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

# THE PREPARATORY SURVEY
# OF
# THE PROJECT FOR IMPROVEMENT OF
# THE ZAI WATER SUPPLY SYSTEM
# IN
# THE HASHEMITE KINGDOM OF JORDAN

# FINAL REPORT

**August 2020**


**JAPAN INTERNATIONAL COOPERATION AGENCY**
**TEC INTERNATIONAL CO., LTD.**


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# PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey on the Project for Improvement of the Zai Water Supply System and entrusted the survey to TEC International Co., Ltd.

The survey team held a series of discussions with the officials concerned of the Government of the Hashemite Kingdom of Jordan and conducted field investigations. As a result of further studies in Japan, the present report was finalized.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Hashemite Kingdom of Jordan for their close cooperation extended to the survey team.

August, 2020

Eiji IWASAKI
Director General
Global Environment Department
Japan International Cooperation Agency

# SUMMARY

## 1. Overview of the Country

The Hashemite Kingdom of Jordan (hereinafter referred to as "Jordan") is a constitutional monarchy. It shares border with the Kingdom of Saudi Arabia, Iraq, Syria, Israel and Palestine. The security within Jordan is relatively stable in the Middle East.

Amman, the project area, is a hilly area between the desert and the Jordan valley, located on a rugged terrain with 19 hills at an altitude of about 900 m.

Amman has a hot-summer Mediterranean climate (Köppen Climate Zone Csa) and has a monthly mean high temperature of 33.4 ℃, monthly mean low of 6.2 ℃, and an annual mean rainfall of 120 mm. The weather in Amman can be hot, dry and harsh, with temperatures near 40 ℃ on some days in summer. On the other hand, Amman has seen snowfall in some winters, when the temperature can drop below freezing.

Jordan's economic growth rate has been sluggish since the global financial crisis of 2008. It has been in the 1-3% range since 2010 and 1.9 % in 2018 (IMF, 2018). High unemployment is also a problem, with the 2018 unemployment rate at 18.3 % (IMF, 2018). The gross domestic product (GDP) was US$ 42.29 billion and gross domestic product per capita (GDP/capita) was US$ 4,270 in 2018 (IMF, 2018). According to Jordan's estimated industrial breakdown for 2017, the primary sector accounts for 4.5 % of GDP while the secondary and tertiary sectors account for 28.8 % and 66.6 % respectively (CIA, The World Factbook, 2020).

Jordan lacks natural resources such as water and crude oil, and its main exports in 2017 were phosphate ore, clothing, pharmaceuticals and fertilizer, while its imports included vehicles, liquefied petroleum gas and oil (OEC, 2019). The balance of trade in 2018 was US$ 7.773 billion for exports and US$ 20.216 billion for imports, resulting in a trade deficit of US$ 12.4 billion(UNCTAD, 2018).

## 2. Background and Overview of the Project

Jordan's population was about 10.3 million people in 2018 (Department of Statistics) out of which about 4.3 million people lived in Amman governorate, which covers an area of 1,086 $km^2$. The Zai Water Supply System produces about 200,000 $m^3$/day and provides Amman as the second major source of water after Disi fossil groundwater (274,000 $m^3$/day). It is also an important system as it is used to dilute the amount of radiation in the Disi fossil groundwater supplied to Amman.

However, at present, the equipment of the Zai Water Supply System is in a state of deterioration. Therefore, there is an urgent need for the replacement of equipment to prevent the decline in water supply and water quality due to further functional degradation and outages in the future.

In addition, the water source of the Zai Water Supply System which feeds Amman located at an altitude of about 900 m, is in the Jordan Valley at an altitude of about -230 m. So the large amount of electricity is required to pump the water approximately 1,260 m of elevation difference. Therefore, there is a need to improve the energy efficiency of pumps, improve operating efficiency, and reduce operating costs by upgrading systems, facilities and equipment.

Jordan has formulated a comprehensive national strategy, "the National Vision and Strategy for Jordan 2025," which describes issues to be addressed and solutions in various sectors. Major issues in the water sector include shortage of water per capita, improvement of financial efficiency, sector structural reform, and reconstruction of the distribution network.

The National Water Strategy (2016-2025) identifies the following five areas as important strategic areas:

(1) Comprehensive water source planning
(2) Water and sewage service
(3) Water use for irrigation, energy, etc.
(4) Organizational reform
(5) Sector information management and monitoring.

Jordan has formulated "Water Sector Capital Investment Plan (2016-2025)" under the National Water Strategy (2016-2025). "The Project for Improvement of the Zai Water Supply System" is requested based on "Rehabilitation and Improvement of Facilities in Zai Water Treatment Plants and Zai Booster Pumping Stations (2016-2019)" in this Investment Plan.
In accordance with the above strategic plan, the Project aims to prevent reduction in water supply quantity and deterioration in water quality and improve the operational efficiency of equipment and eventually to reduce overall operating costs by replacement of the existing facilities and equipment of the Zai Water Supply System in Amman Governorate.

The construction and renewal of the Zai Water Supply System have so far been carried out either by Jordan themselves or by development partners. Recently, USAID is involved in the planning of the Zai Water Treatment Plant Project (2019/8, Draft). In August 2019, the JICA Survey Team obtained the draft report of the USAID project. The JICA Survey Team then concluded that there is no overlap of the USAID project components related to the Zai Water Supply System with the priority list of Project components prepared by the JICA Survey Team.

## 3. Summary of the Survey Results and Outline of the Project

JICA dispatched TEC International Co., Ltd. to the site from July to September in 2019. The Survey Team made a series of discussions with the relevant governmental officials in Jordan and carried out a field survey. The survey results are outlined as below.

### (1) Basic policy

The existing Zai Water Supply System was constructed about 30 years ago and the facilities and equipment, especially the pumps, have been significantly deteriorated since. Therefore, urgent measures are required to prevent the system from stopping.

The Zai Water Supply System requires a large amount of electric power to pump water to a head of approximately 1,260 m. Thus, the electricity cost is extremely high, which is 33% of Miyahuna's operating expenditures It is, therefore, required to improve operating and energy efficiency of the system and reduce operating costs by replacement of aged facilities and equipment such as the pumps and motors. There are different grades of specifications for each equipment. But basically, the same grade as that of the existing ones will be the minimum. The specifications will be upgraded according to the characteristics of the raw water to be handled.

The Project components are selected from many candidate components, which were identified as a result of the field survey of the existing facilities and equipment, based on the priority set in the Project and budget limitation.

1) Current status of the Zai Water Supply System and the priority of the candidate components

The potential effects of aging of the existing Zai Water Supply System such as failure, shutdown for repair, burden of maintenance, and risk of failure have been analyzed through surveys, and the priority of the candidate components has been determined. The analysis was carried out based on the following criteria. The expected effects of renewal/replacement are summarized, and the priority has been determined.

1. Prevention of deteriorating raw water quality and decreasing water production due to malfunctioning of facilities, if unattended
2. Maintenance cost reduction[1]
3. Reduction in energy consumption[2]

The highest priority is to ensure that water supply continues without deterioration in quality and decrease in quantity of supplied water. Therefore, higher weightage with a maximum score of 10 points was given to the item “Deteriorating raw water quality and decreasing water production due to malfunctioning of facilities, if unattended.” Then, weightage with a maximum score of 5 points was given to other two criteria: “2. Maintenance cost reduction” and “3. Reduction in energy consumption.” Based on total score of components calculated by this scoring system, the priority was determined.

The first priority was given to the replacement of pumps of intake, raw water and transmission pumping stations, and their motors and valves; the second was to replace the traveling screen; and the third priority was given to reinforce the end cap of header pipe.

The JICA Survey Team also confirmed the priorities of the Jordanian side with Miyahuna. The priority list made by the Jordanian side was the same as that of the Japanese side except the renewal of telemetry

[1] The pumps, motors, traveling screen, end cap of header pipe and water quality equipment are applicable to this item.
[2] The pumps and motors are applicable to this item.

systems placed in the tenth in the list which was ranked at 14th on the Japanese priority list.

2) Selection of equipment for replacement based on priority and project scale

Based on the above considerations, from the equipment that was determined to need renewal in this survey, the equipment with high priority was selected for this project considering the project scale. The equipment up to the 3rd priority, i.e., (1) pumps of intake, raw water and transmission pumping stations, and their motors and valves, (2) traveling screens, and (3) discharge header pipe, is selected as the target of this project.

Table 1 shows the contents of the equipment and facilities that WAJ considered necessary to be upgraded or replaced as of 2018 and determined by this preparatory survey.

**Table 1 Equipment to be upgraded or replaced**

| Location | Major Existing Facilities | | Requests by WAJ as of 2018 | Equipment to be upgraded or replaced |
|---|---|---|---|---|
| Grit Settling Basin | W25mxL125mxD4mx4 lines | 1 set | 1set (Reconstruction) | - |
| Intake Pumping Station (IPS) | Traveling screen | 4 sets | 4 sets | 4 sets |
| | Vertical axis mixed flow pump | 4 sets | 3 sets | 3 sets |
| | Motor for the above pump | 4 sets | 3 sets | 3 sets |
| Raw water Pumping Stations (PS1-4) | Horizontal axis centrifugal pump | 16 sets | 12 sets | 12 sets |
| | Motor for the above pump | 16 sets | 8 sets | 9 sets |
| | Discharge header pipe | 4 sets | Discharge header pipe x 4 sets | End plate x 4 sets |
| Transmission Pumping Station (PS5) | Horizontal axis centrifugal pump | 4 sets | 3 sets | 3 sets |
| | Motor for the above pump | 4 sets | 2 sets | 3 sets |
| | Electric ball valve | 3 sets | - | 3 sets |
| | Check valve | 4 sets | - | 4 sets |
| | Discharge header pipe | 1 set | - | End plate x 1 set |

(Source: JICA Survey Team)

(2) Renewal plan of equipment to be procured

1) Traveling screen

Four traveling screens shall be replaced with new ones. The existing screen system is severely corroded due to prevailing adverse raw water quality. In consideration of extending the life of the traveling screen, the specifications of travelling screen shall require the intensive anti-corrosion measures such as painting.

2) Intake pump

Although the impact of foreign matter will be reduced by replacing the traveling screen in the renewal work, the impeller and casing ring shall be replaced with high strength and wear resistant cast stainless steel in order to improve the durability.

3) Raw water pump

The JICA Survey Team requested the Japan Society of Corrosion Protection (Corrosion Center) to survey wearing and corrosion conditions of the pumps. It concluded the followings:

a) Damage to the cast steel casing tongue was most likely caused by slurry. (Slurry indicates a suspension of liquid and particles such as sand, silt, etc.)
b) Partial corrosion of 13Cr stainless steel parts, corrosion of cast steel parts, and damage to cast steel casing tongues were due to increase in the corrosion rate caused by high chloride ion concentration in raw water. It might also be due to injection of chlorine dioxide and potassium permanganate.

Regarding a) above, the Center recommends changing the material of the cast steel casing of the raw water pumps, and regarding b), they recommend that the material of corroded casings and other parts be changed to duplex stainless steel.

Due to very high total head of about 300m of the raw water pump and the quality issue of the raw water, the internal parts of the pump are severely abraded and corroded. This results in significant decrease in performance of pumps. The pump casing is currently made of cast steel (JIS SCW480) but this material is not suitable for corrosive liquid as it is highly susceptible to corrosion. Therefore, the material of the casing should be changed to duplex (austenitic / ferritic) stainless steel. This material has excellent strength and provides better corrosion resistance in chloride environments, and therefore, it is widely used in applications such as chemical plants or seawater equipment. Use of this material can eliminate the need for lining of the inner surface, which is applied to the existing casing, and consequently, it is expected that it reduces maintenance costs and improves durability of the facilities.

The impeller is currently made of cast stainless steel (JIS SCS5) which has a characteristic of low corrosion resistance but high strength as it is martensitic stainless steel. Use of this material has an advantage that repair work such as in the event of impeller damage can be done by welding. However, since it is found that the damage is caused by cavitation in the present case, the material of impellers shall also be changed to duplex stainless steel having high cavitation resistance similar to that of casing. Furthermore, since martensitic stainless cast steel (JIS SCS1) material, which has low corrosion resistance, is currently used for the wear ring as in the case of the impeller, the material of the wear ring shall also be changed to duplex stainless steel.

4) Clear water transmission pump

Three transmission pumps in PS5 were installed in 2003 and one of these pumps was replaced with a new one for the first time in 2018. Since the water handled by this pump is treated clean water, the influence of abrasion is small. Its corrosion is also judged to be within the range of normal deterioration. Therefore, it is considered that the transmission pumps do not have a specific problem and thus the transmission pumps to be renewed shall be of the same specifications as the existing ones.

5) Electric motor

The current protection type of the motor from water is the open drip-proof type (IP[3]22), but the protection type shall be improved to IP24 that protects the motor from splashed water from the pump. The environment in the pumping stations is hot and humid, the water leaking from the gland of the raw water pump contains a lot of silt, and the silt enters and adheres to the inside of the motor. The improved protection type protects the motors from this condition. The motor that has been renewed by Miyahuna has already IP24 protection type.

6) Discharge header pipe

As a result of the measurement of thickness of the discharge header pipe, it is considered that the renewal of the discharge header pipe is not required. At present, an emergency restoration has been adopted to the end of the discharge header pipe when this part was damaged. There have been several cases of damages of this part despite this restoration. Therefore, the end of the discharge header pipe at 5 places of PS1 to PS5 shall be changed with the end cap as originally designed.

7) Electric ball valve and check valve

One electric ball valve of PS5 was renewed in 2018, but the other valves have not been replaced since the initial installation, resulting in high risk of decrease in water supply capacity of transmission pumping station. Therefore, four (4) check valves and three (3) electric ball valves shall be replaced with valves of the same specifications as the existing ones.

Table 2 summarizes the specifications and quantities of the equipment to be replaced with new ones.

**Table 2 Specifications and quantities of the equipment to be replaced**

| PS | Equipment | Main Specification | Q'ty |
|---|---|---|---|
| Intake Pumping Station (IPS) | Traveling Screen | W 1.4～1.9m x L 3.55m x D 7.15m | 4 |
| | Vertical type mixed flow pump | 43.8 $m^3$/min x 30m x 990 $min^{-1}$ x 280 kW (Impeller：SCS13)<br>Pump Eff.：83% (See Note) | 3 |
| | Motor for the above | 280kW x 6P x 0.4kV x 50Hz | 3 |
| Raw water Pumping Station (PS1～4) | Horizontal type centrifugal pump | 43.5 $m^3$/min x 300～314m x 1,490 $min^{-1}$ x 3,200～3,500 kW<br>(Main parts：Duplex stainless steel casting)<br>Pump Eff.：83% (See Note) | 12 |
| | Motor for the above | 3,200～3,500kW x 4P x 6.6kV x 50Hz (Protection：IP24) | 9 |
| | End cap of discharge header pipe | DN1,000 | 4 |
| Transmission Pumping Station (PS5) | Horizontal type centrifugal pump | 42.9 $m^3$/min x 195 m x 1,490 $min^{-1}$ x 1,800 kW<br>(Same spec as the existing model)<br>Pump Eff.：84% (See Note) | 3 |
| | Motor for the above | 1,800kW x 4P x 6.6kV x 50Hz<br>(Protection：IP24) | 3 |
| | Electric ball valve | DN450 | 3 |
| | Check valve | DN450 | 4 |
| | End cap of discharge header pipe | DN1,000 | 1 |

Note：The applicable standards at the pump factory test shall be ISO 9906 (1B), JIS B 8301 (Gr.1) or approved international standards. (The pump efficiency up to 3% lower than the specified pump efficiency is acceptable.)
(Source: JICA Survey Team)

[3] Ingress Protection [Degrees of protection against water and dust as defined in international standard]

## 4. Project Implementation Schedule and Cost Estimation

The project is planned to implement the detailed design and bidding for approximately 6 months and the construction works for approximately 24 months. The estimated project costs of the Jordan portion are 24 million yen.

## 5. Project Evaluation

(1) Relevance

1) Population benefitted

The target area to receive the benefit of the Project is Amman Governorate. The estimated population to be benefitted by water supplied from this system is 5,046,000 in 2026.

2) Project's contribution to basic human needs, and improving living condition of the residents and stabilizing their livelihood

The objectives of the Project are: 1) to replace the existing aged equipment of the Zai Water Supply System to prevent any reduction in water supply quantity and deterioration in water quality; and 2) to improve the operational efficiency of equipment and reduce operating costs, and thereby contribute to fulfillment of basic human needs (BHN).

3) Contribution to realization of targets of medium and long-term development plans

Under the "National Water Strategy", which is a medium- to long-term plan for Jordan, the policy is to supply safe and abundant water to all Jordanians. This project contributes to achieving the objective of the medium- to long-term plan through replacing equipment and thus preventing the water supply cut to Amman.

4) Consistency with Japan's aid policy and guidelines

The priority issues of the Country Development Cooperation Policy for the Hashemite Kingdom of Jordan (September 2016) is "Supporting Autonomous and Sustainable Economic Growth", and the JICA Country Analysis Paper for Jordan (March 2015) pointed "Climate Change Countermeasures and Sustainable Utilization and Management of Resources" as priority issues. The Project is consistent with these policies and priority issues. The Project is also consistent with Jordan's development issues and policies, as well as with Japan and JICA's cooperation policies. The Project contributes to improvement and sustainable operation and management of water supply services and thereby leads to realization of safe, resilient and sustainable city. Therefore, there is much need to support the implementation of the Project to contribute to SDGs Goals 6 and 11. In addition, it is significant from the humanitarian point of view to implement the Project urgently considering the two key issues: 1) there is a rapid population increase due to the influx of Syrian refugees; and 2) increased financial burden on public services which

cover water supply in Amman area.

(2) Effectiveness

1) Quantitative effects

The expected effects of implementing the Project are given in Table below. The expected quantitative effects of the Project in terms of baseline value in 2019 and after implementation of the Project in 2026 are shown in Table 3.

**Table3 Quantitative effects of the Project**

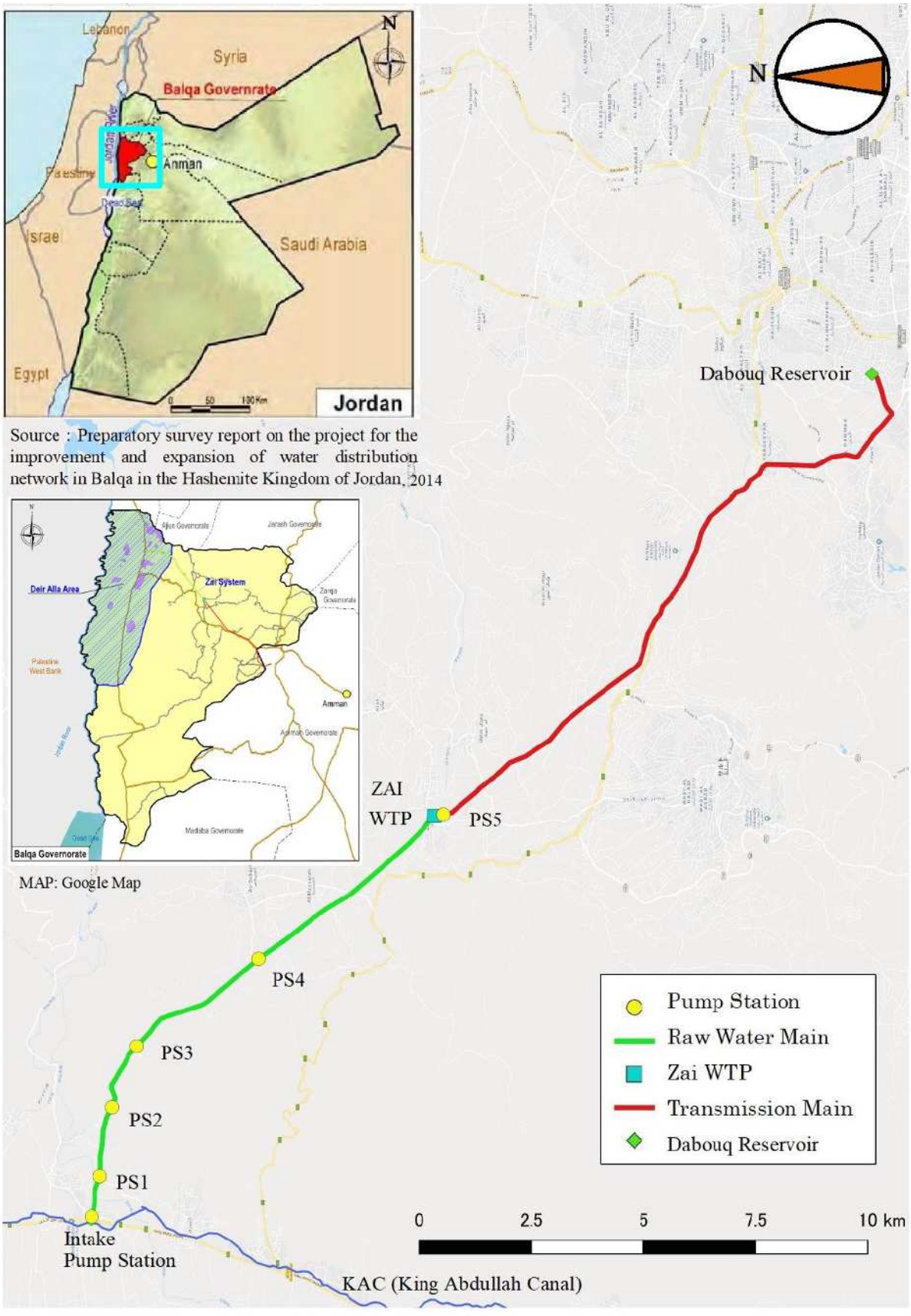
| Name of index | Baseline value (2019) | Target value (2026) |
|---|---|---|
| Electricity consumption per $m^3$ of water supplied by the Zai Water Supply System ($kWh/m^3$)[4] | 5.10 | 4.91 |
| GHG emission/year ($Mt\text{-}CO_2$/year)[5] | 191.97 | Less than 185 |

(Source: JICA Survey Team)

2) Qualitative effects

The prevention of drop in pump discharge due to pump failure or repair of the Zai Water Supply System will ensure a stable water supply in future. Consequently, the Project will contribute to improving the living environment of residents in the target area.

[4] Appendix 9 Electricity consumption per m3 of water supplied by Zai water supply system
[5] Appendix10 Baseline and Target Values of Greenhouse Gas (GHG) Emissions per Year



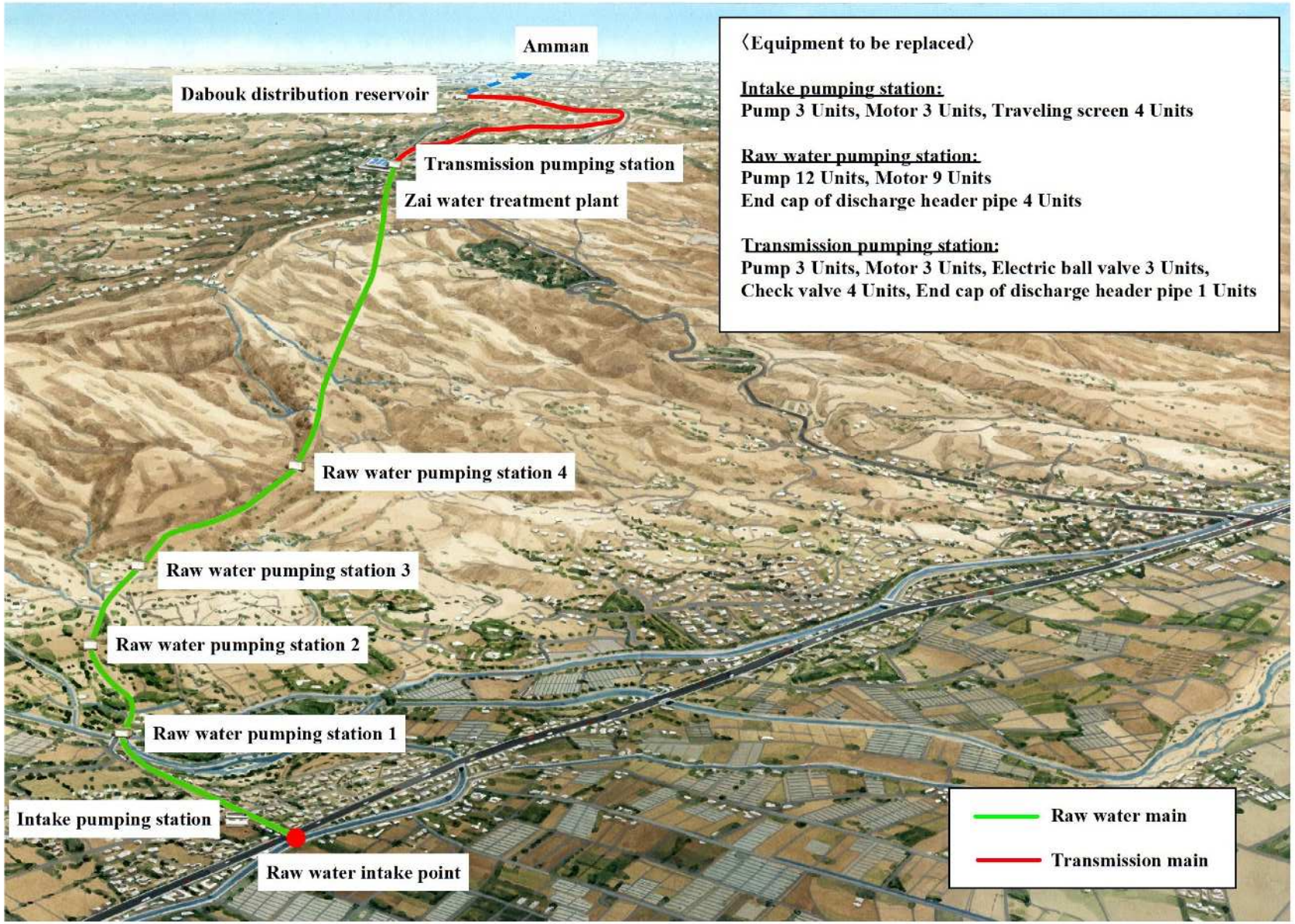

Source : Preparatory survey report on the project for the improvement and expansion of water distribution network in Balqa in the Hashemite Kingdom of Jordan, 2014

MAP: Google Map

MAP : Google Map

# LOCATION MAP

PERSPECTIVE



Preface
Summary
Table of Contents
Location Map / Perspective
List of Figures & Tables
Abbreviations

## TABLE OF CONTENTS

## APPENDICES

## LIST OF TABLES

## LIST OF FIGURES



## LIST OF PHOTOS

## ABBREVIATION

| | |
|---|---|
| AFD | Agence Française de Développement |
| BHN | Basic Human Needs |
| CEF | Carbon Emission Factors |
| CEO | Chief Executive Officer |
| CIA | Central Intelligence Agency |
| CMMS | Computerized Maintenance Management System |
| Cr | Chromium |
| Csa | C: Temperate, s: Dry summer, a: Hot summer [Köppen Code] |
| DOS | Department of Statistics |
| EC | Electric Conductivity |
| E/N | Exchange of Notes |
| EIA | Environmental Impact Assessment |
| EIB | European Investment Bank |
| EU | European Union |
| EUR | EURO |
| FAO | Food and Agriculture Organization of the United Nations |
| G/A | Grant Agreement |
| GCF | Green Climate Fund |
| GDP | Gross Domestic Product |
| GHGs | Greenhouse Gases |
| GNI | Gross National Income |
| GRDP | Gross Regional Domestic Product |
| IFAD | International Fund for Agricultural Development |
| IMF | International Monetary Fund |
| IP | Ingress Protection [Degrees of protection against water and dust as defined in international standard] |
| IPCC | Intergovernmental Panel on Climate Change |
| IPS | Intake Pumping Station |
| IUCN | International Union for Conservation of Nature and Natural Resources |
| JEPCO | Jordan Electric Power Company |
| JICA | Japan International Cooperation Agency |
| JIS | Japan Industrial Standards |
| JMP | Joint Monitoring Program for Water Supply, Sanitation and Hygiene |
| JOD | Jordan Dinar |
| JRP | Jordan Response Plan for the Syria Crisis |
| JSCE | Japan Society of Civil Engineers |
| JVA | Jordan Valley Authority |

| | |
|---|---|
| KAC | King Abdullah Canal |
| KfW | Kreditanstalt für Wiederaufbau |
| kWh | Kilowatt hour |
| Lpcd | Liters per capita per day（L/capita/day） |
| MCM | Million cubic meters |
| MCM/y | Million cubic metres per year |
| Miyahuna | Miyahuna Water Company |
| MOE | Ministry of Environment |
| MPa | Mega Pascal = 10.19716 kgf/cm$^2$ |
| MPN | Most Probable Number |
| MPWH | Ministry of Public Works and Housing |
| Mt-$CO_2$/year | Megatonnes $CO_2$ per year |
| MVA | Mega volt ampere |
| MWI | Ministry of Water and Irrigation |
| NARC | National Agricultural Research Center |
| NEPCO | National Electric Power Company |
| NTU | Nephelometric Turbidity Unit |
| NWS | National Water Strategy 2016-2025 |
| O&M | Operation & Maintenance |
| OEC | Observatory of Economic Complexity |
| OECD | Organisation for Economic Co-operation and Development |
| pH | potential of hydrogen |
| PLC | Programmable Logic Controller |
| PMU | Project Management Unit |
| PS | Pumping Station |
| SCS | Steel Casting Stainless |
| SDGs | Sustainable Development Goals |
| SMS | Short Message Service |
| TEU | Twenty Foot Equivalent Unit |
| TOR | Terms of Reference |
| TTS | Telegraphic Transfer Selling rate |
| UN | United Nations |
| UNCTAD | United Nations Conference on Trade and Development |
| UNHCR | United Nations High Commissioner for Refugees |
| UNICEF | United Nations Children's Fund |
| UNRWA | United Nations Relief and Works Agency |
| USAID | United States Agency for International Development |
| VAT | Value Added Tax |

| | |
|---|---|
| VHC | Village Health Center |
| WAJ | Water Authority of Jordan |
| WFP | United Nations World Food Programme |
| WHO | World Health Organization |
| WTP | Water Treatment Plant |

Exchange rate：1US$ = JPY108.57, 1JOD = JPY153.34

# CHAPTER 1 Background of the Project

## 1.1 Outline of the Project

(1) Background to the Project

The Amman Governorate includes the capital city of Amman and its surroundings, whose population accounts for a half of the total population of the country. Some 4.3 million people are connected to water supply in this Governorate. Main water sources serving the Governorate include Disi fossil water (274,000 $m^3$/day) and the Zai Water Supply System (200,000 $m^3$/day). The Zai water treatment plant (hereinafter referred to as "Zai WTP") obtains its raw water from King Abdullah Canal through four stages of pumping stations (PS1 to PS4) in addition to one intake pumping station (hereinafter referred to as "IPS"). The elevation difference between the canal and the Zai WTP is 1,120 m. The raw water pumped up from the canal is treated by rapid sand filtration system at the Zai WTP. The treated water is pumped to Dabouk distribution reservoir located at western part of Amman city for distribution to Amman and surrounding areas.

The Zai Water Supply System was initially constructed by USAID in 1985 and renovated by Japan's grant aid in 1997 and 2001 and further renovated by KfW in 2002. However, at present, most of the facilities are aged to a greater extent and the mechanical and electrical equipment need to be urgently reinstalled to prevent reduced water supply and deteriorated water quality. Moreover, since huge amount of power is required to lift water for 1,260 m head, the operation and maintenance (hereinafter referred to as "O&M") costs have to be reduced by adopting more energy efficient pumps and other mechanical equipment. It is also necessary to improve operational efficiency thorough replacement of system and equipment.

From the above-mentioned background, the Government of the Hashemite Kingdom of Jordan (hereinafter referred to as "Jordan") requested the Government of Japan to upgrade the existing facilities and equipment of the Zai Water Supply System so as to prevent reduction of water supply quantity and deterioration in water quality and reduce operating costs by improving the operational efficiency of equipment. Upon request from Jordan, the Government of Japan decided to implement the project for improvement of the Zai Water Supply System (hereinafter referred to as "the Project").

(2) Contents of the Request

The contents of the request made by Jordan in February 2017 are listed as follows:

1) Facilities and equipment

【Facilities】

- Improvement of grit settling basin including sand removal equipment

- Modification of pump discharge pipe and valves
- Installation of ultrasonic flowmeters

【Equipment】

- Overhaul of pumps including impeller and related parts
- Provision of spare impellers
- Overhaul of motors including bearing and related parts

2) Design, and supervision of procurement and construction

As a result of consultations by the Jordanian side, Jordan's request changed in April 2019 before the Preparatory Survey as follows:

1) Facilities and equipment

【Facilities】

- Reconstruction of deteriorated grit settling basin(s)
- Expansion of sludge drying beds

【Equipment】

- Renewal of travelling screens
- Renewal of 18 pumps and 13 motors at intake, raw water and transmission pumping stations
- Repair of raw water main, etc., in raw water pumping stations
- Renewal of chemical feeding facility at the Zai WTP

2) Consulting services and soft component
   - Consulting services: detailed design, assistance for bidding, and procurement and construction supervision
   - Soft component: operation and maintenance (O&M) of facilities at the Zai WTP

After the field survey by the JICA Survey Team and as a result of discussions with the Jordanian side, the following changes in the request have been confirmed:

1) The number of motors to be replaced is to be sixteen (16) units at intake, raw water and transmission pumping stations instead of thirteen (13) units only in IPS in the original request. This change has been found inevitable after a close technical examination of conditions of all existing pumps.

2) Three (3) electric ball valves and four (4) check valves at transmission pumping station shall be replaced since these valves, on which corrosion and erosion due to cavitation were observed, are not functioning properly.

JICA Survey Team has carried out the site survey based on the following conditions.

1) USAID was supposed to implement the survey of the parts of the facilities and equipment (including the pipeline system) of the Zai Water Supply System, which the Preparatory Survey did not cover.
2) Details of the Project components are confirmed in the Preparatory Survey based on the priority of

the need and availability of the budget.

However, the discussions with USAID after the start of the Preparatory Survey revealed the following:

- The survey of USAID components would be implemented by USAID, but USAID did not have any plan to implement these components, even if the Jordanian side requests USAID to implement these components in future, according to the information from USAID in September 2019.

Therefore, the survey has been conducted according to the following policy:

- The survey is conducted to examine both requested Japanese components and initially expected USAID components. As the result of the survey, the priority table has been prepared considering the need and urgency of components.

(3) Target area

The target area of the Project is in Zai and Deir Alla districts in Balqa Governorate where raw water intake point, pump stations and the Zai WTP are located

(4) Major counterpart agencies for the Project

- Implementing agency: Water Authority of Jordan, Ministry of Water and Irrigation (hereinafter referred to as "WAJ")
- Operating agency: Miyahuna Water Company (hereinafter referred to as "Miyahuna")

## 1.2 Environmental and Social Considerations

### 1.2.1 Outline of the Project components that may cause environmental and social impacts

The following are the final Project components (see Table 2.13 for detail):

1) Intake facility:
    - Replacement of traveling screens
2) Intake, raw water and transmission facilities:
    - Replacement of 18 pumps at intake, raw water and transmission pumping stations
    - Replacement of 15 motors
    - Replacement of control valves and check valves
    - Reinforcement of end caps of header pipes

All the above components are to renew or replace existing equipment within the facilities of the Zai Water Supply System. There will be no requirement for new or alternative land/sites for the Project implementation. No resettlement is envisaged. Therefore, the impact of the Project on the natural and

social environment, which is designated as Category B, is expected to be insignificant. The outline of institutional arrangement in Jordan and site conditions of the Project is described below according to "JICA Guidelines for Environmental and Social Considerations (issued in April 2010)."

### 1.2.2 Overview of the present conditions of the proposed Project site

#### 1.2.2.1 Natural Environment

(1) General Description

Jordan is divided into 4 biogeographic regions based on the natural environmental conditions such as temperature, precipitation, terrain, flora and soil characteristics[6]. Zai, the Project site is located in the Irano-Turanian Region with altitude ranging around 500 to 700 m. Average annual precipitation is 150-300 mm with annual minimum and maximum temperatures of 2 - 5 and 15 - 25 degrees C respectively. This climate corresponds to Mediterranean hot summer climate (Csa) according to the Köppen-Geiger climate classification by the warmest month average temperatures. The geology is dominated by Mesozoic sedimentary rocks and calcite (limestone). Dolomites mixed with sand and mud are widely distributed. These rocks become the source of soil by mechanical weathering, which predominantly forms Inceptisols with A-C horizon on the land surface. In addition, dark Aridisols, which are formed by repeated seasonal wet and dry conditions, are distributed in depressions. Horizon differentiation of each soil is undeveloped and generally each soil has low natural fertility. Rain-fed agriculture and grazing are performed on these soils in the site. Olive plantation with simple irrigation facilities is also seen occasionally. The forest ecosystem is mainly composed of Aleppo Pine (*Pinus halepensis*) and other species including Palestine oak (*Quercus calliprinos*), Mount Tabor oak (*Quercus ithaburensis*) and Pheninicean juniper (*Cupressaceae, Juniperus phoenicea*). An overview of the natural environment surrounding the site is shown in photo-1 below.

a) General view of the Project site　b) Rain-fed tomato cultivation　c) Livestock grazing

**Photo- 1 Overview of the natural environment in the Zai area**

(Source: JICA Survey Team, taken in August 2019)

Monitored data concerning noise and vibration are not available in Deir Alla and Zai areas. Based on the field survey result, no source of significant noise or vibration is found in both areas and the

[6] Kasapligil, Baki, Plants of Jordan with notes on their ecology and economic uses, Amman: Forestry Dept, 1956, p.32.

environment is normally calm.

(2) Flora and Fauna

Table 1.1 summarizes the list of flora usually found in Balqa Governorate, in which the Project site is located, based on the existing data. The species include mainly edible, medicinal and cattle feed plants and are distributed throughout the Irano-Turanian region. No ecologically valuable flora is identified.

**Table 1.1 Flora in Balqa Governorate**

| Scientific name | English name | Status | Purpose |
|---|---|---|---|
| **Amaranthaceae** | | | |
| *Amaranthus blitoides* | Amaranth | Common | (No use) |
| **Boraginaceae** | | | |
| *Heliotropium* spp. | Heliotrope | Common | (No use) |
| **Capparaceae** | | | |
| *Capparis aegyptica* | Large caper | Common | Medical use, Human edible |
| **Chenopodiacaea** | | | |
| *Chenopodium murale* | Nettle leaf | Common | Animal feed |
| **Compositae** | | | |
| *Centurea* spp. | Garden cornflower | Common | (No use) |
| *Cichorium pumilum* | Small Chicory | Common | Human edible |
| *Dittrichia viscosa* | False yellow head | Common | (No use) |
| *Echinops* spp. | Globe thistle | Common | (No use) |
| *Notobasis syriaca* | Syrian thistle | Common | Human edible |
| *Silypum marianum* | Milk thistle | Common | Human edible |
| **Cruciferae** | | | |
| *Cardaria draba* | Hoary cress | Common | (No use) |
| *Sinapis alba* | White mustard | Common | (No use) |
| **Graminae** | | | |
| *Cyndon dactylon* | Bermuda grass | Common | Animal feed |
| *Sorghum halepnse* | Sorghum | Common | Animal feed |
| **Labiatae** | | | |
| *Mariubium vulgare* | Horehound | Common | Medical use |
| **Mimosaceae** | | | |
| *Prosopis farcata* | Syrian mesquite | Common | Animal feed |
| **Rhamnaceae** | | | |
| *Ziziphus lotus* | (N/A) | Common | Animal feed |
| **Solonaceae** | | | |
| *Withania somnifera* | Indian ginseng | Common | (No use) |
| **Urticaceae** | | | |
| *Urtica pilulifera* | Roman nettle | Common | Medical use |
| *Parietaria judicua* | Spreading pellitory | Common | (No use) |

(Source: JICA Survey Team based on the existing data)

Table 1.2 shows the list of fauna recorded in Balqa Governorate. Three (3) species of mammals and eight (8) species of amphibians and reptiles have been identified. None of these species fall under endangered categories as per conservation status specified by IUCN Red list 2019-3 (published 10

December 2019) and are mainly categorized as Least Concern (LC) or Data Deficient (DD).

**Table 1.2 Fauna in Balqa Governorate**

| Scientific name | English name | IUCN category |
|---|---|---|
| **Mammals** | | |
| *Vulpes vulpes* | Red fox | Least Concern (LC) |
| *Meles meles* | Eurasian badger | Least Concern (LC) |
| *Spalax leucodon* | Palestine mole rat | Data Deficient(DD) |
| **Reptiles/Amphibia** | | |
| *Bufo viridis* | Green toad | Least Concern (LC) |
| *Hyla savignyi* | Savignys tree frog | Least Concern (LC) |
| *Rana bedriagae* | Levantine frog | Least Concern (LC) |
| *Daboia palaestinae* | Palestine viper | Least Concern (LC) |
| *Coluber jugularis* | Syrian black snake | Least Concern (LC) |
| *Hemorrhois nummefer* | Coined snake | Least Concern (LC) |
| *Eirenis rothi* | Roths dwarf snake | Least Concern (LC) |
| *Laudakia stellio stellio* | Starred agama | Least Concern (LC) |

(Source: JICA Survey Team based on the existing data)

Jordan is located on the migratory route of birds between African and the Eurasian continents and resident birds are only 16% out of 436 bird species identified in the country (SA Oran, 2016). In Balqa Governorate, 7 species are identified and classified as LC category on the IUCN Red List 2019-3 as indicated below (Table 1.3).

**Table 1.3 Avifauna in Balqa Governorate**

| Scientific name | English name | Habitats | IUCN category |
|---|---|---|---|
| **Columbidae** | | | |
| *Streptopelia senegalensis* | Laughing dove | Resident | Least Concern (LC) |
| **Upupidae** | | | |
| *Upupa epops* | Hoopoe | Resident/Immigrant | Least Concern (LC) |
| **Alaudidae** | | | |
| *Galerida cristata* | Crested lark | Resident | Least Concern (LC) |
| **Hirundinidae** | | | |
| *Hirundo daurica* | Red-rumped swallow | Resident/Immigrant (local) | Least Concern (LC) |
| **Turdidae** | | | |
| *Turdus merula* | Blackbird | Resident/Immigrant | Least Concern (LC) |
| **Paridae** | | | |
| *Parus major* | Great tit | Resident | Least Concern (LC) |
| **Passeridae** | | | |
| *Passer hispaniolensis* | Spanish sparrow | Resident/Immigrant | Least Concern (LC) |

(Source: JICA Survey Team based on the existing data)

(3) Solid Waste Collection and Treatment Condition

The photo-2 below show the current situation of solid waste collection in the Project site. In Zai area, the local government collects solid waste every day at designated places. In the Deir Alla area solid waste generated by business establishments is collected by private contractors. When establishments

discard industrial waste and/or oversized garbage, contractors licensed by the government collect and treat them in an appropriate manner.

a) Waste separation at the Zai WTP

b) Garbage collection box near the Zai WTP

c) Garbage collection box at Deir Alla

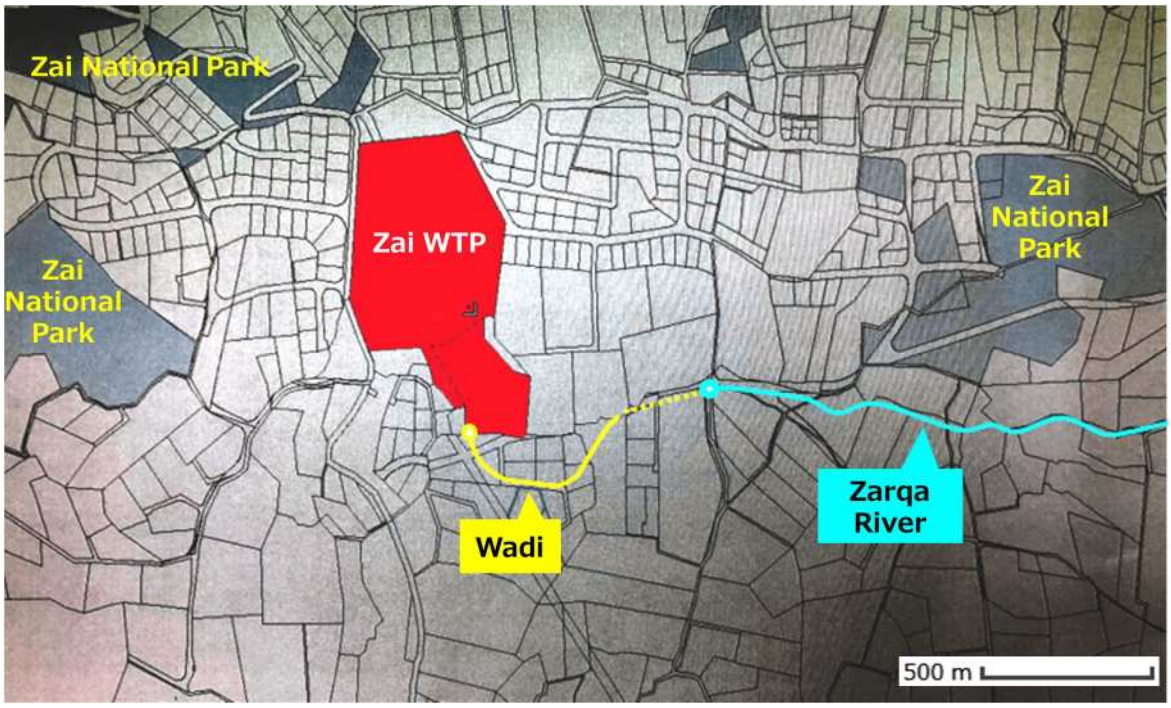
(Source: JICA Survey Team, taken in August 2019)

**Photo- 2 Current status of waste separation and collection**

(4) Zai National Park

Some parcels designated as "Zai National Park" (Figure 1.1) are scattered around the Zai WTP. These parcels are located at a distance of at least 500 m from the Zai WTP. Operation of the Zai WTP or implementation of the Project is not anticipated to affect the park.

According to the Natural Reserves and National Parks Regulations in Jordan, protected areas are divided into four types (Table 1.4). The natural reserves and national parks are not necessarily publicly owned lands. Article 6 of the regulations states that “The owners of these lands shall have the right to use their lands in a manner not in conflict with the protection objectives and the management plan of the Natural Reserve or National Park." In addition, Article 7 stipulates that "Issues concerning service revenue received from the Natural Reserves or National Parks and the relevant procedures and methods for keeping and spending such revenue shall be set in accordance with instructions issued by the Minister." Furthermore, Article 9 states that "Subject to the provisions of any other legislation, no person is permitted to carry out any activities within the boundaries of the Natural Reserve or National Park including the exploitation of the natural resources thereof, without the approval of the Specialized Entity managing the Natural Reserve or National Park, and in accordance with bases and conditions set pursuant to instructions issued by the Minister for this purpose." Based on the above provisions, it is considered that Natural Reserves and National Parks in Jordan are not inviolable protected areas but are designated conservation areas whose resources can be utilized.




(Source: JICA Survey Team)

**Figure 1.1 Location of Zai National Park around the Zai WTP**

**Table 1.4 Classification of protected areas in Jordan**

| | |
|---|---|
| **Natural Reserve** | An area of land, sea or water surface that contains ecosystems and special natural sanctuaries, and in which unique creatures live, and which is designated a natural reserve by decision of the Council of Ministers. |
| **National Park** | An area of land, water, coasts, oases, forests or archaeological locations designated a national park by decision of the Council of Ministers. |
| **Protected Land** | Any land designated as protected by decision of the Council of Ministers. |
| **Area of Special Protection** | An area containing a special ecosystem or wildlife threatened with extinction and needing special protection to ensure the preservation of the ecosystems and wildlife. |

(Source: Regulations No. (29) of 2005 Natural Reserves and National Parks Regulations)

(5) Outflow Condition of Sludge Generated in the Water Treatment Process

The sludge discharged from outlet of the Zai WTP reaches to the Zarqa River after travelling about 600 m through a channel. As noted during the field survey, the river water with the sludge disappears due to infiltration after it flows down around 10 km from the discharged point.

The values of pH and electrical conductivity (hereinafter referred to as "EC") of the sludge discharged from the Zai WTP were tracked along the channel. Although slight differences were observed along the channel, in general, they showed weak alkalinity (pH 7.82-8.53) and EC values (113-130 mS $m^{-1}$) similar to those of KAC from which the raw water of the Zai WTP comes.

The chemical properties of sludge discharged from the Zai WTP were analyzed multiple times by National Agriculture Research Center (hereinafter referred to as "NARC"). The analysis results have proved that the sludge does not contain any components which affect the natural environment or health (Table 1.5).

**Table 1.5 Chemical properties of the sludge**

| Items | Values | | Items | Values | |
|---|---|---|---|---|---|
| pH | 7.5 | — | Total phosphorus (P) | 1.20 | g $kg^{-1}$ |
| Electric Conductivity | 6.7 | S $m^{-1}$ | Potassium (K) | 0.86 | g $kg^{-1}$ |
| Ash | 27.2 | % (wt.) | Magnesium (Mg) | 2.91 | g $kg^{-1}$ |
| Water content | 9.4 | % (wt.) | Manganese (Mn) | 0.24 | g $kg^{-1}$ |
| Organic matter | 63.4 | % (wt.) | Zinc (Zn) | 0.71 | g $kg^{-1}$ |
| Calcium (Ca) | 38 | g $kg^{-1}$ | Cupper (Cu) | 0.12 | g $kg^{-1}$ |
| Iron (Fe) | 26 | g $kg^{-1}$ | CN Ratio | 73 | — |
| Total nitrogen (N) | 4.62 | g $kg^{-1}$ | Cadmium | <0.0012 | mg $kg^{-1}$ |

(Source: NARC Certificate of Analysis (COA) No. F18 / 08/14 (August 9, 2018))

According to hearing survey from the Zai WTP, complaints were raised by neighboring residents in the past regarding the discharged sludge, but no clear record was observed. In contrast, some residents use supernatant of the sludge for agriculture. Therefore, it is concluded that there is no social impact at present by the discharged sludge.

#### 1.2.2.2 Social conditions

(1) Population

Amman, the main beneficiary area of the Project, is the most populous city in Jordan. Table 1.6 shows the population of Amman from 2011 to 2016 as provided by the Department of Statistics (hereinafter referred to as "DOS"). The estimated population of Amman at the end of 2018 was 4,317,800, of which 2,034,066 (47%) were women and 2,283,734 (53%) were men. The population density is estimated to be 3,143 people / $km^2$.

**Table 1.6 Population trends in Amman**

| Year | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|
| Population | 2,940,200 | 3,122,700 | 3,411,400 | 3,701,500 | 4,019,100 | 4,119,500 |

(Source: DOS, Jordan)

According to statistical data of the Balqa Governorate, there were 7,906 people (1,449 households) in Deir Alla area in 2018, where the intake facilities and pumping station of the Zai Water Supply System are located. Of these, 4,690 (59%) were male and 3,216 (41%) were female. The estimated population

in the Zai area was about 21,000 as of the end of 2018, accounting for about 4% of the population in the Balqa Governorate. The ratio of male and female in the total population was almost 50% each.

(2) Education

In Jordan, the Ministry of Education administers various stages of education starting from kindergarten up to secondary levels and covers both academic and vocational education. The Jordanian Armed Forces and the United Nations Relief and Works Agency for Palestine Refugees (hereinafter referred to as "UNRWA") also have their own educational facilities. The Ministry of Higher Education and Scientific Research supervises education in the Jordanian universities and the community colleges. According to statistics of the Ministry of Education, the total number of schools in 2017 was 7,227 and the total number of students was 1,992,481 in Jordan. The numbers of schools and students in Amman and Deir Alla in 2017-2018 are shown in the Tables 1.7-1.10

**Table 1.7 The number of schools in Amman in 2017-2018**

| Education system | Public schools | | Private school | UNRWA administrative | Total |
|---|---|---|---|---|---|
| | Ministry of Education | Other governmental | | | |
| All-male school | 839 | 6 | 1416 | 75 | 2336 |
| All-female school | 151 | 1 | 6 | 33 | 191 |
| Co-education school | 374 | 0 | 1386 | 8 | 1768 |

(Source: Ministry of Education, http://www.moe.gov.jo/en/reports, 2019-08-31 accessed)

**Table 1.8 The number of students in Amman in 2017-2018**

| Education system | Public schools | | Private school | UNRWA administrative | Total |
|---|---|---|---|---|---|
| | Ministry of Education | Other governmental | | | |
| All-male school | 190,012 | 162,211 | 2,103 | 25,316 | 379,642 |
| All-female school | 227,351 | 122,414 | 1,150 | 24,963 | 375,878 |
| Co-education school | (N/A) | (N/A) | (N/A) | (N/A) | (N/A) |

(Source: Ministry of Education, http://www.moe.gov.jo/en/reports, 2019-08-31 accessed)

**Table 1.9 The number of schools in Deir Alla in 2017-2018**

| Education system | Public schools | | Private school | UNRWA administrative | Total |
|---|---|---|---|---|---|
| | Ministry of Education | Other governmental | | | |
| All-male school | 20 | 0 | 0 | 1 | 21 |
| All-female school | 2 | 0 | 0 | 1 | 3 |
| Co-education school | 26 | 0 | 11 | 0 | 37 |

(Source: Ministry of Education, http://www.moe.gov.jo/en/reports, 2019-08-31 accessed)

**Table 1.10 The number of students in Deir Alla in 2017-2018**

| Education system | Public schools | | Private school | UNRWA administrative | Total |
|---|---|---|---|---|---|
| | Ministry of Education | Other governmental | | | |
| All-male school | 7,796 | 0 | 766 | 254 | 8,816 |
| All-female school | 7,744 | 0 | 513 | 229 | 8,486 |
| Co-education school | (N/A) | (N/A) | (N/A) | (N/A) | (N/A) |

(Source: Ministry of Education, http://www.moe.gov.jo/en/reports, 2019-08-31 accessed)

In Zai District[7], which lies under the Salt Directorate of the Ministry of Education, 9 Co-ed schools, 8 male schools, and 1 female school exist. The available information shows one male secondary school in Zai town.

(3) Health Facilities

Table 1.11 summarizes the number of medical facilities in the Project site in 2016. Medical facilities in Jordan are broadly divided into national, military and private institutions. It is said that the medical standards in Jordan are relatively high among the Arab countries. However, large influxes of Syrian refugees have been a heavy burden on domestic health services since the starting of Syrian conflict in 2011. Village health centers (hereinafter referred to as "VHC") are set up in villages in Jordan. There are 10 VHCs in Amman, 15 in the Balqa Governorate, of which 10 are located in Deir Alla according to the Ministry of Health's data for 2016 (Table 1.12).

