Palestinian Authority
Jericho Municipality

Palestinian Authority
Capacity Development for Sustainable Wastewater Management of Jericho Municipality

Final Report

July 2023

Japan International Cooperation Agency (JICA)

NJS Co., Ltd.
TEC International Co., Ltd.

GE
JR
23-077

Executive Summary

1. Project Background

The Japanese Government implemented a grant aid project for the construction of sewerage facilities to improve sanitation and living conditions, and to prevent contamination of groundwater, a major source of water in Jericho city and the surrounding areas. The wastewater treatment plant (WWTP) and sewers were completed in June 2014. To ensure the proper operation of the facilities, the Japan International Cooperation Agency (JICA) supported the development of an implementation system and capacity development for the operation, maintenance and management of the facilities of the Jericho sewerage project through the technical cooperation project "Technical Assistance and Capacity Building Project for the Jericho Sanitation Project" (TeCSOM*-I) (2012-2018).

The "Capacity Development for Sustainable Wastewater Management of Jericho Municipality (TeCSOM-II)" (July 2021 - July 2023) aimed to establish a sewerage service management system in the Jericho Municipality; provide sustainable sewerage services through water quality management of increased wastewater inflow by expanding the sewerage network and connecting facilities and homes to the sewerage system; study the effective use of treated sewage sludge; analyse the Jericho Municipality's management; and improve the capacity to obtain public budget and external funding for the sewer network expansion.

*TeCSOM is the Project abbreviation and stands for "Technical Assistance for Capacity Building Sewerage System Operation Management".

2. Project Activities and Achievements

Project Purpose

A Sustainable Wastewater Management System is established in Jericho Municipality.

Overall Goal

Sound environmental and social wastewater services are delivered in Jericho City in a sustainable manner.

(1) Output-1: Activities and Achievement of Improved Planning Capacity for Expansion of Sewer Networks

Activity 1-1: Analysis of Sewerage Management

1) Key Performance Indicators (KPIs)

The Jericho Sewerage Project was assessed using nine KPIs. The formula for calculating each KPI is presented in Table 1, while the KPIs (2015-2023) for the sewerage services management of the

Jericho Municipality are presented in Table 2.

In particular, the sewerage coverage, treated wastewater reuse, WWTP operation and sewerage fee collection ratios were plotted over time from 2015 to 2023 to identify improvement status and problems. Figure-1 shows changes in KPIs (in part) from year to year.

Table-1 Formula for Calculating KPIs

	KPI	Unit	Formula
1	Sewer Network Coverage Ratio	%	$\frac{Constructed\ Sewer\ Length}{Target\ Sewer\ Length}$
2	House Connection Coverage Ratio	%	$\frac{Connected\ Household\ Number\ with\ Access\ to\ Sewerage\ Services}{Total\ Household\ Number\ within\ Service\ Area}$
3	Wastewater Quality Compliance	%	$\frac{Total\ Number\ of\ Samples\ Passed}{Total\ Number\ of\ Samples\ Tested}$
4	Sewage Sludge Quality Compliance	%	$\frac{Total\ Nubmer\ of\ Samples\ Passed}{Total\ Number\ of\ Samples\ Tested}$
5	Facility Operating Ratio	%	$\frac{Daily\ Average\ Inflow}{Design\ Daily\ Average\ Inflow}$
6	Reuse Ratio of Treated Wastewater	%	$\frac{Amount\ of\ Supplied\ Treated\ Wastewater\ to\ Farmers}{Amount\ of\ Treated\ Wastewater}$
7	Unit Treatment Cost	NIS/ m^3	$\frac{Operating\ Expense\ in\ a\ Year}{Amount\ of\ Inflow\ Wastewater\ per\ Year}$
8	Operation Ratio		$\frac{Operating\ Expense\ in\ Year}{Operating\ Income\ from\ Sewerage\ Tariff\ in\ a\ Year}$
9	Collection Ratio	%	$\frac{Income\ from\ Sewerage\ Tariff\ in\ a\ Year}{Billed\ Amount\ of\ Sewerage\ Tariff\ in\ a\ Year}$

Source: TeCSOM-II Survey Results, 2023

Table-2 Jericho Sewerage KPIs

	KPI	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	Sewer Network Coverage Ratio	%	33.9	33.9	33.9	47.3	47.3	47.3	47.3	47.3	47.3
2	House Connection Coverage Ratio	%	10.4	9.9	13.6	13.2	13.1	18.2	17.1	24.5	36.0
3	Wastewater Quality Compliance	%	89	92	-	-	-	-	97.3	94.6	100
4	Sewage Sludge Quality Compliance	%	100	-	-	-	-	-	100	100	100
5	Facility Operating Ratio	%	3.8	7.5	11.9	16.2	17.2	20.1	28.9	38.7	35.8
6	Reuse Ratio of Treated Wastewater	%	0	0	84	73	79	86	75	49	51
7	Unit Treatment Cost	NIS/ m^3	1.14	1.03	1.05	1.04	1.06	1.06	1.05	0.96	-
8	Operation Ratio		24.57	11.74	13.98	4.45	11.35	3.25	4.22	2.77	-
9	Collection Ratio	%	22.5	52.9	30.9	65.5	30.6	62.4	45.6	59.1	-

Source: TeCSOM-II Survey Results, 2023

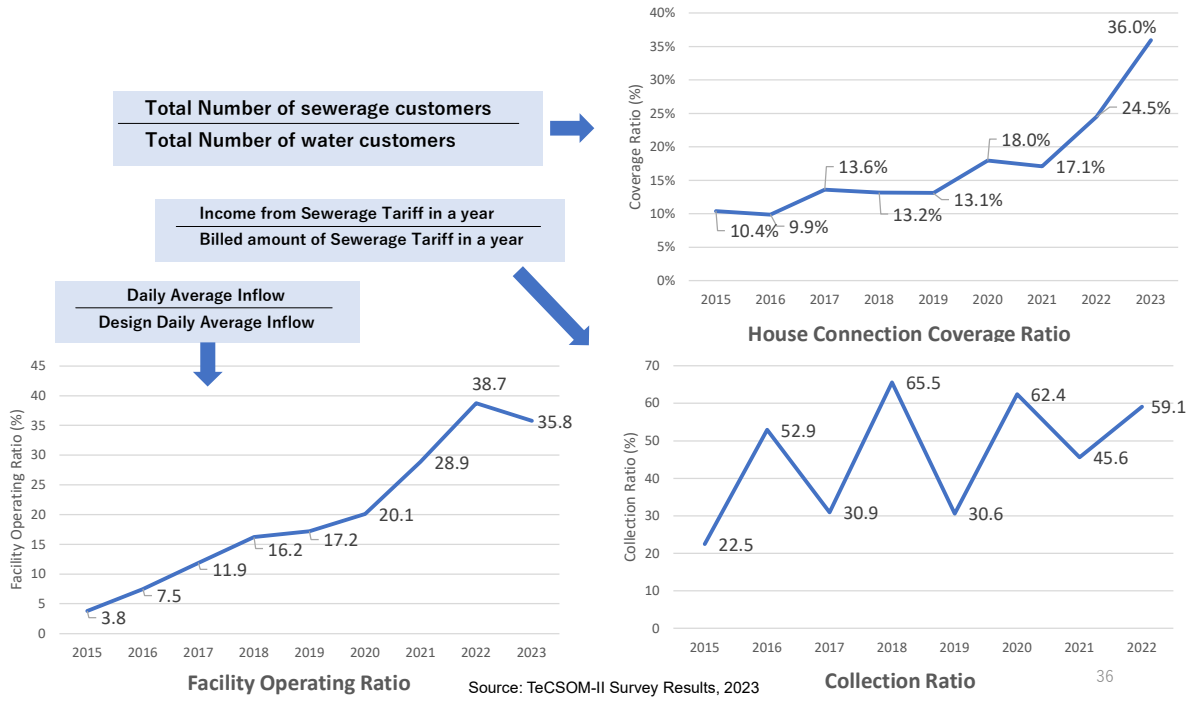


Figure-1 Transition KPIs

2) Study measures to increase revenue from water and wastewater fees and improve their effectiveness

The Jericho Municipality has, through this Project, implemented and improved the effectiveness of the following measures sequentially since around 2021 with the aim of collecting outstanding water fees, increasing the collection rate of water and sewerage fees, eliminating unbilled fees and increasing revenue sources.

Table-3 Measures Taken by Jericho Municipality

	Challenge	Measure
1	Collection of unpaid fees	[Individual] • Suspension of water supply • Introduction of prepaid water meters [Government] • Letter issued to the Ministry of Finance • Direct discussions with the Ministry of Finance
2	Improved collection ratio of water and wastewater fees	• Introduction of prepaid water meters • Procurement of donor-supported prepaid water meters • Enforcement of integrated collection of water and wastewater fees • Penalties for unpaid fees
3	Elimination of unbilled fees	• Sewer house connection completed (Pilot Projects) building surveys to collect connection fees and start collecting sewerage fees • Elimination of zero-readings (replacement of faulty water meters, relocation of water meters)
4	Increased revenue sources	• Elimination of sewerage fee discount campaign (0.5 NIS/m^3→1.0 NIS/m^3) • Water tariff increases for commercial and new buildings • Increase in water connection fees

	Challenge	Measure
5	Public Awareness	• Request for integrated collection of water and sewerage fees • Dissemination of investment of part of the collected amount in water and wastewater services

Source: TeCSOM-II Survey Results, 2023

3) Analysis of changes in unpaid water bills

Accumulated unpaid water supply bills were categorised into 1) individuals with more than 30,000 NIS, 2) government institutions with more than 30,000 NIS and 3) 30,000 NIS and below (both individuals and government institutions). The reason for separating by 30,000 NIS was that the 23 unpaid persons (approximately 0.28% of the total unpaid persons) accounted for approximately 13.2% of the total unpaid amount and were therefore considered to have a significant impact. A comparison of the accumulated unpaid water supply fees from September 2021 to August 2022 is shown in Figure-2.

The measures taken by Jericho Municipality, as shown in Table-3, have helped reduce the accumulated unpaid amount of individual water bills over 30,000 NIS by approximately 34.3% while that of government institutions increased by approximately 22.7%, and the accumulated unpaid amount below 30,000 NIS also increased by approximately 17.2%, resulting in an overall increase in the accumulated unpaid amount of approximately 6.3%.

Following this result, Jericho Municipality requested the Ministry of Finance to pay the unpaid amount, and a portion of the accumulated unpaid water fees of 1.09 million NIS (equivalent to approximately 12.4% of the accumulated unpaid amount for government institutions) was paid.

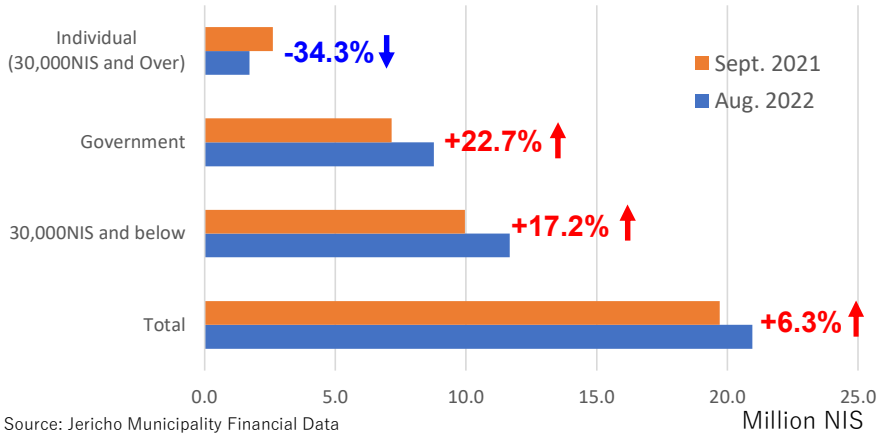


Figure-2 Amount of Unpaid Water Bills

Activity 1-2: Prediction of Sewage Inflow into Jericho Wastewater Treatment Plant

1) Analysis of the amount of sewage inflow into the wastewater treatment plant

Nine years have passed since the Jericho Wastewater Treatment Plant started operation in June 2014, and the amount of influent sewage has increased by a factor of approximately ten, from an initial volume of approximately 250 m^3/day to 2,437 m^3/day in August 2022. Comparing the inflow of sewage at the start of the project (July 2021) and at the end of the project (July 2023), the inflow shows an increasing trend.

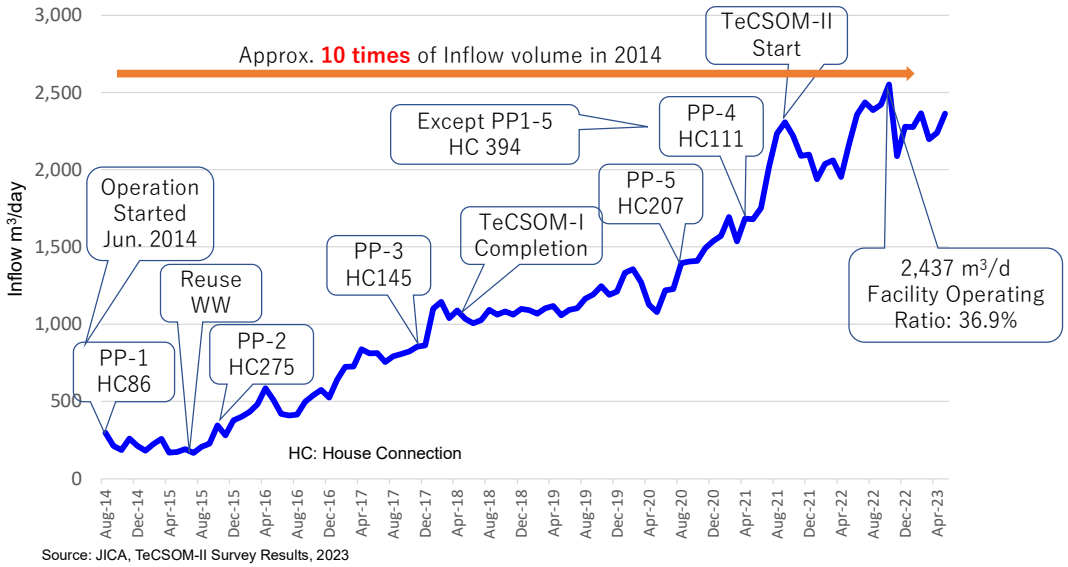


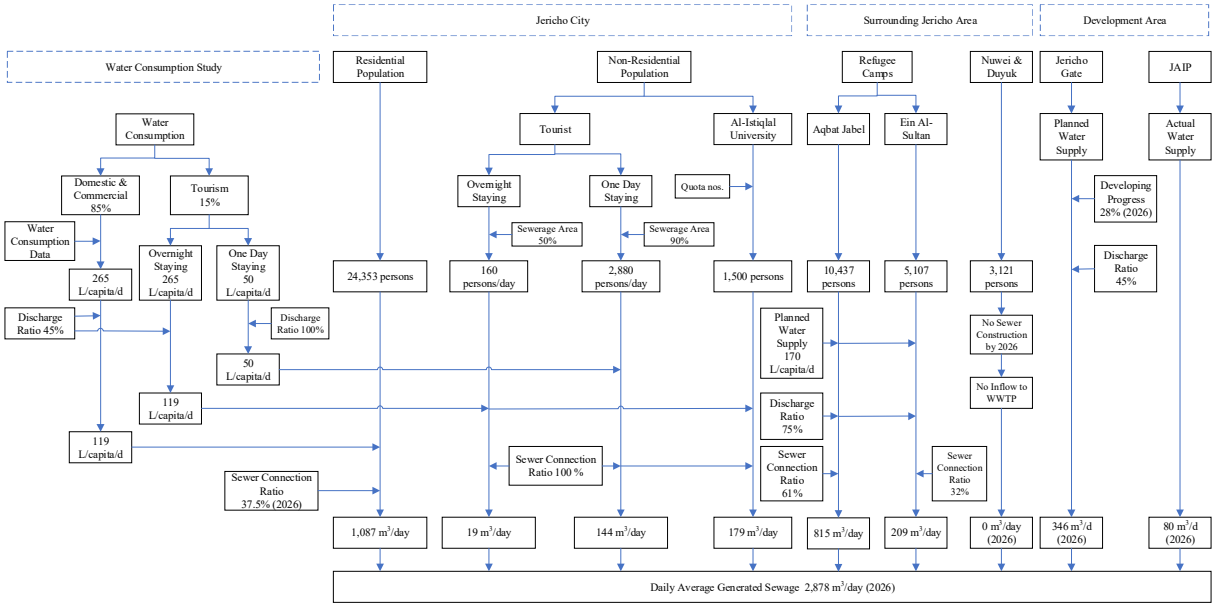
Figure-3 Amount of Sewage Inflow

2) Prediction of sewage inflow

Predicting the volume of wastewater entering the Jericho WWTP is useful not only for the operation and maintenance of the plant, but also for predicting the consumption of electricity and reagents (disinfection) for the operation and planning of wastewater management. In Jericho, treated wastewater is sold to farmers for agricultural use, and trends in the volume of treated effluent also affect revenues from the sale of treated wastewater.

The volume of sewage inflow into the WWTP up to 2026 has been projected, taking into account factors such as population growth (e.g. resident population, tourist population), water supply demand and land use plans (development of the surrounding areas, i.e. Jericho Agro-Industrial Park (JAIP), Jericho Gate as a new housing development area and refugee camp sewage reception) and connections to sewerage systems. Figure-4 shows the factors related to the prediction of the sewage inflow volume and the inflow projection. Jericho Municipality can now continue to predict the volume of sewage inflow in accordance with the procedure for formulation of Figure-4. As a precondition for this projection, other donor support for the expansion of sewer networks is not

taken into consideration.



Source: TeCSOM-II Survey Results, 2023

Figure-4 Planning for Sewage Inflow Projection

Projected sewage inflow into the wastewater treatment plant showed that the second reactor would need to be operational in 2024.

Table-4 Planned Sewage Inflow

Year	2022	2023	2024	2025	2026
Planned Daily Average Inflow (m^3/day)	2,053	2,294	2,618	2,744	2,878
Planned Daily Maximum Inflow (m^3/day)	2,690	3,005	3,430	3,595	3,771
Reactor No.1	On	On	On	On	On
Reactor No.2	-	-	On	On	On

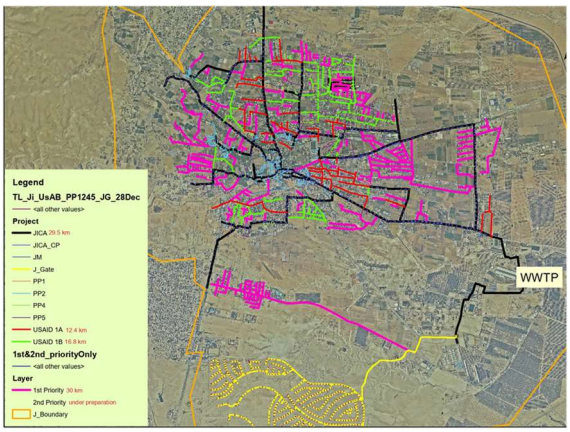
Source: TeCSOM-II Survey Results, 2023

Activity 1-3: Sewer Network Expansion Plan

Information on the existing sewers (JICA Grant Aid Project, United States Agency for International Development (USAID), Sewer House Connection Construction (Pilot Project)) was entered into the Geographic Information System (GIS) and a centralized management system was established. In addition, sewer information (e.g., location, extension, diameter, etc.) was categorized by phase including information on projects of other development partners. The latest sewer information can now be shared with the relevant departments and sections in Jericho Municipality.

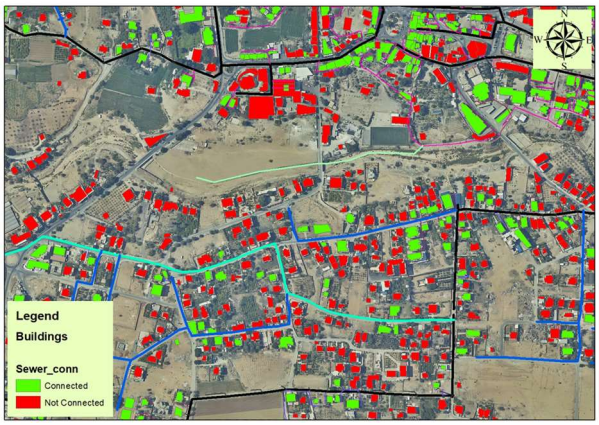
In addition, it is now possible to identify houses that are connected or unconnected to the sewerage system and to identify priority areas for development with GIS data. As a result, this makes it much easier to explain to the public and can be used for further investments. In fact, it was shared during discussions with the USAID consultants that GIS was used to easily screen priority areas/routes in the sewer expansion plan.

The existing sewer routes and information on houses connected to the sewerage system (in part) are shown in Figures - 5 and 6 respectively.



Source: TeCSOM-II Survey Results, 2023

Figure-5 Existing and Planned Sewers

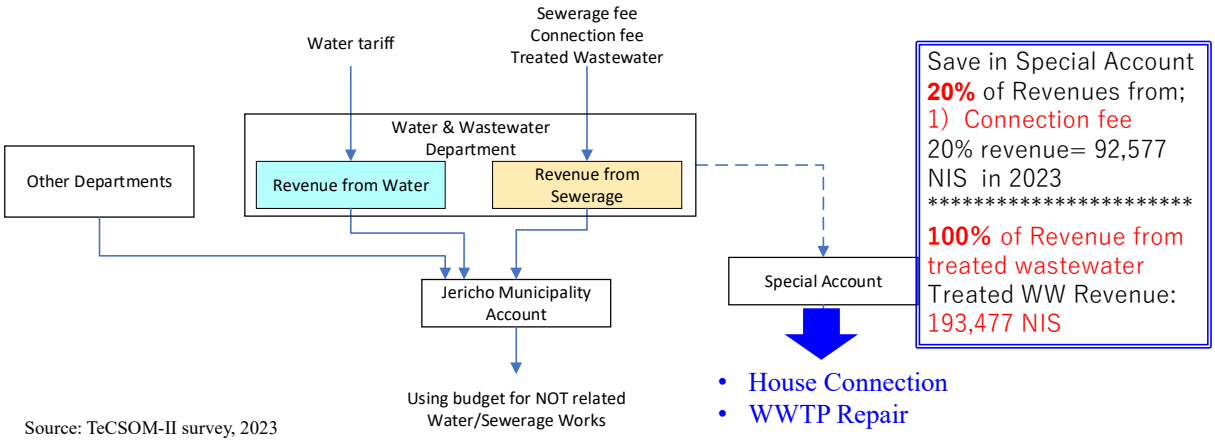


Source: TeCSOM-II Survey Results, 2023

Figure-6 Connected and Unconnected Houses

Activity 1-4: Securing Financial Resources for Sewerage Project

The Project has created a new Special Account in the Water and Wastewater Department. This was set up as a sustainable, dedicated source of funding to cover sewerage development and WWTP maintenance costs. Specifically, 20% of the sewerage connection fees are earmarked as the revenue source for sewerage development, and 100% of the revenue from the sale of treated wastewater is to be saved in the Special Account to be used for WWTP maintenance costs.



Source: TeCSOM-II survey, 2023

Figure-7 Special Account

The following measures have been taken by Jericho Municipality to secure the financial resources for the sewerage development costs:

i) Start collecting sewer house connection fees for houses with on-premises sewer connections, and collecting their sewerage fees;

ii) Enforcement of integrated collection of water and wastewater fees;

iii) Penalties by means of water supply suspensions to individual consumers due to unpaid water and sewerage fees.

Sewer house connection completed (Pilot Projects) building surveys to collect connection fees and start collecting sewerage fees

Activity 1-5: Promotion of Opinion Exchanges between Related Organizations for the Sewerage Expansion by PWA

The PWA has allocated 1 million NIS to the Jericho Municipality for support in 2023. The purpose of the budget is to complete sewerage development, especially the construction of sewers in the Kitf Alwad area & around the Ein Sultan spring.

The Water and Wastewater Department of Jericho Municipality has reported to the PWA on their activities and achievements towards improving the sewerage service management in the Project. In addition, the PWA participated in the Joint Coordinating Committee (JCC) and recognised the commitment of Jericho Municipality to the sewerage project. Thereby, the PWA made it known to other donors, such as the European Union (EU), that Jericho Municipality was worthy of additional investments, and the PWA ranked the Jericho sewerage project as a high investment priority, with support from the EU.

As one of the achievements, with USAID support, the sewer development was studied, planned and designed in March 2023. USAID visited the Jericho Wastewater Treatment Plant in September 2022, where support for sewerage projects was discussed and a full study was conducted in January 2023. The proposed support includes: i) construction of sewers; ii) solar power generation facility; and iii) road pavement improvements in areas of subsidence due to the USAID sewer construction project. In July 2023, the sewer planning and design by the USAID consultant was completed.

(2) Output-2: Activities and Achievement of Improved Water Quality Monitoring Capacity

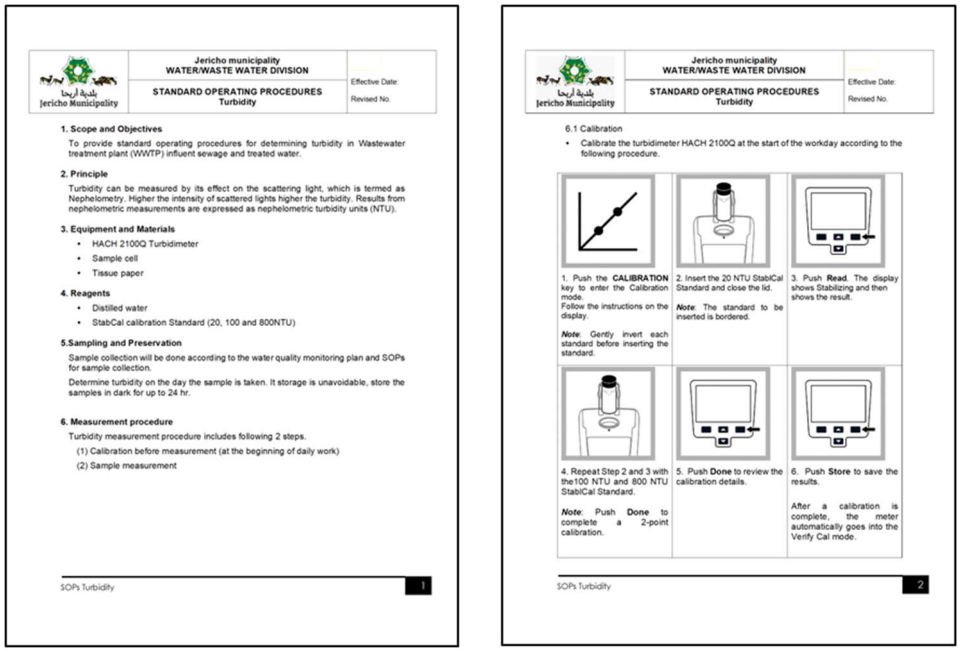
Activity 2-1: Prepare and Revise Water Quality Testing Manuals/SOPs

Prior to the start of the Project, the laboratory technician in Jericho Municipality had been concurrently responsible for water and wastewater services. However, Jericho Municipality has hired additional full-time laboratory technicians in the Jericho Wastewater Treatment Plant. The achievements out of this activity are as follows:

i) Development of a water quality monitoring plan: The frequency of measurement was determined for each water quality parameter, and the quality of influent sewage and treated wastewater at the Wastewater Treatment Plant was measured.

ii) Development of a procurement plan for water quality measuring reagents and securing a budget for Jericho Municipality: The required budget for the quantity of reagents was allocated according to the water quality monitoring plan. Jericho Municipality secured the necessary budget and procured the reagents.

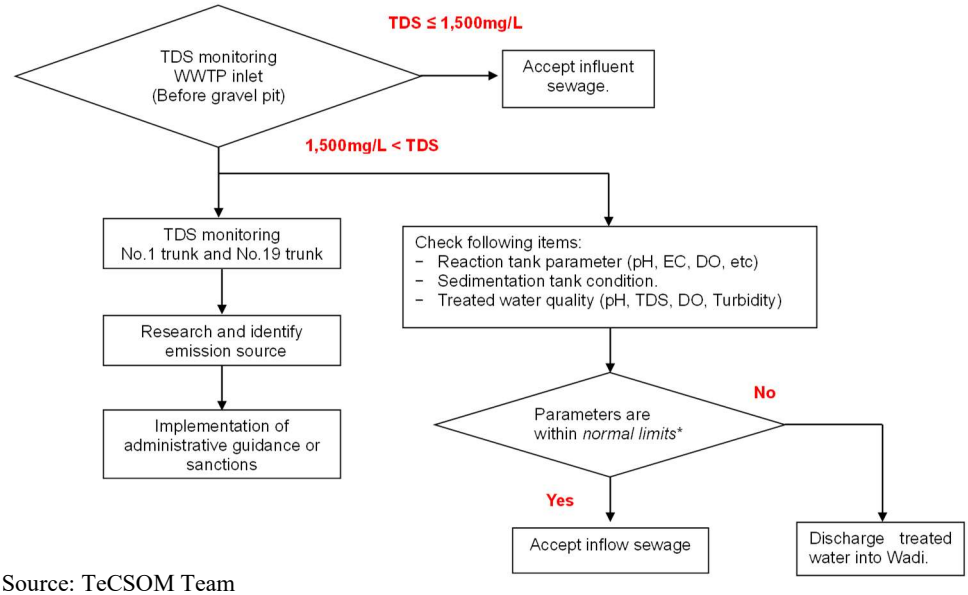
iii) Preparation/revision of 12 SOPs: The existing Standard Operating Procedures (SOPs) were revised and new SOPs were prepared for measurement in the water quality laboratory. The SOPs incorporate diagrams to make the content easy to understand and are laminated on both sides in A4 size so that they can be checked at any time.



Source: TeCSOM Team

Figure-8 SOP

iv) Procedures in case of unusual water quality inflows: Procedures for detecting and responding to unusual values in influent sewage using Total Dissolved Solids (TDS) and pH indicators were developed.



Source: TeCSOM Team

Figure-9 Procedures in Case of Unusual Water Quality Inflow (TDS)

Activity 2-2: Training on Water Quality Testing

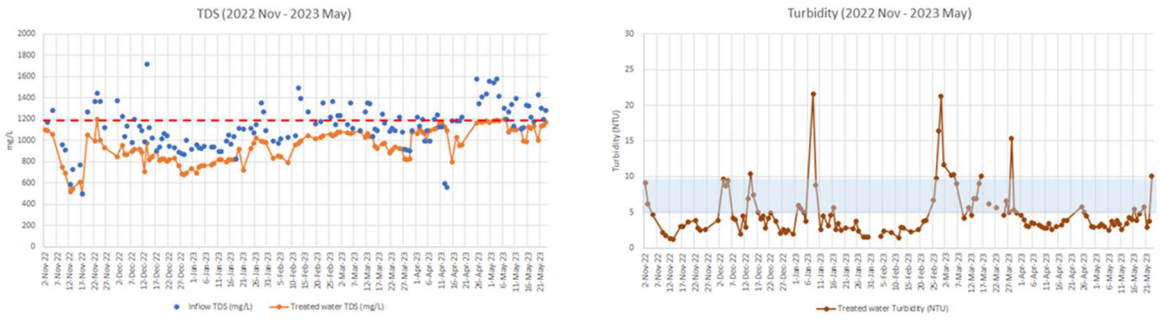
The training on water quality testing included the following menus:

i) Proper use of water quality measuring equipment;

ii) Water quality measurement in accordance with the prepared monitoring plan and SOPs;

iii) Data accuracy control through regular calibration of measuring equipment.

Achievements include improved water quality measurement capacity (knowledge, skills), accumulation of data on water quality analysis and its management, and use of the data (understanding of water quality behaviour and detection of unusual values) of the laboratory technicians.



Source: TeCSOM-II Survey Results, 2023

Figure-10 Water Quality Behaviours and Associated Values

Activity 2-3: Seminar on Water Testing Results

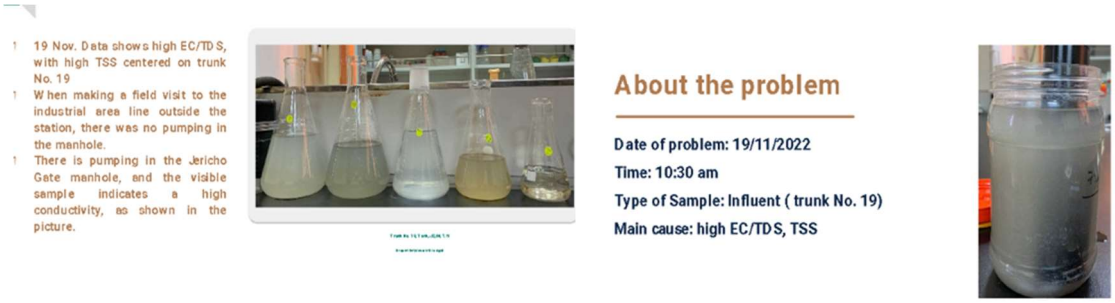
The counterparts presented the accumulated water quality measurement data and results from the On-the-Job Training (OJT) at weekly meetings, workshops and Joint Coordinating Committees (JCCs).

i) Explanation of water quality measurement results and compliance with standards for the treated wastewater reuse;

ii) Collaboration between the Jericho WWTP operator and laboratory technicians to share data and improve operational control;

iii) Detection and response to abnormal water quality values;

iv) Understanding of the safety of treated wastewater through the publication of water quality data.



Source: TeCSOM Team

Photo-1 Inflow Sewage Problem

During the Project period, 37 water quality parameters of the treated wastewater were measured three times, with a good water quality compliance rate of approximately 97.3%. Water quality parameters that did not meet the reuse standard[*1] were also exceeded by approximately 10%, but the reuse of treated wastewater was not affected.

*1: Palestine Standard (PS) 742-2015, Treated Wastewater Effluent for Agriculture Purpose

(3) Output-3: Activities and Achievement of Treated Sewage Sludge Reuse

Activity 3-1: Evaluation of Sewage Sludge Treatment Method

At the Jericho Wastewater Treatment Plant, the excess sludge generated is thickened and solar-dried in sludge beds. The following issues were therefore studied:

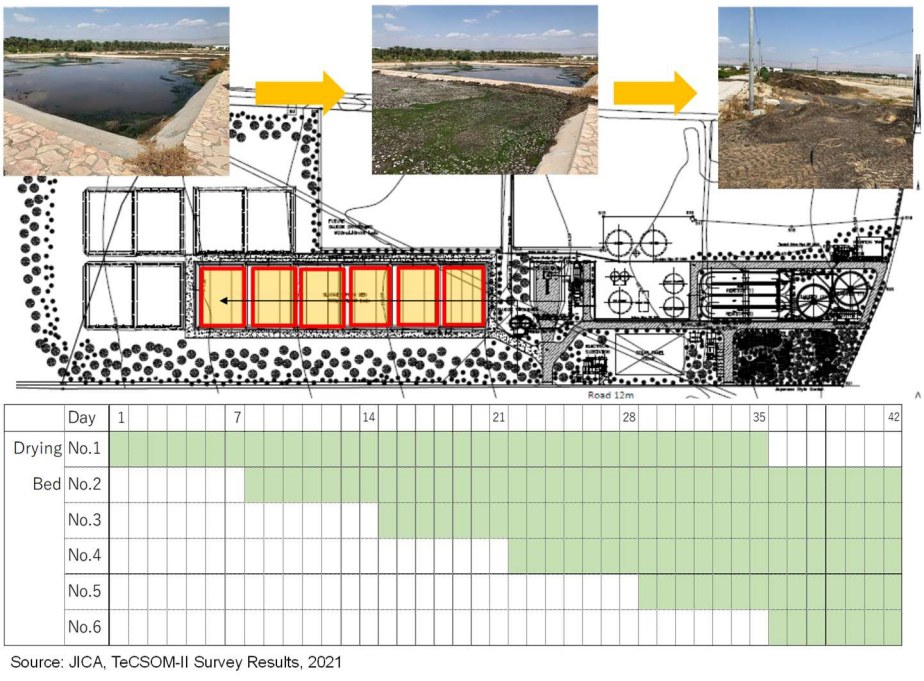
i) Assessing the amount of dried sewage sludge generated and planning sludge drying cycles in drying beds;

ii) Verifying proper treatment of the sewage sludge with compositional analysis results of the dried sludge, approximately 10% moisture content and no Total Faecal Coliform detected.

Dried sludge treatment can be carried out in the existing facilities (six beds) if sludge is treated in cycles of up to five weeks. Palestine's "Technical Instructions, 59 for year 2015 - Treated Sludge for Agricultural Reuse" (Refer to Appendix 2.3.4) lists biological, chemical and thermal treatment as appropriate sludge treatment methods. The Jericho Wastewater Treatment Plant uses solar drying, which is in line with the Technical Instructions.

The Ministry of Agriculture, in discussions with the Jericho Municipality, advised that the solar-dried sludge treated at the Jericho Wastewater Treatment Plant is of high quality (equivalent to PS 898-2010 classification Class I, refer to Appendix 2.3.5) and therefore the treated sludge can be considered for use as a soil conditioner. The Ministry of Agriculture verbally mentioned that the dry sludge treatment at the Jericho Wastewater Treatment Plant is appropriate.

