.0 m, D= 3 m, N= 2
V= 2,394 m^3 × 2 = 4,788 m^3
MLSS = 4,000 mg/l
MLVSS (MLSS *0.85) = 3,400 mg/l
Design BOD/MLVSS Load = 0.300 kgBOD/kgSS/d
Actual BOD/MLVSS Load = BOD * MDF / MLVSS / V
= 0.138 kgBOD/kgSS/d
Design Retention Time (θ) = BOD / MLVSS / Design Load
= 1.16 days
Actual Retention Time (θ) = 2.52 days

Sedimentation Tank: Circular Tank
Diameter = 15 m, D= 3.8 m, N= 2
A= 177 m^2 × 2 = 353 m^2
Maximum SVI = 200
Required Surface Load = = 14.59 m^3/m^2/day
(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))
Actual Surface Load = = 5.38 m^3/m^2/day

Polishing Pond: 2 Steps
L= 88.0 m, W= 60.0 m, D= 1.8 m, N= 4
V= 9,504 m^3 × 4 = 38,016 m^3
Actual Retention Time (θ) = 20.01 days
BOD Reduction (k= 0.1)= 1/(1+kθ/n)^n = 0.25

Disinfection Facilities: Chlorine Contact Basin
V= 100 m^3 × 1 = 100 m^3
Design Retention Time = 20.0 minutes
Actual Retention Time = 51.4 minutes

Sludge Gravity Thickener: Diameter = 11.2 m, N= 1
Surface Area = 98.5 m^2
Design Surface Load = 90.0 kg/m^2/day
Actural Surface Load = 14.3 kg/m^2/day

Sludge Drying Bed: Solid Weight (for ADF) = 0.95 t/day
= 347 t/year
L= 30.0 m, W= 6.0 m, N= 16
A= 180 m2 × 16 = 2,880 m^2
Required Surface Load = = 120 kg/m^2/year
Actual Surface Load = = 120 kg/m^2/year

6. Capacity Calculation for Ramtha WWTP

Design Flow

Average Daily Flow (ADF)	=	5,400	m^3/day
Maximum Daily Flow (MDF)	=	6,300	m^3/day
Maximum Hourly Flow (MHF)	=	9,500	m^3/day

Actual Influent Quality

BOD	=	794	mg/l (Including return water =	873	mg/l)
SS	=	351	mg/l (Including return water =	386	mg/l)

Temperaure 15 ～ 28 ℃

Removal Efficiency

Extended Aeration Activated Sludge

BOD	=	95.0%
SS	=	95.0%

Polishing Pond

BOD	=	30.0%
SS	=	30.0%

Total Removal Efficiency

BOD	=	96.5%
SS	=	96.5%

Treated Wastewater Quality

After extended aeration activated sludge

BOD	=	43.7	mg/l
SS	=	19.3	mg/l

After polishing pond

BOD	=	30.6	mg/l (< 30 mg/L)
SS	=	13.5	mg/l (< 30 mg/L)

Generated Sludge Amount

Removal Solid Weight	=	386.1	mg/l ×	6,300	m^3/day ×	96.5%
	=	2.3	t/day			

Sludge Gravity Thickener

Collection Rate	=	80.0%	
Tickenered Sludge Weight	=	1.9	t/day
Solid Concentration	=	3.0%	
Dewatered Sludge Volume	=	62.6	m^3/day

Sludge Drying Bed

Collection Rate	=	95.0%	
Tickenered Sludge Weight	=	1.8	t/day
Solid Concentration	=	20.0%	
Dewatered Sludge Volume	=	8.9	m^3/day

Pretreatment Facilities								
Coarse Screen	Manual							
Fine Screen	Automatical							
Grit Chamber	Aerated Grit Chamber with Grease Trap							
	Diameter =	5.0	m, D=	3.3	m, N=	2		
	Volume =	64.8	m^3 ×	2 =	129.6	m^3		
	Retention Time =	19.64	mins					
Equalization Tank (for rain season)								
	L=	70.0	m, W=	25.0	m, D=	3	m, N=	2
	V=	5,250	m^3 ×	2	=	10,500	m^3	
	Retenciotn Time (at MHF)				=	26.5	hours	
Biocemical Facilities								
Aeration Tank	Extended Aeration Activated Sludge							
	L=	50.1	m, W=	33.4	m, D=	4.5	m, N=	2
	V=	7,530	m^3 ×	2	=	15,060	m^3	
	MLSS				=	5,000	mg/l	
	MLVSS (MLSS *0.85)				=	4,250	mg/l	
	Design BOD/MLVSS Load				=	0.200	kgBOD/kgSS/d	
	Actual BOD/MLVSS Load				=	BOD * MDF / MLVSS / V		
					=	0.086	kgBOD/kgSS/d	
	Design Retention Time (θ)				=	BOD / MLVSS / Design Load		
					=	1.03	days	
	Actual Retention Time (θ)				=	2.39	days	
Sedimentation Tank	Circular Tank							
	Diameter =	22	m, D=	3.0	m, N=	2		
	A=	380	m^2 ×	2	=	760	m^2	
	Maximum SVI				=	200		
	Required Surface Load =				=	10.79	m^3/m^2/day	
	(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))							
	Actual Surface Load =				=	8.29	m^3/m^2/day	
Polishing Pond	5 Steps							
	L=	33.0	m, W=	82.0	m, D=	2	m, N=	10
	V=	5,412	m^3 ×	10	=	54,120	m^3	
	Actual Retention Time (θ)				=	8.59	days	
	BOD Reduction (k=			0.14	)= 1/(1+kθ/n)^n =		0.34	
Disinfection Facilities	Chlorine Contact Basin							
	L=	52.5	m, W=	1.40	m, D=	3.50	m, N=	2
	V=	257	m^3 ×	2	=	515	m^3	
	Design Retention Time				=	20.0	minutes	
	Actual Retention Time				=	78.0	minutes	
Irrigation Reservoir (for rain season)								
	L=	63.2	m, W=	43.0	m, D=	3.5	m, N=	1
	V=	8,123	m^3 ×	1	=	8,123	m^3	
	Retenciotn Time (at MDF)				=	30.9	hours	

Sludge Gravity Thickener	Diameter =	9.0	m, N=	3		
	Surface Area			=	190.9	m^2
	Design Surface Load			=	90.0	$kg/m^2/day$
	Actural Surface Load			=	12.3	$kg/m^2/day$
Sludge Drying Bed	Solid Weight (for ADF)			=	1.61	t/day
				=	587	t/year
	L= 25.0	m, W=	6.0	m, N=	100	
	A= 150	$m^2 \times$	100	=	15,000	m^2
	Required Surface Load =			=	200	$kg/m^2/year$
	Actual Surface Load =			=	39	$kg/m^2/year$

7. Capacity Calculation for Mafraq WWTP

Design Flow					
Average Daily Flow (ADF)	=	6,550	m^3/day		
Maximum Daily Flow (MDF)	=	7,700	m^3/day		
Maximum Hourly Flow (MHF)	=	11,500	m^3/day		
Design Influent Quality (no actual deta)					
BOD	=	707	mg/l (Including return water =	778	mg/l)
SS	=	653	mg/l (Including return water =	718	mg/l)
Temperaure	15	～	28 ℃		
Removal Efficiency					
Sedimentation Tank					
BOD	=	35.0%			
SS	=	60.0%			
MBBR					
BOD	=	30.0%			
SS	=	0.0%			
Aerated Stabilization Pond + Facltative Pond					
BOD	=	90.0%			
SS	=	90.0%			
Sand Filter + Reed Beds					
BOD	=	50.0%			
SS	=	50.0%			
Total Removal Efficiency					
BOD	=	97.7%			
SS	=	98.0%			
Treated Wastewater Quality					
After Sedimentation Tank					
BOD	=	505.5	mg/l		
SS	=	287.3	mg/l		
After MBBR					
BOD	=	353.9	mg/l		
SS	=	287.3	mg/l		
After Aerated Stablization Pond + Facultative Pond					
BOD	=	35.4	mg/l (<	60 mg/L)	
SS	=	28.7	mg/l (<	60 mg/L)	
After Sand Filter + Reed Beds					
BOD	=	17.7	mg/l		
SS	=	14.4	mg/l		

Generated Sludge Amount

Removal Solid Weight

From Sedimentation Tank	=	718.3	mg/l ×	7,700	m^3/day ×	60.0%
	=	3.3	t/day			
From Facalutative Pond	=	258.6	mg/l ×	7,700	m^3/day ×	90.0%
	=	1.8	t/day			

Sludge Stabilization Basin from Sedimentation Tank

Tickenered Sludge Weight	=	3.3	t/day
Solid Concentration	=	3.0%	
Dewatered Sludge Volume	=	110.6	m^3/day
Required Retention Time	=	15.0	days
Required Tank Volume	=	1,659	m^3

Solids in Faculatative Basin

Tickenered Sludge Weight	=	1.8	t/day
Reduction Rate in Pond	=	66%	
Solid Concentration	=	15.0%	(after consolidation)
Dewatered Sludge Volume	=	7.9	m^3/day

Sludge Drying Bed from Sludge Stabilization Basin

Reduaction Rate in Basin	=	86%	
Tickenered Sludge Weight	=	2.9	t/day
Solid Concentration	=	50.0%	
Dewatered Sludge Volume	=	5.7	m^3/day

Pretreatment Facilities

Coarse Screen	Manual									
Fine Screen	Automatical									
Oil & Grease Removal	Diameter =	5.9	m, D=		3	m, N=	2			
	Volume =	82.0	m^3 ×		2 =	164.0	m^3			
	Actural Retention Time				=	20.54	mins			
Primary Settling Tank with Grit Chamber										
	L=	8.3	m, W=	4.3	m, D=	6.75	m, N=	2		
	Area =	35.7	m^2 ×		2 =	71.4	m^2			
	Design Surface Load				=	120.0	m^3/m^2/day			
	Actural Surface Load				=	107.9	m^3/m^2/day			
Wet Weather Strage Lagoon (for rain season)										
	L=	60.0	m, W=	60.0	m, D=	4	m, N=	1		
	V=	14,400	m^3 ×	1	=	14,400	m^3			
	Retenciotn Time (at MHF)				=	30.1	hours			

Biocemical Facilities

Denitrification Tank (MBBR)	NO_3-N Concentration of Circulation :					15.0	mg/L (g/m^3)	
	Circulation Rate for Denitrificaiton :					5.0	times	
	NO_3-N Load				=	578	kg/day	
	Denitrificaiton Rate				=	1.24	g/m^2/day	
	Plastic Media Specific Surface				=	500	m^2/m^3	
	Volume of Denitrification Media				=	931	m^3	
	Media Volume / Tanks Volume				=	0.45		
	Effective Tank Volume				=	2,070	m^3	
	L=	26.0	m, W=	15.0	m, D=	3.5	m, N=	2
	V=	1,365	m^3 ×	2	=	2,730	m^3	
	Retenciotn Time (at MDF)				=	8.5	hours	
	BOD Removal Rate				=	3.40	gBOD/gNO_3-N	
	BOD Removal Amount				=	1,964	kgBOD/day	
	BOD Concentration of Circulation :					40.0	mg/L (g/m^3)	
	Influent BOD				=	5,990	kgBOD/day	
	Toatl Removal Rate of BOD				=	32.8%		
Aeration Stablization Basins	5 Steps							
	L=	84.0	m, W=	34.0	m, D=	3.5	m, N=	10
	V=	9,996	m^3 ×	10	=	99,960	m^3	
	Actual Retention Time (θ)				=	12.98	days	
	BOD Reduction (k=			0.3	)= 1/(1+kθ/n)^n =		0.056	
Denitrification Tank (MBBR)	TKN Concentration of Influent =					115.0	mg/L (g/m^3)	
	TKN Concentration of Effluent =					15.0	mg/L (g/m^3)	
	TKN Load				=	770	kg/day	
	Nitrificaiton Rate				=	0.95	g/m^2/day	
	Plastic Media Specific Surface				=	500	m^2/m^3	
	Volume of Denitrification Media				=	1,621	m^3	
	Media Volume / Tanks Volume				=	0.67		

	Effective Tank Volume				=	2,419 m^3		
	L= 26.0	m, W=	15.0	m, D=	3.5	m, N=	2	
	V= 1,365	m^3 ×	2		=	2,730 m^3		
	Retenciotn Time (at MDF)				=	8.5 hours		
Facultative Pond with Rock Filter	1 Steps							
	L= 73.0	m, W=	37.0	m, D=	3.5	m, N=	2	
	V= 9,454	m^3 ×	2		=	18,907 m^3		
	Actual Retention Time (θ)				=	2.46	days	
	BOD Reduction (k=		0.1	)= 1/(1+kθ/n)^n =		0.803		
	Rcok Media Load				=	1.00	m^3/m^3 of rock /day	
	Required Rock Volume				=	7,700 m^3		
					=	5,750 m^3/basin		
Sand Filter	L= 80.0	m, W=	45.0	m, N=	3			
	V= 3,600	m^2 ×	3		=	10,800 m^2		
	Design Surface Load				=	0.80	m^3/m^2/day	
	Actual Surface Load				=	0.71	m^3/m^2/day	
Reed Beds	L= 50.0	m, W=	30.0	m, N=	2			
	V= 1,500	m^2 ×	2		=	3,000 m^2		
	Design Surface Load				=	2.60	m^3/m^2/day	
	*2.60 m^3/m^2/day=80kg/ha/day(NO_3-N)/0.003kg/m^3							
	Actual Surface Load				=	2.18	m^3/m^2/day	
Disinfection Facilities	Chlorine Contact Basin							
	L= 50	m, W=	2.00	m, D=	1.80	m, N=	1	
	V= 180	m^3 ×	1		=	180 m^3		
	Design Retention Time				=	20.0	minutes	
	Actual Retention Time				=	22.5	minutes	
Sludge Strage Tank	L= 15.0	m, W=	15.0	m, D=	3	m, N=	2	
	V= 675	m^3 ×	2		=	1,350 m^3		
	Design Retention Time				=	15.00	days	
	Actual Retention Time				=	12.20	days	
Sludge Drying Bed	Solid Weight (for ADF)				=	2.43 t/day		
					=	886 t/year		
	L= 35.0	m, W=	12.0	m, N=	26			
	A= 420	m^2 ×	26		=	10,920 m^2		
	Required Surface Load =				=	100	kg/m^2/year	
	Actual Surface Load =				=	81	kg/m^2/year	

APPENDIX III-B CAPACITY CALCULATION FOR PLANNED FACILITIES OF EACH WWTP IN MASTER PLAN

The capacity calculations on planned facilities of each WWTP in this master plan are shown as follows.