**Table 1.11 The number of medical facilities at the Project site in 2016**

| Governorate | Ministry of Health | | Private | | Other Governmental | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Hospitals | Beds | Hospitals | Beds | Hospitals | Beds | Hospitals | Beds |
| Amman | 5 | 1,876 | 44 | 3,794 | 9 | 2330 | 58 | 8,000 |
| Balqa Governorate | 5 | 657 | 1 | 126 | 0 | 0 | 6 | 783 |

(Source: Ministry of Health, 2016)

**Table 1.12 The number of health related facilities at the Project site in 2016**

| Governorate | VHCs | Dental Clinic | Pharmacies |
|---|---|---|---|
| Amman | 10 | 48 | 36 |
| Balqa Governorate | 15 | 29 | 25 |
| Deir Alla | 4 | 14 | 11 |

(Source: Ministry of Health, 2016)

[7] Zai District: administrative district
Zai area: town area and suburb
Zai town: town area

Table 1.13 to 1.15 summarize the waterborne disease and national nutritional status in Jordan.

**Table 1.13 Status of diarrhoeal diseases in Jordan (Unicef, 2017)**

| Parameter | Number |
|---|---|
| Number of total neonatal deaths | 2,602 |
| Number of total post-neonatal deaths | 1,660 |
| ・ Number of neonatal deaths due to diarrhoea | (No data) |
| ・ Number of post-neonatal deaths due to diarrhoea | 117 |
| ・ Number of under-five deaths due to diarrhoea | 117 |
| ・ Neonatal death rate from diarrhoea (per 1,000 live births) | (No data) |
| ・ Post-neonatal death rate from diarrhoea (per 1,000 live births) | 0.5% |
| ・ Under-five death rate from diarrhoea (per 1,000 live births) | 0.5% |
| ・ % neonatal deaths due to diarrhoea | (No data) |
| ・ % post-neonatal deaths due to diarrhoea | 7.0% |
| ・ % under-five deaths due to diarrhoea | 2.7% |

(Source: https://data.unicef.org/topic/child-health/diarrhoeal-disease/)

**Table 1.14 Major etiology of waterborne diseases in children under 5 years of age (2015)**

| Disease (Bacteria/Virus) | Percentage |
|---|---|
| *Vibrio cholerae* | 13.3% |
| Rotavirus | 6.8% |
| *Salmonella* | 4.9% |
| Enterotoxigenic *Escherichia coli* | 2% |
| Adenovirus | 3% |
| *Entamoeba histolytica* | 1% |
| *Aeromonas hydrophila* | 7% |
| *Shigella* spp | 0.3% |
| *Cryptosporidium* spp | 0.2% |
| Enteropathogenic *Escherichia coli.* | 0.2% |
| Norovirus | 0.2% |
| *Clostridium difficile* | 0.2% |

(Source: Troeger, C., Blacker, B. F., Khalil, I. A, Rao, P. C., Cao, S. Z., Stephanie R. M.,…Reiner, R. C., (2017). Estimates of global, regional, and national morbidity, mortality, and aetiologies of diarrhoeal diseases: a systematic analysis for the Global Burden of Disease Study 2015. LANCET INFECTIOUS DISEASES, 17 (9), 909-948.）

**Table 1.15 National nutritional status in Jordan**

| Indicators of Nutritional status | Number | Statistical year |
|---|---|---|
| Undernourished people | 1.3 million | 2015-17 |
| Severe food insecurity in the total population | 1.3 million | 2017 |
| Wasting in children (under 5 years of age) | N/A | 2017 |
| Stunting in children (under 5 years of age) | N/A | 2017 |
| Overweight in children (under 5 years of age) | N/A | 2017 |
| Prevalence of obesity in the adult population (18 years and older) | 1.6 million | 2016 |
| Anaemia among women of reproductive age (15–49) | 0.7 million | 2016 |
| Exclusive breastfeeding among infants 0–5 months of age | N/A | 2017 |

(Source: FAO, IFAD, UNICEF, WFP and WHO. *The State of Food Security and Nutrition in the World*. Food and Agriculture Organization of the United Nations, Rome, 2018)

(4) Economic Activity

The World Bank classifies Jordan as a lower middle-income country. According to The World Factbook 2019[8], the GDP per capita of Jordan was approximately 8,720 JOD in 2019 with 2.1% of the GDP growth rate per annum and the consumer price index was 115.5. The following three main economic sectors contribute to the GDP of Jordan:

- Agriculture: 4.3% (3.8% according to the DOS)
- Industry: 28.9%
- Services: 66.8%

In Deir Alla and Zai Districts, the most common means of livelihood are either agriculture or governmental sectors. Industrial activities in these areas are limited to small hardware workshops in photo-3 below.


a) Town street in Deir Alla area

b) Agricultural land in Deir Alla area

c) Town street in Zai area

d) Sheep farming in Zai area (in front of the Zai WTP)

(Source: JICA Survey Team, taken in August 2019)

**Photo- 3 General views of Deir Alla and Zai area**

[8] https://www.cia.gov/library/publications/the-world-factbook/

#### 1.2.2.3 System and organizations related to environmental and social considerations

(1) Relevant Laws and Regulations

In Jordan, the Environmental Protection Law No. 52 of 2006 is the basic law that governs highest-level framework for environmental protection. This Law consists of 27 articles. Articles 1 and 2 define basic concepts such as environment, pollution, environmental protection, and sustainable development. Articles 3 to 5 describe role and functions of the Ministry of Environment (hereinafter referred to as "MOE") as a competent authority for protection of environment. Article 6 deals with the regulation on prohibition of hazardous wastes and Article 7 assigns the environmental monitoring and inspection responsibilities to MOE. Other articles of the Law cover prohibition of marine and coastal water pollution (Article 8 and 9), handling and disposal of harmful materials (Article 10), regulations and penalties for noise generation (Article 11), and requirements for conducting Environmental Impact Assessment for projects (Article 13).

Furthermore, environmental studies from the financial and technical standpoints (Article 14), establishment of a Consultative Committee (Article 15), establishment of Environmental Protection Fund (Articles 16 and 17), violation and punishment for activities in the Protected Areas (Article 18), obligation of necessary measures to prevent environmental pollution (Article 19), delegation of duties and powers to other organizations (Articles 22 to 24) and mandate of MOE to issue a number of bylaws (Article 25) are also included and described in the Law.

Based on the Article 23 of this Law, Environmental Impact Assessment Regulations of 2005 (By-law No. 37 of 2005) was enacted in March 2005. The regulation is composed of 21 Articles and 5 Annexes. Annexes 2 and 3 list the projects that require Comprehensive Environmental Impact Assessment (Comprehensive EIA) and Preliminary EIA, respectively (Table 1.16 and Table 1.17). The Project, which includes renewal and replacement of equipment only at the existing water supply facilities, does not require Comprehensive or Preliminary EIA and no environmental clearance is necessary for the Project implementation in accordance with Jordan's current laws and regulations.

**Table 1.16 Projects which need comprehensive EIA in Jordan**

| | |
|---|---|
| 1. | Raw petroleum refining |
| 2. | Electricity generating plants |
| 3. | An establishment designed as permanent store or as landfill for the radioactive nuclear wastes |
| 4. | Iron and steel factories |
| 5. | Establishments for extracting, treatment, or conversion of the asbestos and the facilities which include asbestos as a part of their structure |
| 6. | Integrated chemical industries such as:<br>1) Petrochemicals<br>2) Fertilizers, pesticides and peroxides industries<br>3) Chemical products, petrochemicals and petroleum storage facilities |
| 7. | Roads, airports and rails construction projects |
| 8. | Hazardous wastes treatment plants and disposal from these wastes |

| |
|---|
| 9. Establishing the industrial cities |
| 10. Extraction industries<br>1) The excavating processes for water and the geo-thermal digging except the digging for investigating the soil<br>2) Mining processes and relevant industries<br>3) Natural gemstone extraction |
| 11. Energy generation industries<br>1) The industrial establishments which generate electricity, vapor, hot water<br>2) The industrial establishments which convey gas, vapor, hot water and electrical energy<br>3) Natural gas surface storage<br>4) Flammable gases storage; underground or surface<br>5) Fossil fuels surface storage |
| 12. Tanning (leathers) factories |
| 13. Sugar factories |
| 14. Yeast factories |
| 15. Construction of marine ports |
| 16. Establishing ships and boats for industrial and recreational purposes |
| 17. Sea dumping for using the land in industrial and recreational uses |
| 18. Glass factories |
| 19. Establishing slaughterhouses (abattoirs) |

(Source: Annex (2), EIA Regulation No. (37) of 2005)

**Table 1.17 Projects which need preliminary EIA in Jordan**

| |
|---|
| 1. Agriculture projects<br>1) Poultry farms if the capacity exceed 30,000 birds<br>2) Cow/dairy farms if the capacity exceed 50,000 cows<br>3) Sheep farms if the capacity exceed 1,000 sheep |
| 2. Minerals treatment projects<br>1) Iron and steel works including galvanizing and varnish factories<br>2) Establishments producing non-iron minerals including production, purification (washing), liquefying, demonetizing (pulling) and galvanizing processes<br>3) Compressing bullions<br>4) Treatment of mineral surfaces and covering (coating)<br>5) Boilers, cisterns, tanks, industrialized from minerals plates<br>6) Establishments for felting and scorching (roasting) raw minerals<br>7) Complexes industry and aligning (collecting) |
| 3. Food industries<br>1) Oils, animal and vegetable fats<br>2) Bottling, packaging the animal and vegetable products<br>3) Milk products industry |
| 4. Fabric, leather, wood, papers and tissues industries |
| 5. Rubber industry |
| 6. Infrastructure projects including housing projects |
| 7. Other projects<br>2) Municipal landfills<br>3) Landfill for disposal of junk<br>4) Sports activities centers<br>5) Junk storage establishments |
| 8. Any additions, amendments on the projects that is mentioned in this annex |

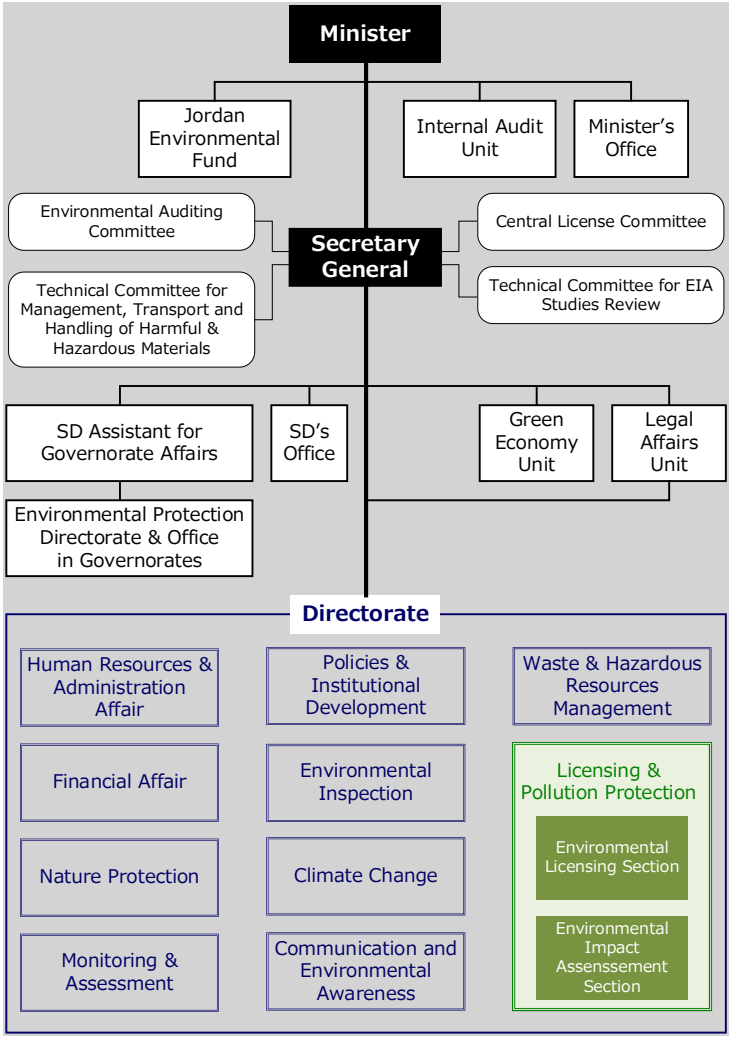
(Source: Annex (3), EIA Regulation No. (37) of 2005)

(2) Related Organizations

MOE is responsible for ensuring proper legal compliance through the development, licensing, and

monitoring of environmental policies and regulations. MOE also designates national parks, natural reserves and other protected areas and administrates the appropriate management of these designated areas.

Figure 1.2 illustrates the organization chart of the MOE as of August 2019. The environmental impact assessment is divided into Environmental Licensing Section and Environmental Impact Assessment Section in the Directorate of Licensing & Pollution Prevention.




(Source: JICA Survey Team)

**Figure 1.2 Organization chart of MOE as of August 2019**

(3) Differences between JICA Guidelines and Jordanian EIA Regulations

To meet the requirements of the Japanese ODA Grant Aid in order to implement a Project, not only compliance with the Jordanian environmental laws and regulations, but also with Japan International Cooperation Agency (JICA) Guidelines for Environmental and Social Considerations (April 2010) must be observed. Table 1.18 shows the differences between the two regulations.

**Table 1.18 Comparison between JICA guidelines and EIA regulations in Jordan**

| Content | JICA Guidelines for Environmental and Social Considerations 2010 | Environmental Impact Assessment Regulations of 2005 (By-law No.37 of 2005) | Difference between JICA Guidelines and Jordanian EIA Regulations /Action to be taken |
|---|---|---|---|
| Introduction | (N/A) | (N/A) | No gap. |
| Executive Summary | Concise discussion with significant findings and recommended actions required. | Annex (5): A condensed summary is required with a brief analysis of the outcomes (conclusions) and recommendations in two versions (Arabic and English). | Basically No difference. However, Arabic version of the summary should be prepared. |
| Legal framework on environmental and social considerations | Requires that projects do not deviate significantly from the World Bank's Safeguard Policies and refers as a benchmark to the standards of international financial organizations. | (N/A) | A few differences:<br>- The EIA guidelines and standards in global treaties, international organizations and/or international development partners should be referred. |
| Environmental Impacts | Requires to predict and assess the project's likely positive and negative impacts in quantitative terms, to the extent possible. It also requires to identify mitigation measures and any negative environmental impacts that cannot be mitigated and to explore opportunities for environmental enhancement. Similarly, identification and estimate of the extent and quality of available data, essential data gaps and uncertainties associated with predictions is required. It specifies topics that do not require further attention. | - Article 11<br>- APPENDIX (5):<br>・ Environmental Impacts | A few differences:<br>- The process leading up to the scoping and background of EIA item selection needs to be explained.<br>- The degree of uncertainty in EIA and additional future environmental impact caused by such uncertainty needs to be mentioned.<br>- Some environmental/social information can be added based on the final scoping drafts and results of the supplemental survey. |
| Analysis of Alternatives | Requires to systematically compare feasible alternatives to the proposed project site, technology, design, and operation including "Zero-Option" (without project) situation in terms of the following: the potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives environmental impacts should be quantified to the extent possible, and economic values should be attached where feasible. It also states the basis for selecting the proposed project design should be provided and justification for recommended emission levels and approaches to pollution prevention and abatement should be offered. | - APPENDIX (1):<br>・ Paragraph 2<br>- APPENDIX (5):<br>・ Analysis of Alternatives: | A few differences:<br>- "Zero-Option" (without project) needs to be examined.<br>- The degree of environmental impact of each alternative plan needs to be assessed in a quantitative manner. |
| Mitigation Measures | Requires to identify mitigation measures and any negative environmental impacts that | - APPENDIX (5):<br>・ Mitigation Plan | No difference. |

| Content | JICA Guidelines for Environmental and Social Considerations 2010 | Environmental Impact Assessment Regulations of 2005 (By-law No.37 of 2005) | Difference between JICA Guidelines and Jordanian EIA Regulations /Action to be taken |
|---|---|---|---|
| | cannot be mitigated and explore opportunities for environmental enhancement. | | |
| Environmental Management Plan | Requires to describe mitigation, monitoring, and institutional measures to be taken during construction and operation to eliminate adverse impacts, offset them, or reduce them to acceptable levels. | - APPENDIX (5):<br>・ Mitigation Plan<br>・ Monitoring and Environmental Post Auditing Plan | No difference. However, In the case of monitoring items are added or changed based on supplementary findings, it is necessary to deal with the plan. |
| Budget, financial sources and implementation arrangements | Appropriate follow-up plans and systems, such as monitoring plans and environmental management plans, must be prepared; the costs of implementing such plans and systems, and the financial methods to fund such costs, must be determined. Plans for projects with particularly large potential adverse impacts must be accompanied by detailed environmental management plans. | - Article 20:<br>・ Paragraph B<br>- APPENDIX (5):<br>・ Analysis of Alternatives<br>・ Mitigation Plan<br>・ Monitoring and Environmental Post Auditing Plan | No difference. However, in the case of mitigation measures and/or monitoring items are added or changed based on supplementary findings, it is necessary to modify the cost. |
| Public Consultation with Stakeholder Meeting | In preparing EIA reports, consultations with stakeholders, such as residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared. | - APPENDIX (5):<br>・ Appendices | A few differences:<br>- Another stakeholder meeting needs to be conducted at the preparation stage of scoping drafts. |
| Information Disclosure | Requires to disclose the results of such categorization on its website including the name of each project and its country, location, project outline, category, and its reason before making the decision to undertake preparatory surveys. | (N/A) | Environmental Protection Law and Environmental Impact Assessment Regulations don't stipulate any information disclosure system. Website of MOE does not have information disclosure page for EIA results. The implementing agency of projects needs to disclose the EIA results independently. |

(Source: JICA Survey Team)

#### 1.2.2.4 Scoping results of natural and social environmental survey

Table 1.19 shows the results of scoping and anticipated impacts without avoidance or mitigation measure based on impact item according to the JICA Guidelines for Environmental and Social Considerations.

**Table 1.19 Results of scoping**

| Item | Impact | | Rating: Pre-/ Construction Phase | Rating: Operation Phase | Results |
|---|---|---|---|---|---|
| Pollution Controll | 1 | Air Quality | B- | D | **Pre-/Construction phase:** Air pollutants (SOx, NOx, etc.) and dust will be generated through the operation of heavy machinery and trucks, but the impact will be limited to the surrounding area.<br>**Operation phase:** Air pollutants and dust will not be generated by the operation of the facilities. |
| | 2 | Water Quality | D | D | **Pre-/Construction phase and Operation phase:** No specific impacts to natural water quality are anticipated both in construction period and operation period.<br>(Note: The supernatant water of sludge released outside the Zai WTP does not cause water pollution as it does not contain any hazardous components.) |
| | 3 | Soil Quality | D | D | **Pre-/Construction phase and Operation phase: No** soil pollution and soil erosion are predicted by the Project implementation.<br>(Note: The supernatant water of sludge released outside the water treatment plant does not cause soil pollution as it does not contain any hazardous components .) |
| | 4 | Sediment | D | D | **Pre-/Construction phase and Operation phase:** Sediment pollution and adverse impacts on aquatic life will not be caused by the Project.<br>(Note: It was confirmed that sludge generated at the Zai WTP and released outside did not have hazardous components including harmful heavy metals.) |
| | 5 | Noise and Vibration | B- | D | **Pre-/Construction phase:** The operation of heavy machinery and trucks will cause noise and vibration, but it will be limited to the surrounding area.<br>**Operation phase:** No specific noise or vibration is expected. |
| | 6 | Odor | D | D | **Pre-/Construction phase and Operation phase:** No odor is predicted by the Project implementation. |
| | 7 | Waste | B- | D | **Pre-/Construction phase:** General, domestic and industrial wastes are generated in the construction phase.<br>**Operation phase:** No waste is expected.<br>(Note: Sludge generated through the water treatment process will be properly disposed by the Jordan Government according to its commitment made in July 2019.) |
| | 8 | Subsidence | D | D | **Pre-/Construction phase and Operation phase:** There is no possibility of land subsidence due to Project activities. |
| Natural Environment | 9 | Protected Area | D | D | **Pre-/Construction and Operation phase:** Zai National Park is located near the Zai WTP. However, no specific negative impact is expected because the Project renovates/renews the facilities only in the existing properties. |
| | 10 | Ecosystem | D | D | **Pre-/Construction phase and Operation phase:** No major impact to local/regional ecosystem is anticipated due to Project activities which mainly involve renovation/renewal of facilities in the existing properties. |
| | 11 | Topography and Geology | D | D | **Pre-/Construction and Operation phase:** The Project activities which mainly involve renovation/renewal of the facilities, will be conducted in the existing properties, and will not cause any changes in topography or geology. |
| Social Environment | 12 | Land acquisition and Resettlement | D | D | **Pre-construction/Construction phases and Operation phase:** The final disposal site for sludge generated at the Zai WTP will be secured by the Jordanian Government before the Project is implemented. The Project activities which mainly involve renovation/renewal of the facilities require no land acquisition or resettlement. |
| | 13 | Poor People | D | D | **Pre-/Construction and Operation phase:**. There is no possibility of Project activities adversely affecting people's livelihood. Conversely, positive impacts may be predicted due to stable water supply by the Project implementation. |
| | 14 | Ethnic Minority Groups and Indigenous People | D | D | **Pre-/Construction and Operation phase:**. There is no specific negative impact anticipated. |
| | 15 | Deterioration of Local Economy | D | D | **Construction and Operation phase:** The Project will not cause any adverse effect to the local economy. |
| | 16 | Land Use and Utilization of Local Resources | D | D | **Pre-/Construction and Operation phase:**. There is no specific negative impact anticipated. |
| | 17 | Disturbance to Water Usage, Water Rights, etc. | D | D | **Pre-/Construction and Operation phase:**. The Project will not affect existing water usage and water rights because there are no changes to the water intake volume from the water source and water supply plan to the distribution area. |
| | 18 | Disturbance to the Existing Social Infrastructure and Services | D | D | **Pre-/Construction and Operation phase:** No major impact is anticipated. |
| | 19 | Social Institutions such as Social Infrastructure and Local Decision- | D | D | **Pre-/Construction and Operation phase:** No specific impacts to the local communities are anticipated both in construction and operation phases. |

| Item | | Impact | Rating: Pre-/ Construction Phase | Rating: Operation Phase | Results |
|---|---|---|---|---|---|
| | | making Institutions | | | |
| | 20 | Misdistribution of Benefits and Losses | D | D | **Pre-/Construction and Operation phase:** There is no specific negative impact anticipated in terms of misdistribution of benefits and losses. |
| | 21 | Local Conflicts of Interest | D | D | **Pre-/Construction and Operation phase:** No local conflicts of interest is expected to arise due to the implementation of the Project. |
| | 22 | Cultural Heritage | D | D | **Pre-/Construction and Operation phase:** There are no cultural heritages around the Project site according to the Department of Land and Survey. |
| | 23 | Landscape | D | D | **Pre-/Construction and Operation phase:** The Project will not affect local landscape because it is implemented in the existing properties. |
| | 24 | Gender | D | D | **Pre-/Construction and Operation phase:** No specific impact is expected to gender issues. |
| | 25 | Children's Rights | D | D | **Pre-/Construction and Operation phase:** No specific impact is expected on children's rights. |
| | 26 | Infectious Diseases such as HIV/AIDS | D | D/B+ | **Pre-/Construction and Operation phase:** The Project does not need massive influx of construction workers and is less likely to trigger infectious disease epidemic. Conversely, positive impacts for disease prevention may be predicted due to stable water supply by the Project implementation in the future. |
| | 27 | Work Environment (Including Work Safety) | B- | D | **Pre-/Construction phase:** Risks of accidents are high through the construction work.<br>**Operation phase:** No major impact is anticipated. |
| Other | 28 | Accidents | B- | B- | **Pre-/Construction phase:** Accidents may occur due to the constrution work. Also traffic accidents may occur due to increase in traffic volume.<br>**Operation phase:** Accidents can occur during operation and maintenance work. |
| | 29 | Cross-boundary Impact and Climate Change | D | D | **Pre-/Construction and Operation phase:** No impact on climate change is predicted although $CO_2$ will be produced in the construction work at relatively limited scale. |

Note:
A+/-: Significant positive/negative impact is expected,
B+/-: Positive/negative impact is expected to some extent,
C+/-: Extent of positive/negative impact is unknown (further examination is needed, and the impact may be clarified as the study progresses)
D: No impact is expected.
(Source: JICA Survey Team)

### 1.2.2.5 TOR for natural and social environmental survey

Table 1.20 shows the terms of reference (hereinafter referred to as "TOR") for the natural and social environmental survey based on the scoping result.

**Table 1.20 TOR for natural and social environmental survey**

| Environmental Item | Survey Item | Survey Method | Possible Countermeasures |
|---|---|---|---|
| Air Quality | ・ Related standard<br>・ Existing condition of air quality | ・ Collection of the national air quality standards<br>・ Confirmation of emission source of air pollutants at the Project site | ・ Consideration of antipollution measures in the construction phase |
| Noise and Vibration | ・ Related standard<br>・ Existing level of noise and vibration | ・ Collection of the national standards for noise and vibration<br>・ Confirmation of generation source of noise and vibration at the Project site | ・ Consideration of mitigation measures for noise and vibration in the construction phase |
| Waste | ・ Confirmation of the existing condition of waste handling in the water supply facilities | ・ Site observation and discussion with relevant staff-members | ・ Consideration of disposal plan for industrial and domestic wastes in the construction phase |

| Environmental Item | Survey Item | Survey Method | Possible Countermeasures |
|---|---|---|---|
| Work Environment (Including Work Safety) | ・ Existing status of safety measures at work sites | ・ Site observation and discussion with relevant staff-members | ・ Thorough safety measures to prevent work accidents |

(Source: JICA Survey Team)

### 1.2.2.6 Environmental and social survey results

(1) Ambient Air Quality

The National Air Quality Standards of Jordan and the guideline values of World Health Organization (hereinafter referred to as "WHO") are given in Table 1.21.

**Table 1.21 National ambient air quality standards in Jordan**

| Pollutants | Duration | Maximum allowable limits | Allowable times for exceeding limits | Expected health effects due to exposure |
|---|---|---|---|---|
| **$SO_2$** | 1-hour mean | 3μg $m^{-3}$ | 3 times during a year | 1. Respiratory system<br>• Lungs<br>• Inflammation of the respiratory tract<br>• Shortness of breath<br>• Coughing<br>• Mucus secretion<br>• Asthma<br>2. Cardiac diseases<br>3. Mortality |
| | 24-hour mean | 140 μg $m^{-3}$ (WHO: 20 μg $m^{-3}$) | Once a year | |
| | Annual mean | 40 μg $m^{-3}$ | — | |
| **CO** | 1-hour mean | 26 μg $m^{-3}$ | 3 times a year | • Headache<br>• Dizziness<br>• Vomiting<br>• Nausea<br>• Unconsciousness or death as CO binds preferentially to hemoglobin<br>• Reduced work capacity<br>• Reduced mental function<br>• Poor learning ability<br>• Heart diseases<br>The early symptoms of CO poisoning are compared to food poisoning symptoms:<br>• Headache<br>• Dizziness<br>• Weakness and clumsiness<br>• Nausea and vomiting<br>• Quick irregular heartbeat<br>• Chest pain<br>• Hearing loss<br>• Blurry vision<br>• Disorientation or confusion seizures |
| | 8-hour mean | 9 μg $m^{-3}$ | 3 times a year | |
| **$NO_2$** | 1-hour mean | 210 μg $m^{-3}$ (WHO: 200 μg $m^{-3}$) | 3 times a year | • Bronchitis & impaired lung development in asthmatic children |

| Pollutants | Duration | Maximum allowable limits | Allowable times for exceeding limits | Expected health effects due to exposure |
|---|---|---|---|---|
| | 24-hour mean | 80 μg $m^{-3}$ | 3 times a year | • Reduced lung function growth<br>• Inflammation of the lining of the lungs<br>• Reduced immunity to lung infections<br>• Wheezing<br>• Coughing<br>• Colds<br>• Flu |
| | Annual mean | 50 μg $m^{-3}$ (WHO: 40 μg $m^{-3}$) | — | |
| **$H_2S$** | 1-hour mean | 0.03 μg $m^{-3}$ | 3 times a year | • Irritation of eyes, nose, and throat<br>• Bronchial constriction in asthmatic individuals, spontaneous abortion<br>• Increased blood lactate concentration, decreased skeletal muscle citrate synthase activity<br>• Headache, dizziness, nausea, vomiting, coughing, difficulty in breathing<br>• Olfactory paralysis<br>• Severe respiratory tract irritation, eye irritation/acute conjunctivitis, shock, convulsions, coma and death in severe cases |
| | 24-hour mean | 0.01 μg $m^{-3}$ | 3 times a year | |
| **$O_3$** | 8-hour mean | 80 μg $m^{-3}$ (WHO: 100 μg $m^{-3}$) | — | • Breathing problems<br>• Irritation of the mucous membranes of the nose, throat and airways<br>• Triggering of asthma<br>• Reduced lung function<br>• Cough<br>• Chest pain<br>• Throat and eye irritation<br>• Lung diseases |
| | 1-hour mean | 120 μg $m^{-3}$ | — | |
| **$NH_3$** | 24-hour mean | 270 μg $kg^{-1}$ | 3 times a year | • Burning of the nose, throat and respiratory tract<br>• Bronchiolar and alveolar edema<br>• Airway destruction resulting in respiratory distress or failure<br>• Coughing<br>• Nose and throat irritation<br>• Olfactory fatigue<br>• Skin or eye irritation |
| | Annual mean | 8 μg $kg^{-1}$ | — | |
| **PM10** | 24-hour mean | 120μg $m^{-3}$ (WHO: 50 μg $m^{-3}$) | 3 times a year | • Coughing<br>• Wheezing<br>• Asthma attacks<br>• Bronchitis<br>• High blood pressure<br>• Heart attack<br>• Strokes<br>• Premature death<br>• Cancer |
| | Annual mean | 70μg $m^{-3}$ (WHO: 20 μg $m^{-3}$) | — | |

| Pollutants | Duration | Maximum allowable limits | Allowable times for exceeding limits | Expected health effects due to exposure |
|---|---|---|---|---|
| **PM2.5** | 24-hour mean | 65μg $m^{-3}$ (WHO: 25μg $m^{-3}$) | 3 times a year | • Mortality risk, particularly from cardiovascular causes<br>• Lung diseases<br>• Heart diseases<br>• Increased deaths |
| | Annual mean | 15 μg $m^{-3}$ (WHO: 10μg $m^{-3}$) | — | |

(Source：Jordan Institution for Standards and Metrology)

No air quality monitoring data was available for Deir Alla and Zai areas where the Project is to be implemented. Based on the survey, vehicular traffic was light in both areas. There are no air pollution sources associated with industrial activities and air quality was observed as extremely clear. The following photo-4 show the air quality condition at the Project site.

a) Environs of the Zai WTP

b) Distant view from the pumping station (PS1)

(Source: JICA Survey Team, taken in August 2019)

**Photo- 4 Air quality condition at the Project site**

Dust will be generated due to traffic of construction vehicles but the impact will be temporary. Generation of air pollutants (SOx, NOx, etc.) could be expected from operation of heavy machinery and trucks but the impact will be limited to the surrounding area. To reduce dust generation due to traffic in dry season, watering of roads and construction sites will be effective. Speed of the vehicles will be limited and periodic maintenance of all construction machinery and vehicles will be conducted so that exhaust gas discharged from them will be reduced.

(2) Noise and Vibration

The ambient noise standards for various categories in Jordan are given in Table 1.22. Regulation related to vibration standards could not be found.

**Table 1.22 Ambient noise standards in Jordan**

| Area | Limit for Equivalent Sound Level dB(A) | |
|---|---|---|
| | 6:00～20:00 | 20:00～6:00 |
| Residential areas in cities | 60 dB(A) | 50 dB(A) |
| Residential areas in suburbs | 55 dB(A) | 45 dB(A) |
| Residential areas in villages | 50 dB(A) | 40 dB(A) |
| Residential areas that have some workshops or simple vocational activity or business and commercial and administrative areas and downtown | 65 dB(A) | 55 dB(A) |
| Industrial areas (heavy industrial) | 75 dB(A) | 65 dB(A) |
| Tuition, worshipping and treatment places and hospitals | 45 dB(A) | 35 dB(A) |

(Source Jordan Standards and Metrology Organization)

The noise and vibration generated during the construction phase will be temporary and almost limited to the existing facilities. Use of well-maintained low-noise construction vehicles and heavy equipment should be considered to reduce noise and vibration. In general, noise generated by construction vehicles can be complied with environmental standard of 50 dB or less if the speed of vehicle is limited to 40 km/hour.

(3) Solid waste

As explained above, contractors licensed by the government collect and treat solid waste in an appropriate manner. Therefore, if segregating solid waste appropriately at source and its recycling and reuse are carried out during the construction phase, water contamination and hygiene problems caused by solid waste can be prevented.

(4) Accident prevention

Preventive measures against work accidents and safety management are thoroughly practiced at every facility of the Zai Water Supply System in Photo-5 below. Safety management guidance is regularly provided through workshops and is also included as a training item for new employees. Therefore, new safety measures for the implementation of the Project are not required. Current guidance is expected to be continued.


a) Safety indications in IPS

b) Outdoor meeting point sign in IPS


c) Evacuation route map in the facility

d) Chemicals characteristics and management personnel table


e) Safety indications for chlorine dioxide injection facilities


f) MSDS posted in the laboratory

(Source: JICA Survey Team, taken in August 2019)

**Photo- 5 Status of work safety management in Zai Water Supply System**

### 1.2.2.7 Environmental impact evaluation

The results of environmental and social impact evaluation based on evaluation results of the scoping according to the JICA Guidelines for Environmental and Social Considerations are summarized in Table 1.23. Anticipated impacts are described in the table assuming that avoidance/mitigation measures are not taken.

**Table 1.23 Results of environmental and social impact evaluation for the Project**

| Item | Impact | | Assessment based on | | | | Results |
|---|---|---|---|---|---|---|---|
| | | | Scoping | | Survey result | | |
| | | | Pre- / construction Phase | Operation phase | Pre- / construction Phase | Operation phase | |
| Pollution Controll | 1 | Air Quality | B- | D | B- | D | **Pre-/Construction phase:** Air pollutants (SOx, NOx, etc.) and dust will be generated through the operation of heavy machinery and trucks, but the impact will be limited to the surrounding area. |
| | 2 | Water Quality | D | D | D | D | **Pre-/Construction phase and Operation phase:** No specific impacts to natural water quality are anticipated both in construction and operation phases. |
| | 3 | Soil Quality | D | D | D | D | **Pre-/Construction phase and Operation phase:** No adverse impacts on soil quality is anticipated by the Project. |
| | 4 | Sediment | D | D | D | D | **Pre-/Construction phase and Operation phase:** Sediment pollution and adverse impacts on aquatic life cannot be caused by the Project. |
| | 5 | Noise and Vibration | B- | D | B- | D | **Pre-/Construction phase:** The operation of heavy machinery and trucks will cause noise and vibration, but it will be limited to the surrounding area. |
| | 6 | Odor | D | D | D | D | **Pre-/Construction phase and Operation phase:** No odor is predicted in particular by the Project implementation. |
| | 7 | Waste | B- | B- | B- | B- | **Pre-/Construction phase and Operation phase:** General (domestic), industrial and hazardous wastes will be generated during the construction work.<br>**Operation phase:** Sludge will be generated from the Zai WTP. |
| | 8 | Subsidence | D | D | D | D | **Pre-/Construction phase and Operation phase:** There is no possibility of land subsidence due to Project activities. |
| Natural Environment | 9 | Protected areas | D | D | D | D | No specific negative impact is expected. |
| | 10 | Ecosystem | D | D | D | D | **Pre-/Construction and Operation phase:** Zai National Park is located near the Zai WTP. However, no specific negative impact is expected because the Project renovates/renews the facilities only in the existing properties. |
| | 11 | Hydrosphere | D | D | D | D | **Pre-/Construction phase and Operation phase:** No major impact to local/regional ecosystem is anticipated due to renovation/renewal of facilities in the existing properties. |
| | 12 | Topography and | D | D | D | D | **Pre-/Construction and Operation phase:** Renovation/ renewal |

| Item | | Impact | Assessment based on: Scoping: Pre- / construction Phase | Assessment based on: Scoping: Operation phase | Assessment based on: Survey result: Pre- / construction Phase | Assessment based on: Survey result: Operation phase | Results |
|---|---|---|---|---|---|---|---|
| | | Geology | | | | | of the facilities will be conducted in the existing properties which will not involve any changes in topography or geology. |
| Social Environment | 13 | Land acquisition | D | D | D | D | **Pre-construction/Construction and Operation phase:** The final disposal site for sludge generated at the Zai WTP will be secured by the Jordanian Government before the Project is implemented. Renovation/renewal of the facilities in the Project requires no land acquisition or resettlement. |
| | 14 | Disturbance to Poor People | D | D | D | D | **Pre-/Construction and Operation phase:** There is no possibility of adversely affecting people's livelihood. Conversely, positive impacts may be predicted due to stable water supply by the Project implementation. |
| | 15 | Disturbance to Ethnic Minority Groups and Indigenous People | D | D | D | D | **Pre-/Construction and Operation phase:** No specific negative impact is anticipated. |
| | 16 | Deterioration of Local Economy such as Losses of Employment and Livelihood Means | D | D | D | D | **Construction and Operation phase:** The Project will not affect the local economy. |
| | 17 | Land Use and Utilization of Local Resources | D | D | D | D | **Pre-/Construction and Operation phase:** No specific negative impact is anticipated. |
| | 18 | Disturbance to Water Usage, Water Rights, etc. | D | D | D | D | **Pre-/Construction and Operation phase:** The Project would not affect existing water usage and water rights because there are no changes to the water intake volume from the water source and water supply plan to the distribution area. |
| | 19 | Disturbance to the Existing Social Infrastructure and Services | D | D | D | D | **Pre-/Construction and Operation phase:** No major impact is anticipated. |
| | 20 | Social Institutions such as Social Infrastructure and Local Decision-making Institutions | D | D | D | D | **Pre-/Construction and Operation phase:** No specific impacts to the local communities are anticipated both in construction and operation phases. |
| | 21 | Misdistribution of Benefits and Losses | D | D | D | D | **Pre-/Construction and Operation phase:** No specific negative impact is anticipated in terms of misdistribution of benefits and losses. |
| | 22 | Local Conflicts of Interest | D | D | D | D | **Pre-/Construction and Operation phase:** No local conflicts of interest is likely to arise due to the implementation of the Project. |
| | 23 | Cultural Heritage | D | D | D | D | **Pre-/Construction and Operation phase:** There are no cultural heritages around the Project site according to the Department of Land and Survey. |
| | 24 | Landscape | D | D | D | D | **Pre-/Construction and Operation phase:** The Project will not affect local landscape because it is implemented in the existing propeties. |
| | 25 | Gender | D | D | D | D | **Pre-/Construction and Operation phase:** No specific impact is expected to gender issues. |
| | 26 | Children's Rights | D | D | D | D | **Pre-/Construction and Operation phase:** No specific impact is expected on children's rights. |
| | 27 | Infectious Diseases | D | D | D | D | **Pre-/Construction and Operation phase:** The Project does not need massive influx of construction workers and is less likelyto trigger infectious disease epidemic. Conversely, positive impacts for disease prevention may be predicted due to stable water supply by the Project implementation in the future. |
| | 28 | Work Environment | B- | D | D | D | **Pre-/Construction and Operation phase:**No major impact is anticipated. |
| Other | 29 | Accidents | B- | B- | D | D | **Pre-/Construction and Operation phase:**No major impact is anticipated. |
| | 30 | Cross-boundary Impact and Climate Change | D | D | D | D | **Pre-/Construction and Operation phase:** No impact on climate change is predicted although $CO_2$ will be produced in the construction work at relatively limited scale. |

Note:
A+/-: Significant positive/negative impact is expected,
B+/-: Positive/negative impact is expected to some extent,
C+/-: Extent of positive/negative impact is unknown (further examination is needed, and the impact may be clarified as the study progresses)

D: No impact is expected.
(Source: JICA Survey Team)

### 1.2.3 Comparison of alternative plans (i.e., Non-implementation of the Project)

Based on the field survey results, the components in the Project have been finally decided through prioritization taking the following points into consideration:

- renewal/replacement effect,
- risk of water supply capacity decrease due to malfunction,
- cost reduction,
- energy consumption reduction, and
- economic efficiency.

There is no room for considering alternatives for the Project since the Project is comprised of only replacement of the equipment in the existing facilities. Accordingly, this subsection describes the potential environmental and social impacts in case that the Project was not implemented (zero option; Table 1.24).

**Table 1.24 Anticipated impacts when the Project is not implemented**

| Items | Positive Impacts | Negative Impacts |
|---|---|---|
| Water Demand, Stable Water Supply | - Positive impacts are not predicted. | - There is a possibility that quantity of water supply to Amman will be reduced and quality of water will be deteriorated, which makes it difficult to supply water to meet the demand in a stable manner. |
| Environmental Pollution | - No impact on the air quality and no increase in noise level of surrounding area of the Project sites. | - If the Project is not implemented, no negative impacts are anticipated. |
| Natural Environment | - Positive impacts are not predicted. | - If the Project is not implemented, no negative impacts are anticipated. |
| Social Environment | - Positive impacts are not predicted. | - If the Project is not implemented, no negative impacts are anticipated. |
| Others | - Positive impacts are not predicted. | - If the Project is not implemented, GHG generation and water supply costs will not be reduced. |

(Source: JICA Survey Team)

### 1.2.4 Environmental Management Plan and Monitoring

#### 1.2.4.1 Environmental management plan (EMP)

Table 1.25 shows major source of potential impacts, management efforts (mitigation measures) and organizations responsible for each impact item during the construction and operation phases of the Project.

**Table 1.25 Environmental management plan for the Project**

(1) Pre-/Construction phase

1) Air Quality

| Sources of Potential Impact | Relevant Standard | Objectives | Management Effort | Management Institution |
|---|---|---|---|---|
| ・Dust generated from construction activities<br>・Pollutant emissions from heavy machinery and trucks (e.g. Sox, Nox etc.) | ・National Ambient Air Quality Standards (Jordanian Standard 1140/2006) | ・Protection of social and biological environment from adverse impacts of dust and emissions.<br>・Ensuring compliance with emission limit values. | ・Water spraying will be applied in work sites for dust suppression.<br>・Speed limits will be applied for vehicles.<br>・Well maintained vehicles will be used. | ・Supervision: Miyahuna<br>・Implementation: Contractor |

2) Noise and Vibration

| Sources of Potential Impact | Relevant Standard | Objectives | Management Effort | Management Institution |
|---|---|---|---|---|
| ・Heavy machinery and trucks<br>・Work personnel transportation vehicles | ・Noise Level Control Regulation (year 2003). | ・Elimination of anxiety and inconvenience to the local population.<br>・Ensuring occupational health and safety.<br>・Protection of environment. | ・Works will be undertaken during the daytime.<br>・Noise control measures will be implemented.<br>・Health and safety management for workers will be implemented as necessary. | ・Supervision: Miyahuna<br>・Implementation: Contractor |

3) Waste

| Sources of Potential Impact | Relevant Standard | Objectives | Management Effort | Management Institution |
|---|---|---|---|---|
| ・Domestic waste<br>・Industrial and hazardous waste | ・Regulation concerning Solid Waste Management, No. 27 of 2005.<br>・Regulation of Harmful and Hazardous Waste Management, Transfer and Handling, No. 54 of 2002 and No.47 of 2008. | ・Protection of environment from adverse impacts of solid and hazardous waste. | ・Different types of waste (e.g. hazardous waste, domestic waste) will be collected and disposed of separately.<br>・Efforts will be made to have a contract with waste disposers licensed by MOE to collect and treat household wastes. | ・Supervision: Miyahuna<br>・Implementation: Contractor |

(2) Operation phase

1) Waste

| Sources of Potential Impact | Relevant Standard | Objectives | Management Effort | Management Institution |
|---|---|---|---|---|
| ・Domestic waste<br>・Industrial and hazardous waste | ・Regulation concerning Solid Waste Management, No. 27 of 2005.<br>・Regulation of Harmful and Hazardous Waste Management, Transfer and | ・Protection of environment from adverse impacts of solid and hazardous waste. | ・Different types of waste (e.g. hazardous waste, domestic waste) will be collected and disposed of separately.<br>・Efforts will be made to have a contract with waste | ・Supervision: Miyahuna<br>・Implementation: Contractor |

| | | | | |
|---|---|---|---|---|
| | Handling, No. 54 of 2002 and No.47 of 2008. | | disposers licensed by MOE to collect and treat household wastes. | |

(Source: JICA Survey Team)

#### 1.2.4.2 Environmental Monitoring Plan (EMoP)

Table 1.26 shows major impacts to be monitored along with monitoring parameters and methods. The same table also shows implementing and responsible organizations, and approximate expenses for monitoring during the construction phase for the Project. The impacts on the natural and social environment caused by the implementation of the Project are expected to be insignificant as mentioned above in addition to regular monitoring. The contractor can manage to prevent undesirable effects through mitigation measures and in principle, the monitoring costs should be regarded to be included in the construction cost.

**Table 1.26 Environmental monitoring plan**

(1) Pre-/Construction phase

| **Significant Impact to be Monitored** | | **Air Quality** | **Noise and Vibration** |
|---|---|---|---|
| Monitoring parameter | | (1) PM10, (2) $SO_2$, (3) $NO_2$ | Noise level |
| Monitoring method | Method of collecting and analyzing data | (1) Gravimetric method<br>(2) UV-Fluorescence method<br>(3) Colorimetric method | On-site by Sound-level meter (on-site measurement) |
| | Location | Deir Alla IPS, 4 Pumping Stations and the Zai WTP (total 6 sites) | |
| | Duration and frequency | Upon complaint | |
| Implementing organization | | Contractor | |
| Responsible organization | | Miyahuna | |
| Approx. cost (included in the construction fee) | | USD1,200/time (USD200×6 sites) | USD1,200/time (USD200×6 sites) |

| **Significant Impact to be Monitored** | | **Waste** | **Odor** |
|---|---|---|---|
| Monitoring parameter | | Discharge amount | Offensive odor |
| Monitoring method | Method of collecting and analyzing data | (1) Recording of discharge amount<br>(2) Visual investigation | On-site confirmation |
| | Location | Deir Alla IPS, 4 Pumping Stations and the Zai WTP (total 6 sites) | |
| | Duration and frequency | Monthly | |
| Implementing organization | | Contractor | |
| Responsible organization | | Miyahuna | |
| Approx. cost (included in the construction fee) | | USD600/time (USD100×6 sites, waste and odor package deal) | |

| Significant Impact to be Monitored | | Machinery Maintenance | Work Environment |
|---|---|---|---|
| Monitoring parameter | | Content of maintenance | Workers' health and safety |
| Monitoring method | Method of collecting and analyzing data | Recording of the maintenance | Observation and inspection |
| | Location | Contractor's office | All work places |
| | Duration and frequency | Continuous records (Monthly/Daily) | |
| Implementing organization | | Contractor | |
| Responsible organization | | Miyahuna | |
| Approx. cost (included in the construction fee) | | (Expenses to be included in contract cost by Contractor) | |

| Significant Impact to be Monitored | | Traffic Volume | Accidents |
|---|---|---|---|
| Monitoring parameter | | Vehicles and other equipment used for the transportation and construction work | (1) Number of traffic accidents<br>(2) Number of accidents (human and fire cases) |
| Monitoring method | Method of collecting and analyzing data | Record of numbers of cars being used | Record of accidents |
| | Location | Principal roads around Project site | Contractor's office |
| | Duration and frequency | Continuous records (Monthly/Daily) | |
| Implementing organization | | Contractor | |
| Responsible organization | | Miyahuna | |
| Approx. cost (included in the construction fee) | | (Expenses to be included in contract cost by Contractor) | |

(2) Operation phase

| Significant Impact to be Monitored | | Waste |
|---|---|---|
| Monitoring parameter | | (1) Sludge generation amount, (2) Sludge collection amount |
| Monitoring method | Method of collecting and analyzing data | (1) Recording of sludge generation amount from the Zai WTP<br>(2) Recording of sludge collection amount by the licensed waste disposers |
| | Location | The Zai WTP |
| | Duration and frequency | Continuous records (Monthly/Daily) |
| Implementing organization | | Miyahuna |
| Responsible organization | | Miyahuna |
| Approx. cost | | (Expenses are to be included in the cost of personnel in charge of Miyahuna) |

(Source: JICA Survey Team)

#### 1.2.4.3 Draft Monitoring Format

Draft Monitoring Format is attached as Appendix 6.

#### 1.2.4.4 Environmental Check List

Environmental Check List is attached as Appendix 7.

# CHAPTER 2 Contents of the Project

## 2.1 Basic Concept of the Project

Jordan has formulated a comprehensive national strategy, "the National Vision and Strategy for Jordan 2025," which describes issues to be addressed and solutions in various sectors. Major issues in the water sector include shortage of water per capita, improvement of financial efficiency, sector structural reform, and reconstruction of the distribution network.

The National Water Strategy (2016-2025) identifies the following five areas as important strategic areas:

(1) Comprehensive water source planning
(2) Water and sewage service
(3) Water use for irrigation, energy, etc.
(4) Organizational reform
(5) Sector information management and monitoring.

In accordance with the above strategic plan, the Project aims to prevent reduction in water supply quantity and deterioration in water quality and improve the operational efficiency of equipment and eventually to reduce overall operating costs by replacement of the existing facilities and equipment of the Zai Water Supply System in Amman Governorate.

## 2.2 Outline Design of the Japanese Assistance

### 2.2.1 Design policy

(1) Basic policy

The existing Zai Water Supply System was constructed about 30 years ago and the facilities and equipment, especially the pumps, have been significantly deteriorated since. Therefore, urgent measures are required to prevent the system from stopping.

The Zai Water Supply System requires a large amount of electric power to pump water to a head of approximately 1,260 m. Thus, the electricity cost is extremely high, which is 33% of Miyahuna's operating expenditures It is, therefore, required to improve operating and energy efficiency of the system and reduce operating costs by replacement of aged facilities and equipment such as the pumps and motors. There are different grades of specifications for each equipment. But basically, the same grade as that of the existing ones will be the minimum. The specifications will be upgraded according to the characteristics of the raw water to be handled.

The Project components are selected from many candidate components, which were identified as a result

of the field survey of the existing facilities and equipment, based on the priority set in the Project and budget limitation.

1) Grasping replacement/renewal needs of the Zai Water Supply System (Facilities and Equipment)

Table 2.1 shows the facilities and equipment that have effects of improving of the performance of the Zai Water Supply System by renewing or replacing based on the field survey.

**Table 2.1 Grasping replacement / renewal needs of the Zai Water Supply System (Facilities and Equipment)**

| | Equipment and Facilities | Replacement needs |
|---|---|---|
| Intake facility | Intake pumping station (IPS) | Replacement of 3 pumps at IPS |
| | | Replacement of 3 motors |
| | | Replacement of 4 traveling screens |
| | | Reinforcing end cap of header pipe |
| Raw water facility | Raw water pumping station | Replacement of 12 pumps at raw water pumping station |
| | | Replacement of 9 motors |
| | | Reinforcing end cap of header pipe |
| | Grit settling basins | One option is to construct two new basins at the same place after dismantling the two deteriorated existing basins. The other option is to construct two new basins after intake and just before IPS in a land lot to be acquired. |
| | | Installation of two pipe lines from the sedimentation basin to the raw water pumping station |
| Treatment facility (Treatment plant) | Sedimentation basin (1985) | Provision of 4 spare pumps |
| | Air scouring blower | Renewal of two air scour blowers (including one standby) |
| | Rapid sand filter (Constructed in 1985) | Repair of 12 standby valves and renewal of filter media |
| | Backwash water recovery pump | Renewal of 2 backwash water recovery pumps (one of these is standby) |
| | Backwash water tank | Replacement of reinforced concrete backwash water tank |
| | Sludge dewatering system | One option is construction of new sludge thickeners and additional drying beds, while the other is construction of new sludge thickeners and new pressure dewatering equipment. |
| | Electrical equipment | Renewal of monitoring and control equipment (PLC system) and data logger system |
| | | Renewal of telemetry systems to wireless communication network |
| | Laboratory equipment | Provision of new laboratory equipment |
| Transmission facility | Transmission pumping station | Replacement of 3 pumps at transmission pumping station |
| | | Replacement of 3 motors |
| | | Replacement of 3 control valves and 4 check valves |
| | | Reinforcing end cap of header pipe |
| Chemical feeding facility | Chlorine dioxide generators | Replacement of 3 chlorine dioxide generators |
| | Sodium chlorite solution device | Replacement of liquid sodium chlorite solution device |
| | Powdered activated carbon injection | Replacement of 3 powdered activated carbon injection facilities, and construction of a new building |

| | | |
|---|---|---|
| | facility | |
| | Chlorine injection facility (Constructed in 1985) | Replacement of three main equipment (including 1 standby) and one evaporator |
| | Chlorine injection facility (Constructed in 1999) | Replacement of chlorine gas header pipe and two evaporators |
| | Ferric sulfate injection facility | Replacement of 2 spare pumps |
| | Potassium permanganate feed system | Replacement of two injection pumps (including one standby) and three dissolution tanks |
| | Ferrous sulfate injection facility | Replacement of one injection pump |

(Source: Prepared by JICA Survey Team based on the field survey)

2) Current status of the Zai Water Supply System and the priority of the candidate components

The potential effects of aging of the existing Zai Water Supply System such as failure, shutdown for repair, burden of maintenance, and risk of failure have been analyzed through surveys, and the priority of the candidate components has been determined. The analysis was carried out based on the following criteria. The expected effects of renewal/replacement are summarized, and the priority has been determined.

1. Prevention of deteriorating raw water quality and decreasing water production due to malfunctioning of facilities, if unattended
2. Maintenance cost reduction[9]
3. Reduction in energy consumption[10]

The highest priority is to ensure that water supply continues without deterioration in quality and decrease in quantity of supplied water. Therefore, higher weightage with a maximum score of 10 points was given to the item "Deteriorating raw water quality and decreasing water production due to malfunctioning of facilities, if unattended." Then, weightage with a maximum score of 5 points was given to other two criteria: "2. Maintenance cost reduction" and "3. Reduction in energy consumption." Based on total score of components calculated by this scoring system, the priority was determined.

The first priority was given to the replacement of pumps of intake, raw water and transmission pumping stations, and their motors and valves; the second was to replace the traveling screen; and the third priority was given to reinforce the end cap of header pipe.

The JICA Survey Team also confirmed the priorities of the Jordanian side with Miyahuna. The priority list made by the Jordanian side was the same as that of the Japanese side except the renewal of telemetry systems placed in the tenth in the list which was ranked at 14th on the Japanese priority list. The priorities

[9] The pumps, motors, traveling screen, end cap of header pipe and water quality equipment are applicable to this item.
[10] The pumps and motors are applicable to this item.

of the Jordanian and Japanese sides are listed in the priority table which is given in Table2.2.