The results of the component analysis also show that solar drying sludge treatment, which is used at the Jericho Wastewater Treatment Plant, is an appropriate method.



Source: JICA, TeCSOM-II Survey Results, 2021

Figure-11 Sludge Drying Treatment Cycle

Activity 3-2: Study on the Treated Sewage Sludge Reuse

1) Evaluation of the safety of treated sewage sludge and reuse promotion

The heavy metal content in dried sewage sludge was measured and the results confirmed that 100% compliance with the standard*2 was achieved and safety was ensured. The heavy metal content was compared not only with the Palestinian standards, but also with the heavy metal content shown in the Land Application of Sewage Sludge by the United States Environmental Protection Agency (EPA) for reference purposes, and found to be within the standard values.

Meanwhile, sludge composition analyses results showed that the content of nitrogen, phosphorus and potassium was 10 to 40 times higher than that of ordinary soil (Samed Land owned by Jericho Municipality), indicating the effectiveness of dried sludge as a soil improvement material.

*2: Technical Instructions (TI) 59-2015, Use of Sewage Sludge in Agriculture

2) Reuse of treated sewage sludge

i) Discussions with the Ministry of Agriculture and workshops for Jericho farmers (palm farmers)

In the Project, discussions were held with the Ministry of Agriculture and the Palm Farmers Cooperation Association (PFCA) regarding the reuse of treated wastewater and treated sewage sludge, and an understanding was gained regarding the reuse of treated wastewater as irrigation water, the suitability of sludge treatment, the safety of dried sludge and the effectiveness as a soil conditioner.

The Ministry of Agriculture commented that: 1) the heavy metal and moisture contents, etc., meet the standard values; 2) use of the dried sludge as a soil amendment is agreed upon; and 3) the proposed reuse of the treated sludge from the pilot plant in the WWTP and in the city-owned Samed Land is noteworthy. However, the Ministry of Agriculture was reluctant to allow the distribution of dried sludge to ordinary farmers. The reasons for this are as follows:

- Treated sewage sludge should, for the time being, be used under conditions where it can be monitored and controlled. The use of dried sludge where it cannot be controlled is not permitted.
- When treated dried sludge is distributed, regardless of whether it is distributed free of charge, the sludge composition must be verified by the Ministry of Economy.
- When treated sludge is reused as a soil conditioner, soil composition and plant growth are monitored in the pilot plants for a period of at least three years.

Jericho Municipality needs to address these issues in cooperation with other relevant bodies.

Table-5 and Table-6 show the heavy metal content and composition of the dried sludge, respectively.

Table-5 Heavy Metal Content of Dried Sludge

Parameters	Palestine[1)]	EPA[2)]	Soil (2014)	Sludge (2014)	Sludge (2015)	Sludge (2021)	Sludge (2022)	Sludge (2023)
Cadmium	**20**	85	ND[3)]	3.2	1.94	ND	ND	1.2
Copper	**1,000**	4,300	33.6	279.5	153.3	0.179	1.81	230.7
Nickel	**300**	420	39.5	30.2	31.9	0.026	0.15	24.8
Lead	**750**	840	ND	29.7	15.7	0.018	0.15	22.99
Zinc	**2,500**	7,500	100.4	1,258	1,029	0.55	3.59	518.9
Mercury	**16**	57	0.0133	2.969	1.67	ND	ND	ND
Chromium	**400**	3,000	42.4	ND	43.45	0.039	0.28	31.36

Unit: mg/kg of dry matter

1) Certification of Obligatory Technical Instructions, Treated Sludge for Agricultural Reuse, 59 for year 2015
2) United States Environmental Protection Agency, Land Application of Sewage Sludge, A Guide for Land Appliers on the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR Part 503
3) ND: Not Detected

Data Source: JICA, TeCSOM Project Completion Report, 2018, TeCSOM-II Survey Results, 2023

Table-6 Dried Sludge Composition

Parameters	unit	Sludge[1)] (2021)	Sludge[1)] (2022)	Sludge[1)] (2023)	Samed[1)] Soil (2022)	Soil Conditioner Standard[2)]	Improvement of Soil[4)]
Nitrogen (N)	%	2.855	4.0	4.4	0.085	>1.5	
Phosphate (P_2O_5)	mg/kg	219	215	205	22.6		
Kalium (K_2O)	mg/kg	323	326	320	32.5		
pH		6.8	6.9	6.9	7.26	<7.5	5.0-8.5
EC	dS/m	7.7	7.5	8.7	1.32	<15	
Moisture Content	%	9.9	8.9	14.4	9.4	<20	25-40
Total Fecal Coliform[3)]	CFU/100mL	Nil	Nil	Nil	Nil	<10	
Total Organic Matter	%	62.83	63.76	59.9	8.43	>50	>25
Carbon-Nitrogen ratio (C:N)		11:1	8:1	13:1	99.2	<15:1	<25:1

1) TeCSOM-II, Sewage analysis by An-Najah National University, TeCSOM-II Survey Results, 2023
2) Palestine Standard PS609-2014, Organic fertilizers and soil conditioners
3) U.S. EPA, 1999, Environmental Regulations and Technology, EPA stipulates Class A less than 1,000 MNP per 1 gram
4) Palestine Standard PS 2652-2011, Organic Fertilizer (Humus) Compost

ii) Pilot plants (Experimental Farm)

Jericho Municipality has started reusing dried sludge as a soil conditioner on city-owned Samed Land, in addition to the pilot plant (experimental farm) set up at the wastewater treatment plant, where palm trees, lemons, etc. are grown.

In addition, a budget for a plantation project has been secured towards Jericho Municipality's Green City vision, and this plan has been implemented since late May 2023, including the planting of date palms, olives and paulownia. Once completed, it is expected that the plan, as

illustrated below, can be presented to visitors to the wastewater treatment plant as a model for the reuse of treated wastewater and treated sewage sludge.

Photo-2 Plantation Project

Table of Contents

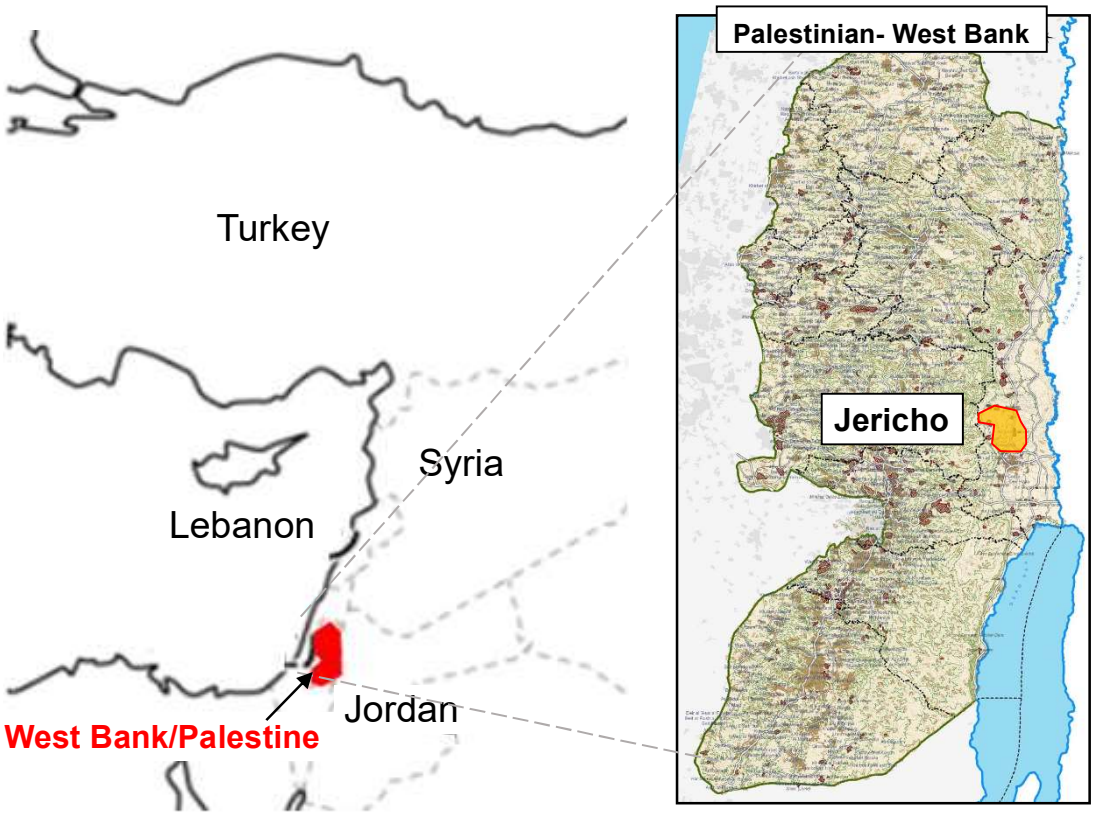
Table of Contents

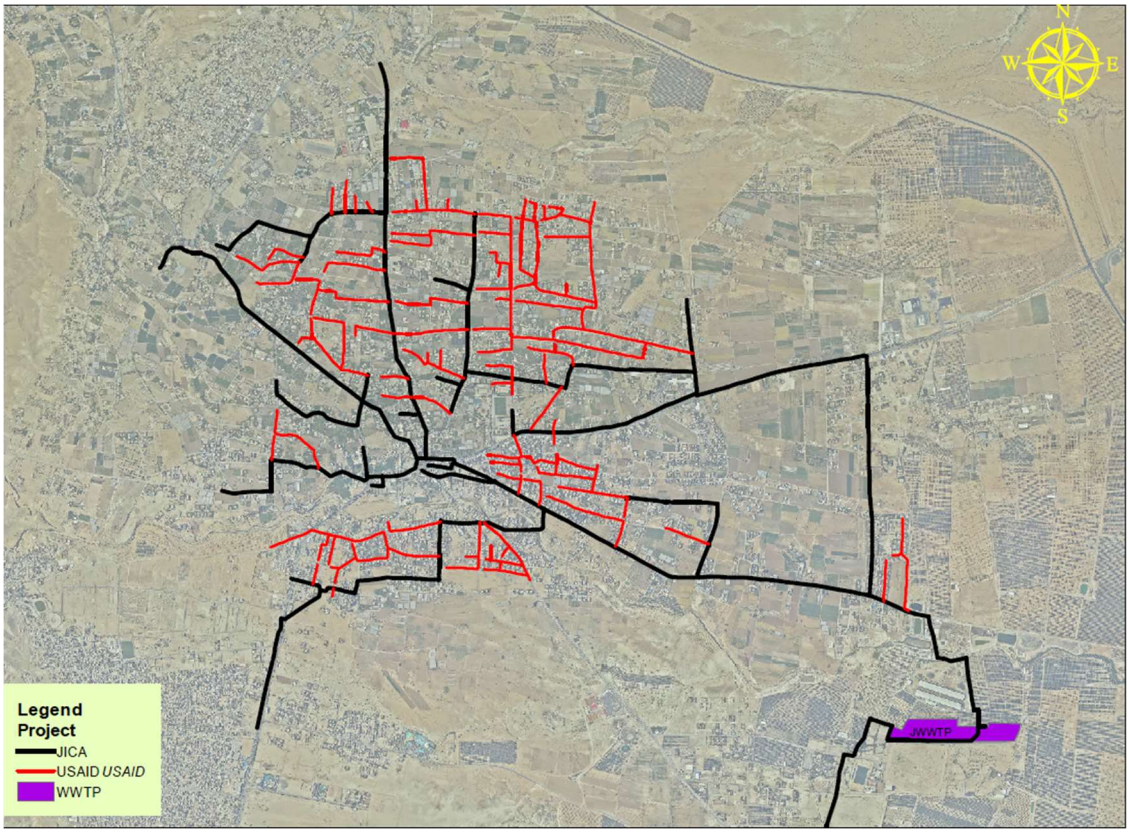
【Abbreviations】

AFD	French Agency for Development
BOD_5	Biochemical Oxygen Demand
CAD	Computer-Aided Design
CO_2	Carbon dioxide
CODcr	Chemical Oxygen Demand
COSTEA	Scientific and Technical Committee of Agricultural Water
C/P	Counterpart
DAF	Dissolved Air Flotation
DO	Dissolved Oxygen
EC	Electricity Conductivity
ECU	Environment Control Unit
EPA	United States Environmental Protection Agency
EQA	Environment Quality Authority
EU	European Union
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit
GPS	Global Positioning System
HWE	House of Water & Environment
IPIEA	Investment Promotion and Industrial Estates Agency
JAIP	Jericho Agro-Industrial Park
JCC	Joint Coordinating Committee
JDECo	Jerusalem District Electricity Company
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
MDLF	Municipal Development and Lending Fund
MEDISS	Mediterranean Integrated System for Water Supply
MLSS	Mixed Liquor Suspended Solids
MoA	Ministry of Agriculture
MoFA	Ministry of Foreign Affairs of Japan
MoLG	Ministry of Local Government
NIS	New Israeli Shekel
NTU	Nephelometric Turbidity Unit
O&M	Operation and Maintenance
ODA	Official Development Assistance
OJT	On-the-Job Training

PP	Pilot Project
PPWM	Prepaid Water Meter
PR	Public Relations
PWA	Palestinian Water Authority
RO	Reverse Osmosis Membrane
ROJ	Representative Office of Japan to Palestine
SCADA	Supervisory Control And Data Acquisition
SDGs	Sustainable Development Goals
SMS	Short Message Service
SOP	Standard Operating Procedure
TeCSOM	Technical assistance for Capacity building Sewerage system Operation Management*1
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UNOPS	United Nations Office for Project Services
USAID	United States Agency for International Development
WBWD	West Bank Water Department
WSRS	Water Sector Regulatory Council
WWD	Water and Wastewater Department
WWTP	Wastewater Treatment Plant

*1) “TeCSOM-I” refers to the technical cooperation project from 2012 to 2018
“TeCSOM-II” refers to this Project
“TeCSOM (without suffix)” refers to counterparts of this Project





Location map

Chapter 1 The Project Outlines

1.1 Overview of the Project

The city of Jericho is located on the West Bank of the Palestinian Authority. The Ein Sultan Spring is used for domestic water supply, and the spring and groundwater are used for agricultural water. Before sewerage projects were implemented, wastewater generated in the city had been discharged untreated from the cesspit tanks of each house and facility, and percolated underground, causing groundwater contamination.

In order to improve abovementioned situation and the water environment, to avoid ground water contamination and to improve the living conditions and sanitation of the residents, the Japanese government implemented "The Jericho Wastewater Collection, Treatment System and Reuse Project", funded on the grant-aid basis, to construct sewerage facilities for the city of Jericho and its surrounding areas. To this effect, the Jericho Wastewater Treatment Plant (WWTP) and sewers were completed in 2014. In order to operate these facilities properly, the Japan International Cooperation Agency (hereinafter referred to as “JICA”) further supported implementation and improvement of the sewerage project by strengthening capacity for its management, operation and maintenance through the “Technical Assistance and Capacity Building Project for the Jericho Sanitation Project” known as “TeCSOM*-I” (2012-2018), funded and carried out in the form of a technical cooperation project.

In this context, another related project to develop sewer networks in Jericho city and its surrounding areas was being implemented with the support of the Palestinian Authority and United States Agency for International Development (USAID), but progress has stalled since the suspension of USAID support in January 2019 and a chronic financial shortfall and lack of management ability of the main bodies of Palestinian side, Palestinian Water Authority (PWA) and Jericho Municipality. Due to the lack of development of the sewer networks, the sewage inflow into the Jericho WWTP had been currently substantially less than the planned “design” sewage influent volume.

Sewage from the areas surrounding Jericho City (Ein Sultan refugee camp, Jericho Gate development complex, Jericho Agro-Industrial Park) is also planned to be received at the Jericho WWTP. It is important to improve water quality testing capacity for inflow sewage at the Jericho WWTP for the relevant operation of the WWTP and the quality of the treated wastewater for reuse.

To improve the abovementioned situation of the wastewater sector in Jericho, the Palestinian Authority requested the Japanese government to dispatch experts who support capacity development in the following areas, with the aim of establishing a sustainable wastewater management system for Jericho.

1) Expansion of the sewer networks and increase of sewage inflows into the Jericho WWTP;
2) Establishment of a water quality monitoring and management system;
3) Effective reuse of sewage sludge;
4) Analysis on the management of Jericho Municipality;
5) Acquisition of funding, from public budget and external sources, for sewer network expansion.

In response to this request, JICA launched the 'Capacity Development for Sustainable Wastewater Management of Jericho Municipality', known as TeCSOM*-II (from September 2021 to July 2023), and commenced dispatching the experts.

*TeCSOM is the Project abbreviation and stands for "Technical Assistance for Capacity Building Sewerage System Operation Management".

1.2 Project Purpose and Outputs

The Project outlines, outputs and activities are shown in Table 1.1.

Table 1.1 Project Summary

Item	Summary
Project Title	Capacity Development for Sustainable Wastewater Management of Jericho Municipality
Overall Goal Project Purpose	Overall Goal: Sound environmental and social wastewater services are delivered in Jericho City in a sustainable manner. **Project Purpose: A Sustainable Wastewater Management System is established in Jericho Municipality.**
Objective of the Project	The objectives of this Project will be achieved by improving the sewerage project operation capacity of the Palestinian counterparts (hereinafter referred to as "C/P").
Target Site	Jericho Municipality, Jericho City
Outputs	**Output-1**: Based on the current status and future projections of wastewater treatment in Jericho, including the water balance, the capacity to plan for the expansion of the sewer network to increase the inflows into the Jericho Wastewater Treatment Plant is strengthened. **Output-2**: Capacity for influent water quality testing in the Jericho Wastewater Treatment Plant is strengthened. **Output-3**: Potential for reuse of the sewage sludge from the Jericho Wastewater Treatment Plant is studied.
Activities	1-1: Analyze the management situation of sewerage services in Jericho Municipality. 1-2: Grasp the sewage influent volume at the Jericho Wastewater Treatment Plant and estimate the future inflows. (This includes understanding the water balance of the sewerage catchment areas, estimating the sewered population, and reviewing the wastewater generation unit volume (litres per capita per day). 1-3: Support the development of a plan for expansion of the sewer network in Jericho. 1-4: Support the study and implementation of methods for securing funding for sewer network expansion projects. 1-5: Support the promotion of opinion exchanges between related organizations for the sewerage expansion by PWA. 2-1: Support the preparation of a water quality manual for the Water and Wastewater Department

	(WWD) of Jericho Municipality. 2-2: Conduct training on testing the influent sewage quality for operatives at the Wastewater Treatment Plant. 2-3: Conduct a seminar on how to evaluate and deal with water quality test results for the Water and Wastewater Department (WWD) in Jericho Municipality. 3-1: Evaluate options for treatment of sludge discharged from the Jericho Wastewater Treatment Plant. 3-2: Conduct training on how to reuse the sewage sludge and support the exchange of opinions between the Ministry of Agriculture and the project implementing agency.
Implementing Agency	Palestinian Water Authority (PWA), Wastewater Department Jericho Municipality, Water and Wastewater Department (WWD)
Implementation Schedule	July 2021 to July 2023

1.3 Assignment of Japanese Experts

The JICA Expert Team (hereafter, "TeCSOM Team") was comprised of three members. Their names, positions and assigned tasks are shown in Table 1.2.

Table 1.2 JICA Expert Team Members

No.	Position and/or Assigned Tasks	Name
1	Chief Advisor/Sewerage Management	Satoru Oniki
2	Water Quality Management	Yasuhiko Morita
3	Sewage Sludge Management	Hirofumi Sano

The mobilization/dispatch for experts is as shown in the figure below. This dispatch considered the efficiency of operations and work schedules.

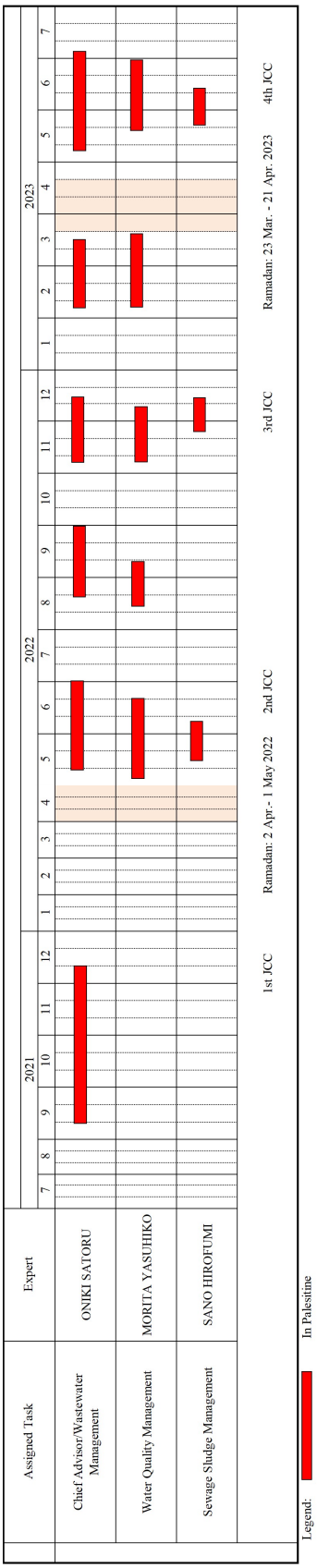


Figure 1.1 Expert Mobilization/Dispatch

1.4 Analysis on Challenges/Issues of Sewerage Management in Jericho Municipality

Figure 1.2 summarizes the status in 2021 and issues related to sewerage management by Jericho Municipality and the relationship between these issues. These issues are classified into three categories:

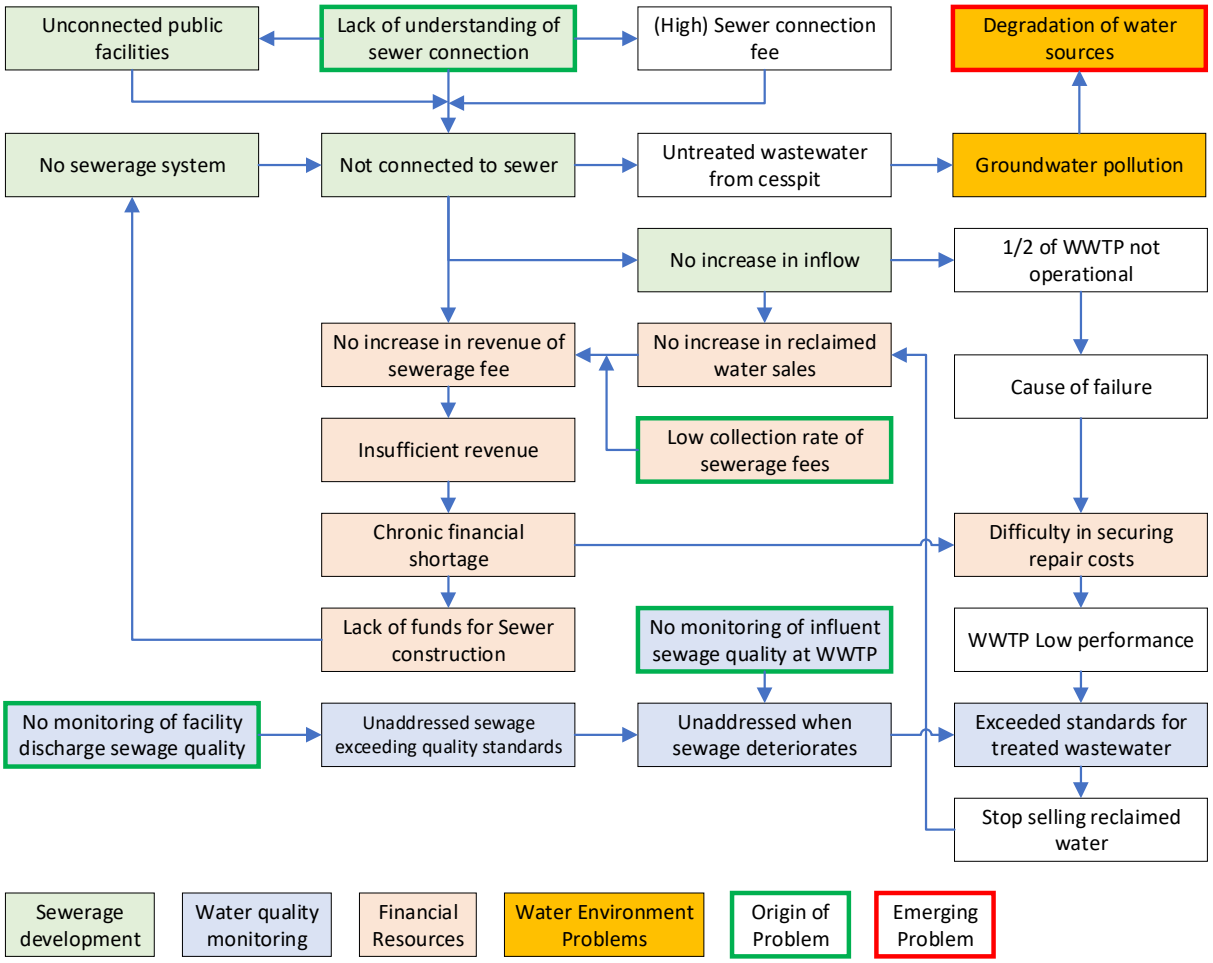
1. Sewer development;
2. Sewerage finance; and
3. Wastewater quality monitoring.

A problem resulting from delay in the expansion of sewer networks is the deterioration of groundwater resources quality through contamination by the discharge of untreated cesspit wastewater.

The upstream problems that were at the root of this issue in the early stage of the TeCSOM-I include:

1) Viewpoint from sewerage development, "Lack of understanding on the necessity of sewer connections (including house connections)".
2) Viewpoint from sewerage finance, "No increase in sewerage fee revenues" and "low collection rate of sewerage fees".
3) Viewpoint from wastewater quality monitoring, "No monitoring of facility discharge sewage quality" and "No monitoring of influent sewage quality at the WWTP".

These issues were therefore predominantly addressed in the Project.



Source: TeCSOM-II Survey Results

Figure 1.2 Relationship between Sewerage Issues in Jericho

The challenges/issues and the measures of the sewerage services in Jericho Municipality are shown below, from the four perspectives of 1) sewerage management (finance), 2) sewerage development, 3) sewage quality management, and 4) sewage sludge management.

1.4.1 Challenges and Measures of Sewerage Management

As part of the Japan Grant Aid project (completed in 2014), the main sewers (total length of sewers 29.66 km, diameter 150-700 mm) were constructed along with the construction of the Jericho Wastewater Treatment Plant. The volume of sewage inflow into the WWTP was 1,100 m^3/day in January 2018 and 1,700 m^3/day in June 2021. The majority of the branch sewers and connection pipes (constructed by Jericho Municipality up to connection pits on the public roads) are the responsibility of the Jericho Municipality, and the implementation of the Jericho Municipality's portion affects the increase in the volume of inflow sewage.

The problem in terms of sewerage services management in Jericho Municipality is chronic financial

shortfalls, and the most specific initiatives to tackle this problem was to increase in revenue from sewerage fees. The measures proposed on the Project were as follows.

1) increase the number of sewerage users; 2) increase the sewerage fee rates (elimination of discount campaigns); 3) increase the collection ratio of sewerage fees.

1.4.2 Challenges and Measures for Sewerage Development

(1) Promoting Connections to Sewerage Systems

In order to increase the number of new household connections to the sewerage system, it was necessary to 1) increase the development of sewers in the public sector; 2) extend connection pits in the public service sector; and 3) accelerate the process of applying for new sewer connections. With regard to 1) and 2), it was important to secure financial resources and donor support for the sewer development.

(2) Donor Support

The construction of the branch sewers as a part of the 1-B project was suspended in January 2019 due to the suspension of the USAID support. Since then, donor support to Jericho Municipality has been discontinued and Jericho Municipality needed to consult strategically with the PWA for expansion of the sewer network.

1.4.3 Challenges and Measures for Water Quality Management

The specific challenges and measures were as follows:

(1) Monitoring of the Quality of Sewage Inflows into the WWTP and Treated Wastewater

The quality of sewage inflows into the WWTP had not been monitored, and in the case of high sewage quality inflows, this could have a negative impact on wastewater treatment, such as exceeding the reuse standards. The quality of treated wastewater should be monitored regularly to ensure that there is no impact on agricultural uses. It was also important to budget for reagents purchases for water quality measurements.

(2) Monitoring of High Water Quality from Jericho Agro-Industrial Park (JAIP)

Sewage from Jericho Agro-Industrial Park (JAIP), which is industrial effluent, has a high concentration of water quality, unlike domestic sewage. Due to the inflow of high concentration of sewage from the JAIP, Jericho Municipality has now stopped accepting it into the WWTP. A condition for the start of acceptance is compliance with the sewage discharge standards. In the JAIP, a pre-treatment plant has been constructed to meet sewage discharge standards. This, however, has not been operational as of July 2023.

Jericho Municipality was also required to monitor the quality of effluent water after receiving sewage. A meat factory (under construction), a hospital and commercial premises are located in the planned sewerage area, and their connection to the sewerage system is subject to compliance with sewage discharge standards. Jericho Municipality also needed to develop a monitoring system.

(3) Establishment of Water Quality Monitoring System

Jericho Municipality established a monitoring system for the quality of water inflows into the WWTP and also established a water quality testing system (e.g. to improve water quality testing capacity, develop manuals, secure reagents, etc.). Water quality parameters that cannot be measured in the water quality laboratory of the WWTP are outsourced and the budget is secured.

1.4.4 Challenges and Measures for Sewage Sludge Management

The final form of sewage sludge at the current Jericho WWTP is solar dried sludge. The fields of reuse, processes, products and reuses of dried sludge are shown in Table 1.3. For energy use, dried sludge has high potential as a heat source and can be used as a sludge fuel conversion in an incineration facility. However, no incineration facility was identified in the Palestinian West Bank. For construction material use, it can be used as a raw material for cement. A cement plant would be an effective use if it were acceptable. However, no cement plant was identified in the West Bank. In TeCSOM-I, dried sludge was studied for reuse with fertilizer and/or soil conditioner.

Photo 1.1 Dried Sludge

Table 1.3 Dried Sludge Reuse

Reuse Field	Process	Product	Reuse Option	Evaluation
1) Compost	Untreated/dry	Dewatered sludge/dried sludge	fertilizer and/or soil conditioner	High potential demand
2) Energy	Dry	Dried sludge	Fuel	No incineration facility
3) Construction materials	Untreated/dry	Dewatered sludge/dried sludge	Cement raw material	No cement plant

Source: Sewerage Facility Planning and Design Guidelines and Commentary, Second Edition 2009, Japan Sewage Works Association, p461

"Technical Assistance and Capacity Building Project for the Jericho Sanitation Project; TeCSOM-I" (2012 to 2018) analyzed the content of heavy metals and the content of components effective as fertilizers to confirm the safety of sewage sludge and to demonstrate the safety and effectiveness of its application. However, three measures were considered to drive the use of fertilizer and/or soil conditioner by farmers.

(1) Publicity of the Safety of Dried Sludge

Jericho Municipality ensured safety (heavy metal content within standard values) when sewage sludge is used as fertilizer and/or soil conditioner. Regular measurement and publicity (information disclosure) were required.

(2) Publicity of the Reuse as a Soil Conditioner

Treated sewage sludge (dried sludge) can be used effectively enough as a soil conditioner based on its composition. Regular measurement and publicity (information disclosure) were required.

(3) Communication with the Ministry of Agriculture

Regarding the reuse of treated sewage sludge, Jericho Municipality provided the Ministry of Agriculture with the results of the sludge composition analysis and discusses possible uses as a fertilizer and/or soil conditioner. Jericho Municipality discussed phasing procedures for the reuse of sludge.

Chapter 2 Project Activities and Achievements

2.1 Output-1: Based on the Current Status and Future Projections for Wastewater Treatment in Jericho, Including the Water Balance, the Capacity to Plan for Expansion of the Sewer Network to Increase Inflow to the Jericho Wastewater Treatment Plant (WWTP) is Strengthened.

2.1.1 Analyse the Management Situation of Sewerage Services in Jericho Municipality (Activity 1-1)

In the Activity 1-1, the TeCSOM team performed an analysis by picking up factors affecting the sewerage service management in Jericho Municipality. Although the WWD plays the main role of the activity, it is inevitable to cooperate with the Financial Department on collecting the water and sewerage fees. The team investigated the fee collection in Jericho suburban areas where Jericho Agro-Industrial Park (JAIP) and the two refugee camps are due to receiving discharge sewage from JAIP and the camps. As the Municipality has sold the treated wastewater for palm farmers, the proper operation and maintenance (O&M) of the Jericho Wastewater Treatment Plant (WWTP) and monitoring of the treated wastewater quality are directly linked to profits for the Municipality and are important. Jericho Municipality visited and referred to the practices of the Nablus WWTP, which is situated in a neighboring city.

The financial status of the Jericho Municipality was visualized by the Key Performance Indicators (KPIs). And the counterparts had continued the weekly meetings to expect self-promoted activities during the absence of the Japanese experts.

This section presents the activities and its outputs as listed below:

(1) Jericho Municipality Organization
(2) Jericho WWTP
(3) Reuse of Treated Wastewater
(4) Tariff collection from Jericho Agro-Industrial Park (JAIP) and Refugee Camps in Jericho
(5) Visit to Nablus WWTP
(6) Financial Status Analysis on the Sewerage Services of Jericho
(7) Sewerage Performance Visualization by Key Performance Indicators: KPIs
(8) How to implement the Project in the absence of Japanese Experts
(9) The Report of Project Activities and Achievement to the Representative Office of Japan to the Palestinian Authority (ROJ)

(1) Jericho Municipality Organization

a) Activities

- The problems and issues facing the Jericho sewerage services in the Project were discussed with the related personnel at the weekly meetings.
- The status of each issue was recorded and the responsible staff and deadline were indicated. The progress of each issue was organized and managed in a simplified list.
- The job description of each department in Jericho Municipality has been established. The TeCSOM team got the original Arabic document and confirmed the job descriptions for the relevant departments. Each activity was checked every time issues or responsibilities arose. Thereafter, the project activities were described with reference to the job descriptions.
- The Economic Development & Investment unit is the contact point for donor-coordination at Jericho Municipality. Technical proposals for each donor are prepared mainly by the Planning & Project Department and submitted through the contact unit.
- The number of employees in Jericho Municipality is 322 (as of 2021).
- The departments and responsible staff related to TeCSOM-II at the Jericho Municipality were identified. The organizational chart with names of the responsible persons is shown in Figure 2.1.1 The organization of the Water and Wastewater Department (WWD), which is the main executive department of TeCSOM-II, is also shown in Figure 2.1.2

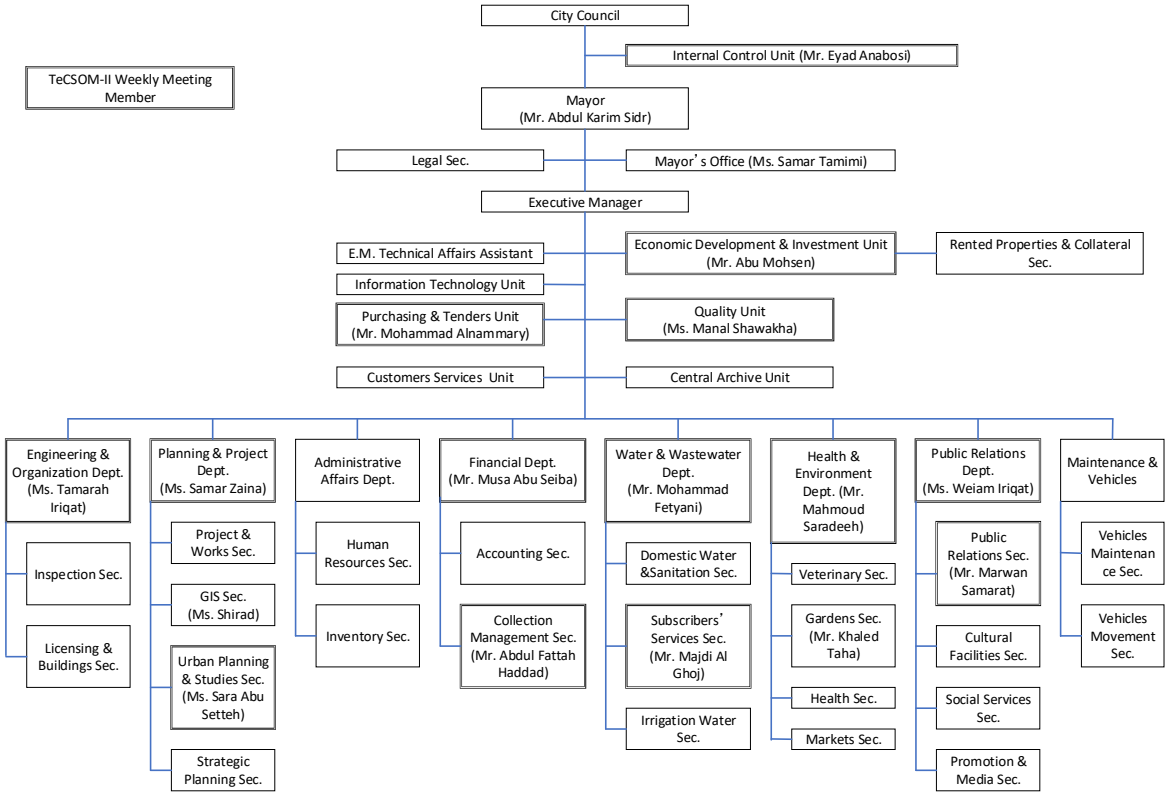


Figure 2.1.1 Jericho Municipality Organization

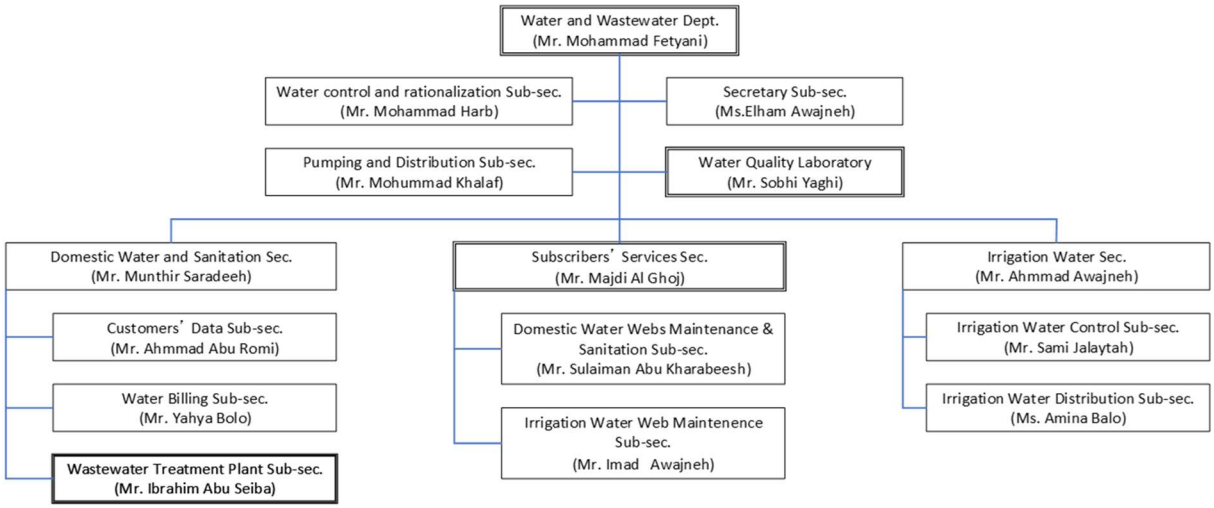


Figure 2.1.2 Water and Wastewater Department (WWD)

- The number of personnel in the key sections of TeCSOM-II is shown below:
  - i) The WWTP Sub-section of the WWD has 7 members;
  - ii) The Subscriber's Service Section of the WWD has 5 members;
  - iii) The Collection Management Section of the Finance Department has 4 members.
- In the weekly meetings with the counterparts (C/Ps) and during discussions with the WWD Director,

the following three requests were raised and explained to the Mayor in November 2021. The Mayor understood the situation and approved the requests.

