Republic of Iraq
Ministry of Construction, Housing and Public Municipality（MCHPM）
Muthanna Water Directorate（MWD）

Republic of Iraq
Preparatory Survey on Samawah Water Supply Improvement Project

Final Report advanced version

July 2023

Japan International Cooperation Agency

Nippon Koei Co., Ltd.
Koei Research & Consulting Inc.

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Exchange Rate applied in this Report

(As of May 2023)

USD 1.0	= JPY 133
USD 1.0	= IQD 1,300
IQD 1.0	= JPY 0.102


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Syria
Iran
Iraq
Jordan
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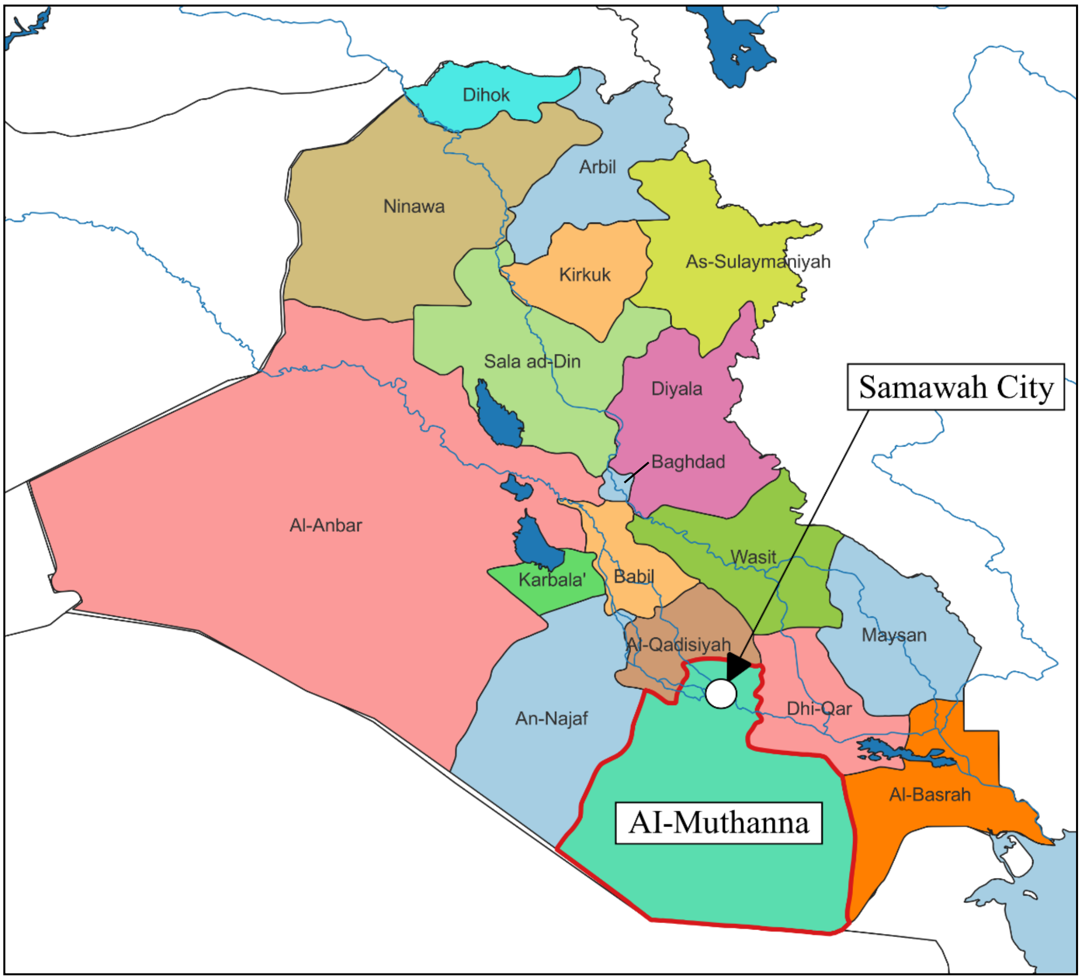
Dihok
Arbil
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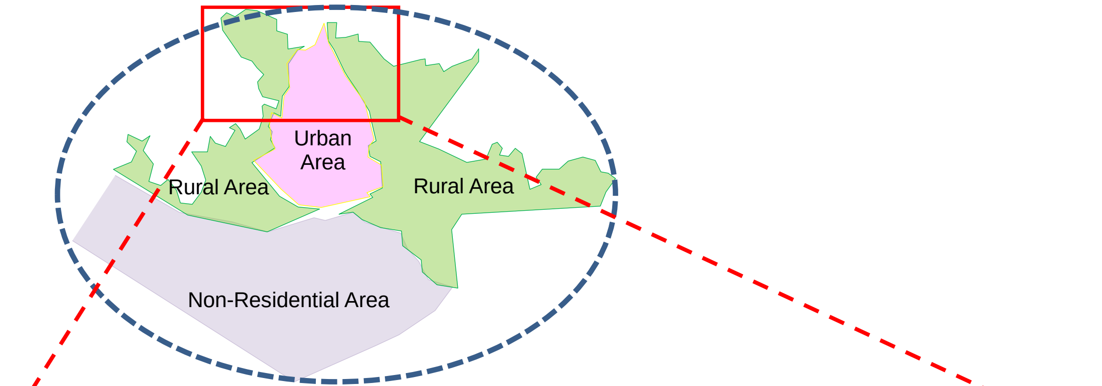
As-Sulaymaniyah
Sala ad-Din
Diyala
Samawah City
Baghdad
Al-Anbar
Wasit
Karbala'
Babil
Maysan
Al-Qadisiyah
An-Najaf
Dhi-Qar
Al-Basrah
Al-Muthanna

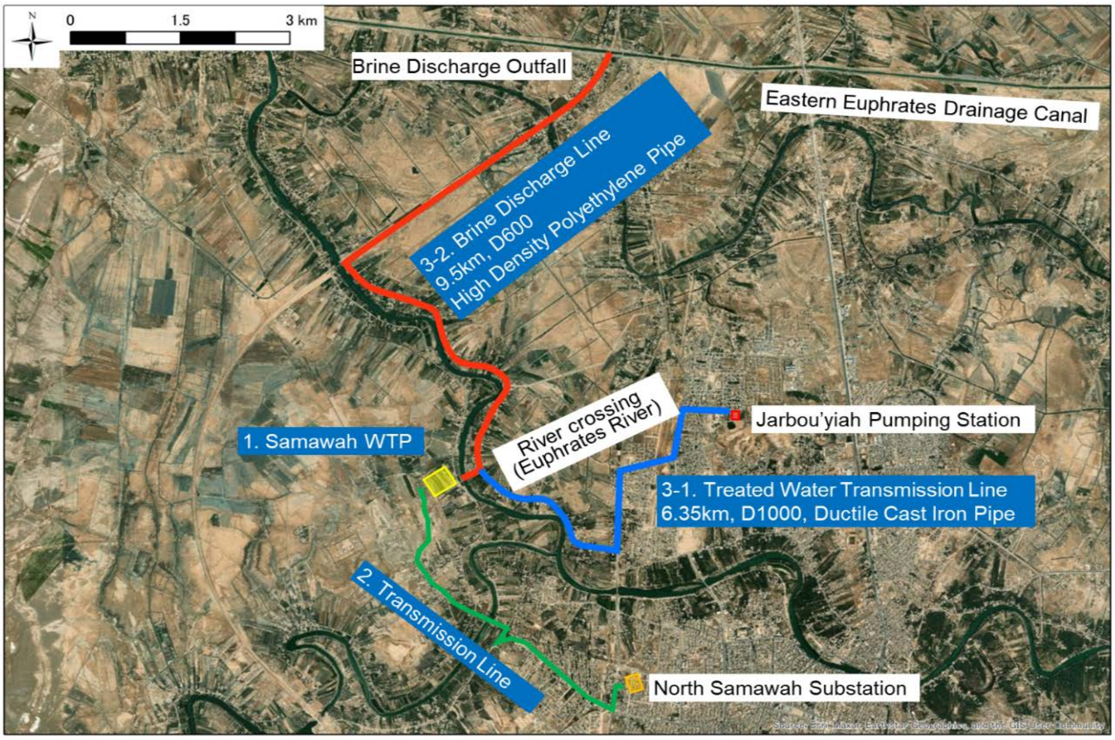
Samawah Water Supply Improvement Project
- Location and components -

Project components

No.	Facilities	Outlines	Contract Package	Remarks
1.	Samawah WTP	81,000 m³/d, with RO	CP-1	
2.	External power transmission line	Power transmission lines to Samawah WTP	CP-2	From North Samawah Substation to Samawah WTP
3-1.	Treated water transmission line	6.35 km	CP-3	From Samawah WTP to Jarbou'yiah PS
3-2.	Brine Discharge line	9.5 km	CP-3	From Samawah WTP to Eastern Euphrates Drainage Canal
4.	Improvement of the existing water distribution system in urban area	Valves, Monitoring and control facility	CP-4	Urban Area of Samawah District



Samawah District (Service Area)



Preparatory Survey on
Samawah Water Supply Improvement Project

Abbreviations

ATP	Affordability to Pay
BOQ	Bill of Quantity
CAPEX	Capital Expenditure
CU	Compact Unit
COVID	COronaVirus Infectious Disease
DC	Disconnection Switch
D/D	Detail Design
DF/R	Draft Final Report
DG	Director General
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ERD	Energy Recovery Device
ESC	Environmental and Social Considerations
F/R	Final Report
FDI	Foreign Direct Investment
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GOI	Government of Iraq
GWD	General Water Directorate
HCPH	High Comission for Population and Housing
ICB	International Competitive Bid
IED	Improvised Explosive Device
IFC	International Finance Corporation
IMF	International Monetary Fund
IQD	Iraqi Dinar
ISIL	Islamic State of Iraq and the Levant
ITR	Interim Report
JCCME	Japan Cooperation Center for the Middle East
JICA	Japan International Cooperation Agency
JST	JICA Study Team
KPI	key Performance Indicator
LA	Lightening Arrester

LCB	Local Competitive Bid
LCC	Life Cycle Cost
M&E	Mechanical and Electrical
MCHPM	Ministry of Construction, Housing and Public Municipality
MMPW	Ministry of Municipalities and Public Works
MOE	Ministry of Electricity
MOEn	Ministry of Environment
MOF	Ministry of Finance
MOH	Ministry of Health
MOP	Ministry of Planning
MWD	Muthanna Water Directorate
NDP	National Development Plan
NIC	National Investment Commission
NRW	Non-Revenue Water
O&M	Operation and Maintenance
ODA	Official Development Assistance
OHS	Occupational Health and Safety
OPEX	Operational Expenditure
PCT	Potential and Current Transformer
PIC	Provincial Investment Commission
PMT	Project Management Team
PMU	Project Management Unit
PPI	Private Participation in Infrastructure
PQ	Pre-Qualification
PS	Pump Station
RAP	Resettlement Action Plan
RO	Reverse Osmosis
SAF	Small Arms Fire
SC	Static Condenser
SOP	Standard Operation Procedure
TDS	Total Dissolved Solid
TOR	Terms of Reference
UMIC	Upper-Middle Income Country
UXO	UneXploded Ordnance
VCB	Vacuum Circuit Breaker
VFD	Variable Frequency Device
WB	World Bank

WTP	Water Treatment Plant
WTP	Willingness to Pay

Preparatory Survey on
Samawah Water Supply Improvement Project

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Executive Summary

1. Outline and Objective of the Study

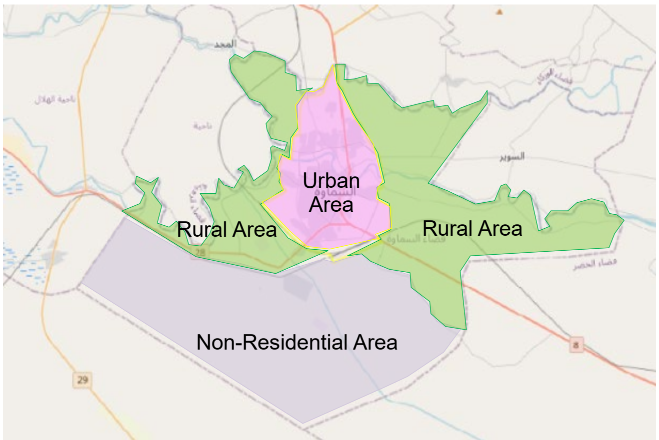
Muthanna Governorate is one of the four directorates located in the southern region of Iraq. The coverage of the piped water supply services in the governorate is 78.8%, which is the second lowest in all 18 governorates in the country and lower than the national average at 89.8%. Samawah District, the capital of Muthanna Directorate, has no major water treatment plant in the city and relies much on the water treatment plants (WTPs) in Rumaitha District, located 25 km north, as a drinking water resource. Water supply duration is less than six hours a day in a wide area and the deteriorated facilities cause a significant amount of volume of water loss in the long-distance transmission line from Rumaitha and in the water distribution network in the city. In addition, the increasing salinity of the Euphrates River deteriorates the water quality of the water from Rumaitha and from small decentralized treatment facilities in Samawah District, which often result in the high salinity in the drinking water which exceeds the permissible value according to the Iraqi drinking water quality standard.

In 2016, the Japan International Cooperation Agency (hereinafter referred to as "JICA") conducted the "Data Collection Survey on Water Sector in Southern Iraq" (hereinafter referred to as the "Previous Study"). In order to improve the situations of the water supply services identified, the Previous Study proposed a project to construct a water treatment plant with desalination process for Samawah District and to improve the water transmission and distribution systems (hereinafter referred to as "the Project").

Under the circumstances above, the Preparatory Survey on Samawah Water Supply Improvement Project (hereinafter, referred to as "the Study") was carried out to provide JICA with information for its appraisal on the validity to provide Japan's official development assistance (ODA) loan to the Project.

2. Study Area

Target area of the Study is Samawah District, Muthanna Directorate (**Figure 1**), including its urban areas and the rural areas. Non-residential area is included in the area of the city, however it is an area with few residents.



Source: JICA Study Team

Figure 1 Target Are of the Study

3. Major Authorities in Iraq Relevant to the Project

The following agencies are the counterpart of the JICA Study Team (hereinafter referred to as "JST") for the Study:

- Ministry of Construction, Housing, and Public Municipality (MCHPM)
- Muthannna Water Directorate (MWD)

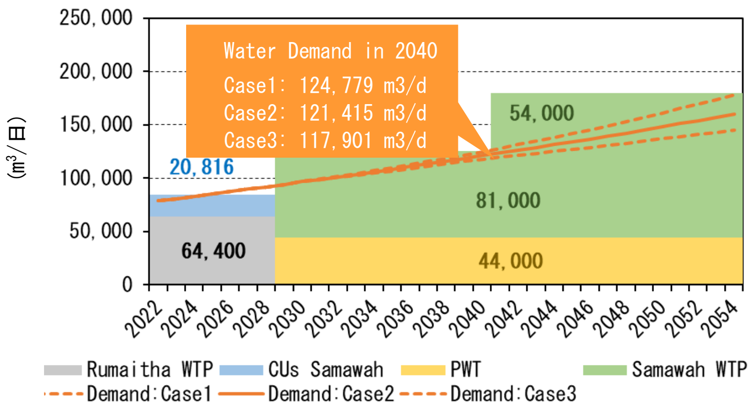
MCHPM will be the Executing Agency of the Project. MWD will participate in the Project implementation and, after the Project's completion, will operate and maintain the facilities to be constructed and/or rehabilitated in the Project.

4. Validity of the Execution of the Project

The Rumaitha WTPs, which are the existing major water sources of Samawah District, is located at about 25 km away from the district. The WTPs have problems in the water production volume due to the deterioration of the facilities and the water quality. In addition, the increasing salinity of the raw water also raises doubt on the sustainability of these WTPs.

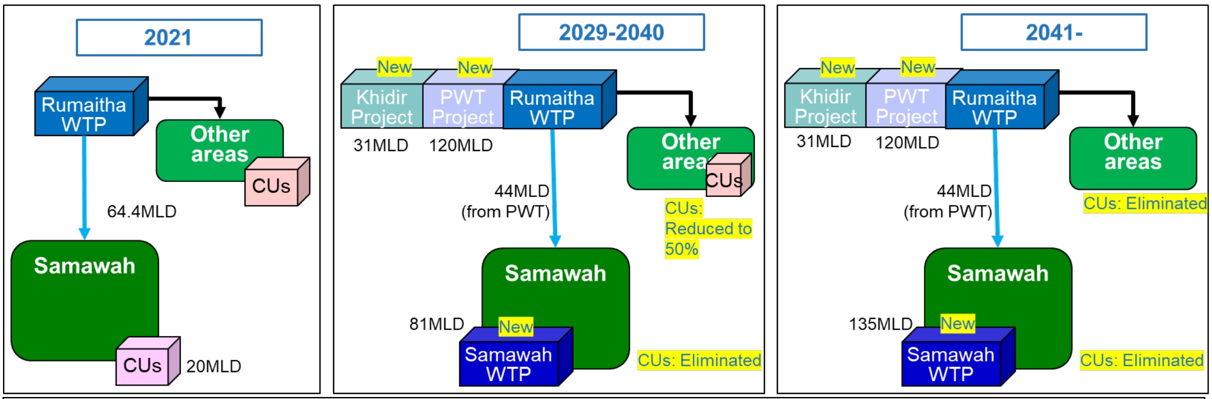
MCHPM is carrying out a new project called the PWT Project, whose water resource (Gamass River) is located more than 50 km from Rumaitha, that will supply a certain amount of treated water to Samawah District. However, there is no water resource other than the Euphrates River which will be available to MWD.

For the reasons above, the Muthanna Governorate needs a WTP to treat the raw water of the Euphrates River. The location shall be near the governorate's capital, which is Samawah District. The water demand and supply gap estimated that the definitive capacity of the WTP will be 135,000 m^3/day to satisfy the water demand in 2050, of which 81,000 m^3/day will be the capacity of the Project to satisfy the water demand in 2040 (**Figure-2**). After execution of the Project, the water source of Samawah District will shift from the current ones (Rumaitha WTPs and small decentralized water treatment facilities) to Samawah WTP to be constructed in the Project and the WTP by the PWT Project (**Figure 3**).



Source: JICA Study Team

Figure 2 Water Supply Demand Balance in Samawah District



- MLD：Million litters per day (＝1,000 m^3/day)
- Khidir Project: Al Khidir and Al Daraiji Water Project (A new project that does not supplywater to Samawah District)
- CU: Small size decentralized water treatment facilit

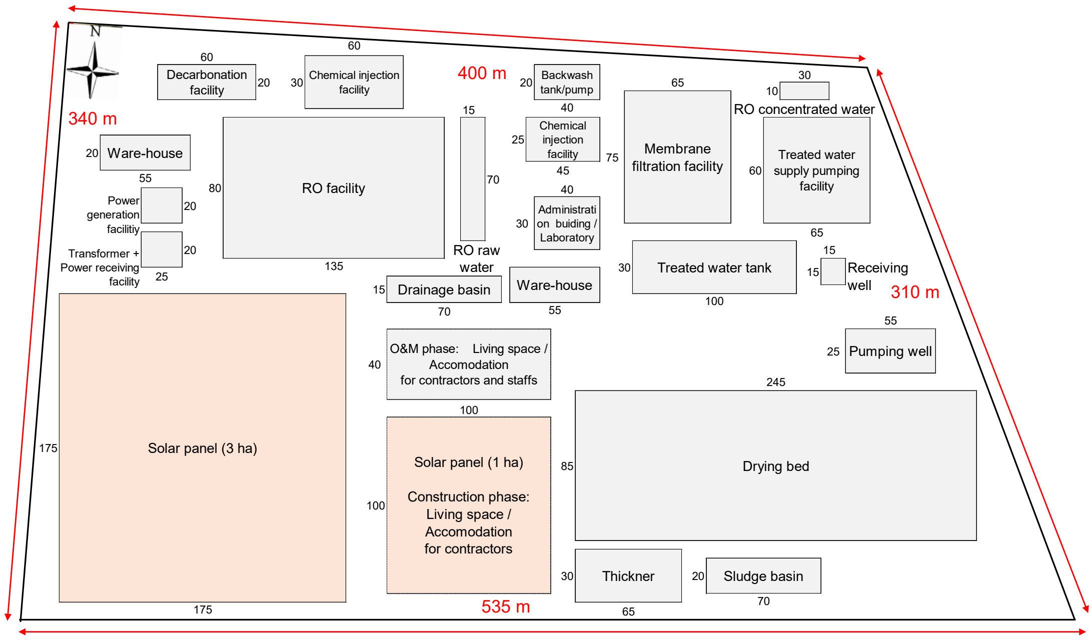
Source: JICA Study Team

Figure 3 Water Supply System to Samawah District Before/After the Project

5. Planning of Samawah Water Treatment Plant

The existing data and JST's sampling data identified that the TDS in the raw water of Samawah WTP sometimes rise to 3,000 mg/L. To satisfy the Iraqi drinking water quality standard, the WTP will need water treatment by the RO technology.

The Samawah WTP was designed to reduce the O&M cost by optimizing the treatment process and choice of equipment/materials, including minimizing the capacity of RO facilities. It also adopts solar power generation system to reduce the energy cost. To tackle frequent power failure anticipated, the WTP will be provided with "Critical Line" by MOE and will also be equipped with power generators (**Figure 4**).



* All buildings and civil structures will be constructed in the Project (Phase-1). The final phase will be the installation works of additional equipment in the buildings and civil structures constructed in the Project.

Source: JICA Study Team

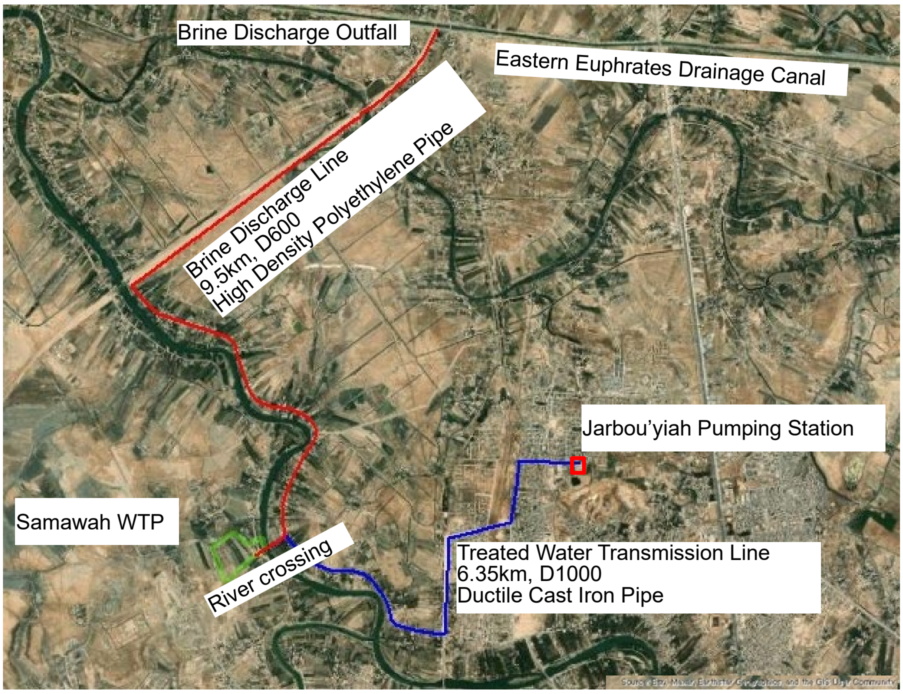
Figure 4 Proposed Layout of WTP

6. Planning of Water Transmission and Distribution Lines and Brine Discharge Line

The treated water by Samawah WTP will be transferred to the existing reservoir at Jarbou'yiah, from which the water will be distributed in the city. The brine from the RO process will be discharged to the Eastern Euphrates Drainage through a discharge pipeline of 9.5 km (**Figure 5**).

The existing distribution network in the city was estimated to have sufficient hydraulic capacity to supply the water to satisfy the water demand in 2040. Therefore, the Project will not include reinforcement of the existing network but will include procurement and installation of some equipment for water flow measurement, interconnections among the major pipelines, and network monitoring system.

The Study executed a preliminary design of the expansion of the water transmission and distribution networks to the urban areas. However, as its scope of work contains a variety of uncertainties, it turned out difficult to well define the measures to be taken for environmental and social aspects including the land acquisition matters. For this reason, the Project will not include the expansion of the water network to the rural areas.



Source: JICA Study Team

Figure 5 Location of Samawah WTP and Alignment of the Pipelines

7. Project Scope

The scope of the Project is summarized in **Table 1**.

Table 1 Summary of the Construction Works in the Project

Work Item	Contents	Work Volume
Intake, Conveyance Pipe	Raw water to be extracted from the Euphrates River and the raw water will be conveyed by the pipe to the Water Treatment Plant	Capacity: 123,700 m^3/day*, Pipe length: approx. 300 m
Water Treatment Plant	Pre-treatment, RO Facility,	112,500 m^3/day* 65,750 m^3/day
Brine Discharge	Brine Discharge Pipe to the Discharge Canal Brine Discharge Pump	Length: 9.5 km Diameter: D600 430 m^3/hour
Transmission Pipe (Primary)	Pipeline from the Water Treatment Plant to the Jarbou'yiah Reservoir	Length: 6.35 km Diameter: D1000
Procurement of Ancillary Facilities of Distribution System	Gate Valve Interconnection Facility Monitoring and Control Facility	D225-D900 D300-D900 Level Meter, Water Pressure and Flow Meter, Flow Control Valve, etc.

*: Full scale of civil structures to cover until Phase-2 of intake, water treatment plant, and transmission pipe will be constructed in Phase-1 (the Project).

Source: JICA Study Team

8. Operation and Maintenance

MWD is responsible for O&M of the facilities to be constructed in the Project including the WTP with RO facility. However, MWD has no experience in the O&M of the RO treatment facility. Therefore, the Project will include two-year O&M services to be provided by the contractor after the construction phase. During the O&M service phase, the contractor will be required to transfer to MWD the knowledge and skill for the O&M of the Samawah WTP, under the supervision of the consultant.

Non-Revenue Water (NRW) in the water supply system is not well monitored and controlled. NRW management is important to ensure the Project's benefit because it is related to the financial and economic benefits derived from the water produced in the Samawah WTP. Therefore, the JST proposed a technical assistance program for MWD to procure equipment, materials, and tools to detect and fix leakages, and to develop the institutional setup of MWD and the capacity of MWD employees to monitor and reduce NRW that consists of both physical and commercial loss.

By taking the measures proposed above, the Project will be implemented efficiently and will deliver the expected benefits to the target area.

9. Environmental and Social Considerations

The Study evaluated the potential impact of the Project on the environment and social aspects during the implementation of the Project and operation of the facilities to be constructed by the Project.

In general, brine from the RO facilities is one of the major potential environmental risks of the water treatment facilities with RO process. According to the water quality testing done in the Study, the TDS of the brine receiving water body (Eastern Euphrates Drainage Canal) is more than 6 g/L in the dry season (assumed to be about 3 g/L on annual average), while the TDS of the brine will be about 12 g/L at maximum (assumed to be about 7.6 g/L on average). Since the TDS of the drainage canal is close to that of the brine and the flow rate of the drainage canal is sufficiently greater than that of the brine, the brine discharge in the Project will not give significant adverse environmental impact on the channel.

Also, the sludge generated in the WTP will be disposed at disposal sites designated by the Muthanna Governorate.

Based on the overall evaluation on the aspects above and others, no significant adverse impact on the environment and social aspect is predicted in the Study for the construction and operation of the Project. Also, there will be no obstacles implementing the Project in compliance with the JICA Guidelines for Environmental and Social Considerations.

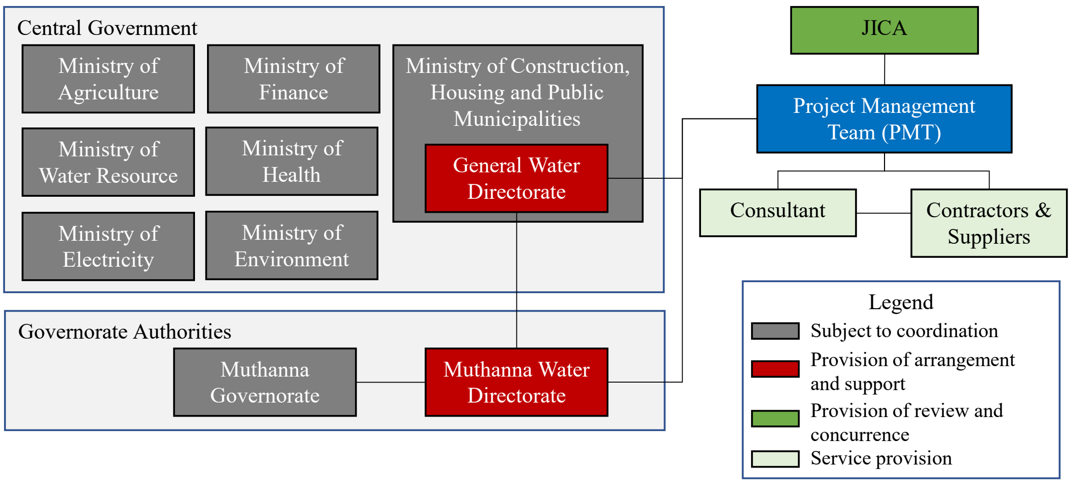
10. Resettlement

Land acquisition for the WTP has already been implemented by MWD and resettlement is not required. Also, the pipelines for the treated water and the brine will be installed in the existing roads so these works will not require land acquisition and/or resettlement.

11. Implementation Organization

Under the arrangement and dispatch of the employees of GWD and MWD, a Project Management Team (PMT) will be created in Samawah, and this PMT will be engaged for the coordination with other relevant ministries of the central government and their branches in Al-Muthanna Governorate, as well as the selection of consultant, contractors, and suppliers/manufacturers (**Figure 6**).

The Study proposed the organizational structure and job descriptions of the Project Management Team (PMT) to be jointly composed by MCHPM and MWD. The proposed organization, which was a modified version of the standard structure presented by MCHPM, was agreed by MCHPM and MWD. Timely and appropriate decision-making inside PMT is critical to the smooth implementation of the Project.



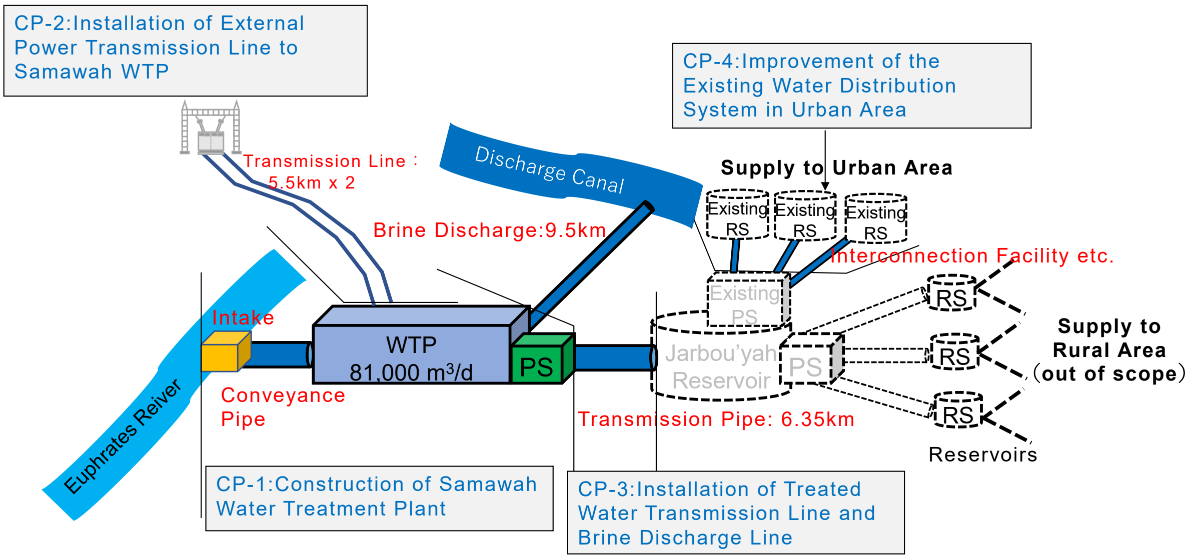
Source: JICA Study Team

Figure 6 Project Implementation Structure of the Project

12. Contract Packages and Procurement Method

The Study proposed that the project will be divided into five contract packages: Construction of Samawah water treatment plant (CP-1), Installation of external power transmission line to Samawah water treatment plant (CP-2), Installation of treated water transmission line and brine discharge line (CP-3) and Improvement of the existing water distribution system in urban area (CP-4) (**Figure 7**)

(**Table 2**).



Source: JICA Study Team

Figure 7 Interfaces of the Contract Packages of the Project

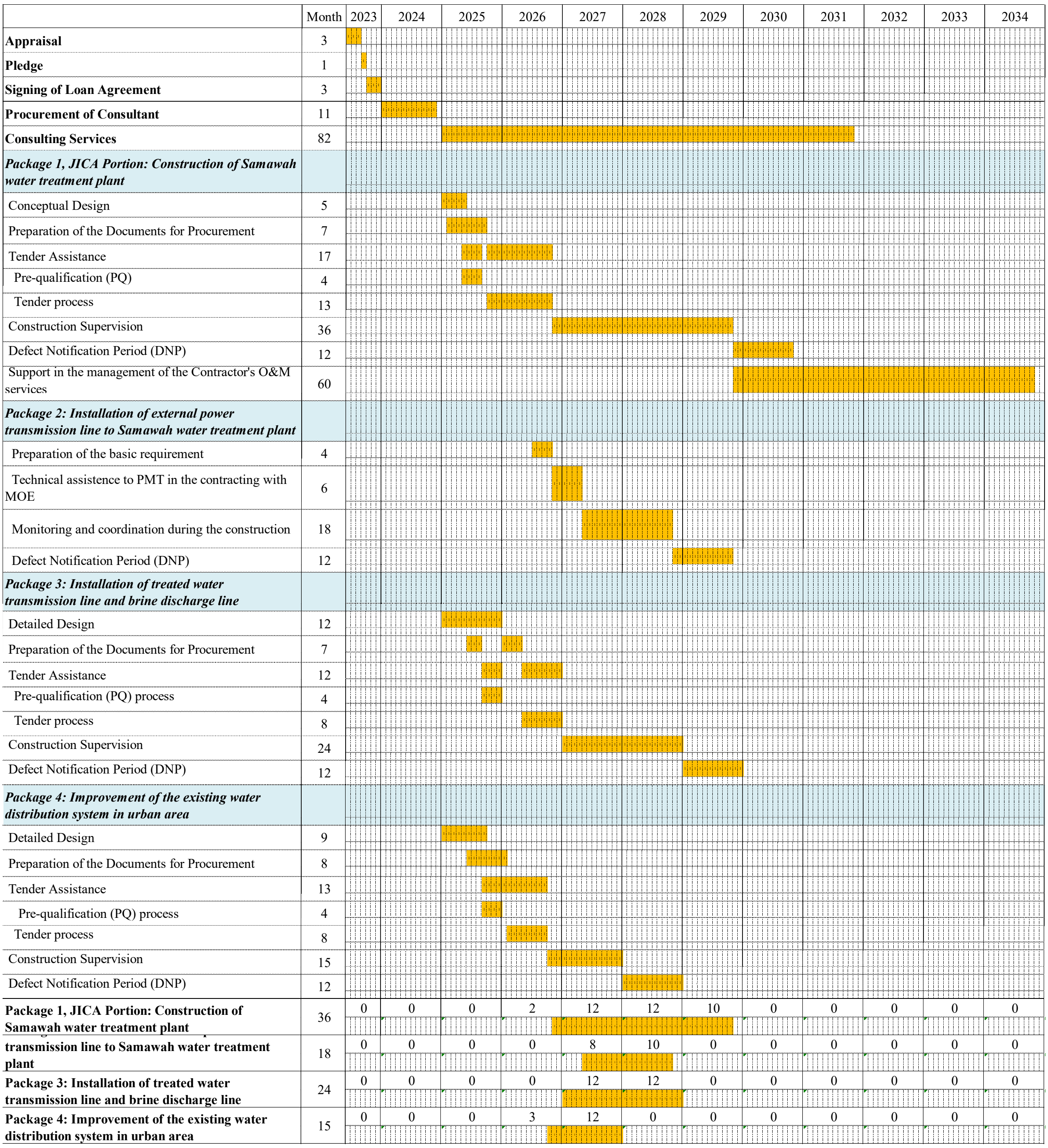
Table 2 Contract Packages and Scope of Work of the Project

Contract Package	Scope of Work	Remarks
Contract Package-1 (CP-1) Construction of Samawah water treatment plant	- Intake facility - Pre-treatment facility - RO facility - Pumping station for treated water transmission - Main substation in the water treatment plant site - Solar power generation system - O&M services for five years	Design-build contract
Contract Package-2 (CP-2) Installation of external power transmission line to Samawah water treatment plant	- Installation of equipment in MOE's substation - High voltage power cable	Entrustment of design and construction to MOE
Contract Package-3 (CP-3) Installation of treated water transmission line and brine discharge line	- Treated water transmission line (6 km) - Brine discharge line (9.5 km)	Design-bid-build contract
Contract Package-4 (CP-4) Improvement of the existing water distribution system in urban area	- Equipment of control and monitoring equipment such as valves and water meters	Design-bid-build contract

Source: JICA Study Team

13. Implementation Schedule

In case that the Project will be implemented by JICA's ODA loan, presuming that the loan agreement will be signed in 2023, the consulting services will begin in January 2024. The construction works of the all contract packages will finish in October 2029, when Samawah WTP will be completed. The overall completion of the Project will be October 2034, when the O&M services of the WTP ends (**Figure 8**).



Source: JICA Study Team

Figure 8 Implementation Schedule of Samawah Water Supply Improvement Project

14. Preliminary Project Cost

Table 3 Preliminary Construction Cost

Source: JICA Study Team

Table 4 Project Cost by Item

Source: JICA Study Team

15. Operation and Effect Indicators of the Project

The indicators for the project's effects and operations were established as shown in **Table 5** and **Table 6**.

Table 5 Effect Indicators of the Samawah Water Supply Improvement Project

Effect	Indicator	Unit	Values	
			Baseline	Target (in 2031)
1. Increase in the **volume of the treated water** in Samawah District	1. Production capacity of water treatment facilities dedicated to Samawah District	m^3/d	0	64,015
2. Improvement of the **treated water quality** in Samawah District	2-1. Turbidity of the treated water from major source	NTU	> 5 (Rumaitha WTPs in 2022)	< 5 (Samawah WTP)
	2-2. Total dissolved solids in the treated water from major source	mg/L	> 1,500 (Rumaitha WTP in 2022)	< 1,000 (Samawah WTP)
3. Extension of the **service hour of piped water**	3. Service hours per day	hours	< 6 hours in 80% of the urban area	> 12 hours in the whole urban area
4. Increase in the **registration** to MWD's piped water service in Samawah District	5. Registration rate in Samawah District	%	60 (in 2022)	75
5. Generation of **renewable energy**	6. CO_2 emissions reduction by the photovoltaic generation in the Samawah WTP	t-CO_2 /Year	0	3,690

Source: JICA Study Team

Table 6 Operational Indicators of the Samawah Water Supply Improvement Project

Component / Sub-component	Indicator	Unit	Values	
			Baseline (in 2022)	Target (in 2031)
Samawah Water Treatment Plant	1-1. Annual production volume by the WTP	m^3/ year	0	23,045,466
	1-2. Satisfaction rate of the treated water of the WTP	%	-	95% out of all samples in a year
	1-3. Annual power generation	MWh	0	3,850

Source: JICA Study Team

16. Risk assessment of the Project and Mitigation Measures

The Study executed risk assessment of the Project and identified mitigation measures. If the mitigation measures are implemented successfully, there will be no critical risk of high probability that may prevent serious delay of the Project or deteriorate the Project's beneficial effects.

The key mitigation measures for the Project's implementation are the establishment of PMT with sufficient power in timely decision-making and with knowledge obtained from Basrah Water Improvement Project. For the Project's beneficial impacts, MCHPM's support to the expansion and improvement of the water network as well as installation of water meter will be the key.

Chapter 1 Introduction

1.1 Background of the Project

By the 1980s, the coverage of the water supply services in the Republic of Iraq (hereinafter referred to as "Iraq") reached 95% in the urban areas and 75% in the rural areas. However, the wars and the consequent deterioration of the security conditions disturbed the operation and maintenance of the water supply systems, which resulted in the deterioration of the water supply services.

Recent various efforts including international and bilateral assistances have improved the national coverage of the water supply services to 82% but the census in 2011 revealed that about 25% of the water users through piped water services receive water only for two hours or less in a day. To tackle the deficiencies in the water supply services, the country's National Development Plan 2018 - 2022 declared that the government would expand and improve the water supply services corresponding to the population growth, improve the service quality, and reduce water loss by more than 10%.

Muthanna Governorate is one of the four directorates located in the southern region of Iraq. The coverage of the piped water supply services in the governorate is 78.8%[1], which is the second lowest in all 18 governorates in the country and lower than the national average at 89.8%. Samawah District, the capital of Muthanna Directorate, has no major water treatment plant in the city and relies much on the water treatment plants (WTPs) in Rumaitha District, located 25 km north, as a drinking water resource. Water supply duration is less than six hours a day in a wide area and the deteriorated facilities cause a significant amount of volume of water loss in the long-distance transmission line from Rumaitha and in the water distribution network in the city. In addition, the increasing salinity of the Euphrates River deteriorates the water quality of the water from Rumaitha and from small decentralized treatment facilities in Samawah District, which often result in the high salinity in the drinking water which exceeds the permissible value according to the Iraqi drinking water quality standard[2].

In 2016, the Japan International Cooperation Agency (hereinafter referred to as "JICA") conducted the "Data Collection Survey on Water Sector in Southern Iraq" (hereinafter referred to as the "Previous Study"). In order to improve the situations of the water supply services identified, the Previous Study proposed a project to construct a water treatment plant with desalination process for Samawah District and to improve the water transmission and distribution systems in the city (hereinafter referred to as "the Project").

Under the circumstances above, the Government of Iraq (GOI) requested the Embassy of Japan in Iraq to extend an official development assistance (ODA) loan to the Project proposed in the Previous Study.

[1] Households' access to public network in 2016 presented in National Development Plan 2018 – 2022. The lowest is Thi-Qar Directorate (70.8%). See Table 3.1 for the data for all directorates.
[2] The maximum permissible limit of salinity in Iraqi drinking water quality standard is 1,000 mg/L as Total Dissolved Solids (TDS).

1.2 Outline of the Project

The Project aimed to improve the water supply services in Samawah District, the capital of Muthanna Governorate of Iraq, in terms of water volume, water quality, and service continuity. In addition, it aims for an efficient use of the water resources by constructing and rehabilitating water supply facilities including a new water treatment plant with desalination facility. It will contribute to stabilize the water supply for the public and to efficiently utilize the water resources for regional economic and social development.

According to the terms of reference (TOR) of the consultancy services for the preparatory survey, the Project may include the following components, which are subject to modifications during the preparatory survey:

1) Water treatment plant (WTP) and treated water transmission system: Construction of intake facilities, raw water transmission facilities, pre-treatment facilities, desalination facilities by reverse osmosis (RO) technologies, treated water transmission facilities in the WTP plant, power receiving facilities for the WTP, and operation and maintenance (O&M) of the WTP.
2) Rehabilitation and expansion of the water distribution system in Samawah District: Construction of water storage tanks (or reservoirs), rehabilitation and expansion of the water transmission and distribution networks, rehabilitation of the existing water transmission pumping stations, and power receiving facilities for the water transmission and distribution facilities.
3) Consulting services: Services for the detailed design, tender assistance, construction supervision, training, and social communication to implement the components above.

1.3 Outline of the Study

1.3.1 Objectives of the Study

The Preparatory Survey for Samawah Water Supply Improvement Project (hereinafter referred to as “the Study”) carried out the services listed in Section 1.3.2 to provide JICA with information for its appraisal on the validity of provision of Japan’s ODA loan to the Project.

1.3.2 Scope of the Study

According to the TOR, the Study includes the following services:

1) Preparation and submission of Work Plan
2) Preparation of and discussion on Inception Report
3) Confirmation of the background and needs for the Project
4) Execution of natural conditions surveys and other surveys for the preparatory survey
5) Study on technical alternatives
6) Preliminary design of the facilities in the Project
7) Preparation of the project implementation plan
8) Study on adoption of Japanese technologies in the Project
9) Estimation of the project cost

10) Preparation of the project procurement plan
11) Study on organization for the project implementation
12) Study on organization for O&M of the facilities in the Project
13) Identification of the obligations of the executing agency
14) Environmental and social considerations
15) Preparation of abbreviated resettlement action plan
16) Gender considerations
17) Survey on tax exemption
18) Identification of points of concern in the implementation of the Project
19) Consulting services
20) Study on the project's impact
21) Information collection and analysis on the Project as climate change measures
22) Preparation of and discussion on the reports
23) Presentation of Draft Final Report to the relevant Iraqi authorities and discussions
24) Considerations on COVID-19 in the project formulation
25) Cooperation to the mission that may be executed by JICA

1.3.3 Study Area

Target area of the Study was Samawah District, Muthanna Directorate. In some topics, when necessary in the implementation of the Project, the Study will look at the whole governorate or the whole country.

1.3.4 Major Authorities in Iraq Relevant to the Project

The following agencies were the counterpart of the JICA Study Team (hereinafter referred to as "JST") for the Study:

- Ministry of Construction, Housing, and Public Municipality (MCHPM)
- Muthannna Water Directorate (MWD)

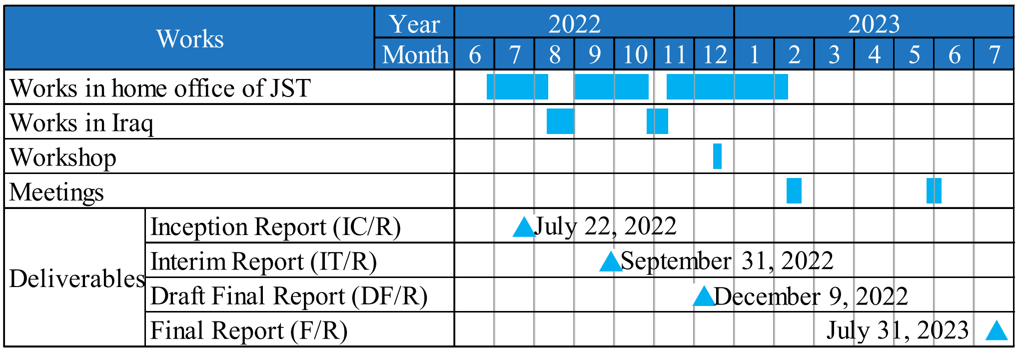
MCHPM will be the Executing Agency of the Project. MWD will participate in the Project implementation and, after the Project's completion, will operate and maintain the facilities to be constructed and/or rehabilitated in the Project.

1.4 Schedule of the Study

Figure 1.1 presents the schedule of the Study. The commencement date of the Study is June 29, 2022 and the due date of the Final Report (F/R) is July 31, 2023. The intermediate deliverables are Interim Report (ITR), submitted on September 31, 2022, and the Draft Final Report (DF/R) submitted on December 9, 2022.

The site surveys were executed in August 2022 and from October to November 2022. The minutes of the meeting for the first mission and the second mission are presented in **Appendix 1.1** and **Appendix 1.2**, respectively.

In addition, an online workshop was on December 26 and 27, 2022 to discuss all elements of the Project according to DF/R. MCHPM and MWD from Iraq participated in the workshop. Also, JST provided assistances to JICA in the meetings between JICA and the Iraqi authorities (MCHPM and MCH) held online on February 15-16 and 19-23, 2023, in Jordan on May 28 - June 2, 2023, and in Iraq on June 4-8, 2023, in which JST participated partly.



Source: JICA Study Team

Figure 1.1 Schedule of the Study

1.5 Study Team

JST was composed of eleven experts for ten positions as presented in **Table 1.1**.

Table 1.1 Members of the JICA Study Team

Position		Name	Company
1)	Team Leader / Water Supply Planner	Takayuki HAGIHARA	Nippon Koei Co., Ltd.
2)	Deputy Team Leader / Construction Planning & Cost Estimation 1	Shoichiro MISAKI	Nippon Koei Co., Ltd.
3)	Water Supply Facility Planning 1 (Water Transmission & Distribution) / Construction Planning / Cost Estimation 2	Hidehisa TAMURA	Nippon Koei Co., Ltd.
4)	Electromechanical Expert	Kenichiro SUGIURA	Nippon Koei Co., Ltd.
5)	Water Supply Facility Planning 2 (Water Treatment Plant)	Takashi NAKAJIMA / Satomi MINEOKA	Nippon Koei Co., Ltd.
6)	Economic Analysis Expert	Risa KIKUCHI	Koei Research & Consulting Inc.
7)	Financing Plan Expert	Takeshi MURAKAMI	Koei Research & Consulting Inc.
8)	Operation and Maintenance Expert	Toshihiko TAMAMA	Nippon Koei Co., Ltd.
9)	Environmental and Social Considerations Expert	Hiroaki NAKAGAWARA	Nippon Koei Co., Ltd.
10)	Assistant Water Supply Planner	Yukako TANAKA	Nippon Koei Co., Ltd.

Source: JICA Study Team

Chapter 2 Basic Information of the Target Area

2.1 Geography and Administration

2.1.1 Geography

The west region of Iraq is a part of the Syrian Desert and borders the Syrian Arab Republic and Jordan. The north region which borders the Republic of Turkey is included in the Kurdistan Mountains; the east borders Iran and the southeast edge forms the Arabian Gulf; and the south region borders the State of Kuwait and the Kingdom of Saudi Arabia, which is included in the Nafud Desert.

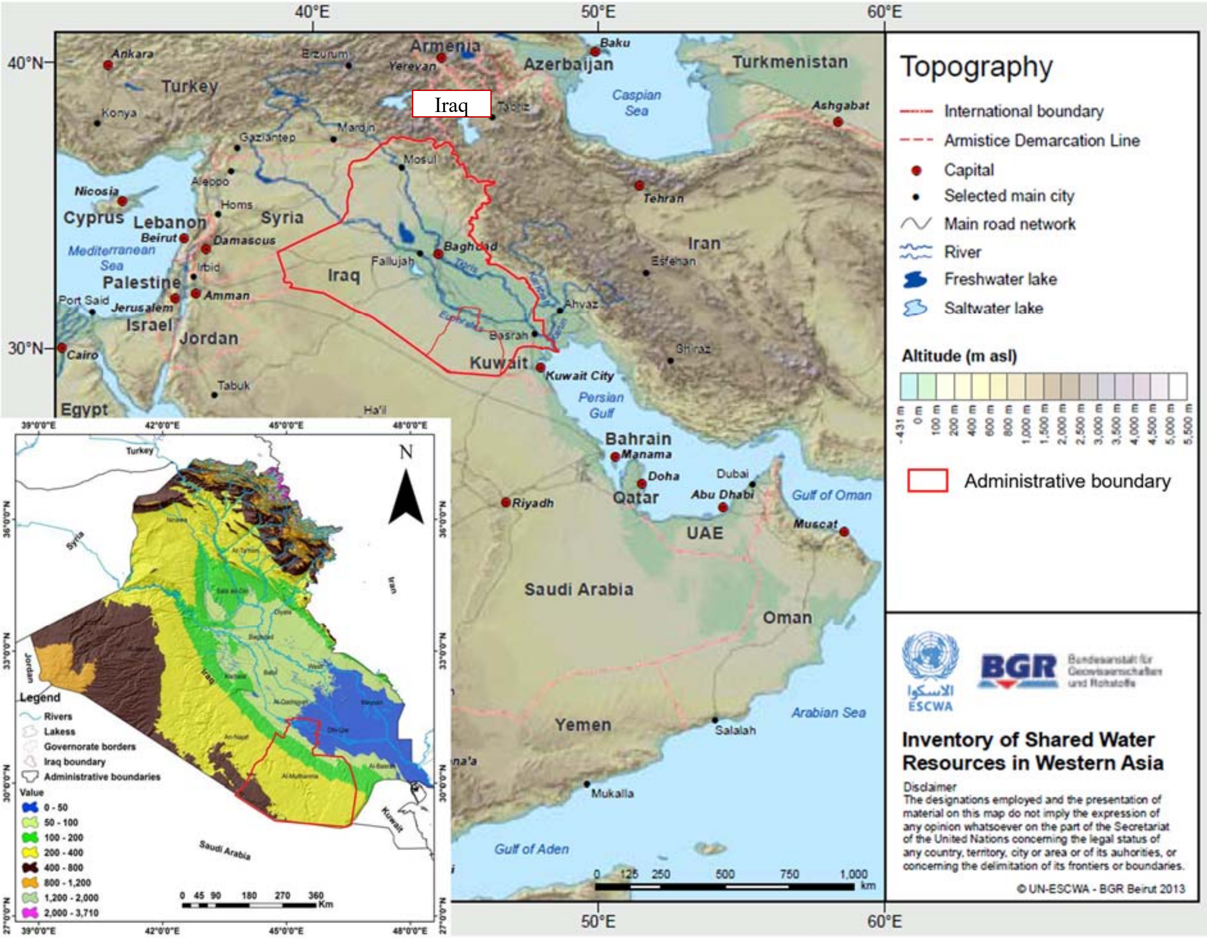
According to the Annual Statistical Abstract (2020-2021), the total land area of Iraq[1] is 435,052 km^2 of which the area of Muthanna Governorate, where Samawah District is located is 51,740 km^2. The governorate's area covers 11.9% of the county area.

2.1.2 Topography

The topography of Iraq is classified into three types. The southern region of the Euphrates is composed of the Syrian Desert and the Nafud Desert with a gentle sloping plateau with an altitude of 1,000 m toward the Euphrates River as shown in **Figure 2.1,** which was prepared in the United Nations Economic and Social Commission for Western Asia by Bundesanstalt fur Geowissenschaften und Rohstoffe (BGR) in 2013. The Mesopotamian Plain extends around the Tigris River and the Euphrates River, and the altitude of the region in the east of the Tigris River rises toward the Zagros Mountains.

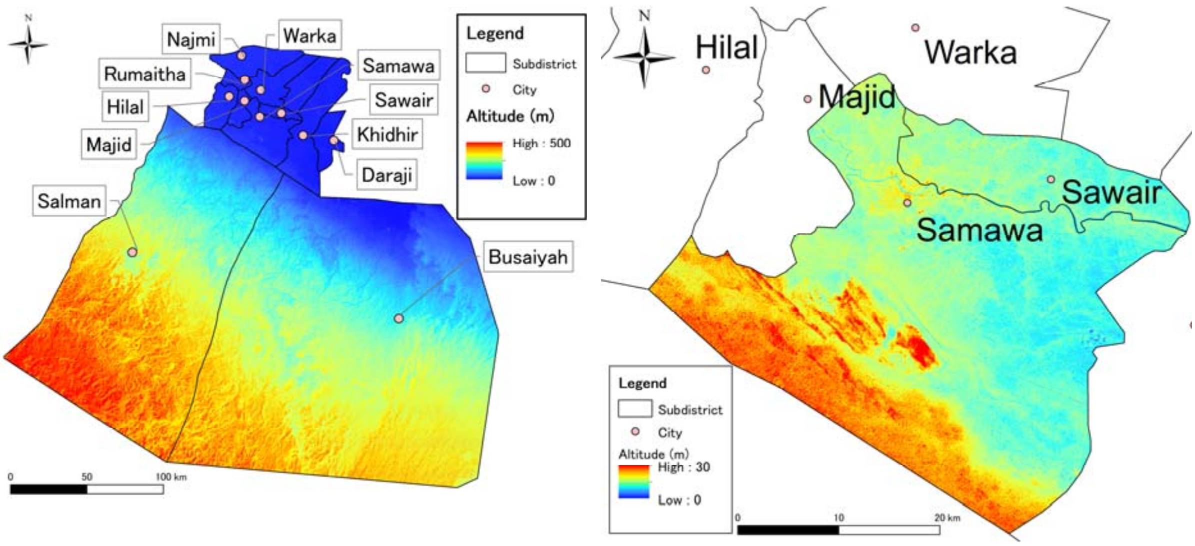
The Muthanna Governorate is located in the slopes between the Saudi Arabia plateau and the Euphrates River as shown in **Figure 2.2**. The location of Samawah District is in a very flat plane area.

[1] Land area of Japan is 378,000 km^2.



Source: United Nations Economic and Social Commission for Western Asia-BGR 2013, Groundwater in Iraq, 2022

Figure 2.1 Topography of Iraq



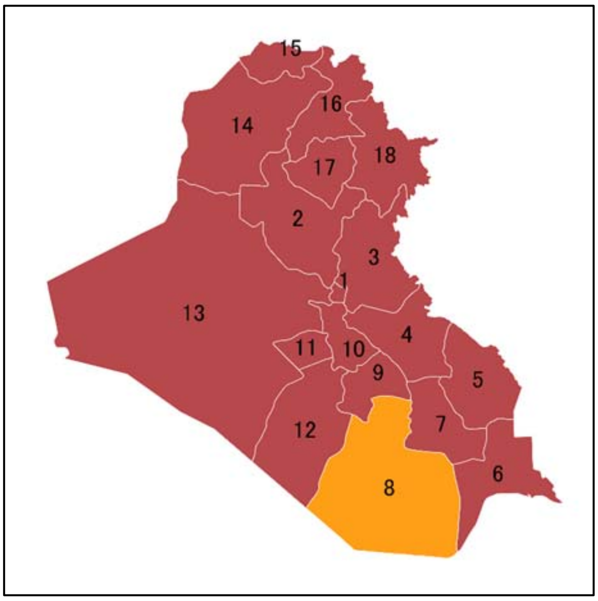
Source: AW3D30, MCHPM

Figure 2.2 Topography of Muthanna Governorate

2.1.3 Administrative Boundaries

(1) Governorate

Iraq has 18 governorates as shown in **Figure 2.3** and their capitals are shown in **Table 2.1**. The governorates are administrative units within their borders.



Source: MCHPM

Figure 2.3 Administrative Boundaries of the Governorates of Iraq

Table 2.1 Governorates and Capitals of Iraq

No.	Governorate	Capital
1	Baghdad	Baghdad
2	Salah Al-Deen	Tikrit
3	Diala	Ba'aqubah
4	Wasit	Kut
5	Missan	Amarah
6	Al-Basrah	Basrah
7	Thi-Qar	Nasiriyah
8	Muthanna	Samawah
9	Al-Qadisiya	Diwaniyah
10	Babylon	Hillah
11	Kerbela	Kerbala
12	Al-Najaf	Najaf
13	Al-Anbar	Ramadi
14	Ninevah	Mosul
15	Dohouk	Dahuk
16	Erbil	Erbile
17	Kirkuk	Kirkuk
18	Sulaimaniya	Sulaimaniya

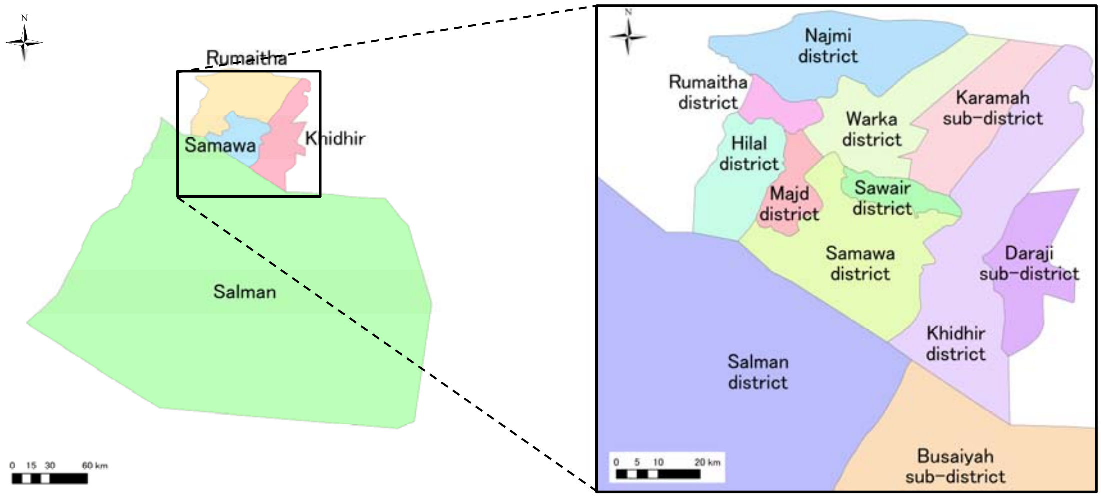
Source: Annual Statistical Abstract 2020-2021

(2) District

Muthanna Governorate is divided into nine districts and three sub-districts as shown in **Figure 2.4** and **Table 2.2**, respectively. Among those districts and sub-districts, Samawah District is the capital of the governorate.

It should be noted that the hierarchy of the districts and sub-districts in the whole country was modified in 2018. In Muthanna Governorate, at the time of the Previous Study in 2016, there were four districts which were subdivided into 11 sub-districts. This administrative hierarchy was modified by the 3rd Amendment of Law No. 21 in 2008 issued in 2018, after which most sub-districts including Samawah Sub-district were promoted to districts such as Samawah District. Exceptionally, the sub-districts of Daraji and Bussaiva remained as sub-districts and are "subject[2]" to Khidir District and Salman District, respectively. Also, Warka Sub-district was divided into Warka District and Karamah Sub-district, where the latter is subject to the former. In this survey, the term "district" is used without distinction between District and Sub-District in the current administrative hierarchy.

[2] The administrative relationship between districts and sub-districts is described in Sub-section 3.2.1 (4).



District Boundary before 2018 District / Sub-district Boundary since 2018

Source: MCHPM

Figure 2.4 Administrative Boundaries for District and Sub-district in Muthanna Governorate

Table 2.2 Districts and Sub-districts in Muthanna Governorate

No.	District /Sub-district (before 2018)		Present District /Sub-district (Since 2018)
	District	Sub-district	
1	Samawah	Samawah	Samawah District
2		Sowair	Sowair District
3	Rumaitha	Rumaitha	Rumaitha District
4		Majid	Majid District
5		Warka	Warka District
6			Karamah Sub-district*
7		Najmi	Najmi District
8		Hilal	Hilal District
9	Khidir	Khidir	Khidir District
10		Daraji	Daraji Sub-district*
11	Salman	Salman	Salman District
12		Bussaiya	Bussaiya Sub-district*

*: Sub-districts are subject to the districts.

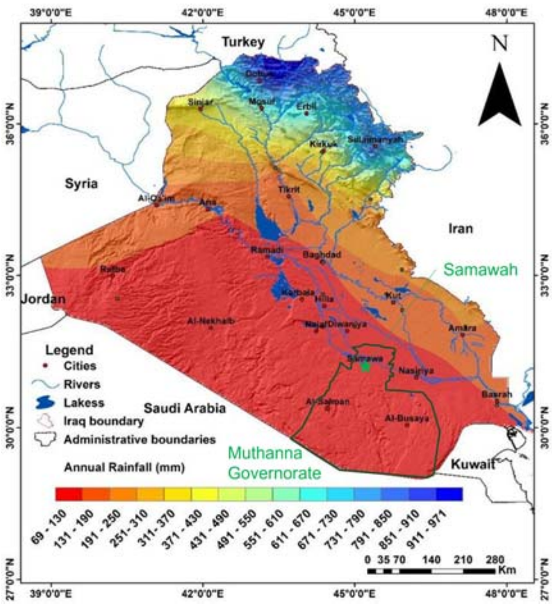
Source: MWD

2.2 Natural Conditions

2.2.1 Climate (Temperature and Precipitation)

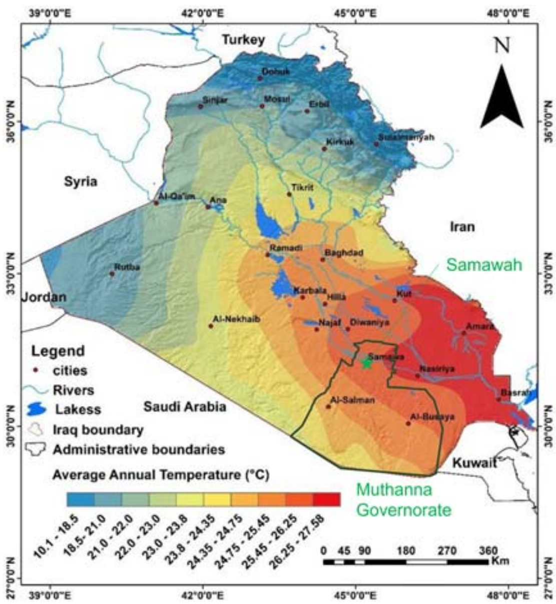
The meteorology of Iraq is classified as desert climate and very small annual precipitation is observed as shown in **Figure 2.5**. More rainfall is observed in the northern mountain area of the country and the rainfall gets smaller toward the southern regions. The annual rainfall around the whole Muthanna Governorate is as small as less than 200 mm.

Figure 2.6 shows the average annual temperature in Iraq. Temperature in the southern area is higher than in the northern area of Iraq. The region which has the highest temperature in Iraq is around the Basrah Governorate which faces the Arabian Gulf. The Samawah District is classified as the area with the second highest temperature in the country.



Source: Groundwater in Iraq, 2022

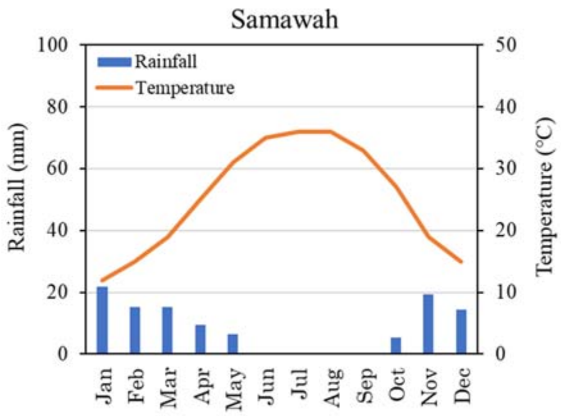
Figure 2.5 Annual Rainfall of Iraq



Source: Groundwater in Iraq, 2022

Figure 2.6 Temperature of Iraq

According to the average value of temperature and rainfall from 1985 to 2015 shown in **Figure 2.7**, the temperature from May to October is the highest in a year, and the highest temperature becomes more than 50 °C, while it becomes lower until less than 10 °C at the minimum from December to February. The average temperature of the data from 1980 to 2015 is 25.3 °C and the average annual rainfall from 1980 to 2015 is 105.7 mm in Samawah. The climate in Samawah could be identified from the typical climate in the desert.



Source: Climatic Water Balance in Al-Amaid Area/ Muthanna Governorate/Southwest Iraq

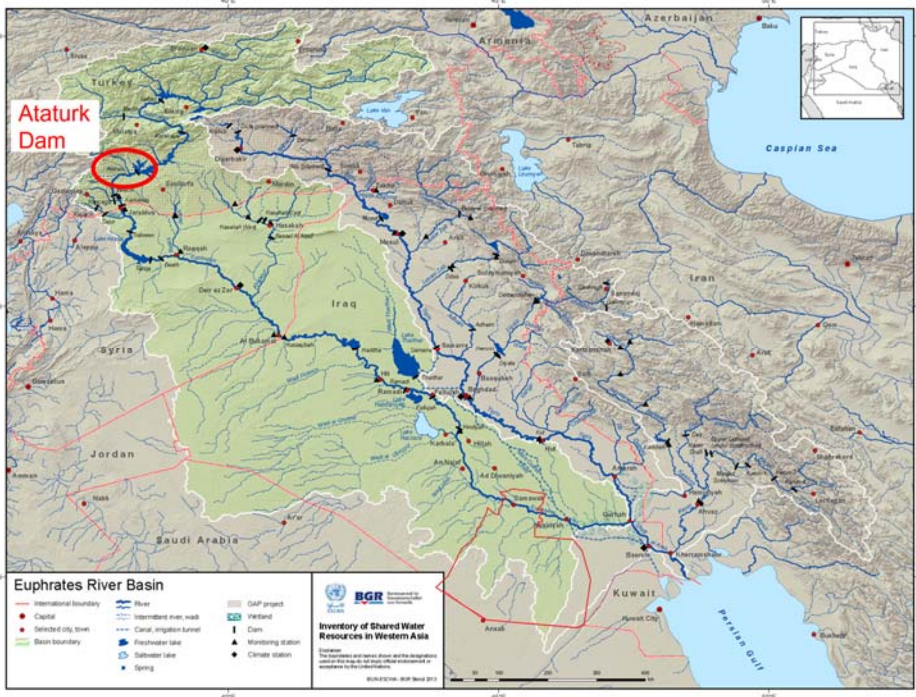
Figure 2.7 Temperature and Rainfall of Samawah (Mean Values for 1980-2015)

2.2.2 Water Resources

(1) Hydrology

Rainfall flows at the mountain side in the northern region of Iraq. The surface and infiltrated water goes mainly to the Tigris River and Euphrates River. These rivers convey the water from the northern area toward the southeast and finally pour into the Arabian Gulf. In this region, the river water has been used for irrigation purposes since the ancient Mesopotamian period and it is still a major water resource in Iraq now.

Figure 2.8 shows the river basin of the Euphrates River. Iraq accounts for 47% of the Euphrates River basin and 56.1% of the Tigris River basin. According to the "Basic Research and Analysis of the Republic of Iraq" (2003, JICA), 90% of the water flow in the Euphrates River is inflow from surrounding countries located in the upstream area of the river, while 50% of the water flow in the Tigris River is inflow from inside Iraq.

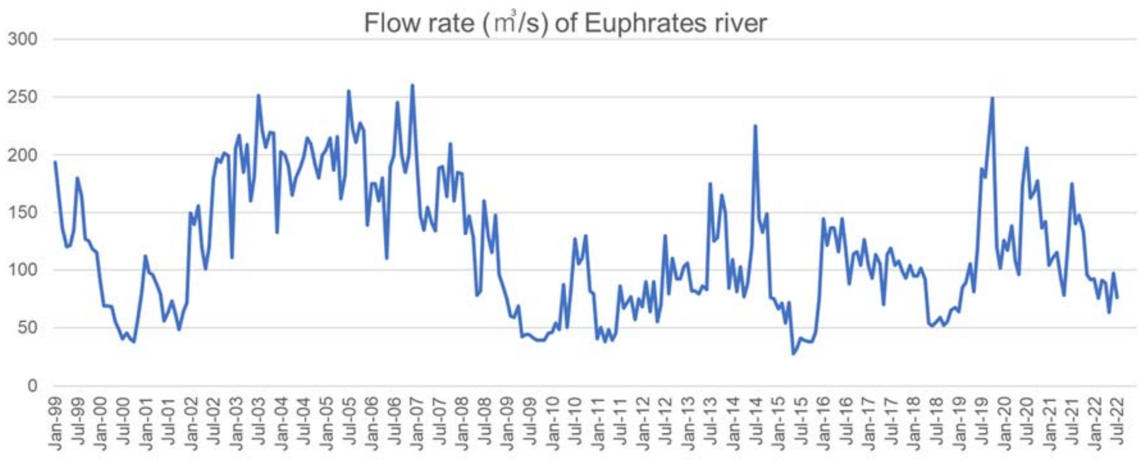


Source: UN-ESCWA BGR 2013

Figure 2.8 Basin of the Euphrates River

(2) Flow rate of the Euphrates River

Figure 2.9 shows the flow rate of the Euphrates River. The low flow rate in 2021 and 2022 is caused by historically low rainfall in 2021[3]. In general, the measured flow rate does not show clear increasing or decreasing trend. A report points out that the river flows have decreased by 40-45% since the 1970s due to the construction of more than 30 dams and barrages[4].



Source: MWD

Figure 2.9 Flow Rate of the Euphrates River (1999 - 2022)

3 https://www.nrc.no/resources/reports/iraqs-drought-crisis-and-the-damaging-effects-on-communities/

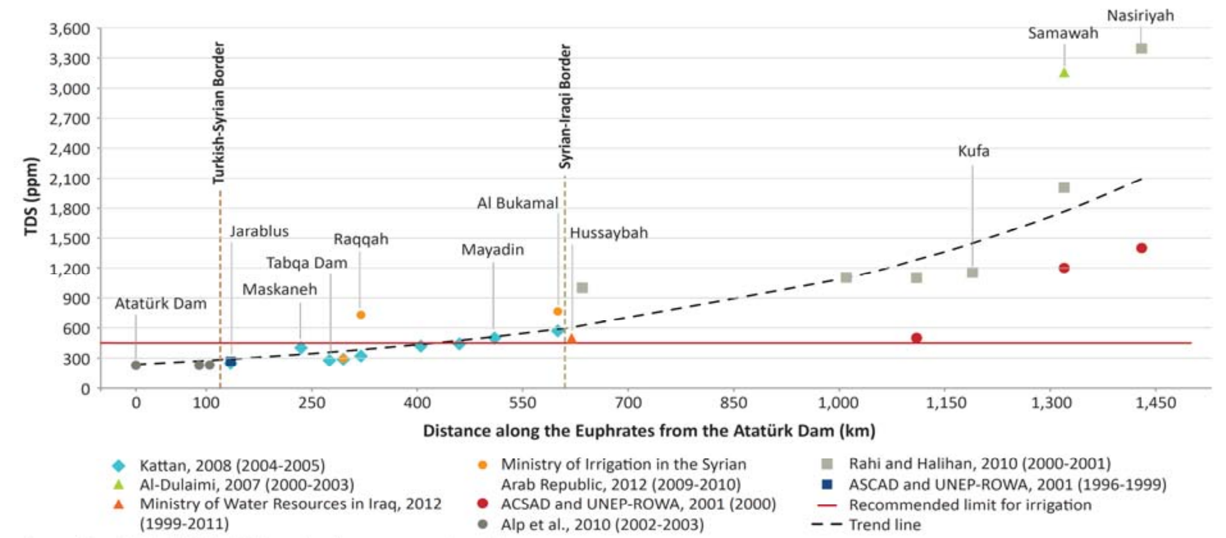
4 Shamout & Lahn, 2015, cited in "Climate change, water and future cooperation and development in the Euphrates-Tigris basin, November 2021" (CASCADE)

(3) Water quality

Figure 2.10 shows the relation of the measured total dissolved solid (TDS) as an index of the salinities and the distance from the Ataturk Dam toward the downstream direction, investigated in the Euphrates River since 1996 (UN-ESCWA, 2013). The TDS rises in the downstream regions as shown by the trend line in **Figure 2.10**, where the TDS increases from less than 300 mg/L at the Ataturk Dam to about 2,000 mg/L at the downstream cities such as Kufa, Samawah, and Nasiryah. In addition, TDS in the Euphrates River and its tributary rivers is gradually increasing[5].

TDS is a dissolved substance; the main components in the tap water are salts and organic matters such as calcium, magnesium, silicic acid, sodium, and potassium. In the Japanese Water Quality Guidelines (1992), the evaporation residues value is 500 mg/L to provide water without taste problems and the target value for "tasty water" is 30 – 200 mg/L[6]. According to the WHO Guideline and USEPA Drinking Water Standards, TDS is listed as an "item which may cause consumer complaints" and the value is targeted as 1,000 mg/L, but it is not mentioned in the EU Standards[7].

The TDS is not a singular substance and the value does not necessarily indicate direct influence to human health, but it may cause issues for the taste of drinking water or limescale for supply pipes, boilers, and other equipment.



Source: Compiled by ESCWA-BGR based on the Sources mentioned above.
Notes:
-This graph aims only to provide a general overview of salinity variations along the Euphrates River and should not be considered fully accurate : data was extracted from a number of literature sources and official data provided by riparian countries; for some stations only individual measurements were available. The margin of error may be significant as readings could differ depending on the methodology used, location and data of measurement, rounding of means, etc. Interpretation of the salinity data is further hampered by the fact that values cannot be compared with river flow data due to information gaps.
-The years in brackets refer to the sampling years. TDS values in Syria were converted from initial EC values. Cities/stations locations and distances along the river were estimated using Google Earth.

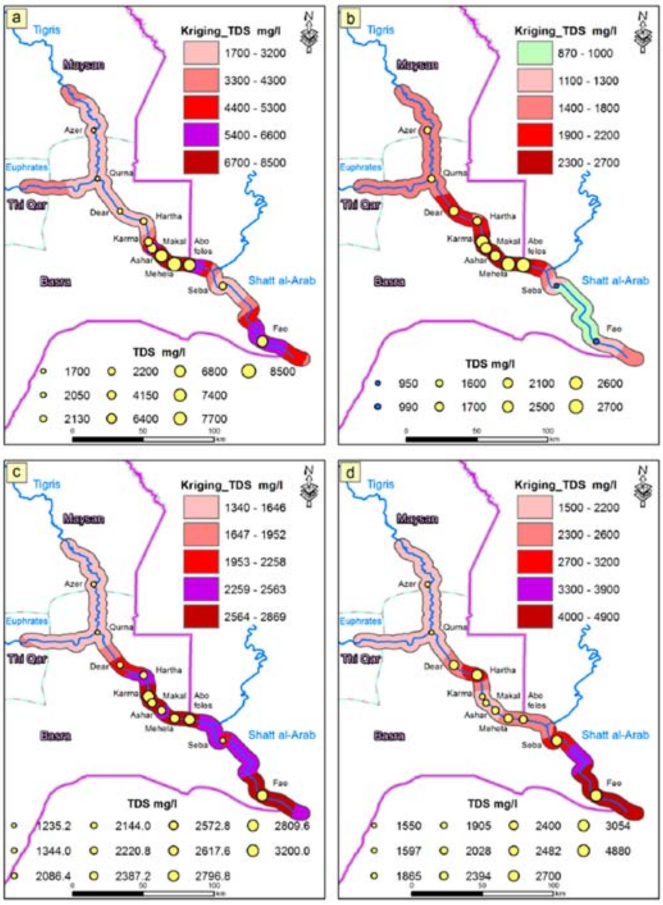
Source: UN-ESCWA BGR 2013

Figure 2.10 TDS Variations along the Euphrates from Ataturk Dam

Figure 2.11 shows the spatial distributions of TDS concentrations using Kriging Interpolation: (a) winter

[5] Section 5.5.2 (1) shows the rise of TDS in the Euphrates River at the intake point of a water treatment facility (Afaat Compact Unit) in Samawah and Section 4.2.1 (2) shows the similar situation of the Rumaitha River, a tributary river of the Euphrates River, at the intake points of the existing water treatment plants (Rumaitha Water Treatment Plants).
[6] http://www.mhlw.go.jp/topics/ bukyoku/kenkou/suido/kijun/dl/k48.pdf
[7] http://www.mhlw.go.jp/shingi/2002/11/s1108-5g.html

2018, (b) spring 2019, (c) summer 2019, and (d) autumn 2019. High TDS concentration has been noticed in the middle portion of the Shatt Al-Arab River during winter. However, a decrease in the TDS concentration towards the south downstream of the river was noticeably observed at Seba Station. Then, it increases to the very south of the river before the entrance of the Arabian Gulf. TDS concentrations in the spring season of 2019 decreased significantly in the far south of the river, recording the lowest value at 950 mg/L. This metric also displayed a gradual increase from 1,235.2 mg/L to 3,200 mg/L in the summer of 2019.



Source: Evaluation of Water Quality Parameters in Shatt AL-Arab, Southern Iraq, Using Spatial Analysis, 2020

Figure 2.11 TDS Variations along the Euphrates from Ataturk Dam

The downstream areas in the southern region are affected by the seawater retroact and the TDS (salts) concentration of groundwater is high. Therefore, the TDS of the river water rises when the inflow water volume of low-salinity water to the Euphrates and Tigris rivers decreases. It is assumed that the high TDS concentration is caused by decreasing water flow volume in the river due to the construction of the dams in the upstream and the increase in the evaporation due to global climate change.

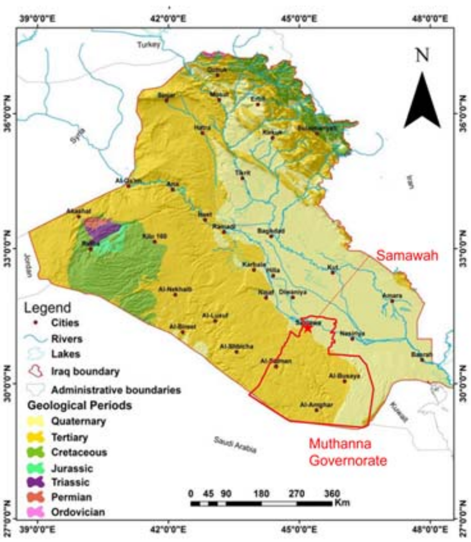
In addition, pollution inflows from urban areas due to sewage discharge and agricultural return flows not only in Iraq but also in Turkey and Syria are reportedly deteriorating the water quality of the river[8].

[8] "Climate change, water and future cooperation and development in the Euphrates-Tigris basin, November 2021" (CASCADE)

2.2.3 Geology and Groundwater

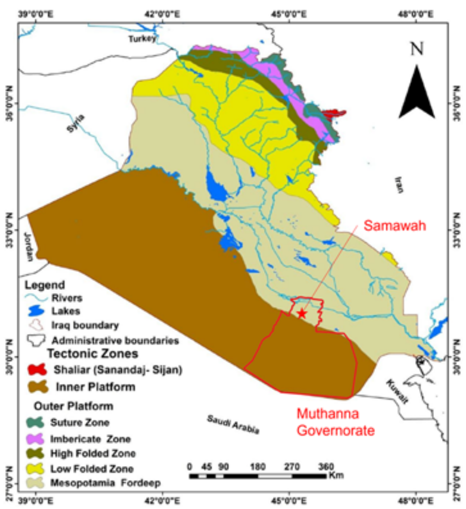
(1) Geology

In the area from Iraq to Saudi Arabia, the ground is composed of sedimentary rocks formed by limestone and sandstone formations that dip in a northeast direction. Therefore, groundwater is supplied from the southwestern direction of Iraq, i.e., from the Saudi Arabian and Kuwaiti sides. **Figure 2.12** and **Figure 2.13** show the geological feature distribution. The exposed geological formations and sediments on the surface of Iraq are categorized according to their age, from Quaternary period to Paleozoic period. The surface geological map shows that the Paleozoic succession appears in small areas north and west of Iraq. The Khabour Formation is the oldest exposed rock unit in Iraq which is from the Cambro – Ordovician age. In contrast, Ga'ara Formation (Permian) is exposed in Western Iraq and it is considered the main aquifer in this area. The Triassic and Jurassic successions are also exposed in western Iraq's central part, represented by Mulosa, Zor Houran, Ubaid, Hussainite, and Amej formations. The outcrops of the Cretaceous sediments are exposed mainly in three parts. The first part is located in the north and northeastern parts of Iraq. The second part represents a very small area and is located in the northeastern part of Iraq near Sinjar Mountain. The third part is located in the western part of Iraq and is extended until the Iraqi-Saudi border. Tertiary successions cover all parts of the Iraqi surface. They appear in the northeastern and northwestern parts and all the western and southwestern regions of Iraq, as they appear in very small areas in the eastern part of Iraq. Quaternary sediments of the Tigris and Euphrates rivers with their tributaries and distributaries cover the area located in the central and eastern parts of Iraq and some parts in the north and west.



Source: Groundwater in Iraq, 2022

Figure 2.12 Surface Geology Map of Iraq



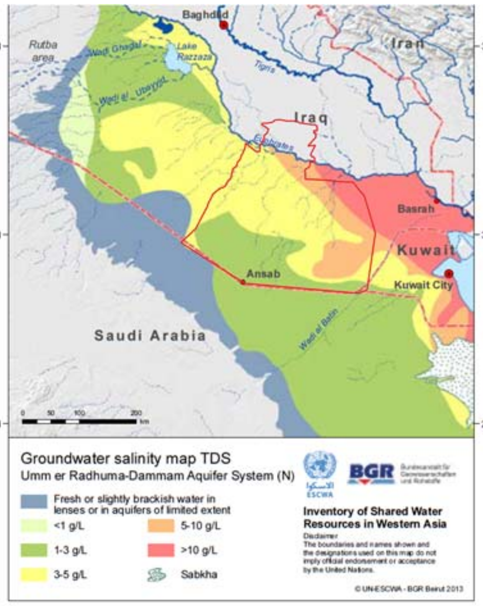
Source: Groundwater in Iraq, 2022

Figure 2.13 Tectonic Divisions of Iraq

(2) Groundwater

As the seawater invades the aquifer, the salinity concentration of the groundwater is rising in Basrah. Groundwater moves from higher elevations and lower salinity on the Saudi Arabian side toward the

Euphrates River and the groundwater salinity concentration is higher than 10 g/L (1.0%) in the right bank of the downstream areas such as Basrah and Kuwait as shown in **Figure 2.14**. It is assumed that the condition on the right bank of the Euphrates River in Muthanna Governate is similar with the above.



Source: UN-ESCWA BGR 2013

Figure 2.14 Salinity Concentration Map of the Groundwater in the Right Bank of the Euphrates River

2.2.4 Disasters

Iraq has experienced natural disasters such as flood, sandstorm, and drought in the northern and the southern part. Some eastern parts of Iraq lying parallel to the Zagros Seismic Belt and in central and western parts of Iraq are earthquake prone. **Table 2.3** and **Table 2.4** show the top five natural disasters in Iraq from 1900 to 2009 in order of the most severely affected population. Mosul Dam was constructed in 1984 and functioned as a flood control for the water from Turkey. However, major floods happened twice in Iraq in 2006 and the drought was also reported as one of the disasters in Iraq. It could be assumed that climate change affects drought and flood which has made them more serious and severe in recent year. No overflow from the Euphrates River at Samawah has been recorded.

Table 2.3 Affected Person at the Disasters in Iraq (1900 - 2009)

Disaster	Date	Total Population Affected
Drought	1969	500,000
Flood	11 May 1967	260,000
Flood	May 1968	150,000
Flood	4 February 2006	41,890
Flood	5 November 2006	18,000

Source: State of Disaster Risk Reduction in Iraq, 2009, United Nations

Table 2.4 Death Toll by Disasters in Iraq (1900 - 2009)

Disaster	Date	Persons Killed
Epidemic	14 August 2017	24
Earthquake	27 July 1991	20

Flood	5 November 2006	20
Epidemic	7 August 2008	11
Flood	10 September 2008	4

Source: State of Disaster Risk Reduction in Iraq, 2009, United Nations

2.3 Economy and Industries

2.3.1 Industrial Structure, Economic Growth, and Prices

(1) Nation

Table 2.5 shows the production per industry in 2019 and 2020. The production in 2020 (IQD 198.8 trillion) decreased by 28% from that in 2019 (IQD 277.9 trillion) due to the COVID-19 pandemic's impact and an oil price shock. The primary sector (agriculture, forestry, hunting, and fishery) produces 6% of the GDP and the tertiary sector produces 57%, while the secondary sector produces 37%. The oil industry is included in the mining and quarrying sector of the secondary sector.

Since the tertiary sector produced 46% in 2019, it grew by 11% from 2019 to 2020[9]. The secondary sector decreased by 13% from 2019 to 2020. The primary sector has similar percentage (6%) of production in 2020 after it was 4% in 2019. As seen above, the tertiary sector of industry of Iraq became the majority of the three sectors in 2020, but this situation could be tentative due to the COVID-19 pandemic's impact and an oil price shock. Therefore, the secondary sector could be the majority again after 2020 by oil price recovery.

Table 2.5 Production Per Industry in 2019 and 2020 of Iraq (Current Price)

Unit: IQD in Million

Industry	Production		Percentage	
	2019*	2020**	2019	2020
(1) The Primary Sector of Industry	10,411,174	11,716,004	4%	6%
Agriculture, Forestry, Hunting, and Fishery	10,411,174	11,716,004	4%	6%
(2) The Secondary Sector of Industry	139,310,853	73,905,405	50%	37%
Mining and Quarrying	114,831,639	61,063,029	41%	31%
Manufacturing Industry	5,902,961	5,988,451	2%	3%
Building and Construction	18,576,253	6,853,925	7%	3%
(3) The Tertiary Sector of Industry	128,162,842	113,152,917	46%	57%
Electricity and Water	8,095,691	7,779,196	3%	4%
Transport, Communication, and Storage	24,037,033	19,661,035	9%	10%
Wholesale, Retail Trade, Hotels, and Others	23,890,368	19,152,206	9%	10%
Banking and Insurance	5,400,352	3,885,115	2%	2%
Ownership of Dwellings	16,928,970	14,807,520	6%	7%
Social and Personal Services	53,410,202	50,342,664	19%	25%
Less imputed Bank Service Charge[10]	-3,599,775	-2,474,818	-1%	-1%
Total	277,884,869	198,774,325	100%	100%

9 CSO Iraq -Ministry of Planning (2021) "The Annual Statistical Abstract 2020-2021"

10 Imputed bank service charge is a specialized imputed calculation item which is used to define a production value of the finance business. It means the amount of difference between interest received, dividend, and interest paid of the finance business. Interest is mainly paid by added value of other industries. On another front, it is also allocated in the production value of the finance business. Therefore, this added value is redundantly allocated. Since imputed bank service charge is deducted in calculation of added value, the value is minus.

*Provisional estimates, **Quarter estimates.

Source: CSO Iraq -Ministry of Planning (2021) "The Annual Statistical Abstract 2020-2021"

Table 2.6 shows the indicators of economic growth and prices of Iraq based on the IMF report. It shows that the economy relies on the production and the export of oil before 2020. According to IMF, the decrease of international travel and trade has reduced non-oil real GDP by 8% in 2020. Oil production has simultaneously been cut by about 13%. After oil GDP consisted 43% of GDP in 2019, it is projected to decrease to 31% in 2020 and to 37% in 2021.

Oil reserves of Iraq are estimated to have 145 billion barrels in 2021[11] and ranked fourth in the world[12].

Table 2.6 Indicators of Economic Growth and Prices

Item	Unit	Actual				Projections				
		2016	2017	2018	2019	2020	2021	2022	2023	2024
Real GDP (% change)	%	15.2	-3.4	0.8	4.5	-10.9	1.2	3.9	5.7	4.1
Non-oil real GDP (% change)	%	1.3	-3.1	4.7	5.7	-8.0	5.0	1.1	2.5	2.7
GDP deflator (% change)	%	-17.0	18.9	11.9	-1.8	-12.6	23.5	3.6	1.6	1.9
GDP per capita	USD	4,637	5,179	5,691	5,687	4,286	4,287	4,498	4,705	4,865
GDP	Trillion IQD	197.9	227.3	256.4	262.9	204.8	255.9	275.5	295.7	313.7
Oil GDP	Trillion IQD	68.4	90.2	119.4	114.0	64.4	95.0	98.0	104.1	108.7
	%	34.6%	39.7%	46.6%	43.4%	31.4%	37.1%	35.6%	35.2%	34.7%
Non-oil GDP	Trillion IQD	129.5	137.1	137.0	148.9	140.4	160.9	177.5	191.6	205.0
	%	65.4%	60.3%	53.4%	56.6%	68.6%	62.9%	64.4%	64.8%	65.3%
GDP *1	Billion USD	167.7	192.3	216.9	222.4	172.0	176.5	190.0	203.9	216.4
Oil production	mbpd	4.63	4.47	4.41	4.58	4.00	3.95	4.18	4.50	4.73
Oil exports	mbpd	3.79	3.80	3.86	3.97	3.43	3.39	3.59	3.86	4.06
Iraq oil export prices *2	USD pb	35.6	48.7	65.2	59.7	38.2	47.0	45.8	45.2	44.8

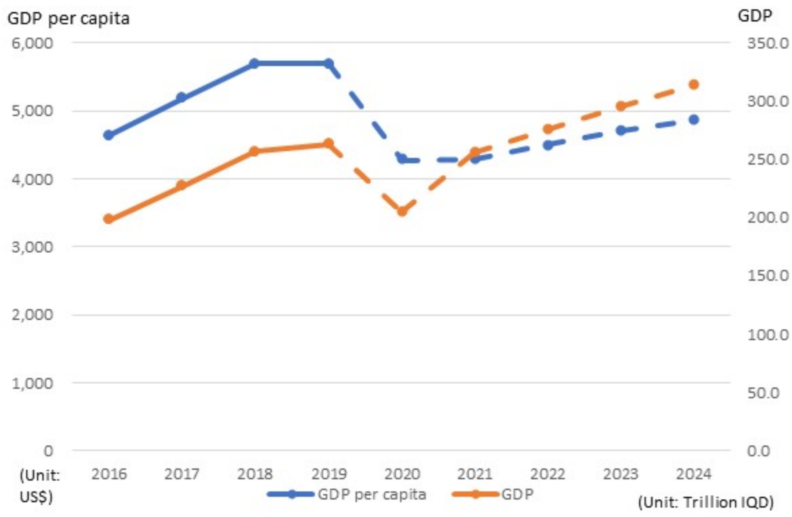
*1: Converted from GDP in local currency using the period-average exchange rate (1191 in 2020).

*2: Negative price differential of about USD 2.9 per barrel compared to the average petroleum spot price (average of Brent, West Texas and Dubai oil prices) in 2020 - 2025.

Source: IMF (2021) "2020 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for IRAQ"

A sharp drop in oil prices and huge production cuts led to a 40% decline in oil exports in 2020 due to the COVID-19 pandemic. The GDP per capita had grew from USD 4,637 in 2016 to USD 5,687 in 2019. As shown in **Figure 2.15**, the GDP per capita decreased to USD 4,286 in 2020. According to IMF, it will take more than five years for Iraqi economy to recover to the level before COVID-19.

[11] OPEC "Annual Statistical Bulletin 2022"
[12] Data excludes oil sands.



Source: IMF (2021) “2020 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for IRAQ”

Figure 2.15 GDP Per Capita and GDP

(2) Muthanna Governorate

1) Industry

Muthanna Governorate has the following industries based on the Embassy of Netherlands, Baghdad (2013)[13].

- Agriculture

The governorate is a large producer of dates. Agriculture in the governorate includes wheat, barley, rice, citrus fruits, tomatoes, dairy and poultry farming, animal feed production, and fishing. Additionally, Samawah is home to the small and rare trade in wild truffles which grow in the desert regions of this province. 45% of the population of Muthanna work in agriculture.

- Brick making

The governorate has a thriving industry in traditional sun-baked brick manufacture existing on the outskirts of Samawah and uses primarily female laborers for forming and drying bricks.

- Cement production

Muthanna is an important center in producing cement[14]. There are reported to be two cement factories operating in Muthanna Governorate. Samawah Cement Plant produces its sulphate resistant cement. It has a capacity of one million tons per year. Al-Muthanna Cement Plant lies to the southwest of the province and produces two million tons of cement per annum.

- Oil production and refining

There is reported to be a small oil refinery in Samawah with an estimated capability of 30,000 bbl/d (4,800 m^3/d). The facility is linked by a pipeline to the Kifl oil field in Samawah District and is designed

[13] Source: Embassy of the Netherlands, Baghdad (2013) “Report, MUTHANNA PROVINCE OVERVIEW”, International Labour Organization (2022) “ILOSTAT database”
[14] NGO Coordinate Committee for IRAQ (NCCI) (2015) “Muthanna Governorate Profile”

for processing heavy crude oil, allowing the light crude to be exported.

- Salt

The salt waters of Lake Sawa provide salt, which is used as a raw material in various industries. The Bahr al Milh, or Salt Sea, is located 70 km southwest of Samawah and is the main source of industrial salts in Iraq. Salt mining and processing facilities are in the region to exploit this resource which is used in many food, pharmaceutical, chemical, and soap industries.

- Textiles

There is a small carpet making industry in Samawah, primarily employing women. Cheap raw materials in the form of wool are obtained from the Bedu Desert which use Samawah as their main trading post.

2) Labor market and poverty

Unemployment rate, female labor participation rate, and ratio of population under poverty rate are shown in **Table 2.7**. Unemployment rate of the province was extremely high (25%) in 2013. Female labor force participation was lower than that of Iraq in 2013. Moreover, Muthanna Governorate was one of the poorest governorates of Iraq since the ratio of population under the poverty line was very high in 2015. The governorate had problems of high unemployment and severe poverty.

Table 2.7 Indicators of Employment and Poverty in Muthanna Governorate and Iraq

Item	Muthanna Governorate	Iraq
Unemployment Rate	25% (2013)*	9.3% (2013)*, 14.2% (2021)**
Female Labor Force Participation	10% (2013)*	12.6% (2013)*, 11.1 (2021)****
Ratio of Population under Poverty Line	29.4% (2015)***	11.5% (2015)***

Source: *Embassy of the Netherlands, Baghdad (2013) "Report, MUTHANNA PROVINCE OVERVIEW", **International Labour Organization (2022) "ILOSTAT database", ***NGO Coordination Committee for Iraq (NCCI) (2015) "Muthanna Governorate Profile", **** The World Bank (2021) "World Development Indicators"

Muthanna Governorate's peripheral location (closed border with Saudi Arabia), nomadic culture and lack of public investment are partially behind the relatively high incidence of daily labor[15].

2.3.2 Inflation, Foreign Exchange, and International Trade Balance

Table 2.8 shows the inflations and indicators of external sector of Iraq. From 2016 to 2020, the average inflation in Iraq stayed in the range from -0.2% to 0.5% then it hiked to 7.1% in 2021 based on IMF (2021)[16]. Inflation rate will decrease after 2022 according to the projections of IMF. Inflation was accelerated in 2021 driven by the increase in demand pressures, the Iraqi dinar's devaluation, and lower agriculture output[17]. Devaluation of the Iraqi dinar by 22.7% in 2020 is announced by the Central Bank of Iraq.

The fiscal and external current account deficit will decrease due to the devaluation, recovering global oil demand, and fiscal reforms. The GOI plans the fiscal reforms which will reduce the current account

[15] Altai Consulting for CCI and the ILO (2021) "Economic Relief, Recovery, Resilience Assessment for southern IRAQ."
[16] IMF (2021) "2020 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for IRAQ"
[17] The World Bank (2022) "Iraq Economic Monitor"

deficit and diminish pressures on reserves as intended. IMF (2021)[18]estimates, as shown in **Table 2.8**, that the reforms will improve the fiscal balance and decrease the requirement for monetary financing of the budget.

Table 2.8 Inflations and Indicators of External Sector and Public Finance

Item	Unit	Actual				Projections				
		2016	2017	2018	2019	2020	2021	2022	2023	2024
Consumer price inflation (% change, end of period)	%	-1.5	0.2	-0.1	0.1	1.0	11.5	4.6	2.6	2.0
Consumer price inflation (% change, average)	%	0.5	0.1	0.4	-0.2	0.5	7.1	7.1	3.3	2.3
Current account	% of GDP	-7.5	-4.7	4.5	0.5	-15.2	-4.1	-3.3	-2.7	-2.7
Trade balance	% of GDP	1.3	4.2	13.6	10.3	-6.6	3.7	3.8	3.7	3.5
Exports of goods	% of GDP	29.8	35.3	42.6	40.3	29.0	34.3	33.0	32.8	32.3
Imports of goods	% of GDP	28.5	31.2	29.0	30.0	35.6	30.7	29.2	29.1	28.8
Overall external balance	% of GDP	-3.9	2.6	6.5	0.8	-8.8	-2.1	-2.6	-3.2	-1.5
Gross reserves	USD billion	45.5	49.4	64.7	68.0	54.1	47.4	40.8	33.2	30.0
Total GIR* (in months of imports of goods and services)	% of GDP	6.7	7.0	8.4	10.7	9.4	9.2	6.7	5.0	4.3
Exchange rate (period average)	IQD per USD	1,180	1,182	1,182	1,182	1,191	1,450	1,450	1,450	1,450
Government revenue and grants (percentage in GDP)	%	28.0	33.6	41.2	37.8	30.0	40.8	40.5	40.6	40.6
Expenditure (percentage in GDP)	%	42.5	35.1	33.0	36.9	50.3	57.0	52.9	48.6	45.5
Overall fiscal balance (including grants) (percentage in GDP)	%	-14.5	-1.5	8.2	0.9	-20.3	-16.2	-12.4	-8.0	-4.9

*GIR: Gross International Reserves

Source: IMF (2021) "2020 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for IRAQ"

2.3.3 Labor Market and Poverty

According to the World Bank (2020)[19], Iraq's GDP per capita might have been higher by 60% at the maximum if it had had the same levels of labor force participation, investment, human capital, and productivity as those in other upper-middle-income countries (UMICs). Iraq has the second lowest female labor force participation rates in the world which was 11.1% (percentage of women working for a wage). In addition, Iraq's youth unemployment rate (percentage of total labor force aged 15-24) is 27.2% according to the World Bank (2021) which ranked 42nd in the world. This situation is especially serious since Iraq has one of the youngest populations in the world.

Also, according to the World Bank, Iraq has one of the highest poverty rates among UMICs. As shown in **Table 2.9**, the rural poverty rate was 27.5% in 2017 while the urban poverty rate was 14.6% in the same year. The urban-rural gap of poverty rate slightly decreased in 2017 (12.9%) compared to 2007,

[19] The World Bank (2020) "Breaking Out of Fragility A Country Economic Memorandum for Diversification and Growth in Iraq"

when it was 16.0% (rural 39%, urban: 23%). Regional disparities within the country relate to risk factors for conflict and instability. The poverty rate of Iraq in 2020 was 12.9% based on the World Bank (2020)[20].

Table 2.9 Labor Market and Poverty

Item	Percentage	Rank in the World
Female labor force participation rate	11.1% (2021)**	192 in 193 countries
Iraq's youth unemployment rate	27.2% (2021)**	42 in 193 countries
Rural poverty rate	39% (2007), 27.5% (2017)*	n.a.
Urban poverty rate	23% (2007), 14.6% (2017)*	n.a.
Poverty rate	12.9% (2020)**	15 in 44 available data

Source: * The World Bank (2020) "Breaking Out of Fragility A Country Economic Memorandum for Diversification and Growth in Iraq",
** The World Bank (2021) "World Development Indicators"

2.3.4 Foreign Direct Investment and Industry Development

IMF (2021)[21] reports that the increase in military and defense spending added budgetary pressures while uncertainty in security situations declined the foreign direct investment (FDI). The financial sector is rapidly changing and its reform is essential to attract FDI, especially in non-oil sectors[22]. FDI (net inflows, percentage of the GDP) was -1.7% in 2020. According to the World Bank[23], ongoing disputes over resource control have invited uncertainty in the oil sector and have bottlenecked the development of oil production and revenue generation. The legal framework is still incomplete. Although national hydrocarbon law and other legal documents were summitted to the Council of Representatives, they have not been adopted. Consequently, significant legal and political risks become a burden to private investors in Iraqi's oil sector, which discourage foreign investment in the sector.

GOI established the National Investment Commission (NIC) in 2007 along with counterparts from the Provincial Investment Commissions (PICs)[24]. The major role of NIC is to provide policy recommendations to the Prime Minister and to support the current and potential investors in Iraq. The NIC promotes investments that can address the country's most critical needs. It provides logistical support, business process support, and introductions of potential investors to various public and private sector contacts[25].

Moreover, strengthening transparency is required in the oil sector since publicly available information on Iraq's oil revenue remains limited and lacks validation according to the World Bank (2020)[26]. Also, it is important for the growth of the Iraqi economy to increase the labor productivity of the oil sector. Additionally, it is critical to enhance the non-oil sector because the oil market has uncertainty in the situation of social events such as the COVID-19 pandemic.