1. Basis of Capacity Calculation

The capacity calculation is based on design flow and quality in this master plan.

The dimensions of each tank are referred to the drawings, hearing and site investigations as Appendix III-A.

The capacity calculations of Mafraq WWTP are conducted two cases.

2. Capacity Calculation for Central Irbid WWTP

Design Flow						
Average Daily Flow (ADF)	=	10,873	m^3/day			
Maximum Daily Flow (MDF)	=	12,721	m^3/day			
Maximum Hourly Flow (MHF)	=	19,086	m^3/day			
Design Influent Quality						
BOD	=	706	mg/l (Including return water =	777	mg/l)	
SS	=	652	mg/l (Including return water =	717	mg/l)	
Temperaure	15 ～ 28 ℃					
Removal Efficiency						
Primary Sedimentation Tank						
BOD	=	50.0%				
SS	=	60.0%				
Oxdation Ditch						
BOD	=	95.0%				
SS	=	95.0%				
Total Removal Efficiency						
BOD	=	97.5%				
SS	=	98.0%				
Treated Wastewater Quality						
After primary sedimentaiton tank						
BOD	=	388.3	mg/l			
SS	=	286.9	mg/l			
After trickling filter						
BOD	=	19.4	mg/l (<	30 mg/L)		
SS	=	14.3	mg/l (<	30 mg/L)		
Generated Sludge Amount						
Removal Solid Weight	=	717.2	mg/l ×	12,721	m^3/day ×	98.0%
	=	8.9	t/day			
Sludge Thickener						
Collection Rate	=	80.0%				
Tickenered Sludge Weight	=	7.2	t/day			
Solid Concentration	=	3.0%				
Dewatered Sludge Volume	=	238.4	m^3/day			
Digested Sludge						
Digestive Efficiency	=	50.0%				
Organic Matter Content Rate	=	85.0%				
Digested Sludge Solid Weight	=	4.1	t/day			
Solid Concentration	=	1.7%				
Dewatered Sludge Volume	=	238.4	m^3/day			

Sludge Holding Tank

Collection Rate	=	80.0%	
Tickenered Sludge Weight	=	3.3	t/day
Solid Concentration	=	2.5%	
Dewatered Sludge Volume	=	131.6	m^3/day

Sludge Dewatering

Collection Rate	=	95.0%	
Tickenered Sludge Weight	=	3.1	t/day
Solid Concentration	=	20.0%	
Dewatered Sludge Volume	=	15.6	m^3/day

Pretreatment Facilities								
Coarse Screen	Manual							
Fine Screen	Automatical							
Grit Chamber	Aerated Grit Chamber with Grease Trap							
	L=	10	m, W=	2.2	m, D=	2	m, N=	2
	Volume =	44	m^3 ×	2 =	88	m^3		
	Retention Time =	6.64	mins					
Primary Sedimentation Tank	Rectanglar Tank							
	L=	36.0	m, W=	6.0	m, D=	3.2	m, N=	2
	A=	216	m^2 ×	2	=	432	m^2	
	Required Surface Load =				=	35	m^3/m^2/day	
	Actual Surface Load =				=	29.45	m^3/m^2/day	
Biocemical Facilities								
Aeration Tank	Oxidation Ditch							
	L=	60.0	m, W=	20.0	m, D=	4.5	m, N=	2
	V=	5,014	m^3 ×	2	=	10,027	m^3	
	MLSS				=	5,000	mg/l	
	MLVSS (MLSS *0.85)				=	4,250	mg/l	
	Design BOD/MLVSS Load				=	0.200	kgBOD/kgSS/d	
	Actual BOD/MLVSS Load				=	BOD * MDF / MLVSS / V		
					=	0.116	kgBOD/kgSS/d	
	Design Retention Time (θ)				=	BOD / MLVSS / Design Load		
					=	0.46	days	
	Actual Retention Time (θ)				=	0.79	days	
Sedimentation Tank	Circular Tank							
	Diameter =	30	m, D=	3.5	m, N=	2		
	A=	707	m^2 ×	2	=	1,414	m^2	
	Maximum SVI				=	200		
	Required Surface Load =				=	10.79	m^3/m^2/day	
	(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))							
	Actual Surface Load =				=	9.00	m^3/m^2/day	
Disinfection Facilities	Chlorine Contact Basin							
	L=	102	m, W=	1.50	m, D=	3.00	m, N=	2
	V=	459	m^3 ×	2	=	918	m^3	
	Design Retention Time				=	20.0	minutes	
	Actual Retention Time				=	69.3	minutes	

Sludge Thickener	Diameter = 18.0 m, N= 1			
	Surface Area	=	254.5	m^2
	Design Surface Load	=	90.00	$kg/m^2/day$
	Actural Surface Load	=	35.14	$kg/m^2/day$
Sludge Digestion Tank	Diameter = 26.0 m, L= 7 m, N= 1			
	Tank Volume	=	3,717	m^3
	Design Surface Load	=	15.0	days
	Actural Retention Time	=	15.6	days
Sludge Holding Tank	Diameter = 8.0 m, N= 1			
	Surface Area	=	50.3	m^2
	Design Surface Load	=	90.00	$kg/m^2/day$
	Actural Surface Load	=	81.82	$kg/m^2/day$
Dewatering Machine	Centrifugal Dewatering			
	Operation Time (in a day)	=	8	hours/day
	(in a week)	=	5.0	days/week
	Required Capacity	=	23	m^3/hour
	Design Machine Capacity	=	30	m^3/hour/machine
	Design Machine Number	=	2	(including sdand-by)

3. Capacity Calculation for Wadi Al-Arab WWTP

Design Flow

Average Daily Flow (ADF)	=	28,429	m^3/day
Maximum Daily Flow (MDF)	=	33,258	m^3/day
Maximum Hourly Flow (MHF)	=	49,895	m^3/day

Design Influent Quality

BOD	=	752	mg/l (Including return water =	827	mg/l)
SS	=	694	mg/l (Including return water =	763	mg/l)

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Removal Efficiency

Biochemical Treatment

BOD	=	95.0%
SS	=	95.0%

Sand Filter

BOD	=	40.0%
SS	=	60.0%

Total Removal Efficiency

BOD	=	97.0%
SS	=	98.0%

Treated Wastewater Quality

After biochemical treatment

BOD	=	41.4	mg/l (<	60 mg/L after Biocemical treatment)
SS	=	38.2	mg/l (<	60 mg/L after Biocemical treatment)

After sand filter

BOD	=	24.8	mg/l (<	30 mg/L after sand filter)
SS	=	15.3	mg/l (<	30 mg/L after sand filter)

Generated Sludge Amount

Removal Solid Weight	=	763.4	mg/l ×	33,258	m^3/day ×	98.0%
	=	24.9	t/day			

Sludge Thickener

Collection Rate	=	80.0%	
Tickenered Sludge Weight	=	19.9	t/day
Solid Concentration	=	3.0%	
Dewatered Sludge Volume	=	663.5	m^3/day

Mechanical Dewatering

Collection Rate	=	95.0%	
Dewatered Sludge Weight	=	18.9	t/day
Solid Concentration	=	20.0%	
Dewatered Sludge Volume	=	94.5	m^3/day

Pretreatment Facilities								
Coarse Screen	Manual							
Fine Screen	Automatical							
Grit Chamber	Aerated Grit Chamber with Grease Trap							
	L= 38 m,	W= 2.8 m,	D= 2 m,	N= 1				
	Volume =	212.8 m^3 ×	1 =	212.8 m^3				
	Retention Time =	6.14 mins						
Biocemical Facilities								
Aeration Tank	Extended Aeration Activated Sludge							
	L= 72.0 m,	W= 18.0 m,	D= 4.5 m,	N= 9				
	V= 5,832 m^3 ×	9	=	52,488 m^3				
	MLSS		=	4,000	mg/l			
	MLVSS (MLSS *0.85)		=	3,400	mg/l			
	Design BOD/MLVSS Load		=	0.160	kgBOD/kgSS/d			
	Actual BOD/MLVSS Load		=	BOD * MDF / MLVSS / V				
			=	0.154	kgBOD/kgSS/d			
	Design Retention Time (θ)		=	BOD / MLVSS / Design Load				
			=	1.52	days			
	Actual Retention Time (θ)		=	1.58	days			
Sedimentation Tank	Circular Tank							
	Diameter = 21 m,	D= 3.4 m,	N= 9					
	A= 346 m^2 ×	9	=	3,117 m^2				
	Maximum SVI		=	200				
	Required Surface Load =		=	14.59	m^3/m^2/day			
	(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))							
	Actual Surface Load =		=	10.67	m^3/m^2/day			
Sand Filer	Filtration Rate		=	300	m/day			
	Required Filtration Area		=	111	m^2			
	L= 10 m,	W= 6.00 m,	N= 2					
	Design Area		=	120	m^2			
Disinfection Facilities	Chlorine Contact Basin							
	L= 150 m,	W= 2.45 m,	D= 2.00 m,	N= 2				
	V= 735 m^3 ×	2	=	1,470 m^3				
	Design Retention Time		=	20.0	minutes			
	Actual Retention Time		=	42.4	minutes			
Sludge Thickener	Diameter = 12.0	m, N= 2						
	Surface Area		=	226.2	m^2			
	Design Surface Load		=	90.00	kg/m^2/day			
	Actural Surface Load		=	110.00	kg/m^2/day			
Dewatering Machine	Centrifugal Dewatering							
	Operation Time	(in a day)	=	8	hours/day			
		(in a week)	=	5.0	days/week			
	Required Capacity		=	116	m^3/hour			
	Design Machine Capacity		=	40	m^3/hour/machine			
	Design Machine Number		=	3				

4. Capacity Calculation for Shallala WWTP

Design Flow

Average Daily Flow (ADF)	=	22,520	m^3/day
Maximum Daily Flow (MDF)	=	26,356	m^3/day
Maximum Hourly Flow (MHF)	=	39,539	m^3/day

Design Influent Quality

BOD	=	887	mg/l (Including return water =	976	mg/l)
SS	=	819	mg/l (Including return water =	901	mg/l)

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Removal Efficiency

Primary Sedimentation Tank

BOD	=	50.0%
SS	=	60.0%

Oxidation Ditch

BOD	=	95.0%
SS	=	95.0%

Total Removal Efficiency

BOD	=	97.5%
SS	=	98.0%

Treated Wastewater Quality

After primary sedimentaiton tank

BOD	=	487.9	mg/l
SS	=	360.4	mg/l

After oxidation ditch

BOD	=	24.4	mg/l (< 30 mg/L)
SS	=	18.0	mg/l (< 30 mg/L)

Generated Sludge Amount

Primary Removal Solid Weight	=	900.9	mg/l ×	26,356	m^3/day ×	60.0%
	=	14.2	t/day			
Secondary Removal Solid Weight	=	360.4	mg/l ×	26,356	m^3/day ×	95.0%
	=	9.0	t/day			

Sludge Gravity Thickener			
Collection Rate	=	80.0%	
Tickenered Sludge Weight	=	11.4	t/day
Solid Concentration	=	4.0%	
Dewatered Sludge Volume	=	284.9	m^3/day
Belt Thickener			
Collection Rate	=	95.0%	
Tickenered Sludge Weight	=	8.6	t/day
Solid Concentration	=	4.0%	
Dewatered Sludge Volume	=	214.3	m^3/day
Digested Sludge (First Stage)			
Digestive Efficiency	=	50.0%	
Organic Matter Content Rate	=	85.0%	
Digested Sludge Solid Weight	=	11.5	t/day
Solid Concentration	=	2.3%	
Dewatered Sludge Volume	=	499.2	m^3/day
Digested Sludge (second Stage)			
Collection Rate	=	80.0%	
Tickenered Sludge Weight	=	9.2	t/day
Solid Concentration	=	3.0%	
Dewatered Sludge Volume	=	306.2	m^3/day
Sludge Dewatering			
Collection Rate	=	95.0%	
Tickenered Sludge Weight	=	8.7	t/day
Solid Concentration	=	20.0%	
Dewatered Sludge Volume	=	43.6	m^3/day