・

1) Increase the number of water quality laboratory technicians

・ After investigating the current water quality analysis organization of the Jericho Municipality, the staffing requirement was identified for water quality testing. The water quality testing organization was staffed by just a single person. It is necessary to assign a dedicated laboratory technician to each of the water supply facilities and sewerage facilities. The other reasons for this are as follows.

- The purification plant with a water quality laboratory and the WWTP are located approximately 7 km apart, making it time-consuming and difficult for one person to carry out water quality monitoring tasks in relation to the workload.
- The JAIP pre-treatment plant is scheduled to start operation in September 2022, however, the plant was not in operation as of July 2023. Jericho Municipality will accept sewage from JAIP only if the plant is in operation and the effluent from JAIP meets the discharge standards. Since the amount of wastewater inflow to the WWTP is expected to increase in the future, it will be more important to monitor both the quantity and the quality of water flowing into the WWTP. This quality-analysis activity is very important because the quality has a direct impact on the performance of the wastewater treatment processes.
- Currently, most of the treated wastewater has been sold to farmers because the quality of the treated wastewater meets the reuse standards. This is due to proper O&M of the WWTP by Jericho Municipality. This sale is also an important source of income for Jericho Municipality. Since an increased quantity of treated wastewater will be sold to more farmers in the future, it is highly critical to monitor the water quality as a commodity.

The employment of a new water quality laboratory technician during the project period enables the transfer of knowledge and skills by providing training in water quality monitoring to the laboratory technician by a Japanese expert. This necessity was accepted by the mayor of Jericho Municipality through discussions.

2) New assignment of an electromechanical technician (pump engineer) at the Jericho WWTP

The Jericho WWTP began operating in June 2014 and has been in operation for nine years by July 2023. The wastewater treatment is being operated well so far, and the treated wastewater is good enough to sell to farmers. However, all the WWTP equipment have an expected service life, which is achievable only through regular maintenance.

However, at the beginning of the Project, the Jericho WWTP did not have a dedicated inspection and maintenance technician. Since there are various equipment in the plant, a dedicated technician who can inspect and manage the equipment is essential to extend the life of the plant.

In the response of the situation, Jericho Municipality had advertised for an electromechanical technician. But no application was received for the post. It indicates that it is difficult to hire a technician who can handle both mechanical and electrical fields.

Jericho Municipality had advertised for a full-time technician for the WWTP later. But it received no applications. The requirements for the application were reviewed and relaxed and the position was re-advertised. However, this effort did not help attracting any additional expression of interest either. Jericho Municipality therefore decided to abandon the recruitment of a technician and to outsource the maintenance of the WWTP. On the other hand, the operation of the WWTP is carried out by Jericho Municipality staff at all times. Japanese experts have supported technical aspect of these activities.

3) Cleaning and maintenance of the Japanese garden and Pilot Plant

- The Jericho WWTP has a Japanese garden and the pilot plant for the reuse of treated wastewater. In TeCSOM-II, with the understanding and cooperation of Jericho Municipality, the effectiveness of sewage sludge as a fertilizer was demonstrated at the pilot plant. A trial as a fertilizer/soil conditioner has been conducted but their sale/distribution has not yet to be done.

Photo 2.1.1 Drying Bed

Phot0 2.1.2 Dried Sludge

- In order to promote the reuse of sewage sludge, the Japanese Garden, the pilot plant has been properly and regularly maintained to portray Jericho Municipality as a place that can be confidently introduced to visitors.

Photo 2.1.3 Japanese Garden（Cleaning）

Photo 2.1.4 Japanese Garden

- After the Mayor was briefed on the demand, he instructed the cleaning and repair of the Jericho WWTP (reference to: Mayor's explanation on 16 November 2021, and instructions from the Mayor on 21 November 2021). The Mayor also visited the WWTP on 29 November 2021 to confirm the site and the status of improvement. The plant manager and the operator accompanied the Mayor while he visited the WWTP and explained the need for the increased manpower and additional equipment.

Photo 2.1.5 Mayor in WWTP (1)

Photo 2.1.6 Mayor in WWTP (2)

- The treated wastewater is pumped from the Irrigation Tank to palm fields. Due to problems with power cables and capacity, only two pumps could be operated simultaneously. As of July 2023, nine pumps are installed, and additional power cables were constructed to increase the power transmission capacity in January 2023.

Photo 2.1.7 Irrigation Tank

Photo 2.1.8 Construction of Power Lines

4) Explanation of the Project's policy to the new mayor in Jericho City

- The TeCSOM team met with the new Jericho Mayor, Mr. Abdulkarim Sidr on 16 May 2022, and explained the progress and results of the sewerage facility construction and TeCSOM-I until now, and the project objectives and efforts so far under TeCSOM-II.
- In particular, the TeCSOM Chief Advisor explained how Jericho Municipality started its sewerage projects from scratch and how it has been able to successfully launch the project on the right track. The Chief Advisor then explained the importance of water quality management and preventive management in order to operate the sewerage project in a more sustainable manner. The Chief Advisor also explained the need for more water quality, mechanical and electrical technicians, and garden maintenance staff to achieve this objective.
- The Chief Advisor explained that the municipal staff have also focused on water and sewerage fee collection, which is part of municipal financial resources. The Chief Advisor promised to continue to share information with the new Mayor, as building a relationship of trust with the TeCSOM team is the first and most important step.
- The Mayor attended the weekly meeting of TeCSOM-II and explained the importance of selling treated wastewater, connecting to the sewer network, and PR activities.

b) Achievements

- Increase in the number of water quality laboratory technicians.
- The budget for the hiring of a water quality technician and a mechanical and electrical technician was approved by the Ministry of Local Government (MoLG), and the hiring was subsequently approved by the Jericho Municipal Council. The recruiting process began in June 2022.
- Nineteen (19) applications were received for the position of water quality laboratory technician, from which one person was selected (hired on 30 August 2023). (Related to Activity 2-2)

- Cleaning and maintenance of the Japanese garden and Pilot Plant
- The cleanup within the WWTP was conducted through the following process: i) The WWD Director made a direct request to the Mayor or municipal council members; ii) The council members agreed to the request and directed the Garden section to clean up; and iii) The Garden section began the cleanup. Since then, the WWD Director and the Deputy Mayor have visited the WWTP several times to monitor the clean-up by the Garden section.
- Under the policy of the Mayor and the WWD Director, the gardener at the WWTP (Garden section staff) are responsible for managing the pilot plant (experimental farm) as well as the Japanese garden.
- The garden and pilot plant of the WWTP is managed by staff from the Gardens Section of the Health and Environment Department (transferred from the Planning and Projects Department).
- Jericho Municipality has employed a full-time employee for the Japanese garden and pilot plots (both onsite and offsite) at the WWTP to maintain and manage these areas since January 2023, following the retirement of one employee of the garden section.

(2) Jericho WWTP

a) Activity

1) Preparation for operation of the second WWTP reactor

- The report included inflow, treated wastewater, treated wastewater sales, and electricity consumption for April and May 2022. The experts requested not only a report of the figures, but also an analysis, for example, a comparison with the same month of the previous year, the percentage of wastewater reuse, the percentage of solar power coverage, and the reasons for the increase or decrease. In response to these points, comparative figures and percentages were presented at the subsequent weekly meetings.
- The volume of inflow sewage has been increasing year by year with the development of the sewer network, reaching approximately 2,552 m^3/day (39% of treatment capacity) in October 2022. In the future, the inflow sewage is expected to increase due to sewer development, sewage from JAIP, the refugee camp and the Jericho Gate development, etc., and therefore preparations are needed for the operation of the second reactor in addition to the current operation of the first one.
- Jericho Municipality has attempted to recruit electromechanical technicians on several occasions, but finally no applications have been received. The WWTP has, by 2023, been in service for 10 years, and is scheduled to put a second reactor into use due to the increase in wastewater inflow.

- The Plant Manager would like to put the currently unused 1/2 ponds (Reactor-Clarifier) into operation and inspect and maintain the facilities in operation. In addition, the use of two final sedimentation tanks (Clarifier) will be considered. To use two final sedimentation tanks, sewage flows in by opening a valve on the connecting pipe, as shown in Figure 2.1.3. What should be considered is the return rate of sludge from the sedimentation tanks. In order to maintain adequate MLSS (Mixed Liquor Suspended Solids) concentrations, it is necessary to consider the operation of returning sludge from two final sedimentation tanks to one reactor tank. As of July 2023, only one final sedimentation tank is in operation.

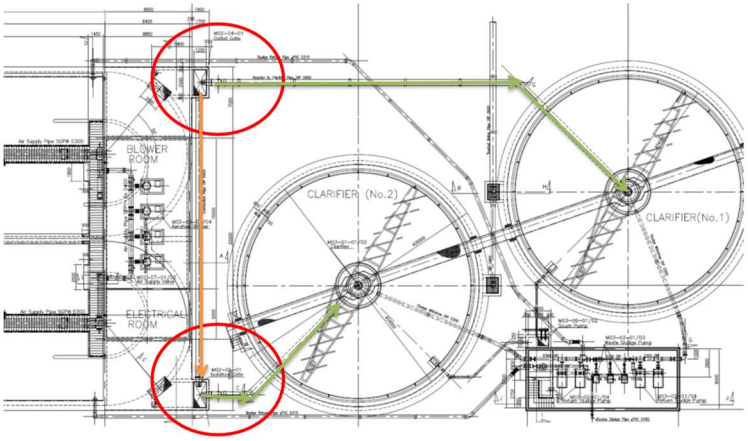


Figure 2.1.3 Bypass Pipe for Clarifier Source: TeCSOM-II Survey Results, 2023

2) WWTP maintenance

- The failure of the mixer in the reaction tank and its repair status were reported. For these, the C/Ps collected information on repair shops (contact information, availability of repair, cost, and repair period) and repaired the equipment.

- Recently, the Jericho WWTP has required maintenance/ repair of the mixer in the reactor (aeration tank) and other components. It is necessary to have spare parts and equipment, some of which cannot be procured in Palestine and must be imported. In addition, it is also necessary to secure a budget for spare parts and repair expenses.

- Until now, small repairs have been handled by repair shops in Palestine. Since the repair costs are anticipated to increase in the near future, Jericho Municipality considered purchasing insurance covering equipment breakdowns. Therefore, the C/Ps and the TeCSOM team visited Nablus WWTP, which already had taken out insurance for breakdowns with the insurance company on 1 June 2022. The C/Ps understood the general policy of insurance coverage.

- The Jericho WWTP has been in operation for nine years. As of now, the equipment has been found faulty and Jericho Municipality has requested a repair shop in Ramallah. However, two months after the request, the completion of the work has not been reported and the WWTP staff are concerned about the response. It was therefore decided to consult with an electromechanical sub-

contractor who had participated in the construction of the WWTP to outsource the equipment repairs. The sub-contractor is responsible for the maintenance of the Nablus and Tubas WWTPs.

- Previously, Jericho Municipality had recruited a mechanical and electrical technician and a pump technician for the WWTP. However, despite several recruitment attempts, no applications were received. Therefore, the WWD decided to abandon the hiring of new employees and changed its policy to outsourcing. Candidates for outsourcing included the sub-contractors during the construction of the WWTP.
- On 13 March 2023, Jericho Municipality staff and the TeCSOM team discussed equipment repairs at the WWTP with the sub-contractor in Ramallah. The sub-contractor explained that spare parts could be procured locally and from international sources (e.g. EU, Japan). The TeCSOM team invited the sub-contractor to the Jericho WWTP to verify the WWTP equipment and obtain quotations for maintenance.
- The TeCSOM team assisted by inviting contractors to proceed with outsourcing of maintenance, confirming the items to be quoted for outsourcing, etc.
- The contractor visited the WWTP on 22 May 2023 to check the current equipment status, number of equipment items and maintenance management items. Management items were categorized into the following three areas: i) periodic inspections, ii) emergency response (breakdowns, functional failure), iii) spare parts and equipment procurement.

3) Solar power generation

- A solar power generation facility is installed in the WWTP, and figures for power consumption and solar power generation in the Jericho WWTP were also presented in the weekly meetings and the Joint Coordinating Committee (JCC). Power consumption was higher in December 2021 and May 2022 due to higher influent sewage pollution loads and higher consumption due to blower operation. The gradual increase in electricity generated from December to May was attributable to longer daylight hours. Note that the six-month average electricity consumption was 2,232 kWh/day, with a solar power coverage of 18.6%.
- The location of the solar generation within the WWTP site is contingent on the location not being affected by the future expansion of the WWTP's facilities. After discussions with the power company; Jerusalem District Electricity Company (JDECo) and Jericho Municipality, it was agreed to build the solar power facility next to the existing one on the west side of the site.
- Jericho Municipality decided that solar power, which is scheduled to be operational in 2023, will be used for facilities in Jericho with higher unit electricity rates (e.g., streetlights) and will not be distributed directly to the WWTP.

b) Achievement

1) Preparation for operation of the second WWTP reactor

- The WWTP has, by 2023, been in service for 10 years, and is scheduled to put the second reactor into use in 2024 due to the increase in wastewater inflow.
- It was confirmed that the second reactor will be fully commissioned after a contract with the maintenance contractor has been signed.

2) WWTP maintenance

- The Jericho Mayor allows the maintenance of the WWTP to be outsourced, but this is contingent on securing the outsourcing costs. The Mayor therefore proposes to use the revenues from the sale of treated wastewater to cover the outsourcing costs. This proposal will be discussed at the municipal council meeting in July 2023.
- Until now, revenues from the sale of treated wastewater have gone to the municipal general fund. However, it is now the policy to allocate these revenues into a specific financial resource to be used for WWTP maintenance costs.

3) Solar power generation

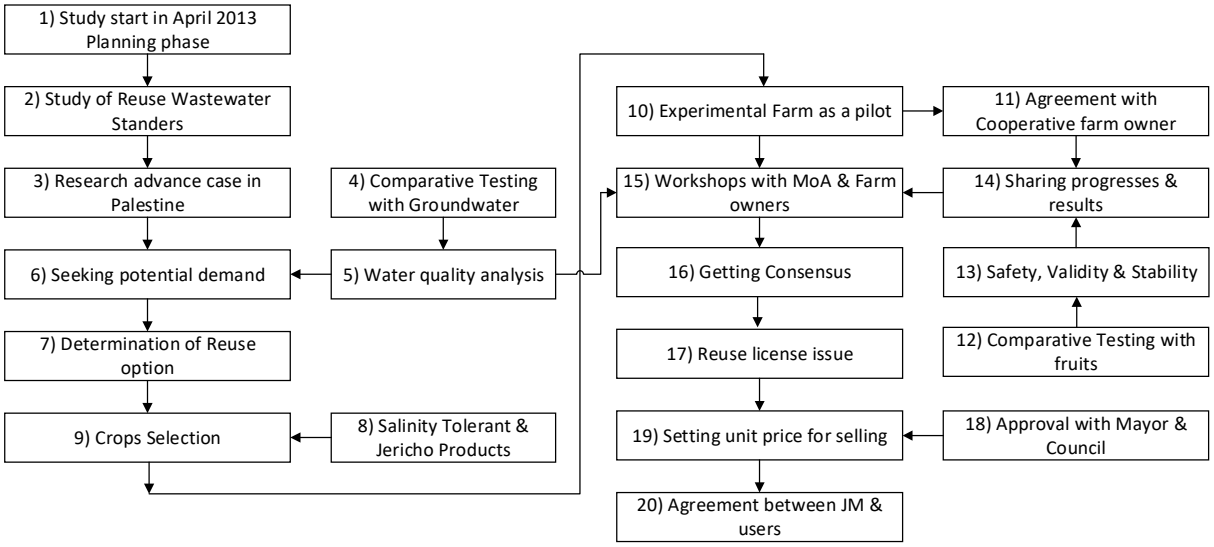
- On 27 June 2022, the PWA approved plans for the construction of a solar power facility in the Jericho WWTP. The construction was carried out by JDECo. Jericho Municipality plans to provide land for the power generation facility and receive 40% of the electricity generated in return.

(3) Reuse of Treated Wastewater

a) Activity

1) Reuse of treated wastewater

- Figure 2.1.4 shows the 20-step process from the start of the study to the reuse of treated wastewater in TeCSOM-I. Each process was essential; however, the most important of all was “16) Getting consensus” from stakeholders. Therefore, the TeCSOM team and Jericho Municipality have set up pilot plants, conducted demonstrations and data accumulation, and explained the results at workshops.
- In TeCSOM-II, a similar approach was taken to promote the reuse of treated sewage sludge, using the knowledge and experience gained from the reuse of treated sewage water. This is discussed in more detail in Activity 3.



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.4 Process for Studying the Reuse of Treated Wastewater

- Existing water supply sources are valuable in Jericho since water supply sources and quantities are limited. In the Palestinian West Bank, development of new water sources (wells) requires the approval of the "Israel and Palestinian Joint Water Committee".

- Construction of wells, especially in Area C, takes more time than in Areas A and B. Construction of wells in Area C is particularly time consuming for the committee's approval due to stricter development restrictions than in Areas A and B. Although there are extensive palm fields in the vicinity of the Jericho WWTP, most of them are located in Area C. Farm owners have a high demand for irrigation water; however, it is difficult to secure new water. Even if existing groundwater is used, its salinity is relatively higher than that of treated wastewater. (Refer to Table 2.1.2)

- Under these conditions, the WWTP was located in the vicinity of the palm fields and the environment was conducive to the promotion of treated wastewater reuse. In TeCSOM-I, the reuse of treated wastewater was commercialized through the process shown in Figure 2.1.4. The palm fields and area "C" boundaries in the vicinity of the WWTP are shown in Figure 2.1.5.

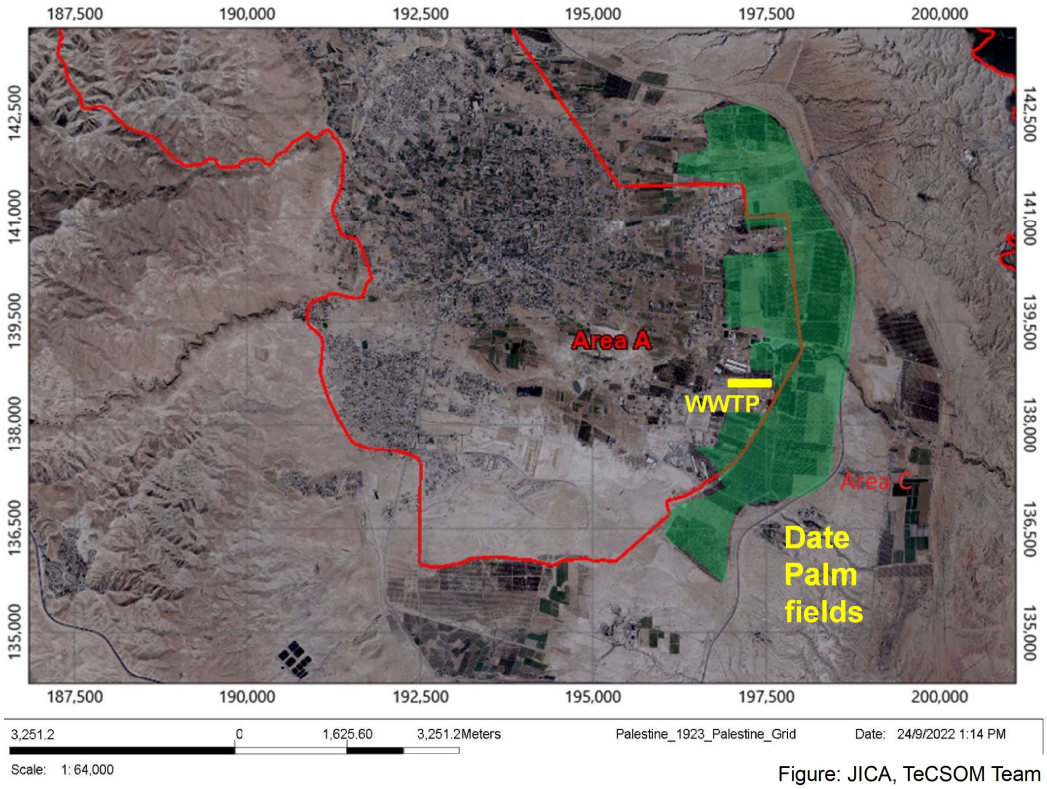


Figure 2.1.5 Area Boundaries and Palm Fields in Jericho

- When it comes to treated wastewater reuse, there are considerations to be observed on the perspectives of both the user and the supplier.

Table 2.1.1 Considerations when Reusing Treated Wastewater

	Precaution
Fame Owner (User)	i) Application and licensing for reuse of treated wastewater ii) The selling price of treated wastewater is low, at half (0.5 NIS/m^3) of the water supply tariff (1.0 NIS/m^3 for domestic use) There is also an irrigation water tariff, which is structured as 0.36 NIS/m^3 up to a certain volume (individual contracts) and 3.0 NIS/m^3 if the contracted usage is exceeded. iii) Back-up irrigation water is needed for maintenance and for supply interruptions in the event of water quality deterioration.
Provider/JM	i) Constant monitoring of treated wastewater quality as part of risk management ii) Communicate with users. Disclose information on the quality of treated wastewater not only in the event of treated wastewater quality abnormalities, but also during standard performance periods.

Source: TeCSOM-II Survey Results, 2023

2) COSTEA workshop on treated wastewater reuse

- A workshop on "Status of Treated Wastewater Reuse in Irrigation in Palestine" was held by COSTEA (The Scientific and Technical Committee of Agricultural Water) at the Jericho WWTP on

30 December 2021.

- COSTEA aims to help improve irrigation policies and projects in French Agency for Development (AFD)'s countries of action, to achieve sustainable irrigation systems while taking into account the need for productivity and all the dimensions of economic, social and environmental sustainability. (COSTEA website).
- Farmers who use treated wastewater in their date palm plantations in Jericho participated in this workshop, and they agreed that the use of treated wastewater is very effective and has a positive impact on improving the quality of dates.
- Jericho Municipality explained that the quality of the treated wastewater is tested on a regular basis and that the water quality results are in compliance with the reuse standards, so there are no safety issues. A farmer also outsourced treated wastewater to an outside water quality laboratory and explained that the safety of the treated wastewater is ensured.

3) Irrigation tank cleaning in the WWTP

- Users of treated wastewater have reported deteriorating water quality due to increased turbidity. The irrigation tank has never been cleaned since it commenced service in 2014. Because a large amount of sediment may have accumulated at the bottom, cleaning was carried out in cooperation with WWD. The period from preparation to completion was 24 hours in order to minimize the impact on users.

  i) As a preparatory step, users of treated wastewater are notified of water distribution restrictions.

  ii) Fishes inhabiting the tank are temporarily relocated to a landscape pond in the Japanese garden.

  iii) During the cleaning period, treated wastewater is temporarily discharged from the existing manhole in front of the chlorine disinfection tank into the Wadi via an existing bypass pipe and discharge pipe.

  iv) Bottom sediments are removed by Jericho Municipality-owned submersible pump, vacuum truck and high-pressure washing vehicle and treated in sludge drying beds.

  v) The sides and bottom plate of the tank are cleaned by high-pressure washing vehicle and manpower, and on completion, the water flow is changed from the existing manhole and returned to normal flow and the fish are released into the tank.

4) Proposed excess treated wastewater reuse

- The study focused on the treated wastewater reuse ratio on agricultural use, and examined ways to improve the reuse ratio. Reviewing the reuse rate of treated wastewater over the past three years (2019-2021), the period of high water demand is generally from April to August, with the reuse ratio close to 100%. On the other hand, water demand is relatively low from September to March,

averaging approximately 67%. The treated wastewater reuse ratio in 2022 is approximately 49%.

- During this period, approximately 33% is excess treated wastewater, which is overflowed from the irrigation tank in the Jericho WWTP and discharged into the wadis. Therefore, the destination of this excess treated wastewater was studied.
- The MEDISS (Mediterranean Integrated System for Water Supply) project had been implemented which intersects with Jericho Sewerage Project. An overview of the project is as follows.
- Project Partners: 1) Palestine (Palestinian Wastewater Engineers Group, Jericho Governorate, Al Aghwar Association), 2) Jordan, 3) Tunisia, 4) Italy
  - Project objective: securing water for agricultural use (mixing groundwater, rainwater and treated sewage water)
  - Project period: 8 August 2019 - 10 October 2022
- The distribution of treated wastewater is based on the assumption that farmers with existing contracts are prioritized. The total revenue from the sale of excess treated wastewater is estimated to be 56,900 NIS per year, calculated at 0.5 NIS/m^3.
- Focusing on MEDISS, it was considered that there is demand for treated wastewater during non-high water demand periods (September-March), which could be supplied to Palm Farmers' Cooperative Association in Jericho and Jordan Valley (PFCA).. However, at the moment, there is no agreement between Jericho Municipality and PFCA on the reuse of treated wastewater.

5) Completion of the electrical room for distribution of treated wastewater.

- The pump electrical room for the distribution of treated wastewater was completed in early February 2023. This increased the electrical supply capacity and enabled the nine existing pumps to operate simultaneously. Previously, three pumps were limited to simultaneous operation, which meant that time adjustments had to be made to water distribution requests from users.

6) MEDISS workshop

- A workshop on treated wastewater reuse was organized by the Palestinian Wastewater Engineers Group on 15 February 2023. Italian experts were the main presenters at the workshop and mainly explained the following: i) soil properties (salinity) of palm fields in Jericho, ii) salinity tolerance of dates, and iii) use of treated wastewater for irrigation to reduce salinity.
- The MEDISS project plans to mix treated wastewater from the Jericho WWTP with groundwater and rainwater during the rainy season and use it to irrigate palm fields. Up to now, the Jericho Municipality and MEDISS side have not reached an agreement on the reuse of the water, and so far the MEDISS side has been using groundwater from wells and rainwater.

- The main reason why both sides cannot reach the consensus lies in the price for the sale of treated wastewater. The MEDISS side sells mixed water to farmers at 1.2 NIS/m^3 while Jericho Municipality sells treated wastewater at 0.5 NIS/m^3 plus electricity, and the terms of agreement with the MEDISS side are i) 0.5 NIS/m^3 plus electricity as offered by Jericho Municipality, and ii) 1.0 NIS/m^3 including electricity as offered by MEDISS.
- The electricity cost of the pumps under the current contract is 1,371.6 NIS (purchased water volume: 13,654 m^3), which is 0.1 NIS per m^3 (actual rate as of January 2023, from data of one farm owner). Therefore, farm owners have bought Jericho treated wastewater, which is approximately 0.6 NIS/m^3, including electricity.
- The TeCSOM team explained that the pilot plant (experimental plant) using treated wastewater and sewage sludge has been conducted inside the Jericho WWTP since 2014, and that there have been no negative results in the analysis of the sewage sludge. Currently, the analysis of treated wastewater and sludge is being supported by An-Najah National University.

b) Achievements

1) Reuse of treated wastewater

- As of June 2023, nine farmers have purchased treated wastewater and used it for irrigation. Users were interviewed in 2022. Five of them responded. The results are shown in Table 2.1.2.
- They all use the water to irrigate their palm fields and expressed a desire to purchase more and expand their palm fields if treated wastewater supplies are available. Therefore, the demand for treated wastewater can be described as high. The fertilizers currently used are cattle manure and chemical fertilizers.

Table 2.1.2 Results of Interviews with Users of Treated Wastewater

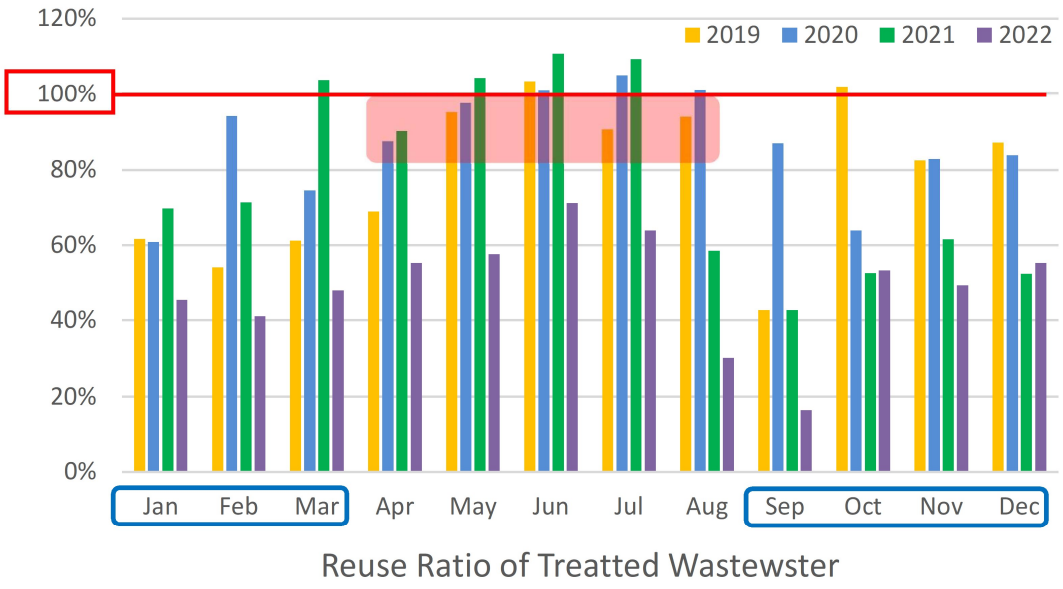
		Farmer-1	Farmer-2	Farmer-3	Farmer-4	Farmer-5
1	Reuse amount (m^3/year)	55,092	32,080	56,907	168,613	59,821
2	Need more water	Yes	Yes	Yes	Yes	Yes
3	Crop Type	Date Palm	Date Palm	Date Palm	Date Palm	Date Palm
4	Irrigated area (dunam)	90 (1,000trees)	70	60	150 (2,000trees)	300
5	Mixing with groundwater	NO	Yes	NO	Yes	Yes, 90% GW
6	Expansion plan	Yes, if treated water available, by 70% increase	Yes, if treated water available by 33% increase	Yes, if treated water available for 550 dunam	NO	Yes, if treated water available
7	Current Fertilizer	Natural manure from cow dung, chemical fertilizer (potassium, ammonia)				-

Source: JICA, TeCSOM-II Survey Results, 2023

- The reuse ratios of treated sewage water for the last four years from 2019 to 2022 are shown in Figure 2.1.6. The reuse ratios vary slightly from month to month, but water demand is high from April to August, usage falls in September/October, when palms are harvested, and water demand is high after the rainy season (December/January). This trend is similar to the trend in water use when palm farm owner was interviewed.

- In 2022, the annual average ratio of treated wastewater reused was 49%, which is a significant drop compared to other years. A check of treated wastewater deliveries showed that two farm owners had stopped demanding water. The reason for this was the presence of turbidity in the treated wastewater. Following this information, Jericho Municipality cleaned the irrigation tank at the WWTP.

- In the reuse of treated wastewater, it is also important to secure water supply recipients (water demand) during the period from September to January, when water demand falls, from the perspective of effective use and securing financial resources. Further discussions with farm owners or PFCA are required to consider, including sales of treated wastewater during periods of low water demand.



Source: JICA, TeCSOM-II Survey Results, 2021

Figure 2.1.6 Reuse Ratio of Treated Wastewater

2) Percentage of treated wastewater compliant with the reuse standards (Class A)

- In TeCSOM-II, 37 water quality measurements of treated wastewater were outsourced to the An-Najah National University once a year (three times in total). The aim is to comply with the most stringent class A for the Reuse Standards. Table 2.1.3 shows the water quality results of treated wastewater conducted in TeCSOM-II, and well water (groundwater level approximately GL-130 m) in the vicinity of the Jericho WWTP conducted in TeCSOM-I. Yellow hatched columns in the table are parameters where class A is exceeded. The water quality test results are shown in Appendix 2.2.2.

i) Water quality compliance ratio (2021-2023)

- The water quality compliance ratio for the last three years against class A is approximately 97.3% (=108/111 x100). The compliance ratio for treated wastewater quality for the period 2014-2016 is approximately 89.9% (=133/148 x 100). Compared to the most recent data, the water quality compliance ratio has improved despite a tenfold increase in sewage inflow.

- The approximately 10-fold increase in sewage inflow from the WWTP operation start in TeCSOM-I and the small exceedance value of approximately 10% indicates that the good treated wastewater quality and treatment process is maintained, and the WWTP O&M is functioning properly.

ii) Comparison with groundwater quality

- The percentage of compliance with class A for groundwater quality and treated wastewater quality is compared. Treated wastewater is approximately 97.3%, whereas groundwater is

approximately 77.5% (=134/173 x100), which means that treated wastewater is more suitable for irrigation water. Groundwater exceedance parameters are mainly in Total Dissolved Solids (TDS), Chloride (Cl), Sodium (Na) and Boron (B). These parameters are mainly derived from salinity, which is why groundwater has a relatively high salinity content. When using groundwater for irrigation, caution should be exercised, e.g. applying it to trees with high salt tolerance (e.g. dates).