Agriculture sector is one of the largest non-oil sectors and contributes to increase the employment

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20 The World Bank (2020) "Poverty & Equity Brief Middle East & North Africa Iraq"
21 IMF (2021) "2020 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for IRAQ"
22 The World Bank (2020) "Breaking Out of Fragility A Country Economic Memorandum for Diversification and Growth in Iraq"
23 The World Bank (2020) "Breaking Out of Fragility A Country Economic Memorandum for Diversification and Growth in Iraq"
24 U.S. Department of States (2021) "2021 Investment Climate Statements: Iraq"
25 NIC website: https://investpromo.gov.iq/ (accessed on September 2, 2022)
26 The World Bank (2020) "Breaking Out of Fragility A Country Economic Memorandum for Diversification and Growth in Iraq"

according to the World Bank[27]. On-farm and off-farm employment will increase if public policy makes an incentive framework that enables private sector productivity and competitiveness to increase. Analysis shows that in a high-growth environment, an approximate of 23,382 small enterprises would be made in the agriculture industry by 2030 and more than 120,000 new jobs (compared to 2015) would be created.

2.3.5 Government Budget

(1) Revenue and expenditure

Based on published data of the Ministry of Finance (MOF), the past revenues, expenditures, and fiscal balance during the last five years are shown in **Table 2.10** and **Figure 2.16**.

Total revenues and total expenditures varied and there are two years when fiscal deficit was recorded. The deficit in 2020 was caused mainly by decreased oil revenue affected by the COVID -19 pandemic. The average fiscal balance from 2017 to 2021 was IQD 7.3 trillion.

Table 2.10 Trend of Revenue and Expenditures of the GOI

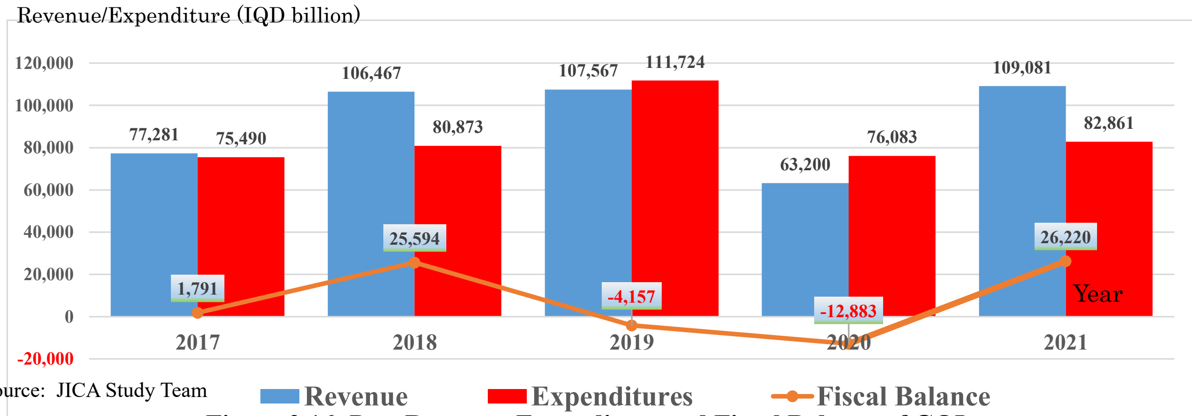
(unit: IQD billion)

Year	2017	2018	2019	2020	2021	Average
Revenue	**77,281**	**106,467**	**107,567**	**63,200**	**109,081**	**92,719**
- Oil Revenue	65,497	96,063	99,491	55,955	96,622	82,726
- Non-oil Revenue	11,784	10,404	8,076	7,245	12,459	9,994
Expenditures	**75,490**	**80,873**	**111,724**	**76,083**	**82,861**	**85,406**
- Current Expenditures	59,026	67,053	87,301	72,874	82,496	73,750
* Salary and Pension	32,867	35,836	40,634	40,037	42,447	38,364
* Others	26,159	31,217	46,667	32,837	40,049	35,386
- Investment Expenditures	16,464	13,820	24,423	3,209	365	11,656
Fiscal Balance	**1,791**	**25,594**	**-4,157**	**-12,883**	**26,220**	**7,313**
Share of Oil Revenue	85%	90%	92%	89%	89%	89%
Share of Investment Exp.	22%	17%	22%	4%	0%	14%
Iraq oil export prices (USD pb)	48.7	65.2	59.7	38.2*	47.0*	51.8

*Forecast in 2020 and 2021 by IMF

Source: MOF home page (2017: end year data, 2018-21: in year data), IMF (2021) "2020 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for IRAQ"

[27] The World Bank (2020) "Breaking Out of Fragility A Country Economic Memorandum for Diversification and Growth in Iraq"



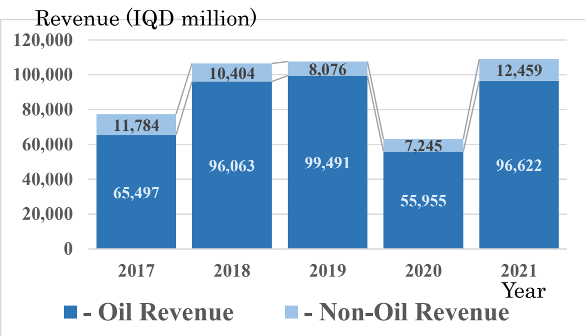
Source: JICA Study Team

Figure 2.16 Past Revenue, Expenditure and Fiscal Balance of GOI

Breakdowns of revenues and expenditures of GOI are shown in **Figure 2.17** and **Figure 2.18**.

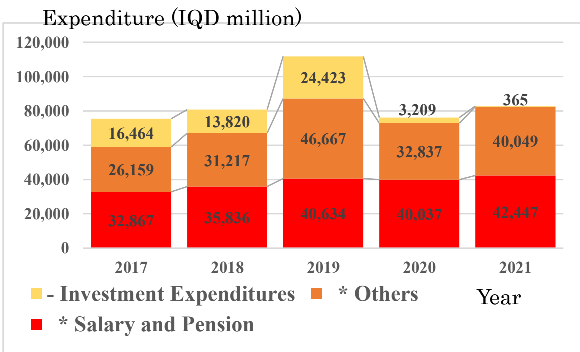
The revenues highly rely on oil revenues. During 2017 to 2021, an average of 89% of the total revenue was obtained from oil production. GOI intended to increase the share of non-oil revenue to strengthen financial sustainability. It remained unchanged at 11% for two consecutive years (2019 and 2020). In 2020, the sharp decrease in the oil price resulted in the lowest amount at IQD 63.2 trillion, while the total revenue in 2021 recovered to IQD 109 trillion as oil demand and oil price increased.

In the current expenditures, the salary and pension cost is constantly increasing from IQD 32.9 to 42.4 trillion during the latest five years, while other costs are also in an increasing trend ranging from IQD 26.2 to 46.7 trillion. Investment expenditures in 2020 and 2021 were quite low at IQD 3.2 and 0.4 trillion influenced by the COVID-19 pandemic in 2020 and political problem in 2021. The share of investment expenditure out of total expenditure is 14% on average during the same period.



Source: JICA Study Team

Figure 2.17 Past Revenue Trend of GOI



Source: JICA Study Team

Figure 2.18 Past Expenditure Trend of GOI

(2) Expenditure of main ministries, MCHPM and Governorate of Muthanna

Actual expenditures and budget execution rate of main ministries and MCHPM are shown in **Table 2.11** and **Figure 2.19**. MOF, the Ministry of Internal Affairs, and the Ministry of Defense take major shares in the total expenditure of GOI, which are 25.0%, 12.9%, and 7.1%, respectively, from 2017-2021 (average total expenditure of GOI is IQD 85,400 billion). MOF repays the international loan where a large amount of budget is allocated.

Table 2.11 Expenditures of the Ministries

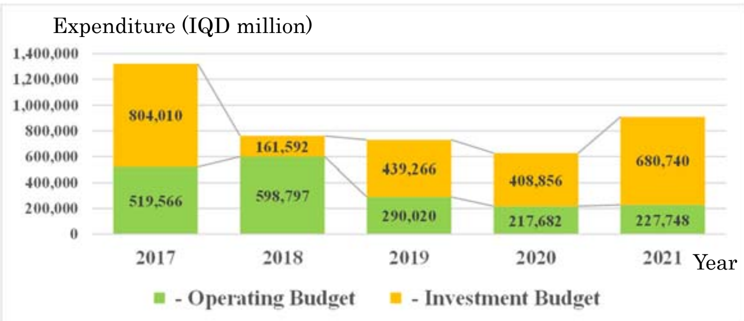
(unit: IQD million)

Year	2017	2018	2019	2020*	2021*	Average	Share
Ministry of Finance	**15,361,063**	**18,910,049**	**26,672,008**	**20,996,749**	**24,745,171**	**21,337,008**	**25.0%**
Budget exec. rate	80.4%	77.8%	89.5%	n.a.	n.a.	82.6%	82.6%
Ministry of Internal Affairs	**10,193,281**	**10,459,267**	**10,852,649**	**11,465,854**	**12,105,238**	**11,015,258**	**12.9%**
Budget exec. rate	95.0%	103.9%	97.7%	n.a.	n.a.	98.9%	
Ministry of Defense	**5,453,398**	**5,546,190**	**5,831,980**	**6,766,258**	**6,909,787**	**6,101,523**	**7.1%**
Budget exec. rate	62.2%	74.1%	75.1%	n.a.	n.a.	70.5%	
MCHPM	**1,323,576**	**760,389**	**729,286**	**626,538**	**908,488**	**869,655**	**1.0%**
- Operating Budget	519,566	598,797	290,020	217,682	227,748	370,763	0.4%
- Investment Budget	804,010	161,592	439,266	408,856	680,740	498,893	0.6%
Budget exec. rate	103.9%	43.0%	41.4%	n.a.	n.a.	62.8%	

Note: Execution rates of the ministries in 2020 and 2021 were not available as financial data has not been finalized as of January 2023.

Source: MOF home page (2017: end year data, 2018-21: in year data)

Expenditures of MCHPM are shown in **Figure 2.19**. Total expenditure of MCHPM varied from IQD 627 to 1,324 billion. The operating budget and investment budget amount changes every year depending on the economic condition and project implementation. Since 2019, some part of the ministry budget has transferred to the provincial governorate and the total amount of the operating budget is reduced. Comparing the budget execution rates of those ministries, MCHPM has the lowest rate which is 62.8% on average from 2017 to 2019. To implement the Project smoothly, careful monitoring would be needed for the administrative and budgetary process of the MCHPM.



Source: JICA Study Team

Figure 2.19 History of Expenditure of MCHPM

(3) Expenditure of Governorate of Muthanna

The actual expenditures and budget execution rate of the Governorate of Muthanna are shown in **Table 2.12** and **Figure 2.20**. The expenditure of the Governorate of Muthanna increased gradually from IQD 253 to 455 billion as the majority is spent on operation. The budget execution rate is also retained high at 97.1% on average.

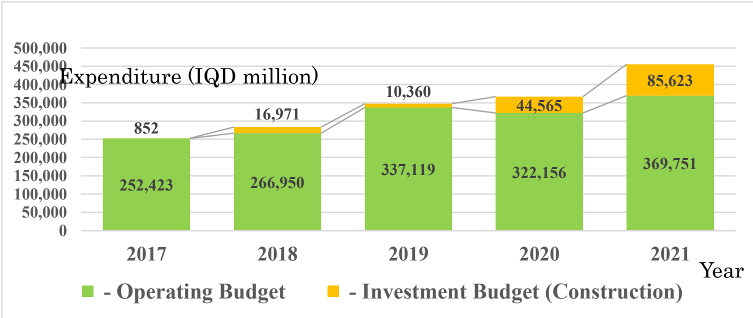
Table 2.12 Expenditures of Governorate of Muthanna

(unit: IQD million)

Year	2017	2018	2019	2020	2021	Average	Share
Governorate of Muthanna	**253,275**	**283,921**	**347,479**	**366,721**	**455,374**	**97,675**	**0.4%**
- Operating Budget	252,423	266,950	337,119	322,156	369,751	75,156	0.4%

Year	2017	2018	2019	2020	2021	Average	Share
- Investment Budget	852	16,971	10,360	44,565	85,623	22,519	0.0%
Budget execution rate	98.5%	103.3%	89.5%	n.a.	n.a.	97.1%	

Source: MOF home page (2017: end year data, 2018-21: in year data)

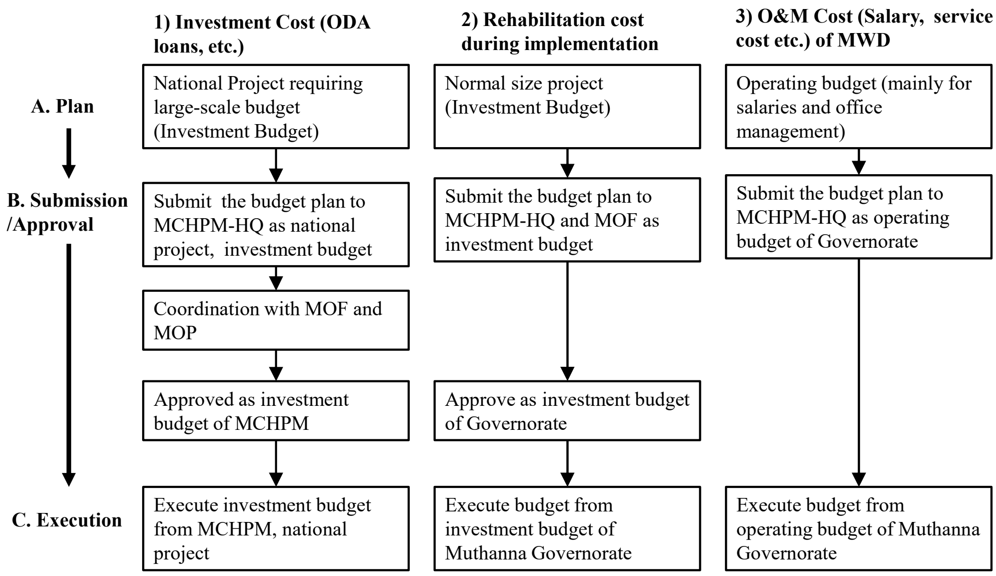


Source: JICA Study Team

Figure 2.20 History of Expenditures of Governorate of Muthanna

(4) Budgeting process of water supply project

The basic budgeting process for water supply services in Iraq is summarized in **Figure 2.21**. "1) Investment cost" of large-scale projects including ODA loan project is managed by MCHPM's investment budget after the coordination with the Ministry of Planning (MOP) and Ministry of Finance (MOF). "2) Rehabilitation cost during implementation" for facilities is provided as the investment budget of the governorate. "3) O&M cost" of the service including salary, management cost, and fuel cost is provided to the governorate water directorates including Muthanna Water Directorate (MWD) as operational budget of the governorate[28].



Note: Definitions of "large-scale project" and "normal size project" are not clearly defined. According to MCHPM staff, WTPs more than 400 m^3/hour might be classified as "large-scale project."

Source: JICA Study Team based on Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq

Figure 2.21 Planning and Execution Process of Budgeting for Water Supply Service

[28] See Section 3.2.1 for institutional structure of water supply sector in Iraq.

2.4 Social Conditions

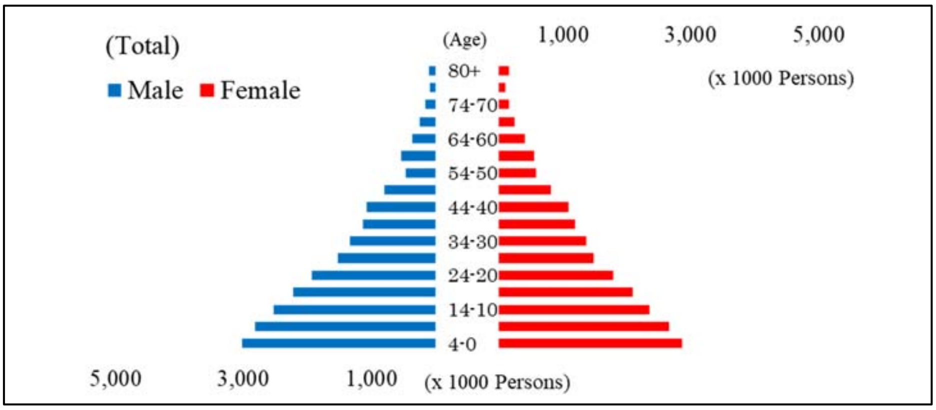
2.4.1 Public Administration

In Iraq, a lot of ministries, agencies, and organizations are involved in the development projects of the water sector. Such organizations include central government organizations, governorate branches of the central government organizations, and local government organizations. The roles of the related organizations are described in Section 3.2.

2.4.2 Population

(1) Population of Iraq

The population of Iraq as of 2009 was approximately 32 million, based on the latest census executed in 2009, and it is estimated to have reached 40 million in 2020. As shown in **Figure 2.23**, the young generation accounts for the majority; therefore, the increasing trend of the population will continue during the 21st century. There will be great needs for infrastructure development to respond to the increasing population.



Source: Annual Statistical Abstract 2020-2021

Figure 2.22 Population by Age and Gender (2020)

The numbers of households and family members are shown in **Table 2.13**. The numbers of family members per household were 7.1 people in the urban areas and 10 people in the rural areas based on the population statistics conducted in 1997; however, such numbers decreased by an average of 6.7 people to 6.3 people in the urban area and 7.8 people in the rural area based on the population statistics conducted in 2009.

Table 2.13 Number of Households and Average Family Size

	1997			2009		
	Urban	Rural	Total	Urban	Rural	Total
Total Households	1,798,153	696,154	2,494,307	3,440,700	1,255,565	4,696,265
Total Population	12,850,589	6,231,977	19,082,566	21,844,413	9,820,053	31,664,466
Ave. Size of Household	7.1	10	7.7	6.3	7.8	6.7

Source: Annual Statistical Abstract 2020-2021

(2) Population of each governorate

The population by governorate of Iraq since 2017 to 2020 are shown in **Table 2.14**. It has been accomplished according to the results of the listing and numbering operation for 2009 by using the software packages (Spectrum, pasex) and depending on the following indicators:

- Age-sex structure for poverty map and maternal mortality (IPMM-2013)
- Governorate proportion based on the listing and numbering Operation (2009)
- Total fertility Rate (TFR) based on the Multiple Indicators Cluster Survey (MICS-2012)
- Life expectancy at birth (LE) based on the Multiple Indicators Cluster Survey (MICS-2012)
- Urbanization ratio based on the listing and numbering operation (2009)

Table 2.15, which calculates the annual growth rate of the population based on **Table 2.14**, shows that the population growth rate of Iraq for each year after 2017 is set at 2.6%. The birth rate in Muthanna governorate from 1997 to 2018 ranged from 37.6% to 38.5%, and over the same period the average natural increase reached to34.5%. Compared to Iraq's natural growth rate of 20.4% during the same period, the reasons for the high natural growth rate in Muthanna governorate include increased births due to security, economic, social, and political stability. In addition, migration from rural to urban areas has contributed significantly to the population growth in Muthanna governorate[29].

[29] Population growth in Muthanna province for the period (1997-2018) and its impact on sustainable development, Haider Hussein Aliwi Al-Shammari, 2018

Table 2.14 Population of Iraq by Governorate (2017-2020)

Governorate	2017			2018			2019			2020		
	Urban	Rural	total	Urban	Rural	total	Urban	Rural	total	Urban	Rural	total
Ninevah	2,203,503	1,430,145	3,633,648	2,261,929	1,468,069	3,729,998	2,321,479	1,506,718	3,828,197	2,382,132	1,546,083	3,928,215
Kirkuk	1,150,607	406,011	1,556,618	1,181,106	416,770	1,597,876	1,212,210	427,743	1,639,953	1,243,881	438,928	1,682,809
Diala	784,734	810,208	1,594,942	805,537	831,689	1,637,226	826,745	853,583	1,680,328	848,350	875,888	1,724,238
Al-Anbar	863,237	862,677	1,725,914	886,115	885,541	1,771,656	909,458	908,860	1,818,318	933,217	932,601	1,865,818
Baghdad	6,926,585	990,262	7,916,847	7,110,234	1,016,521	8,126,755	7,297,432	1,043,279	8,340,711	7,488,087	1,070,538	8,558,625
Babylon	971,137	1,040,569	2,011,706	996,885	1,068,157	2,065,042	1,023,123	1,096,280	2,119,403	1,049,856	1,124,927	2,174,783
Kerbala	793,816	393,429	1,187,245	814,872	403,860	1,218,732	836,316	414,490	1,250,806	858,171	425,313	1,283,484
Wasit	808,359	534,766	1,343,125	829,783	548,940	1,378,723	851,628	563,406	1,415,034	873,884	578,123	1,452,007
Salah AL- Deen	700,760	853,277	1,554,037	719,341	875,894	1,595,235	738,274	898,958	1,637,232	757,567	922,448	1,680,015
Al-Najaf	1,023,818	409,765	1,433,583	1,050,966	420,626	1,471,592	1,078,638	431,700	1,510,338	1,106,811	442,977	1,549,788
Al-Qadisiya	720,490	537,199	1,257,689	739,601	551,447	1,291,048	759,071	565,960	1,325,031	778,901	580,741	1,359,642
Al-Muthanna	360,289	433,054	793,343	369,833	444,538	814,371	388,176	447,621	835,797	398,334	459,318	857,652
Thi Qar	1,310,076	730,990	2,041,066	1,344,810	750,362	2,095,172	1,380,216	770,122	2,150,338	1,416,271	790,243	2,206,514
Maysan	800,628	283,309	1,083,937	821,853	290,820	1,112,673	843,494	298,472	1,141,966	865,530	306,272	1,171,802
Basrah	2,301,111	532,264	2,833,375	2,362,123	546,368	2,908,491	2,424,321	560,752	2,985,073	2,487,658	575,401	3,063,059
15 Governorate Total	21,719,150	10,247,925	31,967,075	22,294,988	10,519,602	32,814,590	22,890,581	10,787,944	33,678,525	23,488,650	11,069,801	34,558,451
Kurdistan Region:												
Erbil	1,504,204	302,667	1,806,871	1,544,091	310,687	1,854,778	1,584,742	318,866	1,903,608	1,626,140	327,201	1,953,341
Duhouk	932,418	326,732	1,259,150	957,135	335,400	1,292,535	982,340	344,222	1,326,562	1,007,997	353,214	1,361,211
AL-Sulaimaniya	1,784,783	321,640	2,106,423	1,832,119	330,160	2,162,279	1,880,342	338,852	2,219,194	1,929,465	347,706	2,277,171
Total of K.R	4,221,405	951,039	5,172,444	4,333,345	976,247	5,309,592	4,447,424	1,001,940	5,449,364	4,563,602	1,028,121	5,591,723
Iraq Grand total	25,940,555	11,198,964	37,139,519	26,628,333	11,495,849	38,124,182	27,338,005	11,789,884	39,127,889	28,052,252	12,097,922	40,150,174

Source: Annual Statistical Abstract 2020-2021

Table 2.15 Population Growth Rate of the Governorates (2017-2020)

Governorate	2017-2018			2018-2019			2019-2020		
	Urban	Rural	total	Urban	Rural	total	Urban	Rural	total
Ninevah	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Kirkuk	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Diala	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Al-Anbar	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Baghdad	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Babylon	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Kerbala	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Wasit	2.65%	2.65%	2.65%	2.63%	2.64%	2.63%	2.61%	2.61%	2.61%
Salah AL- Deen	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Al-Najaf	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Al-Qadisiya	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Al-Muthanna	2.65%	2.65%	2.65%	4.96%	0.69%	2.63%	2.62%	2.61%	2.61%
Thi Qar	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Maysan	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Basrah	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
15 Governorate Total	2.65%	2.65%	2.65%	2.67%	2.55%	2.63%	2.61%	2.61%	2.61%
Kurdistan Region:									
Erbil	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Duhouk	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
AL-Sulaimaniya	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Total of K.R	2.65%	2.65%	2.65%	2.63%	2.63%	2.63%	2.61%	2.61%	2.61%
Iraq Grand total	2.65%	2.65%	2.65%	2.67%	2.56%	2.63%	2.61%	2.61%	2.61%

Note: The birth rate in Muthanna governorate from 1997 to 2018 ranged from 37.6% to 38.5%, and over the same period the average natural increase reached to34.5%. Compared to Iraq's natural growth rate of 20.4% during the same period, the reasons for the high natural growth rate in Muthanna governorate include increased births due to security, economic, social, and political stability. In addition, migration from rural to urban areas has contributed significantly to the population growth in Muthanna governorate.

Source: Calculated base onAnnual Statistical Abstract 2020-2021

2.4.3 Disputes

(1) Recent security information in Iraq

The Islamic State of Iraq and the Levant (ISIL) had been expanding its forces mainly in northern and western Iraq since June 2014, but in December 2017, the Iraqi government declared the liberation of all of Iraq from ISIL after a clean-up operation by the Iraqi army supported by the Coalition of the Willing. However, some believe that there are still more than 3,000 ISIL remnants in Iraq and some areas of the country, including Ninawa, Anbar, Salahuddin, and Kirkuk provinces, have seen frequent terrorist incidents and clashes due to mopping-up operations by security authorities. It is also suspected that fighters have reached some urban areas in the northern provinces and are planning new attacks.

(2) Recent status around Muthanna

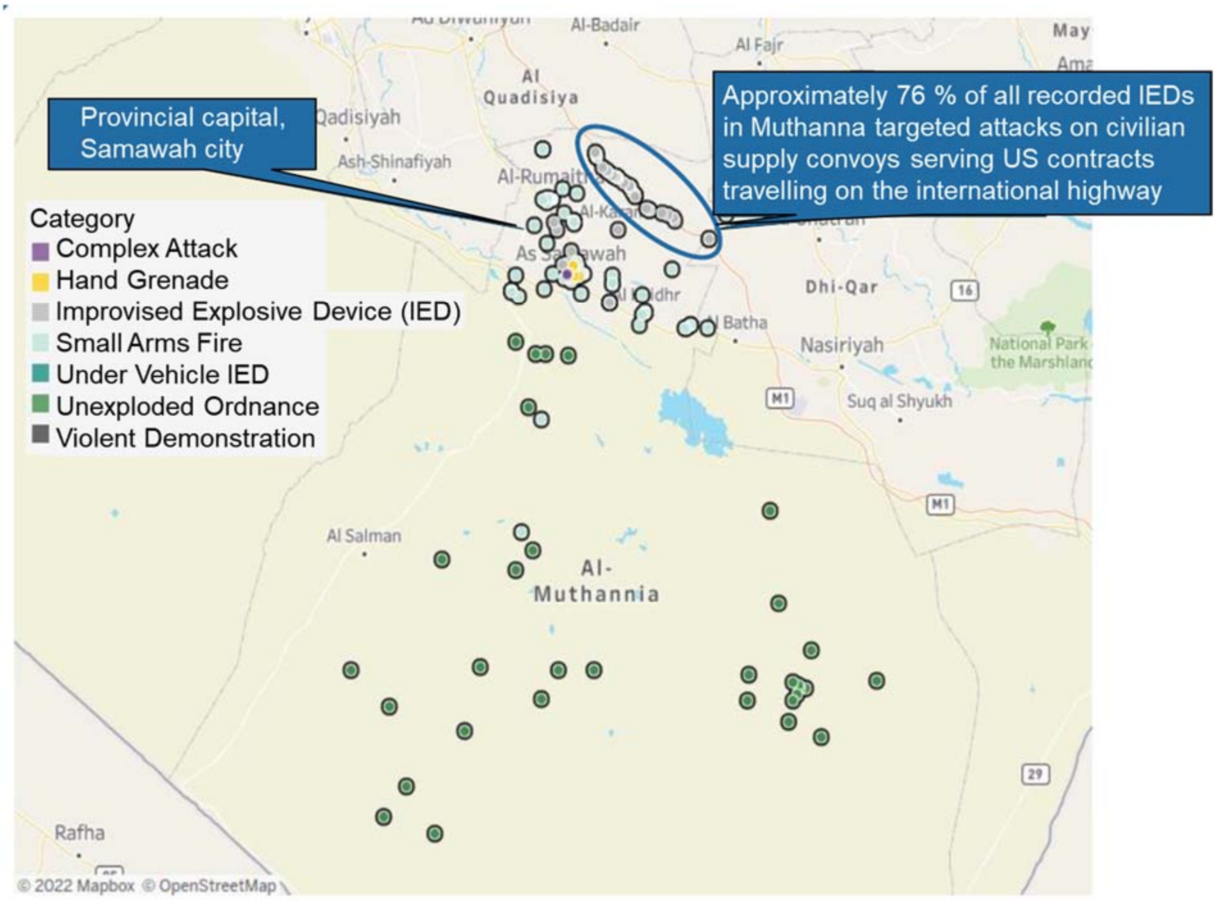
Muthanna Province has one of the lowest rates of violent incidents in southern Iraq (Karbala, Babil, Wasit, Najaf, Qudisiya, Dhi-Qar, Maysan, Muthanna, and Basrah) and it has remained consistently low with respect to neighbouring provinces. Muthanna has accounted for just 3.9% of all recorded violent incident activity in the south over the past five years, with low level small arms fire (SAF) accounting for the vast majority of incidents. Most violent activity in Muthanna is a complex mix of criminality, tribal activity and turf wars. Sporadic SAF and low impact improvised explosive devices (IED) attacks are predominantly intercommunal, arising from local issues and disputes of a personal and commercial nature. Incidents that do occur are usually targeted and typically occur in residential and outlying rural areas after dark and do not impact foreign commercial operations.

Figure 2.23 shows the spots of violent incidents from 2017 to 2022 in Muthanna Governorate. There have been no high impact terrorist attacks in Muthanna in the past five years. More recently, an IED targeted the party of a local judge while walking through the streets in Jarbouya in north Samawah on 26th March, 2021. It is assessed that the attack formed part of a local grievance and was almost certainly carried out by a criminal entity aiming to exact revenge against the criminal justice system.

Since 31st October, 2017, approximately 46 IED detonations have been recorded in Muthanna, just over 5% of all recorded IED incidents in southern Iraq in the past five years.

Of those recorded, approximately 76% are targeted civilian supply convoys serving US contracts travelling on the international highway. The attacks formed part of a broader campaign by pro-Iran resistance splinter groups (RSGs) to expel US forces from Iraq. However, to date, all alleged attacks remain unconfirmed by official sources. The last reported IED attack against a convoy was recorded on 19th May, 2022.

Most non-violent incidents reported were demonstrations, followed by low level criminality, security operations, and accidental unexploded ordnance (UXO), the latter chiefly in Muthanna’s southernmost desert.

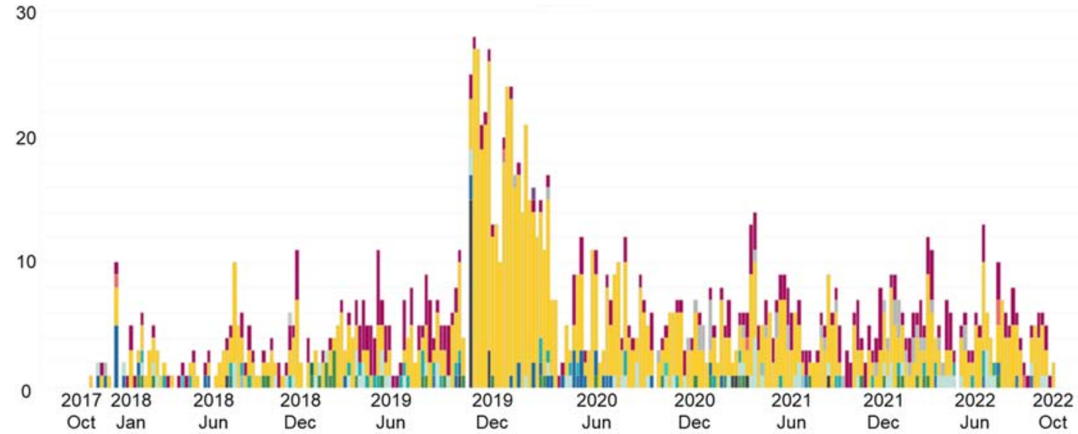


Source: Five-Year Trend Analysis Overview: 2017 – 2022 Muthanna, 31 October 2022, Control Risks

Figure 2.23 Spot of Violent Incidents from 2017 to 2022 in Muthanna Governorate

Muthanna Province has one of the lowest incident rates of all federal Iraq and its rate has remained consistently low with respect to the neighbouring provinces in the south. **Figure 2.24** shows the history of the numbers of violent incidents in Muthanna from 2017 to 2022. In the past five years, the province has accounted for just 5.9% of all recorded incident activities in the south with protests (in yellow) accounting for most incidents at 62.5%, which is significantly above the low level criminal activity (red) at just 18.5%. A combined total of just 8% was recorded for low level asymmetric activity and comprised SAF, IEDs and a single kidnap.

With respect to demonstration levels, there has been a downward trajectory since the end of mass antigovernment protests that peaked between October and November 2019 before petering out mid-2020. Since that time, Muthanna has recorded occasional spikes in protest activity with key drivers of civil unrest being poor socioeconomic conditions and responses to adverse political developments. Based on the trend of the past five years, the outlook for Muthanna is stable.

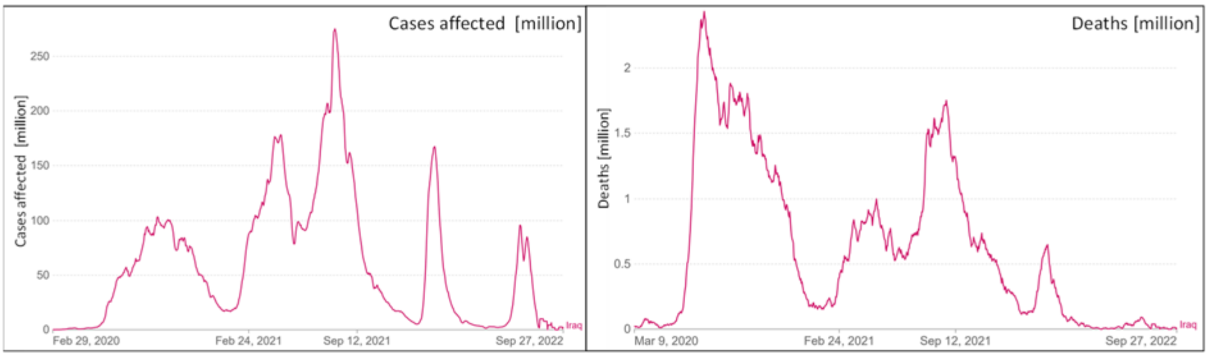


Source: Five-Year Trend Analysis Overview: 2017 – 2022 Muthanna, 31 October 2022, Control Risks

Figure 2.24 Trends of Violent Incidents from 2017 to 2022 in Muthanna

2.4.4 Public Health and COVID-19 Infection Status and its Social Impact

The COVID-19 which spread since 2020 affected Iraq. The number of confirmed persons and deaths accumulated to 2.5 million and 25 thousand, respectively. Recently, the infection became moderate in line with the situation in other countries around the world as shown in **Figure 2.26**.



Source: Johns Hopkins University CSSE COVID-19 Data (as at September 27, 2022)

Figure 2.25 Confirmed Cases and Deaths by COVID-19 in Iraq

Iraq faces two crises, namely, the COVID-19 pandemic and decreasing oil revenue which accounts for 60% of the GDP. Therefore, the COVID-19 pandemic worsened the poverty group and inequality, reduced social cohesion, and increased social tensions. Women who have jobs that are often part time and informal are affected and most likely to be impacted negatively. It also reduced the opportunity for education for children.

2.4.5 Social Survey to the Community in the Study Area

(1) Methodologies

JST conducted a social survey to collect information of customers and people who do not receive the services of MWD and data which was used to measure the economic benefits of the Project. It is a revised version of the "social survey" to update and reinforce the results of the survey implemented in the Previous Study executed by JICA in 2016.[30] The main differences between the social survey in 2016 and that in 2022 is explained in **Table 2.16**. The questionnaires include identification, general information, economic situation, water supply situation, and attitudes on water supply of customers.

Table 2.16 Comparison between the Social Surveys in the Previous Study (2016) and in the Study

Item	Previous Study (2016)	Social Survey in the Study	Reasons for Revision
Survey Period	January-March 2016	August-October 2022	-
Number of Sample Distribution	• 200 (150: served, 50: unserved) households in urban area • 10 commercial entities in urban area • 50 households in rural area	• 320 (240: served, 80: unserved) households • 10 commercial entities in urban area • 80 households in rural area	Number of respondents was not enough statistically for population of the target area of the Project.
Average Income for Households	The average monthly income per household	The average monthly income per person	To get details of the average monthly income
Average Monthly Income for Entities	Selection of income from 5 options (from below IQD240,000 to more than IQD1,200,000)	The amount of average monthly income for each business sector	To get details of the average monthly income
Willingness to Pay (WTP) for households and entities	Selection of monthly payment for flow condition of water at the water tap from 6 options (from less than IQD6,000 to more than IQD30,000)	The increase rate of current monthly water charge for improved water pressure at the water tap	To get details of WTP for improved water pressure at water tap
		The increase rate of the monthly water charge for the provided water for 24 hours continuously without interruption	To get details of WTP for the provided water for 24 hours continuously without interruption
	Selection of monthly payment for water quality at the water tap from 6 options (from less than IQD6,000 to more than IQD30,000)	The increase rate of the monthly water charge for improved water quality at the water tap	To get details of WTP for improved water quality at the water tap
	Selection of monthly payment for the services of MWD from 6 options (from less than IQD6,000 to more than IQD30,000)	The increase rate of the monthly water charge for the improved services of MWD	To get details of WTP for the improved services of MWD

Source: JICA Study Team and "Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq"

(2) Results

Table 2.17 shows the main points of the social survey results in 2016 and 2022. The average monthly incomes per household were IQD 594,878 (JPY 60,202) in the urban area and IQD 425,838 (JPY 43,095) in the rural area in 2022, which increased to 1.9 times and 1.8 times, respectively, since 2016. A high percentage of respondents use the water from the MWD network for drinking and cooking purposes, and also purchase water from private water vendors which is treated by reverse osmosis in 2022.

Survey results on the willingness to pay (WTP) and affordability to pay (ATP) will be given in Section 3.4.5. More information on the satisfaction level on the water supply services of MWD will be given in Section 4.1.1. The survey report of the social survey is shown in **Appendix 2.1**.

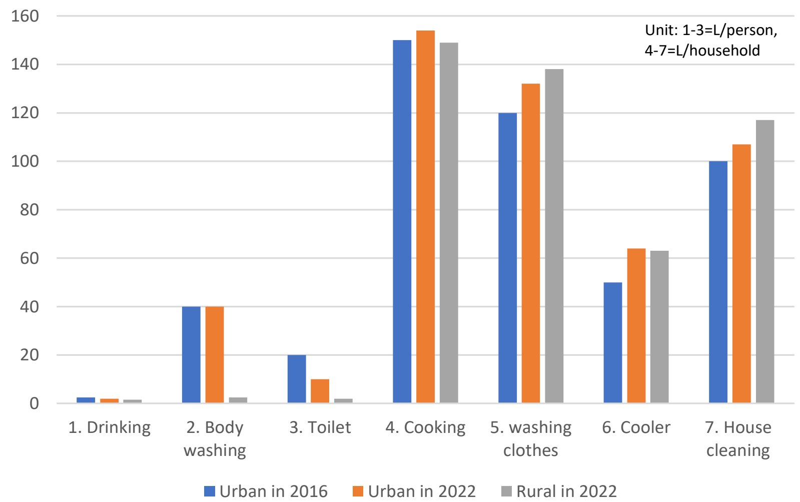
[30] JICA (2016) "Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq"

Table 2.17 Main Points of Results of Social Survey in 2016 and 2022

Item	Region	Results in 2016	Results in 2022
Average monthly income per household (Social Survey Report p. 16, 39)	Urban	IQD320,040 (JPY32,644)	IQD594,878 (Yen 60,667)
	Rural	IQD242,880 (JPY24,773)	IQD425,838 (Yen 43,435)
Main Expenditure* (Social Survey Report p. 17, JST)	Urban	Food: 33% Education: 26% Health: 19%	Food: 33% Education: 24% Health: 24%
	Rural	-	Food: 33% Education: 29% Health: 22%
Daily average hours of water supply (Social Survey Report p. 29, 45)	Urban	Less than 6 hours: More than half	Less than 6 hours: 53% Less than 12 hours: 10%
	Rural	Less than 6 hours: More than half	Less than 6 hours: Majority
The percentages of the residents who answered that they do not use the water from MWD network for drinking purposes (Social Survey Report p. 21, 41)	Urban	81%	35%
	Rural	86%	21%
The percentages of the residents who answered that they do not use the water from MWD network for cooking purposes (Social Survey Report p. 21, 42)	Urban	52%	28%
	Rural	58%	24%
The percentages of the residents who purchase water from private water vendors which are treated by reverse osmosis (Social Survey Report p. 21, 41)	Urban	87%	93%
	Rural	74%	93%
The average volumes of daily water usage for different purposes*		See **Figure 2.27**.	
Services provided by MWD (Social Survey Report p. 33, 46)	Urban	"Bad": 68%	"Not good, not bad": 62% "Bad": 30%
	Rural	"Bad": 93%	"Not good, not bad": 65% "Bad": 35%

*Note: No data in 2016 for rural area.

Source: JICA (2016) "Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq", JICA Survey Team (2022)



Source: JICA Survey Team

Figure 2.26 Average Volumes of Daily Water Usage for Different Purposes

2.5 Development Plan and Current Status of Infrastructure

2.5.1 National Plan

(1) Iraq Vision 2030

"The future we want", Iraq Vision for Sustainable Development 2030, which is called "Iraq Vision 2030", is Iraq's road map for sustainable development issued by the Ministry of Planning (MOP) in February 2019. It was prepared by the initiative of MOP through a series of activities since 2015, which involved the ministries, local governments, NGOs, private sector, academic experts, and international organizations such as the United Nations. The vision's slogan is "Empowered Iraqis in a safe country, a unified society with diversified economy, sustainable environment, justice, and good governance"[31].

The vision presents a set of national development priorities up to 2030 in five sections which are man building, good governance, a diversified economy, safe society, and sustainable environment. **Table 2.18** shows the five priority sections as well as the vision of each section presented in the Iraq Vision 2030.

Table 2.18 Priority Sections and the Visions Presented in Iraq Vision 2030

Section	Section's Vision
1. Man Building	Build spiritual, psychological, and physical well-being to build generations who are capable of innovation, creation, and achievement.
2. Good Governance	Active administrative institutions which ensure the respect of political, civil, and human rights, justice, and equality of all citizens before the law.
3. Diversified Economy	Diversified social market economy which generates decent job opportunities and provides an economic welfare level with a joint management of the public and private sectors to enhance the Iraqi economic capacities.
4. Safe Society	Safe society whose members enjoy peace and in which the values of citizenship, solidarity, and achievement are strengthened.
5. Sustainable Environment	Create clean, safe, and sustainable environment for the current and future generations through incorporating environment in the development plans and policies to achieve a sustainable improvement in human life quality, ensure the sustainability of the production and consumption patterns, and reduce the repercussions of environment pollution and climate changes

Source: "The future we want", Iraq Vision for Sustainable Development 2030

For each section of the Iraq Vision 2030, four to six development goals are presented. **Table 2.19** shows the vision's development goals which are relevant to water supply and environment and target-achieving tools and goal indicators for such development goals. As shown in the table, the improvement of public services in the areas of water supply, sanitation, power supply, transportation, and communications is the major target in infrastructure development, among which water supply service is regarded as the most basic infrastructure for housing environment.

[31] "Empowered Iraqis in the safe country, the unified society with diversified economy, sustainable environment, justice, and good governance"

Table 2.19 Development Goals Relevant to Water and Environment in Iraq Vision 2030

Section	Development Goal	Target Achievement Tools and Indicators relevant to infrastructure Development	
		Target-achieving Tools	Goal Indicators
1. Man Building	Goal (1-5) Provide decent housing and end informal settlements	• Improve the housing environment through improving the quality of municipal services and providing drinking water and sanitation	• Coverage of drinking water services = 100% (Baseline: 86.1% in 2015)
5. Sustainable Environment	Goal (5-2) Efficient use of water resources	• Improve the irrigation and drainage systems • Increase water reserves • Develop the national water resources management systems • Enhance international cooperation on water	• Water stress level = 75% (Baseline: 93% now) • Water agreements with the neighboring countries = three agreements (Baseline: N/A)
	Goal (5-3) Environmental conservation	• Provide sanitation services to all Iraqi areas • Stop the disposal of wastewater in the rivers • Expand the green spaces and green economy • Develop the environmental legislation including imposing environmental taxes	• Basic sanitation services in the rural areas = 100% (Baseline: 85.8%) • People using sanitation services managed safely = 75% (Baseline: 32%)

Source: "The future we want", Iraq Vision for Sustainable Development 2030

(2) National Development Plan 2018 - 2022

National Development Plan 2018 - 2022 (NDP 2022) was issued by MOP in June 2018 as an updated edition of the National Development Plan 2013 – 2017. The update was implemented as a part of the activities to prepare the Iraq Vision 2030. Because of this background, although the issuance of NDP 2022 was before the issuance of Iraq Vision 2030, the introduction part of NDP 2022, issued in 2018, indicates that it is guided by the goals of Iraq Vision 2030, issued in 2019, and NDP 2022 is regarded as the first five-year national development plan for the period of Iraq Vision from 2018 to 2030.

Table 2.20 shows the outline of NDP 2022. After the analysis on the achievement of the previous National Development Plan for 2013 – 2017 and on the latest economic situations, NDP 2022 identified the challenges to be tackled and the strategic objectives of the development, based on which the development objectives for each sector by 2030 and the measures for the development are listed. Drinking water supply is one of the sectors classified in the sector of housing and basic services.

Table 2.20 Outline of National Development Plan 2018 - 2022

Item	Description
Slogans	
• "Establish the foundations of an effective development state with social responsibility" • "Post-recovery option"	
Challenges Identified	
I. Institutional challenges	1. Low efficiency of institutional performance 2. Overstaffing and low productivity of labor force 3. Financial and administrative corruption
II. Economic	1. Poor investment climate

Item	Description
challenges	2. Disrupted production structure 3. Trade imbalance 4. Imbalanced budget structure 5. High public debt 6. Underdeveloped banking system 7. Large informal sector 8. Limited role of the private sector
III. Social challenges	1. Low human development status 2. Dominance of sub-loyalties (pre-state) and weak rule of law and access to justice 3. High levels of multidimensional poverty 4. Weakening and disintegration of social policies 5. Major social crises and poor protectionist policies 6. Gender gap 7. Inability of the State and society to accommodate and integrate young people in public life and provide them with decent work opportunities 8. Large areas occupied by terrorist ISIL 9. Education with no progress in quality, geographical spread, or coverage of infrastructure 10. Healthcare services with continuous decline, limited access, inability to meet the actual needs of the population, and high migration levels of medical professionals
IV. Environmental challenges	1. Environmental pollution from conflict 2. Spread of informal housing development 3. Lack of integrated environmental management and inadequate environmental legislation 4. Desertification 5. Climate change 6. Reliance on non-renewable energy
Strategic Objectives	
1. Establishing the foundations of good governance. 2. Achieving economic reform in all its financial, monetary, banking, and commercial dimensions. 3. Recovery of communities affected by the displacement crisis and the loss of human security. 4. Providing the requirements of an enabling environment for investment in all its forms and enhancing the role of the private sector. 5. Raising the economic growth rate in line with the Iraqi economy's potentials and requirements. 6. Increasing the real per capita income. 7. Reducing unemployment and underemployment. 8. Human security is possible for the poorest and most vulnerable groups. 9. Upgrading sustainable human development indicators. 10. Laying the foundations for decentralized spatial development. 11. The alignment between the general development framework and urban structures based on the foundations of urban planning and spatial comparative advantages.	
Sectoral Development Plan	
Sector	**Development Objectives**
Agriculture and water resources	1. Increase the GDP contribution of the agricultural sector (for non-oil activities) from 4.5% in 2015 to 5.2% in 2022 and achieve a sector growth rate of 8.4% in the target year 2. Achieve sustainable food security 3. Secure the annual demand for sustainable water uses in agricultural, industrial, and municipal fields and achieve water balance with the possibility to reduce annual demand by 500 million m^3 4. Provide sustainable water resources
Energy and manufacturing industries	**Oil and gas**: Eight development objectives are listed. **Electricity sector** 1. Increase the total electricity production capacity to 20,869 MW 2. Increase the per capita electricity consumption to 4,041 kWh 3. Improve the electricity system efficiency

Item	Description
	4. Improve quality of consumer services (household, government, industrial, agricultural, and commercial) 5. Rationalize electricity consumption in different uses and reduce it by 7% annually 6. Improve the environmental impact of electricity activity by reducing CO_2 emissions 7. Enhance the private sector role in managing the energy production and distribution sectors 8. Enhance the governance of electricity sector and institutions
Manufacturing and non-oil industries	Six (6) objectives are listed.
Transport, communications, and storage	**Transport:** Totally 21 development objectives are listed for port, marine transport, airport, passenger transport, land transport of goods by trucks, railway transport, roads, and bridges. **Communications**: Five (5) development objectives are listed. **Storage**: Two (2) development objectives are listed.
Housing and basic services	**Housing sector**: Four development objectives are listed. **Drinking water supply** 1. Provide drinking water according to international standards reach per capita consumption commensurate with population growth (at least 250 l/d in Baghdad and provincial centers and 200 l/d in rural areas 2. Improve the quality of potable water 3. Minimize water loss by at least 10% of the baseline year **Wastewater management** 1. Maximize service coverage to 97% in Baghdad and 72.66% in other provinces 2. Discharge treated water into the rivers according to standard specifications
Culture, tourism, and antiquities	Six development objectives are listed.

*: Development objectives for drinking water supply services

Source: National Development Plan 2018 - 2022

Table 2.21 shows the means of achievement and the key performance indicators for drinking water supply services in NDP 2022. The development objectives focus on the three major elements in water supply services which are water volume (production capacities), water quality, and water loss.

Table 2.21 Means of Achievement and the Key Performance Indicators of Drinking Water Supply Services in National Development Plan 2018 - 2022

Development Objectives	Means of Achievement	Key Performance Indicators
Objective 1: (Production capacities) Provide drinking water according to international standards reach per capita consumption commensurate with population growth	• Adopt an integrated system for managing and organizing production, maintenance, filtration, distribution, and fee processes to ensure the best performance of systems and improve the efficiency of employees to keep up with modern water projects management and implementation. • Prepare plans and studies for pure water needed up to 2030 and qualify and develop current projects to increase and improve production and to increase the capacity of the liquidation projects conducting to population growth. • Lay water networks to uninhabited areas, renew clean water networks, and improve distribution.	**Water consumption per capita per day:** At least 250 L/d in Baghdad and provincial centers (urban) and 200 L/d in rural areas
Objective 2: (Water quality) Improve the quality of potable water	• Improve water quality through annual rehabilitation of the production facilities. • Ensure appropriate quantities of water purification materials (both quantity and quantity). • Improve and develop laboratories in projects and all production	**Number of water quality tests:** 650 tests (Baseline: 550 tests)

Development Objectives	Means of Achievement	Key Performance Indicators
	and distribution sites to increase the number and types of tests according to Iraqi and international specifications.	
Objective 3: (Water loss reduction) Minimize water loss by at least 10% of the baseline year	• Provide modern standards for all participants to control waste and reduce the losses of pure water and ensure the optimal use of water through special awareness programs. • Expand the production and distribution of raw water to all districts of Baghdad and provincial centers to replace the clean water in watering gardens. • Enforce provisions, laws, and legislation on those who violate public networks. • Use modern technologies (photovoltaic cells and others) in water structures and others to reduce losses of pure water.	**Water loss ratio:** 19% (Baseline: 29%)

Source: National Development Plan 2018 – 2022

(3) White Paper

The White Paper is the final report of the Emergency Cell for Financial Reform[32], which was established pursuant to Iraqi Cabinet Resolution No. (12) adopted at its session on 12th May, 2020, with the objective of managing the financial situation in light of the Iraqi current financial crisis and developing the necessary solutions to achieve financial reform and improve the performance of the financial institutions. The Emergency Cell for Financial Reform has formulated the economic reform program mandated by the Domestic and Foreign Borrowing Law No. (5)[33] of 2020 to restructure the Iraqi economy in preparation for impending problems.

The objective of such a document was to establish a common ground to be agreed upon and authorized, followed by the presentation of the relevant laws and, therefore, the implementation processes. The purpose of the White Paper was to articulate, in a manner that is credible locally and globally, a mix of strategies and policies necessary to confront the greatly aggravated economic and budgetary issues of Iraq. The White Paper was developed with profound knowledge and acknowledgement of the urgent necessity to enact fundamental economic changes that cannot be postponed or delayed any longer. The primary idea of the study is that oil prices will no longer grow considerably, providing the Iraqi government with the budgetary flexibility to continue reforms indefinitely.

2.5.2 Regional Development Plan for Muthanna Directorate

The latest development plan for Al Muthanna Directorate is the Structure Plan for Muthanna Governorate issued in 2008 by the Directorate General of Physical Planning under the Ministry of Municipalities and Public Works at that time[34]. The target period of this development plan is for 25 years until the year 2032. **Table 2.22** shows the outline of the Structure Plan for Al Muthanna Governorate.

[32] Emergency Cell for Financial Reform
[33] Domestic and Foreign Borrowing Law No. 5 of 20202
[34] Currently called as the Ministry of Construction, Housing and Public Municipality (MCHPM)

Table 2.22 Outline of Structure Plan for Al Muthanna Governorate

Part		Contents	
Part I	Development Principles	Implementation and Financing of the Plan	Objectives and policies of the plan and financial sources to implement the plan
		Methodological Approach	Explanation on the approach in the preparation of the structure plan
		Vision and Spatial Strategy	Proposal of "Cluster-Based" approach to adopt in the development plan of Muthanna
		Planning Criteria	25-year development scenario of Muthanna based on the "Cluster-Based" approach
Part II	Sectorial Planning Strategy	Crosscutting Projects	Needs, objectives, and actions for capacity building, IT platform, and data management system
		Environmental Aspects	Visions, strategies, recommendations, projects, constraints, and guidelines for environmental management
		Socio-economic Aspects	Visions, strategies, recommendations, projects, constraints, guidelines for economy, industry, agriculture, tourism, and oil and natural resources
		Infrastructures	Visions, strategies, recommendations, projects, constraints, guidelines for transportation, electricity, and telecommunication
		Public Services	Visions, strategies, recommendations, projects, constraints, guidelines for education, health, housing, solid waste, and water supply and sanitation
Priority Projects		A total of 16 projects (3 projects for environment, 2 projects for economy, 2 projects for industry, 3 projects for agriculture, 1 project for tourism, 2 projects for transportation, 1 project for electricity, 1 project for housing, and 1 project for water supply and sanitation)	

Source: Structure Plan for Al Muthanna Governorate (May 2008)

For water supply services, the structure plan points out that the major issues are low access to safe drinking water, insufficient water volume, and low water quality especially in terms of salinity. The structure plan proposed four performance indicators and their target values as shown in **Table 2.23** and proposed three projects as below.

- Project 1: General Survey for the Water and Sanitation Sectors, a baseline survey to serve as the basis for general water and sanitation master plan for the governorate.
- Project 2: The Urban Water Supply Project - Completion of the Water Supply Systems for the Head Towns, a reinforcement project of water supply services in urban areas
- Project 3: The Rural Water Supply Project – The Sustainable Provision of Water in the Rural Areas, a reinforcement project of water supply services in rural areas

Table 2.23 Performance Indicators for Water Supply in Structure Plan for Al Muthanna Governorate

Objectives	Indicator / Value			
	Present	Short-term	Mid-term	Long-term
Extend access to safe drinking water (% of population)	42%	51%	75%	100%
Increase the average per capita daily provision of water	75 – 80 Lpcd	-	200 Lpcd in urban areas, 160 Lpcd in rural areas	200 Lpcd in urban areas, 160 Lpcd in rural areas
Improve the quality of supplied water by lowering its salinity (TDS)	> 1,000 mg/L	< 1,000 mg/L	< 800 mg/L	< 500 mg/L
Improve the quality of water supply services	-	-	Stable quality of water, continuous service	Stable quality of water, continuous service

Source: Structure Plan for Al Muthanna Governorate (May 2008)

In the final chapter, the structure plan lists 16 priority projects, where Project 2, among the three water supply projects above, is included. Project 2 includes several construction works for Samawah District which includes improvement of the transmission mains from Rumaitha WTPs to Samawah District and rehabilitation and extension of the distribution network in the city. As an optional action, the structure plan suggests constructing one or two large-scaled WTPs to desalinate the Euphrates River's water. The plan suggests that the desalination plant may supply water to Samawah District and the district may be excluded from the supply area of Rumaitha WTPs.

Currently, there is no movement in MCHPM and in the governorate to update the structure plan. The fundamental issues in the water supply services in Muthanna remain the same in 2022, 14 years since the issuance of the structure plan. However, the overall situations in Iraq in terms of economy, politics, security, etc. have developed significant differences from the conditions and assumptions in the structure plan. In addition, Iraq Vision 2030 and the NDP 2022 require that national and local development plans shall be compatible. Under these circumstances, therefore, update of the Structure Plan for Muthanna Governorate as well as preparation of general master plan for water supply system according to the updated structure plan will be necessary. Such plans will be useful for the governorate to convince the government to increase the budget for investment and operation and maintenance for water supply services.

2.5.3 Current Status of Infrastructure

(1) Transportation

1) Port

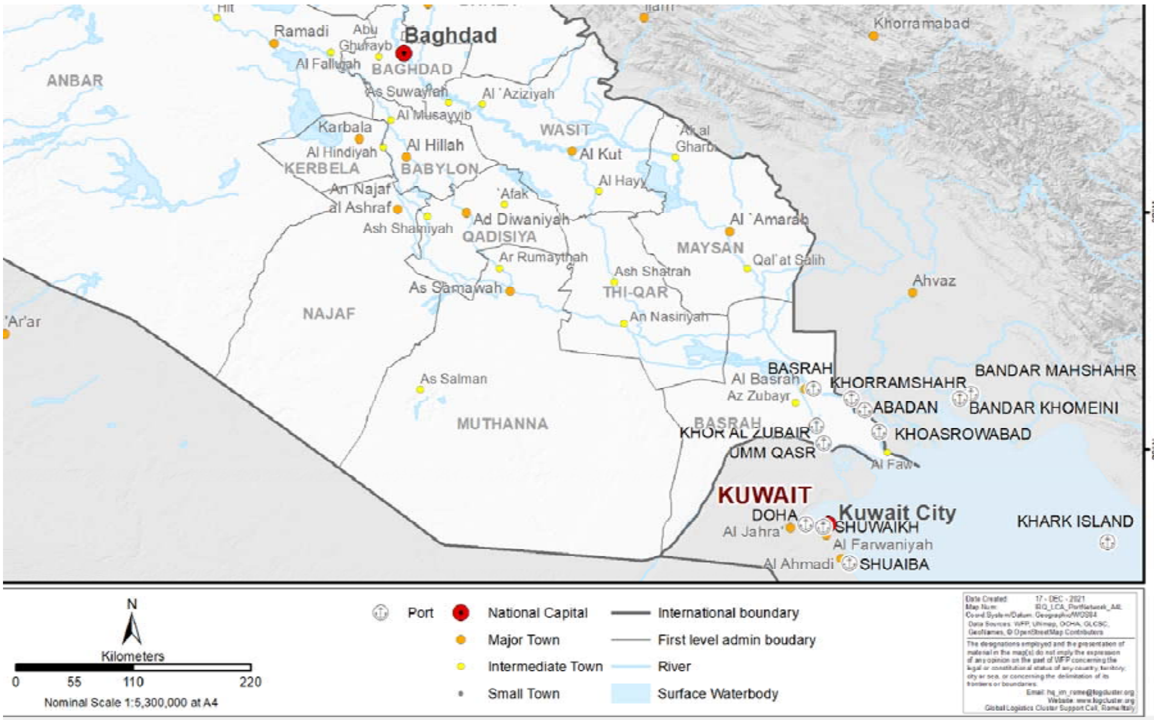
Figure 2.28 shows the locations of the existing ports in Iraq. The number of terminals stood at 48 in 2015 with a capacity of 17 million t/y, much lower than the NDP 2022's goal[35]. The number of working ships owned by the State Company for Maritime Transport increased from three in 2013 to seven in 2016, while the NDP 2022's goal was 19. This failure is due to the financial crisis as well as the requirements for the liberation of Iraqi territory from terrorist groups.

Iraq possesses four commercial ports (Umm Qasr, Khor Al-Zubair, Abu Falous, and Al-Maqal), two ports (Al Basra Oil Terminal and Khor Al Amaya Oil Terminal) for exporting oil, and four rotary platforms to export oil. The capacity of each port is as follows[36]:

- Umm Qasr Port: 50,000 TEU container traffic per month
- Khor Al-Zubair Port: 400,000 t of cargo and 1,440,000 t of fuel oil every year
- Abu Falous Port: 9 forklifts with the capacity of 5 t each
- Al-Maqal Port: 600 TEU but the port was partially destroyed during the Iran-Iraq war, and after 2017 it is not widely used.
- Al Basra Oil Terminal: 3 million barrels of crude oil every day

[35] National Development Plan 2018 - 2022
[36] https://www.marineinsight.com/maritime-law/5-major-ports-in-iraq/

- Khor Al Amaya Oil Terminal: 200,000 to 300,000 bbls/day but it suffered damage during Iraq-Iran War and later during Operation Desert Storm, and after 2017 it is not operated.



Source: Atlassian (https://dlca.logcluster.org/display/public/DLCA/Iraq)

Figure 2.27 Ports in Iraq

2) Aviation

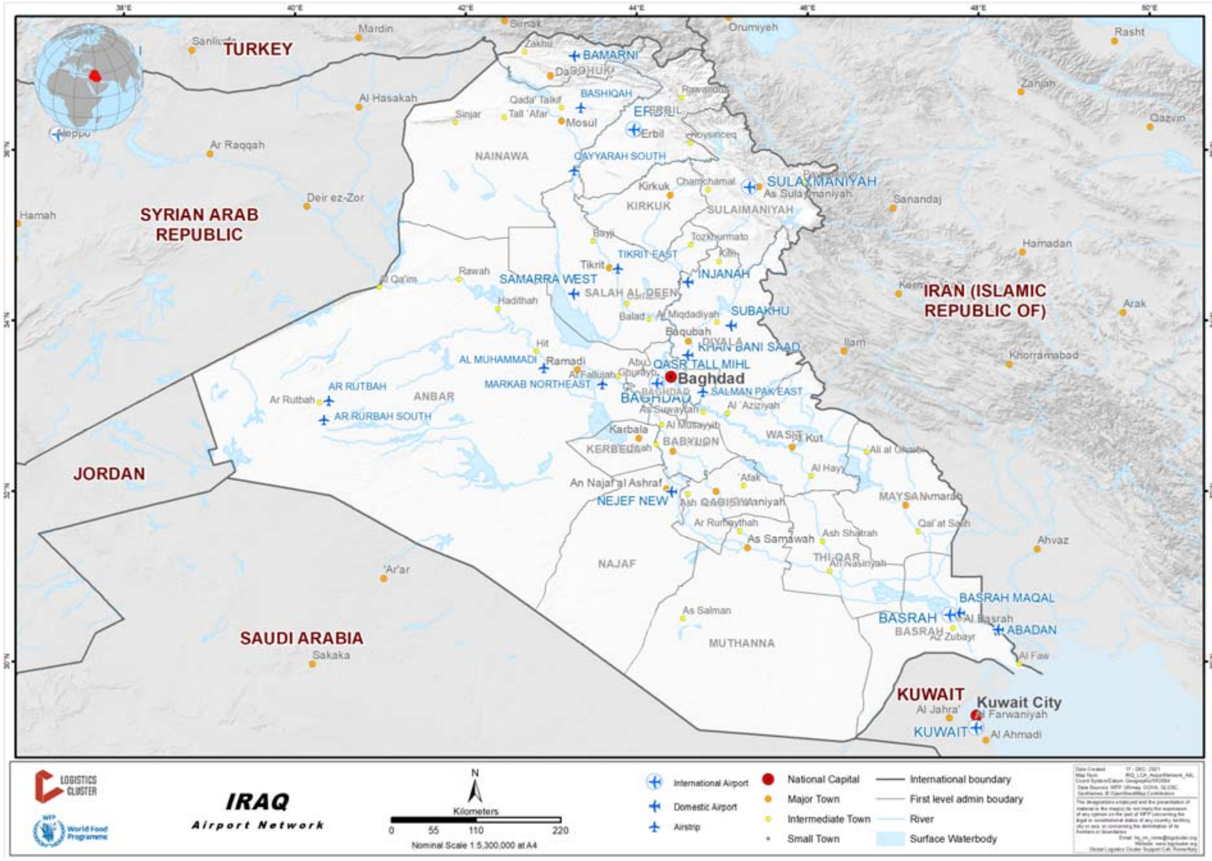
Figure 2.29 shows the locations of the existing airports in Iraq. The number of passengers in internal and external flights increased from 5.26 million in 2013 to 8.28 million in 2016 with a growth rate of 16.3% and the number of flights rose from 55,262 in 2013 to 81,635 in 2016 with a growth rate of 13.9%. The amount of air freight increased from 5,109 t in 2013 to 34,988 t in 2016 at a growth rate of 89.9%. The increase is due to a higher demand for internal and external tourist flights. The civil aviation introduction of internal tourist flights to the Kurdistan Region instead of using road transport is because of people's improved living standards and the risk of road transport under the control of terrorist groups over a number of northern governorates[32].

Currently, there are five international airports in Iraq. Civil aviation consists of the activity of the Iraqi Civil Aviation Authority (central financing) for Baghdad and Basra airports, the regional civil aviation of Erbil and Suleimaniah airports, and Najaf International Airport. The number of passengers of each airport in 2020 is as follows[37]:

- Baghdad International Airport: 928,983
- Basra International Airport: 198,048

[37] https://ina.iq/eng/10961-icaa-counts-the-number-of-passengers-traveling-through-iraqi-airports-in-2020.html

- Erbil International Airport: 493,454
- Suleimaniah International Airport: 110,024
- Najaf International Airport: 272,770

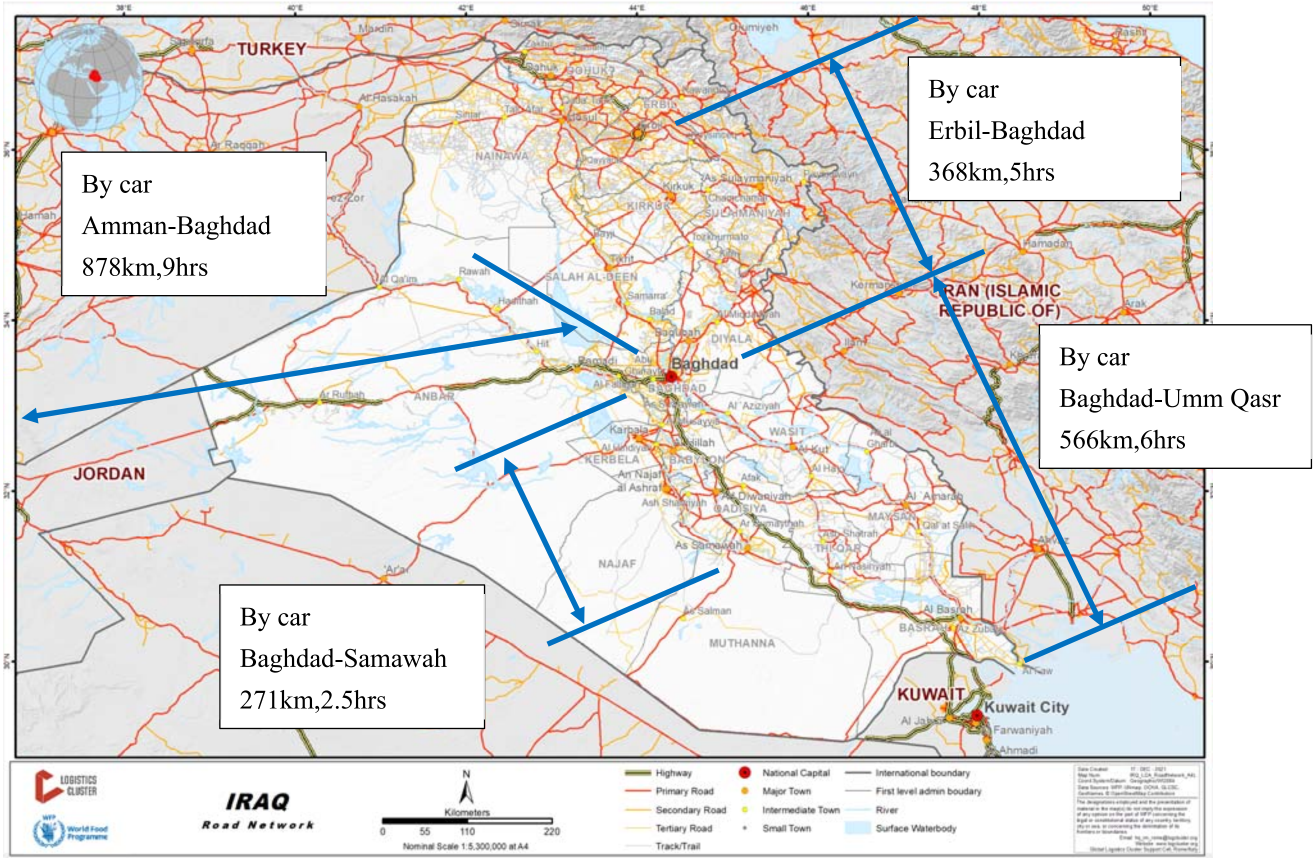


Source: Atlassian (https://dlca.logcluster.org/display/public/DLCA/Iraq)

Figure 2.28 Airports in Iraq

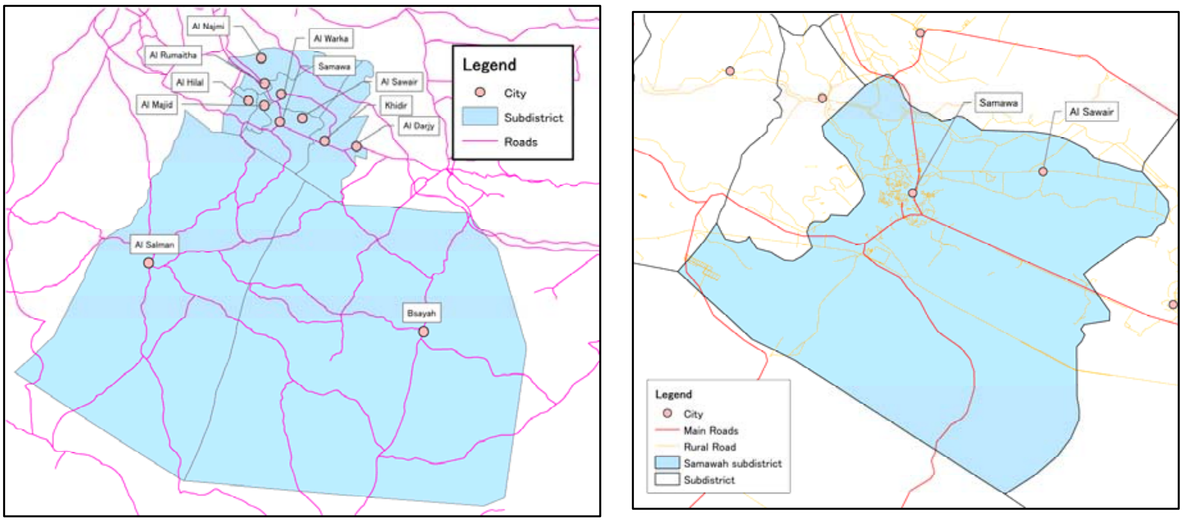
3) Road

Figure 2.30 and **Figure 2.31** show the road networks in Iraq and in Muthanna Governorate, respectively. The length of roads was 42,643 km in 2015 and the total number of bridges was 698, including 296 bridges on the highways. There has been destruction of many roads and bridges in the areas of military operations in Baghdad, Diyala, Salah Al-Din, Nineveh, Anbar, and Kirkuk. The number of destroyed bridges reached 125. Reconstruction of 17 destroyed bridges and nine roads is part of the World Bank's loan for the reconstruction of liberated areas[32].



Source: Atlassian (https://dlca.logcluster.org/display/public/DLCA/Iraq)

Figure 2.29 Road Network in Iraq



Source: Ministry of Municipalities & Pubic Works, Directorate General of Physical Plannning

Figure 2.30 Road Network in Muthanna

4) Railway

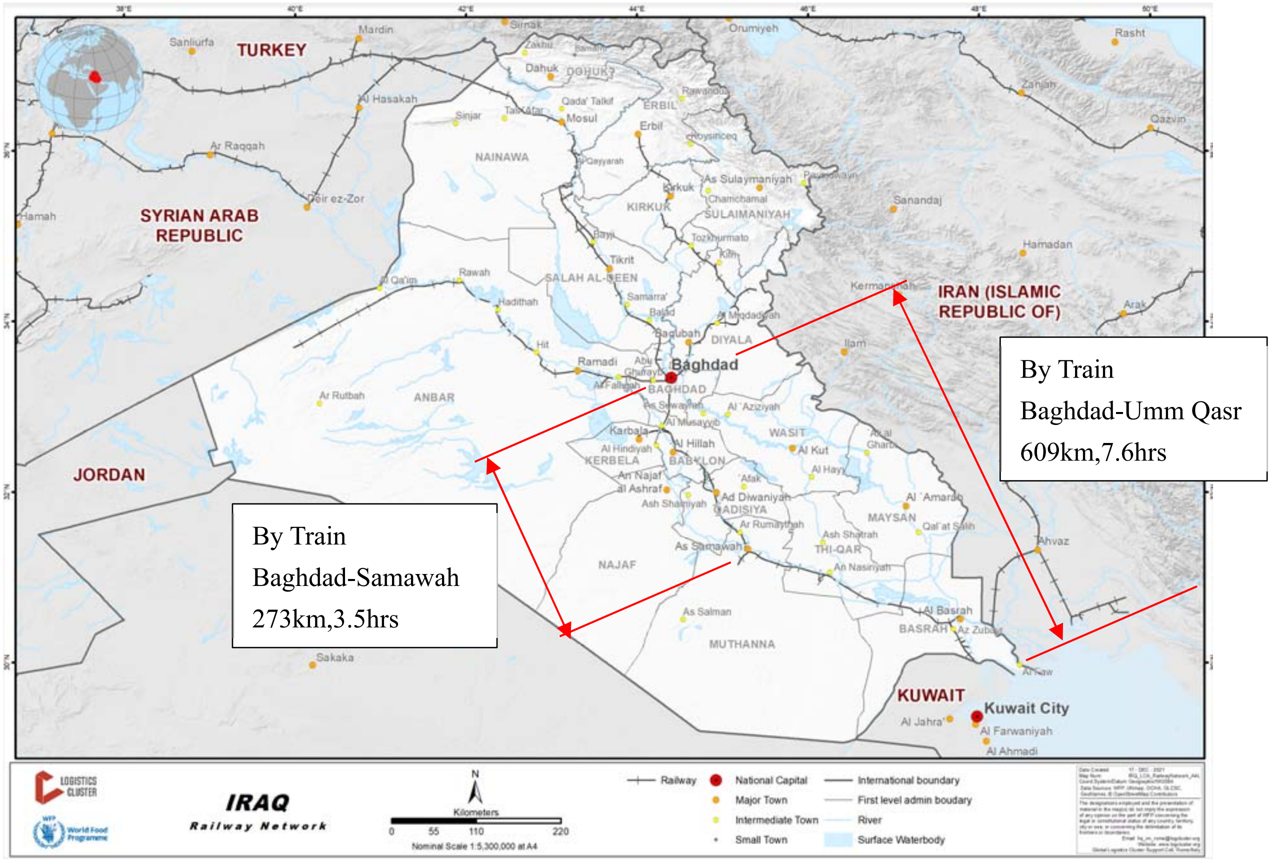
Figure 2.32 shows the railway network in Iraq. The length of the railway lines stood at 2,370 km in 2013 and increased to 2,893 km at the end of 2016, an increase rate of 22%, which is less than the NDP 2022's goal[32].

Security conditions and the subsequent conditions of war against terrorist groups affected rail transport. Of the nine existing lines, only three are operational, including Baghdad-Basrah (Al Makal) and Shaibah-Umm Qasr, as well as the Musayyib-Kerbala line that is only used for religious visits. This affected the implementation rates of NDP 2022's goals with the number of operating diesel locomotives dropping from 66 in 2013 to 52 in 2016. The technical specifications of the line are as shown in **Table 2.24**[32].

Table 2.24 Lengths of Operating and Decommissioned Railways in 2015

No.	Name	Length (km)	Notes
1	Baghdad–Basra (Maqal)	552	In operation 75,528 passengers per year, 299,578 tons goods per year
2	Shaibah–Umm Qasr	56	In operation (branch of No.1) 293,700 tons goods per year
3	Musayyib–Holy Kerbala	25	Used in religious visits 51,380 passengers per year
4	Baghdad–Al-Mousl	408	Decommissioned due to the security situation
5	Mousl–Rabia	112	
6	Baghdad–Al-Qa'im (Haseeba)	376	
7	Al-Qa'im–Akkashat	144	
8	Heet–Kabisa	33	
9	Baiji–Kirkuk	106	Decommissioned due to destruction of the outlet bridge and the security situation.
10	Baiji–Haqlaniyah	146	Decommissioned due to the security situation

Source: National Development Plan 2018 – 2022



Source: Atlassian (https://dlca.logcluster.org/display/public/DLCA/Iraq)

Figure 2.31 Railway Network in Iraq

(2) Electricity

1) Iraq

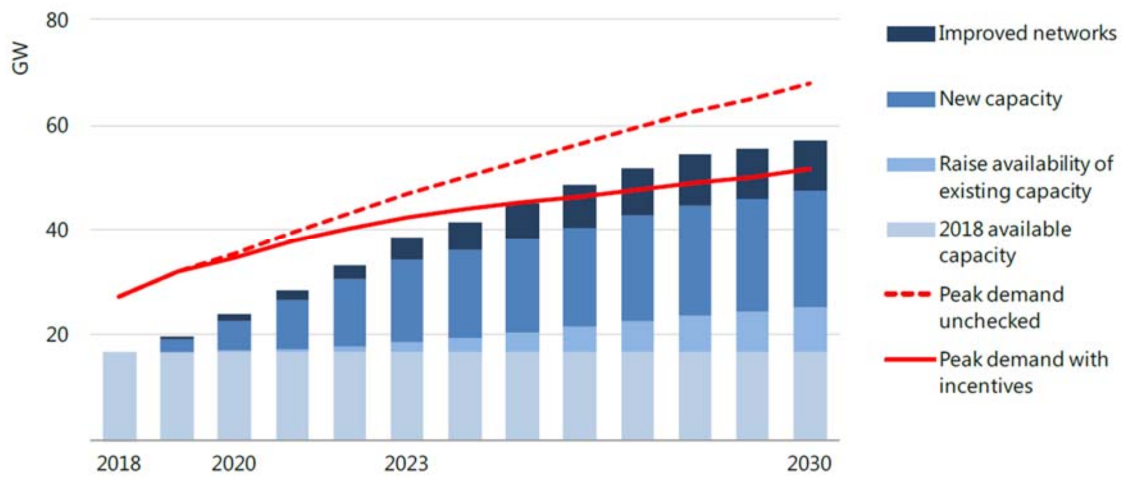
According to NDP 2022, the actual production of electricity increased from 8,062 MW in 2013 to 9,239 MW in 2015 and then to 15,000 MW in 2017. However, production remained below what is planned since it did not meet the full demand. The NDP 2022 goal of increasing the Iraqi per capita share of electrical power from the current rate of around 1,800 to 3,700 kWh in 2017 was not achieved because of the significant difference between design and available capacities. Some stations with a design capacity of 7,094 MW also became out of service due to insecurity in several provinces. The NDP 2022 did not achieve its goal of raising awareness to properly manage energy consumption, as evidenced by the increased per capita consumption of the productive energies. The power transmission and distribution sectors are still plagued by bottlenecks, with electricity loads exceeding the capacity of the transmission network, although many projects for the rehabilitation and implementation of substations were completed[32].

Energy imports increased in 2015 to 1,496 MW from 1,393 MW in 2013 and then declined to 1,100 MW due to the entry into service of gas-operated service investment stations, so the increase in energy purchases transformed into an increase in the purchase of fuel (gas). Energy is imported from Turkey and Iran via transmission lines. There was relative progress towards the NDP 2022 goal of enabling the private sector to develop the performance of electricity both by direct investment in the construction of

7,500 MW generating stations and the management of the distribution sector, i.e., collection companies. Relative progress was made in converting simple-cycle gas power plants to composite cycle power plants where 500 MW was added through this conversion. There was also relative progress in investing in renewable energies, where 1,000 MW was announced for investment, of which 250 MW was awarded for implementation[32].

There is a gap in terms of annual per capita electricity consumption by province in 2015, with the highest being in the Basra Province (2.75 MWh) and the lowest being in Salah al-Din (0.15 MWh). The other provinces have varying close proportions. A family is with no access if they do not get electricity from the public network. The 2014 Socio-Economic Survey shows a decline of 0.57% in the proportion of families without access to the national electricity grid compared to the 2012 Survey. There was relatively little variation among provinces in connection with the percentages of families with no access to the national electricity grid in 2014, with Baghdad ranking first with 0.5% of the total number of families in the province, while the percentage in Missan, Wassit, and Kerbala was almost 0. The percentages were 0.7% in rural areas and 0.2% in urban areas[32].

Iraq's ongoing electricity shortages despite substantial capacity additions, highlights two issues: the difficulty of fully closing the gap between supply and demand without investing heavily in the network to reduce losses; and perpetual challenge of expanding supply to meet unchecked growth in electricity demand, fuelled by population growth and rising incomes. The first issue is well understood and we have illustrated the gains that are possible. But to increase the chances of achieving a reliable electricity supply, measures must also be taken to address rising demand for electricity. Left unchecked, the rise in peak demand will continue to outpace the cumulative effects of new capacity and network improvements through to 2030. This highlights the imperative to boost end-use efficiency and to provide effective incentives to shave the demand peak in the summer with measures that reform grid and neighbourhood tariffs, and that ensure comprehensive bill collection for power provided[38].



Source: Iraq's Energy Sector A Roadmap to a Brighter Future, International Energy Agency, April 2019

Figure 2.32 Available Electricity Supply and Peak Demand to 2030

[38] Iraq's Energy Sector A Roadmap to a Brighter Future, International Energy Agency, April 2019

2) Muthanna Governorate

a. Power Plants and Generators

The following is a detailed list of needs related to the existing generating facilities:

- Samawah Power Plant: Gas turbine power plants with 40 MW x 1 no.[39]
- Samawah Diesel Power Plant: Diesel units with 15 MW x 4 nos[37]. It was constructed in 2008 supported by JICA and under regular rehabilitation[40].
- Samawah Combined Cycle Gas Turbine Power Plant: Combined Cycle Gas Turbine Power Plant with 125 MW x 4 nos. + 250 MW[41]. It is supported by General Electric (Switzerland) GmbH and ENKA UK Construction Limited and planned to start the operation in 2022, but Phase 2 of the project is stopped due to lack of funding[42].
- Al Salman Public Generators: Working out the national grid of Iraq.
- Basyah Public Generators: Working out the national grid of Iraq.

b. Substations:

As of 2019, there is 6 transforming stations with 132 KV operating in the transmission networks in Muthanna[43].

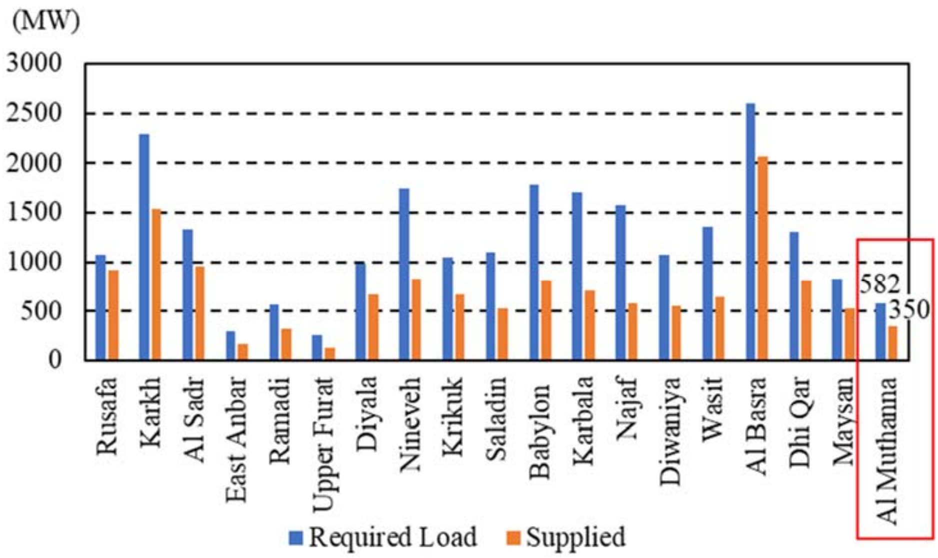
c. Settlements Connected to Power Grid:

Although most of the villages are currently connected to the national grid, or to local power generation facilities, Muthanna remains one of the most poorly served governorates in all Iraq[32]. Average power quantity supplied to Muthanna in 2019 was 1,450,947 MWh[41].

d. Transmission and Distribution Networks:

As of 2019, in Muthanna there is 23 conversion stations (11/33) KV with the total 998 M.V.A capacity in distribution networks and 237 nos. of 11 KV Lines with the total 2,962 km length and 40 nos. of 33 KV Lines with the total 307 km length and 5,494 nos. of transformers 0.4,11 KV with the total 1,917 M.V.A capacity. The highest peak load achieved in the Muthanna governorate was recorded as 427 MW on 21 July 2019, and as shown in **Figure 2.33**, in 2018 the supplied electricity was 350 MW which is only 60 % of the required compared to the required load rate of 582 MW[41].

[39] MOE Plan & Renewable Energy Plan
[40] MWD
[41] Samawa Combined Cycle Gas Turbine Power Plant Project, Environmental and Social Impact Assessment (ESIA) Report, September 2018
[42] The future vision of the Ministry of Electricity for energy_low-carbon
[43] Annual Statistical Report 2019, Department of Informatics and systems, Central Statistics Branch



Source: Annual Statistical Report 2019, Department of Informatics and systems, Central Statistics Branch

Figure 2.33 Average Required and Supplied Load

(3) Drainage and sewerage

1) Iraq

According to the 2015 statistics, the proportion of the population with access to sewage services (excluding the Anbar and Nineveh provinces) was 83.7%. The highest proportion of the population with access to the sewage system is in the provinces of Baghdad (Mayoralty of Baghdad), Missan, and Najaf.

By the end of 2016, the proportion of people with access to sewer systems in Baghdad Province (Mayoralty of Baghdad and the province) was 75.9%, while 24.1% did not have access, including many non-residential and farmlands.

There is still a gap in the proportion of people with access to sewage systems in the provinces except Baghdad, with the proportion of the total population with access to sewage networks amounting only to 28.4%[32].

2) Muthanna

As of 2022, in the southern part (Al-Soub Al-Kabier) of Samawah city in Muthanna governorate the construction of sewerage and drainage networks were almost completed. Treatment method of the existing sewerage treatment plant for Al-Soub Al-Kabier is conventional activated sludge process and it started the operation in 2012 with 37,000m3/day capacity and discharge the treated water to the Euphrates River. Newly established residential quarters like Al Hakeem Neighborhood and other new quarters only have rainwater networks. On the other hand, the northern part (Al Sawb Al Saghir) has only drainage networks and sewerage system with planned 37,501 m3/day wastewater flow for the target year in 2040 is being developed based on Design of Samawa Al-Soub Al-Saghir Sewergae and Stormwater Drainage Systems in 2010[44].

[44] Design of Samawa Al-Soub Al-Saghir Sewergae and Stormwater Drainage Systems"(Ministry of Municipalities & Public Works, Sewerage Directorate, November 2010)

(4) Waste disposal

1) Iraq

Solid waste management methods are still very old and solid waste collection in Iraq only covers urban population since municipal institutions, pursuant to Municipal Administration Act No. 165 of 1964, are not responsible for providing the service to rural areas beyond the basic borders of the municipality.

The 2014 Survey also suggests a decline of 6.9% in the access to waste collection services compared to 2012 at the level of Iraq, with a disparity among provinces. Najaf and Diyala had the highest rates of no access (59.1% and 58.8% respectively) and there was a significant disparity between rural areas (83.6%) and urban areas (22.7%)[32].

2) Muthanna

In the Muthanna Governorate, most of the head towns do not suffer from solid waste, whereas in the rural area of the governorate, solid waste seems to be hardly collected. Given this, it can be assumed that there is low collection coverage, irregular collection service, crude open dumping, and burning with low air and water pollution control[45].

[45] Structure Plan for Al Muthanna Governorate, Ministry of Municipalities & Public Works, Directorate General of Physical Planning, May 2008

Chapter 3 Outlines and Issues of the Water Sector in the Study Area

3.1 Access to Drinking Water and General Issues

Table 3.1 shows the water access in Iraq by governorate presented in the National Development Plan 2018 – 2022 (NDP 2022).

The percentage of households connected to the drinking water network reached 89.8% of the households in Iraq as a whole and it increased by 3.6 points compared to the year 2012. At the province level, in Kirkuk, Najaf, Basra, Erbil, Baghdad, and Diwaniah, it covers more than 90%, while Thi-Qar and Muthanna recorded the lowest household use of public water network of 70.8% and 78.8%, respectively[1].

Households that are not connected to the public network use public taps, water tankers, wells, and river/canal/stream/creek. According to the social baseline surveys conducted in the Previous Study in 2016 and in the Study, there must be households who purchase water from private vendors, but NDP 2022 does not include private vendors in the table for the households' water access. It will be for the reason that the purchased water is not the major water source in terms of the volume in the households.

Table 3.1 Household Access to Drinking Water by Type of Sources in 2016

Governorate	Share of Households by Type of Drinking Water Supply (%)						
	Public Network	Public Tap	Tanker	Well	River/Canal/ Stream/Creek	Others	Total
Dohuk	82.8	15.5	0.6	0.9	0.2	0.1	100.0
Suleimaniah	88.9	0.7	0.3	8.3	1.3	0.5	100.0
Kirkuk	97.5	1.4	0.0	0.3	0.0	0.8	100.0
Erbil	95.9	.9	0.4	1.3	0.9	0.6	100.0
Nineveh	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Diyala	81.2	0.5	4.2	9.1	4.1	0.9	100.0
Anbar	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Baghdad	95.4	0.2	0.0	0.7	1.7	2.0	100.0
Babil	82.8	0.8	2.2	1.9	8.5	3.7	100.0
Kerbala	89.8	0.4	0.1	0.2	7.3	2.2	100.0
Wassit	80.7	0.1	0.4	2.3	3.9	12.6	100.0
Salah al-Din	84.9	4.6	0.7	0.9	8.2	0.7	100.0
Najaf	96.5	2.1	0.6	0.1	0.1	0.5	100.0
Diwaniah	91.6	0.0	0.0	2.9	4.7	0.8	100.0
Muthanna	78.8	4.2	6.2	2.8	6.2	1.8	100.0
Thi-Qar	70.8	3.0	0.1	3.4	22.0	0.7	100.0
Missan	80.8	0.1	0.0	0.0	18.4	0.7	100.0
Basra	96.0	2.2	0.0	0.0	1.0	0.9	100.0
Iraq	89.8	1.6	0.6	2.1	4.2	1.7	100.0

Source: National Development Plan 2018 - 2022

[1] The information on the connection to the public water services will be presented in Section 4.1.

NDP 2022 analyzed the situations of the water supply services in the whole country and identified the challenges as stated below.

- Increased losses of water because of breaking and bypassing networks and intersecting with other services. Old networks and unavailable maintenance of networks and stations in addition to the waste caused by misuse.
- The damage caused by the terrorist attacks also affected the number of served citizens..
- Lack of an integrated system to manage and organize production, maintenance, filtration, distribution, and fee processing to ensure the best performance and improve efficiency of employees to keep up with modern water project implementation technologies.
- Lack of legislation of laws that deter bypassing in various situations (on water networks, on land, etc.) and not amending and activating the existing ones.
- Delay in acquisitions and lack of financial allocations, especially when establishing strategic projects and laying carrier lines.
- Electricity fluctuation and interruption, although most of the projects, power stations, and complexes are excluded from programmed power cut.
- The contamination of the Tigris is due to the dumped waste and not cleaning it from the sediments as well as the loss of water level. As a result, pollutants increase which made drawing water to purification projects' sockets even harder.
- Insufficient private sector involvement and weak experience of local companies in the implementation of water projects.

3.2 Institution

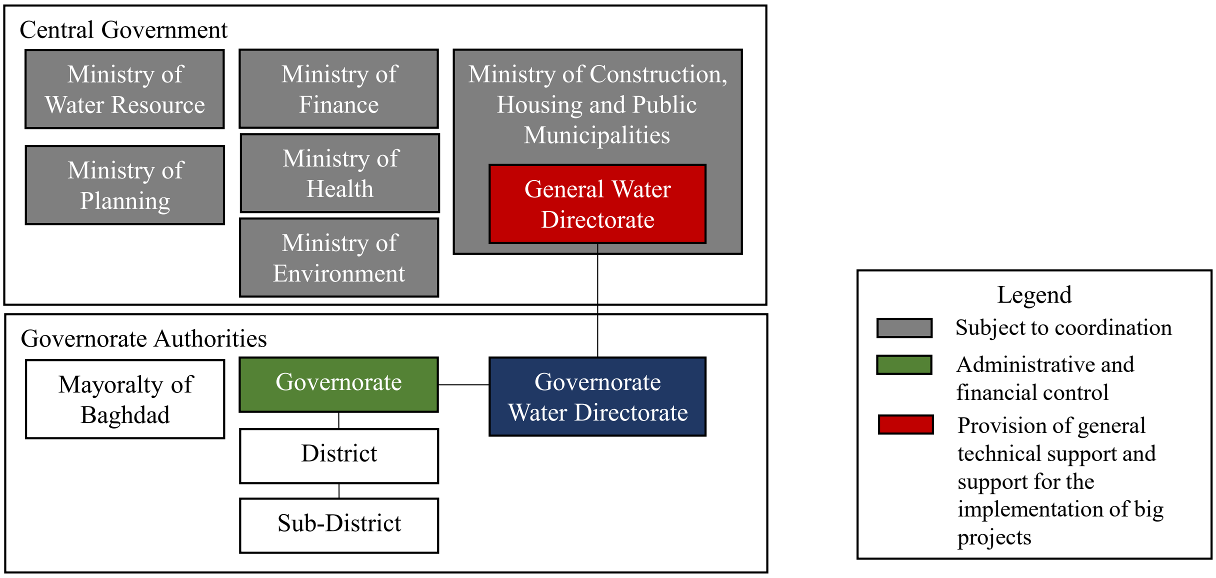
3.2.1 Organizations Involved in the Development and O&M of Waterworks

(1) General

The key organizations involved in the development and O&M of waterworks in Iraq are shown in **Figure 3.1**.

The General Water Directorate (GWD) of MCHPM has the responsibility for the development and implementation of policies and plans related to waterworks and water supply service throughout Iraq. While the Ministry of Water Resource, the Ministry of Planning, the Ministry of Finance, the Ministry of Health, and the Ministry of Environment are the ministries that need coordination with MCHPM in developing and implementing water projects.

At the governorate level, the governorate water directorate in each governorate is responsible for the provision of water supply service and each governorate mainly controls its governorate water directorate for the administrative and financial aspects, while GWD supports the governorate water directorates for the technical aspects, as well as provides support for the implementation of large-scale water projects.



Source: JICA Study Team

Figure 3.1 Organizations Involved in Waterworks

(2) Central government organizations

1) Ministry of Construction, Housing, and Public Municipalities (MCHPM)

MCHPM oversees the citizen services including water, sewerage, and local administration throughout Iraq that are outside of the boundaries of the Mayoralty of Baghdad. It also formulates policies, conducts budget management, and executes projects to develop and improve water supply system.

2) Ministry of Water Resources (MWR)

MWR is in charge of the overall management of water resources (surface water and underground water) in Iraq. The main operations include preservation of water resources, construction of dams and irrigation facilities, flood control, and management of underground water. It is the ministry in charge of water resource management in Iraq, which is directly connected to the development of water supply projects.

3) Ministry of Planning (MOP)

MOP is in charge of the investigation, research, and formulation of development plans that contribute to the economic and social development of Iraq. It has the authority to give the final approval of the water projects which are planned and developed by MCHPM.

4) Ministry of Finance (MOF)

MOF is responsible for the public finance of Iraq, Central Bank of Iraq, and banking regulations. It has the authority to give the final approval for the budget of the water projects which are planned and developed by MCHPM.

5) Ministry of Health

The Ministry of Health is responsible for all national health issues such as dealing with epidemics, conducting inspections on food and water suppliers, establishing and managing healthcare institutions, and ensuring access of Iraqi citizens to adequate healthcare services. In addition, it regulates the discharge of industrial and commercial contaminants to public water resources.

6) Ministry of Environment (MOEn)

MOEn is in charge of overall operation on the environmental management regarding hygienic environment, biodiversity, and natural and cultural assets (heritages). It implements the development of related laws and regulations, and various standards in addition to the formulation of policies regarding environmental conservation. It has the authority to investigate, inspect, and order the review of projects regarding those that are expected to receive unfavorable environmental impacts through the implementation of EIA.

(3) Governorate branches of central government organizations

The ministries have their branch offices at the governorate level that function as the service directorate of each ministry.

The MCHPM has its governorate directorates for the core services such as construction, maintenance, and improvement of streets, bridges, public parks, waterworks, and sewerage. The governorate water directorate is one of them, which is located in the capital of each governorate and responsible for the O&M of waterworks in each governorate.

(4) Local government organization (governorate, district and sub-district)

There are 18 governorates in Iraq and they are further divided into districts and sub-districts. The Baghdad Governorate is the most populous governorate with around 8,559,000 people in 2020, while the Muthanna Governorate is the least populated one with less than 858,000 people in the same year.

The governor is the highest-ranking official in the governorate, which is the largest administrative unit. Under the governor, the head of the districts called as "qaimaqam" has the authority to control the management operations in the districts, while the sub-district managers have the similar authority in the management operations in the sub-districts. As indicated in Sub-section 2.1.3 (2), the sub-districts are not part of any district, but they are subject to the districts. This means that the decisions by the sub-district manager should not conflict with the decisions of the district[2].

3.2.2 General Water Directorate and Governorate Water Directorate

Based on Law No. 27 of 1999 of the General Directorate for Water and Sewerage, the GWD was created in the Ministry of Municipalities and Public Works (currently MCHPM), under which the governorate water directorate was also established in each capital of the 18 governorates, as the arm of GWD at the governorate level. The Muthanna Water Directorate (MWD) is one of them and is responsible for the management of the water supply system in the Muthanna Governorate.

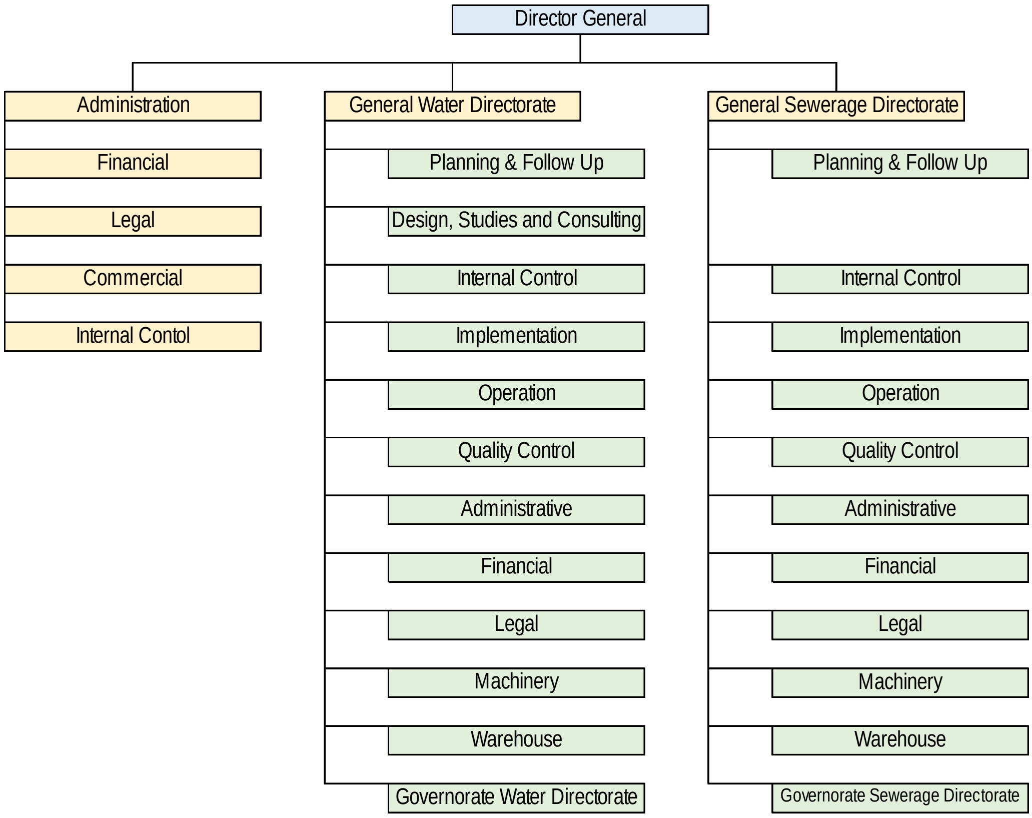
GWD aims to provide and equip drinking water throughout Iraq (outside the boundaries of the Mayoralty of Baghdad) as needed and in accordance with long-term planning, considering economic, social, and health development. To achieve this purpose, GWD is responsible for implementing, managing, and maintaining water projects:

- Conduct surveys and studies in its field of activity.
- Propose annual, and medium- and long-term plans.
- Follow-up the implementation of decisions and plans.
- Supervise the implementation of the plans and work of the departments affiliated to it.

Initially, MWD was put under the direct control of GWD, but then the Iraqi government decided to delegate the management of service directorates like MWD to the local government, e.g., Muthanna Governorate. However, MCHPM through GWD still has some connections between them especially on technical issues. Moreover, MCHPM supports the implementation of big projects financially and technically, while the local government, e.g., Muthanna Governorate, is responsible for the governorate water directorate, e.g., MWD, for its administrative and financial management (such as salaries, budget for O&M, fees, wages, etc.).