## Table 2.2 Priorities of the candidate items

| Priorities | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Priorities (Jordanian side) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 12 |
| Component | Replacement of 18 pumps and 16 motors at intake, raw water and transmission pump stations | Replacement of 4 traveling screens | Reinforcing end cap of header pipe in P.S. 1-5 | Replacement of Chlorine Dioxide Generators | Replacement of Sodium Chlorite Solution Device | Replacement of powdered activated carbon injection facilty, and construction of a new building | Replacement of Chlorine injection facility (1985) | Replacement of chlorine injection facilities (1999) | Provision of Spare Pumps for ferric sulfate injection facility | Renewal of Monitoring and control equipment (PLC system) and Data logger system | Replacement of 2 grit settling basins |
| Current Status | 6 of the 24 pumps and 8 of the 24 motors have been replaced by Miyahuna. The remaining 18 pumps and 16 motors are deteriorated. In addition to replacement of the pumps, measures to protect pump material from chemicals are required since the raw water with high chloride ions is injected with chlorine dioxide and potassium permanganate after the intake pump. | There are four traveling screens, but one is out of order and cannot be operated. The remaining three have become aged and trouble occurred frequently. | There was an accident where the end plate of the end cap part of the discharge header pipe came off due to water hammer pressure in 3 of 5 pumping stations. Currently, the end cap of the discharge header pipe is repaired by the Miyahuna. Regarding the end cap portion of discharge header pipe, the current repair seems to be insufficient for the water hammer pressure. | The chlorine dioxide generators were added by the expansion project in 1999 due to the sterilization of nematodes. Chlorine dioxide is manually injected due to the ageing of devices and malfunction of self-adjustable valves. Since one of the three generators is now out of order, the chlorine dioxide generation is being done with the remaining two generators without any standby. The injection rate reaches maximum in the case of high turbidity. | The sodium chlorite solution device was installed at the same time as the chlorine dioxide generators and is aged. Sodium chlorite powder of 80% concentration is dissolved into water to form 25% solution. As powder sodium chlorite has a risk of explosion when it comes into contact with reducing agent or organic substance, careful handling is required for this chemical during transportation, stock and dissolving. Considering the request from Miyahuna, use of sodium chlorite liquid is required. | The existing powered activated carbon injection facility was installed in 1985. It is deteriorated. Two facilities are working without any standby. The activated carbon is sent and injected into the inlet of the raw water regulating basin located at 30m away from the powdered activated carbon injection facility building. As the injection pipes (HDPE) often gets clogged with activated carbon, it is required to replace the injection pipes every 2 or 3 weeks. | It has been 34 years since the facility was installed in 1985. The facility is deteriorated, and two main equipment and one evaporator installed in 2000 have now malfunction. Thus, only the standby equipment is working. | It has been operated for 20 years since 1999, and is deteriorated. One of the two lines is out of use due to malfunction of the chlorine gas header pipe. Two evaporators in 2000 have now malfunction. | The facilty originally installed in 1985 is not used, but the facilty additionally installed in 1999 is used. For the two pumps including one standby in additionally installed facilty, there are no standby pumps because one pump injects ferric sulfate into the line of year 1985 and another pump injects ferric sulfate into the line of year 1999. | About 20 years have passed since the start of operation of the water treatment plant facilities and the monitoring operation control system of pump facilty. The device of equipment has failed due to aging, and there is a possibility that it leads the system to stop. PLC for some facilities is broken, and it is in the state that the control is not performed automatically. | The existing grit settling basin was originally designed to operate three basins and keep one basin as a standby, but two basins are out of use due to deterioration of reinforced concrete structures. At present, only two basins are in operation. However, 7,600m$^3$ per year of turbidity reduction effect is confirmed even when two basins are in operation. |
| Renewal/repair effects | Three intake pumps are required to be upgraded with cast stainless steel (SCS13) for impellers, and all 12 booster pumps are required to be updated with duplex stainless steel. 15 motors are required to be replaced with those of the existing specifications. Three transmission pumps will be evaluated by experts, including the actual usage, and will be considered as to what kind of plans can be considered under the condition that they are installed in the current pump house. It is an indispensable facility for water supply system and its renewal effect is high. | Four aging screens are required to be replaced with new ones of the same specification as of existing, and the renewal effect is high. | By reinforcing or improving the end cap of the discharge header pipe, it is possible to prevent the booster and transmission pump station from stopping. The renewal effect is high. | All the three generators are required to be replaced as they are aged but they are essential for water treatment processing. The generators are required to be replaced by the ones with higher injection rate than existing since the injection rate has reached the maximum level and it is impossible to cope with further worsening of raw water quality by the generators of present injection rate. The renewal effect is high. | The exisiting equipment could be used, but replacement of piping will be required for sodium chlorite liquid. Renewal effect is high. | The existing three aged facilities including one standby are required to be replaced and a new building is required to be constructed nearby the inlet of the raw water regulating reservoir to install the three facilities. From this measure, reliable injection can be achieved by avoiding the clogging in the injection pipes. High renewal effect is anticipated. | Three main equipment (including 1 standby) and one evaporator are required to be replaced as disinfection is an important water treatment process. The renewal effect is high. | The existing chlorine gas header pipe and two evaporators are required to be replaced, and spare parts are required to be supplied. Disinfection is an important water treatment process. The renewal effect is high. | Standby pumps are required to be installed for injecting ferric sulfate into the injection point of each line. The weighing and dissolving equipment is working without problems. Aggregation is an important process for water treatment in Zai WTP, and the renewal effect is high. | The PLC cannot be partially updated, so the entire system is required to be updated. The software of monitoring is old. Automatic operation and remote control of equipment are important for the Zai water supply system, and the update effect is high. | There are two proposals. One is to construct two new basins at the same place after dismantling the two deteriorated basins. The other is to construct two new basins after intake and just before the intake pump station at a land lot to be acquired. The size of basins is estimated at 22m wide x 59m long x 5m deep for two basins capacity. Further reduction of turbidity can be anticipated by the new construction of settling basins. The renewal effect of grit settling basins is moderate. |
| Total score | 20 | 20 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 9 | 8 |
| Risks of deteriorating raw water quality and decreasing water production due to malfunctioning of facilities, if unattended | Currently, there is no stand-by pump at any pump station, and if one pump stops, the water supply of the whole water supply system will drop to 3/4. Therefore, it is essential that all pumps are always operational. The motor can has a heat accident of the winding. There is a high risk of a decline in water supply capacity due to malfunction. Some of these pumps and motors were installed more than 20 years ago, and their renewal is long over due. | If the traveling screen malfunctions, the inside of the intake pump gets damaged and raw water pump becomes clogged and operation becomes impossible. And it takes time to disassemble and repair the pump, and the raw water system is stopped for a long time. There is a high risk of a decline in water supply capacity due to malfunction. Two of the four units have been over 34 years old and the renewal period has already passed. | Improving the reliability of the discharge header pipe is important issue because the water supply system is stopped when the end cap of the discharge header pipe is broken due to water hammer pressure. In addition, since the repair of the present end cap part is an emergency measure, it is required to be improved immediately. | Without the chlorine dioxide generators, it has a loss of performance of inactivation of nematodes and cryptosporidium and reduction of algae, organic substances and unusual odor and taste. The risk of decreasing water supply amount is high. It is required to be improved immediately. | Without renewal of the facility, it might cause inability of generation of chlorine dioxide. There is a large risk of water supply capacity decline due to malfunction. It is required to be replaced with Chlorine Dioxide Generators at the same time. | Without injection of activated carbon, it becomes impossible to adsorb and remove Trihalomethane precursors, ammonical nitrogen, and unusual odor and taste substances in raw water, and the water treatment process is forced to be suspended. There is a high risk of a decline in water supply capacity due to malfunction. It is required to be improved immediately. | Chlorine is injected as a disinfection facility. If the facility has a trouble, it is obliged to be stopped. There is a high risk of lowering water supply capacity. It is required to be improved immediately. | Since chlorine gas is injected as a disinfectant, there is a high risk of reduction of water supply capacity due to the malfunction of the facility. It is required to be replaced within a few years. | Since ferric sulfate is injected as a coagulant and the aggregation process does not work well in the absence of a coagulant, there is a high risk of water supply capacity decline due to the facility malfunction. It is required to be replaced immediately. | If this system can't operate, automatic operation of the machine, operation of the central integrated monitoring panel and monitoring function are stopped. The risk of water supply capacity loss is high. It is required to be renewed within a few years. | In case that the existing grit settling basin is completely out of order, the Zai WTP needs to process the raw water with high turbidity more often, and it causes a risk of water supply capacity decline. However, the existing two basins are working. The risk of reduction of water supply amount is moderate. |
| Score | 10 | 10 | 9 | 8 | 8 | 7 | 7 | 7 | 7 | 6 | 6 |
| Maintenance cost reduction | By renewing old pumps and motors, it is expected to reduce electricity costs by about 3.2 million JOD per year. By using a pump made of a material that is wear resistant and corrosion resistant, durability is improved and maintenance costs can be significantly reduced. | Since the proposed new screen is the same as the current screen, there is no cost reduction effect. | Currently, the end cap portion of the discharge header pipe is repaired by Miyahuna. The maintenance requirement is reduced. | Since automatic injection based on the residual chlorine dioxide concentration can be done, the injection amount can be easily adjusted. Adequate injection will reduce maintenance cost. | Changing to liquid sodium chlorite (effective concentration 31.5%) increases chemicals cost by about 30%, but personnel cost reduction is anticipated because of easier handling of liquid than powder. | Maintenance cost reduction is anticipated, but its effect is low. | Maintenance cost reduction is anticipated, but its effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction is anticipated, but its effect is low. | The water supply system is currently operated manually due to PLC failure. It is possible to reduce the associated labor costs with automatic operation of equipment. | Expansion of new grit settling basins will increase Sludge removal cost including personnel cost. |
| Score | 5 | 5 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 |
| Energy consumption reduction effect | Renewing old pumps and motors is expected to reduce energy consumption equivalent to approximately 3.2 million JOD per year. | No energy saving effect is anticipated because required power is unchanged. | Not Applicable | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | The power use for automatic operation but it is minor. | No energy saving effect is anticipated because power is not use. |
| Score | 5 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Soft Component (Technical Assistance) | Not Applicable | Not Applicable | Not Applicable | Strengthening operation and maintenance of water supply system (Control of chemical injection: Optimum injection rate of chlorine dioxide to fluctuating turbidity in raw water) | Strengthening operation and maintenance of water supply system (Control of chemical injection: Optimum usage of sodium chlorite) | Strengthening operation and maintenance of water supply system (Control of chemical injection: Optimum injection rate of powdered activated carbon) | Strengthening operation and maintenance of water supply system (Control of chemical injection: Optimum injection rate of chlorine) | Strengthening of operation and maintenance of water treatment plant in terms of control of chemical injection (Optimization of injection rate of chlorine) | Strengthening operation and maintenance of water supply system (Control of chemical injection: Optimum injection rate of ferric sulfate) | Strengthening of operation and maintenance of water supply system in terms of monitoring system (How to change the setting of PLC program, Practical maintenance method for troubles) | Strengthening of operation and maintenance of water supply system in terms of water quality management (Efficient operation method of grit settling basins) |
| Possibility of collaboration with other donors | Not Applicable | Not Applicable | Not Applicable | Not Applicable | Not Applicable | Not Applicable | Not Applicable | Not Applicable | Not Applicable | USAID submitted the survey report draft to WAJ at the end of August, and has drafted a proposal to exchange PLC, telemeter and SCADA at once. The WAJ will consider the USAID proposal in the future. | JICA expert explained the current status of the grit settling basin to KfW in late August. Since he had no knowledge of the situation, he exchanged a report from the Jordanian side through WAJ. |
| Grouping | For continuous and stable supply of the Zai water supply system, reducing power consumption and energy consumption | | | Urgently important for stabilizing important water quality, 2nd priority | | | | | | 3rd priority for continuous and stable supply of Zai water supply system and stabilization of important water quality | |

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 14 | 10 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| Replacement of potassium permanganate feed system | Enhancement of Sludge dewatering system | Renewal of Telemeter systems (Wireless communication network) | Provision of Spare 4 Pumps for Sedimentation basin (1985) | Renewal of Air scour blowers | Repair of devices such as valves (1985) for Rapid sand filter | Provision of Pump and Spare parts for ferrous sulfate injection facility | Replacement of Backwash water tank | Provision of New Laboratory equipment | Repair of devices such as valves (1999) for Rapid sand filter | Renewal of 2 Backwash water recovery pumps | Additional conduit from the sedimentation basin to the raw water pumping station |
| The potassium permanganate facility was installed in 1999 at the same time as the chlorine dioxide generators. As well as restraining Trihalomethane generation and decreasing unusual odor & taste, it is a complementary facility to restrain excessive generation of chlorous acid by chlorine dioxide. Over 20 years have passed, the facility is deteriorated and used only 4-5 times in winter. | Twelve drying beds are working only in summer, but not in winter due to less drying effect in winter. Lack of enough drying beds forces sludge water to drain outside. It is desirable to process sludge inside the plant. The Team confirmed that sludge at the Zai WTP is no environmental and legal problem in Jordan. | The telemeter equipment performs a remote monitoring operation of the integrated monitoring operation panel of the Zai water treatment plant and the monitoring operation panel of each pumping station. It stops frequently during the rainy season. Currently, a buried cable is used for signal transmission. When it stops, the staff are communicating by their cell phone for monitoring and operation. | 34 years have passed since the traveling bridge was installed in 1985.Overhaul of the reduction gear and replacement of parts have been done. Sludge water drawing pumps are severely deteriorated including inside casing. If drawing sludge water is not performed well, it causes trouble in operation of the settling basins. The facilities are aged, but it is working. | 34 years have passed since their installation in 1985, but the pumps have been inspected and found operating well. It is a time to be replaced from the mechanical point of view. | 34 years have passed since their construction, and rubber seats of water leakage has occurred. Air scouring is not done uniformly. The filter media is inspected once every year, but the underdrain system has not been inspected so far, so it is required to be inspected. Since PLC is broken, wash procedure cannot be performed automatically. | The ferric sulfate injection facility installed in 1985 is used as the ferrous sulfate injection facility as a substitute. When raw water quality deteriorates and chlorine dioxide injection rate is increased, the facility reduces chlorous acid generation converting it to harmless chloride. Since the ferrous sulfate is easily oxidized to ferric sulfate when stored for a long period, duration of storage is limited. Weighing and dissolving equipment have been working without problems due to regular inspection, but there are no spare parts. In addition, the injection pump is aging. | The Backwash water tank is steel tank, and 34 years have passed after its installation in 1985. It is still in use by regular inspection but has reached the time for replacement. | The analytical equipment for water quality tests are requested by Process Lab, Drinking Water Chemical Lab and Drinking Water Micro Lab in Zai WTP. The laboratories possess several decrepit equipment, but there are no significant failures or shortages that hinder normal operations for water quality inspection at the present, and current operational status doesn't matter. | 20 years have passed since their construction in 1999, and rubber seats of many valves have been deteriorated and water leakage has occurred. The filter media is inspected once a year, but the underdrain system has not been inspected so far, so it is required to be inspected. | All washing drains flow into a common recovery basin built in 1999. After suspended solids are settled and separated, the sludge is returned to the raw water regulating basin by these pumps. There are 2 pumps each for phase-1 and phase-2 units, but pumps of phase-2 are out of order. | When water is transferred from the intake pump to PS1 via the Grit settling basin, the rated flow (175.2m3 / min) does not flow, and the Grit settling basin cannot be used in summer. However, in the current situation where there are only two Grit settling basin, the Grit settling basin cannot be used effectively even if additional piping is used, because it is necessary to use the sludge for drying and carrying out the sludge in summer. |
| Two injection pumps (including one standby) and three dissolution tanks are required to be replaced with new ones of the same specification as existing. This facility complements the chlorine dioxide injection facility by suppressing excessive injection of chlorine dioxide, which helps reduce generation of disinfection by-products of chlorous acid. This facility has function of reducing the unusual odor and tastes by oxidization of organic matters, and also suppresses the generation of disinfection by-products. The renewal effect is high for maintaining stable water quality. | There are two plans for improvement of sludge drying process; one is construction of new sludge thickeners and additional drying beds, while the other is construction of new thickeners and new pressure dewatering equipment. The former requires construction of about 130 drying beds as the same size as exiting one and securing a large land lot within or near the plant. (The Team estimated about 130 drying beds based on the current sludge amount. It might be difficult to secure a large land lot.) The latter requires the installation of pressure dewatering equipment inside the plant. Expansion effect is moderate. | The transmission method is required to change from cable system to wireless communication network system. Remote control and remote monitoring are important for the water supply system, and the update effect is high. | 4 standby pumps are required to be replaced with new ones having same capacity as existing. The facility is composed of 10 pumps. Only standby pumps are required to be replaced. Replacement effect is moderate. | Two air scour blowers (one standby) are required to be replaced with new ones having same capability as existing. The blowers including the standby are deteriorated but still working . Replacement effect is moderate. | Twelve standby valves and filter media are required to be renewed with same specification as existing. When inspecting the collecting device of each basin, filter media removal is required. Since current filtered water has no problems in quality, renewal effect is moderate. | Injection pumps are required to be replaced with new ones having same capacity as existing, and spare parts are required to be supplied. Replacement effect is moderate. | A new Reinforced concrete Backwash water tank is required to be constructed. Replacement effect is moderate. | The requested equipment is divided into two types; namely, quantitative equipment and general-purpose equipment. The formerincludes Gas Chromatograph, and monitoring capability of trihalomethane will be strengthened by its update. The latter includes Water Purification System (1 unit, updated), Precision Chemical Balance (1 unit, newly introduced), Laboratory Refrigerator (1 unit, update), Automatic Diluter (1 unit, newly introduced), Vacuum Pumps (2 units, updated) and Digital Thermometers (4 units, updated). Update/new introduction of these equipment can improve analytical precision for safe supply of water. Update effect is moderate. | Twelve standby valves and filter media are requested to be renewed with same specification as existing. When inspecting the collecting device of each basin, filter media removal is required. Since current filtered water has no problems in quality, repair effect is moderate. | Two Backwash water recovery pumps (one standby) are requested to replaced with new ones having same capacity as existing. Two wash water pumps (one standby) show leakage from gland but are working. Renewal effect is moderate. | Additional conduit from the sedimentation basin to the raw water pumping station are requested. Renewal effect is low. |
| 7 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 3 |
| It is limited to injecting a moderate quantity of chlorine dioxide to restrain the generation of by-product chlorous acid (standard: 0.7mg/L). Malfunction of the potassium permanganate facility poses problems in water quality aggravation in winter, and it increase a risk of reduction of water supply amount. It is required to be renewed within a few years. | There are no environmental problems if discharging sludge water drain outside. The risk of reduction of water supply capacity is low. | If this system is failed, remote control and monitoring become impossible. The risk of reduction of water supply amount is high. It is required to be renewed within a few years. | Since capability of the sedimentation basin decreases without draining sludge, it is obliged to remove sludge manually after emptying the basins. Since one of four basins is required to suspend during sludge removal work, total amount of treated water decreases. As a result, turbidity becomes high, and it is not able to produce a predetermined amount of treated water. Risk of reduction of water supply amount is high. It is required to be replaced within a few years. | If air washing cannot be used, only backwashing is utilized for washing, as a result, washing effect decreases while wash water volume increases. Risk of water supply decline is high. It is required to be renewed within a few years. | There are 6 filtration basins, but there is no spare filter in the summer when the amount of treated water increases. If one filter malfunctions, it is necessary to reduce the amount of treated water. Risk of reduction of water supply capacity is high. It is required to be renewed within a few years. | Two pumps including a standby pump are working. Risk of reduction of water supply capacity is low. | In case of any accident and breaking of the steel tank, back washing stops, but no such accident has happened in the past. In addition, measurement of steel thickness confirmed that it satisfies the predetermined required value, so the risk of reduction of water supply capacity is low. | Any malfunction of the equipment is directly linked to a reduction in quality and also give rise to fears that water-borne diseases will be increased in the water distribution area. However, current risk is low because there is no serious shortage or failure of the requested equipment as mentioned above. | There are 6 filtration basins, but there is no standby filter for summer when the amount of treated water increases. If one filter stops due to malfunction, it is necessary to reduce the amount of treated water. However, current risk is low because there is no serious sign of operation. | Currently there are two pumps in operation, including one standby pump. Risk of reducution of water supply capacity is low. | In the current situation where there are only two basins, it is necessary to use the two basin for the drying and unloading of sludge in summer. Therefore, even if two conduits are constructed, Grit settling basin cannot be used effectively in summer. Risk of reducution of water supply capacity is low. |
| 5 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 |
| Maintenance cost reduction effect is low. | The personnel cost and maintenance cost will increase for sludge removal. | Maintenance cost reduction effect is low. | Personnel cost for sludge removal is reduced. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| No energy saving effect is anticipated because required power is unchanged. | Since thickeners in both plans require power, and pressure dewatering equipment require a lot of power, energy consumption increases. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Strengthening of operation and maintenance of water treatment plant in terms of water quality management (Optimizing operation method of chlorine dioxide injection rate based on raw water turbidity) | Strengthening of operation and maintenance of water treatment plant in terms of operation of drying beds and usage of generated sludge. | Strengthening of operation and maintenance of water treatment plant in terms of practical maintenance method for troubles | Strengthening of operation and maintenance of water treatment plant in terms of operation method of settling basins | Not Applicable | Strengthening of operation and maintenance of water treatment plant in terms of method of washing of the rapid sand filters and filter media composition. | Strengthening of operation and maintenance of water treatment plant in terms of operation of ferrous sulfate injection facility. | Not Applicable | Not Applicable | Strengthening of operation and maintenance of watertreatment plant in teems of method of washing of the rapid sand filters and filter media composition. | Not Applicable | Not Applicable |
| Not Applicable | Not Applicable | USAID submitted the survey report draft to WAJ at the end of August, and has drafted a proposal to exchange PLC, telemeter and SCADA at once. The WAJ will consider the USAID proposal in the future. | USAID submitted a draft report to WAJ at the end of August, drafting a proposal to replace nine pumps with a speed controller. The WAJ will consider the USAID proposal in the future. | Not Applicable | Not Applicable | Not Applicable | Not Applicable | Not Applicable | Not Applicable | Not Applicable | Not Applicable |
| 3rd priority for continuous and stable supply of Zai water supply system and stabilization of important water quality | | | Low priority in this project due to low effect and urgency | | | | | | | | |

3) Examination of duplication with development plans of Jordan and Projects of other development partners

The construction and renewal of the Zai Water Supply System have so far been carried out either by Jordan themselves or by development partners. Recently, USAID is involved in the planning of the Zai Water Treatment Plant Project (2019/8, Draft). In August 2019, the JICA Survey Team obtained the draft report of the USAID project. The JICA Survey Team then concluded that there is no overlap of the USAID project components related to the Zai Water Supply System with the priority list of Project components prepared by the JICA Survey Team.

The grit settling basins were originally constructed by KfW. These basins are now in a bad condition requiring repair or renewal. The JICA Survey Team explained this situation to KfW and asked if they could repair/renew the basins. They replied that they could not finance the pre-treatment.

4) Selection of equipment for replacement based on priority and project scale

Based on the above considerations, from the equipment that was determined to need renewal in this survey (Table 2.1), the equipment with high priority was selected for this project considering the project scale. The equipment up to the 3rd priority, i.e., (1) pumps of intake, raw water and transmission pumping stations, and their motors and valves, (2) traveling screens, and (3) discharge header pipe, is selected as the target of this project.

Table 2.3 shows the contents of the equipment and facilities that WAJ considered necessary to be upgraded or replaced as of 2018 and determined by this preparatory survey.

**Table 2.3 Equipment to be upgraded or replaced**

| Location | Major Existing Facilities | | Requests by WAJ as of 2018 | Equipment to be upgraded or replaced |
|---|---|---|---|---|
| Grit Settling Basin | W25mxL125mxD4mx4 lines | 1 set | 1set (Reconstruction) | - |
| Intake Pumping Station (IPS) | Traveling screen | 4 sets | 4 sets | 4 sets |
| | Vertical axis mixed flow pump | 4 sets | 3 sets | 3 sets |
| | Motor for the above pump | 4 sets | 3 sets | 3 sets |
| Raw water Pumping Stations (PS1-4) | Horizontal axis centrifugal pump | 16 sets | 12 sets | 12 sets |
| | Motor for the above pump | 16 sets | 8 sets | 9 sets |
| | Discharge header pipe | 4 sets | Discharge header pipe x 4 sets | End plate x 4 sets |
| Transmission Pumping Station (PS5) | Horizontal axis centrifugal pump | 4 sets | 3 sets | 3 sets |
| | Motor for the above pump | 4 sets | 2 sets | 3 sets |
| | Electric ball valve | 3 sets | - | 3 sets |
| | Check valve | 4 sets | - | 4 sets |
| | Discharge header pipe | 1 set | - | End plate x 1 set |

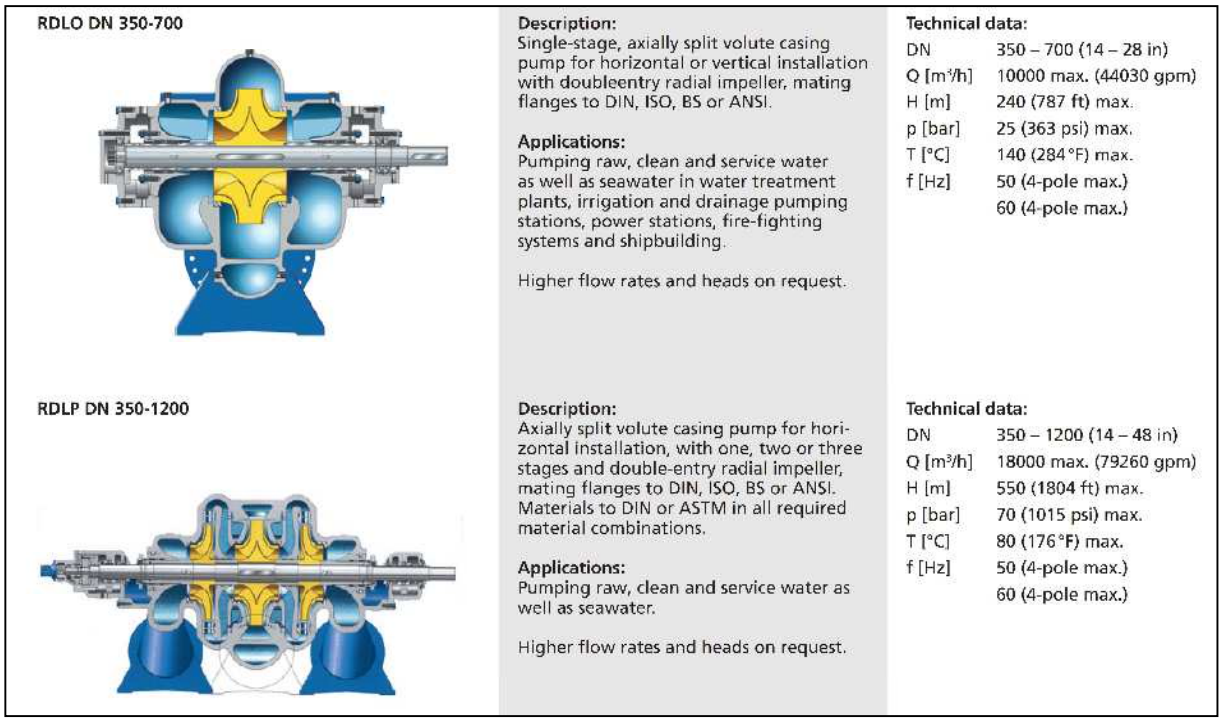
(Source: JICA Survey Team)

(2) Policy on natural conditions

The pumps and their auxiliary equipment are installed inside the pumping stations. The altitude of these stations ranges from -227m to + 875m above sea level, where the ambient temperature ranges from -5 to 50 ° C and the water temperature (raw and treated water) ranges from 4 to 38 ° C and the humidity ranges from 4 to 100%. The water also contains foreign substances such as silt, sand, and corrosive chloride ions. The pumps must, therefore, be designed considering these factors. Similarly, an appropriate protection structure to withstand these adverse conditions is considered necessary for the motors as well, which will be installed in the pumping station, in which both temperature and humidity are higher and water contains floating materials including silt.

(3) Policy on construction conditions, local contractors, utilization of local materials and equipment

The main purpose of the Project is to renew pumps and motors. The pumps are high head pumps with a total head of about 300 m each. As shown in the catalog of KSB of German pump manufacturer (Figure 2.1), the maximum available head of a single-stage centrifugal pump (H) is 240m. Multi-stage centrifugal pump is adopted normally in such a condition. But the axial dimension of the multi-stage centrifugal pump is larger than that of the single-stage centrifugal pump and the available space in the existing pump room is not enough for multi-stage centrifugal pump. For this reason, the same type of single-stage centrifugal pump as the existing one has to be adopted. Japanese pump manufacturers can design and deliver single-stage centrifugal pumps as custom-made pumps same as existing pumps. And, from the point of view of responsibility, basically the motors are replaced together with the replacement of the pumps. The pump equipment will be installed under control and guidance of Japanese contractor's engineers using local contractors and local equipment effectively.




(Source: KSB Catalogue (Axially Split Volute Casing Pumps))

**Figure 2.1 Comparison of single-stage and multi-stage centrifugal pumps**

(4) Policy on operation and maintenance capacity of the executing agency

Miyahuna has sufficient technical skills for operation and maintenance of pumps and motors based on long experience in repairing and overhauling of such equipment. Thus, there may not be any problems in terms of operation and maintenance capacity. In addition, Miyahuna frequently requests local workshops specializing in pumps and motors for repairs of equipment. Therefore, it is judged that operation and maintenance capability of Miyafuna is high together with enhanced technical level of these workshops.

(5) Policy on construction method / procurement method and construction period

Pump and motor installation work will be carried out during low water demand season from 1st September and 31st May. During this period, one pump out of 4 pumps can be stopped for replacement work with the remaining three pumps in operation to mitigate any inconvenience to users.

Replacement work of the end cap should not be carried out at the same timing of the pump and motor replacement work. During the replacement works of the end cap, it is necessary to completely stop the water supply from these pumping stations. It is also required to stop the operation of all the pumps at the IPS for the replacement of the traveling screens. Operation suspension period during their replacement should be maintained as short as possible to shorten the water supply interruption period.

### 2.2.2 Basic plan (Equipment Plan)

(1) Replacement plan of pump and motor

Since the efficiencies of pump and motor could not be measured separately, the combined (total) efficiency was measured in investigating the deterioration of the pump and motor. Based on the results of efficiency measurement, the reduction in annual power cost by replacing old pump / motor whose performance has deteriorated, is estimated as shown in Table 2.4. The efficiency of the pump and the motor after the replacement is assumed to be equal to the original total efficiency of the pump and the motor specified.

**Table 2.4 Expected Reduction of annual electricity cost after replacement of pump and motor**

| Pump Station | Unit No. | Pump Capacity | Pump Total Head | Equipment | Original Efficiency | Original Combined Efficiency | Measured Combined Efficiency | Efficiency after Replacement | Expected Combined Eff. After Replacement | Present Motor Inputo Power | Motor Input Power after Replacement | Improvement for Motor Input Power | Improvement of Annual Electric Power | Improvement of Annual Electricity Costs for each Unit | Improvement of Annual Electricity Costs for each PS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $m^3/m$ | m | - | % | % | % | % | % | kW | kW | kW | kWh | JOD | JOD |
| IPS | 1 | 43.8 | 30 | Pump | 85.0 | 81.9 | 54.3 | 83.0 | 80.0 | 394 | 268 | 127 | 763,060 | 96,146 | 168,318 |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| | 2 | 43.8 | 30 | Pump | 85.0 | 81.9 | 63.1 | 83.0 | 80.0 | 339 | 268 | 72 | 432,725 | 54,523 | |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| | 3 | 43.8 | 30 | Pump | 85.0 | 81.9 | 73.6 | 83.0 | 80.0 | 291 | 268 | 23 | 140,075 | 17,649 | |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| | 4 | 43.8 | 30 | Pump | 85.0 | 81.9 | 65.9 | - | 65.9 | 325 | 325 | 0 | 0 | 0 | |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| PS1 | 1 | 43.5 | 300 | Pump | 83.0 | 79.9 | 74.7 | 83.0 | 79.9 | 2,849 | 2,661 | 188 | 1,131,948 | 142,625 | 376,113 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 2 | 43.5 | 300 | Pump | 83.0 | 79.9 | 77.6 | 80.6 | 77.6 | 2,741 | 2,741 | 0 | 0 | 0 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 3 | 43.5 | 300 | Pump | 83.0 | 79.9 | 74.7 | 83.0 | 79.9 | 2,849 | 2,661 | 188 | 1,131,948 | 142,625 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 4 | 43.5 | 300 | Pump | 83.0 | 79.9 | 76.5 | 83.0 | 79.9 | 2,781 | 2,661 | 120 | 721,130 | 90,862 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| PS2 | 1 | 43.5 | 300 | Pump | 83.5 | 80.4 | 77.8 | 83.0 | 79.9 | 2,735 | 2,661 | 74 | 445,273 | 56,104 | 140,361 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 2 | 43.5 | 300 | Pump | 83.5 | 80.4 | 78.9 | - | 78.9 | 2,696 | 2,696 | 0 | 0 | 0 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 3 | 43.5 | 300 | Pump | 83.5 | 80.4 | 76.8 | - | 76.8 | 2,771 | 2,771 | 0 | 0 | 0 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 4 | 43.5 | 300 | Pump | 83.5 | 80.4 | 76.7 | 83.0 | 79.9 | 2,772 | 2,661 | 111 | 668,706 | 84,257 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| PS3 | 1 | 43.5 | 308 | Pump | 84.0 | 81.1 | 75.9 | 83.0 | 80.2 | 2,876 | 2,724 | 152 | 916,126 | 115,432 | 604,291 |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| | 2 | 43.5 | 308 | Pump | 84.0 | 81.1 | 72.8 | 83.0 | 80.2 | 2,999 | 2,724 | 275 | 1,656,242 | 208,686 | |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| | 3 | 43.5 | 308 | Pump | 84.0 | 81.1 | 74.6 | 83.0 | 80.2 | 2,926 | 2,724 | 202 | 1,217,997 | 153,468 | |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| | 4 | 43.5 | 308 | Pump | 84.0 | 81.1 | 75.6 | 83.0 | 80.2 | 2,891 | 2,724 | 167 | 1,005,597 | 126,705 | |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| PS4 | 1 | 43.5 | 314 | Pump | 84.0 | 81.1 | 73.4 | 83.0 | 80.1 | 3,032 | 2,780 | 252 | 1,520,619 | 191,598 | 729,801 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 2 | 43.5 | 314 | Pump | 84.0 | 81.1 | 70.8 | - | 70.8 | 3,143 | 3,143 | 0 | 0 | 0 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 3 | 43.5 | 314 | Pump | 84.0 | 81.1 | 67.9 | 83.0 | 80.1 | 3,281 | 2,780 | 501 | 3,020,534 | 380,587 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 4 | 43.5 | 314 | Pump | 84.0 | 81.1 | 74.5 | 83.0 | 80.1 | 2,987 | 2,780 | 208 | 1,250,915 | 157,615 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| PS5 | 1 | 42.9 | 195 | Pump | 85.7 | 82.7 | 78.8 | 84.0 | 81.1 | 1,730 | 1,682 | 48 | 288,122 | 36,303 | 616,007 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 2 | 42.9 | 195 | Pump | 85.7 | 82.7 | 60.7 | 84.0 | 81.1 | 2,248 | 1,682 | 566 | 3,411,754 | 429,881 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 3 | 42.9 | 195 | Pump | 85.7 | 82.7 | 77.1 | 84.0 | 81.1 | 1,770 | 1,682 | 88 | 527,639 | 66,483 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 4 | 42.9 | 195 | Pump | 85.7 | 82.7 | 77.2 | 85.3 | 82.3 | 1,766 | 1,657 | 110 | 661,426 | 83,340 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | | | | | | | | | | | | | | Total | 2,634,891 |

Note;
1. Equipment to be replaced with a new one is marked in yellow color.
2. The motor No. 4 of PS5 will be allocated as the spare motor and will be handed over to Miyahuna.
(Source: JICA Survey Team)

The Table 2.4 above shows that “the combined efficiency measured in this survey” is lowered by about 8.3% from “the original combined efficiency.” The combined efficiency can be improved by replacing the pumps and motors marked in yellow color, which have not been replaced or upgraded since the pumping facilities were first constructed. It also turns out that a reduction in electricity costs of 2.63 million JOD (= approximately 410 million yen) per year can be expected by replacing the yellow marked facilities at 6 pumping stations from IPS to PS5. For the calculation, the pump operation ratio of 0.688, the unit price of electricity 0.126 JOD / kWh and the exchange rate of 153.36 yen / JOD are adopted.

As for the replacement of pump, the condition "Applicable standards at the pump factory test is ISO 9906 (1B), JIS[11] B 8301 (Grade 1) or international standard approved by the Consultant," will be specified in tender specifications for the pump efficiency after the replacement. It means that a standard for judging the quality of pump at the time of the factory test is specified as above and the grade 1 is adopted as a judgment standard. The allowance of the grade 1 pump efficiency is -3%, which indicates that the efficiency of the replaced pumps can be allowed up to 3% lower than the pump efficiency specified. Assuming the lowest case (-3%), the annual power cost that could be reduced after replacement is estimated as shown in Table 2.5.

[11] Japan Industrial Standards

**Table 2.5 Expected Reduction of annual electricity cost based on 3% lower efficiency**

| Pump Station | Unit No. | Pump Capacity | Pump Total Head | Equipment | Original Efficiency | Original Combined Efficiency | Measured Combined Efficiency | Efficiency after Replacement | Expected Combined Eff. After Replacement | Present Motor Inputo Power | Motor Input Power after Replacement | Improvement for Motor Input Power | Improvement of Annual Electric Power | Improvement of Annual Electricity Costs for each Unit | Improvement of Annual Electricity Costs for each PS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $m^3/m$ | m | - | % | % | % | % | % | kW | kW | kW | kWh | JOD | JOD |
| IPS | 1 | 43.8 | 30 | Pump | 85.0 | 81.9 | 54.3 | 80.0 | 77.1 | 394 | 278 | 117 | 702,560 | 88,523 | 145,449 |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| | 2 | 43.8 | 30 | Pump | 85.0 | 81.9 | 63.1 | 80.0 | 77.1 | 339 | 278 | 62 | 372,225 | 46,900 | |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| | 3 | 43.8 | 30 | Pump | 85.0 | 81.9 | 73.6 | 80.0 | 77.1 | 291 | 278 | 13 | 79,576 | 10,027 | |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| | 4 | 43.8 | 30 | Pump | 85.0 | 81.9 | 65.9 | - | 65.9 | 325 | 325 | 0 | 0 | 0 | |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| PS1 | 1 | 43.5 | 300 | Pump | 83.0 | 79.9 | 74.7 | 80.0 | 77.0 | 2,849 | 2,761 | 88 | 530,473 | 66,840 | 148,756 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 2 | 43.5 | 300 | Pump | 83.0 | 79.9 | 77.6 | 80.6 | 77.6 | 2,741 | 2,741 | 0 | 0 | 0 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 3 | 43.5 | 300 | Pump | 83.0 | 79.9 | 74.7 | 80.0 | 77.0 | 2,849 | 2,761 | 88 | 530,473 | 66,840 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 4 | 43.5 | 300 | Pump | 83.0 | 79.9 | 76.5 | 80.0 | 77.0 | 2,781 | 2,761 | 20 | 119,655 | 15,077 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| PS2 | 1 | 43.5 | 300 | Pump | 83.5 | 80.4 | 77.8 | 80.0 | 77.0 | 2,735 | 2,761 | -26 | -156,201 | -19,681 | -11,210 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 2 | 43.5 | 300 | Pump | 83.5 | 80.4 | 78.9 | - | 78.9 | 2,696 | 2,696 | 0 | 0 | 0 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 3 | 43.5 | 300 | Pump | 83.5 | 80.4 | 76.8 | - | 76.8 | 2,771 | 2,771 | 0 | 0 | 0 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 4 | 43.5 | 300 | Pump | 83.5 | 80.4 | 76.7 | 80.0 | 77.0 | 2,772 | 2,761 | 11 | 67,231 | 8,471 | |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| PS3 | 1 | 43.5 | 308 | Pump | 84.0 | 81.1 | 75.9 | 80.0 | 77.3 | 2,876 | 2,826 | 50 | 300,530 | 37,867 | 294,030 |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| | 2 | 43.5 | 308 | Pump | 84.0 | 81.1 | 72.8 | 80.0 | 77.3 | 2,999 | 2,826 | 173 | 1,040,645 | 131,121 | |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| | 3 | 43.5 | 308 | Pump | 84.0 | 81.1 | 74.6 | 80.0 | 77.3 | 2,926 | 2,826 | 100 | 602,400 | 75,902 | |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| | 4 | 43.5 | 308 | Pump | 84.0 | 81.1 | 75.6 | 80.0 | 77.3 | 2,891 | 2,826 | 65 | 390,000 | 49,140 | |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| PS4 | 1 | 43.5 | 314 | Pump | 84.0 | 81.1 | 73.4 | 80.0 | 77.2 | 3,032 | 2,884 | 148 | 892,379 | 112,440 | 492,326 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 2 | 43.5 | 314 | Pump | 84.0 | 81.1 | 70.8 | - | 70.8 | 3,143 | 3,143 | 0 | 0 | 0 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 3 | 43.5 | 314 | Pump | 84.0 | 81.1 | 67.9 | 80.0 | 77.2 | 3,281 | 2,884 | 397 | 2,392,295 | 301,429 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 4 | 43.5 | 314 | Pump | 84.0 | 81.1 | 74.5 | 80.0 | 77.2 | 2,987 | 2,884 | 103 | 622,676 | 78,457 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| PS5 | 1 | 42.9 | 195 | Pump | 85.7 | 82.7 | 78.8 | 81.0 | 78.2 | 1,730 | 1,744 | -14 | -87,370 | -11,009 | 474,070 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 2 | 42.9 | 195 | Pump | 85.7 | 82.7 | 60.7 | 81.0 | 78.2 | 2,248 | 1,744 | 504 | 3,036,261 | 382,569 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 3 | 42.9 | 195 | Pump | 85.7 | 82.7 | 77.1 | 81.0 | 78.2 | 1,770 | 1,744 | 25 | 152,146 | 19,170 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 4 | 42.9 | 195 | Pump | 85.7 | 82.7 | 77.2 | 85.3 | 82.3 | 1,766 | 1,657 | 110 | 661,426 | 83,340 | |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | | | | | | | | | | | | | | Total | 1,543,422 |

Note;
1. Equipment to be replaced with new ones is marked in yellow color.
2. The motor No. 4 of PS5 will be allocated as the spare motor.
(Source: JICA Survey Team)

In case the pump efficiency after the renewal becomes 3% lower than the pump efficiency specified for the new pumps, the electricity cost that can be reduced will be 1.54 million JOD (about 240 million yen) annually. It is calculated based on the pump operation ratio of 0.688, the unit price of electricity 0.126 JOD / kWh, and the exchange rate of 153.36 yen / JOD.

Table 2.6 summarizes the list of pumps and motors to be replaced for each pumping station. The renewal plan includes combination of existing and new equipment for pump and motor. However, in order to ensure competitive bidding and clarify defect liability, the combination of pump and motor should be a set of new pump and new motor avoiding a combination of new and existing equipment. To meet this condition, the existing motors are recombined with existing pumps as shown in Table 2.7. Plan A' (Table 2.8) indicates that the number of combinations of the equipment to be replaced is as many as possible. Plan B (Table 2.9) indicates that the equipment to be newly replaced are completely paired. A comparative evaluation among three plans (A, A' and B) was conducted as shown in Table 2.10.

To conclude, Plan A' is adopted in which the possibility of the occurrence of equipment failure and defect liability is low and the burden on the Japanese side is the least. The competitive bidding in procurement of contractor can be ensured as well.

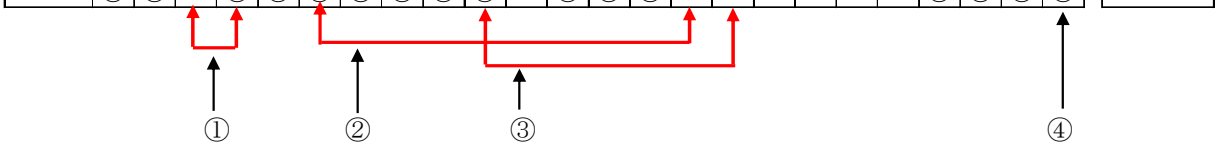
**Table 2.6　Plan A：Replacement of equipment based on survey results**

| PS | IPS | | | | PS1 | | | | PS2 | | | | PS3 | | | | PS4 | | | | PS5 | | | | Total No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | of Sets |
| Pump | ○ | ○ | ○ | | ○ | | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | | 18 |
| Motor | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | | | | | | | ○ | ○ | ○ | ○ | 16 |

○: Equipment to be replaced
Blank: Equipment not to be replaced
(Source: JICA Survey Team)

**Table 2.7　Relocation of existing motors**

| PS | IPS | | | | PS1 | | | | PS2 | | | | PS3 | | | | PS4 | | | | PS5 | | | | Total No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | of Sets |
| Pump | ○ | ○ | ○ | | ○ | | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | | |
| Motor | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | | | | | | | ○ | ○ | ○ | ○ | 4 |




① Interchange IPS No. 4 Motor and IPS No. 3 Motor.
② Interchange PS1 No. 2 Motor and PS3 No. 3 Motor.
③ Interchange PS2 No. 2 Motor and PS3 No. 4 Motor.
④ Replace PS5 No. 4 motor with spare motor owned by Miyahuna.

(Source: JICA Survey Team)

**Table 2.8 Plan A' : Relocation of the motor before installation of new equipment**

| PS | IPS | | | | PS1 | | | | PS2 | | | | PS3 | | | | PS4 | | | | PS5 | | | | Total No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | of Sets |
| Pump | ○ | ○ | ○ | | ○ | | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | | 18 |
| Motor | ○ | ○ | ○ | | ○ | | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | | | | | ○ | ○ | ○ | | 15 |

(Source: JICA Survey Team)

**Table 2.9 Plan B : Relocation of the motor before installation of new equipment and addition of new motors for all new pumps**

| PS | IPS | | | | PS1 | | | | PS2 | | | | PS3 | | | | PS4 | | | | PS5 | | | | Total No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | of Sets |
| Pump | ○ | ○ | ○ | | ○ | | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | | 18 |
| Motor | ○ | ○ | ○ | | ○ | | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | | 18 |

(Source: JICA Survey Team)

**Table 2.10 Comparison of proposed combinations of replacement of equipment**

| Survey Plan | | Plan A | Plan A' | Plan B |
|---|---|---|---|---|
| Outline of the proposal | | Original proposal based on the survey (no motor reallocation by Jordanian side in advance) | Proposal based on reallocation of motor by the Jordanian side in advance | |
| No. of equipment | Pump | 18 sets | | |
| | Motor | 16 sets | 15 sets | 18 sets |
| | Formation of pair with both new equipment | 12 pairs | 15 pairs | 18 pairs |
| Bid | Bidding conditions | Trading company, engineering company, manufacturer or JV among them (Bidder needs experience of pump installation work of similar scale with the Project) | | |
| | Specifications of equipment | The technical specifications are prepared, but brand and manufacturer of equipment are not specified. | | |
| Evaluation results | Burden to Japan | · Heavier than Plan A' (△) | · Lightest in three plans (○) | · Heaviest in three plans (×) |
| | Burden to Jordanian | · No need to relocate the motor in advance (○) | · Need motor relocation in advance (△) | · Need motor relocation in advance (△) |
| | Defect liability | · Have possibility of failure due to combination of different manufacturers and different aging conditions. (△)<br>· May cause defect liability issues. (△) | · Except three pumps, all new pumps are paired with new motors, so has less possibility of failure. (○)<br>· Possibility of defect liability issues is also small. (○) | · Since the number of replacement units is the largest and all new pumps are paired with new motors, the possibility of failure is minimal. (○) |

| Survey Plan | | Plan A | Plan A' | Plan B |
|---|---|---|---|---|
| | | | | · Possibility of defect liability issue is also small. (○) |
| | Competitive bidding | · Due to the defect liability issue, bidding may result in non-competitive because the procurement is limited to a manufacturer who installed the existing equipment. (×) | · Because all new pumps except 3 pumps are paired with new motor, multiple bidders may participate in the bid and competitive bidding is ensured. (○) | · Because all new pumps are paired with new motor, multiple bidders may participate in the bid and competitive bidding is ensured. (○) |
| Final Decision | | × | ○ | × |

Note; ○: Excellent, △: Good, x: Fair

(Source: JICA Survey Team)

The responsibilities of the Jordanian and the Japanese sides regarding pumps and motors in the selected renewal plan A' are as follows:

a) Jordanian side
- Relocation and interchange of one motor at IPS
- Relocation and interchange of two motors at Raw water pumping stations
- Exchange of one motor at transmission pumping station with spare motor

b) Japanese side
- Replacement of 3 sets of intake pump and motor
- Replacement of 9 sets of raw water pump and motor with new ones
- Replacement of 3 raw water pumps (PS4) with new ones
- Replacement of 3 sets of transmission pump and motor with new ones

(2) Renewal plan of equipment to be procured

1) Traveling screen

Four traveling screens shall be replaced with new ones. The existing screen system is severely corroded due to prevailing adverse raw water quality. In consideration of extending the life of the traveling screen, the specifications of travelling screen shall require the intensive anti-corrosion measures such as painting.

2) Intake pump

Although the impact of foreign matter will be reduced by replacing the traveling screen in the renewal work, the impeller and casing ring shall be replaced with high strength and wear resistant cast stainless steel in order to improve the durability.

3) Raw water pump

The JICA Survey Team requested the Japan Society of Corrosion Protection (Corrosion Center) to survey wearing and corrosion conditions of the pumps. It concluded the followings:

a) Damage to the cast steel casing tongue was most likely caused by slurry. (Slurry indicates a suspension of liquid and particles such as sand, silt, etc.)
b) Partial corrosion of 13Cr stainless steel parts, corrosion of cast steel parts, and damage to cast steel casing tongues were due to increase in the corrosion rate caused by high chloride ion concentration in raw water. It might also be due to injection of chlorine dioxide and potassium permanganate.

Regarding a) above, the Center recommends changing the material of the cast steel casing of the raw water pumps, and regarding b), they recommend that the material of corroded casings and other parts be changed to duplex stainless steel.

Due to very high total head of about 300m of the raw water pump and the quality issue of the raw water, the internal parts of the pump are severely abraded and corroded. This results in significant decrease in performance of pumps. The pump casing is currently made of cast steel (JIS SCW480) but this material is not suitable for corrosive liquid as it is highly susceptible to corrosion. Therefore, the material of the casing should be changed to duplex (austenitic / ferritic) stainless steel. This material has excellent strength and provides better corrosion resistance in chloride environments, and therefore, it is widely used in applications such as chemical plants or seawater equipment. Use of this material can eliminate the need for lining of the inner surface, which is applied to the existing casing, and consequently, it is expected that it reduces maintenance costs and improves durability of the facilities.

The impeller is currently made of cast stainless steel (JIS SCS5) which has a characteristic of low corrosion resistance but high strength as it is martensitic stainless steel. Use of this material has an advantage that repair work such as in the event of impeller damage can be done by welding. However, since it is found that the damage is caused by cavitation in the present case, the material of impellers shall also be changed to duplex stainless steel having high cavitation resistance similar to that of casing. Furthermore, since martensitic stainless cast steel (JIS SCS1) material, which has low corrosion resistance, is currently used for the wear ring as in the case of the impeller, the material of the wear ring shall also be changed to duplex stainless steel.

4) Clear water transmission pump

Three transmission pumps in PS5 were installed in 2003 and one of these pumps was replaced with a new one for the first time in 2018. Since the water handled by this pump is treated clean water, the influence of abrasion is small. Its corrosion is also judged to be within the range of normal deterioration. Therefore, it is considered that the transmission pumps do not have a specific problem and thus the transmission pumps to be renewed shall be of the same specifications as the existing ones.

5) Electric motor

The current protection type of the motor from water is the open drip-proof type (IP[12]22), but the protection type shall be improved to IP24 that protects the motor from splashed water from the pump. The environment in the pumping stations is hot and humid, the water leaking from the gland of the raw water pump contains a lot of silt, and the silt enters and adheres to the inside of the motor. The improved protection type protects the motors from this condition. The motor that has been renewed by Miyahuna has already IP24 protection type.

6) Discharge header pipe

As a result of the measurement of thickness of the discharge header pipe, it is considered that the renewal of the discharge header pipe is not required. At present, an emergency restoration has been adopted to the end of the discharge header pipe when this part was damaged. There have been several cases of damages of this part despite this restoration. Therefore, the end of the discharge header pipe at 5 places of PS1 to PS5 shall be changed with the end cap as originally designed.

7) Electric ball valve and check valve

One electric ball valve of PS5 was renewed in 2018, but the other valves have not been replaced since the initial installation, resulting in high risk of decrease in water supply capacity of transmission pumping station. Therefore, four (4) check valves and three (3) electric ball valves shall be replaced with valves of the same specifications as the existing ones.

Table 2.11 summarizes the specifications and quantities of the equipment to be replaced with new ones.

**Table 2.11 Specifications and quantities of the equipment to be replaced**

| PS | Equipment | Main Specification | Q'ty |
|---|---|---|---|
| Intake Pumping Station (IPS) | Traveling Screen | W 1.4～1.9m x L 3.55m x D 7.15m | 4 |
| | Vertical type mixed flow pump | 43.8 $m^3$/min x 30m x 990 $min^{-1}$ x 280 kW (Impeller：SCS13)<br>Pump Eff.：83% (See Note) | 3 |
| | Motor for the above | 280kW x 6P x 0.4kV x 50Hz | 3 |
| Raw water Pumping Station (PS1～4) | Horizontal type centrifugal pump | 43.5 $m^3$/min x 300～314m x 1,490 $min^{-1}$ x 3,200～3,500 kW<br>(Main parts：Duplex stainless steel casting)<br>Pump Eff.：83% (See Note) | 12 |
| | Motor for the above | 3,200～3,500kW x 4P x 6.6kV x 50Hz (Protection：IP24) | 9 |
| | End cap of discharge header pipe | DN1,000 | 4 |
| Transmission Pumping Station (PS5) | Horizontal type centrifugal pump | 42.9 $m^3$/min x 195 m x 1,490 $min^{-1}$ x 1,800 kW<br>(Same spec as the existing model)<br>Pump Eff.：84% (See Note) | 3 |
| | Motor for the above | 1,800kW x 4P x 6.6kV x 50Hz<br>(Protection：IP24) | 3 |
| | Electric ball valve | DN450 | 3 |
| | Check valve | DN450 | 4 |
| | End cap of discharge header pipe | DN1,000 | 1 |

Note：The applicable standards at the pump factory test shall be ISO 9906 (1B), JIS B 8301 (Gr.1) or approved international standards. (The pump efficiency up to 3% lower than the specified pump efficiency is acceptable.)
(Source: JICA Survey Team)

[12] Ingress Protection [Degrees of protection against water and dust as defined in international standard]

### 2.2.3 Outline drawings

Table 2.12 shows the list of outline design drawings of the Project. Outline design drawings are given in Appendix 8 of this report.