Table 2.1.3 Jericho WWTP Treated Wastewater and Groundwater Qualities

Items		Standard Quality A	Treated Wastewater							Well-1 (No.10)					Well-2 (No.12)			
		Sampling Date	1-Dec-14	20-May-15	11-Nov-15	1-Jun-16	24-Nov-21	2-Nov-22	28-Apr-23	Survey-1 Jun 22-13	Survey-2 Sept26-13	Survey-3 Dec21-13	Survey-4 Mar 1-14	Survey-5 Jun 17-14	Survey-1 Jun 22-13	Survey-2 Sept26-13	Survey-4 Mar 1-14	Survey-5 Jun 17-14
Biochemical Oxygen Demand (BOD)	mg/L	20	<5	<5	24	19.7	21	22	14	ND	5	ND	ND	ND	ND	4.2	-	ND
Total Suspended Solids (TSS)	mg/L	30	1	6.7	7	7	9.5	13.6	22	1.5	8.7	8	3	7.25	1	ND	-	10.75
Fecal coliform bacteria	colony/100mL	200	600-800	192	22	1000	60	22	7	0	6	3	0	0	0	0	-	5
Chemical Oxygen Demand (COD)	mg/L	50	<10	<10	54	38.8	39	56	22	ND	16.9	2.3	ND	ND	ND	-	ND	ND
Dissolved Oxygen (DO)	mg/L	1<	2.1	3	2.6	4.96	2.3	2.2	2.5	3.6	6.26	3.55	2.8	-	3.95	6.53	-	-
Total Dissolved Solids (TDS)	mg/L	1,200	867	885	910	367	1,129	1,135	1,140	2,413	2,410	2,247	1,947	2,510	2,860	2,685	-	2,933
Potential of Hydrogen (pH)		6 - 9	7.85	7.68	7.58	7.52	7.6	7.5	7.4	7.98	8.094	7.65	7.372	7.797	7.7	8	-	7.361
Fat, Oil and Grease	mg/L	5	10.2	<1	18.4	11.4	<5	<5	<5	ND	9.85	23.6	ND	ND	ND	19.3	-	ND
Phenol	mg/L	0.002	0.00581	0.018	<0.001	<0.001	0.002	<0.002	<0.002	0.00267	ND	-	0.033	-	0.00418	ND	0.037	-
Detergents (MBAS)	mg/L	15	<0.01	<0.01	<0.01	<0.01	0.1	0.1	0.1	ND	ND	ND	ND	ND	ND	ND	-	ND
Nitrate Nitrogen (NO3-N)	mg/L	20	1.23	0.35	0.42	<0.05	5.6	8.7	10.3	0.97	ND	ND	ND	0.79	8.39	-	9.2	6.89
Ammonium Nitrogen (NH4-N)	mg/L	5	<0.05	<0.05	0.36	0.4	0	<1.0	0	ND	ND	0.07	ND	ND	ND	ND	-	ND
Total Nitrogen (T-N)	mg/L	30	22.3	10.7	35.62	8.94	8.9	<10	<10	0.97	17.3	17.2	8.52	10.86	8.38	27.53	-	14.34
Chloride (Cl)	mg/L	400	237.9	232.9	223.36	215.92	350	355	310	1024.6	947.3	844	803.7	838.7	1007.9	869.82	-	1003.3
Sulfate (SO4)	mg/L	300	85.7	73.5	58.84	76.72	135	123.9	138.3	157.5	158.97	137.1	95.5	135.3	305.2	370.83	-	375.1
Sodium (Na)	mg/L	200	145	107.1	153.3	160.1	196	199	190	491	349.6	558	579.7	645	343	428.5	-	487
Magnesium (Mg)	mg/L	60	30.4	34.67	37.24	35.18	4.9	57.7	19.4	96.3	-	-	-	-	162	-	-	-
Calcium (Ca)	mg/L	300	86.6	83.59	94.84	92.39	126.5	80.8	160	54.4	-	-	-	-	130	-	-	-
Sodium Adsorption Ratio (SAR)	mg/L	5.83	ND	2.47	1.36	3.59	4.7	4.13	3.77	9.26	-	-	-	-	4.74	-	-	-
Phosphate Phosphorus (PO4-P)	mg/L	20	13.2	24.5	3.69	<0.05	9.3	8.3	5.1	20.3	-	-	-	-	ND	-	-	-
Aluminum (Al)	mg/L	5	0.04	0.224	0.008	0.031	0.01382	0.0109	0.0188	0.239	-	-	-	-	0.212	-	-	-
Arsenic (As)	mg/L	0.1	ND	ND	ND	ND	0.00128	0.003	0.0046	ND	-	-	-	-	ND	-	-	-
Copper (Cu)	mg/L	0.2	0.035	0.011	0.015	ND	0.00325	0.0042	0.0038	ND	-	-	-	-	ND	-	-	-
Iron (Fe)	mg/L	5	0.07	0.143	0.041	0.03	0.1822	0.2404	0.3041	0.087	-	-	-	-	0.4	-	-	-
Manganese (Mn)	mg/L	0.2	ND	0.041	0.04	0.032	0.0117	0.0119	0.0272	0.011	-	-	-	-	ND	-	-	-
Nickel (Ni)	mg/L	0.2	ND	ND	ND	ND	0.0047	0.0041	0.0051	ND	-	-	-	-	ND	-	-	-
Lead (Pb)	mg/L	0.2	ND	ND	0.026	ND	0.0002	0.0002	0.0003	ND	-	-	-	-	ND	-	-	-
Selenium (Se)	mg/L	0.02	0.04	ND	ND	ND	0.00509	0.0119	0.0127	ND	-	-	-	-	ND	-	-	-
Cadmium (Cd)	mg/L	0.01	ND	ND	ND	ND	0	0	0	ND	-	-	-	-	ND	-	-	-
Zinc (Zn)	mg/L	2	0.1	0.046	0.073	0.071	0.0125	0.0216	0.0254	0.029	-	-	-	-	0.042	-	-	-
Cyanide (CN)	mg/L	0.05	<0.03	<0.03	<0.03	<0.03	0	0	0	ND	-	-	-	-	ND	-	-	-
Chrome (Cr)	mg/L	0.1	ND	ND	ND	ND	0.00113	0.0035	0.0059	ND	-	-	-	-	ND	-	-	-
Mercury (Hg)	mg/L	0.001	ND	0.00015	0.000564	0.0001	0	0	0	ND	-	-	-	-	ND	-	-	-
Cobalt (Co)	mg/L	0.05	ND	ND	ND	ND	0.00033	0.0004	0.0004	ND	-	-	-	-	ND	-	-	-
Boron (B)	mg/L	0.7	0.4	ND	0.11	0.11	0.111	0.1445	0.1214	2.75	-	-	-	-	2.16	-	-	-
Bacteria E. Coli	(colony/100mL)	100	TMTC	187	22	767	20	8	6	0	-	-	-	0	0	-	-	5
Nematodes	(Eggs/L)	<1	ND	ND	ND	ND	ND	ND	ND	ND	-	-	-	-	ND	-	-	-
Maximum limits for chemical and biological properties (mg/L)										ND: Not detected -: Not sampling								

Source: TeCSOM-II Survey Results, 2023

3) Cleaning of irrigation tank

Findings from the cleaning of the irrigation tanks of the Jericho WWTP are described below.

- The draining of treated wastewater in the irrigation tank allowed visual confirmation of the sedimentation status of the walls and bottom plates of the tank. Since there was not as much sediment as expected and the accumulation was only a few centimeters, it can be said that the frequency of tank cleaning is sufficient once every few years.
- This was the first cleaning after the start of operation, and the C/Ps learnt future cleaning procedures and the preparation details of the necessary materials and equipment.
- Farmers who reuse treated wastewater had the opportunity to observe the cleaning operation, which could be introduced as part of the WWTP's maintenance activities.
- No odors were observed in or around the tank during cleaning.
- The submersible pump for drainage, which is necessary for cleaning the WWTP's tank, has now been purchased from the Jericho Municipality's own budget and is expected to be put to

good use in the future.

Photo 2.1.9 Irrigation Tank Cleaning

(4) Tariff Collection from JAIP and Refugee Camps

a) Activity

- At the weekly meeting with the C/Ps held on September 28, 2021, it was reported that the Aqbat Jabr camp (refugee camp) has not paid the sewerage usage fee. With the water and electricity bills, it has been a difficult issue to solve without a political intervention.
- When confirmed by the JICA Palestine Office, it was pointed out that resolving this issue is outside the scope of the Project or of the Jericho Mayor. Therefore, only two camps (Aqbat Jabr and Ein Sultan) are considered in this Project for improvements of sewerage system and for computing the increase of inflow to the wastewater system.

Photo 2.1.10 Aqbat Jabr Camp

Photo 2.1.11 Ein Sultan Camp

- It is learnt that there is no legal basis for the exemption of refugee camps from payment as there is no explicit law. It could be referenced to the context, when President Mr. Yassir Arafat announced that all camps would be exempted from paying water and electricity bills. The timing of the

announcement is unknown. At that time, there was no sewerage fee, but it can be assumed that this fee is now included in the exemption.

b) Achievements

- The amount billed to JAIP is 98,957.5 NIS for water, 41,447 NIS for sewerage, and 1,917 NIS for sewer cleaning for the period between March 2019 and August 2021. In mid-November 2021, the WWD reviewed the sewerage bill and decided to reduce it.
- Previously, JAIP's water and sewerage bills were unpaid and the payment from JAIP had not been made due to discrepancies in the billed amounts. The TeCSOM team has now confirmed the billing status of the water and sewerage charges in May 2022 and found that JAIP agreed to the billed amount of water and sewerage bills and paid them, thereby extinguishing the debt amount. Since then, only water and sewerage charges have been billed.

(5) Visit to Nablus WWTP

a) Activity

- On 1 June 2022, the C/Ps and the TeCSOM team visited the Nablus WWTP. The purpose of the visit was to hear an example of the Nablus WWTP having insurance on its equipment, which covers the replacement costs in the event of a breakdown.
- The Jericho WWTP has already been in operation for nine years, i.e. June 2014, and has incurred minor component replacements and breakdowns of equipment. In order to ensure the cost of equipment repairs in the near future, the Jericho Municipality considers taking out an insurance, following the example of the Nablus WWTP. However, since the insurance premiums for the Nablus WWTP are high at approximately USD 60,000 per year, insurance coverage was studied as well.
- The Jericho WWTP's current insurance policy covers injuries/accidents to the staff. However, the current insurance does not cover fire, earthquake and other disasters, or visitors, and the Jericho Municipality considered taking out an insurance to cover these.
- Many factories are located in Nablus and the quality and quantity of effluent wastewater from these factories are monitored by the Environment Control Unit (ECU). This system is not in place in Jericho Municipality and was a reference for the water quality monitoring system. It is expected that the amount of wastewater inflows to the Jericho WWTP will increase in the near future, as well as the amount of wastewater discharged from industrial facilities.

b) Achievement

- The visit of Jericho Municipality staffs to the Nablus WWTP provided reference to: i) WWTP equipment, visitor and disaster insurance coverage considerations; ii) the role of the ECU; iii) the method of O&M records (also implemented at the Jericho WWTP, with reference to data items and data management).

(6) Financial Analysis of Jericho Municipality

a) Activity

1) Analysis of water and wastewater services incomes and expenditures

- Following the 1st and 2nd JCC, the incomes, expenditures and fee collection for water and sewerage services were reported, with additional financial data for 2021.
- To study the effectiveness of water and sewerage management, the incomes and expenditures were calculated from the fee-revenues and expenditures (mainly O&M expenses). The net result showed a profit of approximately 3.93 million NIS in 2017, 3.97 million NIS in 2018, 3.61 million NIS in 2019, 1.65 million NIS in 2020 and 2.68 million NIS in 2021. These figures are attributable to both water supply and sewerage management.
- However, the result did not take into account the depreciation of the facilities. If considered, the deficits respectively become -2.63 million NIS in 2019, -4.64 million NIS in 2020 and -3.66 million NIS in 2021.

Table 2.1.4 shows revenues and expenditures in water and wastewater in Jericho Municipality.

Table 2.1.4 Revenues and Expenditures in Water and Wastewater Services

	2015	2016	2017	2018	2019	2020	2021
Water Revenue	3,747,135	4,680,108	7,097,085	6,985,426	6,868,163	5,207,694	4,643,810
Sewerage Revenue	344,186	492,432	559,385	908,755	1,095,658	1,269,960	2,115,002
Total Revenue	4,091,321	5,172,540	7,656,470	7,894,181	7,963,821	6,477,654	6,758,812
O&M Cost (without Admin Costs)							
Water	2,684,009	3,468,091	3,209,631	3,280,580	3,575,011	4,240,928	3,389,968
Sewerage	444,008	706,451	517,110	643,600	780,891	585,319	684,533
Total	3,128,017	4,174,542	3,726,741	3,924,180	4,355,902	4,826,247	4,074,501
Profit							
Water	1,063,126	1,212,017	3,887,454	3,704,846	3,293,152	966,766	1,253,842
Sewerage	-99,822	-214,019	42,275	265,155	314,767	684,641	1,430,469
Total	**963,304**	**997,998**	**3,929,729**	**3,970,001**	**3,607,919**	**1,651,407**	**2,684,311**
Depreciation							
Water	1,971,421	1,971,421	1,971,421	1,971,421	1,971,421	2,024,345	2,077,420
Sewerage	4,270,474	4,270,474	4,270,474	4,270,474	4,270,497	4,270,497	4,270,050
Total	6,241,895	6,241,895	6,241,895	6,241,895	6,241,918	6,294,842	6,347,470
Total Profit	**-5,278,591**	**-5,243,897**	**-2,312,167**	**-2,271,895**	**-2,633,999**	**-4,643,436**	**-3,663,159**

Source: Finance Department, Jericho Municipality

- Rate-revenues have fallen to approximately 85% of the 2019-year level in 2019-2021. This is mostly due to lower revenues from water fees, and in particular to the fact that government institution facilities have not paid their bills. The WWD Director indicated that COVID-19 has also had an impact. The fee-billing process to the ministries was obtained from the Municipality's Finance Department and was analysed.

- In 2021, fee revenues increased by 167% for sewerage and decreased to 68% for water compared to 2020. The proportion of fee revenues is 69% for water and 31% for sewerage (which together makes 100%). Revenues from water and sewerage fees increased by 4% in 2021 compared to 2020. Trend of water and sewerage revenues from 2015 to 2021 is shown in Figure 2.1.7

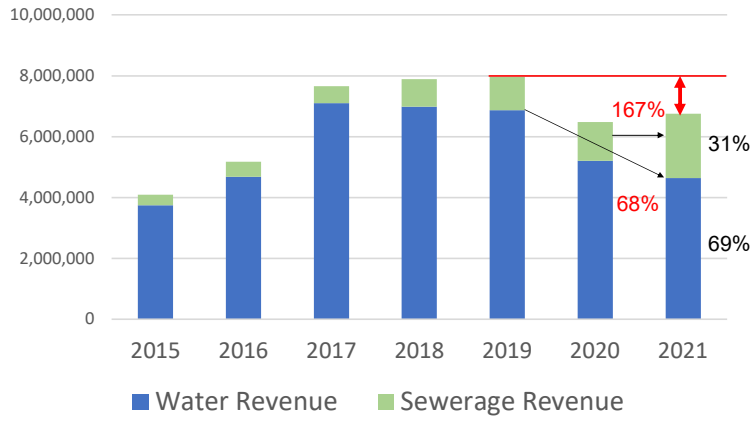


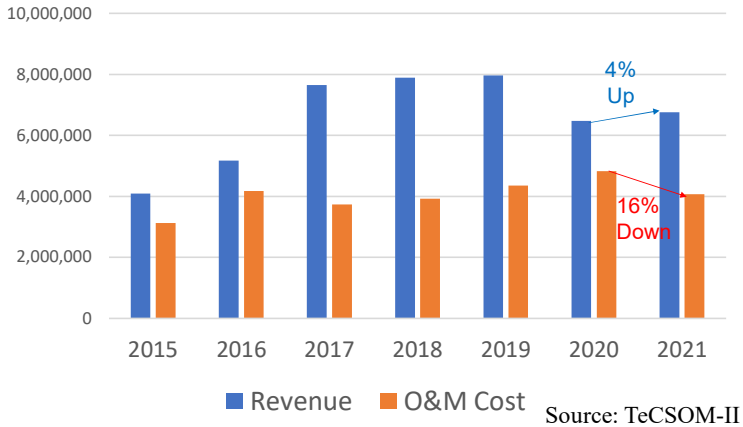
Figure 2.1.7 Water and Wastewater Fee Revenues

Source: TeCSOM-II Survey Results, 2023

- On the other hand, O&M expenses in 2021 decreased by approximately 16% from 2020, resulting in a larger profit margin. The main factor in O&M costs was a significant decrease in personnel costs for both water and wastewater, which decreased by approximately 1.3 million NIS (-45%). Repair costs, on the other hand, have increased.

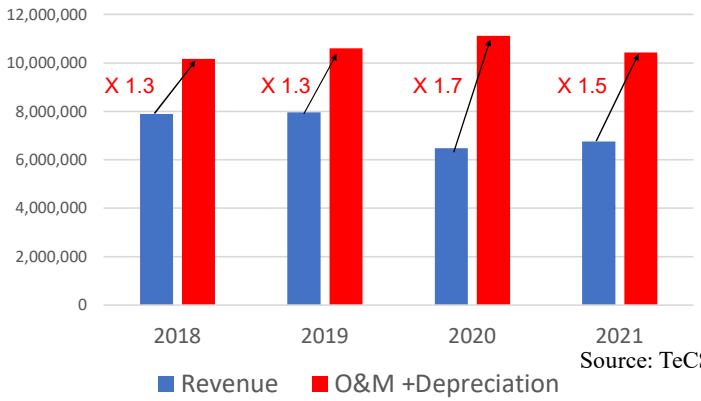
- When depreciation is factored in O&M costs, this has respectively resulted in expenses being approximately 1.3 times (2019), 1.7 times (2020) and 1.5 times (2021) higher than revenues indicating the need to start accumulating funds for facility renewal. The former director of finance (now head of Economic Development & Investment) explained that the Municipality's policy is to cover all O&M expenses with current fee revenues in the first stage (which has been accomplished) and to accumulate funds in the second stage, taking depreciation into account.

- Figure 2.1.8 shows revenues and O&M costs of water and sewerage services. Figure 2.1.9 shows revenues and O&M costs plus depreciation.



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.8 Water and Wastewater Fee Revenues and O&M Costs

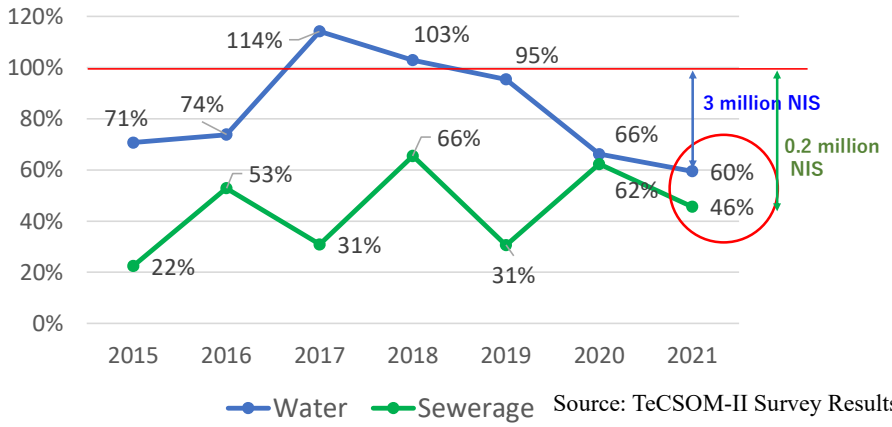


Source: TeCSOM-II Survey Results, 2023

Figure 2.1.9 Revenue vs. O&M Expenses plus Depreciation

- In terms of fee collection rates (in monetary basis), there has been a significant drop in the collection rates for water services, from 95% (2019) to 60% (2021), and for the sewerage services, from 31% (2019) to 46% (2021). The collection rates for sewerage are not necessarily steadily increasing and are due to the fluctuations in the ratios.
- In 2021, there is a trendy decrease in the collection ratio of fees to 60% for water and 46% for sewerage. If a collection ratio of 100% is assumed, the uncollected amount for water and sewerage would be approximately 3.2 million NIS.

The collection rates of water and sewerage fees are shown in Figure 2.1.10.



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.10 Collection Ratio

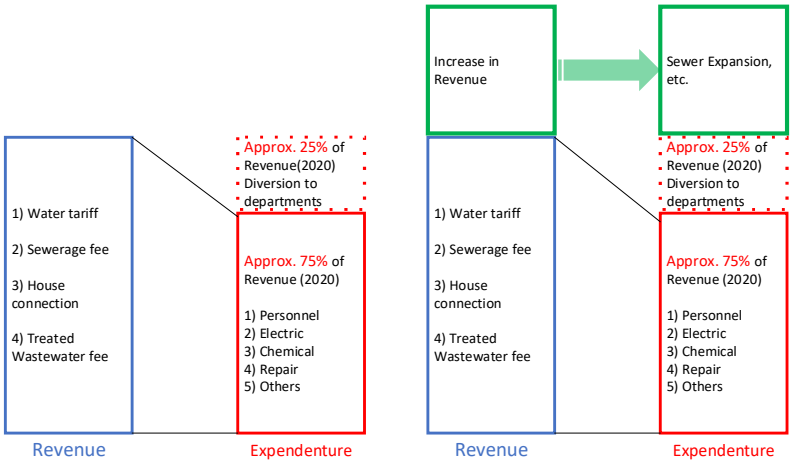
- Excluding depreciation expenses, the water and sewerage services are profitable. However, the revenues go into the municipal common account, from which it is allocated/diverted to other departments. The WWD has its own account, but water and wastewater fee revenues are not deposited into the account. The WWD's O&M costs (electricity, chemicals, repairs, and labor) account for approximately 75% of the revenues, and the remaining 25% is diverted to other departments as administration costs (2021).

- The Palestinian Authority has stipulated in the "Procedure and Policies Manual for accounting in the Big Palestinian Municipalities" (MoLG & MDLF*) that revenues cannot be monopolized by the concerned department and shall be diverted to other departments.

- *Municipal Development and Lending Fund

- When focusing only on the sewerage service, the O&M expenses are approximately 32% of revenues, with the remaining 68% being surplus (2021) according to Table 2.1.3. As described in Activity 1-4, the WWD Director pointed out that without savings from the surplus, it is necessary to rely on donors to develop the sewerage infrastructure.

- The only way to save/reserve for future equipment repairs and sewer pipeline extension/construction is to increase revenues. There are two main ways to increase revenues: 1) increase the unit price of fees, and 2) increase the collection rates. A conceptual diagram of the accumulated funds is shown in Figure 2.1.11.



Source: TeCSOM-II Survey Results, 2023

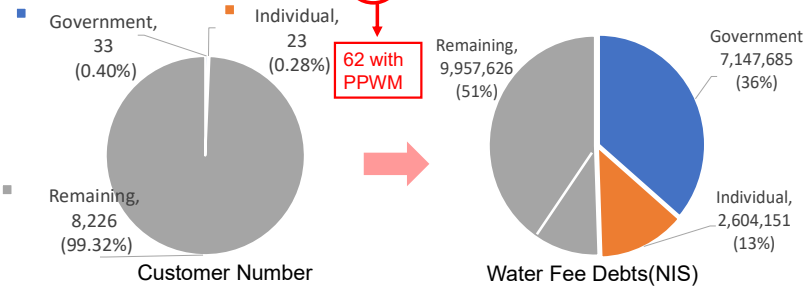
Figure 2.1.11 Conceptual Diagram of Accumulated Funds

- The total amount of unpaid water and sewerage fees is approximately 20.5 million NIS (as of September 2021), with approximately 19.7 million NIS for water and 0.8 million NIS for sewerage. Figure 2.1.12 shows the total unpaid amount of water and sewerage bills.
- For those who have not paid more than 30,000 NIS in water bills, 56 unpaid bills were identified, accounting for approximately 50% of the total unpaid amount (19.7 million NIS). Furthermore, the government institutions facilities' unpaid users are 33 of the 56, representing only 0.4% of the total 8,282 users, but with an unpaid amount of 7.1 million NIS (approximately 36.3% of the total unpaid amount).

	Number of customers	Debts (NIS)
Water Fee	8,282	19,709,462
Sewerage Fee	1,125	761,579

Water Fee	Number	Debts (NIS)
Total Debtors	56 (0.68%)	9,751,836 (49.5%)
Governments	**33** (0.40%)	7,147,685 (36.3%)
Individual	**23** (0.28%)	2,604,151 (13.2%)

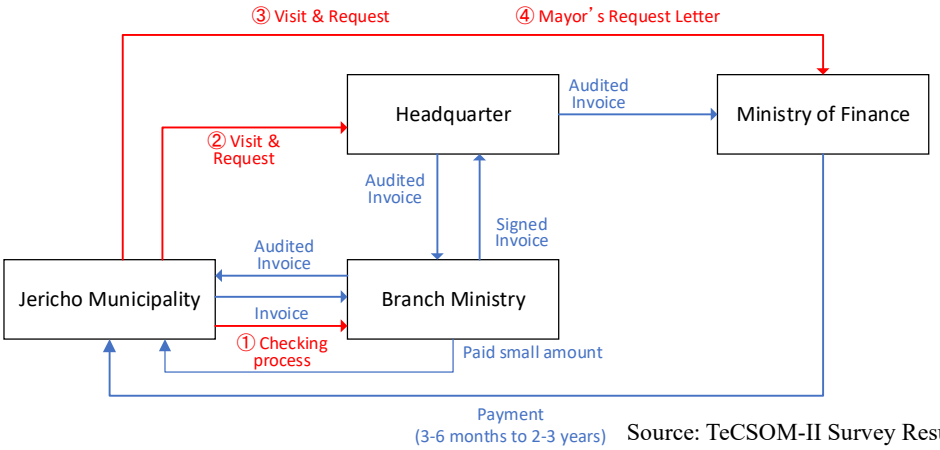
More than 30,000NIS Debts



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.12 Unpaid Bill Amount (As of September 2021)

- Jericho Municipality's procedures for collecting water and sewerage fees from government institution facilities were verified, and are as presented in below.



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.13 Pressing for Payment Procedures to Ministries

i) Jericho Municipality submits water and sewerage fees-invoices to Jericho branches of ministries.

ii) Jericho branches of the ministries confirm the amount of the invoices, sign and submit them to the headquarters.

iii) Headquarters audits the invoices and submits them to the Ministry of Finance.

iv) The Ministry of Finance verifies the invoice and processes the payment to Jericho Municipality. It may take some time, i.e. between three months and three years for payments to be made, and in the meantime, the fees might have been accumulated.

- The primary reason for the delay in payment is the Palestinian Authority's financial difficulties, but in addition, other municipalities are in the position to buy water and pay water fees and sewerage fees, and the Ministry of Finance is in the position to collect water fees. Therefore, it takes time to pay water and sewerage fees to Jericho Municipality (in the opinion of Jericho Municipality officials). In addition, other municipalities have purchased water from the West Bank Water Department, PWA.

- Penalties for unpaid sewerage fees are not stipulated in the Sewerage Bylaw, and penalties have not been stipulated in the Water supply Bylaw either. However, penalties have been stipulated since 2021.

- According to the Tariff Law (Instruction No. 2 of 2021 on the unified tariff system for water and wastewater), water providers can take measures to suspend water supply to those who have not paid their water and sewerage bills.

- In the past, the general response to unpaid customers was for the Jericho Municipality to take the users to court. In fact, until the end of 2020, Jericho Municipality responded to the unpaid users by suspending the water supply. However, since there was no legal basis for this measure, the affected

users took the matter to court and fought against it. The result was that, according to the court's decision, the suspension of the water supply was illegal. And the user was reconnected and received the water supply again.

- However, now the penalty for non-payment of fees was stipulated in the Tariff Law. Accordingly, Jericho Municipality can now show the users the penalty clause or suspend the water supply on a legal basis.
- In addition to the penalties, Jericho Municipality aims to encourage the payment of bills by installing prepaid water meters (PPWM).
- Penalties are also provided for discharges into the sewerage system. The House Connection Law (Cabinet resolution No. 16 for the year 2013) stipulates that a surcharge shall be imposed on the discharger for wastewater exceeding the sewage discharge standard, based on the polluter-pays principle. The specific amount of the surcharge is not indicated.
- Although the sewage discharge standards specify 27 items for water quality monitoring, the House Connection Law stipulates Chemical Oxygen Demand (CODcr) (upper limit: 2,000 mg/L) as the monitoring index.
- The House Connection Law stipulates that connection to the sewerage system is mandatory. However, there are no penalty clauses.

2) Revision of water and sewerage tariffs

- Jericho Municipality has increased water tariffs for villas, commercial and government institutions water services from November 2022, in accordance with the Tariff Law. While, the water tariffs for domestic consumption remain unchanged.
- At the same time, Jericho Municipality decided to charge an application fee for water supply. Whereas it was decided not to collect the application fee for sewerage because, when combined with the connection fee(according to the new tariff law 2021), it would be a high fee (considering that the existing method of calculations of the connection fees considers the pipe construction from the public network up to the property boundary) and complaints from building owners could be expected. The payment items are as follows.

Table 2.1.5 Payment Items

Water Supply	Sewerage	Payer
1) Water Supply tariff	1) Sewerage Tariff	1) User
2) Water house connection fee	2) Sewer house connection fee	2) Building Owner
3) Water Supply Application fee	3) (No Application fee)	3) Building Owner

Source: TeCSOM-II Survey Results, 2023

3) Penalties for illegal dumping

- The Cabinet Resolution No. (4) of 2022 "Health Hazards Prevention System and Waste Collection Fees for Jericho Municipality" (the by-law) was approved by the MoLG on 26 December 2022.
- This Cabinet Resolution is a by-law applicable to the Jericho Municipality. In the sewerage sector, fines (1,500 NIS for each offense) were stipulated for the illegal dumping of sludge into manholes. Other fines include for disposal of sewage on public roads (from households: 500 NIS for each offense) and for sewage spills on public roads (from households: 100 NIS for each offense).
- This is the first time that fines have been imposed for the illegal dumping of sewage sludge. Previously, the prohibition was stated, but no penalties were stipulated.

b) Achievements

1) Response to unpaid water and sewerage bills

- Jericho Municipality decided to take measures to install PPWMs and mandatorily collect fees for 62 individual unpaid customers, excluding government institutions facilities unpaid customers. The list of unpaid users has already been prepared and the targets have been identified. The PPWMs have been purchased by the Municipality.
- Jericho Municipality has four responses to the ministries' unpaid issues: i) confirm the payment status with Jericho branches of the ministries; ii) visit the headquarters and request payment; iii) visit the Ministry of Finance and request payment; and iv) submit a payment request letter to the Ministry of Finance in the name of the Mayor. (Refer to Pressing for Payment Procedures to Governments)
- As of October 2021, letters in the name of the Mayor to the Ministry of Finance have been issued four times this year. In addition, visits to the branch and the ministry premises have been conducted approximately once/month. Therefore, it can be said that Jericho Municipality is making efforts to request payment.
- Judging from these procedures, it can be stated that the installation of PPWMs in government institution buildings is unsuitable.
- A direct dialogue between the Jericho Mayor and the Ministry of Finance is required because collecting fees from the government institutions is labour intensive and time consuming, and in the meantime, the amount of unpaid fees will increase.
- A list of the top 62 unpaid water and sewerage fees customers (excluding government institution customers) was prepared using the 2021 data. The three top-unpaid customers are i) 48,351 NIS (approximately 1,740,000 yen, cumulative amount below), ii) 40,542 NIS (approximately 1,440,000 yen), iii) 39,521 NIS (approximately 1,420,000 yen), and iv) 5,852 NIS (approximately 210,000 yen).

- The accumulated amount unpaid (debt) for water and wastewater fees totalled 20,471,041 NIS in September 2021 and 18,773,353 NIS in December of the same year, representing a decrease of 1,697,688 NIS (-8.3%).

- Accumulated unpaid water supply bills were categorised into 1) individuals with more than 30,000 NIS, 2) government institutions (30,000 NIS or more) and 3) 30,000 NIS and below (both individuals and government institutions). The reason for separating by 30,000 NIS was that the 23 unpaid persons (0.28% of the total unpaid persons) accounted for 13.2% of the total unpaid amount and were therefore considered to have a significant impact.

- In terms of unpaid water fees, the unpaid amounts by individual customers decreased by 573,678 NIS (-22%). The main reason for the decrease in the amount of debts, as explained by the Collection Management section of Jericho Municipality, is the stipulation and enforcement of penalties. Disconnection of water service pipes was legalized from January 2021 for unpaid customers, and 200 disconnections were carried out. As a result, water fees have been paid and the unpaid amounts by individual customers have decreased.

Figure 2.1.14 (a) and 2.1.14 (b) show the amount of unpaid water and sewerage fees and the changes in these amounts.

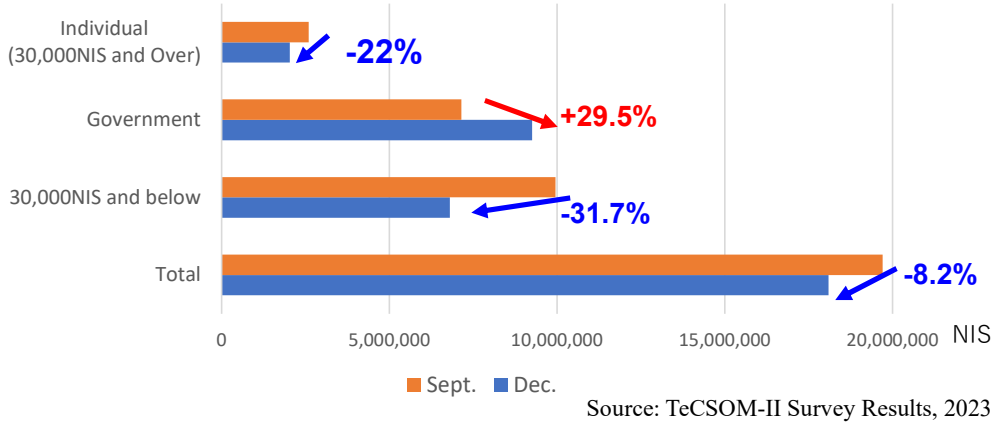
	Number of customers	Debts (NIS) Sept. 2021 A	Debts (NIS) Dec. 2021 B	Difference (NIS) C=B-A
Water Fee	8,282	19,709,462	18,091,941	-1,617,521 **(-8.2%)**
Sewerage Fee (Excluded PP4 &5)	1,125	761,579	681,412	-80,167 **(-10.5%)**

30,000 NIS and Over Debts

Water Fee	September 2021		December 2021	
	Number	Debts (NIS)	Number	Debts (NIS)
Total Debtors	56 (0.68%)	9,751,836 (49.5%)	62 (0.75%)	11,289,729 (62.4%) (+1,537,893)
Governments	**33** (0.40%)	7,147,685 (36.3%)	**47** (0.57%)	9,259,256 (51.2%) (+2,111,571)
Individual	**23** (0.28%)	2,604,151 (13.2%)	**15** (0.18%)	2,030,473 (11.2%) (-573,678)

Source: TeCSOM-II Survey Results, 2023

Figure 2.1.14 (a) Total Debts (Unpaid Bill Amount)



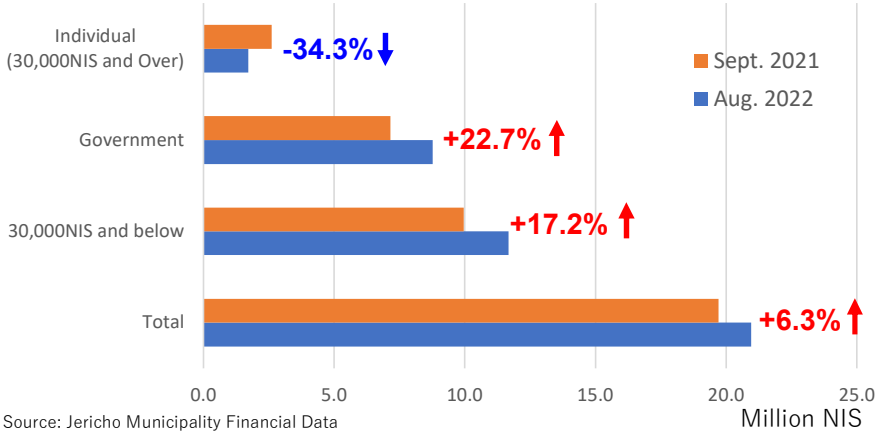
Source: TeCSOM-II Survey Results, 2023

Figure 2.1.14 (b) Total Debts Comparison in 2021

- On the other hand, in government institutions, the debt amount has increased by 2,111,571 NIS (+30%), which requires more prompting of payments from the government institutions. As a track record, fee payments from the government institutions have taken up to three months at the earliest, and up to three years so far.

- A comparison of the accumulated unpaid water supply fees from September 2021 to August 2022 is shown in Figure 2.1.14(c). The fee collection measures taken by Jericho Municipality have reduced the accumulated unpaid amount of individual water bills over 30,000 NIS by approximately 34.3%. While, the accumulated unpaid amount of government institutions increased by approximately 22.7%, and the accumulated unpaid amount below 30,000 NIS also increased by approximately 17.2%, resulting in an overall increase in the accumulated unpaid amount of approximately 6.3%.

- Following this result, Jericho Municipality requested the Ministry of Finance to pay the unpaid amount, and a portion of the accumulated unpaid water fees of 1.09 million NIS (equivalent to approximately 12.4% of the accumulated unpaid amount for government institutions) was paid.



Source: Jericho Municipality Financial Data

Source: TeCSOM-II Survey Results, 2023

Figure 2.1.14 (c) Total Debts Comparison in 2021 and 2022

2) Collection of unpaid water bills

i) Individual Customers

- For the amount of unpaid water bills of one individual (accumulated 1.2 million NIS), the amount of the debt was agreed to be 0.7 million NIS, with a monthly payment of 18,000 NIS (39 monthly payments) in consultation with the Jericho Municipality and the person concerned. The reason for the reduction of 0.5 million NIS (=1.2-0.7) was an acknowledged fault in the water meter. It was also agreed that no fine and interest would be imposed for late payment.

ii) Government Institutions

- The Ministry of Finance made two payments for part of the unpaid water bills: the first payment of 0.509 million NIS (at the end of 2022) and the second payment of approximately 0.5 million NIS (in January 2023). This payment of NIS 1.09 million corresponds to approximately 12.4% of the total unpaid amount of 8.77 million NIS (as of August 2022). Jericho Municipality continues to request payments from the Ministry of Finance.