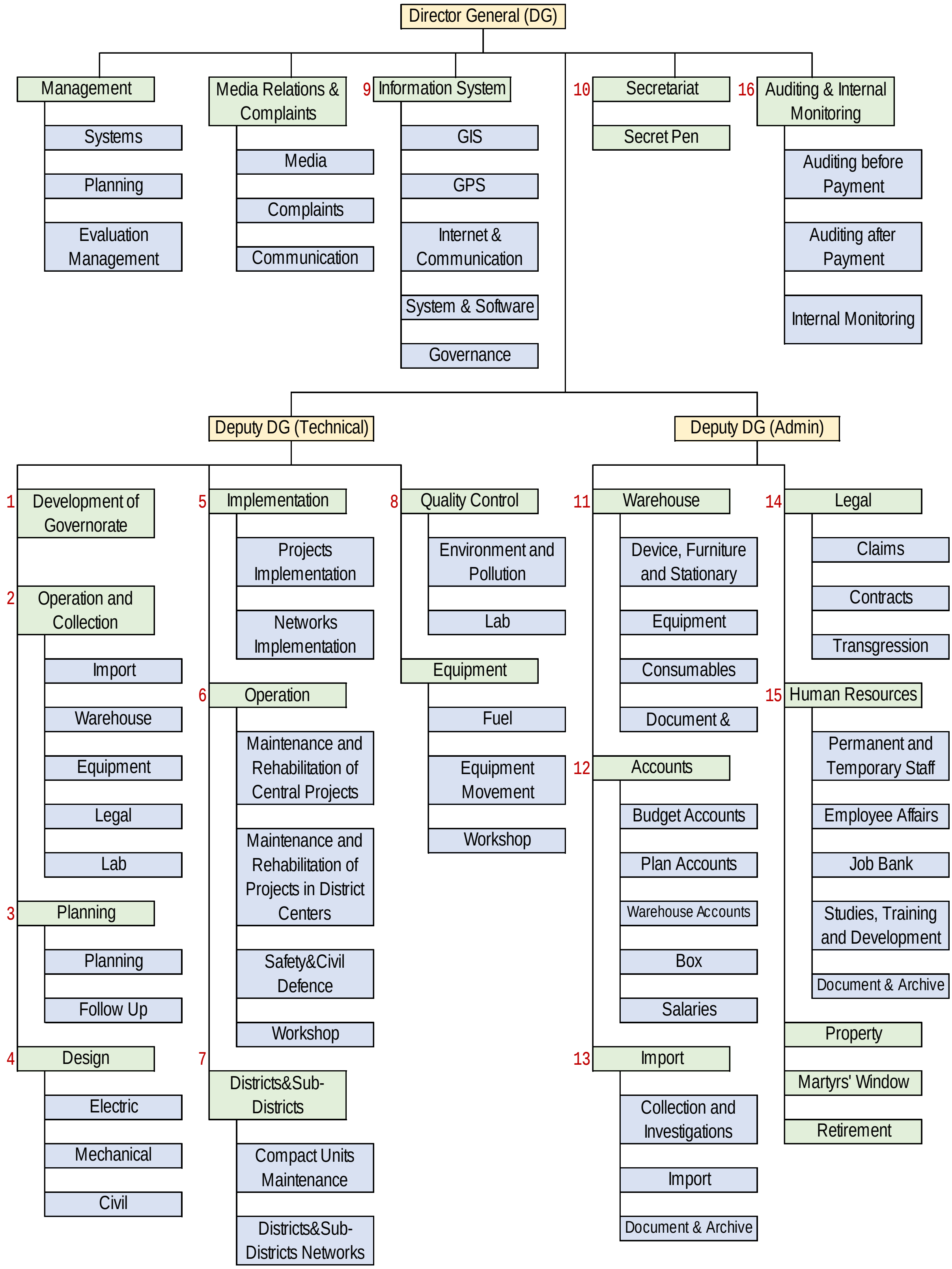
The structure of GWD is specified in the "Instructions for the Divisions and Tasks of the General Directorate for Water and Sewerage" (2000) as shown in **Figure 3.2**, while the organogram of MWD and the main tasks of key departments are shown in **Figure 3.3** and **Table 3.2,** respectively. The O&M of waterworks is conducted by the Operation and Collection Department of MWD with the support of the Operation Department. In case a big (called central) project includes O&M phase executed by the contractor, technical transfer from the contractor to MWD staff (consisting of around 1,400 permanent and temporary employees) on the O&M is conducted before the final handover of the constructed waterworks to MWD.

[2] Clause 6, 3rd Amendment of Regional Law No. 21 in 2008, issued in 2018



Source: Instructions for the Divisions and Tasks of the General Directorate for Water and Sewerage (2000)

Figure 3.2 Structure of General Directorate for Water and Sewerage



Source: JICA Study Team

Figure 3.3 Organogram of Muthanna Water Directorate as of November 2022

Table 3.2 Main Tasks of Key Departments of Muthanna Water Directorate

No.	Department	Main Tasks
1	Development of Governorate	Provide the Governorate with required works and duties; Coordinate the formation of supervision and monitoring committees.
2	Operation and Collection	Work within each district to hand over the requests of citizens to the Directorate including O&M works to fix malfunctions.
3	Planning	Handle everything related to the plans of investment budget and regional development; Follow up the implementation status of projects and compact units.
4	Design	Study and analyze technical and design problems and find solutions; Develop designs for new networks.
5	Implementation	Follow up, implement, and supervise projects, new water compacts units, and network replacement.
6	Operation	Develop, supervise, and follow up maintenance plans for projects; Rehabilitate central project facilities.
7	Districts and Sub-Districts	Develop maintenance plans of the compact units; Follow up the O&M and rehabilitation of the compact units, networks, and generators.
8	Quality Control	Conduct chemical, physical, and bacteriological tests in conformity with standard specifications.
9	Information System	Follow up the work of all central systems in coordination with the other sections; Develop the required programs for the Directorate's work.
10	Secretariat	Manage the office of Director General with all the work that requires organizing the entry of employees and auditors to the office of Director General.
11	Warehouse	Organize the work of warehouses of the Directorate; Keep records, enter and exit the materials supplied to the Directorate.
12	Accounts	Exchange and deposit cash through daily operations; Prepare monthly and annual budgets; Prepare payrolls.
13	Import	Receive collected amounts, deposit them to the bank, and send a statement of receipts issued to the Directorate.
14	Legal	Represent the Directorate before courts, judicial bodies, and committees; File lawsuits related to, and defend the rights of the Directorate.
15	Human Resources	Manage vacations, rewards, penalties, delegations, transfer, retirement transactions, circulars, bonuses, and promotions of the employees.
16	Auditing and Internal Monitoring	Audit the disbursement reports related to the activity of the Directorate; Check the execution of the work of projects; Check the advances; Check the registration of and exchange bonds and sukuk (Islamic bonds).

Source: MWD

The demarcation of responsibilities between GWD and MWD at the stages of construction and O&M of projects is shown in **Table 3.3**. For the project in which the capacity of the constructed plant is more than 4,000 m^3/d, both GWD and MWD are responsible for the planning, detailed design, and project implementation, while MWD is responsible for its O&M. For the project of in which the capacity of the constructed plant is not more than 4,000 m^3/d, MWD is responsible for the planning, detailed design, project implementation, and O&M.

Table 3.3 Responsible Entity at Construction and O&M Stages

Capacity of Plant	Planning, D/D and Project Implementation	O&M	Note
More than 4,000 m^3/d	GWD and MWD	MWD	-
Not more than 4,000 m^3/d	MWD	MWD	Compact units are applied to this category

Source: GWD and MWD

3.3 Legal Framework

3.3.1 Legal Framework for Water Supply Service

In addition to Law No. 27 of 1999 of the General Directorate for Water and Sewerage, the following laws are related to water supply service in Iraq, namely the Constitution of Iraq 2005, the Law No. 25 of 1967 on the Maintenance of Rivers and Public Water from Pollution, and the Law No. 2 of 2001 on Water Resources Conservation, of which outline is overviewed below, but there is no law governing and regulating the water supply service.

(1) The Constitution of Iraq 2005

The Constitution of Iraq 2005 intended to create a federal system in which the region (currently there is only one region in Iraq, which is Iraqi Kurdistan) is granted wider autonomy.

Article 110 enumerates the nine matters on which the federal government shall have exclusive authorities. Among these, Matter No. 8 prescribes 'Planning policies related to water sources from outside Iraq and guaranteeing the rate of water flow to Iraq and its distribution inside Iraq in accordance with international laws and conventions'.

While Article 114 enumerates the seven matters on which competencies shall be shared between the federal authorities and regional authorities. Among these, Matter No. 7 prescribes 'to formulate and regulate the internal water resources policy in a way that guarantees their just distribution and this shall be regulated by law'. For the four matters among the seven matters, namely, management of customs, environment policy, public health policy, and education policy, the federal government and the regional government are required to consult with the governorates except Iraqi Kurdistan before formulating respective policies. On the other hand, for the three matters, namely, regulating power sector, development planning, and internal water resources policy, the consultation with governorates is not required.

The internal water resources policy which guarantees their just distribution stipulated in Matter No. 7 of Article 114 above shall be interpreted to be inclusive of not only the allocation of water resources conducted by the Ministry of Water Resources, but also the construction of water purification plants and wastewater treatment plants conducted by MCHPM. It is because if polluted water is distributed, it is hardly said to be a 'just' distribution. Based on this Matter No. 7 of Article 114, new legislation including the water supply law and the sewerage law may be promulgated in the future.

(2) Law No. 25 of 1967 on the Maintenance of Rivers and Public Water from Pollution

This federal law prescribes related regulations regarding water discharge to public water bodies and sewerage system. Article 7 prohibits the discharge of polluted wastewater to public water bodies. Article 10 prohibits illegal dumping of solid and liquid waste to public water bodies. The law also prescribes the national water quality standard and the effluent water quality standard.

(3) Law No. 2 of 2001 on Water Resources Conservation

This federal law prescribes the regulations of general water utilization including environmental water resource conservation and provides the regulations of water resource development. The central government recognizes water as a fundamental thing for economic and social development. The law stipulates prohibition of wastewater discharge to public water bodies and recycled utilization of wastewater. Article 5 prescribes that the Council for Environmental Protection and Improvement has the authority to regulate the effluent water quality standard for public water bodies, sewage networks, and rainwater networks.

3.3.2 Water Quality Standard

(1) Drinking water quality standard

The Drinking Water Quality Standard of Iraq (IQS 417) is shown in **Table 3.4**.

Table 3.4 Quality Standard for Drinking Water (IQS 417)

No.	Parameter	Maximum Permissible Limit
Natural Characteristics		
N-1	Color	10 units
N-2	Turbidity (NTU)	5 units
N-3	Taste	Acceptable
N-4	Smell	Acceptable
N-5	pH value	6.5-8.5
Chemical Characteristics		
C-1	Arsenic (As)	0.01 mg/L
C-2	Cadmium (Cd)	0.003 mg/L
C-3	Chrome (Cr)	0.05 mg/L
C-4	Cyanide (CN^-)	0.02 mg/L
C-5	Fluoride (F^-)	1.0 mg/L
C-6	Lead (Pb)	0.01 mg/L
C-7	Mercury (Hg)	0.001 mg/L
C-8	Nitrate (NO_3^-)	50 mg/L
C-9	Nitrite (NO_2^-)	3 mg/L
C-10	Selenium (Se)	0.01 mg/L
C-11	Aluminum (Al)	0.2 mg/L
C-12	Chloride (Cl)	250 mg/L
C-13	Copper (Cu)	1.0 mg/L
C-14	Total Hardness (as $CaCO_3$)	500 mg/L
C-15	Iron (Fe)	0.3 mg/L
C-16	Manganese (Mn)	0.1 mg/L
C-17	Sodium (Na)	200 mg/L
C-18	Total Dissolved Solids (TDS)	1,000 mg/L
C-19	Sulphate (SO_4^{2-})	250 mg/L
C-20	Zinc (Zn)	3.0 mg/L
C-21	Calcium (Ca)	50 mg/L
C-22	Magnesium (Mg)	50 mg/L
C-23	Barium (Ba)	0.7 mg/L
C-24	Nickel (Ni)	0.02 mg/L
C-25	Carbon-Chloroform Extract	0.3 mg/L
C-26	Industrial Detergents	0.3 mg/L
C-27	Phenolic Compounds	0.002 mg/L
Biological Characteristics		
B-1	Coliform (100 mL after 24 hr at 35 °C)	<1.1
B-2	E. Coli (100 mL after 24 hr at 44 °C)	<1.1
B-3	E. Coli (250 mL after 24 hr at 35 °C)	Zero
B-4	Plate Count (1 mL after 24 hr at 35 °C)	Zero

No.	Parameter	Maximum Permissible Limit
Pesticides		
P-1	Organic Chlorine	0.7 mg/L
P-2	Organic Phosphorous	0.000005 mg/L
P-3	Multi-Chloro-Diphenolic	0.001 mg/L
Radiation		
R-1	Total Alfa Radiation	0.1 Becquerel/L
R-2	Total Beta Radiation	1 Becquerel/L

Source: Central Organization for Quality Control and Standardization, Council of Ministers, Republic of Iraq (2001), "Drinking-Water Standard IQS: 417".

(2) Water quality standard for public water bodies

Based on the provisions of Article 16 on the "Law No. 25 of 1967 on the Maintenance of Rivers and Public Water from Pollution", the water quality standard for water sources (public water bodies such as rivers, canals, springs, wells, and lakes) is defined as shown in **Table 3.5** in the Instruction No. 80406 of 1980 and the correction of the instructions as published in the Official Gazette No. 2763 of 17-3-1980. Maximum permissible limit is defined for 45 parameters (actually for 32 parameters because no limit is defined for 13 parameters) in four categories of water bodies.

Table 3.5 Water Quality Standard for Water Sources

No.	Item	Unit	Maximum Permissible Limit			
			A-1 rivers and their tributaries and branches	A-2 main and secondary streams, canals, and their branches	A-3 springs, wells, and groundwater	A-4 lakes, basins, and other water complexes
1	Color	-	Natural			
2	Temperature	-	-			
3	Suspended materials (SS)	-	-			
4	pH	-	-	6.5-8.5		
5	Dissolved Oxygen (DO)	mg/L	-	More than 5.0		
6	BOD_5	mg/L	-	Less than 3.0		
7	COD (Cr_2O_7 method)	mg/L	-			
8	Cyanide (CN^-)	mg/L	0.02			
9	Fluoride (F^-)	mg/L	As exists naturally			0.2 or as exists naturally
10	Free Chlorine (Cl_2)	mg/L	Trace			
11	Chloride (Cl^-)	mg/L	As exists naturally			200 or as exists naturally
12	Phenol (C_6H_6O)	mg/L	0.005			
13	Sulphate (SO_4^{2-})	mg/L	200			
14	Nitrate (NO_3^-)	mg/L	50	15		
15	Phosphate (PO_4^{3-})	mg/L	0.4	0.4	0.1	0.4
16	Ammonium (NH_4^+)	mg/L	-	1.0		
17	DDT	mg/L	Nil			
18	Lead (Pb)	mg/L	0.05			
19	Arsenic (As)	mg/L	0.05			
20	Copper (Cu)	mg/L	0.05			
21	Nickel (Ni)	mg/L	0.05			
22	Selenium (Se)	mg/L	0.01			
23	Mercury (Hg)	mg/L	0.001			
24	Cadmium (Cd)	mg/L	0.005			

No.	Item	Unit	Maximum Permissible Limit			
			A-1 rivers and their tributaries and branches	A-2 main and secondary streams, canals, and their branches	A-3 springs, wells, and groundwater	A-4 lakes, basins, and other water complexes
25	Zinc (Zn)	mg/L	0.5			
26	Chromium (Cr)	mg/L	0.05			
27	Aluminum (Al)	mg/L	0.1			
28	Barium (Ba)	mg/L	1.0			
29	Boron (B)	mg/L	1.0			
30	Cobalt (Co)	mg/L	0.05			
31	Iron (Fe)	mg/L	0.3			0.5
32	Manganese (Mn)	mg/L	0.1			
33	Silver (Ag)	mg/L	0.01			
34	Total Hydrocarbons	mg/L	-			
35	Sulfide (S^{2-})	mg/L	-			
36	Ammonium (NH_4^+)	mg/L	-			
37	Ammonia gas (NH_3)	mg/L	-			
38	Sulfur dioxide (SO_2)	mg/L	-			
39	Petroleum alcohol	mg/L	-			
40	Calcium carbide (CaC_2)	mg/L	-			
41	Organic solvents	mg/L	-			
42	Benzene (C_6H_6)	mg/L	-			
43	Chlorobenzene (C_6H_5Cl)	mg/L	0.1	-		
44	TNT	mg/L	0.5	-		
45	Bromine (Br)	mg/L	-			

Source: Instructions Issued under the Maintenance System of Rivers and Public Water from Pollution (Instructions No.80406 of 1980) and the correction of the instructions as published in the Official Gazette No. 2763 of 17-3-1980.

(3) Wastewater quality standard

The Instruction No. 80406 of 1980 and the correction published in the Official Gazette No. 2763 of 17-3-1980 mentioned above also stipulate the wastewater quality standard as shown in **Table 3.6**. Maximum permissible limit is defined for 45 parameters (same as the water quality standard shown in **(2) Table 3.5** but for 40 parameters because no limit is defined for 5 parameters). The receiving water bodies are categorized into two (water source and public sewerage system) and thus, the brine discharged from desalination plants to agricultural drainage canals is not subject to the regulation.

Table 3.6 Wastewater Quality Standard

No.	Item	Unit	Maximum Permissible Limit	
			B-1 Wastewater discharged to water source	B-2 Wastewater discharged to public sewerage system
1	Color	-	-	
2	Temperature	-	Less than 35 °C	45 °C
3	Suspended Solids (SS)	-	60	750
4	pH	-	6-9.5	
5	Dissolved Oxygen (DO)	mg/L	-	
6	BOD_5	mg/L	Less than 40	1000
7	COD (Cr_2O_7 method)	mg/L	Less than 100	-
8	Cyanide (CN^-)	mg/L	0.05	0.5
9	Fluoride (F^-)	mg/L	5.0	10.0

No.	Item	Unit	Maximum Permissible Limit	
			B-1 Wastewater discharged to water source	B-2 Wastewater discharged to public sewerage system
10	Free Chlorine (Cl_2)	mg/L	Trace	100
11	Chloride (Cl^-)	mg/L	• If the ratio of 'amount of wastewater/ amount of water source' is 1/1000 or less, it is allowed to increase the concentration in the source by 1% of the normal concentration in the source before discharging. • If the ratio of 'amount of wastewater/ amount of water source' is more than 1/1000, the concentration of chlorides in the discharged water should not exceed 600 mg/L. • If the concentration of chloride in wastewater is less than 200 mg/L, each case shall be examined separately by the authority responsible for implementing the system.	-
12	Phenol (C_6H_6O)	mg/L	0.05	0.5
13	Sulphate (SO_4^{2-})	mg/L	• If the ratio of 'amount of wastewater/ amount of water source' is 1/1000 or less, it is allowed to discharge water to the source in a concentration and in quantities that lead to an increase in the sulfate concentration in the source by 1% of the natural concentration in the source before discharging. • If the ratio of 'amount of wastewater/ amount of source water' is more than 1/1000, the concentration of sulfate in the discharged water should not exceed 400 mg/L. • If the concentration of sulfate in the source water is less than 200 mg/L, it should be examined on a case-by-case basis by the authority responsible for implementing the system.	300
14	Nitrate (NO_3^-)	mg/L	50	-
15	Phosphate (PO_4^{3-})	mg/L	3.0	-
16	Ammonium (NH_4^+)	mg/L	-	
17	DDT	mg/L	Nil	-
18	Lead (Pb)	mg/L	0.1	
19	Arsenic (As)	mg/L	0.2	0.05
20	Copper (Cu)	mg/L	0.2	-
21	Nickel (Ni)	mg/L	0.05	0.1
22	Selenium (Se)	mg/L	0.005	-
23	Mercury Hg)	mg/L	0.01	0.001
24	Cadmium (Cd)	mg/L	2.0	0.1
25	Zinc (Zn)	mg/L	0.1	
26	Chromium (Cr)	mg/L	5.0	0.1
27	Aluminum (Al)	mg/L	40	20

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Item</th><th rowspan="2">Unit</th><th colspan="2">Maximum Permissible Limit</th></tr>
<tr><th>B-1
Wastewater discharged to water source</th><th>B-2
Wastewater discharged to public sewerage system</th></tr>
<tr><td>28</td><td>Barium (Ba)</td><td>mg/L</td><td>1.0</td><td>0.1</td></tr>
<tr><td>29</td><td>Boron (B)</td><td>mg/L</td><td colspan="2">1.0</td></tr>
<tr><td>30</td><td>Cobalt (Co)</td><td>mg/L</td><td colspan="2">0.5</td></tr>
<tr><td>31</td><td>Iron (Fe)</td><td>mg/L</td><td>2</td><td>15</td></tr>
<tr><td>32</td><td>Manganese (Mn)</td><td>mg/L</td><td>0.5</td><td>-</td></tr>
<tr><td>33</td><td>Silver (Ag)</td><td>mg/L</td><td>0.05</td><td>0.1</td></tr>
<tr><td>34</td><td>Total Hydrocarbons</td><td>-</td><td>• To the water sources A-3 and A-4, no hydrocarbons should be discharged.
• To the water sources A-1 and A-2:
- 10 mg/L if the rate of the ‘amount of discharged water/ amount of water resource’ is equal to or less than 1/1000 under continuous river flow.
- 5 mg/L if the rate of the ‘amount of discharged water/ amount of water resource’ is equal to or less than 1/500 under continuous river flow.
- 3 mg/L if the rate ‘amount of discharged water/ amount of water resource’ is equal to or less than 1/300 under continuous river flow.</td><td>-</td></tr>
<tr><td>35</td><td>Sulfide (S^{2-})</td><td>mg/L</td><td>-</td><td>3.0</td></tr>
<tr><td>36</td><td>Ammonium (NH_4^+)</td><td>mg/L</td><td>-</td><td>10.0</td></tr>
<tr><td>37</td><td>Ammonia gas (NH_3)</td><td>mg/L</td><td>-</td><td>6.0</td></tr>
<tr><td>38</td><td>Sulfur dioxide (SO_2)</td><td>mg/L</td><td>-</td><td>7.0</td></tr>
<tr><td>39</td><td>Petroleum alcohol</td><td>mg/L</td><td>-</td><td>Not allowed</td></tr>
<tr><td>40</td><td>Calcium carbide (CaC_2)</td><td>mg/L</td><td>-</td><td>Not allowed</td></tr>
<tr><td>41</td><td>Organic solvents</td><td>mg/L</td><td>-</td><td>Not allowed</td></tr>
<tr><td>42</td><td>Benzene (C_6H_6)</td><td>mg/L</td><td>-</td><td>0.5</td></tr>
<tr><td>43</td><td>Chlorobenzene (C_6H_5Cl)</td><td>mg/L</td><td colspan="2">-</td></tr>
<tr><td>44</td><td>TNT</td><td>mg/L</td><td colspan="2">-</td></tr>
<tr><td>45</td><td>Bromine (Br)</td><td>mg/L</td><td>-</td><td>1-3</td></tr>
</table>

Note: The limit values of B-1 are larger than those of B-2 in some items from No.14 to No.45, but these are according to the original provision of the instructions No.80406 of 1980 and its correction No. 2763 of 17-3-1980.

Source: Instructions Issued under the Maintenance System of Rivers and Public Water from Pollution (Instructions No.80406 of 1980) and the correction of the instructions as published in the Official Gazette No. 2763 of 17-3-1980.

3.4 Financial Situations

3.4.1 Tariff Level

The water tariff level is regulated by MCHPM, and the same tariff levels are levied in the middle and southern part of Iraq including the Baghdad Metropolitan Aera. There are three user categories which are domestic users, business users and governmental users.

(1) Tariff level without meter (fixed tariff)

Water tariff without meter for domestic user is shown in the following **Table 3.7**, which has not been modified since March 2015, while a modification is being discussed to coincide with the commencement of the meter installation project[3].The tariff is based on the number of rooms and the invoice is sent bimonthly.

Table 3.7 Current Water Tariff of Domestic Users

(unit: IQD)

No. of Rooms	Monthly Tariff	Maintenance Fee	Total Monthly Fee	Total Tariff per Two Months
2-3	2,460	1,000	3,460	6,920
4-5	4,560	1,000	5,560	11,120
6-7	6,650	1,000	7,650	15,300
8 -10	8,760	1,000	9,760	19,520

Source: MWD

The consumptions of business users and governmental users are estimated based on the formula shown in **Table 3.8** and **Table 3.9,** respectively. Tariff rates for business users and governmental users are regulated at IQD 150/m^3 and IQD 120/m^3 and those rates are multiplied to the estimated consumptions to calculate the billing amount. Consumption by business users are estimated based on the numbers of hotel rooms, restaurant area, etc.. Consumptions by governmental users are calculated based on the diameters of connection pipes from the water network to the users.

Table 3.8 Calculation Method of Water Consumption for Business Users

Business Type	Estimated Daily Consumption
Hotel	Number of rooms with toilet x 0.5 m^3/day Number of room without toilet x 0.25 m^3/day With restaurant / kitchen: + 5.0 m^3/day Garden 100 m^2: + 0.5 m^3/day
Restaurant	Area of less than 30 m^2: 10.0 m^3/day Area of more than 30 m^2: 15.00 m^3/day
Tourist Casino	15.0 m^3/day
Toilet	Number of toilet x 3.0 m^3/day
Car Repair Garage	Number of Car Lot x 15.0 m^3 /day (governorate center), 10.0/8.0 m^3/day (District center)
Ice Factory	15 molds: 1 m^3/day

Source: MWD

Table 3.9 Calculation Method of Water Consumption for Governmental Users

Diameter	Daily Consumption (m^3/day)	Diameter	Daily Consumption (m^3/day)
1/2 inch	13	80 mm	540
3/4 inch	30	100 mm	845
1.0 inch	50	150 mm	1,940
1.5 inch	120	200 mm	3,380

[3] See Section 3.5 for the water meter project.

Diameter	Daily Consumption (m^3/day)	Diameter	Daily Consumption (m^3/day)
2.0 inch	210	300 mm	5,225
2.5 inch	360	350 – 1,200 mm	7,555-122,350

Source: MWD

To the water users of all categories who are connected to the sewerage service, the amount of the invoice is doubled as the tariff of sewerage service is the same as that of the water supply service.

(2) Tariff level with meter (tariff per consumption)

As described later in Section 3.5, the meter installation project started in Samawah in November 2022. The increasing block tariff rates per consumption shown in **Table 3.10** are planned to be applied to the users after meter installation. Range of tariff rates for residential users is around IQD 100/m^3 to 180/m^3. Tariff rates for commercial and governmental users are under evaluation. Along with this, as mentioned above, the tariff increase for households without water meters is also being discussed.

Table 3.10 Planned Block Tariff Rate for Residential Users

Number	Consumption	Tariff Rate
1st block	0-30 m^3/month	IQD 100 /m^3
2nd block	31 - 60 m^3/month	IQD 120 /m^3
3rd block	61 – 90 m^3/month	IQD 140 /m^3
4th block	91 – 120 m^3/month	IQD 160 /m^3
5th block	More than 121 m^3/month	IQD 180 /m^3

Source: MWD

(3) Tariff level of supply by water tankers

As described in Section 4.4.3, most people who are not connected to the piped water service are supplied by water tankers. For domestic users supplied by water tankers, two different tariff rates are charged according to the treatment type which are IQD 1,500/m^3 for normal filtered water and IQD 3,000/m^3 for RO water. The tariff is paid at each time of the service. For business and governmental users, RO water is provided at higher tariff rate at IQD 5,000/m^3, and the bill is collected monthly.

3.4.2 Number of Connections and Tariff Collection

MWD has 51 bill collectors and 35 officers in the whole service area to manage tariff billing and collection, of which 21 collectors and 21 officers are deployed in Samawah District. Tariff collection is implemented by paper base and not recorded or controlled electrically.

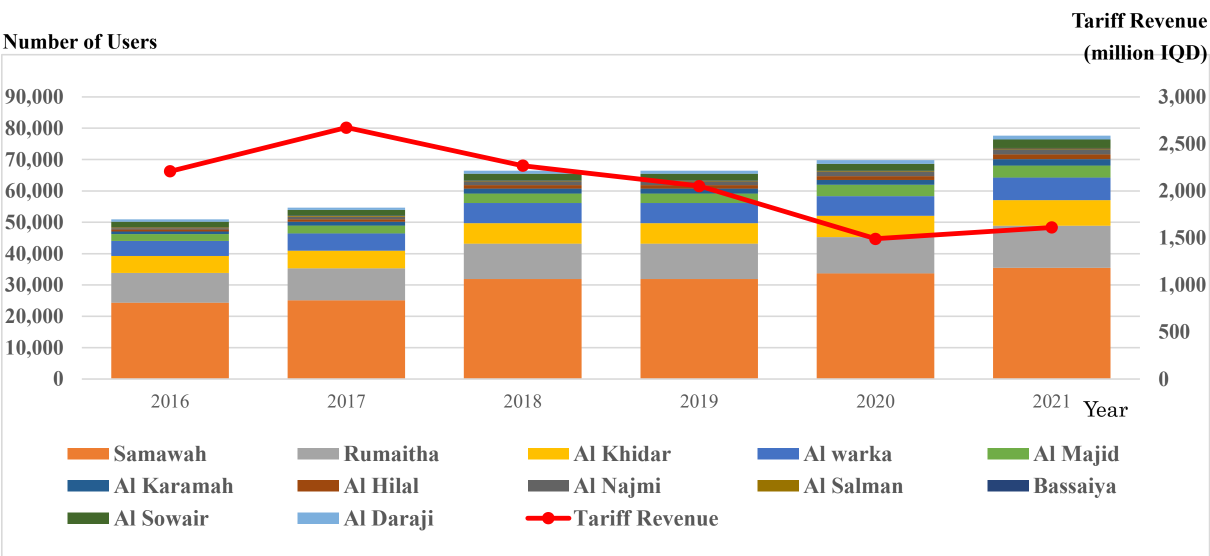
History of user number (households and other categories of users) and revenue amount in the latest six years is shown in **Table 3.11** and **Figure 3.4**. Number of users gradually increased to 77,627 in 2021, whereas the total amount of tariff revenue has decreased since 2017 from IQD 2.7 billion to 1.5 billion.

To evaluate the data closely, JST requested the provision of revenue amount and collection rate per user category to MWD; however, the data was not available because of the lack of information. According to MWD staffs, the main reason of revenue reduction is the influence of COVID-19. It is assumed that the recent increase of tariff collection works with insufficient number of personnel and constraints in the tariff collection activities during the epidemic are the main reasons for the worsening collection rate.

Table 3.11 History of Number of Users and Tariff Revenue

District/Sub-distric	2016	2017	2018	2019	2020	2021
Samawah	24,354	25,112	31,906	31,906	33,646	35,430
Rumaitha	9,480	10,153	11,259	11,259	11,603	13,438
Khidar	5,424	5,696	6,544	6,544	6,782	8,140
Warkaa	4,764	5,489	6,420	6,420	6,351	7,192
Majid	2,261	2,507	3,070	3,070	3,534	3,894
Karamah	819	1,235	1,517	1,517	1,574	2,033
Hilal	579	731	1,138	1,138	1,246	1,551
Najmi	449	832	1,142	1,142	1,265	1,537
Salman	285	290	292	292	313	339
Bassaiya	76	76	76	80	131	136
Sowair	1,663	1,850	2,062	2,062	2,217	2,695
Daraji	741	723	1,044	1,044	1,154	1,242
Total Number of Users	**50,895**	**54,694**	**66,470**	**66,474**	**69,816**	**77,627**
Tariff Revenue (million IQD)	**2,209**	**2,673**	**2,268**	**2,052**	**1,491**	**1,612**

Source: MWD



Source: JICA Study Team

Figure 3.4 History of Number of Users and Tariff Revenue

3.4.3 Financial Condition of MWD

Table 3.12, **Figure 3.5,** and **Figure 3.6** show the profit and loss statements of MWD in the latest three years estimated from the budget data provided from MWD. Total revenue of MWD varies from IQD 18 billion to IQD 22 billion in the latest three years. Tariff revenue takes only 8.6% of the total revenue on average, while the rest of the revenue is mostly subsidy from the central government. It clearly shows that water supply service highly depends on the subsidy granted from the government. Total expenditures vary from IQD 28 billion to IQD 31 billion during the same period and MWD is continuously making a financial loss of IQD 9.5 billion on average during the latest three years which corresponds to 47.8% of the average total revenue.

"Annual profit/loss excluding depreciation" is calculated to exclude the influence of capital cost which is basically subsidized by the government. The figures were positive in 2019 and 2020 but dropped to negative at IQD 1.5 million in 2021, influenced by the increase of O&M cost and service cost.

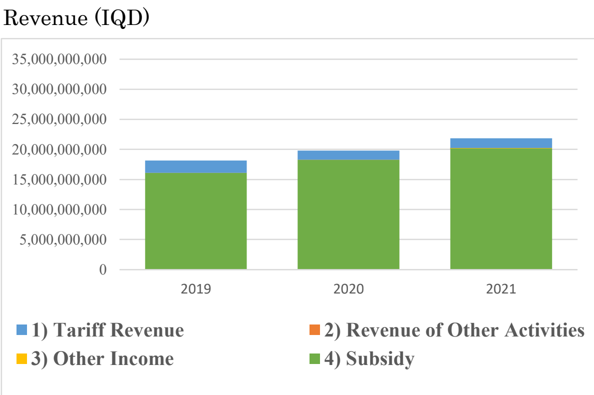
From the evaluation above, it becomes clear that MWD cannot afford to pay the capital cost for large-scale projects. In addition, the total O&M cost is higher than the total revenue in 2021 and the increase of both tariff revenue and subsidy amount is needed to continue the water supply services.

Table 3.12 Estimated Profit and Loss Statement of MWD

(Unit of amounts: Million IQD)

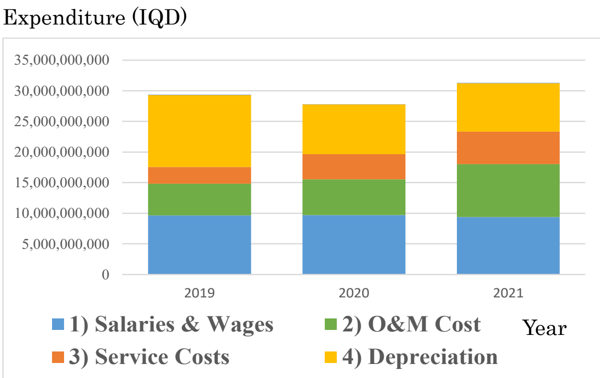
District	2019	2020	2021	Average	Share
Revenue	**18,141.7**	**19,788.7**	**21,866.8**	**19,932.4**	**100.0%**
1) Tariff Revenue	2,051.8	1,491.2	1,611.9	1,718.3	8.6%
2) Revenue of Other Activities	3.9	2.0	3.2	3.0	0.0%
3) Other Income	0.0	0.0	114.1	38.0	0.2%
4) Subsidy	16,086.0	18,295.5	20,137.5	18,173.0	91.2%
Expenditures	**29,326.8**	**27,813.1**	**31,256.6**	**29,465.5**	**100.0%**
1) Salaries & Wages	9,646.6	9,707.3	9,381.7	9,578.5	32.5%
2) O&M Cost	5,195.5	5,839.9	8,648.0	6,561.2	22.3%
3) Service Costs	2,715.8	4,089.9	5,307.5	4,037.7	13.7%
4) Depreciation	11,742.9	8,166.4	7,903.4	9,270.9	31.5%
5) Other expenses	26.1	9.6	16.1	17.2	0.1%
Profit/Loss	**-11,185.2**	**-8,024.4**	**-9,389.9**	**-9,533.2**	
Profit/Loss without Depreciation	**557.7**	**142.0**	**-1,486.5**	**-262.3**	

Source: MWD



Source: JICA Study Team

Figure 3.5 Revenue of MWD



Source: JICA Study Team

Figure 3.6 Expenditure of MWD

3.4.4 Participation of Private Entities

In this subsection, the legal framework and past projects related to private participation in Iraq are explained.

In 2006, GOI issued Investment Law No. 13, 2006[4] to attract foreign investment in Iraq including for public services. Based on this law, the National Investment Commission (NIC) was established in 2007, as prescribed in Section 2.3.4, to serve as promoter, facilitator, and policy advisor for investment. Provision of land, license, soft loans, tax exemption, etc. to investors is allowed after the approval of the NIC.

According to the World Bank's database, Private Participation in Infrastructure (PPI), there were 12 PPP

[4] The law was amended in 2010 and 2015.

projects in Iraq that started since 2007. Project type, starting year of project, and investment amount per sector of such projects are summarized in **Table 3.13**, in which six projects are in electricity sector, four projects are in port sector, and two projects are in ICT sector.

Table 3.13 Implemented or Ongoing PPP Projects in Iraq

Sector	Number of Projects	Project Type and Starting Year of Project	Investment Amount (USD million)
Electricity	6	BOT (2007), BOO (2008,2010,2013,2009), BROT (2016)	2,220
Port	4	BROT (2010), BOO (2014,2017), Lease (2021)	950
ICT	2	BOT (2013,2015)	130

Source: PPI database, World Bank Group

Out of the 12 PPP projects, only the latest port project called “Umm Qasr Terminal 2” was implemented through solicited process led by the public side, while the other 11 projects were implemented by unsolicited process. This lease type project in the port sector is awarded to the private company through competitive bidding for 25 years since 2021. The International Finance Corporation (IFC) and JICA have been supporting the project by means of technical assistance and financing which amounts to USD 125 million (IFC: USD 85 million, JICA: USD 40 million through Private Sector Investment Fund).

Considering the past project’s experience, there is a possibility of utilizing private financing in the water supply sector. However, high profitability and stable economic and political condition should be ensured to attract private partners.

3.4.5 Willingness to Pay for Water Tariff of Residents and Affordability to Pay

(1) Households’ expenditures for water

Table 3.14 shows the main points of payment for water based on the results of social survey in the Study and that in the Previous Study in 2016.

Majority of the households pay for water from the MWD network from IQD 12,000 (JPY 1,224) to IQD 24,000 (JPY 2,448)/month in the questionnaire in 2022 but they pay less than IQD 6,000 (JPY 612)/month for water from the MWD network in 2016. However, JST estimates that the respondents answered their amounts for two month payments for the water from MWD including sewerage tariff based on the surveyor’s information, as they receive the bills bimonthly for the water and sewerage[5].

Therefore, JST assumes that majority of the households pay for water from the MWD network for IQD 3,880 (JPY 396)/month which was calculated based on the basic water tariff for the average number of rooms for the household and maintenance fee.

[5] See Table 3.7 for the tariff system of MWD.

Table 3.14 Main Points of Payment for Water of Social Survey of this Project and that in 2016

Item	Region	Results in 2016	Results in this Project
Payment of household for water from MWD network (Social Survey Report p. 22, 39)	Urban	IQD 6,000 (JPY 612) /month or below: 36%	IQD 12,000 to 24,000 (JPY 1,224 to 2,448) for 2 months*: 49%
	Rural	IQD 6,000 (JPY 612) /month or below: 25%	IQD 12,000 to 24,000 (JPY 1,224 to 2,448) for 2 months: 60%
Average payment of household for water from MWD network (JST)	Urban	IQD 9,000 (JPY 918) for 2 months*	IQD 3,880 (JPY 396) /month**
	Rural	IQD 6,000 (JPY 612) for 2 months*	IQD 3,880 (JPY 396) /month**
Average payment of household for private vendor (Social Survey Report p. 23, 39)	Urban	IQD 17,675 (JPY 1,803) /month	IQD 17,475 (JPY 1,782) /month
	Rural	IQD 11,900 (JPY 1,214) /month	IQD 17,525 (JPY 1,788) /month

*Note: They receive bills bimonthly, so JST assumed that they were amount of two months payment for water and sewerage for MWD.

**Note: JST's estimation

Source: JICA (2016) "Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq", JICA Survey Team (2022)

(2) Willingness to pay

The willingness to pay (WTP) based on the social survey in the Study is explained in **Table 3.15** and **Figure 3.7** with comparison with the WTP based on the social survey executed in 2016.

According to the social survey in the Study, around 80% of the households confirmed that they are willing to pay more than 20% for 1) improved flow conditions, 2) continuous water supply, 3) improved water quality, and 4) improved water service. The amount of the increased tariff based on average payment is IQD 6,984 (JPY 712)/month/household. Since around 63% of respondents pay more than IQD 6,000 in 2016, the WTP increases to around 1.2 times.

This indicates that, if the Project is properly managed, the WTP may increase to more than IQD 6,984 (JPY 712)/month/household according to the average water volume per capita at 156 Lpcd[6] and to the average member of household at 6.4 people in the social survey. WTP per m^3 is calculated as follows:

156 Lpcd x 30 days x 6.4 people/1,000 = 30.0 m^3

WTP per m^3 = IQD 6,984/30.0 m^3 = IQD 233/m^3

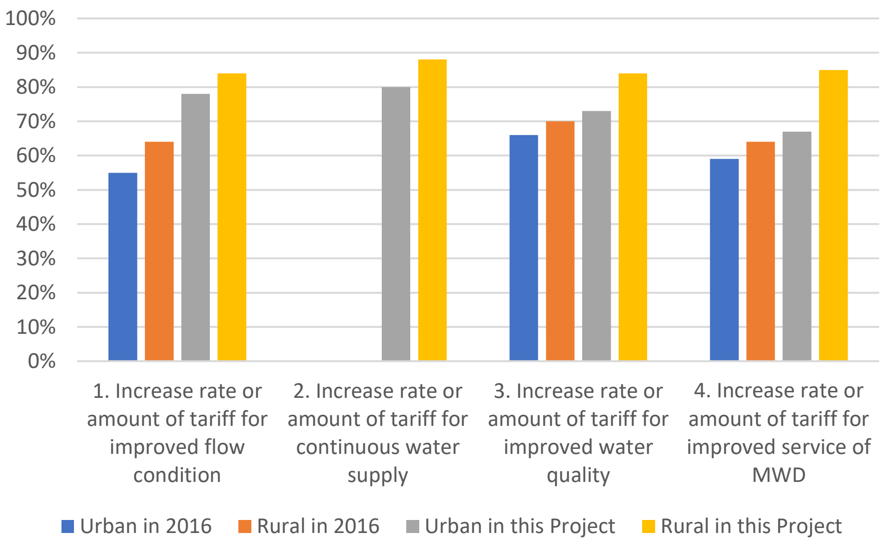
Therefore, WTP is IQD 233/m^3.

[6] See Table 4.3 for the water volume per person per day.

Table 3.15 Comparison of WTP of Social Survey of this Project (2022) and that in 2016

Item	Region	Results in 2016	Results in the Study	
1. Increase rate or amount of tariff for improved flow condition per household	Urban	55% of respondents pay more than IQD 6,000 (JPY 612)/month	78% of respondents pay more than 20%	Amount of increased tariff based on average payment is IQD 4,656 (JPY 475) /month.
	Rural	64% of respondents pay more than IQD6 ,000 (JPY 612) / month	84% of respondents pay more than 20%	
2. Increase rate or amount of tariff for continuous water supply	Urban	-	80% of respondents pay more than 20%	Amount of increased tariff is same as above.
	Rural	-	88% of respondents pay more than 20%	
3. Increase rate or amount of tariff for improved water quality per household	Urban	66% of respondents pay more than IQD 6,000 (JPY 612) / month	73% of respondents pay more than 20%	Amount of increased tariff is same as above.
	Rural	70% of respondents pay more than IQD 6,000 (JPY 612) / month	84% of respondents pay more than 20%	
4. Increase rate or amount of tariff for improved service of MWD per household	Urban	59% of respondents pay more than IQD 6,000 (JPY 612) / month.	85% of respondents pay more than 20%	Amount of increased tariff is same as above.
	Rural	59% of respondents pay more than IQD6,000 (JPY 612) / month.	67% of respondents pay more than 20%	

Source: JICA (2016) "Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq", JICA Survey Team (2022)



Source: JICA Study Team

Figure 3.7 Comparison of Percentage of Respondents Who Pay More Than 20% Tariff Increase in this Project and IQD 6,000 in 2016

(3) Affordability to pay

As shown in **Table 3.16**, the affordability to pay (ATP) was calculated at IQD 767/m^3 as 4% of the average monthly income of the households. It is a much higher level than the price level of the current situation.

Average monthly income was obtained by the social survey results in the Study and the average monthly water volume per household is assumed 30.0m^3 based on the calculation above. The benchmark of affordability to pay for water supply is 4%[7] of the household income. ATP is around 3.3 times of WTP. JST assumes WTP is low based on past experiences of low water tariff in Iraq.

Table 3.16 Calculation of ATP

Average Monthly Income	Benchmark of Affordability to Pay for Water Supply	Average Monthly Water Usage per Household	ATP
IQD 575,522	4%	30.0 m^3	IQD 575,522 x 0.04/30.0 m^3= IQD 767/m^3

Source: JICA Study Team

[7] Japan International Cooperation Agency (2002) “Study on Economic Evaluation Methodologies for Development Studies”

3.5 Meter Installation Project

In October 2022, the Government of Iraq started a water meter installation project in all governorates except for Kurdistan Region under the initiative of MCHPM (GWD) as follows (See **Figure 3.8** for the photos related to the project):

- The Al-Janoob Islamic Bank for Investment and Finance was selected as the investor under the scheme of Design, Build, and Maintenance Module (DBM).
- The investor is to procure and install approximately 2.5 million water meters during the period from 2022 to 2027 for 5 years. In Muthanna Governorate, 63,000 water meters will be allocated, of which 13,000-15,000 will be for Samawah District. The installation work started in the week of November 6, 2022. A total of 2.5 million meters will be adjusted based on the result of the service connection survey, and thus the allocated number of 63,000 meters to be installed in Muthanna Governorate may also be adjusted accordingly.
- Assuming the number of meters to be installed in Muthanna Governorate is kept as the initial 63,000, the installation rate will be 79% of the current users in Muthanna Governorate (79,648[8]) after successful installation). MWD has the policy to put the highest priority to Samawah District so that its installation rate will reach 100%, while other districts may remain less than 100%.
- The investor will update the customer inventory that MWD has, as well as recover the invested cost in the next 15 years (until the year 2037). The incomes of the investor are the meter installation fee at IQD 60,000 per meter and the commission fee for each water, sewerage, and municipal bill amounting to IQD 3,000 for commercial and industrial real estates, IQD 2,500 for agricultural and government properties, and IQD 2,000 for residential properties. The water meter installation fee is collected at the same time as the bi-monthly water tariff payment and it can be paid in six installments. The commission fee is exempted when the invoice amount of the water tariff is less than IQD 1,000.
- The investor will hire and train collectors cum meter readers who will be transferred to MWD after the expiration of the contract in November 2037, in addition to the existing collectors of MWD.
- The investor will design and develop an integrated software system that converts arithmetic and paper operations into electronic transactions (paying at ATMs and governorate sales branches or by credit card), with an integrated financial settlement system that accepts financial audit which will initially start as a pilot in three governorates (Karbala, Diyala, and Kirkuk).
- The investor will supply smart electronic reader devices that contain modern electronic applications which enable to accurately read the meters with portable printers to issue an invoice on site and a magnetic scanner to read all kinds of electronic cards for electronic payment and to transfer the readings directly to the data collection and database center in GWD.
- In the meantime, the German Agency for International Cooperation (GIZ) has offered to develop a billing system to be installed in GPS tablet device in a project signed in 2022 and to be completed by 2024. But the scope seems duplicated with the meter installation project and thus

[8] See Table 4.2 for the number of the connections in Samawah Governorate.

coordination will be necessary.

Source: MWD captured by the JICA Study Team

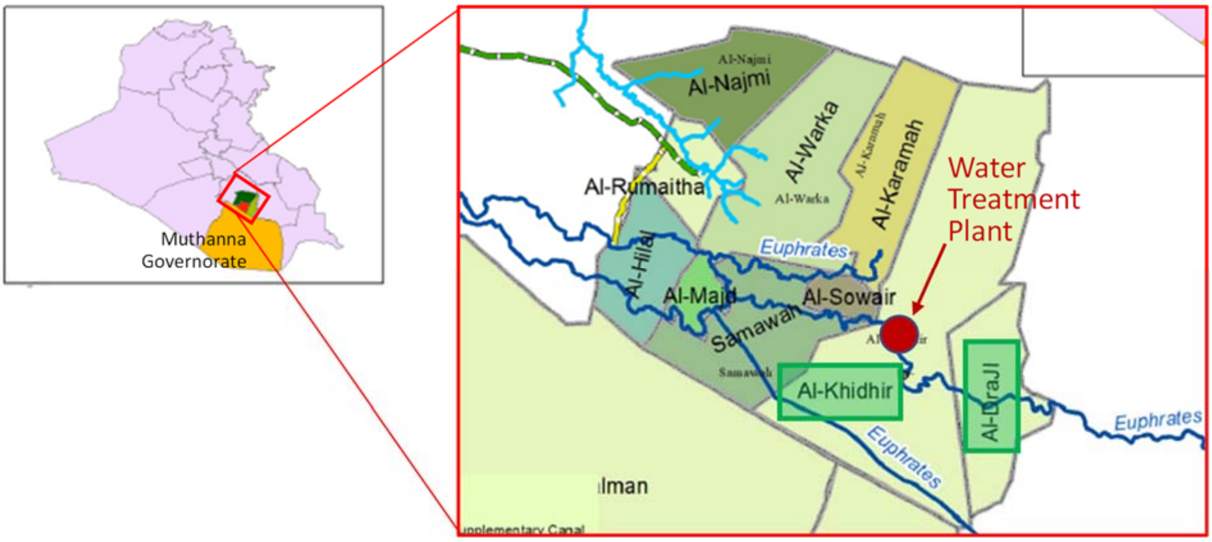
Figure 3.8 On-site Status of Meter Installation Project

3.6 Assistances by Japan and Other Donors

In the southern region of Iraq, bilateral and multilateral financial assistances are provided in various sectors. Among the assistance projects, the most relevant project to the Project is the Water System Project for Al Khidir and Al Daraji (hereinafter referred to as "Al Khidir Water Project"), funded by the German state-owned investment and development bank KfW.

As shown in **Figure 3.9** and **Table 3.17**, the project will construct a water treatment plant (WTP) with RO facilities and include the modernization and extension of the water distribution system in Khidir District and Daraji Sub-district. The WTP will be located at the bank of the Euphrates River in Khidir District, which is 32 km south or downstream along the Euphrates River from Samawah District. The brine from the WTP will be discharged at the East Euphrates Drainage Channel in the similar way to the Project in Samawah District.

In November 2022, the signing ceremony of the financial agreement was carried out. Construction of the WTP will be completed in 2027, which will be followed by the contractor's O&M work for one year that may be extended to two years.



Source: Pre-feasibility Study – Water System Al Khidir and Al Daraji, KfW, August 2022, arranged by the JICA Study Team

Figure 3.9 Location of Water System Project for Al Khidir and Al Daraji by KfW

Table 3.17 Outlines of Water System Project for Al Khidir and Al Daraji by KfW

Item	Descriptions	Descriptions
1) Project component	Water treatment plant	Capacity: 31,000 m^3/day Process: coagulation – flocculation – multi-layer filtration – RO – remineralization - chlorination
	New network	74.6 km
	Network extension	29.1 km
	House connections	18,000 nos.
	Pumping stations	13 nos.
	Elevated reservoirs	13 nos. with a total storage capacity of 2,900 m^3
2) Project cost		EUR 76,322,430
3) Schedule	Construction	2027
	O&M services by the contractor	One year until 2028, may be extended to 2029

Source: Pre-feasibility Study – Water System Al Khidir and Al Daraji, KfW, August 2022

3.7 Issues in the Water Sector

According to the analyses on the basic conditions of the study area presented in Chapter 2 and on the present situations in the water sector presented in this chapter, JST raises certain issues in the water sector in Iraq and in the study area as stated below.

(1) Technical aspects

- Registration rate to the public piped water services in Iraq is generally high (about 90%) but there are some governorates where the registration rate remains at less than 80%. Expansion of the service coverage with geographical integrality is needed.
- Water loss in the water supply system is not well controlled, while water stress is becoming more severe due to the growing population and increase in the salinity in the water bodies. Water security by increasing the water production capacities as well as improvement of water loss management are needed.

(2) Economic and financial aspects

- Water supply service highly relies on governmental subsidy. There is a possibility that investment and operating budget of the water supply service would be reduced when economic condition worsens, and oil revenue is reduced. The water sector needs to secure sufficient budget based on a long-term vision.
- As the water tariff level is retained low, the total water revenue could not even cover the O&M cost of the water supply service. Current financial stability of water supply service is low. A combination of subsidies from the government for the time being and raising of the tariff is needed.
- Fixed rate is charged to water users (not per consumption) and it induces inefficient use of treated water. Introduction of metered rate is necessary.

(3) Institutional and organizational aspects

- There are no technical manuals, standards, and SOPs in MWD and no comprehensive reports have been prepared to assess the O&M status of the waterworks and the performance of MWD. MWD has been facing difficulties to oblige the customers to pay the water tariff and their arrears because of the lack of legal basis. Although the meter installation project mentioned in Section 3.5 started and the selected investor will conduct the meter reading and billing until 2037 after the installation of water meters of the customer, the legal framework to govern the water supply service is needed to define the scope of the water supply service and the rights, duties, and penalties of service providers, users, and other stakeholders; to monitor and evaluate the performance of service providers; and to develop technical standards and guidelines.
- The joint and split control of MWD by GWD and Muthanna Governorate is hampering the integrated management of the water supply service from upstream planning and construction to downstream O&M. Thus, the integrated management of MWD by Muthanna Governorate or phased provision of administrative, technical, and financial independency to MWD is needed to enhance effective and efficient decision-making and customer-oriented approach.

- The experiences and competencies of MWD employees are not enough in the construction management and O&M of large-scale waterworks such as desalination plants. Thus, provision of practical training to MWD employees is needed.
- Computer software is not prevalent in MWD, particularly in the customer management field, which hampers the efficient daily operation. Thus, digitization needs to be accelerated to enhance the efficiency and accuracy of customer management and other services of MWD. The meter installation project includes the development of integrated billing system software, which can be an impetus to the digitalization of the business process in MWD.

Chapter 4 Outlines and Issues of the Existing Water Supply System in the Study Area

4.1 Outlines of the Existing Water Supply System

4.1.1 Service Level

(1) Service level in Muthanna Governorate compared with the other governorates

Table 4.1 shows the coverage of the public water supply services[1] by governorate in 2015 and per capita per day volume of drinking water in 2016. The latest data after 2016 was not provided.

The coverage in Muthanna Directorate remained at 68.8%, which is the second worst coverage among all directorates, while the national coverage was 78.7%. In addition, the drinking water volume per person in Muthanna Governorate (289 Lpcd) is one of the worst with Diala and Babil governorates.

Table 4.1 Registration Rate of Public Water Supply Services and Water Volume in Iraq by Governorate

Governorate	Registration Rate (%) in 2015			Per capita per day Drinking Water Volume (Lpcd) in 2016*
	Urban	Rural	Overall	
Dahuk/central	80	65	79.3	377
Dahuk/periphery	94	90	92.6	
Nineveh	80	70	76.3	N/A
Sulaimaniya/central	100	50	96.0	353
Sulaimaniya/periphery	75	60	71.6	
Kirkuk	100	50	85.8	354
Irbil/central	95	0	87.5	586
Irbil/periphery	55	43	76.3	
Diala	34	66	50.6	284
Anbar	82	78	79.9	N/A
Baghdad/municipality	100	0	100.0	390
Baghdad/periphery	75	55	64.1	
Babil	80	60	69.4	296
Kerbala	96	80	90.7	392
Waset	90	69	81.2	386
Salahuddin	72	38	53.0	421
Najaf	90	75	85.7	384
Qadisiya	80	65	73.5	388
Muthanna	80	60	68.8	289
Dhi-Qar	80	60	72.6	410
Messan	85	75	82.2	423
Basrah	70	60	68.0	450
Total	86.1	62.1	78.7	397

*: Per capita per day volume of drinking water: Production volume of drinking water divided by the number of population

Source: National Development Plan 2018 – 2022

[1] In Iraq, the percentage of households that are regularly connected to water services is called the Registration Rate.

(2) Registration rate and water volume in Muthanna Governorate

Table 4.2 shows the numbers of registrations (legal service connections) of the districts and sub-districts in Muthanna Governorate. Muthanna Water Directorate (MWD) is expanding the water distribution network to have new service connection as well as converting the illegal connections to registered connections, which has resulted in the rapid growth of the registration numbers.

Table 4.3 shows the registration rates and per capita water volume. The registration rates in 2021 are the JICA Study Team (JST)'s estimation based on the number of registrations and number of household members suggested by MWD[2]. The overall registration rate in the governorate is 51% and the rate in Samawah District is 60%.

The Previous Study stated that, although the registration rate was 62% in 2015, the actual connection rate was estimated at around 70%. Such "real" connection rate has not yet been confirmed in the Study. However, according to MWD, their efforts include eliminating the illegal connections so the gap between the registration rate and the connection rate will decrease.

Since 2015, the coverage has improved significantly in most districts and sub-districts, while the rates in the major cities of Samawah District and Rumaitha District are estimated to be reduced. Despite the efforts of MWD, the expansion of the water distribution network is not fast enough to improve the service coverage amid the growing population and the urban area's expansion. In addition, the Previous Study pointed out that the low service quality makes the citizens reluctant to apply for the subscription.

Table 4.2 Number of Registration by District/Sub-district in Muthanna Governorate

District / Sub-district	Number of Registration						Annual Growth Rate 2016 - 2021
	2016	2017	2018	2019	2020	2021	
Samawah District	24,354	25,112	31,906	31,906	33,646	35,430	8%
Sowair District	1,663	1,850	2,062	2,062	2,217	2,695	10%
Rumaitha District	9,480	10,153	11,259	11,259	11,603	13,438	7%
Hilal District	579	731	1,138	1,138	1,246	1,551	22%
Najmi District	449	832	1,142	1,142	1,265	1,537	28%
Majid District	2,261	2,507	3,070	3,070	3,534	3,894	11%
Waraka District	4,764	5,489	6,420	6,420	6,351	7,192	9%
Karama District	819	1,235	1,517	1,517	1,574	2,033	20%
Khidir District	5,424	5,696	6,544	6,544	6,782	8,140	8%
Daraji Sub-district	741	723	1,044	1,044	1,154	1,242	11%
Salman District	285	290	292	292	313	339	4%
Basiyah Sub-district	76	76	76	80	131	136	12%
Total	52,911	56,711	68,488	68,493	71,836	79,648	9%

Source: MWD

[2] The numbers of household members suggested by MWD are 5 in urban areas and 7 in rural areas.

Table 4.3 Registration Rate of Public Water Supply Services and Water Volume in Muthanna Governorate by District

District / Sub-district	Registration Rate		Served Population				Water Volume per Person per Day (Lpcd)*4
			2021				2021
	2015*1	2021*2	Number of Registration	Number of Family Members per HH*3	Number of Served Population	Number of Total Population	(By Total Population)
Samawah District	62%	60%	35,430	5.5	194,865	324,627	156
Sowair District	11%	34%	2,695	6.5	17,518	51,983	17
Rumaitha District	77%	56%	13,438	6.5	73,909	132,601	214
Hilal District	10%	23%	1,551	6.5	10,082	43,677	136
Najmi District	15%	26%	1,537	6.5	9,991	38,658	163
Majid District	47%	53%	3,894	6.5	25,311	47,660	156
Warka District	35%	65%	7,192	6.5	46,748	72,015	107
Karma District		40%	2,033	7.0	14,231	35,872	
Khidir District	42%	45%	8,140	5.5	44,770	99,849	176
Daraji Sub-district	21%	38%	1,242	6.5	8,073	20,971	184
Salman District	14%	21%	339	6.5	2,204	10,714	142
Basaiyah Sub-district		60%	136	6.6	748	1,247	
Total	N/A	51%	79,648	-	448,448	879,874	111

*1: Data from the Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq (2016)

*2: Estimation by JST

*3: MWD suggested that the numbers of household members are 5 in urban areas and 7 in rural areas. JST applied 5.5 to the districts where the majority is urban population and 6.5 to the districts/sub-districts where the majority is rural population. As an exception, 7 was applied to Karama Sub-district as all its population is in the rural area. See Table 5.6 for the population by urban and rural areas.

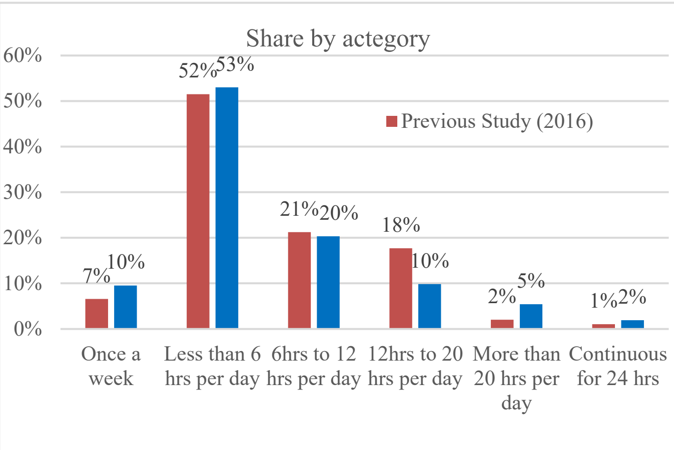
*4: Based on the actual capacity (instead of design capacity) of the water treatment facilities

Source: MWD

(3) Service continuity and water quality

According to MWD, the water supply in most areas in Samawah District is twice a day and its duration is three hours each in the morning and in the evening (6 hours in a day). In some areas, the water supply is once in two days, whose duration is only one to three hours each time. Such situations of the water supply services were confirmed by the social survey in the Study as shown in **Figure 4.1**.

Compared with the same survey in the Previous Study, as also shown in **Figure 4.1**, the service continuity does not show improvement since 2016. Particularly, about 60% of the respondents in both surveys replied that the service continuity is less than six hours.



Frequency/Continuity of Water Supply	Number of Households		Share	
	2016*1	2022*2	2016*1	2022*2
Once a week	13	30	7%	10%
Less than 6 hrs per day	102	167	52%	53%
6 hrs < per day	42	64	21%	20%
12 hrs < per day	35	31	18%	10%
20 hrs < per day	4	17	2%	5%
Continuously	2	6	1%	2%
Total	198	315	100%	100%

*1: Social survey executed in the Previous Study in 2016

*2: Social survey executed in the Study in 2022

Source: Social Survey by the JICA Study Team

Figure 4.1 Water Service Continuity of MWD based on the Social Surveys

Regarding water quality, the social baseline survey in the Study indicates that the water users are not satisfied with the quality of the water supplied by MWD as shown in **Table 4.4**. The results are similar to those in the Previous Study but currently more people seem to feel the water salty.

Table 4.4 Satisfaction Level of Water Users on MWD's Water Quality from the Social Baseline Survey

Element of Water Quality	Satisfaction Level by Percentage of the Respondents		
	Satisfied (Value in the Previous Study in 2016)	Neutral (Value in the Previous Study in 2016)	Dissatisfied (Value in the Previous Study in 2016)
1) Smell	4% (3%)	54% (15%)	42% (82%)
2) Taste	3% (3%)	61% (64%)	36% (33%)
3) Salinity	1% (3%)	37% (49%)	62% (48%)
4) Color	1% (2%)	67% (56%)	32% (42%)

Source: Social Survey in the Study and Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq and in the Study

(4) Water loss

MWD estimated the non-revenue water rate in each city in 2015 as shown in **Table 4.5**. The non-revenue water rate in Samawah City is 16%. However, it should be noted that the accuracy of the estimation is not high because flow meters and water meters are not installed.[3].

Table 4.5 Leakage Ratio by Sub-district in Muthanna Governorate in 2015

District/Sub-district	Leakage Ratio
Samawah District	42%
Sowair District	32%
Rumaitha District	42%
Hilal District	25%
Najmi District	22%
Majid District	30%
Waraka District including Karama Sub-district	32%
Khidir District	33%
Daraji Sub-district	24%
Salman District including Basaiyah Sub-district	7%

Source: Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq

4.1.2 General Configurations of the Water Supply System in Muthanna Directorate

As shown in **Table 4.6,** the water supply systems in Muthanna Governorate include one central system and a good number of decentralized systems. The central system (hereinafter referred to as "Rumaitha Water Supply System") consists of three units of water treatment plants (WTPs) located in Rumaitha District, whose total design capacity is 161,000 m^3/day, and the water transmission mains from the WTPs to various districts. The Rumaitha Water Supply System provides drinking water to all district/sub-districts in Muthanna Governorate excluding Daraji Sub-district, Salman District, and Bussaiya Sub-district.

The decentralized systems include one conventional WTP in Warka District and 113 small water treatment facilities called "Compact Unit" (CU), and the water distribution systems for the surrounding areas of Warka WTP and the CUs.

[3] See 4.5.3 for the estimation of the current situations of the water leakage.

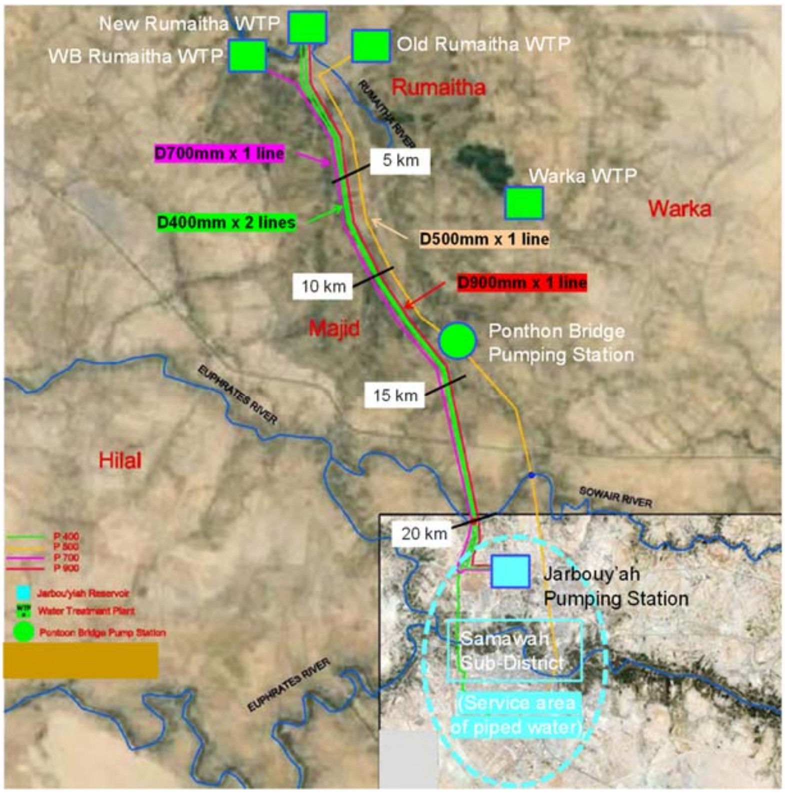
Table 4.6 Existing Water Supply Systems in Muthanna Governorate

Centralized / Decentralized	Water Treatment Facilities (Design Capacity in m³/day)		Water Source (River)	Supply Area (District/Sub-district)
Centralized system (Rumaitha Water Supply System) (Design capacity)	Rumaitha WTPs	Old Rumaitha ($33,000\ m^3$/day)	Rumaitha	Rumaitha, Majid, Warka, Najmi, Majid
		New Rumaitha ($88,000\ m^3$/day		Samawah, Rumaitha, Hilal, Khidir
		World Bank Rumaitha ($40,000\ m^3$/day)		Rumaitha, Samawah
Decentralized systems (Design capacity)	Warka WTP ($14,400\ m^3$/day)		Rumaitha	Warka
	Compact units in 113 locations ($250,810\ m^3$/day)		Euphrates, Rumaitha, Others	Each local supply area

Source: MWD

Figure 4.2 shows the general layout of the major facilities in the water supply systems in Muthanna Governorate. The figure shows the water transmission lines from Rumaitha to Samawah, along which the pipelines will distribute the water to the districts/sub-districts of Rumaitha, Warka, Majid, Hilal, and Khidir. The Old and New Rumaitha WTPs have other transmission lines of D300 mm, which are not shown in the figure, to Rumaitha and Najmi. Warka WTP supplies water to Warka District only.

Samawah District is supplied by the Rumaitha Water Supply System and CUs. The detailed information on the Rumaitha Water Supply System as well as the CUs are described in Section 4.2.



Source: Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq modified by the JICA Study Team

Figure 4.2 General Layout of the Rumaitha Water Supply System

4.2 Present Situation of Water Treatment Facilities

4.2.1 Water Treatment Plants

(1) Capacity and production

Muthanna Governorate has no major water treatment plant on the Euphrates River. The supply of drinking water in the governorate mainly depends on the Rumaitha River due to the fact that the water of the Rumaitha River has lower TDS than the water of the Euphrates River.

The major WTPs on the Rumaitha River are those of the Rumaitha Water Supply System, namely: the Old WTP, the New WTP, and the World Bank (WB) WTP, which supply water to various sub-districts including Samawah District.

As shown in **Table 4.7,** the treatment method in the three WTPs is rapid sand filtration process. Their total production is 105,000 m^3/day, while the design capacity is 161,500 m^3/day. Particularly, MWD estimates that the production of the Old and the New Rumaitha WTPs is only 60% of the design capacity because of the following:

- The limitation in the operation's duration (22 hours) caused by the operational downtime such as the backwash of the sand filters,
- Leakage from the storage tanks, pipelines, equipment, etc. in the treatment process, and
- Deterioration of the efficiencies of the pumps.

The reasons above for the low production are common in all three WTPs in Rumaitha and MWD estimates that the older treatment plants (Old and New) produce less due to their older ages. For the same reasons, in addition, MWD estimates that the present production of the water treatment plant in Warka is also approximately 60% of the design capacity (8,640 m^3/day).

Table 4.7 Existing Water Treatment Plants in Rumaitha

	Old WTP	New WTP	World Bank WTP	Total
Construction year	1962	1980	2007	-
Water source	Rumaitha River			-
Treatment process	Coagulation – Flocculation – Sand filtration – Post-chlorination			-
Design capacity	33,000 m^3/day	88,000 m^3/day	40,500 m^3/day	161,500 m^3/day
Present production	19,800 m^3/day	52,800 m^3/day	32,400 m^3/day	105,400 m^3/day
Present capacity / Design capacity	60%	60%	80%	65%
Daily operation hour	22 hours/day	22 hours/day	22 hours/day	-

Source: MWD

(2) Water quality

1) Analysis of the existing operational data provided by MWD

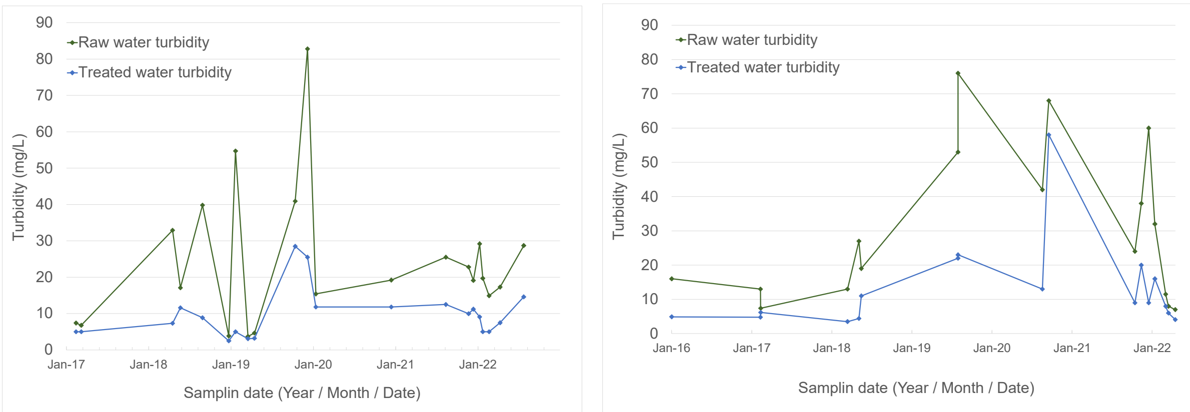
Figure 4.3 shows the turbidity, which is the most typical parameter to evaluate the performance of WTPs, of the raw water and treated water in the Old Rumaitha WTP and the New Rumaitha WTP[4]. High turbidity is greater than 5 NTU, the permissible value in the drinking water quality standard in Iraq, is often observed; particularly, the raw water's turbidity is greater than 10 NTU. In terms of turbidity, there is no significant difference in the performance between these two WTPs.

[4] The World Bank WTP's water quality has not been provided to the JICA Study Team.

In addition to the deterioration of the facilities, it is suspected that the chemical injection is not well controlled according to the raw water's quality, and the maintenance including backwash of the sand filters is not appropriately executed due to the constraints in the operational skill and O&M budget.

Another notable parameter is TDS, which is the parameter used to express the degree of salinity, shown in **Figure 4.4**. According to the Previous Study, the TDS of the Rumaitha WTPs in 2013 and 2014 was always less than 1,000 mg/L, which is the permissible limit in the Iraqi drinking water quality standard. However, in May 2018, the WTPs suffered from high TDS in the raw water at about 2,500 mg/L. TDS was kept lower than 1,000 mg/L in 2019 and 2020 but it rose again in late 2021. Since then, TDS at Rumaitha is always higher than 1,000 mg/L and it is often around 2,000 mg/L, which significantly exceeds the permissible level in the drinking water quality standard.

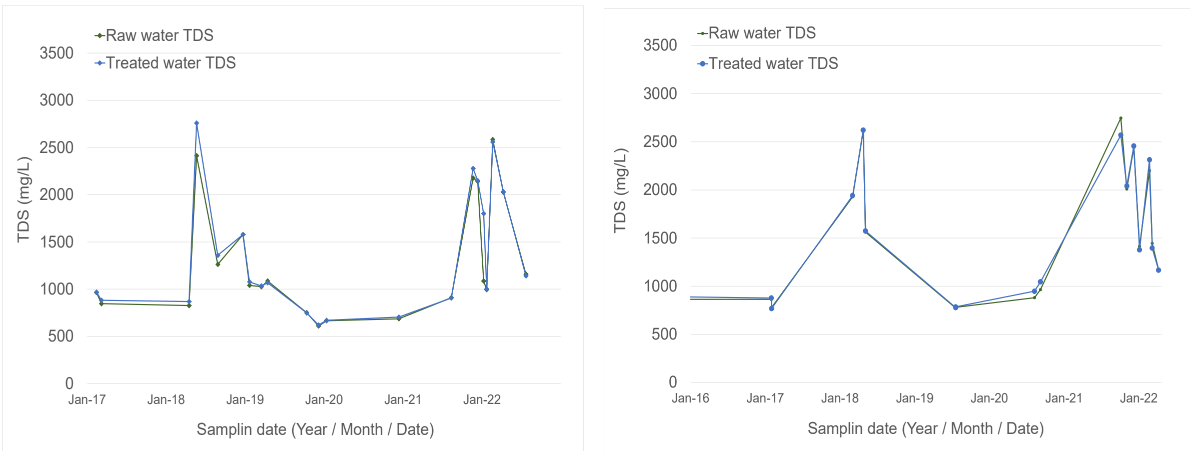
As mentioned in Sub-section 2.2.2 (3), the reasons for the rise in TDS are supposed to be the decreasing water flow in the river due to the construction of the dams, increase in evaporation due to global climate change, pollution inflows from the urban areas, and agricultural return flows, among others.



Old Rumaitha WTP New Rumaitha WTP

Source: MWD

Figure 4.3 Turbidity of the Raw Water and Treated Water in the WTPs in Rumaitha



Old Rumaitha WTP New Rumaitha WTP

Source: MWD

Figure 4.4 TDS of the Raw Water and Treated Water in the WTPs in Rumaitha

2) Findings from the site survey

On October 27, 2022, JST executed an online site survey of the water treatment plants in Rumaitha. The major findings are as follows:

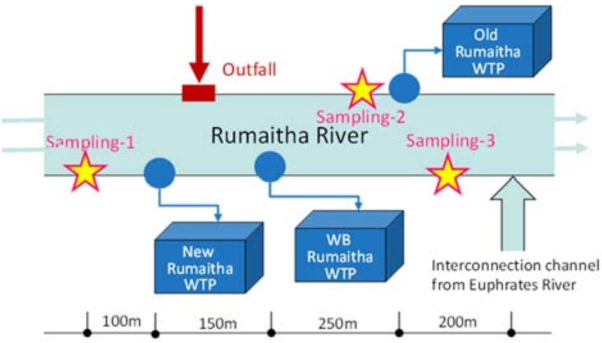
- Water quality of the raw water from Rumaitha River seems to have risk of pollution by wastewater. Detailed analysis of the quality of the raw water will be necessary. Also, water quality testing for all parameters in the Iraqi standard may be necessary.
- Old Rumaitha WTP is extremely dilapidated and needs to be completely renewed.
- New Rumaitha WTP and the WB Rumaitha WTP can be used for the time being but maintenance should be done properly to use them for a long period.
- Various mechanical and electrical equipment and instruments are out of order, which prevent appropriate water treatment. It will be a budgeting issue.

3) Possibility of pollution of the raw water

According to the situation of the river, as shown in **Figure 4.5**, and the information provided by MWD that there is an outfall on the river, JST conducted water quality survey on the river water, whose sampling points and results are shown in **Figure 4.6** and **Table 4.8,** respectively, to analyze the probability of the river's pollution by wastewater. The detailed results are shown in **Appendix 4.1**.

Source: JICA Study Team

Figure 4.5 Situation of the Rumaitha River around the Intakes of Rumaitha WTPs



Sample	Location	Objectives
1	Upstream of the outfall (and intake of New Rumaitha WTP)	To see the natural conditions of the river
2	Downstream of the outfall	To see the impact of the outfall
3	Upstream of the confluence of the Rumaitha River and the interconnection channel from the Euphrates River	To see the upward impact of the confluence with the channel of high TDS

Source: JICA Study Team

Figure 4.6 Locations of the Sampling, Intakes of Rumaitha WTPs, and the Outfall on the River

Table 4.8 Testing Results of the Samples around the Intakes of Rumaitha WTPs

Parameter	Unit	Samples on 07/11/2022			Samples on 16/11/2022			Standard Value	
		1	2	3	1	2	3	Iraq*1	Japan*2
Turbidity	NTU	37	139	48	22	77	40	-	-
TDS	mg/L	1,200	1,310	1,558	1,203	1,525	1,550	-	-
Nitrate (NO_3^-)	mg/L	5.1	8.72	-	5.67	5.84	-	50	10
Nitrite (NO_2^-)	mg/L	0.017	0.020	-	0.024	0.026	-	-	
Chloride (Cl^-)	mg/L	227	273	-	222	333	-	As naturally existing	-
Mercury (Hg)	mg/L	ND	ND	-	ND	ND	-	0.001	0.0005
Cadmium (Cd)	mg/L	ND	ND	-	ND	ND	-	0.005	0.003
Chromium (Cr)	mg/L	0.0002	0.001	-	0.001	0.002	-	0.05	0.02
Viable Bacteria	CFU/1mL	8,680	13,120	-	4,300	480	-	-	-
Total Coliform	MPN/100 mL	> 160,000	> 160,000	-	28,000	35,000	-	-	5,000*3
E. Coli	MPN/100 mL	3,300	4,900	-	13,000	35,000	-	-	-

*1: Maximum permissible limit for "A-1: Rivers and their tributaries and branches in No. 2763, 17-93-1980". See Table 3.5.
*2: Environmental Quality Standards for Water Pollution (2021) except for total coliform and E. Coli (See below). The values for "Class 3", adopted to the water resources used for drinking purpose after high grade treatment such as rapid sand filtration, are referred.
*3: Environmental Quality Standards for Water Pollution (1971), before the revision in 2021, which changed the biological parameter from total coliform to E. Coli in CFU/100 mL (1,000 CFU/mL) instead of MPN/100 mL. To enable the comparison with the tested results in MPV/100 mL, the table shows the old standard value before the revision in MPN/100 mL.

Source: JICA Study Team

As shown in the table above, as a result of water quality analysis, none of the heavy metals (mercury, cadmium, chromium) tested in this test exceeded the standard value. However, it contains extremely higher total coliform compared with the Japanese water quality standard for water resources for drinking purpose even before the outfall and it certainly increases after the outfall. In addition to the number of coliforms, chloride ions, general bacteria, and E. coli also have higher values downstream (Sample 2) than upstream (Sample 1) from the outlet. Although these results do not totally describe the water quality of the river, as the samplings were done only twice with an interval of one week, they suggest the high probability of the pollution of the Rumaitha River by wastewater from the outfall beside the intakes as well as the more upstream areas along the river.

According to the operational data of MWD, total coliform is not detected in the treated water from the WTPs but the frequency of the sampling is less than bi-monthly so that it cannot be confirmed that the tap water supplied was always safe. In addition, if the water source is contaminated with sewage, even if E. coli and general bacteria can be inactivated by disinfection, it is possible that viruses and other harmful substances are causing contamination of drinking water. Therefore, it cannot be concluded the safety.

Possible solution is to relocate the water intakes or the water treatment plant itself upward along the river. The option to relocate the intakes will require lesser investment. Although MWD deems that the right-of-way for new raw water transmission line may not be available, utilizing the existing roads will be technically feasible to link the new upstream intake(s) and the WTPs.

4) Performance of coagulation and flocculation

The carry-over of flocs from the sedimentation tank to the sand filters was observed as shown in **Figure 4.7**. The turbidity of the treated water of the WTPs often exceeds the drinking water quality standard. The performance of coagulation and flocculation may be the cause of the high turbidity of the treater water.

In addition to the fluctuation of the turbidity, a clear reason for the carry-over of the floc is that some flush mixers are out of order. The other reasons may be: 1) the chemical injection rate is not correctly determined based on jar test, 2) there is a lack of information on the water flow (deficiencies in the flow measurement), and 3) there is a problem in the chemical injection pumps.

Source: JICA Study Team

Figure 4.7 Sedimentation Tank of WB WTP

5) Deterioration of the facilities

As shown in **Figure 4.8**, the equipment and civil structures are obviously deteriorated in the Old Rumaitha WTP, whose renewal will be necessary in several to 10 years. Also, the equipment of the other WTPs will need replacement especially the flush mixers and the instruments for measurement and control.

Source: JICA Study Team

Figure 4.8 Equipment and Civil Structure of Old Rumaitha WTP

4.2.2 Compact Units (CUs)

In Muthanna Governorate, there are 113 CUs with a total design capacity of 177,430 m^3/day and a total actual production of 119,5466 m^3/day as shown as shown in **Table 4.9**. The number of CUs for Samawah District is 16. **Table 4.10** shows the characteristics of the CUs for Samawah District and **Figure 4.9** shows their locations.

In general, the performance quality of decentralized systems is difficult to manage with limited human resources and also the total O&M cost of such systems tends to be greater than that of a centralized system. MWD entrusts the O&M of the CUs to the local communities but the treated water from CUs often does not satisfy the drinking water quality standard and some of them are subject to the increase in the TDS. Therefore, MWD has an intention to decommission the CUs if a reliable centralized water supply system is established.

Table 4.9 Number and Capacity of the Compact Units in Muthanna Governorate

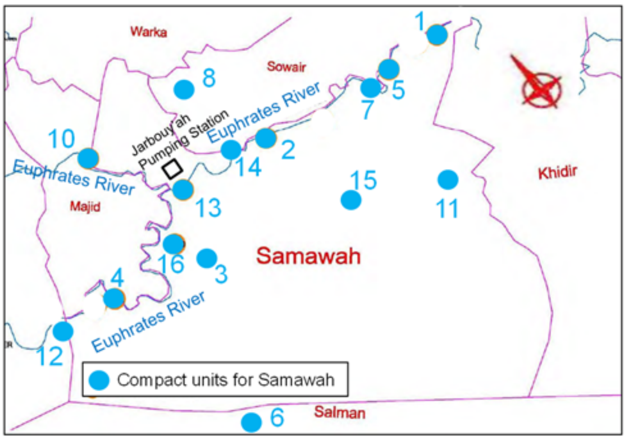
District/Sub-district	Existing CUs			CUs under Construction	
	Number of Working CUs	Capacity (m^3/day)		Number of CUs under Construction	Capacity (m^3/day)
		Design	Actual		
Samawah	16	22,540	20,286	1	9,600
Sowair	12	13,040	8,500	2	11,520
Rumaitha	19	48,490	30,320	0	0
Hilal	7	9,520	6,192	2	11,520
Najmi	10	10,464	6,808	2	6,960
Majid	7	12,000	7,744	1	5,760
Waraka	12	19,492	12,274	2	10,800
Karama	4	5,200	3,232	1	5,760
Khidir	17	28,500	18,554	1	5,760
Daraji	10	6,184	4,036	1	5,760
Salman	1	2,000	1,600	0	0
Total	113	177,340	119,546	13	73,440

Source: MWD

Table 4.10 Characteristics of the Compact Units for Samawah District

No.	Name	Year of Installation	Design Capacity (m^3/day)	Process Type	Type of Water Supply	Daily Operation (hours)	Status
1	Al Bu Sultan Al Abs	2012	800	Filtration	Pipeline	8	Works
2	Al Taha and Al Olwan	2012	1,440	Filtration	Pipeline	6	Works
3	Al Lotof and Al Nameh	2012	800	Filtration	Pipeline	8	Works
4	Al Hanaj and Al Mathboob / Al Zawiya	2012	800	Filtration	Pipeline	8	Works
5	Al Bu Majid Al Abs	2012	1920	Filtration	Pipeline	8	Works
6	Al Ameed Water	2012	0	Filtration	Pipeline	0	Stopped
7	Al Abs	2012	1440	Filtration	Pipeline	6	Works
8	Al Rofosh	2012	800	Filtration	Pipeline	8	Works
9	Al Rawawsha	2011	800	Filtration	Pipeline	8	Works
10	Abu Juwailana	2011	1920	Filtration	Pipeline	8	Works
11	Al Aseeda and Altawayel	2011	1920	Filtration	Pipeline	8	Works
12	Al /mamlaha	2010	400	Filtration	Pipeline	4	Works
13	Barboti / NO. 2	2008	6400	Filtration	Pipeline	16	Works
14	Al Basateen Al Sharqiyah	2008	1600	Filtration	Pipeline	8	Works
15	Al Owileen	2012	300	Filtration	Truck	6	Works
16	Al Shraika	2012	1200	Filtration	Truck	8	Works
Total		-	22,540	-	-	-	-

Source: MWD



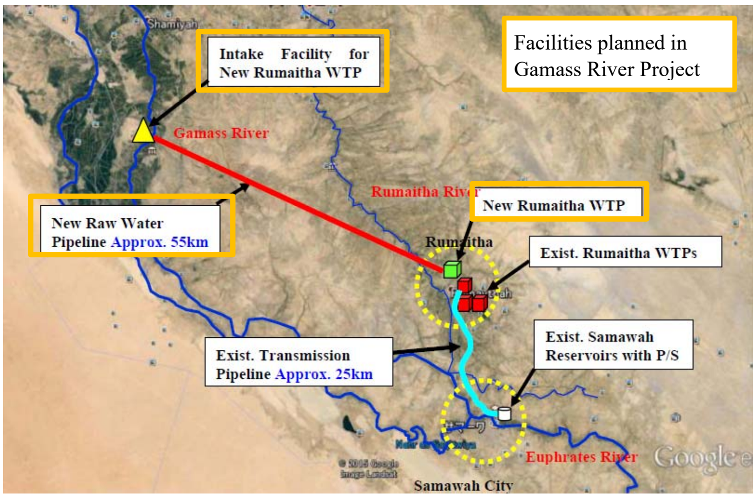
Source: MWD

Figure 4.9 Locations of the Compact Units for Samawah District

4.2.3 Ongoing Projects Relevant to the Water Supply in Samawah District (PWT Project)

As reported in the Previous Study, MWD was executing the "PWT Project[5]", which was to construct raw water intake and transmission line from the Gamass River and to construct the fourth WTP in Rumaitha as shown in **Figure 4.10**. The project was designed to draw 240,000 m^3/day of raw water but the water volume available was found to be 120,000 m^3/day at the maximum due to the low flow rate of the river.

According to MCHPM, however, the contract between MCHPM and the contractor was terminated after contractual issues arose between the two parties. The conflict awaits the final decision by the court. MCHPM has an intention to award the contract to another contractor in 2023, after the final decision. MCHPM and MWD expressed that the PWT Project will be completed before 2029 and it will allocate 44,000 m^3/day of the 120,000 m^3/day treated water to Samawah District, while the project will supply the other part of the production volume to the other districts/sub-districts in the governorate.



Source: Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq

Figure 4.10 General Layout of Gamass River Project (PWT Project)

[5] "PWT" stands for the name of the German Contractor (Prozess-Wärmeträgertechnik GmbH)

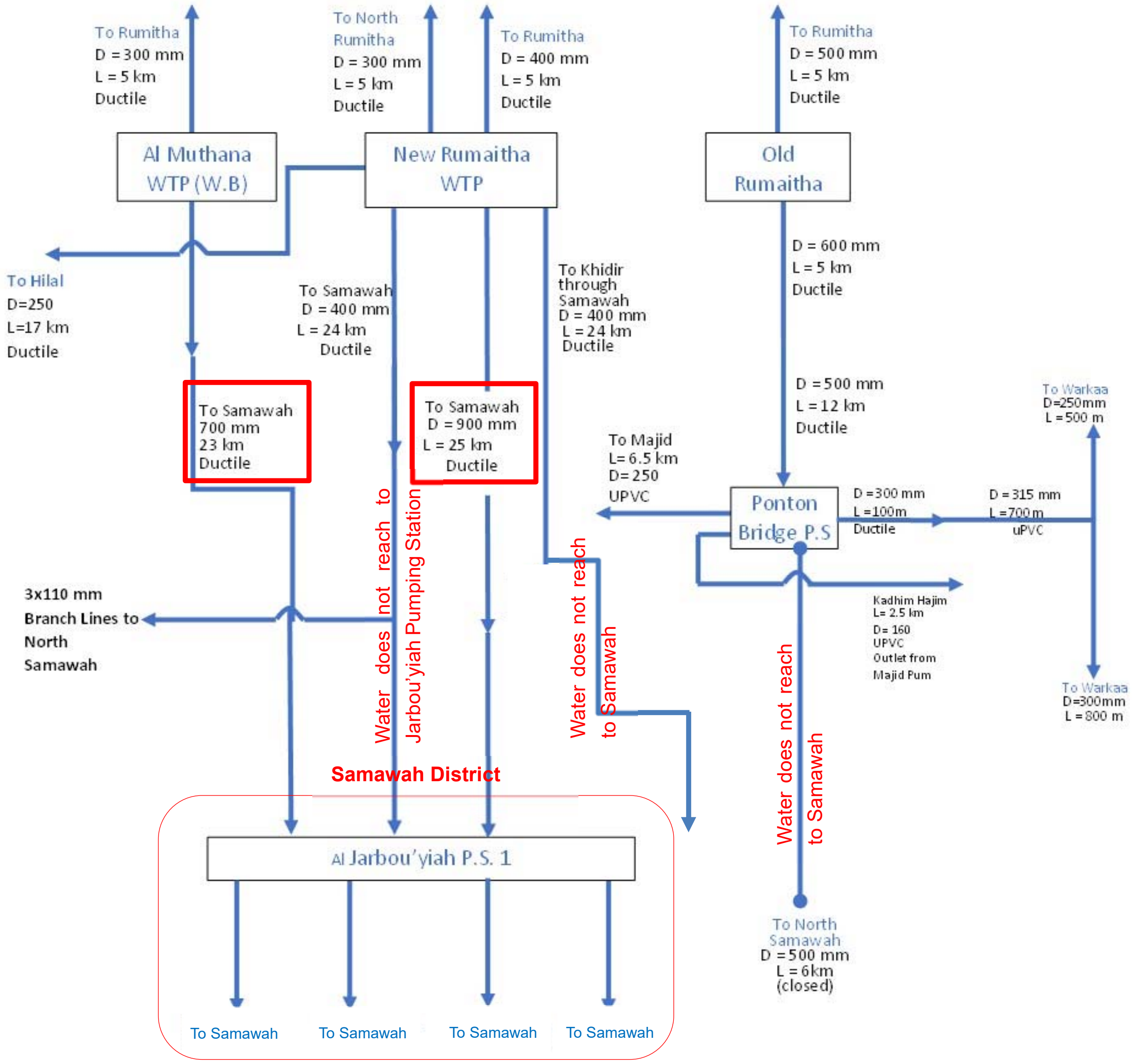
4.3 Present Situation of Water Transmission and Distribution Facilities

4.3.1 Transmission Facilities from Rumaitha WTPs to Samawah

(1) System configuration

The three WTPs in Rumaitha are supplying their treated water to Samawah District, in addition to the districts of Rumaitha, Warka, Majid, Hilal, and Khidir. They are collectively called the Rumaitha Water Supply System.

Figure 4.11 shows the schematic diagram of the Rumaitha Water Supply System. The Jarbou'yiah Pumping Station (PS-1) is a master pumping station in Samawah District, from which the water is distributed to most of the water supply area in the district.



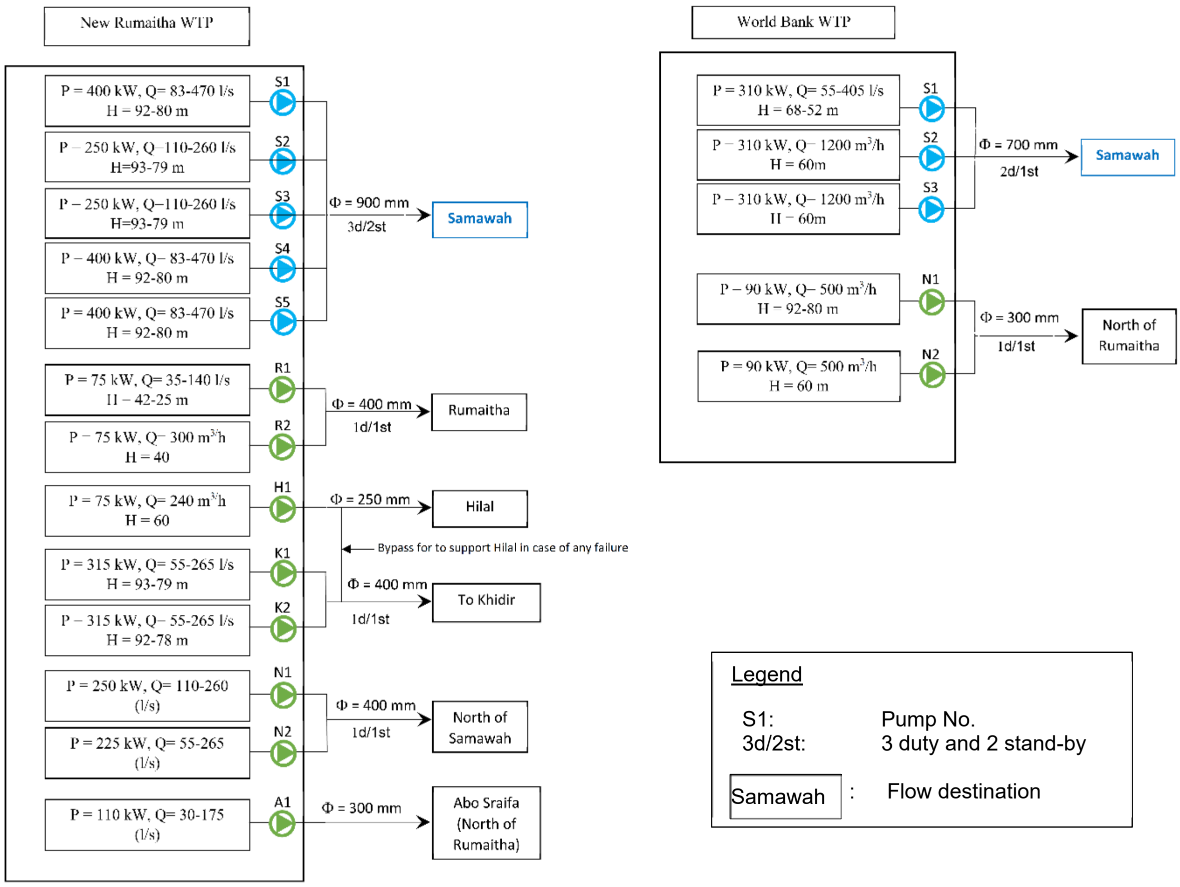
Source: JICA Study Team based on the information from MWD

Figure 4.11 Schematic Diagram of Rumaitha Water Supply System

As shown above, Samawah District is receiving water from the New Rumaitha WTP and WB WTP. Formerly, the treated water from the Old Rumaitha WTP also used to be sent to Samawah District via the Pontoon Bridge Pumping Station but currently, it does not reach to Samawah District as all water is now extracted by the rural villages along the transmission line.

(2) Pump facility

The water transmission pumps to Samawah District are installed in the New Rumaitha WTP and WB WTP as shown in **Figure 4.12**.



Source: JICA Study Team based on the information from MWD

Figure 4.12 Pump Configuration in the Pump Stations of the New Rumaitha WTP and World Bank WTP

Table 4.11 and **Table 4.12** show the pump specifications, number of pumps, and annual operation hours in 2021 (from January 1 to December 31) of the pump stations at the Rumaitha WTP and WB WTP, respectively.

Table 4.11 Characteristics of the Transmission Pumps in New Rumaitha WTP

Flow Destination and Diameter	Pump No.	Year of Installation	Pump Specification			Number of Pumps		Annual Operation Hours in 2021
			kW	Flow	Head (m)	Duty	Stand-by	
Samawah, D900	S1	2020	400	83-470 (l/s)	92-80	3	2	1,742
	S2	2020	250	110-260 (l/s)	93-79			1,742
	S3	2020	250	110-260 (l/s)	93-79			1,742
	S4	2020	400	83-470 (l/s)	92-80			2,376
	S5	2020	400	83-470 (l/s)	92-80			2,376
Rumaitha, D400	R1	2020	75	35-140 l/s	42-25	1	1	2,160
	R2	2020	75	300 m3/h	40			2,160
Hilal, D250	H1	2020	75	240 m^3/h	60	1	-	4,320
Khidir, D400	K1	2020	315	55-265 (l/s)	93-79	1	1	1,080
	K2	2020	315	55-265 (l/s)	92-78			1,080
North of Samawah, D400	N1	1980	250	110-260 (l/s)	93-79	1	1	1,080
	N2	1980	225	55-265 (l/s)	92-78			1,080
Abo Sraifa, D300	A1	1980	110	30-175 l/s	62-48	1	-	2,160

Source: JICA Study Team based on the information from MWD

Table 4.12 Characteristics of the Transmission Pumps in the WB WTP

Flow Destination and Diameter	Pump No.	Year of Installation	Pump Specification			Number of Pumps		Annual Operation Hours in 2021
			kW	Flow	Head (m)	Duty	Stand-by	
Samawah, D700	S1	2006	310	55-405 l/s	68-52	2	1	2,160
	S2	2006	310	1200 m^3/h	60			2,160
	S3	2006	310	1200 m^3/h	60			2,160
North of Rumaitha, D300	N1	2006	90	500 m^3/h	60	1	1	1,620
	N2	2006	90	500 m^3/h	60			1,620

Source: JICA Study Team based on the information from MWD

(3) Transmission pipelines to Samawah

Table 4.13 shows the pipe diameter, pipeline length, pipe material, and installation year of the two transmission pipelines.

Table 4.13 Transmission Pipelines from Rumaitha WTPs to Samawah District

Transmission Pump Station at Rumaitha District	Receiving Pump Station at Samawah District	Diameter of Pipeline	Approximate Length	Pipe Material	Year of Installation
New Rumaitha WTP	Jarbou'yiah Pumping Station (PS-1)	D900	25 km	DCI	1980
World Bank WTP	Jarbou'yiah Pumping Station (PS-1)	D700	23 km	DCI	2007

Source: JICA Study Team based on the information from MWD

There are illegal connections, the number of which is unknown, on the way to Samawah District.

(4) Present operation status

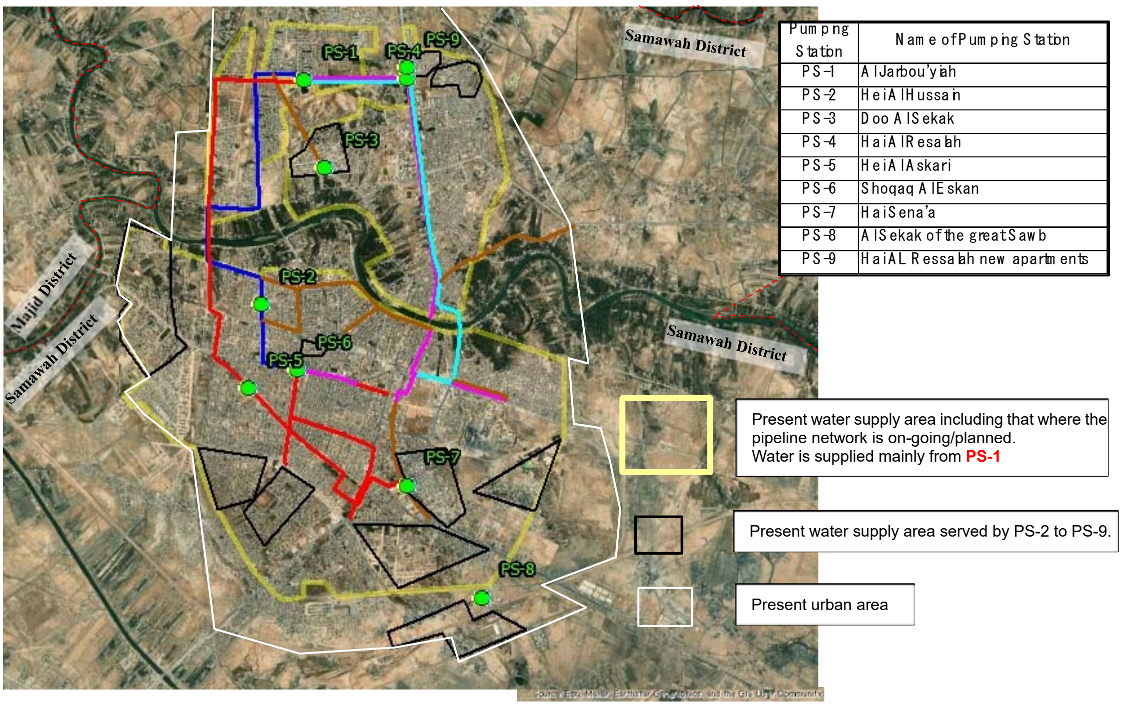
According to MWD, approximately twice the reservoir volume at the Jarbou'yiah Pumping Station (30,000 m^3 x 2 = 60,000 m^3) of water is being transmitted per day from the WTPs at Rumaitha to the Jarbou'yiah Pumping Station. The actual water volume is unknown because there is no flow meter at either the outlet of the WTP or inlet of the Jarbou'yiah Pumping Station.

4.3.2 Distribution Facilities in Samawah District

(1) System configuration

As shown in **Figure 4.13,** the water supply area is basically within the urban area of Samawah District. Some of the rural villages are being supplied water via transmission pipelines extended from the urban area.

The distribution center of Samawah District is Jarbou'yiah Pumping Station (PS-1), located in the northern part of the district. PS-1 has a reservoir of 30,000 m^3(= 7,500 m^3 x 4). PS-1 receives treated water from the New Rumaitha WTP and WB WTP. Water distribution in the urban area of Samawah District is basically conducted by direct pumping from PS-1. In addition, there are eight pumping stations which cover quite limited areas nearby the respective pumping stations.

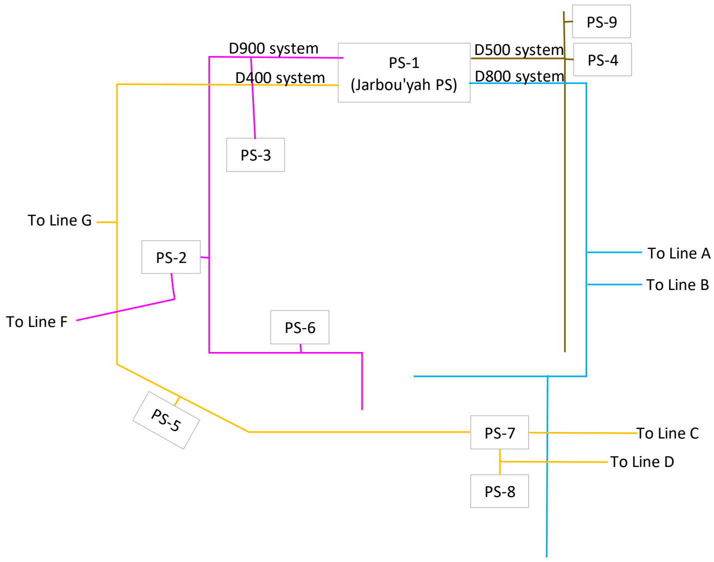


Pumping Station	Name of Pumping Station
PS-1	Al Jarbou'yiah
PS-2	Hei Al Hussain
PS-3	Doo Al Sekak
PS-4	Hai Al Resalah
PS-5	Hei Al Askari
PS-6	Shoqaq Al Eskan
PS-7	Hai Sena'a
PS-8	Al Sekak of the great Sawb
PS-9	Hai AL Ressalah new apartments

Source: JICA Study Team based on the information from MWD

Figure 4.13 Present Service Area and Locations of Pumping Stations and Layout of Water Distribution Mains in Samawah District

Figure 4.14 shows the schematic diagram of the water distribution system in Samawah District. The water distribution system from PS-1 consists of four distribution main systems: D900 main system, D400 trunk main system, D500 main system, and D800 main system. D900 and D400 systems are for distribution to the western part of the distribution area and D500 and D800 systems are for distribution to the eastern part.