**Table 2.12 List of outline drawings**

| Figure No. | Drawing Title | Number of drawings |
|---|---|---|
| Fig-1 | Plan Drawing of Intake Pumping Station | 1 |
| Fig -2 | Sectional Drawing of Intake Pumping Station (IPS) | 1 |
| Fig -3 | Outline Drawing of Intake Pump | 1 |
| Fig -4 | Installation Drawing of Pump and Motor in Raw water and Transmission Pumping Station (PS1-PS5) | 1 |
| Fig -5 | Outline Drawing of Traveling Screen | 1 |
| Fig -6 | End Plate Installation Position (PS1-PS5) | 1 |
| Fig -7 | Outline Drawing of End Plate | 1 |
| Total | | 7 |

(Source: JICA Survey Team)

### 2.2.4 Implementation plan

#### 2.2.4.1 Implementation policy

(1) Project Implementing Entity

The supervisory and responsible agency in Jordan related to the Project is the Ministry of Water and Irrigation (hereinafter referred to as “MWI”). Under the MWI, WAJ is the executing agency for the Project. Operation and maintenance of the Project facilities is performed by Miyahuna.

(2) Consultant

In order to procure the equipment related to the Project, a Japanese consultant (hereinafter referred to as “the Consultant”) makes a contract with the executing agency in Jordan, prepares detail design, and conduct procurement supervision. The Consultant prepares the bid documents and assists the executing agency to carry out the bidding procedure in selecting a contractor through open bidding. After the start of procurement work of equipment, the Consultant conducts procurement supervision from an objective standpoint and monitors the appropriate operation of Japan’s grant aid.

(3) Contractor

Under the framework of Japan's grant aid system, a Japanese contractor (hereinafter referred to as “the Contractor”) is selected through open bidding process and the Contractor procures the equipment of the Project. Since the installation work is carried out in a remote location that has a different social environment and background compared to Japan, the Contractor needs to have sufficient ability to complete the work in overseas conditions.

The equipment to be procured and installed is special equipment that will be installed at pumping stations with large discharge capacity at high pumping heads. The Contractor shall dispatch the Resident Representative and installation instructors from manufacturers of the equipment to the site and shall supervise and implement all activities related to removal of existing equipment, installation of new equipment, and adjustment and operation of trial runs of newly installed equipment.

The Resident Representative of the Contractor and installation instructors shall implement installation work by coordinating with the operation manager of the pumping stations on the operation of the pumping stations and installation work. The Contractor needs to be fully aware of the local market, labor laws, local customs, etc., because the installation work uses local construction workers, locally procured equipment and construction equipment.

After the completion of the Project, the operation and maintenance agency of Jordan requires procuring spare parts for maintenance and after-care services such as providing assistance in the event of a breakdown. The Contractor requires to establish a sufficient and effective communication system with the agency even after installation of the equipment.

#### 2.2.4.2 Implementation conditions

(1) Equipment installation work

All equipment to be replaced will be manufactured in Japan or in the third countries and will be delivered to six pumping stations for installation. The site of temporary storage for the equipment shall be selected before delivery and agreed with the operation manager of pumping stations in Miyahuna.

As the locations of installation of the equipment are mostly inside the pumping stations, the replacement work can be implemented regardless of the weather condition. As for the effect of weather condition on water demand, the following shall be considered in replacing the equipment, and necessary measures shall be taken to prevent any extreme shortage of water supply due to decrease in pumped water:

1) The actual pump operation of each pump station during 2018 is shown in the table 2.13. It takes 9 months to replace all of the pumps and motors [1.5 months x 18 units/(3 units/time) = 9 months]. Construction will begin on September 1st, when water demand begins to drop in order to complete the replacement work in one year, and will be completed on May 31st, before water demand peaks.

**Table 2.13 Actual pump operation of each pumping station**

| Month (year 2018) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of pumps in operation at each pumping station (average) | 2.7 | 2.9 | 2.9 | 2.6 | 3.4 | 3.6 | 3.7 | 3.8 | 3.6 | 3.3 | 3.3 | 3.2 |

2) Only one of the four (4) pumps at each pumping station can be stopped for replacement work of pump and motor. The other three pumps must continue operating to meet the water demand.
3) The improvement work of the end cap of header pipe shall be implemented during the period between 1st October and 30th April for the same reason as above.
4) Planned production and transportation of the equipment for replacement shall be implemented in consideration of the above limited installation periods.

(2) Procurement of labor and materials

The Project site is located on the outskirts of the capital Amman. Basic construction materials such as cement, aggregate, ready-mixed concrete, and reinforcing bars can be locally procured. Local contractors working in Jordan's water and sewerage sectors employ skilled and experienced technicians and workers and own relevant construction machinery required for the Project implementation. Technicians and workers, and machinery required for the Project can also be procured locally.

#### 2.2.4.3 Scope of works

The demarcation of responsibilities of the Project activities between the Japanese and Jordanian sides is shown in Table 2.14.

**Table 2.14 Demarcation of responsibilities between the two countries**

| Installation | Japan | Jordan |
|---|---|---|
| 1. Equipment procurement and installation work | | |
| (1) Equipment procurement and transportation | ● | |
| (2) Equipment installation | ● | |
| (3) Adjustment and test run | ● | |
| (4) Provision of electric power free of charge during test operation | | ● |
| (5) Permission to use overhead crane at pumping station free of charge when installing equipment | | ● |
| (6) Preparation before equipment installation (relocation of 4 existing motors) | | ● |
| 2. Common items for installation works | | |
| (1) Provision of materials and equipment storage free of charge | | ● |
| (2) Provision of management offices for the Contractor and supervision offices for the Consultant free of charge | | ● |
| (3) Securing land (70m$^2$) for disposal of concrete waste | | ● |
| (4) Transportation of replaced and removed equipment to the disposal site | ● | |

(Source: JICA Survey Team)

#### 2.2.4.4 Supervision by Consultant

(1) Work supervision system of the Consultant

The Consultant will supervise and offer guidance to the Contractor to achieve the following main items:

- Procurement of equipment in compliance with tender documents including the technical

specifications,

- Completion of installation of equipment within the predetermined work period, and
- Implementation of safety at the work sites avoiding damages/injury to not only the contractor and its employees but also the third party.

Furthermore, the Consultant has the role of supervising the work from a neutral standpoint by confirming that the work is appropriately implemented under the framework of Japan's grant aid.

1) Main supervisory duties of the Consultant

The main supervisory duties that the Consultant is required to perform are described below.

a) Progress control

The consultant will confirm the validity of the progress chart submitted by the Contractor, compare the actual progress of the work with the planned progress, and confirm the progress status of the work on daily, weekly, and monthly bases. If any delay seems likely and becomes a cause for concern, the Consultant issues a warning to the Contractor. If a delay occurs, the Consultant studies and investigates the causes together with the Contractor and guides the Contractor to adopt the required remedial measures. The work supervision will include the following:

i. Confirm procurement quantity of equipment
ii. Confirm production and transportation results of equipment
iii. Confirm equipment installation / adjustment / test run results
iv. Coordinate with pump operation managers and the Contractor on installation work of equipment and pump operation.

b) Quality control

The Consultant shall ensure the quality of equipment and the installation work as specified in the agreed specifications. If there is any concern about the quality, the Consultant shall issue a warning to the Contractor and request the Contractor to take remedial measures immediately. Quality control shall be implemented using the measures below:

i. Verify specifications and manufacturing drawings of equipment, and approve
ii. Check test results of equipment, and approve
iii. Participate as a witness to equipment/material tests at factory, and approve
iv. Verify equipment installation procedures, and approve
v. Conduct site inspections to maintain quality of work, such as reinforcing bar arrangement, strength of machine foundation concrete, X-ray inspection for end cap, axis alignment check for pomp and motor, etc., and approve
vi. Conduct commissioning and performance test, and approve.

c) Safety control

The Consultant shall perform the validity check of the safety control plan of the Contractor and monitor its implementation status. The Consultant shall supervise the work at preparatory stage to prevent

accidents at work and accidents to a third party. Safety control shall be implemented using the measures listed below:

i. Confirm safety control plan of the Contractor and presence of a safety control manager appointed by the Contractor
ii. Confirm the validity of the safety control plan and the safety manager appointed by the Contractor
iii. Confirm the status of implementation progress of the safety control plan
iv. Check the content of the benefit system for workers (occupational safety and health benefits) and confirm that holidays and recesses are being enforced appropriately
v. Confirm the safety of the routes for carrying in equipment and temporary storage site.

(2) Procurement supervision system of the Consultant

For the purpose of smooth implementation of the Project work, the Consultant shall develop and establish the necessary procurement supervision system focusing on schedule control, quality control and safety control of the processes as mentioned above. Procurement supervision is implemented based on detailed design and procurement supervision plan considering the gist of the outline design. Therefore, a procurement supervision system consistent with the series of tasks of detail design and procurement supervision shall be developed. The Consultant shall establish the supervision system mentioned below as supervision needs to be implemented in Japan or the third country as well as at the Project site.

a) On-site work supervision

Since it is important to confirm that the procurement work is being performed appropriately under the framework of Japan's grant aid, the work supervision on site needs to be performed by Japanese supervision engineer who thoroughly understands the grant aid scheme.

The equipment to be procured is special equipment of large capacity and high head pumps and motors, and its inspection requires in-depth knowledge of an engineer who is familiar with such equipment. In addition, coordination with the operation manager of the pumping stations is required because the installation work of the equipment is carried out while continuing pumping operation.

Equipment installation work will be carried out at three of four pumping stations at the same time, so one resident representative supervision engineer is not able to handle the supervision work. Therefore, one local engineer shall be hired for supervision. Table 2.15 shows the Japanese supervision organization allocated to the site based on the above policy.

**Table 2.15 Japanese supervision organization at site**

| Job title | Field (MM) | No. of trips | Responsible for |
|---|---|---|---|
| Supervision engineer (Chief consultant) | 0.33 | 1 | Equipment inspection and delivery |

| | | | |
|---|---|---|---|
| Resident Supervisor | 10.9 | 2 | Resident supervision during installation and test of equipment (8.9 months for pump & motor, 2 months for travelling screen and end plates) |
| Mechanical engineer | 0.33 | 1 | Prior confirmation of equipment loading and installation work |
| | 0.73 | 1 | Equipment inspection and delivery |
| | 0.23 | 1 | Inspection after one year |
| Electrical engineer | 0.53 | 1 | Equipment inspection and delivery |
| Total | 13.05 | 7 | |

(Source: JICA Survey Team)

b) Procurement supervision in Japan

The system necessary for overall supervision of the Project including items mentioned below shall be maintained in Japan, and the overall work including work at site in Jordan and work in Japan shall be supervised.

i. Check the contents of the agreement and the process, progress, quality and safety
ii. Examine the contents of the design change and decide the response policy
iii. Give technical and financial assistance to Consultant's site office
iv. Coordinate with JICA implementation supervision section and the Contractor

(3) Work control system of the Contractor

a) On-site procurement management

Resident Representative shall supervise the work of installation instructors dispatched from the manufacturers and facilitate smooth installation works. The representative who are proficient in the work of the similar project should be assigned and manage the installation process, quality, safety and cost as a whole. Simultaneously, the representative carries out meetings and reporting for the operation manager of the pumping stations and the Resident Supervisor of the Consultant. Table 2.16 shows the Contractor's procurement management organization. In addition, local procurement management assistants shall be assigned to reduce the burden on the Resident Representative.

**Table 2.16 Contractor's organization for equipment installation and test**

| Job title | Field (MM) | No. of travels | Responsibility |
|---|---|---|---|
| Resident Representative | 11.00 | 3 | Resident procurement management during the procurement period |
| Inspector | 0.23 | 1 | Inspection after one year |
| Total | 11.23 | 4 | |

(Source: JICA Survey Team)

#### 2.2.4.5 Quality control plan

To maintain the quality of the equipment to be procured, the quality and performance required by the specifications shall be confirmed at the time of production (factory inspection), acceptance, and delivery. The quality control of the foundation concrete works of pumps, motors, and other facilities is

implemented by the tests listed in Table 2.17.

**Table 2.17 Quality control plan**

| Type of work | Control item | Method | Standard |
|---|---|---|---|
| Concreting work | Concrete quality | Mixing test<br>Slump test<br>Measurement of temperature<br>Compressive strength test<br>Air test<br>Aggregate grading, deleterious substance test | JIS A 1138<br>JIS A 1101<br>JSCE placing in hot and cold weather<br>JIS A1108<br>JIS A1118<br>JIS A1102, JIS A1103,<br>JIS A1137 |
| Non-shrink mortar work | Mortar quality | Compressive strength test<br>Consistency test | JIS A1108<br>JSCE[13]-F541 |
| Reinforcement | Strength<br>Reinforcing bar arrangement | Tensile test, bending test<br>Reinforcing bar arrangement inspection | JIS G3112<br>JSCE bend, pitch, tie, splice |

(Source: JICA Survey Team)

#### 2.2.4.6 Procurement plan

(1) Procurement of labors, materials and equipment

1) Labor

Technicians, skilled workers (mechanics, electricians, welders, etc.) and unskilled workers involved in equipment installation work can be locally procured. Installation instructor is dispatched from the equipment manufacturer to instruct and supervise local workers and manage the works properly.

2) Materials and equipment

The equipment in the Project will be procured from Japan or third countries, therefore, spare parts for the equipment are required. The same quantity of spare parts as those of built-in replaceable parts of the equipment shall be provided. Consumables shall be provided for two years to prepare for contingencies because it is difficult to predict replacement time accurately.

3) Construction machinery

There is no company in Jordan that lease out construction machinery required for the Project. General construction machinery such as equipment required for transportation and installation can be leased from local construction companies.

Considering the local conditions mentioned above, the procurement plan of main materials and equipment to be used in the Project are shown in Table 2.18.

[13] Japan Society of Civil Engineers

**Table 2.18 Procurement plan for main materials and equipment**

| | Local | Japan | Third Country |
|---|---|---|---|
| **Materials and equipment** | | | |
| Pump (equipment) | | ○ | |
| Motor (equipment) | | ○ | ○* |
| Valve (equipment) | | ○ | ○* |
| Traveling screens (equipment) | | ○ | ○* |
| End cap of header pipe (equipment) | | ○ | |
| Concrete (For machine foundation) | ○ | | |
| Non-shrink mortar (For machine foundation) | | ○ | |
| Reinforcing bars (For machine foundation) | ○ | | |
| Concrete formwork and timbering work materials | ○ | | |
| **Construction machinery** | | | |
| Concrete breaker | ○ | | |
| Truck cranes | ○ | | |
| Trucks with crane | ○ | | |
| Trucks | ○ | | |
| Generator | ○ | | |
| Air compressor | ○ | | |

*For these equipment, Japanese or third-country's products are currently used in the Zai Water Supply System. The country of origin for the third-country products should be considered from the OECD member countries. Procurement of third-country's products is not for the purpose of eliminating Japanese products, but for ensuring competitive bidding.

(Source: JICA Survey Team)

(2) Transportation plan

For material and equipment procured from Japan and third counties, the packaging method of mechanical and electrical parts shall be case packaging considering long-term transportation by sea, loading and unloading at ports and transport on land to the Project site. The unloading port in Jordan is only Aqaba port. Accordingly, the imported materials and equipment will be unloaded at Aqaba port and transported 400km over land to the Project area.

### 2.2.4.7 Operational guidance plan

Appropriate operation and maintenance of the pumping stations is important for ensuring stable operation. In addition to daily proper operation and inspection, periodic inspection and overhaul and maintenance of facilities and equipment should be conducted for preventing accidents and water supply interruption. Table 2.19 gives the contents of instructions to the operators through trial run on the appropriate operation method of the equipment to be replaced in the Project and Table 2.20 gives the operation guidance conducted by the Contractor including operation and maintenance.

**Table 2.19 Contents of initial operation guidance for replaced equipment**

| PS | Equipment | Initial Operation Guidance |
|---|---|---|
| IPS | Traveling screen | Check that startup and shutdown functions can be performed correctly by manual operation. The wash water pump should be operated in conjunction |

| PS | Equipment | Initial Operation Guidance |
|---|---|---|
| | | with the screen, and it should be confirmed that the debris scavenged by the screen is washed off and discharged. Also, confirm that automatic operation is triggered by the water level difference between upstream and downstream of the screen. However, in the trial run, the water level difference will be set artificially. Instruct the operator on the correct operation through the above test operation. |
| | Vertical type mixed flow pump and motor | After installation, perform test run to confirm that the specified pressure and flow rate are achieved, measure vibration, noise, current value, etc. to confirm that there is no problem. Also, check for any leakage from the gland packing and the injection of water into the intermediate bearing. Then, perform continuous operation until the bearing temperature becomes constant and confirm that the bearing temperature remains within the allowable value. |
| PS1-4 | Horizontal type centrifugal pump and motor | After installation, perform test run to confirm that the specified pressure and flow rate are achieved, measure vibration, noise, current value, etc. to confirm that there is no problem. Also check for any leakage from the gland packing. Then, perform continuous operation until the bearing temperature becomes constant and confirm that the bearing temperature remains within the allowable value. |
| | Discharge header pipe | No special guidance necessary for this. |
| PS5 | Horizontal type centrifugal pump and motor | After installation, perform test run to confirm that the specified pressure and flow rate are achieved, measure vibration, noise, current value, etc. to confirm that there is no problem. Also check for any leakage from the gland packing. Then, perform continuous operation until the bearing temperature becomes constant and confirm that the bearing temperature remains within the allowable value. |
| | Electric ball valve | Confirm that its 'fully open' and 'fully closed' operations can be performed correctly with the manual handle and the manual switch. At that time, confirm that the limit switch also operates correctly. Also confirm that the electric ball valve is fully opened and closed in conjunction with the operation of the pump. |
| | Check valve | In relation to the check valve, the Project does not provide any guidance on the initial operation after the replacement with new one, however, it will be confirmed that the valve disc opens and closes properly by ON-OFF of limit switch based on operating and stopping the pump. |
| | Discharge header pipe | No special guidance necessary for this. |

(Source: JICA Survey Team)

**Table 2.20 Operation guidance including maintenance of replaced equipment**

| PS | Equipment | Operation Guidance |
|---|---|---|
| IPS | Traveling screen | 1) Items to be checked daily<br>Appearance, vibration, abnormal sound<br>2) Items to be checked monthly<br>Lubricating oil quantity and quality, condition of mesh screen, condition of wash water pump, confirmation of water level meter, operation of automatic operation system, operation confirmation of protection devices such as alarms.<br>3) Items to be checked yearly<br>Replace lubricant, disassemble and check as necessary<br>4) Notes on operation<br>Since the design capacity of the traveling screen is planned for two intake pumps, two traveling screens are operated when four intake pumps are operated. Therefore, two of the four traveling screens are operated at all times, so four units should be adjusted for equal operation. |
| | Vertical type | 1) Items to be checked daily |

| PS | Equipment | Operation Guidance |
|---|---|---|
| | mixed flow pump and motor | Appearance, vibration, abnormal sound, bearing temperature, leakage from gland packing, water injection into intermediate bearing, discharge capacity, discharge pressure, current value, etc.<br>2) Items to be checked monthly<br>Check the amount and quality of bearing oil, wear of gland packing, operation of protective devices such as flow relay, pressure switch, temperature switch, etc.<br>3) Items to be checked yearly<br>Motor insulation resistance, replacement of bearing oil and gland packing if necessary, and overhaul.<br>4) Notes on operation<br>Since the intermediate bearing is rubber bearing, if the intake pump is started when the suction water level is low, the operation becomes dry and the bearing may be seized. Therefore, when starting the water intake pump, it is necessary to start the pump after confirming the suction water level and the water injection into the intermediate bearing. |
| PS1～4 | Horizontal type centrifugal pump and motor | 1) Items to be checked daily<br>Appearance, vibration, abnormal sound, bearing temperature, leakage from gland packing, discharge capacity, discharge pressure, current value, etc.<br>2) Items to be checked monthly<br>Check the amount and quality of bearing oil, wear of gland packing, operation of protective devices such as temperature switch, etc.<br>3) Items to be checked yearly<br>Motor insulation resistance, replacement of bearing oil and gland packing if necessary, and overhaul.<br>4) Notes on operation<br>Since the capacity of the balancing tank at the water supply destination is not enough comparing with the capacity of the raw water pump, maintaining the water level within a narrow range in the balancing tank increases the frequency of starting and stopping the raw water pump, which affects the life of the motor. Therefore, it is necessary to use the water level difference of the balancing tank as effectively as possible to reduce the frequency of starting and stopping the raw water pump. |
| PS5 | Horizontal type centrifugal pump and motor | Same as PS1～4 |
| | Electric ball valve | 1) Items to be checked daily<br>Visual inspection<br>2) Items to be checked monthly<br>Check valve opening / closing operation (manual or sequential)<br>3) Items to be checked yearly<br>Check the amount and quality of lubricating oil in the actuator, operation of protective devices such as limit switches, torque switches, etc.<br>4) Items to be checked every few years<br>Replace the lubricating oil and disassemble and inspect the actuator and valve body as necessary.<br>5) Notes on operation<br>Basically, the pump discharge valve is used in fully opened or fully closed position. However, caution is required when operating with partial valve opening for the purpose of adjusting the amount of water supplied by the pump since cavitation and erosion may occur in the valve body. |
| | Check valve | 1) Items to be checked monthly<br>Checking the opening and closing operation of the valve<br>2) Items to be checked yearly<br>Checking the operation of protection devices such as limit switches |

(Source: JICA Survey Team)

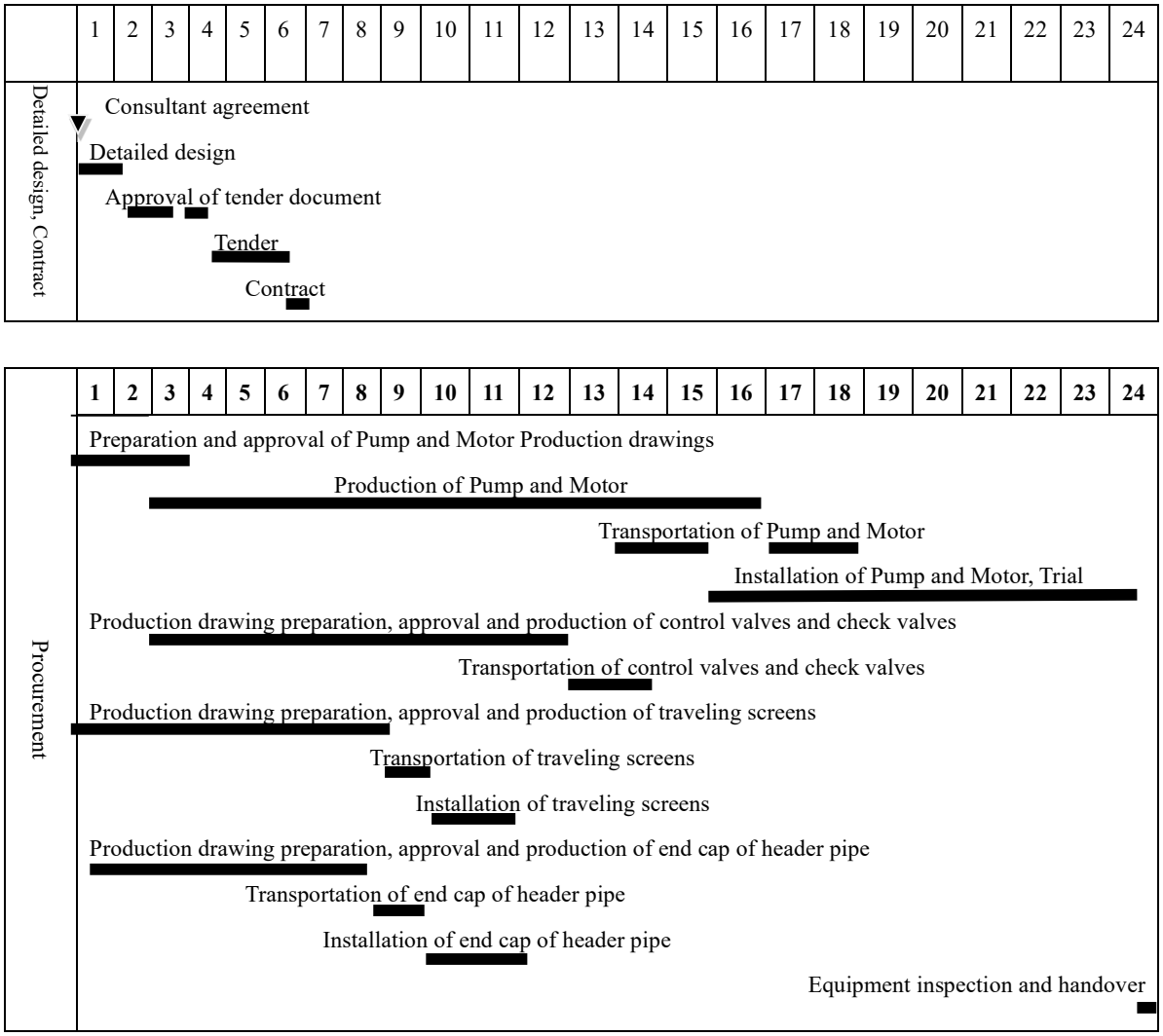
#### 2.2.4.8 Soft component (Technical assistance)

The soft component is the initial technical cooperation conducted by the government of the partner country using the equipment (hard component) procured through the grant aid. The Project comprises of only the replacement of existing equipment and the operation agency has sufficient technical capacity to operate and maintain the equipment procured. Therefore, soft component is not required and thus not included in the Project. However, both initial operation instructions and operation guidance regarding, in principle, all of the equipment will be provided by contractor. The preparation of operation and maintenance manuals will be included.

### 2.2.4.9 Implementation schedule

The planned implementation schedule is shown in Table 2.21.

**Table 2.21 Implementation schedule**




(Source: JICA Survey Team)

## 2.3 Security Plan

Amman, which is near the Project site, is categorized as “Level 2: to refrain from nonessential travel” according to the guidelines in the overseas security information of the Ministry of Foreign Affairs of Japan. It, therefore, requires appropriate attention to avoid danger. However, no continuous risk of security threat is acknowledged in the current situation. Also, no particular security threats were identified during the field survey. Therefore, no special security measures are suggested. However, as in any country of the Middle East region, it is advisable to collect updated information.

## 2.4 Obligations of Recipient Country

The Project is composed of the works borne by Japanese side and the works to be undertaken by the Jordanian side. The necessary measures and obligations of the Jordanian side for the Project are listed in Table 2.22.

**Table 2.22 Obligation of recipient country**

| Items |
|---|
| 1. Equipment installation work |
| (1) Provision of electric power free of charge during trial operation |
| (2) Permission to use overhead crane at pumping station free of charge when installing equipment |
| (3) Preparation before equipment installation (relocation of 4 existing motors) |
| 2. Common items for installation works |
| (1) Provision of material storage space free of charge |
| (2) Provision of local management offices for the Contractor and the Consultant free of charge |
| (3) Securing land (70m$^2$) to be used as disposal site free of charge |
| 3. Other items |
| (1) To coordinate for required approvals and permissions from relevant authorities to implement detailed design and construction works |
| (2) To repair of concrete in case of reinforcing bar expansion in the two grit settling basin |
| (3) To cooperate in consultation with residents living near the construction sites and to coordinate procedures for traffic control required for Project works with relevant authorities |
| (4) To carry out necessary procedures for issue of A/P required for payments to Japanese Consultants and Contractor and to bear the commissions for advising and payment to a bank in Japan for banking services based upon the Bank Arrangement (B/A) |
| (5) To ensure prompt unloading and customs clearance of the goods for the Project at the port of disembarkation in Jordan |
| (6) To accord Japanese nationals whose services may be required in connection with the supply of products and services under the verified contract such facilities as may be necessary for their entry into Jordan and stay there for the performance of their works |
| (7) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Jordan with respect to the supply of the products and services under the verified contract. And to take necessary measures for such tax exemption |
| (8) To use, operate and maintain properly the facilities and equipment constructed or procured under the Japan's Grant Aid program |
| (9) To bear all the expenses, other than to be borne by the Grant Aid, necessary for construction of the facilities. |

(Source: JICA Survey Team)

## 2.5 Project Operation Plan

(1) Organization of operation and maintenance

The Project is mainly composed of the replacement of existing equipment and the number of equipment is not increased. Miyahuna is proficient in handling the equipment to be replaced and has long term experience of operating the pumping stations with their skilled staff. Therefore, it is judged that the increase in the number of operation and maintenance staff is not required.

(2) Major monitoring equipment

The main equipment to be procured in the Project is given in Table 2.23. The operation and maintenance of the same equipment has been appropriately done by Miyahuna on daily basis. Therefore, operation and maintenance of the equipment by Miyahuna is sufficiently implementable.

**Table 2.23 Major equipment to be replaced and maintenance method**

| Equipment | Quantity | | Maintenance Method |
|---|---|---|---|
| Pump | Replacement | 18 sets | Periodic inspection |
| Motor | Replacement | 15 sets | Periodic inspection |
| Traveling screen | Replacement | 4 sets | Periodic inspection |
| Electric ball valve | Replacement | 3 sets | Periodic inspection |
| Check valve | Replacement | 4 sets | Periodic inspection |

(Source: JICA Survey Team)

(4) Items for periodic inspection

The inspection items and period/frequency of inspection of each item for the equipment in the Project are given in Table 2.24.

**Table 2.24 Items and period/frequency of inspection for equipment**

| Equipment | Inspection Items | Inspection Cycle | | |
|---|---|---|---|---|
| | | Daily | Monthly | Yearly |
| Pump and motor | Appearance, vibration, abnormal sound, bearing temperature, leakage from gland packing, discharge capacity, discharge pressure, current value, etc. | ● | | |
| | Check the amount and quality of bearing oil, wear of gland packing, operation of protective devices such as temperature switch, etc. | | ● | |
| | Motor insulation resistance, replacement of bearing oil and gland packing if necessary, and overhaul. | | | ● |
| Traveling screen | Appearance, vibration, abnormal sound | ● | | |
| | Lubricating oil quantity and quality, condition of mesh screen, condition of wash water pump, confirmation of water level meter, operation of automatic operation system, operation confirmation of protection devices such as alarms. | | ● | |
| | Replace lubricant, disassemble and check as necessary | | | ● |
| Electric ball valve | Appearance inspection | ● | | |
| | Check valve opening / closing operation (manual or sequential) | | ● | |
| | Check the amount and quality of lubricating oil in the actuator, operation of protective devices such as limit switches, torque switches, etc. | | | ● |
| Check valve | Checking the opening and closing operation of the valve | | ● | |
| | Checking the operation of protection devices such as limit switches | | | ● |

(Source: JICA Survey Team)

## 2.6 Project Cost Estimate

### 2.6.1 Initial cost estimate

(1) Expenses borne by Japanese side

The outline of the Project cost is given below. It is noted that the Project cost does not necessarily indicate the maximum amount provided in the exchange of notes (E/N) statement.

Outline of the Project cost:

| Items | | Estimated Project cost (million Japanese Yen) |
|---|---|---|
| Equipment | ・ Replacement of 18 pumps, 15 motors, and 4 traveling screens<br>・ Replacement of 3 control valves and 4 check valves<br>・ Reinforcing 5 end cap of header pipe | 2,280 |
| Detailed design and procurement supervision | | 87 |

(Source: JICA Survey Team)

The part of estimated costs of the Project to be borne by the Jordanian side is summarized in Table 2.25.

**Table 2.25 Summary of estimated costs to be covered by Jordan**

| Items | Project cost (thousand JOD) | Remark |
|---|---|---|
| Cost of electric power during test operation of pumps | 100 | |
| Cost of preparation before equipment installation (relocation of 4 existing motors) | 60 | |
| Total | 160 | |

(Source: JICA Survey Team)

Cost estimate conditions

1) Date of estimation : September 2019
2) Exchange rate : 1US$ = JPY108.57, 1JOD = JPY153.34
3) Work period : The work period for detailed design and procurement is given in Table 2.23.
4) Other : The Project cost is estimated in accordance with the Japan's grant aid scheme. The Project is assumed to include preliminary expenses. The application of preliminary expenses and the expense ratio will be determined separately by the Ministry of Foreign Affairs of Japan.

### 2.6.2 Operation and maintenance cost

(1) Maintenance costs for replaced equipment

The main maintenance item of the replaced equipment is repair of pumps and motors. Miyahuna has already assigned staff for monitoring and repair of pumps and motors, which can be carried out under the existing operation and maintenance system. Therefore, no increase in personnel costs is required. In the Project, the pump material will be changed from conventional stainless cast steel to duplex stainless cast steel, which does not require the repair costs such as lining of the pump casing inner surface and ceramic coating of the wear ring and sleeve. As a result, operation and maintenance costs are expected to be reduced.

According to the financial statements of Miyahuna, the financial balance was positive until 2017 but became negative in 2018. Even the operational expense could not be covered in 2018. This is mainly because of electricity tariff increase, and the same trend may be expected in future. The implementation of the Project is expected to reduce the cost by 1,543,422JOD but this reduced cost still cannot cover the deficit. Therefore, the deficit after the completion of the Project may continue (see paragraph 'ii) With the Project, no tariff increase of (2) Proposal for generating funds for next rehabilitation'). When the financial balance of Miyahuna is negative, WAJ shall cover the balance. The covering of the deficit by WAJ shall continue if the deficit is caused by the external factors such as electricity.

As Miyahuna is an autonomous company in nature, if it is not favorable to receive the subsidy from the government, the tariff increase described in '(2) Proposal for generating funds for next rehabilitation' will be inevitable. The deficit may continue for a few years but the balance may be positive from 2022 and the operation and maintenance cost could be secured. For the sound financial operation of the utility, tariff increase is strongly recommended.

(2) Proposal for generating funds for next rehabilitation

The replacement of pumps, motors and other equipment will be implemented by the Japan's grant aid project at one time. In the Project, 2.07 billion yen is required for replacement of pumps and motors only, or 2.37 billion yen is required for replacement of all components including screens and end cap of header pipe.

Then, the funds for the next rehabilitation/replacement work will be borne by the Jordanian side. The next rehabilitation may be required after 20 years from the completion of the Project. About 100 to 120 million yen (650 – 800 thousand JOD) is required to save annually to secure the total amount equal to that of the grant aid project. Assuming that these costs will be covered by WAJ or Miyahuna, the future profit/loss is estimated for examination of the possibility of fund securement. If not secured, a proposal of tariff increase including the rates and timing is prepared.

1) Future estimation of profit/loss of Miyahuna

The profit/loss until 2043, when the next rehabilitation will be required is estimated by the scenario of (i) without Project, no tariff increase, (ii) with Project, no tariff increase, and (iii) with Project and tariff

increase. The conditions of the estimation are as follows:

- Revenue
  Water and sewerage revenue increases by 1.1 % annually due to the reduction of NRW ratio.
  The increase ratio of other revenue is calculated considering the average growth rate and average inflation rate in the past five years.
- Salaries and wages, chemical cost
  The increase ratio is calculated considering the average growth rate and average inflation rate in the past five years.
- Electricity cost
  The average rate of electricity on past is calculated. (The scenario with Project considers the electricity cost reduction by this Project).

i) Without the Project, no tariff increase

As shown in Table 2.27, the current tariff cannot meet even operating expenditures, and the deficit will be increasing every year. As a result, the fund required for the next rehabilitation in 2043 cannot be accumulated.

ii) With the Project, no tariff increase

The future estimation with the Project but no tariff increase is shown in Table 2.28. After 2023 when the Project completes, the electricity cost would be reduced by 1.54 million JOD (240 million yen). However, this reduction is temporal, and the effect does not continue longer. With the Project, the annual electricity cost of Zai system can be reduced by 7.1 %. The electricity consumption of the Zai Water Supply System occupies 57 % of total consumption of Miyahuna so that the effect of electricity reduction by the Project in the operating expenditures of Miyahuna is limited. Moreover, as the electricity consumption is estimated to increase 3 % annually (Strategic Master Plan for Municipal Water Infrastructure 2016), the effect of electricity reduction by the Project is offset by this annual increase. The accumulated deficit from 2020 to 2027 is estimated as 248 million JOD. Compared with the scenario "without the Project, no tariff increase," the deficit will be reduced by 9 million JOD (1.4 billion yen). However, without tariff increase, the balance remains negative, and the fund required for the next rehabilitation in 2043 cannot be accumulated.

iii) With the Project, with tariff increase

To secure the fund by 2043 (20 years after the Project completion), the tariff increase ratio shall be examined. To accumulate 2.37 billion Japanese yen by 2043, the water and sewerage revenue should be increased by 2.1 times. The tariff should be raised stepwise in the years when deficits are expected. The recommended rate of tariff increase for each water consumption class is shown in Table 2.26. It is also examined and confirmed that the water tariff after the rate increase is within 4 % of household income.

**Table 2.26 Proposed tariff increase by class of consumption volume**

| Class ($m^3$ per quarter) | 2021 | 2023 | 2025 | 2033 |
|---|---|---|---|---|
| 0-18 | 0% | 0% | 0% | 0% |
| 19-36 | 7% | 5% | 5% | 5% |
| 37-54 | 15% | 11% | 9% | 8% |
| 55-72 | 15% | 17% | 13% | 10% |
| 73-90 | 20% | 20% | 17% | 10% |
| 91-126 | 22% | 20% | 20% | 12% |
| >127 | 25% | 25% | 20% | 12% |

Though it is not declared as policy/regulations, WAJ owns the principle to consider the least consumption class (18$m^3$/quarter) as for low income households and their tariff should be fixed and at low level. Thus, this policy is considered for tariff increase. Around 30 % of the customers fall in this least consumption class. The following class (19-36 $m^3$/quarter) is about another 30 % of the total customers, who pay an average water tariff of about 85.6 JOD/year. In 2043, the water tariff for this class is estimated to be 140 JOD/year, and this amount is equivalent to 1.9 % of their average annual household income, which is assumed more than 7,500 JOD /year from the income distribution data. Thus, this increase ratio can be affordable for this class. For the customers consuming more than 37 $m^3$/household the tariff shall be increased more than 10% in every stage. The average occupants of households in the Amman Governorate is 4.5 persons, it means one person consumes 90 liter per day in this class. As the average consumption in Jordan is 61 liter/person/day (NWS 2016-2025), the consumption of this class is more than 1.5 times of the average. In addition, the average income of this class is estimated as more than 10,000 JOD/year. The average tariff will be increased from 146 JOD to 290 JOD in 2043 but this tariff is affordable for this class. The same is applied for upper consumption classes.

After applying the above tariff increase, the cumulative profit from 2020 to 2043 is calculated as 15.95 million JOD (equivalent to 2.47 billion yen), which is enough to cover the next rehabilitation cost. At present, any profit is transferred to MOF according to the Surplus Law and deficit is covered by WAJ so that Miyahuna cannot accumulate any profit or loss. However, if the profit/loss can be accumulated within Miyahuna, the fund for the next rehabilitation can be secured within Miyahuna by the tariff increase for four times. In case that the deficit is covered by WAJ and the profit is accumulated within Miyahuna, the fund for the next rehabilitation can be accumulated within Miyahuna by the tariff increase for three times (from 2021 to 2025 in Table 2.26).

**Table 2.27 Profit/loss estimation of Miyahuna (Without the Project, no tariff increase)**

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenue** | **145,435,202** | **146,594,084** | **147,764,831** | **148,947,574** | **150,142,441** | **151,349,564** | **152,569,077** | **153,801,114** | **155,045,811** | **156,303,305** | **176,799,657** | **176,799,657** | **178,281,890** |
| Water & sewerage revenue | 96,445,699 | 97,506,602 | 98,579,174 | 99,663,545 | 100,759,844 | 101,868,203 | 102,988,753 | 104,121,629 | 105,266,967 | 106,424,904 | 125,403,772 | 125,403,772 | 126,783,213 |
| Other revenue | 48,989,503 | 49,087,482 | 49,185,657 | 49,284,028 | 49,382,596 | 49,481,362 | 49,580,324 | 49,679,485 | 49,778,844 | 49,878,402 | 51,395,885 | 51,395,885 | 51,498,677 |
| **Expenditure** | | | | | | | | | | | | | |
| Salaries & Wages | 12,909,440 | 13,322,542 | 13,748,863 | 14,188,827 | 14,642,870 | 15,111,441 | 15,595,007 | 16,094,048 | 16,609,057 | 17,140,547 | 27,492,874 | 27,492,874 | 28,372,646 |
| Chemical | 4,096,421 | 4,227,506 | 4,362,787 | 4,502,396 | 4,646,473 | 4,795,160 | 4,948,605 | 5,106,960 | 5,270,383 | 5,439,035 | 8,724,033 | 8,724,033 | 9,003,202 |
| Electricity & Generator fuel | 85,674,040 | 92,723,507 | 94,948,871 | 97,227,644 | 99,561,108 | 101,950,574 | 104,397,388 | 106,902,925 | 109,468,596 | 112,095,842 | 159,988,532 | 159,988,532 | 163,828,257 |
| Other operating expenditure | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 |
| **Operating Expenditure** | **145,868,344** | **153,461,999** | **156,248,964** | **159,107,310** | **162,038,893** | **165,045,618** | **168,129,443** | **171,292,376** | **174,536,479** | **177,863,867** | **239,393,882** | **239,393,882** | **244,392,548** |
| **Gross operating profit** | **-433,142** | **-6,867,915** | **-8,484,133** | **-10,159,737** | **-11,896,452** | **-13,696,054** | **-15,560,366** | **-17,491,262** | **-19,490,668** | **-21,560,562** | **-62,594,225** | **-62,594,225** | **-66,110,657** |
| Depreciation | 6,013,238 | 6,374,032 | 6,756,474 | 7,161,863 | 7,591,574 | 8,047,069 | 8,529,893 | 9,041,687 | 9,584,188 | 10,159,239 | 24,347,208 | 24,347,208 | 25,808,040 |
| Refundable interest | 17,833 | 17,782 | 17,779 | 17,737 | 17,337 | 16,169 | 14,307 | 12,332 | 10,356 | 8,280 | 0 | 0 | 0 |
| Repayment of loan | 0 | 0 | 61,412 | 562,608 | 2,296,387 | 4,367,407 | 4,798,308 | 4,798,283 | 4,798,283 | 4,798,283 | 0 | 0 | 0 |
| Other expenditure | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 |
| **Comprehensive income before tax** | **-12,143,927** | **-18,939,443** | **-20,999,512** | **-23,581,658** | **-27,481,465** | **-31,806,413** | **-34,582,589** | **-37,023,278** | **-39,563,209** | **-42,206,079** | **-92,621,146** | **-92,621,146** | **-97,598,411** |

(Source: JICA Survey Team)

**Table 2.28 Profit/Loss Estimation of Miyahuna (With the Project, no tariff increase)**

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenue** | **145,435,202** | **146,594,084** | **147,764,831** | **148,947,574** | **150,142,441** | **151,349,564** | **152,569,077** | **153,801,114** | **155,045,811** | **156,303,305** | **176,799,657** | **176,799,657** | **178,281,890** |
| Water & sewerage revenue | 96,445,699 | 97,506,602 | 98,579,174 | 99,663,545 | 100,759,844 | 101,868,203 | 102,988,753 | 104,121,629 | 105,266,967 | 106,424,904 | 125,403,772 | 125,403,772 | 126,783,213 |
| Other revenue | 48,989,503 | 49,087,482 | 49,185,657 | 49,284,028 | 49,382,596 | 49,481,362 | 49,580,324 | 49,679,485 | 49,778,844 | 49,878,402 | 51,395,885 | 51,395,885 | 51,498,677 |
| **Expenditure** | | | | | | | | | | | | | |
| Salaries & Wages | 12,909,440 | 13,322,542 | 13,748,863 | 14,188,827 | 14,642,870 | 15,111,441 | 15,595,007 | 16,094,048 | 16,609,057 | 17,140,547 | 27,492,874 | 27,492,874 | 28,372,646 |
| Chemical | 4,096,421 | 4,227,506 | 4,362,787 | 4,502,396 | 4,646,473 | 4,795,160 | 4,948,605 | 5,106,960 | 5,270,383 | 5,439,035 | 8,724,033 | 8,724,033 | 9,003,202 |
| Electricity & Generator fuel | 85,674,040 | 92,723,507 | 94,948,871 | 97,227,644 | 99,561,108 | 100,407,152 | 102,853,966 | 105,359,503 | 107,925,174 | 110,552,420 | 158,122,649 | 158,122,649 | 161,917,593 |
| Other operating expenditure | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 |
| **Operating Expenditure** | **145,868,344** | **153,461,999** | **156,248,964** | **159,107,310** | **162,038,893** | **163,502,196** | **166,586,021** | **169,748,954** | **172,993,057** | **176,320,445** | **237,527,999** | **237,527,999** | **242,481,884** |
| **Gross operating profit** | **-433,142** | **-6,867,915** | **-8,484,133** | **-10,159,737** | **-11,896,452** | **-12,152,632** | **-14,016,944** | **-15,947,840** | **-17,947,246** | **-20,017,140** | **-60,728,342** | **-60,728,342** | **-64,199,994** |
| Depreciation | 6,013,238 | 6,374,032 | 6,756,474 | 7,161,863 | 7,591,574 | 8,047,069 | 8,529,893 | 9,041,687 | 9,584,188 | 10,159,239 | 24,347,208 | 24,347,208 | 25,808,040 |
| Refundable interest | 17,833 | 17,782 | 17,779 | 17,737 | 17,337 | 16,169 | 14,307 | 12,332 | 10,356 | 8,280 | 0 | 0 | 0 |
| Repayment of loan | 0 | 0 | 61,412 | 562,608 | 2,296,387 | 4,367,407 | 4,798,308 | 4,798,283 | 4,798,283 | 4,798,283 | 0 | 0 | 0 |
| Other expenditure | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 |
| **Comprehensive income before tax** | **-12,143,927** | **-18,939,443** | **-20,999,512** | **-23,581,658** | **-27,481,465** | **-30,262,991** | **-33,039,167** | **-35,479,856** | **-38,019,787** | **-40,662,657** | **-90,755,264** | **-90,755,264** | **-95,687,748** |

(Source: JICA Survey Team)

## Table 2.29 Profit/Loss Estimation of Miyahuna

## (With the Project, with tariff increase)

| | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenue** | **145,435,202** | **146,594,084** | **147,764,831** | **163,897,105** | **165,256,417** | **184,202,059** | **185,782,950** | **205,281,450** | **207,092,431** | **208,922,438** | **210,771,679** | **212,640,364** | **214,528,705** |
| Water & sewerage revenue | 96,445,699 | 97,506,602 | 98,579,174 | 114,613,077 | 115,873,821 | 134,720,698 | 136,202,625 | 155,601,965 | 157,313,587 | 159,044,037 | 160,793,521 | 162,562,250 | 164,350,434 |
| Other revenue | 48,989,503 | 49,087,482 | 49,185,657 | 49,284,028 | 49,382,596 | 49,481,362 | 49,580,324 | 49,679,485 | 49,778,844 | 49,878,402 | 49,978,158 | 50,078,115 | 50,178,271 |
| **Expenditure** | | | | | | | | | | | | | |
| Salaries & Wages | 12,909,440 | 13,322,542 | 13,748,863 | 14,188,827 | 14,642,870 | 15,111,441 | 15,595,007 | 16,094,048 | 16,609,057 | 17,140,547 | 17,689,045 | 18,255,094 | 18,839,257 |
| Chemical | 4,096,421 | 4,227,506 | 4,362,787 | 4,502,396 | 4,646,473 | 4,795,160 | 4,948,605 | 5,106,960 | 5,270,383 | 5,439,035 | 5,613,084 | 5,792,703 | 5,978,069 |
| Electricity & Generator fuel | 85,674,040 | 92,723,507 | 94,948,871 | 97,227,644 | 99,561,108 | 100,407,152 | 102,853,966 | 105,359,503 | 107,925,174 | 110,552,420 | 113,242,720 | 115,997,588 | 118,818,572 |
| Other operating expenditure | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 |
| **Operating Expenditure** | **145,868,344** | **153,461,999** | **156,248,964** | **159,107,310** | **162,038,893** | **163,502,196** | **166,586,021** | **169,748,954** | **172,993,057** | **176,320,445** | **179,733,292** | **183,233,827** | **186,824,341** |
| **Gross operating profit** | **-433,142** | **-6,867,915** | **-8,484,133** | **4,789,795** | **3,217,524** | **20,699,863** | **19,196,928** | **35,532,496** | **34,099,374** | **32,601,993** | **31,038,387** | **29,406,537** | **27,704,364** |
| Depreciation | 6,013,238 | 6,374,032 | 6,756,474 | 7,161,863 | 7,591,574 | 8,047,069 | 8,529,893 | 9,041,687 | 9,584,188 | 10,159,239 | 10,768,793 | 11,414,921 | 12,099,816 |
| Refundable interest | 17,833 | 17,782 | 17,779 | 17,737 | 17,337 | 16,169 | 14,307 | 12,332 | 10,356 | 8,280 | 5,969 | 2,733 | 508 |
| Repayment of loan | 0 | 0 | 61,412 | 562,608 | 2,296,387 | 4,367,407 | 4,798,308 | 4,798,283 | 4,798,283 | 4,798,283 | 4,798,283 | 4,736,898 | 4,318,044 |
| Other expenditure | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 |
| **Comprehensive income before tax** | **-12,143,927** | **-18,939,443** | **-20,999,512** | **-8,632,126** | **-12,367,488** | **2,589,505** | **174,706** | **16,000,481** | **14,026,833** | **11,956,476** | **9,785,628** | **7,572,271** | **5,606,282** |
| Accumulated profit from 2020 | | | -20,999,512 | -29,631,638 | -41,999,126 | -39,409,622 | -39,234,916 | -23,234,435 | -9,207,601 | 2,748,875 | 12,534,502 | 20,106,773 | 25,713,055 |

| 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **216,436,917** | **218,365,215** | **236,787,706** | **238,938,051** | **241,111,142** | **243,307,225** | **245,526,554** | **247,769,381** | **250,035,964** | **252,326,560** | **254,641,434** | **256,980,851** | **259,345,077** |
| 166,158,289 | 167,986,030 | 186,307,763 | 188,357,148 | 190,429,077 | 192,523,797 | 194,641,558 | 196,782,615 | 198,947,224 | 201,135,644 | 203,348,136 | 205,584,965 | 207,846,400 |
| 50,278,627 | 50,379,185 | 50,479,943 | 50,580,903 | 50,682,065 | 50,783,429 | 50,884,996 | 50,986,766 | 51,088,739 | 51,190,917 | 51,293,299 | 51,395,885 | 51,498,677 |
| | | | | | | | | | | | | |
| 19,442,113 | 20,064,261 | 20,706,317 | 21,368,919 | 22,052,725 | 22,758,412 | 23,486,681 | 24,238,255 | 25,013,879 | 25,814,323 | 26,640,382 | 27,492,874 | 28,372,646 |
| 6,169,368 | 6,366,787 | 6,570,525 | 6,780,781 | 6,997,766 | 7,221,695 | 7,452,789 | 7,691,278 | 7,937,399 | 8,191,396 | 8,453,521 | 8,724,033 | 9,003,202 |
| 121,707,260 | 124,665,276 | 127,694,285 | 130,795,990 | 133,935,093 | 137,149,536 | 140,441,125 | 143,811,712 | 147,263,193 | 150,797,509 | 154,416,649 | 158,122,649 | 161,917,593 |
| 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 | 43,188,443 |
| **190,507,183** | **194,284,767** | **198,159,570** | **202,134,133** | **206,174,028** | **210,318,086** | **214,569,038** | **218,929,688** | **223,402,914** | **227,991,672** | **232,698,995** | **237,527,999** | **242,481,884** |
| **25,929,733** | **24,080,448** | **38,628,136** | **36,803,918** | **34,937,114** | **32,989,140** | **30,957,516** | **28,839,693** | **26,633,050** | **24,334,889** | **21,942,440** | **19,452,851** | **16,863,193** |
| 12,825,805 | 13,595,354 | 14,411,075 | 15,275,739 | 16,192,284 | 17,163,821 | 18,193,650 | 19,285,269 | 20,442,385 | 21,668,928 | 22,969,064 | 24,347,208 | 25,808,040 |
| 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 |
| 4,318,044 | 4,318,044 | 4,318,044 | 4,318,044 | 4,318,044 | 4,318,044 | 4,318,044 | 4,318,044 | 4,318,044 | 4,318,044 | 4,318,044 | 4,318,044 | 4,318,044 |
| 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 | 5,679,714 |
| **3,105,662** | **486,829** | **14,218,796** | **11,529,913** | **8,746,565** | **5,827,054** | **2,765,601** | **-443,841** | **-3,807,601** | **-7,332,305** | **-11,024,890** | **-14,892,622** | **-18,943,113** |
| 28,818,718 | 29,305,546 | 43,524,342 | 55,054,255 | 63,800,819 | 69,627,873 | 72,393,474 | 71,949,633 | 68,142,032 | 60,809,727 | 49,784,837 | 34,892,215 | 15,949,102 |

(Source: JICA Survey Team)

2) Future estimation of profit/loss of WAJ

i) Conditions

a) Reduction of NRW ratio

According to NWS 2016-2025 and Strategic Master Plan for Municipal Water Infrastructure 2015, the NRW ratio should be decreased to 25 % by 2025. The same value is adopted for future estimation and it is planned to decrease at stages (2 % decrease annually up to 30 %, then 1 % decrease annually up to 25 %).

b) Improvement of bill-collection ratio

The bill-collection ratio of the five governorates (Madaba, Balqa, Karak, Tafiele, and Ma'an) in which current collection ratio is less than 90 % will be improved to 90%.

c) Tariff increase

As for the revenue increase of WAJ, the reduction of commercial losses (water theft, meter error etc.), increase of collection ratio and water and sewerage tariff increase are proposed, so that the tariff increase is also inevitable. The increase ratio is calculated assuming that the tariff should be less than 4 % of total household income, and timing of tariff revision is every five years. The increase ratio is calculated to be 19 % in 2021, 15 % in 2026 and 15% in 2031. The tariff for least consumption class is not increased as this tariff is for low income households.

d) Implementation of action plans for which budget is secured

The action plans for which budget is already secured in the Structural Benchmark Action Plan to Reduce Water Sector Losses, 2016, are assumed to be implemented so that the effect by those actions are incorporated for the future estimation.

ii) Result of future estimation

The next rehabilitation is expected to be in 2043, but the profit / loss of WAJ will not be improved and continue to be in deficit as shown in the Table 2.30. However, the gross operating profit/deficit will be positive from 2026 to 2035 by the effect of tariff increase, then after 2036 it will be deficit again. If the electricity tariff is raised, the financial situation will be worse than this estimation.

In the past, WAJ could cover the operating expenditures up to 2009, and after 2009 the revenue could not cover the operating expenditures due to electricity tariff increase and cost incurred on the Syrian refugees. NWS 2016-2025 prepared the action plans to cover the operating expenditures of WAJ with increased revenue by 2020, thus the gross positive operating balance can be achievable, though positive total cost and income balance of WAJ are difficult to achieve.

With the effort of WAJ only, the water supply service cannot be sustainable. Furthermore, the budget for future investment cannot be generated. WAJ's operation needs to depend on the government subsidy and the aid from the donors continuously.