3) Collection of unpaid sewerage bills

- The tariff collection management section of Jericho Municipality collects water and sewerage fees together, but previously, approximately 30% of users did not pay the sewerage fee as an option. However, the section continues to explain to users at the counter that they are obliged to pay both fees, and most users now pay the sewerage fee.

(7) Sewerage Performance Visualization by Key Performance Indicators: KPIs

a) Activity

- Nine (9) Key Performance Indicators (KPIs) were formulated to quantitatively evaluate the Jericho Municipal Sewerage Service and explained at the weekly meeting held on 28 June 2022.
- The following were explained for the calculation of KPIs: i) Measurable figures should be used; ii) The sewerage services of Jericho City can be easily and objectively evaluated; iii) The data should be available and official; iv) Different data for the same purpose gets different results; and v) KPIs are easier to understand when used for year-on-year comparisons or comparisons with other cities/municipalities.
- * The data of Ein Sultan Camp and Aqbat Jabr Camp are not included in the KPIs (1, 2, 8, 9) mentioned below.

- The KPIs are as follows:
  1) Sewer Network Coverage Ratio
  2) House Connection Coverage Ratio
  3) Wastewater Quality Compliance
  4) Sewage Sludge Quality Compliance
  5) Facility Operating Ratio
  6) Reuse Ratio of Treated Wastewater
  7) Unit Treatment Cost
  8) Operation Ratio
  9) Collection Ratio

- In addition to the above, (i) Staff Productivity Ratio, which indicates productivity per worker, and (ii) Staff Workload Ratio, which indicates workload per worker, were proposed.
- For (i), the WWD would use it to determine whether the installation of sewers is a self-initiated work or outsourced. The explanatory document on KPIs is presented in Appendix 2.1.1.
- The formula for calculating each KPI is presented in Table 2.16.

Table 2.1.6 Formula for Calculating KPIs

	KPI	Unit	Formula
1	Sewer Network Coverage Ratio	%	$\frac{Constructed\ Sewer\ Length}{Target\ Sewer\ Length}$
2	House Connection Coverage Ratio	%	$\frac{Connected\ Household\ Number\ with\ Access\ to\ Sewerage\ Services}{Total\ Household\ Number\ within\ Service\ Area}$
3	Wastewater Quality Compliance	%	$\frac{Total\ Number\ of\ Samples\ Passed}{Total\ Number\ of\ Samples\ Tested}$
4	Sewage Sludge Quality Compliance	%	$\frac{Total\ Nubmer\ of\ Samples\ Passed}{Total\ Number\ of\ Samples\ Tested}$
5	Facility Operating Ratio	%	$\frac{Daily\ Average\ Inflow}{Design\ Daily\ Average\ Inflow}$
6	Reuse Ratio of Treated Wastewater	%	$\frac{Amount\ of\ Supplied\ Treated\ Wastewater\ to\ Farmers}{Amount\ of\ Treated\ Wastewater}$
7	Unit Treatment Cost	NIS/ m^3	$\frac{Operating\ Expense\ in\ a\ Year}{Amount\ of\ Inflow\ Wastewater\ per\ Year}$
8	Operation Ratio		$\frac{Operating\ Expense\ in\ Year}{Operating\ Income\ from\ Sewerage\ Tariff\ in\ a\ Year}$
9	Collection Ratio	%	$\frac{Income\ from\ Sewerage\ Tariff\ in\ a\ Year}{Billed\ Amount\ of\ Sewerage\ Tariff\ in\ a\ Year}$

Source: TeCSOM-II Survey Results, 2023

b) Achievements

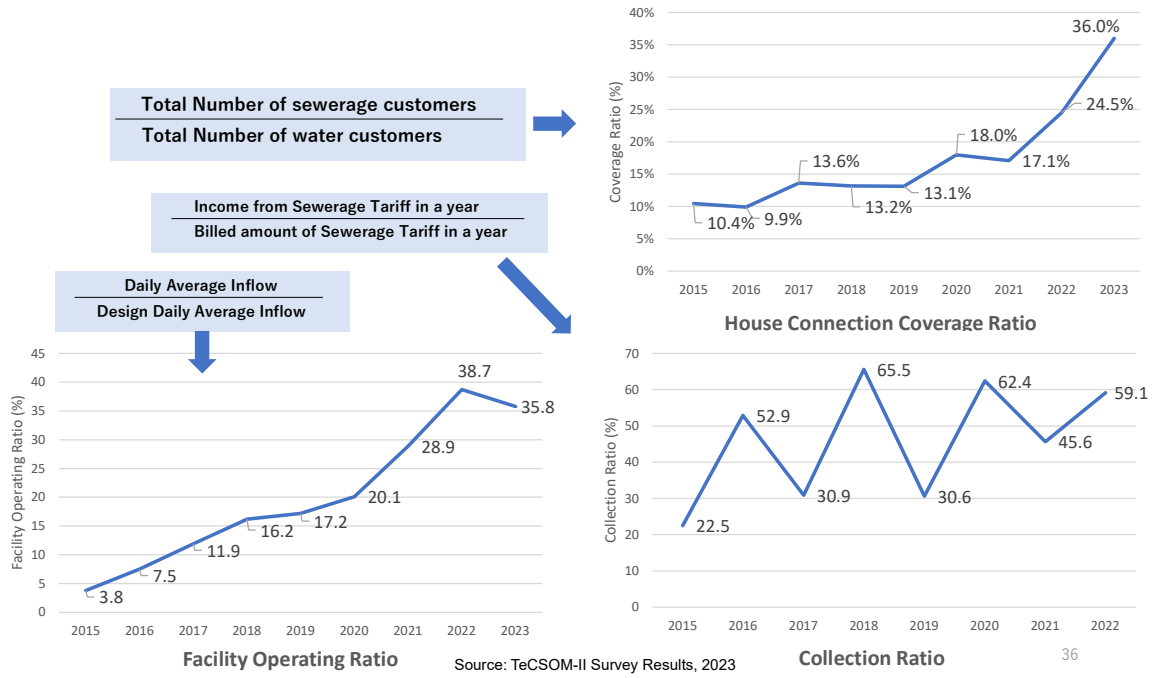
1) KPI transition

- The KPI values for the Jericho Sewerage Project are shown in Table 2.1.7 and Figure 2.1.15 (in part). KPI values are used for 1) data collection and calculation, and 2) KPI evaluation and feedback, and are used for self-evaluation of sewerage projects to understand what needs to be strengthened in the following year.

Table 2.1.7 Nine KPIs for Jericho Sewerage Project

	KPI	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	Sewer Network Coverage Ratio	%	33.9	33.9	33.9	47.3	47.3	47.3	47.3	47.3	47.3
2	House Connection Coverage Ratio	%	10.4	9.9	13.6	13.2	13.1	18.2	17.1	24.5	36.0
3	Wastewater Quality Compliance	%	89	92	-	-	-	-	97.3	94.6	100
4	Sewage Sludge Quality Compliance	%	100	-	-	-	-	-	100	100	100
5	Facility Operating Ratio	%	3.8	7.5	11.9	16.2	17.2	20.1	28.9	38.7	35.8
6	Reuse Ratio of Treated Wastewater	%	0	0	84	73	79	86	75	49	51
7	Unit Treatment Cost	NIS/ m^3	1.14	1.03	1.05	1.04	1.06	1.06	1.05	0.96	-
8	Operation Ratio		24.57	11.74	13.98	4.45	11.35	3.25	4.22	2.77	-
9	Collection Ratio	%	22.5	52.9	30.9	65.5	30.6	62.4	45.6	59.1	-

Source: TeCSOM-II Survey Results, 2023



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.15 KPIs (partial)

2) KPI evaluation

i) House Connection Coverage Ratio

The sewer connection ratio increased from 24.5% (2022) to 36.0% (preliminary figures, 2023). This can be attributed to two factors: 1) GIS compiling of sewer data; and 2) Sewer house connection (Pilot Project: PP) 4&5 building survey results reflected in the number of sewer connections. Refer to Table 2.1.12 for detailed information on PP.

ii) Reuse Ratio of Treated Wastewater

- The reuse ratio of treated wastewater was 49% in 2022, a drop of -26% compared to 2021. One reason for this is that two farm owners discontinued use from September 2022 due to the identification of suspended solids in the treated wastewater. As of May 2023, the farm owners have resumed use. Suspended solids in treated wastewater were reported by other users, which prompted Jericho Municipality to clean the irrigation tank. (Refer to Activity 1-1 (3) Reuse of treated wastewater and 3) Cleaning of irrigation tanks)
- Since there is a surplus of treated wastewater for the amount used and the potential demand is high, the supply (sales) can be increased by making farm owners aware of this. (See Table 2.1.1 Interviews with users of treated wastewater)

iii) Unit Treatment Cost

This KPI indicates the cost (NIS/m^3) of treating 1 m^3 of sewage. In 2022, the value was below 1 for the first time at 0.96 NIS/m^3. While the introduction of solar power is expected in the future, this KPI needs attention since a second reactor will be used due to an increase in the volume of sewage inflow.

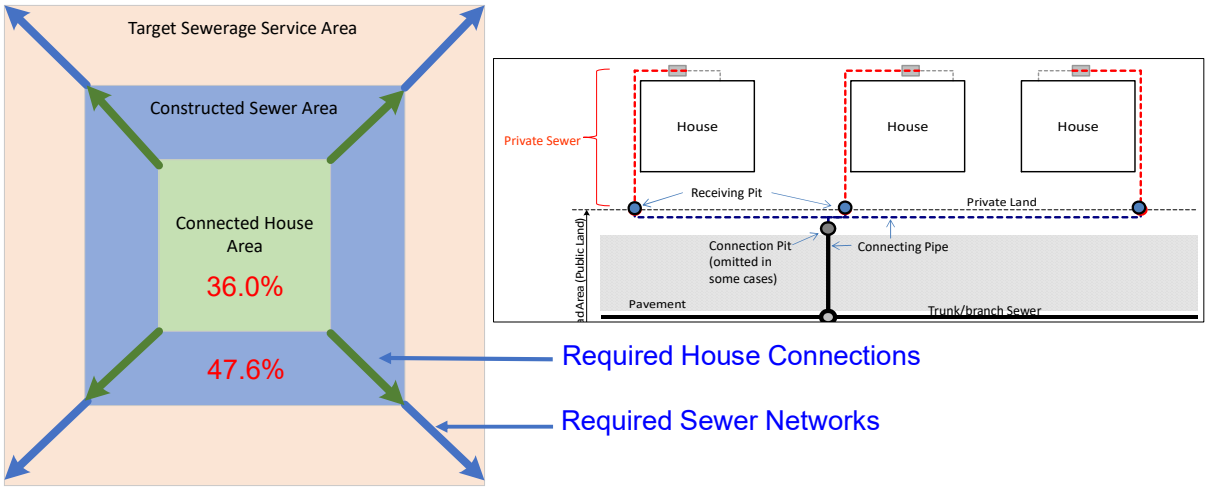
iv) Operation Ratio

The Operation Ratio is the O&M costs divided by the sewerage fee revenues. This value shows a trend towards improvement, with a record low in 2022. This KPI affects 1) sewerage fee revenues (number of connections, number of users) and 2) sewerage fee collection ratio. It is important to identify factors by looking at trends in O&M costs, collection ratios and sewerage fee revenues.

3) Sewerage coverage ratio

- The sewerage coverage ratio is based on two concepts: 1) Existing sewer extension relative to required sewer extension (KPI-1: Sewer Network Coverage Ratio); 2) Percentage of the buildings connected to the sewerage system in the total number of buildings in the sewerage planning area (KPI-2). This concept is illustrated in Figure 2.1.16.
- In regard to KPIs for sewerage coverage, the KPI for sewer extension and the KPI using the number

of connected buildings are targeted differently, resulting in differences in KPI values. In areas where sewers have been constructed, sewerage coverage can be increased by extending connection pipes in the public part and promoting private sewer connections. In areas where sewers have not yet been constructed, it is necessary to construct branch sewers, and the current Jericho Municipality relies heavily on other donors. The route selection and planning design of the branch sewers were carried out by the USAID consultant (completed in July 2023).



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.16 Conceptual Diagram of Sewerage Coverage

(8) How to Implement the Project in the Absence of Japanese Experts

a) Activity

- After discussions with the WWD Director, it was agreed to continue the weekly meetings even in the absence of the Japanese experts. The Japanese experts have been explaining the work, progress, achievements and issues in each Project component. However, the ownership was transferred to the C/Ps and the activities were promoted.
- The work contents were given; the C/P staff were appointed; and a schedule for weekly meetings was set. This was explained to all related persons by the WWD Director at the weekly meeting on 5 December 2021.
- The work categories and group composition were as follows. The work topics were set to resolve issues that were also discussed in the JCC.

Table 2.1.8 Subjects of Weekly Meeting

Group	Subject	In Charge	Supervisor
1	Sewer network updating by GIS	Eng. Majdi & Eng. Shirad	Eng. Fityani
2	Sewer connection & PPWM*	Eng. Majdi & Eng. Sulaiman	Eng. Fityani
3	Water & Sewerage fees	Mr. Abdulfattah	Mr. Musa
4	Jericho WWTP O&M +Water Quality	Eng. Omran & Eng. Yaghi	Eng. Ibrahim
5	Public Relations	Mr. Marwan & Mr. Ali	Ms. Weam & Eng. Fityani
6	Donor Information & strategic plan	Mr. Abu Mohsen (Plan), Eng. Sulaiman (PPWM* & SCADA)	Eng. Fityani

*PPWM: Prepaid Water Meter

- Weekly meetings were held once every two weeks, basically on Mondays at 09:00 (each for approximately 1 hour), in the Jericho Municipality conference room, to establish weekly meetings.
- The transfer of autonomy to the C/Ps in first half of the TeCSOM-I was not smooth as expected, and there were many occasions when Japanese experts took the lead. For the C/Ps, this was unavoidable, particularly in the context that they had just launched a sewerage project and faced many new challenges in a short period of time.
- However, since three and a half years have passed since the end of TeCSOM-I and a strong leadership (WWD Director) has been created, there was an expectation that the activities could continue without slowdown even in the absence of Japanese experts.

(9) The Report of Project Activities and Achievements to the Representative Office of Japan to the Palestinian Authority (ROJ)

1) Report the current status of the Jericho sewerage project representative office of Japan to the Palestinian Authority (ROJ) (7 December 2021)

i) Jericho WWTP

- As of now, the inflow to the Jericho WWTP has been evaluated as a percentage of the wastewater treatment capacity (9,800 m^3/day). However, the wastewater treatment capacity is equivalent to the planned maximum daily wastewater volume, which is the maximum amount of wastewater that can be received. Since the amount of sewage inflow presented by Jericho Municipality is the average daily sewage amount for each month, the planned average daily sewage amount (6,600 m^3/day) is the appropriate target for evaluation.

- Therefore, when evaluating the daily average inflow of 2,221 m^3/day in October 2021, the planned daily average sewage volume is used. Actual inflow/planned daily average inflow = 2,221/6,600 x 100 = 33.7%, which implies that the inflow is approximately 1/3 of the plan.
- Factors that will increase the amount of sewage in the future are the development plans of Jericho City such as Ein Sultan Camp, JAIP and Jericho Gate in addition to the local population growth.
- The sewerage project in Jericho City has been attributed to the formation of a recycling-oriented society, solar power generating society and a society using the treated wastewater for irrigation (the first sale of treated wastewater in Palestine). Further, in TeCSOM-II, Jericho Municipality is aiming to spread the reuse of sewage sludge as a soil conditioner.
- In particular, treated wastewater was sold almost 100% of the time during the season when demand is high, and the ROJ showed a high level of interest towards this achievement. This was emphasized as a point to be appealed by the Jericho Sewerage Project.

ii) Sewerage Management

- O&M costs for water supply and sewerage services are mainly covered by revenues from these tariffs. However, it has not reached the point of reserving for depreciation. When depreciation costs are considered, there is a deficit.
- Once the unpaid water and sewage fees (approximately 720 million yen in total, as of September 2021) are collected, the funds can be used for extending sewage pipes and for covering depreciation. Unpaid bills, especially for government institution buildings, have become more prominent since 2020, and Jericho Municipality has been making efforts to collect the water and sewerage bills.

2) Report the current status of the Jericho sewerage project to the ROJ on 5 July 2023

- Their main considerations were the O&M of the JAIP's pre-treatment plant and an implementation of the sewage to refugee camps.
- Jericho municipality has declared that they can support the O&M of the pre-treatment plant by their knowledge and skills for the operation of Jericho WWTP and for the water quality monitoring, but it does not include any assignment of technicians/engineers. Since there is also shortage of laboratory technicians for the treatment plant, the Municipality is unable to assign staff to supervise the O&M of the pre-treatment plant.
- Sewer house connections in Aqbat Jabr Camp are not completed for all households and buildings. Therefore, a donor support is necessary to develop the sewer connections in the camp while the sewerage development (Phase 1) has currently undertaken in the Ein Sultan camp. Jericho Municipality is only accepting the sewage.

2.1.2 Grasp the Sewage Influent Volume at the Jericho Wastewater Treatment Plant (WWTP) and Estimate the Future Inflow. (This Includes Understanding the Water Balance of the Sewerage Catchment Area, Estimating the Sewered Population, and Reviewing the Wastewater Generation Unit Volume (liters per capita per day) (Activity 1-2)

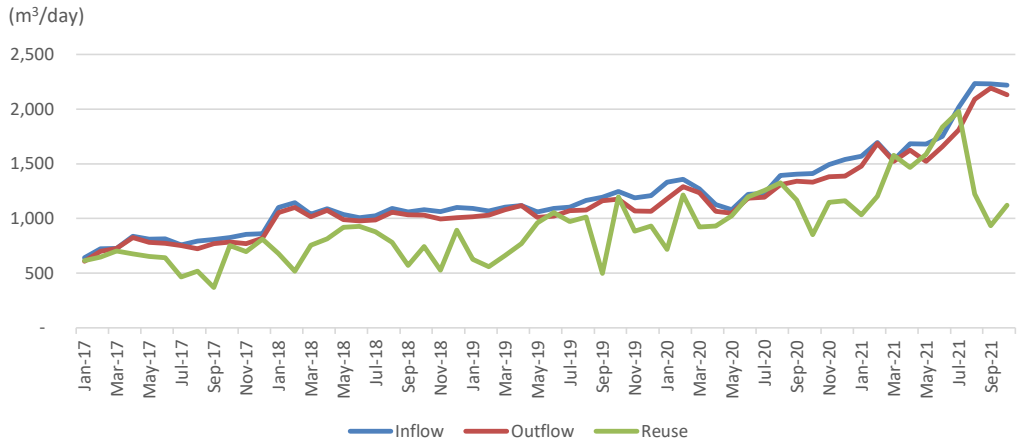
In the Activity 1-2, the TeCSOM team grasped the sewage influent volume at the Jericho WWTP and predicted the future sewage inflow up to year 2026. The WWTP received sewage from the JAIP located nearby but has stopped accepting its discharged sewage due to the high quality of the concentrate, which exceeds the sewage discharge standards. The JAIP has constructed the pre-treatment plant to treat the discharge to meet the standards.

This section presents the activities and achievements of (1) Sewage Influent Volume Prediction at the Jericho WWTP; and (2) the Discharge from the JAIP.

(1) Sewage Influent Volume at the Jericho WWTP

a) Activity

- Inflow to the WWTP, treated water volume and treated water sales volume are measured monthly. The average inflow volume in December 2021 was 2,098 m^3/day, which is approximately 31.8% of the planned average inflow volume (6,600 m^3/day).



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.17 Inflow, Outflow and Reuse Volume at Jericho WWTP

- Ein Sultan Camp is unsewered, but the detailed sewer design has been completed. Currently (20 November 2021), tenders received for Phase 1 have just been submitted to UNOPS. Since the tender evaluations took approximately two months, the construction has commenced in February 2022.
- There are three phases of sewerage development in Ein Sultan Camp, but Phase 2 has been defined in terms of planning specifications. The plan for Phases 1 & 2 is as follows:

Table 2.1.9 Sewerage Plan in Ein Sultan

Phase	Area	Location	Household (2020)	Population (2020)
1	A3	South	271	1,431
2	A2	Middle	364	1,922
2	A1	North	273	1,441
Total			908	4,794

Source: Final Design Report, UNOPS, 2020

- The scope of Phase 1 is to extend the sewer pipes by 5 km, house connections by 4.6 km and storm water by 1.5 km.

- Jericho Gate (housing development area) is being developed in close proximity to Jericho City and was connected to Jericho City water and sewerage. . A summary of the master plan for Jericho Gate is shown below:

Table 2.1.10 Jericho Gate Phased Plan

Stage	Year	Area (ha)	No. of Household	Water Consumed (m^3/d)
1	2020	74.9	261	821
2	2021	15.3	119	137
3	2022	18.1	171	175
4	2023	73.2	0	981
5	2024	23.7	210	215
6	2025	18.7	187	191
7	2026	22.2	218	223
8	2027	22.2	217	221
9	2028	17.6	176	191
10	2029	15.7	148	190
Total		303.4	1,707	3,345

Source: Master Plan, Jericho Gate Real Estate Investment Company

- The O&M status of the Jericho WWTP for the last six months (January 2021 - May 2022) was also presented in the weekly meeting. Figures on inflow, treated wastewater volume, treated wastewater sales (reused volume) and sludge generated were presented, showing that the average inflow for the six months was 2,042 m^3/day, although there were seasonal variations. The average daily inflow in May 2022 was 2,165 m^3/day.

- The C/Ps explained that one of the factors contributing to the slow growth in the inflow sewage volume is the lack of a significant increase in connections to the sewers. Factors that may lead to an increase in the volume of sewage in the future include i) the construction of a sewerage system in Ein Sultan refugee camp (but no sewerage charges are expected to be collected); ii) housing development in the Jericho Gate; and iii) the resumption of acceptance of industrial effluent from the JAIP.

- The experts developed a draft sewage volume projection for the Jericho WWTP and explained it to the Head of the Subscribers Service Section of the WWD. The section manager had one month of training in Japan and understood the contents of the draft projection, since he was in charge of sewer planning.

- The sewage volume projection is calculated on the basis of actual data from Jericho Municipality (e.g. population, water supply, sewage volume), but when this was explained to the water and wastewater Department Director, there were different perceptions concerning the permanent population and mobility population (overnight tourists and one-day tourists). Therefore, part of the sewage volume calculation procedures was revised so that the concept and structure of the projection (flow of sewage volume calculations) can be understood.
- The experts added some explanations in and revised the flow of the sewage volume calculations so that it can be understood. In particular, the projection was revised to clarify the differences between the resident population and the mobile population (overnight visitors and day visitors).
- The calculation method for forecasting sewage inflow is complex and requires an overview of the entire calculation flow in order to understand it. Therefore, the experts showed the flow chart of sewage volume calculations.
- The sewage inflow projection reflects the progress of the sewage pipe network in Ein Sultan refugee camp, where sewage will be generated in the future, as well as the housing development at Jericho Gate and the JAIP pre-treatment plant.
- The location and progress of the new housing development in Jericho city called Moon city was reviewed, but was not considered in the projection as it will not be connected to the sewage system in the near future.

b) Achievements

- The maximum design daily sewage volume for the Jericho sewerage project is 9,800 m^3/day, which is the treatment capacity of the WWTP. The evaluation of the inflow sewage volume is not based on the facility's capacity, but on the design average daily sewage volume. The current situation is that about 1/3 of the planned amount of sewage is inflowing. The trends in the volume of inflow of sewage into the Jericho WWTP and the timing of the Pilot Project (PP) are shown in Figure 2.1.18. Detailed information on PP is shown in Table 2.1.12.

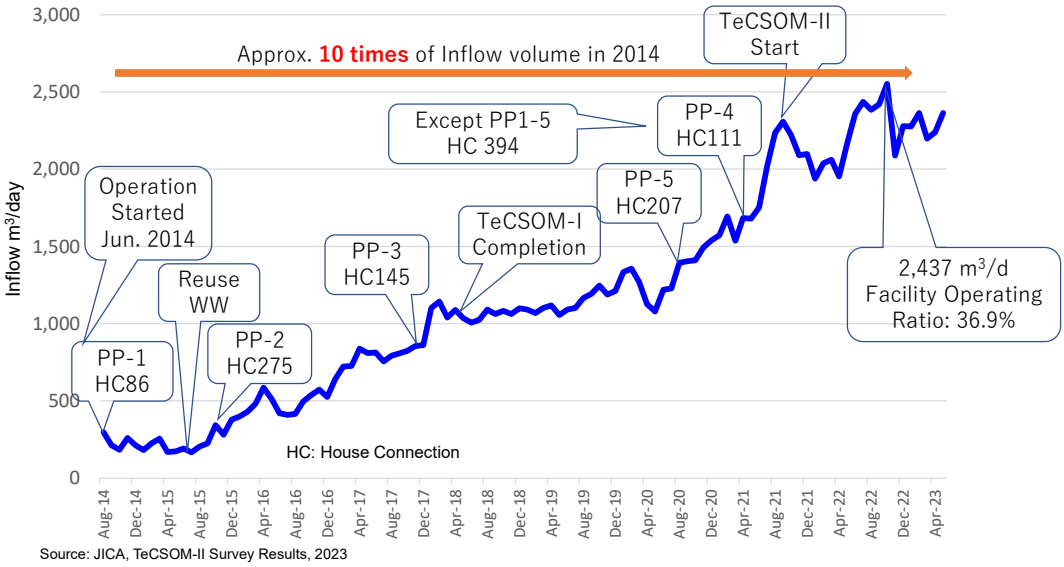


Figure 2.1.18 Inflow Volume at Jericho WWTP

- The following data were collected to predict sewage inflows. The data adopted were as follows. (1) Population of the planned sewerage area: "Palestinian Central Bureau of Statistics"; (2) Tourist population of Jericho: Ministry of Tourism data (for the past 3 years).
- The methodology for forecasting future sewage inflows was explained to the WWD staff in Jericho Municipality, and upon understanding, actual water supply data, which is the basic data (for the past three years) needed for the study, was obtained. The need for the data and its use is important knowledge for future projections of sewage inflow.
- The "Water Master Plan for Jericho City 2011" was referred to in order to confirm the concept of the calculation of sewage per capita in Jericho City, especially the breakdown of water consumption, and to understand the percentage that flows into the sewerage system. This document was referenced as basic data because of its detailed rationale and approval.
- A draft projection of the volume of sewage inflow into the WWTP was developed by the experts. The sewage inflow projections considered key factors such as future population, water supply volume per capita, sewage volume per capita, JAIP, two refugee camps and Jericho Gate. These projections were drafted and the concept and methodology were explained in detail to the C/Ps.
- In forecasting sewage inflows, the population, water supply and sewage volumes that have been set are calculated based on actual figures from Jericho Municipality. However, it was confirmed that there are no discrepancies with the future plans assumed by the Municipality.
- In September 2022, the sewage inflow projection for the Jericho WWTP was explained to the Head of the Subscribers Service Section of the WWD. At that time, some supplementary explanations were required in the sewage volume calculations.

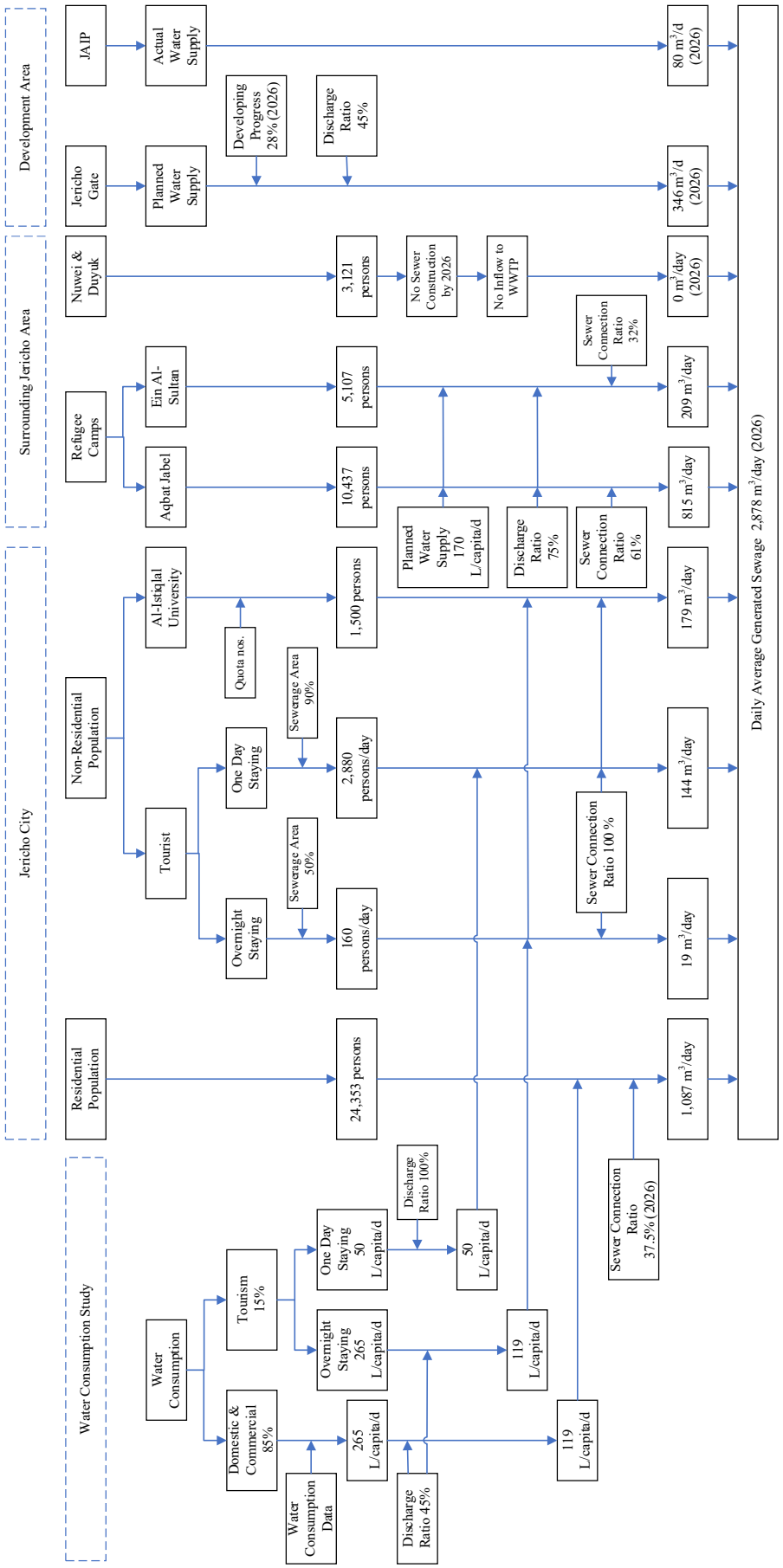
- In December 2022, the experts explained the revised projection to the Head of the WWD and the Head of Section again, so that the approach and procedure for calculating the sewage volume was understood.
- The projection, including the data used in the calculations, was reviewed within the WWD. As the sewage inflow projections to the WWTP are updated annually, the various basic data are checked and updated on a regular basis on the C/P side.
- The planned daily average and maximum sewage flows are shown in Table 2.1.11. It can be predicted that the 2nd reactor will be operational from 2024.
-

Table 2.1.11 Planned Daily Maximum Inflow and 2nd Reactor Operation

Year	2022	2023	2024	2025	2026
Planned Daily Average Inflow (m^3/day)	2,053	2,294	2,618	2,744	2,878
Planned Daily Maximum Inflow (m^3/day)	2,690	3,005	3,430	3,595	3,771
Reactor No.1	On	On	On	On	On
Reactor No.2	-	-	On	On	On

Source: TeCSOM-II Survey Results, 2023

- The formulation procedure for forecasting the sewage volume is shown in Figure 2.1.19. The draft future projections of sewage inflows are shown in Appendix 2.1.2.



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.19 Planning for Sewage Flow Projections

(2) Jericho Agro-Industrial Park: JAIP

a) Activity

1) Pre-treatment plant

- The status of tenant locations and the pre-treatment plant construction at Jericho Agro-Industrial Park (JAIP) were observed. Detailed data on tenants (industry, water consumption) was obtained from JICA Palestine Office. The pre-treatment plant was completed in June 2022.

- Instead of each tenant, JAIP Co. pays the water and sewage fees to the Jericho Municipality. The water fee is 2.5 NIS/m^3 and the sewerage fee is 1.0 NIS/m^3. Each tenant pays JAIP Co. a total of 4.5 NIS/m^3 as the water and sewerage fees and an additional O&M fee of 1.0 NIS/m^3.

- As of July 2023, the Jericho Municipality has stopped accepting wastewater from the JAIP. Jericho Municipality has previously stopped accepting wastewater after JAIP discharged water quality exceeding the sewage discharge standards (House connection law, cabinet resolution decision No 16 (2013)) into the sewer system.

  The current procedure being followed is described below. (Related to Activity 2.2)

  i) Stop accepting wastewater

  - i) Jericho Municipality measures the water quality of wastewater from JAIP; ii) If the wastewater exceeds the sewage discharge standard, the WWD Director, the Plant Manager and the Mayor discuss and verbally inform JAIP of their intention to stop accepting the wastewater; and iii) The Mayor issues a letter to JAIP to stop accepting the wastewater.

  ii) Resume accepting wastewater

  - i) JAIP issues a letter to the Mayor with the results of the wastewater quality measurement and a request to resume wastewater discharge; ii) The Mayor instructs the WWD Director, to remeasure and confirm the wastewater quality; iii) The WWD Director reports to the Mayor that the results of the water quality measurement are in compliance with the standard values; and iv) The Mayor issues a letter to JAIP in the name of the Mayor to resume receiving wastewater.

Photo 2.1.12 JAIP Entrance

Photo 2.1.13 JAIP

- The average daily water supply at JAIP is approximately 53 m^3 (data from June to September 2021). The design inflow water quality at the treatment facility is: CODcr 3,900 mg/L and Total Suspended Solids (TSS) 1,600 mg/L. The sewage discharge standards prescribed is: CODcr 2,000 mg/L and TSS 600 mg/L and are referred in Sewerage By-law of Palestine. No. 27. The water quality parameters are specified in the sewage discharge standards. The treatment capacity of the JAIP pre-treatment plant is 400 m^3/day in Phase 1 (1,200 m^3/day in overall plan).
- The issue of wastewater acceptance from JAIP has arisen since the end of TeCSOM-I (2017). The agreement with Jericho Municipality and JAIP to accept sewage effluent was signed on 11 August 2016, and since then, they have repeatedly refused and resumed accepting effluent.
- Representative Office of Japan to the Palestinian Authority (ROJ) will honour the O&M costs of the JAIP pre-treatment plant for the first three years. After that, the Palestinian Authority and Investment Promotion and Industrial Estates Agency (IPIEA, under the Ministry of National Economy) will discuss and decide on an administrator of the O&M costs.

Photo 2.1.14 Pre-treatment Plant (Sept. 2021)

Photo 2.1.15 Pre-treatment Plant (Nov. 2021)

- Regarding the penalties in JAIP it is worth noting that, although there should be penalties in IPIEA,

the supervising authority of the industrial park does not have any penalty clauses. Therefore, JAIP/ consultants are discussing with the Environment Quality Authority (EQA) to issue a recommendation to suspend operations until the situation is improved. However, the EQA requires JAIP/consultants to present a legally appropriate process. Although the developer has submitted a draft procedure to the IPIEA, it had taken several months for the IPIEA's legal department to confirm it and thus delayed the process. (From JAIP/consultants, October 2021)

- On 11 and 21 May 2022, the TeCSOM team visited the JAIP pre-treatment plant to confirm the construction progress. Pre-commissioning took place from 21-26 May 2022, and the installation of transmission lines were also completed.

Photo 2.1.16 Pre-treatment Plant (May 2022)

Photo 2.1.17 Pre-treatment Plant (Jun. 2022)

- Jericho Municipality is not part of the JAIP Pre-treatment Plant Commissioning Committee because Jericho Municipality considers this an internal issue between IPIEA/JAIP and UNOPS side, but will participate in the pre-treatment operation agreement. The members are IPIEA, JAIPCo and Jericho Municipality.

- In mid-September 2022, IPIEA approached the WWD in Jericho Municipality about outsourcing the O&M of the JAIP pre-treatment plant (not officially, but at the consultation level). At this moment, a contractor for the O&M of the pre-treatment plant has not been decided upon.

- When asked by Jericho Municipality for their opinion on the O&M contracting, the experts mentioned the following considerations and advantages, respectively. Points to consider: i) Jericho Municipality does not have sufficient staff for O&M; ii) the pre-treatment plant uses DAF (Dissolved Air Flotation), and Jericho Municipality does not have the knowledge and technology for this treatment method; and iii) there is a concern that O&M-related costs cannot be secured in three years. The advantages are i) centralized control of water quality at the WWTP and JAIP; ii) improved technical capabilities for O&M and water quality control; and iii) Jericho Municipality will have more influence in the effluent from JAIP/tenants.