Note:
PS-1 covers most of the water supply area in the urban area of Samawah District.
PS-2 to PS-9 cover quite limited area nearby the respective pumping stations.
Lines A, B, C, D, F, and G are for the transmission pipeline to rural villages.

Source: JICA Study Team based on the information from MWD

Figure 4.14 Schematic Diagram of Water Distribution System in Samawah District

The distribution networks branching from the above distribution main are basically grouped by "mahalla", which is the smallest administrative unit. The oldest network was constructed in the 1980s. Pipe replacement was conducted in some of the old network from 2006 to 2012. However, many old pipe networks remain in the urban area.

(2) Facility outlines

1) Functions of the existing pumping stations and pipelines

The destination of the transmission and distribution pipelines of the existing pumping stations and their reservoir capacity are presented in **Table 4.14**.

Table 4.14 Function of the Existing Pumping Stations in Samawah District

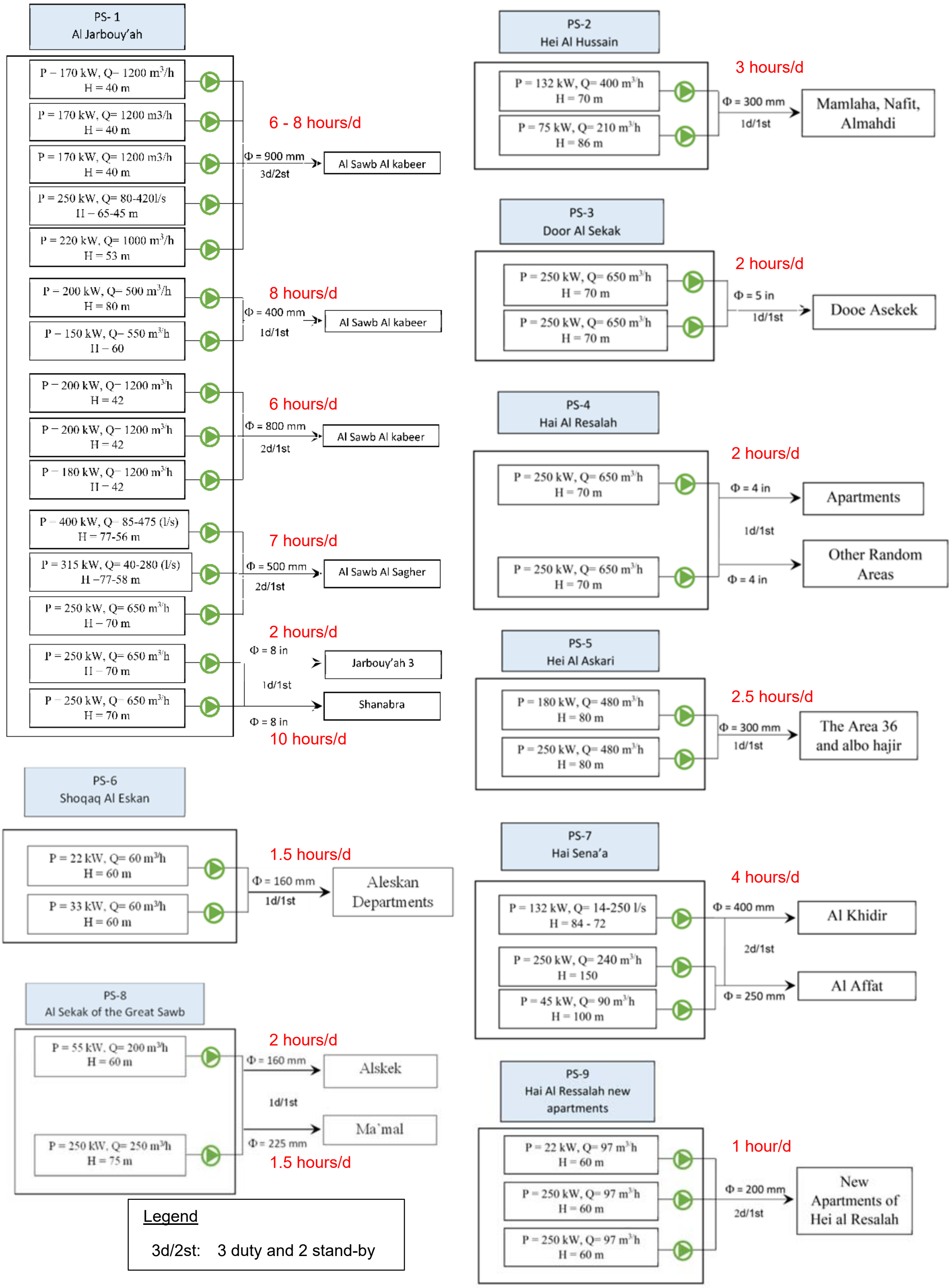
No.	Name of Pump Station	Dia. of Outlet Pipeline	Transmission To	Distribution Area	Storage Capacity of Reservoir (m^3)
PS-1	Al Jarbou'yiah	D900	PS-2, PS-3, PS-6, PS-7	Southern urban area Rural villages (Line G)	30,000
		D800		Southern urban area Rural villages (Lines A, B)	
		D500	PS-4	Northern urban area (Shanabrah)	
		D400		Southern urban area Rural villages (Line G)	
		D250	PS-9		
		D200		Northern urban area (Jarbou'yiah)	
PS-2	Hei Al Hussain	D300		Rural villages (Line F)	1,150
PS-3	Doo Al Sekak	D125		Northern urban area (Doo Al Sekak)	300
PS-4	Hai Al Resalah	D100		Northern urban area (Apartments)	400
		D100		Northern urban area	
PS-5	Hei Al Askari	D300		Southern urban area (The Area366 and AlboHajir)	3,000
PS-6	Shoqaq Al Eskan	D160		Southern urban area (Al Eskan Departments)	100
PS-7	Hai Sena'a	D400		Rural villages (Line C)	400
		D250	PS-8	Rural villages (Line D)	
PS-8	Al Sekak of the Great Sawb	D225		Southern urban area (Ma'mal Factory)	400
		D160		Southern urban area (Alskek)	
PS-9	Hai Al Ressalah New Apartments	D200		Northern urban area (New apartments of Hai Al Ressalah)	730

Source: JICA Study Team based on the information from MWD

As shown in the table above, D900 pipeline, D500 pipeline, and D250 pipeline have both water transmission and distribution functions.

2) Outline of pump facility

Figure 4.15 shows the pump configuration of existing 9 pumping stations and normal daily operation hours. The water supply is not continuous but intermittent. The reason is insufficient water amount received from the Rumaitha WTPs and limited power supply hours.



Source: JICA Study Team based on the information from MWD

Figure 4.15 Pump Configuration and Normal Daily Operation Hour of the Existing Pumping Stations

As shown above, the operating hours in the PS-1 coverage area is around 6 hours (3 hours x 2) per day.

Regarding other pumping stations' coverage areas, the daily supply hour is limited to 1 to 4 hours per day.

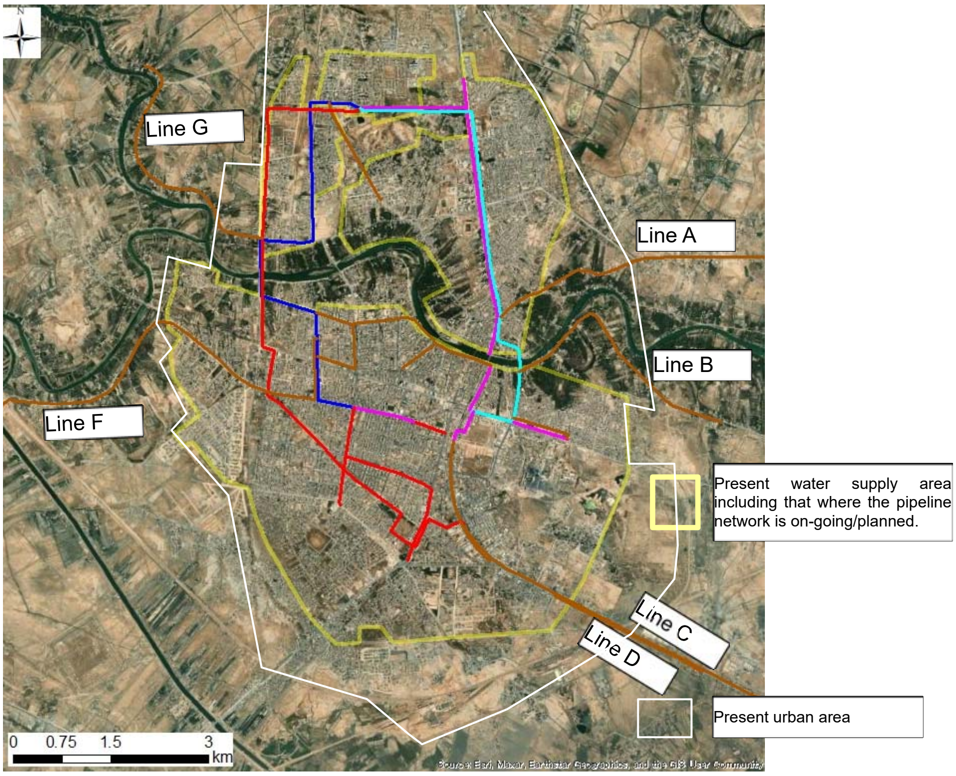
3) Outline of transmission pipeline to rural villages

Table 4.15 and **Figure 4.16** show the outline of the transmission pipeline to the rural villages.

Table 4.15 Outline of Transmission Pipeline to Rural Villages

Transmission Pipeline	Diameter of Pipeline	Number of Served Villages
Line A	D200, D150	5
Line B	D200	7
Line C	N.A.	3
Line D	D250	7
Line F	D300	7
Line G	D150, D100	3

Source: JICA Study Team based on the information from MWD



Source: JICA Study Team based on the information from MWD

Figure 4.16 Outline of Transmission Pipeline to Rural Villages

(3) Present operation status

Based on the pumping operating hours of PS-1 at 6 to 8 hours per day, approximately 50,000 to 53,000 m^3 of water is being distributed to Samawah District by piped water supply. However, the actual water volume sent from PS-1 and received by the residents is unknown, since neither bulk meter nor customer water meter is installed.

4.4 Present Situation of Service Facilities

4.4.1 Service Connections

As shown in **Table 4.3**, the registration rate to MWD's piped water service is 60% at Samawah District and the number of registration (authorized connections) is 35,430. In most of the service area, the water supply is twice a day, approximately three hours in the morning and three hours in the evening. In some areas, the water supply is only once a day and for one to three hours per day, whose main cause is the insufficient water pressure in the influence areas of PS-2 to PS-9.

To survive with such intermittent water supply conditions, most of the residents have a rooftop storage tank in each house. A good number of residents install booster pumps connected to their service pipes that are then connected to MWD's distribution pipes. The pumping system pumps up the water to the rooftop storage tank, from where the water is distributed to the water taps in the house. The households introduce such pumping systems to secure water supply, but it further deteriorates the water pressure and water quality in the water distribution network of MWD.

The household connections do not have flow meters and the water tariff is fixed according to the number of rooms. The lack of water meter discourages water saving in the households who are located in advantageous areas that can secure water, which may further worsen the insufficiency of the water volume in the overall service area.

4.4.2 Flow Meters and Water Meters

To date, bulk flows are neither measured in the Rumaitha WTPs, Jarbou'yiah Pumping Station[6], and the other eight pumping stations, nor along the transmission and distribution pipelines. The volume of water transmitted and distributed is roughly estimated based on the average operation hours and the maximum capacity of each pump.

Regarding household water meters, GWD started a water meter installation project in October 2022 as stated in Section 3.5, and approximately 63,000 water meters will be installed at Rumaitha Governorate by November 2027, putting the highest priority for Samawah District to be 100% metered.

4.4.3 Water Tanker

MWD has 28 tankers in Samawah District that deliver water from the Jarbou'yiah Reservoir to the customers in the urban area with short service continuity and in the rural areas where the water distribution network is not extended, and compact units are not available. The capacity of the water tanker is 20 m^3, and each tanker makes a round trip between the Jarbou'yiah Pumping Station and the water supply destination about 4 to 6 times a day.

The tariff for domestic use is IQD 1,500/m^3 (filtered water) and IQD 3,000/m^3 (Reverse Osmosis (RO) water). For commercial and governmental use, only the RO water is supplied at IQD 5,000/m^3. The domestic users are paying daily and the commercial and governmental users are paying monthly through official bills.

[6] The distribution mains of D400, D500, D800 and D900 were equipped with bulk flow meters at the outlet from the Jarbou'yiah Pumping Sta but they do not function since long years ago.

4.5 Operational Conditions

4.5.1 Water Quality Control

MWD conducts regular water quality test (raw water and treated water) and samples are taken at the three WTPs in Rumaitha and major CUs, of which frequency varies from daily, weekly, and quarterly according to the parameter. The water quality of the tap water is not monitored, while the satisfaction level of the residents with the water quality is low as shown in **Table 4.4**. On the other hand, GWD conducts its own water quality test quarterly including bacteriological test, of which the latter samples are taken at major distribution sites as well as WTPs and CUs. The water quality tests conducted by MWD and GWD are shown in **Table 4.16**.

As shown in **Table 3.4**, the Iraqi standard on the water quality of drinking water (IQS417) lists 41 parameters which consists of five parameters for natural characteristics, 27 parameters for chemical characteristics, four parameters for biological characteristics, three parameters for pesticides, and two parameters for radiation. However, as shown in **Table 4.16**, only 7 and 15 parameters of IQS417 are monitored in the tests of MWD and GWD, respectively.

Table 4.16 Water Quality Tests Conducted by MWD and GWD

Entity	S/N	No. in IQS417	Parameter	Sampling Point	Frequency		
					Daily	Weekly	Quarterly
MWD	1	C-18	TDS	WTPs	*		
				Compact Units		*	
	2	N-2	Turbidity	WTPs	*		
				Compact Units		*	
	3	-	Free Chlorine	Outlet of WTPs	*		
	4	-	Alkalinity	Outlet of WTPs		*	
	5	-	K			*	
	6	C-19	SO_4^{2-}			*	
	7	C-12	Cl^-			*	
	8	C-22	Mg			*	
	9	C-21	Ca			*	
	10	C-11	Al			*	
GWD	1	N-2	Turbidity	❖ For S/N 1-18, raw water and treated water are sampled in: ・Muthanna water project; ・New Rumaitha WTP; and ・Other water projects, water complexes in the governorate. ❖ For S/N 19-22, treated/ distributed water is sampled in markets and other distribution sites, as well as WTPs and the CUs.			*
	2	-	Temperature				*
	3	N-5	pH				*
	4	-	EC				*
	5	-	Alkalinity				*
	6	C-14	Hardness				*
	7	C-21	Ca				*
	8	C-22	Mg				*
	9	C-12	Cl^-				*
	10	C-15	Fe				*
	11	C-11	Al				*
	12	C-19	SO_4^{2-}				*
	13	C-17	Na				*
	14	-	K				*
	15	C-18	TDS				*
	16	-	TSS				*
	17	C-4	Cr				*
	18	-	SiO_2				*
	19	-	Residual Chlorine				*
	20	B-1	Total Coli				*
	21	B-2	E. Coli				*
	22	B-4	Plate Count				*

Source: MWD and GWD edited by the JICA Study Team

4.5.2 Water Pressure Control

Currently, water flow meter or pressure meter is not installed in the transmission and distribution pipeline in Samawah District. Thus, water pressure control is not being undertaken. According to MWD, the residual head at the end section of the distribution pipeline is less than one meter. Proper water pressure control system by the monitoring and control facility is required.

4.5.3 Non-revenue Water (NRW)

Due to the absence of bulk flow meters at Jarbou'yiah Pumping Station and the lack of water meters at the house connections, it is not possible to assess the NRW inside Samawah District. Moreover, MWD has no specific department in charge of systematic NRW reduction including leakage detection and has not been preparing annual reports on its O&M activities and key performance indicators (KPIs) including the estimation of NRW.

Besides, the Previous Study reported that approximately 24% of water transmitted from the three WTPs in Rumaitha to Samawah District was lost on the way. That is, the maximum volume of transmission was 111,200 m^3/day from Rumaitha while the volume received by Samawah was estimated to be 84,300 m^3/day as of 2014 (thus, 26,900 m^3/day was lost), and the reason of this gap was considered to be due to the leakage from the transmission lines and the illegal connections by residents living in the vicinity. Moreover, around 42% of the received water (84,300 m^3/day) was lost through the leakage from the distribution pipeline network in Samawah and accordingly, the amount of water that could be consumed by customers was 48,907 m^3/day (assuming the water consumption per day per person is 240 Lpcd).

The updated estimation of water loss during the transmission from the Rumaitha WTPs to Jarbou'yiah Pumping Station is shown in **Table 4.17** and **Table 4.18.** From these tables, the daily volume lost during the transmission is roughly estimated as: 61,871 –55,510 = 6,361 m^3/day, which is approximately equal to 10% of the water transmitted from the Rumaitha WTPs. It should be noted that this estimation is not accurate as the actual pump capacity is not available (the rated value was used according to the MWD guidelines), and it is recommended to use portable flow meters to get more accurate estimation. According to the discussion with MWD, the majority of the loss during the transmission is considered to be due to illegal connections by farmers along these pipelines.

Table 4.17 Estimated Daily Water Volume Transmitted from Rumaitha WTPs to Jarbou'yiah Pumping Station

Transmission Pipeline WTP	Transmission Pipeline Diameter (mm)	Pump Serial No.	Annual Operation Hours (hr/year)	Rated Capacity per Pump (m^3/hr)	Estimated Annual Flow Volume (m^3/year)	Estimated Daily Flow Volume (m^3/day)
New Rumaitha WTP	D900	535533/3	1,742	1,692	2,948,141	8,077
		535537/1	1,742	936	1,630,886	4,468
		499315/2	1,742	936	1,630,886	4,468
		N.A.	2,376	1,692	4,020,192	11,014
		506485/4	2,376	1,692	4,020,192	11,014
		Sum			14,250,297	39,041
World Bank WTP	D700	506485/3	2,160	1,458	3,149,280	8,628
		N.A.	2,160	1,200	2,592,000	7,101
		N.A.	2,160	1,200	2,592,000	7,101
		Sum			8,333,280	22,830
Total					22,583,577	61,871

Source: MWD as of September 2022

Table 4.18 Estimated Daily Water Volume Transmitted/ Distributed from Jarbou'yiah Pumping Station

Discharge Pipeline (mm)	Rated Pump Capacity (m^3/hr)	Normal Daily Operation Hours (hr)	Estimated Daily Transmission and Distribution Volume (m^3/day)
D900	1,200	6	4,320
	1,200	6	4,320
	1,200	6	4,320
	1,512	8	7,257
	1,000	8	4,800
D400	500	8	2,000
	550	8	2,200
D800	1,200	6	4,800
	1,200	6	4,800
	1,200	6	4,800
D500	1,008	7	4,704
	576	4	1,536
	650	4	1,733
D200	210	2	420
D200	350	10	3,500
Total			55,510

Note: Estimated daily transmission and distribution volume is calculated by the formula "rated pump capacity x normal daily operation hours x share of operational pumps", where the share of operational pumps is 3/5, 1/2, 2/3, 2/3, and 1/1 for the pipeline of D900, D400, D800, D500, and D200, respectively.

Source: MWD as of September 2022

Likewise, the updated water loss in the distribution network in Samawah is calculated as follows:

- Daily transmitted and distributed volume from Jarbou'yiah Pumping Station is estimated at around 55,510 m^3/day as shown in **Table 4.18**.
- Daily water consumption is estimated based on the assumption that (a) the number of served population in Samawah District is estimated at 194,865 (from **Table 4.3**); (b) the average per capita consumption is estimated by the government to be 250 Lpcd for urban areas and 200 Lpcd for rural areas (estimated to be at 240 Lpcd as combined average).

- The daily consumption per day is calculated as (194,865 x 240)/1000 = 46,768 m^3/day, and the loss is calculated by the formula “55,510 m^3/day – 46,768 m^3/day = 8,742 m^3/day” which is approximately equal to 16% of the supplied water.

Since this estimation is based on the rated capacity and average operation hours of pumps and the daily average per capita consumption, the water meters should be installed at the outlet of pumps and the household connections for more accurate figures.

4.5.4 Asset Inventory and Customer Management

(1) Asset inventory

The JST could not access the financial statements of MCPWM and Muthanna Governorate because of the confidentiality, so the status of the asset inventory of GWD and MWD remains to be analyzed.

(2) Customer management

Regarding the customer inventory, no computer software has been in use in MWD to manage the data of customers regarding water connection status, personal information, and billing, payment, and arrears of water tariff, and the data has been managed on paper basis. Moreover, the geographic information of each customer has not been managed on GIS. While MWD conducted in 2018 a series of site inspection survey by collectors who checked the existence of illegal connections in parallel to their routine collection tasks. Urban areas were thoroughly inspected while rural areas were not 100% done. Around 5% or less of all the connections were found to be illegal at that time. In 2019, GWD provided all Governorate Water Directorates including MWD with a software application for customer inventory management, where each customer’s data such as registration, billing, and payment can be referred to online on an individual page. MWD recognizes the necessity to introduce this software application, and is willing to strengthen the management and collection of arrears of water tariff in particular, through converting the paper-based customer inventory into digital database.

4.6 Issues in the Existing Water Supply Systems

Based on the analysis of the present situation in Muthanna Directorate particularly those in Samawah District, JST points out certain issues in the existing water supply systems in the study area as stated below.

- Registration rate in the public piped water services in Muthanna Directorate is one of the lowest in the country. Furthermore, the registration rate in Samawah District (60%) remains lower than the governorate's average rate. Extension of the water distribution network is urgently needed corresponding to the growing population and expanding urban area.
- The actual treatment capacities of the Rumaitha WTPs are very low compared with their design capacities. Rehabilitation of the civil structures, pipelines, and equipment will be necessary.
- In the WTPs at Rumaitha, turbidity in the treated water does not satisfy the permissible level of turbidity in the drinking water quality standard. Not only the rehabilitation of the old equipment but also the improvement of operational skill is needed. Securing sufficient budget for O&M will also be needed.
- The WTPs and CUs are facing the increase in the salinity of the raw water. Development of water treatment facilities that are not subject to salinity or that are able to eliminate TDS is needed.
- The raw water for the WTPs is suspected to be polluted by wastewater. If the pollution is concluded relocation of the water intakes will be necessary.
- As the water supply systems do not have bulk flow meters and customer water meters, water loss is uncontrollable. Installation of flow meters and water meters is needed.
- Low performance and high cost of decentralized water supply systems by CUs cause financial problems of low service quality. Ideally, a reliable centralized system needs to take over them for good service quality with optimized O&M cost.
- Currently, the operation of switching on and off of the distribution pumps is conducted in accordance with the precedent practice of intermittent water supply service. Establishing quantitative water supply control, as well as development of sufficient water treatment capacity, is necessary for continuous water supply service.
- NRW in the water supply system is not well controlled, while water stress is becoming more severe due to the growing population and increase in the salinity in the water bodies. Thus, water security by increasing the water production capacity is needed. Moreover, it is necessary for MWD to procure equipment, materials, and tools to detect and fix leakages, and to develop the capacity of MWD employees to monitor and reduce NRW that consists of both physical and commercial loss.
- People in the urban area install suction pumps in their service connections to extract maximum water from the distribution network, which further worsens the water pressure and water quality. It is necessary to develop and enforce regulations on water supply service that include the ban to install such suction pumps, as well as to improve the quality of water supply service.

- Digitalization of customer inventory is needed for effective and efficient customer management.

Chapter 5 Project Planning and Preliminary Design

5.1 Project Planning in the Previous Study

5.1.1 Project Scope Proposed in the Previous Study

(1) Basic planning conditions

In 2016, JICA conducted “Data Collection Survey on Water Sector in Southern Iraq" (the Previous Study). After overall examination of the present situations of the existing water supply system for Samawah District, the Previous Study identified the scope of the Project according to the basic planning conditions shown in **Table 5.1**.

Table 5.1 Basic Planning Conditions in the Previous Study

Item	Conditions
Target Year	2030
Supply Area	Samawah District
Planned service population in 2030	The population projection up to the target year (2030) was made based on the population data between 2010 and 2015. Urban area (North): 203,002 Urban area (South): 135,334 Rural: 123,109 Total: 461,445
Per capita consumption (not including water leakage)	Urban area: 250 Lpcd Rural area: 140 Lpcd
Registration ratio to the piped water supply services	Reach 100% by 2030
Ratio of water leakage	15%
Planned water demand	119,787 m^3/d in 2030
Source of water	Euphrates River

Source: JICA Study Team based on the Previous Study

(2) Project scope

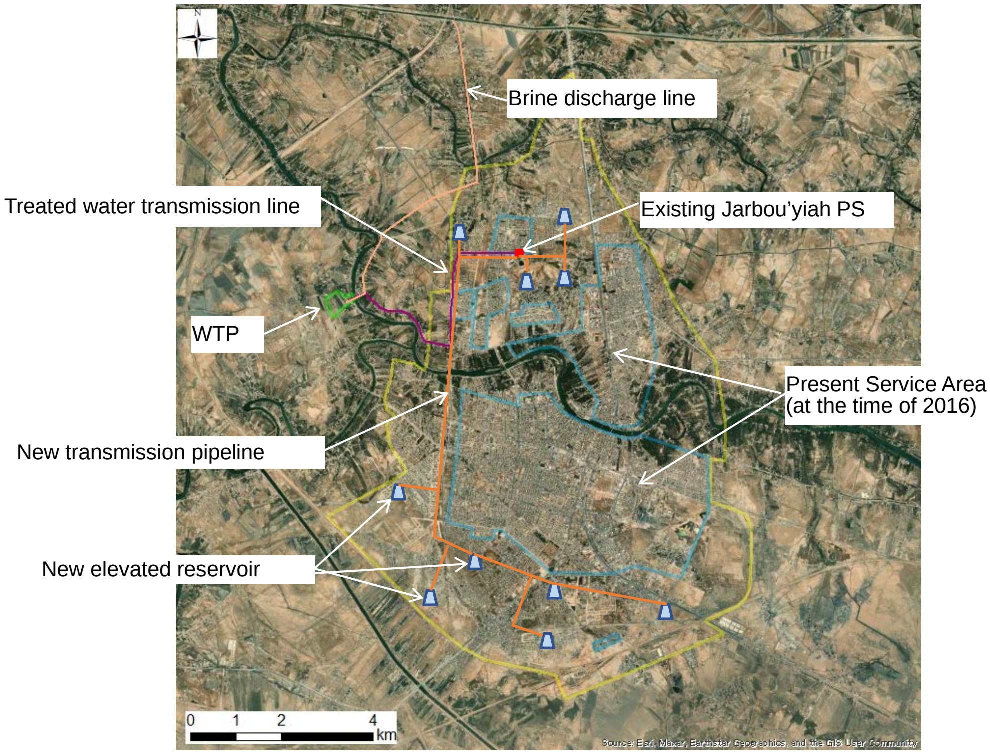
The project scope developed based on above conditions is shown in **Table 5.2** and **Figure 5.1**.

Table 5.2 Project Scope Proposed in the Previous Study

Facility	Feature
(1) Intake	Capacity: 184,800 m^3/d Components: Screen, gate, open channel, grid basin, lift pump
(2) Water Treatment Plant (WTP)	1. Pre-Treatment Capacity:168,000 m^3/day Components: Receiving well, mixing basin, flocculation basin, sedimentation basin, rapid sand filter, activated carbon filter, sludge treatment facility
	2. Reverse Osmosis (RO) Facility Capacity 120,000 m^3/day Components: Pre-filter, RO membrane units, degassing facility, chemical dosing facility
(3) Transmission facility from WTP	1. Treated water transmission facility to Jarbou’yiah Pumping Station Transmission pump: 120,000 m^3/day, Transmission pipeline: D1000 L = 6 km Pipe bridge across the Euphrates River L = 200 m

Facility	Feature
	2. Brine discharge facility Discharge pump: 48,000 m^3/day, Discharge pipeline: D600 L = 8 km Pipe bridge across the Euphrates River L = 200 m
(4) Transmission facility from Jarbou'yiah Pumping Station to each distribution reservoir	1. Transmission and booster pump Transmission pump: 36,000 m^3/d Booster pump: 25,920 m^3/d
	2. Transmission pipeline D500 L = 6 km, D400 L = 2 km, D300 L = 5 km, D200 L = 9 km
(5) Distribution facility	1. Distribution reservoir Elevated reservoir 2000 m^3 x 10nos.
	2. Distribution pipeline L = 280 km (for new service area) L = 50 km (rehabilitation of existing distribution pipeline) 3. Service connection including customer meter 4. Rehabilitation of existing reservoir and pumps

Source: JICA Study Team based on Previous Study



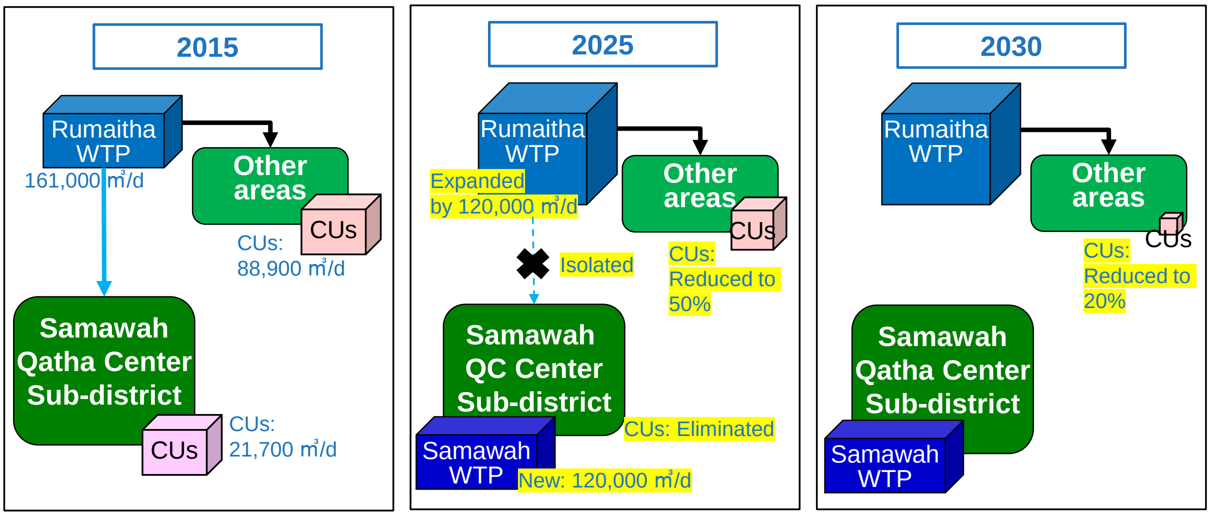
Source: JICA Study Team based on Previous Study

Figure 5.1 Layout Plan of the Water Transmission and Distribution Facilities in the Previous Study

(3) Development scenario of the water treatment facilities

As a result of the water balance study between water demand and supply capacity of the entire Muthanna Governorate by 2030, the design capacity of the new WTP in the Project (hereinafter called as "Samawah Water Treatment Plant" or Samawah WTP) was proposed to be 120,000 m^3/d.

The Previous Study intended that the Samawah WTP would satisfy the whole water demand in Samawah without any supply from the Rumaitha WTPs or from CUs, while the other areas will be served by the Rumaitha Water Supply System, after expansion through the WBT Project, and a part of the existing CUs as illustrated in **Figure 5.2**. The treated water of the Samawah WTP would be transmitted to the existing Jarbou'yiah Pumping Station, from which the water would be distributed to the supply area.



Source: JICA Study Team based on the "Data Collection Survey on Water Sector in Southern Iraq" (2016, JICA)

Figure 5.2 Development Scenario of Water Treatment Facilities Proposed in the Previous Study

(4) Plan for the Samawah WTP

The location of the WTP was determined to be the right bank of the Euphrates River. The treatment method of the WTP was to be reverse osmosis (RO) with pre-treatment due to high TDS and salinity of raw water. Due to limited water quality data of the Euphrates River, the pre-treatment process was tentatively planned to consist of flocculation, sedimentation, sand filtration, and activated carbon filtration. The brine was planned to be discharged to the Eastern Euphrates drainage canal.

(5) Plan for the water transmission and distribution facilities

The treated water of the Samawah WTP would be transmitted to the existing Jarbou'yiah Pumping Station, from which the water would be distributed to the supply area. Such water transmission and distribution systems were planned based on the following assumptions and concept:

- The population in the existing service area (as of 2016) will not increase. The population increase will occur outside of the existing service area.
- Existing transmission/distribution facilities have sufficient capacity for water distribution within the existing service area.
- Existing transmission/distribution facility shall be used for water supply within the existing service area. New transmission/distribution facility shall be separately constructed for water distribution within a new service area.
- The method of water distribution in the new service area shall be through gravity flow. Elevated tanks with capacity of half day of each water demand shall be constructed. The treated water transmitted from Jarbou'yiah Pumping Station to each elevated tank shall be distributed to each distribution area by gravity.

In the Study, regarding the results of the previous study above, the planning year and planned water supply area were updated according to the latest development situation, based on which the planned capacity of the Samawah water treatment plant was also reviewed. In addition, the plan of water treatment plant was re-examined based on the latest water quality information of the Euphrates River, Iraq's drinking water quality standards, and information from similar projects. Furthermore, planning of the water transmission and distribution facilities was also reviewed according to the water demand forecast, updated capacity of the water treatment plant and the current situation of the existing facilities.

5.1.2 Key Considerations in the Study in the Review of the Project Plan by the Previous Study

In accordance with the scope of the work of the preparatory survey, which is to provide JICA with sufficient information for project appraisal, the Study updates the project plan proposed by the Previous Study and finalize the project scope with the following key considerations according to the latest situations in the Study Area.

(1) Target year

The Project’s target year needs to be updated as six years have passed since the Previous Study.

(2) Service area of MWD for Samawah District

It is supposed that the urban area is prioritized for expansion of the service area, although the design capacity of the WTP takes into account the demand in the rural area.

(3) Design capacity of Samawah WTP

The design capacity of Samawah WTP needs to be re-analyzed after updating the water demand projection and identification of the best development scenario of the water treatment facilities for the Samawah District.

In updating the water demand projection, it is necessary to consider the latest population growth estimated by the Ministry of Planning (MOP). The water demand projection needs to be harmonized with the latest planning criteria instructed also by MOP. The best development scenario needs to be identified based on the actual situations of the water supply systems and MWD’s future plan.

(4) Planning concept for the Samawah WTP

In the Study, the qualities of the raw water and product water need to be reconsidered according to the latest data of the river water quality, Iraqi drinking water quality standard, and the case studies from other similar projects. The overall treatment system and each plant component will be redesigned based on the plant capacity determined in the Study, water quality conditions, and the updated technical trend in the water treatment area especially from the viewpoint of the optimization of the life cycle cost of the WTP.

(5) Planning concept of the water transmission and distribution facilities

In the Previous Study, the water transmission and distribution facility plan in the new service area was developed separately from the existing service area. No facility construction was planned in the existing service area, with the assumption that no population increase would occur in the existing service area.

However, the population in the existing service area has increased. Moreover, the service area has been expanded since 2016. To make a reasonable water transmission and distribution plan, it is necessary to consider the existing and new service areas as one service area, based on the present condition of the facility as well as the future development plan of MWD.

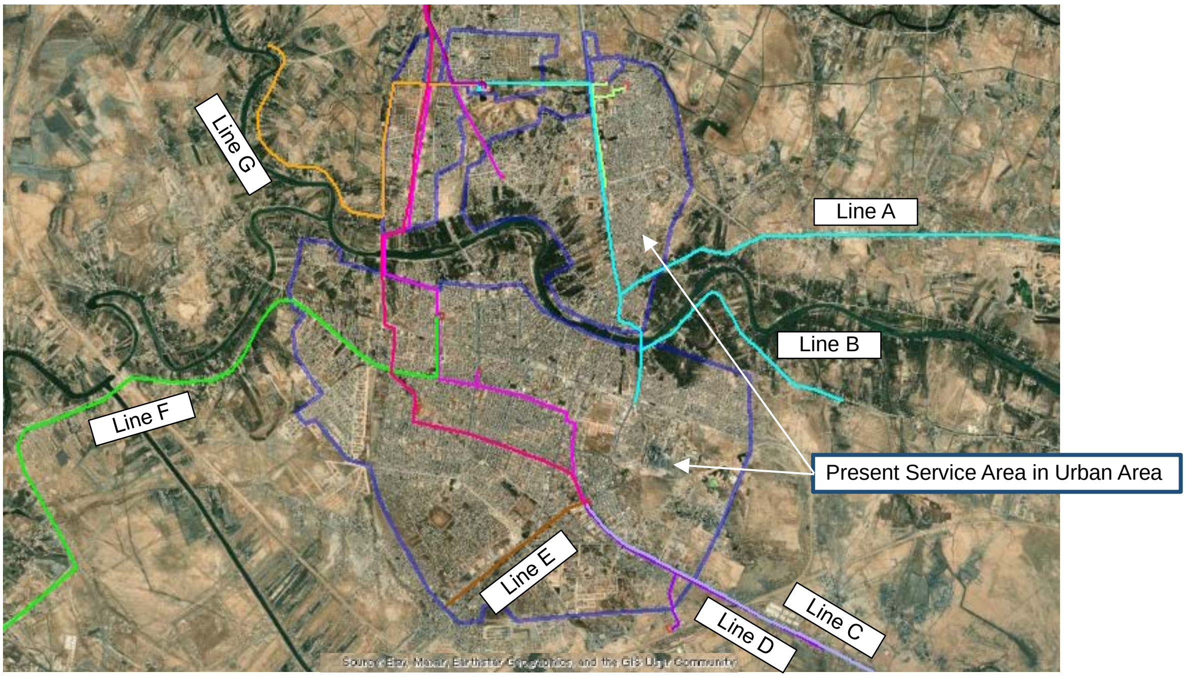
Moreover, it is proposed to include the following as measures for water leakage reduction:

- Installation of water flow/pressure monitoring and control facility, and
- Rehabilitation of the distribution pipeline.

5.2 Study on Water Supply Area and Facility Improvement/Expansion Area in the Project

(1) Present water supply area

The present service area of MWD is basically within the urban area of Samawah District. In addition, several rural villages are supplied via water distribution pipelines extending from the present service area, as shown in **Figure 5.3**.



Source: JICA Study Team based on the Previous Study Report

Figure 5.3 Existing Distribution Pipelines to Rural Villages

Table 5.3 shows the number of villages which are supplied by MWD piped water.

Table 5.3 Number of Rural Villages Served with MWD Piped Water

Distribution Line	Diameter	Approximate Length	No. of Villages Receiving Water
Line A	D200 and D150	12 km	5
Line B	D200	4 km	7
Line C	D400	10 km	3
Line D	D250	3 km	7
Line E	D250	3 km	4
Line F	D300	24 km	7
Line G	D150	4 km	3
Total			36

Source: JICA Study Team based on the Previous Study Report

(2) Water supply area and facility improvement/expansion

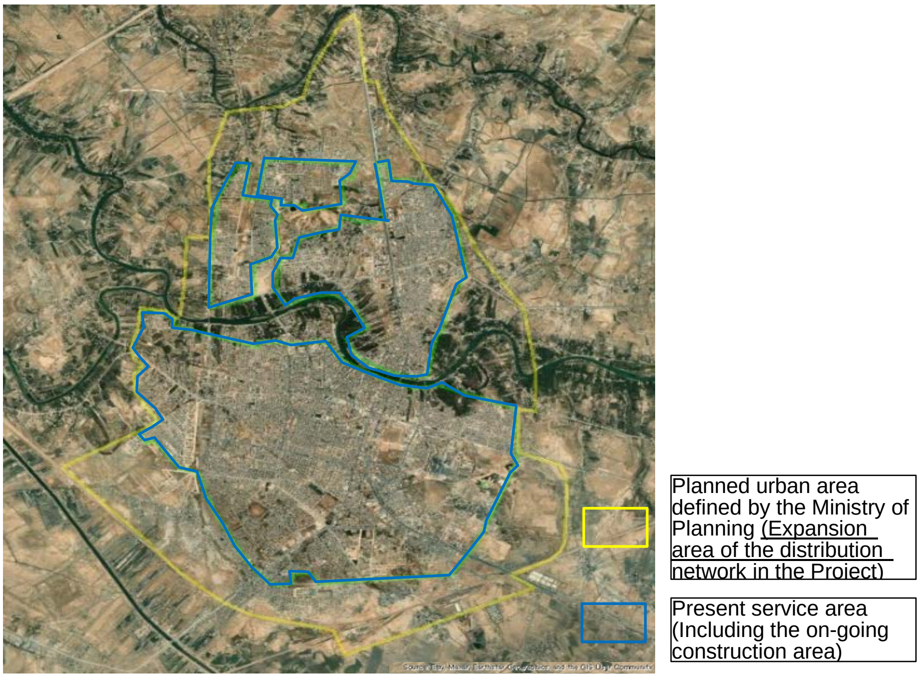
Approximately 10% of the rural population is currently served with MWD's piped water. The remaining population is served with water tanker of MWD, compact unit, private vendors and/or their own saline well water. Meanwhile, MWD is continuously extending the distribution network into the urban area.

Considering the cost effectiveness of facility construction, expansion of the supply area and improvement of service hour in the urban area should be prioritized. In addition, taking into account the water demand in the rural area is included in the design capacity of the WTP, expansion of the water transmission systems to the rural area shall be executed.

Thus, it is proposed that:

- Service area of piped water supply will be expanded basically to the planned urban area boundary defined by the Ministry of Planning (MOP).
- In addition to the 36 villages that is already connected to piped water supply, the Project will expand the water transmission system to the surrounding villages and construct the reservoir for each village. The distribution network of each village will be developed by MWD according to the evolution of the population growth[1].

Figure 5.4 shows the present service area and planned urban area defined by MOP.



Source: JICA Study Team based on the information from MWD

Figure 5.4 Planned Urban Area and Present Service Area

[1] In this chapter, facility planning was carried out on the water transmission and distribution facilities in the rural areas with a view to including these facilities in the Project. However, as there were a variety of uncertainties in the scope of the expansion of the water distribution networks, it turned out that it was difficult to well define the measures to be taken for environmental and social considerations including the land acquisition matters. Thus, the water transmission and distribution facilities to rural areas will not be included in the scope of the Project and is assumed to be implemented by Iraq's competent authorities by their own expenses.
In the rest of this chapter, the term "the Project" may occasionally be interpreted to include the expansion of water transmission and distribution facilities to the rural areas, but ultimately it does not consist of the Project.

The population of the present urban area has increased since 2015 and is projected to continue to grow. Thus, facility improvement and expansion are required in the entire planned urban area including the present service area.

5.3 Water Demand Projection and Scale of the Project

5.3.1 The Previous Study

(1) Conditions of the water demand projection

The Previous Study carried out water demand projection based on the conditions shown in **Table 5.4**.

Table 5.4 Basic Planning Conditions in the Previous Study

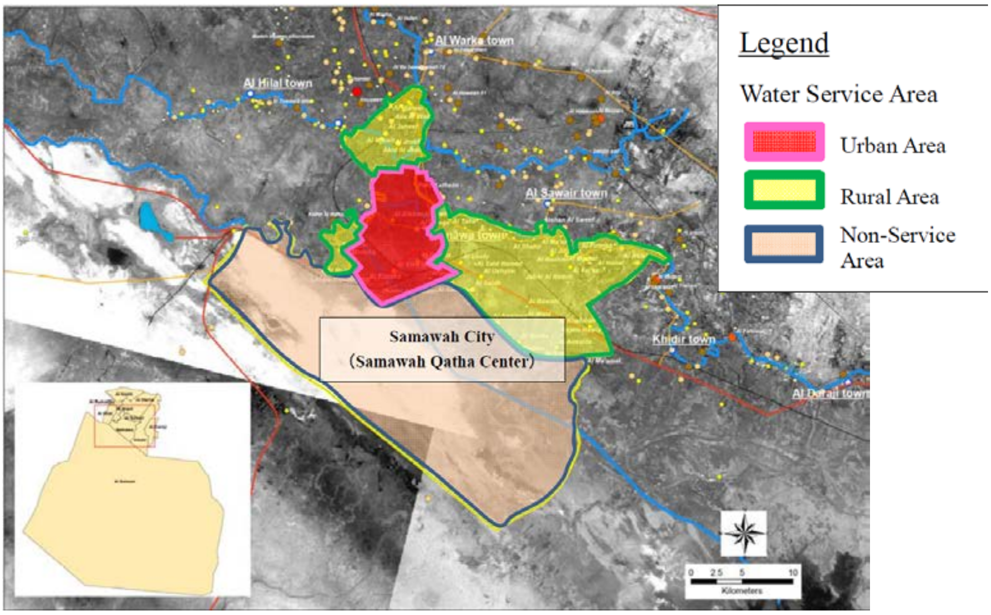
<table>
<tr><th>Item</th><th>Conditions</th><th>Remarks</th></tr>
<tr><td>Target year</td><td>2030</td><td>8 years after the anticipated completion year of the project</td></tr>
<tr><td>Target area of the water demand projection</td><td>Whole Muthanna Governorate excluding Al Salman District</td><td>Salman was excluded for its isolation from the water supply system from Rumaitha WTPs</td></tr>
<tr><td>Base population</td><td>Population for the year 2015 estimated by HCPH[*1]</td><td>The latest population census was done in 2009.</td></tr>
<tr><td>Population growth ratio</td><td>Constant growth ratio until 2030 by Samawah/others and by urban/rural based on the projection as follows:
<table>
<tr><th rowspan="2">District/
Sub-district</th><th colspan="2">2015-2030</th></tr>
<tr><th>Urban</th><th>Rural</th></tr>
<tr><td>Samawah</td><td>3.2%</td><td>2.9%</td></tr>
<tr><td>Others</td><td>2.0%</td><td>2.0%</td></tr>
</table></td><td>• For Samawah (3.2% and 2.9%): Estimated growth ratio for 2010 – 2015 by HCPH[*1]
• For Others (2.0%): Estimated growth ratio by Muthanna Statistical Directorate of CSO[*2]</td></tr>
<tr><td>Per capita consumption (Not including water leakage)</td><td>Daily maximum water demand per person per day (liter per person per day: Lpcd)
• Urban area: 250 Lpcd
• Rural area: 140 Lpcd</td><td>Set at about 30% lower than the values instructed by the Ministry of Municipalities and Public Works (MMPW) (2012)</td></tr>
<tr><td>Registration ratio to the piped water supply services</td><td>Reach 100% by 2030</td><td>Registration ratio in 2015 was 62% by contract base and was estimated at 70% by physical base.</td></tr>
<tr><td>Ratio of water leakage</td><td>• 15% for Samawah and 20% for other areas in the scenario where the water loss is well controlled
• Various ratios by area in the scenario where the water loss management is not well done</td><td>• For Samawah in 2015: Water leakage ratio was estimated at 42%
• For other areas in 2015: Water leakage ratio was estimated at 22% to 42%</td></tr>
<tr><td>Scenarios</td><td>Water demand was projected in four scenarios as follows:
<table>
<tr><th rowspan="2">Case</th><th rowspan="2">The Project</th><th colspan="2">Water Loss Reduction</th></tr>
<tr><th>Samawah</th><th>Others</th></tr>
<tr><td>Case-1</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td>Case-2</td><td>No</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Case-3</td><td>Yes</td><td>Yes</td><td>No</td></tr>
<tr><td>Case-4</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
</table></td><td>Finally, <u>Case-3 was adopted</u> in the Previous Study for the capacity of the water treatment plant in the Project.</td></tr>
</table>

*1: High Commission for Population and Housing, Ministry of Planning
*2 Central Statistical Organization, Ministry of Planning
Source: JICA Study Team based on the Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq

(2) Service area

Figure 5.5 shows the water supply service area of the Project presented in the Previous Study. As shown in the figure, the water supply service area was the northern part of Samawah District. The water supply service area was categorized into two areas: urban area (marked in red) and rural area (marked in yellow). As the boundaries among the urban areas and the rural areas are re-defined time to time according to the urbanization, however, the Study uses the latest boundaries.

On the other hand, although it was included in the population forecast area, the southern part of Samawah District had almost no inhabitants and therefore, the area was considered as a non-service area, while some distribution pipes from the urban area and local CUs are supplying water to the small number of inhabitants. Water demand in such areas was taken into account in the water demand projection in Samawah District.



* The Previous Study defined the southern part of the sub-district as "Non-Service Area" but there is a small number of inhabitants. These inhabitants are supplied by some distribution pipes extended from the urban areas and local CUs. Water demand in such areas was taken into account in the water demand projection in Samawah Qatha Center (Currently Samawah District).

Source: Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq

Figure 5.5 Water Supply Service Area in the Previous Study

(3) Scenario in the development of water treatment facilities

Among the four cases for the water demand projection, the Previous Study adopted Case-3, where the water loss reduction will be implemented in Samawah District but would not be implemented in other areas. The water transmission from the Rumaitha WTPs to Samawah District will be suspended and, in addition, all the CUs in Samawah District will be decommissioned when the new water treatment plant is constructed, while the production by the CUs in other areas will be reduced to 50% by 2025 and to 20% by 2030 compared with their treatment capacity in 2015 as shown in **Figure 5.2**.

(4) Capacity of the water treatment plant

According to the water demand projection and the other conditions above, the Previous Study concluded that the capacity of the water treatment plant in the Project will be 120,000 m^3/day as shown in **Table 5.5**.

Table 5.5 Highlight of the Study on the Capacity of the Water Treatment Plant in the Previous Study

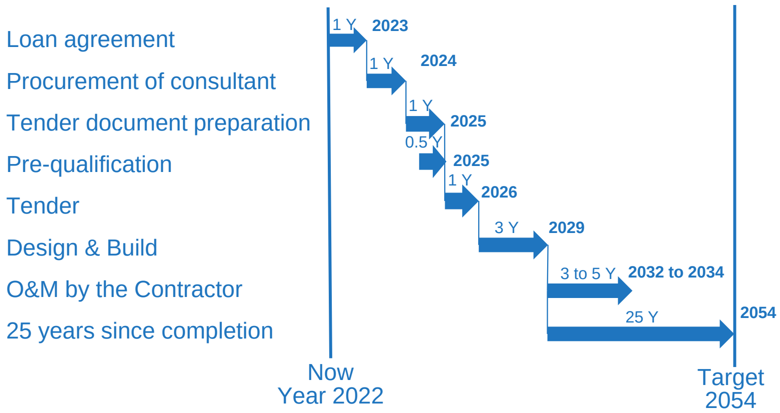
Item	Unit	2015	2030
Administrative population	person	291,116	461,445
Registration ratio	%	70	100
Service population	person	203,781	461,445
Leakage ratio	%	42	15
Daily maximum water demand	m^3/day	84,100	119,788
Capacity of CU	m^3/day	21,700	0
Capacity of WTP	m^3/day	0	120,000

Source: Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq

5.3.2 Water Demand Projection in the Study

(1) Target year

As shown in **Figure 5.6**, the target year was set as 2054, following the MCHPM's policy[2] which requires to apply 25 years after the completion of construction of all the main facilities. The main facilities of the Project are expected to be completed in 2029[3].



Source: JICA Study Team

Figure 5.6 Target Year of the Project Planning

(2) Existing population data

Table 5.6 shows the population of Muthanna Governorate in 2015 and 2021.

[2] Tasks and Duties of the GWD, Ministry of Construction, Housing and Public Municipalities
[3] See Section 11.5 for the Project's schedule.

Table 5.6 Population of Muthanna Governorate by District / Sub-district in 2015 and 2021

District / Sub-district	2015			2021		
	Urban	Rural	Total	Urban	Rural	Total
Samawah	210,937	80,179	291,116	239,580	85,047	324,627
Sowair	1,353	44,649	46,002	1,633	50,350	51,983
Rumaitha	77,046	35,129	112,175	92,986	39,615	132,601
Majid	2,945	39,110	42,055	3,555	44,105	47,660
Najmi	818	33,405	34,223	987	37,671	38,658
Hilal	2,876	35,654	38,530	3,470	40,207	43,677
Warka	3,401	92,031	95,432	4,104	67,911	72,015
Karama	N/A*	N/A*	N/A*	0	35,872	35,872
Khidir	38,338	47,515	85,853	55,339	44,510	99,849
Daraji	1,897	16,565	18,462	2,290	18,681	20,971
Salman	2,920	6,376	9,296	3,524	7,190	10,714
Bussaiya	982	88	1,070	1,185	62	1,247
Total Muthanna Governorate			774,214			879,874

*: Karama Sub-district is settled in 2018, so there is no data for 2015.

Source: MWD

Table 5.7 shows the average annual growth rate for the population of Muthanna Directorate from 2015 to 2021 calculated from the populations in **Table 5.6**.

On the other hand, the Ministry of Planning, Central Organization for Statistics, Statistical Directorate of Muthanna issued the letter showing the annual growth rate for the population in Samawah District from 2020 to 2021 to be 2.58% (Letter No. 284, Date: 28/3/2022). As the population in 2020 has not been provided, the JICA Study Team (JST) is not able to verify the value at 2.58% and to have the separate growth rates for urban and rural areas. The birth rate in Muthanna governorate from 1997 to 2018 ranged from 37.6% to 38.5%, and over the same period the average natural increase reached to34.5%. Compared to Iraq's natural growth rate of 20.4% during the same period, the reasons for the high natural growth rate in Muthanna governorate include increased births due to security, economic, social, and political stability. In addition, migration from rural to urban areas has contributed significantly to the population growth in Muthanna governorate[4].

Table 5.7 Annual Population Growth Rate for the Muthanna Directorate from 2015 to 2021

District/ Sub-district	2015-2021		
	Urban	Rural	Total
Samawah	2.14%	0.99%	1.83%
Sowair	3.18%	2.02%	2.06%
Rumaitha	3.18%	2.02%	2.83%
Majid	3.19%	2.02%	2.11%
Najmi	3.18%	2.02%	2.05%
Hilal	3.18%	2.02%	2.11%
Warka	3.18%	-4.94%	-4.58%
Qarama	-	-	-
Khidir	6.31%	-1.08%	2.55%
Daraji	3.19%	2.02%	2.15%
Salman	3.18%	2.02%	2.39%
Bussaiya	3.18%	-5.67%	2.58%
Total Muthanna Governorate			2.16%

Source: JICA Study Team

[4] Population growth in Muthanna province for the period (1997-2018) and its impact on sustainable development, Haider Hussein Aliwi Al-Shammari, 2018

(3) Population projection

1) Reference data

In addition to the annual growth rate calculation based on the existing population data for each district/sub-district above, the population projection for the whole country by the United Nations (UN) is available as reference. **Table 5.8** shows the population forecast for the whole of Iraq conducted by the UN in 2019.

Table 5.8 Population Forecast for Iraq by the UN (2019 Revision)

Growth Rate	2020	2030	2040	2050
High	40,222,493	51,355,256	63,943,764	77,474,064
Medium	40,222,493	50,193,756	60,583,723	70,940,126
Low	40,222,493	49,032,255	57,235,451	64,625,485

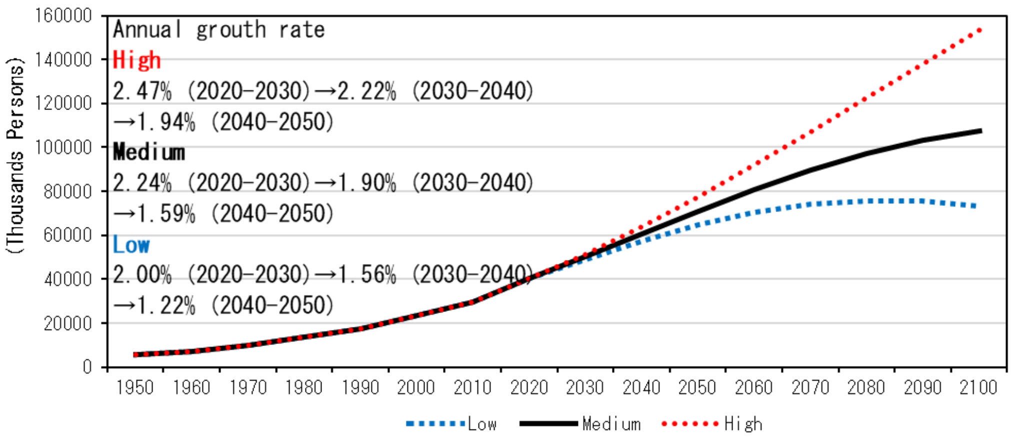
Source: United Nations Population Division[5]

Table 5.9 shows the average annual growth rate for the population in Iraq calculated based on the population forecast in **Table 5.8**. All three cases suppose that the annual growth rate will gradually decrease.

Table 5.9 Annual Growth Rate for Population by UN (2019)

Growth Rate	2020-2030	2030-2040	2040-2050
High	2.47%	2.22%	1.94%
Medium	2.24%	1.90%	1.59%
Low	2.00%	1.56%	1.22%

Source: JICA Study Team



Source: United Nations Population Division

Figure 5.7 Projected Population for Iraq by the United Nations

2) Population projection in the Study

In the Study, the population projection applies three cases for the annual growth rate as shown in **Table 5.10**. According to MWD, MOP recommends to adopt 2.58%, which is the growth rate in Samawah District in 2021, in the projection until the target year. Case1 refers to the recommendation and the other cases refer to the national trend projected by the UN.

[5] https://data.un.org/Data.aspx?q=iraq&d=PopDiv&f=variableID%3A12%3BcrID%3A368

Table 5.10 Annual Growth Rate of Population

Case	2021-2030	2030-2040	2040-2054	Description of the Case
Case1		2.58%		MWD's recommendation
Case2	2.58%	2.30%	2.00%	Correspond to High Case in UN's projection
Case3	2.58%	2.00%	1.50%	Correspond to Medium Case in UN's projection

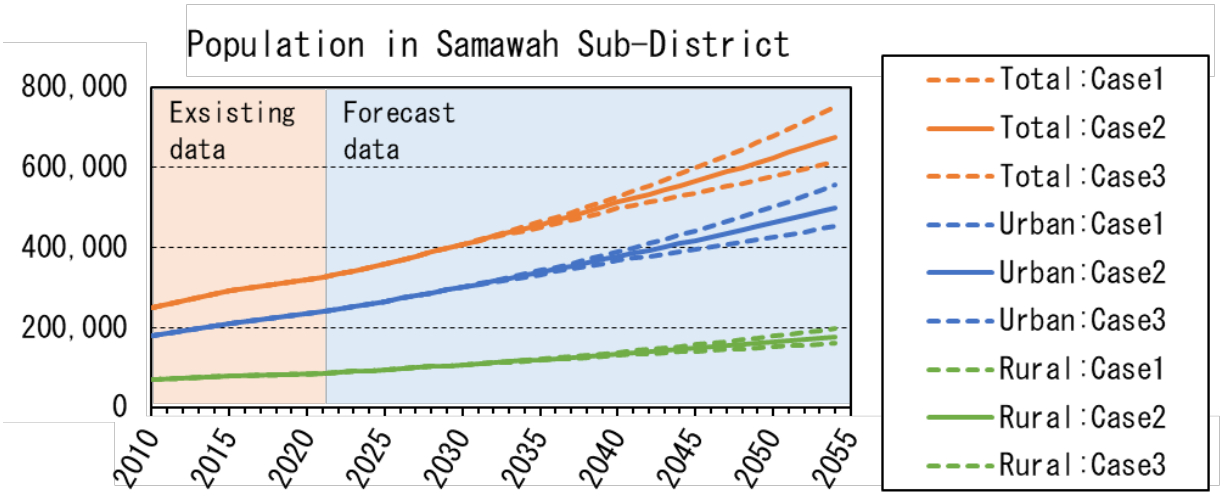
Source: JICA Study Team

Population forecast from 2022 to 2054 in Samawah District is as shown in **Table 5.11** and **Figure 5.8**.

Table 5.11 Population Forecast for Samawah District up to 2054

Case	2030			2040			2054		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Case1	301,311	106,960	408,271	388,724	137,991	526,715	555,290	197,119	752,408
Case2	301,311	106,960	408,271	378,243	134,270	512,513	499,084	177,167	676,251
Case3	301,311	106,960	408,271	367,296	130,384	497,680	452,419	160,601	613,021

Source: JICA Study Team



Source: JICA Study Team

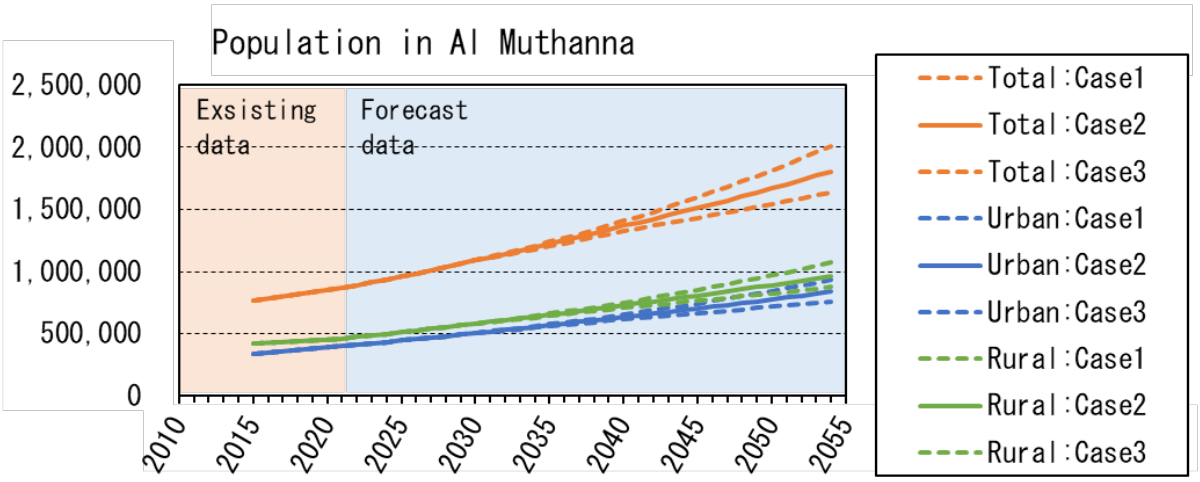
Figure 5.8 Projected Population for Samawah District

Population forecast from 2022 to 2054 in Muthanna Directorate excluding Salman District is shown in **Table 5.12**.

Table 5.12 Population Forecast for Muthanna (Excluding Salman District) up to 2054

	2030			2040			2054		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Case1	508,025	583,517	1,091,542	655,409	752,801	1,408,210	936,246	1,075,370	2,011,616
Case2	508,025	583,517	1,091,542	637,737	732,503	1,370,240	841,481	966,522	1,808,003
Case3	508,025	583,517	1,091,542	619,280	711,303	1,330,584	762,802	876,152	1,638,954

Source: JICA Study Team

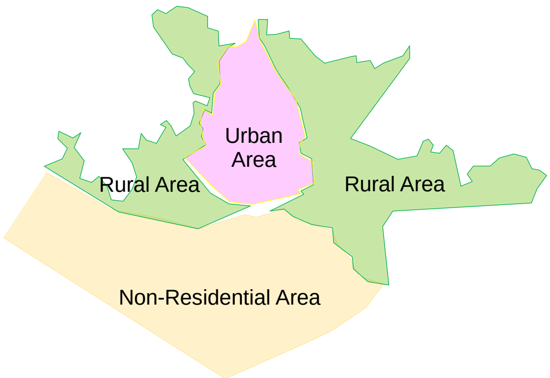


Source: JICA Study Team

Figure 5.9 Projected Population for Muthanna Directorate (Excluding Salman District)

(4) Service area

The water supply service area for the Project is the whole area of Samawah District as shown in **Figure 5.10**. The outer boundary of the service area in the Study is the same as that in the Previous Study but the urban area has been expanded.



Source: JICA Study Team

Figure 5.10 Water Supply Service Area in the Study

(5) Service population

According to the recommendation by MWD, the water demand projection in the Study presumes the service ratio at 100% as shown in **Table 5.13**. This means that in the water demand projection, it was assumed that all population in the urban service area will consume 250 Lpcd and 200 Lpcd in the rural area (See Sub-section 5.3.2(6).)

The JST deems that the water demand may have been overestimated based on the assumption. As the current registration rate, which is the percentage of the registered households to MWD's piped water services against the total households, is 65% in urban and 60% in rural, the major water sources of the remaining population of about 35% will be mostly water tankers, hence, will not consume 250 Lpcd or

200 Lpcd.

The increase of the registration rate needs additional investment of MWD on the water transmission and distribution networks and the willingness of the inhabitants.

Table 5.13 Service Ratio for Water Supply

Item	2022-2054	Remarks
Service ratio	100%	250 Lpcd in urban and 200 Lpcd in rural are uniformly adopted to the served population

Source: JICA Study Team

For reference, **Table 5.14** shows the assumption for the service ratio by the JST.

Table 5.14 Projection of Registration Ratio to Piped Water Service by JST

District/ Sub-district	(Existing Data)		Projection		
	2015	2021	2025	2040	2054
Samawah	62%	60%	70%	100%	100%
Sowair	11%	34%	60%	90%	100%
Rumaitha	77%	56%	70%	100%	100%
Majid	47%	53%	60%	90%	100%
Najmi	15%	26%	60%	90%	100%
Hilal	10%	23%	50%	90%	100%
Warka	35%	65%	80%	100%	100%
Qarama		40%	60%	90%	100%
Khidir	42%	45%	60%	90%	100%
Daraji	21%	38%	50%	90%	100%
Salman	Not Applicable because it does not belong to Rumaitha Water Supply System				

Source: JICA Study Team

(6) Unit water supply

The unit water supply is set as shown in **Table 5.15** following the letter by the Ministry of Planning, Directorate of Planning Sectors, Services and Buildings Department (Letter No.: 2/5/4/14127, Date: 19/10/2020).

Table 5.15 Unit Water Supply Used in the Water Demand Projection

Item	Urban	Rural
Unit Water Supply	250 Lpcd	200 Lpcd

Source: JICA Study Team

For reference, **Table 5.16** shows the calculation results of Lpcd under the conditions that:

- Registration ratio will follow the trend in **Table 5.14**,
- Unit water supply for piped water shall be as assumed in **Table 5.15**, and
- Non-registered people shall use tanked water and its unit water supply shall be 70 Lpcd for urban, and 40 Lpcd for rural areas.

Table 5.16 Projection of Registration Ratio to Piped Water Service by JST

District / Sub-district	2021		2040	
	Urban (Lpcd)	Rural (Lpcd)	Urban (Lpcd)	Rural (Lpcd)
Samawah	187	136	232	184
Sowair	250	150	250	184
Rumaitha	243	162	250	184
Majid	250	133	250	184
Najmi	250	166	250	184
Hilal	250	130	250	184
Warka	250	91	250	184
Qarama	-	91	-	184
Khidir	214	163	250	184
Daraji	250	168	250	184
Salman	Not Applicable because it does not belong to Rumaitha Water Supply System			

Source: JICA Study Team

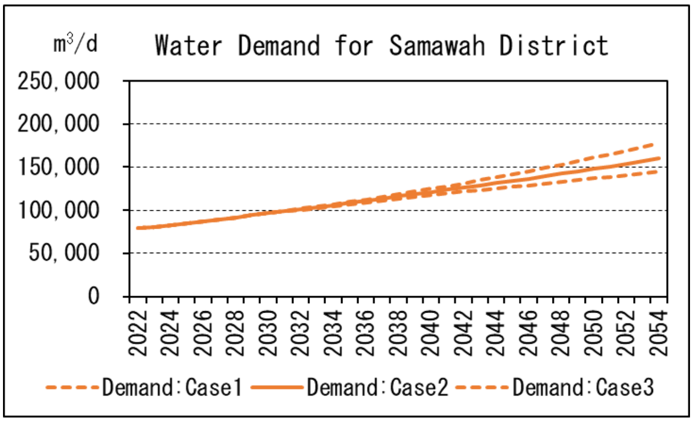
(7) Water demand

Water demand for Samawah District is calculated as shown in **Table 5.17** and **Figure 5.11**.

Table 5.17 Water Demand for Samawah District up to 2054

	2030 (m^3/d)	2040 (m^3/d)	2054 (m^3/d)
Case1	96,720	124,779	178,246
Case2	96,720	121,415	160,204
Case3	96,720	117,901	145,225

Source: JICA Study Team



Source: JICA Study Team

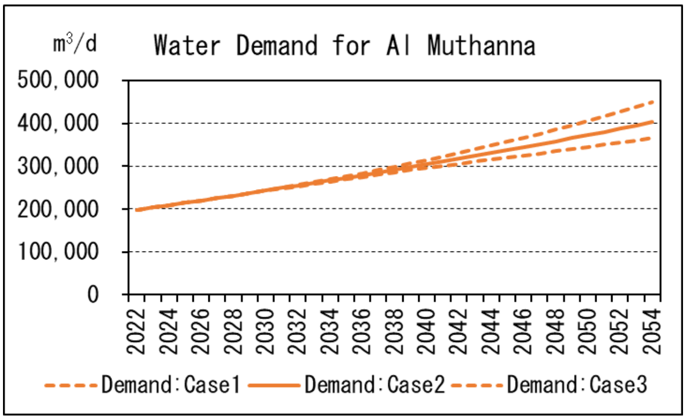
Figure 5.11 Water Demand for Samawah District

Water demand for Muthanna Governorate is calculated as presented in **Table 5.18** and **Figure 5.12**.

Table 5.18 Water Demand for Al Muthanna Governorate up to 2054

	2030 (m^3/d)	2040 (m^3/d)	2054 (m^3/d)
Case1	247,014	318,676	455,226
Case2	247,014	310,083	409,148
Case3	247,014	301,109	370,893

Source: JICA Study Team



Source: JICA Study Team

Figure 5.12 Water Demand for Muthanna District

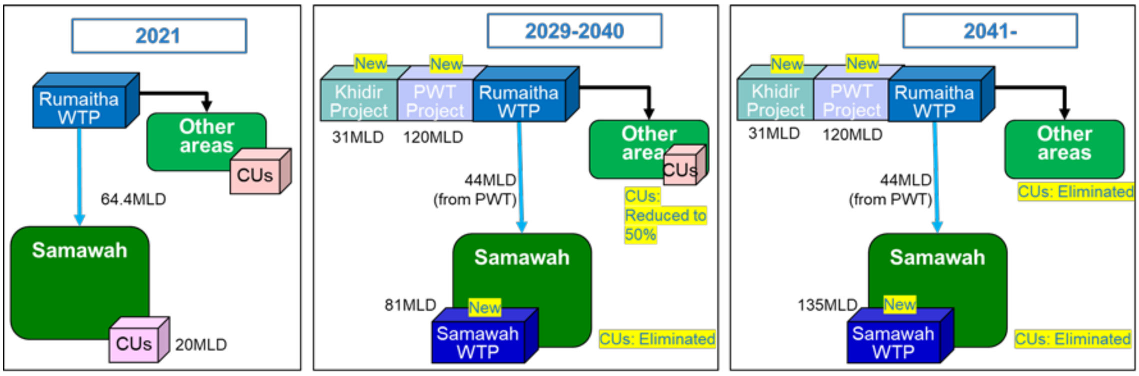
5.3.3 Capacity of Samawah WTP

(1) Methodologies and assumptions in the Study

Capacity of the WTP is studied based on an examination of the balance or gap between the water demand and the water supply facilities for Samawah District. The plant capacity will be proposed so that the WTP will bridge the gap between the water demand and the water supply capacity of the other facilities. The examination of the gap is conducted under the following conditions:

- From 2029, when Samawah WTP starts its operation, the PWT Project will start to supply water to Samawah District at a water volume of 44,000 m^3/d by utilizing the existing water transmission line constructed in 2007, while all water produced by the Rumaitha WTP will be used in other areas in the governorate[6]. (See **Figure 5.13**)
- All the CUs for Samawah District will also be cancelled in 2029.
- It may result in an overinvestment to constructing a WTP for a capacity to cater for the water demand 25 years after the completion. Moreover, mechanical and electrical equipment's life is in general in about 15 years. As "Phase 1" of the project, therefore, the capacity of the WTP is set based on the supply-demand gap as of 2040, which is 11 years after the Project's completion.
- The definitive capacity of the WTP will be proposed according to the water demand in the final target year (2054).

[6] This assumption suggests that some illegal water users along the transmission lines may be affected, to whom MWD has an intention to supply water by utilizing CUs and/or extending the water network. (See II 6. in MOM on 6th November 2022 in Appendix 1-2.)



Source: JICA Study Team

Figure 5.13 Water Supply System to Samawah District Before/After the Project

(2) Proposal on the plant capacity

Based on the above conditions and the water supply volumes that will be supplied to Samawah District from the existing and future water treatment facilities as shown in **Table 5.19**, the capacity of Samawah WTP is proposed at 81,000 m^3/day in the first phase whose planning horizon is the year 2040. Together with the PWT Project, the Samawah WTP will satisfy the water demand in Samawah District of 124,779 m^3/day in 2040. After the Project, Samawah WTP may be expanded to 135,000 m^3/day, by adding a capacity of 54,000 m^3/day, to satisfy the water demand in 2054.

Figure 5.14 shows the water demand and supply balance for the Samawah District with Samawah WTP as well as PWT Project.

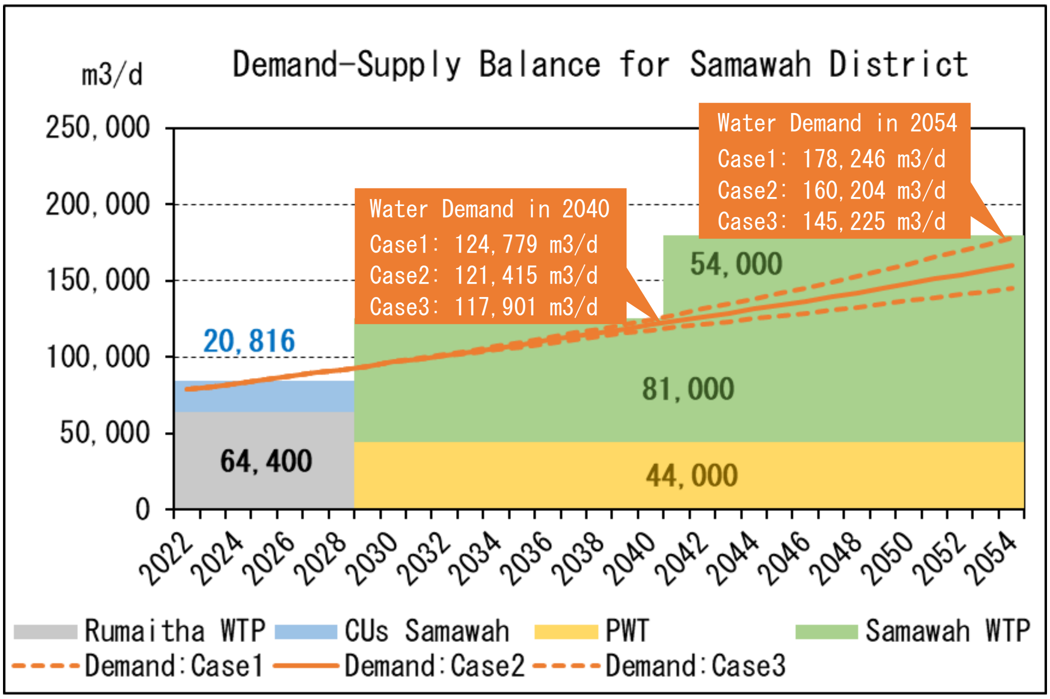
Table 5.19 Maximum Water Supply Volume for Samawah District

Water Treatment Facilities	2021-2029	2029-2040 (After the Project)	2040 – (After the Expansion of Samawah WTP)
Rumaitha WTPs	64,400 m^3/d*1	0	0
CUs	20,286 m^3/d*2	0	0
Samawah WTP	0	81,000 m^3/d	135,000 m^3/d
PWT	0 m^3/d	44,000 m^3/d	44,000 m^3/d
Total	84,686 m^3/d	125,000 m^3/d	179,000 m^3/d

*1: 60% of the actual production volume of the Rumaitha WTPs (See Section 4.2.2 Table 4.6), presuming 40% is sent to the other areas.

*2: Actual capacity of the CUs for the Samawah District (See Section 4.2.2 Table 4.8)

Source: JICA Study Team



Source: JICA Study Team

Figure 5.14 Water Supply Demand Balance in Samawah District

(3) Water balance in the whole Muthanna Governorate

Examination of the overall balance of water supply and demand in Muthanna Governorate was conducted under the following conditions:

- It is assumed that the capacity of Rumaitha WTP will be halved in 2029 when the Samawah WTP starts its operation. From 2040, the production will be reduced to 80% of the design capacity of the WB Rumaitha WTP, assuming the decommissioning of the New Rumaitha WTP.
- It is assumed that all the CUs in Samawah District will be decommissioned also in 2029. Production of the CUs in other areas will be halved in the same year and they will all be decommissioned in 2040.
- The PWT Project and Al Khidir Water[7] Project will start operation in 2029.

Table 5.20 shows the maximum water supply volume for the whole Muthanna Directorate. **Figure 5.15** shows the water demand and supply balance for the directorate before and after the Project (without the expansion).

[7] See Section 3.6.2.

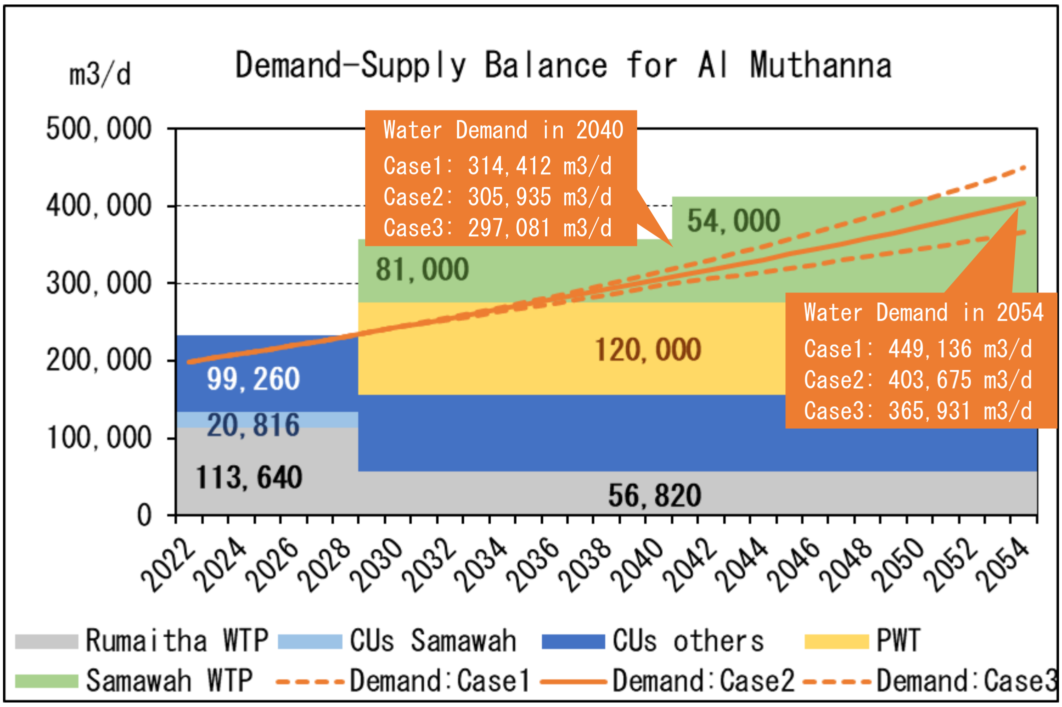
Table 5.20 Maximum Water Supply Volume for the Whole Muthanna Governorate

	2021-2029	2029-2040 (After the Project)	2040 – (After the Expansion of Samawah WTP)
Rumaitha WTPs	113,640*1 m³/d	56,820 m³/d	32,400 m³/d
CUs	119,546*2 m³/d	49,630 m³/d	0
Samawah WTP	0 m³/d	81,000 m³/d	135,000 m³/d
PWT	0 m³/d	120,000 m³/d	120,000 m³/d
Al Khidir Water Project	0 m³/d	31,000 m³/d	31,000 m³/d
Total	233,186 m³/d	338,450 m³/d	318,400*1 m³/d

*1: Actual production volume of the Rumaitha WTPs and Warka WTP (See Section 4.2.2 Table 4.6 and Table 4.7).

*2: Actual capacity of the CUs for the Muthanna Governorate (See Section 4.2.2 Table 4.8)

Source: JICA Study Team

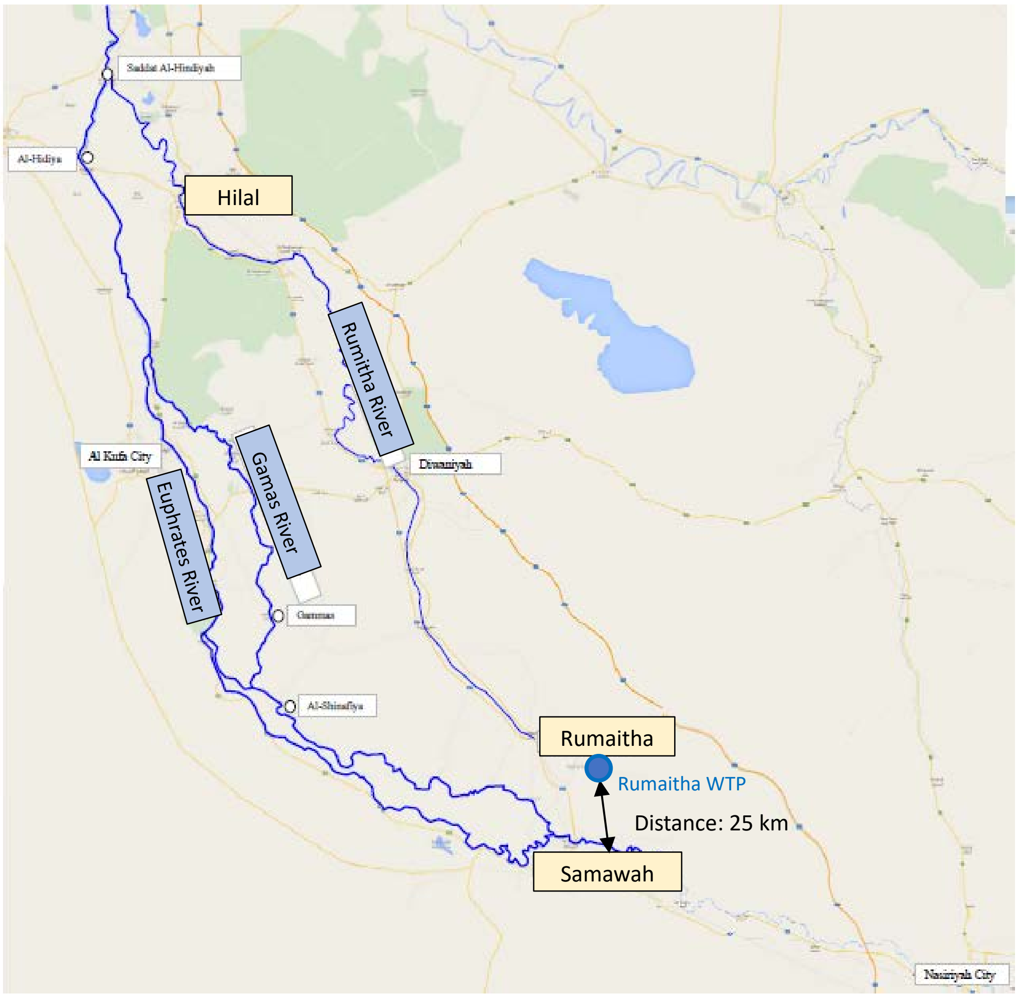


Source: JICA Study Team

Figure 5.15 Water Supply Demand Balance in the Whole Muthanna Governorate

5.4 Necessity of the Project

For the water supply service in Samawah, which is the capital city and whose population accounts for around 37% of Muthanna Governorate, there is no water treatment plant at present except for the CUs. To confirm the necessity of the Project, the potential future water sources among the possible resources shown in **Figure 5.16** to meet the demand for Samawah were studied as follows:



Source: UN-ESCWA-BGR 2013

Figure 5.16 Water Resources in Iraq

1) Rumaitha River

At present the major water source to Samawah District is the water treatment plants in Rumaitha which is 25 km away. In the transmission lines from Rumaitha much amount of water is lost by extraction and connection. Also the Previous Study in 2016 reported that the water volume of the Rumaitha River became 10 m^3/s due to exploitation of raw water from the upstream, while the volume was originally estimated at 35 m^3/s. It may be the reason why the TDS concentration is recently getting higher in comparison with the data in 2016.

2) Surface water in northern area of Muthanna Governorate

As the water availability in the Rumaitha River is limited, the MCHPM is implementing the PWT Project whose raw water will be taken from the Gamass River to correspond to the deteriorating water volume and water quality of Rumaitha River. However, the Ministry of Water Resources announced that no water shall be newly taken from the tributaries of the Euphrates River (Letter No. 19285 dated 29th June, 2022), such as the Rumaitha River or the Gamass River, for the future projects. Therefore, water resources available to MWD's new projects will only be the Euphrates River, which suffers from increase in the salinity.

3) Compact Units (CUs)

Existing water treatment facilities in Rumaitha and CUs are no longer able to operate fully, and the water transmission volume to Samawah became insufficient to meet the demand. The MWD identified that the locations of the existing CUs are spread throughout Samawah, and that makes operation and maintenance by MWD difficult to implement. The MWD is thus thinking to stop operation of the existing CUs after the completion of the new central water treatment plant in the Project.

4) Groundwater

It was stated in the previous report that available raw water per person from groundwater is only one tenth of the surface water in Iraq. Moreover, as mentioned in Item (2) of Section 2.2.3, the TDS concentration in the groundwater is high in the southern region due to the influence of sea water intrusion. It was confirmed by MWD that groundwater cannot be used since its TDS is very high especially in the center of Samawah.

5) Euphrates River

Although the raw water can be evaluated to have enough volume to supply the water to Samawah, TDS at the Euphrates River has become high recently as indicated in **Figure 4.4** in Section 4.2.1 and **Figure 5.19** in Section 5.5.2.

As studied above, although it is the capital city with the greatest volume of water demand in the governorate, Samawah District highly depends on the water supply from the distant Rumaith WTP. For the reasons of the deteriorating production capacities of the Rumaitha WTP and the compact units, as well as the water loss in the transmission lines from Rumaitha WTP, the water supply in the capital city is not sufficient. Furthermore, no additional water from the tributary river of the Euphrates River, except for the Gamas River in the PWT Project, will be available and the groundwater is not suitable to be used for water supply. In addition, the existing CUs have the difficulties in operation and maintenance. In order to satisfy the water demand in Samawah District, therefore, new water supply system dedicated to Samawah District with desalination process on the river water from the Euphrates River is highly required.

5.5 Planning of Water Treatment Plant

5.5.1 General Site Conditions of the Water Treatment Plant

The proposed site[8] of the Samawah Water Treatment Plant (Samawah WTP) shown in **Figure 5.17** is located in Samawah District. Intake point is located at approximately 200 m from the southeast corner of WTP and the brine discharge point is approximately 6.7 km to the north from the site. Besides, 200 m to the southeast, there is the Afaat CU that has close intake point to that of the Samawah WTP. The WTP site has an area of 15.1 ha. General site conditions for the plant design are summarized in **Table 5.21**.

Soil information shall be referred to the results of the soil investigation in 2016 such as N values and bearing capacity according to the depth and ground pressure of the WTP site. In the Study, JST has carried out the topographic survey. According to the results of the survey, it has been confirmed that there has been no large change in the topographic features since 2016.

Source: JICA Study Team

Figure 5.17 Proposed Site of Samawah WTP

Table 5.21 General Site Conditions for the Design of Samawah WTP

Items	General Condition	Ref.
Temperature/ Precipitation	The mean temperature from 1980 to 2015 is 25.3℃ and the mean annual rainfall from 1980 to 2015 is 105.7 mm. The dry season is from May to October.	Chapter 2.2.1
Topography/ Water Resources	Samawah is located in the slopes between the Saudi Arabia plateau and in the Euphrates River system, and the Euphrates and Tigris rivers are connected to the Shatt al Arab River as upstream/downstream relationship within the system.	Chapter 2.2.2
Soil Property	From the ground surface to the depth of 5 m is slightly soft soil layer and from 5 m to 10 m is a better soil layer. In general, this condition is preferable as WTP site.	Chapter 2.2.2
Groundwater	Salinity is not an issue on the left bank side of the Euphrates River, but in the lower right bank, groundwater salinity is as high as 10 g/L (1.0%).	Chapter 2.2.3
Sludge Disposal Site	Sludge disposal site is a disposal site designated by the Muthanna Governorate for disposal[9].	Chapter 8.7
Electricity	Power supply for this project is expected to be improved as called the “Critical Line” but frequent power outage will happen. Power generators should be installed.	Chapter 2.5.3

Source: JICA Study Team

[8] See Appendix 5.1 for photos of the WTP site.
[9] Design consultation meeting with MWD and MCHPM

5.5.2 Water Qualities of Raw and Product Water

Table 5.22 shows the standards and existing data of raw water and product water that were referred in the setting of the design conditions.

Table 5.22 Design Water Quality (Raw Water and Product Water)

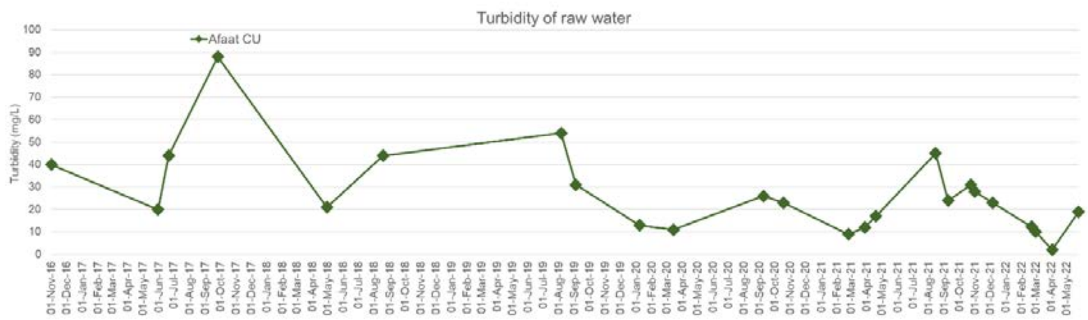
Item※1	Unit	Raw Water Quality			Product Water Quality	
		Design Value	MWD's Test Results※2	Study Team's Survey Results※3	Design Quality	WHO Standard
Water Temperature※4	℃	17-37	17-37	24.3-27.6	-	-
pH	-	6.5-8.5	7.7-8.2	6.6-7.9	6.5-8.5	6.5-8.5
TDS	mg/L	≤ 3,000	1,130-3,150	1,422-1,620	<1,000	<1,000
Chloride	mg/L	300-600	216-854	343-384	<250	<250
Hardness※5	mg $CaCO_3$/L	600-1,000	470-1,117	633-769	<200	<80-200
Turbidity	NTU	30-80	1.8-88	25-106	<1.0	<1.0
Langelier Index	-	-	-	-	-	0-1

※1: Quality Standard for Drinking Water (IQS 417) is mentioned in Table 3.4.
※2: The test has been carried out in Afaat CU as stated in Chapter 5.5.1.
※3: The test has been carried out in an accredited laboratory.
※4: In the study, design calculation for RO facility has been carried out on the condition of maximin and minimum temperature case.
※5: Hardness of MWD teat and Study Team survey has been estimated by the concentration of Ca and Mg.
Source: JICA Study Team

(1) Raw water quality

Design values for raw water quality was determined based on the recent raw water quality data of Afaat CU, which is located beside the Samawah WTP, provided by MWD. The results of the water quality survey[10] carried out in the Study were utilized to reinforce the validity of the data from Afaat CU.

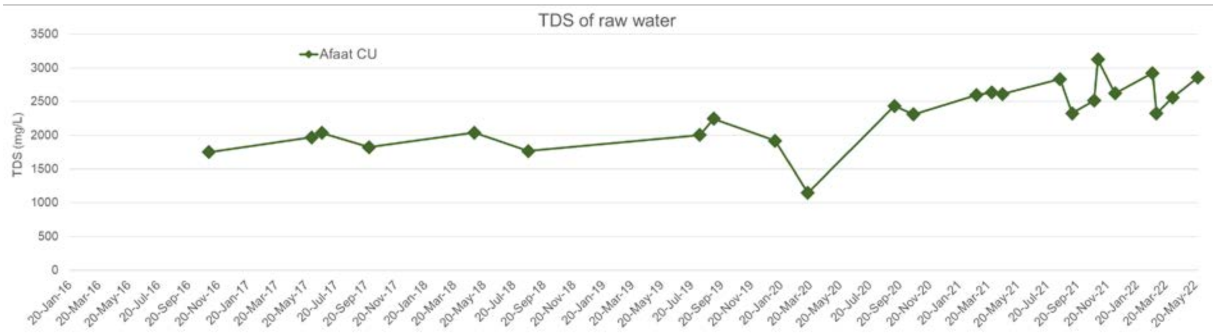
Turbidity and TDS, the most critical parameters in the design of the Samawah WTP, of the raw water during 2016 to 2021 at Afaat CU are shown in **Figure 5.18** and **Figure 5.19**. In addition, the summarized results of the water quality survey by JST from August to October in the Study are shown in **Table 5.23**. The fluctuation of the values of turbidity is taken into account in the planning of pretreatment as mentioned in Sub-section 5.5.3(6) and that of TDS is taken into account in the planning of RO as mentioned in Sub-section 5.5.3(7).



Source: JICA Study Team

Figure 5.18 Turbidity of the Raw Water at Afaat CU from 2016 to 2022

[10] The sampling location is the intake point of Afaat CU. The depth of sampling shall be approximately 2 m. The results of water quality survey are shown in Appendix 5.1.



Source: JICA Study Team

Figure 5.19 TDS of Raw Water at Afaat CU from 2016 to 2022

Table 5.23 Results of Water Quality Survey (August 2022 to September 2022)

Item※1, ※2	29th Aug	30th Aug	5th Sep	20th Sep	25th Sep
Water Temperature (℃)	24.7 / 24.4	25.7 / 25.0	24.8 / 24.3	24.5 / 25.0	27.4 / 27.6
pH (-)	7.47 / 7.16	6.60 / 7.26	7.88 / 7.37	7.40 / 7.33	7.40 / 7.54
TDS (mg/L)	1,528 / 1540	1,482 / 1,508	1,476 / 1,481	1,472 / 1,422	1,620 / 1,612
Chloride (mg/L)	384 / 374	359 / 343	348 / 364	379 / 364	369 / 374
Turbidity (NTU)	56 / 25	30 / 49	106 / 58	35 / 54	38 / 50

※1: 2 samples were taken in each 2 days. The numbers of all measured items are 32 including biological and chemical.
※2: The test has been carried out in an accredited laboratory.
Source: JICA Study Team

(2) Product water quality

According to the discussion with MWD, the JST decided that the product water quality shall follow Iraqi standards and the values are compared with global standards such as WHO standards as reference. If the design standard values vary between the Iraqi standards and WHO standards, the standards have been decided according to the discussion with MWD in terms of actual condition of MWD operation for existing facilities and the optimization of life cycle cost (LCC, considering all the costs that will be incurred during the lifetime of the product). In conclusion, the values meet both standards.

5.5.3 Water Treatment Facility Planning

(1) General planning concept

As a result of discussions with MWD, the JST applies the following general planning concept to the overall process configurations and to each facility in the WTP:

- Reduction of OPEX (Operational Expenditure) is the top priority in terms of the Project's sustainability.
- CAPEX (Capital Expenditure) is often in the relationship of trade-off with OPEX. Therefore, reduction of CAPEX must be studied carefully so that it would not increase the OPEX much. In other words, the life cycle must be taken into account in the plant planning.
- Operational flexibility of the WTP according to the variations of water demand and TDS is required.
- There is no need to follow the design of the existing facilities of MWD as Samawah WTP is the

first full-scale WTP with desalination process in Muthanna Directorate.

- Materials and equipment shall be those available in Middle East markets as much as possible. Also, consideration will be given to applying the specifications/materials that may optimize the WTP's OPEX.

As a reference, comparison of design conditions with the Previous Study is shown in **Appendix 5.2**.

(2) WTP capacity

The WTP capacity in the Project is 81,000 m^3/d as the 1st phase of the Samawah WTP to meet the water demand in 2040. The final capacity of the WTP will be 135,000 m^3/d for the water demand in 2054 as mentioned in Section 5.5.3[11]. In the preliminary design of WTP, the design of each facility and equipment shall be based on the assumption of 135,000 m^3/day for the final phase. In addition, the facilities and equipment to be constructed in the Project (phase 1) shall be selected according to the consideration for final phase. The specifications of the facilities and equipment to be extended from the Project to the final phase shall in principle be the same as in the Project.

(3) WTP site

The Previous Study identified two candidate sites (Site 1 and Site 2) for the WTP[12] and there is no other potential site available to the Project in and around the suburbs of Samawah.

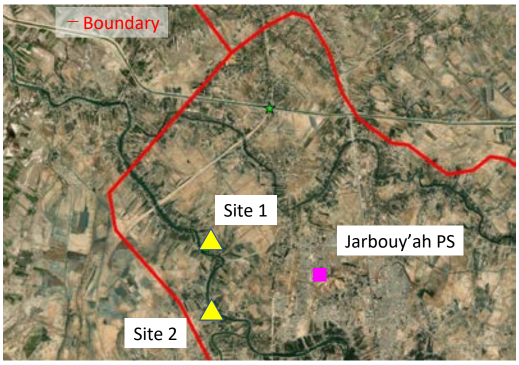
Site 1, located on the left bank of the Euphrates River, had advantage in the cost reduction in the product water transmission and brine discharge due to its short distances to the urban center and to the discharge point. As Site 1 does not have enough area to install all facilities for the WTP, however, Site 2 on the right bank of the river was selected. JST reanalyzed the minimum footprint of the WTP but as studied in the Previous Study, it was concluded that Site 1 is too narrow to contain the WTP. Therefore, Site 2 should be the final WTP site as explained in **Table 5.24**.

After the Previous Study, the Ministry of Agriculture (MOA) amended the lease agreement with the farmers in order to expand the available area in Site 2 to 15 ha. As the WTP may need to be expanded according to the increase of the water demand in the future, even after the Project’s planning horizon (Year 2054) as indicated in Sub-section 5.3.2 (1), Site 2 has the advantage for its potentials to expand the plant capacity.

[11] In the Study the WTP is presumed to be step-wisely developed until the ultimate capacity of the WTP to correspond to the water demand in 2054. However, it does not mean that the execution of the final phase has been determined.

[12] Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq, JICA, Yachiyo Engineering Co., Ltd, NJS Co., Ltd., July 2016

Table 5.24 Comparison of WTP Site Alternatives

Items	Site 1 (left bank)	Site 2 (right bank)
Location※1 (The land shape of Site 2 is mentioned in Section 5.5.1)		
Land area	1～2 ha※2 (WTP requires at least 4 ha)	15 ha (Layout: Sub-section 5.5.3(15))
Land acquisition	Required	Required but already completed by MOA
Area reduction	Even in case of maximum consideration of area reduction, it cannot be allocated.	No special consideration.
Future expansion		Enough potential
Evaluation	Not selected (Not enough land area)	**Selected**

※1: Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq, JICA, Yachiyo Engineering Co., Ltd, NJS Co., Ltd., July 2016

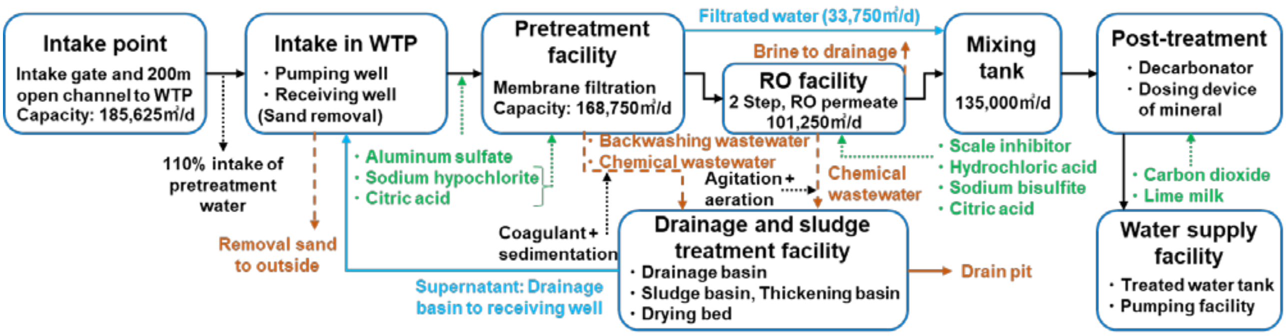
※2: Design consultation meeting with MWD and MCHPM

Source: JICA Study Team

(4) Process flow and RO capacity

General process flow of Samawah WTP is shown in **Figure 5.20**. Blending of pretreated water with RO permeate reduces the capacity of RO, which will reduce CAPEX and OPEX of the WTP. The maximum blend ratio shall be 25% to ensure the compliance with the upper limit of treated water TDS with some margin, and the ratio shall be adjusted by the plant operator according to the variation of water demand and raw water TDS. The relationships between raw water volume, TDS and blend ratio are summarized in **Table 5.25**. In addition, detailed explanation for determination of blend ratio is stated in **Appendix 5.2**.

RO capacity is 101,250 m^3/d in the final phase to produce the treated water volume of 135,000 m^3/d in case of standard condition (Raw water TDS: 3,000 mg/L, blend ratio: 25%). Operational simulation of RO facilities is described in Sub-section 5.5.3(7). The number of train is 6 in terms of the optimization of balance of CAPEX/OPEX and ability to respond to emergency situations such as breakdown and cleaning of train as mentioned in Sub-section 5.5.3(7).