Pretreatment Facilities								
Coarse Screen	Manual							
Fine Screen	Automatical							
Grit Chamber	Aerated Grit Chamber with Grease Trap							
	L=	30	m, W=	3	m, D=	2	m, N=	2
	Volume =	180	m3 ×	2 =		360	m^3	
	Retention Time =	13.11	mins					
Equalization Tank (for rain season)								
	L=	72.0	m, W=	10.0	m, D=	5	m, N=	5
	V=	3,493	m^3 ×	5	=	17,463	m^3	
	Retenciotn Time (at MHF)				=	10.6	hours	
Primary Sedimentation Tank	Rectanglar Tank							
	L=	32.0	m, W=	7.0	m, D=	3	m, N=	3
	A=	224	m^2 ×	3	=	672	m^2	
	Required Surface Load =				=	35	m^3/m^2/day	
	Actual Surface Load =				=	39.22	m^3/m^2/day	
Biocemical Facilities								
Aeration Tank	Oxidation Tank							
	L=	58.0	m, W=	20.0	m, D=	4.5	m, N=	4
	V=	4,834	m^3 ×	4	=	19,335	m^3	
	MLSS				=	5,000	mg/l	
	MLVSS (MLSS *0.85)				=	4,250	mg/l	
	Design BOD/MLVSS Load				=	0.200	kgBOD/kgSS/d	
	Actual BOD/MLVSS Load				=	BOD * MDF / MLVSS / V		
					=	0.156	kgBOD/kgSS/d	
	Design Retention Time (θ)				=	BOD / MLVSS / Design Load		
					=	0.57	days	
	Actual Retention Time (θ)				=	0.73	days	
Sedimentation Tank	Circular Tank							
	Diameter =	42	m, D=	3	m, N=	3		
	A=	1,385	m^2 ×	3	=	4,156	m^2	
	Maximum SVI				=	200		
	Required Surface Load =				=	10.79	m^3/m^2/day	
	(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))							
	Actual Surface Load =				=	6.34	m^3/m^2/day	
Disinfection Facilities	Chlorine Contact Basin							
	No Data							

Sludge Gravity Thickener	Diameter = 10.0 m, N= 3				
	Surface Area	=	235.6	m^2	
	Design Surface Load	=	90.00	$kg/m^2/day$	
	Actural Surface Load	=	60.46	$kg/m^2/day$	
Belt Thickener	Solid Weight	=	9.02	t/day	
	Solid Concentration	=	0.80%		
	Required Capacity	=	1,128	$m^{3/}day$	
		=	47	m^3/hour	
	Actual Capacity	=	60	m^3/hour ×	2
			(45 - 90	m^3/hour)	
Sludge Digestion Tank					
Fist Stage	Diameter 18.0 m, L= 13 m, N= 3				
	Tank Volume	=	9,924	m^3	
	Design Surface Load	=	20.0	days	
	Actural Retention Time	=	19.9	days	
Second Stage	Diameter 12.0 m, L= 10 m, N= 1				
	Surface Area	=	113.1	m^2	
	Design Surface Load	=	90.00	$kg/m^2/day$	
	Actural Surface Load	=	100.77	$kg/m^2/day$	
Dewatering Machine	Centrifugal Dewatering				
	Operation Time (in a day)	=	8	hours/day	
	(in a week)	=	5.0	days/week	
	Required Capacity	=	53.58	m^3/hour	
	Design Machine Capacity	=	30	m^3/hour/machine	
	Design Machine Number	=	2	(including sdand-by)	

5. Capacity Calculation for Wadi Hassan WWTP

Design Flow			
Average Daily Flow (ADF)	=	2,490	m^3/day
Maximum Daily Flow (MDF)	=	2,914	m^3/day
Maximum Hourly Flow (MHF)	=	4,372	m^3/day
Design Influent Quality			
BOD	=	924	mg/l (Including return water = 1,016 mg/l)
SS	=	853	mg/l (Including return water = 938 mg/l)
Temperaure		15 ～ 28	℃
Removal Efficiency			
Oxidation Ditch			
BOD	=	95.0%	
SS	=	95.0%	
Polishing Pond			
BOD	=	50.0%	
SS	=	50.0%	
Total Removal Efficiency			
BOD	=	97.5%	
SS	=	97.5%	
Treated Wastewater Quality			
After oxidation ditch			
BOD	=	50.8	mg/l
SS	=	46.9	mg/l
After polishing pond			
BOD	=	25.4	mg/l (< 30 mg/L)
SS	=	23.5	mg/l (< 30 mg/L)
Generated Sludge Amount			
Removal Solid Weight	=	938.3	mg/l × 2,914 m^3/day × 95.0%
	=	2.6	t/day
Sludge Gravity Thickener			
Collection Rate	=	80.0%	
Tickenered Sludge Weight	=	2.1	t/day
Solid Concentration	=	3.0%	
Dewatered Sludge Volume	=	69.3	m^3/day
Sludge Drying Bed			
Collection Rate	=	90.0%	
Tickenered Sludge Weight	=	1.9	t/day
Solid Concentration	=	50.0%	
Dewatered Sludge Volume	=	3.7	m^3/day

Pretreatment Facilities								
Coarse Screen	Manual							
Fine Screen	Automatical							
Grit Chamber	Aerated Grit Chamber with Grease Trap							
	L=	20	m, W=	2	m, D=	1.6	m, N=	1
	Volume =	64	$m^3 \times$	1 =		64	m^3	
	Retention Time =	21.08	mins					
Biocemical Facilities								
Aeration Tank	Oxidation Tank							
	L=	60.0	m, W=	14.0	m, D=	3	m, N=	2
	V=	2,394	$m^3 \times$	2	=	4,788	m^3	
	MLSS				=	5,000	mg/l	
	MLVSS (MLSS *0.85)				=	4,250	mg/l	
	Design BOD/MLVSS Load				=	0.200	kgBOD/kgSS/d	
	Actual BOD/MLVSS Load				=	BOD * MDF / MLVSS / V		
					=	0.146	kgBOD/kgSS/d	
	Design Retention Time (θ)				=	BOD / MLVSS / Design Load		
					=	1.20	days	
	Actual Retention Time (θ)				=	1.64	days	
Sedimentation Tank	Circular Tank							
	Diameter =	15	m, D=	3.8	m, N=	2		
	A=	177	$m^2 \times$	2	=	353	m^2	
	Maximum SVI				=	200		
	Required Surface Load =				=	10.79	m^3/m^2/day	
	(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))							
	Actual Surface Load =				=	8.24	m^3/m^2/day	
Polishing Pond	2 Steps							
	L=	88.0	m, W=	60.0	m, D=	1.8	m, N=	4
	V=	9,504	$m^3 \times$	4	=	38,016	m^3	
	Actual Retention Time (θ)				=	13.05	days	
	BOD Reduction (k=			0.1	)= 1/(1+kθ/n)^n =		0.37	
Disinfection Facilities	Chlorine Contact Basin							
	V=	100	$m^3 \times$	1	=	100	m^3	
	Design Retention Time				=	20.0	minutes	
	Actual Retention Time				=	32.9	minutes	
Sludge Gravity Thickener	Diameter =	11.2	m, N=	1				
	Surface Area				=	98.5	m^2	
	Design Surface Load				=	90.0	kg/m^2/day	
	Actural Surface Load				=	26.4	kg/m^2/day	
Sludge Drying Bed	Solid Weight (for ADF)				=	1.78	t/day	
					=	648	t/year	
	L=	30.0	m, W=	6.0	m, N=	36		
	A=	180	$m^2 \times$	36	=	6,480	m^2	
	Required Surface Load =				=	100	kg/m^2/day	
	Actual Surface Load =				=	100	kg/m^2/day	

6. Capacity Calculation for Ramtha WWTP

Design Flow						
Average Daily Flow (ADF)	=	17,269	m^3/day			
Maximum Daily Flow (MDF)	=	20,204	m^3/day			
Maximum Hourly Flow (MHF)	=	30,308	m^3/day			
Design Influent Quality						
BOD	=	757	mg/l (Including return water =		833	mg/l)
SS	=	699	mg/l (Including return water =		769	mg/l)
Temperaure	15 ～	28 ℃				
Removal Efficiency						
Extended Aeration Activated Sludge						
BOD	=	95.0%				
SS	=	95.0%				
Polishing Pond						
BOD	=	30.0%				
SS	=	30.0%				
Total Removal Efficiency						
BOD	=	96.5%				
SS	=	96.5%				
Treated Wastewater Quality						
After extended aeration activated sludge						
BOD	=	41.6	mg/l			
SS	=	38.4	mg/l			
After polishing pond						
BOD	=	29.1	mg/l (<	30 mg/L)		
SS	=	26.9	mg/l (<	30 mg/L)		
Generated Sludge Amount						
Removal Solid Weight	=	768.9	mg/l ×	20,204	m^3/day ×	96.5%
	=	15.0	t/day			
Sludge Gravity Thickener						
Collection Rate	=	80.0%				
Tickenered Sludge Weight	=	12.0	t/day			
Solid Concentration	=	3.0%				
Dewatered Sludge Volume	=	399.8	m^3/day			
Sludge Dewatirn Machine						
Collection Rate	=	95.0%				
Dewatered Sludge Weight	=	11.4	t/day			
Solid Concentration	=	20.0%				
Dewatered Sludge Volume	=	57.0	m^3/day			

Pretreatment Facilities									
Coarse Screen	Manual								
Fine Screen	Automatical								
Grit Chamber	Aerated Grit Chamber with Grease Trap								
	Diameter =	5.0	m, D=	3.3	m, N=	2			
	Volume =	64.8	$m^3 \times$	2 =	129.6	m^3			
	Retention Time =	6.16	mins						
Equalization Tank (for rain season)									
	L=	70.0	m, W=	25.0	m, D=	3	m, N=	2	
	V=	5,250	$m^3 \times$	2	=	10,500	m^3		
	Retenciotn Time (at MHF)				=	8.3	hours		
Biocemical Facilities									
Aeration Tank	Extended Aeration Activated Sludge								
	L=	50.1	m, W=	33.4	m, D=	4.5	m, N=	4	
	V=	7,530	$m^3 \times$	4	=	30,120	m3		
	MLSS				=	4,000	mg/l		
	MLVSS (MLSS *0.85)				=	3,400	mg/l		
	Design BOD/MLVSS Load				=	0.200	kgBOD/kgSS/d		
	Actual BOD/MLVSS Load				=	BOD * MDF / MLVSS / V			
					=	0.164	kgBOD/kgSS/d		
	Design Retention Time (θ)				=	BOD / MLVSS / Design Load			
					=	1.22	days		
	Actual Retention Time (θ)				=	1.49	days		
Sedimentation Tank	Circular Tank								
	Diameter =	22	m, D=	3.0	m, N=	4			
	A=	380	$m^2 \times$	4	=	1,521	m^2		
	Maximum SVI				=	200			
	Required Surface Load =				=	14.59	m^3/m^2/day		
	(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))								
	Actual Surface Load =				=	13.29	m^3/m^2/day		
Polishing Pond	5 Steps								
	L=	33.0	m, W=	82.0	m, D=	2	m, N=	10	
	V=	5,412	$m^3 \times$	10	=	54,120	m^3		
	Actual Retention Time (θ)				=	2.68	days		
	BOD Reduction (k=			0.14	)= 1/(1+kθ/n)^n =			0.70	
Disinfection Facilities	Chlorine Contact Basin								
	L=	52.5	m, W=	1.40	m, D=	3.50	m, N=	2	
	V=	257	$m^3 \times$	2	=	515	m^3		
	Design Retention Time				=	20.0	minutes		
	Actual Retention Time				=	24.4	minutes		
Irrigation Reservoir (for rain season)									
	L=	63.2	m, W=	43.0	m, D=	3.5	m, N=	1	
	V=	8,123	$m^3 \times$	1	=	8,123	m^3		
	Retenciotn Time (at MDF)				=	9.6	hours		

Sludge Gravity Thickener	Diameter = 9.0 m, N= 3			
	Surface Area	=	190.9	m^2
	Design Surface Load	=	90.0	$kg/m^2/day$
	Actural Surface Load	=	78.5	$kg/m^2/day$
Dewatering Machine	Centrifugal Dewatering			
	Operation Time (in a day)	=	8	hours/day
	(in a week)	=	5.0	days/week
	Required Capacity	=	69.96	m^3/hour
	Design Machine Capacity	=	40	m^3/hour/machine
	Design Machine Number	=	2	(including sdand-by)