**Table 2.30 Profit/loss estimation of WAJ**

| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenues | | | | | | | | | | | | | | | |
| water & Sewerage Revenues | 212,552,833 | 257,922,547 | 258,155,307 | 265,949,794 | 265,949,794 | 271,686,462 | 330,133,524 | 336,960,158 | 343,786,793 | 350,613,427 | 357,440,062 | 418,183,526 | 421,747,253 | 425,310,980 | 428,874,707 |
| Other revenues | 20,338,762 | 24,803,756 | 36,219,533 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 |
| Total Revenues | 232,891,595 | 282,726,303 | 294,374,840 | 311,558,957 | 323,860,957 | 326,934,625 | 384,297,687 | 390,161,321 | 389,395,956 | 396,222,590 | 403,049,225 | 463,792,689 | 467,356,416 | 470,920,143 | 474,483,870 |
| Expenditures | | | | | | | | | | | | | | | |
| Salaries & wages | 73,054,433 | 75,787,134 | 78,420,111 | 78,194,251 | 79,758,136 | 81,353,299 | 82,980,365 | 84,639,972 | 86,332,771 | 88,059,427 | 89,820,615 | 91,617,028 | 93,449,368 | 95,318,356 | 97,224,723 |
| Electricity & Fuel | 120,698,286 | 124,033,304 | 130,610,481 | 166,744,277 | 171,746,605 | 176,899,003 | 182,205,974 | 187,672,153 | 190,331,595 | 196,041,543 | 201,922,790 | 207,980,473 | 214,219,887 | 220,646,484 | 227,265,879 |
| Other operating expenditures | 63,565,408 | 118,541,665 | 122,092,185 | 111,315,003 | 113,541,303 | 115,812,129 | 118,128,372 | 120,490,939 | 122,900,758 | 125,358,773 | 127,865,949 | 130,423,268 | 133,031,733 | 135,692,368 | 138,406,215 |
| Total Operating Expenditures | 257,318,127 | 318,362,103 | 331,122,777 | 356,253,531 | 340,768,025 | 349,793,636 | 378,388,710 | 392,803,064 | 399,565,125 | 409,459,743 | 419,609,353 | 430,020,768 | 440,700,989 | 451,657,207 | 462,896,816 |
| Gross operating profit/deficit | -24,426,532 | -35,635,800 | -36,747,937 | -44,694,574 | -16,907,068 | -22,859,012 | 5,908,977 | -2,641,743 | -10,169,169 | -13,237,153 | -16,560,129 | 33,771,920 | 26,655,427 | 19,262,936 | 11,587,054 |
| Depreciation | 171,627,963 | 137,014,014 | 133,877,103 | 118,729,487 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 |
| Refundable interest | 41,369,917 | 49,030,293 | 60,116,678 | 69,590,787 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 |
| Other expenditures | -33,250,606 | 8,689,044 | 37,331,923 | 9,366,020 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 |
| Total Expenditures | 437,065,401 | 513,095,454 | 562,448,481 | 553,939,825 | 553,679,314 | 562,704,925 | 591,299,999 | 605,714,353 | 612,476,414 | 622,371,032 | 632,520,642 | 642,932,057 | 653,612,278 | 664,568,496 | 675,808,105 |
| Income before tax | -204,173,806 | -230,369,151 | -268,073,641 | -242,380,868 | -229,818,357 | -235,770,301 | -207,002,312 | -215,553,032 | -223,080,458 | -226,148,442 | -229,471,418 | -179,139,369 | -186,255,862 | -193,648,353 | -201,324,235 |

| | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Revenues | | | | | | | | | | | | | | |
| water & Sewerage Revenues | 432,438,435 | 501,266,852 | 503,926,350 | 503,926,350 | 503,926,350 | 503,926,350 | 503,926,350 | 503,926,350 | 503,926,350 | 503,926,350 | 503,926,350 | 503,926,350 | 503,926,350 | 503,926,350 |
| Other revenues | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 | 45,609,163 |
| Total Revenues | 478,047,598 | 546,876,015 | 549,535,513 | 549,535,513 | 549,535,513 | 549,535,513 | 549,535,513 | 549,535,513 | 549,535,513 | 549,535,513 | 549,535,513 | 549,535,513 | 549,535,513 | 549,535,513 |
| Expenditures | | | | | | | | | | | | | | |
| Salaries & wages | 99,169,217 | 101,152,602 | 103,175,654 | 105,239,167 | 107,343,950 | 109,490,829 | 111,680,646 | 113,914,258 | 116,192,544 | 118,516,395 | 120,886,722 | 123,304,457 | 125,770,546 | 128,285,957 |
| Electricity & Fuel | 234,083,855 | 241,106,371 | 248,339,562 | 255,789,749 | 263,463,441 | 271,367,344 | 279,508,365 | 287,893,615 | 296,530,424 | 305,426,337 | 314,589,127 | 324,026,801 | 333,747,605 | 343,760,033 |
| Other operating expenditures | 141,174,339 | 143,997,826 | 146,877,782 | 149,815,338 | 152,811,645 | 155,867,878 | 158,985,235 | 162,164,940 | 165,408,239 | 168,716,404 | 172,090,732 | 175,532,546 | 179,043,197 | 182,624,061 |
| Total Operating Expenditures | 474,427,411 | 486,256,798 | 498,392,998 | 510,844,253 | 523,619,036 | 536,726,051 | 550,174,245 | 563,972,814 | 578,131,206 | 592,659,135 | 607,566,581 | 622,863,804 | 638,561,348 | 654,670,051 |
| Gross operating profit/deficit | 3,620,186 | 60,619,217 | 51,142,515 | 38,691,259 | 25,916,477 | 12,809,462 | -638,733 | -14,437,301 | -28,595,694 | -43,123,622 | -58,031,068 | -73,328,291 | -89,025,835 | -105,134,538 |
| Depreciation | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 | 103,897,557 |
| Refundable interest | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 | 67,623,748 |
| Other expenditures | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 | 41,389,984 |
| Total Expenditures | 687,338,700 | 699,168,087 | 711,304,287 | 723,755,542 | 736,530,325 | 749,637,340 | 763,085,534 | 776,884,103 | 791,042,495 | 805,570,424 | 820,477,870 | 835,775,093 | 851,472,637 | 867,581,340 |
| Income before tax | -209,291,103 | -152,292,072 | -161,768,774 | -174,220,030 | -186,994,812 | -200,101,827 | -213,550,022 | -227,348,590 | -241,506,983 | -256,034,911 | -270,942,357 | -286,239,580 | -301,937,124 | -318,045,827 |

(Source: JICA Survey Team)

3) Proposal for generating funds for next rehabilitation

Since WAJ is responsible for major investment in water supply facilities, WAJ should generate the funds for next rehabilitation of pumping stations. However, as mentioned above, it is impossible to generate the required funds in the situation of deficit even after the reduction of NRW rate, improvement of tariff collection ratio, and increase of tariff. With the Project, Miyahuna can generate surplus by electricity consumption reduction and water tariff increase. However, Miyahuna obliges to pay the surplus to Ministry of Finance by Surplus Law, so that Miyahuna cannot secure and accumulate the surplus for future investment. Therefore, to secure the funds for next rehabilitation, following measures are proposed.

- The profit/loss of Miyahuna should be accumulated for future investment. Based on the estimation, the required fund can be accumulated by tariff increase for four times. In the case that the deficit is covered by WAJ and the profit is accumulated within Miyahuna, tariff increase for three times is enough to secure the fund.
  - ✓ To make this possible, it is necessary to modify the Surplus Law and make consensus among the concerned organizations to accumulate the surplus for future investment.
  - ✓ The staged increase of water tariff is essential.
  - ✓ If the electricity tariff is increased, the water tariff should also be adjusted.
- The operating surplus should be accumulated for future investment when the WAJ's operating balance is positive. If one million JOD can be accumulated between 2026 and 2035 when the operating balance is positive, the fund can be secured.
  - ✓ It is necessary to modify the regulations and make consensus among the concerned organizations so that the operating surplus can be accumulated even though the total balance is negative.
  - ✓ The staged increase of water tariff is essential.
  - ✓ If the electricity tariff is increased, the water tariff should also be adjusted.

# CHAPTER 3 Project Evaluation

## 3.1 Preconditions

(1) Budgetary measures by the Jordanian side for implementation of the Project
Project budget to be borne by the Jordanian side should be secured and budget expenditures should be executed without delay according to implementation schedule of the Project.

(2) Tax exemption measures
The Jordanian side shall guarantee exemption from taxes related to Project materials and activities such as value added tax (VAT), customs duty, and various other taxes and financial surcharges. WAJ shall carry out the necessary formalities required for tax exemption, and if the exemption is not approved, WAJ shall bear the relevant taxes.

## 3.2 Necessary Inputs by the Jordanian side

(1) Proper implementation of work under the responsibility of the Jordanian side
The supply of electrical power free of charge for trial test during the pump installation work, permission to use overhead cranes free of charge at the pumping station during equipment installation, preparation before equipment installation (relocation of four (4) existing motors), and the provision of material storage area free of charge for Project activities should be adequately performed by the Jordanian side. WAJ can afford to implement these works. The firm implementation of these works by the Jordanian side is required for the start and successful completion of the Project without problem.

## 3.3 Important Assumptions

Issues to be addressed by the Jordanian side for realizing the overall plan of the Project and external conditions that may influence the Project are described below.

(1) Political and security status in Jordan
The political and security situation in the Middle East around Jordan is not stable. There may be factors that destabilize security situation in Jordan as well. They are, for example, entry of large number of refugees into Jordan because of sudden unrest in neighboring countries. For smooth completion of the Project, it is necessary that the level of security in Jordan does not deteriorate excessively.

(2) Continuous supply of electric power needed for the Project equipment
Electric power supply required for operation of the equipment installed under the Project must be continuously secured by the Jordan Electric Power Company limited (JEPCO) to achieve the continuous outcome of the Project.

## 3.4 Project Evaluation

### 3.4.1 Relevance

(1) Population benefitted

The target area to receive the benefit of the Project is Amman Governorate. The estimated population to be benefitted by water supplied from this system is 5,046,000 in 2026.

(2) Project's contribution to basic human needs, and improving living condition of the residents and stabilizing their livelihood

The objectives of the Project are: 1) to replace the existing aged equipment of the Zai Water Supply System to prevent any reduction in water supply quantity and deterioration in water quality; and 2) to improve the operational efficiency of equipment and reduce operating costs, and thereby contribute to fulfillment of basic human needs (BHN).

(3) Contribution to realization of targets of medium and long-term development plans

Under the "National Water Strategy", which is a medium- to long-term plan for Jordan, the policy is to supply safe and abundant water to all Jordanians. This project contributes to achieving the objective of the medium- to long-term plan through replacing equipment and thus preventing the water supply cut to Amman.

(4) Consistency with Japan's aid policy and guidelines

The priority issues of the Country Development Cooperation Policy for the Hashemite Kingdom of Jordan (September 2016) is "Supporting Autonomous and Sustainable Economic Growth", and the JICA Country Analysis Paper for Jordan (March 2015) pointed "Climate Change Countermeasures and Sustainable Utilization and Management of Resources" as priority issues. The Project is consistent with these policies and priority issues. The Project is also consistent with Jordan's development issues and policies, as well as with Japan and JICA's cooperation policies. The Project contributes to improvement and sustainable operation and management of water supply services and thereby leads to realization of safe, resilient and sustainable city. Therefore, there is much need to support the implementation of the Project to contribute to SDGs Goals 6 and 11. In addition, it is significant from the humanitarian point of view to implement the Project urgently considering the two key issues: 1) there is a rapid population increase due to the influx of Syrian refugees; and 2) increased financial burden on public services which cover water supply in Amman area.

### 3.4.2 Effectiveness

(1) Quantitative effects

The expected effects of implementing the Project are given in Table 3.1. The expected quantitative effects of the Project in terms of baseline value in 2019 and after implementation of the Project in 2026

are shown in the table.

**Table 3.1 Quantitative effects of the Project**

| Name of index | Baseline value (2019) | Target value (2026) |
|---|---|---|
| Electricity consumption per $m^3$ of water supplied by the Zai Water Supply System ($kWh/m^3$)[14] | 5.10 | 4.91 |
| GHG emission/year ($Mt\text{-}CO_2$/year)[15] | 191.97 | Less than 185 |

(Source: JICA Survey Team)

(2) Qualitative effects

The prevention of drop in pump discharge due to pump failure or repair of the Zai Water Supply System will ensure a stable water supply in future. Consequently, the Project will contribute to improving the living environment of residents in the target area.

4-4-3 Conclusion

The Project will contribute to improving the level of BHN and the living environment of residents widely. It is consistent with the policy of providing support for Syrian refugees and the development policies of the water sector in Jordan. It is expected that Project implementation will improve the operational efficiency of equipment and will reduce the operation cost. Therefore, it is judged that relevance of the Project is high and its implementation is expected to be very effective for improvement of living conditions in the Project area.

[14] Appendix9 Electricity consumption per m3 of water supplied by Zai water supply system
[15] Appendix10 Baseline and Target Values of Greenhouse Gas (GHG) Emissions per Year

# Appendices

Appendix 1: Member List of the Study Team

1. Member List of the Study Team in the Preparatory Survey

| Name | Responsibility | Occupation | Visit Duration |
|---|---|---|---|
| Mr. Yoshiki OMURA | Team Leader /Water Supply | Senior Advisor (Water Supply Development), JICA | 2019/7/7－2019/7/18 |
| Ms. Akiko FUJITA | Cooperation Planning | Deputy Director, Water Resources Team I, Water Resources Group, Global Environment Department, JICA | 2019/7/7－2019/7/18 |
| Mr. Yoshitaka KUBOSAKI | Chief Consultant/ Water Supply Planning | TEC International Co., Ltd. | 2019/7/7－2019/9/2 |
| Mr. Makoto HOMMA | Deputy Chief Consultant/ Water Supply Planning 2 | Ditto | 2019/7/7－2019/7/29<br>2019/8/21－2019/9/2 |
| Mr. Jiro KINOSHITA | Water Pumping Facility Planning & Design/<br>Operation & Maintenance Planning | Ditto | 2019/7/7－2019/8/3 |
| Mr. Tatsuzo SUZUKI | Water Purification Facility Planning & Design/<br>Operation & Maintenance Planning | Ditto | 2019/7/7－2019/8/8 |
| Mr. Hirokatsu UTAGAWA | Environment and Social Consideration/ Water Quality | Kokusai Kogyo Co., Ltd. | 2019/7/14－2019/9/2 |
| Ms. Shoko YAMADA | Finance & Management | TEC International Co., Ltd. | 2019/7/17－2019/8/8 |
| Mr. Eichi HASEGAWA | Electrical Equipment | Ditto | 2019/7/7－2019/8/3 |
| Mr. Hiroshi KOBAYASHI | Construction Procurement/ Cost Estimation | Ditto | 2019/8/6－2019/9/2 |
| Mr. Koichi OGATA | Project Coordinator/ Construction Procurement 2/ Cost Estimation 2 | Ditto | 2019/7/18－2019/9/2 |
| Mr. Shungo SOYOSHI | OJT/ Project Coordinator 2 | Ditto | 2019/7/7－2019/8/3 |

Appendix 2: Study Schedule

1. Preparatory Survey

| | | Team Leader /Water Supply | Cooperation Planning | Chief Consultant/ Water Supply Planning | Deputy Chief Consultant/ Water Supply Planning 2 | Water Pumping Facility Planning & Design/ Operation & Maintenance Planning | Water Purification Facility Planning & Design/ Operation & Maintenance Planning | Environment and Social Consideration/ Water Quality | Finance & Management | Electrical Equipment | Construction Procurement/ Cost Estimation | Project Coordinator/ Construction Procurement 2/ Cost Estimation 2 | Project Coordinator 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Yoshiki OMURA | Akiko FUJITA | Yoshitaka KUBOSAKI | Makoto HOMMA | Jiro KINOSHITA | Tatsuzo SUZUKI | Hirokatsu UTAGAWA | Shoko YAMADA | Eichi HASEGAWA | Hiroshi KOBAYASHI | Koichi OGATA | Shungo SOYOSHI |
| 2019/7/6 | S | Leave Narita | Leave Narita | Leave Narita | Leave Narita | Leave Narita | Leave Narita | | | Leave Narita | | | Leave Narita |
| 2019/7/7 | S | Arrive in Amman<br>・Meeting (JICA Office) | Arrive in Amman<br>・Meeting (JICA Office) | Arrive in Amman<br>・Meeting (JICA Office) | Arrive in Amman<br>・Meeting (JICA Office) | Arrive in Amman<br>・Meeting (JICA Office) | Arrive in Amman<br>・Meeting (JICA Office) | | | Arrive in Amman<br>・Meeting (JICA Office) | | | Arrive in Amman<br>・Meeting (JICA Office) |
| 2019/7/8 | M | ・Meeting (WAJ)<br>・Kick off meeting | ・Meeting (WAJ)<br>・Kick off meeting | ・Meeting (WAJ)<br>・Kick off meeting | ・Meeting (WAJ)<br>・Kick off meeting | ・Meeting (WAJ)<br>・Kick off meeting | ・Meeting (WAJ)<br>・Kick off meeting | | | ・Meeting (WAJ)<br>・Kick off meeting | | | ・Meeting (WAJ)<br>・Kick off meeting |
| 2019/7/9 | T | ・Joint survey with CDM | ・Joint survey with CDM | ・Joint survey with CDM | ・Joint survey with CDM | ・Joint survey with CDM | ・Joint survey with CDM | | | ・Joint survey with CDM | | | ・Joint survey with CDM |
| 2019/7/10 | W | | | | | | | | | | | | |
| 2019/7/11 | T | ・Meeting with related organizations | ・Meeting with related organizations | ・Meeting with related organizations | ・Meeting with related organizations | ・Meeting with related organizations | ・Meeting with related organizations | | | ・Meeting with related organizations | | | ・Meeting with related organizations |
| 2019/7/12 | F | Organizing materials | Organizing materials | Organizing materials | Organizing materials | Organizing materials | Organizing materials | | | Organizing materials | | | Organizing materials |
| 2019/7/13 | S | | | | | | | Leave Narita | | | | | |
| 2019/7/14 | S | ・Meeting with related organizations | ・Meeting with related organizations | ・Meeting with related organizations | ・Meeting with related organizations | ・Survey on travelling screens<br>・Survey on pump facilities etc. | ・Survey on targeted PS<br>・KAC survey<br>・Survey on chemical feed facility in WTP<br>・Survey on chemical injection facility in WTP<br>・Survey on facility of sludge drying bed in WTP | Arrive in Amman | | ・Survey on WTP, SCADA<br>・Survey on electrical and control equipment in WTP | | | Project coordination |
| 2019/7/15 | M | M/M execution | M/M execution | M/M execution | M/M execution | | | ・Visiting WAJ and Ministries<br>・Preparation for survey<br>・Selection of workers | | | | | |
| 2019/7/16 | T | ・Survey on ongoing related projects etc. | ・Survey on ongoing related projects etc. | ・Survey on past and ongoing related projects etc.<br>・Survey on water demand | ・Check conditions of Baha Project<br>・Survey on O&M<br>・Analysis of collection data | | | | Leave Narita | | | | |
| 2019/7/17 | W | | | | | | | | Arrive in Amman | | | Leave Narita | |
| 2019/7/18 | T | Leave Amman | Leave Amman | | | | | | ・Preparation for survey | | | Arrive in Amman | |
| 2019/7/19 | F | Arrive in Narita | Arrive in Narita | Organizing materials | Organizing materials | Organizing materials | Organizing materials | Organizing materials | Organizing materials | Organizing materials | | Organizing materials | Organizing materials |
| 2019/7/20 | S | | | | | | | | | | | | |
| 2019/7/21 | S | | | Survey on upper level plans and development plans related water supply and sewerage | ・Survey on O&M<br>・KAC survey<br>・Survey on related laws | ・Measurement of pump efficiency | ・Survey on chlorine dioxide injection facility<br>・Survey on grid setting basin<br>・Survey on facility of WTP | ・Survey on referential law and organizational structure<br>・Survey on current condition of WTP | ・On site visit<br>・Collection and confirmation on data with management and finance<br>・Meeting<br>・Analysis of collection data | ・Survey on electrical and control equipment in each PS | | Project coordination | Project coordination |
| 2019/7/22 | M | | | | | | | | | | | | |
| 2019/7/23 | T | | | | | | | | | | | | |
| 2019/7/24 | W | | | | | | | | | | | | |
| 2019/7/25 | T | | | | | | | | | | | | |
| 2019/7/26 | F | | | Organizing materials | Organizing materials | Organizing materials | Organizing materials | Organizing materials | Organizing materials | Organizing materials | | Organizing materials | Organizing materials |
| 2019/7/27 | S | | | | | | | | | | | | |
| 2019/7/28 | S | | | ・Survey on project conditions conducted by other donors (USAID and KfW etc.) | Preparing results of survey | ・Measurement of pipe thickness | ・Survey on chlorine dioxide injection facility<br>・Survey on facility of WTP | ・Gap analysis<br>・Scoping<br>・Survey on source water quality | ・Analysis of collection data<br>・Requesting insufficient data<br>・Meeting on cost of O&M | ・Examination of electric motor in each PS | | Project coordination | ・Project coordination<br>・Measurement of pipe thickness |
| 2019/7/29 | M | | | | Leave Amman | | | | | | | | |
| 2019/7/30 | T | | | | Arrive in Narita | | | | | | | | |
| 2019/7/31 | W | | | | | | | | | | | | |
| 2019/8/1 | T | | | | | | | | | | | | |
| 2019/8/2 | F | | | Organizing materials | | Organizing materials | Organizing materials | Organizing materials | Organizing materials | Organizing materials | | Organizing materials | Organizing materials |
| 2019/8/3 | S | | | | | Leave Amman | | | | Leave Amman | | | Leave Amman |
| 2019/8/4 | S | | | ・Examination of evaluation index<br>・Collecting related information | | Arrive in Narita | ・Examination of flocculating agent<br>・Organizing results of survey | ・Assessment of natural/ social and environmental impact<br>・Examining measure<br>・Survey on operation of laboratory | ・Analysis of collection data<br>・Meeting on construction cost<br>・Organizing results of survey | Arrive in Narita | Leave Narita | Project coordination | Arrive in Narita |
| 2019/8/5 | M | | | | | | | | | | | | |
| 2019/8/6 | T | | | | | | | | | | Arrive in Amman<br>・Site survey | | |
| 2019/8/7 | W | | | | | | | | | | | | |
| 2019/8/8 | T | | | | | | Leave Amman | | Leave Amman | | | | |
| 2019/8/9 | F | | | Organizing materials | | | Arrive in Narita | Organizing materials | Arrive in Narita | | Organizing materials | Organizing materials | |
| 2019/8/10 | S | | | | | | | | | | | | |
| 2019/8/11 | S | | | Organizing materials (Holiday) | | | | Organizing materials (Holiday) | | | Organizing materials (Holiday) | Organizing materials (Holiday) | |
| 2019/8/12 | M | | | | | | | | | | | | |
| 2019/8/13 | T | | | | | | | | | | | | |
| 2019/8/14 | W | | | | | | | | | | | | |
| 2019/8/15 | T | | | ・Survey on current condition of Syrian refugees | | | | ・Preliminary selection of CHG<br>・Preliminary calculation of JICA FIT<br>・Preparing monitoring plan | | | ・Survey on unit price of labor service and material etc. | ・Project coordination<br>・Cost estimation assistance | |
| 2019/8/16 | F | | | Organizing materials | | | | Organizing materials | | | Organizing materials | Organizing materials | |
| 2019/8/17 | S | | | | | | | | | | | | |
| 2019/8/18 | S | | | ・Examination of self-reliant expansive projects and project risks | | | | ・Preparing category B report<br>・Compiling measures against water quality control | | | ・Survey on unit price of labor service and material etc. | ・Project coordination<br>・Cost estimation assistance | |
| 2019/8/19 | M | | | | | | | | | | | | |
| 2019/8/20 | T | | | | Leave Narita | | | | | | | | |
| 2019/8/21 | W | | | | Arrive in Amman | | | | | | | | |
| 2019/8/22 | T | | | | Make plans of Soft Component<br>・Preparing technical notes | | | | | | | | |
| 2019/8/23 | F | | | Organizing materials | Organizing materials | | | Organizing materials | | | Organizing materials | Organizing materials | |
| 2019/8/24 | S | | | | | | | | | | | | |
| 2019/8/25 | S | | | ・Preparing technical notes<br>・Organizing results of survey | ・Making plans of Soft Component<br>・Preparing technical notes | | | ・Preparing technical notes<br>・Organizing results of survey | | | ・Survey on unit price of labor service and material etc. | ・Project coordination<br>・Cost estimation assistance | |
| 2019/8/26 | M | | | | | | | | | | | | |
| 2019/8/27 | T | | | | | | | | | | | | |
| 2019/8/28 | W | | | | | | | | | | | | |
| 2019/8/29 | T | | | | | | | | | | | | |
| 2019/8/30 | F | | | Organizing materials | Organizing materials | | | Organizing materials | | | Organizing materials | Organizing materials | |
| 2019/8/31 | S | | | | | | | | | | | | |
| 2019/9/1 | S | | | Organizing results of survey | Organizing results of survey | | | Organizing results of survey | | | Organizing results of survey | Organizing results of survey | |
| 2019/9/2 | M | | | Leave Amman | Leave Amman | | | Leave Amman | | | Leave Amman | Leave Amman | |
| 2019/9/3 | T | | | Arrive in Narita | Arrive in Narita | | | Arrive in Narita | | | Arrive in Narita | Arrive in Narita | |

Appendix 3: List of Parties Concerned in the Recipient Country

<Jordan>

| Occupation | Name | Responsibility |
|---|---|---|
| Water Authority of Jordan | Eng. Iyad Dahiyat | CEO |
| | Eng. Salameh Mahasne | Project Director/ Advisor |
| | Mr. Hussein Alsourkhi | Director of Commercial Accounting |
| | Eng. Samaher AL-Akhrass | Assistant Secretary General for water Affairs |
| Miyahuna Water Company | Eng. Ghazi Khaleel | CEO |
| | Eng. Haitham Al-kilani | Production Directorate |
| | Eng. Hani Dradkeh | Stations Efficiency Improving & Energy Saving Unit |
| | Eng. Mohamed Hamdan | Head of Zai WTP |
| | Eng. Ashraf Abu Alsondous | Head of Maintenance Section in Zai WTP |
| | Eng. Ehab Awad | Head of Electrical Maintenace Subsectionin in Zai WTP |
| | Eng. Ghassan Alsalhi | Head of Raw Waters Section in Zai WTP |
| | Eng. Rayyan Abdullh | Process (Operation) Section in Zai WTP |
| | Eng. Mohamedo Aburuman | Process (Operation) Section in Zai WTP |
| | Eng. Bahaa Baghdadi | Director of Finance Affaires |
| | Eng. Mohammad Ouran | Director of Customer services |
| | Mr. Mohammad Zakaria Talafha | Director of Human Resources |
| | Mr. Adbullah al Jarrah | Director of NRW |
| | Ms. Malak S. Al-Ma'aita | Head of Technical Support Unit/CD Directorate |
| Ministry of Planning and International Cooperation | Ms. Wafa Al-Saket | Consultant in Asiana Relations Division |
| Custom Department in Ministry of Finance | Dr. Abdelmajid A.Al-Rahamneh | Director General |
| Sales Tax Exemption Section | Ms. Majeda QuiAbdelmajid | Sales Tax Exemption Expert |

<Donor>

| | | |
|---|---|---|
| Kreditanstalt für Wiederaufbau (KfW) | Dr. Dareq A.Zabarah | Senior Project Manager |
| | Eng. Nisreen Haddadin | Senior Project Coordinater |
| European Investment Bank (EIB) | Mr. Sander Van Kooten | Representative |

| | | |
|---|---|---|
| USAID | Eng. Akram AlQehaiwi | Senior Project Management Specialist |
| CDM Smith | Eng. Richard Minkwitz | Project Manager |

<Japan>

| | | |
|---|---|---|
| JICA Jordan Office | Ms. Chie MIYAHARA | Director |
| | Mr. Noriharu MASUGI | Deputy Director |
| | Mr. Ryuji OGATA | Specialist |
| | Ms. Natsuko FUJII | Officer |

**Minutes of Discussions**
**on the Preparatory Survey for the Project for**
**Improvement of the Zai Water Supply System**

In response to the request from the Government of the Hashemite Kingdom of Jordan (hereinafter referred to as the "Jordanian Government"), Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") of the Project for Improvement of the Zai Water Supply System (hereinafter referred to as "the Project") to the Hashemite Kingdom of Jordan. The Team held a series of discussions with the authorities concerned and conducted field surveys. In the course of the discussions, both sides have confirmed the main items described in the attached sheets.

Amman, 15th July 2019

Yoshiki Omura
Leader,
Preparatory Survey Team,
Japan International Cooperation Agency,
Japan

Iyad Dahiyat
Secretary General,
Water Authority of Jordan,
Ministry of Water and Irrigation,
The Hashemite Kingdom of Jordan

Ghazi Khaleel
CEO,
Jordan Water Company/ Miyahuna,
The Hashemite Kingdom of Jordan

## ATTACHMENT

1. Objective of the Project

The objective of the Project is to enhance the water security of Amman, the capital of Jordan, through renewal of pumping equipment and water treatment plant (WTP) facilities of the Zai Water Supply System.

2. Title of the Preparatory Survey

Both sides confirmed the title of the Preparatory Survey as "the Preparatory Survey for the Project for Improvement of the Zai Water Supply System".

3. Project site

Both sides confirmed that the Project sites are in Amman Governorate and Balqa Governorate, which are shown in Annex 1.

4. Responsible authority for the Project

Both sides confirmed the authorities responsible for the Project are as follows:

4-1. The Water Authority of Jordan (hereinafter referred to as "WAJ"), Ministry of Water and Irrigation will be the executing agency of the Project (hereinafter referred to as "the Executing Agency"). The Executing Agency shall coordinate with all the relevant authorities to ensure smooth implementation of the Project and ensure that the undertakings for the Project shall be managed by relevant authorities properly and on time.

4-2. Jordan Water Company/Miyahuna (hereinafter referred to as "Miyahuna") is in charge of operation and maintenance of the Zai Water Supply System according to the assignment agreement with WAJ.

5. Items requested by the Jordanian Government

The items requested by the Jordanian Government are as follows:

- Renewal of travelling screen
- Renewal of 18 pumps and 13 motors at intake, raw water and transmission pump stations
- Renewal of chemical feeding facilities at Zai WTP
- Repair of raw water main (header pipe etc.) in raw water pump station
- Replacement of grit settling basins
- Sludge drying bed

- consulting services and soft component

JICA will assess the necessity and feasibility of the above requested items through the survey and will report the findings to the Japanese Government. The final scope of the Project will be decided by the Japanese Government.

6. Procedures and Basic Principles of Japanese Grant

6-1. The Jordanian side agreed that the procedures and basic principles of Japanese Grant (hereinafter referred to as "the Grant") as described in Annex 2 shall be applied to the Project.

As for the monitoring of the implementation of the Project, JICA requires the Jordanian side to submit the Project Monitoring Report, of which form is attached as Annex 3.

6-2. The Jordanian side agreed to take the necessary measures, as described in Annex 4, for smooth implementation of the Project. The contents of the Annex 4 will be revised as necessary and refined during the Preparatory Survey and be agreed during the next mission for presentation of the Draft Preparatory Survey Report to be fielded around April 2020.

The revised contents of Annex 4 will be attached to the Grant Agreement to be made between WAJ and JICA.

7. Schedule of the Survey

7-1. The Team will proceed with further survey in Jordan until 3rd September 2019.

7-2. JICA will prepare a draft Preparatory Survey Report and field a mission to Jordan in order to explain its contents around April 2020.

7-3. If the contents of the draft Preparatory Survey Report is accepted and the undertakings for the Project are fully agreed by the Jordanian side, JICA will finalize the Preparatory Survey Report and submit it to Jordanian Government around May 2020.

7-4. The above schedule is tentative and subject to change.

8. Environmental and Social Considerations

8-1. The Jordanian side confirmed to give due environmental and social considerations during implementation, and after completion of the Project, in accordance with the JICA Guidelines for Environmental and Social Considerations (April, 2010).

8-2. The Project is categorized as "B" from the following considerations:

The project is neither located in an environmentally sensitive area, nor has sensitive characteristics, nor falls into sensitive sectors under the JICA Guidelines for Environmental and Social Considerations (April 2010), and its potential adverse impacts on the environment are not likely to be significant.

The Jordanian side confirmed to conduct the necessary procedures concerning the environmental assessment (including stakeholder meetings, Environmental Impact Assessment (EIA) /Initial Environmental Examination (IEE) and information disclosure, etc.) and make EIA/IEE report of the Project. The EIA/IEE approval shall be received from the responsible authorities and submitted to JICA by the end of March 2020.

8-3. There is no resettlement in the Project site.

9. Other Relevant Issues

9-1. The current sludge disposal process at the Zai WTP

During the site visit, the Team observed part of sedimentation sludge was directly discharged to outside of the plant despite at least eight vacant sludge drying beds remaining unused. According to the draft report by USAID dated on 14th November 2018, WTP staff estimated that 50%-60% of the sludge is directly discharged to a nearby wadi without drying process. The Team considers that such a practice provides significant load on environment and make a serious concern in environmental assessment. Therefore, the Jordanian Government is committed to immediately review the current practice of sludge disposal and to dispose of dried sludge at an environmentally safe site. Although WAJ requested providing additional drying beds or mechanical sludge dewatering facilities, the Team does not find any document to justify increasing drying beds or necessity of such machine under circumstances described above.

From the viewpoint of environmental protection regardless of implementation of the Project, the Jordanian Government is agreed to submit a feasible plan of the environmentally safe sludge disposal to JICA Jordan Office in writing by the end of October 2019 and implement the plan by the end of March 2020.

9-2. Tax Exemption

The Jordanian side agreed to arrange an issue of the Cabinet letter immediately after the Exchange of Note signed, which authorize the exemption of taxes and duties to be imposed by the government such as customs duties and other expenses related to customs clearance, work permit fees and stay permit fees, to related organizations such as Ministry of Finance and Ministry of Municipalities.

9-3. Sustainable Use

The Team observed that the facilities of Zai Water Supply System is well maintained with great efforts by Miyahuna and WAJ. But there is lack of the budget for the major renovation/rehabilitation which needs once in 20-30 years. For sustainable use of the facilities, Miyahuna and WAJ are required to prepare funds for the next major renovation/rehabilitation.

List of Annexes

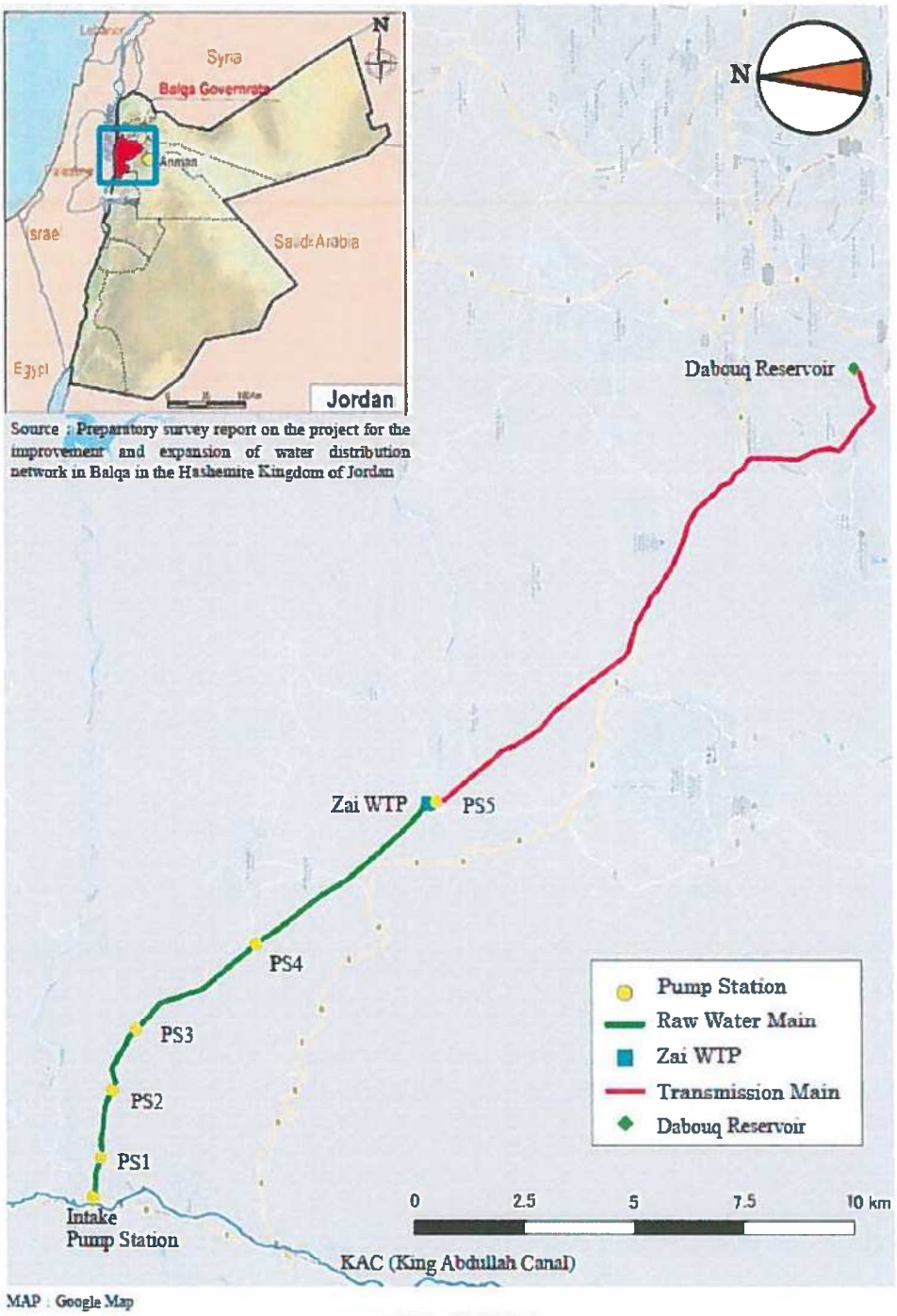
Annex 1 Project Site

Annex 2 Japanese Grant

Annex 3 Project Monitoring Report (template)

Annex 4 Major Undertakings by the Jordanian Government

**PROJECT SITE**




LOCATION MAP

# JAPANESE GRANT

The Japanese Grant is non-reimbursable fund provided to a recipient country (hereinafter referred to as "the Recipient") to purchase the products and/or services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. Followings are the basic features of the project grants operated by JICA (hereinafter referred to as "Project Grants").

## 1. Procedures of Project Grants

Project Grants are conducted through following procedures (See "PROCEDURES OF JAPANESE GRANT" for details):

(1) Preparation

- The Preparatory Survey (hereinafter referred to as "the Survey") conducted by JICA

(2) Appraisal

-Appraisal by the government of Japan (hereinafter referred to as "GOJ") and JICA, and Approval by the Japanese Cabinet

(3) Implementation

Exchange of Notes

-The Notes exchanged between the GOJ and the government of the Recipient

Grant Agreement (hereinafter referred to as "the G/A")

-Agreement concluded between JICA and the Recipient

Banking Arrangement (hereinafter referred to as "the B/A")

-Opening of bank account by the Recipient in a bank in Japan (hereinafter referred to as "the Bank") to receive the grant

Construction works/procurement

-Implementation of the project (hereinafter referred to as "the Project") on the basis of the G/A

(4) Ex-post Monitoring and Evaluation

-Monitoring and evaluation at post-implementation stage

## 2. Preparatory Survey

(1) Contents of the Survey

The aim of the Survey is to provide basic documents necessary for the appraisal of the the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the Recipient necessary for the implementation of the Project.

- Evaluation of the feasibility of the Project to be implemented under the Japanese Grant from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of an outline design of the Project.
- Estimation of costs of the Project.
- Confirmation of Environmental and Social Considerations

The contents of the original request by the Recipient are not necessarily approved in their initial form. The Outline Design of the Project is confirmed based on the guidelines of the Japanese Grant.

JICA requests the Recipient to take measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the executing agency of the Project. Therefore, the contents of the Project are confirmed by all relevant organizations of the Recipient based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA contracts with (a) consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the feasibility of the Project.

**3. Basic Principles of Project Grants**

(1) Implementation Stage

1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes (hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the Recipient to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Recipient to define the necessary articles, in accordance with the E/N, to implement the Project, such as conditions of disbursement, responsibilities of the Recipient, and procurement conditions. The terms and conditions generally applicable to the Japanese Grant are stipulated in the "General Terms and Conditions for Japanese Grant (January 2016)."

2) Banking Arrangements (B/A) (See "Financial Flow of Japanese Grant (A/P Type)" for details)

a) The Recipient shall open an account or shall cause its designated authority to open an account under the name of

the Recipient in the Bank, in principle. JICA will disburse the Japanese Grant in Japanese yen for the Recipient to cover the obligations incurred by the Recipient under the verified contracts.

b) The Japanese Grant will be disbursed when payment requests are submitted by the Bank to JICA under an Authorization to Pay (A/P) issued by the Recipient.

3) Procurement Procedure

The products and/or services necessary for the implementation of the Project shall be procured in accordance with JICA's procurement guidelines as stipulated in the G/A.

4) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the Recipient to continue to work on the Project's implementation after the E/N and G/A.

5) Eligible source country

In using the Japanese Grant disbursed by JICA for the purchase of products and/or services, the eligible source countries of such products and/or services shall be Japan and/or the Recipient. The Japanese Grant may be used for the purchase of the products and/or services of a third country as eligible, if necessary, taking into account the quality, competitiveness and economic rationality of products and/or services necessary for achieving the objective of the Project. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm, which enter into contracts with the Recipient, are limited to "Japanese nationals", in principle.

6) Contracts and Concurrence by JICA

The Recipient will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be concurred by JICA in order to be verified as eligible for using the Japanese Grant.

7) Monitoring

The Recipient is required to take their initiative to carefully monitor the progress of the Project in order to ensure its smooth implementation as part of their responsibility in the G/A, and to regularly report to JICA about its status by using the Project Monitoring Report (PMR).

8) Safety Measures

The Recipient must ensure that the safety is highly observed during the implementation of the Project.

9) Construction Quality Control Meeting

Construction Quality Control Meeting (hereinafter referred to as the "Meeting") will be held for quality assurance and smooth implementation of the Works at each stage of the Works. The member of the Meeting will be composed by the Recipient (or executing agency), the Consultant, the Contractor and JICA. The functions of the Meeting are as followings:

a) Sharing information on the objective, concept and conditions of design from the Contractor, before start of

construction.

b) Discussing the issues affecting the Works such as modification of the design, test, inspection, safety control and the Client's obligation, during of construction.

(2) Ex-post Monitoring and Evaluation Stage

1) After the project completion, JICA will continue to keep in close contact with the Recipient in order to monitor that the outputs of the Project is used and maintained properly to attain its expected outcomes.

2) In principle, JICA will conduct ex-post evaluation of the Project after three years from the completion. It is required for the Recipient to furnish any necessary information as JICA may reasonably request.

(3) Others

1) Environmental and Social Considerations

The Recipient shall carefully consider environmental and social impacts by the Project and must comply with the environmental regulations of the Recipient and JICA Guidelines for Environmental and Social Considerations (April, 2010).

2) Major undertakings to be taken by the Government of the Recipient

For the smooth and proper implementation of the Project, the Recipient is required to undertake necessary measures including land acquisition, and bear an advising commission of the A/P and payment commissions paid to the Bank as agreed with the GOJ and/or JICA. The Government of the Recipient shall ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the Recipient with respect to the purchase of the Products and/or the Services be exempted or be borne by its designated authority without using the Grant and its accrued interest, since the grant fund comes from the Japanese taxpayers.

3) Proper Use

The Recipient is required to maintain and use properly and effectively the products and/or services under the Project (including the facilities constructed and the equipment purchased), to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Japanese Grant.

4) Export and Re-export

The products purchased under the Japanese Grant should not be exported or re-exported from the Recipient.

**PROJECT MONITORING REPORT (template)**

Date:
Ref. No.

JAPAN INTERNATIONAL COOPERATION AGENCY
JICA XXX OFFICE
*[Address specified in the Article 5 of the Grant Agreement]*

Attention: Chief Representative

Ladies and Gentlemen:

NOTICE CONCERNING PROGRESS OF PROJECT

Reference : Grant Agreement, dated (signed date of the G/A), for (name of the Project)

In accordance to the Article 6 (3) of the Grant Agreement, we would like to report on the progress of the Project up to the following stages:

[Common]
- ☐ Preparation of bidding documents - result of detailed design
- ☐ Completion of final works under construction/procurement contract

[Construction]
- ☐ Monthly progress [Month/Year]

[Procurement of Equipment]
- ☐ Shipping/delivery, hand-over (take over) of equipment
- ☐ Installation works
- ☐ Operational training

- ☐ Other _____

Please see the details as per attached Project Monitoring Report (PMR).

Very truly yours,

***[Signature]***_____
*[Name of the signer]*
*[Title of the signer]*
*[Name of the executing agency]*

cc:

Director General
Financial Cooperation Implementation Department
Japan International Cooperation Agency
*[Address specified in the Article 5 of the Grant Agreement]*

***Project Monitoring Report***
***on***
***Project Name***
***Grant Agreement No. XXXXXXX***
20XX, Month

## Organizational Information

| | | |
|---|---|---|
| **Signer of the G/A** (Recipient) | Person in Charge | (Designation) |
| | Contacts | Address:<br>Phone/FAX:<br>Email: |
| **Executing Agency** | Person in Charge | (Designation) |
| | Contacts | Address:<br>Phone/FAX:<br>Email: |
| **Line Ministry** | Person in Charge | (Designation) |
| | Contacts | Address:<br>Phone/FAX:<br>Email: |

## General Information:

| | |
|---|---|
| **Project Title** | |
| **E/N** | Signed date:<br>Duration: |
| **G/A** | Signed date:<br>Duration: |
| **Source of Finance** | Government of Japan: Not exceeding JPY _____ mil.<br>Government of (_____): _____ |

## 1: Project Description

### 1-1 Project Objective

### 1-2 Project Rationale

- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

### 1-3 Indicators for measurement of "Effectiveness"

| Quantitative indicators to measure the attainment of project objectives | | |
|---|---|---|
| Indicators | Original (Yr ) | Target (Yr ) |
| | | |
| | | |
| | | |
| **Qualitative indicators to measure the attainment of project objectives** | | |
| | | |

## 2: Details of the Project

### 2-1 Location

| Components | Original *(proposed in the outline design)* | Actual |
|---|---|---|
| 1. | | |

### 2-2 Scope of the work

| Components | Original* *(proposed in the outline design)* | Actual* |
|---|---|---|
| 1. | | |
| | | |
| | | |
| | | |

Reasons for modification of scope (if any).

*(PMR)*

## 2-3 Implementation Schedule

| Items | Original | | Actual |
|---|---|---|---|
| | *(proposed in the outline design)* | *(at the time of signing the Grant Agreement)* | |
| | | | |

Reasons for any changes of the schedule, and their effects on the project (if any)

| |
|---|
| |

## 2-4 Obligations by the Recipient

### 2-4-1 Progress of Specific Obligations

See Attachment 2.

### 2-4-2 Activities

See Attachment 3.

### 2-4-3 Report on RD

See Attachment 11.

## 2-5 Project Cost

### 2-5-1 Cost borne by the Grant(Confidential until the Bidding)

| Components | | | Cost (Million Yen) | |
|---|---|---|---|---|
| | Original *(proposed in the outline design)* | Actual *(in case of any modification)* | Original[1),2)] *(proposed in the outline design)* | Actual |
| | 1. | | | |
| | | | | |
| | | | | |
| Total | | | | |

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

### 2-5-2 Cost borne by the Recipient

| Components | | | Cost (1,000 Taka) | |
|---|---|---|---|---|
| | Original *(proposed in the outline design)* | Actual *(in case of any modification)* | Original[1),2)] *(proposed in the outline design)* | Actual |
| | 1. | | | |
| | | | | |
| | | | | |
| | | | | |

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

| *(PMR)* |
|---|
| |

**2-6 Executing Agency**

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

| **Original** *(at the time of outline design)*<br>name:<br>role:<br>financial situation:<br>institutional and organizational arrangement (organogram):<br>human resources (number and ability of staff): |
|---|
| **Actual** *(PMR)* |
| |

**2-7 Environmental and Social Impacts**

- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

## 3: Operation and Maintenance (O&M)

**3-1 Physical Arrangement**

- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

| **Original** *(at the time of outline design)* |
|---|
| |
| **Actual** *(PMR)* |
| |

**3-2 Budgetary Arrangement**

- Required O&M cost and actual budget allocation for O&M

| **Original** *(at the time of outline design)* |
|---|
| |

| **Actual** *(PMR)* |
|---|
| |

## 4: Potential Risks and Mitigation Measures

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

**Assessment of Potential Risks** (*at the time of outline design*)

| Potential Risks | Assessment |
|---|---|
| 1. (Description of Risk) | Probability: High/Moderate/Low |
| | Impact: High/Moderate/Low |
| | Analysis of Probability and Impact: |
| | |
| | Mitigation Measures: |
| | |
| | Action required during the implementation stage: |
| | |
| | Contingency Plan (if applicable): |
| | |
| 2. (Description of Risk) | Probability: High/Moderate/Low |
| | Impact: High/Moderate/Low |
| | Analysis of Probability and Impact: |
| | |
| | Mitigation Measures: |
| | |
| | Action required during the implementation stage: |
| | |
| | Contingency Plan (if applicable): |
| | |
| 3. (Description of Risk) | Probability: High/Moderate/Low |
| | Impact: High/Moderate/Low |
| | Analysis of Probability and Impact: |
| | |
| | Mitigation Measures: |
| | |
| | Action required during the implementation stage: |
| | |

| | Contingency Plan (if applicable): |
|---|---|
| | |
| **Actual Situation and Countermeasures** | |
| (PMR) | |

## 5: Evaluation and Monitoring Plan (after the work completion)

### 5-1 Overall evaluation

Please describe your overall evaluation on the project.

| |
|---|
| |

### 5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

| |
|---|
| |

### 5-3 Monitoring Plan of the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

| |
|---|
| |

Attachment

1. Project Location Map
2. Specific obligations of the Recipient which will not be funded with the Grant
3. Monthly Report submitted by the Consultant

Appendix - Photocopy of Contractor's Progress Report (if any)
- Consultant Member List
- Contractor's Main Staff List

4. Check list for the Contract (including Record of Amendment of the Contract/Agreement and Schedule of Payment)
5. Environmental Monitoring Form / Social Monitoring Form
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final )only)
8. Pictures (by JPEG style by CD-R) (PMR (final)only)
9. Equipment List (PMR (final )only)
10. Drawing (PMR (final )only)
11. Report on RD (After project)

Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

| | Items of Specified Materials | Initial Volume A | Initial Unit Price (¥) B | Initial total Price C=A×B | 1% of Contract Price D | Condition of payment | |
|---|---|---|---|---|---|---|---|
| | | | | | | Price (Decreased) E=C－D | Price (Increased) F=C＋D |
| 1 | Item 1 | ●●t | ● | ● | ● | ● | ● |
| 2 | Item 2 | ●●t | ● | ● | ● | | |
| 3 | Item 3 | | | | | | |
| 4 | Item 4 | | | | | | |
| 5 | Item 5 | | | | | | |
| | | | | | | | |

2. Monitoring of the Unit Price of Specified Materials

(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

| | Items of Specified Materials | 1st ●month, 2015 | 2nd ●month, 2015 | 3rd ●month, 2015 | 4th | 5th | 6th |
|---|---|---|---|---|---|---|---|
| 1 | Item 1 | | | | | | |
| 2 | Item 2 | | | | | | |
| 3 | Item 3 | | | | | | |
| 4 | Item 4 | | | | | | |
| 5 | Item 5 | | | | | | |
| | | | | | | | |

(3) Summary of Discussion with Contractor (if necessary)

-
-
-

Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)
(Actual Expenditure by Construction and Equipment each)

| | Domestic Procurement (Recipient Country) A | Foreign Procurement (Japan) B | Foreign Procurement (Third Countries) C | Total D |
|---|---|---|---|---|
| Construction Cost | (A/D%) | (B/D%) | (C/D%) | |
| Direct Construction Cost | (A/D%) | (B/D%) | (C/D%) | |
| others | (A/D%) | (B/D%) | (C/D%) | |
| Equipment Cost | (A/D%) | (B/D%) | (C/D%) | |
| Design and Supervision Cost | (A/D%) | (B/D%) | (C/D%) | |
| Total | (A/D%) | (B/D%) | (C/D%) | |

## MAJOR UNDERTAKINGS BY THE JORDANIAN GOVERNMENT

Specific obligations of the Jordanian Government which will not be funded with the Grant

(1) Before the Bidding

| NO | Items | Deadline | In charge | Estimated Cost | Ref. |
|---|---|---|---|---|---|
| 1 | To sign the banking arrangement (B/A) with a bank in Japan (the Agent Bank) to open bank account for the Grant | within 1 month after the signing of the G/A | CBJ<br>WAJ | | |
| 2 | To issue A/P to the Agent Bank for the payment to the consultant | within 1 month after the signing of the contract(s) | CBJ<br>WAJ | | |
| 3 | To bear the following commissions to the Agent Bank for the banking services based upon B/A | | WAJ | | |
| | 1) Advising commission of A/P | within 1 month after the signing of the contract(s) | | | |
| | 2) Payment commission for A/P | every payment | | | |
| 4 | To approve IEE/EIA(Conditions of approval should be fulfilled, if any) and secure the necessary budget for implementation for EMP and EMoP (and fulfilling conditions of approval, if any). | within 1 month after the signing of the G/A | MOE | | |
| 5 | To secure the necessary budget and implement land acquisition and resettlement (including preparation of resettlement sites), and compensation with full replacement cost in accordance with RAP | before notice of the bidding documents | WAJ | | |
| 6 | To implement social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report | until land acquisition and resettlement complete | WAJ | | |
| 7 | To secure and clear the following lands<br>1) project sites<br>2) temporary construction yard and stock yard near the Project area<br>3) disposal site near the Project area | before notice of the bidding documents | WAJ | | |
| 8 | To obtain the planning, zoning, building permit | before notice of the bidding documents | WAJ | | |
| 9 | To submit Project Monitoring Report (with the result of Detailed Design) | before preparation of the bidding documents | WAJ | | |

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable, CBJ: Central Bank of Jordan, WAJ: Water Authority of Jordan)

( 2) During the Project Implementation

| NO | Items | Deadline | In charge | Estimated Cost | Ref. |
|---|---|---|---|---|---|
| 1 | To issue A/P to the Agent Bank for the payment to the supplier and the contractor | within 1 month after the signing of the contract(s) | WAJ | | |
| 2 | To bear the following commissions to the Agent Bank for the banking services based upon the B/A | | | | |
| | 1) Advising commission of A/P | within 1 month after the signing of the contract(s) | WAJ | | |
| | 2) Payment commission for A/P | every payment | WAJ | | |
| 3 | to ensure prompt unloading and customs clearance at ports of disembarkation in the country of the Recipient and to assist the Supplier(s) with internal transportation therein | during the Project | WAJ | | |
| 4 | To accord Japanese physical persons and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work | during the Project | MOPIC<br>MOI<br>WAJ | | |
| 5 | To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the services [be exempted by its designated authority without using the Grant]; | during the Project | MOPIC<br>MOF<br>WAJ | | |
| 6 | To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project | during the Project | WAJ | | |
| 7 | To notify JICA promptly of any incident or accident, which has, or is likely to have, a significant adverse effect on the environment, the affected communities, the public or workers. | during the construction | WAJ | | |
| 8 | 1) To submit Project Monitoring Report | every month | WAJ | | |
| | 2) To submit Project Monitoring Report (final) (including as-built drawings, equipment list, photographs, etc.) | within 1 month after issuance of Certificate of Completion for the works under the contract(s) | WAJ | | |
| 9 | To submit a report concerning completion of the Project | within 6 months after completion of the Project | WAJ | | |
| 10 | To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the site(s) | | WAJ | | |
| | 1) Electricity<br>The distributing line to the site | before start of the construction | | | |
| | 2) Water Supply<br>The city water distribution main to the site | before start of the construction | | | |
| | 3) Drainage<br>The city drainage main ( for storm, sewer and others ) to the site | 6 months before completion of the construction | | | |

| | | | | | |
|---|---|---|---|---|---|
| 11 | To take measure necessary for security and safety of the Project<br>- maintaining the safety of workers and the general public by thorough implementation of safety measures and immediate action in the case of accident<br>- traffic control around the site(s) and on transportation routes of construction materials<br>- | during the construction | WAJ | | |
| 12 | To implement EMP and EMoP | during the construction | WAJ | | |
| 13 | To submit results of environmental monitoring to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report | during the construction | WAJ | | |
| 14 | To implement social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report, if necessary | - for 2 years after land acquisition and resettlement complete | WAJ | | |

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable, MOPIC: Ministry of Planning and International Cooperation, MOI: Ministry of Interior, MOF: Ministry of Finance, WAJ: Water Authority of Jordan)

(3) After the Project

| NO | Items | Deadline | In charge | Estimated Cost | Ref. |
|---|---|---|---|---|---|
| 1 | To implement EMP and EMoP | for a period based on EMP and EMoP | WAJ | | |
| 2 | To submit results of environmental monitoring to JICA, by using the monitoring form, semiannually<br>- The period of environmental monitoring may be extended if any significant negative impacts on the environment are found. The extension of environmental monitoring will be decided based on the agreement between WAJ and JICA. | for 3 years after the Project | WAJ | | |
| 3 | To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid<br>1) Allocation of maintenance cost<br>2) Operation and maintenance structure<br>3) Routine check/Periodic inspection | After completion of the construction | WAJ | | |

Other obligations of the Jordanian Government funded with the Grant

| NO | Items | Deadline | Amount (Million Japanese Yen)* |
|---|---|---|---|
| 1 | To construct water supply facilities and provide equipment<br>1) To conduct the following transportation<br>a) Marine(Air) transportation of the products from Japan to the country of the Recipient<br>b) Internal transportation from the port of disembarkation to the project site | | |

| | | | |
|---|---|---|---|
| | 2) To construct access roads<br>a) Within the site | | |
| | 3) To construct the temporary building | | |
| | 4) To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities<br>a) Electricity<br>- The drop wiring and internal wiring within the site<br>- The main circuit breaker and transformer<br>b) Water Supply<br>- The supply system within the site (receiving and/or elevated tanks)<br>c) Drainage<br>- The drainage system (for toilet sewer, ordinary waster, storm drainage and others) within the site<br>d) Furniture and Equipment<br>- Project equipment | | |
| | 5) To provide equipment with installation and commissioning | | |
| 2 | To implement detailed design, bidding support and construction supervision<br>(Consulting Service) | | |
| 3 | Contingencies | | |
| | Total | | XXX |

*The Amount is provisional. This is subject to the approval of the Government of Japan.