Source: JICA Study Team

Figure 5.20 Overview of Process Flow (Final Phase)

Table 5.25 Variation of Maximum Blend Ratio According to Product Water Volume and Raw Water TDS

<table>
<tr><th>Product Water Volume</th><th>Raw Water TDS</th><th>Blend Ratio</th><th>Active Train (pretreatment)</th><th>Active Train (RO)</th><th>Treated Water TDS</th></tr>
<tr><td rowspan="4">67,500 m³/d
(50%)</td><td>1,500 mg/L</td><td>55%</td><td rowspan="4">3 / 6</td><td>2 / 6</td><td>839 mg/L</td></tr>
<tr><td>2,000 mg/L</td><td>40%</td><td rowspan="4">3 / 6</td><td>824 mg/L</td></tr>
<tr><td>2,500 mg/L</td><td>35%</td><td>908 mg/L</td></tr>
<tr><td>3,000 mg/L</td><td>25%</td><td>795 mg/L</td></tr>
<tr><td rowspan="4">101,250 m³/d
(75%)</td><td>1,500 mg/L</td><td>55%</td><td rowspan="4">5 / 6</td><td>839 mg/L</td></tr>
<tr><td>2,000 mg/L</td><td>40%</td><td rowspan="2">4 / 6</td><td>824 mg/L</td></tr>
<tr><td>2,500 mg/L</td><td>35%</td><td>908 mg/L</td></tr>
<tr><td>3,000 mg/L</td><td>25%</td><td>5 / 6</td><td>795 mg/L</td></tr>
<tr><td rowspan="4">135,000 m³/d
(100%)</td><td>1,500 mg/L</td><td>55%</td><td rowspan="4">6 / 6</td><td>4 / 6</td><td>839 mg/L</td></tr>
<tr><td>2,000 mg/L</td><td>40%</td><td>5 / 6</td><td>824 mg/L</td></tr>
<tr><td>2,500 mg/L</td><td>35%</td><td rowspan="2">6 / 6</td><td>908 mg/L</td></tr>
<tr><td>3,000 mg/L</td><td>25%</td><td>795 mg/L</td></tr>
</table>

※: Consideration for the number of trains is stated in Section 5.5.3(7).

Source: JICA Study Team

(5) Intake facility

1) Location of intake point and conduit route

Intake point is located 200 m from the southeast corner of the WTP site as mentioned in **Figure 5.17**. For the reduction of CAPEX and OPEX for transmission, as there is no constraint in the land availability, the intake point will be located at the closest point on the river from the WTP site and the raw water transmission channel will be installed beside the existing pathway to the river bank.

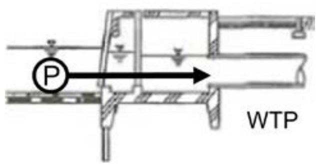
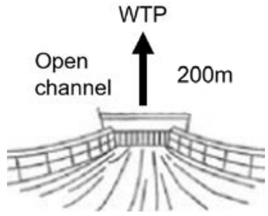
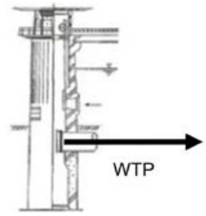
2) Intake method

As the alignment is flat in the elevation (The maximum difference in elevation within the site is approximately 2.0 m only.), the raw water transmission needs lift pumps at the intake point or in the WTP site. The intake facility including pumping system will have three basic options in its configurations as mentioned in **Table 5.26**. As a conclusion, the option of open channel and pumping up in the WTP is adopted. This option shows the best life cycle cost and in terms of the prevention of sand suction for pump and oil intrusion, sand can be removed naturally in open channel before pumping up and oil removal function can be installed in the pumping well inside the WTP site. The detailed explanations such as example of open channel route are stated in **Appendix 5.3**.

3) Variable frequency device

Variable frequency device (VFD) can be adapted to the raw water transmission pumps installed in the intake facility. The effect for cost reduction is almost 10% in terms of LCC in this case.

Table 5.26 Comparison of Intake System

Items	Submerged Pump in the River and Transmission to WTP by Pipeline		Open Channel and Pumping Up in WTP Site		Water Intake Tower and Transmission to WTP by Pipeline	
Image						
Practice in Iraq	Used in existing compact units		Used in Basra WTP		-	
General features	• Simple for construction and stable for O&M if water flow and water level is stable.		• Suitable in case of low fluctuation of water level • Little impact for water flow and flood control of the river		• Suitable in case of large scale water intake • Large structures compared with intake pipelines and channel	
Structure / Scale	Only parts of revetment must be demolished for intake	A	Only parts of revetment must be demolished for intake	A	Large structure must be constructed in the river	C
Environmental impact	Small impact on the river's natural conditions	B	Small impact on the river's natural conditions	B	Impact on the river's natural conditions should be carefully examined	C
O&M	• Sand and oil removal become severe problems • Pump is located in outside of WTP	C	• Sand removal can be expected naturally • Oil removal can be considered inside of WTP	A	• Removal function for sand and oil can be installed in the facility	B
CAPEX	90～100	B	100	B	150～200	C
OPEX	120～130	C	100	B	90～100	B
Evaluation	• Countermeasures for sand suction is necessary • Pumps are located outside, which is not preferable in terms of O&M • High OPEX	C	• No concerns for sand removal • The best life cycle cost	A	• Potential impact on the river environment is unpreferable • High CAPEX	B

※Evaluation of each item: A (Excellent), B (Very good), C (Good)

Source: JICA Study Team

(6) Pre-treatment facility

1) Overview of pre-treatment method for RO process

Pre-treatment methods for RO process are mainly classified into two types, coagulation and sedimentation with sand filtration method (hereinafter referred to as sand filtration) and membrane filtration method. Both sand filtration and membrane filtration are further classified into two types as the following and slow sand filtration is adopted in most of the existing compact units, even in high turbidity cases[13].

- Sand filtration: Rapid sand filtration / Slow sand filtration
- Membrane filtration: Organic membrane (e.g., Polyethylene) / Inorganic membrane (e.g., Ceramic)

In general, although the membrane filtration is a high quality and stable treatment method, the sand

[13] Design consultation meeting with MWD and MCHPM

filtration has a long history and more operational records with accumulated various findings and is often less expensive than the membrane treatment. Therefore, the sand filtration is the predominant method in conventional WTPs. However, in case of the application as pre-treatment for the RO process, the membrane filtration is the major option based on the overall evaluation on not only the pre-treatment-related cost but also on the benefits by reduction of the load on the subsequent RO membranes, reduction of wastewater and sludge volumes as well as the operational flexibility according to the fluctuation of raw water condition.

2) Selection of pre-treatment method

Table 5.27 shows a comparative study of the pre-treatment methods[14]. Membrane filtration is selected as it is the best in the life cycle cost and filtered water's quality according to the raw water condition of Samawah WTP. Rapid sand filtration is also competitive in general but, as proven in the existing WTPs operated by MWD in Rumaitha, maintenance of good water quality by appropriate coagulation, flocculation, sedimentation, and sand filtration is not easy amid the varying turbidity. On the contrary, in the membrane filtration case, the operation can be automated and the quality of treated water is guaranteed even if the coagulation process does not work perfectly.

Table 5.27 Comparison of Pre-treatment Method

Items※1	Membrane Filtration		Rapid Sand Filtration	
Raw water	• Strong to fluctuations in turbidity. • Maximum turbidity is 500 NTU. • Cartridge filters are required when large particle size turbidity is present.	A	• Relatively strong to fluctuations in turbidity. • Applicable turbidity is 10 or higher. • Even in the presence of large particles, there is no significant impact on operation.	B
Land area	Small(Requirement of sedimentation process depends on membrane types)	A	Large※2 (sedimentation and rapid filtration pond are required)	C
Wastewater treatment	• Low use of coagulant and low sludge volume. • High recovery rate and good settling of sludge.	B	• High use of coagulant and high sludge volume. • Control is required for raw water quality.	C
O&M	• Membranes should be replaced once every 5-10 years for organic membrane and around 20 years for inorganic membrane. • Automatic and unmanned operation is possible. • Remote monitoring of operating conditions is possible. • Inexpensive powdered activated carbon can be applied. • Oil detection sensor is required.	B	• Regular equipment inspections and replacement of filtration sand are necessary. • Automatic operation is possible partly. • Unmanned operation is difficult due to the necessity for coagulation management. • Granular activated carbon is required. • Oil detection sensor is required.	C
Life cycle cost※3	100	B	110～120（Depending on the raw water condition and the kinds of membrane）	C
Evaluation	• Very good water quality • Unmanned operation • Low life cycle cost	A	• Good water quality • Partly automatic operation※4 • High life cycle cost	B

※1: Evaluation of each item: A (Excellent), B (Very good), C (Good), D (Fair)
※2: In Samawah WTP, adoption of rapid sand filtration will make it difficult to secure the lands for the solar panel generation, drying bed and the living space for the contractor during the construction and O&M services.
※3: LCC means the total cost of pre-treatment facility and subsequent RO facility. Load reduction of RO facility was taken into account.
※4: Additional costs will be required depending on the scope of automation to be implemented.

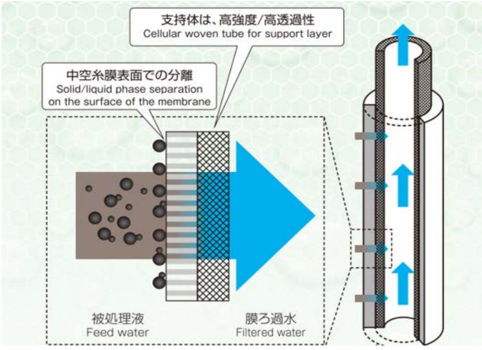
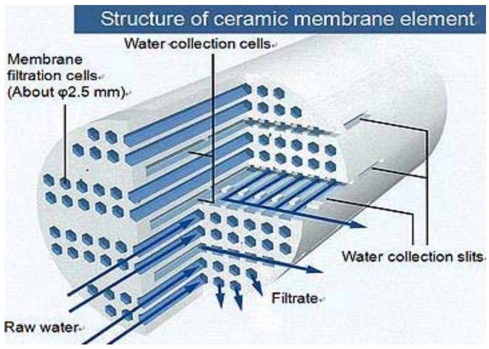
Source: JICA Study Team

[14] The details of the comparative study are presented in Appendix 5.4.

3) Membrane materials

Table 5.28 shows the comparison in terms of general features such as maintainability and cost. The JST proposes to apply inorganic membrane in terms of the high maintainability and low OPEX with the consideration for O&M skill and loads for WTP staff such as low frequency of chemical cleaning and possibility for unmanned operation. While the organic membrane is also applicable in terms of technical points such as treated water quality, according to the raw water conditions of Samawah WTP, in case of application of organic membrane, flocculation and sedimentation process might be installed prior to the membrane treatment to deal with high turbidity. Therefore, regarding with CAPEX, although organic membrane is generally less expensive compared independently as membrane facilities, inorganic membrane is less expensive for the overall pretreatment facility in case that the flocculation and sedimentation process similar to that of the rapid filtration facility are installed in the prior stage. Details especially for specific products that can be applied to Samawah WTP are stated in **Appendix 5.4**.

Table 5.28 Comparison of Membrane Materials for Samawah WTP

Items※1	Organic Membrane		Inorganic Membrane	
Image※2				
Materials※3	PE, PTFE, PP, CA, PAI, PS		Alumina, Zirconia, Titania, SUS, SPG	
Service life	5～10 years, depending on the products	B	15～20 years※4	A
Chemical resistance※5	Low – Medium, depending on the material	B	Generally high	A
Maintainability	• High frequency for chemical cleaning※6 • Shutdown in case of severe fouling • Limited operating temperature / pressure • Oil intrusion requires immediate shutdown to avoid replacement of the membrane	B	• Low frequency for chemical cleaning※6 • Fewer emergency shutdown for fouling • Relatively fragile to strong impact※7 • Oil intrusion requires shutdown but the chemical cleaning will restore membrane function even if exposed to the oil.	A
Land area※8	Relatively small (at low turbidity)	B	Relatively high (at low turbidity)	B
Procurement※9	Long history and record all over the world	A	Rapidly expanding market in recent years	B
CAPEX※10	Relatively low (100)	A	Relatively high (100-150)	B
OPEX※10	Relatively high (100)	B	Relatively low (50-75)	A
Evaluation	Applicable	B	Most Suitable for Samawah WTP	A

※1: Evaluation of each item: A (Very good), B (good)
※2: Source of picture: Toray Industries, Inc.(Left), METAWATER Co., Ltd. (Right)
※3: PE: Polyethylene, PTFE: Polytetrafluoroethylene, PP: Polypropylene, CA: Cellulose acetate, PAI: Polyamideimide, PS: polystyrene, SUS: Steel use stainless, SPG: Shirasu porous glass
※4: A manufacturer told JST that no breakage has been reported, since 25 years ago, on their ceramic membranes units during normal operation..
※5: Resistance for chemicals injected in pre-treatment process.
※6: The frequency of chemical cleaning is usually 1 to 2 times per year for inorganic membrane. The frequency for organic membrane varies greatly depending on the type of membrane but generally more frequent by several times than that for inorganic membranes.
※7: Assuming unexpected man-caused hard impact such as that by dropping from high place. No record of damage during normal operation.
※8: In general, compared to inorganic membrane, organic membrane requires relatively smaller footprint when the turbidity is low. With the design conditions of Samawah WTP, there is no significant difference between the land areas required by those membrane types.
※9: The both membranes have multiple suppliers who cover Europe and the Middle East. Therefore, there will be no problem in the competitive environment in the procurement both at the tender of the contractor and at replacement during the O&M phase.
※10: Cost for membrane equipment only (not include flocculation and sedimentation processes as stated above).

Source: JICA Study Team

Inorganic membranes (ceramic membranes) have two major models, which are immersed flat model (cross-flow filtration system using bubbly swirling flow in the tank) and casing contained monolithic model (full filtration system). Casing contained monolithic model has some advantages in terms of the wide range of effective pressure (flat model: 15～70KPa, monolithic model: 5～150KPa) for high flux, the flexibility to easily change the amount of coagulant according to the raw water conditions and the ease of identifying failures and its locations since the equipment is installed individually on dry area. Therefore, casing contained monolithic model is recommended in consideration with the prioritizing ease of maintenance and management in case of Samawah WTP. The selection between these models is assumed to be given in the technical specifications in the bidding documents of the Project.

(7) RO facility

1) Type of membrane material

Cellulose acetate (CA), aromatic polyamides (PA), or, nowadays, thin film polymer composites are used as membrane materials. The Project applies PA membrane for the following benefits compared with CA membrane and thin film polymer composites. The details of materials and features are shown in **Appendix 5.5**.

- More than 30% low operating pressure compared with CA membrane
- Almost 99.5% salinity removal rate (CA membrane: almost 95%)
- Wide applicable pH ranges from 2 to 12 and high maintainability and easy for membrane cleaning
- Thin film polymer composite is suitable for high salinity water such as seawater[15]

2) Type of module of membrane

There are spiral wound and hollow fine fiber membranes. The Project applies spiral wound module in terms of membrane cost, dominating market share with various manufacturers, better pre-treated water quality and fouling prevention. Details on the type of membrane modules are stated in **Appendix 5.5**.

3) Type of membrane products

As the TDS of the raw water is low, polyamide composite low-pressure membrane, which is usually called as RO membrane for brackish water, is adopted. As reference, comparison of membrane products is stated in **Appendix 5.5**.

4) Recovery ratio

Recovery ratio means the ratio of product water flow against the feed water flow. In general, for saving construction cost of the intake and pre-treatment, higher recovery is preferred. However, at the same time, higher recovery ratio creates higher concentration of rejected water. It raises the risk of fouling of the membrane. In addition, the reject's high osmotic pressure caused by the high concentration requires feed pressure, which increase the energy cost of the plant. In the Study, the recovery rate is at 75%, which is the medium value in the typical range of recovery rate for brackish water reverse osmosis (70% to 80%).

[15] Thin film composite reverse osmosis membranes prepared via layered interfacial polymerization, Wansuk Choi, Journal of Membrane Science, 2017

5) Number of RO trains

The number of the RO trains will affect the CAPEX and OPEX directly. In general, a case of lesser number of RO trains, which in other words a case of greater capacity per train, reduces CAPEX, while it deteriorates operational flexibility and increases impact on the production volume in emergency cases. Also, such lower flexibility may increase OPEX because a lesser number of RO trains sometimes force the WTP to produce excess amount of RO treated water compared with the theoretical demand. On the contrary, in case of more trains, flexibility for operation shall be enhanced, while CAPEX is high.

Table 5.29 shows a comparison of the options for the number of the RO trains for the Samawah WTP, which takes into account the CAPEX and OPEX for a variety of the water demand and raw water TDS. As a conclusion, the JST decided that six trains are the best for the following reasons:

- In the assumption of flexible operation based on the water demand (50-100%, **Table 5.25**) and maximum case (TDS: 3,000 mg/L, blend ratio: 25%), six trains show one of the most reasonable LCC and the best balance of LCC and operational flexibility.
- The trend for raw water TDS is generally stable, therefore, the maximum case occupies a large part of the whole operation period and change of blend ratio is not of high frequency.
- The unit capacity should be uniform in terms of the operation in Phase-1 (Demand: 60,750 m^3/d for RO facility) according to the amount of treated water in final phase and the number of train; the difference (6,750 m^3/d) plays an important role for the control of effective capacity. It allows the operator to optimize the number of operating trains (less than seven trains case) in the low water demand case (50-75%).

Table 5.29 Comparison of the Number of Train

Items	Five Trains (Three in Phase-1)		Six Trains (Four in Phase-1)		Seven Trains (Five in Phase-1)	
Unit capacity	20,250 m^3/d		16,875 m^3/d		14,464 m^3/d	
RO Capacity in Phase-1	60,750 m^3/d Same as demand	B	67,500 m^3/d Suitable room to demand	A	72,320 m^3/d Over room to demand	C
CAPEX	94% of standard	A	Standard (100)	B	110% of standard	D
OPEX (TDS fluctuation)	Approximately 95-110% 【Trend】High values in high TDS case	C	Standard (100)	B	Approximately. 85-105% 【Trend】Low value in low TDS case	B
OPEX (demand fluctuation)	Approximately 95-115% 【Trend】 High value in low demand case	D	Standard (100)	C	Approximately. 95-105% 【Trend】 low value in high demand case	B
Maintainability / Flexibility	Larger impact in emergency case such as 50% power supply	D	Flexible (Even in 50% capacity, it can be treated in low TDS case)	B	Very flexible	A
Evaluation	Good (The best LCC)	B	Very good (Almost same LCC with left with high flexibility)	A	Fair (High CAPEX)	C

※Evaluation of each item: A (Excellent), B (Very good), C (Good), D (Fair)

Source: JICA Study Team

6) General specifications of RO train

Samawah WTP will operate six RO trains at maximum in the final phase and, when the membranes are replaced or cleaned, one of the six trains will be shut down. In addition, each membrane skid will have extra space that can contain additional 20% of the pressure vessels to the designed number for the final phase. The Project (first phase) will install four RO trains and the future expansion in the final phase will install additional two trains.

The major characteristics of the RO membranes and the pressure vessels in Samawah WTP are listed below;

- Average service life of membrane: 8 years (Annual membrane replacement: 12.5%)
- RO salinity permeation increasing rate: 15% / year
- The number of pressure vessel: 124 vessel / skid
- The number of RO elements: 7 element / vessel, 868 element / train
- The layout of pressure vessel (including spare vessel): vertical 8 line and horizontal 17 row

7) Other considerations for optimization of CAPEX and OPEX

The following points have been considered to ensure the good performance of the WTP with optimized CAPEX and OPEX:

a. Adaptation of variable frequency device (VFD) to the high-pressure pumps

Variable frequency devices are used for adjusting flow or pressure to the actual demand. They control the frequency of the electrical power supplied to pumps or fans. Significant power savings can be achieved when using a VFD pump.

In the Project, VFD will be applied to high-pressure pump, filtered water pump and booster pump for energy recovery device, and permeate pump according to the comparison of the incremental CAPEX and OPEX reduction by introduction of VFD.

b. Adaptation of energy recovery device (ERD)

In the Project, unit power consumption in case of the application of ERD (PX pressure exchanger) installation has been calculated. As a result, the reduction rate for power consumption is almost 20% (it depends on the water temperature and membrane ages) in maximum TDS case (3,000 mg/L). In addition, compared with the introduction cost of ERD, the introduction cost is around 75% for the increment of power cost in without ERD case in case of the assumption of 10 years operation.

As a conclusion, ERD should be applied into the system in terms of the optimization of LCC. Detailed explanations of ERD are mentioned in **Appendix 5.5**.

c. Choice of materials for the pumps and pipelines

In seawater desalination with high TDS of more than 30,000 mg/L, Super Duplex SS, which has very high corrosion resistance, is applied in pumps and pipelines that are exposed to raw water. In the Basra WTP case, Duplex SS was applied as the maximum TDS of raw water exceeds 10,000 mg/L, although not as high as seawater. In the Project, whose raw water TDS is 3,000 mg/L, SS316L is applied through the interviews with pump manufacturers (Section 5.12) as it has sufficient resistance to lower the TDS raw water. The unit cost of SS316L per unit weight is 50% to 70% of Super Duplex SS. Detailed comparison of materials for the pumps and pipelines are presented in **Appendix 5.5**.

d. Application of DX technology

DX technology such as automatic operation and remote monitoring system will be applied to some elements in the WTP. For instance, the operation of membrane facility can be fully automated by a client server system with photonic network technology. The changes of these operations can be feedback to former processes such as pumping well and chemical injection and later processes such as the water transmission process.

(8) Post treatment method

Carbonic acid as mineral components and alkaline components as hardness are added for the adjustment of taste and prevention of pipeline corrosion which can be caused by the low concentration of mineral component such as calcium, magnesium and iron as well as alkaline content in RO permeate[16]. In the treated water, dissolved gases such as oxygen, nitrogen and carbon dioxide, which may cause bad taste and odor, remain, while it has extremely low hardness. Therefore, the functions of gas removal and mineral adjustment must be required.

1) Gas removal

Decarbonator, which is an aeration system, will be installed for the gas removal and pH adjustment. In this case, carbon dioxide gas will be dissolved to adjust the treated water pH at around 4.

2) Mineral adjustment

There are two types of mineral adjustment methods, which is dosing lime (solid limestone or liquid lime milk) into the treated water and installing filter device consisting of particle of limestone. In the Project, dosing lime milk into the treated water will be applied in terms of the simplicity and availability of lime milk in Iraq.

(9) Chemicals for treatment (Pre-treatment facility, RO facility, Post-treatment facility)

Table 5.30 shows chemicals to be used in the WTP for each treatment stage. The injection rates were estimated according to the specification of pre-treatment membrane and RO membrane. All chemicals are commercially available or produced in Iraq.

For chlorine used in the pre-treatment and post-treatment, in terms of the production cost, the WTP applies a hypochlorite generator instead of chlorine gas which is normally used in Iraq. As reference, the general comparison of hypochlorite and chlorine production method is shown in **Appendix 5.6**.

Table 5.30 Chemicals for Treatment

Injection Point	Chemical	Purpose	Amount (mg/L) (Each Membrane)	
			Organic	Inorganic
Pre-treatment	Aluminum sulfate	Coagulation	0～10	0～5 mg/L (as Al_2O_3)
	Sodium hypochlorite	Membrane cleaning	100～200	100
	Citric acid		1～2%	
RO facility	Scale inhibitor	Scale prevention	0.8	
	Hydrochloric acid	pH adjustment	130	
	Sodium bisulfite	Removal of chlorine	>10	
	Citric acid	Membrane cleaning	1～2%	
Post-treatment	Carbon dioxide (gas)	Enhance dissolution of lime	75	

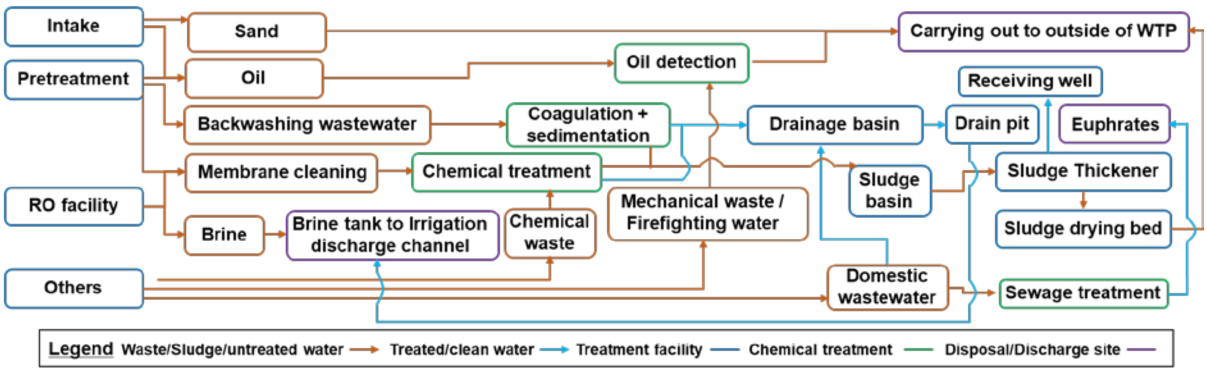
16 Removal method of dissolved carbon dioxide gas in pure water production equipment, Kenichi USHIKOSHI, 1986

Injection Point	Chemical	Purpose	Amount (mg/L) (Each Membrane)	
			Organic	Inorganic
	Lime milk (Ca (OH)2)	pH adjustment	60	

Source: JICA Study Team

(10) Wastewater management method

Figure 5.21 shows the wastewater and sludge treatment flow. Wastewater such as backwash wastewater from the pre-treatment membrane system and chemical wastewater (Sodium bisulfate soda (SBS), sulfuric acid intermittently added to the RO membranes for cleaning) must be treated and discharged correctly in compliance with the effluent standards in Iraq (Notification No. 80406 of 1980 based on Law No. 25 of 1967) and the process flow in the figure will satisfy the Iraqi standard.



Source: JICA Study Team

Figure 5.21 Wastewater and Sludge Treatment Flow

1) Backwash wastewater and chemical wastewater from pre-treatment membrane system

After aeration treatment, polymer coagulant shall be added and treated in specific sedimentation tank before the drainage basin. The supernatant is mixed with treated oil containing wastewater and transfered to the drainage basin for discharge.

2) Chemical wastewater

UF membrane cleaning water, RO membrane cleaning water and wastewater generated during chemical injection and conditioning process will be agitated and aerated in neutralization treatment, transferred to the backwash wastewater treatment system of pre-treatment membrane and finally drained from the drainage pit.

3) Oil containing wastewater

Wastewater containing oil generated in the system is treated by flotation and the floating oil component is stored in a waste oil tank. The sludge component containing oil is stored in a sludge tank for transportation and disposal.

(11) Sludge treatment system

Sludge thickening and dewatering are adopted as sludge treatment method. In general, the sludge quality of membrane filtration pre-treated water is better in terms of less amounts of coagulants and the footprint of sludge thickener becomes small.

1) Thickenening method

Gravity thickeners are installed to improve the efficiency and reduce the load on the subsequent dewatering equipment.

2) Dewatering method

Sun sludge drying bed shall be adopted in terms of the cost reduction and optimal operation based on water demand. Comparison of the dewatering method is stated in **Appendix 5.7**.

(12) Sludge utilization

The current disposal site of sludge is the disposal site designated by the Muthanna Governorate. Regarding reuse of the sludge such as reclamation, ground, raising seedling, and cement raw material as mentioned in **Appendix 5.7**, it depends on the quality of sludge such as salinity, alkalinity, SS, VTS, and EC [17]. The JST proposed that sludge property is investigated after commencement of operation and according to the results, it shall be reused as fertilizers in the surrounding agricultural land.

(13) Brine discharge

Brine from the WTP will be discharged to agricultural drainage channel called the Eastern Euphrates Drainage Channel as proposed in the Previous Study in 2016.

The JST studied an option to discharge the brine to the Euphrates River in order to reduce CAPEX as well as OPEX for the pump operation. The study estimated that the maximum increase of the river water's salinity due to the brine discharge would be 4.1% to the current salinity (3,000 mg/L as TDS)[18]. This impact may not cause any adverse impact on the ecology in the river but it can influence the raw water quality of the CUs that are located downstream. The JST concluded that the Eastern Euphrates Drainage Channel is the only viable discharge point.

(14) Instrumentation and monitoring control system

1) General concept

Most parts of the entire facility are designed for automatic operation to minimize the requirement for manual intervention. The flow rate of raw water, pre-treated water, RO feed water, product water and so on will be controlled as per flow rates and will be continuously monitored by flow meters.

2) Consideration for measurement point and control items of main water quality indicators

Table 5.31 shows the location of measurement points and **Table 5.32** presents the control system of each monitoring item. The monitoring control system must match the ability of the O&M staff in the plant. An overview of the system maintenance is presented in **Appendix 5.9**.

Table 5.31 Location of Measurement Points

Item※1	Intake	Pre-treatment Inlet	Pre-treatment Outlet	RO Inlet	RO Concentration	RO Permeate	RO Treated Water
Turbidity	○		○	△		△	
TDS※2	○				△	○	○
EC※2			△	○	△	○	○

17 Japanese Design Manual of Water Facility in 2012, Japan Water Works Association
18 See Appendix 5.8 for the simulation of the impact of the brine discharge on the Euphrates River's salinity.

Item※1	Intake	Pre-treatment Inlet	Pre-treatment Outlet	RO Inlet	RO Concentration	RO Permeate	RO Treated Water
Oil and grease	○		○				
VOC※2, Organic				○			
pH	○	○	○	○	○	○	○
ORP※2				○	○		
Residual chlorine			○				○
Silt density index	△		○				

※1: ○: Necessary, △: Depending on the condition under operation

※2: TDS: Total dissolved solid, EC: Electrical conductivity, VOC: Volatile organic compounds, ORP: Oxidation-Reduction Potential

Source: JICA Study Team

Table 5.32 Control System of Each Control Item

Item	Control System	Devices / Measurement for Control
Intake volume	Constant volume and water level control	Flow meter
RO permeate volume	Constant volume control	Flow meter
RO membrane operation	Head loss and filtration time control	Venturi meter, manometer
RO treated water	Constant volume control	Flow meter
Water collection ratio	Constant collection ratio control	Flow meter
Cleaning of RO membrane	Differential pressure control	Pressure meter, densitometer
Chemical injection	Constant injection ratio control	Chemical injector, storage tank

Source: JICA Study Team

3) Key control points for RO feed water (Turbidity monitoring on pre-treated water quality)

One of the most important points in pre-treatment membrane filtration is turbidity control. The Project will install online automatic turbidity meter at the intake and membrane filtration inlet and outlet to monitor raw water quality, of which the turbidity meter at the outlet will have high sensitivity.

4) Recommendation for pre-detection of troubles

Water quality analyzer (for instance, HACH absorbance spectrophotometer: DR6000) for detecting scale components and membrane contaminants would help to quickly determine the problem of the plant. Especially for in case of the large changes or fluctuations in raw water quality, installation of the water quality analyzer shall be considered.

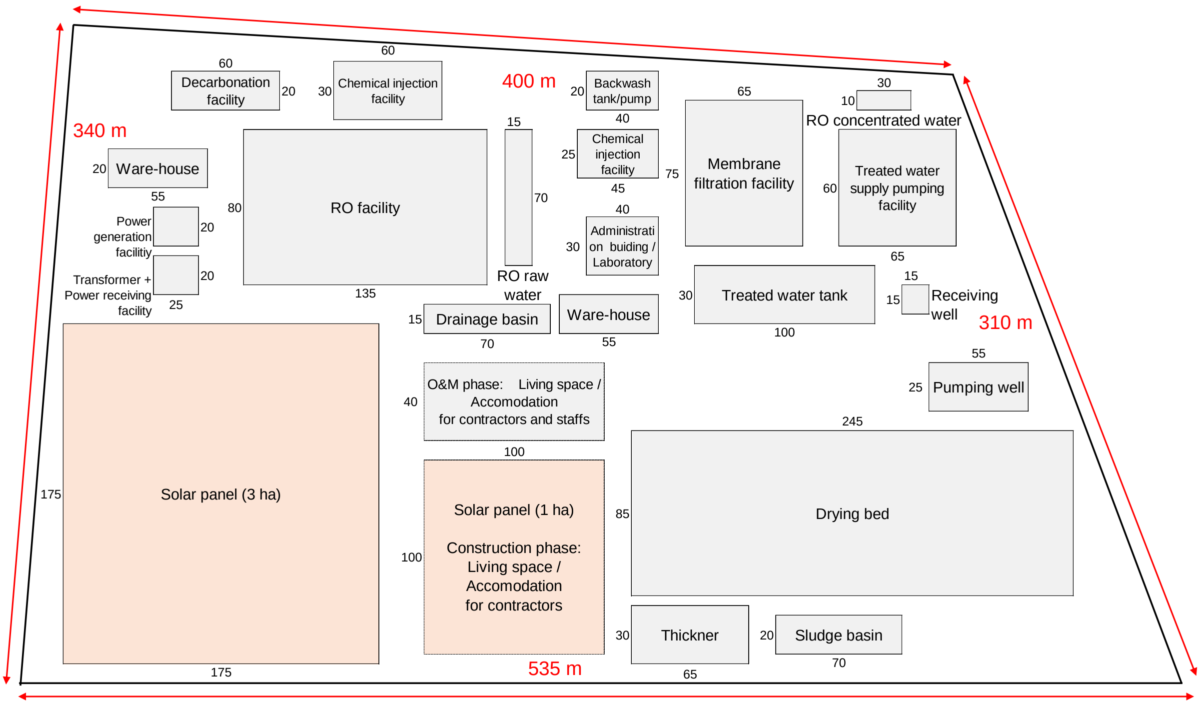
(15) General layout of the WTP

Figure 5.22 shows the layout of the WTP (135,000 m^3/d) at the final phase. All civil structures and buildings will be constructed in Phase-1 (the Project) and equipment will be added in the final phase. The key concepts in the layout planning are as follows:

- The difference of elevation is almost less than 2 m in the construction site, therefore, the intake facility and receiving well are located in the Euphrates side and raw water is pumped up into the pumping well.
- Water treatment process flows from the Euphrates side (East) to the inland (West), and the administration building is located around the middle of the flow, close to the main facility such as the pre-treatment and RO facility. In addition, the parking lot and welfare facilities are located around the administration building.
- The power receiving facility is located near to the power transmission line and transmission facility, and the emergency generator is located near the RO facility which requires large amount

of electricity.

- Drainage basin and sludge drainage basin are located in the Euphrates side and the drain could be discharged into the Euphrates River with the shortest drain pipeline.
- The treated water tank is located close to the transmission pump facility, the solar panel area of 4 ha (**Appendix 5.10**) is gathered and not distributed in the area, and the water purification facility and sludge treatment facility are separated. This separation plays an important role for further future expansion that might be considered in the future[19].
- General specifications of each architecture facility such as living space and accommodation (1 ha) for the contractor and other personnel engaged in the Project follow the Urban Housing Standard in Iraq published in 2010. After the construction phase in the Project, this 1 ha will be utilized for other use such as for solar panels or additional future expansion.
- Safety measures such as the installment of fence or wall along the plant side boundary are summarized in following chapter.



* All buildings and civil structures will be constructed in the Project (Phase-1). The final phase will be the installation works of additional equipment in the buildings and civil structures constructed in the Project.

Source: JICA Study Team

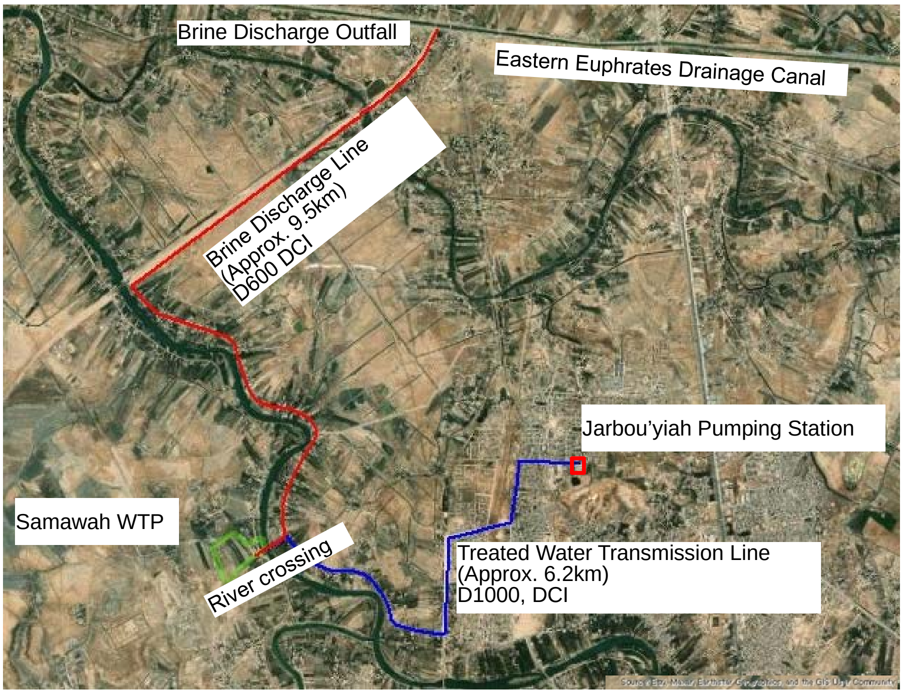
Figure 5.22 Proposed Layout of WTP (135,000 m^3/d)

[19] Design consultation meeting with MWD and MCHPM

5.6 Plan of Water Transmission System from Samawah WTP to Jarbou'yiah Pumping Station and Brine Discharge System

5.6.1 Outlines of the Systems

The Samawah WTP will be located at the right bank of the Euphrates River. The treated water will be transmitted to Jarbou'yiah Pumping Station (PS), from where the water will be distributed to the service area. The brine will be discharged to the Eastern Euphrates Drainage Canal. **Figure 5.23** shows the location of the Samawah WTP and the alignment of the transmission and discharge lines which was confirmed though a site visit by the MWD.



Source: JICA Study Team

Figure 5.23 Location of Samawah WTP and Alignment of the Pipelines

5.6.2 Pipeline Diameters

(1) Design flow

Based on the treatment capacities of Samawah WTP in the Project, which will correspond to the water demand in 2040 as the 1st Phase, and the final phase for the water demand in 2054, design flows of the pipelines are set as shown in **Table 5.33**.

Table 5.33 Final Design Flow and First Stage Design Flow

	Final Design Flow (2054 Demand)	First Stage Flow by the Project
Treated Water Transmission Pipeline	135,000 m^3/d	81,000 m^3/d
Brine Discharge Pipeline	33,750 m^3/d	20,250 m^3/d

Source: JICA Study Team

The optimum pipe diameter was determined based on the final design flow. The number of pumps to be installed by the Project shall be correspond to the first stage flow.

(2) Selection of the diameters

Optimal pipe diameter was determined by comparing the life cycle cost (construction cost + O&M cost) for the pipelines and the pumps. **Table 5.34** and **Table 5.35** show the comparison of the life cycle costs among various diameters for the treated water transmission line and the brine discharge line, respectively. The detailed calculation is shown in **Appendix 5.14**.

Table 5.34 Selection of Pipe Diameter for the Treated Water Transmission Line

Design Flow: 135,000 m^3/d (Equivalent to 1.56 m^3/s)

Optional Pipe Diameter	Required Pump Head (m)	Construction Cost (Thousand USD)	O&M Cost (NPV of 30 years) (Thousand USD)	Life Cycle Cost (Thousand USD)	Selection
D1100	20	6,743	4,484	11,218	
D1000	25	5,825	5,203	11,209	Selected
D900	40	5,325	7,654	12,979	

Source: JICA Study Team

Table 5.35 Selection of Pipe Diameter for the Brine Discharge Line

Design Flow: 33,750 m^3/d (Equivalent to 0.39 m^3/s)

Optional Pipe Diameter	Required Pump Head (m)	Construction Cost (Thousand USD)	O&M Cost (NPV of 30 years) (Thousand USD)	Life Cycle Cost (Thousand USD)	Selection
D700	20	5,601	1,768	7,369	
D600	35	4,804	2,238	7,042	Selected
D500	75	4,410	3,903	8,313	

Source: JICA Study Team

5.6.3 Method of the River Crossing

For the crossing method of the Euphrates River just outside the WTP, two alternatives were considered as follows:

- Pipe bridge alternative: Install the pipelines on a new steel truss bridge
- Pipe jacking alternative: Install the pipelines in a concrete casing pipe set up under the river by pipe jacking method

Between the alternatives above, the Project will adopt the pipe bridge because of the cost, constructability, and operational convenience. The comparison is shown in **Table 6.3**. Although the comparison results suggested the pipe jacking method, it is assumed that the construction will be implemented by the pipe bridge which can be reliably implemented since there is a possibility that the approval from the Ministry of Water Resources will not be obtained, and based on the MWD's past experiences after the re-discussion with MWD.

In addition, for the crossing of the Sowair River, the brine discharge pipe will be installed by open cut method with a temporary shoring since the water level in the dry season is much lower than in the other season.

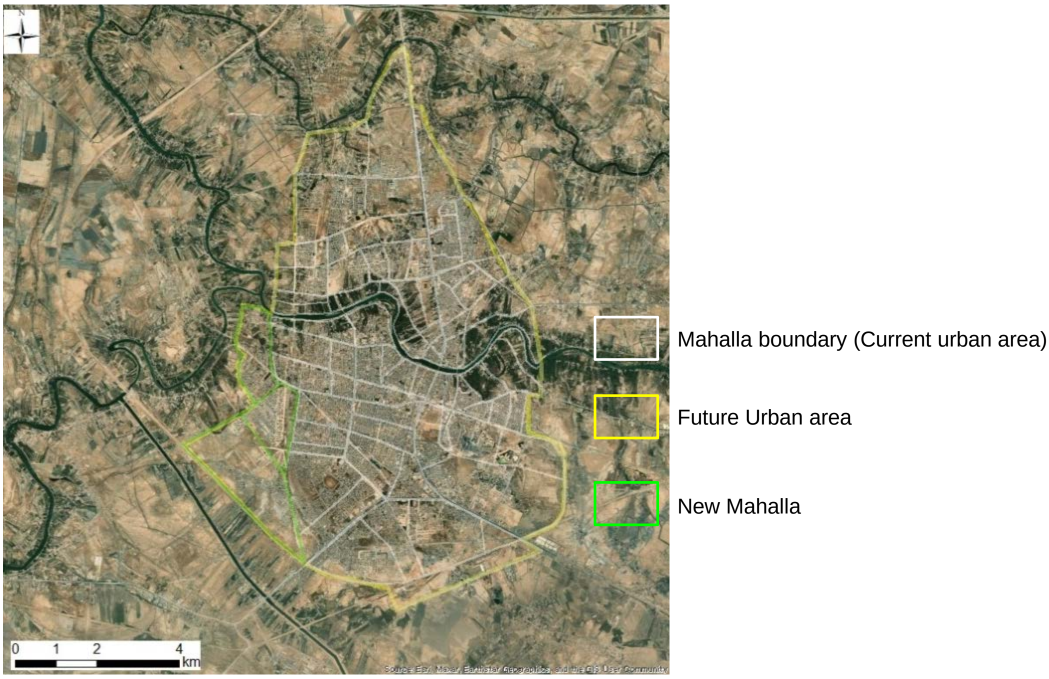
5.7 Plan of Water Distribution System

5.7.1 Distribution of Future Water Demand in the Water Supply Service Area

(1) Water supply service area

The current urban area of Samawah District is divided into 78 "*mahalla*", which is the smallest administrative unit. The water supply service area will be expanded up to the boundary of the future urban area which is defined by MOP.

Figure 5.24 shows the boundaries of *mahallas*, whose outer boundary represent the boundary of the current urban area (while lines), and the future urban area (yellow lines) defined by MOP. Three new *mahallas* (green lines) will be created as a new urban area in the southwestern part of the future urban area.



Source: JICA Study Team

Figure 5.24 Mahalla Boundary (Current Urban Area) and Future Urban Area Boundary

(2) Population and water demand projection

In the planning of water transmission and distribution facilities, it is necessary to grasp the population distribution in the water supply area and the distribution of water demand. Population projection has been made up to 2054, as shown in **Table 5.36**. the future urban population (2040, 2054) distribution was estimated based on the following assumptions.

- Three *mahallas* will be created in the southwestern part of the district by 2040
- Population density of such *mahallas* will be the same as those of the overall future urban area

The distribution of water demand was calculated based on the population's distribution above and the unit water consumption per capita is estimated at 250 Lpcd. The distribution of population and water demand in the urban area is presented in **Appendix 5.15** and summarized in **Table 5.37**.

Table 5.36 Population Projection up to 2054

2021 (Present)			2040			2054		
Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
239,580	85,047	324,627	388,724	137,991	526,715	555,290	197,119	742,408

Note: The population projection refers to Case 1 used in the determination of the capacity of Samawah WTP (See Table 5.11 in Section 5.3.2)

Source: JICA Study Team

Table 5.37 Distribution of Population and Water Demand in Urban Areas

Mahalla ID.	Area (ha)	2021				2040				2054			
		Person	Person/ha	Water demand		Person	Person/ha	Water demand		Person	Person/ha	Water demand	
				(m3/day)	(L/s)			(m3/day)	(L/s)			(m3/day)	(L/s)
Total of 100's	792.7	40,252	51	10,063	116.47	58,326	74	14,582	168.77	83,319	105	20,830	241.08
Total of 200's	1,047.6	26,991	26	6,748	78.10	39,111	37	9,778	113.17	55,869	53	13,967	161.66
Total of 300's	1,722.6	38,055	22	9,514	110.11	55,143	32	13,786	159.56	78,771	46	19,693	227.93
Total of 400's	2,559.0	134,282	52	33,571	388.55	194,578	76	48,644	563.02	277,954	109	69,488	804.26
2021 urban area	6,121.9	239,580	39	59,895	693.23	347,157	57	86,789	1,004.51	495,912	81	123,978	1,434.93
New 1	169.0	0	-	0	0.00	9,584	57	2,396	27.73	13,690	81	3,423	39.61
New 2	154.0	0	-	0	0.00	8,733	57	2,183	25.27	12,475	81	3,119	36.10
New 3	410.0	0	-	0	0.00	23,250	57	5,813	67.27	33,213	81	8,303	96.10
New urabn area	733.0	0	-	0	0.00	41,567	57	10,392	120.27	59,378	81	14,844	171.81
Total Urban Area	6,854.9	239,580	35	59,895	693.23	388,724	57	97,181	1,124.78	555,290	81	138,823	1,606.74

Source: JICA Study Team

5.7.2 Capacity Assessment of Existing Water Distribution System

To examine the necessity of reinforcement of the water distribution network in the urban area, a hydraulic analysis of the existing network was conducted.

(1) Prerequisites for the examination

In the framework of the PWT Project[20], the MWD is constructing the following facilities in the water distribution system for Samawah District:

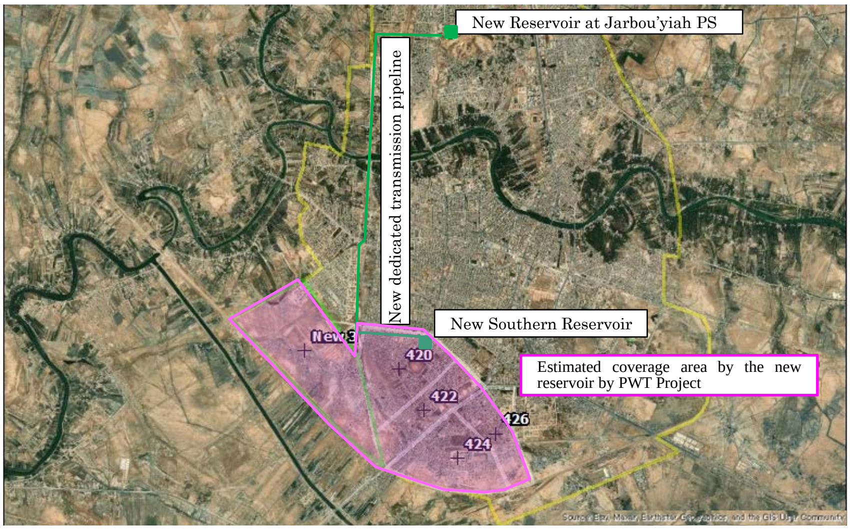
a. A new reservoir (20,000 m^3) at Jarbou'yiah PS, which totals the storage capacity in the PS at 50,000 m^3.

b. A new reservoir (6,000 m^3) with a pumping station at the southern part of the urban area.

c. A dedicated water transmission system with a design flow of 2,800 m^3/hr from a. to b. above.

The estimated coverage area of the new southern reservoir is shown in **Figure 5.25**.

[20] See Section 4.2.3.



Source: JICA Study Team

Figure 5.25 Estimated Coverage Area of the New Southern Reservoir by PWT Project

(2) Hydraulic modeling

The hydraulic model of the existing distribution system was built in EPANET, a hydraulic network calculation software provided by the U.S. Environmental Protection Agency (USEPA), based on the pipeline information (location, diameter, length) provided by MWD. The distribution network in the district consists of four distribution main systems:

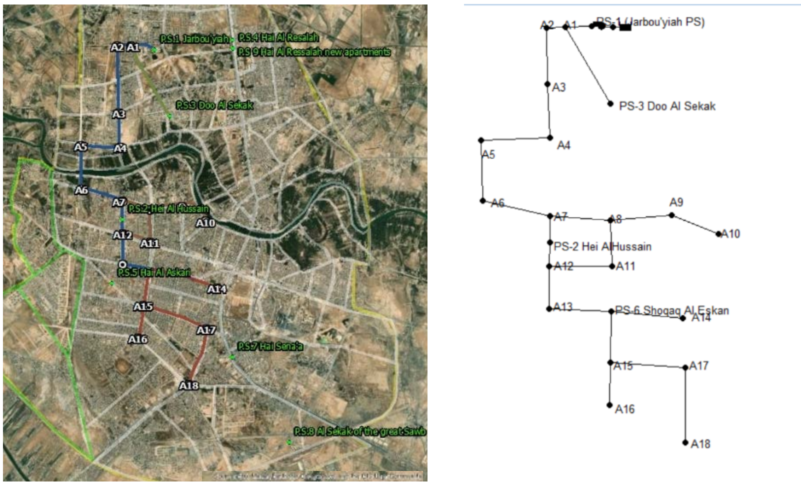
a. D900 distribution main system covering the central and western part of the supply area,

b. D400 distribution main system covering the western part of the supply area,

c. D500 distribution main system covering the middle and eastern part of the supply area, and

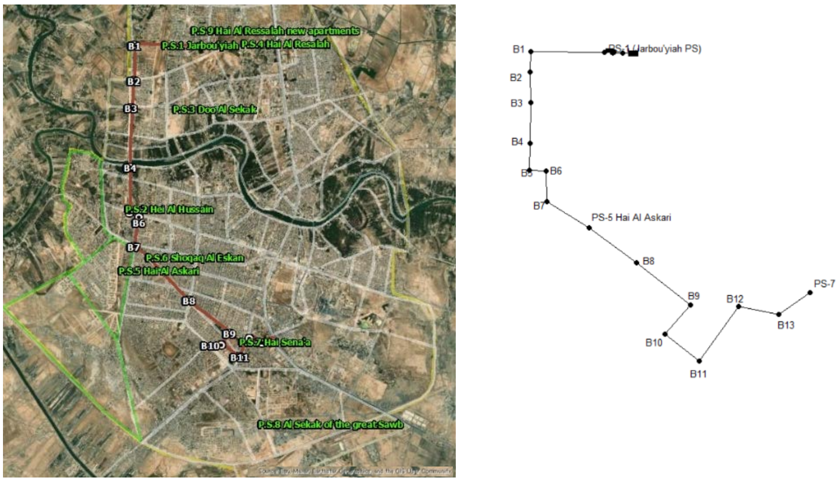
d. D800 distribution main system covering the middle and southern part of the supply area.

The hydraulic models of the distribution main systems are shown from **Figure 5.26 to Figure 5.29**.



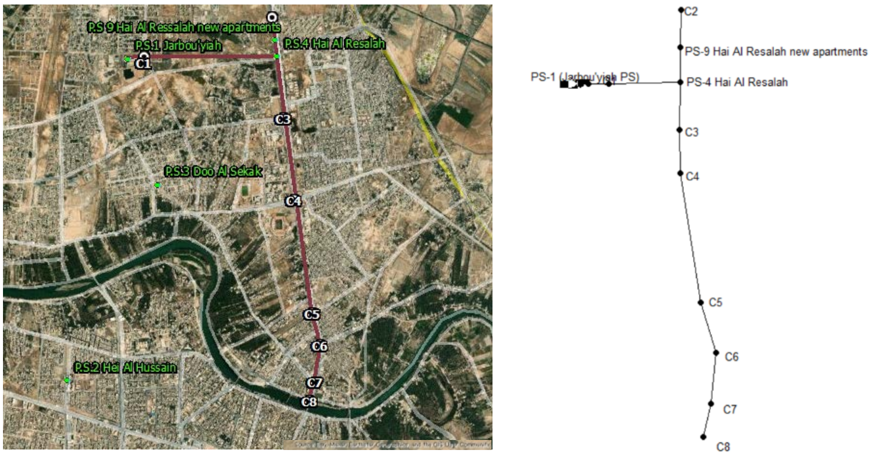
Source: JICA Study Team

Figure 5.26 Hydraulic Model of D900 Distribution Main System



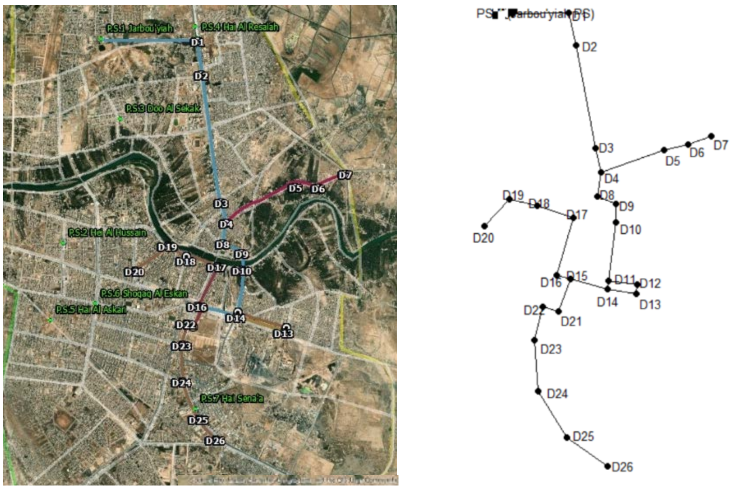
Source: JICA Study Team

Figure 5.27 Hydraulic Model of D400 Distribution Main System



Source: JICA Study Team

Figure 5.28 Hydraulic Model of D500 Distribution Main System



Source: JICA Study Team

Figure 5.29 Hydraulic Model of D800 Distribution Main System

The water demand of each *mahalla* calculated in Section 5.7.1 was allocated to each node in the hydraulic model. The H-Q curve of each pump was set based on the inventory information for the distribution pumps in Jarbou'yiah PS provided by the MWD.

(3) Design flows

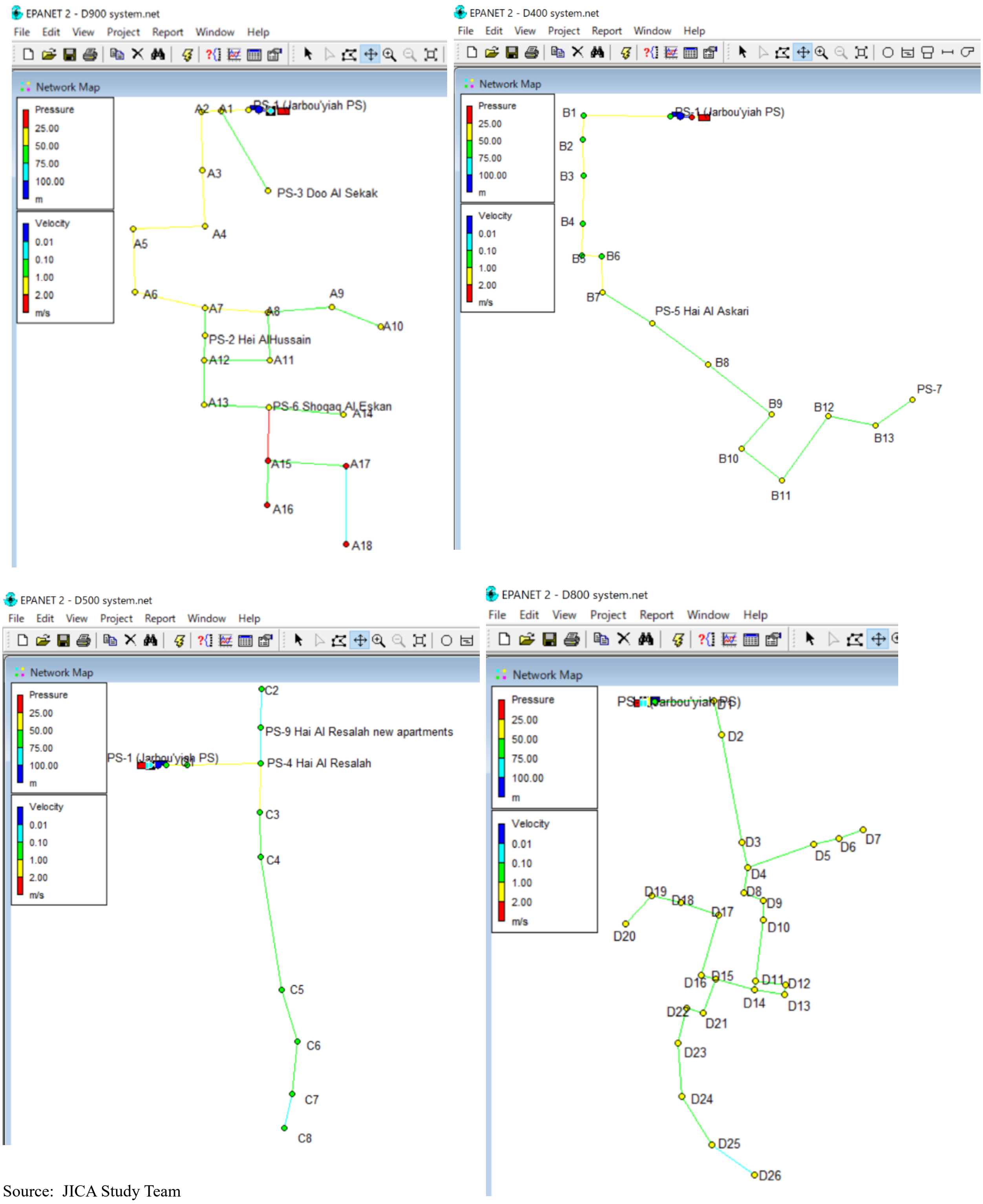
The design flows were set under the following conditions:

- Water demand: Water demand in Year 2040 as the average flow.
- Design flow: Average flow x peak factor at 1.8 (Served population is more than 10,000 and supply condition is 24 hours/day supply).

(4) Results of the hydraulic calculation

Figure 5.30 shows the hydraulic calculation results of EPANET. The input and output data are presented in **Appendix 5.16**.

As shown in the figure, the water pressure (head) of each node was calculated at more than 25 m, except for some nodes whose pressure is less than 25 m but only slightly (A15 at 23.7 m, A16 at 21.8 m, A17 at 21.0 m, and A18 at 20.9 m). Therefore, the existing distribution network is evaluated to have sufficient hydraulic capacity to deliver the water to the end point of the distribution network to satisfy the water demand in 2040.



Source: JICA Study Team

Figure 5.30 Hydraulic Calculation Results

5.7.3 Equipment for Improvement of the Water Distribution System

According to MWD, no shut-off valve is installed on the distribution mains extended from Jarbou'yiah PS. In addition, the distribution main systems are completely independent without interconnections. Therefore, MWD is forced to suspend the water supply to the whole influence area of the PS each time of the repair works in the distribution mains. In addition, the existing distribution facilities lack the instruments such as level meters in the reservoirs and flow meters and pressure meters in the distribution network.

Considering the above deficiencies in the water distribution system, the Project will procure the equipment as shown in **Table 5.38** in order to improve the reliability and flexibility of the water supply services.

Table 5.38 Proposed Ancillary Facility of the Distribution System

Equipment	Purpose
Pipes, Fittings, and Valves	
(1) Gate valve	Shut-off the pipeline to repair some portion and to continue the water flow of the remaining portion
(2) Interconnection facility (Tee and gate valve)	Interconnections of four distribution main systems, which enable them to share the water to each other
Monitoring and Control Facility	
(1) Level meter for reservoir	To monitor the water level of the reservoir for control the distribution system
(2) Water pressure and flow measurement facility	To monitor the water pressure and flow for control of the distribution system and also for detect an accident, if any, on the system
(3) Flow control valve at the outlet of the distribution pump	To control the water flow for efficient operation of the distribution system
(4) Monitoring system	To efficiently monitor the entire system

Source: JICA Study Team

5.7.4 Water Supply to the Rural Areas

Expansion of the water transmission and distribution network to the rural areas will be planned in Section 5.9.2 (4).

5.8 Design of Power Receiving Facilities

5.8.1 Study on Availability of Required Electrical Power

(1) Analysis of power demand and power supply capacity

The power demand and supply in Iraq is very tight, and the Ministry of Electricity (MOE) is also facing problems in operation and maintenance of infrastructures such as power generation, distribution, and transmission facilities. In addition, the conflict with ISIS made it difficult to maintain those facilities. Under such situation, blackout often happens especially in summer when the demand increases. The weather in the southern region including Samawah has a feature of higher temperature among regions in Iraq. The balance between supply and demand throughout Iraq, especially in the southern region, will affect reliability of the required power supply to the new water treatment plant in the Project.

JST intended to obtain the information on the current and projected balance between the power demand and supply from MOE through MCHPM but such information were not provided. Continuous availability of electricity is the key element of the Project. Therefore, the Study executed the planning of the power receiving facilities and the emergency generator presuming that the power supply to Samawah WTP may not be stable.

(2) Power supply to Samawah WTP

During the Previous Study in 2016, a letter regarding the “Critical Line” dated May 4th, 2015 by the MOE to MWD confirmed that 33 kV power would be supplied to Samawah WTP from the 132/33/11 kV system of North Samawah Substation. In November 2022, as the validity of the letter has expired, the MWD through an official letter asked MOE to re-issue the confirmation letter on the “Critical Line” to the Project but the MWD has not received any response from MOE. However, based on his interview to the MOE, the MWD deems that the Samawa WTP will receive two lines of high voltage (33 kV) power supply from North Samawah Substation.

The reason for the power reception by two lines is a solution for accidental shutdown of one line. In addition, emergency generator equipment will be installed, since the operation of the Jarbou’yiah PS, which also receives critical line, suffers from frequent power failure of one to six hours according to its operational record from January to October in 2022. Another reason for the installation of the emergency generator is that the two lines of 33kV will come from only a single substation. In addition, with two-line power reception from a single substation rather than from different substations, backup can be expected in the event of an accident in the transmission system from the substation, but it will function as a backup if a problem occurs at the substation itself or power generation facility. Therefore, it is necessary to install an emergency generator at the Samawah WTP as well.

The route of the 33kV lines from the North Samawah Substation will be determined in the execution stage of the Project. The Study presumes a route shown in Figure 5.31 based on the locations of the WTP and the substation as well as the layout of the existing roads.

5.8.2 Design of Incoming Facilities

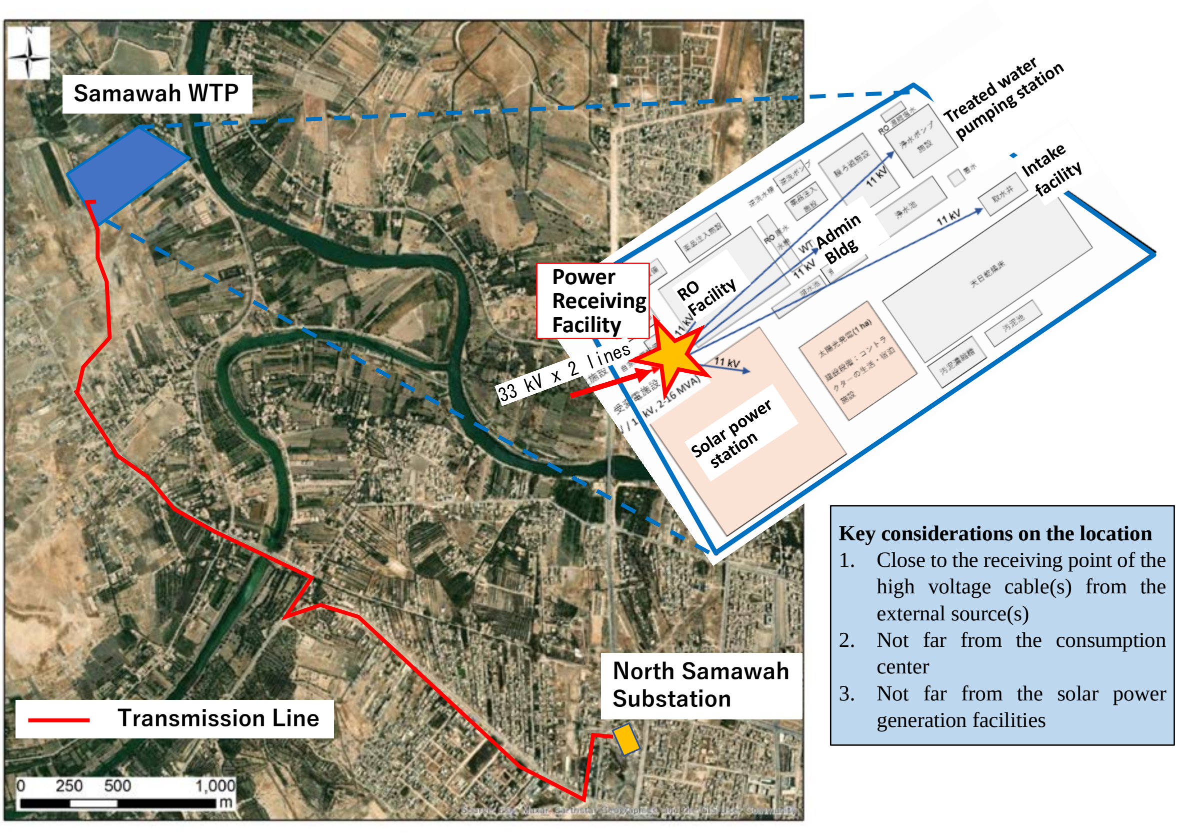
(1) Voltage of power supply

The WTP will receive the power supply by two high voltage lines of 33 kV.

(2) Location of incoming facilities and required area

The incoming facilities are planned in the WTP site. It will be located at a strategic point which is close to the receiving point of the high voltage cable(s) and not far from any consumption center, such as the intake facilities, pre-treatment facilities, RO facilities, treated water transmission facilities and administration building, and solar power generation facilities as shown in **Figure 5.31**. The location will be finalized according to the reception point of the external high voltage cable(s) which will be determined in the execution stage of the Project.

Necessary area for the incoming facilities will have approximately 20 m width and 25 m length.



Source: JICA Study Team

Figure 5.31 Location of the Incoming Facilities in Samawah WTP

(3) Required capacity of power supply

The required power supply demand of Samawah WTP is 13 MVA based on the plant's final treatment capacity of 135,000 m^3/day. Detailed calculations of the load for each equipment and power supply capacity are shown in **Appendix 5.17**. Among the total power capacity, the share of the RO facilities including feed pumps, high pressure pumps, brine discharge pumps is 60% as shown in **Table 5.39**.

The electrical equipment in the Project will be designed for the final capacity of the WTP.

Table 5.39 Power Supply Demand of Samawah WTP

Facilities	Number of Units*	Power Capacity (MVA)	Share
Intake facilities	6 pumps	1.06	8%
Pre-treatment facilities	6 trains	2.58	20%
RO facilities	6 trains	7.77	60%
Treated water transmission facilities	4 pumps	0.87	7%
Sludge treatment facilities	3 units	0.10	1%
Others	-	0.62	5%
Total	-	13.00	100%

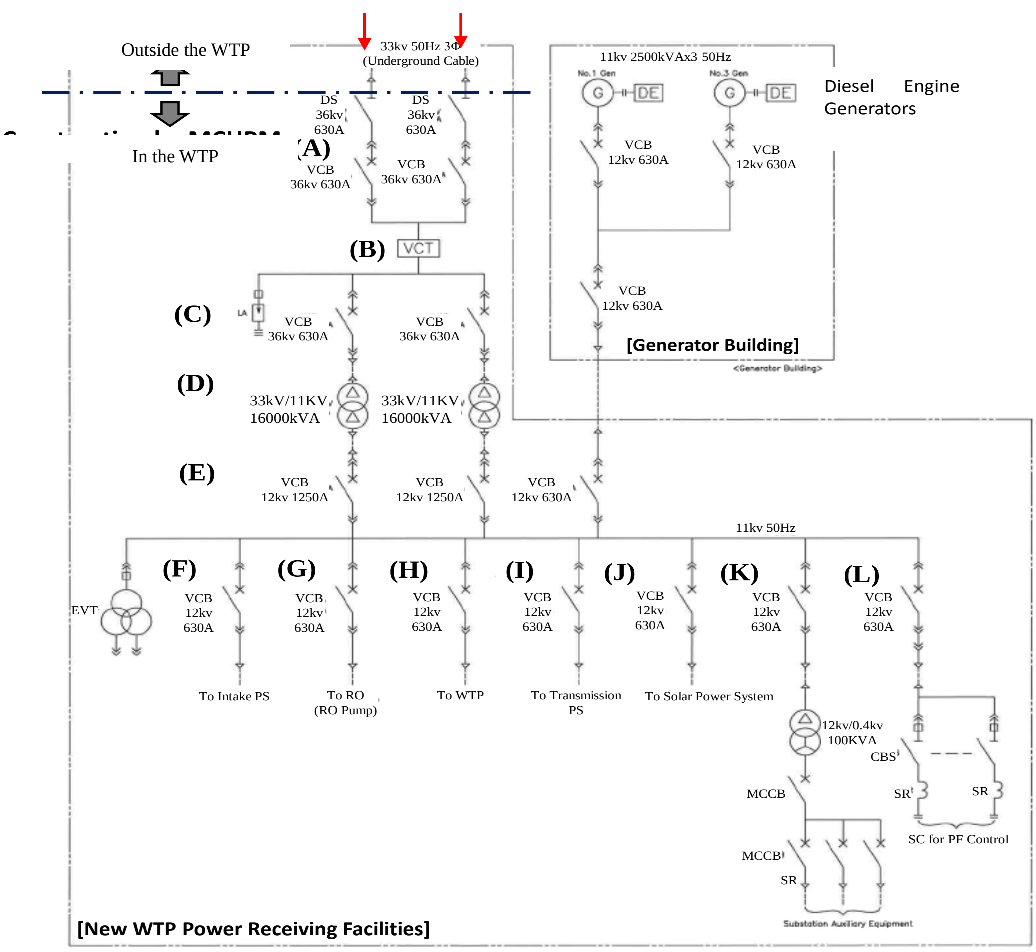
* The power demand is calculated for the final phase of the WTP.

Source: JICA Study Team

5.8.3 Planning of Power Distribution Facilities

(1) Single line diagram

A single line diagram of the incoming and distribution facilities is presented in **Figure 5.32**. The power supply is designed to be a duplex line and duplex transformer system. The main substation will be equipped with two units of transformers of 33 kV/11 kV with a capacity of 16 MVA, which covers the overall power demand for the final phase, including one for stand-by.



Note: See Table 5.40 for the principal features of the equipment A) to L).

Source: JICA Study Team

Figure 5.32 Single Line Diagram of Samawah WTP Incoming and Distribution Facilities

The major equipment to be installed in the incoming and distribution facilities are shown in **Table 5.40**.

Table 5.40 Equipment in the Incoming and Distribution Facilities

Symbol in Figure 5.32	Equipment
(A)	An incoming panel with two 33 kV disconnection switches (DCs) and two vacuum circuit breakers (VCBs) for duplex power supply system
(B)	A feeder panel with a 33 kV instrument voltage and current transformer (VCT)
(C)	A feeder panel with two 33 kV VCBs and a lightening arrester (LA) to two power transformers
(D)	Two units of transformers of 16 MVA, 33/11 kV
(E)	A 11 kV feeder panel with two VCBs for two feeder lines
(F)	A feeder panel for Intake Facilities
(G)	A feeder panel for RO Facilities
(H)	A feeder panel for Pre-treatment Facilities
(I)	A feeder panel for Treated Water Supply Pumping Facilities
(J)	A feeder panel for Solar Power Generation Facilities
(K)	A feeder panel for substation auxiliary equipment
(L)	A feeder panel for static condensers (SCs) for power factor control

Source: JICA Study Team

5.8.4 Planning of Emergency Power Supply

The MWD advised that the backup capacity of the emergency generators will cover 50% load of the whole WTP since the two-line power reception would reduce the possibility of power failure although Samawah WTP will be installed with an emergency private power generator. Taking into account this advice, the JST proposed to install three units of 2,500 kVA generators (2,500 x 3 = 7,500 kVA), whose capacity is greater than 50% load in the final phase (13 MVA x 50% = 6.5 MVA), as shown in **Figure 5.32**. Voltage of the emergency power supply is planned to be 11 kV following the General Water Directorate standard. Required area for the generation room has approximately 16 m width and 25 m length.

As shown in **Table 5.41**, the generators will be able to operate 50% of the RO units for Phase-1 (the Project), while other equipment can be operated at their full capacities.

Regarding the fuel tank, it is calculated for more than six hours operation of the generators since duration of the power failure in the existing water treatment plants at Rumaitha is approximately six hours.

Table 5.41 Typical Operational Mode with the Emergency Generator

Operational mode	100% Operation		75% Operation		50% Operation		RO-50% Operation*	
Facilities	Number of Units/Trains	Power Capacity (MVA)	Number of Units/Trains	Power Capacity (MVA)	Number of Units/Trains	Power Capacity (MVA)	Number of Units/Trains	Power Capacity (MVA)
Intake facilities	4 pumps	0.71	3 pumps	0.53	2 pumps	0.35	4 pumps	0.71
Pre-treatment facilities	4 trains	1.72	3 trains	1.29	2 trains	0.86	4 trains	1.72
RO facilities	4 trains	5.18	3 trains	3.88	2 trains	2.59	2 trains	2.59
Treated water transmission facilities	3 pumps	0.65	3 pumps	0.65	2 pumps	0.44	3 pumps	0.65
Sludge treatment facilities	2 units	0.07	2 units	0.07	1 units	0.03	2 units	0.07
Others	-	0.62	-	0.62	-	0.62	-	0.62

Total	-	8.95	-	7.05	-	4.89	-	6.36
	Normal operation mode		Possible to be operated with the generator 2,500 kVA x 3 (= 7,500 kVA)					

* : In “RO-50% Operation” mode, the WTP will produce 81,000 m^3/d, while RO will be operated at 50% rate (with two trains out of four). In this case, maximum raw water TDS will be 1,550 mg/L to produce the water lower than 1,000 mg/L. Higher TDS may be accepted as emergency case or dilution by the water from the PWT Project may lower the TDS of the water consumed by the users.

Source: JICA Study Team

5.8.5 Study on Solar Power Generation Facilities

(1) Need for solar power generation in Samawah WTP

Samawah WTP is the first large-scale WTP in Muthanna Governorate with RO, which consumes much electricity compared with the conventional WTP such as the existing ones in Rumaitha. Taking into account the financial difficulties of MWD, whose tariff revenue is not enough for O&M, and the anticipated power failures especially in summer, introduction of solar power generation may contribute to the reinforcement of the Project’s viability.

The solar power generation also coincides with the global movement for CO_2 emission reduction as well as the development objectives in energy and manufacturing industries sector presented in the National Development Plan 2018 - 2022 [21].

(2) Estimation of solar power potential

The presumed capacity of solar power generation system is 2,750 kW with the available 4-ha area in Samawah WTP site. In order to estimate the expected annual amount of solar generation, it is necessary to know the solar radiation amount data throughout the year in Samawah.

In the Study, the JST estimated the annual solar power generation by a solar power facility which will be installed in Samawah WTP based on the radiation amount data presented in the Journal of Renewable and Sustainable Energy (2016) “Solar Energy Status in Iraq”. As shown in **Table 5.42**, the estimated annual power generation is 3,800,000 kWh/year, which is equivalent to 879 kWh/hour assuming average daily sunshine of 12 hours.

In general, the product guarantee period of the solar panel is 15 years, while the manufacturers guarantee the panels’ performance for 25 years. As the performance and the guaranteed period of the solar panel will not be affected even by the extreme heat in Iraq, replacement or renewal of the solar panels are not presumed during 25 years since commencement of the WTP’s operation except for case of accidental physical damage.

[21] See Table 2.20 in Sub-section 2.5.1 (2).

Table 5.42 Estimation of Solar Power Generation

Month	Solar Radiation for Baghdad in MJ: a (MJ/m2/day)	Ratio of Annual Solar Radiation between Baghdad and Samawah: b Baghdad: 6997MJ/m2/year Samawah: 7124MJ/m2/year	Presumed Solar Radiation for Samawah in MJ: c c=axb (MJ/m2/day)	Days: d (days)	Solar Radiation for Samawah in kWh: H H=bx1,000,000/3,600,000 (kWh/m2/day)	Efficiency: K	Solar System Capacity: P (kW)	Generation Power: Hp Hp=HxKxPxd (kWh/month)
1	10.60	1.018	10.79	31	3.00	0.73	2750	186,566
2	13.33	1.018	13.57	28	3.77	0.73	2750	211,911
3	17.70	1.018	18.02	31	5.01	0.73	2750	311,530
4	21.60	1.018	21.99	30	6.11	0.73	2750	367,909
5	23.40	1.018	23.82	31	6.62	0.73	2750	411,853
6	27.00	1.018	27.49	30	7.64	0.73	2750	459,886
7	26.00	1.018	26.47	31	7.35	0.73	2750	457,615
8	24.60	1.018	25.05	31	6.96	0.73	2750	432,974
9	20.80	1.018	21.18	30	5.88	0.73	2750	354,282
10	15.80	1.018	16.09	31	4.47	0.73	2750	278,089
11	11.90	1.018	12.12	30	3.37	0.73	2750	202,690
12	9.80	1.018	9.98	31	2.77	0.73	2750	172,486
				Average Solar Radiation: (kWh/m2/day)	5.25		Annual Generation Power: (kWh/year)	3,847,792
Source: Solar Energy Status in Iraq	TABLE VII: Sunshine and global solar radiation estimated from measured meteorological data (2004-2008)	TABLE V: Location of meteorological stations and measured values of solar radiation (1961-1992)						

Note: Efficiency K includes dirtiness, degradation etc. based on JIS C 8907

Source: JICA Study Team

(3) Viability of the solar power generation in Samawah WTP

The benefits of introducing solar power generation in the WTP are summarized in **Table 5.43**. Based on the benefits shown in the table, introduction of the solar power generation is evaluated as viable in the Project for the following reasons:

- Annual saving of USD 316,250/year equivalent to 2% of the present annual O&M cost of MWD. The savings will have a certain impact on MWD's financial conditions.
- Compared to the manufacturers' guarantee period, the theoretical payout time of 9.2 years proves the financial viability of the solar power generation.

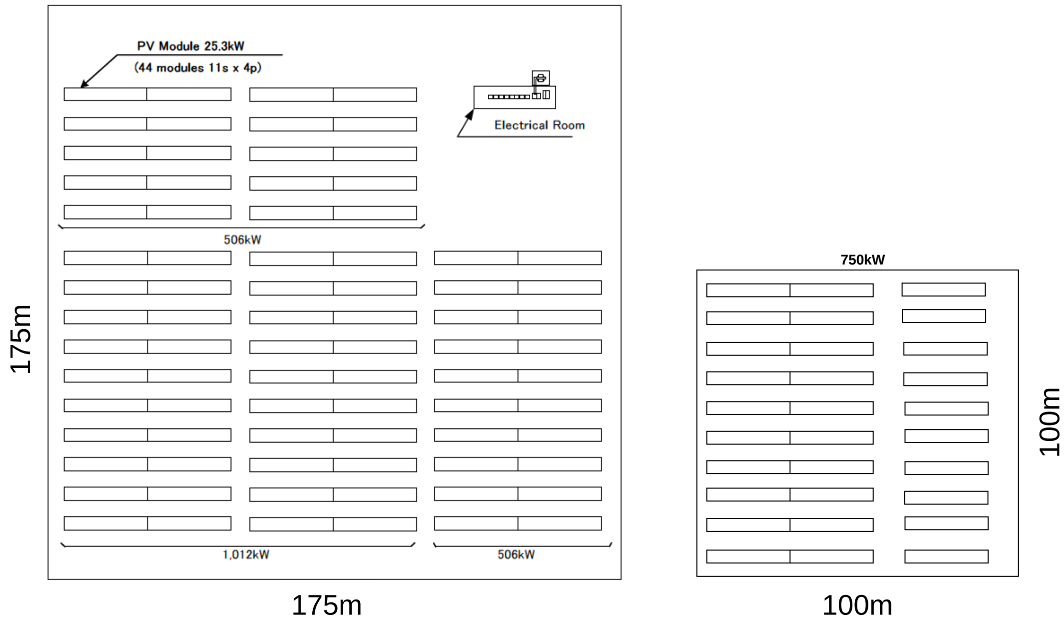
Table 5.43 Benefits of the Solar Power Generation in Samawah WTP

Item		Benefits
A. Operational Impact	1) Solar power generated	1a) 3,850,000 kWh/year, or 1b) 879 kWh/hour
	2) Percentage of hourly solar generation against the overall WTP load	**8.8%** (Greater than loads of the pre-treatment facilities) 1b) (= 879 kWh/hour) / 10,000 kWh/hour = 8.8%
	3) Percentage of annual solar generation against the overall WTP load	**4.4%** 1a) (= 3,850,000 kWh/year) / (10,000 kWh/24h/365days) = 4.4%
	4) Potential reduction of CO_2 emission	**3,690 t-CO_2/year** Emission Factor (= 971 g-CO_2/kWh) x Estimated Annual Power Generation (= 3,800,000 kWh/year) = 3,690 t-CO_2/year
B. Financial Impact	5) Annual savings in electricity cost	**IQD 462,000,000/year = USD316,250/year** 3,850,000 kWh/year x IQD120/kWh = IQD462,000,000/year
	6) Payout time of the investment cost on the solar power generation	**9.2 Years** Construction cost (= USD2,900,000) / Annual savings (= USD 316,250) = 9.2 years

Source: JICA Study Team

(4) Layout of the equipment

As explained in **Figure 5.31**, the solar power generation system will be installed in the 4 ha spaces on southwestern part of the WTP site. Layout of the solar power generation facilities is shown in **Figure 5.33**.



Source: JICA Study Team

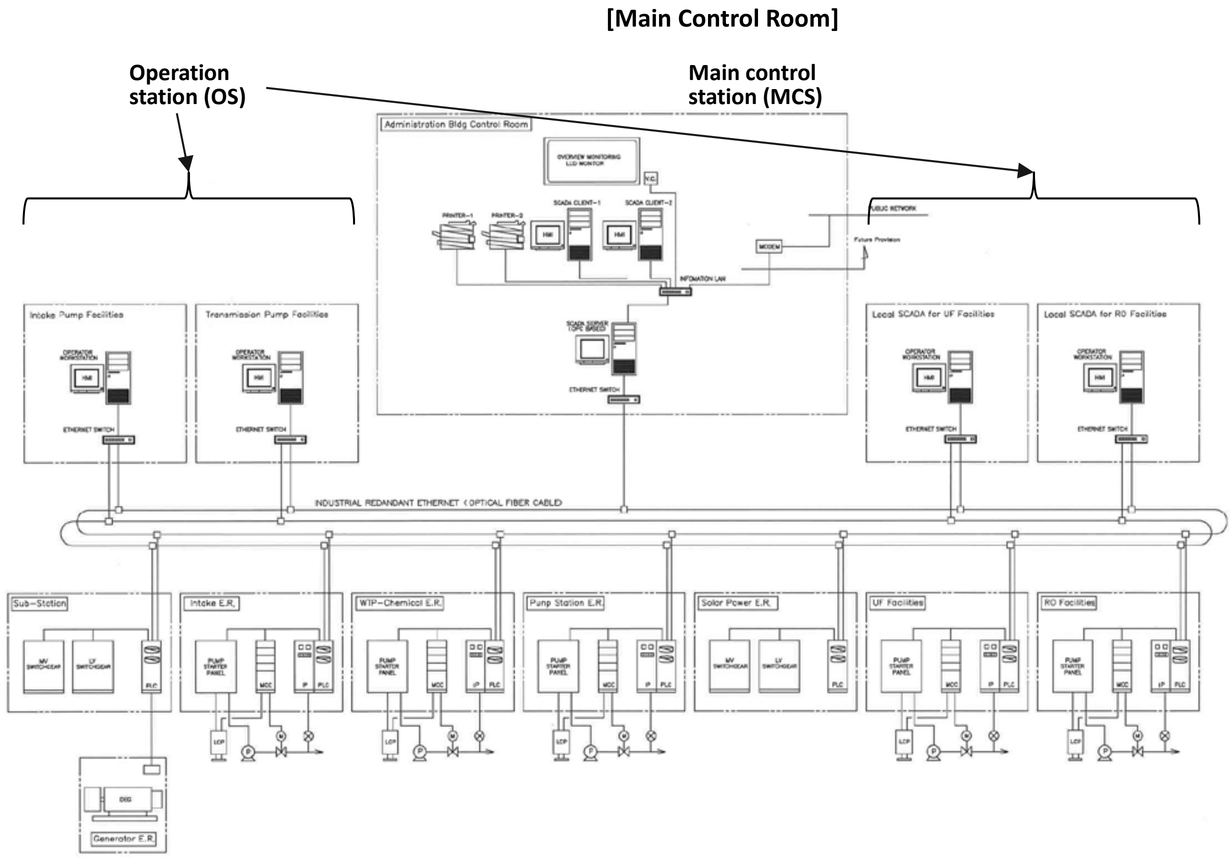
Figure 5.33 Layout Plan of Solar Power Generation Facilities

5.8.9 Study on SCADA System

The SCADA system will provide the performance capability to monitor and control plant operation at Samawah WTP. Main control station (MCS) will be installed in the control room in the administration building and will be connected to four local operation stations (OSs) located at the water intake facilities, pre-treatment facilities, RO facilities, and treated water transmission facilities via ethernet.

All the information collected from the facilities, including the substation and generator station, will be transmitted to MCS and OSs for monitoring. Furthermore, establishment of the integrated SCADA system combined with MWD and/or other WTPs/PSs can be realized by future project.

The SCADA system architecture is shown in **Figure 5.34**.



Source: JICA Study Team

Figure 5.34 SCADA System Architecture

5.9 Preliminary Design

5.9.1 Water Treatment Plant

(1) Intake facility

In addition to the considerations stated in Section 5.5, specific general concepts for the intake are explained below.

- According to the situation of the Euphrates River and raw water condition including seasonal fluctuation, if sand in the river is difficult to be removed naturally, sand removal function such as sand scraper and filter must be installed for the prevention of damages to pump suction and impeller parts.
- Iraq is an oil-producing country and spills of crude oil and other oil-derived substances are common[22] (For instance, in Basrah WTP, intake of water has been suspended due to the oil intrusion), so it is necessary to take measures such as suspending water intake and shutting down plants when oil is detected under the monitoring system. In addition, according to the raw water condition after construction, oil removal function such as advanced treatment shall be considered in the intake facility for prevention of breaching for water quality standard.
- Stoplogs shall be installed before the overturning point under the road and flexible container bags shall be prepared in the WTP for stopping the water flow when the intake channels are cleaned.

Table 5.44 summarizes the specifications of the intake facilities of Samawah WTP.

Table 5.44 Specifications of the Intake Facilities

Items	Specification	Capacity for One Channel / Quantity
Intake capacity	185,625 m^3/d	One channel: 92,813 m^3/d
Intake gate	Screen with oil detector or fence	-
Number of channels	2	-
Intake pump	Double suction volute pump, DSS SCS11/SUS329, 6 pump	21.5 m^3/min, 20 m H

Source: JICA Study Team

(2) Pre-treatment Facility

In addition to the considerations stated in Section 5.5, specific general concepts for the pre-treatment facility are as follows:

- Disinfection by-products precursor is removed for the prevention for bio-fouling of the RO membrane.
- Bypass line from the pre-treated water to the treated water tank should be prepared more than two trains in case of breakdown. Regarding the whole capacity of blend water pipeline, the JST proposed that the assumed minimum raw water TDS for operational change is 1,500 mg/L and maximum blend ration shall be 50% in terms of the optimization of the number of active train

[22] In the water quality survey carried out in this Study, oil has not been detected.

according to the amount of raw water. The maximum blend ratio in Phase 1 is 40% and for the final phase is 50% in case of the installation of same capacity blending pipeline in stages installation in terms of efficiency for diameter and the number of active trains.

In accordance with these concepts, **Table 5.45** shows the results of the preliminary design of the pre-treatment facility. The overview of planning is stated in Sub-section 5.5.3(6).

Table 5.45 Preliminary Design of Pre-treatment Facility

Items	Specification	Capacity for One Train / Quantity
Planned intake volume	185,625 m^3/d	-
Pre-treatment recovery rate	95%	-
Pre-treatment feed water volume	177,632 m^3/d	One train: 29,605 m^3/d
Treated water volume	168,750 m^3/d	One train: 28,125 m^3/d
RO feed water volume	135,000 m^3/d	One train: 22,500 m^3/d
Blend water volume	33,750 m^3/d	One train: 5,625 m^3/d
Number of trains	6	-
Treated water pump	Double suction volute pump DSS SCS11/SUS329, 6 pump	20.6 m^3/min, 25 m H
Membrane filtration unit	• Monolith type, Ceramic • Element size: 8 inches • Number of modules: 30 • Element / module: 90	• Number of trains: 6 • Module / train: 5 • Element / train: 450
Membrane treated water tank	Rectangular shape, RC, 2 tanks	Effective tank volume: 1,200 m^3
Backwashing water pump	Single suction volute pump S SCS13 / CS S45C, 6 pump	20.6 m^3/min, 50 m H
Blend water transmission pump	Single suction volute pump DSS SCS11/SUS329, 6 pump	7.8 m^3/min, 10 m H

Source: JICA Study Team

(3) RO facility

In addition to the considerations stated in Section 5.5, specific general concepts for the RO facility are mentioned as follows:

- The RO facility consists of six lines to secure 50% of the designed capacity even if three lines are stopped due to power break.
- The CIP cleaning system is equipped with a system that can clean one line at a time; the CIP cleaning system does not require the membrane elements to be removed and can be cleaned on site to deal with membrane fouling and scaling. The cleaning solution used is treated and neutralized in the wastewater treatment plant.
- Same as pretreatment facilities, as an optimization for operation in the low TDS (minimum 1,500 mg/L) case, the JST proposed that the blend ratio is maximum 40% (blend volume: 32,400 m^3/d, treated water TDS: 618 mg/L) with pipeline capacity of 33,750 m^3/d in Phase 1 and maximum 50% (blend volume: 67,500 m^3/d, treated water TDS: 765 mg/L) with pipeline capacity of 67,500 m^3/d in the final phase. JST proposed that pipelines of pre-treated water for blending (33,750 m^3/d) should be constructed in Phase 1 and one more line with same capacity will be added in the final phase for the optimization of LCC.

Based on these concepts, **Table 5.46** and **Table 5.47** show the results of the preliminary design of the RO facility. The overview of planning is described in Sub-section 5.5.3(7).

Table 5.46 Preliminary Design of RO Facility

Items	Specification	Capacity for One Train / Quantity
RO feed water volume	135,000 m^3/d	One train: 22,500 m^3/d
RO production water	101,250 m^3/d	One train: 16,875 m^3/d
Raw water concentration	3,000 mg/L – TDS	Same as left
RO recovery ratio	75 %	Same as left
The number of trains	6	-
Water supply pump	Double suction volute pump DSS SCS11/SUS329, 6 pump	15.6 m^3/min, 40 m H
High pressure RO pump	Multistage volute pump DSS SCS11/SUS329, 6 pump	117.2 m^3/min, 200 m H
Energy recovery device, booster pump	PX, DeROs※1, or similar	3.92 m^3/min, according to concentration volume
RO membrane unit	• Spiral wound type※2, Polyamide composite low-pressure membrane • Partial two-stage treatment, without intermediate pressure boosting • Vessel with 7 elements	
	1 train case	6 train case
	• Number of vessels: 124(82+42) • Number of elements: 868	• Number of vessels: 744 • Number of elements: 5,208
Blend water volume	33,750 m^3/d	5,625 m^3/d
Final production water volume	135,000 m^3/d	22,500 m^3/d

※1: Details are stated in Section 5.5.3(7), Appendix 5.5 and Appendix 5.13.

※2: Details are stated in Section 5.5.3(7) and Appendix 5.5.

Source: JICA Study Team

Table 5.47 Summary of the Capacity for Phase-1 (the Project) and Phase-2 (Final Phase)

Phase	Feed	Phase-1 (the Project)	Phase-2 (Final Phase)
Train	-	4	6
Capacity (m^3/d)	185,600	81,000	135,000
Raw and treated water TDS (mg/L)	3000	Max 1000 (Max 25% blend of pre-treated water)	
Intake volume (m^3/d)	-	123,700	185.600
RO Capacity (m^3/d)	-	65,750	101,250
Unit Capacity one train	-	22,500 m^3/d	

Source: JICA study team

(4) Waste and sludge facility

- Backwashing water flows into the drainage basin and supernatant of sludge treatment is returned to the receiving well at the point of water conservation.
- The area of sludge drying bed should be controlled according to the actual requirement after construction. If the area will not be sufficient in the future, introduction of mechanical sludge drying bed would be considered.
- Residual chlorine sensor is installed in the treated water basin.

(5) Treated water tank

- The capacity of treated water tank will be 33,750 m^3 (16,875 m^3 × 2 tanks) for keeping the 6 hours capacity according to Japanese standard.
- According to the actual operational situation in the future, the volume of the clean tank can be expanded and the site shall be close to the pumping facility.

(6) Equipment list and specifications

The overview of specifications of each facility and equipment is summarized in **Table 5.48**. This table is summarized for the final phase and the number of facilities in Phase 1 is mentioned with brackets and lines.

Table 5.48 Equipment List and Specifications

Main Items	Main Equipment / Specifications	Detailed Equipment Specification / Design Capacity		
		Scale/ Number (Duty)/ Spec	Design Value	Criteria / Note
No 1. Intake Facility (Design capacity: 185,625 m^3/d)				
Intake Channel	Open channel (RC)	• 2 m W×4 m H×2 lines ×200 m with stoplog • Flexible container bag stored in STP warehouse	Water level of Euphrates: 5.5-8.0m	5.5.3 (5)
Intake Gate	• Intake Gate (Steel) • Bar Screen (Steel)	• 6 m W×5 m H×2 • 4 m W×5 m H×4(3)	-	Duplex SS (DSS) (SCS11/SUS329)
Pumping Well	• Basin structure (RC) • Sand Pump (each basin) • Double suction volute pump for lifting	• 8 m W×25 m L×5 m EH×6 • 3.2 m^3/min×6(4) • 21.5 m^3/min×20 m H×6(4) (DSS SCS11/SUS329)	• Surface Load: 0.35 m/min • Horizontal Flow: 0.07 cm/s	• Surface Load: 0.2～0.5 m/min • Horizontal Flow: 0.02～0.07 cm/s
Receiving Well	• Basin structure (RC) • Chemical injection facility (End of the basin) • Measurement Equipment	• 7 m W×7 m L×4.7 m EH×2 • Aluminum sulfate injection 5 mg/L • Turbidity, TDS, pH + Oil detector	Retention time: 3.0 min	Retention time: More than 1.5 min
No 2. Pre-treatment Facility (Design inlet flow rate: 185,625 m^3/d, Design capacity: 168,750 m^3/d)				
Membrane Filtration (MF/UF)	• Ceramic membrane (Monolith type) • Double suction volute pump for filtration • Single suction volute pump for blending water • Measurement Equipment • Treated water tank	• 8 inch, 30 modules, 90 element, 6(4) trains • 20.6 m^3/min, 25 m H×6(4) (DSS SCS11/SUS329) • 7.8 m^3/min, 10 m H×6(4) (DSS SCS11/SUS329) • Turbidity, pH, SDI • 16 m W×15 m L×5 m×2	Retention time of treated water tank: 0.5 hours	5.5.3 (6) Assumption: Application of ceramic membrane
Backwashing Tank	• Elevated tank (Steel) • Single suction volute pump for surface water • Double suction volute pump for backwashing	• 20 m W×20 m L×3.0 m H (EH) • 20.6 m^3/min,10 m H×6(4) (SCS10/SCS10) • 20.6 m^3/min, 50 m H×3(2) (S SCS13 / CS S45C)	Required Volume for elevated tank: 800 m^3	700 m^3 per one backwash
Chemical Injection Facility	Chemical injection unit for membrane cleaning	• Sodium hypochlorite: 100 mg/L • Citric acid: 1.5%	-	-
No 3. Sludge Treatment Facility				
Drainage Basin	• Basin structure (RC) • Single suction volute pump for transmission • Sludge Transmission	• 20 m W×12 m L×4 m H (EH)×3 basin • 10.3 m^3/min,8 m H×3(2) (SCS10/SCS10)	Required Volume for basin 1,795 m^3	5.5.3 (10) More than total drainage amount for each facility

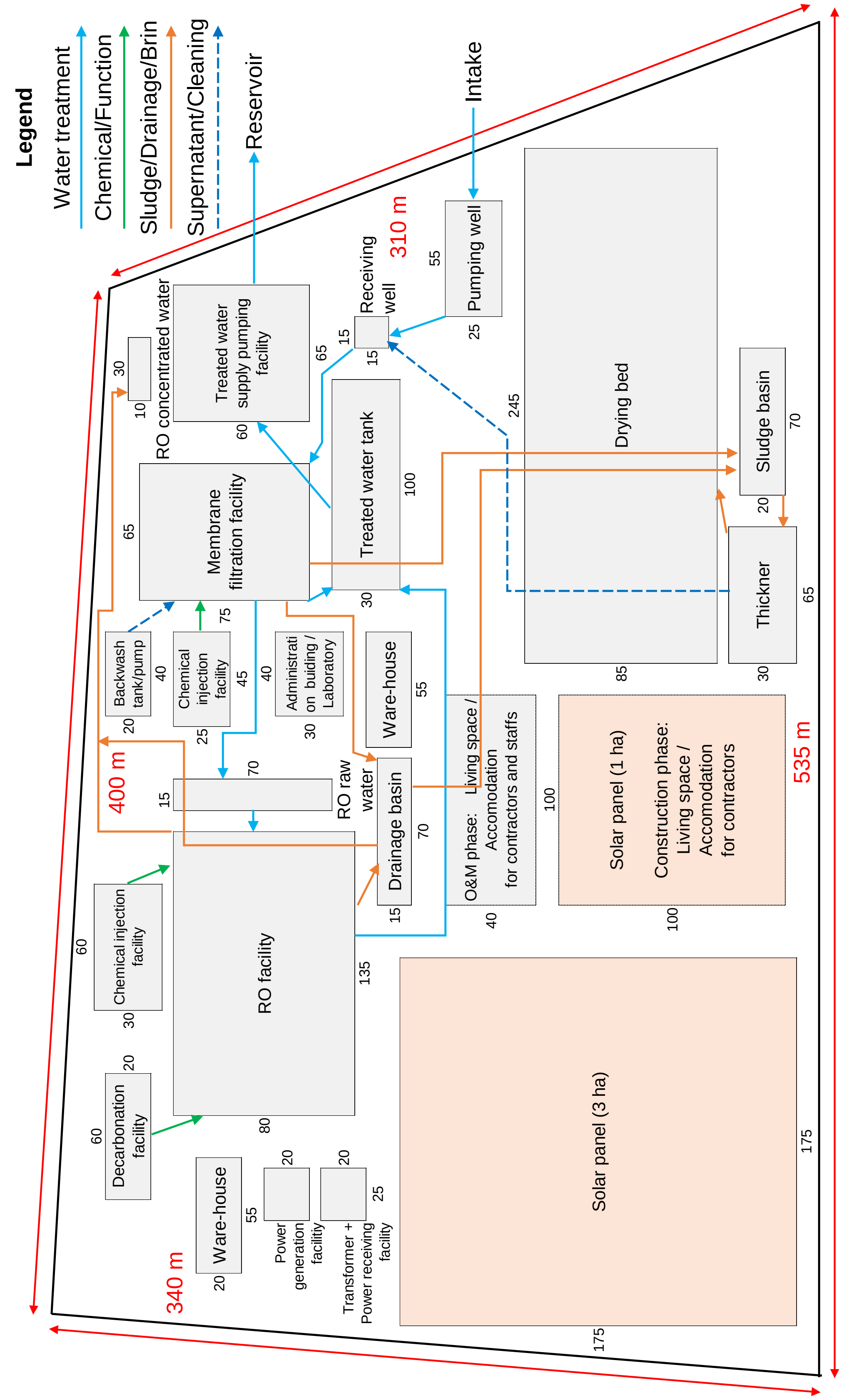
Main Items	Main Equipment / Specifications	Detailed Equipment Specification / Design Capacity		
		Scale/ Number (Duty)/ Spec	Design Value	Criteria / Note
	Pump	• 2.0 m^3/min, 5 m H×3(2) (SCS10/SCS10)		
Sludge Basin	• Basin structure (RC) • Sludge Transmission Pump	• 18 m W×16 m L×4 m H (EH)×3 Basin • 4.0 m^3/min, 8mH×3(2)	Required Volume for basin 785 m^3	5.5.3 (10) More than total sludge amount generated in each facility
Thickener	• Basin structure (RC) • Collector (each basin) • Sludge extraction pumps	• φ20m×4mH (EH)×3 Basin • 1mW×9m L×3 • 2.0 m^3/min, 4m H× 3 (2)	Sludge load: 11.5kg-DS/m^2	Sludge load: 10～20kg-DS/m^2
Sludge Drying Bed	Sun sludge drying bed (flat)	20m W×40m L×1m H×24 basin	Sludge load: less than 29 kg-DS/m^2 Days for drying: more than 60 days	Sludge load: less than 30 kg-DS/m^2 Days for drying: more than 60 days
Drain Pit	Drain channel (RC)	4m W×3m L×2m H	-	-
No 4. RO Facility (RO feed water: 135,000 m^3/d, Design capacity: 101,250 m^3/d, Brine: 33,750 m^3/d)				
Raw Water Tank	• Basin structure (RC) • Measurement Equipment • Double suction volute pump for RO feeding	• 35 m W×9.6 m L × 3.5 m EH × 3 • TDS, EC, ORP, pH • 15.6 m^3/min×40 m×6(4) (DSS SCS11/SUS329)	RT: at least 30.0 min with the consideration for pump efficiency	Retention time: more than 10 min
Pre-Filter	Filter instrument	22,500 m^3/day×6 Line	-	-
High Pressure Pump	Horizontal shaft multistage volute pump	11.7 m^3/min×200 m H×6(4) (DSS SCS11/SUS329)	Same as design inlet flow rate	Same as design inlet flow rate
RO Unit	• Spiral wound, PA low pressure membrane • Measurement equipment • Flushing pumps • ERD, end suction volute pump for booster	• 6(4) trains, 124 vessels × 6, 7 elements • TDS, EC, ORP, pH • The amount of flushing×6 (4) • 3.92 m^3/min×20 m×6 (4) (DSS SCS11/SUS329)	Flux: Less than 0.48 m^3/ m^2 • day ERD: PX	5.5.3 (7) Flux: Less than 0.5 m^3/ m^2 • day
Degasifier	• Degasifier • Fan equipment	• φ2.4 m×4.5 m H×12 • 30.0 m^3/min×12	LV: 92 m/hr	LV: Less than 100 m/hr
Receiving Tank for RO Treated Water	Basin structure (RC)	15 m W×12 m L×4 m H (EH)×6	Retention time: 1 hour for 1 train	Same as Raw Water Tank
Transmission Pump	Double suction volute pump for transmission	7.8 m^3/min×10 m H×6(4)	Same as design capacity	Same as design capacity
Chemical Injection Facility	Chemical injection unit for chemical adjustment, membrane cleaning and post treatment	• Scale inhibitor 0.8 mg/L • Hydrochloric acid 130 mg/L • Citric acid 1.5% • CO_2: 75 mg/L • Lime: 60 mg/L	-	
CIP Unit	Rince Unit	5 m W×10 m L×1.5 m H	-	
No 5. Water Transmission Facility (Design capacity for treated water: 135,000 m^3/d, Brine: 33,750 m^3/d)				
Treated Water Tank	• Basin structure (RC) • Measurement equipment (Before the basin)	• 50 m W× 30 m L × 6 m H (EH) × 2 • Turbidity, TDS, pH + Residual chlorine	RT: 6 hours	More than 6 hours
Transmission	Double suction volute pump	23.4 m^3/min×25 m H× 4	-	-

Main Items	Main Equipment / Specifications	Detailed Equipment Specification / Design Capacity		
		Scale/ Number (Duty)/ Spec	Design Value	Criteria / Note
Pump	for treated water transfer	(3)		
RO concentrated water tank	• Basin structure (RC) • End suction volute pump for brine transmission	• 25 m W × 10 m L × 2 m H • 5.9 m^3/min× 35 m H×4(3)	RT: 15 min	More than 10 min for concentrate
No 6. Others				
Electrical Facility	• Power receiving facility • Emergency generator • Motor control center	• 13 MW • 2,500 kVA×3 • Required system	-	5.8
Solar Panel	Solar panel (PV modules)	3 ha + 1 ha, 2,024 kW	-	1 ha will be utilized for living space for the contractor during the construction
Administration Building	Staff room, Control room, Laboratory, Training room, Prayer Room	30 m W × 40 m L	-	-
Warehouse	Warehouse building including chemical storage, spare parts storage	20 m W × 55 m L×2	-	-
Living Space, Accommodation	Accommodation building, Living space for contractors	100 m W×100 m L	-	Temporary facility in construction

Source: JICA Study Team

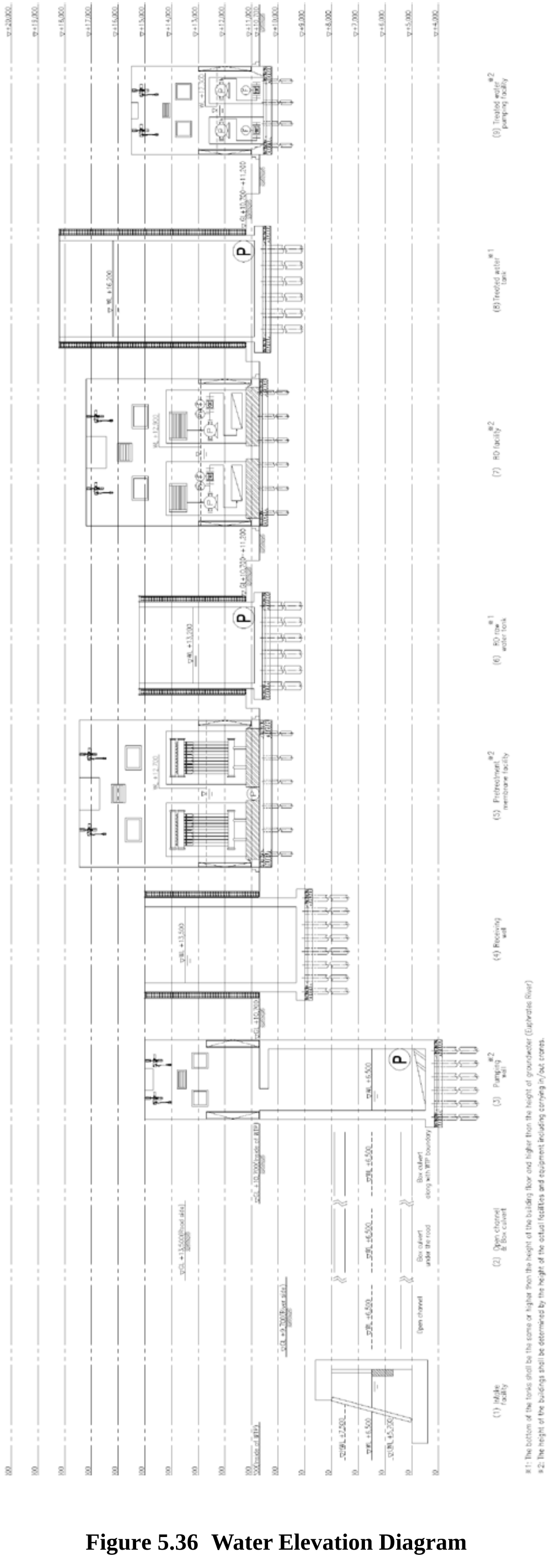
(7) General layout, water elevation diagram, process flow diagram

Figure 5.35 shows general layout with water flow lines, **Figure 5.36** shows water elevation diagram and **Figure 5.37** shows process flow diagram.