7.1 Capacity Calculation for Mafraq WWTP (Case 1 with site expansion)

Design Flow

Average Daily Flow (ADF)	=	14,353	m^3/day
Maximum Daily Flow (MDF)	=	16,792	m^3/day
Maximum Hourly Flow (MHF)	=	25,190	m^3/day

Design Influent Quality

BOD	=	707	mg/l (Including return water =	778	mg/l)
SS	=	653	mg/l (Including return water =	718	mg/l)

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Removal Efficiency

Sedimentation Tank

BOD	=	35.0%
SS	=	60.0%

MBBR

BOD	=	30.0%
SS	=	0.0%

Aerated Stabilization Pond + Facltative Pond

BOD	=	90.0%
SS	=	90.0%

Sand Filter + Reed Beds

BOD	=	50.0%
SS	=	50.0%

Total Removal Efficiency

BOD	=	97.7%
SS	=	98.0%

Treated Wastewater Quality

After Sedimentation Tank

BOD	=	505.5	mg/l
SS	=	287.3	mg/l

After MBBR

BOD	=	353.9	mg/l
SS	=	287.3	mg/l

After Aerated Stablization Pond + Facultative Pond

BOD	=	35.4	mg/l (<	60 mg/L)
SS	=	28.7	mg/l (<	60 mg/L)

After Sand Filter + Reed Beds

BOD	=	17.7	mg/l
SS	=	14.4	mg/l

Generated Sludge Amount

Removal Solid Weight

From Sedimentation Tank	=	718.3	mg/l	×	16,792	m^3/day	×	60.0%
	=	7.2	t/day					
From Facalutative Pond	=	258.6	mg/l	×	16,792	m^3/day	×	90.0%
	=	3.9	t/day					

Sludge Stabilization Basin from Sedimentation Tank

Tickenered Sludge Weight	=	7.2	t/day
Solid Concentration	=	3.0%	
Dewatered Sludge Volume	=	241.2	m^3/day
Required Retention Time	=	15.0	days
Required Tank Volume	=	3,619	m^3
Reduaction Rate in Basin	=	78%	
Tickenered Sludge Weight	=	5.6	t/day

Solids in Faculatative Basin

Generated Sludge Weight	=	3.9	t/day
Reduction Rate in Pond	=	30%	
Solid Concentration	=	15.0%	(after consolidation)
Consolidated Sludge Weight		1.2	t/day
Consolidated Sludge Volume	=	7.8	m^3/day

Sludge Drying Bed from Sludge Stabilization Basin

Toatl Sludge		6.8	t/day
Solid Concentration	=	50.0%	
Dewatered Sludge Volume	=	13.6	m^3/day

Pretreatment Facilities

Coarse Screen	Manual								
Fine Screen	Automatical								
Oil & Grease Removal	Diameter =	5.9	m, D=	3	m, N=	4			
	Volume =	82.0	m^3 ×	4 =	328.1	m^3			
	Actural Retention Time			=	18.75	mins			
Primary Settling Tank with Grit Chamber									
	L=	8.3	m, W=	4.3	m, D=	6.75	m, N=	4	
	Area =	35.7	m^2 ×	4 =	142.8	m^2			
	Design Surface Load			=	120.0	m^3/m^2/day			
	Actural Surface Load			=	117.6	m^3/m^2/day			
Wet Weather Strage Lagoon (for rain season)									
	L=	60.0	m, W=	60.0	m, D=	4	m, N=	1	
	V=	14,400	m^3 ×	1	=	14,400	m^3		
	Retenciotn Time (at MHF)			=	13.7	hours			

Biocemical Facilities

Denitrification Tank (MBBR)	NO_3-N Concentration of Circulation :			15.0	mg/L (g/m^3)			
	Circulation Rate for Denitrificaiton :			5.0	times			
	NO_3-N Load	=		1,259	kg/day			
	Denitrificaiton Rate	=		1.24	g/m^2/day			
	Plastic Media Specific Surface	=		500	m^2/m^3			
	Volume of Denitrification Media	=		2,031	m^3			
	Media Volume / Tanks Volume	=		0.45				
	Effective Tank Volume	=		4,514	m^3			
	L= 26.0	m, W= 15.0	m, D=	3.5	m, N=	4		
	V= 1,365	m^3 × 4	=	5,460	m^3			
	Retenciotn Time (at MDF)	=		7.8	hours			
	BOD Removal Rate	=		3.40	gBOD/gNO_3-N			
	BOD Removal Amount	=		4,282	kgBOD/day			
	BOD Concentration of Circulation :			40.0	mg/L (g/m^3)			
	Influent BOD	=		13,062	kgBOD/day			
	Toatl Removal Rate of BOD	=		32.8%				
Aeration Stablization Basins	5 Steps							
	L= 84.0	m, W= 34.0	m, D=	3.5	m, N=	20		
	V= 9,996	m^3 × 20	=	199,920	m^3			
	Actual Retention Time (θ)	=		11.91	days			
	BOD Reduction (k= 0.3	)= 1/(1+kθ/n)^n =		0.068				
Denitrification Tank (MBBR)	TKN Concentration of Influent =			115.0	mg/L (g/m^3)			
	TKN Concentration of Effluent =			15.0	mg/L (g/m^3)			
	TKN Load	=		1,679	kg/day			
	Nitrificaiton Rate	=		0.95	g/m^2/day			
	Plastic Media Specific Surface	=		500	m^2/m^3			
	Volume of Denitrification Media	=		3,535	m^3			
	Media Volume / Tanks Volume	=		0.67				

	Effective Tank Volume				=	5,276 m^3		
	L=	26.0	m, W=	15.0	m, D=	3.5	m, N=	4
	V=	1,365	m^3 ×	4	=	5,460 m^3		
	Retenciotn Time (at MDF)				=	7.8 hours		
Facultative Pond with Rock Filter	1 Steps							
	L=	73.0	m, W=	37.0	m, D=	3.5	m, N=	4
	V=	9,454	m^3 ×	4	=	37,814 m^3		
	Actual Retention Time (θ)				=	2.25	days	
	BOD Reduction (k=			0.1	)= 1/(1+kθ/n)^n =		0.816	
	Rcok Media Load				=	1.00	m^3/m^3 of rock /day	
	Required Rock Volume				=	16,792 m^3		
					=	6,298 m^3/basin		
Sand Filter	L=	80.0	m, W=	45.0	m, N=	6		
	V=	3,600	m^2 ×	6	=	21,600 m^2		
	Design Surface Load				=	0.80	m^3/m^2/day	
	Actual Surface Load				=	0.78	m^3/m^2/day	
Reed Beds	L=	50.0	m, W=	30.0	m, N=	4		
	V=	1,500	m^2 ×	4	=	6,000 m^2		
	Design Surface Load				=	2.60	m^3/m^2/day	
	*2.60 m^3/m^2/day=80kg/ha/day(NO_3-N)/0.003kg/m^3							
	Actual Surface Load				=	2.39	m^3/m^2/day	
Disinfection Facilities	Chlorine Contact Basin							
	L=	50	m, W=	2.00	m, D=	1.80	m, N=	2
	V=	180	m^3 ×	2	=	360 m^3		
	Design Retention Time				=	20.0	minutes	
	Actual Retention Time				=	20.6	minutes	
Sludge Strage Tank	L=	15.0	m, W=	15.0	m, D=	3	m, N=	6
	V=	675	m^3 ×	6	=	4,050 m^3		
	Design Retention Time				=	15.00	days	
	Actual Retention Time				=	16.79	days	
Sludge Drying Bed	Solid Weight (for ADF)				=	5.83 t/day		
					=	2,127 t/year		
	L=	35.0	m, W=	12.0	m, N=	52		
	A=	420	m^2 ×	52	=	21,840 m^2		
	Required Surface Load =				=	100	kg/m^2/year	
	Actual Surface Load =				=	97	kg/m^2/year	

7.2 Capacity Calculation for Mafraq WWTP (Case 2 without site expansion)

Design Flow for Three Stepfeed Nitrification and Denitrification Treatment is a half of design flow in Mafrap.
Because the half of flow is treated by exsiting treatment facilities.

Average Daily Flow (ADF)	=	7,177	m^3/day
Maximum Daily Flow (MDF)	=	8,396	m^3/day
Maximum Hourly Flow (MHF)	=	12,595	m^3/day

Design Influent Quality

BOD	=	707	mg/l (Including return water =	778	mg/l)
SS	=	653	mg/l (Including return water =	718	mg/l)

Temperaure 15 ～ 28 ℃

Removal Efficiency

Sedimentation Tank

BOD	=	35.0%
SS	=	60.0%

Three Steps Ntrification-Denitrification Reactor

BOD	=	90.0%
SS	=	90.0%

Sand Filter + Reed Beds

BOD	=	50.0%
SS	=	50.0%

Total Removal Efficiency

BOD	=	96.8%
SS	=	98.0%

Treated Wastewater Quality

After Sedimentation Tank

BOD	=	505.5	mg/l
SS	=	287.3	mg/l

After Three Steps Nitrification-Denitrication Reactor

BOD	=	50.6	mg/l
SS	=	28.7	mg/l

After Sand Filter + Reed Beds

BOD	=	25.3	mg/l (<	60 mg/L)
SS	=	14.4	mg/l (<	60 mg/L)

Generated Sludge Amount

Removal Solid Weight

From Sedimentation Tank	=	718.3	mg/l ×	8,396	m^3/day ×	96.0%
(Primary and Final)	=	5.8	t/day			

Sludge Stabilization Basin from Sedimentation Tank

Tickenered Sludge Weight	=	5.8	t/day
Solid Concentration	=	3.0%	
Dewatered Sludge Volume	=	193.0	m^3/day
Required Retention Time	=	15.0	days
Required Tank Volume	=	2,895	m^3

Sludge Drying Bed from Sludge Stabilization Basin

Reduaction Rate in Basin	=	86%	
Tickenered Sludge Weight	=	5.0	t/day
Solid Concentration	=	50.0%	
Dewatered Sludge Volume	=	10.0	m^3/day

Pretreatment Facilities

Coarse Screen — Manual

Fine Screen — Automatical

Oil & Grease Removal — Diameter = 5.9 m, D= 3 m, N= 4
Volume = 82.0 $m^3 \times$ 4 = 328.1 m^3
Actural Retention Time = 37.51 mins

Primary Settling Tank with Grit Chamber
L= 8.3 m, W= 4.3 m, D= 6.75 m, N= 4
Area = 35.7 $m^2 \times$ 4 = 142.8 m^2
Design Surface Load = 120.0 $m^3/m^2/day$
Actural Surface Load = 58.8 $m^3/m^2/day$

Wet Weather Strage Lagoon (for rain season)
L= 60.0 m, W= 60.0 m, D= 4 m, N= 1
V= 14,400 $m^3 \times$ 1 = 14,400 m^3
Retenciotn Time (at MHF) = 27.4 hours

Biocemical Facilities

Three Step Feed — ASRT=29.7･e-0.102T

Nitrification Denitrification — T= 15 ℃
ASRT= 6.4 days
MLSS= 3000
VDN=θCA･Q･(a･SCS + b･SSS)/(N･XN･(1+C･θ))
= Qx 0.29764
= 2,499 m^3 → 7.14 hrs

Rate of Concentration
N1 = (0.5+1)/(0.5+1/3) = 1.80
N2 = (0.5+1)/(0.5+2/3) = 1.29

Required Retention Time for a Tank
V1 = VDN/N1 = 1,388 m^3= 3.97 hours
V2 = VDN/N2 = 1,944 m^3= 5.56 hours
Total = (VDN+V1+V2) x 2 33.3 hours

Reactor Volume
VT= 8,396 x 33.3 / 24 = 11,662 m^3

L= 70.0 m, W= 9.5 m, D= 4.5 m, N= 4
V= 2,993 $m^3 \times$ 4 = 11,970 m3
MLSS = 3,000 mg/l
MLVSS (MLSS *0.85) = 2,550 mg/l
Design BOD/MLVSS Load = 0.150 kgBOD/kgSS/d
Actual BOD/MLVSS Load = BOD * MDF / MLVSS / V
= 0.139 kgBOD/kgSS/d
Design Retention Time (θ) = 1.39 days
Actual Retention Time (θ) = 1.43 days

Sedimentation Tank — Circular Tank
Diameter = 17 m, D= 3.4 m, N= 4
A= 227 $m^2 \times$ 4 = 908 m^2
Maximum SVI = 200