- According to UNOPS, the O&M of the pre-treatment plant is subject to the following conditions: i) O&M will be performed by the Palestinian side, using Japanese funds for the first three years; ii)

UNOPS pays JDECo for the installation of transmission lines and JDECo undertake the construction work. The construction cost is included in the contract; iii) The manual preparation and O&M training will be carried out by the contractor.

- The WWD Director pointed out to the Mayor that if Jericho Municipality undertakes O&M of the pre-treatment plant, three additional staff members will be needed: an operator, a laboratory technician, and a worker. He also noted that there would be increased water quality management responsibilities. The Mayor responded by stating that Jericho Municipality is not prepared to take on the O&M with additional staff due to the current financial difficulties at Jericho Municipality, and that he intends to decline IPIEA's offer.

- On 10 May 2023, the TeCSOM team discussed with IPIEA the planned commissioning of the JAIP pre-treatment plant. The remaining work is energization testing by JDECo, followed by handover. At present, IPIEA is preparing an O&M tender, but no contractor has expressed interest and the date of commissioning of the pre-treatment plant is unknown.

- In May 2023, the IPIEA approached the Jericho Municipality again to outsource the O&M of the pre-treatment plant. The WWD of the Jericho Municipality visited the pre-treatment plant site and discussed O&M and effluent quality with the IPIEA. The WWD mentioned that although they could provide the IPIEA with guidance on O&M, they could not accept the O&M contract for the pre-treatment plant under the current situation of insufficient staffing. However, the WWD suggested to the JAIP that it could assist in providing guidance on O&M and water quality monitoring, given its experience and knowledge of WWTP operation and water quality testing. As of July 2023, there is no contractor for the pre-treatment plant. The IPIEA continues to discuss with Jericho Municipality to find a contractor for the pre-treatment plant. In the discussions, Jericho Municipality introduced the IPIEA to a candidate for the contracting of the maintenance of the Jericho WWTP.

- The current maximum water supply to JAIP is 150 m^3/day (50 m^3/day from Jericho Municipality and 100 m^3/day from Mekorot (Israel water corporation)).

2) JAIP workshop

- A workshop on wastewater pre-treatment plant at JAIP was held at JAIP administration office on 9 June 2022. The purpose of the workshop, organized by IPIEA, was to discuss the i) water quality of industrial effluents, and ii) an overview of the pre-treatment plant. During the workshop, Jericho Municipality presented an overview of the Jericho WWTP and background to the suspension of wastewater acceptance.

- UNOPS which is responsible for the construction supervision of the pre-treatment plant, presented an overview of the project. The objective of this plant is to treat effluent from JAIP's tenants in the pre-treatment plant to sewage quality that meets the discharge standards, before discharging to the

sewer system of Jericho Municipality.

- The facility was scheduled to be handed over three months later, in September 2022. The electricity contract with JDECo and the wiring work had not yet been started at the time. The water quality parameters constantly monitored by JAIP are pH, TSS and CODcr. Other water quality parameters will be outsourced.
- The IPIEA, the supervisory body of the JAIP, explained the water quality parameters of industrial effluents. The effluent standards from JAIP's tenants were presented. These standards are also indicated in the contracts with tenants. If these effluent standards are exceeded, discharges from tenants will stop being accepted.
- It was confirmed that the Jericho Municipality is entitled to comment on the agreement on the O&M of the facility before the pre-treatment plant starts operating.

2.1.3 Support the Development of a Plan for the Expansion of the Sewer Network in Jericho. (Activity 1-3)

When planning sewer networks, it was necessary to integrate the data of the existing sewers in the Jericho Municipality's possession. The integration by GIS of the sewer data, which had been implemented by different donors (JICA, USAID and PWA), has facilitated the planning of the sewer expansion.

In addition, there were requests for sewer connections from the villa developer. There were several issues on the sewer connection such as fees and apportion of the construction costs.

This section presents the activities and achievements of (1) Centralized Management of Sewer Information; and (2) Study on sewer connection from the Jericho Hills Village.

(1) Centralized Management of Sewer Information

a) Activity

- At the beginning of the TeCSOM-II, after reviewing the data on existing sewer pipelines in Jericho City, it was found that the sewer data was managed by different donors (JICA, USAID and PWA) and the databases were not integrated. Therefore, the Directors of the WWD and the Engineering Department of Jericho Municipality discussed the need to integrate these data and agreed to implement the integration plan. The data integration can be done using the GIS software as recommended by TeCSOM-II experts.

- An aerial photograph was obtained from the Planning & Project Department of the Jericho Municipality and was used as a diagram of the sewer network. The location and attribute information (extensions, diameters, pipe types, etc.) of the existing sewer pipes and house connections were managed as the basis for sewer pipe planning. There were two issues to be solved.

    i) Employment of GIS engineers: GIS section has been established in the Planning & Project department, but at present, existing sewer data is not managed centrally. There are completion drawings, CAD data, and attribute data, but the data has not been compiled into GIS containers. The WWD Director also pointed out that centralized management of data through GIS is one of the important issues. Jericho Municipality has employed an Engineer since 31 October 2022 to develop GIS-based information management.

    ii) Problems with PP1-3: Although drawings and CAD data are available, there is no coordinate information. So, a study is underway to determine the appropriate method to incorporate this information into the map. Since survey coordinates of each connection pipe is not effective enough for the time and labor required, visual inputs based on the as-built drawings are considered practical. On the other hand, for PP4-5, the CAD data was obtained from PWA.

- The input of sewer data into GIS have been completed for JICA grant aid project and Pilot Project (PP) 2 & 4, and the as-built drawings for PP 1, 3, and 5 have been obtained and were being input into GIS. However, the coordinates of manhole locations may be off by several meters, so the C/Ps were measuring the coordinates by GPS on site and revised the data. While, since it was unclear

whether the USAID sewer drawings are shop drawings or as-built drawings, the sewer information was finally entered into the GIS based on the current drawings.

- A database of information on sewage culverts in Jericho was developed using GIS. The main objectives of the database development are as follows: i) management of completed sewer as-built drawings (target project: JICA grant aid project, USAID, and PP 1-5); ii) improving the ease of managing and updating sewer information; iii) sharing sewer information with other departments; iv) determining the feasibility of connecting sewer to houses/buildings; v) identifying undeveloped sewer areas; and vi) supporting sewer extensions and planning.
- As the coordinates of the manholes varied depending on the projects, the coordinates were verified on site using GPS. The head of the customer service section in the WWD measured the manhole positions himself on site for the database development.

b) Achievements

- Sewer data has been input using GIS, and the input of information (sewer routes) on a two-dimensional level has largely been completed. The previously discrete sewer information can now be managed centrally, enabling the identification of underdeveloped areas/routes and the identification of houses that can be connected. In order to plan the construction of sewers, sewer extensions by diameter can be calculated for each area and used to formulate a phased development plan including the quantity of required sewers and the estimated sewer construction costs.
- The input of sewer data for the JICA grant aid project, USAID project and PP1-5 has been completed. The results of this work have provided information on the locations of existing sewers and enabled the identification of priority sewer maintenance areas/routes and the formulation of the maintenance policy. The WWD discussed the selection of sewer routes with USAID based on this data.
- The routes of existing sewers and information on houses connected to the sewerage system (in part) are shown in Figures 2.1.20 and 2.1.21, respectively.

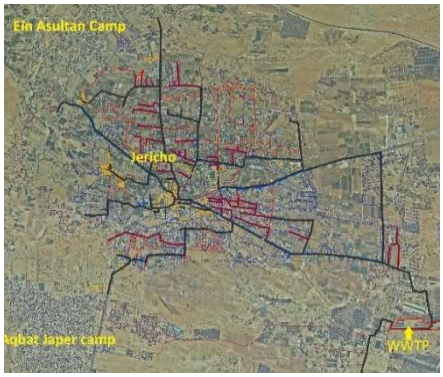


Figure 2.1.20 Existing Sewer Network

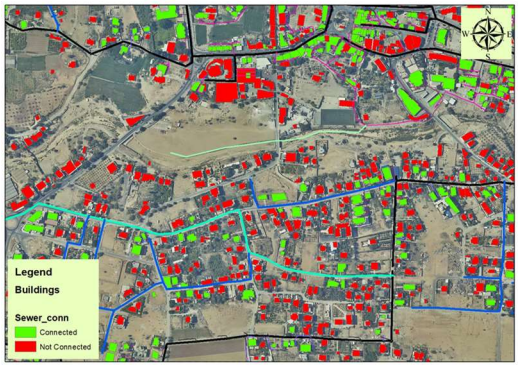


Figure 2.1.21 Connected and Unconnected Buildings

- The location information (coordinates) of the manholes requires GPS measurement, which is the work of the WWD. The remaining tasks for Jericho Municipality in the integration of the sewer data into the GIS include: i) input of the sewer attribute data (diameters, slopes, invert levels, etc.); and ii) measurement and input of manhole locations.

Source: TeCSOM-II Survey Results, 2023

(2) Study on Sewer Connection from Jericho Hills Village

a) Activity

- A developer in Jericho Hills Village, located near the Jericho WWTP, approached the WWD of the Jericho Municipality to discontinue the cesspit tanks currently in use and to connect to the sewer line. The experts examined the economic advantages of the connection, taking into consideration the mutual cost burden and economics on both the Village and Jericho Municipality sides. The target area is shown in Figure 2.1.22.

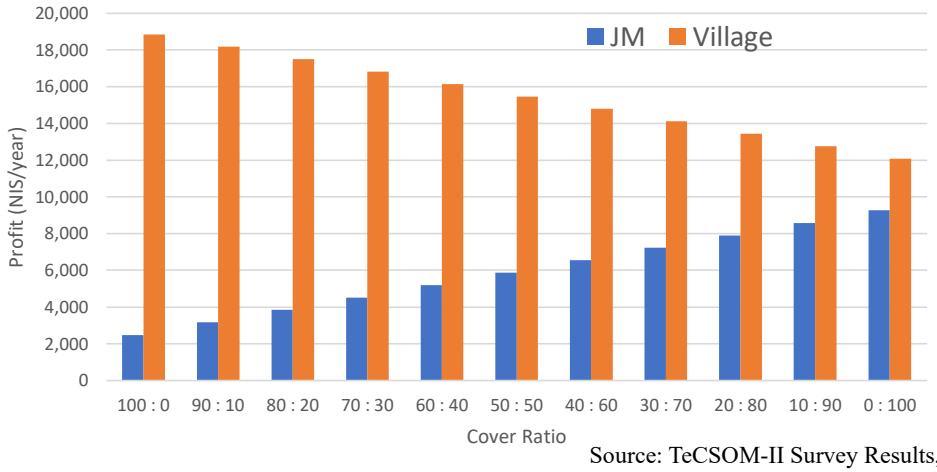
Source: TeCSOM-II Survey Results, 2023

Figure 2.1.22 Location Map

- The results of the project study indicated that it would be economically advantageous for both sides even if Jericho Municipality covered the entire costs of the sewer construction. However, the Village side has offered to share up to 50% of the construction costs and instead waive the sewer connection fee, while Jericho Municipality does not have sufficiently financial resources to construct the sewer and is in need of construction contributions and donor support.

b) Achievement

- The problem in this case is that both sides have started discussions without presenting any data (location information, Village overview, current maintenance costs, etc.). In previous responses, there were many cases where both sides only expressed their opinions and did not proceed to concrete discussions. Therefore, in order to learn the appropriate approach to solve the problem, the experts explained the solution together with case studies during the weekly meeting. The explanatory material is shown in Appendix 2.1.3.
- The results of the discussions on 28 September between the WWD Director and Village were as follows: 1) Jericho Municipality considers whether the sewer connection fee can be waived; 2) more accurate culvert construction costs are calculated. The matter then was discussed again.
- Jericho Municipality calculated a more accurate sewer construction cost for the connecting sewer from the Village to the existing sewer. The expert reviewed and reached a study result based on this construction cost. The results show that the Jericho Municipality could benefit from covering all construction costs (Jericho Municipality : Village = 100 : 0). The result of cost allocation is shown in Figure 2.1.23. The WWD Director reported these results to the Mayor and discussed the cost allocation with the Village side.



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.23 Construction Cost Allocation

- In November 2022, the discussion was initiated to cover 50% of all costs related to the connection (connection costs, design, bidding, construction, construction supervision, etc.).
- Finally, both parties agreed that the targeted sewer construction would be included in USAID's support for the sewer construction due to the high cost for both sides.

2.1.4 Support the Study and Implementation of Methods for Securing Funding for Sewer Network Expansion Projects (Activity 1-4)

The Jericho Sewerage Services requires the construction of sewers and the proper O&M of sewerage facilities. Therefore, the sustainable budget source has to be secured. There are three main revenue sources: 1) Sewerage fee, 2) Sewer Connection fee and 3) Treated Wastewater sales. In addition, the TeCSOM team analysed the water supply fee collection which has been an important revenue source of the Municipality.

This section presents the activities and achievements of (1) Sewer Connection, (2) Sewerage Fee Collection and (3) Water Supply Fee Collection. This section also provides factors for better management of the Jericho Sewerage Service management issues explained in Chapter 1.

(1) Sewer Connection

a) Activity

- There are three main sources of revenues in the Jericho Sewerage Services: 1) Sewerage fee (1.0 NIS*/m^3), 2) Sewer Connection fee, and 3) Treated wastewater sales fee (0.5 NIS/m^3). In water and wastewater services, the collection of water fees is also important and is financed through 4) the introduction of PPWMs.

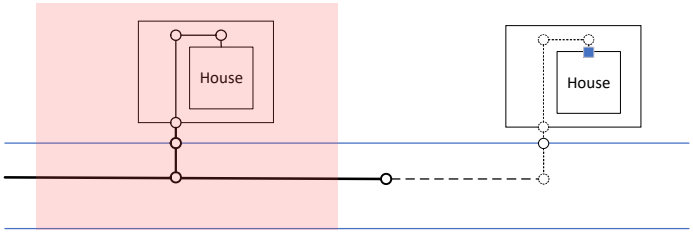
*NIS: New Israeli Shekel

1) Sewer Connection Fee

Jericho Municipality has identified two cases of challenges in developing its sewer network.

i) Within the sewer service area (area where sewage pipes are constructed)

- When the building owner is willing to connect to the sewer network and pay the fee: With the non-availability of city workers and equipment, the work could be done, which will, however, take time. The efficiency of this work can be improved if a budget is allocated for providing workers and equipment.
- When the building owner is willing to connect to the sewerage network but does not have the funds: The Municipality has established an instalment payment system, which allows for interest-free payments in instalments of up to one year.
- When building owners have no intention to connect to the sewerage network: Public awareness and PR activities are necessary. However, when the sewerage service was first started (2014), PR activities were emphasized in order to gain the understanding of residents, but in recent years, the problems mentioned in a) and b) above have become more numerous, and the number of cases where residents do not connect due to lack of PR has decreased (Water Supply and Wastewater Department Director).

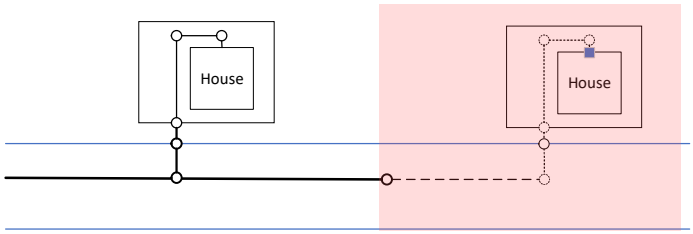


Source: TeCSOM-II Survey Results, 2023

Figure 2.1.24 Within Sewer Service Area

ii) Without the sewer service area (area where sewage pipes are not constructed)

- The building owner is willing to connect to the sewer network, but there is no sewerage service. This work is currently difficult to be carried out due to lack of funds, which have so far relied on donor support.
- In the case of newly constructed cesspits (sludge storage tanks): even if sewers are installed at a later date, the building owner will not accept the sewer connection because the cesspit is new. However, the cost of constructing a cesspit is high: approximately 2,500 NIS for a single house and 10,000 to 15,000 NIS for a building complex. In three or four cases so far, building owners have built their own sewers (including public roads) and connected the buildings instead of constructing cesspits. This was determined to be less expensive than the cost of constructing a cesspit.



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.25 Without Sewer Service Area

- As mentioned above, cases a), b) and d) are the main issues, and securing and increasing the budget for sewer development is a prerequisite to solve these issues (except with donor support). However, Jericho Municipality still relies on donor support.
- In order to solve the above issues, there are two basic ways to raise funds: i) increase the fee collection ratio, and ii) raise fee rates. For i), there are means of i) water supply fee, ii) water supply connection fee, iii) sewerage fee, iv) sewer connection fee, and v) treated wastewater sales fee. I) and iii) have improved the collection ratio, v) is 100%, and for iv), the first step is to approach through a house survey. As for ii), from October 2021, the discount campaign for sewerage fees was terminated and returned to 0.5 to 1.0 NIS/m^3.
- Currently, the sewer connection fee adopted by Jericho Municipality is calculated by multiplying

the unit price per building floor area (13 NIS/m^2) by the floor area. On the other hand, the Water Sector Regulatory Council (WSRC) states that it calculates and collects the fee based on "extension of on-premises connection cost + fixed amount" and has instructed Jericho Municipality to use the same calculation.

- This reason is to ensure fairness in cost sharing, for example, the floor area of a building with a first floor and a tenth floor are very different. In a meeting between Jericho Municipality and WSRC held on 13th January 2022, the Municipality indicated that it would not accept the new Tariff law "Instruction No.2 of 2021 on the unified tariff system for water and wastewater" of WSRC.

- Jericho Municipality has submitted a written opinion to the WSRC on continuing the existing calculation method, and no conclusion has been reached. For now, Jericho Municipality carries out their policy, by which the method of calculating the sewer connection fee (13 NIS/m^2) is not changed.

- The WWD Director explained that the collection of the connection fee is not a problem because the building owners are required to pay the connection fee when they apply for any construction approval by the Municipality. However, for existing buildings (before the start of connection fee collection), collecting the connection fee is not easy because there is no data on the floor area of the buildings and the surveyor needs to measure the floor area.

- Regarding the building floor area ledger, the Inspection section in the Engineering & Organization Department of Jericho Municipality collects and manages the data of building floor area. For newly constructed buildings, the floor area is measured from the drawings, and for existing buildings, the data is physically measured on site by surveyors.

- However, the Jericho Municipality does not have all the building data in record and relies only on actual measurements for existing buildings. Currently, the pilot project (PP) No. 1-5 has been implemented and the floor area of the buildings in PP1-3 has been measured and invoices have been successively issued to the building owners in order to collect the connection fee (13 NIS/m^2 for new buildings and 7 NIS/m^2 for existing buildings).

- The Pilot Project (PP) is a project/ construction work to connect a sewer from a cesspit in a residential area to a receiving pit in a public area in order to promote sewer connections. The PPs have been implemented a total of five times from 2014 to the present. The PP's construction costs were not covered by the building owner; its funders were JICA, PWA, and the Jericho Municipality. Issues related to PP1-5 data are described in Activity 1-3. A summary of PP1-5 is as follows.

Table 2.1.12 Outline of Pilot Project (Sewer House Connection)

PP	Funder	Implementation	No. of House Connection	CAD Data	Completion Year
1	JICA	JICA	86	Existing	July 2014
2	JICA	JICA	275	Existing	October 2015
3	JM*	JM	145	Existing	2017
4	PWA	PWA	111	Existing	August 2021
5	JICA	PWA	207	Existing	July 2020
-	JM	JM	394	-	From 2015

Source: Jericho Municipality, Water and Wastewater Department
*JM: Jericho Municipality

- The process of collecting the sewer connection fee is as follows: i) The Inspection section of Jericho Municipality surveys/measures the building area; ii) The floor area data is passed to the Subscribers' Service section of the WWD to calculate the connection fee; iii) The invoiced amount is then passed to the Collection Management section of the Finance Department to be invoiced to building owners.
- In the five months from January to May 2022, 393 applications for connection to the sewer system were received. Of these, 153 applications were not accepted because the area was not yet developed with sewers. The remaining 240 applications are under investigation to determine whether they can be connected to the sewer system; 95 applications were received from Jericho Gate (residential development area) before January 2022 and were connected to the sewer system after approval. There is a growing demand from residents for sewer connections.
- On 28 June 2022, the Chief Advisor met with the Mayor before returning to Japan and asked for continued cooperation with TeCSOM-II. In this context, he explained that i) a new draft PR leaflet had been developed; ii) requests and complaints should be directed to the customer service centre because the WWD Director is always very busy; iii) a house/building survey of PP4&5 is the first step for collecting fees; and iv) he would continue to request payment of water and wastewater fees from the Ministry of Finance.
- In response, the Mayor instructed the officer in charge (Purchasing & Tender Unit in the Municipality) to carry out the survey on an overtime basis to ensure that the house/building survey was staffed. Arrangements were made for information from customers to be passed on to the customer service centres. There was also a clear statement that discussions would continue with the Ministry of Finance to recover as much of the unpaid amount as possible.

2) Special Account in the WWD

- In order to secure the WWD's own budget: It was explained at the 2nd JCC that the WWD intends to accumulate sewer connection fees as revenue in the WWD's Special Account to cover the WWTP repair, depreciation and sewer connection costs.
- Basically, although approved by the Mayor, the account is not yet functioning as a reserve account and starts recovering the costs by promoting connections to the sewer system.

- First, Jericho Municipality collects the uncollected PP4&5 connection fees.
- To receive revenues in the special account for the WWD, two options were therefore considered to secure the WWD's budget.

  Option 1: Both water connection fees and sewer connection fees are used to obtain funding specifically for water and sewerage services.

  Option 2: A percentage (e.g. 20%) of water and sewerage revenues, such as water and sewerage connection fees, and/or water and sewerage charges, is used for water and sewerage services.

- The WWD considered option 2, and the approval was in writing from the Mayor.

Figure 2.1.26 shows diversion of funds to other departments in Jericho Municipality.

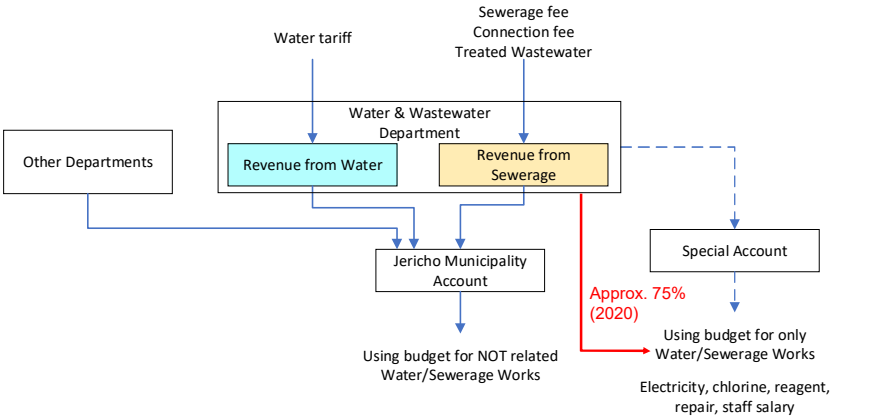
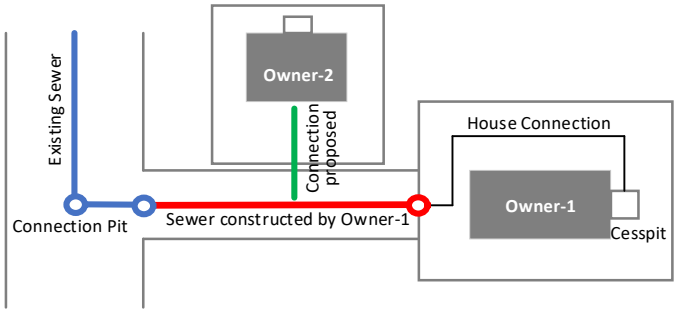


Figure 2.1.26 Diversion of Funds to other Departments

3) Supervision on sewer construction

- Following the approval of the residents' application for connection to the sewerage system, a construction of a sewer branch (public road) has so far been carried out by Jericho Municipality. However, the progress of the connection work has stagnated, mainly due to staff shortages. Therefore, following discussions between the WWD Director and the Mayor, Jericho Municipality has decided to outsource sewer construction.
- As of now, Jericho Municipality has recommended that a building owner-1 pay part of the construction costs of branch sewers to promote sewer connections. However, when another building owner-2 in the neighbourhood tries to connect to this branch sewer, this owner-2 is sometimes rejected by the owner-1 who is already connected. To avoid such problems, a procedure manual is being developed by Jericho Municipality. The effects of this are i) avoiding problems with neighbours, ii) maintaining an adequate sewer diameter, iii) complying with construction standards,

and iv) reducing the application acceptance period. A schematic diagram of this case is shown in Figure 2.1.27.



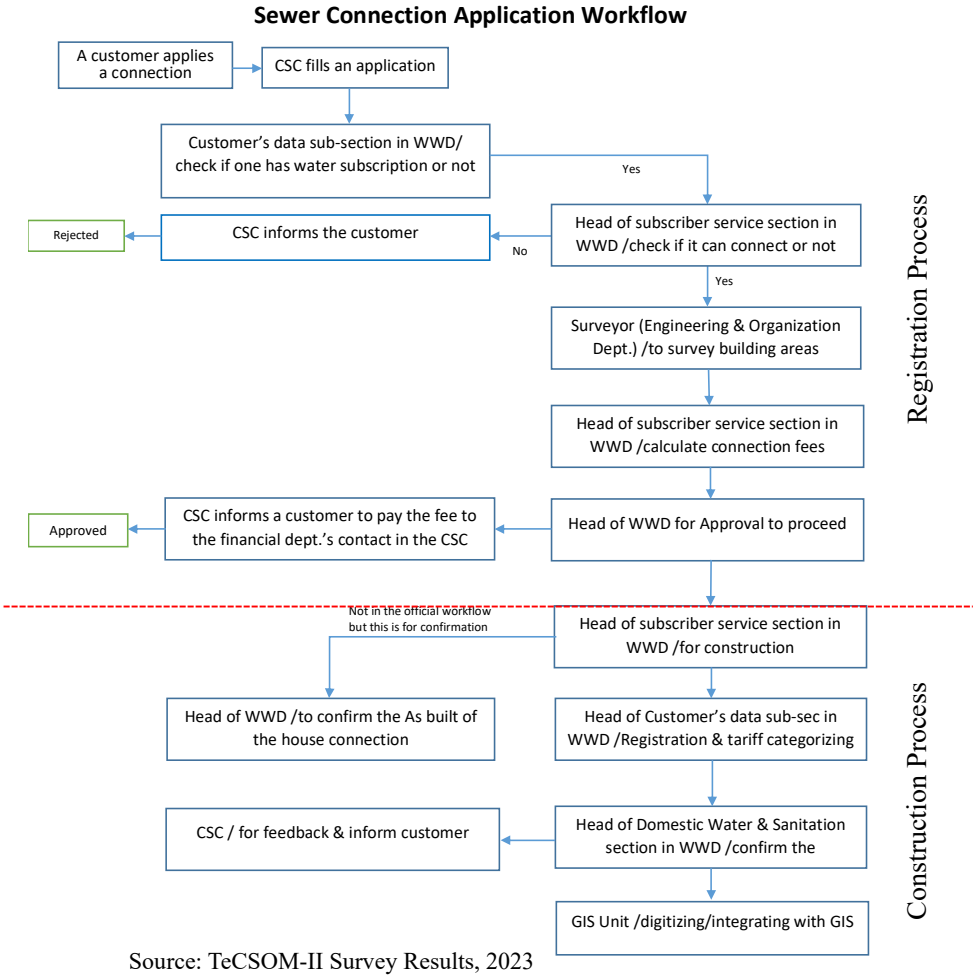
Source: TeCSOM-II Survey Results, 2023

Figure 2.1.27 Examples of Problems with Sewer Connections

4) Application for sewer connections

- As of 9 March 2023, there were 875 applications for sewer connections. Since last year, it was reported that the procedures for these applications have been stagnant, and the Jericho Municipality pointed out that there was a lack of manpower. Therefore, the process from application for the sewer connection to construction and data entry was checked to ascertain which process is causing the stagnation of the procedure.
- Jericho Municipality had to confirm the location of the sewer connection upon receiving an application and check whether a gravity flow connection was possible by visiting the site one by one, which was time-consuming partly due to a lack of manpower.
- The integration of sewer data has reduced the workload required to check the connection points on site, as it is easier to confirm the connection points from the GIS. Once the process and reasons were identified, it is easier to take countermeasures.

Figure 2.1.28 shows the flow from connection application to GIS data entry.



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.28 Sewer Connection Application Workflow

b) Achievements

1) Collection of sewer connection fees

- Jericho Municipality has conducted a building survey of PP4&5 houses, the calculation of the connection fee has been completed and the fee collection has started from all buildings. Meanwhile, as the calculation of sewerage fees before December 2021 is uncertain, the municipal council has decided that sewerage fees were collected from January 2022.

- PP4 and PP5 were completed in 2021 and 2020, respectively. However, the building survey was not conducted and sewer connection fees and sewerage fees were not collected. Sewerage fees prior to December 2021 were not collected due to difficulty in calculation while sewer connection fees were collected from all buildings in PP4&5.

- House/buildings surveys for PP4 and PP5 were completed and the results were reported by the WWD. The results are as follows.

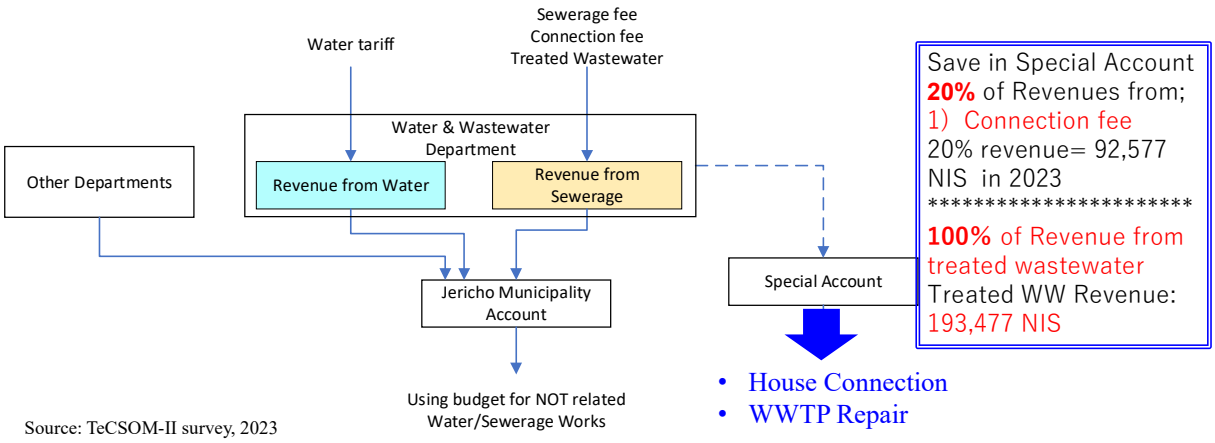
Table 2.1.13 Pilot Project 4&5

	PP4	PP5
Number of households (subject to sewerage fee)	137	412
Number of buildings (subject to connection fee)	111	207

Source: Jericho Municipality WWD

2) Special Account in the WWD

- As described in the issues in Jericho Municipality Financial Status, as of now, all revenues relating to water and sewerage were deposited in a common account at the Jericho Municipality. However, the WWD needed to accumulate funds for the WWTP equipment repair, sewer system connection and depreciation costs.
- The WWD Director, therefore, discussed with and requested the Mayor that the sewer connection revenues be deposited into the special account for the WWD. The Mayor agreed to this. This is one of the achievements to solve the financial problems of the sewerage service. Figure 2.1.29 shows the Special Account in the WWD. Water and sewerage fees continue to be credited to the common account as before.



Source: TeCSOM-II survey, 2023

Figure 2.1.29 Save in WWD Special Account

- Building surveys for pilot projects 4&5 (sewer connection of houses) have been completed. Based on the results of these surveys, connection and sewerage fees are being calculated; collection of sewerage connection fees and sewerage fees started in January 2023. 20% of the sewer connection fees are allocated to the Special Account as a specific financial resource.
- The Special Account for the WWD was officially approved by Jericho Municipal council (Approval document available).

(2) Sewerage Fee Collection

a) Activity

- The WWD Director explained that the sewerage service revenue is not necessarily used only for the expenses of the sewerage operation (treatment plant electricity, chemicals, repairs, labour, etc.), but is also diverted to other departments in Jericho Municipality.

- The fee collection rate in 2021 was calculated as follows: Water: 60% (66% in 2020), sewerage: 46% (62% in 2020), both lower than the previous year.

- As of end-August 2022, the amount of unpaid water bills was 20,950,581 NIS (19,709,462 NIS). *Data in parentheses are for end-September 2021. The total unpaid amount has increased by 6.3% since September 2021.

- There are 66(56) debtors of unpaid amounts of 30,000 NIS or more, with 8,768,069 NIS (7,147,685 NIS) for government institutions affiliates and 1,711,766 NIS (2,604,151 NIS) for individuals. The amount unpaid by the government institutions increased by 22.7%, while the amount unpaid by individuals decreased by 34.3%. The collection of unpaid amounts by individuals has improved.

- Complaints received are forwarded to the relevant department/sections for actions. Once the relevant departments/sections have taken actions, it informs the customer centre of the results. During January-May 2022, there have been 13 complaints relating to water and sewerage services. Eight of these were in relation to connection fees and five were in relation to sewerage fees. All complaints have been dealt with according to WWD, but some results have not received feedback to the customer service centres. The WWD checks the status of the complaints and address them. No complaints have been received regarding the increase in sewerage fees to 1.0 NIS/m^3 (end of the discount campaign), which doubles the previous rate from November 2022.

- The Mayor participated in the third JCC and understood the activities and management of the sewerage services. In particular, the fee collection ratios and the amount of debt (unpaid amount) were issues in financial matters, and after the JCC, the Mayor directed the following points to be addressed.

    i) Jericho Municipality has been ensuring the collection of water supply fees through PPWM, while sewerage fees have not been collected in households with PPWM. Therefore, the relevant heads of department and section heads in charge of fee collection were convened and instructed to collect sewerage fees. As a tentative measure, sewerage fees are calculated manually, but the sewerage bills will be migrated to the current system.

    ii) Instructions for administrative guidance to backfill cesspit sites when switching from cesspits (storage tanks) to sewers.

- The above instructions were acted upon in response to the JCC report, and are the achievement of TeCSOM-II's activities, with thanks to the Mayor for moving quickly to improve the sewerage services.

- Regarding the increased governmental debts in the 3rd JCC, the Mayor stated that if the Ministry of Finance continues to delay payment of water bills in the future, the Jericho Municipality will consider deducting the debt amount from taxes (particularly taxes to the Ministry of Education).
- Supplementary information: the West Bank Water Department (WBWD, a subsidiary organization of the PWA) purchases water from Mekorot and cities (except Jericho) often purchase water from the WBWD.
- If ministries use this water (supplied by WBWD), it incurs water fees, which must be paid to the water supplier. However, municipalities have other debts to the Palestinian Authority. The Authority often does not pay by deducting the water fees from the other debts. The Jericho Mayor's statement is considered to follow the Authority's action.

b) Achievements

- The WWD Director mentioned the increase in the sewerage fee rate. Jericho Municipality has decided to discontinue the discounted tariff campaign of 0.5 NIS/m^3 and return to the regular tariff of 1.0 NIS/m^3 starting from November 2021.
- Regarding the sewerage fee, which was studied in TeCSOM-I, taking into account Operation & Maintenance (O&M) costs and other factors, the fee rate was set at 1.0 NIS/m^3, and was approved by the Jericho municipal council. However, since the collection rate from the city citizens was initially slow, a limited time discount rate was set to increase the collection rate 50% off. The discount has now been abolished and the fee was set back to the fixed rate of 1.0 NIS/m^3. Billings have already been calculated using the flat rate since late October 2021.
- Jericho Municipality has started to increase the sewerage fee, raising the fee from 0.5 NIS/m^3 to 1.0 NIS/m^3 for commercial in 2020 and for domestic consumption in October 2021.
- The Collection section in the Jericho Municipality sent warning letters to 72 unpaid customers and suspended the water supply in February 2022. Eight of the unpaid customers paid the delinquent amounts and water supply was resumed. The measures to suspend water supply have had some effect.
- The amount of unpaid water supply bills decreased from 19,709,462 NIS (end of September 2021) to 18,091,941 NIS (end of December 2021), a decrease of 1,617,521 NIS (-8.2%) over the three-month period.
- The amount of unpaid sewerage bills decreased from 761,579 NIS (end of September 2021) to 681,412 NIS (end of December 2021), a decrease of 80,167 NIS (-10.5%) over the three-month period.
- The Mayor and the Director of the Finance Department visited the Accounting Division of the

Ministry of Finance on 21 August 2022 to request payment for the collection of unpaid water and wastewater fees for government institutions. In response, the Accounting Division promised to pay part of the unpaid amount.

(3) Water Supply Fee Collection

a) Activity

1) Prepaid Water Meter (PPWM)

- As a measure to improve the collection rate of water and sewerage fees, PPWMs are being considered and introduced. If this is combined with AFD's support, it could be more effectively implemented.
- Jericho Municipality has installed 444 PPWMs (as of August 2021, Elektromed company), which is approximately 3.5% of all water subscribers. As of June 2022, the number of the meters has increased to 505.