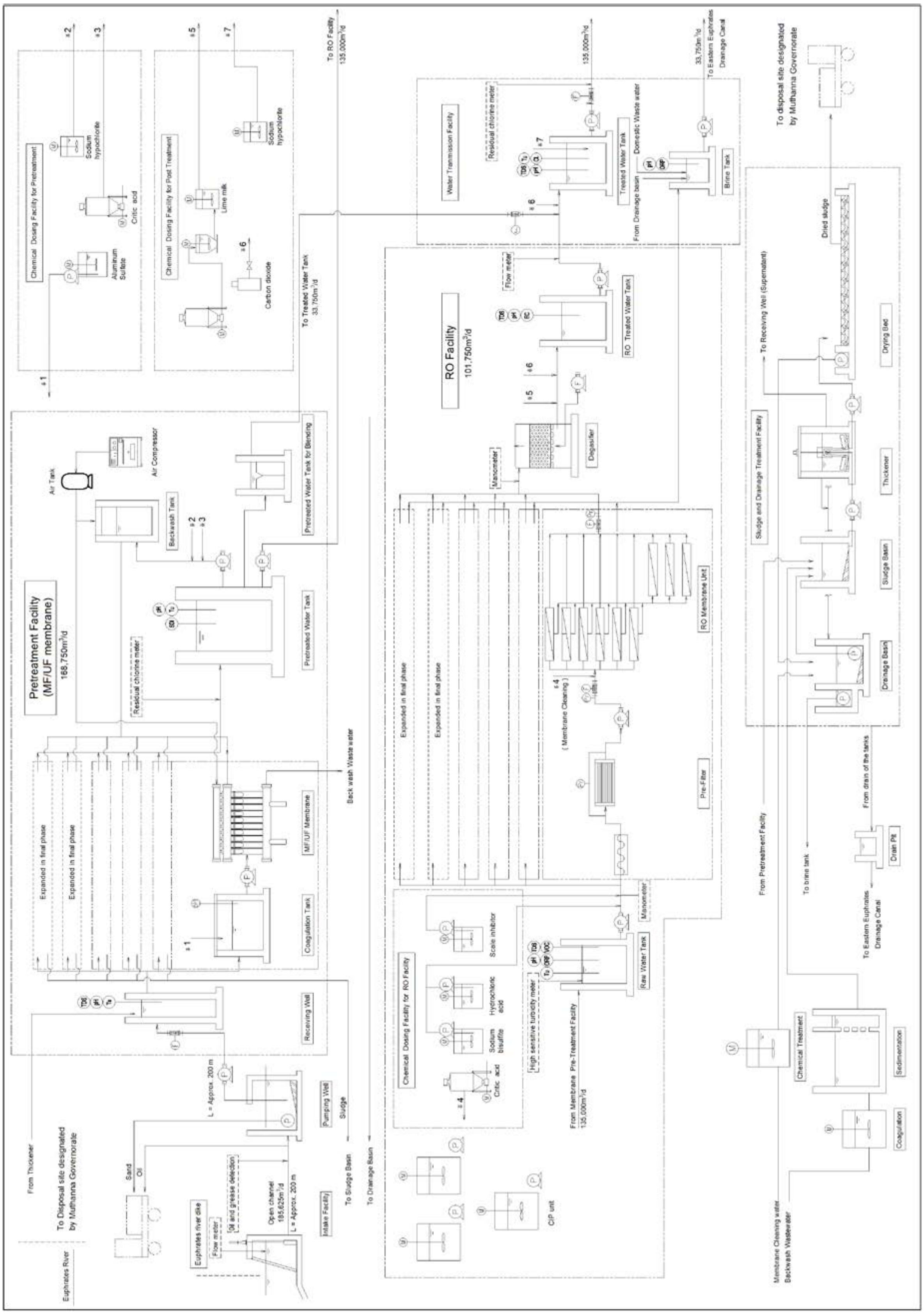
Source: JICA Study Team

Figure 5.35 General Layout with Water Flow Lines



Source: JICA Study Team

Figure 5.36 Water Elevation Diagram



Source: JICA Study Team

Figure 5.37 Process Flow Diagram

5.9.2 Preliminary Design of Water Transmission and Distribution Facility

(1) Treated water transmission facilities from Samawah WTP to Jarbou'yiah PS

Table 5.49 shows the preliminary design of the water transmission facilities.

Table 5.49 Preliminary Design of Water Transmission Facility

Item	Design Considerations	
Design Condition	Final stage capacity: 135,000 m^3/d First stage capacity by the project: 81,000 m^3/d Pipe diameter: D1000 Pipeline length: 6,150 m	
Pump Facility		
Item	Design	Remarks
(1) Number of Pumps	4 duty + 2 stand-by	
(2) Pump Type	Horizontal centrifugal pump	In view of its durability and easiness of maintenance.
(3) Pump Discharge	1,406.25 m^3/hr x 4 duty = 5,625 m^3/hr in Total	135,000 m^3/d = 5,625 m^3/hr x 24 hr
(4) Design Total Pump Head	(see table below)	
(5) Installation for First Stage Project	3 duty + 1 stand-by 1,406.25 m^3/hr x 3 = 4,219 m^3/hr > 3,375 m^3/hr	81,000 m^3/d = 3,375 m^3/hr x 24 hr
Pipeline		
Item	Design	Remarks
(1) Pipeline Route	See **Figure 5.23**	
(2) Pipe Material	[Selection of the pipe material] (see table below)	
(3) Ancillary Facility	Air valve: three locations Stop valve: two locations at before and after crossing of the Euphrates River	
(4) Installation Method	Based on the site survey results, open trench method without sheet pile shall be applied, except for the crossing of the Euphrates River. For the crossing of the Euphrates River, the pipe shall be installed in the concrete casing pipe with diameter of 1500 mm, which shall be installed by pipe jacking method.	

(4) Design Total Pump Head:

Chainage (km)	Flow (MLD)	Pipe Dia (mm)	Velocity (m/s)	Friction Loss (m)	Other loss (m)	Remarks
0					5.00	at PS (assumed)
	135	1000	1.99	18.39		
6.15					0.92	5% of Friction loss
				18.39	5.92	
				Total head	24.31	

Design Total Pump head 25 m

(2) Pipe Material – [Selection of the pipe material]:

	Advantage	Disadvantage
Ductile iron pipe (DCI pipe)	• High strength, toughness, shock resistance, and durability • High workability of installation	• Heavy weight • Protection of pipe fittings is necessary
Mild steel pipe	• High strength, toughness, shock resistance, and durability • Complete integration by welding joint to avoid separation	• Special skills are necessary for high-quality welding of the joints • Prone to corrosion in case surface coating is damaged during construction works or O&M works
HDPE pipe	• High corrosion resistance • Complete integration by fusion joint to avoid separation • Roughness of inner side does not change by time	• Low strength compared with metal material • Weak to heat and UV • Special tools are necessary for fusion joint
Selection	Selected	-

Source: JICA Study Team

(2) Brine discharge facility

Table 5.50 shows the preliminary design of brine discharge facility

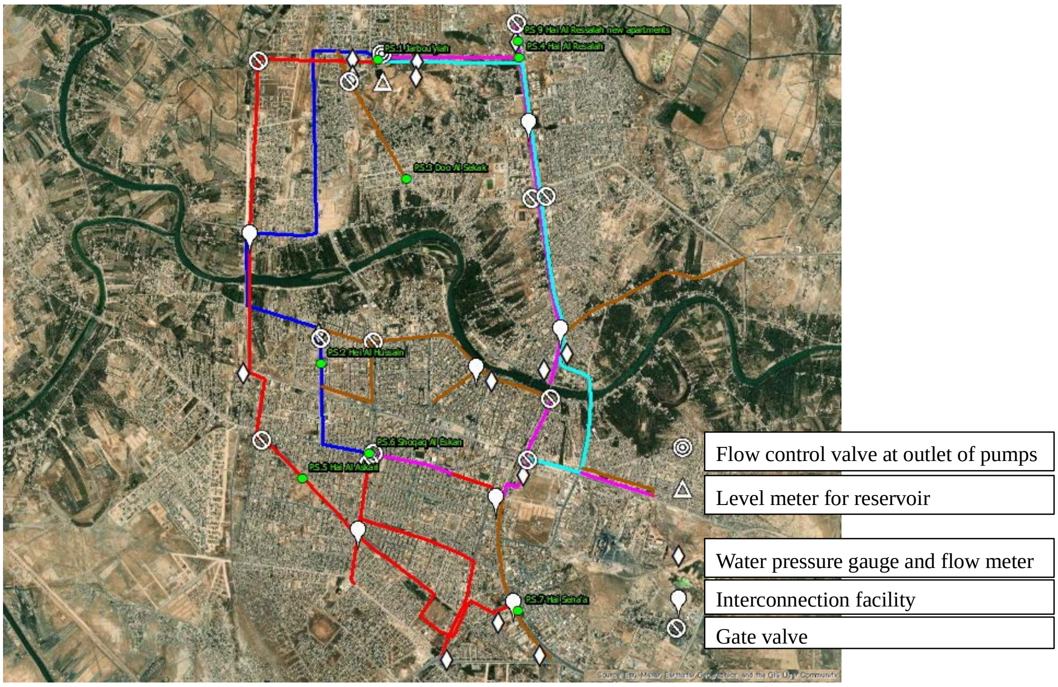
Table 5.50 Preliminary Design of Brine Discharge Facility

Item	**Design Considerations**						
Design Condition	Final stage capacity: 33,750 m^3/d First stage capacity by the project: 20,250 m^3/d Pipe diameter: D600 Pipeline length: 9,520 m						
Pump Facility							
Item	Design						Remarks
(1) Number of Pumps	4 duty + 2 stand-by						
(2) Pump Type	Horizontal centrifugal pump						In view of its durability and easiness of maintenance.
(3) Pump Discharge	351.75 m^3/hr x 4 duty = 1,407 m^3/hr in Total						33,750 m^3/d = 1,407 m^3/hr x 24h
(4) Design Total Pump Head	Chainage (km)	Flow (MLD)	Pipe Dia (mm)	Velocity (m/s)	Friction Loss (m)	Other loss (m)	Remarks
	0					5.00	at PS (assumed)
		33.75	600	1.38	26.36		
	9.52					1.32	5% of Friction loss
					26.36	6.32	
					Total head	32.68	
	Design Total Pump head 35 m						
(5) Installation for First Stage Project	3 duty + 1 stand-by 351.75 m^3/hr x 3 = 1,056 m^3/hr > 844 m^3/hr						20,250m^3/d = 844 m^3/hr x 24 hr
Pipeline							
Item	Design						Remarks
(1) Pipeline Route	See **Figure 5.23**.						
(2) Pipe Material	Same as **Table 5.49**. Ductile iron pipe (DCI pipe) is selected						
(3) Ancillary Facility	Air valve: Four (4) locations Stop valve: Two (2) locations at before and after crossing of the Euphrates River						
(4) Installation Method	Same as **Table 5.49**. The casing pipe shall be same as **Table 5.49** because same pipe jacking machine should be used in view of machine mobilization cost.						

Source: JICA Study Team

(3) Ancillary facility of distribution system in urban areas

Figure 5.38 shows the location of ancillary facilities proposed in Section 5.7.3.



Source: JICA Study Team

Figure 5.38 Location of Ancillary Facilities

Table 5.51 shows the list of above facilities.

Table 5.51 Ancillary Facilities for the Distribution System in Urban Areas

Facility	Principal Features
Pipes, Fittings, and Valves	
(1) Gate valve	D900: 1 no. D800: 2 nos. D500: 3 nos. D400: 2 nos. D300: 2 nos. D225: 1 no.
(2) Interconnection Facility	
1) D900 - D400	Tee 900x900x400 Tee 400x400x400 Gate valve: D900: 1 no. D400: 2 nos. D400 pipe L=5 m
2) D400 - D400	Tee 400x400x400: 2 nos. Gate valve: D400: 3 nos. D400 pipe L=5 m
3) D800 - D500	Total: 2 nos. Per 1no. Tee 800x800x500 Tee 500x500x500 Gate valve: D800: 1 no. D500: 2nos. D500 pipe L=5 m
4) D300 - D300	Tee 300x300x300: 1 no. Gate valve: D300: 2 nos. D300 pipe L=10 m
5) D400 - D300	Tee 300x300x300: 1no. Gate valve: D300: 2 nos. Reducer: 400x 300: 1no. D300 pipe L= 280 m
6) D400 - D300	Tee 400x400x300 Tee 300x300x300 Gate valve: D400: 1no. D300: 2 nos. D300 pipe L=10 m
Monitoring and Control Facility	
(1) Level meter for reservoir	Hydrostatic level measurement equipment: 4 nos.
(2) Water pressure and flow measurement facility	Water pressure gauge and ultrasonic flow meter: For D900 pipeline: 2 nos. For D800 pipeline: 2 nos. For D500 pipeline: 4 nos. For D400 pipeline: 5 nos. For D300 pipeline: 1 no.

(3) Flow control valve	Butterfly valve to be installed at discharge outlet of pumps For pumps of D900 pipeline: D350: 5 nos. For pumps of D800 pipeline: D350: 3 nos. For pumps of D500 pipeline: D300: 3 nos. For pumps of D400 pipeline: D250: 2 nos.
(4) Monitoring system	Monitoring system of above measurement item: Water level: 4 reservoirs Water pressure: 14 locations Water flow: 14 locations

Source: JICA Study Team

(4) Water transmission system to rural areas *(Out of the Scope of the Project)*

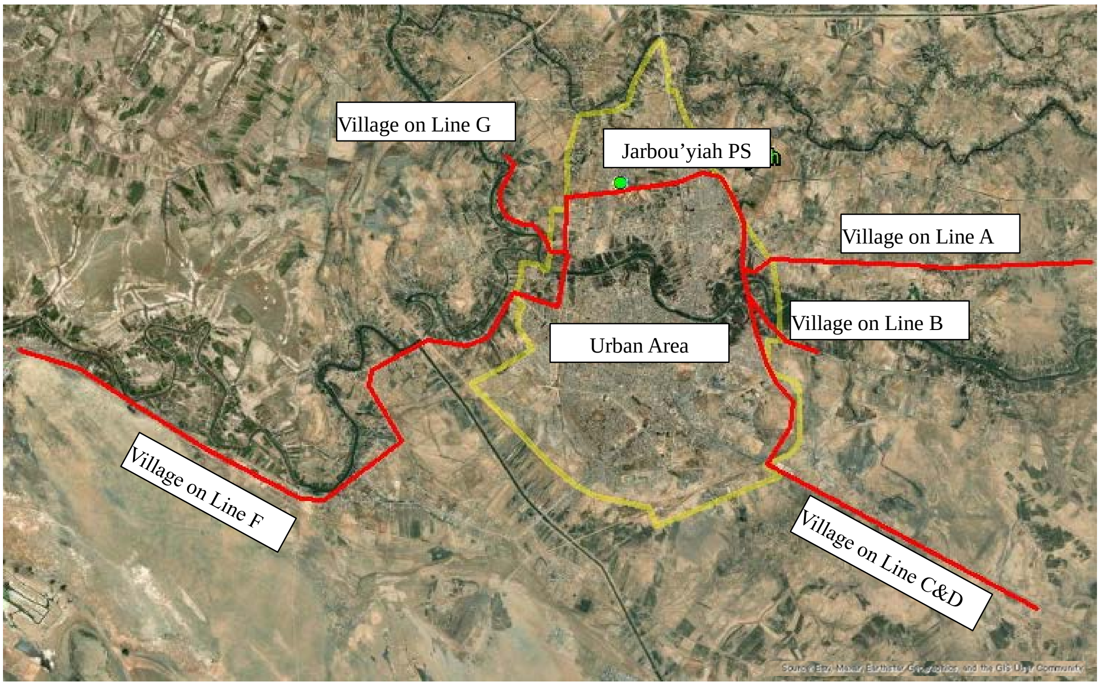
The final capacity of the WTP (135,000 m^3/d) considers the water demand in rural areas:

- 197,119 (population in 2054) x 200 Lpcd = 39,424 m^3/d

Although they are not included in the Project, the Study planned the following water transmission facilities to the rural villages which were supposed to be the supply area of the Project:

- Eastern area: 5 villages (Line A), 7 villages (Line B), 10 villages (Line C&D), Total 22 villages
- Western area: 7 villages (Line F), 3 villages (Line G), Total 10 villages

The alignment of the transmission pipeline to the above villages is tentatively shown in **Figure 5.39**.



Source: JICA Study Team

Figure 5.39 Transmission Pipeline to Rural Villages

The list of planned transmission facilities to the above villages is shown in **Table 5.52**.

Regarding the expansion of water transmission and distribution facilities to rural areas, there are many uncertainties in the scope, and it is difficult to determine the measures that should be taken in terms of environmental and social considerations including the land acquisition matters. Therefore, it is not included in the scope of the project.

In other words, expansion of water transmission and distribution facilities to rural areas is not included in the table below, as it is assumed that Iraq will implement the project independently of this project at its own expense.

Table 5.52 Transmission Facilities to Rural Areas (*Out of the Scope in the Project)*

Transmission Line	Principal Features
(1) Line A - D (22 villages) Daily demand (2054): 27,104 m^3/d	Transmission pump: Total discharge: 1,200 m^3/h H=60 m Number of pump (3 Duty + 1 Stand-by) Transmission pipeline: D600: 6,500 m D450: 13,900 m D350: 12,600 m Distribution reservoir: 600 m^3 x 22 nos.
(2) Line F – G (10 villages) Daily demand (2054): 12,320 m^3/d	Transmission pump: Total discharge: 600 m^3/h H=50 m Number of pump (3 Duty + 1 Stand-by) Transmission pipeline: D450: 3,200 m D400: 22,500 m D300: 4,200 m Distribution reservoir: 600 m^3 x 10 nos.

Source: JICA Study Team

The basis for the above facility plan is shown in **Appendix 5.18**.

5.10 Project Scope

Based on the studies above, the tentative scope of the Project is summarized in **Table 5.53**.

Table 5.53 Scope of the Samawah Water Supply Improvement Project

Facility	Principal Feature
1. Water Treatment Plant	
(1) Intake Facility	First stage capacity by the project: 123,700 m^3/d
(2) Pretreatment Facility	First stage capacity by the project: 112,500 m^3/d
(3) RO Facility	First stage capacity by the project: 81,000 m^3/d High Pressure RO Pump: 117.2 m^3/min, 200 m H
(4) Water Transmission Pumps	20.5 m^3/min, 40 m H
(5) Power Receiving Facility	33 kV / 11 kV, 13 MVA
(6) Solar Power Supply	Power generation: 2,750 kW
2. Transmission System from the WTP	
2.1 Treated Water Transmission System from WTP to PS-1 (Jarbou'yiah PS)	
(1) Pump Station	Final design capacity: 135,000 m^3/d First stage capacity by the Project: 81,000 m^3/d 1,125 m^3/hr, H=25 m, 3W+2S
(2) Transmission Pipeline	D1000, L= 6,350m (including 210 m of trenchless section) Ductile cast iron (DCI) pipe
2.2 Brine Discharge System from the WTP to the Eastern Euphrates Drainage Canal	
(1) Pump Station	Final design capacity: 33,750 m^3/d First stage capacity by the Project: 20,250 m^3/d 430 m^3/hr, H=35 m, 2W+1S
(2) Discharge Pipeline	D600, L= 9,500 m (including 210 m of trenchless section) High Density Polyethylene (HDPE) Pipe
3. Installation of Ancillary Facility of Distribution System in Urban Areas	
3.1 Valve Facility	
(1) Gate Valve	D900: 1 no. D800: 2 nos. D500: 3 nos. D400: 2 nos., D300: 2 nos. D225: 1 no.
(2) Interconnection Facility	
1) D900 - D400	Tee 900x900x400 Tee 400x400x400 Gate valve: D900: 1 no. D400: 2 nos. D400 pipe L=5 m
2) D400 - D400	Tee 400x400x400: 2 nos. Gate valve: D400: 3 nos. D400 pipe L=5 m
3) D800 - D500	Total: 2 nos. Per 1no. Tee 800x800x500 Tee 500x500x500 Gate valve: D800: 1no. D500: 2 nos. D500 pipe L=5 m
4) D300 - D300	Tee 300x300x300: 1 no. Gate valve: D300: 2nos. D300 pipe L=10m
5) D400 - D300	Tee 300x300x300: 1 no. Gate valve: D300: 2 nos. Reducer: 400x 300: 1 no. D300 pipe L= 280 m
6) D400 - D300	Tee 400x400x300 Tee 300x300x300 Gate valve: D400: 1 no. D300: 2 nos. D300 pipe L=10 m
3.2 Monitoring and Control Facility	
(1) Level Meter for reservoir	Hydrostatic level measurement equipment: 4 nos.
(2) Water Pressure and Flow Measurement Facility	Water pressure gauge and ultrasonic flow meter: For D900 pipeline: 2 nos. For D800 pipeline: 2 nos. For D500 pipeline: 4 nos. For D400 pipeline: 5 nos. For D300 pipeline: 1 no.
(3) Flow Control Valve	Butterfly valve to be installed at discharge outlet of pumps For pumps of D900 pipeline: D350: 5 nos.

Facility	Principal Feature
	For pumps of D800 pipeline: D350: 3 nos. For pumps of D500 pipeline: D300: 3 nos. For pumps of D400 pipeline: D250: 2 nos.
(4) Monitoring System	Monitoring system of the above measurement item: Water level: 4 reservoirs Water pressure: 14 locations Water flow: 14 locations

Source: JICA Study Team

5.11 Projection of the Water Production Volume by Samawah WTP

(1) Water Production Projection

Since the commencement of the operation, Samawah WTP will satisfy the water demand in Samawah District together with the PWT Project. The water volume provided by the PWT Project to Samawah District will be estimated as 80% of the planned volume (44,000 m^3/d), while the production by the Samawah WTP will vary according to the evolution of the water demand. This condition in **Table 5.54** was assumed for the following reasons:

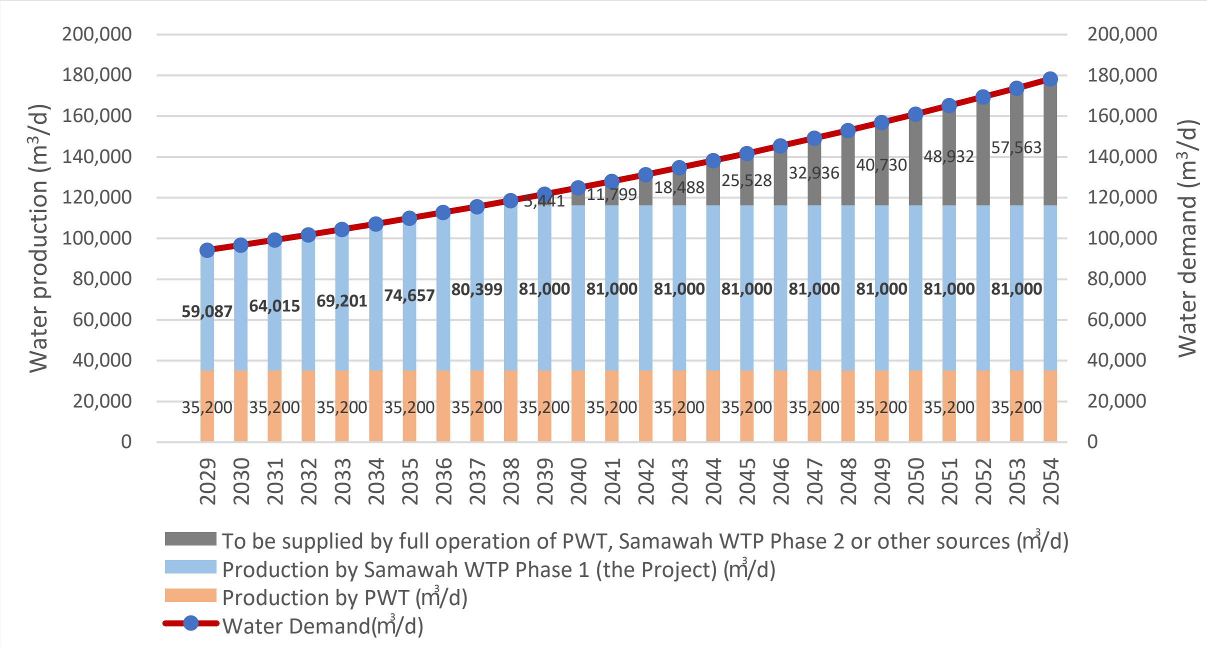
- Utilization of the PWT Project will be prioritized to that of the Samawah WTP as the operation cost of the PWT Project including the transmission cost to Samawah District will be lower.
- Production volume of the PWT Project will not be very stable as the available volume from the Gamass River, whose flow rate is much smaller than the Euphrates River, is more sensitive to hydrological situations.
- The New Rumaitha WTP and WB Rumaitha WTP, whose water sources are the tributary of the Euphrates River in the same manner as the PWT Project, are estimated to be operated at about 80% or less of their design capacities.
- According to the current operational situations, the MWD faces difficulties to satisfy the drinking water quality standard in the WTPs with the conventional treatment method. From the viewpoint of assurance of water quality, the MWD will maintain a certain level of production in the Samawah WTP even when the water demand is not high.

The projection of the water demand as daily average is presented in **Figure 5.39**.

Table 5.54 Conditions of the Water Production Projection by Samawah WTP

Water Treatment Plant	Planned Maximum Volume	Water Volume	Remarks
Samawah WTP	81,000 m^3/d	X - 35,200 m^3/d (Maximum at 81,000 m^3/d)	X: Water demand (m^3/d)
PWT Project	44,000 m^3/d	35,200 m^3/d	80% of the planned volume
Total	125,000 m^3/d	X m^3/d	-

Source: JICA Study Team



Source: JICA Study Team

Figure 5.40 Projection of Production Volume by Samawah WTP

(2) Water Sales Volume from the Production Volume

Water sales volume was calculated based on the water production volume and the non-revenue water (NRW) ratio. In the projection of the water sales volume, NRW ratio was presumed at 25% for the following reasons:

- As explained in Section 4.5.3, the current NRW ratio in Samawah District was estimated at about 16% but due to the lack of bulk flow meter and water meters, the estimated rate may not be accurate.
- The MWD is replacing the old pipes which were installed in the 1980s. In addition, the expansion of the water transmission and distribution networks will reduce the share of the old pipes, which will reduce water leakage. In addition, MWD is executing the efforts to convert illegal connections to authorized connections.
- The water meter installation project, whose commencement in Muthanna Governorate was in November 2022, will install water meters for all house connections by 2027. It will further eliminate the illegal connections and illegal consumptions including water resale and will accelerate MWD's activities to reduce water leakage.

Thus, the water sales volume will be calculated as follows:

Water sales volume = Water production / (1.00 – 0.75)

Based on the assumptions above, water sales volume was calculated as shown in **Table 5.55**.

Table 5.55 Projection of Water Sales Volume by the Project

Year	A. Daily Production Volume (m³/d)	B. Number of Months per year	C. = A x B Annual Production Volume (m^3/y)	D. NRW Ratio	E. = C x (1-D) Annual Sales Volume (m^3/y)
2029	59,087	2	3,545,232	25%	2,658,924
2030	61,520	12	22,147,132	25%	16,610,349
2031	64,015	12	23,045,466	25%	17,284,099
2032	66,575	12	23,966,976	25%	17,975,232
2033	69,201	12	24,912,262	25%	18,684,196
2034	71,894	12	25,881,936	25%	19,411,452
2035	74,657	12	26,876,627	25%	20,157,471
2036	77,492	12	27,896,982	25%	20,922,736
2037	80,399	12	28,943,662	25%	21,707,746
2038 -2054	81,000	12	29,160,000	25%	21,870,000

Source: JICA Study Team

5.12 Consideration of Possibility of Application of Japanese Technology

Table 5.56 shows the products and manufacturers that have potential and possibility of application for the Project. Detailed explanation in terms of strength of Japanese manufacturers for each category are stated in **Appendix 5.13**.

Table 5.56 Products and Manufacturers with Potentials of Application for the Project

No.	Category	Manufacturers	Product (Representative, Example)
1	Organic (PVDF, PTFE) membrane	Asahi Kasei Corporation	Microza
		Mitsubishi Chemical Corporation	Sterapore
		Sumitomo Electric Industries, Ltd.	Pore flow
2	Inorganic (ceramic) membrane	METAWATER Co., Ltd	Package type ceramic membrane facility
		Meidensha Corporation	Flat sheet ceramic membrane
		Kubota Corporation	Fil cera, porous bottom, Kubota run fil
3	RO membrane	Toray Industries, Inc.	TMG series
		Nitto Denko Corporation	SWC, HG, HR series
		Toyobo Co., Ltd.	Hollosep series
4	High pressure pump and booster pump	Torishima Pump Mfg. Co., Ltd.	HB, MT, MB series
		DMW CORPORATION	MODEL MT-RD
		Ebara Corporation	CD model
5	Energy recovery device	DMW CORPORATION	DeROs
		Kubota Corporation	Rotary type
		Ebara Corporation	Pressure conversion chamber type
6	SCADA	Yokogawa Electric Corporation	FAST/TOOLS
		Hitachi, Ltd.	Micro SCADA X and Network manager series
		Aichi Tokei Denki Co., Ltd.	DL series

Source: JICA Study Team

Chapter 6 Construction Plan and Procurement Plan

6.1 Consideration of Construction Method

Construction works to be implemented under the Project will be expected as shown in **Table 6.1**.

Table 6.1 Summary of the Construction Works to be Studied in the Construction Plan

Work Item	Contents	Work Volume in Phase-1
Intake, Conveyance Pipe	Raw water to be extracted from the Euphrates River and the raw water will be conveyed by the pipe to the Water Treatment Plant	Capacity: 123,700 m^3/day*, Pipe length: approx. 300 m
Water Treatment Plant	Pre-treatment, RO Facility,	112,500 m^3/day* 65,750 m^3/day
Brine Discharge	Brine Discharge Pipe to the Discharge Canal Brine Discharge Pump	Length: 9.5 km Diameter: D600 430 m^3/hour
Transmission Pipe (Primary)	Pipeline from the Water Treatment Plant to the Jarbou'yiah Reservoir	Length: 6.35 km Diameter: D1000
Procurement of Ancillary Facilities of Distribution System	Gate Valve Interconnection Facility Monitoring and Control Facility	D225-D900 D300-D900 Level Meter, Water Pressure and Flow Meter, Flow Control Valve, etc.

*: Full scale of civil structures to cover until Phase-2 of intake, water treatment plant, and transmission pipe will be constructed in Phase-1 (the Project).

Source: JICA Study Team

Pipelines are assumed to be laid in the existing roads or in the road shoulder so the installation works will not have constraint. Installation depth is mostly shallow so that no large-scale earth shoring is required and only simple shoring is assumed to apply.

6.2 Construction Method of the River Crossing

Primary transmission pipe from the new water treatment plant to the Jarbou'yiah Reservoir will need to cross the Euphrates River. The brine discharge pipe will also cross the Euphrates River and the canal crossing the alignment of the brine discharge to the drainage canal to be discharged. Pipes for each crossing and their recommended construction methods are shown in **Table 6.2**. For the installation of the brine discharge pipe crossing the Sowair River, construction by open cut with a temporary shoring is adopted since the water level in the dry season is much lower than in the other season. In addition, it is required to consider whether the river flow can be secured although temporary shoring will reduce the flow area of the river. In case the flow will not be enough, it will be required to consider the installation of diversion pipe to secure an enough flow of the river.

Table 6.2 Pipes for Crossing Rivers and Recommended Construction Method

Location		Length	Pipe Diameter	Pipe Material	Recommended Method
Transmission Pipe to the Jarbou'yiah Reservoir	Euphrates River	Total length of transmission pipe of 6 km, of which river crossing is 200 m	1000 mm	Ductile Cast Iron	Pipe jacking method under the river
Brine Discharge Pipe	Euphrates River	Total length of brine discharge pipe of 8 km, of which river crossing is 200 m	600 mm	Ductile Cast Iron	
	Sowair River	Total length of transmission pipe of 8 km, of which river crossing is 100 m	600 mm	High-density Polyethylene	Open cut method in the river

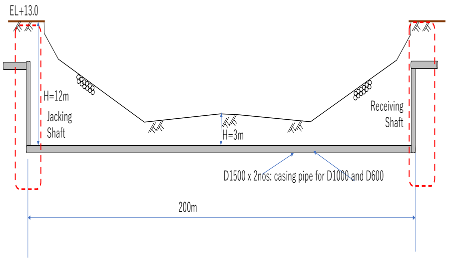
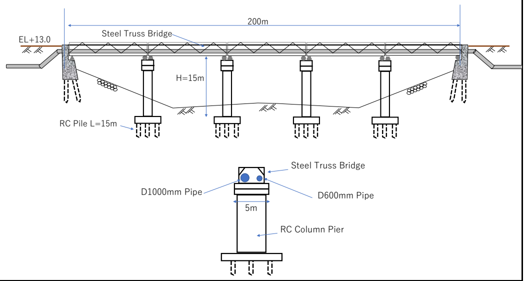
Source: JICA Study Team

Two construction methods for the crossing of the Euphrates River, namely, water pipe bridge method and pipe jacking method, were compared as shown in **Table 6.3**. The pipe jacking method is recommended as it is beneficial in terms of construction cost, constructability, and environmental impact.

MWD raised concerns about maintenance in the case of the pipe jacking method. However, similar scale of transmission pipelines crossing the river is often applied widely in the world and such pipes do not have major problem for a long period. In the Study, the earth cover from the riverbed was set at 3 m to avoid damage on the pipes in case of some accident such as during dredging of the riverbed.

On the other hand, installing pipes under the Euphrates River requires approval from the Ministry of Water Resources in terms of the maintenance of the river. JST recommends the pipe jacking method as shown in **Table 6.3** taking into account the fact that the Ministry of Water Resources approved the pipe jacking method to cross the Shatt Al-Arab River in the Basrah Water Supply Improvement Project. However, based on the re-discussion with MWD, the Study presumes the pipe bridge method, which MWD is much familiar with and the feasibility in terms of the authorization by the ministry may be higher.

Table 6.3 Comparison of the Construction Methods for the Crossing of Euphrates River

Item	Pipe Jacking Method	Pipe Bridge Method
General Sketch		
Construction Features	To install the two pipelines under the Euphrates River by the pipe jacking method. For each pipeline, two vertical shafts are needed at both ends of the pipeline. The pipelines will be installed inside the concrete pipes installed by jacking. **[Pipe jacking work]** ・ Diameter: 1,500 mm x 2 lines ・ Length: 200 m x 2 lines ・ Pipe material: Concrete pipe ・ Depth: 3 m under the riverbed **[Vertical shafts]** ・ Number: 4 sites ・ Dimensions ・ Jacking shafts: 8 m x 4 m x 2 sites ・ Receiving shafts: 6 m x 4 m x 2 sites ・ Depth: 13 m ・ Structure: Liner plates **[Pipe installation]** ・ Diameter：1,000 mm, 600 mm ・ Pipe material: Ductile cast iron, High-density polyethylene	To install the two pipelines on a new bridge to cross the Euphrates River. **[Bridge]** ・ Length: 200 m ・ Superstructure: Stiffening truss type ・ Base structure: Reinforced concrete ・ Foundation: Concrete piles of 15 m depth in the WTP side and 25 m depth in the city side ・ Span length: 40-m interval ・ Elevation: Bridge girder at +13.0 m, the same elevation as the river dyke **[Pipe installation]** ・ Diameter: 1,000 mm, 600 mm ・ Pipe material: Mild steel
Const. Cost	USD 4.7 million	USD 5.5 million
O&M	□ No maintenance is required. ■ Visual inspection and repair are almost impossible.	■ Periodic painting of the bridge and the pipelines is required. □ Visual inspection and repair are easy.
Reliability	□ Many cases in the world including a pipeline of 1,600 mm (Length: 250 m) in Basrah Water Supply Improvement Project	□ Many cases in the world
Constructa-bility	□ Enough space along the river for the vertical shafts □ No constraint by season or weather	■ Workable but needs wide working space beside the river and needs working in the river ■ Not workable when the river's water level is high
Environment	□ No impact on the transportation and on the river	■ Certain impact on the river environment during the construction ■ Impact on the transportation along the river during the construction
Evaluation	・ No longer a special technology in Iraq ・ Lower cost of construction and O&M and good constructability	・ Classic method that enables easy inspection and maintenance ・ High cost and need of periodic maintenance
	Recommended	Not Recommended

□: Positive, ■: Not positive

Source: JICA Study Team

6.3 Procurement of Materials and Equipment

Procurement sources of the required materials and equipment for the construction of the water supply facilities in the Project are summarized in **Table 6.4**. Materials for general civil works and pipe installation can be procured in Iraq or from local agents. On the other hand, RO membranes and high-pressure pumps required for the desalination plant will be procured from other countries.

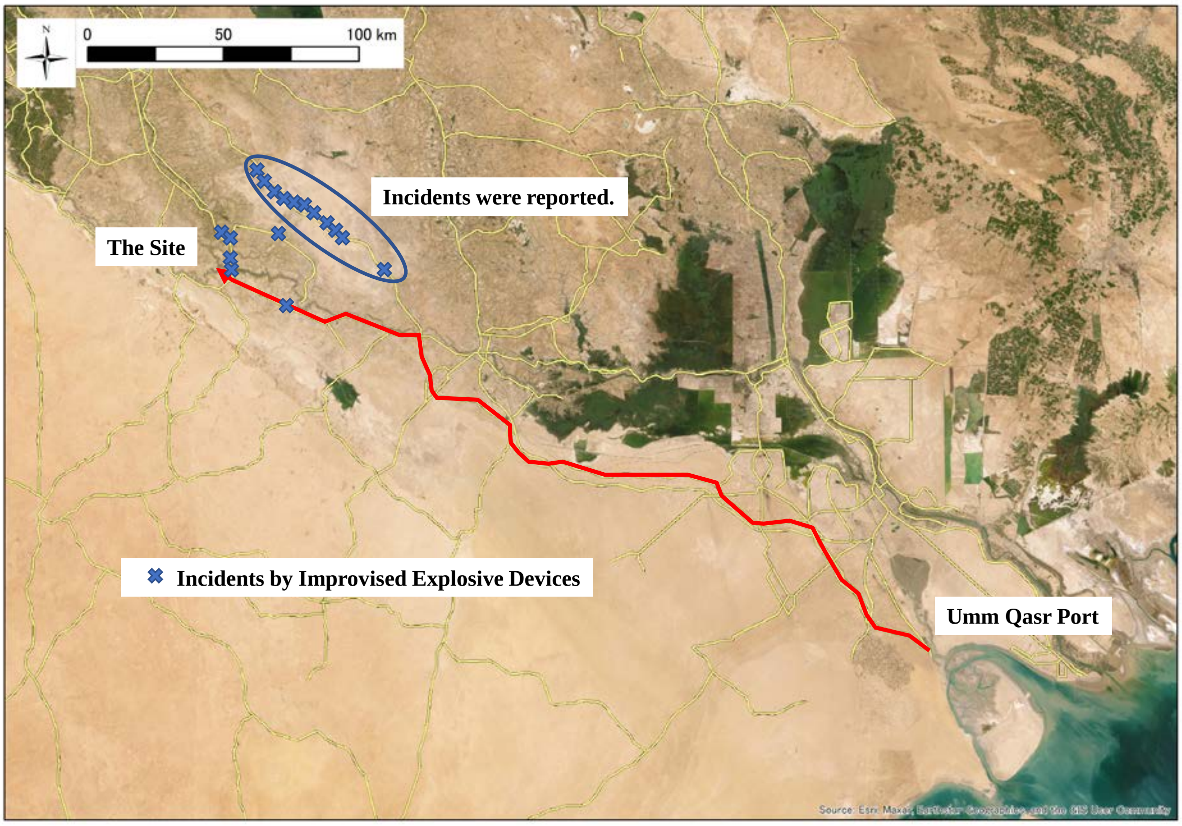
Table 6.4 Procurement Sources for the Major Materials and Equipment

Materials	Source Country	Remarks
Civil and Building Works		
Sand, Aggregate, Stone	Iraq	
Cement	Iraq	
Asphalt	Iraq	
Reinforcement Bar	Surrounding countries such as Iran, Turkey, Jordan	Possible to procure an imported material from the agent
General Steel	Iraq	
General Lumber	Iraq	
Pipes (PVC, DIC, PE)	Surrounding countries such as Iran, Turkey, Jordan	Possible to procure an imported material from the agent
Mechanical and Electrical Equipment	Surrounding countries such as Iran, Turkey, Jordan	Possible to procure an imported material from the agent
Water Treatment Chemicals (Coagulant, Hypochlorous Acid)	Surrounding countries such as Iran, Turkey, Jordan	Possible to procure an imported material from the agent
Construction Machinery, Heavy Equipment	Iraq	
RO Membranes, High-pressure Pump	Japan, Europe, China, etc.	

Source: JICA Study Team

6.4 Procurement Route

The materials and equipment will be imported from other countries to the Umm Qasr Port and it is assumed that those will be transported overland by trailer. On the route to Samawah from the Umm Qasr Port, some incidents with explosive device were reported and some not so serious incidents also happened around the Muthanna Governorate. Those incidents almost targeted the civilian supply convoys serving US contracts traveling on the international highway. To avoid such risks, the transportation route from the Umm Qasr Port to the site at Samawah was selected as shown in **Figure 6.1**.



Source: Control Risks Group Holdings Ltd.

Figure 6.1 Route of the Inland Transportation from the Port

6.5 Capability of Iraqi Contractors

The contract package for the construction of the desalination plant as presented in Chapter 11 should be implemented by international competitive bidding (ICB) due to the difficulty and scale of the work based on the discussion with MWD. On the other hand, construction by Iraqi contractors under the local competitive bidding (LCB) is proposed for the installation of the transmission pipe, brine discharge pipe, construction of power supply facilities from substation to water treatment plant, procurement of materials and equipment such as valves and water meter, and installation of the water distribution pipe network to the rural areas. Therefore, it was observed whether Iraqi contractors can construct these kinds of works.

It can be observed that these works can be implemented by Iraqi contractors based on the information from the bidders on the Basrah Water Improvement Project, which was implemented under Japanese yen loan. Although pipe jacking method is proposed for the river crossing, no other difficult construction work that will be a concern for Iraqi contractors is expected since construction by the pipe jacking method is also included in the Basrah Water Improvement Project.

It should be noted that the detailed design and construction shall be implemented taking into consideration the safety aspect. The construction including the Project does not have major serious hazardous construction since the construction for water treatment plant and installation of pipelines will be almost on the ground without deep excavation. However, it is better to take care of the vertical shaft during the construction at the river crossing. The Japan International Cooperation Agency (JICA) has published the “JICA Standard Safety Specification: JSSS” which describes the construction safety considerations that commonly happen at the site, so that it is recommended to use the JSSS in the ICB contracts. In addition to the construction of water treatment plant by ICB, JST proposes to apply JSSS to the installation of the treated water transmission line and the brine discharge line as their diameters are relatively large and as they involves deep excavation, although it will be by LCB..

6.6 Construction Period

Table 6.5 shows the construction period of the Project by contract package[1]. The period includes all phases from the contractors' execution of design, construction works, and testing/commissioning but do not include the defects liability period.

Table 6.5 Construction Period of the Project by Contract Package

Contract Package	Description	Construction Period
CP-1: Construction of Samawah water treatment plant	Capacity: 81,000 m^3/day including intake, conveyance pipe, pre-treatment facility, RO facility, substation, solar power facility, etc. - Contractor's design: 8 months - Construction, procurement, and installation: 24 months - Commissioning: 4 months	36 months
CP-2: Installation of external power transmission line to Samawah WTP	Transmission line from North Samawah Substation Total length: 5.5km x 2 lines	18 months
CP-3: Installation of treated water transmission line and brine discharge line	Treated water transmission line: L = 6 km, Diameter 1000 mm Brine discharge line: L = 9.5 km, Diameter 600 mm	24 months
CP-4: Improvement of the existing water distribution system in urban area	Installation of control and monitoring facilities such as valves and water meters	15 months

JICA Study Team

[1] See Section 11.3.2 for the contract packaging plan.

Chapter 7 Operation and Maintenance

7.1 Organization and Staffing

The responsible entities for the planning, detailed design, and construction of the Project shall be both the General Water Directorate (GWD) and Muthanna Water Directorate (MWD), while the operation and maintenance (O&M) of the facilities shall basically be the responsibility of MWD. MWD is exclusively authorized to collect and use water tariff for the O&M of its waterworks, salaries, and other administrative expenses without transferring it to MOF and with the approval of budget by the Muthanna Governorate.

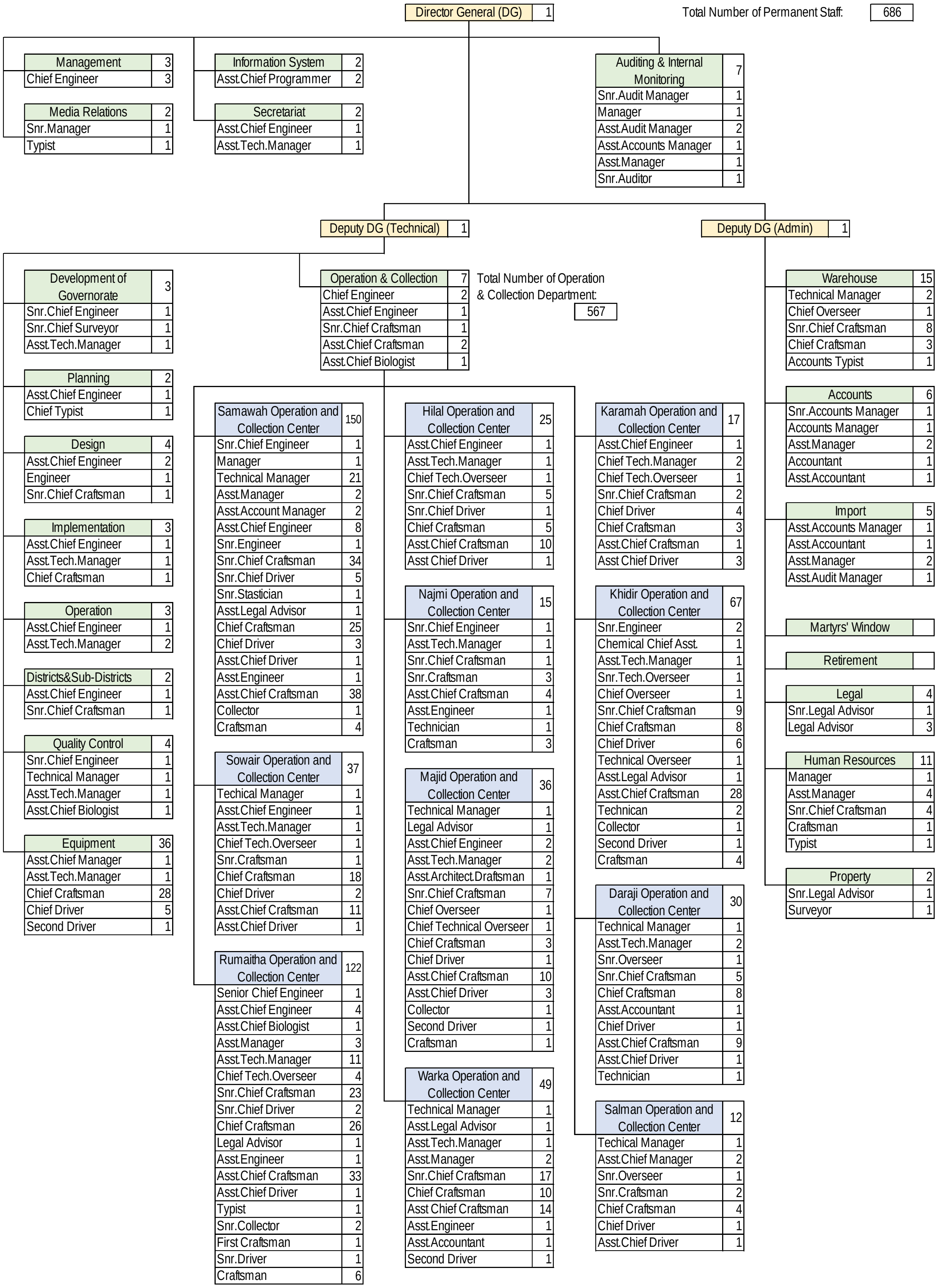
7.1.1 Current Situation of Water Supply Facilities operated by MWD

(1) Staffing

Figure 7.1 shows the number of permanent staff in each department of MWD as of November 2022. A total of 686 permanent employees are assigned, of which 567 employees (83%) are assigned in the Operation and Collection Department. Apart from the permanent staff, over 700 temporary staffs are assigned, of which 200 and 315 are working as maintenance workers and operators, respectively.

As indicated in **Figure 7.1**, administrative and financial staff is smaller in number than the technical staff, because the key functions of MWD are to deal with technical and engineering issues. In case of shortage of staff in administrative and financial fields, some staff act the role of another position, e.g., administrative staff acting the role of an accountant, or by hiring a temporary staff.

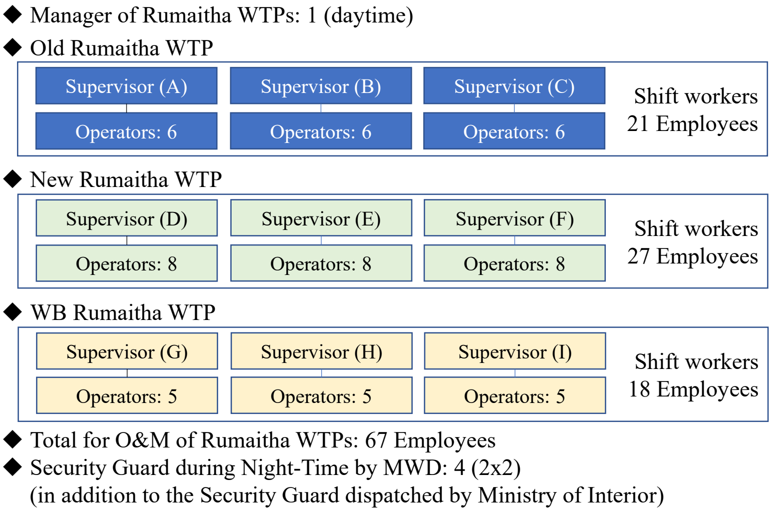
The "Operation and Collection Center", established under the control of Operation and Collection Department in each of the 11 districts/sub-districts of Muthanna Directorate (Al-Busaiyah Sub-district is managed by Al-Salman District Operation and Collection Center), is engaged in the O&M of the facilities that were constructed in central projects located in its jurisdictional district/sub-district. The water treatment facilities to be constructed in the Project will be operated and maintained by the Majid Operation and Collection Center, which should be strengthened both in number and capacity.



Source: JICA Study Team

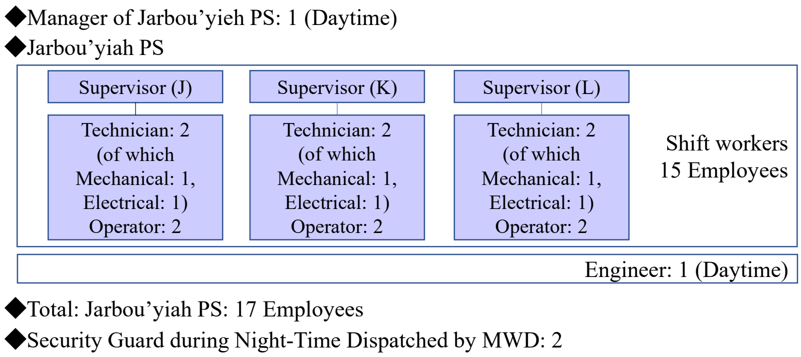
Figure 7.1 Current Staffing of Permanent Employees in MWD

The number of staff in charge of the O&M of the existing three Rumaitha WTP (Old, New, and the World Bank) as well as Jarbou'yiah PS is shown in **Figure 7.2** and **Figure 7.3**. The total number of staff for the O&M of the WTPs is 67, while the total number of staff for the O&M of the receiving tanks and PS is 17.



Source: JICA Study Team

Figure 7.2 Current Staffing of Rumaitha WTPs



Source: JICA Study Team

Figure 7.3 Current Staffing of Jarbou'yiah PS

(2) Performance and challenges of O&M by MWD

MWD conducts maintenance work on an ad hoc basis whenever any problem occurs. Remote monitoring system of facilities from closed-circuit television (CCTV) to mobile display is being used. Except for mid-month reports of maintenance work for the networks and transmission pipes, MWD has not established key performance indicators (KPIs) nor prepared annual reports on O&M and water utility management.

Regarding the performance of O&M by MWD, the Previous Study suggested the following, based on the result of water quality analysis. The similar issues were observed during the on-site visits conducted by JST.

- Some problems in operation or facilities to control turbidity: The turbidity of treated water of the WTP in Rumaitha often exceeded five NTU, which is equivalent to water quality standard of

World Health Organization (WHO). This suggested that operation or facilities regarding coagulation, sedimentation, and sand filtration had some problems.

- Contamination of treated water: The concentration of free residual chlorine went down and only a small concentration of combined chlorine was detected at the tanks and the reservoirs in Samawah, although the concentration of free residual chlorine reached above 2 mg/L in treated water of WTP in Rumaitha. Also, *Escherichia coli* (E. coli) was detected at the receiving tanks and reservoir tanks in Samawah. This suggested that the decrease of residual chlorine was caused by the substance contained in the treated water, which consumed residual chlorine such as ammonium during the transportation from WTP in Rumaitha to receiving tanks in Samawah.
- Need for chlorine dosing facilities and periodical test of residual chlorine: There were no additional chlorine dosing facilities in the existing receiving tanks in Samawah and analysis of residual chlorine was not conducted periodically, although normally residual chlorine should be continuously monitored, and chlorine should be added when needed.

7.1.2 Equipment and Materials for O&M

(1) Water quality laboratory in Muthanna Governorate

According to the Previous Study, approximately 250 samples per month were sent from the WTPs in Muthanna to the water quality laboratory in Muthanna, and the test was conducted by two permanent staff and one technician. The equipment for water quality analysis owned by the laboratory is shown in **Table 7.1**. The parameters that can be tested in the laboratory are water temperature, turbidity, pH, electro-conductivity, total alkalinity, total hardness, calcium, magnesium, chloride, sulphate, total dissolved solids (TDS), total suspended solids (TSS), sodium, potassium, aluminum, bacteria, E. coli, etc.

Table 7.1 Laboratory Equipment in Central Laboratory in Muthanna Governorate

Equipment	Quantity
Distilled Water Equipment	1 unit
Spectrophotometer	1 unit
Flame Photometer	1 unit
Turbidity Meter	1 unit
pH Meter	1 unit
Electroconductivity Meter	1 unit
Dryer	1 unit
Autoclave	1 unit
Incubator	1 unit
Others, Chemicals, Glassware	1 set

Source: Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq

(2) Equipment and materials for O&M activities

Detailed information of the equipment used and the materials stocked for daily O&M of waterworks was not obtained. According to the site survey, some important deficiencies in the flush mixers and instruments were observed. On the other hand, according to MWD, clamps and pipe fittings are frequently used for pipeline maintenance to fix reported leakages, and motors and breakers are regularly maintained and replaced in case of irremediable damage, which bring temporary shortage of supply from time to time.

7.1.3 Training programs

The training programs organized in MWD during the period 2018-2022 are shown in **Table 7.2**. The programs cover all the fields from general, administrative, technical, and financial ones, but a systematic training plan should be developed based on the assessment of the needs among the employees, and the effect of each training program should be properly evaluated and reflected in the improved plan.

Table 7.2 Training Programs Implemented from 2018 to 2022

Program	Year	Category	Funding Authority
Training programs for the year 2018	2018	General	MCHPM
Paying instructions	2018	Financial	Al Muthanna Training Center
Checking before and after exchange	2018	Financial	Ditto
Microsoft Windows 2003	2018	General	Ditto
Execution of government contract instructions	2018	Administrative	Ditto
Fixing motors	2019	Technical	MWD technical workshop
How to prepare accounting and administrative tables in Microsoft Excel	2019	Financial Administrative	MWD general and local administration
Anti-administrative and financial corruption	2019	Administrative Financial	Al-Muthanna Inspection Directorate
Uniform retirement law	2019	Administrative	Integrity Commission /Muthanna Office
National water monitoring project	2019	Technical	Al Muthanna Training Center
Middle management jobs	2020	Administrative	Al Muthanna Training Center
Preparing memos and official correspondence	2020	General	Ditto
Fifth civil defense course	2020	Administrative	Directorate of Civil Defense in Muthanna
Contracts and tenders	2020	Administrative	Al Muthanna Training Center
Problem analysis and decision making	2020	General	Ditto
Civil defense course for governmental employees	2021	General	Directorate of Civil Defense in Muthanna
Barcode system cycle	2021	General	Retirement Directorate / Muthanna
Training on water quality monitoring	2021	Technical	United Nations Children's Fund / Basra Office
Human resources management	2021	Administrative	Al Muthanna Training Center
Machinery maintenance	2021	Technical	Ditto
Civil defense course for governmental employees	2022	General	Directorate of Civil Defense in Muthanna
Human resources management	2022	Administrative	Al Muthanna Training Center
Secretarial and office management	2022	Administrative	Ditto
Problem analysis and decision making	2022	General	Ditto
Maintenance and repair of control panels and electric motors	2022	Technical	Ditto

Source: MWD edited by the JICA Study Team

7.2 Finance and Budget

According to the O&M cost estimated in **Table 10.4**, MWD's annual O&M costs of Samawah WTP will be IQD 15.770 million excluding depreciation cost when the WTP is operated at its full capacity. Referring to **Table 3.12**, the total cost for operation including salaries, O&M cost, and service cost (fuel, chemical cost),excluding depreciation cost is IQD 23,311 million, and the incremental costs of the new WTP corresponds to the additional 68%.

This O&M cost will be paid by the collected tariff revenue of MWD and granted subsidy from the central government. For sustainable operation of the water supply services, it is ideal that the whole O&M cost is covered by the collected tariff revenue. However, the share of the tariff revenue out of the total revenue of MWD is only 8.6% during the latest three years. The ongoing installation of the water meters to the service connections and simultaneous reformulation of the tariff system may increase the tariff revenue, but it will not drastically change the situations in a decade or two in general as it is difficult to raise the water tariff rapidly, and as confirmed in the social survey done in the Study, the current affordability to pay (ATP) of the people in Samawah District is not enough to provide MWD with sufficient finance for the O&M of the Project[1].

During the O&M phase of the Project, while waiting for the economic growth which will gradually increase the affordability of water users, provision of sufficient subsidy to MWD should be assured by the central government.

[1] See the result of the financial analysis of the project shown in Section 12.2.3.

7.3 Experience and Competency of the Operator of the Facilities

The Previous Study enumerated the following points related to the technical capacity of O&M of waterworks at the governorate level including MWD:

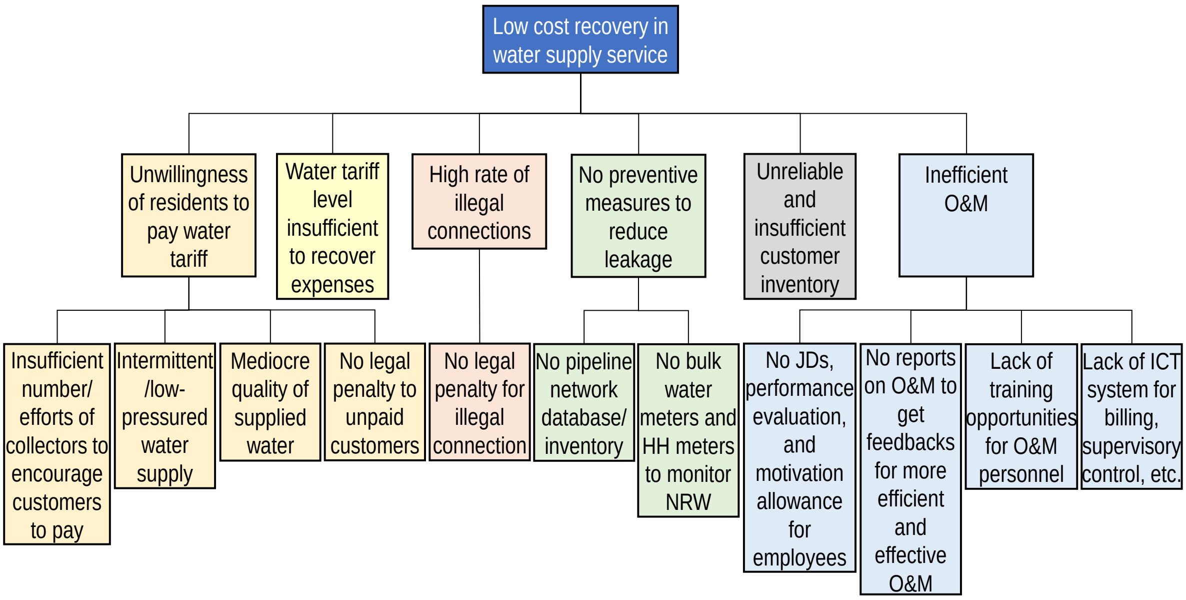
- Lack of data for evaluation and analysis of existing facilities: records of the maintenance works are not managed sufficiently, such as the operation record of WTP and maintenance record of the piping system. Thus, it is difficult to examine and analyze current status, problems, and countermeasures based on the real data.
- Insufficient capacity and experiences of the O&M staff: since the majority of staff lack experience in actual maintenance work and their knowledge and technical capacity on waterworks are limited, the current O&M cannot be assessed as appropriate. In particular, half of the total labor forces in Iraq are employees of government agencies, government affiliated oil industries, or state corporations, which is the same in the water sector. The governorate water directorates employ vast number of employees, e.g., the number of MWD staffs was 956 at the time of Previous Study, and the indicator to measure the productivity of staffs “number of connections per staff” in MWD is calculated only 59 connection/staff. This figure is quite low compared with the standard of value 200 connection/staff set by the World Bank.

Besides, it has been clarified by MWD that there have been no technical standards nor standard operation procedures (SOPs) developed by MWD for its O&M works. Instead, the manuals provided by the contractors or manufacturers have been used. And the capacity of MWD for the O&M of membrane treatment facilities should be developed since MWD has had no experience in it, of which necessity MWD is fully aware of.

7.4 Issues and Proposed Technical Support

7.4.1 Problems Analysis

The existing problems of MWD on O&M of waterworks and management of water supply service identified in the previous sections and chapters were sorted out by applying the relationship of "causes and effects" between the problems. The core problem was set as the "low cost recovery in water supply service" and a problem tree was developed accordingly as shown in **Figure 7.4**.



(Abbreviation) HH: Household; JD: Job description; ICT: Information and Communication Technology

Source: JICA Study Team

Figure 7.4 Problem Tree of O&M and Management of Water Supply Service in MWD

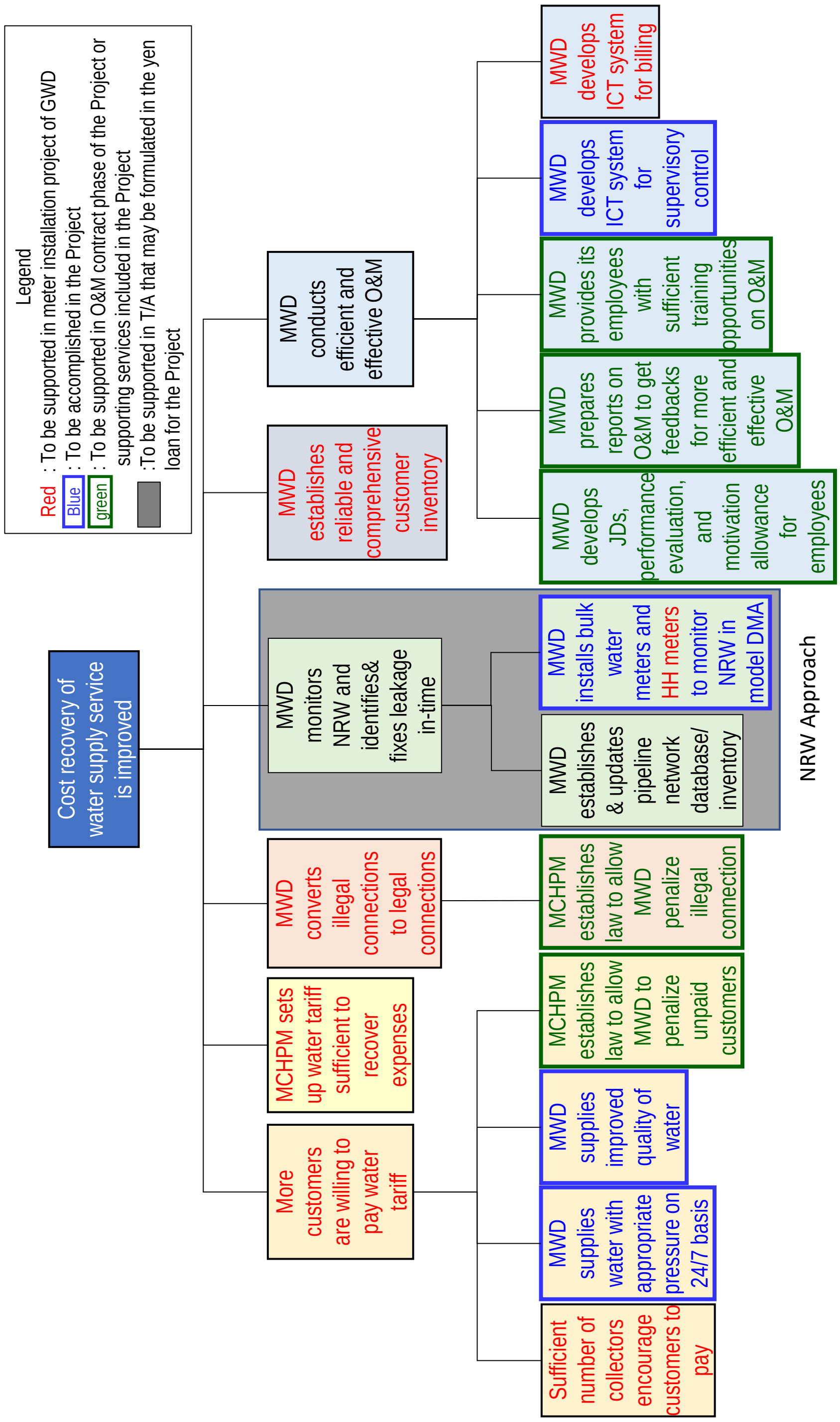
7.4.2 Objectives Analysis and Proposed Technical Support

An objective tree was developed based on the problem tree shown above by transforming the problems and the "causes and effects" relationship into the objectives and the "means and ends" relationship as shown in **Figure 7.5**. The recently-launched meter installation project of GWD will contribute much to solving the issues (shown in red), together with the achievements of the Project (of which the main component and the O&M phase contract / supporting service component are shown in blue and green, respectively). The chain of objectives hatched in gray and named "NRW Approach" in **Figure 7.5** will need more inputs of experts than the supporting services to be included in the Project, and thus a separate technical assistance (T/A) project is proposed to be formulated in the yen loan for the Project (to be described in detail in Section 7.4.3). The proposed technical support is summarized in **Table 7.3**.

Table 7.3 Proposed Technical Support

Category		Program	Implementing Entity and Expected Period
O&M phase contract or supporting service component in the Project	Legal	Legal support for GWD to establish a law related to water supply service including the penalty to unpaid customers and illegal connections.	Consultant from 2025 to 2027 for 3 years
	Institutional development	Institutional development support to develop job descriptions, performance evaluation system, and motivation allowance for MWD employees.	
	O&M	Technical support to prepare reports on O&M and analyze the status of waterworks for more efficient and effective O&M.	Consultant from 2029 to 2034 for five years
		Hands-on training on the O&M of the facilities constructed in the Project.	Contractor from 2029 to 2034for five years
Separate T/A proposed to be included in the yen loan for the Project	NRW reduction	• Establish and update pipeline network inventory and GIS database. • Cluster and segregate district metered areas (DMAs) by installing bulk inflow/outflow meters (bulk water meters may be partly installed in the Project). • Monitor and fix NRW in each DMA using leakage detection device.	Consultant from 2028 (after the completion of water meter installation) to 2031 for three years

Source: JICA Study Team



Source: JICA Study Team

Figure 7.5 Objective Tree of O&M and Management of Water Supply Service in MWD

7.4.3 Proposed Technical Assistance Project

An outline of project design matrix for the proposed technical assistance on NRW reduction is shown in **Table 7.4**. The project consists of the development of pipeline inventory in GIS, followed by clustering District Metered Areas (DMAs), leakage detection and NRW reduction works in three model DMAs, and monitoring and assessing physical and commercial loss. Considering the current security condition in Southern Iraq including Muthanna Governorate, the Japanese experts may be forced to reside in more safe regions such as Basra and Erbil in Iraq or Amman in Jordan and control the project in a remote manner, while hired local consultants (including those who reside in third nearby country) would conduct the site works together with the counterparts of MWD under the direction and on-line participation of the Japanese experts.

Table 7.4 Outline of Project Design Matrix for NRW Reduction in MWD

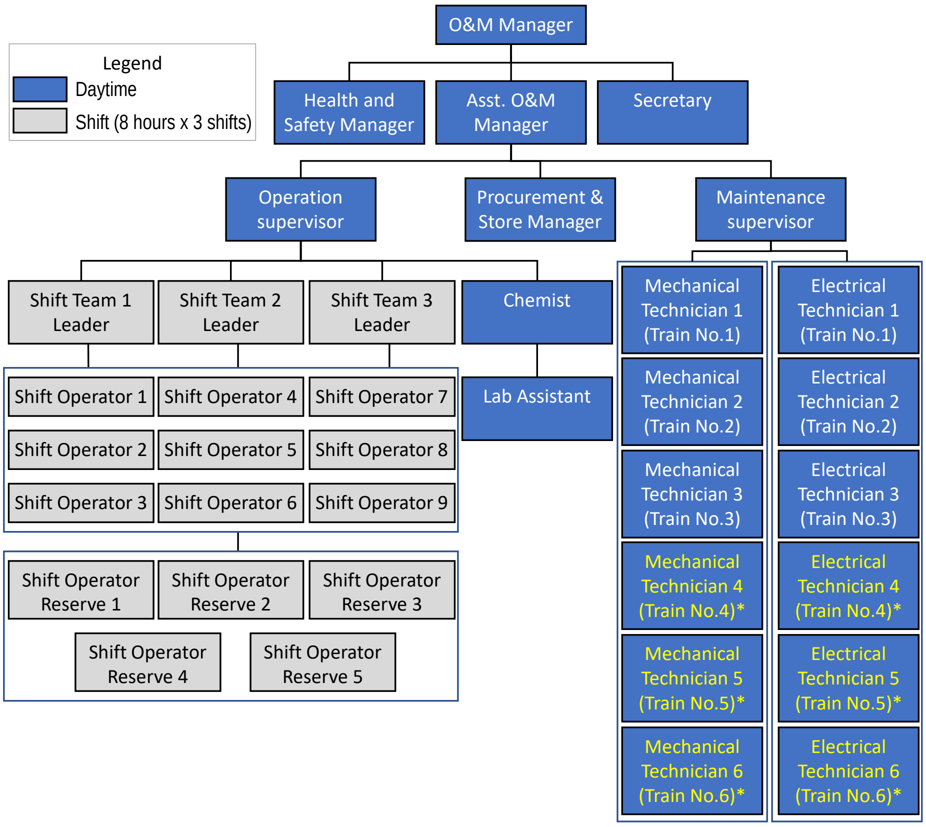
<table>
<tr><th colspan="3">Narrative Summary</th></tr>
<tr><td>Project Title</td><td colspan="2">Project to Enhance the NRW Reduction in Muthanna Water Governorate (MWD)</td></tr>
<tr><td>Target Period</td><td colspan="2">From January 2028 for three years (after the completion of household meter installation which is presumed in November 2027)</td></tr>
<tr><td>Project Area</td><td colspan="2">Three district metered areas (DMAs) in the distribution area of Jarbou’yiah PS</td></tr>
<tr><td>Overall Goal</td><td colspan="2">Cost recovery of water supply service is improved in MWD.</td></tr>
<tr><td>Project Purpose</td><td colspan="2">NRW reduction capacity of MWD is strengthened.</td></tr>
<tr><th>Activity</th><th colspan="2">Input</th></tr>
<tr><td>1. Conduct pipeline network survey and develop pipeline inventory in GIS.
2. Develop institutional setup of MWD for NRW management.
3. Cluster the distribution area of Jarbou’yiah PS into DMAs and develop the plan to install sluice valves and bulk water meters.
4. Select three model DMAs and segregate each DMA by installing necessary sluice valves and bulk meters.
5. Conduct on-the-job training (OJT) on leak detection in model DMAs.
6. Conduct NRW reduction activities in model DMAs.
7. Monitor and assess the physical loss and commercial loss in model DMAs.</td><td>Japanese side
<u>1. Dispatch of Expert</u>
・ Pipeline Network Planning (12 M/M)
・ Leakage Detection (6 M/M)
<u>2. Local Assistant</u>
・ Senior Engineer (36 M/M)
・ GIS and CAD Operator (36 M/M)
<u>3. Equipment</u>
・ Leak detection tools and equipment
・ Portable ultrasonic flowmeters
・ Bulk meters and valves with fittings
・ Vehicle for leakage detection
・ Excavator
・ Repair clamps
・ Generator
・ Welding machine
・ Manual ratchet threader
・ Other equipment if necessary
<u>4. Trainings</u>
・ Training in Japan, etc.</td><td>Iraqi side
<u>1. Counterparts</u>
・ Project Director
・ Project Manager
<u>2. Facilities</u>
・ Venue for trainings and workshops
・ Storage space for tools and equipment
<u>3. Local Cost</u>
・ Necessary cost to establish three DMAs, e.g., construction of valve boxes and meter chambers, and meter installation cost
・ Cost of value-added tax (VAT) and import tax necessary for importing tools and equipment
・ Cost for maintenance of tools and equipment provided by the project</td></tr>
</table>

Source: JICA Study Team

7.5 Proposed O&M Structure of Samawah WTP

The O&M organization structure for the Samawah WTP to be constructed in the Project is proposed as shown in **Figure 7.6**. It should be noted that the name of the positions does not correspond to the ones currently used in MWD.

In total, 38 personnel are required, of which daytime workers are 21 and shift workers are 17. These personnel are subject to be trained on-site during the O&M contract phase of the Project or through participating in a training program for the O&M of Basra Desal Plant provided by the contractor of Basra Water Project. For the latter training, it is proposed that GWD develops human resource exchange programs among Governorate Water Directorates, particularly between MWD and Basra Water Directorate (BWD) to enable MWD to dispatch its engineers and operators to BWD and vice versa.



	Daytime	Shift	Sum
O&M Manager	1	-	1
Asst. O&M Manager	1	-	1
Operation Supervisor	1	-	1
Health and Safety Manager	1	-	1
Secretary	1	-	1
Shift Team Leader	-	3	3
Shift Operator	-	14	14
Procurement & Store Manager	1	-	1
Chemist	1	-	1
Lab Assistant	1	-	1
Maintenance Supervisor	1	-	1
Mechanical Technician	6	-	6
Electrical Technician	6	-	6
Sum	21	17	38

Note: the personnel noted with * shall maintain RO unit No.4 ,5, and 6 after the completion of phase 2.

Source: JICA Study Team

Figure 7.6 Proposed O&M Structure for Samawah WTP

Chapter 8 Environmental and Social Considerations

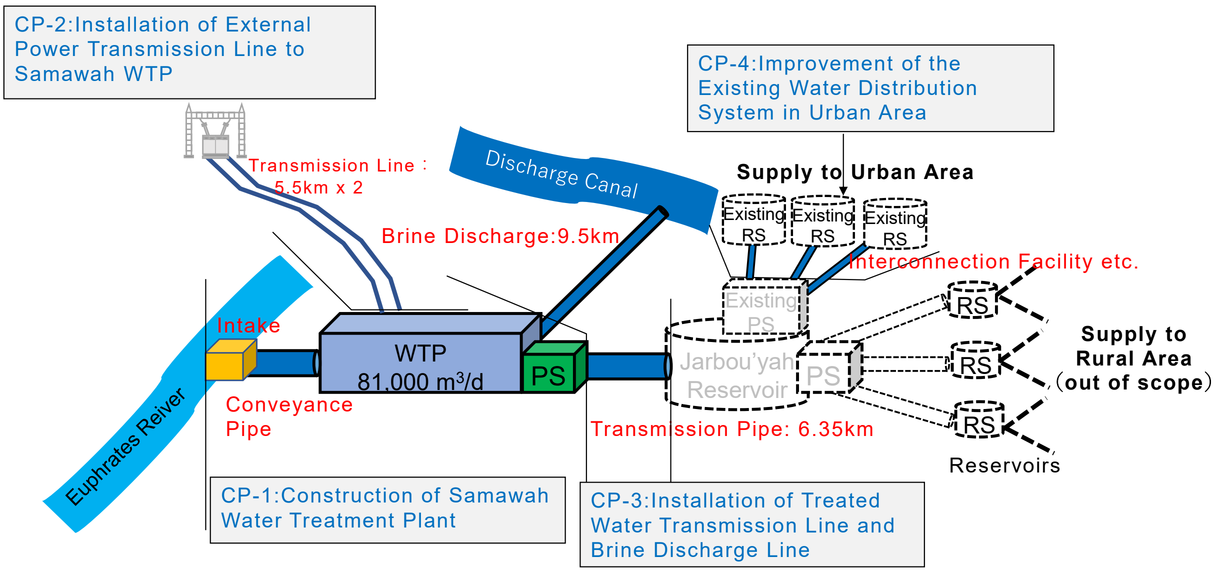
8.1 Project Components that May Cause Environmental and Social Impacts

The Samawah Water Supply Improvement Project (the Project) will treat raw water taken from the Euphrates River and supply it to Samawah District after RO treatment process.

Through the Project, facilities such as intake facility, water treatment plant (WTP) including the high voltage power supply system to the plant, water transmission line, and brine discharge line will be constructed. These construction activities are identified as the main project components that may cause environmental and social impacts.

Figure 8.1 shows the contract packages for the scope of work (refer to Section 11.3.1 in detail), and **Table 8.1** shows the identified project components. **Figure 8.2** and **Figure 8.3** show the detailed map of the proposed site for WTP, and location of Samawah WTP and proposed alignment of the pipelines (refer to Section 5.6.1 in detail).

The latest information was entered into the Japan International Cooperation Agency (JICA) environmental checklist for water supply (see **Appendix 8.1**).



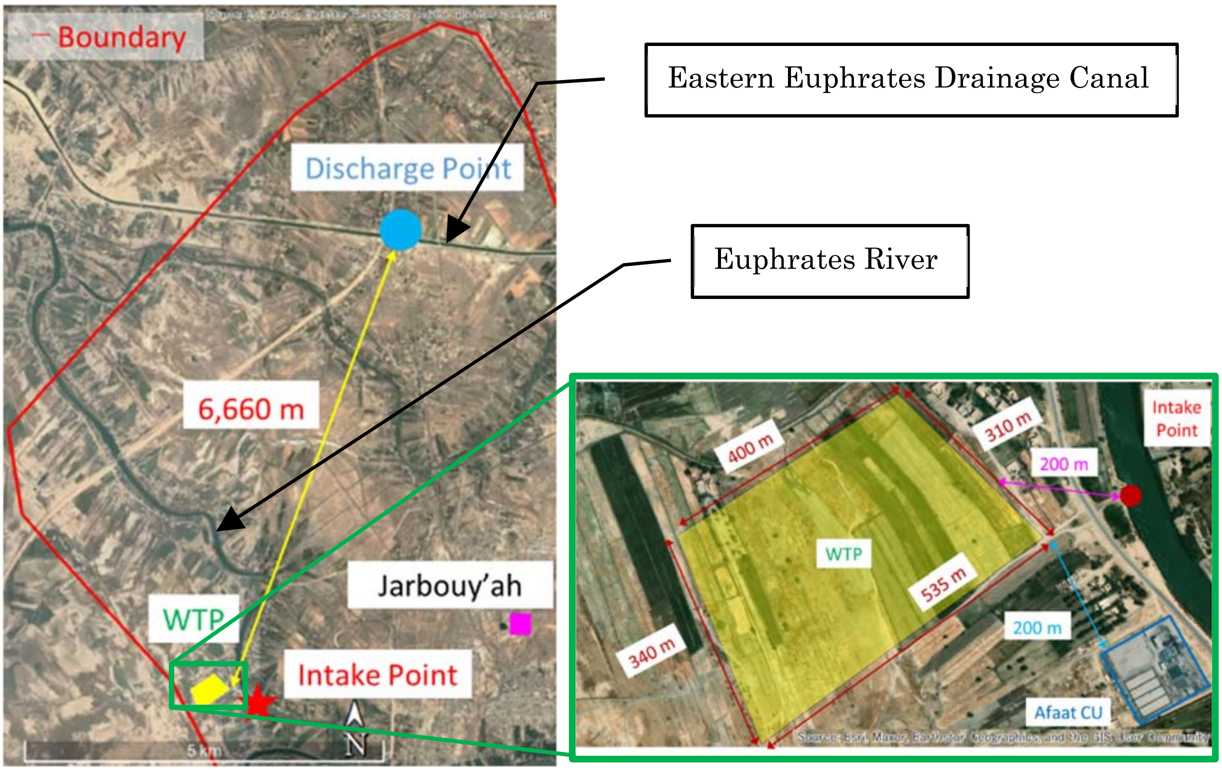
Source: JICA Study Team

Figure 8.1 Scope of Work of the Project and Interfaces Among the Contract Packages

Table 8.1 Project Components by Contract Package

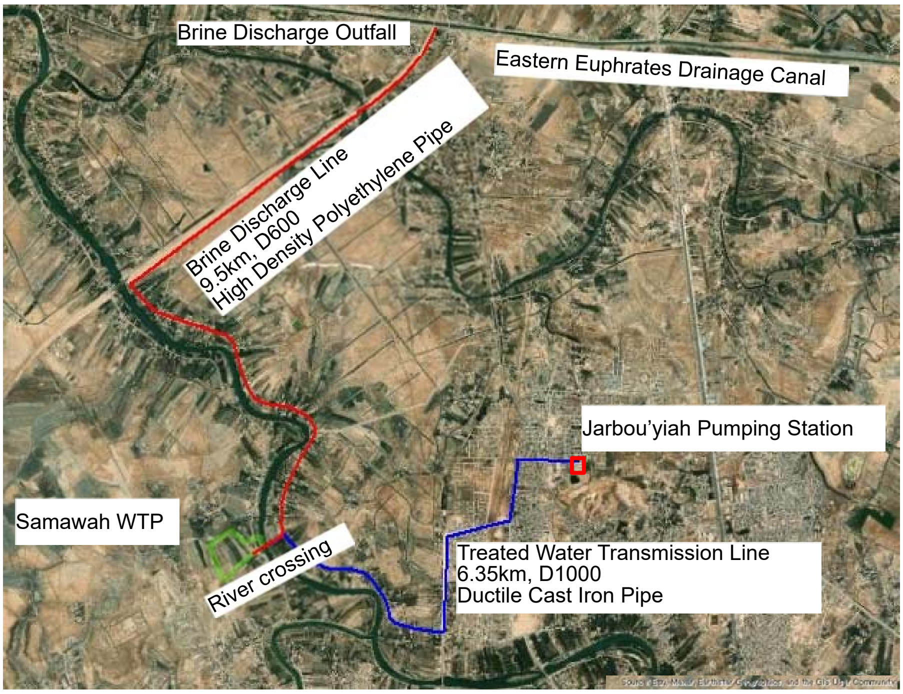
CP	Project Component	Sub-component
1	Construction of Samawah water treatment plant	Construction of intake facilities at the Euphrates River
		Construction of water treatment facilities, pumping station for treated water transmission, main substation, and solar power generation system
2	Installation of external power transmission line to Samawah water treatment plant	Installation of equipment in MOE's substation
		Installation of high voltage cable
3	Installation of treated water transmission line and brine discharge line (includes crossing of the Euphrates River)	Installation of treated water transmission line
		Installation of brine discharge line (approximately 6.7 km in a straight line from WTP to Eastern Euphrates Drainage Canal)
4	Improvement of the existing water distribution system in urban area	Equipment of control and monitoring equipment such as valves and water meters

Source: JICA Study Team



Source: JICA Study Team

Figure 8.2 Proposed Sites for Samawah WTP



Source: JICA Study Team

Figure 8.3 Location of Samawah WTP and the Routes of the Pipelines

8.2 Institution and Organization

In 2005, the Iraqi government amended and ratified the Iraqi Constitution, the basis for the country's political system and administrative rules. Under its laws, Iraq forms a federal state consisting of a central government and independent regional administrations.

The overview of the institution and organization related to the environmental area is described below.

8.2.1 Institutional Framework

As the overall framework for environmental protection and conservation, Law No. 37/2008 was enacted in 2008 as a law pertaining to environmental administration, including the establishment of the Ministry of Environment (MOEn) and the Environmental Impact Assessment (EIA).

Law No. 27/2009 on environmental protection and improvement was also enacted as a principal law, which regulates that the project proponents have the responsibility to implement EIA and submit the EIA report to MOEn.

Notification No. 3/2011 on environmental categorization on development project regulates the screening criteria that regulates which level of EIA is required for each development project.

Table 8.2 shows the list of laws and regulations related to environmental protection and improvement.

Table 8.2 Laws and Regulations Related to Environmental Protection and Improvement

Laws and Regulations	Title	Remarks
Overall		
Law No. 37 of 2008	Law on Establishment of the Ministry of Environment	Establishment of MOEn, and its responsibility including the approval of EIA
EIA		
Law No. 27 of 2009	Law on Environmental Protection and Improvement	Regulation of the responsibility and need for EIA
Notification No. 3 of 2011	Notification of Environmental Limitations in Development Projects	Regulation of the screening criteria for EIA
Living Environment/ Pollution Control		
<Water>		
Law No. 25 of 1967	System of Rivers and Other Water Resources Protection	Regulation of the water discharge to public water areas and sewerage systems
Notification No. 80406 of 1980	Notification for the Prevention of Water Pollution	Responsibility for water quality and effluent standards
Law No. 12 of 1995	Law on Irrigation Canal and Drainage Channel	Operation and management of irrigation and drainage channels to prepare agricultural water and prevent a high concentration of effluents
Law No. 27 of 1999	General Authority for Water and Sewerage Law	Regulation of the water supply and sewerage service
Regulation No. 2 of 2001	Regulations for Preserving Water Resources	Regulation of the general water utilization and water resource development
<Air>		
Law No. 471 of 2012	Preservation of Air Quality	MOEn's responsibility for preserving and improving air quality

Laws and Regulations	Title	Remarks
<Solid Waste>		
Law No. 29 of 2009	Law on the Management of Debris	
Notification No. 2 of 2014	Notification on the Management of Urban Waste	
Natural Environment		
Law No. 12 of 2008	Law on the Ratification of Ramseur Convention	
Law No. 31 of 2008	Law on Joining the Convention of Biological Diversity	Responsibility for Biological Diversity
Law No. 30 of 2009	Law on Forests and Nurseries	
Law No. 1 of 2010	Law on the Protection of Wild Animals and Birds	
Social Environment		
<Land Acquisition>		
Law No. 55 of 1932	Law on Categorizing Land Types in Iraq	
Law No. 117 of 1970	Law on the Development of Farmland	
Law No. 12 of 1981 (Revised No. 6 of 1998)	The Republic of Iraq's Acquisition Law	Regulation of the Land Acquisition
<Cultural Heritage>		
Law No. 55 of 2002	Law on Antiquities and Heritage	
Law No. 12 of 2008	Law on Ratification of the Convention on Protection of the World Cultural and Natural Heritage	
<Health>		
Law No. 89 of 1981	Law on Public Health	Responsibility for Preserving and Improving Public Health
Others		
Law No. 7 of 2008	Law on Ratification of the Convention on Climate Change and Kyoto Protocol	Global Warming
EU Council Directive 86/278/EEC	Standards for Sewerage Sludge for Farming	

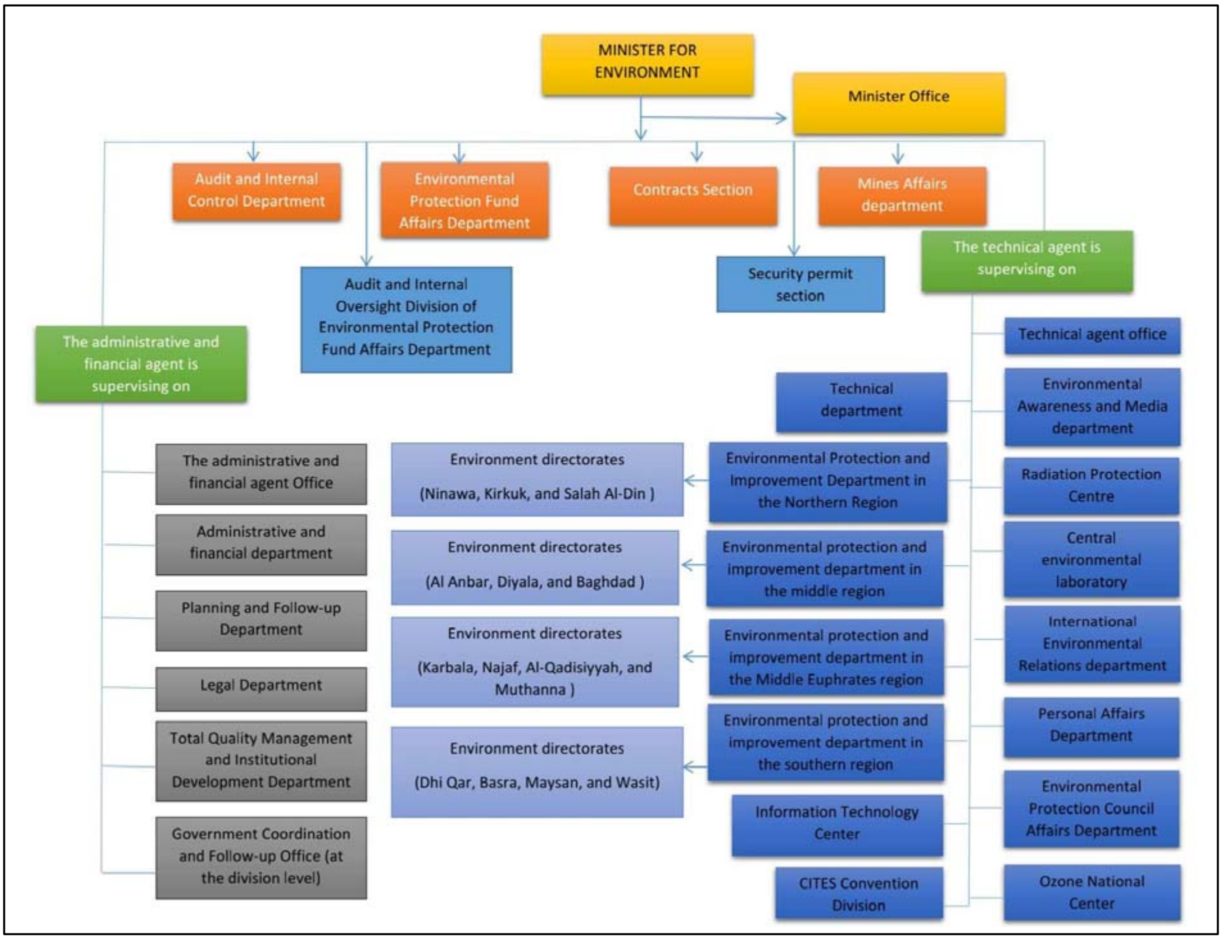
Source: JICA Study Team

8.2.2 Environmental Administration for Conducting Environmental Clearance

As described in Section 8.2.1, Law No. 37/2008 regulates the establishment of MOEn and the responsibility of MOEn including the approval related to EIA issues. According to Article 8, MOEn has the responsibility on site selection of the development project and identification of the environmental regulation of the project.

In principle, MOEn has the responsibility of EIA approval; however, the Environmental Directorate under each governorate has this responsibility for projects that are determined to have no significant environmental and social impacts.

Figure 8.4 shows the organization chart of MOEn and **Table 8.3** shows the responsibilities of technical departments.



Source: JICA Study Team

Figure 8.4 Organization Chart of MOEn

Table 8.3 Responsibilities of the Technical Department in MOEn

Department	Responsibility
Directorate of Environment Protection and Improvement – Southern Region	The directorates are in-charge of environmental pollution monitoring and evaluating the status of environmental parameters (air, water, soil, biodiversity) using the approved methods for monitoring, and they are responsible for the monitoring and auditing and approval of the industrial and municipal projects that may impact the environment, according to the Iraqi local legislation for environmental protection.
Directorate of Environment Protection and Improvement of the Middle Region	
Directorate of Environment Protection and Improvement – Middle Euphrates Region	
Directorate of Environment Protection and Improvement – Northern Region	

Source: JICA Study Team

8.2.3 Legal Basis for Iraqi's Environmental Conservation

As described in Section 8.2.1, Law No. 27/2009 on environmental protection and improvement is the basic environmental law and states the regulated process and that the project proponents have the responsibility to implement EIA and submit the EIA report to MOEn.

8.2.4 Environmental Impact Assessment

Notification No. 3/2011 on environmental categorization on development project shows the criteria of each development project. According to Article 2, the development projects are classified into the following categories:

- Category A: Projects with significant environmental impacts such as negative ecological impacts, resettlement, and widespread impacts
- Category B: Projects with partially irreversible impacts on ecosystems
- Category C: Projects with low or no significant environmental impacts

The Article 65 of Notification No. 3/2011, on Environmental Categorization on Development Project, shows the screening criteria for the project which builds WTP for producing drinking water. There are five conditions as follows:

1) The WTP should be built within the city boundaries, and it is preferred to be in the area of river entry to the city.
2) The intake of the WTP should be distant from the contaminated water discharge point by at least 3 km if the water intake is located downstream and by at least 1 km if the water intake is located upstream.
3) The intake of the WTP should be distant from the edge of the river, and water levels change during the flood season and summer season should be considered.
4) Each WTP should have a laboratory for the chemical, physical, and bacteriological analysis of the raw water and the treated water.
5) Chlorine bottles should be immersed in water to avoid the leakage of chlorine if the liquid chlorine is used for disinfection.

On the other hand, there is no specific statements regarding the need for the information disclosure or holding of stakeholder meeting in this notification.

8.2.5 Living Environment/ Pollution Control

(1) Water quality

Law No. 25/1967 aims for conservation of rivers and public water by preventing water pollution and sets the ambient water quality standards and effluent standard for this purpose.

The Ministry of Health has the responsibility of approval for the discharge to rivers and public water.

(2) Air quality

Law No. 471 of 2012 shows the responsibility of MOEn for preserving and improving air quality.

According to this law, MOEn has the responsibility to develop a national air quality monitoring program, record results, and evaluate emissions compliance from fixed emission source, but ambient air quality standards have not been established in Iraq.

(3) Solid waste

Law No. 29 of 2009 regulates the management of debris. According to this law, each municipality is responsible for setting up a collection point for construction waste, which must be located in a suburban area in consideration of the local population. Article 3 stipulates that construction waste generators must transport construction waste to the collection site within a schedule (within ten days) agreed upon with the municipality, or the municipality will transport it for them at a cost three times the amount of the original cost.

Notification No. 2 of 2014 regulates the management of urban waste. According to Article 3, any person who generates 50 kg or more of waste is responsible for its disposal.

8.2.6 Natural Environment

Iraq has ratified the Ramseur Convention through Law No. 12 of 2008, and the Convention of Biological Diversity through Law No. 31 of 2008.

Law No. 30 of 2009 regulates the issues on forests and nurseries for the protection of water resources. This law aims to preserve the environment and green spaces as well as protecting ecosystems and conserving water resources. Article 9 prohibits private companies from logging trees unless there is a technical necessity or legitimate compensation.

Law No. 1 of 2010 was established to protect wild animals and birds. This law outlines hunting but makes no mention of wildlife trade within the country or in neighboring countries.

8.2.7 Social Environment

(1) Land acquisition

Law No. 55 of 1932 categorizes the type of land and Law No. 117 of 1970 regulates the development of lands for farming, while Law No. 12 of 1981 (Revised No. 6 of 1998) regulates the land acquisition issues (see Section 9.4 for details).

(2) Cultural heritage

Law No. 55 of 2002 provides a system of communication between the public and the authorities for tangible/intangible, discovered/undiscovered historical cultural properties. This regulation is applicable when construction work, such as road construction, intersects with protected areas of historic cultural properties.

Iraq has also ratified the Convention for the Protection of the World Cultural and Natural Heritage through Law No. 12 of 2008.

(3) Health

Law No. 89 of 1981 shows that health is a right of citizen and the responsibility of the government is to preserve and improve public health. On the other hand, kinds of occupational safety standards were not identified through the Project and it is assumed that these standards are not well developed in Iraq.

8.3 Outline of the Existing EIA and Progress of Environmental Clearance

8.3.1 Outline of the Existing EIA and Progress of Environmental Clearance

After the previous study, EIA report was prepared by Al Muthanna University and submitted in 2016. Not only consultants but also governmental universities are allowed to submit EIA report in Iraq, and if governmental university prepares and submits EIA report, the review usually proceeds more smoothly than if consultants do it. In this regard, Al Muthanna University, representative higher-education institution in Muthanna Governorate, prepared EIA report for this project.

As described in Section 8.2, the screening criteria for water supply projects is regulated by Article 65, Notification No. 3/2011 on Environmental Categorization on Development Project. Since the Project meets the five conditions described in Article 65, it was classified as “Category C” and Muthanna Environmental Department (MED) under Muthanna Governorate, rather than MOEn Headquarters, is responsible for approving the EIA, and the EIA report was already approved in 2019.

Table 8.4 shows the outline of the existing EIA.

Table 8.4 Outline of the Existing EIA

Contents	Remarks
Study of the environmental impact of the Japanese loan project	MWD, in cooperation with JICA, will construct the new water treatment plant. This project considers a type C project according to Iraq legislation which means the project has no significant impact on the environment.
Details of the production process of the project	The project will have advanced water treatment units (RO) to reduce TDS from a concentration of 2,500 to 500 ppm.
Social impact of the project	Impact on social aspect is limited due to: No resettlement is expected. There are no ethnicity/ indigenous people near the project site, cultural heritages are not affected by the project. Health conditions will be improved due to clean water. The project will benefit the citizens with new job opportunities and enhance their economic status.
Waste from the project	The project will dispose about ten tons of sludge daily and 0.53 m^3/sec of the drain with 10,000 ppm TDS
Reduction measures	Apply pollution prevention techniques and technology to minimize human and environmental harm while remaining technically and financially feasible. Implement energy and resource efficiency measures, like wind and solar cells energies. Manage waste following the principles of waste management hierarchy. Develop suitable emergency response plans. Monitor effluents and emissions on an ongoing basis
Conclusion	The project has no significant impact on the environment, and the project will enhance the economic and health conditions of the society.