**Minutes of Discussions**
**on the Preparatory Survey for the Project for**
**Improvement of the Zai Water Supply System**
**（Explanation on Draft Preparatory Survey Report）**

With reference to the minutes of discussions signed among Water Authority of Jordan (Hereinafter referred to as “WAJ”), Ministry of Water and Irrigation, Jordan Water Company /Miyahuna (hereinafter referred to as “Miyahuna”), and the Japan International Cooperation Agency (hereinafter referred to as "JICA") on 15 July 2019, and in response to the request from the Government of Hashemite Kingdom of Jordan (hereinafter referred to as "Jordan”),JICA held the on-line meeting forthe explanation of Draft Preparatory Survey Report (hereinafter referred to as “the Draft Report”) for the Project for Improvement of the Zai Water Supply System (hereinafter referred to as “the Project”).

As a result of the discussions, both sides agreed on the main items described in the attached sheets.

Amman, 28th July 2020

MIYAHARA Chie
Chief Representative
Japan International Cooperation Agency
Jordan Office

Ali Subah
Secretary General,
Water Authority of Jordan,
Ministry of Water and Irrigation,
The Hashemite Kingdom of Jordan

Mohammed Ouran
Acting CEO,
Jordan Water Company/ Miyahuna,
The Hashemite Kingdom of Jordan

## ATTACHEMENT

1. Contents of the Draft Report

After the explanation of the contents of the Draft Report by the JICA side, the Jordanian side agreed to its contents. JICA will finalize the Preparatory Survey Report based on the confirmed items. The report will be sent to the Jordanian side around October 2020.

2. Cost estimate

Both sides confirmed that the cost estimate including the contingency explained by JICA is provisional and will be examined further by the Government of Japan for its approval. The contingency would cover the additional cost against natural disaster, unexpected natural conditions, etc.

3. Confidentiality of the cost estimate and technical specifications

Both sides confirmed that the cost estimate and technical specifications of the Project should never be disclosed to any third parties until all the contracts under the Project are concluded.

4. Timeline for the project implementation

JICA explained to the Jordanian side that the expected timeline for the project implementation is as attached in Annex 1.

5. Expected outcomes and indicators

Both sides agreed that key indicators for expected outcomes are as follows. The Jordanian side will be responsible for the achievement of agreed key indicators targeted in year 2026 and shall monitor the progress for Ex-Post Evaluation based on those indicators.

[Quantitative indicators]

| Name of index | Baseline value (2019) | Target value (2026) |
|---|---|---|
| Electricity consumption per $m^3$ of water supplied by the Zai Water Supply System ($kWh/m^3$) | 5.10 | 4.91 |
| GHG emission/year ($Mt\text{-}CO_2$/year) | 191.97 | Less than 185 |

(Source: JICA Survey Team)

[Qualitative indicators]

Ensure a stable water supply to Amman in future.

6. Ex-Post Evaluation

JICA will conduct ex-post evaluation after three (3) years from the project completion, in principle, with respect to five evaluation criteria (Relevance, Effectiveness, Efficiency, Impact, and Sustainability). The result of the evaluation will be publicized. The Jordanian side is required to provide necessary support for the data collection.

7. Undertakings of the Project

Both sides confirmed the undertakings of the Project as described in Annex 2.With regard to exemption of customs duties, internal taxes and other fiscal levies as stipulated in (2)-5of Annex 2, both sides confirmed that such customs duties, internal taxes and other fiscal levies, shall be clarified in the bid documents by WAJ during the implementation stage of the Project. For the exemption of customs duties, internal taxes and other fiscal levies to proceed progressively and without fault, the "Cabinet Letter", which is issued by the Cabinet, shall describe the items to be exempted (or zero taxed) specifically and clearly. Especially, the levies of work permit fee and stay permit fee shall be exempted.

The Jordanian side assured to take the necessary measures and coordination including allocation of the necessary budget which are preconditions of implementation of the Project. It is further agreed that the costs are indicative, i.e. at Outline Design level. More accurate costs will be calculated at the Detailed Design stage.

Both sides also confirmed that the Annex 2 will be used as an attachment of G/A.

8. Monitoring during the implementation

The Project will be monitored by the WAJ and reported to JICA by using the form of Project Monitoring Report (PMR) attached as Annex 3.The timing of submission of the PMR is described in Annex 2.

9. Project completion

Both sides confirmed that the Project completes when all the facilities constructed and equipment procured by the Grant are in operation. The completion of the Project will be reported to JICA by WAJ promptly, but in any event not later than six months

after completion of the Project.

10. Environmental and Social Considerations

10-1 General Issues

10-1-1 Environmental Guidelines and Environmental Category

JICA explained that 'JICA Guidelines for Environmental and Social Considerations (April 2010)' (hereinafter referred to as "the Guidelines") is applicable to the Project. The Project is categorized as B because the project is not located in a sensitive area, nor has sensitive characteristics, nor falls into sensitive sectors under the Guidelines, and its potential adverse impacts on the environment are not likely to be significant.

10-1-2 Environmental Checklist

The environmental and social considerations including major impacts and mitigation measures for the Project are summarized in the Environmental Checklist attached as Annex4. Both sides confirmed that in case of major modification of the content of the Environmental Checklist, the Jordanian side shall submit the modified version to JICA in a timely manner.

10-2 Environmental Issues

10-2-1 Environmental Impact Assessment (EIA)

Both sides confirmed the EIA report is not required for the Project in Jordan's legal system.

10-2-2 Environmental Management Plan and Environmental Monitoring Plan

Both sides confirmed Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) of the Project are as Annex5,respectively. Both sides agreed that environmental mitigation measures and monitoring shall be conducted based on the EMP and EMoP, which may be updated during the detailed design stage.

10-2-3 Other specific environmental issues which need to be confirmed/agreed between the parties.

Jordanian side will start removing the dry sludge from Zai after the government reduce the restrictions, which is expected in September 2020.

Both sides also confirmed that there is no social impact at present by the discharged sludge in Zai National Park.

10-3 Social Issues

10-3-1 Environmental Monitoring

Both sides agreed that the Jordanian side will submit results of environmental monitoring to JICA by using the monitoring form attached as Annex6.The timing of submission of the monitoring form is described in Annex 2. .

10-3-2 Information Disclosure of Monitoring Results

Both sides confirmed that the Jordanian side will disclose results of environmental and social monitoring to local stakeholders through their websites / in their field offices. .

The Jordanian side agreed to JICA's policy to disclose results of environmental and social monitoring submitted by the Jordanian side as the monitoring forms attached as Annex 6 on its website. .

11. Other Relevant Issues

11-1 Disclosure of Information

Both sides confirmed that the Preparatory Survey Report from which project cost is excluded will be disclosed to the public after completion of the Preparatory Survey. The comprehensive report including the project cost will be disclosed to the public after all the contracts under the Project are concluded.

11-2 Financial Management

JICA side explained the results of financial evaluation of Miyahuna and WAJ. The results show that both Miyahuna and WAJ cannot secure the fund for future rehabilitation (20 years after the Project completion) nor even future O&M cost without increase of water tariff. JICA recommended the staged increase of water tariff, coordination and making consensus among the concerned organizations to accumulate the surplus of Miyahuna and operating surplus of WAJ for future O&M cost and investment.

In addition, JICA also recommended to modify the audit financial statements of WAJ and Miyahuna to clearly show the items such as expenditures and assets by water supply and sewerage services separately.

The Jordanian Side agreed to carefully consider the recommendations of JICA.

11-3 Grit settling basin

Both sides confirmed that the Grit settling basin is out of scope of this Project.

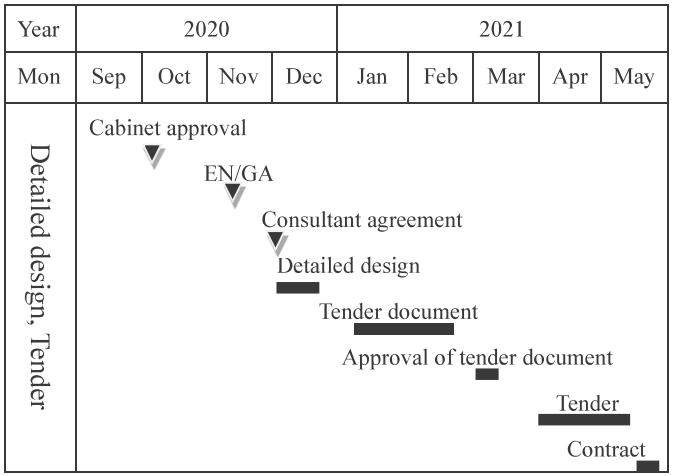
The Jordanian side agreed to maintain and repair the concrete in case of reinforcing bar expansion in the two Grit settling basin.

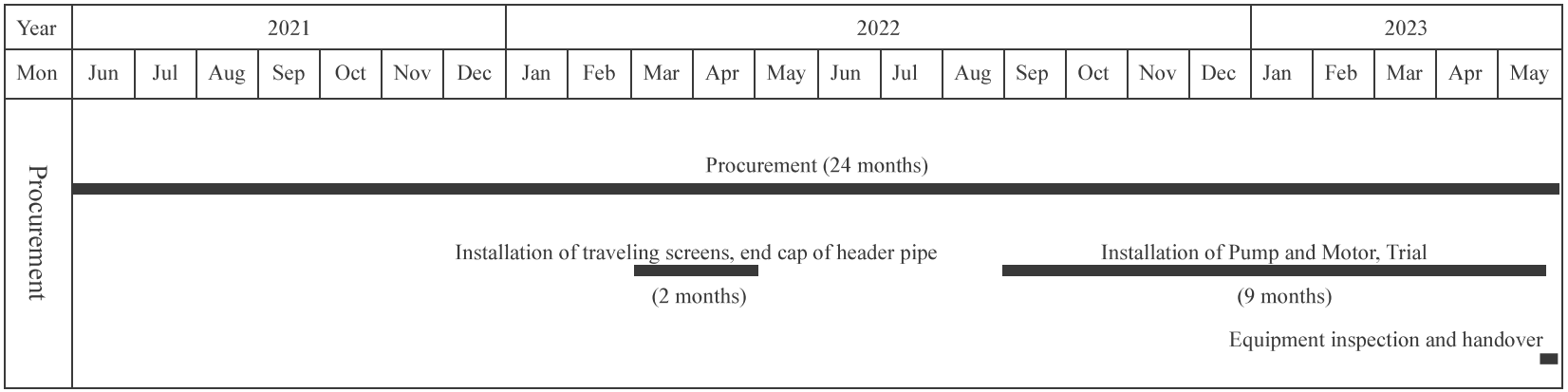
11-4 Replacement Plan of Pump and Motor

The new pump and new motor is recommended to installed and used by pair as the pump manufacture can guarantee the operation totally. To make the pair as many as possible, both sides confirmed the Replacement Plan of Pump and Motor of the Project is as Annex 7.

Annex 1 Project Implementation Schedule
Annex 2 Major Undertakings to be taken by the Government of Jordan
Annex 3 Project Monitoring Report (template)
Annex 4 Environmental Check List
Annex 5 Environmental Management Plan/Environmental Monitoring Plan
Annex 6 Environmental and Social Monitoring Form
Annex 7 Replacement Plan of Pump and Motor

# Project Implementation Schedule



Annex 2

## MAJOR UNDERTAKINGS BY THE JORDANIAN GOVERNMENT

Specific obligations of the Jordanian Government which will not be funded with the Grant

(1) Before the Bidding

| NO | Items | Deadline | In charge | Estimated Cost | Ref. |
|---|---|---|---|---|---|
| 1 | To sign the banking arrangement (B/A) with a bank in Japan (the Agent Bank) to open bank account for the Grant | within 1 month after the signing of the G/A | CBJ<br>WAJ | | |
| 2 | To issue A/P to the Agent Bank for the payment to the consultant | within 1 month after the signing of the contract(s) | CBJ<br>WAJ | | |
| 3 | To bear the following commissions to the Agent Bank for the banking services based upon B/A | | WAJ | | |
| | 1) Advising commission of A/P | within 1 month after the signing of the contract(s) | | | |
| | 2) Payment commission for A/P | every payment | | | |
| 4 | To approve IEE/EIA(Conditions of approval should be fulfilled, if any) and secure the necessary budget for implementation for EMP and EMoP (and fulfilling conditions of approval, if any). | within 1 month after the signing of the G/A | MOE | | |
| 5 | To secure the necessary budget and implement land acquisition and resettlement (including preparation of resettlement sites), and compensation with full replacement cost in accordance with RAP | before notice of the bidding documents | WAJ | | |
| 6 | To implement social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report | until land acquisition and resettlement complete | WAJ | | |
| 7 | To secure and clear the following lands<br>1) project sites<br>2) temporary construction yard and stock yard near the Project area<br>3) disposal site near the Project area | before notice of the bidding documents | WAJ | | |
| 8 | To obtain the planning, zoning, building permit | before notice of the bidding documents | WAJ | | |
| 9 | To submit Project Monitoring Report (with the result of Detailed Design) | before preparation of the bidding documents | WAJ | | |

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable, CBJ: Central Bank of Jordan, WAJ: Water Authority of Jordan)

( 2) During the Project Implementation

| NO | Items | Deadline | In charge | Estimated Cost | Ref. |
|---|---|---|---|---|---|
| 1 | To issue A/P to the Agent Bank for the payment to the supplier and the contractor | within 1 month after the signing of the contract(s) | WAJ | | |
| 2 | To bear the following commissions to the Agent Bank for the banking services based upon the B/A | | | | |
| | 1) Advising commission of A/P | within 1 month after the signing of the contract(s) | WAJ | | |
| | 2) Payment commission for A/P | every payment | WAJ | | |
| 3 | to ensure prompt unloading and customs clearance at ports of disembarkation in the country of the Recipient and to assist the Supplier(s) with internal transportation therein | during the Project | WAJ | | |
| 4 | To accord Japanese physical persons and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work | during the Project | MOPIC<br>MOI<br>WAJ | | |
| 5 | To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the services [be exempted by its designated authority without using the Grant]; | during the Project | MOPIC<br>MOF<br>WAJ | | |
| 6 | To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project | during the Project | WAJ | | |
| 7 | To notify JICA promptly of any incident or accident, which has, or is likely to have, a significant adverse effect on the environment, the affected communities, the public or workers. | during the construction | WAJ | | |
| 8 | 1) To submit Project Monitoring Report | every month | WAJ | | |
| | 2) To submit Project Monitoring Report (final) (including as-built drawings, equipment list, photographs, etc.) | within 1 month after issuance of Certificate of Completion for the works under the contract(s) | WAJ | | |
| 9 | To submit a report concerning completion of the Project | within 6 months after completion of the Project | WAJ | | |
| 10 | To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the site(s) | | WAJ | | |
| | 1) Electricity<br>The distributing line to the site | before start of the construction | | | |
| | 2) Water Supply<br>The city water distribution main to the site | before start of the construction | | | |
| | 3) Drainage<br>The city drainage main ( for storm, sewer and others ) to the site | 6 months before completion of the construction | | | |

| | | | | | |
|---|---|---|---|---|---|
| 11 | To take measure necessary for security and safety of the Project<br>- maintaining the safety of workers and the general public by thorough implementation of safety measures and immediate action in the case of accident<br>- traffic control around the site(s) and on transportation routes of construction materials<br>- | during the construction | WAJ | | |
| 12 | To implement EMP and EMoP | during the construction | WAJ | | |
| 13 | To submit results of environmental monitoring to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report | during the construction | WAJ | | |
| 14 | To implement social monitoring, and to submit the monitoring results to JICA, by using the monitoring form, on a quarterly basis as a part of Project Monitoring Report, if necessary | - for 2 years after land acquisition and resettlement complete | WAJ | | |
| 15 | To relocate 4 existing motors | before equipment installation | WAJ | 60 thousand JOD | |
| 16 | To supply electric power | during test operation of pumps | WAJ | 100 thousand JOD | |

(B/A: Banking Arrangement, A/P: Authorization to pay, N/A: Not Applicable, MOPIC: Ministry of Planning and International Cooperation, MOI: Ministry of Interior, MOF: Ministry of Finance, WAJ: Water Authority of Jordan)

(3) After the Project

| NO | Items | Deadline | In charge | Estimated Cost | Ref. |
|---|---|---|---|---|---|
| 1 | To implement EMP and EMoP | for a period based on EMP and EMoP | WAJ | | |
| 2 | To submit results of environmental monitoring to JICA, by using the monitoring form, semiannually<br>- The period of environmental monitoring may be extended if any significant negative impacts on the environment are found. The extension of environmental monitoring will be decided based on the agreement between WAJ and JICA. | for 3 years after the Project | WAJ | | |
| 3 | To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid<br>1) Allocation of maintenance cost<br>2) Operation and maintenance structure<br>3) Routine check/Periodic inspection | After completion of the construction | WAJ | | |

Other obligations of the Jordanian Government funded with the Grant

| NO | Items | Deadline | Amount (Million Japanese Yen)* |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1 | To construct water supply facilities and provide equipment<br>1) To conduct the following transportation<br>a) Marine(Air) transportation of the products from Japan to the country of the Recipient<br>b) Internal transportation from the port of disembarkation to the project site | by the project completion | |
| | 2) To construct access roads<br>a) Within the site | | |
| | 3) To construct the temporary building | | |
| | 4) To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities<br>a) Electricity<br>- The drop wiring and internal wiring within the site<br>- The main circuit breaker and transformer<br>b) Water Supply<br>- The supply system within the site (receiving and/or elevated tanks)<br>c) Drainage<br>- The drainage system (for toilet sewer, ordinary waster, storm drainage and others) within the site<br>d) Furniture and Equipment<br>- Project equipment | | |
| | 5) To provide equipment with installation and commissioning | | |
| 2 | To implement detailed design, bidding support and construction supervision<br>(Consulting Service) | | |
| 3 | Contingencies | | |
| | Total | | XXX |

*The Amount is provisional. This is subject to the approval of the Government of Japan.

**PROJECT MONITORING REPORT (template)**

Date:
Ref. No.

JAPAN INTERNATIONAL COOPERATION AGENCY
JICA XXX OFFICE
*[Address specified in the Article 5 of the Grant Agreement]*

Attention: Chief Representative

Ladies and Gentlemen:

NOTICE CONCERNING PROGRESS OF PROJECT

Reference : Grant Agreement, dated (signed date of the G/A), for (name of the Project)

In accordance to the Article 6 (3) of the Grant Agreement, we would like to report on the progress of the Project up to the following stages:

[Common]
- ☐ Preparation of bidding documents - result of detailed design
- ☐ Completion of final works under construction/procurement contract

[Construction]
- ☐ Monthly progress [Month/Year]

[Procurement of Equipment]
- ☐ Shipping/delivery, hand-over (take over) of equipment
- ☐ Installation works
- ☐ Operational training

- ☐ Other _____

Please see the details as per attached Project Monitoring Report (PMR).

Very truly yours,

**[*Signature*]**
[*Name of the signer*]
[*Title of the signer*]
[*Name of the executing agency*]

cc:

Director General
Financial Cooperation Implementation Department
Japan International Cooperation Agency
*[Address specified in the Article 5 of the Grant Agreement]*

# ***Project Monitoring Report***
# ***on***
# ***Project Name***
# ***Grant Agreement No. XXXXXXX***

20XX, Month

## Organizational Information

| | |
|---|---|
| **Signer of the G/A** (Recipient) | Person in Charge (Designation)<br>Contacts Address:<br>Phone/FAX:<br>Email: |
| **Executing Agency** | Person in Charge (Designation)<br>Contacts Address:<br>Phone/FAX:<br>Email: |
| **Line Ministry** | Person in Charge (Designation)<br>Contacts Address:<br>Phone/FAX:<br>Email: |

## General Information:

| | |
|---|---|
| **Project Title** | |
| **E/N** | Signed date:<br>Duration: |
| **G/A** | Signed date:<br>Duration: |
| **Source of Finance** | Government of Japan: Not exceeding JPY _____ mil.<br>Government of (_____): _____ |

## 1: Project Description

### 1-1 Project Objective

### 1-2 Project Rationale

- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

### 1-3 Indicators for measurement of "Effectiveness"

| **Quantitative indicators to measure the attainment of project objectives** | | |
|---|---|---|
| Indicators | Original (Yr ) | Target (Yr ) |
| | | |
| | | |
| | | |
| **Qualitative indicators to measure the attainment of project objectives** | | |
| | | |

## 2: Details of the Project

### 2-1 Location

| **Components** | **Original** *(proposed in the outline design)* | **Actual** |
|---|---|---|
| 1. | | |

### 2-2 Scope of the work

| **Components** | **Original*** *(proposed in the outline design)* | **Actual*** |
|---|---|---|
| 1. | | |
| | | |
| | | |
| | | |

Reasons for modification of scope (if any).

| |
|---|
| *(PMR)* |

**2-3 Implementation Schedule**

| Items | Original | | Actual |
|---|---|---|---|
| | *(proposed in the outline design)* | *(at the time of signing the Grant Agreement)* | |
| | | | |

Reasons for any changes of the schedule, and their effects on the project (if any)

| |
|---|
| |

**2-4 Obligations by the Recipient**

**2-4-1 Progress of Specific Obligations**

See Attachment 2.

**2-4-2 Activities**

See Attachment 3.

**2-4-3 Report on RD**

See Attachment 11.

**2-5 Project Cost**

**2-5-1 Cost borne by the Grant(<u>Confidential until the Bidding</u>)**

| Components | | | Cost (Million Yen) | |
|---|---|---|---|---|
| | Original *(proposed in the outline design)* | Actual *(in case of any modification)* | Original[1),2)] *(proposed in the outline design)* | Actual |
| | 1. | | | |
| | | | | |
| | | | | |
| Total | | | | |

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

**2-5-2 Cost borne by the Recipient**

| Components | | | Cost (1,000 Taka) | |
|---|---|---|---|---|
| | Original *(proposed in the outline design)* | Actual *(in case of any modification)* | Original[1),2)] *(proposed in the outline design)* | Actual |
| | 1. | | | |
| | | | | |
| | | | | |
| | | | | |

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

| |
|---|
| *(PMR)* |

**2-6 Executing Agency**

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

| |
|---|
| **Original** *(at the time of outline design)*<br>name:<br>role:<br>financial situation:<br>institutional and organizational arrangement (organogram):<br>human resources (number and ability of staff): |
| **Actual** *(PMR)* |

**2-7 Environmental and Social Impacts**

- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

## 3: Operation and Maintenance (O&M)

**3-1 Physical Arrangement**

- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

| |
|---|
| **Original** *(at the time of outline design)* |
| **Actual** *(PMR)* |

**3-2 Budgetary Arrangement**

- Required O&M cost and actual budget allocation for O&M

| |
|---|
| **Original** *(at the time of outline design)* |

| **Actual** *(PMR)* |
|---|
| |

## 4: Potential Risks and Mitigation Measures

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

**Assessment of Potential Risks** (*at the time of outline design)*

| Potential Risks | Assessment |
|---|---|
| 1. (Description of Risk) | Probability: High/Moderate/Low |
| | Impact: High/Moderate/Low |
| | Analysis of Probability and Impact: |
| | |
| | Mitigation Measures: |
| | |
| | Action required during the implementation stage: |
| | |
| | Contingency Plan (if applicable): |
| | |
| 2. (Description of Risk) | Probability: High/Moderate/Low |
| | Impact: High/Moderate/Low |
| | Analysis of Probability and Impact: |
| | |
| | Mitigation Measures: |
| | |
| | Action required during the implementation stage: |
| | |
| | Contingency Plan (if applicable): |
| | |
| 3. (Description of Risk) | Probability: High/Moderate/Low |
| | Impact: High/Moderate/Low |
| | Analysis of Probability and Impact: |
| | |
| | Mitigation Measures: |
| | |
| | Action required during the implementation stage: |
| | |

| | |
|---|---|
| | Contingency Plan (if applicable): |
| **Actual Situation and Countermeasures** | |
| (PMR) | |

## 5: Evaluation and Monitoring Plan (after the work completion)

### 5-1 Overall evaluation

Please describe your overall evaluation on the project.

| |
|---|
| |

### 5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

| |
|---|
| |

### 5-3 Monitoring Plan of the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

| |
|---|
| |

Attachment

1. Project Location Map
2. Specific obligations of the Recipient which will not be funded with the Grant
3. Monthly Report submitted by the Consultant

Appendix - Photocopy of Contractor's Progress Report (if any)
- Consultant Member List
- Contractor's Main Staff List

4. Check list for the Contract (including Record of Amendment of the Contract/Agreement and Schedule of Payment)
5. Environmental Monitoring Form / Social Monitoring Form
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final )only)
8. Pictures (by JPEG style by CD-R) (PMR (final)only)
9. Equipment List (PMR (final )only)
10. Drawing (PMR (final )only)
11. Report on RD (After project)

Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

| | Items of Specified Materials | Initial Volume A | Initial Unit Price (¥) B | Initial total Price C=A×B | 1% of Contract Price D | Condition of payment | |
|---|---|---|---|---|---|---|---|
| | | | | | | Price (Decreased) E=C－D | Price (Increased) F=C＋D |
| 1 | Item 1 | ●●t | ● | ● | ● | ● | ● |
| 2 | Item 2 | ●●t | ● | ● | ● | | |
| 3 | Item 3 | | | | | | |
| 4 | Item 4 | | | | | | |
| 5 | Item 5 | | | | | | |
| | | | | | | | |

2. Monitoring of the Unit Price of Specified Materials

(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

| | Items of Specified Materials | 1st ●month, 2015 | 2nd ●month, 2015 | 3rd ●month, 2015 | 4th | 5th | 6th |
|---|---|---|---|---|---|---|---|
| 1 | Item 1 | | | | | | |
| 2 | Item 2 | | | | | | |
| 3 | Item 3 | | | | | | |
| 4 | Item 4 | | | | | | |
| 5 | Item 5 | | | | | | |
| | | | | | | | |

(3) Summary of Discussion with Contractor (if necessary)

-
-
-

Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)
（Actual Expenditure by Construction and Equipment each）

| | | Domestic Procurement (Recipient Country) A | Foreign Procurement (Japan) B | Foreign Procurement (Third Countries) C | Total D |
|---|---|---|---|---|---|
| Construction Cost | | (A/D%) | (B/D%) | (C/D%) | |
| | Direct Construction Cost | (A/D%) | (B/D%) | (C/D%) | |
| | others | (A/D%) | (B/D%) | (C/D%) | |
| Equipment Cost | | (A/D%) | (B/D%) | (C/D%) | |
| Design and Supervision Cost | | (A/D%) | (B/D%) | (C/D%) | |
| Total | | (A/D%) | (B/D%) | (C/D%) | |

**The Project for Improvement of the Zai Water Supply System, Environmental Checklist**

| Category | Environmental Item | Main Check Items | Yes: Y<br>No: N | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures) |
|---|---|---|---|---|
| 1 Permits and Explanation | (1) EIA and Environmental Permits | (a) Have EIA reports been already prepared in official process?<br>(b) Have EIA reports been approved by authorities of the host country's government?<br>(c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?<br>(d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government? | (a) N<br>(b) N<br>(c) N<br>(d) N | (a) Since the Project does not fall under "Projects requiring Comprehensive/Preliminary EIA Report" as defined in Annex 2 and 3 of the Jordan Environmental Impact Assessment Regulations (EIA Regulations, 2005), no EIA report will be prepared by the executing agency (WAJ).<br>(b) Not applicable<br>(c) Not applicable<br>(d) No environmental permission required |
| | (2) Explanation to the Local Stakeholders | (a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders?<br>(b) Have the comment from the stakeholders (such as local residents) been reflected to the project design? | (a) N<br>(b) N | (a) It is not necessary to explain to local stakeholders because the Project replaces equipment and facilities only in the existing site.<br>(b) Not applicable |
| | (3) Examination of Alternatives | (a) Have alternative plans of the project been examined with social and environmental considerations? | (a) N | (a) Prioritization studies of the proposed coponents has already conduct insted of considering alternative plans. The impacts on the natural and social environment are minimal because all the components are implemented in the existing facilities. |
| 2 Pollution Control | (1) Air Quality | (a) Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Are any mitigating measures taken?<br>(b) Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards? | (a) N<br>(b) Y | (a) No air pollution due to chlorine is expected.<br>(b) Occupational safety standards of Jordan are adhered including the storage and injection facilities of chlorine. |
| | (2) Water Quality | (a) Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards? | (a) Y | (a) SS, BOD, COD, pH, etc. in the Wastewater meet the national environmental standards. Besides, organic pollution is evaluated by total organic carbon (TOC) instead of BOD and COD. |
| | (3) Wastes | (a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country's regulations? | (a) Y | (a) Sludge generated in the water treatment process in Zai WTP will be planned to dispose by MIYAHUNA. |
| | (4) Noise and Vibration | (a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards? | (a) Y | (a) Noise and vibration levels will be matched with the national environmental standards by mitigation measures. |
| | (5) Subsidence | (a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence? | (a) N | (a) Not applicable. The Project does not utilize any groundwater. |
| 3 Natural Environment | (1) Protected Areas | (a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas? | (a) N | (a) Forest stands designated as Zai National Parks are scattered in the vicinity, but their impact is not foreseen. |

| Category | Environmental Item | Main Check Items | Yes: Y<br>No: N | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures) |
|---|---|---|---|---|
| 3 Natural Environment | (2) Ecosystem | (a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?<br>(b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?<br>(c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?<br>(d) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms? | (a) N<br>(b) N<br>(c) N<br>(d) N | (a) Not applicable<br>(b) Not applicable<br>(c) Not applicable<br>(d) Not applicable |
| | (3) Hydrology | (a) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect surface water and groundwater flows? | (a) N | (a) Since there is no change in water intake volume, any adversely affect on hydrology will not be foreseen. |
| 4 Social Environment | (1) Resettlement | (a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?<br>(b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement?<br>(c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?<br>(d) Is the compensations going to be paid prior to the resettlement?<br>(e) Is the compensation policies prepared in document?<br>(f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?<br>(g) Are agreements with the affected people obtained prior to resettlement?<br>(h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?<br>(i) Are any plans developed to monitor the impacts of resettlement?<br>(j) Is the grievance redress mechanism established? | (a) N<br>(b) N<br>(c) N<br>(d) N<br>(e) N<br>(f) N<br>(g) N<br>(h) N<br>(i) N<br>(j) N | (a) No resettlement will occur in the Project.<br>(b) Not applicable<br>(c) Not applicable<br>(d) Not applicable<br>(e) Not applicable<br>(f) Not applicable<br>(g) Not applicable<br>(h) Not applicable<br>(i) Not applicable<br>(j) Not applicable |

**The Project for Improvement of the Zai Water Supply System, Environmental Checklist**

| Category | Environmental Item | Main Check Items | Yes: Y<br>No: N | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures) |
|---|---|---|---|---|
| 4 Social Environment | (2) Living and Livelihood | (a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?<br>(b) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses? | (a) N<br>(b) N | (a) There will be no adverse impact on residents' lives.<br>(b) The current water intake volume will not be changed. Besides, no new chemical injection or civil engineering work will be planned on the water source. So there is no impact on existing water use and water area use. |
| | (3) Heritage | (a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws? | (a) N | (a) There are no UNESCO-designated World Heritage sites inside or outside the project site. Also, there are no historical, culturally or religiously valuable heritages or historic sites designated by Jordanian law. In addition, there is also no heritage based on local customs or culture. |
| | (4) Landscape | (a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken? | (a) N | (a) There are no landscapes to consider at the project site. In addition, since this project will be carried out on the existing site, it is not expected |
| | (5) Ethnic Minorities and Indigenous Peoples | (a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples?<br>(b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected? | (a) N<br>(b) N | (a) Not applicable<br>(b) Not applicable |
| | (6) Working Conditions | (a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project?<br>(b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials?<br>(c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.?<br>(d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents? | (a) Y<br>(b) Y<br>(c) Y<br>(d) Y | (a) Jordan's domestic laws on working conditions will be respected and health and safety will be prioritized.<br>(b) Hard and soft safety considerations related to occupational accident prevention are thoroughly implemented.<br>(c) Training courses on safety education are kept implementing by MIYAHUNA.<br>(d) Safety measures are thoroughly enforced by MIYAHUNA. Furthermore, seculity guards are stationed. |
| 5 Others | (1) Impacts during Construction | (a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?<br>(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?<br>(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?<br>(d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts? | (a) Y<br>(b) N<br>(c) Y<br>(d) Y | (a) Mitigation measures for air pollution, vibration and noise will be prepared by MIYAHUNA<br>(b) No adverse effects on the ecosystem due to construction are expected.<br>(c) There is a slight possibility that an accident will occur due to traffic of construction vehicles. Mitigation measures will be prepared by MIYAHUNA as necessary.<br>(d) As traffic congestion is a little expected due to traffic of construction vehicles in the town area. Mitigation measures will be prepared by MIYAHUNA as occasion demands. |

**The Project for Improvement of the Zai Water Supply System, Environmental Checklist**

| Category | Environmental Item | Main Check Items | Yes: Y<br>No: N | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures) |
|---|---|---|---|---|
| 5 Others | (2) Monitoring | (a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?<br>(b) What are the items, methods and frequencies of the monitoring program?<br>(c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?<br>(d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities? | (a) Y<br>(b) –<br>(c) Y<br>(d) Y | (a) During construction, environmental monitoring for air quality and generation of noise and vibration will be conducted by the constructor.<br>(b) The monitoring method and frequency will be described in the monitoring form by the constructor.<br>(c) Under the supervision of MIYAHUNA, the monitoring system will be established.<br>(d) The constructor shall report the monitoring results to WAJ and MIYAHUNA periodically. |
| 6 Note | Reference to Checklist of Other Sectors | (a) Where necessary, pertinent items described in the Dam and River Projects checklist should also be checked. | (a) N | (a) Not applicable. Any civil works will not be conducted on the intake source. |
| | Note on Using Environmental Checklist | (a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming). | (a) N | (a) GHG emission is expected to reduce by 7.06 Mt-$CO_2$ per year after the Project implementation. |

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is located.

**Environmental management plan**

(1) Pre-/Construction phase

1) Air Quality

| Sources of Potential Impact | Relevant Standard | Objectives | Management Effort | Management Institution |
|---|---|---|---|---|
| ・Dust generated from construction activities<br>・Pollutant emissions from heavy machinery and trucks (e.g. Sox, Nox etc.) | ・National Ambient Air Quality Standards (Jordanian Standard 1140/2006) | ・Protection of social and biological environment from adverse impacts of dust and emissions.<br>・Ensuring compliance with emission limit values. | ・Water spraying will be applied in work sites for dust suppression.<br>・Speed limits will be applied for vehicles.<br>・Well maintained vehicles will be used. | ・Supervision: Miyahuna<br>・Implementation: Contractor |

2) Noise and Vibration

| Sources of Potential Impact | Relevant Standard | Objectives | Management Effort | Management Institution |
|---|---|---|---|---|
| ・Heavy machinery and trucks<br>・Work personnel transportation vehicles | ・Noise Level Control Regulation (year 2003). | ・Elimination of anxiety and inconvenience to the local population.<br>・Ensuring occupational health and safety.<br>・Protection of environment. | ・Works will be undertaken during the daytime.<br>・Noise control measures will be implemented.<br>・Health and safety management for workers will be implemented as necessary. | ・Supervision: Miyahuna<br>・Implementation: Contractor |

3) Waste

| Sources of Potential Impact | Relevant Standard | Objectives | Management Effort | Management Institution |
|---|---|---|---|---|
| ・Domestic waste<br>・Industrial and hazardous waste | ・Regulation concerning Solid Waste Management, No. 27 of 2005.<br>・Regulation of Harmful and Hazardous Waste Management, Transfer and Handling, No. 54 of 2002 and No.47 of 2008. | ・Protection of environment from adverse impacts of solid and hazardous waste. | ・Different types of waste (e.g. hazardous waste, domestic waste) will be collected and disposed of separately.<br>・Efforts will be made to have a contract with waste disposers licensed by MOE to collect and treat household wastes. | ・Supervision: Miyahuna<br>・Implementation: Contractor |

(2) Operation phase

1) Waste

| Sources of Potential Impact | Relevant Standard | Objectives | Management Effort | Management Institution |
|---|---|---|---|---|
| ・Domestic waste<br>・Industrial and hazardous waste | ・Regulation concerning Solid Waste Management, No. 27 of 2005.<br>・Regulation of Harmful and Hazardous Waste Management, Transfer and Handling, No. 54 | ・Protection of environment from adverse impacts of solid and hazardous waste. | ・Different types of waste (e.g. hazardous waste, domestic waste) will be collected and disposed of separately.<br>・Efforts will be made to have a contract with waste disposers licensed | ・Supervision: Miyahuna<br>・Implementation: Contractor |

| | | | | |
|---|---|---|---|---|
| | of 2002 and No.47 of 2008. | | by MOE to collect and treat household wastes. | |

(Source: JICA Survey Team)

## Environmental monitoring plan

(1) Pre-/Construction phase

| Significant Impact to be Monitored | | Air Quality | Noise and Vibration |
|---|---|---|---|
| Monitoring parameter | | (1) PM10, (2) $SO_2$, (3) $NO_2$ | Noise level |
| Monitoring method | Method of collecting and analyzing data | (1) Gravimetric method<br>(2) UV-Fluorescence method<br>(3) Colorimetric method | On-site by Sound-level meter (on-site measurement) |
| | Location | Deir Alla IPS, 4 Pumping Stations and the Zai WTP (total 6 sites) | |
| | Duration and frequency | Upon complaint | |
| Implementing organization | | Contractor | |
| Responsible organization | | Miyahuna | |
| Approx. cost (included in the construction fee) | | USD1,200/time (USD200×6 sites) | USD1,200/time (USD200×6 sites) |

| Significant Impact to be Monitored | | Waste | Odor |
|---|---|---|---|
| Monitoring parameter | | Discharge amount | Offensive odor |
| Monitoring method | Method of collecting and analyzing data | (1) Recording of discharge amount<br>(2) Visual investigation | On-site confirmation |
| | Location | Deir Alla IPS, 4 Pumping Stations and the Zai WTP (total 6 sites) | |
| | Duration and frequency | Monthly | |
| Implementing organization | | Contractor | |
| Responsible organization | | Miyahuna | |
| Approx. cost (included in the construction fee) | | USD600/time (USD100×6 sites, waste and odor package deal) | |

| Significant Impact to be Monitored | | Machinery Maintenance | Work Environment |
|---|---|---|---|
| Monitoring parameter | | Content of maintenance | Workers' health and safety |
| Monitoring method | Method of collecting and analyzing data | Recording of the maintenance | Observation and inspection |
| | Location | Contractor's office | All work places |
| | Duration and frequency | Continuous records (Monthly/Daily) | |
| Implementing organization | | Contractor | |
| Responsible organization | | Miyahuna | |
| Approx. cost (included in the construction fee) | | (Expenses to be included in contract cost by Contractor) | |

| Significant Impact to be Monitored | | Traffic Volume | Accidents |
|---|---|---|---|
| Monitoring parameter | | Vehicles and other equipment used for the transportation and construction work | (1) Number of traffic accidents<br>(2) Number of accidents (human and fire cases) |
| Monitoring | Method of collecting and | Record of numbers of cars being | Record of accidents |

| | | | |
|---|---|---|---|
| method | analyzing data | used | |
| | Location | Principal roads around Project site | Contractor's office |
| | Duration and frequency | Continuous records (Monthly/Daily) | |
| Implementing organization | | Contractor | |
| Responsible organization | | Miyahuna | |
| Approx. cost (included in the construction fee) | | (Expenses to be included in contract cost by Contractor) | |

(2) Operation phase

| **Significant Impact to be Monitored** | | **Waste** |
|---|---|---|
| Monitoring parameter | | (1) Sludge generation amount, (2) Sludge collection amount |
| Monitoring method | Method of collecting and analyzing data | (1) Recording of sludge generation amount from the Zai WTP<br>(2) Recording of sludge collection amount by the licensed waste disposers |
| | Location | The Zai WTP |
| | Duration and frequency | Continuous records (Monthly/Daily) |
| Implementing organization | | Miyahuna |
| Responsible organization | | Miyahuna |
| Approx. cost | | (Expenses are to be included in the cost of personnel in charge of Miyahuna) |

(Source: JICA Survey Team)

## Monitoring form

### I. Construction phase

#### i. Air Quality

**(a) $SO_2$**

| Location | Date | 24 hours average | National standard | WHO Guideline |
|---|---|---|---|---|
| | / / | ppm | 0.14 ppm (24 hours average) | 20 μg $m^{-3}$ (Interim-Target -3, 24 hours average) |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |

**(b) $NO_2$**

| Location | Date | 1 hour average | National standard | WHO Guideline |
|---|---|---|---|---|
| | / / | ppm | 0.21 ppm (1 hour average) | 200 μg $m^{-3}$ (1 hour average) |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |

**(c) PM10**

| Location | Date | 24 hours average | National standard | WHO Guideline |
|---|---|---|---|---|
| | / / | ppm | 150 ppm (24 hours average) | 120 μg $m^{-3}$ (Interim-Target -1, 24 hours average) |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |

**(d) PM2.5**

| Location | Date | 24 hours average | National standard | WHO Guideline |
|---|---|---|---|---|
| | / / | ppm | 65 ppm (24 hours average) | 75 μg $m^{-3}$ (Interim-Target -1, 24 hours average) |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |

### ii. Ambient Noise Level

| Time | | Location |
|---|---|---|
| From | To | |
| | | |
| | | |
| | | |
| | | |

**Reference Value: National Standards of Ambient Noise***

| Category of Area | Limits in dB (A) Leq | |
|---|---|---|
| | Day time (6 AM - 8 PM) | Night time (8 PM - 6 AM) |
| Residential Area (urban area) | **60** | 50 |
| Residential Area (suburb area) | **55** | 45 |
| Residential Area (rural area) | **50** | 40 |

* Article (4) of the Standards for the Prevention and Elimination of Noise (2003)

### iii. Waste with Odor

Date……

| Location | Discharge amount | | Rate of recycle/Reuse | |
|---|---|---|---|---|
| | Industrial (ton) | Domestic (kg) | Industrial (%) | Domestic (%) |
| | | | | |
| Odor | □ Acceptable | | □ Not-acceptable | |

### iv. Record of machinery maintenance

| Date | Machinery name | ID No. | Content of maintenance |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

### v. Disturbance to Existing Social Infrastructure and Services

Traffic volume (vehicles and others used for the transportation and construction work)

| Date | Location | Start time | End time | Weather |
|---|---|---|---|---|
| / / | | : | : | |

| Traffic | Tally |
|---|---|
| Bicycle | |
| Motorcycle | |

| Traffic | Tally |
|---|---|
| Articulated lorry | |
| Bus/Coach | |

| | | | |
|---|---|---|---|
| Car | | Construction vehicle | |
| Van/Pick-up | | Farm vehicle | |
| Small lorry | | Other | |

**vi. Work Environment (daily and monthly)**

Monitor record of trainings on health and safety, observation and inspection on site, workers' health condition and medical check-ups' record, number of accidents and their working hours

_____

_____

_____

**vii. Accidents Record**

**(a) Number of traffic accidents**

_____

**(b) No. of accidents (human and fire cases)**

_____

**(c) Record of accidents**

- Date & Time:_____
- Location:_____
- Accident details:_____

_____

**II. Operation stage**

**i. Work Environment and Accidents**

**(a) Check of cautionary signs placed on required points on site**

- _____
- _____
- _____

**(b) Record of accidents**

- Date & Time:_____
- Location:_____
- Accident details:_____

_____

**Replacement Plan of Pump and Motor for Zai Water Supply System**

○ : Equipment to be replaced
□ : Equipment not to be replaced

**1) Replacement equipment based on survey results**

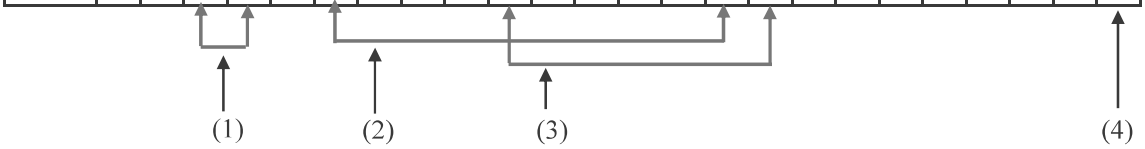
| PS | IPS | | | | PS1 | | | | PS2 | | | | PS3 | | | | PS4 | | | | PS5 | | | | Total No. of Sets |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| Pump | ○ | ○ | ○ | | ○ | | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | | 18 |
| Motor | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | | | | | | | ○ | ○ | ○ | ○ | 16 |

**Comment of the above replacement plan**

The new pump and new motor are recommended to installed and used by pair as the pump manufacturer can guarantee the operation totally.

**2) Examination of motor replacement method**

| PS | IPS | | | | PS1 | | | | PS2 | | | | PS3 | | | | PS4 | | | | PS5 | | | | Total No. of Sets |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| Pump | ○ | ○ | ○ | | ○ | | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | | |
| Motor | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | | | | | | | ○ | ○ | ○ | ○ | 4 |




**Preparation Work by Jordanian Side**

(1) Interchange IPS No. 4 Motor and IPS No. 3 Motor.
(2) Interchange PS1 No. 2 Motor and PS3 No. 3 Motor.
(3) Interchange PS2 No. 2 Motor and PS3 No. 4 Motor.
(4) Replace PS5 No. 4 motor with spare motor owned by Miyahuna.

**3) Final replacement plan**

| PS | IPS | | | | PS1 | | | | PS2 | | | | PS3 | | | | PS4 | | | | PS5 | | | | Total No. of Sets |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| Pump | ○ | ○ | ○ | | ○ | | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | ○ | | ○ | ○ | ○ | ○ | ○ | | 18 |
| Motor | ○ | ○ | ○ | | ○ | | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | | | | | ○ | ○ | ○ | | 15 |

**Replacement Work by Japanese Side**

(1) Replacement of 3 sets of intake pump and motor
(2) Replacement of 9 sets of raw water pump and motor with new ones
(3) Replacement of 3 raw water pumps (PS4) with new ones
(4) Replacement of 3 sets of transmission pump and motor with new ones

# TECHNICAL NOTES
# ON
# THE PREPARATORY SURVEY
# FOR
# THE PROJECT FOR THE IMPROVEMENT OF THE ZAI WATER SUPPLY SYSTEM

Based on the Minutes of Discussions (hereinafter referred to as "M/D") on the Preparatory Survey for the Project for the Improvement of the Zai Water Supply System (hereinafter referred to as "the Project") signed on 15th July, 2019 between the Preparatory Survey Team (hereinafter referred to as "the Team") of Japan International Cooperation Agency (hereinafter referred to as "JICA") and the Government of the Hashemite Kingdom of Jordan (hereinafter referred to as the "Jordanian Government"), the consultant members of the Team had a series of discussions and conducted field surveys from 7th July to 2nd September, 2019.

As a result of the discussions and the surveys, both sides confirmed the technical conditions described as per attached.

Amman, 28th August, 2019

Yoshikata Kubosaki
Chief Consultant,
Preparatory Survey Team,
Japan

Iyad Dahiyat
Secretary General,
Water Authority of Jordan,
Ministry of Water and Irrigation,
The Hashemite Kingdom of Jordan

Ghazi Khaleel
CEO,
Jordan Water Company/ Miyahuna,
The Hashemite Kingdom of Jordan

Eng. Salameh Mahasneh

# ATTACHMENT

Both parties agreed on and confirmed the following items:

## 1. Requested components by Jordanian Government

The requested components by Jordanian Government are as follows:

- Renewal of 18 pumps and 16 motors at the intake Pump Station (IPS), raw water PS (PS1-4) and transmission PS (PS5)
- Renewal of chemical feeding facilities
- Repair of raw water main pipe etc. at raw water pump stations
- Renewal of travelling screens
- Rehabilitation of grit settling basins
- Enhancement of Sludge dewatering system
- Soft component

## 2. Results of the survey and proposal for replacement and/or repair on the items requested by Jordanian Government

2.1 Renewal of 18 pumps and 16 motors at the intake PS (IPS), raw water PS (PS1-4) and transmission PS (PS5)

[Results of the survey]
6 of the 24 pumps and 8 of the 24 motors have been replaced by Miyahuna. The remaining 18 pumps and 16 motors are deteriorated. In addition to replacement of the pumps, measures to protect pump material from chemicals are required since the raw water with high chloride ions is injected with chlorine dioxide and potassium permanganate after the intake pump. 3 control valves and 4 check valves are deteriorated in PS5.

[Proposal]

Three intake pumps are required to be upgraded with cast stainless steel (SCS13) for impellers, and all 12 booster pumps are required to be upgraded with duplex stainless steel. All 16 motors are required to be replaced with those of the existing specifications. Three transmission pumps will be evaluated by experts, including the actual usage, and will be considered as to what kind of plans can be considered under the condition that they are installed in the current pump house. Some of these pumps and motors were installed more than 20 years ago, and their renewal is long over due. 3 control valves and 4 check valves are required to be replaced in PS5.

Such renewal is expected to reduce energy consumption equivalent to approximately 3.2 million JOD per year.

2.2 Renewal of chemical feeding facilities

Various chemicals are applied in Zai water supply system. (Deir Alla intake pump station and Zai water treatment plant). Regarding all chemicals used in this system, the dosing order is well considered, and dosing rate is determined by regular water analysis.

2.2.1 In Deir Alla intake station, chlorine dioxide and potassium permanganate are dosed into lifting pipeline. They are both strong oxidant with properties of no generating Trihalomethane. The details are given in Appendix-1.

2.2.2 In Zai WTP, the powdered activated carbon (PAC) is dosing at the inlet regulating basin, and ferrous sulfate and polymer, ferric sulfate with polymer are dosing at a rapid mixing. The details are given in Appendix-1.

2.2.3 Chlorine dioxide generators

[Results of the survey]
Chlorine dioxide is manually injected due to the ageing of devices and malfunction of self-adjustable valves. Since one of the three generators is now out of order, the chlorine dioxide generation is being done with the remaining two generators without any standby. The injection rate reaches maximum in the case of high turbidity.

[Proposal]
All the three generators are required to be replaced as they are aged but they are essential for water treatment processing. The generators are required to be replaced by the ones with higher injection rate than existing since the injection rate has reached the maximum level and it is impossible to cope with further worsening of raw water quality by the generators of present injection rate. It is required to be replaced immediately.

2.2.4 Sodium chlorite solution device

[Results of the survey]
The sodium chlorite solution device is aged. Sodium chlorite powder of 80% concentration is dissolved into water to form 25% solution. As powder sodium chlorite has a risk of explosion when it comes into contact with reducing agent or organic substance, careful handling is required for this chemical during transportation, stock and dissolving. Considering the request from Miyahuna, use of sodium chlorite liquid is required.

[Proposal]
The existing equipment could be used, but replacement of piping will be required for sodium chlorite liquid. It is required to be replaced with Chlorine Dioxide Generators at the same time.