Photo 2.1.18 PPWM (1)

Photo 2.1.19 PPWM (2)

- In Jericho Municipality, water tariffs are based on a metered system as follows. The sewerage fee was based on a fixed rate (0.5 NIS/m^3 regardless of the amount of water used). It is learnt that the rate was revised to 1.0 NIS/m^3 in October 2021. The water tariff in Jericho Municipality is shown as below.

Table 2.1.14 Water Tariff

Domestic		Commercial	
Consumption water (m^3)	Unit price (NIS/m^3)	Consumption water (m^3)	Unit price (NIS/m^3)
0 – 100	1.0	0 – 50	1.0
101 – 125	2.0	51 – 100	2.0
126 – 150	4.0	101 – 150	4.0
151 – 200	8.0	151 – 200	8.0
201 -	10.0	201 –	10.0

Source: Jericho Municipality

- The Jericho Municipal Council intends to review the water tariff structure (see table above). Currently, the lowest unit cost is 1.0 NIS/m^3, compared to 2.6 NIS/m^3 for water production (O&M costs only).
- The following actions were taken in consultation with the Mayor, the WWD Director and the water meter readers regarding water meters: 1) replace faulty meters; 2) motivate meter readers and fee collection staff; 3) improve the accuracy of meter readings
- The cost of purchasing the PPWM is paid by the user. The PPWM cost is approximately 500 NIS, including the meter itself plus the connection cost. As of August 2022, 514 PPWMs have been installed by Jericho Municipality. As of June 2023, 572 PPWMs have been installed.
- AFD support was agreed with Jericho Municipality in October 2022. The number of PPWMs granted is approximately 680.
- Jericho Municipality began operating a new billing system in October 2022. This is a major step toward eliminating “zero-reading”. This new system is not for PPWM, but for normal water meters.

2) Abolition of "zero-reading"

- “Zero-reading" means that the water meter is not read and only the basic water charge (minimum charge) of 40 NIS is charged.
- Factors that prevent water meter reading are as follows: i) Water meters are not totalizing water consumption due to malfunction; ii) the surface of the meter is dirty and cannot be read; iii) the meter is installed in a location where it is difficult to read the meter (in a narrow space, in a locked box, underground, etc.).
- The previous billing system allowed for "zero-reading," but the new billing system can estimate consumption and bill based on water consumption over the past three years.
- Jericho Municipality replaced 135 water meters over a three-month period (November 2022-January 2023). The collection of water bills through the metered system as directed by the Mayor is being implemented reliably.

3) Study on improvements in water revenue profitability

- The increase in water tariff revenues is to be achieved by reducing uncollected and unbilled amounts to a minimum and securing new sources of water revenues.

  i) Reduction of uncollected water fees: Jericho Municipality has decided to increase the fee collection ratio and has adopted the following measures:

  - The meters of customers who have unpaid water bills are being progressively switched from normal water meters to PPWMs, which account for approximately 6.6% of the total number of meters installed.

- Legalization of water supply suspensions: Municipal by-laws legalized and enabled the implementation of a water supply suspension. Customers who have outstanding balance may have their water supply resumed upon payment of their unpaid bills.

ii) Elimination of unbilled water fees: The following measures have been undertaken to ensure that appropriate water fees are billed.

- Sequentially replace water meters that are faulty or show abnormal readings.
- The water meter can be reinstalled in a location where it can be easily accessed and can be cleaned regularly.

iii) Securing new sources of water tariff revenues: Aiming to increase revenues by securing a new source of water tariff revenue.

- Increase in water tariffs: Jericho Municipality has the lowest domestic water tariffs compared to other municipalities in the Palestinian West Bank, and it is not easy to increase the tariffs for the domestic use.
- The Municipality therefore established a new tariff structure for the relatively affluent commercial consumers.
- Jericho Municipality has not increased water tariffs for domestic use since 1998.
- As a comparison, the other municipalities in the West Bank have water tariffs that are approximately 3.7 - 8.2 times higher than those of Jericho, when assessed using the median volume of water consumption for domestic use. The estimated values are shown in Figure 2.1.30.

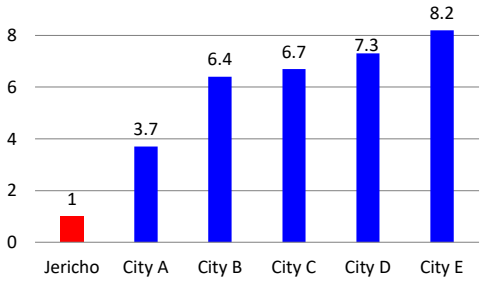
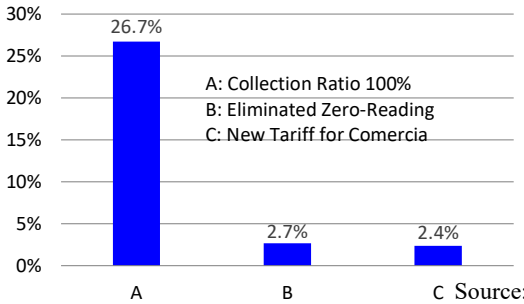


Figure 2.1.30 Water Tariffs Comparison

Source: TeCSOM-II Survey Results, 2023

- The aforementioned measures i) to iii) can be expected to have the following effects shown in Figure 2.1.31.



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.31 Water Revenue Increase Ratio (2022 base)

i) The sequential introduction of water supply suspension measures and PPWMs shall increase the revenues by approximately 26.7% once the unpaid amount has been eliminated and the water fee collection ratio reaches 100%.

ii) In case all zero-readings were eliminated, the revenues shall increase by approximately 2.7%.

iii) The new water tariffs for commercial consumers will result in an increase in revenue gain of approximately 2.4%.

b) Achievements

1) Prepaid Water Meter (PPWM)

- In October 2021, Jericho Municipality discussed the introduction of PPWMs and decided to install the meters in the top 206 households with unpaid water bills starting 2022. 206 meters was purchased by Jericho Municipality.
- The importation of PPWMs by the supplier had been delayed, but has resumed and approximately 200 meters were delivered to Jericho Municipality by the end of June, 2022.
-

2) Abolition of "zero-readings"

- Jericho Municipality is simultaneously replacing and cleaning water meters to reduce "zero-readings". This is to ensure proper billing as directed by the Mayor. The number of "zero-readings" is shown below, and is rapidly decreasing by 2022.

Table 2.1.15 Elimination of Zero-Readings

In 2022	Mar. – Apr.	May – Jun.	Jul. – Aug.	Sept. – Oct.
Zero-readings	1,200	962	650	171

Source: Jericho Municipality

(4) Jericho Sewerage Service Management

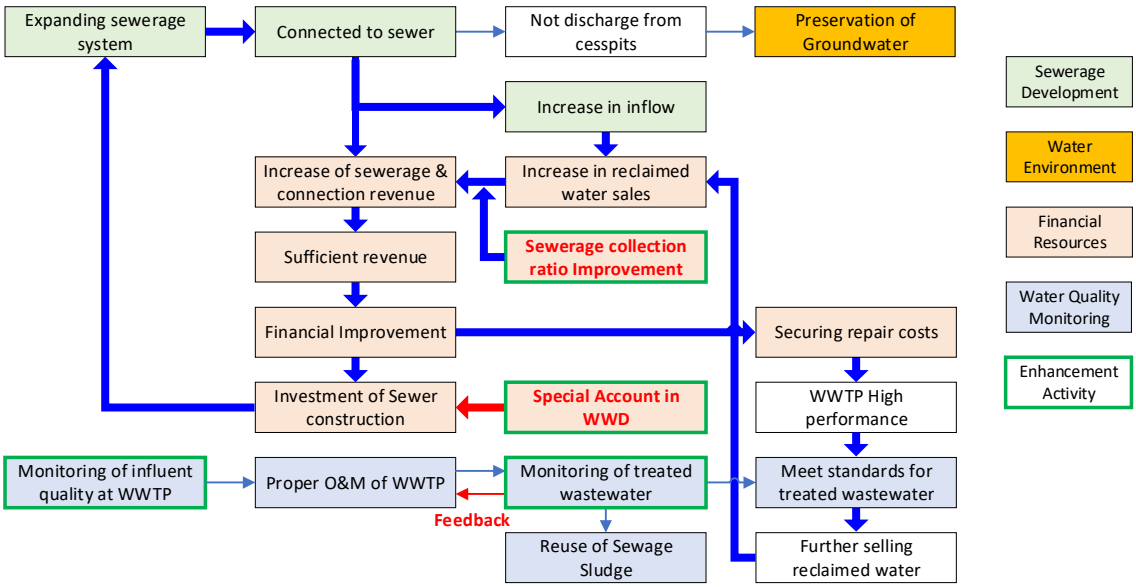
b) Achievement

1) Spiral up improvements in sewerage management

In Chapter 1.3 Jericho Municipality Sewerage Services Challenges, in response to the challenges of the Jericho Municipal Sewerage Services, there are i) campaign to promote connection to the sewerage system; ii) improved collection of sewerage fees (discontinuation of discount campaigns and integrated collection of water and sewerage fees); iii) conversion of sewer connection fees and revenues from the sale of treated wastewater into specific funds (savings to the Special Account); and iv) proper water quality management. The management of sewerage services has improved

(spiralled up) as a result of these and other measures.

The virtuous circle is shown in Figure 2.1.32.



Source: TeCSOM-II Survey Results, 2023

Figure 2.1.32 Virtuous Circle of Jericho Sewerage Management

i) The number of Jericho inhabitants wishing to be connected to the sewerage system increased since their understanding on the role of the sewerage system has improved.

ii) When the number of connections to the sewerage system increases, connection fees and revenues from sewerage fees increase.

iii) Funds saved in the Special Account are used for construction of sewers and connection pits, which promotes sewer development and sewer house connections. The funds can also be used for the WWTP maintenance (outsourced) to maintain the functionality of the WWTP and to extend the life of the facilities.

iv) When more connections are made to the sewerage system, the supply and revenues of treated wastewater also increase.

v) When the WWTP treatment function is maintained in good condition, it can produce good quality treated wastewater, which can be supplied to the farm owners. Should the purchase of treated wastewater by farmers continue, the revenues from its sale would provide a stable and important source of revenues for the Jericho Municipality, which could, in return, be invested in the WWTP.

2.1.5 Support the Promotion of Opinion Exchanges between Related Organizations for the Sewerage Expansion by PWA (Activity 1-5)

Jericho Municipality is in need of the sewer expansion, but it has to rely on other donors. Jericho Municipality and PWA exchanged their opinions to attract donors' support. Public relations activities are also important in order to inform other donors of the good practices of the Jericho Sewerage Services.

This section presents the activities and achievements of (1) Exchanges of opinions with PWA to attract other donors; and (2) Public Relations of the Jericho Sewerage Project.

(1) Donor Support

a) Activity

1) Explanation of Jericho sewerage project progress to PWA

- On 8 September 2022, the WWD Director and experts visited the PWA and explained the progress of TeCSOM-II and the sewerage management activities to PWA. Appendix 2.1.4 shows the presentation material of the project activities and achievements.
- The main explanations are: 1) Jericho Municipality's self-help efforts to improve sewerage services; 2) use of KPIs to evaluate sewerage services; 3) promotion of fee collection; and 4) acknowledgement of PWA's support for the construction of solar power facilities.
- Since Jericho Municipality is working on integrating sewer data, it is urgent to identify priority areas/routes for development and to calculate the amount of construction and project costs in order to receive donor support. The presentation of these data makes it easier for donors to select the project for support, since the project costs and effects was clear.
- On 14 December 2022, the WWD in Jericho Municipality and the TeCSOM team discussed EU support with PWA. Jericho Municipality was trying to improve its sewerage project management through TeCSOM-II and is trying to visualize the results. PWA mentioned that for donors, it is important to demonstrate the sustainability of water and sewerage services. These achievements should be visible to the outsiders (donors).
- In response, PWA commented: i) tackling the SDGs; ii) the high reuse rate of treated sewage water; iii) tackling the reuse of sewage sludge; and iv) tackling the reuse experiments with An Najah National University.
- Regarding attracting other donors to Jericho Municipality, PWA advised: i) applying water supply suspension measures to improve the collection rate of fees; ii) promoting PPWM installation; iii) encouraging payment of fees through penalties and compulsory collection but also through public awareness; iv) investing collected fees in water and sewerage projects; and v) Visualization of business improvements through KPIs.

- It was explained that communicating Jericho Municipality activities and their achievements to the external world is important for attracting donors.

2) USAID

- USAID officials visited the Jericho WWTP and discussed future assistance with the Jericho Municipality on 6 September 2023. The Jericho Municipality explained the progress of the sewerage project and requested completion of the sewer construction that was incomplete under USAID support the project phase 1-B (there was a history of withdrawing from the sewer construction project midway). The incomplete projects feature i) approximately 1.5 km of sewage culverts, ii) 575 connection pits, iii) one manhole pumping station, and iv) approximately 500 m of sewage force pipe.
- On 10 November 2022, US Embassy, ROJ and JICA Palestine officials visited the Jericho WWTP. The purpose of the U.S. Embassy official was to interview the Jericho Municipality about its efforts to address environmental issues.
- The WWD Director gave a presentation material on the Jericho Sewerage Project and its efforts to address the SDGs. The Director also requested continued support for the remaining USAID-supported sewer work (the project phase 1-B). Questions and answers were as follows.

  Q1: How is sewage sludge reuse being tackled (U.S. Embassy)?

  Answer: The Pilot Plant has been set up inside the WWTP and dried sludge is being used as fertilizer/soil conditioner. TeCSOM-II is also being prepared for reuse as a soil conditioner outside the WWTP in the experimental farm. This is the first trial in the West Bank.

  Q2: Has there been any impact of the WWTP on the surrounding environment? (U.S. Embassy)

  Answer: Groundwater, the water supply source, is being conserved through the sewerage system improvements. The wastewater treatment plant has no negative impact on the surrounding area, and there is no odour problem. The sewage sludge generated is also dried and treated according to Jericho's climate, and no total fecal coliform has been confirmed from the dried sludge.

3) European Union (EU)

- PWA reported in the 3rd JCC held on 6 December 2022 that sewerage projects to the Palestinian Authority will be supported by the EU.
- In regard to the sewerage projects, it is intended to target the facility and sewer construction. The reasons for this are: i) Donor support will be implemented immediately. For this required condition, the survey and planning has been completed and the facility construction can be started immediately; and ii) Projects that require more time for survey and planning and have a smaller

amount of support will be given a lower priority.

- Part of the EU support will be allocated to sewerage projects, and Jericho City is a candidate for support. Jericho Municipality submitted the following materials for requesting support to the PWA: i) construction of a sewage pipe network; ii) spare parts and working equipment for the WWTP; and iii) water quality measuring equipment and reagents.
- 224.8 million euros in aid from the EU to Palestine has been decided in January 2023. Part of this will be invested in water and sewage projects. Jericho Municipality may also receive support for the extension of sewers.
- Regarding EU support, according to the PWA, the target list will be named in the third quota (from the beginning of next year 2024).
-

4) Official Development Assistance: ODA

- The French Official Development Assistance (ODA) implementing agency, the Agence Française de Développement (AFD), and the City of Paris are planning to provide PPWMs to the service providers of Jenin(West Water Joint Service Council) and Jericho. The total amount of aid is €1,325,000 (or approximately 170 million yen), of which 755,000 € (or approximately 0.97 billion yen) is from AFD.
- Donor information was received from the WWD of the Jericho Municipality, and AFD is planning to provide the Jericho Municipality with 500-600 PPWMs and a Supervisory Control and Data Acquisition (SCADA) system to manage the meters (implementation started in October 2022 due to delays).
- AFD's support (document is in French) was confirmed and the number of meters provided is 500-600. The purpose of the program is to improve fee collection by introducing PPWMs. The installation of the meters, including selection, is carried out by Jericho Municipality. The project period is two years.
- The construction of a slaughterhouse was implemented with ADF support. The location is far from the sewage trunk line but is connected to it. In the slaughterhouse, animal blood is discharged. However, it is stored in a tank and not discharged into the sewer.
- The slaughterhouse construction was signed in November 2021. According to the design report dated 2014, the pre-treatment plant is of a Dissolved Air Flotation (DAF) type with a capacity of 2-7 m^3/hour (assuming about 8 hours operation/day), and was delivered under a design-build contract.
- The signing ceremony of support for the provision of PPWMs and SCADA by AFD and the Paris Municipality took place on 17 October 2022.

The provided support include;

Table 2.1.16 AFD Support

No.	Support Item
1	Water service : SCADA modernization: flow meters, pressure sensors, electrical equipment, VFD (Variable Frequency Drive) pumps, electrical meters, and turbidity sensors
2	Non-Revenue Water reduction and sectorization: monitoring development in conjunction with WSRC (Water Sector Regulatory Council)
3	Equipment of PPWMs campaign
4	Tariff structure study for water services
5	Awareness raising of beneficiaries
6	Share the experience in wastewater project management with Jenin West Service Council (Water provider for Jenin Western Villages), and take the experience of PPWM from Jenin West Service Council.

Source: Jericho Municipality

5) ROJ

- On September 15, 2022, ROJ visited the Jericho WWTP to review the management and O&M of the Jericho sewerage service. The WWD Director gave a presentation on the Jericho sewerage project. The main topics were: 1) Project efforts towards SDGs, especially solar power generation and treated wastewater reuse; 2) Proper O&M, well treated wastewater and staff training; 3) First sale of treated wastewater in Palestine; 4) Water quality management efforts; 5) Efforts to improve sewerage services; and 6) Acknowledgement for the construction of the JAIP pre-treatment plant, etc.
- The WWD Director explained that unlike Nablus and Al-bire municipalities, Jericho Municipality has built its sewer pipe networks from scratch, and that the wastewater treatment plant O&M and sewerage business management also started from scratch, but is progressing smoothly with Japanese cooperation. The Director expressed his commitment to further improving the sewerage project with the support of TeCSOM-II.

b) Achievements

1) PWA

- PWA has allocated 1 million NIS to Jericho Municipality for financial support in the current financial year, 2023. Use of the funds is intended for completion of the sewer construction, in particular the remaining scope of the USAID project called 1-B (sewer construction around Kitf Alwad area & Ein Sultan spring). Budget disbursements are expected from August 2023.

2) USAID

- The WWD Director reported that sewer construction is being considered for USAID support. Requests for support from the Jericho Municipality include: 1) the remaining scope of the 1-B project; 2) sewer construction; 3) solar power generation facility; and 4) road pavement improvement in Jericho city (road subsidence areas due to the USAID sewer construction project).
- USAID has requested the Jericho Municipality to present priority areas/routes for sewer construction. TeCSOM-II has integrated the location information of existing sewers using GIS. These sewer and house location information has been used to identify priority areas/routes.
- The WWD submitted the first priority sewer routes. Those extension (approximately 32 km) and project costs including construction, pipe materials, manholes and supervision to USAID based on the GIS data. The second priority route has been continuously selected. USAID local consultants visited the Jericho WWTP to collect data (e.g. power generation) on the expansion of solar power.
- On 14 March 2023, a USAID consultant visited the WWD of Jericho Municipality to discuss the extension of sewers. The consultant is considering supporting the construction of sewers and requested the location of the first priority route (approximately 32 km) and information on existing sewers (GIS data, pipe diameter, etc.). Support for solar power generation is also being considered.
- In response to the consultant's requests, Jericho Municipality provided sewer data and proposed sites for expansion of solar power generation within the WWTP. Following the discussions, the city staff showed the consultant the priority routes, explaining and confirming the existing sewer connection points.
- Jericho Municipality requested the consultant to include sewer connections in the support in addition to the 1-B project.
- The UASAID consultant's sewerage planning report was submitted on 15 July 2023.
- Approximately 30 km of sewer routes were selected and surveyed by the USAID consultant. The consultant identified the construction of sewer house connections to connect to public sewers as a top priority in order to increase the volume of inflows into the WWTP.

(2) Public Relations

a) Activity

1) SDGs

- Goals related to the Sustainable Development Goals (SDGs) in the Jericho Municipality were discussed. The staff member who participated in the SDG study session presented its content at the weekly meeting on 1 November 2021. Regarding the SDG efforts in Jericho Municipality, the

Central Archive Unit presented part of the SDG training organized by GIZ (Deutsche Gesellschaft fur Internationale Zusammenarbeit, a German donor). The contents are as follows: 1) Definition of SDGs, 2) Projects in the Jericho City and their relation to SDGs, 3) Projects to promote SDGs.

- The Jericho Strategic Plan (2019) proposes 74 projects and aims to achieve 13 of the 17 SDG goals.

2) Jericho Strategic Four-Year Plan

- On 13 February 2023, Jericho Municipality organized a meeting of the Jericho Municipality Strategic Plan to explain the goals and progress to stakeholders in the development of the plan. Water and wastewater services are part of the plan and the current status, evaluation and targets were explained. The target year is 2027, four years from now. A long-term target of 2039, 16 years later, has also been set.

- Water supply project targets: 4-year targets: i) database of distribution pipes with GIS; ii) renewal of distribution pipes (approximately 7 km); iii) water conservation campaign; iv) reduction of O&M costs (introduction of solar power generation, adoption of high efficiency pumps); v) introduction of PPWM/ remote meter reading, quality improvement of water meters; 16-year targets: vi) development of new water sources (wells) in suburban areas.

- Wastewater project targets: four-year targets: i) Construction of sewers (25 km in the higher priority area); ii) Sewer house connections in sewerage service areas; iii) Construction of treated wastewater distribution pumps and irrigation distribution pipes; iv) Reuse of treated sewage sludge; v) Construction of sewers (54 km in the second priority area); vi) Construction of sewers in the Ein Sultan camp.

- On 5 March 2023, a workshop was held on the development of a strategic four-year plan being prepared by the Jericho Municipality. The plan is to develop a vision for the Jericho City for the next four years. City officials, relevant institutions and citizens participated in the workshop.

- One of the visions includes water and sewerage development, and the following plans are listed: i) water supply line extensions; ii) sewer extensions; iii) waste disposal site management; and iv) road asphalt redevelopment. With regard to iv), asphalt pavement damage due to differential settlement/ insufficient compaction has occurred since the sewer construction. Asphalt pavement damages have mainly occurred along the USAID project route.

- The challenges for the Municipality were i) the accumulated amount of unpaid water and sewerage bills, and ii) dealing with natural disasters such as earthquakes.

-

3) Jericho WWTP visit

- ARTE (Association Relative à la Télévision Européenne) TV representatives visited the Jericho

WWTP as part of a study on water issues in the Middle East, including Palestine. The purpose was to collect data on the water situation in Palestine and Middle Eastern countries.

- On 9 May 2022, the Director of Development, his delegation, Eco Peace, and the Embassy of Switzerland in Jordan visited the Jericho WWTP. The objective was to promote the Palestinian role in water supply and sanitation. As part of their activities, they visited the WWTP and reviewed the sewage services. The response was made by the WWD Director, the WWTP manager, and the operators in Jericho Municipality.
- Efforts to promote sewer connection: (1) Jericho Municipality has been conducting PR activities together with TeCSOM-I&II; (2) Approval for construction of new houses/buildings was conditioned on connection to the sewer system.
- On 31 August 2022, the Deputy Mayor of Speyer, Germany, and two accompanying persons visited the WWTP. The Deputy Mayor visited various facilities in Jericho (Ein Sultan Spring, etc.). The Jericho Sewerage Project was explained by the WWD Director and the Plant Manager, who gave a presentation material and distributed a leaflet.
- On 3 December 2022, a professor and 17 students from Al-Quds University in Palestine visited the WWTP. The main interest was in the reuse of treated wastewater; Al-Quds University and Jericho Municipality have agreed to build a pilot plant using treated wastewater and sewage sludge in September 2022. At present, preparations for the pilot plant have started.
- A group of eight members of the Solidarity Expert Foundation in France visited the WWTP on 5 December 2022. The purpose was to exchange information on sustainable water management issues. The main interest was in the reuse of treated wastewater.
- On 9 February 2023, a Kreditanstalt für Wiederaufbau (KfW) consultant visited the Jericho WWTP. The aim was to learn how to reuse treated wastewater for agricultural irrigation.
- The WWTPs currently in operation with KfW support are in Nablus, Salfit (located between Nablus and Ramallah) and Al Bireh, while Ein Jariot (located in Ramallah) is preparing a tender for construction.
- On 15 February 2023, the House of Water & Environment (HWE) and 20 farm owners visited the Jericho WWTP from Jenin. HWE is an association (non-governmental local association) implementing a solar power project in Jenin for wastewater treatment and its distribution. The purpose of the visit was to learn about the operation of the Jericho WWTP as a good practice example of treated wastewater reuse for agricultural irrigation.
- On 7 March 2023, the Ministry of Foreign Affairs (2 officials), the ROJ (1 official) and the JICA Headquarters (2 officials) visited the Jericho WWTP. The Jericho Mayor, the WWD Director and WWTP staff received the delegation, and the Director explained the history and achievements of the Jericho Sewerage Project. The participants found the presentation by the Director to be clear

and the WWTP's O&M to be well managed. Appendix 2.1.5 shows presentation materials of project activities and achievements.

b) Achievements

- Draft leaflets for explaining to visitors to the WWTP were developed jointly with the TeCSOM team and the C/Ps. Two types of leaflets were prepared, one in English and the other in Arabic. The Arabic wording, in particular, was reviewed and finalized by Jericho Municipality staff.

Source: TeCSOM-II Survey Results, 2023

Figure 2.1.33 Jericho Sewerage Leaflet

- Leaflets introducing the Jericho Sewerage Services, draft leaflets on water quality management and explanations for children are shown in Appendix-1.
- Jericho Municipality has begun posting monthly reports from the WWTP on the Jericho municipal website. Although some improvements have been observed, progress has been made as presented in the information disclosure.
- A PR video (of approximately 9 minutes long) on the Jericho Sewerage Project prepared by the

JICA Palestine Office was screened at the 3rd JCC. The video has English captions in addition to explanations in Arabic, making it highly versatile for the general public. The video introduces the role of sewage systems, the O&M of the WWTP, the reuse of treated wastewater and its use in social study visits.

Photo 2.1.20 Scenes from a Visit to the Jericho WWTP in a Primary School Class (JICA PR Video)

2.2 Output-2: Capacity for Influent Water Quality Testing in the Jericho Wastewater Treatment Plant is Strengthened

2.2.1 Support the Preparation of a Water Quality Manual for the Water and Wastewater Department of Jericho Municipality (Activity 2-1)

The TeCSOM team assessed the handling of water quality monitoring equipment and reagents in the laboratory at the WWTP, work content and skills of the laboratory technicians, and measured water quality of inflow and outflow at the WWTP as a baseline survey under the Activity. The manuals, Standard Operating Procedures (SOPs), water quality monitoring plan and response manual against unusual sewage inflow were developed based on the survey for an appropriate management system of the laboratory. The water quality analysis has now been conducted to these SOPs and the monitoring plan as a result of the activity.

For countermeasures against unusual sewage inflow, the "unusual sewage inflow" was defined by TDS as an indicator based on the water quality data. The process of defining the unusual sewage can be utilized as a case study for analysis and utilization of the water quality data.

a) Activities

1) Baseline survey on water quality management

- There is one water quality laboratory technician at the Jericho Municipality. The technician who was supervised by TeCSOM-I retired and a new one was subsequently employed in April 2018. The water quality laboratory technician is under the direct control of the Water and Wastewater Department (WWD) Director.
- The water quality laboratory technician was interviewed under the context of a baseline survey based on his job descriptions at Jericho Municipality. A summary of the results is as follows.
- Job Descriptions: At Jericho Municipality, mainly engaged in water quality testing. Five days a week is for water quality measurement/control and one day is for treated wastewater measurement/control. Table 2.2.1 shows the work description before August 2022 (until one dedicated laboratory technician was employed at the WWTP).

Table 2.2.1 Water Quality Routine Works

Item	Water Supply	Sewerage
Sampling	Water tap: 10 samples/week Water purification facility: 3 samples/day	1 day/week
Item	Residual chlorine, turbidity, general bacteria	The table below shows the items. Influent water quality is also measured irregularly at the direction of the WWD Director and Plant Manager.

Analysis	Technician (approved by the WWD Director)	Technician (approved by the WWD Director)
Abnormal value	A few days in rainy season, high turbidity, low residual chlorine concentration, and turbidity from the water taps.	Wastewater quality from JAIP sometimes exceeds the sewage discharge standards.
Response to abnormalities	Notify the WWD Director and inform the pump operator to stop operation. Change and monitor the amount of chlorine injection.	Contact the plant manager and the Water and Wastewater Department Director for their decision. (See Activity 2-2 for JAIP response)
Report	Daily, weekly, monthly, and annual reports	Weekly reports
Improvement request	Renewal of measurement equipment and replenishment of reagents	Replenishment of reagents for coliform count, and Replenishment of staff.

Source: TeCSOM Team

- It was reported that the frequency and items of water sampling for treated wastewater and influent sewage quality are insufficient. The response was that the water quality is measured once a week. However, the record book shows that it is approximately once every two weeks. The measurement devices are not calibrated, and guidance is needed on how to calibrate the devices.

- The one-person water quality monitoring of water and sewage systems was discussed with the Water and Wastewater Department Director and it was concluded that it would be difficult to carry out the monitoring with a single person. The importance of establishing a water quality monitoring system was explained to the Jericho Mayor, and a request was made to recruit additional water quality laboratory technicians. (See Activity 1.1)

- Since the water quality management of the water supply affects users' health, it is obvious that the work on the water supply system would be unevenly distributed, in a one-person system. However, since water quality monitoring and management in the sewerage system is also important, it is necessary to consider how to improve individual capabilities and how to deal with this management as an organization. The following is the content of the Mayor's explanations.

- The water quality monitoring system is currently staffed just with one laboratory technician. It is necessary to assign a separate laboratory technician to the water supply facilities and another to the sewerage facilities. The Waterworks and Wastewater Department Director also agrees with this opinion, and on 16 November 2021, he explained the situation to the Mayor and requested additional laboratory technicians.

    i) The pre-treatment plant of JAIP will start operating in 2023, and if it meets the sewage discharge standards, the Jericho Municipality will accept sewage from JAIP. At that time, it will be more important to monitor the quality of wastewater flowing not only to JAIP but also to the WWTP where the volume of wastewater has increased.

    ii) At present, most of the treated wastewater has been sold to the farmers through proper operation and maintenance and efforts by the Jericho Municipality, which has become an important source of revenue. In the future, with the increase in inflow, increased quantity of treated wastewater will be sold to more farmers. Therefore, monitoring the quality of treated wastewater as a salable product is very important.

2) Water quality measurements of the WWTP influent wastewater and treated wastewater

- The analysis of influent water quality, treated wastewater quality and sewage sludge (dried sludge) at the WWTP was outsourced to An-Najah National University.
- There are a total number of 44 items for sewage influent and treated wastewater quality. These are the items of the sewage discharge standards and the treated wastewater reuse standards that are subject to water quality measurement. In addition to the above, there are 12 items for sewage sludge analysis. Recently, "Arsenic" was added to the list of seven heavy metal content standard items published by the Ministry of Agriculture for verifying the safety of sludge to be used as a soil conditioner. The effectiveness of the sludge as a soil conditioner was also examined through component analysis.
- A total number of three sampling rounds (November 2021, September 2022, and April 2023) are planned. The first round of sampling was conducted on November 23, 2021.

Photo 2.2.1 Sampling Treated Wastewater

Photo 2.2.2 Sampling Wastewater

3) Water quality monitoring equipment

A list of equipment used in the laboratory is shown in Table 2.2.2.

Table 2.2.2 Analysis Equipment Used in Jericho WWTP Laboratory

Equipment	Purpose of use (Measurement item)
20 ºC Incubator	Biochemical oxygen demand（BOD_5）
BOD manometer (Brand name: OxiTop)	BOD_5
200ºC Oven	Total Suspended Solid (TSS)
Vacuum manifold	TSS
Absorption photometer (Brand name: Photoflex）	Chemical oxygen demand (CODcr), Phosphate (PO_4-P) and Total nitrogen (T-N)
Heat block	Thermal decomposition of sample for CODcr, PO_4-P, T-N
pH/EC/TDS meter	pH, Electric conductivity (EC), Total dissolved solids (TDS)
Turbidity meter	Turbidity
DO meter	Dissolved oxygen (DO)
Distilled water generator	Production of distilled water

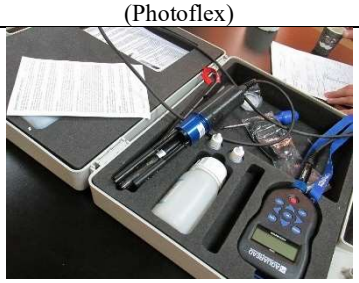
Source: TeCSOM Team

BOD_5 manometer (OxiTop)

Absorption photometer (Photoflex)

Heat block

pH/EC/TDS meter



DO meter

Distilled water generator and Incubator

Photo 2.2.3 Water Quality Analysis Equipment Used in Jericho WWTP Laboratory

- A comparison of monitoring items that can be measured in the WWTP laboratory, Palestinian sewage discharge water quality parameters and treated wastewater quality parameters for agricultural land reuse is shown in Table 2.2.3. Water quality parameters in the red box are not measurable in water quality laboratory.NO3-N and NH4-N are feasible in the WWTP laboratory by means of the procurement of reagents. However, fat/oil/grease (FOG), inorganics, heavy metals and microorganisms (Red boxes in Table 2.2.3) are not feasible due to lack of dedicated analysis equipment in the WWTP laboratory. These difficult-to-implement analytical items should be considered for implementation by outsourcing to external institutions such as An-Najah National University.

Table 2.2.3 Practicable Monitoring Items in Jericho WWTP Laboratory

Item	Available in WWTP lab. As of June, 2023	WWTP inflow		Treated water quality			
		Wastewater discharge Cabinet resolution No.16, 2013[1)]	Jericho WWTP design value	Reuse for irrigation Palestine standard PS742-2015[2)]			
				High (A)	Good (B)	Medium (C)	Low (D)
BOD_5	✓		500	20	20	40	60
TSS	✓	600	500	30	30	50	90
CODcr	✓	2000		50	50	100	150
DO	✓			>1	>1	>1	>1
pH	✓	5.5 ≤ pH ≤ 9.5		6-9	6-9	6-9	6-9
NO_3-N	✓			20	20	30	40
T-N	✓		75	30	30	45	60
Temperature	✓	65		35	35	35	35
Turbidity	✓			5-10	5-10	5-10	5-10
TDS	✓			1200	1500	1500	1500
Fat, Oil, & Grease		100		5	5	5	5
Phenol		100		0.002	0.002	0.002	0.002
MBAS		40		15	15	15	25
NH_4-N	✓			5	5	10	15
PO_4^{3-} -P	✓			30	30	30	30
Cl^-				400	400	400	400
SO_4^{2-}				300	300	300	300
Na^+				200	200	200	200
Mg^{2+}				60	60	60	60
Ca^{2+}				300	300	300	300
SAR				5.83	5.83	5.83	5.83
Al		10		5	5	5	5
As		5		0.1	0.1	0.1	0.1
Cu		4.5		0.2	0.2	0.2	0.2
Fe		50		5	5	5	5
Mn				0.2	0.2	0.2	0.2
Ni		4		0.2	0.2	0.2	0.2
Pb		0.6		0.2	0.2	0.2	0.2
Se		0.05		0.02	0.02	0.02	0.02
Cd		1		0.01	0.01	0.01	0.01
Zn		15		2	2	2	2
CN				0.05	0.05	0.05	0.05
Cr		5		0.1	0.1	0.1	0.1
Hg		0.5		0.001	0.001	0.001	0.001
Co		0.05		0.05	0.05	0.05	0.05
B		5		0.7	0.7	0.7	0.7
Sn		10					
Be		5					
Ba		10					
Mg		10					
Ag		1					
Li		5					
V		0.1					
Nematodes				≤1	≤1	≤1	≤1
Coliform bacteria				100	1000	1000	1000

Faecal coliform				200	1000	1000	1000

Unit
Temperature: ºC, Turbidity: NTU, Coliform bacteria and Fecal coliform: Colony count / 100mL
Items not listed above: mg/L

Source: 1) Cabinet Resolution 16-2013_House Connection to Sewer Network By Law (Refer to Appendix 2.2.11)

2) PS 742-2015_Treated Wastewater for Agricultural Purposes (Refer to Appendix 2.2.12)

Source: TeCSOM Team

4) Revision of SOPs for water quality monitoring

- The manuals/ Standard Operating Procedures (SOPs) used in the water quality laboratory at the Jericho WWTP were reviewed by the TeCSOM-II expert to determine their content, utilization, and improvement points.
- Water quality analysis SOPs need to be revised as measurement methods or equipment used are updated. Existing water quality analysis SOPs were developed in TeCSOM-I, but their content is detailed and their considerable number of pages make them difficult to use in routine laboratory work.
- For this reason, SOPs were not referred to in routine water quality analysis work in laboratories, and measurement operations relied solely on the operators' memory (including their misunderstanding of the measurement methods). Therefore, SOPs were revised for the current water quality analysis items, methods and equipment used. SOPs were revised in accordance with following principles.
  - ➢ One SOP is prepared for each analytical item.
  - ➢ Briefly describe only the measurement method and relevant items (e.g. calibration procedure, dilution factor of the sample).
  - ➢ Use diagrams and tables to make the content visually comprehensible.