	Required Surface Load =				=	21.51	$m^3/m^2/day$		
	(= 4.8*10^6*Min Temp^0.95*MLSS^(-1.35)*SVI^(-0.77))								
	Actual Surface Load =				=	9.25	$m^3/m^2/day$		
Sand Filter	L=	80.0	m, W=	45.0	m, N=	3			
	V=	3,600	m^2×	3	=	10,800	m^2		
	Design Surface Load				=	0.80	$m^3/m^2/day$		
	Actual Surface Load				=	0.78	$m^3/m^2/day$		
Reed Beds	L=	50.0	m, W=	30.0	m, N=	2			
	V=	1,500	m^2×	2	=	3,000	m^2		
	Design Surface Load				=	2.60	$m^3/m^2/day$		
	*2.60 m^3/m^2/day=80kg/ha/day(NO_3-N)/0.003kg/m^3								
	Actual Surface Load				=	2.39	$m^3/m^2/day$		
Disinfection Facilities	Chlorine Contact Basin								
	L=	50	m, W=	2.00	m, D=	1.80	m, N=	2	
	V=	180	m^3×	2	=	360	m^3		
	Design Retention Time				=	20.0	minutes		
	Actual Retention Time				=	41.2	minutes		
Sludge Strage Tank	L=	15.0	m, W=	15.0	m, D=	3	m, N=	6	
	V=	675	m^3×	6	=	4,050	m^3		
	Design Retention Time				=	15.00	days		
	Actual Retention Time				=	20.99	days		
Sludge Drying Bed	Solid Weight (for ADF)				=	4.26	t/day		
					=	1,553	t/year		
	L=	35.0	m, W=	12.0	m, N=	36			
	A=	420	m^2×	36	=	15,120	m^2		
	Required Surface Load =				=	100	$kg/m^2/year$		
	Actual Surface Load =				=	103	$kg/m^2/year$		

APPENDIX IV RESULTS OF ECONOMIC EVALUATION

1. Overall Evaluation consolidating 6 SWDs

EIRR (Economic Internal Rate of Return)	18.6%

(JD million)

Year		Cost			Benefit	Net Benefit
		Investment	O&M	Total		
2016	-1	0.0	0.0	0.0	0.0	0.0
2017	0	15.2	0.1	15.4	3.8	-11.6
2018	1	15.4	0.2	15.6	5.8	-9.8
2019	2	12.3	0.3	12.6	7.8	-4.8
2020	3	20.2	0.4	20.5	10.0	-10.6
2021	4	20.2	0.4	20.7	12.2	-8.5
2022	5	10.9	0.6	11.4	14.4	3.0
2023	6	10.8	0.6	11.5	16.7	5.2
2024	7	11.6	0.7	12.3	18.6	6.3
2025	8	14.9	0.9	15.7	20.5	4.8
2026	9	12.9	0.9	13.8	22.5	8.7
2027	10	14.5	1.1	15.6	24.9	9.4
2028	11	19.9	1.2	21.1	27.4	6.3
2029	12	17.2	1.3	18.5	30.0	11.5
2030	13	11.7	1.4	13.1	32.7	19.6
2031	14	13.4	1.4	14.9	35.5	20.6
2032	15	13.5	1.5	14.9	37.1	22.2
2033	16	0.0	1.5	1.5	38.9	37.3
2034	17	0.0	1.6	1.6	40.6	39.0
2035	18	0.0	1.6	1.6	42.5	40.8
2036	19	0.0	1.7	1.7	42.5	40.8
2037	20	0.0	1.7	1.7	42.5	40.8
2038	21	0.0	1.7	1.7	42.5	40.8
2039	22	0.0	1.7	1.7	42.5	40.8
2040	23	0.0	1.7	1.7	42.5	40.8
2041	24	0.0	1.7	1.7	42.5	40.8
2042	25	0.0	1.7	1.7	42.5	40.8
2043	26	0.0	1.7	1.7	42.5	40.8
2044	27	0.0	1.7	1.7	42.5	40.8
2045	28	0.0	1.7	1.7	42.5	40.8
2046	29	0.0	1.7	1.7	42.5	40.8
2047	30	-59.7	1.7	-58.0	42.5	100.5

Note: Salvage value is estimated at 59.7 in 2047.

2. Each SWD

(1) Central Irbid

EIRR (Economic Internal Rate of Return)	50.2%

(JD million)

Year		Cost			Benefit	Net Benefit
		Investment	O&M	Total		
2016	-1	0.00	0.00	0.00	0.00	0.00
2017	0	0.69	0.01	0.70	0.3	-0.43
2018	1	0.70	0.01	0.71	0.3	-0.37
2019	2	0.00	0.04	0.04	0.4	0.37
2020	3	0.00	0.05	0.05	0.5	0.44
2021	4	0.00	0.05	0.05	0.6	0.50
2022	5	0.00	0.05	0.05	0.6	0.57
2023	6	0.00	0.05	0.05	0.7	0.64
2024	7	0.00	0.06	0.06	0.8	0.71
2025	8	0.00	0.06	0.06	0.8	0.78
2026	9	0.00	0.06	0.06	0.9	0.85
2027	10	0.00	0.06	0.06	1.0	0.92
2028	11	0.00	0.07	0.07	1.1	1.00
2029	12	0.00	0.07	0.07	1.1	1.07
2030	13	0.00	0.07	0.07	1.2	1.14
2031	14	0.00	0.07	0.07	1.3	1.21
2032	15	0.00	0.08	0.08	1.4	1.29
2033	16	0.00	0.08	0.08	1.4	1.36
2034	17	0.00	0.08	0.08	1.5	1.43
2035	18	0.00	0.08	0.08	1.6	1.51
2036	19	0.00	0.09	0.09	1.6	1.50
2037	20	0.00	0.09	0.09	1.6	1.50
2038	21	0.00	0.09	0.09	1.6	1.50
2039	22	0.00	0.09	0.09	1.6	1.50
2040	23	0.00	0.09	0.09	1.6	1.50
2041	24	0.00	0.09	0.09	1.6	1.50
2042	25	0.00	0.09	0.09	1.6	1.50
2043	26	0.00	0.09	0.09	1.6	1.50
2044	27	0.00	0.09	0.09	1.6	1.50
2045	28	0.00	0.09	0.09	1.6	1.50
2046	29	0.00	0.09	0.09	1.6	1.50
2047	30	-0.02	0.09	0.07	1.6	1.52

Note: Salvage value is estimated at 0.02 in 2047.

(2) Wadi Al-Arab

EIRR (Economic Internal Rate of Return)	24.6%

(JD million)

Year		Cost			Benefit	Net Benefit
		Investment	O&M	Total		
2016	-1	0.0	0.0	0.0	0.0	0.0
2017	0	4.5	0.1	4.6	1.5	-3.1
2018	1	4.5	0.1	4.6	2.3	-2.3
2019	2	4.5	0.1	4.6	3.2	-1.5
2020	3	6.7	0.1	6.9	4.1	-2.8
2021	4	6.7	0.2	6.9	5.0	-1.9
2022	5	2.4	0.2	2.6	5.6	3.0
2023	6	2.4	0.2	2.6	6.2	3.6
2024	7	4.2	0.2	4.4	6.8	2.4
2025	8	4.2	0.3	4.5	7.4	3.0
2026	9	2.4	0.3	2.7	8.1	5.4
2027	10	1.4	0.3	1.7	8.5	6.8
2028	11	1.4	0.3	1.7	8.9	7.2
2029	12	1.4	0.4	1.7	9.3	7.5
2030	13	1.4	0.4	1.8	9.7	7.9
2031	14	3.2	0.4	3.6	10.1	6.5
2032	15	3.2	0.4	3.6	10.2	6.6
2033	16	0.0	0.4	0.4	10.3	9.9
2034	17	0.0	0.4	0.4	10.4	10.0
2035	18	0.0	0.4	0.4	10.5	10.1
2036	19	0.0	0.4	0.4	10.5	10.1
2037	20	0.0	0.4	0.4	10.5	10.1
2038	21	0.0	0.4	0.4	10.5	10.1
2039	22	0.0	0.4	0.4	10.5	10.1
2040	23	0.0	0.4	0.4	10.5	10.1
2041	24	0.0	0.4	0.4	10.5	10.1
2042	25	0.0	0.4	0.4	10.5	10.1
2043	26	0.0	0.4	0.4	10.5	10.1
2044	27	0.0	0.4	0.4	10.5	10.1
2045	28	0.0	0.4	0.4	10.5	10.1
2046	29	0.0	0.4	0.4	10.5	10.1
2047	30	-11.3	0.4	-10.9	10.5	21.4

Note: Salvage value is estimated at 11.3 in 2047.

(3) Shallala

EIRR (Economic Internal Rate of Return)	32.6%

(JD million)

Year		Cost			Benefit	Net Benefit
		Investment	O&M	Total		
2016	-1	0.0	0.0	0.0	0.0	0.0
2017	0	2.7	0.0	2.7	0.8	-1.9
2018	1	2.8	0.0	2.9	1.3	-1.6
2019	2	2.4	0.1	2.5	1.8	-0.7
2020	3	2.4	0.1	2.5	2.3	-0.1
2021	4	2.4	0.1	2.5	2.9	0.4
2022	5	1.8	0.1	1.9	3.7	1.8
2023	6	1.8	0.1	1.9	4.5	2.6
2024	7	1.1	0.1	1.2	4.9	3.7
2025	8	1.1	0.2	1.2	5.2	4.0
2026	9	1.1	0.2	1.2	5.6	4.4
2027	10	2.9	0.2	3.1	6.5	3.4
2028	11	8.3	0.2	8.5	7.4	-1.1
2029	12	8.4	0.2	8.6	8.4	-0.2
2030	13	2.9	0.3	3.2	9.4	6.3
2031	14	2.9	0.3	3.2	10.5	7.3
2032	15	2.9	0.3	3.2	11.5	8.3
2033	16	0.0	0.4	0.4	12.6	12.2
2034	17	0.0	0.4	0.4	13.7	13.3
2035	18	0.0	0.4	0.4	14.8	14.4
2036	19	0.0	0.4	0.4	14.8	14.4
2037	20	0.0	0.4	0.4	14.8	14.4
2038	21	0.0	0.4	0.4	14.8	14.4
2039	22	0.0	0.4	0.4	14.8	14.4
2040	23	0.0	0.4	0.4	14.8	14.4
2041	24	0.0	0.4	0.4	14.8	14.4
2042	25	0.0	0.4	0.4	14.8	14.4
2043	26	0.0	0.4	0.4	14.8	14.4
2044	27	0.0	0.4	0.4	14.8	14.4
2045	28	0.0	0.4	0.4	14.8	14.4
2046	29	0.0	0.4	0.4	14.8	14.4
2047	30	-14.2	0.4	-13.8	14.8	28.7

Note: Salvage value is estimated at 14.2 in 2047.

(4) Wadi Hassan

EIRR (Economic Internal Rate of Return)	11.9%

(JD million)

Year		Cost			Benefit	Net Benefit
		Investment	O&M	Total		
2016	-1	0.00	0.00	0.00	0.00	0.00
2017	0	0.00	0.00	0.00	0.00	0.00
2018	1	0.00	0.00	0.00	0.00	0.00
2019	2	0.00	0.00	0.00	0.00	0.00
2020	3	0.00	0.00	0.00	0.00	0.00
2021	4	0.00	0.00	0.00	0.00	0.00
2022	5	0.50	0.00	0.50	0.00	-0.50
2023	6	0.50	0.00	0.50	0.00	-0.50
2024	7	0.50	0.00	0.50	0.04	-0.46
2025	8	0.71	0.00	0.71	0.08	-0.62
2026	9	0.50	0.00	0.50	0.13	-0.37
2027	10	0.96	0.03	0.99	0.23	-0.76
2028	11	0.96	0.03	0.99	0.34	-0.65
2029	12	0.96	0.03	0.99	0.46	-0.54
2030	13	0.96	0.04	1.00	0.57	-0.42
2031	14	0.96	0.04	1.00	0.70	-0.30
2032	15	0.96	0.05	1.01	0.90	-0.11
2033	16	0.00	0.05	0.05	1.11	1.05
2034	17	0.00	0.06	0.06	1.32	1.27
2035	18	0.00	0.06	0.06	1.55	1.49
2036	19	0.00	0.06	0.06	1.55	1.49
2037	20	0.00	0.06	0.06	1.55	1.49
2038	21	0.00	0.06	0.06	1.55	1.49
2039	22	0.00	0.06	0.06	1.55	1.49
2040	23	0.00	0.06	0.06	1.55	1.49
2041	24	0.00	0.06	0.06	1.55	1.49
2042	25	0.00	0.06	0.06	1.55	1.49
2043	26	0.00	0.06	0.06	1.55	1.49
2044	27	0.00	0.06	0.06	1.55	1.49
2045	28	0.00	0.06	0.06	1.55	1.49
2046	29	0.00	0.06	0.06	1.55	1.49
2047	30	-3.14	0.06	-3.08	1.55	4.63

Note: Salvage value is estimated at 3.14 in 2047.