Source: JICA Study Team

8.3.2 Gap Analysis

The Project was classified as “Category B” under JICA’s criteria. The EIA report was approved under the institutional framework in Iraq; however, the contents of the existing EIA was limited, and it does not meet the requirements stipulated in the JICA Guidelines for Environmental and Social Considerations (ESC).

Table 8.5 shows the gap analysis between the JICA Guidelines for ESC and legislations in Iraq. One of the significant gaps is the lack of specific laws or guidelines in Iraq regarding information disclosure and stakeholder meeting. Other gaps are lacks of detailed procedure for monitoring and guidelines for flora and fauna, ecosystem, and indigenous people in Iraq.

Table 8.5 Gap Analysis between the Legislations in Iraq and the Latest JICA Guidelines for ESC

Classification	JICA Guidelines for ESC	Legislations in Iraq	Gap	Measures to resolve Gap
General	Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible at the planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.	Law No. 37/2008 and Law No. 27/2009 regulates the responsibility to implement EIA.	While there are no major gaps, the project was classified as Category C, the least impactful of the three categories (A, B, and C) in Iraq.	-
Information Disclosure	EIA reports (which may be referred to differently indifferent systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them.	There is no specific laws or guidelines for information disclosure.	Since it was classified as Category C, the EIA was approved by the Environmental Directorate under the Muthanna Governorate, and there was no information disclosure.	MWD sent out information about the project, and additional stakeholder meeting to be conducted (Section 8.12).
	EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted.			
Stakeholder Meeting	Projects must be adequately coordinated so that they are accepted in a manner that is socially appropriate to the country and locality in which they are planned. For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans.	There is no specific laws or guidelines for stakeholder meeting.	Stakeholder consultations were conducted through the previous study such as meetings with related governmental organizations in the field of water resource and irrigation, which were held in 2016 and a three-day workshop was conducted for 40 – 50 local people. On the other hand, there was	Additional stakeholder meeting was conducted (Section 8.12).
	In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared.			
	Consultations with relevant			

Classification	JICA Guidelines for ESC	Legislations in Iraq	Gap	Measures to resolve Gap
	stakeholders, such as local residents, should take place, if necessary, throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared.		no stakeholder meeting to collect and reflect the comments of the stakeholders to the Project.	
Target Items of EIA	In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project.	Law No. 27/2009 regulates the target not only the direct impacts but also mitigation measures, installation of low energy consumption technology, etc.	While there are no major gaps, the project was classified as Category C, the least impactful of the three categories (A, B, and C) in Iraq.	-
Monitoring	Project proponents should make efforts to make the results of the monitoring process available to local project stakeholders. When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents should make efforts to reach an agreement on procedures to be adopted with a view to resolve problems.	Regulation No. 2/2001 regulates the conservation of water resources and requests the submission of report during operation to Environmental Protection and Implementation Authority (EPIA) under MOEn.	Some regulations on water quality exist in Iraq; however, no detailed procedures are identified.	Draft environmental monitoring plan was prepared in accordance with the JICA Guidelines for ESC, including a statement that efforts will be made for information disclosure in Iraq (Section 8.10).
Flora and Fauna, and Ecosystems	Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests.	Article 33 of the Iraqi Constitution declares the responsibility of conservation of environment and biodiversity.	No actual guidelines are identified.	Draft environmental management plan was prepared in accordance with the JICA Guidelines for ESC, including a statement that efforts will be made for information disclosure in Iraq (Section 8.9).

Classification	JICA Guidelines for ESC	Legislations in Iraq	Gap	Measures to resolve Gap
Indigenous People	Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses.	Article 125 of the Iraqi Constitution declares the responsibility of government to provide protection to every citizen.	No actual guidelines are identified.	Not applicable for this project.

Source: JICA Study Team

8.4 Baseline of the Environmental and Social Conditions

The baseline of the environmental and social conditions was surveyed. **Table 8.6** shows the outline of the environmental baselines survey. Since past surveys have shown no significant differences in monitoring values between the dry season and rainy season, water quality and air quality were monitored only during the dry season (from May to October), whose results are usually considered worse than that during the rainy season (from November to April).

Table 8.6 Outline of the Environmental Baseline Survey

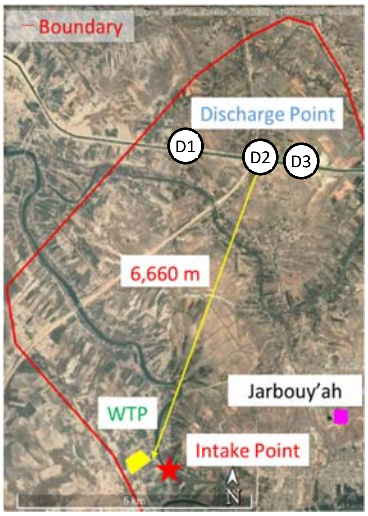
Item	Date	Location	Parameter/ Method
Water Quality	26th September 2022	Ambient water quality at three points near discharge points	The parameters were selected under the river water quality standard. All measuring and sampling methods will be according to Iraqi and EPA standards.
Air Quality	From 12:00 p.m. on 26th September 2022 to 12:00 p.m. on 27th September 2022 (24 hours)	Ambient air quality near the site for WTP	PM_{10}, $PM_{2.5}$, NHMC, H_2S, TSP, O_3, THC, SO_2, NO_2, CO, CH_4 (24 hours), meteorological data (wind speed, wind direction, temperature, and real humidity)
Noise Monitoring	From 12:00 p.m. on 26th September 2022 to 12:00 p.m. on 27th September 2022 (24 hours)	Noise monitoring near the site for WTP	Equivalent noise level measurement in accordance with Law No. 41 of 2015.
Flora and Fauna, and Ecosystems	17th October 2022	Near the discharge point and the site for WTP	- Field visit to the study area, taking photographs, bringing samples and classifying them by the Iraqi National Herbarium as well as mapping for the distribution of the study sample (animals or plants) in the study area and each type has separate maps and special presence areas. - Fishing using gill nets, baskets, hand grids, thread and reed, in addition to the electric shock device. - Isolation, Serial Dilution and Colony Forming Unit (CFU)

Source: JICA Study Team

8.4.1 Water Quality

(1) Survey locations

As shown in **Figure 8.5**, ambient water quality monitoring was conducted at three points (D1, D2, and D3) of Eastern Euphrates Drainage Canal, one of the biggest agricultural drainage systems in Iraq. D2 is the nearest point of the planned discharge point of the brine from Samawah WTP, while D1 is located at the upstream and D3 at the downstream.



Source: JICA Study Team

Figure 8.5 Location of Water Quality Monitoring

(2) Survey results

Table 8.7 shows the results of ambient water quality monitoring. BOD_5 and COD at all monitoring points exceeded the emission standard values (for public waters) stipulated in Law No. 25 of 1967 (phenol was also exceeded at one monitoring point, but the average of the three monitoring points was within the standards). Eastern Euphrates Drainage Canal receives agricultural wastewater, etc., and it is considered that BOD_5 and COD of those wastewater exceeded the standard so that those parameters at the canal exceeded the standard as well.

There is no emission standard value for TDS; however, it also shows high value at all monitoring points and its average is 6.63 g/L[1].

Table 8.7 Ambient Water Quality Results

<table>
<tr><td>Date</td><td>26-9-2022</td><td rowspan="2">GPS</td><td>N</td><td>E</td><td rowspan="2">GPS</td><td>N</td><td>E</td><td rowspan="2">GPS</td><td>N</td><td>E</td><td rowspan="2">Applicable Law</td></tr>
<tr><td>Time</td><td>1:00 – 2:30 PM</td><td>31 23 893</td><td>45 14 379</td><td>31 23 787</td><td>45 15 367</td><td>31 23 745</td><td>45 15 740</td></tr>
<tr><td>No</td><td>Water parameters</td><td colspan="3">Propose U/S Discharge Point (D2)</td><td colspan="3">Potential Discharge Point (D1)</td><td colspan="3">Propose D/S Discharge Point (D3)</td><td>Iraqi law No. (25) of 1967</td></tr>
<tr><td>1</td><td>pH</td><td colspan="3">8.5</td><td colspan="3">8.58</td><td colspan="3">8.63</td><td>6-9.5</td></tr>
<tr><td>2</td><td>Temp. (°C)</td><td colspan="3">24.5</td><td colspan="3">24.4</td><td colspan="3">24.37</td><td>< 35</td></tr>
<tr><td>3</td><td>EC ($\mu S/cm^{-1}$)</td><td colspan="3">9.96</td><td colspan="3">11.2</td><td colspan="3">10.8</td><td>N.S</td></tr>
<tr><td>4</td><td>DO (mg/L)</td><td colspan="3">5.25</td><td colspan="3">5.8</td><td colspan="3">5.61</td><td>N.S</td></tr>
<tr><td>5</td><td>TDS (g/L)</td><td colspan="3">6.27</td><td colspan="3">6.91</td><td colspan="3">6.72</td><td>N.S</td></tr>
<tr><td>6</td><td>TSS (mg/L)</td><td colspan="3">25</td><td colspan="3">35</td><td colspan="3">20</td><td>60</td></tr>
<tr><td>7</td><td>Al (mg/L)</td><td colspan="3">5.1</td><td colspan="3">5</td><td colspan="3">6.1</td><td>20</td></tr>
<tr><td>8</td><td>K (mg/L)</td><td colspan="3">19</td><td colspan="3">20</td><td colspan="3">17</td><td>N.S</td></tr>
<tr><td>9</td><td>Na (mg/L)</td><td colspan="3">650</td><td colspan="3">600</td><td colspan="3">620</td><td>N.S</td></tr>
<tr><td>10</td><td>SO_4 (mg/L)</td><td colspan="3">1867</td><td colspan="3">1910</td><td colspan="3">1766</td><td>*</td></tr>
<tr><td>11</td><td>Cl (mg/L)</td><td colspan="3">3327</td><td colspan="3">3292</td><td colspan="3">3290</td><td>**</td></tr>
</table>

1 Even the seawater's TDS is in general 3.5 g/L.

Date	26-9-2022	GPS	N	E	GPS	N	E	GPS	N	E	Applicable Law
Time	1:00 – 2:30 PM		31 23 893	45 14 379		31 23 787	45 15 367		31 23 745	45 15 740	
No	Water parameters	Propose U/S Discharge Point (D2)			Potential Discharge Point (D1)			Propose D/S Discharge Point (D3)			Iraqi law No. (25) of 1967
12	Mg (mg/L)	115			120			110			N.S
13	Ca (mg/L)	278			312			200			N.S
14	TH (mg/L)	3050			3100			3000			N.S
15	Alkalis (mg/L)	240			244			450			N.S
16	Turb. (NTU)	156			165			162			N.S
17	PO_4 (mg/L)	0.11			0.14			0.17			3
18	NO_3 (mg/L)	1.15			1.32			2.33			50
19	BOD_5 (mg/L)	107			169			119			<40
20	COD (mg/L)	192			350			206			<100
21	Total coli	+++			+++			+++			N.S
22	E.coli	+++			+++			+++			N.S
23	Oil and grease	10			13			16			N.S
24	Arsenic (mg/L)	0.0018			0.001			0.001			0.05
25	Boron (mg/L)	-			-			-			1.0
26	Copper (mg/L)	0.0016			0.001			0.0012			0.2
27	Nickel (mg/L)	B.D.L			B.D.L			B.D.L			0.2
28	Selenium(mg/L)	B.D.L			B.D.L			B.D.L			0.05
29	Mercury(mg/L)	B.D.L			B.D.L			B.D.L			0.005
30	Cd (mg/L)	B.D.L			B.D.L			B.D.L			0.01
31	Zinc	0.0045			0.003			0.0035			2
32	Chromium	0.0013			0.001			B.D.L			0.1
33	Barium	0.073			0.035			0.065			4
34	Fluoride (mg/L)	-			-			-			5
35	Lead (mg/L)	B.D.L			B.D.L			B.D.L			0.1
36	Phenol (mg/L)	0.11			0.066			0.027			0.01-0.05
37	DDT (mg/L)	B.D.L			B.D.L			B.D.L			0

Note: N.S. No specified limitation for B1 categories where specific limits shall be designated for the wastewater drained into the drains.

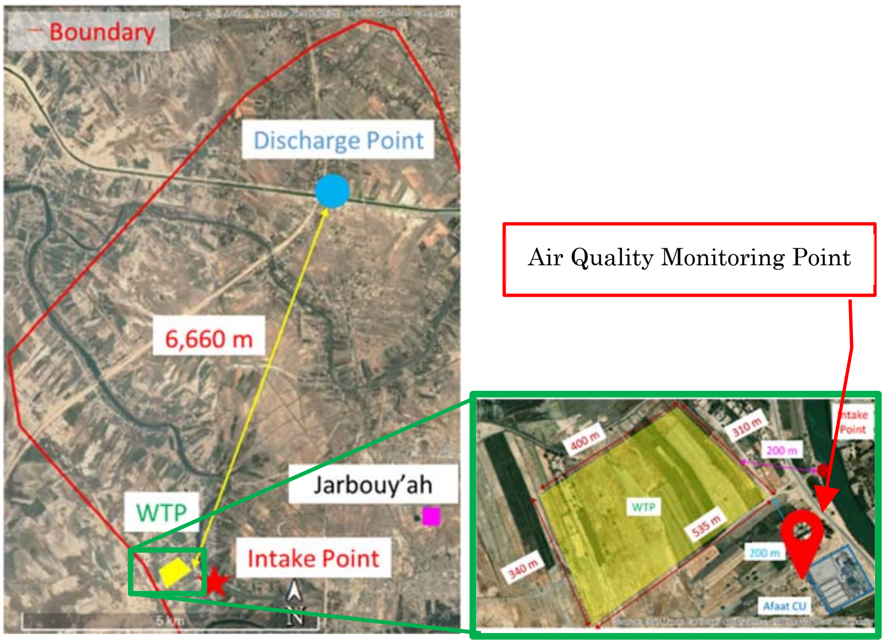
B.D.L: below detection limits

Source: JICA Study Team

8.4.2 Air Quality

(1) Survey location

Ambient air quality monitoring was conducted at locations close to the boundary of the site for WTP as shown in **Figure 8.6**. The monitoring started at 12:00 p.m. on 26th September 2022 to 12:00 p.m. on 27th September 2022.



Source: JICA Study Team

Figure 8.6 Location of Air Quality Monitoring

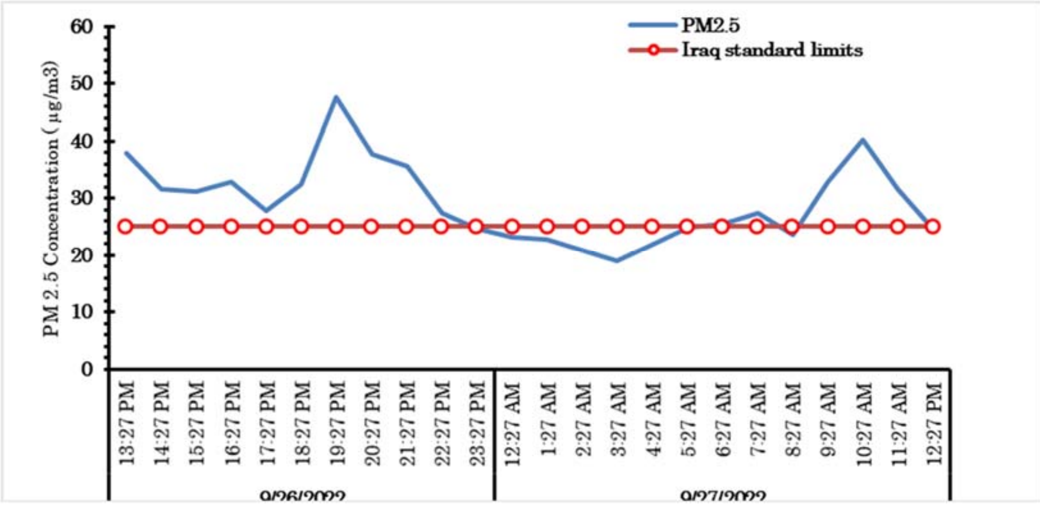
(2) Survey results

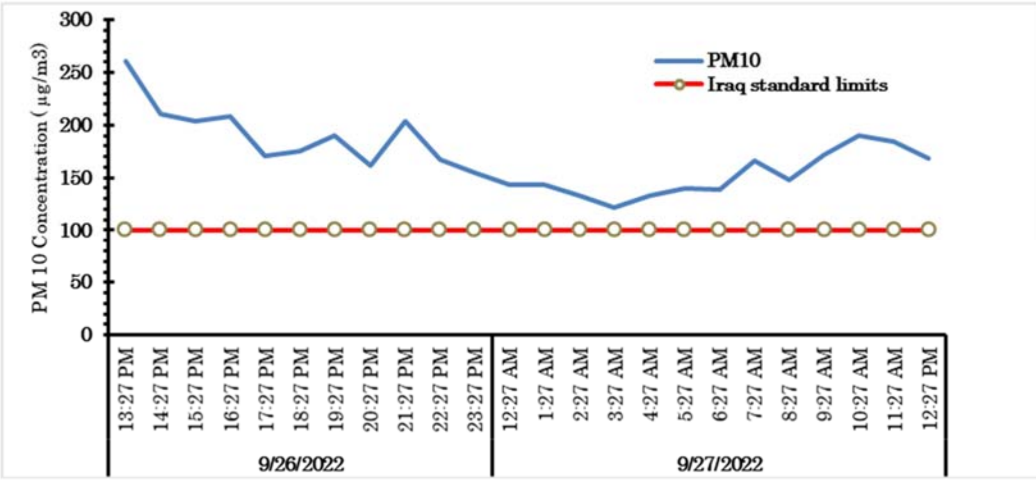
Table 8.8 shows the ambient air quality standards in Iraq and **Figure 8.7** shows the particulate matter 2.5 ($PM_{2.5}$) and PM_{10} of ambient air quality monitoring result. $PM_{2.5}$ and PM_{10} exceeded the standard values, while other parameters monitored complied with the standard values.

Table 8.8 Ambient Air Quality Standards in Iraq (Notification No.2 of 2018)

Parameter	Duration	Standard Value (ppm)	Standard Value (µg/m³)
SO_2	1 hour	0.15	423
	24 hours	0.06	169
	1 year	0.02	50
NO_2	1 hour	0.1	200
	24 hours	0.05	100
	1 year	0.02	40
CO	1 hour	35	43,000
	8 hours	9	11,000
O_3	1 hour	0.1	211
	8 hours	0.06	127
Non-Methane Hydrocarbons	8 hours	0.24	160
Lead (Pb)	24 hours	-	2
	3 months	-	1.5
	1 year	-	1
Total Suspended Particulate Matter	24 hours	-	300
	1 year	-	100
PM_{10}	24 hours	-	100
	1 year	-	50
$PM_{2.5}$	24 hours	-	25
	1 year	-	10

Source: Ambient Air Quality Standards in Iraq (Notification No.2 of 2018)





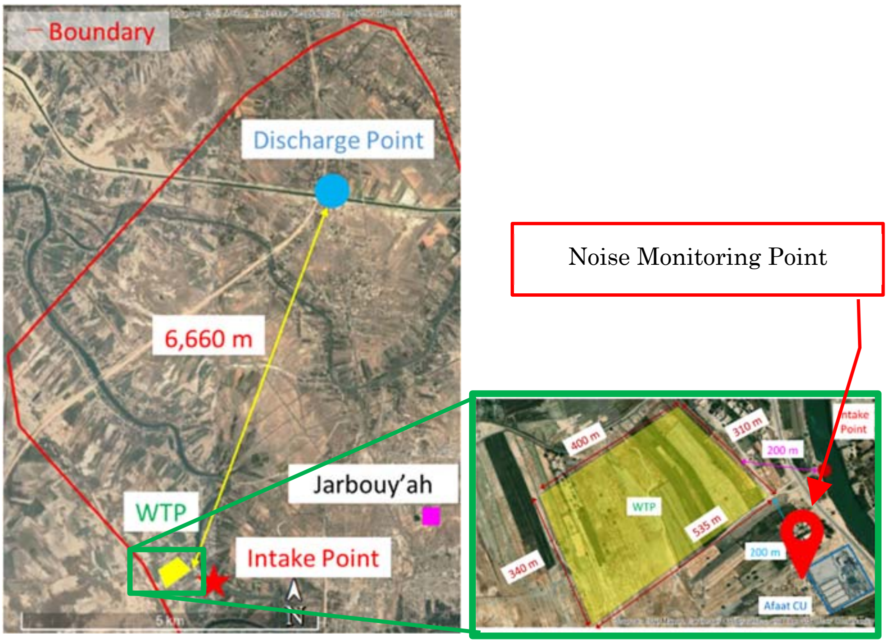
Source: JICA Study Team

Figure 8.7 Air Quality Monitoring Result ($PM_{2.5}$ and PM_{10})

8.4.3 Noise

(1) Survey location

As shown in **Figure 8.8**, noise monitoring was conducted at the same point with the ambient air quality monitoring, close to the boundary of the site for WTP. The monitoring started at 12:00 p.m. on 26th September 2022 to 12:00 p.m. on 27th September 2022.



Source: JICA Study Team

Figure 8.8 Location of Noise Monitoring

(2) Survey results

Table 8.9 shows the noise level guideline values in International Finance Corporation (IFC) Environmental, Health and Safety (EHS) Guidelines, and **Figure 8.9** shows the noise monitoring result.

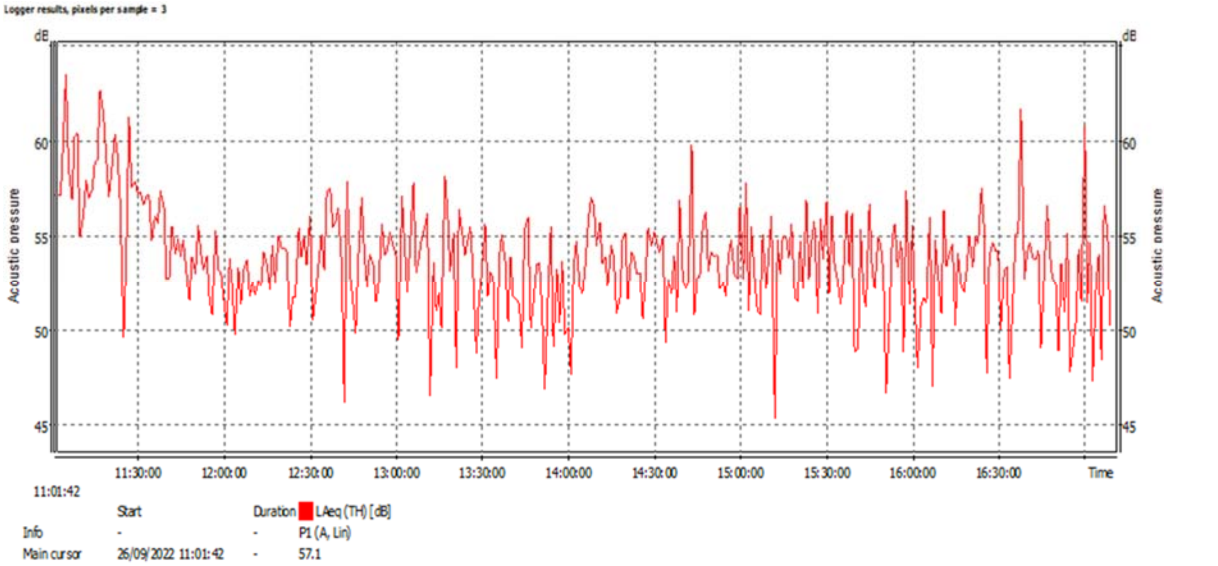
The Leq averages state that the daily average of noise level is within the guideline limit during the daytime, while it was higher than the guideline limit during the night-time, especially at 4:00 am to 6:00 am. This can be attributed to the early morning activities in the rural regions.

Examples from the area could cause this noise such as transportation, agricultural trucks, and sometimes minor noise sources such as dogs and farm animals.

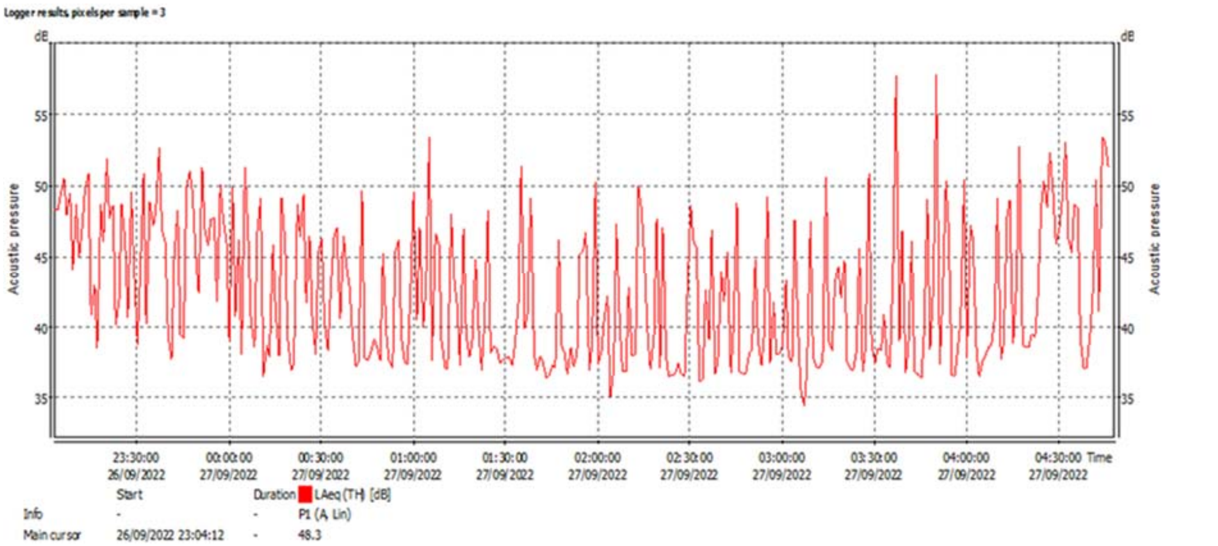
Table 8.9 Noise Level Guideline Values (IFC EHS Guidelines)

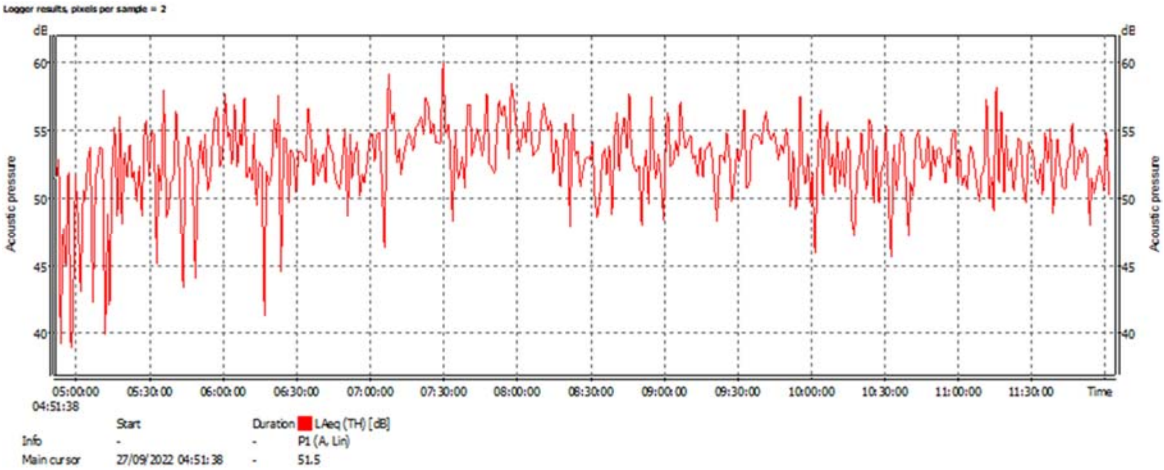
Receptor	Unit	Daytime (07:00 – 22:00)	Nighttime (22:00 – 07:00)
Residential; institutional; educational	One Hour L_{Aeq} (dBA)	55	45
Industrial; commercial	One Hour L_{Aeq} (dBA)	70	70

Source: IFC EHS Guidelines


Logger results, pixels per sample = 3
dB
Acoustic pressure
60
55
50
45
11:30:00
12:00:00
12:30:00
13:00:00
13:30:00
14:00:00
14:30:00
15:00:00
15:30:00
16:00:00
16:30:00
Time
11:01:42
Start
Duration
LAeq (TH) [dB]
Info
P1 (A, Lin)
Main cursor
26/09/2022 11:01:42
57.1


Logger results, pixels per sample = 3
dB
Acoustic pressure
60
55
50
45
40
17:30:00
18:00:00
18:30:00
19:00:00
19:30:00
20:00:00
20:30:00
21:00:00
21:30:00
22:00:00
22:30:00
Time
17:13:06
Start
Duration
LAeq (TH) [dB]
Info
P1 (A, Lin)
Main cursor
26/09/2022 17:13:06
54.4


Logger results, pixels per sample = 3
dB
Acoustic pressure
55
50
45
40
35
23:30:00 26/09/2022
00:00:00 27/09/2022
00:30:00 27/09/2022
01:00:00 27/09/2022
01:30:00 27/09/2022
02:00:00 27/09/2022
02:30:00 27/09/2022
03:00:00 27/09/2022
03:30:00 27/09/2022
04:00:00 27/09/2022
04:30:00 27/09/2022
Time
Start
Duration
LAeq (TH) [dB]
Info
P1 (A, Lin)
Main cursor
26/09/2022 23:04:12
48.3



Source: JICA Study Team

Figure 8.9 Noise Monitoring Result

8.4.4 Protected Area

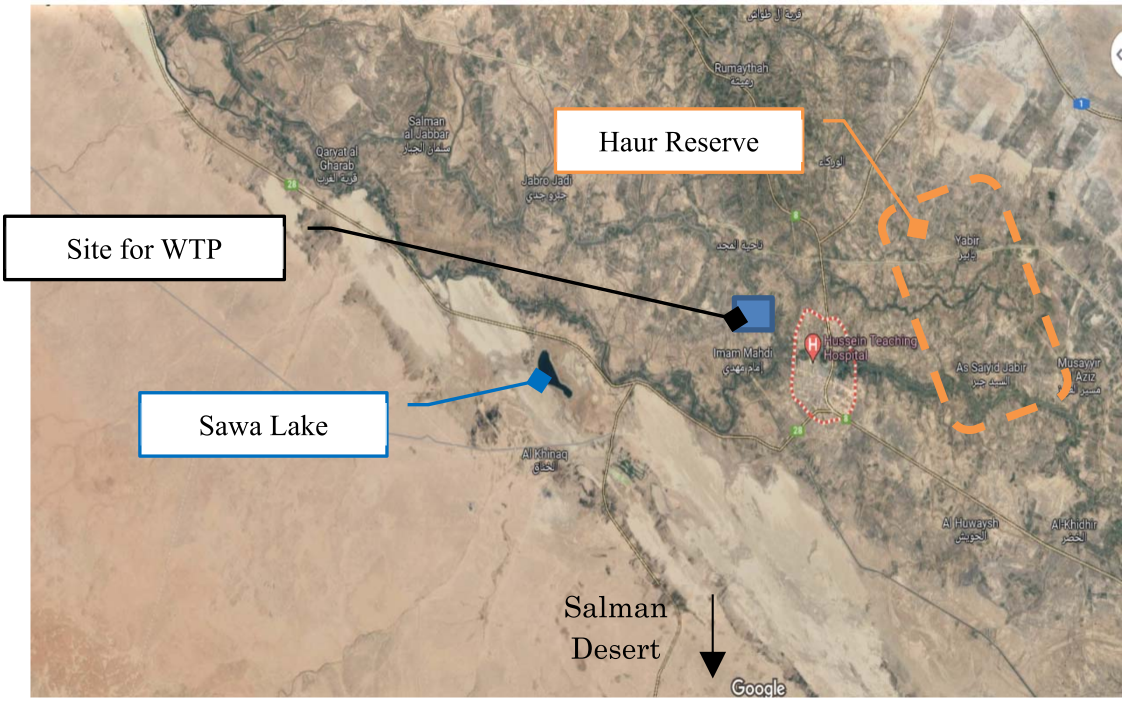
There are one Ramsar site and two protected areas in Muthanna Governorate.

Table 8.8 shows the list of protected areas in Muthanna Governorate and **Figure 8.10** shows their location.

Table 8.10 List of Protected Areas

Name	Location	Description
Sawa Lake	20 km away southwestward	Ramsar site protection is fed by groundwater that originates from the higher western desert areas and has no outlet Area: 20,058 ha -Altitude: 20–30 m *The size and depth of the lake have greatly reduced over time and the current conditions are likely due to declining underground water resources within the region and global climate change, which cause drought.
Haur Reserve	15 km away northeastward	Proposed protected area *Listed as a wetland of international importance, and was considered to be possibly of great importance for wintering waterbirds, but there is no specific ornithological information available.
Salman Desert Natural Park	83 km away southeastward	Proposed protected area of oasis

Source: JICA Study Team



Source: JICA Study Team

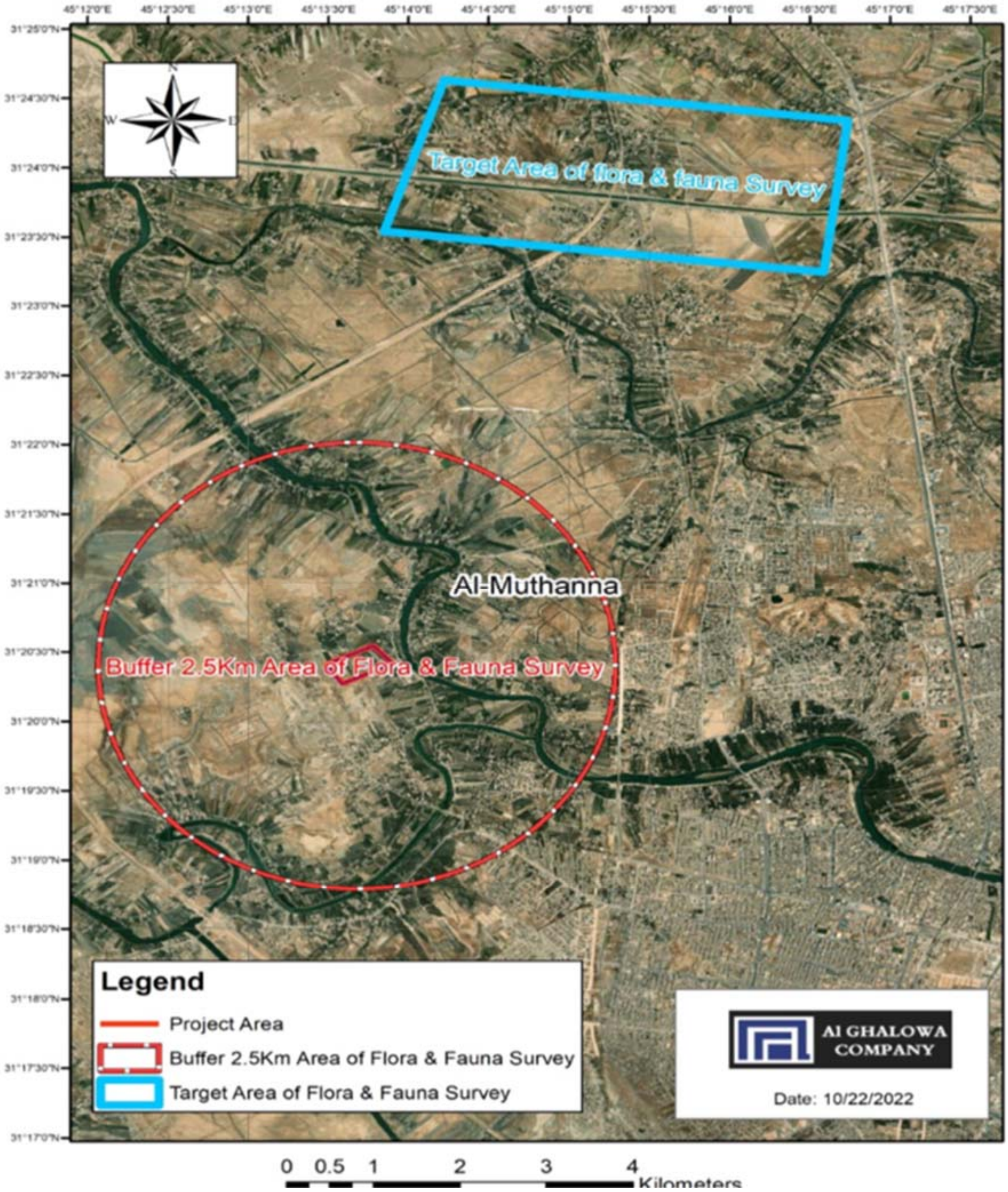
Figure 8.10 Area of Flora and Fauna Survey

8.4.5 Flora and Fauna

(1) Survey area

The flora and fauna survey was conducted in a radius of about 2.5 km from the site for WTP and in the Eastern Euphrates Drainage Canal, the receiving water body the brine from the WTP.

Figure 8.11 shows the area of flora and fauna survey.



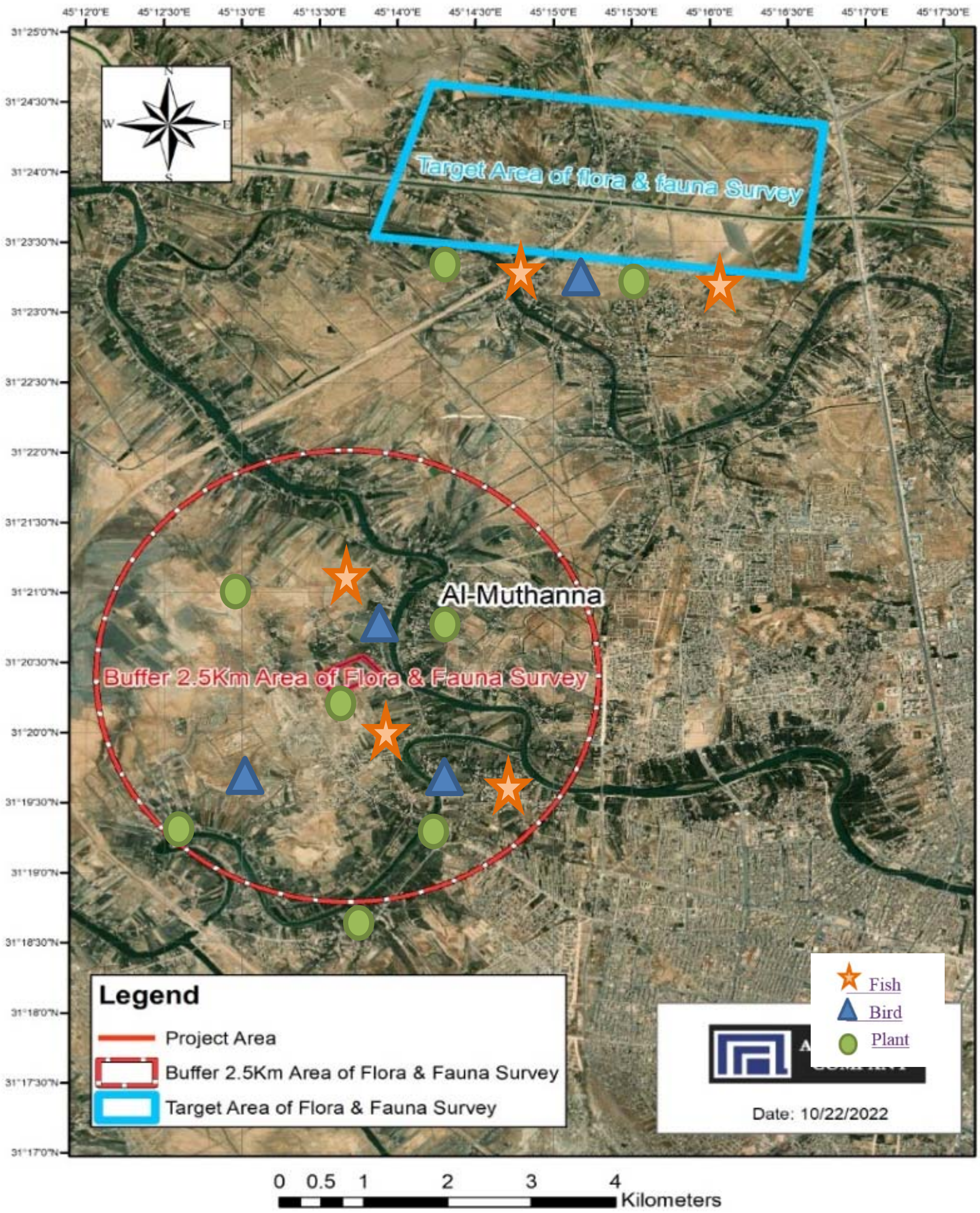
Source: JICA Study Team

Figure 8.11 Area of Flora and Fauna Survey

(2) Survey results

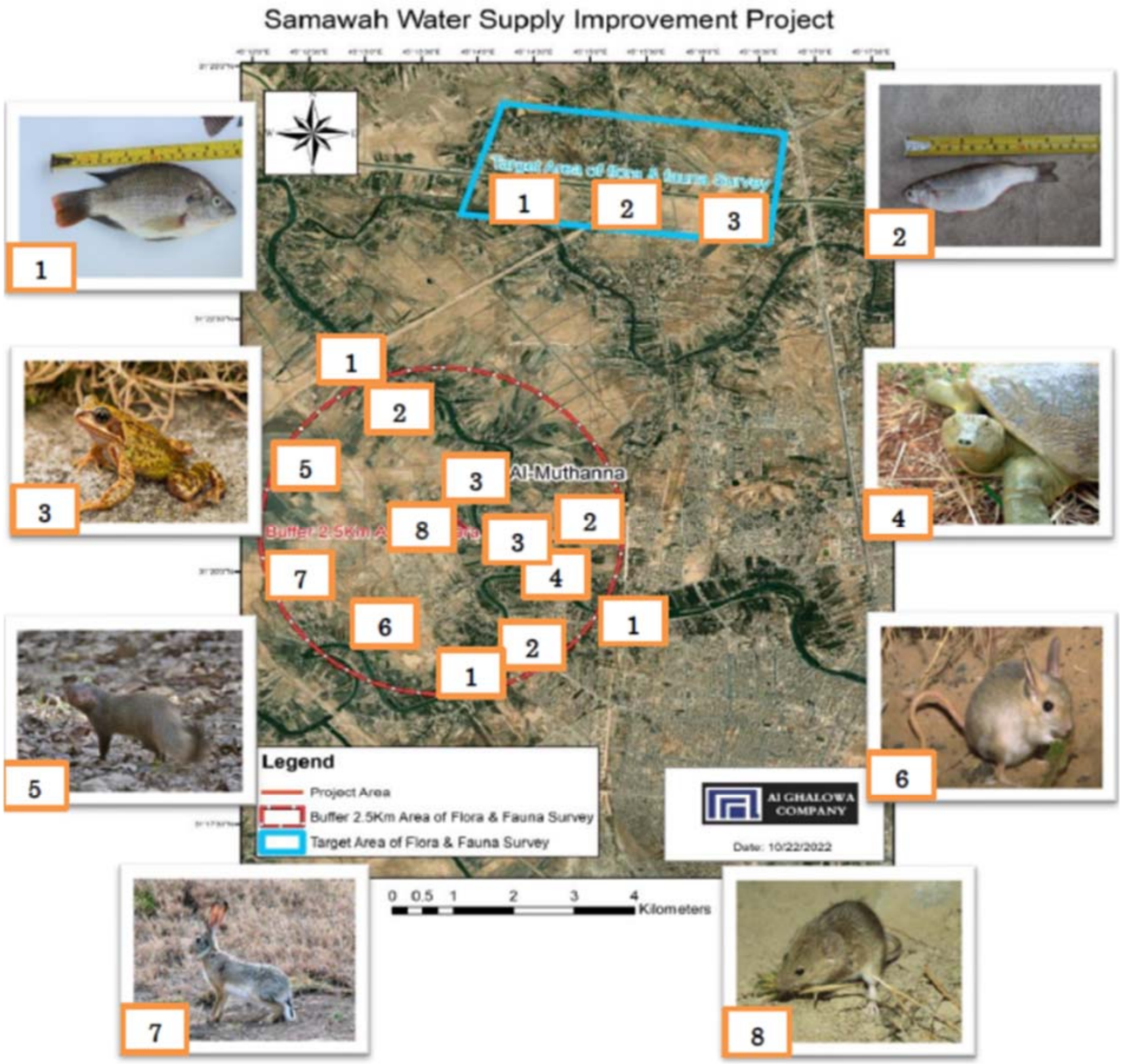
Identified species through the flora and fauna survey were categorized as the least-concern species (LC) by the International Union for Conservation of Nature (IUCN) category, and no species to be protected were found such as critically endangered (CR), endangered (EN), and vulnerable (VU).

Figure 8.12 shows the overall results of flora and fauna survey, **Figure 8.13** shows the animal habitat survey result, **Figure 8.14** shows the bird habitat survey result, **Figure 8.15** shows the plant habitat survey, and **Appendix 8.2** shows those results with IUCN category.



Source: JICA Study Team

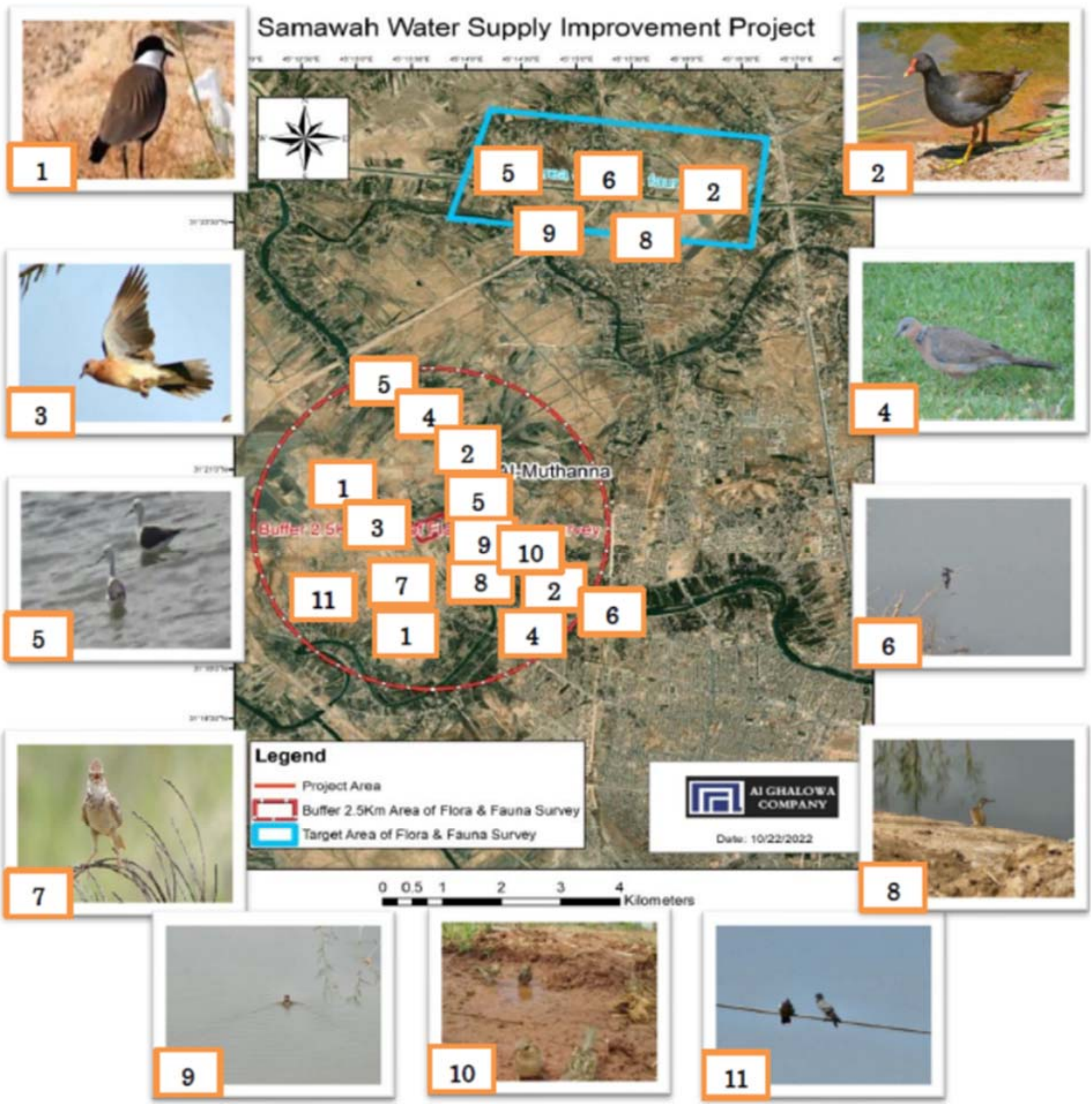
Figure 8.12 Overall Results of Flora and Fauna Survey



No.	Name	No.	Name
1	Tilapia zilli	2	Planiliza
3	Rana temporaia	4	Refetus euphraticus
5	Herpestes javanicus	6	Allactaga euphratica
7	Lepus capensis	8	Mus musculus

Source: JICA Study Team (some photos are taken from MED database)

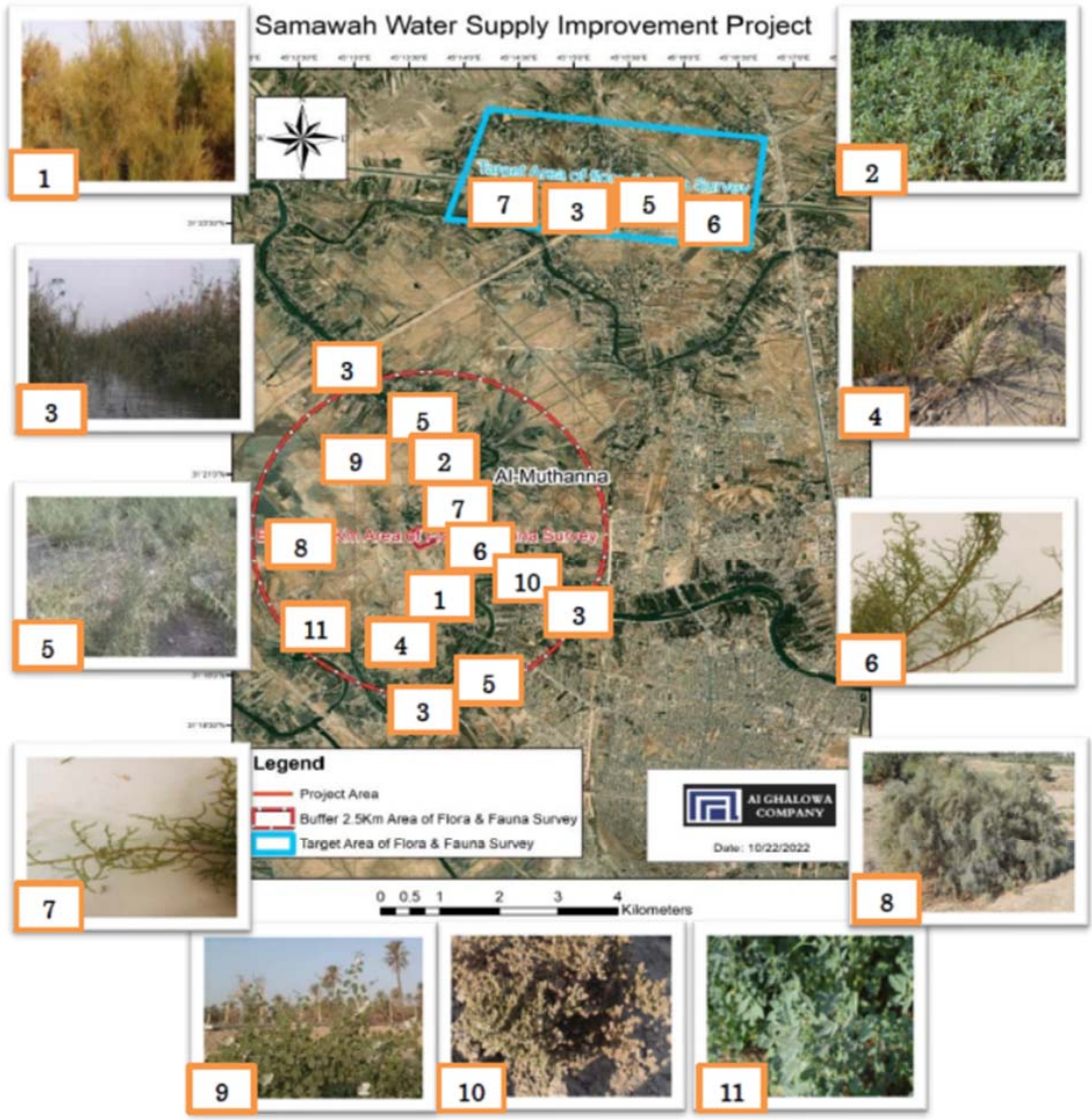
Figure 8.13 Results of Animal Habitat Survey



No.	Name	No.	Name
1	Hoplopterus indicus	2	Water chicken
3	Streptopelia decaocto	4	Pycnonotus leucogenys
5	Himantopus Himantopus	6	Cerlye rudis
7	Galerida cristata	8	Ixobrychus minutus
9	Tachybaptus ruficollis iraquensis	10	Passer domesticus
11	Columba		

Source: JICA Study Team (some photos are taken from MED database)

Figure 8.14 Results of Bird Habitat Survey



No.	Name	No.	Name
1	Tamarix mannifera ehrenb	2	Heliotropium curassavicum L
3	Phragmites australis	4	Ammophila arenaria
5	Alhagi mauroum	6	Tamarix gallica
7	Cupressus sempervirens	8	Tamarix chinensis Lour.
9	Capparis Spinosa	10	Cressa cretica
11	Medicago sativa		

Source: JICA Study Team (some photos are taken from MED database)

Figure 8.15 Results of Plant Habitat Survey

8.4.6 Historical/ Cultural Heritage

No historical/ cultural heritages were identified around and at the site for WTP.

8.5 Study on Alternatives including the "Without Project" Situation (Zero Option)

Alternatives study for the options including the "without project" situation (zero option) was executed to examine if the Project adopted good technical decision among the options. **Table 8.9** shows the results of alternative analysis, and the outline is as follows:

- Zero Option "Without Project" Situation: It is not recommended since the current serious issues related to water volume and water quality will not be resolved.
- Discharge Point: It is recommended to discharge to the Eastern Euphrates Drainage Canal compared with the Euphrates River, since the river is used for some activities such as fishery, agriculture, and water resources for downstream treatment facilities, while the Eastern Euphrates Drainage Canal is not used for such activities.
- Sludge Utilization: Landfill after dewatering is recommended compared with utilization of fertilizer after dewatering since the quality of fertilizer cannot be guaranteed and the needs are not clear.
- Solar Power Generation: Installation of solar power generation system is recommended since greenhouse gases (GHGs) from the project will be reduced.

Table 8.11 Results of Alternative Analysis

Item	Zero Option "Without Project" Situation	Project					
		Discharge Point		Sludge Utilization		Solar Power Generation	
		Euphrates River	Eastern Euphrates Drainage Canal	Landfill after Dewatering	Fertilizer after Dewatering	Installed	Not Installed
Technical Aspect	-	The length of pipeline will be less than 1 km.	Installation of pipelines (around 9.5 km) is required	Necessary to secure around 2 ha in WTP site.	Necessary to secure around 2 ha in WTP site.	Necessary to secure around 3 ha in WTP site.	-
Cost	-	Low	1.5 billion JPY	-	-	2.5 billion JPY	-
Impact on Living Environment	-	Possible impacts on water quality are expected.	No significant impacts are expected.	Necessary to deliver to landfill.	Positive impacts can be expected.	No significant impacts are expected.	No significant impacts are expected.
Impact on Natural Environment	-	Possible impacts on fish and aquatic organisms are expected.	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.
Impact on Social Environment	Issues related to water demand and supply, water leakage, etc., are not resolved	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.
Others	-				The quality of fertilizer cannot be	GHGs from the Project can be	-

Item	Zero Option "Without Project" Situation	Project					
		Discharge Point		Sludge Utilization		Solar Power Generation	
		Euphrates River	Eastern Euphrates Drainage Canal	Landfill after Dewatering	Fertilizer after Dewatering	Installed	Not Installed
					guaranteed at the planning stage and it is unclear about the demand.	reduced.	
Evaluation Results	Not recommended since the current serious issues related to water demand and supply are not resolved.	Not recommended since impact is not only on natural environment but also on the activities such as fishery, agriculture and water resources, can be expected and mitigation measures for possible impacts will be expensive.	Recommended since no significant impacts are expected and cost is not so expensive.	Recommended since the quality of fertilizer is not clear at the planning stage.	Not recommended. *But can be considered at the implementation stage.	Recommended since the quality of GHGs can be reduced and cost is not so expensive.	Not recommended.
Refer to Chapter	-	Chapter 5 Project Planning and Preliminary Design		5.5 Planning of Water Treatment Plant		5.8 Design of Power Receiving Facilities	

Source: JICA Study Team

8.6 Scoping and TOR of Survey on Environmental and Social Impacts

Scoping is the process of determining the scope of important and potentially important environmental and social considerations to be assessed and the methodology to be used.

As to the scoping results, environmental items to be assessed are checked ("✓") during the construction and operation, respectively in **Table 8.10**, and based on these results, the terms of reference (TOR) of the survey on environmental and social impacts was prepared in **Table 8.11**.

Table 8.12 Scoping Results

No.	Environmental Item	During Construction	During Operation	Reasons for Selection (C: During Construction, O: During Operation)
Living Environment/ Pollution Control				
1	Air Pollution	✓		C: Air pollutants from the use of heavy machines during construction are expected. O: No emission is expected.
2	Water Pollution	✓	✓	C: Water pollutants from excavation work are expected. O: Concentrated wastewater from WTP is expected.

No.	Environmental Item	During Construction	During Operation	Reasons for Selection (C: During Construction, O: During Operation)
3	Solid Waste	✓	✓	C: Construction waste is expected. O: Sludge from WTP is expected.
4	Soil Contamination			C/O: No hazardous materials which cause soil contamination are expected.
5	Noise/ Vibration	✓	✓	C: Noise from construction work is expected. O: Noise from the operation of waste treatment plant is expected.
6	Ground Subsidence			C/O: No activity which causes ground subsidence is expected.
7	Offensive Odor			C/O: No activity which causes offensive odor is expected.
8	Bottom Sediment Contamination			C/O: No activity which causes bottom sediment contamination is expected.
	Natural Environment			
9	Protected Area/ Forest			C/O: No protected area/ forest near the site exists and pipelines will not pass through those areas.
10	Ecosystem, Flora and Fauna, and Biodiversity	✓	✓	C/O: Water pollutants may affect aquatic life.
11	Hydrology		✓	C: No activity which may affect hydrology is expected. O: Water intake may affect hydrology.
12	Geology/ Topography			C/O: No activity which may affect geology/ topography such as large-scale excavation or land fill is expected.
	Social Environment			
13	Land Acquisition/ Involuntary Resettlement	✓		C: Land acquisition (and resettlement) can be expected. O: No land acquisition during operation is expected.
14	Poor People	✓		C: Resettlement may include poor people. O: No activity which may affect poor people is expected.
15	Ethnic Minorities /Indigenous People			C/O: No ethnic minorities/ indigenous people around the target site is identified.
16	Local Economy and Livelihood	✓	✓	C: Construction work may increase the income of local workers and temporarily improve their livelihoods. O: The stabilization of water supply may increase the income of local workers and temporarily improve their livelihoods.
17	Land-use/ Utilization of Local Resources			C/O: No activity which may cause land use/ utilization of local resources is expected.
18	Water Use	✓	✓	C/O: Water pollutants may affect the negative impact on water use.
19	Social Infrastructure and Services			C/O: Impact on social infrastructure and services such as traffic jam is not expected since the site of water treatment plant is not located in the urban area.
20	Social Institutions			C/O: Activity which may cause impact on social institutions is not expected.
21	Unequal Distribution of Benefit and Damage		✓	C: Activity which may cause unequal distribution of benefit and damage is expected. O: The stabilization of water supply may cause positive/ negative impact for distribution of benefit.

No.	Environmental Item	During Construction	During Operation	Reasons for Selection (C: During Construction, O: During Operation)
22	Local Conflict and Inequity		✓	C: Activity which may cause local conflict and inequity is expected. O: The stabilization of water supply may cause positive/ negative impact for equity.
23	Cultural and Historical Heritage			C/O: No cultural/ historical heritage near the site exists and pipelines will not pass through those areas.
24	Landscape			C/O: No activity which may cause landscape is expected.
25	Gender	✓	✓	C/O: No specific negative impacts are expected, but the conditions will be checked.
26	Children's Rights	✓	✓	C/O: No specific negative impacts are expected, but the conditions will be checked.
27	Infectious Diseases such as HIV/AIDs	✓		C: Workers from outside may cause the spread of infectious diseases. O: No activity may cause infectious diseases.
28	Occupational Health and Safety (OHS)	✓		C: Necessary to take care of OHS for workers. O: No work which may cause negative impact on OHS is expected.
Others				
29	Accidents	✓		C: Accidents during construction can be expected. O: No traffic accidents during operation is expected.
30	Climate Change/ GHG Emission		✓	C: No specific impact on climate change is expected. O: Project's potential as mitigation measures and/or adaptation measures will be reviewed.

Source: JICA Study Team

Table 8.13 TOR of Survey on Environmental and Social Impacts

No.	Environmental Item	Survey Item	Survey Method
1	Air Pollutants	(1) Ambient air quality standards in Iraq, Japan, and WHO (2) Ambient air quality monitoring at the site (3) Identification of affected vulnerable people	(1) Survey of existing materials (2) Field survey at expected site for WTP (dry season, one day) (3) Field survey and/or interview survey
2	Water Pollutants	(1) Ambient water quality standards in Iraq, Japan, and WHO (2) Ambient water quality monitoring at the discharge point	(1) Survey of existing materials (2) Field survey at potential discharge point (dry season, one time)
3	Solid Waste	(1) Disposal site for construction waste	(1) Survey of existing materials and interview survey
5	Noise/ Vibration	(1) Noise standards in Iraq, Japan and WHO (2) Noise monitoring at the site	(1) Survey of existing materials (2) Field survey at expected site for WTP (dry season, one day)
10	Ecosystem, Flora and Fauna, and Biodiversity	(1) Identification of vulnerable species	(1) Survey of existing materials and field survey
11	Hydrology	(1) Discharge volume, etc.	(1) Survey of existing materials
13	Land Acquisition/ Involuntary Resettlement	(1) Identification of the scale of land acquisition/ resettlement (2) A-RAP preparation as needed	(1) Field survey (2) Survey of exiting law/ regulation
14	Poor People	Same as "13. Land Acquisition/ Involuntary Resettlement"	-

No.	Environmental Item	Survey Item	Survey Method
16	Local Economy and Livelihood	(1) Identification of affected local economy and livelihood	(1) Survey of existing materials and field/ interview survey as necessary
18	Water Use	(1) Identification of water use around the site	(1) Survey of existing materials and field/ interview survey
21	Unequal Distribution of Benefit and Damage	Same as "16. Local Economy and Livelihood"	-
22	Local Conflict and Inequity	Same as "16. Local Economy and Livelihood"	-
25	Gender	(1) Policy in Iraq (2) Impact on gender	(1) Survey of existing materials (2) Field/ interview survey
26	Children's Rights	(1) Policy in Iraq (2) Impact on children's rights	(1) Survey of existing materials (2) Field/ interview survey
27	Infectious Diseases such as HIV/AIDs	(1) HIV/AIDS incidence in the neighborhoods near the project sites	(1) Survey of existing materials, and interview survey with relevant organization
28	Occupational Health and Safety (OHS)	(1) Policy of the project proponents	(1) Interview survey
29	Accidents	Same as "28, OHS"	-
30	Climate Change/ GHG Emission	(1) Policy in Iraq (2) Impact assessment based on the facility design	(1) Survey of existing materials (2) Interview survey with relevant organization
-	Stakeholder Meeting (SHM)	(1) After the confirmation of the project design	(1) Public disclosure/ SHM - Date: End of 2022 or early 2023 - Venue: TBC - Participants: Government, local people and other relevant authorities

Source: JICA Study Team

8.7 Result of the Survey on Environmental and Social Impacts

Results of the survey on environmental and social impacts are shown in **Table 8.12**, based on the scoping results in **Table 8.10**. No specific vulnerable living, natural, or social environmental item was identified.

Table 8.14 Results of the Survey on Environmental and Social Impacts

No.	Environmental Item	Description
1	Air Pollutants	$PM_{2.5}$ exceeded the international ambient air quality standards. During construction, dust can increase $PM_{2.5}$ higher. *During operation, no impact is expected.
2	Water Pollutants	TDS at the discharge point is high (6.63 g/L in average), and close to that of discharge water which is expected to be a maximum of 12 g/L. The calculation of TDS at brine discharge point is shown in **Appendix 5.8**. *No other parameters of discharge water will cause significant impact.
3	Solid Waste	There are some disposal sites around the site of WTP, and solid waste such as construction waste and sludge during operation can be delivered to those disposal sites designated by Muthanna Governorate.
5	Noise/ Vibration	Pump during the operation can cause some noise, however, the location will be far enough from the nearest neighbor.
10	Ecosystem, Flora and Fauna, and Biodiversity	There is no endangered species and the affected area is limited based on the size of the project, so that the impact from the project can be limited.
11	Hydrology	Impact on hydrology will be limited since amount of water use of the Euphrates River by the project (approximately 2 m^3/s) will be limited compared with the water volume of the Euphrates River (100 m^3/s or more in average).

No.	Environmental Item	Description
13	Land Acquisition/ Involuntary Resettlement	No further land acquisition is needed for water treatment plant and no resettlement which requires abbreviated resettlement action plan is expected.
14	Poor People	No resettlement is expected and project affected poor people are not identified.
16	Local Economy and Livelihood	Project affected local economy or livelihood are not identified.
18	Water Use	Impact on water quality will be limited and amount of water use of the Euphrates River by the Project (approximately 2 m^3/s) will be limited compared with the water volume of the Euphrates River (100 m^3/s or more in average).
21	Unequal Distribution of Benefit and Damage	Same as "16. Local Economy and Livelihood"
22	Local Conflict and Inequity	Same as "16. Local Economy and Livelihood"
25	Gender	Inequity because of the difference of gender is not expected.
26	Children's Rights	Inequity because of the difference of age is not expected.
27	Infectious Diseases such as HIV/AIDs	No statistic data about HIV/AIDS were identified. According to WHO's report, there were 287 cases of cholera in Muthanna in 2015, but the number was decreased. 60 doctors and 150 nurses work at the two hospitals and 14 health centers in Muthanna.
28	Occupational Health and Safety (OHS)	Law No. 37 in 2015 is the Labor Standard Act and it is necessary for PMT to comply with this law.
29	Accidents	Same as "28. OHS".
30	Climate Change/ GHG Emission	Iraq has ratified the Convention on Climate Change and Kyoto Protocol through Law No. 7 of 2008 and also formally ratified the Paris Agreement in 2021 and decided on a nationally determined contribution (NDC). Specific measures are in the process of being developed.
-	Stakeholder Meeting (SHM)	SHM was held on 30th November 2022.

Source: JICA Study Team

8.8 Evaluation of the Impacts

Table 8.13 shows the results of evaluation of the environmental and social impacts. According to the classification as shown below, there is no environmental item which was assessed as "A: Significant impact is expected":

- A: Significant impact is expected (+: Positive impact, -: Negative impact)
- B: Some impact is expected (+: Positive impact, -: Negative impact)
- C: Extent of impact is unknown, further examination will be required
- D: No impact is expected.

Table 8.15 Evaluation Results

No.	Environmental Item	Scoping Results		Evaluation Results		Reasons for Evaluation
		C: During Construction, O: During Operation				
		C	O	C	O	
Living Environment/ Pollution Control						
1	Air Pollution	✓		B-	D	C: Air pollutants from the use of heavy machines during construction is expected, but its impact is assessed as limited considering the size of construction. O: No emission is expected.
2	Water Pollution	✓	✓	B-	B-	C: Water pollutants from excavation work are expected, but its impact is assessed as limited considering the size of construction. O: Concentrated wastewater from WTP is expected, but its impact is assessed as limited since the current TDS of Eastern Euphrates Drainage Canal is already high and its water volume is sufficiently large.
3	Solid Waste	✓	✓	B-	B-	C: Construction waste is expected, but its impact is assessed as limited since no hazardous materials such as heavy metals are expected. O: Sludge from WTP is expected, but its impact is assessed as limited since no hazardous materials such as heavy metals are expected.
4	Soil Contamination			D	D	C/O: No hazardous materials which cause soil contamination are expected.
5	Noise/ Vibration	✓	✓	B-	B-	C: Noise from construction work is expected. O: Noise from the operation of waste treatment plant is expected.
6	Ground Subsidence			D	D	C/O: No activity which causes ground subsidence is expected.
7	Offensive Odor			D	D	C/O: No activity which causes offensive odor is expected.
8	Bottom Sediment Contamination			D	D	C/O: No activity which causes bottom sediment contamination is expected.
Natural Environment						
9	Protected area/ Forest			D	D	C/O: No protected area/ forest near the site exists and pipelines will not pass through those areas.
10	Ecosystem, Flora and Fauna, and Biodiversity	✓	✓	D	D	C/O: Water pollution was assessed as limited and the presence of valuable species that should be protected was not identified.
11	Hydrology		✓	D	D	C: No activity which may affect hydrology is expected. O: The percentage of water use will be less than 5% of the volume of the Euphrates River and it is sufficiently low.
12	Geology/ Topography			D	D	C/O: No activity which may affect geology/ topography such as large-scale excavation or land fill is expected.
Social Environment						
13	Land Acquisition/ Involuntary Resettlement	✓		B-	B-	C/O: No further land acquisition is needed for water treatment plant, and no resettlement which requires abbreviated resettlement action plan is expected
14	Poor People	✓		D	D	C: Resettlement is not expected.

No.	Environmental Item	Scoping Results		Evaluation Results		Reasons for Evaluation
		C: During Construction, O: During Operation				
		C	O	C	O	
						O: No activity which may affect poor people is expected.
15	Ethnic Minorities /Indigenous People			D	D	C/O: No ethnic minorities/ indigenous people around the target site is identified.
16	Local Economy and Livelihood	✓	✓	B+	B+	C: Construction work may increase the income of local workers and temporarily improve their livelihoods. O: The stabilization of water supply may increase the income of local workers and temporarily improve their livelihoods.
17	Land-use/ Utilization of Local Resources			D	D	C/O: No activity which may cause land use/ utilization of local resources is expected.
18	Water Use	✓	✓	D	D	C/O: Water pollution was assessed as limited.
19	Social Infrastructure and Services			D	D	C/O: Impact on social infrastructure and services such as traffic jam is not expected since the site of water treatment plant is not located in the urban area.
20	Social Institutions			D	D	C/O: Activity which may cause impact on social institutions is not expected.
21	Unequal Distribution of Benefit and Damage		✓	D	B+	C: Activity which may cause unequal distribution of benefit and damage is expected. O: The stabilization of water supply may cause positive/ negative impact for distribution of benefit.
22	Local Conflict and Inequity		✓	D	B+	C: Activity which may cause local conflict and inequity is expected. O: The stabilization of water supply may cause positive/ negative impact for equity.
23	Cultural and Historical Heritage			D	D	C/O: No cultural/ historical heritage near the site exists and pipelines will not pass through those areas.
24	Landscape			D	D	C/O: No activity which may cause landscape is expected.
25	Gender	✓	✓	D	D	C/O: No specific negative impacts are expected, but the conditions will be checked.
26	Children's Rights	✓	✓	D	D	C/O: No specific negative impact is expected, but the conditions will be checked.
27	Infectious Diseases such as HIV/AIDs	✓		B-	D	C: Workers from outside may cause the spread of infectious diseases. O: No activity may cause infectious diseases.
28	Occupational Health and Safety (OHS)	✓		B-	D	C: Necessary to take care of OHS for workers. O: No work which may cause negative impact on OHS is expected.
Others						
29	Accidents	✓		B-	B-	C: Accidents during construction may take place, but the size of construction is not large, and the impact will be limited if the construction contractor makes efforts for safety management based on the environmental management plan. O: Accidents during operation such as traffic

No.	Environmental Item	Scoping Results		Evaluation Results		Reasons for Evaluation
		C: During Construction, O: During Operation				
		C	O	C	O	
						accident and work-related accident may take place.
30	Climate Change/ GHG Emission		✓	D	B+ B-	C: No specific impact on climate change is expected. O: Project's potential as mitigation measures and/or adaptation measures will be reviewed.

Source: JICA Study Team

8.9 Environmental Management Plan (Mitigation Measures and their Costs)

The project proponent is responsible for establishing the Environmental Management Plan (EMP) that describes mitigation measures for expected environmental impacts and their costs.

Table 8.14 shows the draft EMP proposed by JICA Study Team (JST). Throughout the project, there is little concern about significant impacts. Most of the environmental management activities during construction shall be implemented by construction contractor, while those during operation shall be implemented by MWD.

Although the project is not expected to have any significant impact on flora, fauna, or ecosystems, MWD has the responsibility to give necessary consideration in accordance with the JICA Guidelines for ESC. In case of involuntary resettlement due to the project, consideration shall be given in accordance with the policy described in Section 9.5, based on the JICA Guidelines for ESC.

Table 8.16 Draft Environmental Management Plan

No.	Environmental Item	Evaluation Results	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
Construction						
1	Air Pollution	B-	Sprinkle water to control unnecessary dust generation.	Construction Contractor	MWD	Included in construction cost
2	Water Pollution	B-	Take appropriate measures such as retention pond to prevent turbid water from entering the Euphrates River.			
3	Solid Waste	B-	Transport waste from construction to an appropriate disposal site.			
5	Noise/ Vibration	B-	Restrict construction hours when implementing noisy construction work in the neighborhood of residential areas (e.g., stop construction at night, etc.).			
27	Infectious Diseases such as HIV/AIDs	B-	Implement an infection control program for construction personnel, including security personnel.	Construction Contractor		Included in construction cost
28	Occupational Health and Safety (OHS)	B-	- Implement safety training programs for construction personnel, including security personnel. - Select appropriate routes to avoid traffic accidents involving construction vehicles.			
29	Accidents	B-				
Operation						
2	Water Pollution	B-	Monitor water quality of	MWD	MWD	Included in

No.	Environmental Item	Evaluation Results	Proposed Mitigation Measures	Implementing Organization	Responsible Organization	Cost
			discharged water periodically, and take actions once accidents happen.			operation cost
3	Solid Waste	B-	Decrease the volume of sludge by dewatering, and transport sludge to an appropriate disposal site.			
5	Noise/ Vibration	B-	The distance from noise sources to the boundary of the site is considered sufficient, but install facility to reduce noise as needed.			
29	Accidents	B-	Select appropriate routes to avoid traffic accidents involving construction vehicles.			
30	Climate Change/ GHG Emission	B+ B-	Install solar system to decrease the electricity consumption and generated GHGs.			

Source: JICA Study Team

8.10 Environmental Monitoring Plan (EMoP)

The project proponent is responsible for establishing Environmental Monitoring Plan (EMoP) to implement appropriate environmental and social considerations in accordance with the JICA Guidelines for ESC and EMP.

Table 8.15 shows the draft EMoP proposed by JST, and **Appendix 8.3** shows the draft environmental monitoring form. While most of environmental monitoring activities during construction shall be implemented by construction contractor, excluding land acquisition/ involuntary resettlement issue. Those during operation shall be implemented by MWD

In accordance with the JICA Guidelines for ESC, MWD has the responsibility to make every effort to disclose the results of monitoring, and will also disclose information when requested to do so by a third party.

Table 8.17 Draft Environmental Monitoring Plan

No.	Environmental Item	Item/ Parameter	Location	Frequency	Implementing Organization	Responsible Organization	Cost
Construction							
1	Air Pollution	Confirmation of water sprinkling during construction	Site for WTP and other sites for pipelines, etc.	Daily	Construction Contractor	MWD	Included in construction cost
2	Water Pollution	Confirmation of construction wastewater treatment status		Daily			
3	Solid Waste	- Confirmation of waste volume during construction and proper disposal - Record of transport to final disposal site		Monthly			
5	Noise/ Vibration	Confirmation of the existence of complaints from neighbors		Daily			
27	Infectious Diseases such as HIV/AIDs	Confirmation of implementation of infectious disease control program	Site for WTP and other sites for pipelines, etc.	Daily	Construction Contractor	MWD	Included in construction cost
28	Occupational Health and Safety (OHS)	- Confirmation of implementation of safety training program - Record of					
29	Accidents						

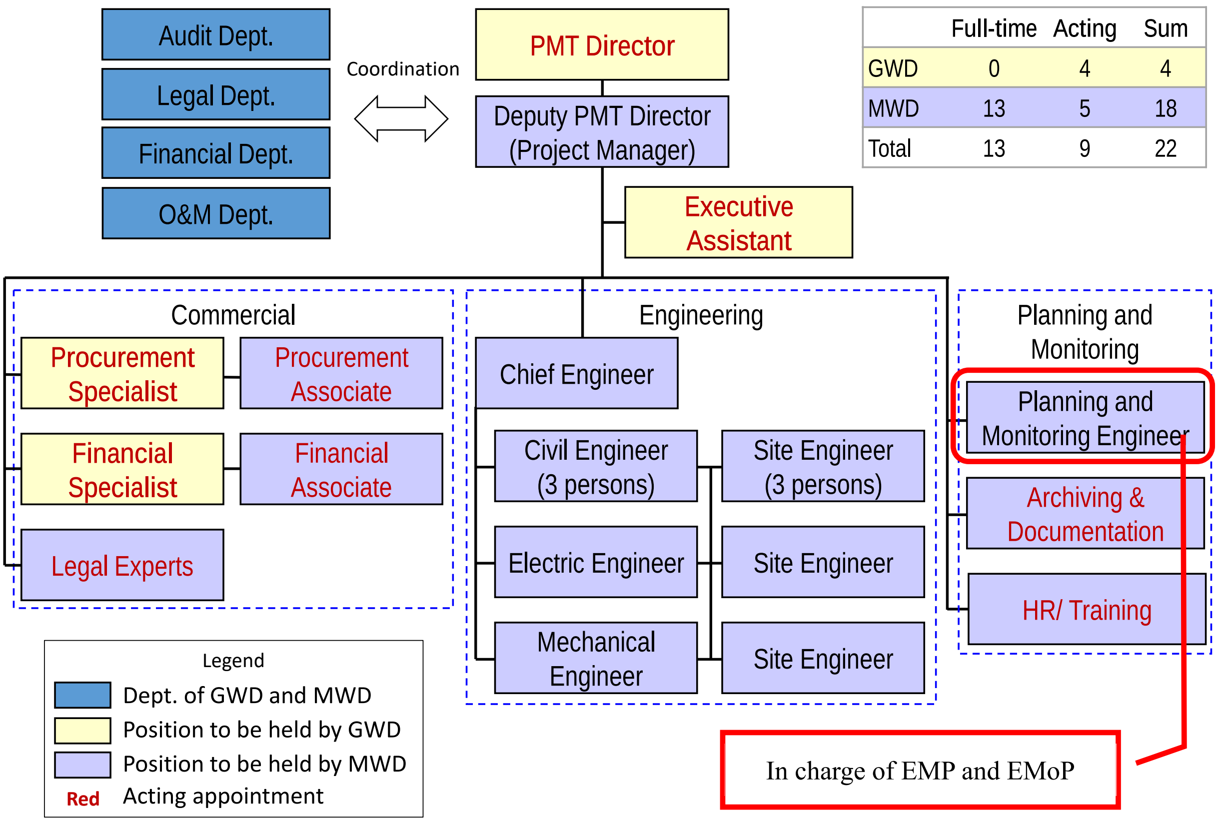
No.	Environmental Item	Item/ Parameter	Location	Frequency	Implementing Organization	Responsible Organization	Cost
		number of accidents					
Operation							
2	Water Pollution	1) Water volume, color and temperature 2) TDS, pH, DO, and BOD	(i) Discharged water and (ii) Eastern Euphrates Drainage Canal	(i) Continuously (ii) 4 times per year	MWD	MWD	Included in operation cost
3	Solid Waste	- Confirmation of waste volume of sludge after dewatering and proper disposal - Record of transport to final disposal site	Site for WTP	Monthly			
5	Noise/ Vibration	Confirmation of the existence of complaints from neighbors	Site for WTP	Daily			
29	Accidents	Record of number of accidents	Site for WTP	Daily			
30	Climate Change/ GHG Emission	Record of electricity generated by solar power	Site for WTP	Monthly			

Source: JICA Study Team

8.11 Implementation Organization

MWD has no specific sections or focal point to take care of environmental and social issues such as environmental monitoring. Therefore, JST proposes that MWD will assign a person to take responsibility for EMP and EMoP within the PMT structure. As shown in **Figure 8.16**, the person in charge of EMP and EMoP will be a "Planning and Monitoring Engineer."[2]

The system for land acquisition and grievance mechanism is described in Sections 9.6 and 9.7 and is assumed to be handled by the "Planning and Monitoring Engineer" as well.



	Full-time	Acting	Sum
GWD	0	4	4
MWD	13	5	18
Total	13	9	22

Source: MCHPM

Figure 8.16 Position of the Contact Person for Grievance in Proposed PMT Structure

[2] See Table 11.1 for the overall tasks of "Planning and Monitoring Engineer."

8.12 Stakeholder Meeting

Stakeholder consultations were conducted through the Previous Study. For example, the meetings with the related governmental organizations in the field of water resource and irrigation, etc., were held in 2016 and a three-day workshop was conducted only for local people with the attendance around 40–50 persons. The details cannot be identified since there are no minutes of the meetings.

On the other hand, there was no information disclosure and stakeholder meeting to collect and reflect the comments of the stakeholders to the Project, and it does not meet the JICA Guidelines for ESC. Therefore, JST proposed to conduct information disclosure in Arabic language and English, and the stakeholder meeting based on the latest study result, MWD agreed.

Figure 8.17 shows the screenshot of the information disclosure through the social network service by MWD. The stakeholder meeting was held at 09:30 a.m. on 30th November 2022 and **Table 8.16** shows the outline of the meeting, while **Appendix 8.4** shows the minutes of the meeting.


اعلام ماء المثنى مع إعلام ماء الخضر والدراجي و٢٥ آخرين.
11 س ·

تقوم مديرية ماء محافظة المثنى وبالتعاون مع الوكالة اليابانية للتعاون الدولي (JICA) بعقد ندوة تعريفية حول انشاء (محطة معالجة المياه) الخاص بمشروع تحسين مياه الشرب في مدينة السماوة بتاريخ (الاربعاء 2022-11-30) الذي سيقام في (مديرية بيئة المثنى) في تمام الساعة التاسعة والنصف صباحاً
وتتضمن الندوة مقدمة عن مشروع إنشاء محطة معالجة المياه في مدينة السماوة (أم العكف) والتاثير الإيجابي المتوقع على المجتمع من حيث تلبية متطلبات تجهيز مياه الشرب في السماوة. وسيتضمن مناقشة نتائج دراسة الأثر البيئي والمجتمعي للمشروع. ويعد الاجتماع فرصة للاستماع لملاحظات و استفسارات أصحاب المصلحة والسكان المعنيين بالمشروع.

Al Muthana Water Directorate in collaboration with Japan International Cooperation Agency (JICA) will hold stakeholder meeting for Environmental and Social Considerations (ESC) of the Samawah Water Supply Improvement Project on Wednesday the (30) November 2022 in the Convention Room / Al Muthana Environment Directorate at 09:30 AM.

The meeting will include an introduction to the project for constructing a water treatment plant in the city of Samawah, Umm Al-Akf district, and the expected positive impact on the community in terms of fulfilling the demand for drinking water supplies in Samawah, and a discussion about the results of the environmental and social impact study of the project. This stakeholder meeting is also an opportunity to collect the comment from stakeholders.

Source: JICA Study Team

Figure 8.17 Screenshot of Information Disclosure via Social Network Service by MWD

Table 8.18 Outline of Stakeholder Meeting

Item	Description	Remarks
Date & Time	09:00 a.m. – 11:45 a.m. on 30th November 2022	
Venue	Convention Room	Muthanna Environment Directorate
Attendance	26 persons	(i) Government: 10 (including Mayor, MWD, Muthanna Environment Directorate and Chamber of Industry) (ii) Private: 16 (including 4 residents, 6 NGOs/NPOs or journalist and 6 consultants)
Agenda	**Time**	**Subject**
	09:30 – 10:00	Registration
	10:00 – 10:10	Opening Remarks
	10:10 –10:30	Project Explanation
	10:30 – 11:10	Result of the Environmental Impact Assessment
	11:10 – 11:30	Question and Answer
Major Comments	(1) Is it possible to filter or treat the saline water coming out from the membrane system (RO) before it is thrown into the drain canal and if that to be done in the future; would it affect the aquatic environment of drain canal? <Response> It was calculated and presented him with the table in Section 5. Expected Environmental/ Social Impacts that the TDS will increase from (6.63 to 6.64 g/L) so that this will not affect the aquatic life in the drainage canal.	
	(2) How much is the estimated cost of the project? <Response> It will be calculated after finishing the final project design and the bill of quantity (BOQ). The first price prediction for the project is between USD 280 million to UD 300 million.	
	(3) Is it possible to obtain the same quantity of water supplied with the same quality at a lower cost from other sources? <Response> This subject was studied from the beginning, and the best choice was the source of raw water from the Euphrates River. The site selection was the best option available. The agreements and acceptances from many ministries were obtained, such as the Ministry of Agriculture, Ministry of Water Resources, Ministry of Electricity, Ministry of Finance, Ministry of Health, and Ministry of Environment.	
	(4) What policy will be implemented to force the rationalization of water? <Response> Work is required to educate citizens living in the urban and rural areas about the need to rationalize potable water consumption, work on legislation and laws to hold those responsible for wasting water accountable, impose immediate fines on violators, and set meters in every house to measure the extent of water consumption.	
	(5) Will the project cover the demand volume (actual need) for the year 2052 (target design year) and what percentage of Samawah's needs will be covered by the project? <Response> About 50% of the total demand would be supplied from the Samawah WTP, and the other 50% would be supplied from another project outside of the city from Al Rumetha City.	
	(6) In view of the current diseases, such as kidney disease in the rural areas, which are caused by high-salt drinking water, can the project deliver potable water to the countryside to address this matter? <Response> Yes, the new network and many storage tanks with a volume of 2000 m^3 for each will be constructed in the rural area to supply good drinking water with TDS of about 500 mg/L	
	(7) Will there be reservoirs to store water for emergencies or future scarcity? <Response> Yes, the main storage tank is Jarbouy'ah Storage Tank in addition ten storage tanks will be constructed with a volume of 2,000 m^3.	
	(8) Is the project only for the city of Samawah exclusively, or will it cover the rest of the cities in Al-Muthanna Governorate? <Response> It is only for Samawah City and it will cover most rural and urban areas of Samawah City.	
	(9) Will the project provide new chances for Samawah youth to work in the construction and	

Item	Description	Remarks
	operation stages? <Response> Yes, most engineers, workers, and employees will be from Samawah so the project will have economic benefits for the youth from the project.	
		

Source: JICA Study Team

As stated above, MWD has conducted social communications about the Project to raise public awareness to the Project through meetings held in 2016 and the stakeholder meeting held in November 2022. Regarding the tariff payment, which is closely related to the success of the Project, the nationwide project for water meter installation has been launched in October and water meter installation in Muthanna Directorate started in November 2022. This project will certainly raise the residents' awareness to tariff payment. In October 2022, the Government of Iraq started a water meter installation project in all governorates except for Kurdistan Region under the initiative of MCHPM (GWD).

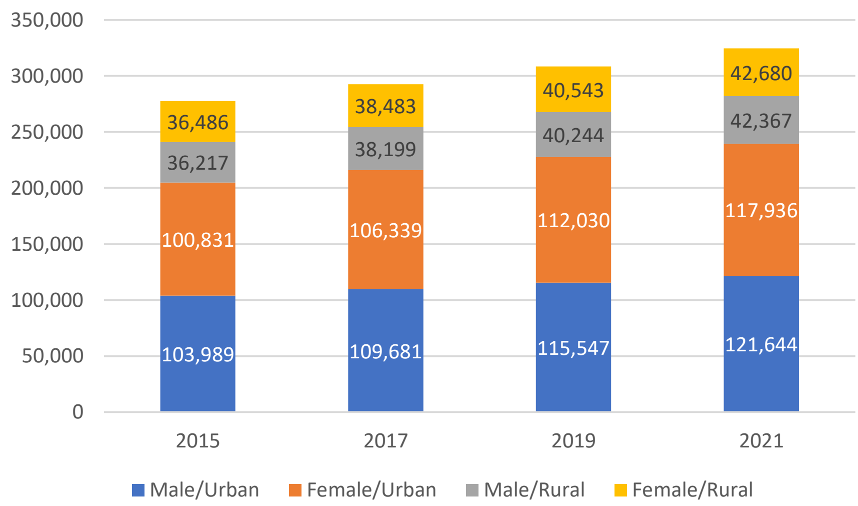
8.13 Considerations on Gender and Vulnerable Groups

8.13.1 Gender Considerations

Iraq's new constitution (adopted in 2005) states that all Iraqis are equal before the law and prohibits discrimination based on sex (Article 14). Iraq also ratified the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), the most important international treaty on gender equality in 1986, but has not yet ratified the Optional Protocol on Violence Against Women. Under these circumstances, according to the United Nations Entity for Gender Equality and the Empowerment of Women (UN Women), 26.4% of parliamentary seats were held by women in Iraq, as of February 2021, while 7.6% in 2000.

On the other hand, in reality, the implementation of women's rights is not fully guaranteed, and domestic compliance with obligations of the above convention has not been completed. Legal reform, coupled with positive enforcement mechanisms, is still required to ensure equal rights for women. For example, women and girls aged ten and older spend 24.1% of their time on free care and housework, compared with 4.2% for men. As shown in **Table 8.17**, Iraq also ranks 154th (out of 156) in the World Economic Forum's Gender Gap Index 2021, lower than Japan's 120th place.

Figure 8.18 shows the population and sex ratio in the urban and rural areas in Samawah District.



Source: Directorate of Population and Manpower Statistics, Iraq Population Estimates 2015 - 2018

Figure 8.18 Population and Sex Ratio in the Urban and Rural Areas in Samawah

Table 8.19 Ranking of Gender Gap Index

Rank	Rank in Middle East and North Africa	Country	Score
1	-	Iceland	0.892
60	1	Israel	0.724
72	2	United Arab Emirates	0.716
120	-	Japan	0.656
126	3	Tunisia	0.649
150	16	Iran	0.582
152	17	Syria	0.568
154	18	Iraq	0.535
155	19	Yemen	0.492
156	-	Afghanistan	0.444

Source: JICA Study Team based on "Global Gender Gap Report 2021", World Economic Forum

8.13.2 Draft Gender Action Plan

Although the Project is expected to improve the convenience of water supply and indirectly reduce household chores related to water use, the gender action plan as shown in **Table 8.18** is proposed to resolve gender issues that should be implemented within the framework of the project, given the existence of the issues mentioned above.

Table 8.20 Draft Gender Action Plan

Action	Output	Index	Responsible Organization	Phase
Include women in PMTs and consultants as much as possible	Several female staff will be assigned to the PMT and a female consultant will be hired.	(i) Number of female members of PMT (ii) Number of female consultants	PMT	Preparation and Implementation Phase
In accordance with the Iraqi Constitution, the contractor's contract should clearly state the active employment of women, consideration for women workers, equal pay for equal work, etc., to ensure the equality of women in all project activities.	Women involved in all activities of the Project will be treated equally with men in terms of employment and compensation. Gender-specific considerations will also be clearly stated in the contractor's agreement and will be understood and implemented.	Gender considerations specified in the contract (Yes or No) and implemented (Yes or No)	PMT	Preparation and Implementation Phase

Source: JICA Study Team

8.13.3 Other Vulnerable Groups

Iraq ratified the Convention on the Rights of the Child (CRC) and the International Covenant on Civil and Political Rights (ICCPR) in 1994 and 1971, respectively.

In Samawah, the majority of the population is Muslim Shiite Arabs, and there are no or limited ethnic groups that would be unfairly affected by the Project.

8.14 Project's Potential as Measures Against Climate Change

Iraq has ratified the Convention on Climate Change and Kyoto Protocol through Law No. 7 of 2008.

Iraq also formally ratified the Paris Agreement in 2021 and decided on a nationally determined contribution (NDC) with the support of the United Nations Development Program. In addition, according to the UN Environment Program, Iraq is the fifth most vulnerable to climate change in the world, and events such as drying up of Lake Sawa near Samawah in April 2022 have increased the concerns in Iraq about climate change.

The project's potential as measures against climate change is as follows:

8.14.1 Adaptation Measures

Small rivers and streams in the study area are prone to reduction of flow rate and salinity increase due to the effects of climate change; therefore, water intake from small streams is vulnerable to climate change. In this context, the Project, which takes water from the Euphrates River, while the existing WTPs and another ongoing project take water from the narrower rivers of Rumaitha and Gamas, is regarded as an adaptation measure to climate change as it will contribute to the stable water supply to people in Samawah amid the increasing influences of climate change to such rivers.

In addition, saving water resources by reducing the water transmission volume from Rumaitha by the old transmission lines can also be an adaptation measure to climate change. As shown in Subsection 5.3.1 of the Previous Study.

8.14.2 Mitigation Measures

Since the Project will construct the WTP using RO technology, energy consumption will increase compared with the without-project condition. Against such an increase of energy consumption, meanwhile, the Study proposed various mitigation measures by installing an energy-efficient equipment, who will reduce greenhouse gas emissions as below.

(1) Energy saving effect

As shown in Section "5.5 Planning of Water Treatment Plant", unit power consumption in case of the application of energy recovery device (ERD) installation, was calculated. As a result, reduction rate of power consumption is about 20% as maximum (from 0.775 kWh/m^3 to 0.625 kWh/m^3). This energy saving effect is based on the assumption that the salinity of raw water is at its maximum level (3,000 mg/L as TDS). On condition of the average level of TDS (1,500 to 2,000 mg/L), the effect of energy saving will be halved from the above calculation. The CO_2 emission reduction by the introduction of ERD must be calculated based on the halved energy consumption.

(2) Emission reductions

According to Annex 3 of JICA Climate-FIT Version 4.0, 788 g-CO_2/kWh is the combined margin grid emission factor for energy efficiency in Iraq.

If the operation rate of the WTP is presumed at 75%, which is equivalent to the production rate of 60,750

m^3/day (81,000 m^3/day x 75%), the CO_2 emission reductions are calculated as follows:

CO_2 emission reductions = Emission Factor x Energy Saving Effect x Treatment Volume

= 788 g-CO_2/kWh x (0.775 – 0.625)/2 kWh/m^3 x 60,750 m^3/day

= 3,590 kg-CO_2/day

= 1,310 t CO_2/year

Chapter 9 Resettlement

9.1 Necessities of Land Acquisition, Resettlement, and/or Tree Cutting

9.1.1 Necessities of Land Acquisition and Resettlement

According to MWD at the discussion on 16th August 2022, the background and current status regarding land acquisition for Samawah water treatment plant (WTP) is as follows and it was confirmed that no additional land acquisition for the WTP would be required, and resettlement that would require abbreviated resettlement action plan would occur.

- The land was owned by the Ministry of Finance (MOF) originally and MOF had lent it to farmers.
- The rental contract between MOF and farmers was already terminated and the land was already transferred to MWD.

Also, no land acquisition/resettlement associated with the expansion of existing reservoir or construction of new reservoirs is expected since the capacity of existing water distribution reservoirs was found to be sufficient.

Table 9.1 shows the necessities of land acquisition and resettlement for each component. MWD explained that, in general, it is not necessary to obtain a road occupancy permit for public projects.

Table 9.1 Necessities of Land Acquisition and Resettlement for Each Project Component

Project Component		Necessity of Land Acquisition	Necessity of Resettlement	Status
Construction of Samawah wtp	Construction of intake facilities at the Euphrates River	Not necessary	Not expected	-
	Construction of water treatment facilities, pumping station for treated water transmission, main substation and solar power generation system	Necessary	Not expected	Already agreed and confirmation letters from the relevant organization were issued.
Installation of external power transmission line to Samawah water treatment plant	Installation of equipment in MOE's substation	Not necessary	Not expected	No expansion of the substation is planned.
	Installation of high voltage cable	Not necessary	Not expected	Cable will be installed within the road right-of-way.
Installation of treated water transmission line and brine discharge line (includes crossing of the Euphrates River)	Installation of treated water transmission line	Not necessary	Not expected	Transmission line will be installed within the road right-of-way.
	Installation of brine discharge line (approximately 6.7 km in a straight line from WTP to Eastern Euphrates Drainage Canal)	Not necessary	Not expected	Discharge line will be installed within the road right-of-way.
Improvement of the existing water distribution system in urban area		Not necessary	Not expected	-

Source: JICA Study Team

9.1.2 Founding from the Site Visit Survey

(1) Execution of site survey

On October 19, 2022, the JICA Study Team (JST) conducted an online site visit survey by dispatching a local surveyor with a mobile web camera and a 360-degree panoramic camera to the WTP site to confirm the latest situations of the site. **Figure 9.1** shows the photos and their location of this site visit survey.

Source: JICA Study Team

Figure 9.1 Present Situations of the Site for Samawah WTP (19th October 2022)

(2) Residence

No housing was found on the site (see no. 8, 9, 10, and 12 in **Figure 9.1**), while around ten buildings including small ones were identified at the outer side of the eastern part of the site.

JST suggested that MWD should take the following actions for the neighbors at the meeting on November 4, 2022, and MWD agreed:

1) To invite the residents to the stakeholder meeting, to reconfirm the above agreement,
2) To install fences to visualize and secure the boundary of the site, and
3) To periodically take photos of the site for continuous monitoring of the situation.

(3) Agricultural activities

At the time of the site survey conducted in October 2016 during the Previous Study, a farmer had leased a part of the site but had not used it for agriculture during the past two years, which legally authorized that the contract could be terminated. In addition, the farmer is using another land and, in the field survey in October 2022, no land use by any farmer or local people was observed in the WTP site.

(4) Tree cutting

The target area is around 15 ha in size and several trees will need to be cut down in the site.

In the site visit on October 19, 2022, no tree was found to be a part of the forest, which may have a significant impact on the ecosystem or to be valuable species.

9.2 Policies and Procedures for Abbreviated Resettlement Action Plan

9.2.1 Policies for Abbreviated Resettlement Action Plan (A-RAP) in Iraq

Resettlement is not anticipated since the acquired area for WTP needs no resettlement and the water supply pipe will be installed basically under the existing road or government-owned land. Therefore, it is considered unnecessary to formulate a resettlement action plan (RAP) for the Project.

If the need for resettlement is identified in later stage of Project, however, it is suggested that MWD will develop an abbreviated resettlement action plan (A-RAP) in accordance with the policies of the Japan International Cooperation Agency (JICA) (see Section 9.2.2) since Iraqi laws do not have the specific regulation for establishment of A-RAP.

9.2.2 Policies for Abbreviated Resettlement Action Plan (A-RAP) of JICA

The A-RAP of the project must comply not only with the Iraqi Constitution and other relevant laws but also with JICA Guidelines for ESC as well. The JICA Guidelines for ESC stipulates that a Resettlement Action Plan (RAP) must be prepared for any project that involves land acquisition or resettlement. In cases where small-scaled resettlement occurs, the project proponent is required to prepare an Abbreviated RAP (A-RAP) in accordance with JICA Guidelines for ESC, which refers World Bank Operational Policies (OP) 4.12 (involuntary resettlement).

Table 9.2 shows the typical contents of A-RAP based on JICA Guidelines for ESC and the World Bank OP 4.12.

Table 9.2 Typical Structure of A-RAP

Item	Description	Policy
1) Project Outline	Describe the latest project outline.	-
2) Necessity and Objectives of Land Acquisition and Resettlement	Describe the extent of land acquisition, the scale of land acquisition and resettlement, the project components that will cause relocation, the impact area, and the initial design alternatives considered to avoid or minimize relocation.	To minimize social impacts, public lands will be prioritized as construction site when land acquisition turns out to be necessary.
3) Legal Framework for Land Acquisition and Resettlement	Summarize the relevant laws on land acquisition and resettlement in Iraq and analyze the differences from JICA Guidelines for ESC.	See Section 9.3
4) Scale and Scope of Land Acquisition and Resettlement	Conduct (i) a population census survey, (ii) a property and site survey, and (iii) a household and livelihood survey of all occupants of the project site (including landowners, irregular occupants, renters, traders, and store employees), and describe the results.	See Section 9.3
5) Compensation Policy and Specific Measures for Compensation and Support	After confirming the details of compensation provided in similar JICA-funded projects implemented in Iraq in the past, a policy for compensation in the project will be established. Specific measures will be discussed based on the policy.	The reacquisition price of the asset will also be investigated, as the policy for compensation describes.
6) Grievance Mechanism	Describe the members, authority, and grievance procedures of the organization responsible for	MWD does not have a specific section or person in charge of

Item	Description	Policy
	handling grievances. Identify whether there are existing reputable dispute arbitration organizations and procedures (independent of the judicial system) in the project site, and consider whether these should be utilized or whether a new organization should be established.	receiving complaints from local residents, farmers, and other stakeholders. Therefore, MWD will consider appointing a contact person in charge of handling grievance in the PMT's organizational structure.
7) Organization for Land Acquisition and Responsible Authority	Describe the organizational chart, personnel, roles of staff, etc., of the related organizations. If there are multiple related organizations, describe the method of coordination among the related organizations.	Since no further land acquisition for the WTP or any other component in the Project is expected, the contact person in charge of handling grievance will be the one working on other tasks. (see Section 11.5)
8) Schedule	Include items related to resettlement and land acquisition in the overall project schedule (if the overall project schedule is included in other chapters, be consistent with them).	No further land acquisition for the WTP or any other component is expected in the Project.
9) Cost/Finance	Provide an itemized cost estimate for all relocation activities in a table.	No further land acquisition for the WTP or any other component is expected in the Project but, when it becomes necessary, the cost of land acquisition shall be borne by the Iraqi side.
10) Monitoring and Supervision	Describe the monitoring items (status of compensation payment, implementation of various types of assistance, completion of relocation, etc.), indicators to measure inputs and results, the monitoring continuation period, and the implementing/responsible agency.	MWD will be the implementing and responsible organization and conduct monitoring in accordance with the general monitoring items in Section 9.9.

Source: JICA Study Team based on the JICA Guidelines for Environmental and Social Considerations

9.2.3 Gap Analysis between International Policies for ESC and Iraqi Legislations

Table 9.3 shows the gaps in the policies on resettlement action plan between the JICA Guidelines for ESC/ the World Bank OP 4.12 and Legislations in Iraq such as Law No. 12 of 1981.

Although the Iraqi legal system states that compensation should be based on market prices, there are gaps on many items such as impact minimization, livelihood restoration for resettled residents, resettlement action plan, information disclosure, and stakeholder meeting.

Table 9.3 Gaps of International Policies and Legislations in Iraq

No.	JICA Guidelines for ESC/ World Bank OP 4.12.	Legislation in Iraq	Gap	Measures to resolve Gap
1	Involuntary resettlement and loss of means of livelihood must be avoided by considering all possible measures. (JICA GL)	Iraqi Constitution Article 23: … land acquisition will not be permitted unless adequate compensation is provided for the public good.	Clear procedures are not specified in the legislation.	No involuntary resettlement will occur under the project. With regard to land acquisition, alternatives will be considered to minimize the impact, and avoidance/minimization will be undertaken to the extent possible.