2.2.5 Powdered activated carbon injection facility

[Results of the survey]
The existing powered activated carbon injection facility is deteriorated. Two facilities are working without any standby. The activated carbon is sent and injected into the inlet of the raw water regulating basin located at 30m away from the powdered activated carbon injection facility building. As the injection pipes (HDPE) often gets clogged with activated carbon, it is required to replace the injection pipes every 2 or 3 weeks.

[Proposal]
The existing three aged facilities including one standby are required to be replaced and a new building is required to be constructed nearby the inlet of the raw water regulating reservoir to install the three facilities. From this measure, reliable injection can be achieved by avoiding the clogging in the injection pipes. It is required to be replaced immediately.

2.2.6 Chlorine injection facility (1985)

[Results of the survey]
The facility is deteriorated, and two main equipment and one evaporator installed in 2000 have now malfunction. Thus, only the standby equipment is working.

[Proposal]
Three main equipment (including 1 standby) and one evaporator are required to be replaced as disinfection is an important water treatment process. It is required to be replaced immediately.

2.2.7 Chlorine injection facility (1999)

[Results of the survey]
One of the two lines is out of use due to malfunction of the chlorine gas header pipe. Two evaporators in 2000 have now malfunction.

[Proposal]
The existing chlorine gas header pipe and two evaporators are required to be replaced, and spare parts are required to be supplied. Disinfection is an important water treatment process. It is required to be replaced immediately.

2.2.8 Ferric sulfate injection facility

[Results of the survey]
There are no spare pumps.

[Proposal]
Spare pumps are required to be installed for injecting ferric sulfate into the injection point of each line. It is required to be replaced immediately.

2.2.9 Potassium permanganate feeding system

[Results of the survey]
Over 20 years have passed, the facility is deteriorated.

[Proposal]
Two injection pumps (including one standby) and three dissolution tanks are required to be replaced with new ones of the same specification as existing. This facility complements the chlorine dioxide injection facility by reducing excessive injection of chlorine dioxide, which helps reduce generation of disinfection by-products of chlorous acid. This facility has function of reducing the unusual odor and tastes by oxidization of organic matters, and also suppresses the generation of disinfection by-products. It is required to be renewed within a few years.

2.2.10 Ferrous sulfate injection facility

[Results of the survey]
Weighing and dissolving equipment have been working without problems due to regular inspection, but there are no spare parts. In addition, the injection pump is aging.

[Proposal]
Injection pumps are required to be replaced with new ones having same capacity as existing, and spare parts are required to be supplied.

2.3 Repair of raw water main pipe etc. at raw water pump stations

[Results of the survey]
Currently, the end cap of the discharge header pipe is repaired by the Miyahuna. Regarding the end cap portion of discharge header pipe, the current repair seems to be insufficient for the water hammer pressure.

[Proposal]
By reinforcing or improving the end cap of the discharge header pipe, it is possible to prevent the booster and transmission pump station from stopping. It is required to be improved immediately.

2.4 Renewal of travelling screens

[Results of the survey]
There are four traveling screens, but one is out of order and cannot be operated. The remaining three have become aged and trouble occurred frequently.

[Proposal]
Four aging screens are required to be replaced with new ones of the same specification as of existing.

2.5 Rehabilitation of grit settling basins

[Results of the survey]
Two basins are out of use due to deterioration of reinforced concrete structures. At present, only two basins are in operation. However, turbidity reduction effect is confirmed even when two basins are in operation.

[Proposal]
There are two proposals. One is to construct two new basins at the same place after dismantling the two deteriorated basins. The other is to construct two new basins after intake and just before the intake pump station at a land lot to be acquired. The size of basins is estimated at 22m wide x 59m long x 5m deep for two basins capacity. Grid settling basin has effect to remove almost all sand or silt except for fine colloidal particles. If turbidity is defined as colloidal particle concentration, turbidity removal effect would not be expected so much.

2.6 Sludge drying beds

[Results of the survey]
Twelve drying beds are working only in summer, but not in winter due to less drying effect in winter. Lack of enough drying beds forces sludge water to drain outside. It is desirable to process sludge inside the plant. The Team confirmed that sludge at the Zai WTP is no environmental and legal problem in Jordan.

[Proposal]
There are two plans for improvement of sludge drying process; one is construction of new sludge thickeners and additional drying beds, while the other is construction of new thickeners and new pressure dewatering equipment. The former requires construction of about 130 drying beds as the same size as exiting one and securing a large land lot within or near the plant. (The Team estimated about 130 drying beds based on the current sludge amount. It might be difficult to secure a large land lot.) The latter requires the installation of pressure dewatering equipment inside the plant.

2.7 Soft component

The Team explained that it will examine the necessity and possibility of technical assistance such as a soft component and then will inform its results.

**3. Results of the survey and necessary replacement and/or repair of the other relevant items**

The Team also surveyed the other relevant items mentioned below. The details are given in Appendix-2.

- Water treatment plant
  - Rapid sand filter (1985)
  - Rapid sand filter (1999)
  - Sedimentation basin (1985)
  - Air scour blowers
  - Backwash water tank
  - Backwash water recovery pumps

- Electrical Facilities
  - Monitoring control equipment (PLC system) and Data logger system
  - Telemeter systems

- Laboratory equipment

**4. Priorities of the candidate items to be considered by the Government of Japan**

The following criteria have been considered in prioritizing of the replacement/repair plans of items (Appendix-2).

- Renewal/repair effects (Benefits of facility renewal/repair)
- Risks of deteriorating raw water quality and decreasing water production due to malfunctioning of facilities, if unattended (Risks of system stopping and water quality degradation)
- Maintenance cost reduction (Improvement of financial conditions of Miyahuna)
- Energy consumption reduction effect (Reduction of power consumption)

The Team explained that the final scope of the Project will be decided by the Japanese Government with due consideration of benefit and budget. The Jordanian Government agreed to it.

**5. Other relevant survey results**

5.1 Examination on the cause of corrosion/erosion of raw water pumps (PS1 to PS4)

The casing interior seems being corroded and cavitation erosion is found on the impeller. In addition, the impeller ring and casing ring have been worn out possibly due to silt. For the detail of cause and measures, refer to the attached Appendix-3.

5.2 Water Quality (Raw Water Quality of King Abdullah Canal)

Based on the monitoring data provided by Miyahuna, the Team has analyzed the data to grasp the current condition and recent trend of raw water quality of King Abdullah Canal (KAC). The summary refers to the attached Appendix-4 and 5.

The Team judged based on the above analytical results that it was necessary to continuously study the impact of the raw water quality on the water supply system, and requested Miyahuna to periodically monitor water qualities at the intake point at KAC, settling basin and WTP until January 2020. Miyahuna agreed to it.

**6. Operation and maintenance (O&M)**

The O&M is executed in systematic and effective manner using a computer program such as CMMS (Computer Maintenance Management System). Therefore, the Project does not require the technical assistance for O&M. However, in the field of water treatment process such as a chemical injection, technical assistance may be required. The Team will examine its possibility in Japan and inform the

result later.

**7. Environmental and Social Consideration**

In accordance with the JICA Guidelines for Environmental and Social Considerations (April 2010), the Team has developed the scoping draft (Appendix-6), and concluded tentatively that implementation of the Project would not have serious impacts on natural and social environment around the Project site because it is basically aiming at replacement/repair of water treatment facilities only in the existing properties. However, it is necessary to pay enough attention to preventions of air pollution, noise and vibration, discarded wastes and traffic/work related accidents. Based on the results of the study, the Team will prepare an initial environmental examination (IEE) level report for Category B project in accordance with JICA form at the end of October 2019 and send it to WAJ. WAJ will submit it with a specific application to Ministry of Environment to review and classify in categories by the Technical Committee. After that, the Jordanian Government will conduct the necessary procedure concerning the environmental assessment and make environmental impact assessment (EIA) or IEE report of the Project. The EIA/IEE approval shall be received from the responsible authorities and submitted to JICA by the end of March 2020 as per Minutes of Discussion of 15 July 2019.

**8. Tax exemption**

Both parties confirmed that all taxes, duties and levies applicable to goods and services to be rendered in relation with the Project are exempted, and the exemption process will be completed in advance. For tax exemption, it is needed that the Cabinet Letter is issued by Jordanian Government indicating that tax exemption is applicable to the Project.

**9. Third countries procurement**

The Team explained that some equipment may be procured from third countries. The Jordanian Government agreed to it.

**10. Sustainable Use**

For sustainable use of the facilities, Miyahuna and WAJ are required to prepare funds for the next major renovation/rehabilitation.

**The contents of this Technical Notes might be changed subject to results of further analysis in Japan and discussions with JICA.**

## Appendix-1 Chemicals in Zai Water Supply System

| Location | Chemical | Function | Dosing point | Dosing rate (mg/L) |
|---|---|---|---|---|
| Deir Alla IPS | Chlorine dioxide | Disinfectant<br>Oxidant | Pipeline to PS1 | 1 to 3.0 |
| | Potassium permanganate | oxidant | Pipeline to PS1 | 1.5 to 3.0<br>Not always |
| Zai WTP | PAC | absorbent | Inlet recovery basin | 5.0 to 35 |
| | Ferrous sulfate | Coagulant<br>reductant | Rapid Mixing basin | 1.0 to 10<br>Not always |
| | Ferric sulfate | Coagulant | Rapid Mixing basin | 10 to 50 |
| | Cationic polymer 1<br>Con. 4% | Coagulant aid | Rapid Mixing basin or Flocculation basin | 0.5 to 5.0 |
| | Cationic polymer 2<br>Conc. 2% | Filter aid | Filter inlet channel | 0.2 to 3.0 |
| | Chlorine | Disinfection | Filter inlet channel | 0.5 to 2.5 |
| | | | Filter outlet basin | 0.1 to 1.0 |

## Appendix-2 Priorities of the candidate items

| Priorities | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Priorities (Jordanian side) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 12 |
| Component | Replacement of 18 pumps and 16 motors at intake, raw water and transmission pump stations | Replacement of 4 traveling screens | Reinforcing end cap of header pipe in P.S. 1-5 | Replacement of Chlorine Dioxide Generators | Replacement of Sodium Chlorite Solution Device | Replacement of powdered activated carbon injection facility, and construction of a new building | Replacement of Chlorine injection facility (1985) | Replacement of chlorine injection facilities (1999) | Provision of Spare Pumps for ferric sulfate injection facility | Renewal of Monitoring and control equipment (PLC system) and Data logger system | Replacement of 2 grit settling basins |
| Current Status | 6 of the 24 pumps and 8 of the 24 motors have been replaced by Miyahuna. The remaining 18 pumps and 16 motors are deteriorated. In addition to replacement of the pumps, measures to protect pump material from chemicals are required since the raw water with high chloride ions is injected with chlorine dioxide and potassium permanganate after the intake pump. 3 control valves and 4 check valves are deteriorated in PS5. | There are four traveling screens, but one is out of order and cannot be operated. The remaining three have become aged and trouble occurred frequently. | There was an accident where the end plate of the end cap part of the discharge header pipe came off due to water hammer pressure in 3 of 5 pumping stations. Currently, the end cap of the discharge header pipe is repaired by the Miyahuna. Regarding the end cap portion of discharge header pipe, the current repair seams to be insufficient for the water hammer pressure. | The chlorine dioxide generators were added by the expansion project in 1999 due to the sterilization of nematodes. Chlorine dioxide is manually injected due to the ageing of devices and malfunction of self-adjustable valves. Since one of the three generators is now out of order, the chlorine dioxide generation is being done with the remaining two generators without any standby. The injection rate reaches maximum in the case of high turbidity. | The sodium chlorite solution device was installed at the same time as the chlorine dioxide generators and is aged. Sodium chlorite powder of 80%~ concentration is dissolved into water to form 25% solution. As powder sodium chlorite has a risk of explosion when it comes into contact with reducing agent or organic substance, careful handling is required for this chemical during transportation, stock and dissolving. Considering the request from Miyahuna, use of sodium chlorite liquid is required. | The existing powered activated carbon injection facility was installed in 1985. It is deteriorated. Two facilities are working without any standby. The activated carbon is sent and injected into the inlet of the raw water regulating basin located at 30m away from the powdered activated carbon injection facility building. As the injection pipes (HDPE) often gets clogged with activated carbon, it is required to replace the injection pipes every 2 or 3 weeks. | It has been 34 years since the facility was installed in 1985. The facility is deteriorated. One of the two lines is out of use due to malfunction of the chlorine gas header pipe. Two evaporators in 2000 have now malfunction. | The facility originally installed in 1985 is not used, but the facility additionally installed in 1999 is used. For the two pumps including one spare in additionally installed facility, there are no standby pumps because one pump injects ferric sulfate into the line of year 1985 and another pump injects ferric sulfate into the line of year 1999. | About 20 years have passed since the start of operation of the water treatment plant facilities and the monitoring operation control system of pump facility. The device of equipment has failed due to aging, and there is a possibility that it leads the system to stop. PLC for some facilities is broken, and it is in the state that the control is not performed automatically. | The existing grit settling basin was originally designed to operate three basins and keep one basin as a standby, but two basins are out of use due to deterioration of reinforced concrete structures. At present, only two basins are in operation. However, turbidity reduction effect is confirmed even when two basins are in operation. |
| Renewal/repair effects | Three intake pumps are required to be upgraded with cast stainless steel (SCS13) for impellers, and all 12 booster pumps are required to be upgraded with duplex stainless steel. All 16 motors are required to be replaced with those of the existing specifications. Three transmission pumps will be evaluated by experts, including the actual usage, and will be considered as to what kind of plans can be considered under the condition that they are installed in the current pump house. 3 control valves and 4 check valves are required to be replaced in PS5. It is an indispensable facility for water supply system and its renewal effect is high. | Four aging screens are required to be replaced with new ones of the same specification as of existing, and the renewal effect is high. | By reinforcing or improving the end cap of the discharge header pipe, it is possible to prevent the booster and transmission pump station from stopping. The renewal effect is high. | All the three generators are required to be replaced as they are aged but they are essential for water treatment processing. The generators are required to be replaced by the ones with higher injection rate than existing since the injection rate has reached the maximum level and it is impossible to cope with further worsening of raw water quality by the generators of present injection rate. The renewal effect is high. | The existing equipment could be used, but replacement of piping will be required for sodium chlorite liquid. Renewal effect is high. | The existing three aged facilities including one standby are required to be replaced and a new building is required to be constructed nearby the inlet of the raw water regulating reservoir to install the three facilities. From this measure, reliable injection can be achieved by avoiding the clogging in the injection pipes. High renewal effect is anticipated. | Three main equipment (including 1 standby) and one evaporator are required to be replaced as disinfection is an important water treatment process. The renewal effect is high. | The existing chlorine gas header pipe and two evaporators are required to be replaced, and spare parts are required to be supplied. Disinfection is an important water treatment process. The renewal effect is high. | Spare pumps are required to be installed for injecting ferric sulfate into the injection point of each line. Aggregation is an important process for water treatment in Zai WTP, and the renewal effect is high. | The PLC cannot be partially upgraded, so the entire system is required to be upgraded. The software of monitoring is old. Automatic operation and remote control of equipment are important for the Zai water supply system, and the upgrade effect is high. | There are two proposals. One is to construct two new basins at the same place after dismantling the two deteriorated basins. The other is to construct two new basins after intake and just before the intake pump station at a land lot to be acquired. The size of basins is estimated at 22m wide x 59m long x 3m deep for two basins capacity. Grid settling basin has effect to remove almost all sand or silt except for fine colloidal particles. If turbidity is defined as colloidal particle concentration, turbidity removal effect would not be expected so much. The renewal effect of grit settling basins is moderate. |
| Risks of deteriorating raw water quality and decreasing water production due to malfunctioning of facilities, if unattended | Currently, there is no stand-by pump at any pump station, and if one pump stops, the water supply of the whole water supply system will drop to 3/4. Therefore, it is essential that all pumps are always operational. The motor can has a heat accident of the winding. There is a high risk of a decline in water supply capacity due to malfunction. Some of these pumps and motors were installed more than 20 years ago, and their renewal is long over due. | If the traveling screen malfunctions, the inside of the intake pump gets damaged and raw water pump becomes clogged and operation becomes impossible. And it takes time to disassemble and repair the pump, and the raw water system is stopped for a long time. There is a high risk of a decline in water supply capacity due to malfunction. Two of the four units have been over 34 years old and the renewal period has already passed. | Improving the reliability of the discharge header pipe is important issue because the water supply system is stopped when the end cap of the discharge header pipe is broken due to water hammer pressure. In addition, since the repair of the present end cap part is an emergency measure, it is required to be improved immediately. | Without the chlorine dioxide generators, it has a loss of performance of inactivation of nematodes and cryptosporidium and reduction of algae, organic substances and unusual odor and taste. The risk of decreasing water supply amount is high. It is required to be improved immediately. | Without renewal of the facility, it might cause inability of generation of chlorine dioxide. There is a large risk of water supply capacity decline due to malfunction. It is required to be replaced with Chlorine Dioxide Generators at the same time. | Without injection of activated carbon, it becomes impossible to adsorb and remove Trihalomethane precursors, ammoniacal nitrogen, and unusual odor and taste substances in raw water, and the water treatment process is forced to be suspended. There is a high risk of a decline in water supply capacity due to malfunction. It is required to be improved immediately. | Chlorine is injected as a disinfection facility. If the facility has a trouble, it is obliged to be stopped. There is a high risk of lowering water supply capacity. It is required to be improved immediately. | Since chlorine gas is injected as a disinfectant, there is a high risk of reduction of water supply capacity due to the malfunction of the facility. It is required to be replaced within a few years. | Since ferric sulfate is injected as a coagulant and the aggregation process does not work well in the absence of a coagulant, there is a high risk of water supply capacity decline due to the facility malfunction. It is required to be replaced immediately. | If this system can't operate, automatic operation of the machine, operation of the central integrated monitoring panel and monitoring function are stopped. The risk of water supply capacity loss is high. It is required to be renewed within a few years. | In case that the existing grit settling basin is completely out of order, the Zai WTP needs to process the raw water with high turbidity more often, and it causes a risk of water supply capacity decline. However, the existing two basins are working. The risk of reduction of water supply amount is moderate. |
| Maintenance cost reduction | By renewing old pumps and motors, it is expected to reduce electricity costs by about 3.2 million JOD per year. By using a pump made of a material that is wear resistant and corrosion resistant, durability is improved and maintenance costs can be significantly reduced. | Since the proposed new screen is the same as the current screen, there is no cost reduction effect. | Currently, the end cap portion of the discharge header pipe is repaired by Miyahuna. The maintenance requirement is reduced. | Since automatic injection based on the residual chlorine dioxide concentration can be done, the injection amount can be easily adjusted. Adequate injection will reduce maintenance cost. | Changing to liquid sodium chlorite (effective concentration 31.5%) increases chemicals cost by about 30%, but personnel cost reduction is anticipated because of easier handling of liquid than powder. | Maintenance cost reduction is anticipated, but its effect is low. | Maintenance cost reduction is anticipated, but its effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction is anticipated, but its effect is low. | The water supply system is currently operated manually due to PLC failure. It is possible to reduce the associated labor costs with automatic operation of equipment. | Expansion of new grit settling basins will increase Sludge removal cost including personnel cost. |
| Energy consumption reduction effect | Renewing old pumps and motors is expected to reduce energy consumption equivalent to approximately 3.2 million JOD per year. | No energy saving effect is anticipated because required power is unchanged. | Not Applicable | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | The power use for automatic operation but it is minor. | No energy saving effect is anticipated because power is not use. |
| Soft Component (Technical Assistance) | Not Applicable | Not Applicable | Not Applicable | Strengthening operation and maintenance of water supply system (Control of chemical injection; Optimum injection rate of chlorine dioxide to fluctuating turbidity in raw water) | Strengthening operation and maintenance of water supply system (Control of chemical injection; Optimum usage of sodium chlorite) | Strengthening operation and maintenance of water supply system (Control of chemical injection; Optimum injection rate of powdered activated carbon) | Strengthening operation and maintenance of water supply system (Control of chemical injection; Optimum injection rate of chlorine) | Strengthening of operation and maintenance of water treatment plant in terms of control of chemical injection (Optimization of injection rate of chlorine) | Strengthening operation and maintenance of water supply system (Control of chemical injection; Optimum injection rate of ferric sulfate) | Strengthening of operation and maintenance of water supply system in terms of monitoring system (How to change the setting of PLC program, Practical maintenance method for troubles) | Strengthening of operation and maintenance of water quality management (Efficient operation method of grit settling basins) |

5-9

## Appendix-2 Priorities of the candidate items

| 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 14 | 10 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| Replacement of potassium permanganate feed system | Enhancement of Sludge dewatering system | Renewal of Telemeter systems (Wireless communication network) | Provision of Spare 4 Pumps for Sedimentation basin (1985) | Renewal of Air scour blowers | Repair of devices such as valves (1985) for Rapid sand filter | Provision of Pump and Spare parts for ferrous sulfate injection facility | Replacement of Backwash water tank | Provition of New Laboratory equipment | Repair of devices such as valves (1999) for Rapid sand filter | Renewal of 2 Backwash water recovery pumps |
| The potassium permanganate facility was installed in 1999 at the same time as the chlorine dioxide generators. As well as restraining Trihalomethane generation and decreasing unusual odor & taste, it is a complementary facility to restrain excessive generation of chlorous acid by chlorine dioxide. Over 20 years have passed, the facility is deteriorated and used only 4-5 times in winter. | Twelve drying beds are working only in summer, but not in winter due to less drying effect in winter. Lack of enough drying beds forces sludge water to drain outside. It is desirable to process sludge inside the plant. The Team confirmed that sludge at the Zai WTP is no environmental and legal problem in Jordan. | The telemeter equipment performs a remote monitoring operation of the integrated monitoring operation panel of the Zai water treatment plant and the monitoring operation panel of each pumping station. It stops frequently during the rainy season. Currently, a buried cable is used for signal transmission. When it stops, the staff are communicating by their cell phone for monitoring and operation. | 34 years have passed since the traveling bridge was installed in 1985.Overhaul of the reduction gear and replacement of parts have been done. Sludge water drawing pumps are severely deteriorated including inside casing. If drawing sludge water is not performed well, it causes trouble in operation of the settling basins. The facilities are aged, but it is working. | 34 years have passed since their installation in 1985, but the pumps have been inspected and found operating well. It is a time to be replaced from the mechanical point of view. | 34 years have passed since their construction, and rubber seats of many valves have deteriorated and water leakage has occurred. Air scouring is not done uniformly. The filter media is inspected once every year, but the underdrain system has not been inspected so far, so it is required to be inspected. Since PLC is broken, wash procedure cannot be performed automatically. | The ferric sulfate injection facility installed in 1985 is used as the ferrous sulfate injection facility as a substitute. When raw water quality deteriorates and chlorine dioxide injection rate is increased, the facility reduces chlorous acid generation converting it to harmless chloride. Since the ferrous sulfate is easily oxidized to ferric sulfate when stored for a long period, duration of storage is limited. Weighing and dissolving equipment have been working without problems due to regular inspection, but there are no spare parts. In addition, the injection pump is aging. | The Backwash water tank is steel tank, and 34 years have passed after its installation in 1985. It is still in use by regular inspection but has reached the time for replacement. | The analytical equipment for water quality tests are requested by Process Lab, Drinking Water Chemical Lab and Drinking Water Micro Lab in Zai WTP. The laboratories possess several decrepit equipment, but there are no significant failures or shortages that hinder normal operations for water quality inspection at the present, and current operational status doesn't matter. | 20 years have passed since their construction in 1999, and rubber seats of many valves have been deteriorated and water leakage has occurred. The filter media is inspected once a year, but the underdrain system has not been inspected so far, so it is required to be inspected. | All washing drains flow into a common recovery basin built in 1999. After suspended solids are settled and separated, the sludge is returned to the raw water regulating basin by these pumps. There are 2 pumps each for phase-1 and phase-2 units, but pumps of phase-2 are out of order. |
| Two injection pumps (including one standby) and three dissolution tanks are required to be replaced with new ones of the same specification as existing. This facility complements the chlorine dioxide injection facility by suppressing excessive injection of chlorine dioxide, which helps reduce generation of disinfection by-products of chlorous acid. This facility has function of reducing the unusual odor and tastes by oxidization of organic matters, and also suppresses the generation of disinfection by-products. The renewal effect is high for maintaining stable water quality. | There are two plans for improvement of sludge drying process; one is construction of new sludge thickeners and additional drying beds, while the other is construction of new thickeners and new pressure dewatering equipment. The former requires construction of about 130 drying beds as the same size as exiting one and securing a large land lot within or near the plant. (The Team estimated about 130 drying beds based on the current sludge amount. It might be difficult to secure a large land lot.) The latter requires the installation of pressure dewatering equipment inside the plant. Expansion effect is moderate. | The transmission method is required to change from cable system to wireless communication network system. Remote control and remote monitoring are important for the water supply system, and the upgrade effect is high. | 4 standby pumps are required to be replaced with new ones having same capacity as existing. The facility is composed of 10 pumps. Only standby pumps are required to be replaced. Replacement effect is moderate. | Two air scour blowers (one standby) are required to be replaced with new ones having same capability as existing. The blowers including the standby are deteriorated but still working . Replacement effect is moderate. | Twelve standby valves and filter media are required to be renewed with same specification as existing. When inspecting the collecting device of each basin, filter media removal is required. Since current filtered water has no problems in quality, renewal effect is moderate. | Injection pumps are required to be replaced with new ones having same capacity as existing, and spare parts are required to be supplied. Replacement effect is moderate. | A new Reinforced concrete Backwash water tank is required to be constructed. Replacement effect is moderate. | The requested equipment is divided into two types; namely, quantitative equipment and general-purpose equipment. The formerincludes Gas Chromatograph, and monitoring capability of trihalomethane will be strengthened by its upgrade. The latter includes Water Purification System (1 unit, upgrade), Precision Chemical Balance (1 unit, newly introduced), Laboratory Refrigerator (1 unit, upgrade), Automatic Diluter (1 unit, newly introduced), Vacuum Pumps (2 units, upgrade) and Digital Thermometers (4 units, upgrade). Upgrade/new introduction of these equipment can improve analytical precision for safe supply of water. Upgrade effect is moderate. | Twelve standby valves and filter media are requested to be renewed with same specification as existing. When inspecting the collecting device of each basin, filter media removal is required. Since current filtered water has no problems in quality, repair effect is moderate. | Two Backwash water recovery pumps (one standby) are requested to replaced with new ones having same capacity as existing. Two wash water pumps (one standby) show leakage from gland but are working. Renewal effect is low. |
| It is limited to injecting a moderate quantity of chlorine dioxide to restrain the generation of by-product chlorous acid (standard: 0.7mg/L). Malfunction of the potassium permanganate facility poses problems in water quality aggravation in winter, and it increase a risk of reduction of water supply amount. It is required to be renewed within a few years. | There are no environmental problems if discharging sludge water drain outside. The risk of reduction of water supply capacity is low. | If this system is failed, remote control and monitoring become impossible. The risk of reduction of water supply amount is high. It is required to be renewed within a few years. | Since capability of the sedimentation basin decreases without draining sludge, it is obliged to remove sludge manually after emptying the basin. Since one of four basins is required to suspend during sludge removal work, total amount of treated water decreases. As a result, turbidity becomes high, and it is not able to produce a predetermined amount of treated water. Risk of reduction of water supply amount is high. It is required to be replaced within a few years. | If air washing cannot be used, only backwashing is utilized for washing, as a result, washing effect decreases while wash water volume increases. Risk of water supply decline is high. It is required to be renewed within a few years. | There are 6 filtration basins, but there is no spare filter in the summer when the amount of treated water increases. If one filter malfunctions, it is necessary to reduce the amount of treated water. Risk of reduction of water supply capacity is high. It is required to be renewed within a few years. | Two pumps including a standby pump are working. Risk of reduction of water supply capacity is low. | In case of any accident and breaking of the steel tank, back washing stops, but no such accident has happened in the past. In addition, measurement of steel thickness confirmed that it satisfies the predetermined required value, so the risk of reduction of water supply capacity is low. | Any malfunction of the equipment is directly linked to a reduction in quality and also give rise to fears that water-borne diseases will be increased in the water distribution area. However, current risk is low because there is no serious shortage or failure of the requested equipment as mentioned above. | There are 6 filtration basins, but there is no standby filter for summer when the amount of treated water increases. If one filter stops due to malfunction, it is necessary to reduce the amount of treated water. However, current risk is low because there is no serious sign of operation. | Currently there are two pumps in operation, including one standby pump. Risk of reduction of water supply capacity is low. |
| Maintenance cost reduction effect is low. | The personnel cost and maintenance cost will increase for sludge removal. | Maintenance cost reduction effect is low. | Personnel cost for sludge removal is reduced. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. | Maintenance cost reduction effect is low. |
| No energy saving effect is anticipated because required power is unchanged. | Since thickeners in both plans require power, and pressure dewatering equipment require a lot of power, energy consumption increases. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated. | No energy saving effect is anticipated because required power is unchanged. | No energy saving effect is anticipated because required power is unchanged. |
| Strengthening of operation and maintenance of water treatment plant in terms of water quality management (Optimizing operation method of chlorine dioxide injection rate based on raw water turbidity) | Strengthening of operation and maintenance of water treatment plant in terms of operation of drying beds and usage of generated sludge. | Strengthening of operation and maintenance of water treatment plant in terms of practical maintenance method for troubles | Strengthening of operation and maintenance of water treatment plant in terms of operation method of settling basins | Not Applicable | Strengthening of operation and maintenance of water treatment plant in terms of method of washing of the rapid sand filters and filter media composition. | Strengthening of operation and maintenance of water treatment plant in terms of operation of ferrous sulfate injection facility. | Not Applicable | Not Applicable | Strengthening of operation and maintenance of waterTreatment plant in terms of method of washing of the rapid sand filters and filter media composition. | Not Applicable |

## Appendix-3 Examination on the cause of corrosion/erosion of raw water pumps (PS1 to PS4)

From the observation, the casing interior seems being corroded by an oxidant like chloride. On the other hand, cavitation erosion is found on the impeller. In addition, the impeller ring and casing ring have been worn out possibly due to silt.

The cause of corrosion is strongly suspected to be corrosion by chlorine ions in the raw water, so it must be taken into account when selecting the pump material. In addition, the pumps are also affected by chlorine dioxide and potassium permanganate. To protect the main parts of the pumps from corrosion, pump materials is recommended to be changed to duplex stainless steel.

# Appendix-4 Water Quality
# (Raw Water Quality of King Abdullah Canal)

Based on the monitoring data provided by Miyahuna, the Team has analyzed the data to grasp the current condition and recent trend of raw water quality of King Abdullah Canal (KAC). The summary is as follows:

1) Physical properties

In the past, turbidity of the raw water showed remarkably higher values in winter season. However, seasonal variations became subsequently smaller, and the lowest yearly values have been increasing gradually from around 2014 (Appendix-5). In order to reduce turbidity load on Zai WTP, it will be necessary to take measures to control turbidity in the future. Besides, since there is no clear relationship between algae count and turbidity, the increase in turbidity is mainly attributed to suspended inorganic materials such as silt and clay in the raw water (Fig.-a2).

2) Chemical properties

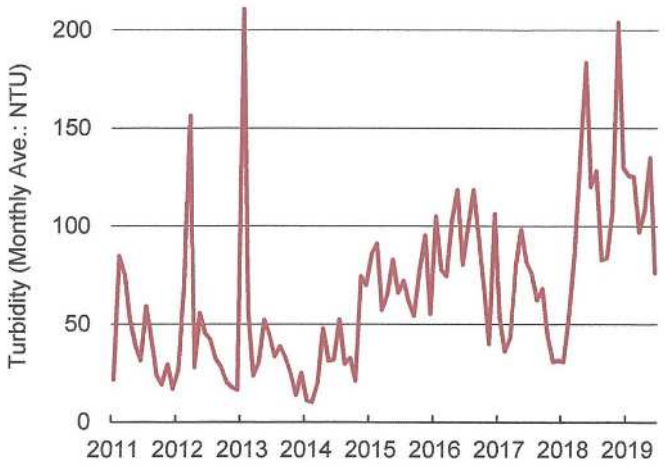
Electric conductivity, which indicates the total amount of dissolved materials, is extremely high even in the rainy season. This is the obvious feature of KAC raw water and the annual average is more than 100 mS $m^{-1}$ in general. In recent years, chloride and sulfate tend to increase gradually (-b1) and contribute to the increase in electrical conductivity (-b2).

3) Microbiological properties

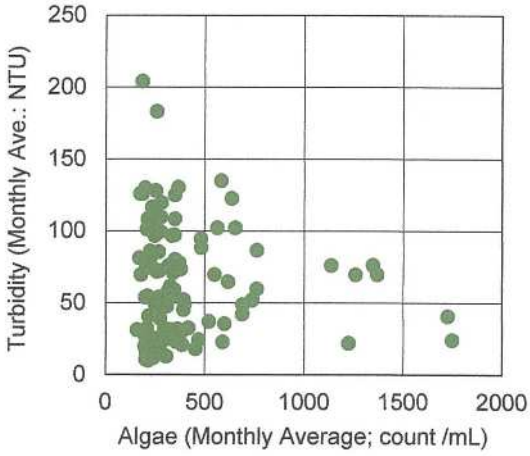
Algae tend to be abundant in summer season. Injecting potassium permanganate ($KMnO_4$) and chlorine dioxide ($ClO_2$) at the intake point reduce it to approximately 40% (-c1). On the other hand, a nutrient salts concentration, especially nitrate concentration in the water is also high annually and the number of fecal coliform shows a positive correlation with it (-c2).

From the above, injection of oxidizers such as $KMnO_4$ and $ClO_2$ is essential for hygiene purpose, but excessively adding may cause corrosion and/or corrode steel products in the water supply system.

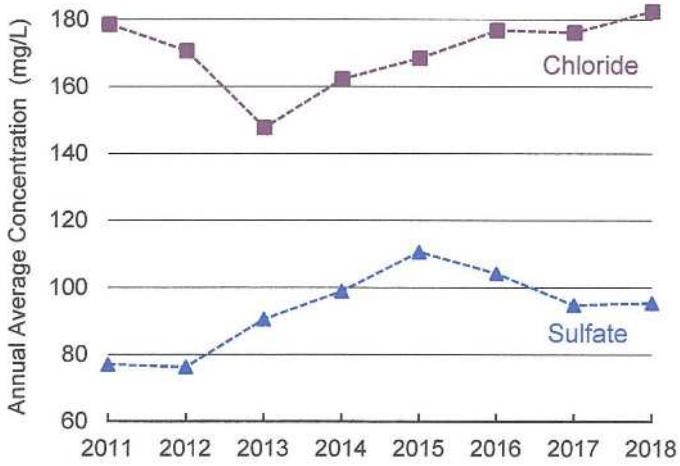
# Appendix-5 Recent Trend of Raw Water Quality of KAC



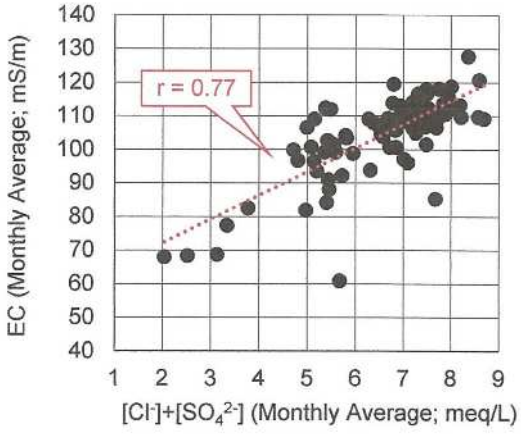

a1) Historical Change of Turbidity



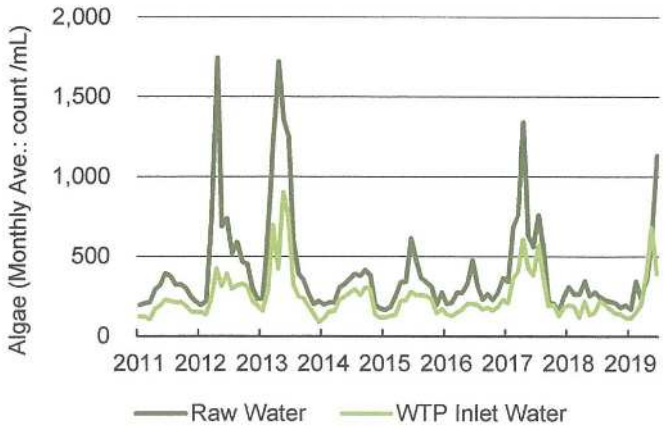

a2) Relationship between Algae & Turbidity



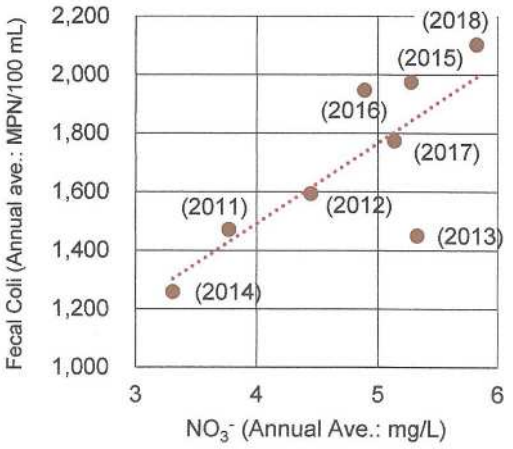

b1) Historical Change of Chloride & Sulfate ions




b2) Relationship between $[Cl^-]+[SO_4^{2-}]$ & EC




c1) Comparison between Raw & WTP Inlet Water on Algae




c2) Relationship between Nitrate & Coliform

| Item | Impact | | Rating | | Results |
|---|---|---|---|---|---|
| | | | Pre-/ Construction Phase | Operation Phase | |
| | | | | | is implemented in the existing propeties. |
| | 24 | Gender | D | D | **Pre-/Construction and Operation phase:** No specific impacts to gender issues. |
| | 25 | Children's Rights | D | D | **Pre-/Construction and Operation phase:** No specific impacts on children's rights. |
| | 26 | Infectious Diseases such as HIV/AIDS | D | D/B+ | **Pre-/Construction and Operation phase:** The Project does not need massive influx of construction workers and may not trigger any infectious disease epidemics. Conversely, positive impacts for disease prevention may be predicted due to stable water supply by the Project implementation in the future. |
| | 27 | Work Environment (Including Work Safety) | B- | D | **Pre-/Construction phase:** Risks of accidents are high through the construction work.<br>**Operation phase:** No major impact is anticipated. |
| Other | 28 | Accidents | B- | B- | **Pre-/Construction phase:** Accidents may occur due to the constrution work. Also traffic accidents may occur due to the increase of traffic volume.<br>**Operation phase:** Accidents can occur during operation and maintenance work. |
| | 29 | Cross-boundary Impact and Climate Change | D | D | **Pre-/Construction and Operation phase:** No impact on climate change is predicted although $CO_2$ will be produced in the construction work at a relatively limited scale. |

Source: JICA Study Team

Note:
A+/-: Significant positive/negative impact is expected,
B+/-: Positive/negative impact is expected to some extent,
C+/-: Extent of positive/negative impact is unknown (further examination is needed, and the impact may be clarified as the study progresses)
D: No impact is expected.

# Monitoring form

## I. Construction phase

### i. Air Quality

#### (a) $SO_2$

| Location | Date | 24 hours average | National standard | WHO Guideline |
|---|---|---|---|---|
| | / / | ppm | 0.14 ppm (24 hours average) | 20 μg $m^{-3}$ (Interim-Target -3, 24 hours average) |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |

#### (b) $NO_2$

| Location | Date | 1 hour average | National standard | WHO Guideline |
|---|---|---|---|---|
| | / / | ppm | 0.21 ppm (1 hour average) | 200 μg $m^{-3}$ (1 hour average) |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |

#### (c) PM10

| Location | Date | 24 hours average | National standard | WHO Guideline |
|---|---|---|---|---|
| | / / | ppm | 150 ppm (24 hours average) | 120 μg $m^{-3}$ (Interim-Target -1, 24 hours average) |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |

#### (d) PM2.5

| Location | Date | 24 hours average | National standard | WHO Guideline |
|---|---|---|---|---|
| | / / | ppm | 65 ppm (24 hours average) | 75 μg $m^{-3}$ (Interim-Target -1, 24 hours average) |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |
| | / / | ppm | | |

### ii. Ambient Noise Level

| Time | | Location |
|---|---|---|
| From | To | |
| | | |
| | | |
| | | |
| | | |

**Reference Value: National Standards of Ambient Noise***

| **Category of Area** | **Limits in dB (A) Leq** | |
|---|---|---|
| | **Day time (6 AM - 8 PM)** | **Night time (8 PM - 6 AM)** |
| Residential Area (urban area) | **60** | 50 |
| Residential Area (suburb area) | **55** | 45 |
| Residential Area (rural area) | **50** | 40 |

* Article (4) of the Standards for the Prevention and Elimination of Noise (2003)

### iii. Waste with Odor

Date……

| **Location** | Discharge amount | | Rate of recycle/Reuse | |
|---|---|---|---|---|
| | Industrial (ton) | Domestic (kg) | Industrial (%) | Domestic (%) |
| | | | | |
| Odor | □ Acceptable | | □ Not-acceptable | |

### iv. Record of machinery maintenance

| Date | Machinery name | ID No. | Content of maintenance |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

### v. Disturbance to Existing Social Infrastructure and Services

Traffic volume (vehicles and others used for the transportation and construction work)

| Date | Location | Start time | End time | Weather |
|---|---|---|---|---|
| / / | | : | : | |

| Traffic | Tally |
|---|---|
| Bicycle | |
| Motorcycle | |

| Traffic | Tally |
|---|---|
| Articulated lorry | |
| Bus/Coach | |

| | | | | |
|---|---|---|---|---|
| Car | | | Construction vehicle | |
| Van/Pick-up | | | Farm vehicle | |
| Small lorry | | | Other | |

**vi. Work Environment (daily and monthly)**

Monitor record of trainings on health and safety, observation and inspection on site, workers' health condition and medical check-ups' record, number of accidents and their working hours

_____

_____

_____

**vii. Accidents Record**

**(a) Number of traffic accidents**

_____

**(b) No. of accidents (human and fire cases)**

_____

**(c) Record of accidents**

- Date & Time:_____
- Location:_____
- Accident details:_____

_____

**II. Operation stage**

**i. Work Environment and Accidents**

**(a) Check of cautionary signs placed on required points on site**

- _____
- _____
- _____

**(b) Record of accidents**

- Date & Time:_____
- Location:_____
- Accident details:_____

_____

**The Project for Improvement of the Zai Water Supply System, Environmental Checklist**

| Category | Environmental Item | Main Check Items | Yes: Y<br>No: N | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures) |
|---|---|---|---|---|
| 1 Permits and Explanation | (1) EIA and Environmental Permits | (a) Have EIA reports been already prepared in official process?<br>(b) Have EIA reports been approved by authorities of the host country's government?<br>(c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?<br>(d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government? | (a) N<br>(b) N<br>(c) N<br>(d) N | (a) Since the Project does not fall under "Projects requiring Comprehensive/Preliminary EIA Report" as defined in Annex 2 and 3 of the Jordan Environmental Impact Assessment Regulations (EIA Regulations, 2005), no EIA report will be prepared by the executing agency (WAJ).<br>(b) Not applicable<br>(c) Not applicable<br>(d) No environmental permission required |
| | (2) Explanation to the Local Stakeholders | (a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders?<br>(b) Have the comment from the stakeholders (such as local re ents) been reflected to the project design? | (a) N<br>(b) N | (a) It is not necessary to explain to local stakeholders because the Project replaces equipment and facilities only in the existing site.<br>(b) Not applicable |
| | (3) Examination of Alternatives | (a) Have alternative plans of the project been examined with s al and environmental considerations? | (a) N | (a) Prioritization studies of the proposed coponents has already conduct insted of considering alternative plans. The impacts on the natural and social environment are minimal because all the components are implemented in the existing facilities. |
| 2 Pollution Control | (1) Air Quality | (a) Is there a possibility that chlorine from chlorine storage fac s and chlorine injection facilities will cause air pollution? Are any mi ing measures taken?<br>(b) Do chlorine concentrations within the working environmen omply with the country's occupational health and safety standards? | (a) N<br>(b) Y | (a) No air pollution due to chlorine is expected.<br>(b) Occupational safety standards of Jordan are adhered including the storage and injection facilities of chlorine. |
| | (2) Water Quality | (a) Do pollutants, such as SS, BOD, COD contained in effluen discharged by the facility operations comply with the country's effluent standards? | (a) Y | (a) SS, BOD, COD, pH, etc. in the Wastewater meet the national environmental standards. Besides, organic pollution is evaluated by total organic carbon (TOC) instead of BOD and COD. |
| | (3) Wastes | (a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country's regulations? | (a) Y | (a) Sludge generated in the water treatment process in Zai WTP will be planned to dispose by MIYAHUNA. |
| | (4) Noise and Vibration | (a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards? | (a) Y | (a) Noise and vibration levels will be matched with the national environmental standards by mitigation measures. |
| | (5) Subsidence | (a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence? | (a) N | (a) Not applicable. The Project does not utilize any groundwater. |
| 3 Natural Environment | (1) Protected Areas | (a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas? | (a) N | (a) Forest stands designated as Zai National Parks are scattered in the vicinity, but their impact is not foreseen. |

**The Project for Improvement of the Zai Water Supply System, Environmental Checklist**

| Category | Environmental Item | Main Check Items | Yes: Y<br>No: N | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures) |
|---|---|---|---|---|
| 3 Natural Environment | (2) Ecosystem | (a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?<br>(b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?<br>(c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?<br>(d) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms? | (a) N<br>(b) N<br>(c) N<br>(d) N | (a) Not applicable<br>(b) Not applicable<br>(c) Not applicable<br>(d) Not applicable |
| | (3) Hydrology | (a) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect surface water and groundwater flows? | (a) N | (a) Since there is no change in water intake volume, any adversely affect on hydrology will not be foreseen. |
| 4 Social Environment | (1) Resettlement | (a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?<br>(b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement?<br>(c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?<br>(d) Is the compensations going to be paid prior to the resettlement?<br>(e) Is the compensation policies prepared in document?<br>(f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?<br>(g) Are agreements with the affected people obtained prior to resettlement?<br>(h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?<br>(i) Are any plans developed to monitor the impacts of resettlement?<br>(j) Is the grievance redress mechanism established? | (a) N<br>(b) N<br>(c) N<br>(d) N<br>(e) N<br>(f) N<br>(g) N<br>(h) N<br>(i) N<br>(j) N | (a) No resettlement will occur in the Project.<br>(b) Not applicable<br>(c) Not applicable<br>(d) Not applicable<br>(e) Not applicable<br>(f) Not applicable<br>(g) Not applicable<br>(h) Not applicable<br>(i) Not applicable<br>(j) Not applicable |

**The Project for Improvement of the Zai Water Supply System, Environmental Checklist**

| Category | Environmental Item | Main Check Items | Yes: Y<br>No: N | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures) |
|---|---|---|---|---|
| 4 Social Environment | (2) Living and Livelihood | (a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?<br>(b) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses? | (a) N<br>(b) N | (a) There will be no adverse impact on residents' lives.<br>(b) The current water intake volume will not be changed. Besides, no new chemical injection or civil engineering work will be planned on the water source. So there is no impact on existing water use and water area use. |
| | (3) Heritage | (a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws? | (a) N | (a) There are no UNESCO-designated World Heritage sites inside or outside the project site. Also, there are no historical, culturally or religiously valuable heritages or historic sites designated by Jordanian law. In addition, there is also no heritage based on local customs or culture. |
| | (4) Landscape | (a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken? | (a) N | (a) There are no landscapes to consider at the project site. In addition, since this project will be carried out on the existing site, it is not expected |
| | (5) Ethnic Minorities and Indigenous Peoples | (a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples?<br>(b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected? | (a) N<br>(b) N | (a) Not applicable<br>(b) Not applicable |
| | (6) Working Conditions | (a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project?<br>(b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials?<br>(c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.?<br>(d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents? | (a) Y<br>(b) Y<br>(c) Y<br>(d) Y | (a) Jordan's domestic laws on working conditions will be respected and health and safety will be prioritized.<br>(b) Hard and soft safety considerations related to occupational accident prevention are thoroughly implemented.<br>(c) Training courses on safety education are kept implementing by MIYAHUNA.<br>(d) Safety measures are thoroughly enforced by MIYAHUNA. Furthermore, seculity guards are stationed. |
| 5 Others | (1) Impacts during Construction | (a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?<br>(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?<br>(c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?<br>(d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts? | (a) Y<br>(b) N<br>(c) Y<br>(d) Y | (a) Mitigation measures for air pollution, vibration and noise will be prepared by MIYAHUNA<br>(b) No adverse effects on the ecosystem due to construction are expected.<br>(c) There is a slight possibility that an accident will occur due to traffic of construction vehicles. Mitigation measures will be prepared by MIYAHUNA as necessary.<br>(d) As traffic congestion is a little expected due to traffic of construction vehicles in the town area. Mitigation measures will be prepared by MIYAHUNA as occasion demands. |

**The Project for Improvement of the Zai Water Supply System, Environmental Checklist**

| Category | Environmental Item | Main Check Items | Yes: Y<br>No: N | Confirmation of Environmental Considerations<br>(Reasons, Mitigation Measures) |
|---|---|---|---|---|
| 5 Others | (2) Monitoring | (a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?<br>(b) What are the items, methods and frequencies of the monitoring program?<br>(c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?<br>(d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities? | (a) Y<br>(b) –<br>(c) Y<br>(d) Y | (a) During construction, environmental monitoring for air quality and generation of noise and vibration will be conducted by the constructor.<br>(b) The monitoring method and frequency will be described in the monitoring form by the constructor.<br>(c) Under the supervision of MIYAHUNA, the monitoring system will be established.<br>(d) The constructor shall report the monitoring results to WAJ and MIYAHUNA periodically. |
| 6 Note | Reference to Checklist of Other Sectors | (a) Where necessary, pertinent items described in the Dam and River Projects checklist should also be checked. | (a) N | (a) Not applicable. Any civil works will not be conducted on the intake source. |
| | Note on Using Environmental Checklist | (a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming). | (a) N | (a) GHG emission is expected to reduce by 7.06 Mt-$CO_2$ per year after the Project implementation. |

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which the project is located.