(5) Ramtha

EIRR (Economic Internal Rate of Return)	18.3%

(JD million)

Year		Cost			Benefit	Net Benefit
		Investment	O&M	Total		
2016	-1	0.0	0.0	0.0	0.0	0.0
2017	0	2.0	0.0	2.1	0.6	-1.4
2018	1	2.0	0.0	2.1	1.0	-1.1
2019	2	2.0	0.0	2.1	1.3	-0.8
2020	3	5.0	0.1	5.0	1.7	-3.4
2021	4	5.0	0.1	5.1	2.0	-3.0
2022	5	1.4	0.1	1.5	2.4	0.9
2023	6	1.4	0.1	1.5	2.7	1.2
2024	7	1.4	0.1	1.5	3.1	1.5
2025	8	1.4	0.1	1.6	3.4	1.9
2026	9	1.4	0.2	1.6	3.8	2.2
2027	10	5.3	0.2	5.4	4.4	-1.0
2028	11	5.3	0.2	5.5	5.1	-0.4
2029	12	3.0	0.2	3.2	5.7	2.5
2030	13	3.0	0.3	3.3	6.4	3.2
2031	14	2.9	0.3	3.2	7.1	4.0
2032	15	2.9	0.3	3.2	7.3	4.2
2033	16	0.0	0.3	0.3	7.5	7.2
2034	17	0.0	0.3	0.3	7.7	7.4
2035	18	0.0	0.3	0.3	7.9	7.6
2036	19	0.0	0.3	0.3	7.9	7.6
2037	20	0.0	0.3	0.3	7.9	7.6
2038	21	0.0	0.3	0.3	7.9	7.6
2039	22	0.0	0.3	0.3	7.9	7.6
2040	23	0.0	0.3	0.3	7.9	7.6
2041	24	0.0	0.3	0.3	7.9	7.6
2042	25	0.0	0.3	0.3	7.9	7.6
2043	26	0.0	0.3	0.3	7.9	7.6
2044	27	0.0	0.3	0.3	7.9	7.6
2045	28	0.0	0.3	0.3	7.9	7.6
2046	29	0.0	0.3	0.3	7.9	7.6
2047	30	-12.4	0.3	-12.1	7.9	20.0

Note: Salvage value is estimated at 12.4 in 2047.

(6) Mafraq

EIRR (Economic Internal Rate of Return)	6.3%

(JD million)

Year		Cost			Benefit	Net Benefit
		Investment	O&M	Total		
2016	-1	0.0	0.0	0.0	0.0	0.0
2017	0	5.3	0.0	5.3	0.6	-4.7
2018	1	5.3	0.1	5.3	0.8	-4.5
2019	2	3.3	0.1	3.4	1.1	-2.3
2020	3	6.0	0.1	6.1	1.4	-4.7
2021	4	6.1	0.1	6.1	1.7	-4.5
2022	5	4.8	0.1	4.9	2.1	-2.8
2023	6	4.8	0.1	4.9	2.6	-2.3
2024	7	4.4	0.1	4.6	3.0	-1.6
2025	8	7.5	0.2	7.7	3.5	-4.2
2026	9	7.5	0.2	7.7	3.9	-3.8
2027	10	4.0	0.3	4.2	4.3	0.1
2028	11	4.0	0.3	4.2	4.6	0.4
2029	12	3.5	0.3	3.8	5.0	1.2
2030	13	3.5	0.3	3.8	5.4	1.6
2031	14	3.5	0.3	3.8	5.7	1.9
2032	15	3.5	0.3	3.8	5.8	2.0
2033	16	0.0	0.3	0.3	5.9	5.6
2034	17	0.0	0.3	0.3	6.0	5.7
2035	18	0.0	0.3	0.3	6.1	5.8
2036	19	0.0	0.3	0.3	6.1	5.8
2037	20	0.0	0.3	0.3	6.1	5.8
2038	21	0.0	0.3	0.3	6.1	5.8
2039	22	0.0	0.3	0.3	6.1	5.8
2040	23	0.0	0.3	0.3	6.1	5.8
2041	24	0.0	0.3	0.3	6.1	5.8
2042	25	0.0	0.3	0.3	6.1	5.8
2043	26	0.0	0.3	0.3	6.1	5.8
2044	27	0.0	0.3	0.3	6.1	5.8
2045	28	0.0	0.3	0.3	6.1	5.8
2046	29	0.0	0.3	0.3	6.1	5.8
2047	30	-18.6	0.3	-18.2	6.1	24.3

Note: Salvage value is estimated at 18.6 in 2047.

Sensitivity Analysis

(1) Central Irbid

Items		Benefits				
		+20%	+10%	**base case**	-10%	-20%
Investment costs	-20%	90.1%	77.5%	66,7%	57.4%	49.2%
	-10%	74.4%	65.2%	57.1%	49.8%	43.2%
	base case	64.0%	56.8%	**50.2%**	44.3%	38.7%
	+10%	56.6%	50.6%	45.1%	40.1%	35.3%
	+20%	50.9%	45.9%	41.2%	36.7%	32.5%

(2) Wadi Al-Arab

Items		Benefits				
		+20%	+10%	**base case**	-10%	-20%
Investment costs	-20%	47.2%	40.3%	34.3%	29.0%	24.3%
	-10%	38.4%	33.3%	28.6%	24.5%	20.7%
	base case	32.5%	28.4%	**24.6%**	21.2%	18.0%
	+10%	28.1%	24.7%	21.6%	18.6%	15.8%
	+20%	24.8%	21.9%	19.2%	16.6%	14.1%

(3) Shallala

Items		Benefits				
		+20%	+10%	**base case**	-10%	-20%
Investment costs	-20%	58.0%	50.6%	43.9%	37.8%	32.3%
	-10%	48.5%	42.7%	37.4%	32.4%	27.8%
	base case	41.7%	37.0%	**32.6%**	28.4%	24.5%
	+10%	36.7%	32.7%	28.9%	25.3%	21.9%
	+20%	32.8%	29.3%	26.0%	22.8%	19.8%

(4) Wadi Hassan

Items		Benefits				
		+20%	+10%	**base case 1**	-10%	-20%
Investment costs	-20%	17.2%	16.0%	14.6%	13.2%	11.8%
	-10%	15.6%	14.4%	13.2%	11.8%	10.4%
	base case 2	14.2%	13.1%	**11.9%**	10.7%	9.3%
	+10%	13.0%	12.0%	10.9%	9.6%	8.4%
	+20%	12.0%	11.0%	9.9%	8.8%	7.6%

(5) Ramtha

Items		Benefits				
		+20%	+10%	**base case**	-10%	-20%
Investment costs	-20%	32.2%	28.2%	24.5%	21.2%	18.1%
	-10%	27.1%	23.9%	21.0%	18.2%	15.6%
	base case	23.4%	20.8%	**18.3%**	15.9%	13.6%
	+10%	20.7%	18.4%	16.2%	14.1%	12.1%
	+20%	18.5%	16.5%	14.6%	12.6%	10.8%

(6) Mafraq

Items		Benefits				
		+20%	+10%	**base case**	-10%	-20%
Investment costs	-20%	11.5%	10.2%	8.8%	7.5%	6.2%
	-10%	9.8%	8.6%	7.5%	6.3%	5.0%
	base case	8.5%	7.4%	**6.3%**	5.2%	4.1%
	+10%	7.4%	6.4%	5.4%	4.4%	3.3%
	+20%	6.4%	5.5%	4.6%	3.6%	2.6%

APPENDIX V LEGAL FRAMEWORK AND PROCEDURE ON LAND ACQUISITION

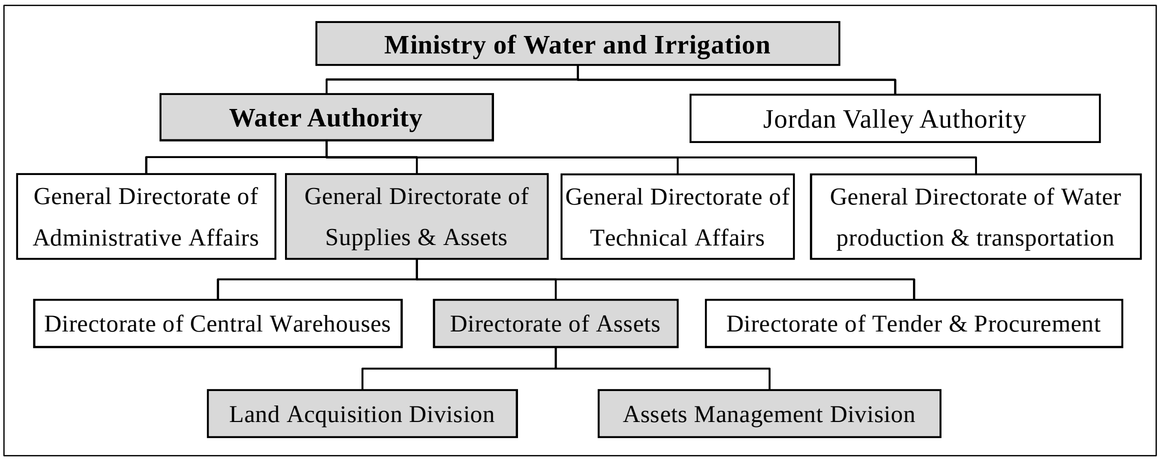
V-1-1 Legal framework and institutional responsibility for implementing land acquisition

Land acquisition in Jordan is implemented in accordance with Land Acquisition Law No. 12, 1987. According to the Land Acquisition Law, general process of land acquisition can be summarized as shown below.

1) Announcement of the intention of land acquisition by the implementer to the Council of Ministers
2) Issuing of the decision of the Council of Ministers on land acquisition (within 6 months)
3) Investigation on current status of the real estate subject to land acquisition by the implementer
4) Detail announcement of land acquisition by the implementer to the owner of the real estate
5) Negotiation with the owner to fix the amount of compensation (within 30 days)
6) Ownership transfer from the owner to the implementer after the payment of compensation to the owner

WAJ, the responsible body for land acquisition in the implementation of the M/P, has the Directorate of Assets which is in charge of all procedures in relation to land acquisition.

Figure V-A-1 shows the organization structure of the Directorate, followed by main tasks and duties of Land Acquisition Division and Assets Management Division under the Directorate as shown in Table V-A-1.



Source: WAJ

Figure V-A-1 Organogram of the Directorate of Assets

Table V-A-1 Main tasks and duties of Divisions under the Directorate of Assets

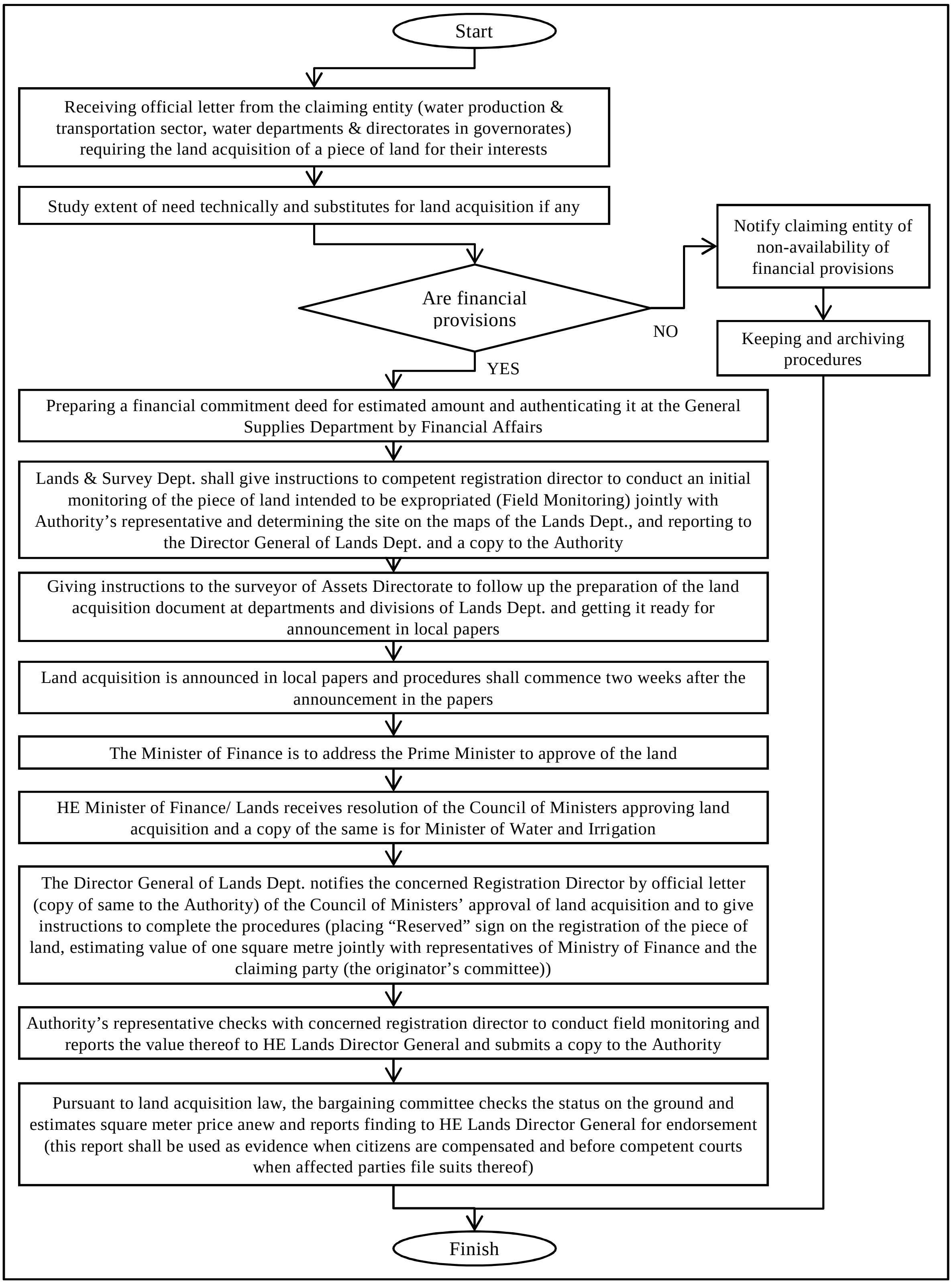
Division	Land Acquisition Division	Assets Management Division
Main tasks and duties	・ Verify land acquisition requirements for the various Water Authority's sites in respect of areas, sites, roads, etc. ・ Participate in the Technical Committees with respect to land acquisition, assessment of values of lands and damages arising out of the land acquisition ・ Participate with the Lands & Survey Department in	・ Leasing of buildings in favour of the Water Authority ・ Evacuate buildings and hand them over to their owners