No.	JICA Guidelines for ESC/ World Bank OP 4.12.	Legislation in Iraq	Gap	Measures to resolve Gap
2	If involuntary resettlement is unavoidable, effective measures must be taken to minimize impacts and compensate for losses. (JICA GL)	Law No. 12 of 1981 (Article 13): The private landowner and the project proponent will dispute in court over the private land included in the public project. The Land Evaluation Committee will determine the amount of compensation and how it will be calculated (divided into real compensation, cash compensation, and property compensation).	Impact mitigation is not specified in the legislation.	No involuntary resettlement will occur under the project. When acquiring land for the project, a project plan that minimizes impacts will be considered, and compensation will be provided commensurate with losses.
3	The resettled residents will be provided with compensation and assistance to improve or at least restore their standard of living, income opportunities, and production levels prior to their relocation. (JICA GL)		Compensation for livelihood restoration is not specified in the legislation.	Compensation and assistance shall be provided to improve or restore living standards, income opportunities, and production levels, taking into consideration the type and extent of impacts on the project affected people.
4	Compensation must be based on reacquisition costs whenever possible. (JICA GL)		No major gap. The method of calculating compensation is defined by law, which stipulates that it should be based on market prices.	-
5	Compensation and other assistance must be provided prior to physical resettlement. (JICA GL)	Law No. 12 of 1981: Ownership of the land is not transferred until both parties agree.	No major gap.	-
6	For projects where large-scale involuntary resettlement will occur, a resettlement action plan must be prepared and disclosed to the public. (JICA GL)	No applicable laws and regulations	Resettlement Action Plan is not specified in the legislation.	Large-scale involuntary resettlement will not occur under the project.
7	In preparing a resettlement action plan, sufficient information must be disclosed to the public in advance, and consultation with project affected people and communities must be conducted based on this information. (JICA GL)	No applicable laws and regulations	Information disclosure and stakeholder meeting are not specified in the legislation.	Since involuntary resettlement will not occur under the project, there will be no public disclosure or consultation on the resettlement action plan.
8	Consultations must include explanations in a language and format that	No applicable laws and regulations	Stakeholder meeting is not specified in the	Since involuntary resettlement will not occur under the project, there

No.	JICA Guidelines for ESC/ World Bank OP 4.12.	Legislation in Iraq	Gap	Measures to resolve Gap
	is understandable to those project affected people. (JICA GL)		legislation.	will be no public disclosure or consultation on the resettlement action plan.
9	Appropriate participation of project affected people and communities must be promoted in the planning, implementation, and monitoring of measures for involuntary resettlement and loss of means of livelihood. (JICA GL)	No applicable laws and regulations	Stakeholder meeting is not specified in the legislation.	Since involuntary resettlement will not occur under the project, there will be no public disclosure or consultation on the resettlement action plan. Recommend to the implementing agencies that the participation of affected communities be encouraged in the implementation and monitoring of land acquisition.
10	A grievance mechanism from project affected people and communities must be established. (JICA GL)	Law No. 12 of 1981 (Article 51 – 53) stipulates the damage to third parties caused by land acquisition. It also describes the court procedures and the determination of the amount of compensation by the Land Evaluation Committee.	Establishment of grievance mechanism itself Stakeholder meeting is not specified in the legislation.	Consider efficient grievance mechanisms, utilizing existing administrative procedures and local customs.
11	Project affected people will be identified and documented through an initial baseline survey (including a population census, asset and property survey, and socioeconomic survey) to establish entitlements to compensation and assistance. This should be done as early in the project as possible to prevent undue influx of people seeking compensation, assistance, or other benefits. (WB OP4.12 Para.6)	No applicable laws and regulations	Survey on project affected people Stakeholder meeting is not specified in the legislation.	Whenever private land is acquired, the necessary survey should be conducted in the early stages of the project.
12	The recipients of compensation and assistance shall be those who have legal rights to the land, those who do not have legal rights to	Law No.55 of 1932 stipulates the right of land ownership.	Compensation for informal residents is not specified in the legislation.	Suggest that the implementing agency provide compensation to informal residents as well.

No.	JICA Guidelines for ESC/ World Bank OP 4.12.	Legislation in Iraq	Gap	Measures to resolve Gap
	the land but whose rights are recognized under the legal system of the country concerned if they claim the rights, and those who occupy the land in fact, although their legal rights and claims cannot be confirmed. (WB OP4.12 Para.11)			
13	If the livelihoods of the relocated residents are rooted in the land, land-based relocation strategies shall be prioritized. (WB OP 4.12 Para.11)	No applicable laws and regulations	Prioritizing land-based relocation strategies is not specified in the legislation.	Since resettlement will not occur under the project, no resettlement strategy will be developed.
14	Provide assistance during the transition period. (WB OP 4.12 Para.6)	No applicable laws and regulations	Providing assistance during the transition period is not specified in the legislation.	Ditto
15	Special consideration will be given to the socially vulnerable among the relocated residents, especially the poor, landless, the elderly, women, children, indigenous peoples, and ethnic minorities. (WB OP4.12 Para.8)	No applicable laws and regulations	Consideration to the socially vulnerable is not specified in the legislation.	Resettlement will not occur, but if socially vulnerable groups will be negatively impacted in any way as a result of the project, it is necessary to propose that the implementing agencies provide appropriate assistance.
16	For projects involving the relocation of less than 200 residents or land acquisition, an abbreviated resettlement action plan will be prepared. (WB OP 4.12 Para. 25)	No applicable laws and regulations	Resettlement Action Plan is not specified in the legislation.	Since resettlement will not occur under the project, an abbreviated resettlement action plan will not be prepared.

Note: “JICA GL” means the JICA Guidelines for ESC, and “WB OP” means the World Bank's Operational Policies.

Source: JICA Study Team

9.3 Population, Assets, Lands, and Social Conditions

Since the Project does not require any private land acquisition or resettlement, information on population, assets, lands, and social condition associated with land acquisition are not collected in the study.

9.4 Legislations Relevant to Land Acquisition

Table 9.4 shows the list of laws and regulations on land acquisition and the outlines of land tenure and land acquisition are described in Sections 9.4.1 and 9.4.2.

Table 9.4 List of Laws and Regulation on Land Acquisition

Law	Article	Brief Description
Iraqi Constitution	Article 23	Landowners may develop and dispose of their personal property and that expropriation is not permitted except with adequate compensation in the public interest.
Law No. 55 of 1932	Land Tenure	Types of landownerships like (i) private owned land, (ii) inherited land, (iii) government-owned land, and (iv) desert land.
Law No. 12 of 1981	Appropriation Law	The acquisition of real estate is given to the project proponent and the project proponent's rights when implementing public works projects.
	Article 1	Decides unified rules and basis for justful compensation for appropriated real estate, to insure owner's rights, without violation of public interests. Also, simplification of appropriation procedures to ensure their safety and speedy execution.
	Article 2	This applies to all properties, including agricultural, and non-agricultural lands and orchards which have their legislation for expropriating ownership or cancelling the disposal rights.
	Article 4-8	Agreements for the acquisition of property may be made in kind or cash, depending on the value estimated by the commission established following this law, and may be reached between directorates, social sectors, and joint sectors and the owner of the property or the land.
	Article 9	To execute their projects, state departments and the socialist sector have the legal right in real estate appropriation, to demand appropriation of a real estate, a part therefrom or related original rights in rem.
	Article 10	The appropriator shall submit to the court of first-instance appropriation. An application confirming that there is no planning or legal objection to appropriation, enclosing the following documents: - A copy of the last land registry for the real estate, or a letter from the concerned land registry office showing non-registration of the real estate. - A certified map from the land registry office, showing the area demanded appropriation. - A statement of real estate owners, or their real owners if it is not registered, their addresses or at least the address of one of them.
	Article 11	The court shall fix a date for consideration of the appropriation request, within ten days from the date of its registration at the court. It shall demand that the land registry office may not take any measures concerning the real estate and inform the court of any procedures in this regard. - The court shall ask both sides for an appearance at the fixed date. If the dispossessed are more than, or if any of them is dead, the court may inform one of them and call others by advertisement in a local daily newspaper, according to their names as shown in the last land registration. This procedure is considered as information for all partners and the dead heirs. If the real estate is not registered, the real possessor shall be informed.
	Article 12	In its first hearing, the court shall ascertain of the availability of conditions in this law concerning appropriation requests. If there is a lack of conditions, the court shall ask for completion of the same. If the court rules rejection of the appropriation request, it shall notify the land registry office to remove the mark of non-disposal from the real estate register, in case its ruling is final.
	Article 13	Private landowners and project proponents argue in court over private lands included in public projects.
	Articles 9-21	Legal possession in which government departments, social and joint sectors

Law	Article	Brief Description
		that have the right to legal possession of property can request possession of any real estate.
	Articles 22-28	Administrative acquisition is in which the property is administratively acquired, and compensation is established by the agreement of the parties. If the property to be purchased is owned by government departments, social or public sectors.
	Articles 29-30	Real compensation, if the property that needs to be acquired is land or agricultural, the actual compensation is paid to the owner of the property at the same value as the administrative unit of that land that is needed to be acquired.
	Articles 31-32	Monetary compensation is made when estimating the value of the land in dunams (the unit of measurement 2,500 m^2) and at prices by referring to the sale procedures of the real estate registry office.
	Articles 33-36	Property compensation, when estimating the value of the residential, commercial, and industrial real estate and lands allocated for the construction of buildings following the going rates during the inspection and estimating their value following the project's implementation.
	Articles 26-39	Only private landowners are eligible to be compensated.

Source: JICA Study Team

9.4.1 Land Tenure

Article 23 of the Iraqi Constitution states that landowners may develop and dispose of their personal property and that expropriation is not permitted except with adequate compensation in the public interest.

Law No. 55/1932 on land tenure defines the types of land ownership like (i) private owned land, (ii) inherited land, (iii) government owned land, and (iv) desert land.

9.4.2 Land Acquisition

Law No. 12/1981 on Land Acquisition stipulates the acquisition of real estate given to the project proponent and the project proponent’s rights when implementing public works projects.

Table 9.5 shows the key points of this law.

Table 9.5 Key Points in Law No. 12/1981 on Land Acquisition

Item	Type	Description
Types of Acquisition	1) Agreement Acquisition	Directorates, social and joint sectors having the right to possess property can agree with the property owner or the landowner to possess the property by an agreement either in kind or in cash depending on the price estimated by the commission established pursuant to this law.
	2) Juridical Acquisition	Government departments, social and common sectors of having the right to legally possess a property can request to possess any property.
	3) Administrative Acquisition	The property shall be possessed administratively, and the compensation is determined by the parties' agreement if the property or the real estate right requested for acquisition is owned by government departments or the social or common sectors.
Types of Compensation	1) Real Compensation	
	2) Cash Compensation	
	3) Property Compensation	

Source: JICA Study Team based on the Data Collection Survey for the Water Supply and Sewerage System Development Plan in Southern Iraq

The law regulation of real estate appropriation described as related to the rights published by the state departments and socialist sector. Article 1 of this law describes the rules and their basis for a fair compensation for appropriated real estate, to guarantee the landowner's rights, without violation of public interests. Also, this law simplifies the appropriation procedures to ensure their safety and speedy execution.

Article 2 of the law applies to all properties, including agricultural, and non-agricultural lands and orchards which have their legislation for expropriating ownership or cancelling the disposal rights.

The following three categories of acquisition are governed by this law.

1) Articles 4-8, agreements for the acquisition of property may be made in non-monetary or monetary, depending on the value estimated by the commission, who established this law. An agreement may be reached according to this law between directorates, social sectors, and joint sectors and the owner of the property or the land.
2) Articles 9-21, legal possession in which government departments, social and joint sectors that have the right to legal possession of property can request possession of any property.
3) Articles 22-28, the administrative acquisition in which the property is administratively acquired, and compensation is established by the agreement of the parties. If the property to be purchased is owned by government departments, social or public sectors.

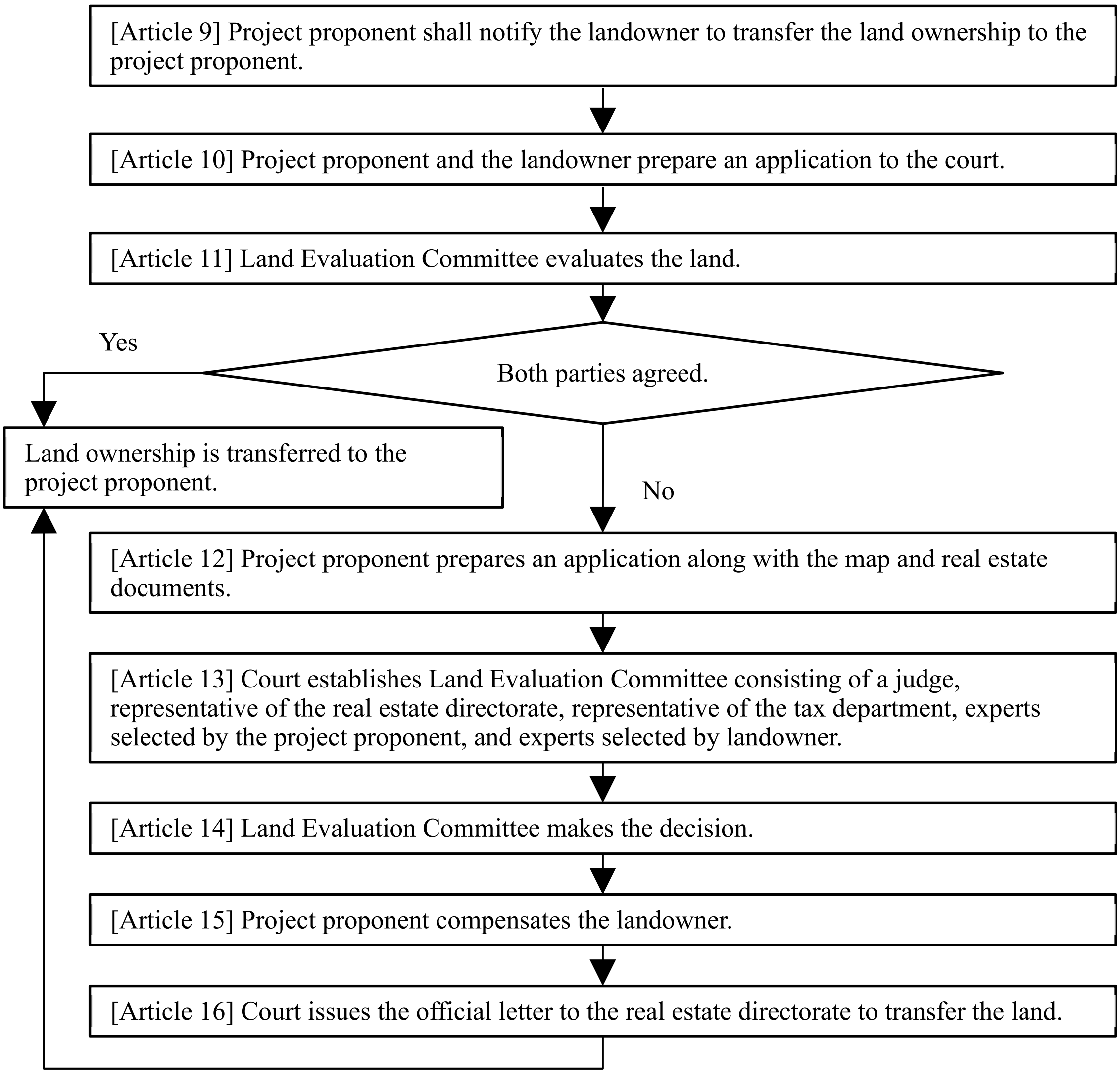
In addition, this law covers three forms of compensation as follows:

4) Real compensation: according to Articles 29–30 of this law, this kind of compensation apply, if the property that needs to be acquired is a just empty land or an agricultural land, the compensation is to be paid to the owner of the property at the same value as the administrative unit of that land value it at that time.
5) Monetary compensation: according to Articles 31-32, monetary compensation is applied when estimating the value of the land in dunams (the unit of measurement 2,500 m^2) the prices and the sale procedures to be checked by the land registry office.
6) Property compensation: according to Articles 33 to 36, estimating the value of the residential, commercial, and industrial estate or any land allocated for the construction work, according to the rates at the time of valuation during the inspection and following the project's completion.

(1) Process of Land Acquisition

Law No. 12/1981 on Land Acquisition also stipulates the process of land acquisition. This process depends on the types of land ownership whether it is private or governmental. If the project site is on a government land, only the land administrative procedures between the project proponent and the governmental organization are required.

On the other hand, if the project site is a private land, as shown in **Figure 9.2**, the land ownership is converted through a court dispute between the project proponent and the landowner. The dispute will be handled in court until both parties reach an agreement.



Source: JICA Study Team

Figure 9.2 Process of Land Acquisition According to Law No. 12/1981

9.5 Policies of the Project Executing Agency in Land Acquisition

GWD and MWD do not have their own specific policies in land acquisition and when land acquisition occurs, they will follow the procedures of Law No. 12/1981 described in Section 9.4.

In the event of involuntary resettlement, consideration shall be given in accordance with the following policies based on the JICA Guidelines for Environmental and Social Considerations. In particular, the policy for compensation shall be based on the reacquisition price.

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.

II. When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.

III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.

IV. Compensation must be based on the full replacement cost[1] as much as possible.

V. Compensation and other kinds of assistance must be provided prior to displacement.

VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.

IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.

XI. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.

XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

XIII. Provide support for the transition period (between displacement and livelihood restoration.

[1] Description of "replacement cost" is as follows:

Land	Agricultural Land	The pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes.
	Land in Urban Areas	The pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes.
Structure	Houses and Other Structures	The market cost of the materials to build a replacement structure with an area and quality similar or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes.

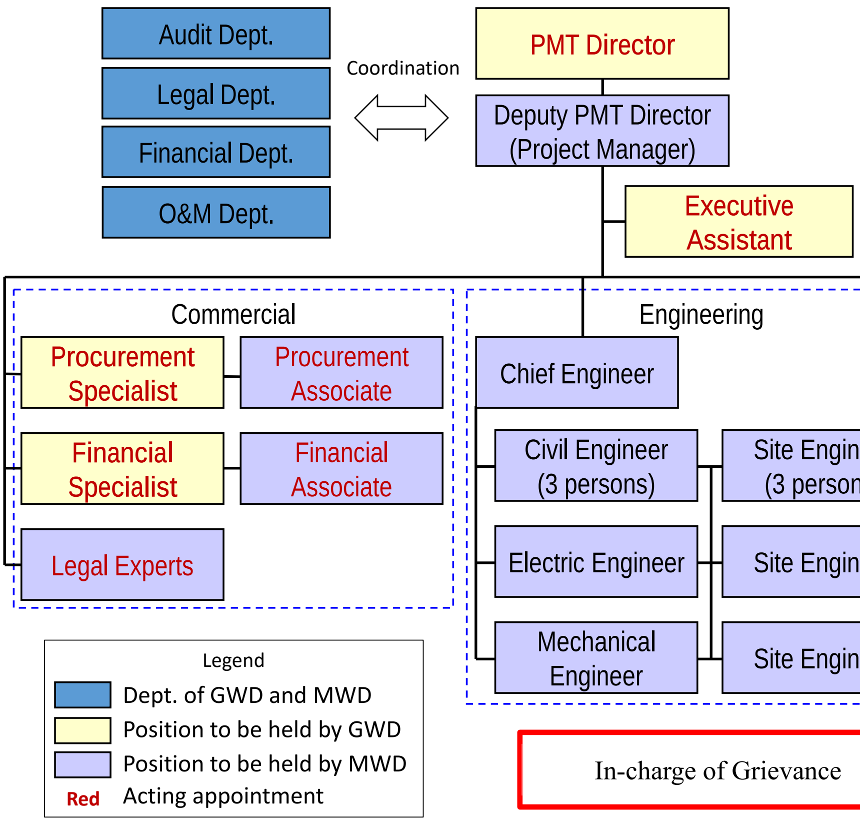
XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc.

9.6 Grievance Mechanism

MWD has no specific sections or focal point to receive complaints from stakeholders such as local residents and farmers. Therefore, JST proposes that MWD will assign a contact person to take care of grievance within the PMT structure. As shown in **Figure 9.3**, the contact person will be the "Planning and Monitoring Engineer."[2]



	Full-time	Acting	Sum
GWD	0	4	4
MWD	13	5	18
Total	13	9	22

Source: MCHPM

Figure 9.3 Position of the Contact Person for Grievance in the Proposed PMT Structure

[2] See Table 11.1 for the overall tasks of the "Planning and Monitoring Engineer."

9.7 Organization for Land Acquisition and Responsible Authority

The Project does not require any private land acquisition or resettlement, but JST proposes that MWD will organize the unit to take care of land acquisition issues within the PMT structure. Since some grievance can occur, therefore the "Planning and Monitoring Engineer" who is in-charge of grievance is desirable as the head of this unit.

9.8 Schedule and Cost/ Finance of Resettlement

Since no private land acquisition or resettlement is planned, no schedule and cost/ finance of resettlement were also planned.

9.9 Monitoring

Since no private land acquisition or resettlement was planned, no monitoring is required.

But if land acquisition or resettlement occurs in the Project, a policy and monitoring system for land acquisition should be established based on the size and nature of the land acquisition.

Table 9.6 shows the general monitoring items, and actual monitoring items will be determined when land acquisition occurs.

Table 9.6 General Monitoring Items for Land Acquisition

No.	Item
1) Overall progress	To organize the progress of the overall work based on a comparison of the implementation schedule and actual progress of land acquisition.
2) Satisfaction level of affected residents (support program)	To organize the level of satisfaction of affected people, especially those who are the target of the support program.
3) Satisfaction of the affected residents (other than the support program)	To organize the level of satisfaction of those who have been provided with alternative housing, compensation for business profits expected to be lost, and compensation for damage to buildings and repairs among the affected people.
4) Consistency with compensation policy	To confirm and organize whether compensation is appropriately provided based on the ownership relationship of the site in accordance with the compensation implementation policy to be developed.
5) Appropriateness of response to complaints	To confirm and organize what complaints were filed during the subject period and how they were handled. In addition, the time taken to respond to complaints and feedback from residents who lodged complaints shall be verified, and improvements shall be examined if there are any problems with the complaint response system.

Source: JICA Study Team

Chapter 10 Preliminary Cost Estimation

10.1 Estimation of the Construction Cost

(1) Methodologies of the estimation

The methodology for preliminary cost estimation for the Study is summarized in **Table 10.1**. The unit rate for each work item was referred to the similar project such as Basrah Water Improvement Project. The unit rate per m^3 or per m which includes all materials, equipment, and labor cost, was prepared and the construction cost was estimated by multiplying with the capacity or length for each facility. The cost which was referred to the Basrah Water Improvement Project was including the price escalation from the base cost.

Table 10.1 Methodology for Preliminary Cost Estimation

Work Items	Reference Information	Estimation in the Study
Water Treatment Plant		
- Intake - Pre-treatment - RO Facility - Pump Facilities - Power Supply	✓ Basrah Water Improvement Project ✓ Price quotation provided by international suppliers for mechanical and electrical equipment ✓ Related past projects in the world	Based on the preliminary design for each water supply facility, preliminary cost was estimated by multiplying the quantity by the unit rate and price escalation, as collected and prepared from the reference information.
Transmission Pipe Brine Discharge Pipe	✓ Basrah Water Improvement Project ✓ Price quotation provided by the local supplier for the other materials	Preliminary cost was estimated by multiplying the quantity by the unit rate per meter.
Reservoir / Elevated Tank	✓ Estimated unit rate for implementing construction works in Iraq	Preliminary cost was estimated based on the estimated unit rate per the capacity.
Pump Facility	✓ Price quotation provided by pump manufacture ✓ Estimated unit rate for implementing construction works in Iraq	Based on the price for the pump facility itself, total construction cost including civil works was estimated by assuming the cost ratio between civil works and M&E works.
Distribution Pipe	✓ Estimated unit rate for implementing construction works in Iraq	Based on the preliminary design for each water supply facilities, preliminary cost was estimated by multiplying the quantity by the unit rate, as collected and prepared from the reference information.
Security for Transportation and the Site	✓ Other related projects in Iraq ✓ Asking for security company for transportation cost from Umm Qasr Port to the site and security during the construction at the site.	Based on the collected information, cost for security is added on the total construction cost.
OM Service (two years after the completion of the construction)	✓ Refer to see the Section 10.2	Two years after the completion of the construction, OM service will be included into the CP-1 for empowerment of the MWD

Work Items	Reference Information	Estimation in the Study
		operating capacity. 20% of total OM cost was added on the cost estimated in the section 10.2 as an administrative cost for the Contractor.

Source: JICA Study Team

(2) Construction cost estimated

Preliminary construction cost for each contract package based on the above methodology was estimated as shown in **Table 10.2**. The detail of the cost estimation for each contract package is shown in Appendix 10.1.

Table 10.2 Preliminary Construction Cost

Contract Package	Construction Amount (JPY)
CP-1: Construction of Samawah Water Treatment Plant	
- General (design, temporary works, survey etc.)	
- Intake facilities	
- Water treatment facilities	
- Pumping station for treated water transmission	
- Main substation in the water treatment plant site	
- Solar power generation system	
- Other facilities (administrative building, warehouse, contractor’s accommodation)	
- Security cost	
- OM service (two years after completion of construction)	
- OM service (from the 3rd year to 5th year after completion of construction)	
CP-2: Installation of External Power Transmission Line To Samawah WTP	
- General (temporary works, survey etc.)	
- Installation of equipment in MOE’s substation	
- Installation of high voltage cable	
CP-3: Installation of Treated Water Transmission Line and Brine Discharge Line	
- General (temporary works, survey etc.)	
- Installation of treated water transmission line	
- Installation of brine discharge line	
- Security cost	
CP-4: Improvement of the Existing Water Distribution System in Urban Area	
- General (temporary works, survey etc.)	
- Installation of distribution facilities	
- Equipment for technical assistance project	
Total	

Note: the above preliminary construction cost will be updated in accordance with the discussion between JICA and implementation agency during their mission, and the amount will not be an indication of the maximum loan amount.

Source: JICA Study Team

10.2 Estimation of the Operation and Maintenance Cost

(1) Methodologies of the estimation

Operation and maintenance (O&M) cost will be required soon after the completion of construction for the water treatment plant, reservoirs, pumping station, and pipelines. **Table 10.3** shows the methodology for the estimation of yearly O&M cost. In addition to the O&M cost, replacement costs especially for electrical and mechanical (M&E) facility (See Section 10.2 for the calculation.) are also put into the project cost which will be required for analyzing the financial viability for the project period around 30-40 years.

Table 10.3 Methodology for Preliminary Operation and Maintenance Cost of Samawah WTP

Expenditure Items	Methodologies of Estimation
Personnel	According to the MWD, average personnel expenditure per day was confirmed. Personnel expenditure was estimated by multiplying the average personnel expenditure by the number of required persons for the new WTP.
Electricity	Annual cost for new WTP or pump operation will be estimated based on the assumed consumption of power multiplied by ID 120/kwh.
Chemical Cost	Estimate from the required amount of chemical at the new WTP and the unit price of each chemical.
Replacement Cost	It is normally known in other developing countries that the RO membrane was replaced every 5-7 years. Other M&E facilities shall be replaced every 15-20 years. For the other civil facilities, it was assumed that the durable life is for 50 years. It means that there is no replacement during the project period.
Disposal of Sludge	Times for disposal were estimated as 4 times per day. The cost was estimated by multiplying with transportation cost per time.
Spare Parts	The cost was estimated as 3% of construction cost for mechanical and electrical facilities.
Others	For application of solar energy, deduction of the energy consumption was taken into account.

Note: Cost for electricity and chemical cost will be a variable cost which will be increased in accordance with the increasing treated volume year by year, while the other cost can be estimated as a fixed cost.

Source: JICA Study Team

(2) O&M cost in the operation on the ultimate design conditions

Based on the methodologies above, O&M cost was estimated as shown in **Table 10.4**.

Among the various cost elements, electricity cost, chemical cost, and sludge disposal cost are variable according to the production volume and raw water quality, while personnel cost, membrane replacement cost, spare parts costs, and depreciation costs are fixed costs which are not variable to the water volume and water quality. The O&M cost in the table is an estimation based on the ultimate design conditions, when the production volume is 81,000 m^3/d and the raw water quality is 3,000 mg/L in TDS and 80 NTU in turbidity.

Table 10.4 Operation and Maintenance Cost of Samawah WTP on the Ultimate Design Conditions

Cost Elements	Annual O&M Cost (USD/Year)	O&M Cost per m^3 (USD/m^3)	Characteristics (Fixed or Variable to Production Volume)
Personnel Cost			
Electricity Cost			
Chemical Cost			
Membrane Replacement Cost			
Sludge Disposal Cost			
Spare Parts Cost			
O&M Cost Without Depreciation Costs			
Depreciation Costs			
Total			

Source: JICA Study Team

(3) Projection of the average O&M costs

In order to project the O&M cost of Samawah WTP in the average conditions, JST presumes the water volume and water quality as well as the solar power generation as shown in **Table 10.5**.

Table 10.5 Operational Conditions for the Average O&M Cost of Samawah WTP

Expenditure Items	Condition
Production Volume	Increase by year as projected in Section 5.11.1
Water Quality	TDS: 2,000 mg/L
	Turbidity: 30 NTU
Solar Power Generation	3,850,000 kWh/year as projected in **Table 5.43**.

Source: JICA Study Team

According to the classification of the cost elements, the O&M cost in the ultimate conditions can be separated into the annual fixed O&M cost and the variable O&M per m^3 of produced water as shown in **Table 10.6**. Based on these costs and the projected production volume[1] of Samawah WTP, the annual O&M cost by year was projected and calculated as shown in **Table 10.7**.

In the cost projection, renewal cost of the major equipment is estimated as 20% of the foreign currency portion of the construction cost of Contract Package-1. It is presumed to be paid 15 years after the commencement of the WTP's operation.

Table 10.6 Estimated O&M Cost of Samawah WTP by Fixed and Variable Elements

Expenditure Items	Fix Cost or Variable Cost	Annual Fixed O&M Cost (USD)	Variable O&M Cost per m^3 (USD/m^3)
Personnel Cost	Fixed		
Electricity Cost	Variable		
Chemical Cost	Variable		
Membrane Replacement Cost	Fixed		
Disposal of Sludge	Variable		
Spare Parts	Fixed		
Total	-		

Source: JICA Study Team

[1] See Section 5.11

Table 10.7 Projection of Annual O&M Cost of Samawah WTP

Year	A. Annual Production (m^3/d)	B. Fixed Cost (USD/y)	C. Variable Cost		D. Saving by Solar Power Generation (USD/y)	E. Total O&M Cost		F. Renewal of Equipment (USD)
			C.1 USD/m^3	C.2 USD/y		E1 = B + C1 x A - D USD/y	E2 = E1 / A USD/m^3	
2029	3,545,232							
2030	22,147,132							
2031	23,045,466							
2032	23,966,976							
2033	24,912,262							
2034	25,881,936							
2035	26,876,627							
2036	27,896,982							
2037	28,943,662							
2038	29,160,000							
2039	29,160,000							
2040	29,160,000							
2041	29,160,000							
2042	29,160,000							
2043	29,160,000							
2044	29,160,000							
2045-2054	29,160,000							

Source: JICA Study Team

10.3 Capital Expenditures (CAPEX) of the Brackish Water RO Desalination Plant

Trend for construction cost of the brackish water RO plant could be illustrated in **Figure 10.1**. The cost information for the brackish water RO has very limited samples; however, the cost range could be identified around [redacted] in case the new WTP plant capacity is 81,000 m^3/d. On the other hand, the estimated cost in the Study is [redacted] as shown in Section 10.1.

The estimated cost in the Study may be regarded as too high compared to the other plant costs shown in the figure but JST deems it is a rational amount at the stage of feasibility study. The reasons are that the cost includes the security cost taking into account the security situations in Iraq, that the amount takes into account the recent price escalation caused by the global situations including the pandemic and the war, and that the prices of other projects in the figure are the contract prices after the bid. The above amount dose not include OM service fee for two years.

Source: Jeffrey L. Pearson, Economics and Energy Consumption of Brackish Water Reverse Osmosis Desalination, Membranes, 2021,11

Figure 10.1 CAPEX of Brackish Water RO Desalination Plant

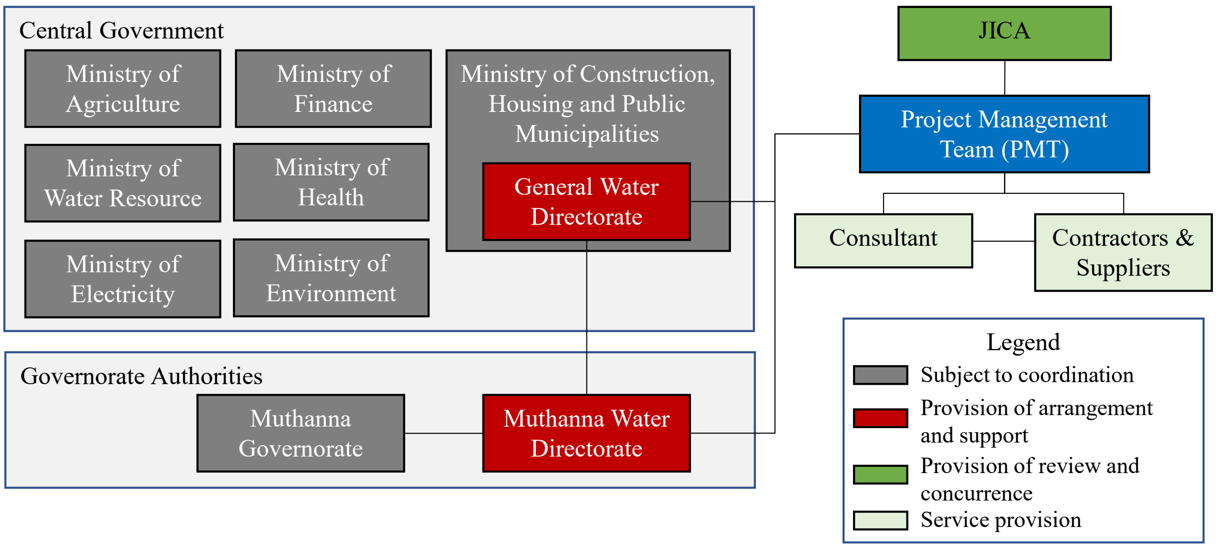
Chapter 11 Project Implementation Plan

11.1 Project Implementation Structure

According to the demarcation scheme between GWD and MWD for the project implementation (refer to Section 3.2.1) and considering the planned capacity of the WTP to be constructed, the responsible entities for the planning, detailed design, and construction of the Project shall be both General Water Directorate (GWD) and Muthanna Water Directorate (MWD), while O&M of the facilities shall be the responsibility of MWD although GWD shall provide technical and financial assistances from time to time in case of emergency such as water shortage event.

Under the arrangement and dispatch of the employees of GWD and MWD, a Project Management Team (PMT) will be created in Samawah, and this PMT will be engaged for the coordination with other relevant ministries of the central government and their branches in Al-Muthanna Governorate, as well as the selection of consultant, contractors, and suppliers/manufacturers. The consultant is presumed to be engaged in the detailed design, preparation of specifications and contract documents, tender assistance, construction supervision, and facilitation to implement the Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) in compliance with the "Guidelines for the Employment of Consultants under Japanese ODA Loans" published in April 2012. JICA will give necessary review and concurrence to the PMT on the occasions stipulated in the "Guidelines for Procurement under Japanese ODA Loans" (JICA Procurement Guidelines) and on any other occasions.

The implementation structure of the Project is shown in **Figure 11.1**.



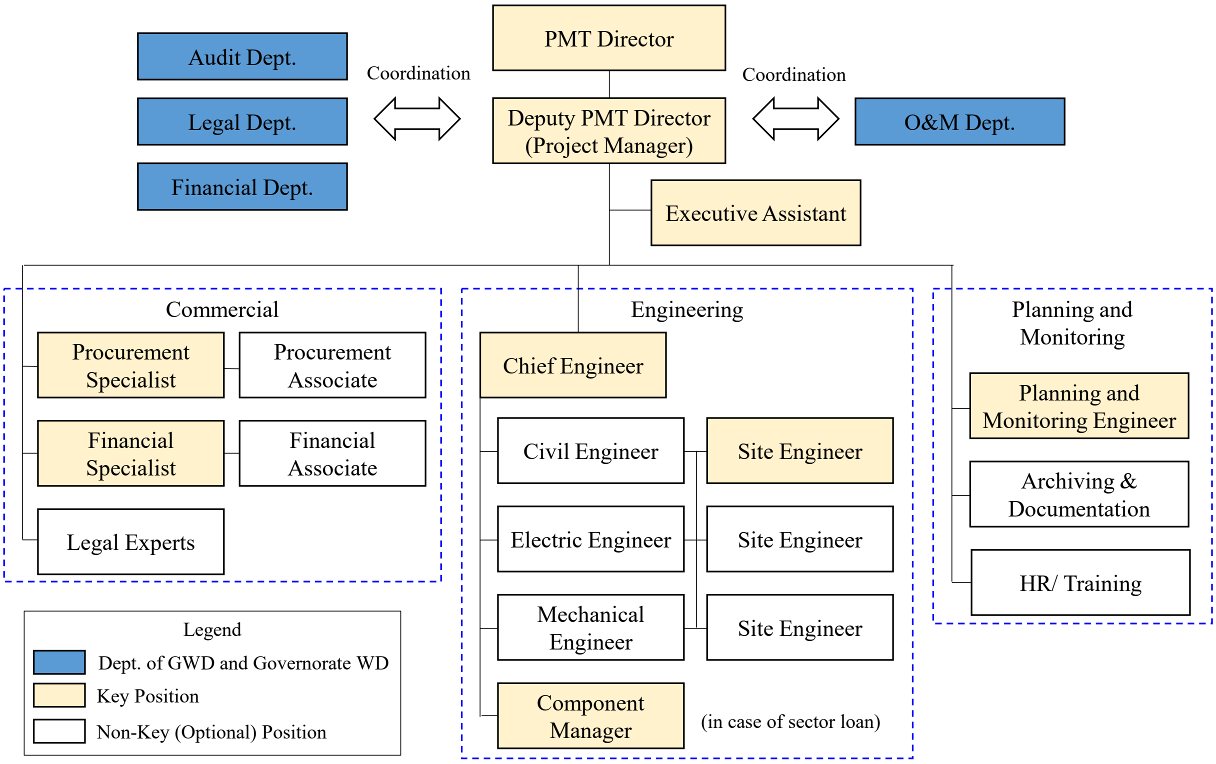
Source: JICA Study Team

Figure 11.1 Project Implementation Structure of the Project

11.2 Project Management Team

(1) Standard organization structure of the PMT

The standard structure of PMT has been established by GWD as shown in **Figure 11.2**, which has been applied to all loan projects in water supply sector by bilateral and international donors such as JICA and World Bank.



Source: MCHPM

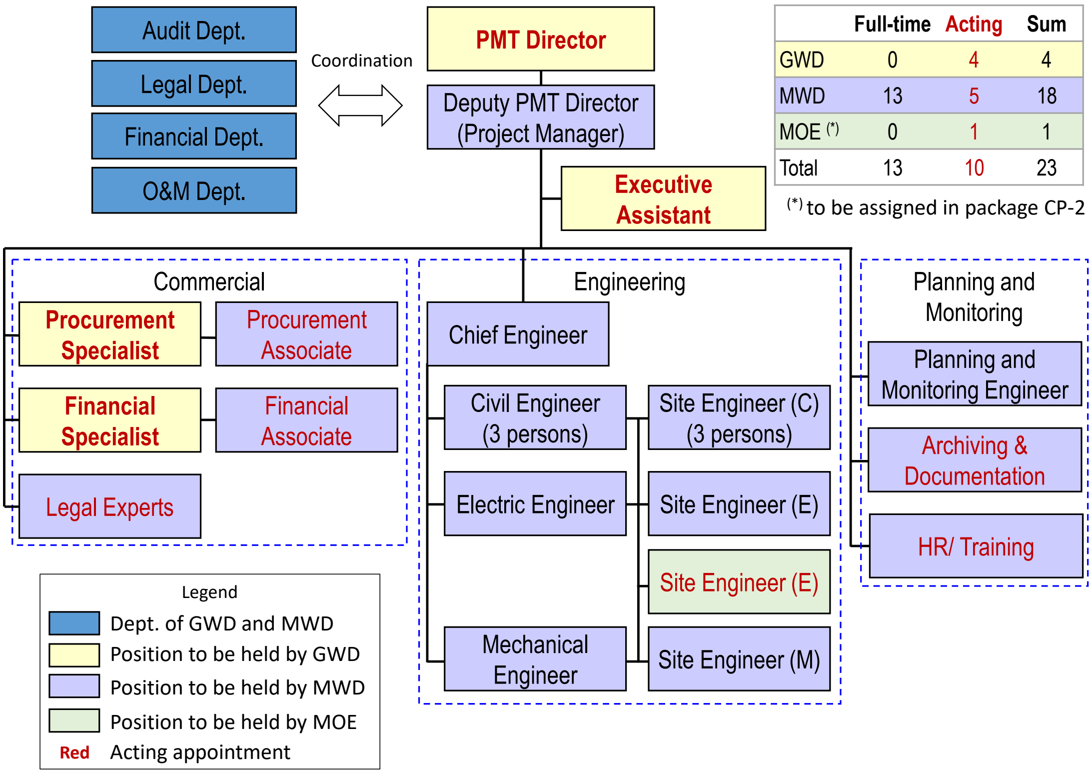
Figure 11.2 Standard PMT Structure Prepared by GWD

(2) Assignment of PMT staff for the Project and allocated tasks

The PMT for the Project is recommended to be established in MWD in Samawah with the participation and support of GWD residing in Baghdad, considering the following: a) large capacity of the facilities to be constructed, b) use of advanced technology such as RO membrane, and c) inclusion of O&M phase in the contract with the contractor in which MWD should be mainly engaged.

Figure 11.3 shows the proposed structure of the PMT for the Project, where the positions to be nominated by GWD, MWD, and MOE are colored yellow, purple, and green, respectively (the personnel from MOE is to be assigned to the contract package LP-2). It should be noted that the component manager specified in the standard PMT structure shown in **Figure 11.2** was deleted since this position is for the sector loan project only.

The proposed staffing plan of the PMT and the assigned task of each position are shown in **Table 11.1**. The head of PMT shall be given the full authority to make necessary decisions about the project implementation, particularly on the procurement issues, supported by the consultant and subject to the review and concurrence of JICA. In total, 23 personnel shall be assigned, of which GWD will assign four personnel while MWD is proposed to assign 18 personnel and MOE is proposed to assign 1 person in the contract package-2 (CP-2).



Source: JICA Study Team

Figure 11.3 Proposed PMT Structure of the Project

Table 11.1 Staffing and Assigned Tasks of PMT

Position	Assigned Tasks	Qualification	Number	Note
PMT Director	・Review and approve the annual work program and budgets for the Project. ・Make final decisions on all key issues of the Project. ・Coordinate with relevant organizations and departments of GWD and MWD. ・Keep communication with JICA.	Senior Manager/ GWD	1	Acting appointment residing in Baghdad
Deputy PMT Director (Project Manager)	・Prepare annual work programs and budgets for the Project. ・Keep control of the expenditure in conformity with the approved programs and budgets. ・Assist PMT Director in commercial, engineering, planning, and monitoring aspects of the Project. ・Act the role of PMT Director as per his/her direction.	Senior Chief Engineer/ MWD	1	Full-time appointment
Executive Assistant	・Assist Project Manager in commercial, engineering, planning, and monitoring aspects of the Project. ・Check the compliance with the rules and regulations in respect of the payment to	Senior Manager/ GWD	1	Acting appointment residing in Baghdad Acting

Position	Assigned Tasks	Qualification	Number	Note
	consultant, contractors, and suppliers.			appointment of experienced person of BWD in desal project is optional.
Procurement Specialist	・Organize the preparation of the bill of quantities (BOQ) and tender documents to procure the design and supervision consultant, contractors, equipment, and materials. ・Manage the evaluation of the submitted tenders.	Chief Engineer/ GWD	1	Acting appointment residing in Baghdad
Procurement Associate	・Assist the preparation of BOQ and tender documents to procure the design and supervision consultant, contractors, equipment, and materials. ・Provide logistical support for the evaluation of the submitted tenders.	Chief Engineer/ MWD	1	Acting appointment
Financial Specialist	・Assist the Deputy PMT Director in preparing annual work program and budgets for the Project from financial aspect. ・Review the bills from contractors and suppliers and approve the payment arrangement prepared by the Financial Associate. ・Consult with JICA on disbursement issues and request the government to release the fund from Treasury.	Senior Accountant/ GWD	1	Acting appointment residing in Baghdad
Financial Associate	・Receive the bills from contractors and suppliers and arrange the payment. ・Maintain the records and files relevant to foreign exchange disbursement.	Assistant Accounts Manager/ MWD	1	Acting appointment
Legal Expert	・Prepare/review contracts, agreements, memorandum of understanding, and any other legal transaction related to the Project. ・Legally check and ensure that the contracts with consultant, contractors, and suppliers are implemented in accordance with the contracts.	Assistant Legal Advisor/ MWD	1	Acting appointment
Chief Engineer	・Assist the Deputy PMT Director in preparing annual work programs and budgets for the Project from technical aspect. ・Review the reports submitted by Engineers and give needed directions for the timely fixing of identified problems in the Project. ・Keep liaison with the consultant and contractors on engineering matters.	Chief Engineer/ MWD	1	Full-time appointment
Civil/ Electrical/ Mechanical Engineer	・Take the initiative in implementing field activities with Site Engineers. ・Participate in the meetings with the consultant on engineering matters.	Chief Engineer/ MWD	C: 3; E: 1; M: 1	Full-time appointment

Position	Assigned Tasks	Qualification	Number	Note
	・Timely report to the Chief Engineer on the progress, emergency, and challenges if any of the Project.			
Site Engineer (Civil/ Electrical/ Mechanical)	・Visit the Project sites and supervise field activities to maintain progress and ensure completion in conformity with the plans. ・Ensure that the quality control systems are adhered to, and the health and safety procedures are complied with by consultant and contractors.	Senior Technical Manager/ MWD and MOE	C: 3; E: 2; M: 1	MWD: Full-time during construction period; MOE: Acting appointment
Planning and Monitoring Engineer	・Assist the Deputy PMT Director in preparing annual work program and budgets for the Project from the aspect of environmental and social consideration. ・Monitor the Project activities in accordance with the JICA Guidelines on Environmental and Social Considerations. ・Keep communication with local stakeholders and timely disclose necessary information related to environmental and social considerations of the Project.	Chief Engineer/ MWD	1	Full-time appointment
Archiving and Documenting	・Collect and systematically document the final versions of design documents and as-built drawings of the Project. ・Register the collected design documents and as-built drawings on the Project computer server in a prescribed digital format.	Senior Technical Manager/ MWD	1	Acting appointment
HR/ Training	・Ensure, plan, and arrange the necessary lectures and on-the-job trainings on the O&M of constructed facilities for the MWD employees in-charge of O&M, in cooperation with the contractors or in accordance with the requirements of the contracts with the contractors.	Assistant Manager/ MWD	1	Acting appointment
Total			GWD: 4 MWD: 18 MOE: 1 Total: 23	・GWD: Full-time 0; Acting 4. ・MWD: Full-time 13; Acting 5. ・MOE: Full-time 0; Acting 1.

Source: JICA Study Team; Note: C: Civil, M: Mechanical, E: Electrical

11.3 Procurement of the Contractors

11.3.1 Procurement for the Similar Project

The Basrah Water Supply Improvement Project is a similar project to the Samawah Water Supply Improvement Project as it constructs a WTP equipped with RO facility and installs pipelines relevant to the WTP. The Basrah Water Supply Improvement Project is being executed with four contract packages as shown in **Table 11.2**.

Table 11.2 Contract Packages in the Basrah Water Supply Improvement Project

Contract Package	Scope of Work	Contract Type
Contract Package-1R (P1R) Construction of Transmission Pipelines	- Transmission Pipe: 500-1,600 mm (DIP) - Length 38 km	Design-Bid- Build
Contract Package-2R (P2R) Construction of Transmission Reservoir and Transmission Pump Station	- Blending chamber - Transmission reservoir - Transmission pump station - Chlorine building - Substation building - Generator building and fuel tank - Guard house - Watch tower	Design-Bid- Build
Contract Package-3 (P3) Construction of Proposed Al Hartha Water Treatment Plant	- Intake - Raw water conveyance pipeline - Pre-treatment for RO system - Clear water connection pipe (D1500/D1200) - Rehabilitation of existing Basrah Unified WTP	Design-Bid- Build
Contract Package-4 (P4) Construction of RO Plant and 132 kV/33 kV GIS Substation	- Water storage tank - RO system - Power supply in the 33 kV substation - SCADA system - Stand-by generator - Staff quarters, Admin building - Boundary wall - Drain water culvert - Domestic wastewater treatment plant	Design-Build

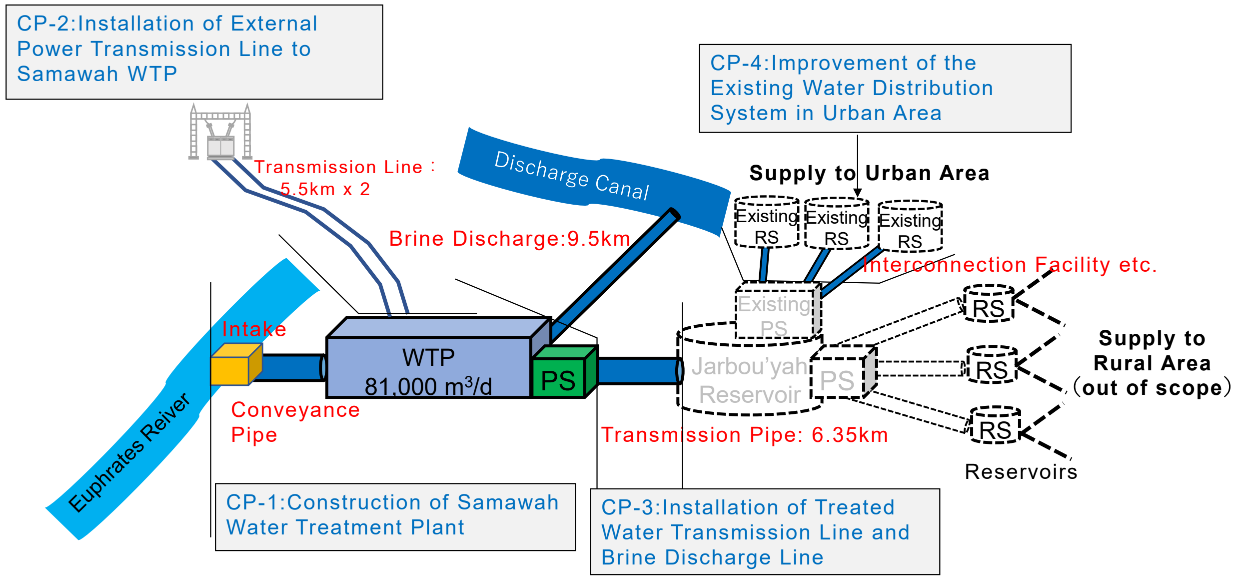
Source: MCHPM

11.3.2 Contract Packaging Plan

Contract packaging shall be determined from the viewpoint of smooth implementation of the Project and quality assurance of the construction taking into consideration the project scale, technical features of each facility, and type of construction work, among others. After the discussions with MCHPM and MWD on the points below, the components of the Project were classified into four contract packages as shown in **Figure 11.4** and **Table 11.3**.

- Water treatment plant including intake, pre-treatment, and RO facility shall be in one package so that a single contractor would have the responsibility to design and construct all facilities based on the best solutions in terms of quality and cost, with guarantee on the overall performance of the treatment plant. It can also be expected to have bidders who specialize in the construction of plant by making one package.

- Dividing the WTP into multiple packages may require complicated coordination in terms of technical specification, construction schedule, allocation of work site, among others. It may also make the responsibility for the plant performance among the contractors unclear.
- The power supply to the WTP will be supplied from the Ministry of Electricity's (MOE) substation to the WTP's power receiving facility. Due to the special nature of the construction, the installation of the high voltage power transmission system to the WTP needs to be implemented by a contractor designated by MOE. Therefore, it will be prudent to let MOE select the contractor under an independent contract package from the WTP package. If the power transmission is included in the WTP package, several concerns are anticipated as follows:
  - The contractor will need management cost on the subcontract with the designated contractor by MOE. It may include some cost risks due to delay or default that may be caused by some reasons not controllable by the contractor. Such incremental price is not beneficial to MCHPM.
  - The requirement to have a designated contractor by MOE as subcontractor may discourage oversea contractors from bidding.
- Both transmission pipe and brine discharge pipe will require crossing of the Euphrates River. Therefore, it is wise that both pipelines will be implemented in the same contract.
- The construction of the WTP, the installation of power transmission lines, and installation of treated water transmission line will enable the WTP to send the treated water to the existing Jarbou'yah pumping station, and the existing water distribution system after the pumping station will be able to deliver water to the users in the present service areas even without completion of the Project's component in the water distribution system in the urban areas to improve the current functions. Also, the expansion of the water transmission and distribution system to the rural area is not yet clear in the project scope. Therefore, it is not desirable to combine any work in the upstream of the Jarbou'yah pumping station with any work in the downstream works.in a same contract package.
- MWD has not yet developed a specific water supply plan for the rural areas. The facility plan proposed in the Study is a provisional one. Therefore, the scope of the expansion of the water transmission and distribution network to the rural areas has a variety of uncertainties and it turned out that it was difficult to well define the measures to be taken for environmental and social considerations including the land acquisition matters. Thus, the water transmission and distribution facilities to rural areas will not be included in the scope of the Project and is assumed to be implemented by Iraq's competent authorities by their own expenses.



Source: JICA Study Team

Figure 11.4 Interfaces of the Contract Packages of the Project

Table 11.3 Contract Packages and Scope of Work of the Project

Contract Package	Scope of Work	Remarks
Contract Package-1 (CP-1) Construction of Samawah water treatment plant	- Intake facility - Pre-treatment facility - RO facility - Pumping station for treated water transmission - Main substation in the water treatment plant site - Solar power generation system - O&M services for five years	Contract type will be design-build.
Contract Package-2 (CP-2) Installation of external power transmission line to Samawah water treatment plant	- Installation of equipment in MOE's substation - High voltage power cable	Entrustment of design and construction to MOE.
Contract Package-3 (CP-3) Installation of treated water transmission line and brine discharge line	- Treated water transmission line (6.35 km) - Brine discharge line (9.5 km)	Contract type will be design-bid-build.
Contract Package-4 (CP-4) Improvement of the existing water distribution system in urban area	- Equipment of control and monitoring equipment such as valves and water meters	Contract type will be design-bid-build.

Source: JICA Study Team

11.3.3 Procurement Method and Contract Type

(1) Procurement rules to be applied

When a project is implemented under JICA's ODA loan, the contractor(s) shall be procured in accordance with the "Guidelines for Procurement under Japanese ODA Loans (April 2012)" (hereinafter referred to as the "JICA Procurement Guidelines"). As indicated in (5) of this sub-section, JICA's Standard Bidding Documents are applied to the tender.

(2) Pocurement process

Among the contract packages proposed above, international competitive bidding (ICB) will be adopted to CP-1 and CP-3, while local competitive bidding (LCB) will be adopted for CP-2 and CP-4 considering the characteristics of each contract package.

The ICB package shall use the standard bidding documents of JICA and LCB packages can use the local format of the bidding documents if agreed by JICA.

Pre-qualification (PQ) procedure shall be taken prior to the bidding to procure the appropriate contractor and to achieve the general implementation schedule of the Project. The executing agency of the Project (MCHPM) will ask PQ applicants about the following: 1) Experience of similar project, 2) Capability of the contractor such as number of staff and equipment, and 3) Financial situation.

(3) Entrustment to MOE for CP-2

As for CP-2, the Study presumes that MCHPM will entrust the design and construction to MOE.

(4) Contract type

Contract type of CP-1 will be design-build (DB) to fully utilize the special contractor's know-how for the good quality of the Project and minimum life cycle cost. DB was applied to the RO facility in CP-4 of Basrah Water Supply Improvement Project.

Regarding the other contract packages, excluding CP-2 that will be entrusted to MOE, design-bid-build contract, where MCHPM will execute the detailed design.

Table 11.4 summarizes the procurement method and contract type of the Project by contract package.

Table 11.4 Consultant's Works for Each Contract Package

Contract Package	Procurement Process	Contract Type
CP-1: Construction of Samawah water treatment plant	International Competitive Bidding (ICB)	Design-Build
CP-2: Installation of external power transmission line to Samawah water treatment plant	Local Competitive Bidding (LCB)	Entrustment of design and construction to MOE
CP-3: Installation of treated water transmission line and brine discharge line	International Competitive Bidding (ICB)	Design-Bid-Build
CP-4: Improvement of the existing water distribution system in urban area	Local Competitive Bidding (LCB)	Design-Bid-Build

Source: JICA Study Team

(5) JICA's standard bidding documents

Table 11.5 shows JICA's standard bidding documents that are applied to ICB contract packages under JICA's ODA loan. JST proposed to apply "Design Build" to CP-1. "Plant" is also applicable but "Design-Build" will be more preferable as its contract conditions use the International Federation of Consulting Engineers (FIDIC), which all international contractors are familiar with. To CP-3 "Works" will be applied.

To the other contract packages of LCB, the local bidding documents can be applied if JICA agrees. However, as shown in the table below, application of JICA's standard bidding documents may be applied to CP-4 to reduce the risk of the project's delay due to conflict with the contractors. On the other hand, JICA's standard bidding documents are obviously not applicable to CP-2, which will be the entrustment between the ministries.

Table 11.5 Type of Standard Bidding Document Applicable to the Project

Type (version)	Conditions of Contract	General Application	Application in the Project
Works (October 2019)	FIDIC*1: Red MDB Version (Pink Book)	To general civil works including pipe installation, construction of reservoirs	May be adopted to CP-3, CP-4 and CP-5
Plant (May 2021)	ENAA*2 Standard Form	To design and build for plant construction including WTP	-
Design Build (May 2021)	FIDIC*1: Plant and Design Build (Yellow Book)	To design and build for plant construction including WTP	Adopted to CP-1
Procurement of Goods (May 2021)	No specific contract conditions	To procurement of goods	-
Small Works (May 2021)	No specific contract conditions	To small civil works whose price is less than JPY 1 billion	May be adopted to CP-4

*1: FIDIC: International Federation of Consulting Engineers

*2: ENAA: Engineering Advancement Association of Japan

Source: JICA Study Team

11.3.4 Procurement of Consultant

The procurement of the consultants will be implemented in accordance with the "Guidelines for the Employment of Consultants under Japanese ODA Loans (April 2012)". Consultants are usually selected through competitive bidding from the shortlisted consultants by the executing agency. In the Project, the consultants will implement mainly the following: 1) Detailed design, 2) Tender assistance, and 3) Construction supervision. It is assumed that the consultants will implement the work for each contract package as shown in **Table 11.6**.

In addition to the services in the table, the consultant may implement the consulting services for the technical assistance proposed in Section 7.4.3.

Table 11.6 Consultant's General Scope of Work by Contract Package

Contract Package	Conceptual Design	Detailed Design	PQ Assistance	Tender Assistance	Construction and Procurement Supervision
CP-1: Construction of Samawah water treatment plant	✓	-	✓	✓	✓
CP-2: Installation of external power transmission line to Samawah water treatment plant	✓*	-	-	✓*	✓*
CP-3: Installation of treated water transmission line and brine discharge line	-	✓	✓	✓	✓
CP-4: Improvement of the existing water distribution system in urban area	-	✓	✓	✓	✓

*: The consultant services for CP-2 are presumed to include i) preparation of basic requirement to MOE as conceptual design, ii) technical advices to MCHPM in the contract discussions with MOE as tender assistance, and iii) monitoring of the construction's progress and coordination on the interfaces with CP-1.

Source: JICA Study Team

11.4 Affairs to be Executed by the Executing Agencies

Through the information collection and the analyses, JST proposes that the Project's executing agencies, which are MCHPM and MWD, would carry out the activities shown in **Table 11.7** for the smooth and efficient implementation of the Project and enhancement of the Project's effects.

Table 11.8 shows the specifications of the water quality monitoring of the Euphrates River at the intake point of Samawah WTP proposed in **Table 11.7**.

Table 11.7 Affairs to be Executed by MCHPM and MWD

No.	Activities	Actor	Timing	Objectives / Remarks
1	Water quality monitoring of the Euphrates River at the intake point of Samawah WTP	MWD	Periodically since March 2022 until preparation of the bid documents	- To enhance the accuracy of the technical specifications of CP-1. - See **Table 11.8** for the specifications of the survey.
2	Preparation of the inventory map of the existing water transmission and distribution networks	MCHPM/ MWD	By the preparation of the TOR of the consulting services	- To implement the Project efficiently and correctly - See point 7 in **Table 14.1***1 for the background of the proposal.
3	Security and monitoring of the site for the Samawah WTP	MWD	Continuously until commencement of the work by the contractor of CP-1	- To avoid conflict with the neighborhoods - See point 1 in **Table 14.1***1 for the background of the proposal.
4	Establishment of the PMT	MCHPM	By commencement of the TOR of the consulting services	- To implement the Project in an efficient and consistent manner from the beginning. - See Section 11.2 for PMT's organization.
5	Clarification of the tax exemption procedure to be taken by MCHPM, the consultant, and the contractors	MCHPM	By the preparation of the TOR of the consulting services	- To present clear information about the tax exemption before the financial proposal by the consultant and the contractors - To avoid tax problem not attributed to the consultants and contractors . - See Section 11.7 for the tax exemption anticipated in the Project.
6	Prioritization of the expansion of the water network and water meter installation in Samawah District	MCHPM	Continuously	- To enhance the Project's effects. - See Point 8 in **Table 14.1***1 for the background of the proposal. - The expansion shall be executed not only in the urban areas but also in the rural areas*3.
7	Implementation of the customer satisfaction survey for post-evaluation of the Project	MCHPM/ MWD	2 years after the Project's completion	- To measure the impact of the Project. - See Point 4 in **Table 13.2***2 for indicators concerned.

*1 : Table 14.1 Summary of Risk Assessment on the Project
*2 : Table 13.2 Effect Indicators of the Samawah Water Supply Improvement Project
*3 : It should be noted that the capacity of Samawah WTP takes into account the water demand in the rural areas.
Source: JICA Study Team

Table 11.8 Plan of the Water Quality Monitoring to be Executed by MWD for CP-1

No.	Items	Onsite	Laboratory
1	Turbidity, Electro-Conductivity(EC)	Every two weeks	Every month
2	Temperature, pH value		-
3	Boron(B), Calcium(Ca), Chloride(Cl)	-	Every two weeks or

No.	Items	Onsite	Laboratory
4	TDS, Magnesium(Mg), Silica(SiO2), Sulfate(SO_4)		Every month
5	Aluminum(Al), Ammonia Nitrogen, Barium(Ba)		Every month
6	Bicarbonate(HCO_3), Carbonate(CO_3), Evaporation residue		
7	Fluoride(F), Iron(Fe), Manganese(Mn)		
8	n-hexane Extracts, Nitrate(NO_3), Phosphate(PO_4)		
9	Potassium(K), SDI15, Sodium(Na), Strontium(Sr)		
10	Total Hardness, Total organic carbon (TOC)		
11	Antimony(Sb), Arsenic(As), Cadmium(Cd)		Every two months
12	Color, Copper(Cu), Cyanide(CN), Escherichia coli		
13	General bacteria, Hexavalent chromium(Cr), Lead(Pb)		
14	Mercury(Hg), Molybdenum(Mo), Nickel(Ni), Nitrite(NO2)		
15	Selenium(Se), Total Alkalinity, zinc(Zn)		

Source: JICA Study Team

11.5 Project Schedule

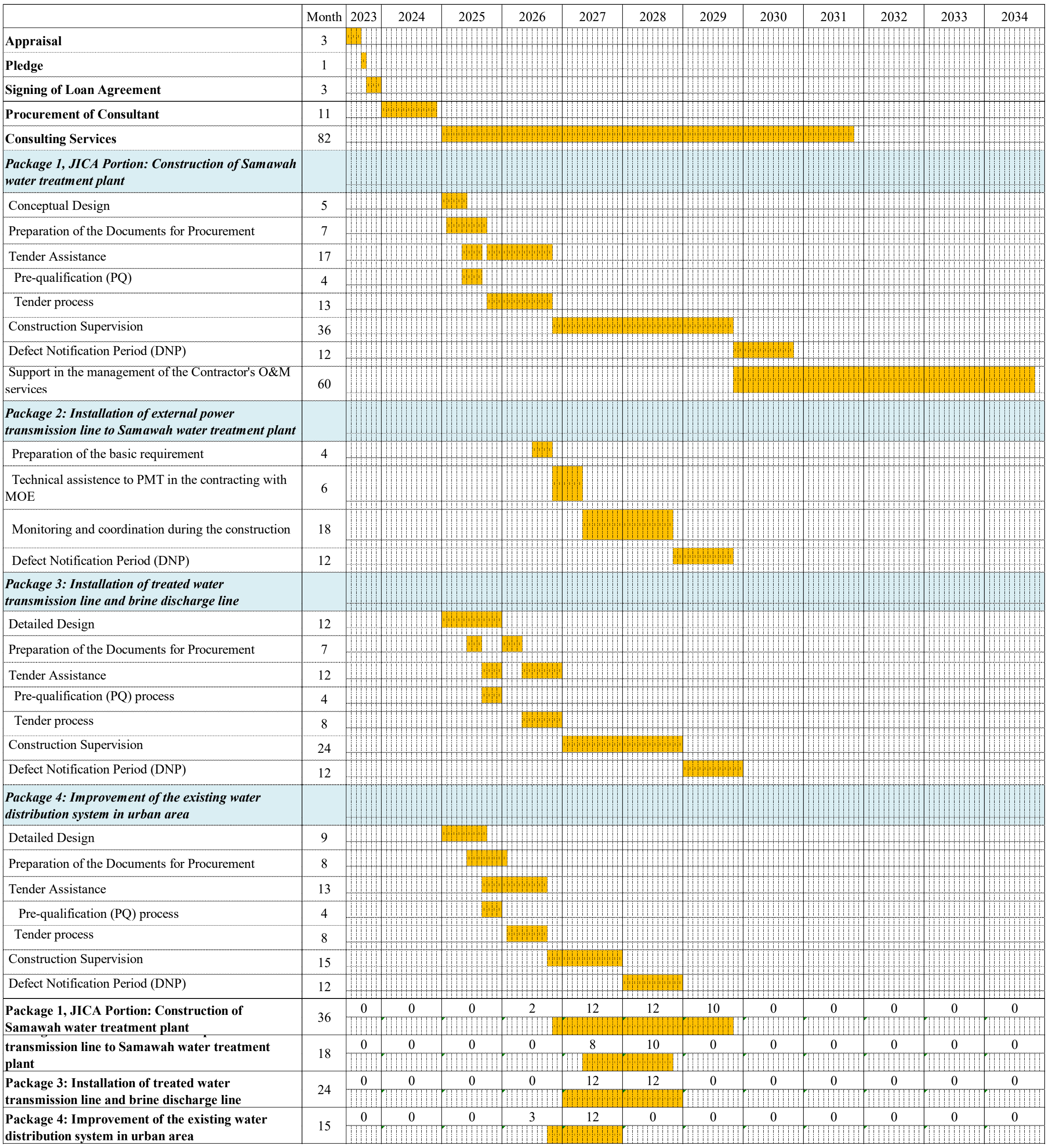
Table 11.9 and **Figure 11.5** show the schedule of the Project on condition that the loan agreement is extended. The detailed schedule is given in **Appendix 11.1**. Key considerations in the scheduling are listed below.

- Procurement procedure of the consultant was presumed to start after the loan agreement, while it can be started when the Government of Japan (GOJ) gives pledge to the loan. After the request for proposal is prepared, the procurement procedure may need eight months until the contract signing.
- CP-1, CP- 3 and CP-4 are presumed to implement pre-qualification (PQ) procedure. Necessary durations for the PQ procedure as well as the tender process until the contract signing are presumed as shown in **Table 11.10**.
- Construction periods of the contract packages were estimated in Section 6.6. In addition, the Defects Liability Period (DLP) will be 12 months in all contract packages.
- CP-2 is presumed to be completed 12 months before the completion of CP-1 so that the electricity would be provided during the test operation of the major equipment.
- CP-3 must be completed before the commencement of the commissioning of CP-1.
- CP-4 shall be completed before the completion of the commissioning of CP-1 to maximize the Project effects.
- After completion of the commissioning of CP-1, the Contractor will provide O&M services for five years.

Table 11.9 Durations and Periods of the Activities in Samawah Water Supply Improvement Project

Project Activities		Duration	Period Anticipated
Procedure of Loan Agreement (LA)	Pledge	1 month	Sep. 2023
	Exchange of Notes, LA	3 months	Oct. 2023 – Dec. 2023
Procurement of the Consultant	Request for Proposal, Shortlist, Tender, Tender evaluation, Contract	11 months	Jan. 2024 – Nov. 2024
Consulting Services	Design, Preparation of PQ documents, Preparation of bid documents, Tender assistance, Construction supervision, Soft component (technical assistance)	82 months	Jan. 2025 – Oct. 2031
Pre-qualifications	CP-1	4 months	May 2025 – Aug. 2025
	CP-3	4 months	Sep. 2025 – Dec. 2025
	CP-4	4 months	Sep. 2025 – Dec. 2025
Tenders	CP-1	13 months	Oct. 2025 – Oct. 2026
	CP-2	6 months	Nov. 2026 – Apr. 2027
	CP-3	8 months	May 2026 – Dec. 2026
	CP-4	8 months	Feb. 2026 – Sep. 2026
Construction	CP-1	36 months	Nov. 2026 – Oct. 2029
	CP-2	18 months	May. 2027 – Oct. 2028
	CP-3	24 months	Jan. 2027 – Dec. 2028
	CP-4	15 months	Oct. 2026 – Dec. 2027
Defects Liability Period (DLP)	CP-1	12 months	Nov. 2029 – Oct. 2030
	CP-2	12 months	May. 2029 – Oct. 2028
	CP-3	12 months	Jan. 2029 – Dec. 2029
	CP-4	12 months	Jun. 2027 – Dec. 2028
O&M Services of CP-1		60 months	Nov. 2029 – Oct. 2034

Source: JICA Study Team



Source: JICA Study Team

Figure 11.5 Implementation Schedule of Samawah Water Supply Improvement Project

Table 11.10 Duration of the Procurement Procedures

Procedure	Contract Package	Step	Duration of Each Step	Overall Duration
Pre-qualification	CP-1, CP-3 CP-4	Advertising	2 months	4 months
		Evaluation	1 month	
		JICA's concurrence	1 month	
Tender	CP-1	Advertising	5 months	13 months
		Technical evaluation	2 months	
		JICA's concurrence on the technical evaluation	1 month	
		Financial evaluation	1 month	
		JICA's concurrence on the financial evaluation	1 month	

Procedure	Contract Package	Step	Duration of Each Step	Overall Duration
		Contract negotiation	2 months	
		JICA's concurrence on the signed contract	1 month	
	CP-2, CP-3, CP-4	Advertising	2 months	8 months
		Technical evaluation	1 month	
		JICA's concurrence on the technical evaluation	1 month	
		Financial evaluation	1 month	
		JICA's concurrence on the financial evaluation	1 month	
		Contract negotiation	1 month	
		JICA's concurrence on the signed contract	1 month	

Source: JICA Study Team

11.6 Financial Plan

11.6.1 Possible Conditions of the Loan

The Study is to provide JICA with information for its appraisal on the validity of provision of Japan's ODA loan to the Project. According to the classification of recipient countries by income categories issued by JICA as of April 2023, Iraq is categorized as an "Upper-Middle-Income Countries and Uppermost-Middle-Income Countries". The percentage of the provided loan amount out of the total project cost is determined by JICA at a maximum of 85% for the above country categorization, and the rest of the cost should be shouldered by the budget of the Government of Iraq (GOI).

The options of loan conditions for the above category are summarized in **Table 11.11**. On repayment period and grace period, there are four options for the fixed rate case and five options for the floating rate case. If the floating rate is selected, the interest rate will change every six months depending on the Tokyo Term Risk Free Rate (TORF).

The currency of the loan is basically JPY, but USD could be selected if the GOI prefers.

The applied conditions explained above will be discussed and determined between GOI and JICA.

Table 11.11 General Conditions of JICA ODA Loan for the Upper-Middle-Income Countries and Uppermost-Middle-Income Countries

Terms	Option	Interest Rate		Repayment Period	Grace Period
		Fixed	Floating		
General Terms	Longer Option	-	TORF + 130 bp	40 years	10 years
	Standard	2.30%	TORF + 110 bp	30 years	10 years
	Option 1	2.15%	TORF + 100 bp	25 years	7 years
	Option 2	1.95%	TORF + 90 bp	20 years	6 years
	Option 3	1.70%	TORF +860 bp	15 years	5 years

* TORF: Tokyo Term Risk Free Rate (6 months)

Source: Terms and Conditions of Japanese ODA Loans for Upper-Middle-Income Countries and Uppermost-Middle-Income Countries (Effective from April 1, 2023, JICA)

11.6.2 Project Cost and Disbursement Schedule

Table 11.12 and **Table 11.13** show the project cost and annual disbursement schedule, respectively. The overall project cost was estimated at JPY 55.9 billion (IQD 548,568 million), of which the loan amount may be JPY 45.9 billion (IQD 449,970 million).

As the loan amount must not exceed 85% of the overall project cost, the Study presumed that the costs of CP-1's O&M services for the 3rd to the 5th years and all construction costs of CP-2 and CP-3 will be implemented by Iraqi government's finance as shown in **Table 11.4**. The expansion of the water transmission and distribution network to the rural areas, which were planned in Chapter 5, were not taken into account in the project cost as this expansion work is not included in the Project.

Table 11.12 Project Cost by Item

Source: JICA Study Team

Table 11.13 Annual Disbursement Schedule

(Unite: Million JPY)

Source: JICA Study Team

Table 11.14 Finance Sources of the Project Presumed in the Study

Contract Package		Procurement method	Finance sources presumed in the Study
CP-1	Construction of Samawah water treatment plant	ICB	JICA ODA Loan
	O&M services-1: the 1st and 2nd years		
	O&M services-2: the 3rd to 5th years		Iraqi government's finance
CP-2	Installation of external power transmission line to Samawah water treatment plant	LCB	Iraqi government's finance
CP-3	Installation of treated water transmission line and brine discharge line	ICB	Iraqi government's finance
CP-4	Improvement of the existing water distribution system in urban area	LCB	JICA ODA Loan

Source: JICA 調査団

11.6.3 Financial Management

11.7 Tax Exemption

During the project implementation, tax (income tax, VAT, others) and custom duty are expected to be exempted as approved by the Council of Ministers, MOF, and MOP. To obtain the approval, the implementing agency needs to send request to MOP and MOF with the project scope, loan conditions, contract outline, and import goods before the Project starts.

In the Republic of Iraq, several projects funded by JICA ODA loan were implemented. In the case of the Basrah Water Supply Improvement Project (Phase I and Phase II), the consulting company was exempted from tax. Regarding the construction phase, tax, and custom duty, exemptions were granted only to the Japanese contractor and it took a long time for other companies (suppliers, etc.), who are not the contractor with MCHPM, to get approval. Therefore, to avoid the confusion and delay of approval, all the entities and import goods which can obtain the right of tax and custom duty exemption should be clearly described in the related documents of the loan.

Chapter 12 Economic and Financial Analyses

12.1 Methodologies and Conditions

The financial situation during the project period was analyzed and evaluated by simulating financial models. The financial analysis calculated the financial internal rate of return (FIRR) of the Project by using revenue, subsidies, and financial costs. Moreover, economic analysis evaluated the social and economic validity of the Project by calculating the economic benefits and costs of the "With" and "Without" cases of the Project and then by calculating the economic internal rate of return (EIRR).

Economic and financial analyses were conducted based on the following conditions as shown in **Table 12.1**.

Table 12.1 Conditions of Economic and Financial Analysis

Item	Conditions	Remarks
Project Period	2026-2054	Construction period: 2026-2029 (4 years), Operation period: 2029-2054 (26 years)
Price Level Year	2022	
Physical Contingency	20%	Construction and Consultant
Exchange Rate	USD 1=IQD 1,300 USD 1=JPY 133 IQD 1=JPY 0.102	-
Social Discount Rate	6%*	It is used for economic analysis.

Source: JICA Study Team, JICA (2022) "General Guideline, November 2022", *JICA (2015) "Master Plan Study for Port Sector in the Republic of Iraq"

The social survey was conducted in the Study. The results of Affordability to Pay (ATP) and costs of alternative water sources are used in economic analysis. Calculation results of ATP (IQD 767/m^3) are explained in Sub-section 3.4.5 (3).

12.2 Financial Analysis

12.2.1 Financial Costs

(1) Capital investment costs

The following costs are calculated in the financial analysis: i) direct construction cost, ii) administration cost, iii) consulting service cost, and iv) physical contingency. Transfer payment (subsidies) is included in the financial analysis. The financial costs of capital investment are shown in **Table 12.2**.

Table 12.2 Financial Costs of Capital Investment

Source: JICA Study Team

(2) Operation and maintenance costs

The annual operation and maintenance (O&M) costs and renewal costs are shown in **Figure 12.1**[1]. O&M costs from 2029 to 2034 are included in the above capital investment costs. Major equipment's renewal cost is taken into account in 2044, which is 15 years after commencement of the operation of the water treatment plant. Residual value in 2054 is shown in **Table 12.3**. Details of depreciation is shown in **Appendix 12.2**.

Source: JICA Study Team

Figure 12.1 O&M Costs and Renewal Costs of the Project

[1] See Table 10.7 in Section 10.2 for calculation of the O&M cost used in the financial and economic analyses.

Table 12.3 Residual Value in 2054 of the Assets by the Project

Source: JICA Study Team

12.2.2 Revenues and Subsidies

Revenues of the Project are tariff revenue and subsidies from the central government to the Muthanna Water Directorate (MWD). The tariff revenue is calculated by the water tariff and the water sales volume. The subsidies will be provided so that the O&M cost of the Project will be secured.

(1) Assumptions on the water tariff

As it was obvious that the current tariff is not sufficient to cover the project cost, the analysis presumed various several scenarios on the tariff increase as shown in **Table 12.4**. The scenarios presumed are:

- Case 1: No Tariff Increase Case
- Case 2: Tariff Increase Every Five Years at 25%
- Case 3: Tariff Increase Every Five Years at 50%
- Case 4: Tariff Increase to ATP in 2031 and Every Five Years at 10%

As the ATP (IQD 767/m^3) is much higher than the current tariff (IQD 120/m^3), it is evaluated that the tariff increase will be socially tolerable but can take place only every five years taking into account the period for the government's decisions and procedures. According to such a tariff increase at 25%, the final tariff in 2054 (IQD 366/m^3) may be affordable by 2051, which is 29 years since the social survey.

Case 4 is the most aggressive case, where the government may increase the tariff to the current ATP level by 2031 and then continue to gradually increase at 10% every five years.

Table 12.4 Presumed Tariff of Water Consumption

Case	Item	2029-2030	2031-2035	2036-2040	2041-2045	2046-2050	2051-2054
Case 1	Average Price of Water (IQD/m^3)	120	120	120	120	120	120
	Tariff Increase Rate	-	0%	0%	0%	0%	0%
Case 2	Average Price of Water (IQD/m^3)	120	150	188	234	293	366
	Tariff Increase Rate	-	25%	25%	25%	25%	25%
Case 3	Average Price of Water (IQD/m^3)	120	180	270	405	608	911
	Tariff Increase Rate	-	50%	50%	50%	50%	50%
Case 4	Average Price of Water (IQD/m^3)	120	720	792	871	958	1,054
	Tariff Increase Rate	-	500%	10%	10%	10%	10%

Source: JICA Study Team

(2) Projection of water sales volume

Projection of water sales volume by the Project was explained in Section 5.11.

(3) Assumptions on the subsidies

On the subsidies, the other elements in the project's revenue, the financial analysis presumed that the government would provide MWD with the subsidies so that they would cover the O&M costs and renewal costs of equipment. According to the variant cases for the tariff increase, the amounts of the subsidies were also estimated in four cases as shown in **Table 12.5 to Table 12.8**. Since tariff does not increase in Case 1, subsidies are the most expensive in all cases. Those in Case 4 are the lowest in all cases.

Table 12.5 Presumed Evolution of the Subsidies (Case 1)

Source: JICA Study Team

Table 12.6 Presumed Evolution of the Subsidies (Case 2)

Source: JICA Study Team

Table 12.7 Presumed Evolution of the Subsidies (Case 3)

Source: JICA Study Team

Table 12.8 Presumed Evolution of the Subsidies (Case 4)

Source: JICA Study Team

12.2.3 Results and Evaluation

Cashflow of financial analysis is shown in **Appendix 12.1**. The FIRR and Net Present Value (NPV) were calculated for Cases 1 to 4 as shown in **Table 12.9**.

Table 12.9 FIRR and NPV of the Project

Source: JICA Study Team

12.3 Economic Analysis

12.3.1 Economic Costs

(1) Capital investment costs

The following costs to be estimated in the Study was used in the economic analysis: i) direct construction cost, ii) administration cost, iii) consulting service cost, and iv) physical contingency. Price contingency and transfer payment (tax and subsidies) are excluded from the economic costs. Standard conversion factor (SCF) is used to convert financial (market) prices to economic prices. SCF 0.85, which is used for economic analysis in Iraq[2], was applied. The economic costs of capital investment are shown in **Table 12.10**.

Table 12.10 Economic Costs of Capital Investment of the Project

Source: JICA Study Team

(2) Operation and maintenance costs

Figure 12.2 shows the O&M costs and renewal costs of the Project adopted in the economic analysis. These costs were estimated in Section 10.2. O&M costs from 2029 to 2034 are included in the above capital investment costs. Equipment's renewal cost is IQD 22,880 million[3] in 2044.

[2] JICA (2015) "Master Plan Study for Port Sector in the Republic of Iraq"
[3] See Section 10.2.

Source: JICA Study Team

Figure 12.2 O&M Costs and Renewal Costs of the Project

12.3.2 Economic Benefit

Economic benefits of the Project are (1) benefit of increased water, (2) benefit of reduction of alternative water costs, and (3) benefit of decrease of water related diseases by continuous supply of potable water of good quality to more residents.

(1) Benefit of increased water consumption

The Project will increase the water consumption at the price of the beneficiaries' ATP for the water service. Since the WTP (IQD 233/m^3) is extremely low compared with the ATP (IQD 767/m^3), WTP is not regarded as appropriate for the price of water for benefit calculation. The annual sales of water volume of the Project is shown in **Table 12.11**.

Annual benefit of increased water is calculated as follows:

Annual benefit of increased water (IQD/year) = Annual sales of water volume (m^3/year)
x ATP (IQD 767/m^3)

Table 12.11 Annual Sales Water Volume of the Project

Unit: m^3/year

2029	2030	2031	2032	2033	2034	2035
2,112,062	13,285,392	13,914,226	14,559,283	15,220,983	15,899,755	16,596,039
2036	2037	2038	2039	2040	2041-54	
17,310,287	18,042,963	18,794,542	19,565,512	20,412,000	20,412,000	

Source: JICA Study Team

(2) Benefit of reduction of alternative water costs

By having improved piped water services being realized by the Project, the residents will save the cost for water by avoiding or reducing the usage of other water sources. The benefit of such a reduction of alternative water costs of the Project is estimated as the current cost of alternative water sources. The beneficiaries of the Project will use alternative water sources in the "Without-Project" case. Therefore, the Project will reduce the costs which would be spent on those alternatives.

JST conducted the social condition survey, which included a questionnaire regarding alternative water costs without the Project. According to the survey results, average monthly payments for the alternative water sources, which are private vendors and pet bottles, were IQD 14,760/household and IQD 15,803/household.

The economic analysis presumed that the usage of private vendor will not be necessary any more and that the pet bottles purchases will be reduced by 90%, if residents receive improved water continuously from MWD after the Project. Since daily average water usage per household for private vendors and 90% of pet bottles is 993 L/month/ household, and that per capita is 5.2 Lpcd as shown in **Table 12.12**, average cost of alternative water sources is IQD 29,201/m^3. The number of potential beneficiaries is shown in **Table 12.13**. Registration ratio to the piped water is estimated as shown in **Table 12.14**.

Table 12.12 Daily Average Water Usage per Capita for Private Vendors and 90% of Pet Bottles

Daily Average Water Usage for Private Vendors	Daily Average Water Usage for Pet Bottles	Daily Average Water Usage for Private Vendors + Pet Bottles x 90%	Daily Average Water Usage Per Capita for Private Vendors + Pet Bottles x 90%
403 L/month/household	655 L/month/household	993 L/month/household	(933 L/30 days)/ 6.4 people =5.2 Lpcd

Source: JICA Study Team

Table 12.13 Number of the Potential Beneficiaries of the Project

Unit: people

2029	2030	2031	2032	2033	2034	2035	2036	2037
397,180	408,271	419,362	430,454	441,545	452,636	463,727	476,325	488,922
2038	2039	2040	2041	2042	2043	2044	2045	2046
501,520	514,118	526,715	541,024	555,333	569,642	583,950	598,259	614,511
2047	2048	2049	2050	2051	2052	2053	2054	
630,764	647,016	663,268	679,521	694,098	708,676	723,253	752,408	

Note: The numbers are based on the population forecast for Samawah District presented in Table 5.11.

Source: JICA Study Team

Table 12.14 Registration Ratio to Piped Water

2029	2030	2031	2032	2033	2034	2035	2036	2037
78.0%	80.0%	82.0%	84.0%	86.0%	88.0%	90.0%	92.0%	94.0%
2038	2039	2040-54						
96.0%	98.0%	100.0%						

Note: The numbers are based on the projected registration rate for Samawah District presented in Table 5.14.

Source: JICA Study Team

Annual benefit of reduction of alternative water sources is calculated as follows:

Annual benefit of reduction of alternative water sources = (Number of beneficiaries x 5.2 Lpcd x 365 days)/1,000 x Average cost for alternative water sources (IQD 29,201/ m^3) x Registration ratio

(3) Benefit of decrease of waterborne diseases

According to the social survey results, average frequency of hospital visits due to diarrhea is 0.40625 times per household per year and the average cost of treatment is IQD 71,247 per visit. The beneficiaries of the Project are shown in **Table 12.13**. The average household members is 6.4 people also based on the social survey. Registration ratio to the piped water is estimated as shown in **Table 12.14**.

If the water quality is improved and supplied continuously, the waterborne diseases will be decreased.

Therefore, the annual economic benefit of the decrease in water-related diseases is calculated as follows:

Annual economic benefit of decrease of water related diseases = (Number of beneficiaries/6.4 people) x Registration ratio x 0.40625 times x IQD 71,247 per visit

12.3.3 Results and Evaluation

(1) Results

Table 12.15 Results of Economic Analysis

Source: JICA Study Team

(2) Sensitivity analysis

Table 12.16 Results of Sensitivity Analysis

Source: JICA Study Team

Chapter 13 Operational and Effect Indicators of the Project

13.1 Quantitative and Qualitative Effects

The Project may achieve various quantitative and qualitative effects as listed in **Table 13.1**. The Project will directly improve the water volume and water quality. Furthermore, the Project will increase the registration ratio by the improvement of the water volume and water quality which will attract more residents to MWD's water supply services.

The photovoltaic generation to be installed in the WTP site will produce renewable energy. The soft component proposed in Section 7.4.3 will contribute to the improvement of NRW management.

Table 13.1 Quantitative and Qualitative Impacts of the Project

Project Component	Effect	Quantitative/Qualitative
Contract Package-1 (CP-1) Construction of Samawah Water Treatment Plant **Contract Package-1 (CP-2)** Installation of power transmission line to Samawah WTP **Contract Package-3 (CP-3)** Installation of treated water transmission line and brine discharge line **Contract Package-4 (CP-4)** Improvement of the existing water distribution system in urban area	Increase in the **volume of the treated water** in Samawah District	Quantitative
	Improvement of the **treated water quality** in Samawah District	Quantitative
	Extension of the **service hour of piped water** in Samawah District	Quantitative
	Generation of **renewable energy**	Quantitative
	Industrial and economic development in Samawah District and in the whole Muthanna Governorate	Qualitative
Soft Component (Technical Assistance) Capacity development on O&M	Improvement of the capacity of NRW management of MWD	Quantitative and Qualitative

Source: JICA Study Team

13.2 Indicators for Project Effects and Project Operation

(1) Effect indicators

Table 13.2 shows the indicators, baseline values, and target values of the quantitative effects of the Project. The target year is set in 2031 presuming JICA's post-evaluation on the Project will be implemented two years after the completion.

Table 13.2 Effect Indicators of the Samawah Water Supply Improvement Project

Effect	Indicator	Unit	Values: Baseline	Values: Target (in 2031)
1. Increase in the **volume of the treated water** in Samawah District	1. Distribution volume from water treatment facilities in Samawah District	m^3/d	0*1	64,015*2
2. Improvement of the **treated water quality** in Samawah District	2-1. Turbidity of the treated water from major source	NTU	> 5 (Rumaitha WTPs in 2022)	< 5 (Samawah WTP)
	2-2. Total dissolved solids in the treated water from major source	mg/L	> 1,500 (Rumaitha WTP in 2022)	< 1,000 (Samawah WTP)
3. Extension of the **service hour of piped water**	3. Service hours per day	hours	< 6 hours in 80% of the urban area*3	> 12 hours in the whole urban area*4
4. Increase in the **registration** to MWD's piped water service in Samawah District	5. Registration rate in Samawah District	%	60*5 (in 2022)	75*6
5. Generation of **renewable energy**	6. CO_2 emissions reduction by the photovoltaic generation in the Samawah WTP	t-CO_2 /Year	0	3,690*7

*1: The compact units are not counted as water treatment facilities in the baseline.
*2: See Figure 5.41.
*3: According to the social baseline survey, 197 residents out of 315 (63%) responded that the service hours is less than 6 hours (See Figure 4.1).
*4: To monitor the indicator, MWD will conduct customer survey on the satisfaction level on the water pressure.
*5: See Table 4.3.
*6: Population in the urban area is about 75% in Samawah District. The target value of the registration assumes that almost all urban population and some rural population will be registered by the targe year.
*7: See Table 5.43.
Source: JICA Study Team

(2) Operational indicators

Table 13.3 shows the indicators, baseline values, and target values to evaluate the operational situation of the Project. In the same manner as the effect indicators, the target year is set in 2031 for JICA's post-evaluation on the Project.

Table 13.3 Operational Indicators of the Samawah Water Supply Improvement Project

Component / Sub-component	Indicator	Unit	Values	
			Baseline (in 2022)	Target (in 2031)
Samawah Water Treatment Plant	1-1. Annual production volume by the WTP	m^3/ year	0	23,045,466[*1]
	1-2. Satisfaction rate of the treated water of the WTP	%	-	95% out of all samples in a year
	1-3. Annual power generation	MWh	0	3,850[*2]

*1: See Table 5.55.
*2: See Table 5.42.
Source: JICA Study Team

Chapter 14 Conclusions and Recommendations

14.1 Evaluation of the Viability of the Project

Project evaluation includes i) technical, ii) environmental and social, iii) financial and economic, and iv) organizational and institutional viewpoints, these are as follows:

(1) Technical evaluation

a. The necessity of the Project is to construct a new WTP (i.e., Samawah WTP) along the Euphrates River exclusively for Samawah District was confirmed through analyses of water demand and supply gap, the current situations of the existing water treatment facilities, and availability of the water resources other than the Euphrates River.

b. The Rumaitha WTPs, which are the existing major water sources of Samawah District, located at about 25 km away, are not capable to produce the water at the flow rates of their production capacities due to the deterioration of the facilities and the challenges in the water quality. Increasing salinity of the raw water also raises doubt on the sustainability of these WTPs.

c. MCHPM is carrying out a new project called the PWT Project, whose water resource (Gamass River) is located more than 50 km from Rumaitha, that will supply a certain amount of treated water to Samawah District. However, there is no water resource other than the Euphrates River which will be available to MWD.

d. For the reasons described in Items b. and c. above, the Muthanna Governorate needs a WTP to treat the raw water of the Euphrates River. The location shall be near the governorate's capital, which is Samawah District. The water demand and supply gap estimated that the capacity of the WTP will be 81,000 m^3/day to satisfy the water demand in 2040 in the whole district including urban and rural areas, together with the water to be supplied by the PWT Project.

e. The existing data and JST's sampling data identified that the TDS in the raw water of Samawah WTP sometimes rise to 3,000 mg/L. To satisfy the Iraqi drinking water quality standard, the WTP will need water treatment by the RO technology. A comparative study in the Study identified that membrane pre-treatment is the best option. The brine from the RO process will be discharged to the Eastern Euphrates Drainage through a discharge pipeline of 9.5 km. A discharge back to the Euphrates River will not be adopted to avoid influence on the water treatment facilities in the downstream.

f. The Samawah WTP was designed to reduce the O&M cost by optimizing the treatment process and choice of equipment/materials, including minimizing the capacity of RO facilities. It also adopts solar power generation system to reduce the energy cost.

g. It is anticipated that the WTP will suffer frequent power failure. To tackle this issue, the WTP will be provided with "Critical Line", to be confirmed by MOE, from North Samawah Substation and will also be equipped with power generators.

h. The treated water will be transferred to the existing reservoir at Jarbou'yiah, from which the water will be distributed in the city. The existing distribution network in the city was estimated to have sufficient hydraulic capacity to supply the water to satisfy the water demand in 2040. Therefore, the Project will not include reinforcement of the existing network but will include procurement and installation of some equipment for water flow measurement, interconnections among the major pipelines, and network monitoring system.

i. The Project will include expansion of the water network to the rural areas as the WTP's capacity was determined to cover the water demand in the whole district.

j. A nationwide project by a private investor will install water meters in all house connections in Samawah District by 2027. This project as well as the ongoing efforts by MWD to convert the illegal connections to authorized connections will enhance the probability of the efficient use of water to be provided by the Samawah WTP.

k. MWD is replacing old distribution pipes which were installed in the 1980s. This replacement work and the extension of the water network will reduce the water leakage ratio. This will also enhance the efficient use of the water from the Samawah WTP.

(2) Environmental and social evaluation

l. JST evaluated the potential impact of the Project on the environment and social aspects during the implementation of the Project and operation of the facilities to be constructed by the Project.

m. In general, brine from the RO facilities is one of the major potential environmental risks of the water treatment facilities with RO process. According to the water quality testing done by JST, the TDS of the brine receiving water body (Eastern Euphrates Drainage Canal) is more than 6 g/L in the dry season (assumed to be about 3 g/L on annual average), while the TDS of the brine will be about 12 g/L at maximum (assumed to be about 7.6 g/L on average). Since the TDS of the drainage canal is close to that of the brine and the flow rate of the drainage canal is sufficiently greater than that of the brine, the brine discharge in the Project will not give significant adverse environmental impact on the channel.

n. The sludge generated in the WTP will be disposed at disposal sites designated by the Muthanna Governorate.

o. Public consultation was implemented on November 30, 2022.

p. No significant adverse impact on the environment and social aspect is predicted in the Study for the construction and operation of the Project. There will be no obstacles implementing the Project in compliance with the JICA Guidelines for Environmental and Social Considerations.

q. Land acquisition for the WTP has already been implemented by MWD and resettlement is not required. Also, the pipelines for the treated water and the brine will be installed in the existing roads so these works will not require land acquisition and/or resettlement.

(3) Financial and economic evaluation

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t. The Financial Internal Rate of Return (FIRR) of the Project was not calculated as the Project's financial balance is negative even in the case where the water tariff is presumed to increase to the level of the Affordability to Pay (ATP) of the people in Samawah District. It means that the Project needs a good number of subsidies.

u.

v. To seize the positive economic benefit to the society, MCHPM and MWD need to make efforts to avoid the project cost increase and to ensure the Project's benefit by expanding the water network and managing NRW.

(4) Organizational and institutional evaluation

w. The JST proposed the organizational structure and job descriptions of the Project Management Team (PMT) to be jointly composed by MCHPM and MWD. The proposed organization, which was a modified version of the standard structure presented by MCHPM, was agreed by MCHPM and MWD. Timely and appropriate decision-making inside PMT is critical to the smooth implementation of the Project.

x. MWD is responsible for O&M of the facilities to be constructed in the Project including the WTP with RO facility. However, MWD has no experience in the O&M of the RO treatment facility. In addition, the current situation of the existing WTPs suggests that the O&M of the WTPs has not been well implemented.

y. To tackle the situations above, the Project will include five-year O&M services to be provided by the contractor after the construction phase. During the O&M service phase, the contractor will be required to transfer to MWD the knowledge and skill for the O&M of the Samawah WTP, under the supervision of the consultant.

z. NRW in the water supply system is not well monitored and controlled. NRW management is important to ensure the Project's benefit because it is related to the financial and economic benefits derived from the water produced in the Samawah WTP. Therefore, the JST proposed a technical assistance program for MWD to procure equipment, materials, and tools to detect and fix leakages, and to develop the institutional setup of MWD and the capacity of MWD employees to monitor and reduce NRW that consists of both physical and commercial loss.

aa. By taking the measures proposed above, the Project will be implemented efficiently and will deliver the expected benefits to the target area.

14.2 Potential Risks in the Project Implementation and their Mitigation Measures

Through the project evaluation above, the JST conducted a risk assessment, whose result is incorporated in the format of a risk assessment framework as shown in **Appendix 14.1**. The risk framework identified the project risks by classifying them into the following categories:

- 1. Stakeholder Risk
- 2. Executing Agency Risk (Capacity Risk, Governance Risk, and Fraud and Corruption Risk)
- 3. Project Risk (Design Risk, Program and Donor Risk, and Delivery Quality Risk)

Table 14.1 shows the summary of the risk assessment framework, which lists the risks identified and mitigation measures/action.

JST deems that, if the countermeasures are implemented successfully, there will be no critical risk of high probability that may cause serious delay of the Project or deteriorate the Project's beneficial effects. The key mitigation measures for the Project's implementation are the establishment of PMT with sufficient power in timely decision-making and with knowledge obtained from the Basrah Water Improvement Project. For the Project's beneficial impacts, MCHPM's support to the expansion and improvement of the water network as well as installation of water meter will be the key.

Table 14.1 Summary of Risk Assessment on the Project

Potential Project Risks	Mitigation Measures / Action Plans
1. Delay in the project implementation due to **illegal entry to the project site** WTP site: Some resident(s) may enter the WTP site and use the land even though it is owned by MWD	- MWD will continue to communicate with the neighborhoods and will prevent illegal entry by installing fences around the WTP site. - MWD will follow the monitoring plan and establish and maintain the grievance redressal mechanism proposed by JST.
2. Delay in the project implementation due to **incapability of the Project Executing Agency** If the executing agency is not capable enough to handle daily works, timely decision makings, or coordination with relevant authorities, the project implementation may be seriously delayed. Such incapability may also lead to a dispute with the consultant or the contractor on contractual issues.	- MCHPM and MWD will start the joint establishment of PMT and mobilize the personnel who have good experiences and capabilities including those engaged in the Basrah Water Supply Improvement Project. - PMT will apply compliance with JICA's procurement guidelines and standard bidding documents. - PMT will consider applying JICA's standard bidding documents or FIDIC to the contract packages of local competitive bidding. - JICA, PMT, and other relevant authorities will hold periodic meetings to supervise the project implementation.
3. Delay in the project implementation due to **budgeting issues for the Iraqi government's finance portion** Recently the government is legally entitled to allocate a budget not only for a single fiscal year but also for several fiscal years at once to a project. However, procedural obstacles and/or financial constraints, which may be caused by oil price or other reasons, may precent the budget's allocation. It may delay the Project.	- MCHPM will coordinate with PMT, supported by the consultant, to continuously update the Project's disbursement plan to allow itself to take timely measures for budgeting.

4. Delay or suspension of the Project implementation due to **political issue or security issue** Political issue and security issue may disturb the project implementation.	- MWD will continue the information sharing with the local communities about the Project and identify the key people to control the local security. - PMT will employ a social communication expert by itself or request the consultant to engage such an expert in the consultant team. - (Political risk and national and regional security risks are not controllable by the Project.)
5. **Corruption in the procurement procedure** of PMT or the contractor If corruption happens at any process of the Project, such as procurement procedures of the consultant or the contractor, this will prevent the implementation of the Project.	- PMT will include a procurement specialist who is familiar with relevant Iraqi laws and regulations. - JICA will provide the procurement specialist and some other key experts of PMT with a training course about JICA's procurement guidelines and implementation of JICA's ODA loan projects. - JICA will monitor the procurement procedures of the PMT through the concurrence processes.
6. **Complexity of the technologies** adopted The facilities to be constructed may be not fully utilized if the Project contains too complex technologies or requires high skill of O&M	- The Project will include O&M services in the contract for the construction of the WTP, where the contractor will transfer O&M skills to MWD. The consultant will monitor the skills transfer from the contractor to MWD during the contractor's O&M phase. - MCHPM will coordinate the knowledge sharing and human resource exchange between Basrah Water Directorate and MWD.
7. **Ambiguity of the project scope** for improvement of the existing water transmission and water distribution network in the city The Study identified some equipment to improve the function of the existing water network in the urban area of Samawah District, according to the limited information provided by MWD. However, as the inventory is not well developed in MWD, final identification of the equipment needed for the improvement may not be done appropriately.	- (Before the implementation) MWD will prepare drawings which illustrate the existing water transmission pipelines with the diameters, pipe materials, alignment in the roads, and positions of the accessories by utilizing the existing paper-based information and information from the veteran personnel. - (During the Project) MWD will utilize the drawings to prepare an improvement plan of the existing network to identify the necessary equipment. - (During the implementation) MWD will instruct the consultant to review the MWD's improvement plan and propose the equipment to be procured in the Project.
8. Lower Project effect than expected due to **low water sales volume by the Project** The Samawah WTP may not be fully utilized if the residents' registrations do not increase. The same problem may arise also if the water network is leaking, or it allows many illegal consumptions.	- MCHPM will prioritize the investment in the water transmission and distribution network in Samawah District so that the Samawah WTP would be utilized as much as possible. - MCHPM will request the investor of the water meter installation project to prioritize the meter installation in Samawah District. - MWD will look for opportunities to develop its NRW management capacity by collaborating with CWD and other water directorates. The technical assistance program proposed in the Study may be one of the potential options.

9. Lower Project effect than expected due to **high Project cost** Price escalation is very sharp after the rise of the COVID-19 pandemic, which is being accelerated by the war. A higher price than the estimated cost in the Study will deteriorate the Project's financial and economic impact.	- (Before the implementation) JICA and MCHPM may discuss adopting a higher price escalation rate than the current assumption. - After the pledge by the Government of Japan, MCHPM and MWD will quickly formulate the PMT and start the procurement of the consultant. - PMT will pay attention on the appropriate risk sharing with the contractor in the preparation of the bidding documents.
10. Lower Project effect due to **low quality works by the contractors** If the quality of the construction works by the contractors is not good enough, the Project may not bring about the Project effect as expected.	- PMT will implement pre-qualification procedure to screen the non-qualified firms before the tender documents. - PMT will eliminate the bidders whose technical proposal does not satisfy the criteria given in the tender document. - PMT will prepare the technical specifications which clearly stipulate the requirements to the contractor. - PMT will timely mobilize the consultant's experts for the construction supervision.

Source: JICA Study Team