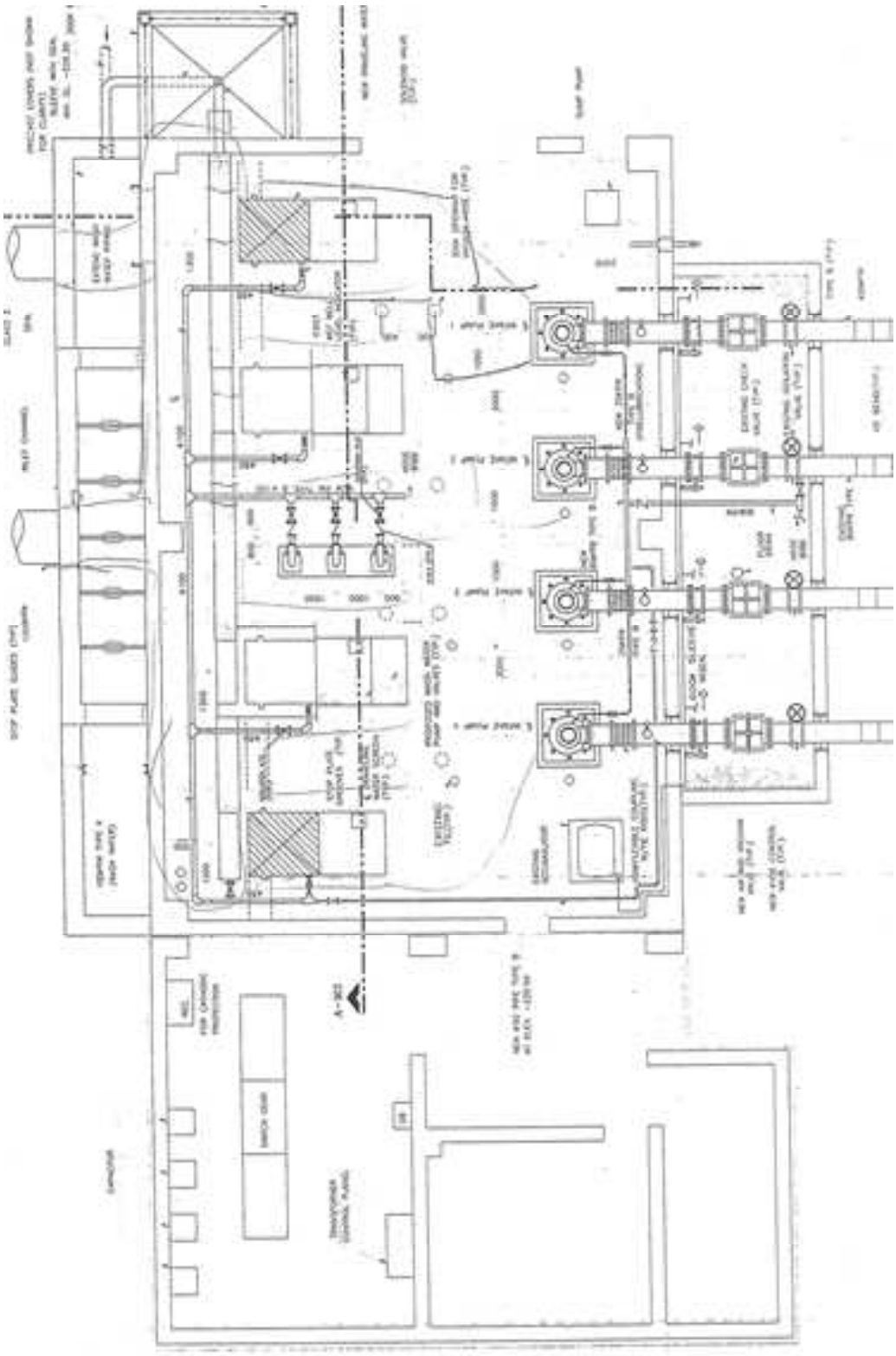


Fig-01 The Project for Improvement of the Zai Water Supply System

Plan Drawing for Intake Pump Station

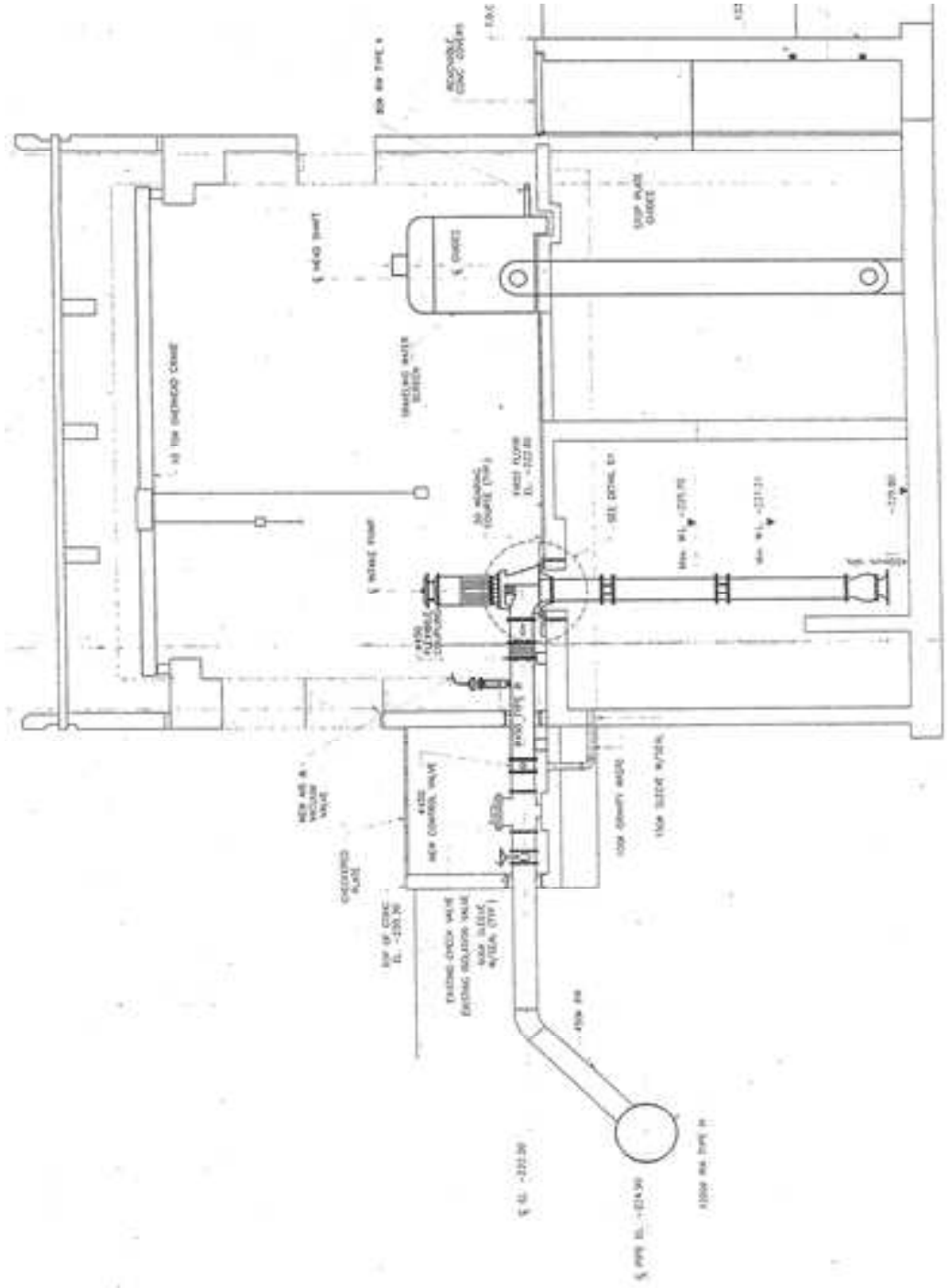


Fig-02 The Project for Improvement of the Zai Water Supply System

Sectional Drawing for Intake Pump Station

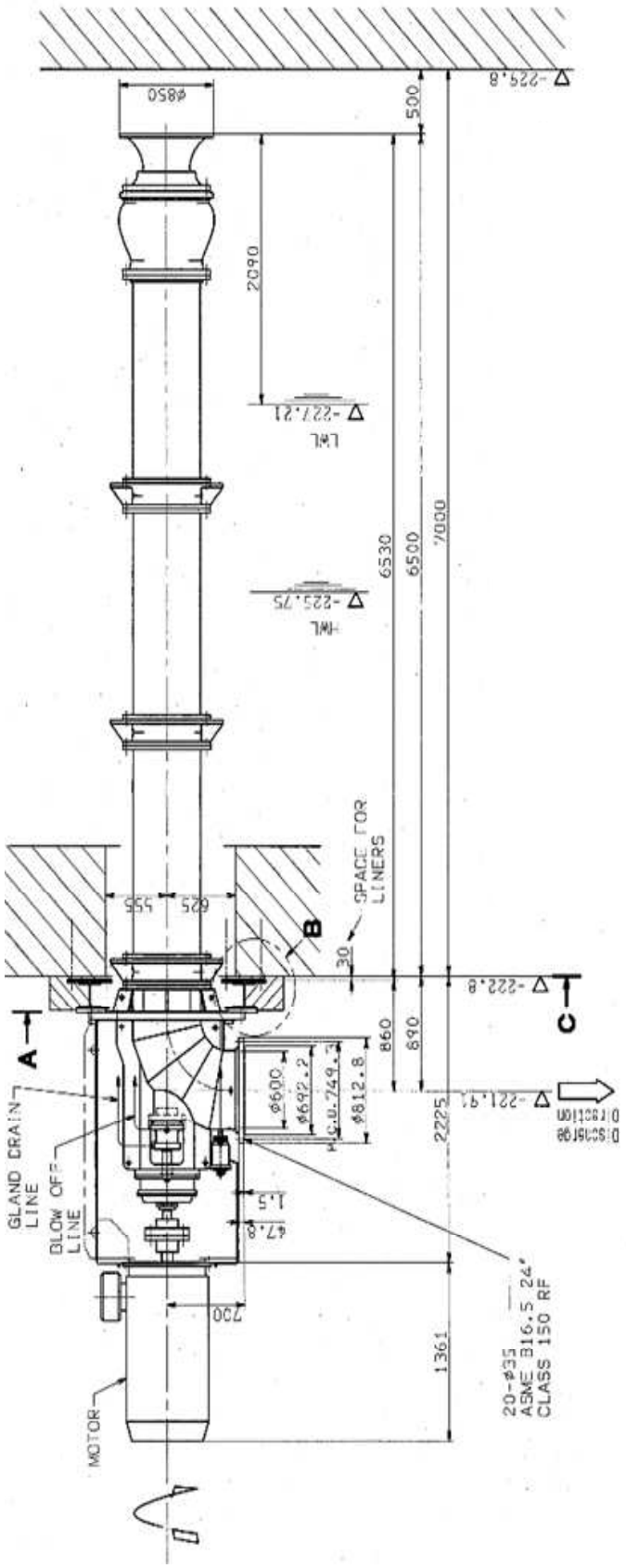



Fig-03 The Project for Improvement of the Zai Water Supply System

Oultine Drawing for Intake Pump

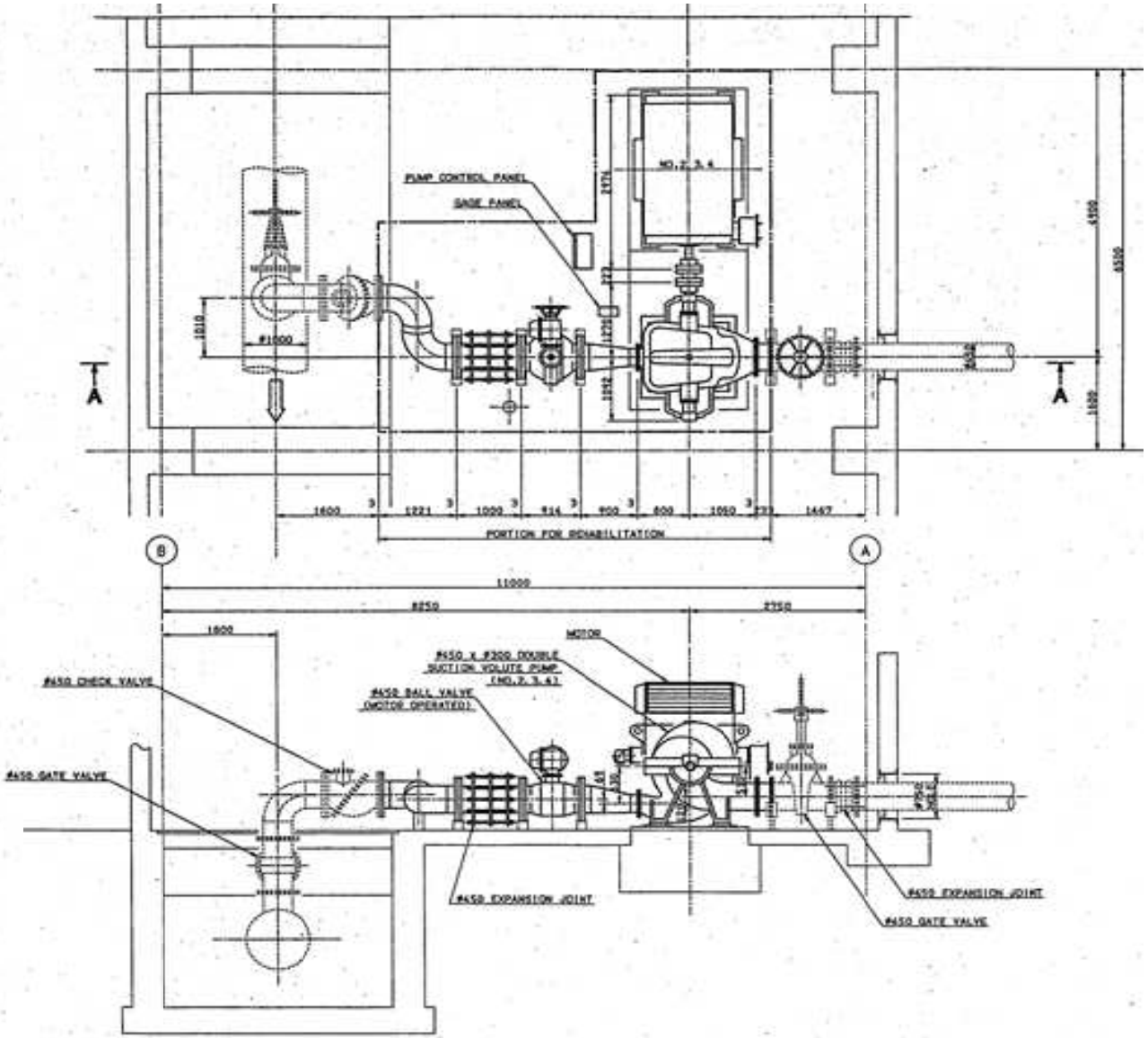



Fig-04 The Project for Improvement of the Zai Water Supply System

Installalation Drawing for Pump and Motor in Booster and Transmission Pump Station (PS1-5)

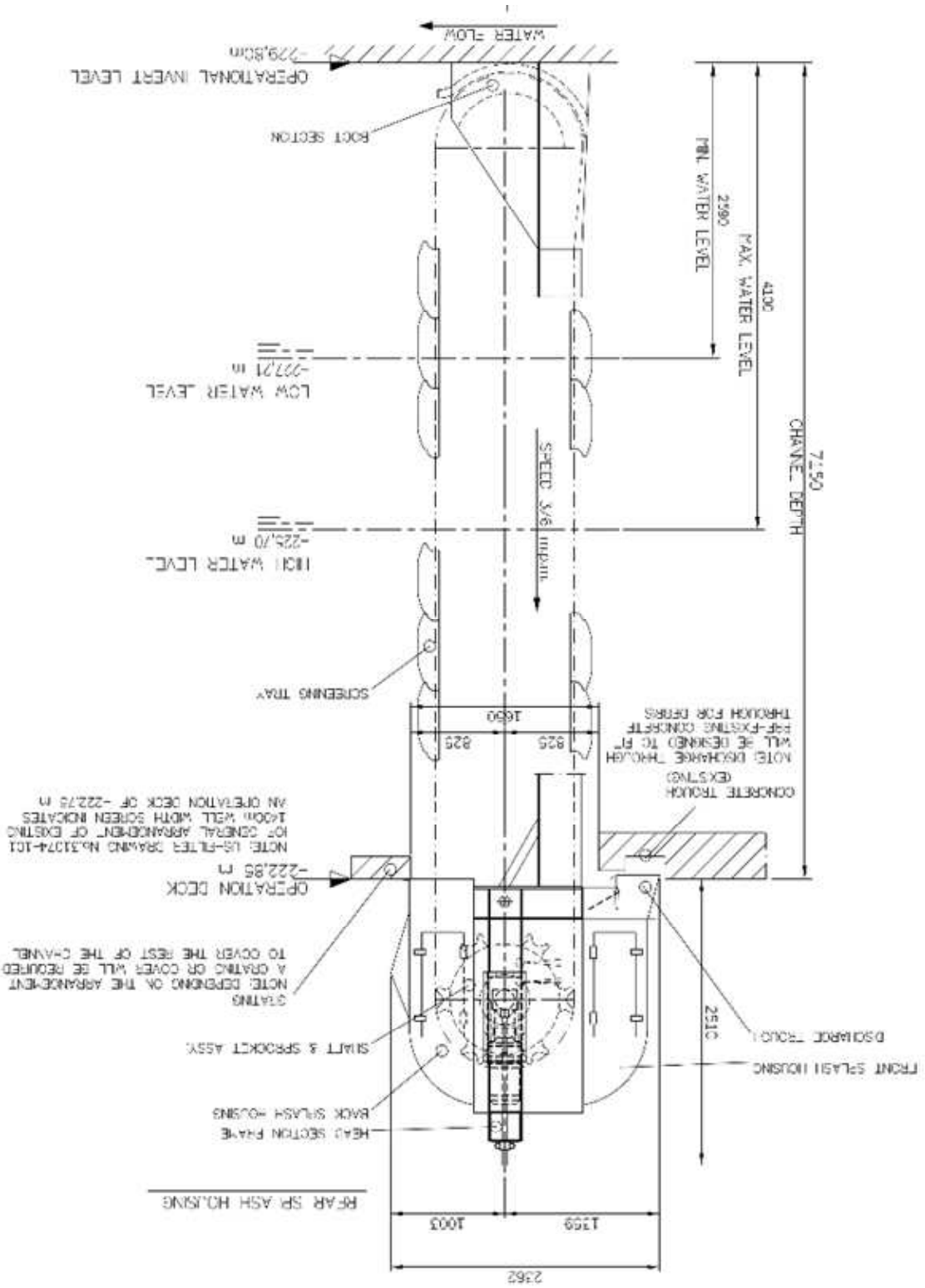



Fig-05 The Project for Improvement of the Zai Water Supply System

Outline Drawing for Traveling Screen

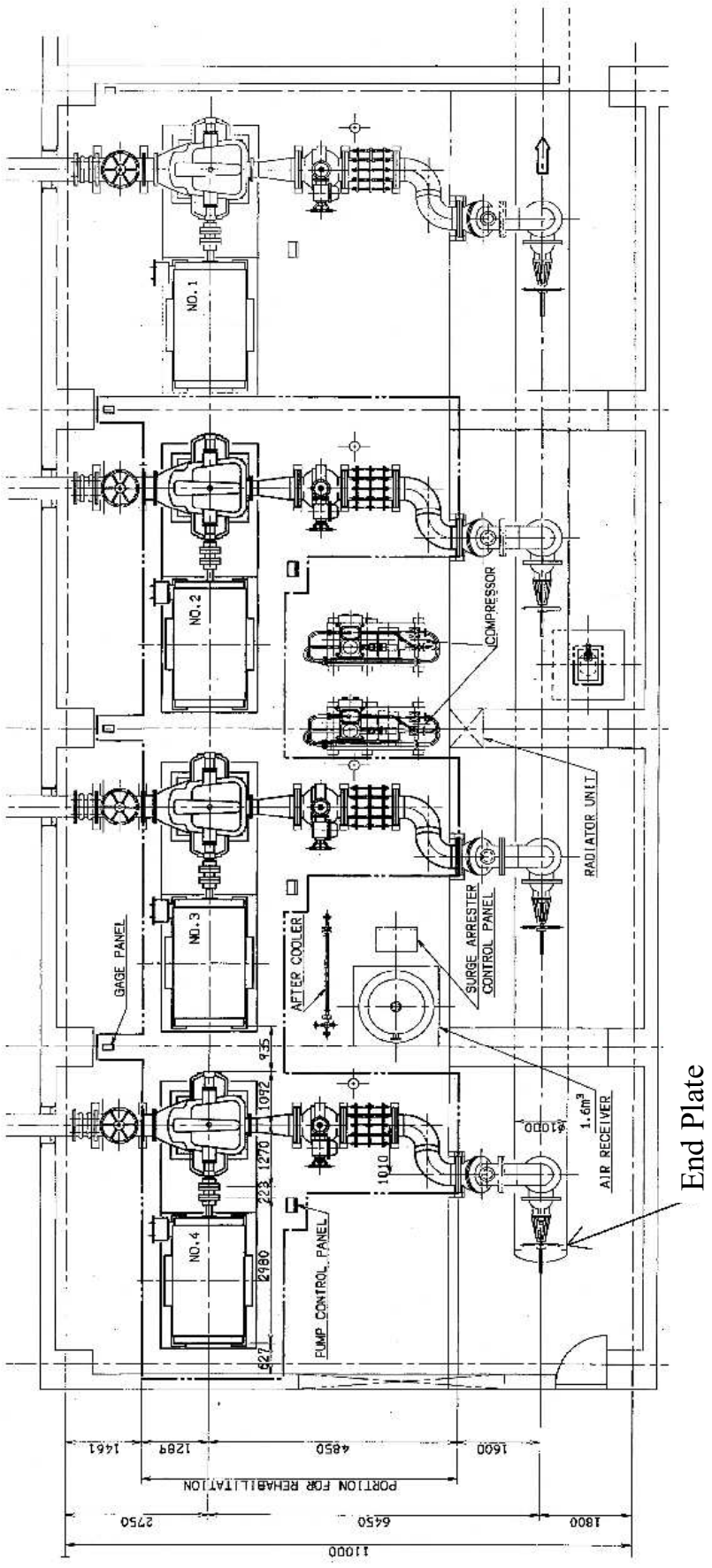



Fig-06 The Project for Improvement of the Zai Water Supply System

End Plate Installation Position (PS1-5)

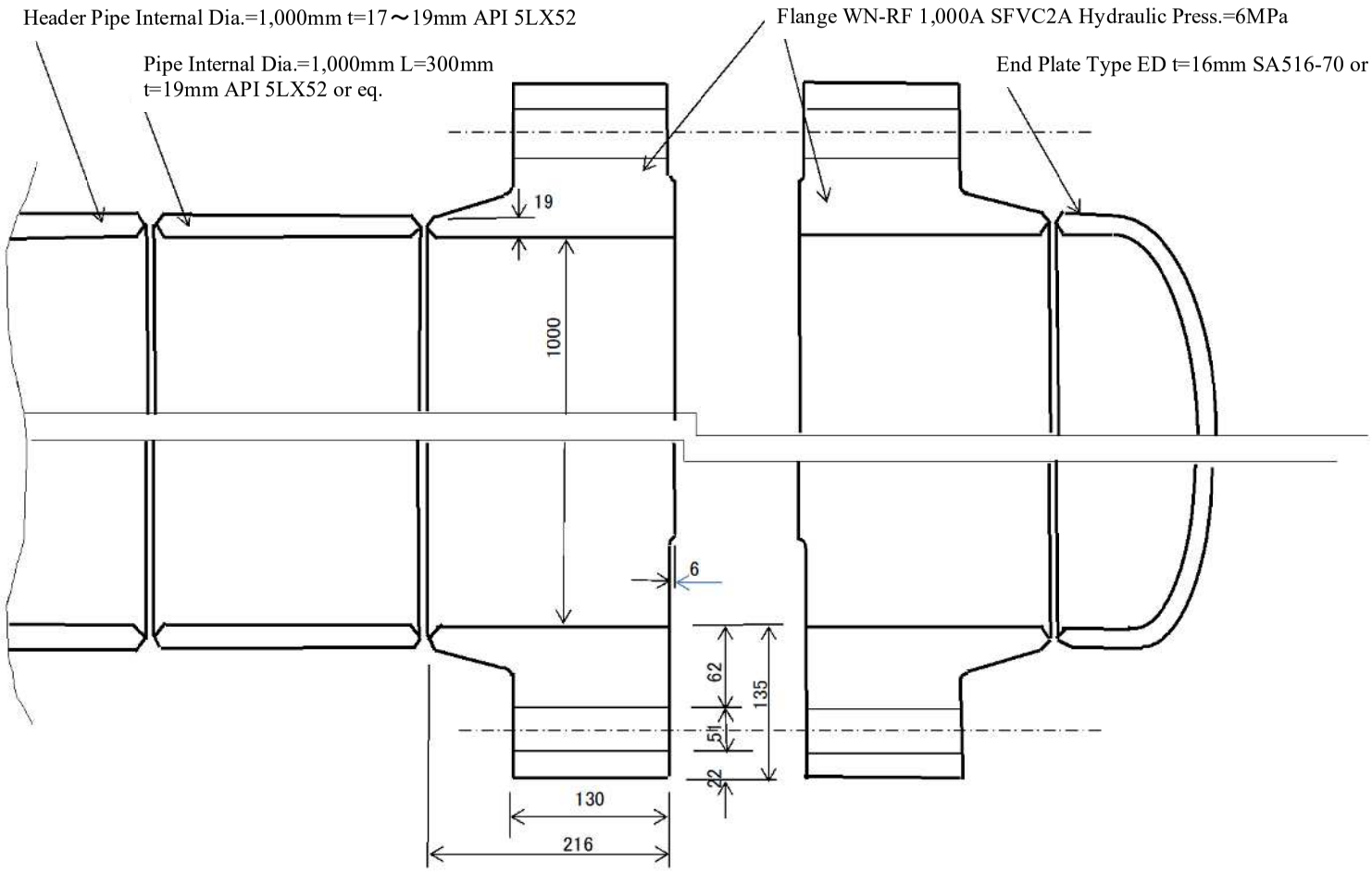



Fig-07 The Project for Improvement of the Zai Water Supply System

Outline Drawing for End Plate

Appendix9 Electricity consumption per m3 of water supplied by Zai water supply system

| Pump station | Unit. No. | Pump Capacity | Pump Total Head | Equipment | Original Efficiency | Original Total Efficiency | Measured Total Efficiency | Efficiency after Replacement | Eccepted Total Effi. after Replacement | Present Motor Input Power | Motor Input Power after Replacement | Improvement for Motor Input Power | Pump operation ratio | Current Annual Electricity Power | Annual Electricity Power after Replacement |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $m^3/m$ | m | - | % | % | % | % | % | kW | kW | kW | - | kWH | kWH |
| IPS | 1 | 43.8 | 30 | Pump | 85.0 | 81.9 | 54.3 | 80.0 | 77.1 | 394 | 278 | 117 | 0.688 | 2,376,379 | 1,673,819 |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| | 2 | 43.8 | 30 | Pump | 85.0 | 81.9 | 63.1 | 80.0 | 77.1 | 339 | 278 | 62 | 0.688 | 2,046,044 | 1,673,819 |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| | 3 | 43.8 | 30 | Pump | 85.0 | 81.9 | 73.6 | 80.0 | 77.1 | 291 | 278 | 13 | 0.688 | 1,753,395 | 1,673,819 |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| | 4 | 43.8 | 30 | Pump | 85.0 | 81.9 | 65.9 | - | 65.9 | 325 | 325 | 0 | 0.688 | 1,958,800 | 1,958,800 |
| | | | | Motor | 96.4 | | | 96.4 | | | | | | | |
| PS1 | 1 | 43.5 | 300 | Pump | 83.0 | 79.9 | 74.7 | 80.0 | 77.0 | 2,849 | 2,761 | 88 | 0.688 | 17,171,280 | 16,640,807 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 2 | 43.5 | 300 | Pump | 83.0 | 79.9 | 77.6 | 80.6 | 77.6 | 2,741 | 2,741 | 0 | 0.688 | 16,516,930 | 16,516,930 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 3 | 43.5 | 300 | Pump | 83.0 | 79.9 | 74.7 | 80.0 | 77.0 | 2,849 | 2,761 | 88 | 0.688 | 17,171,280 | 16,640,807 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 4 | 43.5 | 300 | Pump | 83.0 | 79.9 | 76.5 | 80.0 | 77.0 | 2,781 | 2,761 | 20 | 0.688 | 16,760,463 | 16,640,807 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| PS2 | 1 | 43.5 | 300 | Pump | 83.5 | 80.4 | 77.8 | 80.0 | 77.0 | 2,735 | 2,761 | -26 | 0.688 | 16,484,606 | 16,640,807 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 2 | 43.5 | 300 | Pump | 83.5 | 80.4 | 78.9 | - | 78.9 | 2,696 | 2,696 | 0 | 0.688 | 16,248,514 | 16,248,514 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 3 | 43.5 | 300 | Pump | 83.5 | 80.4 | 76.8 | - | 76.8 | 2,771 | 2,771 | 0 | 0.688 | 16,701,508 | 16,701,508 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| | 4 | 43.5 | 300 | Pump | 83.5 | 80.4 | 76.7 | 80.0 | 77.0 | 2,772 | 2,761 | 11 | 0.688 | 16,708,038 | 16,640,807 |
| | | | | Motor | 96.3 | | | 96.3 | | | | | | | |
| PS3 | 1 | 43.5 | 308 | Pump | 84.0 | 81.1 | 75.9 | 80.0 | 77.3 | 2,876 | 2,826 | 50 | 0.688 | 17,332,034 | 17,031,504 |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| | 2 | 43.5 | 308 | Pump | 84.0 | 81.1 | 72.8 | 80.0 | 77.3 | 2,999 | 2,826 | 173 | 0.688 | 18,072,150 | 17,031,504 |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| | 3 | 43.5 | 308 | Pump | 84.0 | 81.1 | 74.6 | 80.0 | 77.3 | 2,926 | 2,826 | 100 | 0.688 | 17,633,905 | 17,031,504 |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| | 4 | 43.5 | 308 | Pump | 84.0 | 81.1 | 75.6 | 80.0 | 77.3 | 2,891 | 2,826 | 65 | 0.688 | 17,421,504 | 17,031,504 |
| | | | | Motor | 96.6 | | | 96.6 | | | | | | | |
| PS4 | 1 | 43.5 | 314 | Pump | 84.0 | 81.1 | 73.4 | 80.0 | 77.2 | 3,032 | 2,884 | 148 | 0.688 | 18,273,659 | 17,381,280 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 2 | 43.5 | 314 | Pump | 84.0 | 81.1 | 70.8 | - | 70.8 | 3,143 | 3,143 | 0 | 0.688 | 18,944,442 | 18,944,442 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 3 | 43.5 | 314 | Pump | 84.0 | 81.1 | 67.9 | 80.0 | 77.2 | 3,281 | 2,884 | 397 | 0.688 | 19,773,575 | 17,381,280 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 4 | 43.5 | 314 | Pump | 84.0 | 81.1 | 74.5 | 80.0 | 77.2 | 2,987 | 2,884 | 103 | 0.688 | 18,003,956 | 17,381,280 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| PS5 | 1 | 42.9 | 195 | Pump | 85.7 | 82.7 | 78.8 | 81.0 | 78.2 | 1,730 | 1,744 | -14 | 0.688 | 10,426,430 | 10,513,800 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 2 | 42.9 | 195 | Pump | 85.7 | 82.7 | 60.7 | 81.0 | 78.2 | 2,248 | 1,744 | 504 | 0.688 | 13,550,061 | 10,513,800 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 3 | 42.9 | 195 | Pump | 85.7 | 82.7 | 77.1 | 81.0 | 78.2 | 1,770 | 1,744 | 25 | 0.688 | 10,665,947 | 10,513,800 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | 4 | 42.9 | 195 | Pump | 85.7 | 82.7 | 77.2 | 85.3 | 82.3 | 1,766 | 1,657 | 110 | 0.688 | 10,645,223 | 9,983,796 |
| | | | | Motor | 96.5 | | | 96.5 | | | | | | | |
| | | | | | | | | | | | | | Total | 332,640,122 | 320,390,741 |

Electricity consumption per m3 (kWh/m3)

Standard value：332,640,122 (kWh)/ 65,200,000($m^3$) = 5.10 (kWh/m3)

Target value： 320,390,741 (kWh)/ 65,200,000(m3) = 4.91 (kWh/m3)

# Baseline and Target Values of Greenhouse Gas (GHG) Emissions per Year

## 1. Calculation of electricity $CO_2$ emission factor

Baseline values from Annual Report 2017 of National Electric Power Company (NEPCO):

i Electricity Generation by Source: *EG* (GWh)

Steam Units: 1,963.40 GWh

Combined Cycle: 15,289.50 GWh (a)

Gas Turbines (Diesel): 18.8 GWh (b)

Gas Turbines (NG): 1022.7 GWh (c)

Diesel Engines: 12.7 GWh (d)

Hydro: 38.0 GWh (e)

Wind: 449.2 GWh (f)

From the above,

Electricity generation from heavy fuel oil (HFO): 1,963.4 GWh

Electricity generation from natural gas: 16,312.2 GWh [(a)+(c)]

Electricity generation from diesel oil: 31.5 GWh [(b)+(d)]

Electricity generation from renewable energy: 487.2 GWh [(e)+(f)]

Total: 18,794.3 GWh

ii Fuel consumption: $FC_{TTOE}$ (TTOE*/year) *Thousand Tons of Oil Equivalent

HFO:454.1 TTOE/year

NG:3340.9 TTOE/year

Diesel Oil: 9.4 TTOE/year

Total: 3804.4 TTOE/year

Fuel consumption (*FC*, Gg/year) is given by the following equation.

$FC$ (Gg/year) = Fuel consumption (TTOE/year) × Net Calorific Value of HFO ($NCV_{HFO}$, TJ/Gg$\times 10^3 \div NCV$ (TJ/Gg)

Default value of IPCC 2006 Guideline (Volume 2 Energy) are as follows:

| | Crude Oil | Natural Gas | Diesel Oil |
|---|---|---|---|
| Default carbon content (kg/GJ) | 20.00 | 15.30 | 20.20 |
| Effective $CO_2$ emission factor: EF (kg/TJ) (TJ/Gg) | 73,333 | 56,100 | 74,067 |
| Net calorific value: NCV (TJ/Gg) | 42.30 | 43.00 | 48.00 |

Therefore,

HFO: $FC_{HFO}$ = 454.1×42.30×$10^3$÷42.30 = 454.1×$10^3$ (Gg/year)

NG: $FC_{NG}$ = 3,340.9×42.30×$10^3$÷43.0 = 3,287×$10^3$ (Gg/year)

Diesel Oil: $FC_{diesel}$ = 9.4×42.30×$10^3$÷48.0 = 8.28×$10^3$ (Gg/year)

$CO_2$ emissions [$PE_{FC}$, (t-$CO_2$/year)($FC$×$NCV$×$EF$)] is given by the following equation.

$PE_{FC}$ = Fuel consumption ($FC$, Gg/y) × $CO_2$ emission factor ($EF$, kg/TJ) × Net Calorific Value [$NCV$ (TJ/Gg)×$10^{-8}$]

Therefore,

HFO: $PE_{HFO}$ = 454.1×$10^3$×73,333×42.30×$10^{-8}$ = 14,086.1 (t-$CO_2$/year)

NG: $PE_{NG}$ = 3,340.9×$10^3$×56,100×42.30×$10^{-8}$ = 80,592.5 (t-$CO_2$/year)

Diesel Oil: $PE_{diesel}$ = 9.4×42.30×42.30×$10^{-8}$ = 334.2 (t-$CO_2$/year)

Total 95,012.8 (t-$CO_2$/year)

According to $CO_2$ emission factor ($CEF$, t-$CO_2$/MWh) = $CO_2$ emissions by the source ($PE$×$10^3$) ÷ [Total Electricity generation ($EG$) × 8,760 hours],

Electricity $CO_2$ emission factor ($CEF$, t-$CO_2$/MWh) = 95,012.8×$10^3$÷ (18,794.3×8,760)

= **0.5771 t-$CO_2$/MWh**

2. Calculation of GHG emissions based on baseline annual electric energy

Baseline annual electric energy (332,646,365 kWh/year) × Electricity CO2 emission factor (0.5771 t-$CO_2$/MWh) = 191.97 (Mt-$CO_2$/year)

3. Calculation of GHG reduction based on pump and motor updates

The GHG reduction amount at each pump station is as shown in the table below.

| Pump Station | IPS | PS1 | PS2 | PS3 | PS4 | PS5 | Total |
|---|---|---|---|---|---|---|---|
| Electricity reduction amount (MWh/year) | 1.15 | 1.18 | -0.09 | 2.33 | 3.91 | 3.76 | 12.24 |
| GHG reduction amount (Mt-$CO_2$/year) | 0.66 | 0.68 | -0.05 | 1.34 | 2.26 | 2.17 | **7.06** |

GHG reduction after update = Electricity reduction after update (12.24 MWh/year) ×Electricity CO2 emission factor (0.5771t-$CO_2$/MWh) = 7.06 (Mt-$CO_2$/year)

4. GHG emissions after update

Baseline GHG emissions (191.97 Mt-$CO_2$/year) - GHG reduction after update (7.06 Mt-$CO_2$/year) = 184.91 (Mt-$CO_2$/year)

5. Baseline and target values of GHG emissions per year (Mt-$CO_2$/year)

Based on the above 2-4 results, the reference and the target value of annual GHG emissions will be set **191.97 (Mt-$CO_2$/year)** and **185 (Mt-$CO_2$/year) or less**, respectively.

The units used above are defines as:

Mt : million ton
GWh : gigawatt hour
kWh : kilowatt hour
MWh: megawatt hour
GJ : gigajoule
TJ : terajoule
Gg : gigagram

(The subject ends herewith.)

# The Project for Improvement of the Zai Water Supply System

## Replacement of Pump Equipment

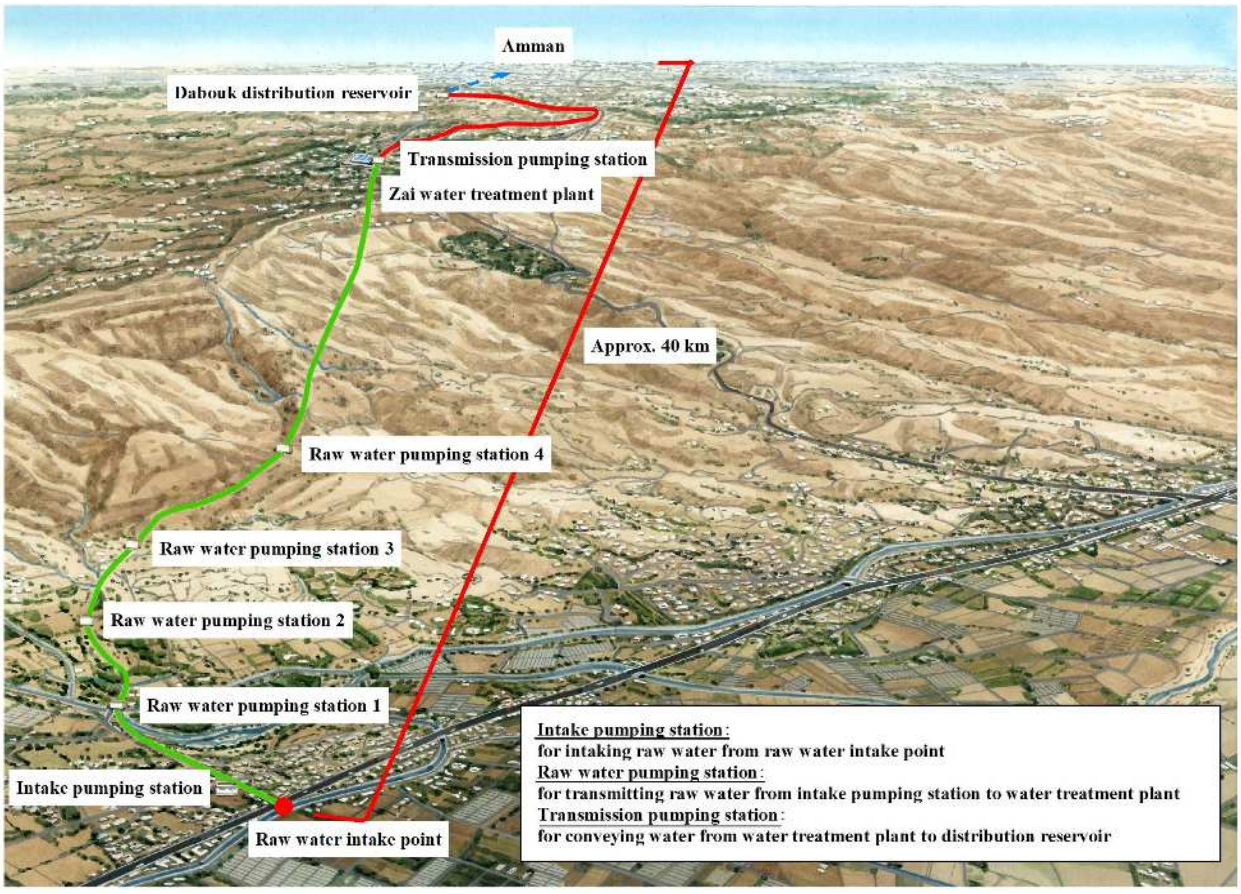
**Basic Information of Zai Water Supply System and the Project for Improvement of the Zai Water Supply System**

| | |
|---|---|
| Project Outline | Zai Water Supply System provides water to Amman and Balqa governorates. This project aims to ensure a stable water supply to Amman by replacing deteriorated water supply equipment of the Zai Water Supply System. |
| Construction Period | June 2021 - May 2023 (Scheduled period) |
| Quantity of supplied water | 72,000,000 $m^3$/year (year 2018) |
| Daily average quantity of treated water | 200,000 $m^3$/day (year 2018) |
| Number of Pumps | Intake pump: 4 sets, Raw water pump: 16 sets (4 pumping stations x 4 pumps each), Transmission pump: 4 sets |
| Population in Amman | About 4.3 million people (year 2018) |

### 1. Zai Water Supply System

. Amman, the capital city of Jordan, is a large city with a population of about 4.3 million, located on a hilly terrain with an average elevation of 850 meters above mean sea level. There are no rivers around Amman which could serve as a source of water to Amman, rainfall is very limited (less than 400 mm/year), and the quantity of water which could be withdrawn from the wells is limited.

For this reason, the raw water is taken from the King Abdullah Canal and treated at the Zai water treatment plant. The raw water intake point is located at about 40 km from Amman at an elevation of 227 m below mean sea level. The treated water from the Zai WTP is transmitted to Dabouk distribution reservoir for supply to Amman using high performance pumps.



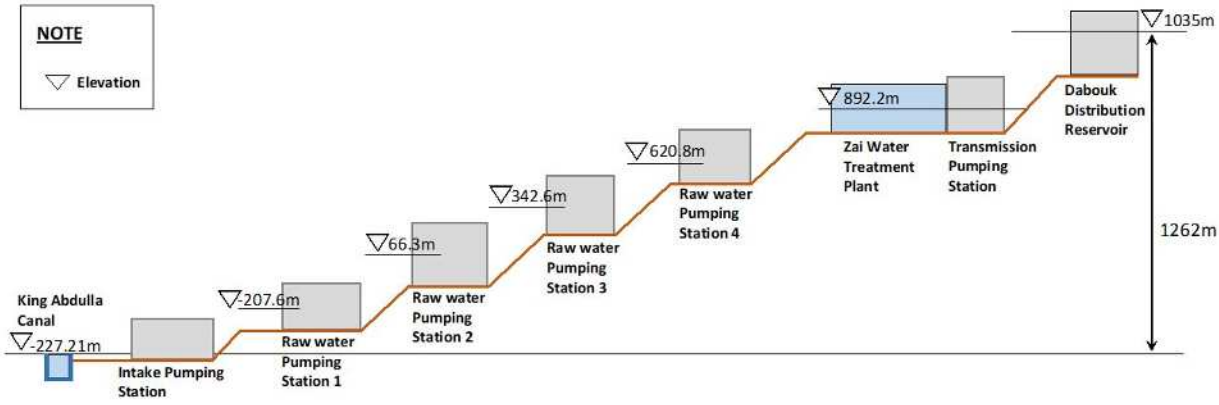

**Bird's-eye view of Zai Water Supply System** (Image source: Google earth)

The Zai Water Supply System was constructed in 1985, and currently covers about 56 % of Amman's water supply.

The distance from the intake point to Dabouk distribution reservoir is about 25 km, and water is relayed through six pumping stations, including one intake pumping station, four raw water pumping stations and one transmission pumping station before conveyed to Dabouk distribution reservoir with about 1,260 m of elevation difference..

In spite of its important function as a major source of water to national capital and need of highly efficient equipment to minimize power consumption, the same old system has been in operation for over 35 years. It has become a problem due to the deterioration of the system's performance and the decline in water supply quantity and quality. The increase in power consumption due to the decline in pump efficiency is an urgent issue.

For this reason, the pump equipment will be upgraded with Japan's grant aid.




**Elevation Profile of Zai Water Supply System**

## 2. Pump Equipment to be Upgraded

### a) Adoption of single-stage centrifugal pump

The total head required for each pump used in this system is about 300 meters, which is an extremely high head. The multistage centrifugal pumps can generate high pressure with multiple stage impellers, which reduces the load on the individual impellers. But multi-stage centrifugal pumps are longer in length. Due to the limited size of building of the existing pumping stations, it is not possible to install the multi-stage centrifugal pumps. Therefore, a single stage centrifugal pump should be adopted in these pumping stations. However, to generate such a high pressure with a single stage impeller, the excessive load is generated on the impeller. For this countermeasure, custom-designed single-stage centrifugal pumps made in Japan will be adopted.

In addition to their compact design, the Japanese-made single-stage centrifugal pumps feature high water absorption performance, high efficiency, low noise and high reliability.

**Raw water pumping station**

**Single-stage centrifugal pump**

**b) Application of wear and corrosion protection technology**

The main parts of the existing raw water pumps are made of stainless-steel casting, and they are abnormally worn and corroded. It is considered that the cause of wear is particles (sand / silt) and the cause of corrosion is high chloride ion, in the raw water.

In order to improve these conditions, the main parts of the pump will be changed to duplex stainless-steel casting, which features high strength and high corrosion resistance. This will improve the durability of the pump against sand and silt, and high chloride ion concentration in the raw water, thus enabling stable performance of pumps, which results in stable water supply.

**c) Reduction of power costs by improving efficiency**

The current pumping equipment is overaged, and the efficiency of the pumps is declining. Replacement of the pumping equipment is estimated to reduce electricity costs by approximately 1.54 million JOD (=240 million yen) per year. (The calculation is based on a pump operating ratio of 68.8%, electricity unit cost of 0.126 JOD / kWh, and the exchange rate of 153.36 yen / JOD.)

**d) Effect on greenhouse gas reduction and significance on climate change mitigation measures**

The implementation of this project will significantly reduce the energy consumption of the pumps, which reduces greenhouse gas emission. The greenhouse gas emission is estimated to reduce from 191.97 Mt-$CO_2$/year (year 2019) to less than 185 Mt-$CO_2$/year by implementation of this project. This project also has high significance on a climate change mitigation measure by reducing greenhouse gas emissions.

**Comment: Eng. Haitham Al-kilani (Miyahuna Water Company: Production Directorate)**

Jordan is one of the poorest water resources countries in the world, and taking into consideration that about 50% of Jordan's population live in Amman, the treated water from Zai Water Treatment Plant is considered as one of the main and important drinking water sources in Jordan. Therefore, it should be kept running efficiently and producing the required water quality and quantity properly.

# مشروع تحسين نظام إمدادات المياه في زي

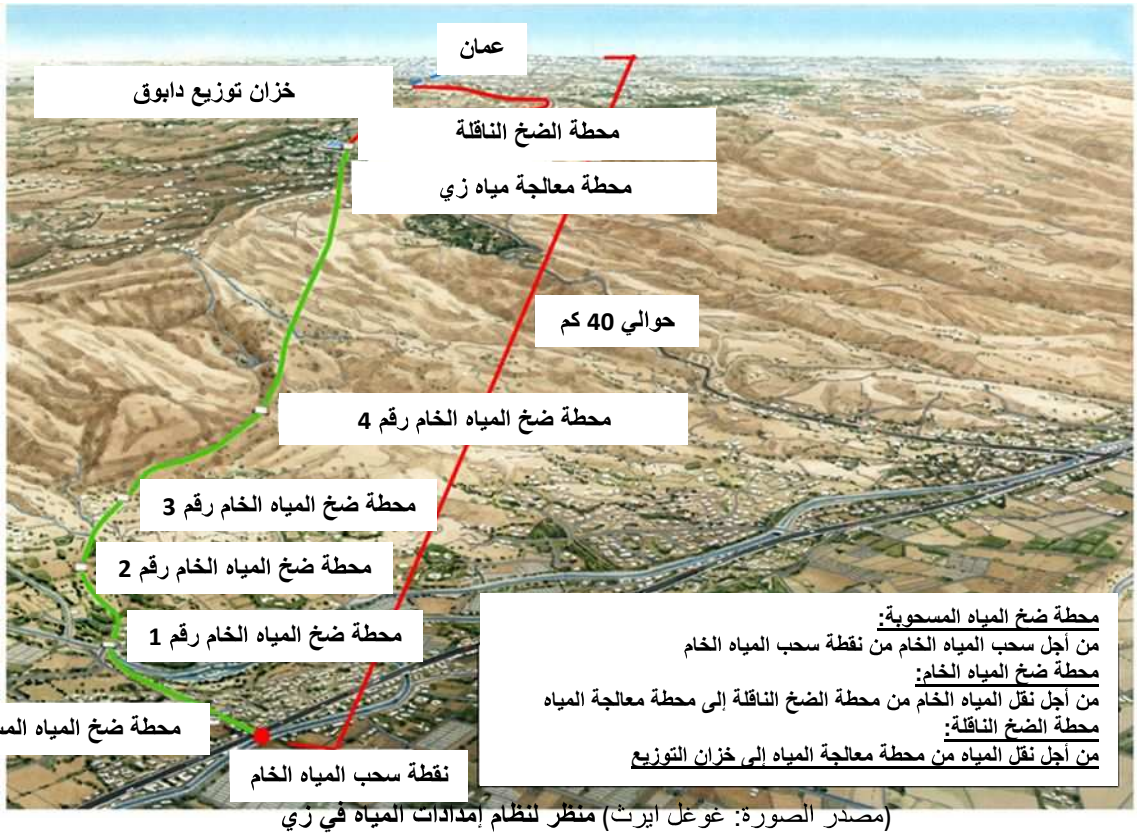
## استبدال معدات المضخة

**المعلومات الأساسية لنظام إمدادات المياه في زي ومشروع تحسين نظام إمدادات المياه في زي**

| | |
|---|---|
| مشروع غير نشط | يقوم نظام إمدادات المياه في زي بتقديم المياه لمحافظتي عمان والبلقاء. ويهدف هذا المشروع إلى ضمان إمدادات مياه مستقرة لعمان من خلال استبدال معدات إمدادات المياه التالفة من نظام إمدادات المياه في زي. |
| فترة الإنشاء | حزيران 2021 – أيار 2023 (الفترة المقررة) |
| كمية المياه المزودة | 72،000،000 م$^3$ / سنة (لسنة 2018) |
| المتوسط اليومي لكمية المياه المعالجة | 200،000 م$^3$ / يوم (لسنة 2018) |
| عدد المضخات | مضخة السحب: 4 مجموعات، مضخة الماء الخام: 16 مجموعة (4 محطات ضخ × 4 مضخات لكل منها)، مضخة النقل: 4 مجموعات |
| عدد السكان في عمان | حوالي 4.3 مليون شخص (سنة 2018) |

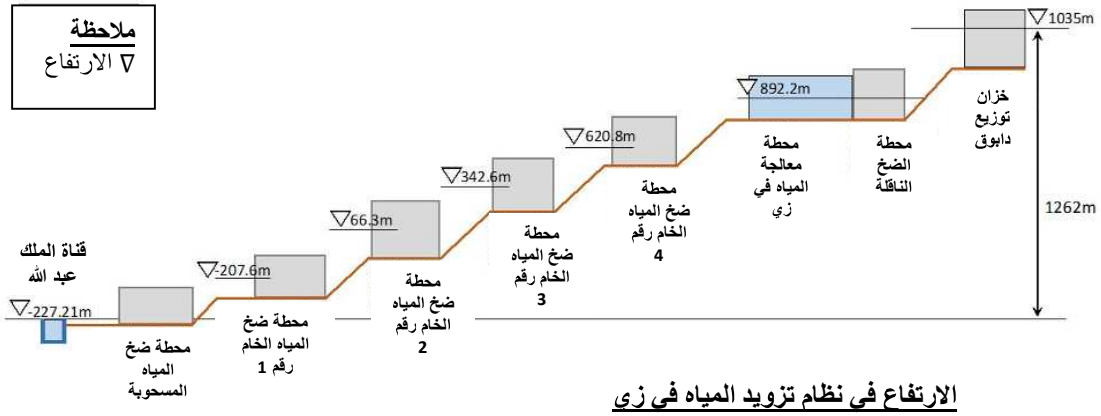
**1) نظام إمدادات المياه في زي**

تعتبر العاصمة الأردنية عمان مدينة كبيرة يبلغ عدد سكانها حوالي 4.3 مليون نسمة وتقع على أراض جبلية يصل متوسط ارتفاعها إلى 850 مترا فوق معدل مستوى سطح البحر. ليس هناك أنهار حول عمان يمكن أن تشكل مصدرا لمياه عمان ويعتبر هطول الأمطار محدود للغاية (أقل من 400 ملم / سنة) كما تعتبر كمية المياه التي يمكن سحبها من الآبار محدودة. لهذا السبب يتم سحب المياه الخام من قناة الملك عبد الله ومعاملتها في محطة معالجة مياه زي. وتقع نقطة دخول المياه الخام على بعد حوالي 40 كم من عمان على ارتفاع 227 م تحت معدل مستوى سطح البحر. حيث يتم نقل المياه المعالجة من محطة معالجة مياه زي ونقلها إلى خزان توزيع دابوق من أجل توريدها إلى عمان باستخدام مضخات عالية الأداء.




(مصدر الصورة: غوغل ايرث) **منظر لنظام إمدادات المياه في زي**

تم بناء نظام إمدادات المياه في زي عام 1985 ويغطي حاليا حوالي 56% من إمدادات المياه في عمان.
تبلغ المسافة من نقطة سحب المياه إلى خزان توزيع دابوق حوالي 25 كم ويتم نقل المياه من خلال ست محطات ضخ وتشمل محطة ضخ واحدة للمياه المسحوبة وأربع محطات لضخ المياه الخام ومحطة ضخ ناقلة واحدة قبل نقل المياه إلى خزان توزيع دابوق وبارتفاع حوالي 1260 م.
على الرغم من وظيفته الهامة كما مصدر مياه رئيسي للمخزون الأساسي الوطني والحاجة إلى معدات عالية الكفاءة لتقليل استهلاك الطاقة فقد كان النظام القديم نفسه يعمل منذ أكثر من 35 عاما مما أصبح مشكلة بسبب تلف أداء النظام وانخفاض كمية وجودة إمدادات المياه. وتشكل الزيادة في استهلاك الطاقة مشكلة ملحة بسبب انخفاض كفاءة المضخة.
لهذا السبب سيتم تحديث معدات المضخات بمساعدة المنح اليابانية.




**الارتفاع في نظام تزويد المياه في زي**

**2) معدات المضخة الواجب تحديثها**

**أ) اعتماد مضخة طرد مركزي أحادية المرحلة**

يبلغ إجمالي الرأس المطلوب لكل مضخة مستخدمة في هذا النظام حوالي 300 متر وهو رأس مرتفع جدا. ويمكن لمضخات الطرد المركزي متعددة المراحل توليد ضغط مرتفع باستخدام دافعات متعددة المراحل مما يقلل من الحمل على الدافعات الفردية. لكن تكون مضخات الطرد المركزي متعددة المراحل أطول. ولا يمكن تثبيت مضخات الطرد المركزي متعددة المراحل نظرا للحجم المحدود لبناء محطات الضخ الموجودة. لذلك يجب استخدام مضخة طرد مركزي أحادية المرحلة في محطات الضخ هذه. ومع ذلك يتم إنشاء الحمل الزائد على الدافعة لتوليد مثل هذا الضغط العالي باستخدام دافعة أحادية المرحلة. وسيتم في هذا الإجراء المضاد اعتماد مضخات طرد مركزي أحادية المرحلة مصممة خصيصا ومصنوعة في اليابان.
تتميز مضخات الطرد المركزي اليابانية أحادية المرحلة بالإضافة إلى تصميمها المضغوط بأداء عالي لامتصاص الماء وكفاءة عالية وضوضاء منخفضة وموثوقية عالية.

**محطة ضخ المياه الخام**

**مضخة طرد مركزي أحادية المرحلة**

**ب) تطبيق تكنولوجيا الحماية من التآكل والصدأ**

تصنع الأجزاء الرئيسية لمضخات المياه الخام الحالية التي تتآكل وتصدأ بشكل غير طبيعي من صبة فولاذ مقاوم للصدأ. ويعتبر سبب التلف هو جسيمات (الرمل / الطمي) وسبب الصدأ هو أيون الكلوريد العالي في الماء الخام.
ومن أجل تحسين هذه الظروف سيتم تغيير الأجزاء الرئيسية للمضخة إلى صبة مزدوجة من الفولاذ المقاوم للصدأ والذي يتميز بقوة ومقاومة عاليتين للصدأ. سيؤدي ذلك إلى تحسين متانة المضخة ضد الرمل والطمي وتركيز أيون الكلوريد العالي في الماء الخام وبالتالي تمكين أداء مستقر للمضخات مما يؤدي إلى استقرار إمدادات المياه.

**ج) تخفيض تكاليف الطاقة من خلال تحسين الأداء**

قد تقادمت معدات الضخ الحالية بشكل مفرط وتناقصت كفاءة المضخات. حيث يقدر استبدال معدات الضخ بتقليل تكاليف الكهرباء بحوالي 1.54 مليون دينار أردني (= 240 مليون ين) سنويا. (يعتمد الحساب على تشغيل المضخة بنسبة 68.8% وتكلفة وحدة الكهرباء 0.126 دينار أردني / كيلووات × ساعة وسعر الصرف 153.36 ين / دينار أردني.)

**د) التأثير على تقليل الغازات الدفيئة وأهميتها في إجراءات التخفيف من تغير المناخ**

سوف يؤدي تنفيذ هذا المشروع إلى تقليل استهلاك طاقة المضخات بشكل كبير مما يقلل من انبعاث غازات الاحتباس الحراري. ومن خلال تنفيذ هذا المشروع يقدر تقليل انبعاث غازات الاحتباس الحراري من 191.97 طن متري من ثاني أكسيد الكربون / سنويا (لعام 2019) إلى أقل من 185 طن متري من ثاني أكسيد الكربون / سنويا. ويتمتع هذا المشروع أيضا بأهمية كبيرة على إجراء التخفيف من التغير في المناخ عن طريق تقليل انبعاثات غازات الاحتباس الحراري.

**تعليق: المهندس هيثم الكيلاني (شركة مياه مياهنا: مديرية الإنتاج)**

يعد الأردن من أفقر دول العالم في الموارد المائية ومع الأخذ بعين الاعتبار أن حوالي 50% من سكان الأردن يعيشون في عمان تعتبر المياه المعالجة من محطة معالجة مياه زي واحدة من أهم مصادر مياه الشرب في الأردن. لذلك يجب الحفاظ على تشغيلها بكفاءة وإنتاج جودة المياه المطلوبة وكميتها بشكل صحيح.