Division	Land Acquisition Division	Assets Management Division
	determining the parts to be expropriated and delimiting it in- situ · Verify and demarcate the expropriated parts and organize the land acquisition transactions for the purpose of advertising same in the local newspapers · Indexing and classifying the files of expropriated plots of land · Enter the land acquisition particulars and archive documents in the computerized systems · Follow up land acquisition compensation, allocation, leasing and other cases with the Legal Department and Authority's Lawyer · Follow up the land acquisition transactions with the governmental departments and official parties as well as acceleration thereof such as Lands & Survey Department, Amman Municipality, Ministry of Municipalities, and Council of Ministers, etc. · Compensate citizens for the land acquisition located in their lands · Follow up appropriation of plots of land needed by the Authority for its services with the concerned parties · Follow up obtaining the deeds of registration of the expropriated lands and the compensation of owners thereof has been finalized	· Compensations in lieu of damages (water lines-wastewater lines) · Compensate citizens in lieu of irrigation rights · Follow up encroachments on properties of Authority · Follow up lease contracts of the Electricity Company to the Authority's sites · Follow up of settlement works with the lands · Pay in lieu of buildings lease which are leased in favour of the Water Authority · Participate in the Technical Committees pertaining to encroachments upon the Authority's properties · Establish the Authority's properties on the digital maps (GIS)

Source: WAJ

General procedure on land acquisition

General procedure on land acquisition by WAJ is shown in Figure V-A-2.



Source: WAJ

Figure V-A-2 General procedure on land acquisition by WAJ

Requirements for the implementation of land acquisition in WAJ are shown in Table V-A-2.

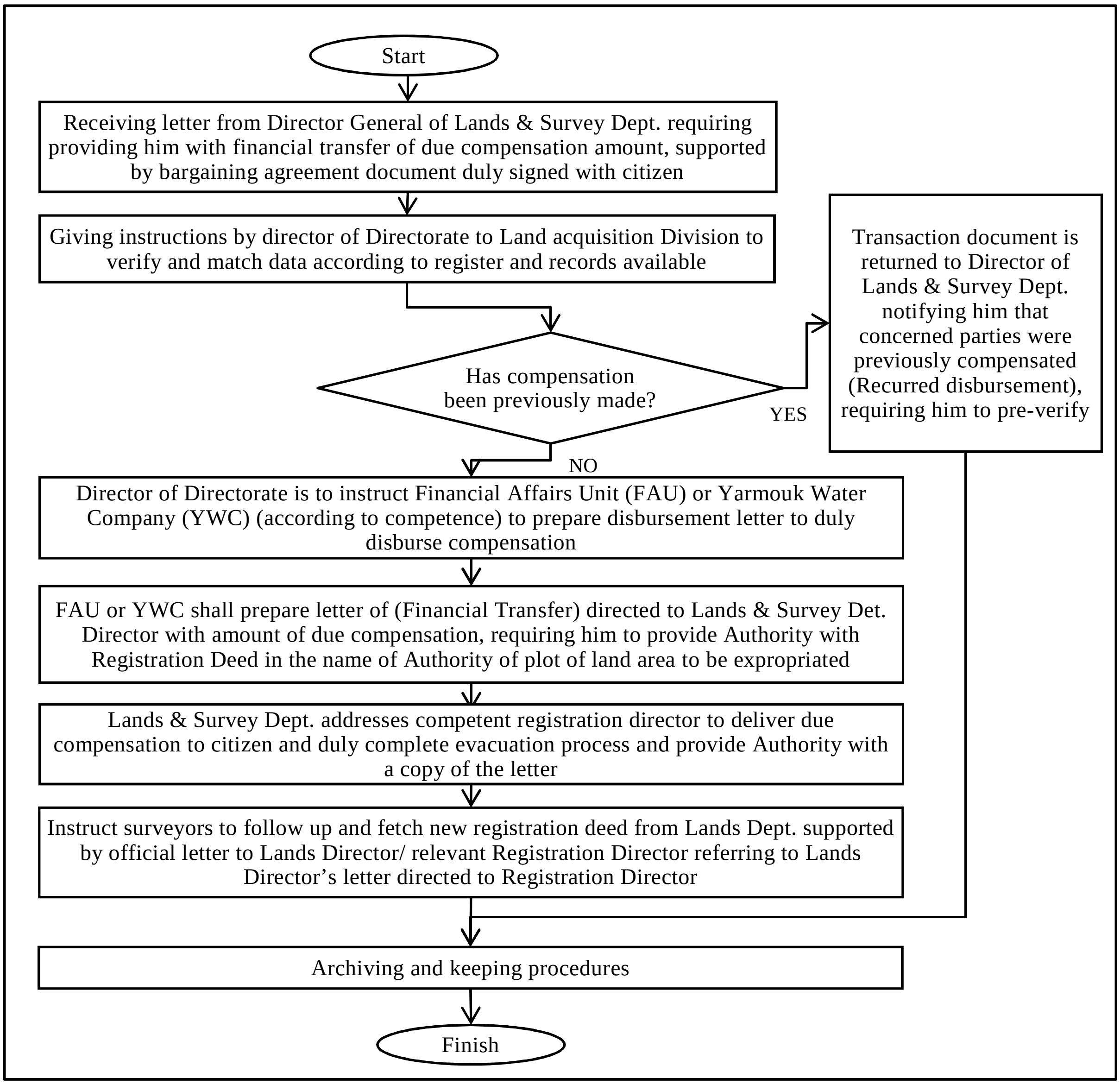
Table V-A-2 Requirements for the implementation of land acquisition in WAJ

No.	Implementation requirements	Provider	Partners in WAJ	Partners out of WAJ
1.	Official letter from entity requiring land acquisition including (plot number, basin number, neighborhood number, size area of plot to be expropriated and purpose of land acquisition)	Entity requiring land acquisition	Technical Affairs Sector, Water Production & Transport Sector, Water Depts. & Directorates in governorates, Financial Affairs Unit	Council of Ministers, Ministry of Finance, Lands & Survey Dept., Registration Depts. in governorates and districts, Ministry of Municipalities. Settlement Directorates, Grand Amman Municipality, Municipalities in governorates
2.	Financial allocation	Financial Affairs Unit		
3.	Recent registration deed of the plot of land	Requiring entity		
4.	Recent plan of the plot of land	Requiring entity		
5.	Recent regulatory site scheme of the plot of land	Requiring entity		
6.	Estimation of preliminary value of land acquisition	Requiring entity		

Source: WAJ

10-3-1.1 Measures for compensation and grievance redress

Compensation procedure for land acquisition is shown in Figure V-A-3.



Source: WAJ

Figure V-A-3 Procedure of compensation for land acquisition

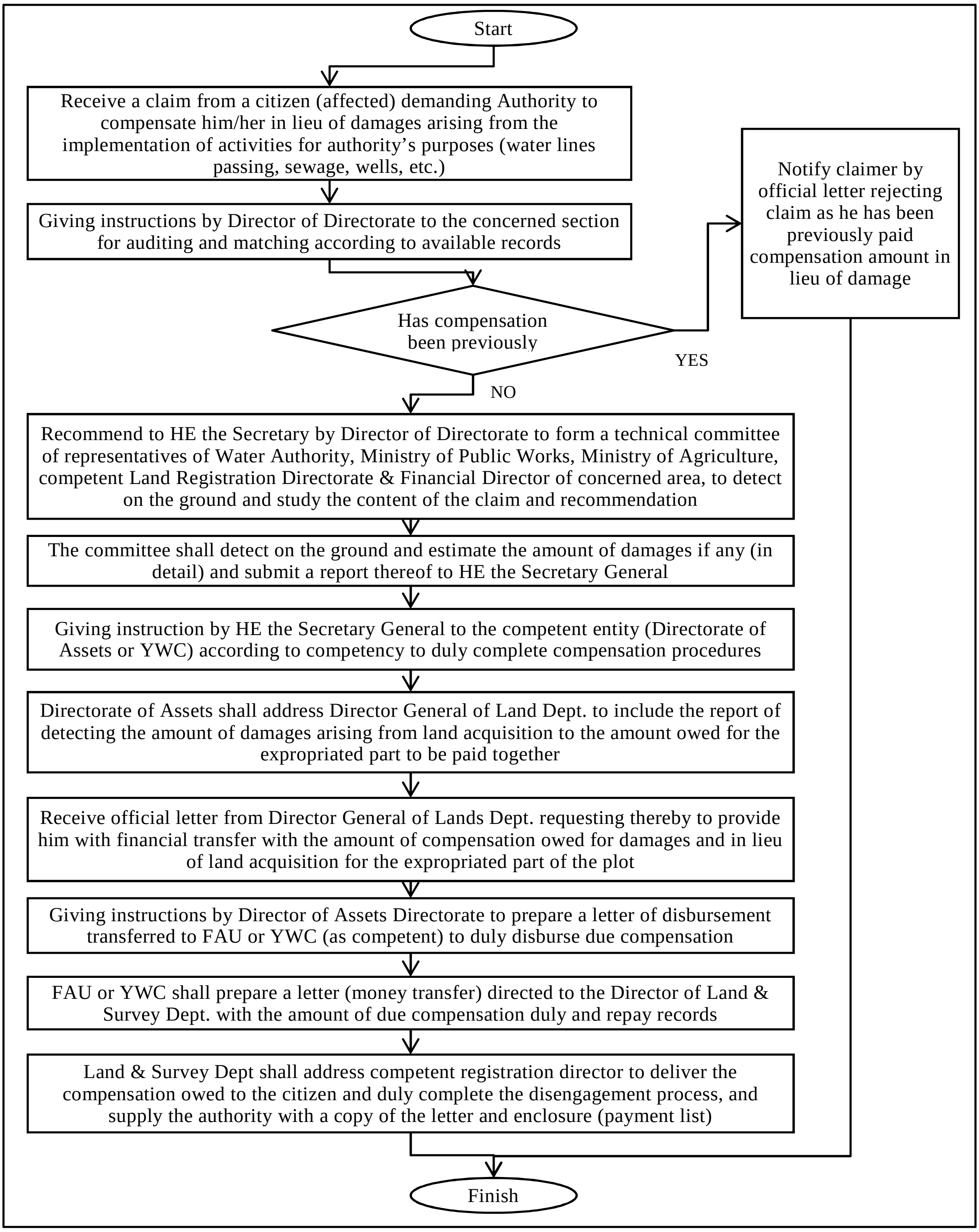
Requirements for disbursement as compensation for land acquisition are shown in Table A-3.

Table V-A-3 Requirements for compensation disbursement

No.	Implementation requirements	Provided entity	Partners within Authority	Partners out of Authority
1.	Bargaining Agreement	Lands and Survey Dept.	-Financial Affairs Unit (FAU) - Legal Department - YWC	- Lands and Survey Dept. - Registration Directorates at governorates - Owner of plot or his agent
2.	Report of Bargaining Committee			
3.	Recent registration deed of plot of land			
4.	Any other requirements / Inheritance deed, proxy for someone…			

Source: WAJ

Procedure of the compensation for damage due to land acquisition in accordance with grievance by citizens is shown in Figure V-A-4.



Source: WAJ

Figure V-A-4 Procedure of the compensation for damage due to land acquisition

Requirements of the compensation for damage due to land acquisition in accordance with grievance by citizens are shown in Table V-A-4.

Table V-A-4 Requirements of the compensation for damage due to land acquisition

	Implementation requirements	Provided entity	Partners within Authority	Partners out of Authority
1.	Claim from affected citizen	Affected citizen	Technical Affairs Sector, Water Production & Transport Sector, Water Depts. & Directorates in governorates	Land & Survey Dept. / Registration Directorates in governorates
2.	Official letter from Water Departments/ based on affected citizen's claims	Water departments		
3	Memo from assistant secretary for production / based on affected citizen's claim	Water Production & Transport sector		
4	Official letter from HE Director General/ to form a technical committee to identify & estimate amount of damages caused by authority's activities referred to in the claim	Secretary General		
5	Committee report identifying damages, estimating their amount and recommending disbursement of amount in lieu of damages	Formed committee		
6	The placement of HE the Secretary General to duly disburse the amount of damages	Secretary General		

Source: WAJ

APPENDIX V-2　Monitoring Form（Example）

The latest results of the below monitoring items shall be submitted to the lenders as part of Progress Report throughout the construction phase.

Construction Phase

1. Response/ Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results during Report Period
Number and contents of formal comments made by the public	
Number and contents of responses from Government agencies	

2. Pollution

Air Quality (Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
Dust	mg/m^3					0.1(24h), 0.2(1h)		Monthly

Water Quality

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
Total coliforms	MPN/100mL			<1.1		0/100mL		3 times / construction section nearby water source
Fecal coliforms	MPN/100mL			0		0/100mL		
pH	-			6.5-8.5		-		
TDS	mg/L			<500-1500		1000		
Chloride	mg/L			200-500		250		
Sodium	mg/L			200-400		200		
Manganese	mg/L			0.1-0.5		0.1-0.5		
Nitrate	mg/L			50-70		50		
Nitrite	mg/L			2		3		
Total hardness	mg/L			100-500		-		
Iron	mg/L			0.3-1.0		0.3		

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
Copper	mg/L			0.1-1.5		1-2		
Lead	mg/L			0.01		0.01		
Zinc	mg/L			<3.5		3		
Turbidity	NTU			1-5		-		

Note: Drainage is the sprinkling water for dust control during excavation and washing water for construction machines and vehicles, the using water volume is little, the raw water is well water in the vicinity, and the water use will be saved near the water source well. Although the impact on the water source is considered to be little, for the confirmation, the above water quality analysis will be carried out in water sources nearby construction section operating.

Noise

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
Noise Level.	dB			35-55 (night)				Monthly
Vibration Level.	dB			55-60 (night)				Monthly

Offensive Odor

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
Ammonia	ppm					2		Monthly
Methylmercaptan	ppm					0.04		
hydrogen sulfide	ppm					0.06		
methyl sulfide	ppm					0.05		

Soil pollution

Monitoring Item	Contents	Monitoring Results during Report Period	Measures to be Taken
Oil leakage condition	Check of oil leakage situation from construction machines and vehicles, and repairmen situation Confirmation of remove of contaminated soil, and dumpling to the specified disposal site (Weekly)		

3. Social Environment

Monitoring Item	Contents	Monitoring Results during Report Period	Measures to be Taken
Local Economy	Confirmation of securement of approach paths to commercial places on traffic control for construction work		
Existing Social Infrastructure and Social Service	Same in "Water Quality"		
Cultural Heritage	Confirmation of accurate inspection by MOTA		
Infectious Diseases including HIV/AIDS	Confirmation of education of health management for workers (monthly)		
Work Environment	Confirmation of wearing of specified wearing goods for work (weekly)		
Accident	Confirmation of accurate traffic control and securement situation of safety for workers (weekly)		

APPENDIX V-3 Environmental Check List (Wastewater Master Plan)

Classification	Environmental Item	Major Check Items	Yes: Y No: N	Specific Environmental and Social Considerations (Reason for the Yes / No, basis, mitigation, etc.)
1 licensing and explanation	(1) EIA and Environmental licensing	(a) Environmental assessment report (EIA report), etc. was created? (b) EIA report was either approved by the country's government? (c) Approved EIA report has collateral condition? If there is a collateral condition, the conditions are satisfied? (d) In the case other than the above, if necessary, environmental licensing from the competent authority of the local was acquired?	(a) N (b) N (c) N (d) N	(a) (b) (c) (d) EIA at the planning stage (MP) is not legalized in Jordan, but SEA was conducted according to JICA's Environmental and Social Consideration Guideline.
	(2) Explanation to local stakeholders	(a) About the impact and the contents of the project, an appropriate description to local stakeholders including information disclosure was carried out, and the understanding was gained? (b) The comments from the residents were reflected on project content ?	(a) Y (b) Y	(a) (b) Stakeholder's meeting as a part of SEA was held, and the opinions and comments from participants were collected to reflect on the finalization of the MP.
	(3) Consideration of alternatives	(a) Multiple alternatives of the project plan (when studying, and including items related to environmental and social) were considered?	(a) Y	(a) Development alternatives at concept level (new water source development or rehabilitation of existing facilities) and component level (land acquisition for new facilities or reinforcement of existing facilities, etc.) were examined in view of environmental and social impacts.
2 Pollution measures	(1) Water quality	(a) SS, BOD, COD, pH, and the like item of sewerage effluent are consistent with drainage standards of the country? (b) Does untreated waste water contain heavy metals?	(a) Y (b) Y	(a) Drainage standard is stipulated in "Jordanian Reclaimed Wastewater Standard-JS 893/2006. (b) Untreated waste water contains heaveay metal.
	(2) Waste	(a) Waste sludge generated in accordance with the facility operation is either treated and disposed of properly in accordance with the provisions of the country?	(a) Y	(a) Sludges generated from wast water treatment plans in YWC is diiposed in Al Akaydar Landfill.
	(3) Soil pollution	(a) In the case that the content of heavy metals in sludge or other waste is suspected, are countermeasures taken for prevention of the pollution of groundwater and soil due to the leakage of wastewater from the waste?	(a) Y	(a) Sludges and wastes with heavy metals are desposed in Al Akaydar final landfill.
	(4) Noise and vibration	(a) Noise and vibration from waste water treatment plant and pump facilities, etc., are consistent with the standards of the country?	(a) Y	(a) Noise and vibration levels of waste water treatment plants in YWC are within the Jordanian standard.
	(5) Offensive odor	(a) Are preventive measures of offensive odor from sludge treatment facilities taken?	(a) N	(a) Dewatering facilities incorporate from new construction or rehabilitation of waste water treatment plant, but many WWTPs use suludge drying beds because many WWTPs locate away from residential area.

Classification	Environmental Item	Major Check Items	Yes: Y No: N	Specific Environmental and Social Considerations (Reason for the Yes / No, basis, mitigation, etc.)
3 Natural environment	(1) Protected areas	(a) Are the site and treated water discharge point located in protected areas designated by laws of the country or international treaties and conventions? Project affects the protected areas?	(a)N	(a) The project area has more than 10km away from the Reserves the country specify, the impact does not affect.
	(2) Ecosystem	(a) Do the site and treated water discharge point include virgin forest, tropical natural forest, habitat ecologically important (coral reefs, mangrove swamps, tidal flats, etc.) ? (b) Do the site and treated water discharge point include the habitats of endangered species required protection by law of the country or international treaties and conventions? (c) If a significant impact on the ecosystem is concerned, measures to reduce the impacts on the ecosystem is conducted? (d) Water intake (surface water, underground water) by the project affects the aquatic environment such as rivers? Measures to reduce the impacts on the aquatic organisms, etc., are carried out?	(a) N/A (b) N/A (c) N/A (d) N/A	(a) (b) (c) (d) The project site locates in urban area and suburb area of Irbid, Ramtha, and Mafraq, important species, rare species and endangered critical species of fauna and flora do not exist. In addition, since the components of the MP are rehabilitation of facilities and water supply network, and new construction of reservoir and pump station, the project does not participate in the intake of water sources, the significant impact on the ecosystem is not concerned.
4 Social environment	(1) Resettlement	(a) With the implementation of the project, involuntary resettlement occurs ? If that occurs, efforts to minimize the impact of relocation is conducted? (b) For residents to transfer , appropriate description of compensation and life reconstruction measures would be done before the transfer ? (c) Search for residents relocation was carried out, and the resettlement plan including compensation by the replacement cost and the recovery of livelihoods after relocation is conducted ? (d) Payment of compensation is either carried out in the pre-transfer ? (e) Compensation policy has been developed in the document ? (f) The plan, among the relocated residents, in particular for socially vulnerable such as women, children, the elderly, the poor, ethnic minorities, indigenous peoples, etc. has been made with appropriate consideration ? (g) For relocated residents, the pre-transfer agreement can be gotten ? (h) The organizational framework established to properly implement the resettlement is considered ? Enough capacity to implement the plan and budget measures can be secured ? (i) Monitoring for the impacts of resettlement is planned ? (j) System for the complaint process is built ?	(a)N/A (b)N/A (c) N/A (d) N/A (e) N/A (f) N/A (g) N/A (h) N/A (i) N/A (j) N/A	(a) (b) (c) (d) (e) (f) (g) (h) (i) (j) In this project, resettlement does not occur.
	(2) Life and livelihood	(a) Do the changes of land use and water area use due to the project affect negatively on the life of residents? (b) Does the project affect negatively on the life of residents? Adequate measures is considered to reduce the negative impacts, if necessary?	(a) N (b) N	(a) The projects planned in the MP are expantion of facilities in the existing WWTP lands or in land owned by YWC, and along existing roads. Change of land use is not implemented. (b) Element afects on the life of residents is not expected.

Classification	Environmental Item	Major Check Items	Yes: Y No: N	Specific Environmental and Social Considerations (Reason for the Yes / No, basis, mitigation, etc.)
4 Social environment	(3) Cultural heritage	(a) Is there risk by the project to heritages and historical sites which are archeologically, historically, culturally, and religiously precious ? In addition, measures that have been stipulated in accordance with the country's laws are taken into account ?	(a) Y	(a) There is a possibility to find archaeological remains during construction. If any, construction activity will be implemented under the supervision of the Ministry of Tourism and Antiquities.
	(4) Landscape	(a) When the landscape to be considered particularly presents, the project adversely affects to it? If it is affected, necessary precautions is taken?	(a) N	(a) Since the MP is composed of the rehabilitation of existing waste water treatment facilities and network, adverse effect to landscape is not expected.
	(5) Ethnic minorities, indigenous	(a) Consideration to reduce the impact to minority of the country, indigenous cultures and lifestyle have been made? (b) Rights related to land and resources of ethnic minorities and indigenous people are respected?	(a)N/A (b)N/A	(a) (b) Distinction of ethnic minorities and indigenous peoples is not performed. Original Palestine refugees, Syria refugees in recent years has been living. Discrimination to minorities does not occur through rehabilitation of waste water treatment facilities.
	(6) Working environment	(a) In the project, the Act on the working environment of the country must be observed is kept? (b) Safety considerations in in the hard part of the individuals involved in the project such as installation of safety equipment according to industrial accident prevention, management of hazardous substances, etc. are being measures? (c) Support implementation in the soft part of the individuals involved in the project such as the establishment of safety and health plan and safety training for workers (including public health and traffic safety) is planned and implemented? (d) Appropriate measures that security personnel involved in the project make sure not to violate the safety of the project stakeholders and local residents are taken ?	(a) Y (b) Y (c) Y (d) Y	(a) Adhering to the law is stipulated in the contract, and supervision is also carried out. (b) Dress code related to industrial accident prevention, measures for necessary equipment handling safety check or the like are performed. (c) Formulation of safety and health plan, safety training is carried out. (d) Prior guidance and OJT is performed.
5 Others	(1) Impact under construction	(a) Mitigation measures are prepared against pollution during construction (noise, vibration, turbid water, dust, exhaust gas, waste, etc.) ? (b) The construction adversely affects the natural environment (ecosystem) ? In addition, adequate measures considered to reduce impacts is prepared? (c) The construction adversely affects the social environment construction ? In addition, adequate measures considered to reduce impacts is prepared? (d) The construction causes road congestion? Adequate measures considered to reduce impacts are prepared?	(a) Y (b) N (c) Y (d) Y	(a) Vibration, Noise; Construction work is carried out during the day time. Dust; Periodical watering will be conducted. Waste is ensured to the disposal site. (b) The construction work is in existing operationg WWTP and along existing road with traffic. The impact to the natural environment (ecosystem) is very small. (c) During the construction period, approach to commercial places is disturbed by traffic control in construction section, mitigation measures is carried out by ensuring the approach pathes for passers. (d) Enclosure of construction section, installation of signs, placement of traffic-induced persons are carried out to secure the traffic safety.

Classification	Environmental Item	Major Check Items	Yes: Y No: N	Specific Environmental and Social Considerations (Reason for the Yes / No, basis, mitigation, etc.)
5 Others	(2) monitoring	(a) For items that are considered to have potential impacts of the above environment items, monitoring of project operators are planned and implemented? (b) How item of the plan, method, frequency, etc. are determined? (c) Monitoring system of the project operator (Continuity of the organization, personnel, equipment, and adequate budget) or be established? (d) The reporting procedure or the frequency, etc. from the project operator to the competent authority are stipulated?	(a) Y (b) Y (c) Y (d) Y	(a) Monitoring plan is implemented. (b) The patrol check of working environment, measures for residents, impact for cultural heritage is conducted once a week during construction. (c) Monitoring system is established. (e) Report is done once a month.
6 points to note	Notes on using the environmental checklist	(a) If necessary, it should also be confirmed if the impact might cross the border or affect on global environmental issues.	(a) Y	(a) The MP considers the impact of corresponds to the population growth due to the influx of refugees

Note 1) For the "standard of the country concerned" in the table, when there is a significant deviation as compared to the baseline which is internationally recognized, countermeasures are examined, if necessary. Items, which are not yet to be established in the local environmental regulations of the country, is examined by comparison with appropriate standards other than the country (including experience in Japan).

Note 2) Environmental Checklist is intended only to show the standard environment check items. Depending on the condition of the project and the local, it is necessary to add or delete items.