5) Development water quality monitoring plan

- Water quality monitoring plan was developed. A summary is shown in Table 2.2.4. In this monitoring plan, the wastewater treatment process of influent sewage (before grit chamber), reaction tanks and treated wastewater are monitored. In addition, monitoring of influent pipe No. 1 (sewage from the city centre) and influent pipe No. 19 (sewage from JAIP and Jericho gate) is also carried out to detect abnormal wastewater inflows at an early stage. The monitoring plan is presented in Appendix 2.2.1.

Table 2.2.4 Summary of Water Quality Monitoring Plan

Monitoring point	Monitoring item	Schedule	Remarks
Trunk No.1	Water temperature, pH, EC / TDS	Daily	Monitored daily as basic water quality parameters
	CODcr, T-N, PO_4-P	Weekly	Implemented when unusual sewage inflows are identified.
TrunkNo.19	Water temperature, pH, EC/TDS	Daily	Monitored daily as basic water quality parameters
	CODcr, T-N, PO_4-P	Weekly	Implemented when unusual sewage inflows are identified.
WWTP inlet (Before grit chamber)	Water temperature, pH, EC / TDS	Daily	Monitored daily as basic water quality parameters
	T-N, PO_4-P, CODcr	Sun / Thu	If unusual sewage inflow is observed, an unusual response schedule is implemented. This unusual response schedule is implemented within the stock of available reagent quantities.
	NO_3-N, NH_4-N	Sun	
	BOD_5	Mon	BOD reading (readout of respirometer) is taken on Saturday
WWTP reactor tank	Water temperature, pH, EC / TDS, MLSS, SV_{30}, ORP, Microscopic observation.	Daily	Daily monitoring item for the process management of reactor tank.
WWTP treated wastewater tank	Water temperature, pH, EC / TDS, DO, Turbidity	Daily	Monitor daily as basic water quality parameters
	T-N, PO_4-P, CODcr	Sun / Tue / Thu	If unusual sewage inflow is observed, an unusual response schedule is implemented. This unusual response schedule is implemented within the stock of available reagent quantities.
	NO_3-N, NH_4-N	Sun	
	BOD_5	Mon	BOD reading (readout of respirometer) is taken on Saturday.
	TSS	Sun / Thu	TSS measurements take two days. Measurements are obtained on Monday and Wednesday.

Source: TeCSOM Team

- Jericho Municipality commented that monitoring of effluent from the JAIP would be carried out in the event of abnormal sewage quality. Permanent monitoring should be carried out on the drainage routes from JAIP and military facilities (with a separate route in the WWTP site). The expert also instructed that drainage points from major sewage sources other than JAIP (Ein Al Sultan refugee camp, Jericho Gate) be designated as monitoring points, and that sampling surveys of these points be conducted immediately when water quality abnormalities are detected at the WWTP.
- The C/Ps and the expert worked together to estimate the amount of reagents used based on the annual frequency of water quality testing, and developed a procurement plan. In addition, an estimate of the amount required was provided in order to secure a budget for procurement.

6) Determination of unusual sewage inflow and response

- A procedure for detecting unusual sewage influent and measure when it is detected has been

developed. The water quality indicators used for this purpose are pH and TDS, which are measured daily and for which results can be obtained quickly on site. (TDS in particular is an indicator of salinity, which is important in agricultural water reuse.)

- If measurement values of pH or TDS that are measured at the WWTP inlet (before grid chamber) exceed predefined ranges (pH) or value (TDS), unusual sewage inflow is considered to have occurred. Then decide the direction of emission source approximately by the monitoring of Trunk No. 1 and Trunk No. 19 (both monitoring points are located in the WWTP site), the investigation proceeds towards the upstream to identify the emission source. Guidance and other measures are enforced by Jericho Municipality to the identified sources.

7) Determination value for unusual sewage

[pH]

- If the measured pH falls outside the range of $6 \leq pH \leq 9$ as defined in PS 742-2015 High quality (A) (refer to Table 2.2.3), it is considered an unusual sewage inflow.

- Figure 2.2.1 shows measured pH in sewage influent and treated wastewater from November 2022 to May 2023. In 2023, inflow sewer pH ranges within 6 to 9. Exceedances of pH in inflow sewer were observed in November to December 2022 (It was presumed to originate from an any plant using alkaline agents). However, even in influent sewage with high alkalinity, the pH of treated wastewater ranges to 7-8 (i.e. neutralized).

Source: TeCSOM Team

Figure 2.2.1 pH Data in the WWTP

[TDS]

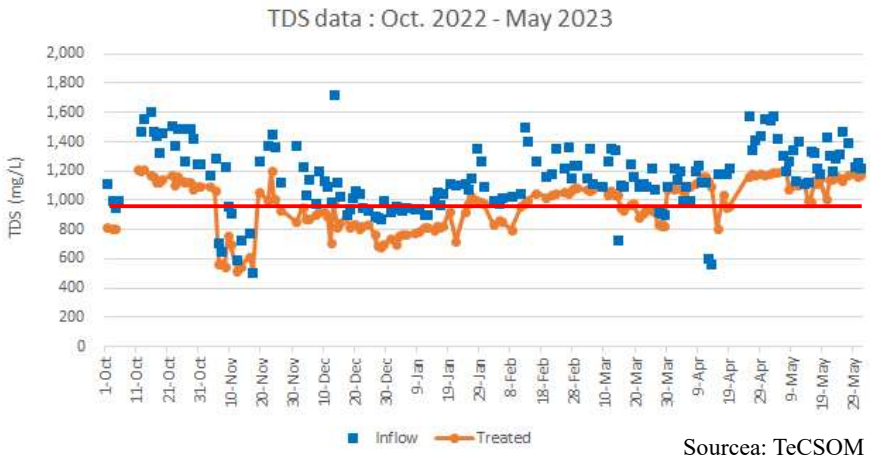
- TDS of sewage influent: 1,500 mg/L < TDS (over 1,500 mg/L) is judged as an unusual value. The basis for this is described below.

- TDS data of sewage influent and treated wastewater from November 2022 to May 2023 are shown

in Figure 2.2.2 and Table 2.2.5. TDS of sewage influent was a maximum of 1,725 mg/L and a median of 1,156 mg/L. In contrast, the TDS of treated wastewater was a maximum of 1,213 mg/L and a median of 1,005 mg/L. Thus, TDS is reduced by biological treatment, and this reduction in TDS is presumed to be due to adsorption and consumption by the microorganisms in the reactor tank.

- The removal ratio of TDS by biological treatment based on data from this period is shown in Table 2.2.6 and the histogram of obtained removal ratios is shown in Figure 2.2.3. The maximum removal ratio was 55.3%, the minimum was 0.1% and the median was 17.5% (mean 18.1%). On the other hand, from the view of the frequency of appearance of the value of removal ratio (Figure 2.2.3), removal ratios with the range of 15-20% and 20-25% were appeared with high frequency.

  From this analysis, the removal ratio of TDS in the Jericho WWTP was estimated to be between 15% and 25%.



Sourcea: TeCSOM Team

Figure 2.2.2 TDS in Influence Sewage and Treated Water

Table 2.2.5 Summary of TDS Data

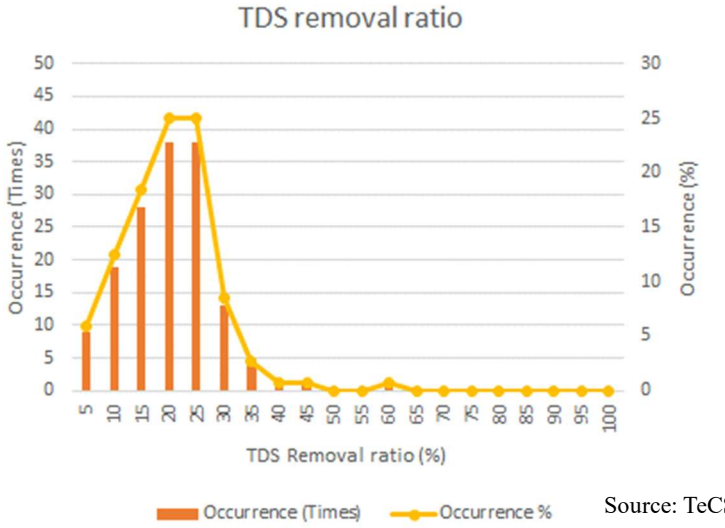
TDS measurement	Influent sewage	Treated water
Max	1,725 mg/L	1,213mg/L
Mid	1,156mg/L	1,005mg/L
Min	503mg/L	509mg/L

Source: TeCSOM Team

Table 2.2.6 TDS Removal Ratio

TDS Removal ratio Oct 2022 – Mar 2023	
Max	55%
Mid	18%
Min	0.1%

Source: TeCSOM Team



Source: TeCSOM Team

Figure 2.2.3 Histogram of TDS Removal Ratio

- Considering the reduction of TDS in the biological treatment process, the allowable TDS level of influent sewage is estimated. TDS concentration in the treated wastewater should satisfy 1,200 mg/L which is specified in PS 742-2015, High Quality (A) (refer to Table 2.2.3).
- Here, assuming a TDS removal rate of 15% to 25%, the allowable influent sewage TDS value in each TDS removal ratio which satisfies 1,200 mg/L can be found in Table 2.2.7.

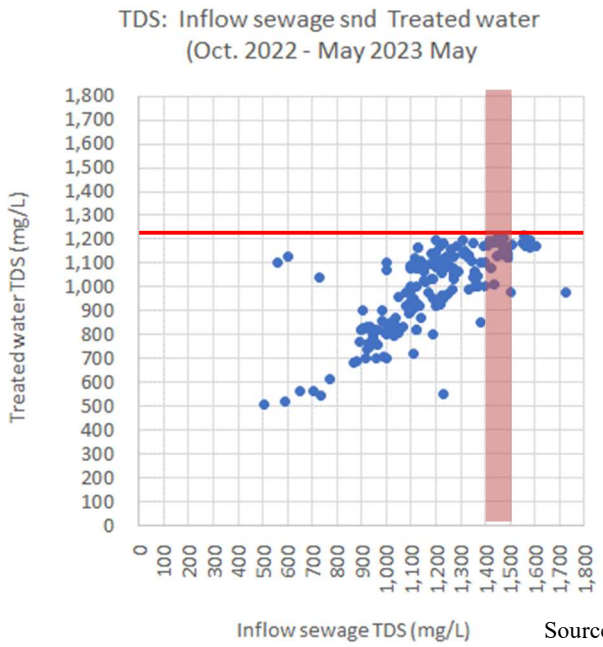
Calculation: Inflow sewage TDS allowance level = 1,200 + 1,200 x (Removal ratio %)

Table 2.2.7 Estimation of Allowable TDS Value in Influent Sewage in Different Removal Ratio

Removal ratio (%)	Allowable TDS value in influence sewage (mg/L)
15	1,380
20	1,440
25	1,500

Source: TeCSOM Team

- The validity of the estimated allowable TDS in inflow sewage (refer to Table 2.2.7) is verified by comparison with measured TDS data (refer to Figure 2.2.4). In Figure 2.2.4, the range of estimated allowable TDS values of inflow sewage (1,400-1,500 mg/L) is highlighted by orange shading. As shown in Figure 2.2.4, TDS in influent sewage of the range 1,400-1,500 mg/L, the treated wastewater TDS was almost 1,200 mg/L.
- Although it is possible to decide the allowable TDS value for influent sewage above 1,500 mg/L, considering the probable TDS removal ratio ranges 15 - 25%, it is considered reasonable to set 1,500 mg/L as the upper limit of the allowable value.



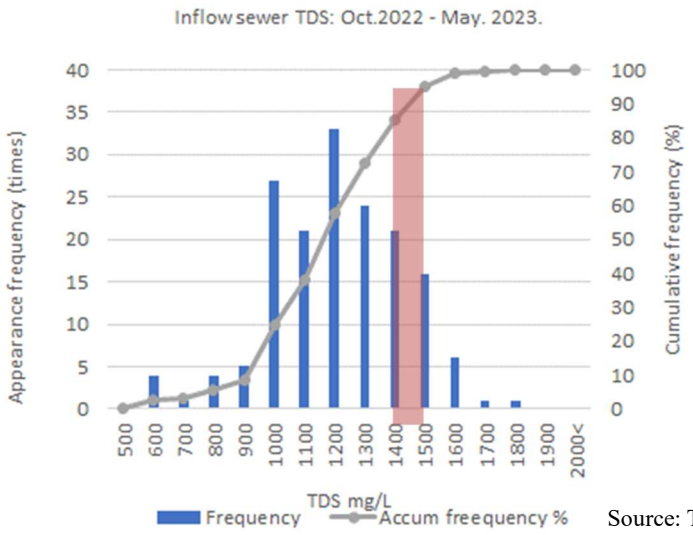
Source: TeCSOM Team

Figure 2.2.4 Concentration of Inflow Sewage TDS and Treated Water TDS

- The number of occurrences of TDS measurements in influent sewage from October 2022 to May 2023 and their cumulative ratios (Pareto plot) are shown in Figure 2.2.5. In this figure, the range of allowable TDS value estimated from TDS removal ratio (1,400 - 1,500 mg/L) is indicated by orange shading.

- The influent sewage TDS below 1,400 mg/L was 85% of all measurement data and below 1,500 mg/L was 95% of all measurement data. In other words, if the allowance level of inflow sewage TDS is decided at around 1,400 mg/L, this allowance value will exceed on a total of 24 times out of 164 measurements, and if the allowance level is decided at 1,500 mg/L, this allowance value will exceed on a total of 8 times. If this is converted into one year (365 days), it is estimated that TDS in influent sewage exceeds the allowance level a total of 53 times/year for an allowance level of 1,400 mg/L and 18 times/year for an allowance level of 1,500 mg/L.

- If the TDS of influent sewage exceeds the allowable level, the treated wastewater is to be discharged to the wadi and its reuse as agricultural water is to be suspended for a certain period of time. Therefore, it is desirable that the allowable level for inflow sewage TDS is set so that the possibility (number of times) of it being exceeded is as low as possible. In this reason, this assessment supports the 1,500 mg/L of TDS as the allowance value of inflow sewage.



Source: TeCSOM Team

Figure 2.2.5 Cumulative Ratios (Pareto plot)

- It should be noted that the quantity and quality of inflow sewage may change in the near future due to the increase in industrial effluents as a result of the full operation of JAIP and the slaughterhouse, as well as the increase in the population connected to the sewage network in the city and in the refugee camps. Jericho Municipality needs to monitor water quality, and the allowable TDS level needs to be reviewed using a similar approach.

b) Achievements

1) Water quality measurement of sewage inflow and treated wastewater

i) The 1st measurement results sampled in November 2021

- The results (November 2021 sampling) of the first water quality measurement of sewage inflow and treated wastewater were obtained. In the influent water quality, only oil (Fat, Oil & Grease) exceeded the standard value out of 28 parameters, at 144 mg/L against the sewage discharge standard of 100 mg/L. However, the treated wastewater for oil met the Class A criteria according to MoA standards at <5 mg/L.

- In treated wastewater, BOD exceeded the standard value of 20 mg/L by 21 mg/L, slightly. The other 43 parameters were within the standard values. The compliance ratio of treated wastewater to Class A of the reuse standards is 97.3%, which is good.

- There are various possible sources of "Fat, Oil & Grease". As there are no factories located in the sewerage treatment area, cooking oil from household wastewater and wastewater from restaurants are considered as the major source. The results of this water quality measurement do not mean that the reuse of the treated wastewater for agricultural purposes is immediately suspended.

ii) The 2nd measurement results sampled in November 2022

- The second water quality test results (November 2022 sampling) were obtained for sewage inflow and treated wastewater at the WWTP.
- In the influent water quality, only oil (Fat, Oil & Grease) exceeded the standard value out of 28 parameters, at 137.5 mg/L against the sewage discharge standard of 100 mg/L. However, the treated wastewater for oil met the Class A criteria at <5 mg/L.
- In treated wastewater, BOD exceeded the standard value of 20 mg/L by 22 mg/L and CODcr exceeded the standard value of 50 mg/L by 56 mg/L, slightly. The other 35 parameters were within the standard values. The compliance ratio of treated wastewater to Class A of the reuse standards is 94.6%, which is good.

iii) The 3rd measurement results sampled in April 2023

- The third water quality test results (April 2023 sampling) were obtained for sewage inflow and treated wastewater at the WWTP.
- In the influent water quality, only oil (Fat, Oil & Grease) exceeded the standard value out of 28 parameters, at 118 mg/L against the sewage discharge standard of 100 mg/L. However, the treated wastewater for oil met the Class A criteria at <5 mg/L.
- In treated wastewater, BOD there is no exceeded the standard value. All 37 parameters were within the standard values. The compliance ratio of treated wastewater to Class A of the reuse standards is 100%, which is good.

iv) Results of three measurements

- Table 2.2.8 and Table 2.2.9 show the water quality of the sewage inflow to the WWTP and treated wastewater, respectively. The detailed measurement report is presented in Appendix 2.2.2.
- By comparing the influent characteristics of the samples collected in November of 2021, 2022 and April of 2023 to the requirements of the Palestinian regulations on connection of premises to public sewers #16-2013 (Table 2.2.8), the influent is described as of mostly domestic origin, and can be received by the WWTP without any additional pre-treatment. All values of the influent results are well below the requirements, except for oil (Fat, Oil & Grease), which can be easily removed from the treated wastewater in the grit chamber. Oil (Fat, Oil & Grease) is mostly of domestic (residential houses) and commercial (restaurants and hotels) origins. In case of no use of grease traps in restaurant and hotels, and providing

that Jericho is a touristic city especially for winter times, such values of oil (144, 137.5, and 118 mg/L) are expected to be found in raw wastewater.

Table 2.2.8 Influent Sewage Quality

No.	Parameter	Unit	Results Nov. 21	Results Nov. 22	Results Apr. 23	Limits according to 16/2013[1)]
1	Total Suspended Solids (TSS)	mg/L	585	595	450	600
2	Chemical oxygen Demand (CODcr)	mg/L	1,050	1002	878	2,000
3	Fat, Oil and Grease	mg/L	144	137.5	118	100
4	Phenol	mg/L	0.08	0.07	.07	10
5	Detergents (MBAS)	mg/L	6.5	6.0	4.0	40
6	Chloride (Cl^-)	mg/L	375	325	395	500
7	Sulphate (SO_4)	mg/L	50	76.4	91.1	1,000
8	Sodium (Na)	mg/L	205.5	192	213	500
9	Aluminum (Al)	µg/L	2858.5	1198.7	333.9	10,000
10	Arsenic (As)	µg/L	2.46	2.8	6.7	5,000
11	Cupper (Cu)	µg/L	74.8	66.6	24.2	4,500
12	Iron (Fe)	µg/L	3650.1	1348.9	903.1	50,000
13	Manganese (Mn)	µg/L	84.8	58.6	44.4	10,000
14	Nickel (Ni)	µg/L	16.4	8.4	8.4	4,000
15	Selenium (Se)	µg/L	3.94	10.7	31.9	50
16	Cadmium (Cd)	µg/L	0.53	0.3	0.1	1,000
17	Zinc (Zn)	µg/L	344.6	141.8	90.6	15,000
18	Cobalt (Co)	µg/L	1.64	0.8	0.7	50
19	Chrome (Cr)	µg/L	21.6	11.5	13.1	5,000
20	Boron (B)	µg/L	213.3	139.2	144.5	5,000
21	Cyanide (CN)	µg/L	0.0	0.0	0.0	2,000
22	Mercury (Hg)	µg/L	0.0	0.0	0.0	500
23	Tin (Sn)	µg/L	0.0	0.0	0.0	10,000
24	Beryllium (Be)	µg/L	0.13	0.04	0.06	5,000
25	Barium (Ba)	µg/L	85.0	70.0	47.5	10,000
26	Silver (Ag)	µg/L	0.1	0.3	0.2	1,000
27	Lithium (Li)	µg/L	1.3	12.9	18.3	5,000
28	Vanadium (V)	µg/L	16.54	9.2	16.3	100
29	Biochemical Oxygen Demand (BOD_5)	mg/L	675	647	485	---
30	Dissolved Oxygen (DO)	mg/L	0.0	0.0	0.0	---
31	Total Dissolved Solids (TDS)	mg/L	1272	1218	1260	---
32	pH	---	7.9	7.8	7.28	---
33	Nitrate Nitrogen (NO_3-N)	mg/L	0.0	0.0	0.0	---

No.	Parameter	Unit	Results Nov. 21	Results Nov. 22	Results Apr. 23	Limits according to 16/2013[1)]
34	Ammonium Nitrogen (NH_4-N)	mg/L	70	92	82	---
35	Total Nitrogen	mg/L	101	118	107	---
36	Magnesium (Mg)	mg/L	4.7	58.99	29.2	---
37	Calcium (Ca)	mg/L	162.5	93.5	168	---
38	Sodium Adsorption (SAR)	mg/L	4.3	3.8	3.98	---
39	Phosphate Adsorption (PO_4-P)	mg/L	39.1	37.5	33	---
40	Lead (Pb)	µg/L	8.9	5.3	2.2	---
41	Eggs of intestinal warms Nematodes	Egg/50ml	Detected	Detected	Detected	---
42	Fluoride (F)	µg/L	5.28	5.1	4.8	---
43	Fecal Coliform bacteria	CFU/100ml	$9*10^6$	$7*10^6$	TMTC	---
44	Bacteria *E.*coli	CFU/100ml	$5*10^6$	$4*10^6$	TMTC	---

Source: 1) Cabinet Resolution 16-2013_House Connection to Sewer Network By Law (Refer to Appendix 2.2.11)
Source: TeCSOM Survey Results,

Table 2.2.9 Treated Wastewater Quality

No.	Parameter	Unit	Results Nov. 21	Results Nov. 22	Results Apr. 23	Quality Criteria based on PS 742-2015[2)]			
						Type A	Type B	Type C	Type D
1	Biochemical Oxygen Demand (BOD_5)	mg/L	21	22	14	20	20	40	60
2	Total Suspended Solids (TSS)	mg/L	9.5	13.6	22	30	30	50	90
3	Fecal coliform bacteria (Before Chlorination)	CFU/100ml	$7.0*10^4$	$3.6*10^4$	$3*10^3$	200	1000	1000	1000
	Fecal coliform bacteria (After Chlorination)	CFU/100ml	60	22	7	200	1000	1000	1000
4	Chemical oxygen Demand (CODcr)	mg/L	39	56	22	50	50	100	150
5	Dissolved Oxygen (DO)	mg/L	2.3	2.2	2.5	>1	>1	>1	>1
6	Total Dissolved Solids (TDS)	mg/L	1129	1135	1140	1200	1500	1500	1500
7	pH	----	7.6	7.5	7.4	6-9	6-9	6-9	6-9
8	Fat, Oil and Grease	mg/L	< 5	<5	<5	5	5	5	5
9	Phenol	mg/L	0.002	<0.002	<0.002	0.002	0.002	0.002	0.002
10	Detergents (MBAS)	mg/L	0.1	0.1	0.1	15	15	15	25
11	Nitrate Nitrogen (NO_3-N)	mg/L	5.6	8.7	10.3	20	20	30	40
12	Ammonium Nitrogen (NH_4-N)	mg/L	0.0	<1.0	0.0	5	5	10	15
13	Total Nitrogen (T-	mg/L	8.9	<10	<10	30	30	45	60

No.	Parameter	Unit	Results Nov. 21	Results Nov. 22	Results Apr. 23	Quality Criteria based on PS 742-2015[2)]			
						Type A	Type B	Type C	Type D
	N)								
14	Chloride (Cl^-)	mg/L	350	355	310	400	400	400	400
15	Sulphate (SO_4)	mg/L	135	123.9	138.3	300	300	300	300
16	Sodium (Na)	mg/L	196	199	190	200	200	200	200
17	Magnesium (Mg)	mg/L	4.9	57.7	19.4	60	60	60	60
18	Calcium (Ca)	mg/L	126.5	80.8	160	300	300	300	300
19	Sodium Adsorption Ratio (SAR)	-	4.7	4.13	3.77	5.83	5.83	5.83	5.83
20	Phosphate Phosphorous (PO_4-P)	mg/L	9.3	8.3	5.1	15-20	15-20	15-20	15-20
21	Aluminum (Al)	µg/L	13.82	10.9	18.8	5000	5000	5000	5000
22	Arsenic (As)	µg/L	1.28	3.0	4.6	100	100	100	100
23	Copper (Cu)	µg/L	3.25	4.2	3.8	200	200	200	200
24	Iron (Fe)	µg/L	182.2	240.4	304.1	5000	5000	5000	5000
25	Manganese (Mn)	µg/L	11.7	11.9	27.2	200	200	200	200
26	Nickel (Ni)	µg/L	4.7	4.1	5.1	200	200	200	200
27	Lead (Pb)	µg/L	0.20	0.20	0.3	200	200	200	200
28	Selenium (Se)	µg/L	5.09	11.9	12.7	20	20	20	20
29	Cadmium (Cd)	µg/L	0.0	0.0	0.0	10	10	10	10
30	Zinc (Zn)	µg/L	12.5	21.6	25.4	2000	2000	2000	2000
31	Cobalt (Co)	µg/L	0.33	0.4	0.4	50	50	50	50
32	Chrome (Cr)	µg/L	1.13	3.5	5.9	100	100	100	100
33	Boron (B)	µg/L	111.0	144.5	121.4	700	700	700	700
34	Cyanide (CN)	µg/L	0.0	0.0	0.0	50	50	50	50
35	Mercury (Hg)	µg/L	0.0	0.0	0.0	1	1	1	1
36	Bacteria *E.*coli (Before Chlorination)	CFU/100ml	$3.0*10^4$	$6.0*10^2$	$5.0*10^2$	1000	1000	1000	100
	Bacteria *E.*coli (After Chlorination)	CFU/100ml	20	8	6	1000	1000	1000	100
37	Eggs of intestinal warms Nematodes	Egg/500ml	Not Detected	Not Detected	Not Detected	<1	<1	<1	<1
38	Fluoride (F)	µg/L	0.47	0.45	0.4	---	---	---	---
39	Tin (Sn)	µg/L	0.0	0.0	0.0	---	---	---	---
40	Beryllium (Be)	µg/L	0.0	0.0	0.0	---	---	---	---
41	Barium (Ba)	µg/L	17.1	31.5	38.5	---	---	---	---
42	Silver (Ag)	µg/L	0.2	0.0	0.2	---	---	---	---
43	Lithium (Li)	µg/L	14.8	14.0	9.3	---	---	---	---
44	Vanadium (V)	µg/L	3.5	6.2	9.9	---	---	---	---

Source: 2) PS 742-2015_Treated Wastewater for Agricultural Purposes (Refer to Appendix 2.2.12)

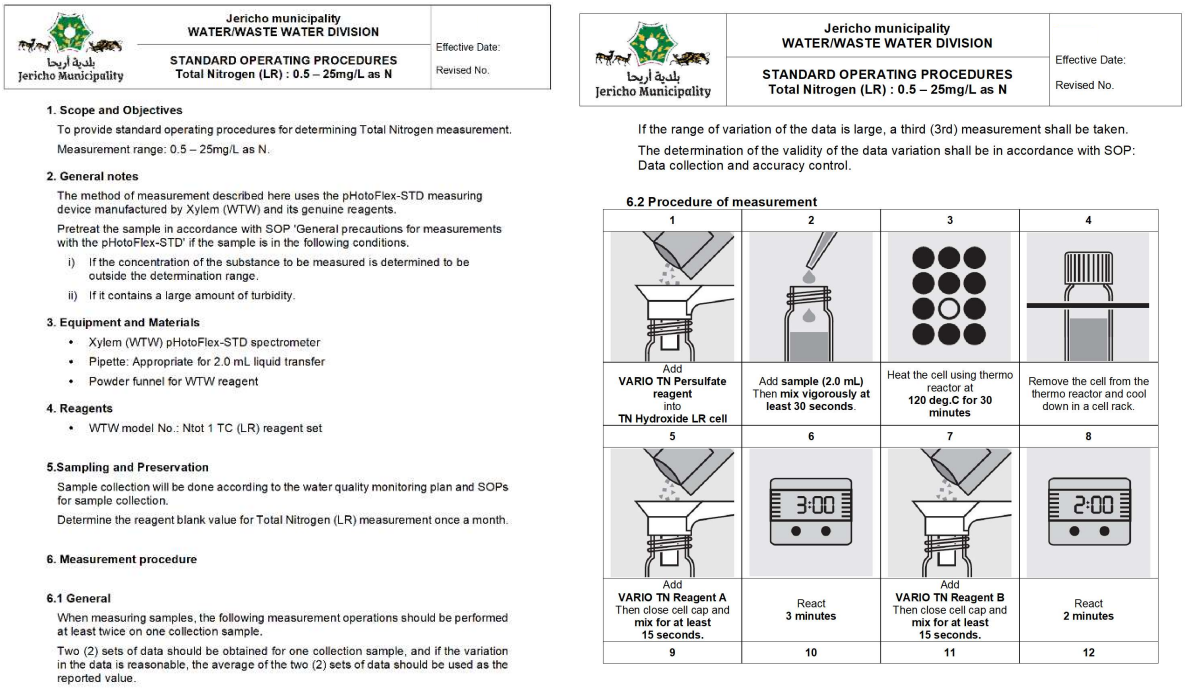
Source: TeCSOM Survey Results,

2) Development/revision of SOPs

A list of the SOPs developed/revised is presented in Table 2.2.10. The SOPs are attached in Appendix 2.2.3.

Table 2.2.10 SOPs for Water Quality Analysis

No.	Monitoring item	Contents	Remarks
1	pH/EC/TDS	pH/EC/TDS measurement by HANNA HI9811-5	May 2022: 1st edition
2	Turbidity	Turbidity measurement by HACH 2100Q	May 2022: 1st edition
3	BOD_5	BOD_5 measurement using OxiTop respirometer	May 2022: 1st edition
4	Photo spectrometer operation guide	Simple operation guide of pHotoFlex (Xylen) spectro photometer	March 2023: 1st edition
5-1 5-2	NH_4-N（Low range） NH_4-N（High range）	Ammonia measurement by colorimetry using spectrometer Independent SOPs were prepared for the high and low concentration ranges respectively.	March 2023: 1st edition
6-1 6-2	NO_3-N（Low range） NO_3-N（High range）	Nitrate measurement by colorimetry using spectrometer Independent SOPs were prepared for the high and low concentration ranges respectively.	March 2023: 1st edition
7-1 7-2	T-N（Low range） T-N（High range）	Total nitrogen measurement by colorimetry using spectrometer Independent SOPs were prepared for the high and low concentration ranges respectively.	March 2023: 1st edition
8-1 8-2	CODcr（Low range） CODcr（High range）	CODcr measurement by colorimetry using spectrometer Independent SOPs were prepared for the high and low concentration ranges respectively.	March 2023: 1st edition
9-1 9-2	PO_4-P（Low range） PO_4-P（High range）	Phosphate measurement by colorimetry using spectrometer Independent SOPs were prepared for the high and low concentration ranges respectively.	March 2023: 1st edition
10	TSS	TSS measurement by gravimetry	March 2023: 1st edition
11	Sampling procedure	Technical instruction of sampling procedure	March 2023: 1st edition
12	Analysis data quality management	Technical instruction of monitoring data quality control	May 2022: 1st edition March 2023: 2nd edition



Jericho municipality
WATER/WASTE WATER DIVISION
STANDARD OPERATING PROCEDURES
Total Nitrogen (LR) : 0.5 – 25mg/L as N
Effective Date:
Revised No.

بلدية أريحا
Jericho Municipality

1. Scope and Objectives

To provide standard operating procedures for determining Total Nitrogen measurement.

Measurement range: 0.5 – 25mg/L as N.

2. General notes

The method of measurement described here uses the pHotoFlex-STD measuring device manufactured by Xylem (WTW) and its genuine reagents.

Pretreat the sample in accordance with SOP 'General precautions for measurements with the pHotoFlex-STD' if the sample is in the following conditions.

i) If the concentration of the substance to be measured is determined to be outside the determination range.

ii) If it contains a large amount of turbidity.

3. Equipment and Materials

- Xylem (WTW) pHotoFlex-STD spectrometer
- Pipette: Appropriate for 2.0 mL liquid transfer
- Powder funnel for WTW reagent

4. Reagents

- WTW model No.: Ntot 1 TC (LR) reagent set

5.Sampling and Preservation

Sample collection will be done according to the water quality monitoring plan and SOPs for sample collection.

Determine the reagent blank value for Total Nitrogen (LR) measurement once a month.

6. Measurement procedure

6.1 General

When measuring samples, the following measurement operations should be performed at least twice on one collection sample.

Two (2) sets of data should be obtained for one collection sample, and if the variation in the data is reasonable, the average of the two (2) sets of data should be used as the reported value.

If the range of variation of the data is large, a third (3rd) measurement shall be taken.

The determination of the validity of the data variation shall be in accordance with SOP: Data collection and accuracy control.

6.2 Procedure of measurement

1	2	3	4
Add **VARIO TN Persulfate reagent** into **TN Hydroxide LR cell**	Add **sample (2.0 mL)** Then **mix vigorously at least 30 seconds**.	Heat the cell using thermo reactor at **120 deg.C for 30 minutes**	Remove the cell from the thermo reactor and cool down in a cell rack.
5	**6**	**7**	**8**
Add **VARIO TN Reagent A** Then close cell cap and **mix for at least 15 seconds.**	React **3 minutes**	Add **VARIO TN Reagent B** Then close cell cap and **mix for at least 15 seconds.**	React **2 minutes**
9	**10**	**11**	**12**

Figure 2.2.6 SOP

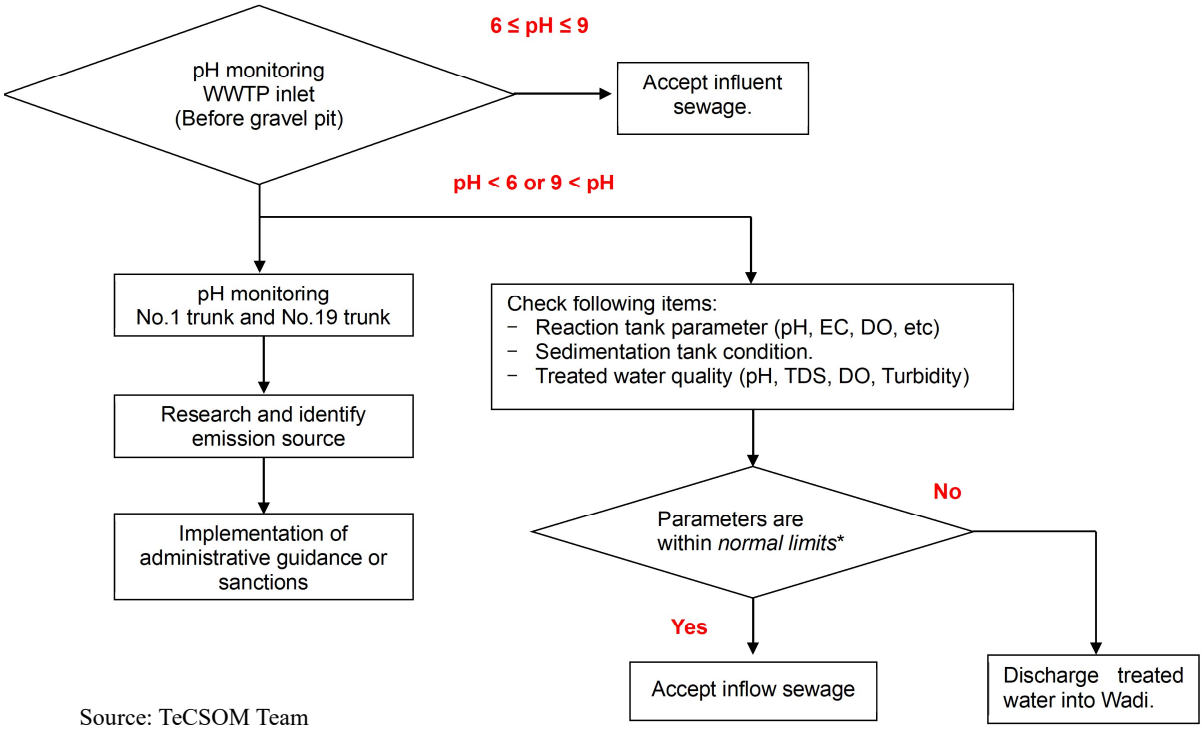
3) Response to unusual sewage inflows

- The detection and response procedure in the event of unusual sewage inflow for pH and TDS respectively are shown in Figures 2.2.7 and 2.2.8.
- In the event of an inflow of sewage with unusual water quality and/or the treated wastewater exceeded the standards, the treated wastewater will not be used for agricultural reuse. Wastewater treatment is carried out as it is, but the treated wastewater is not put into the irrigation tank.
- Treated wastewater will be discharged into a nearby wadi. The discharge channel is switched at a gate in front of the disinfection facility (Photo 2.2.4).

Close（Normal）

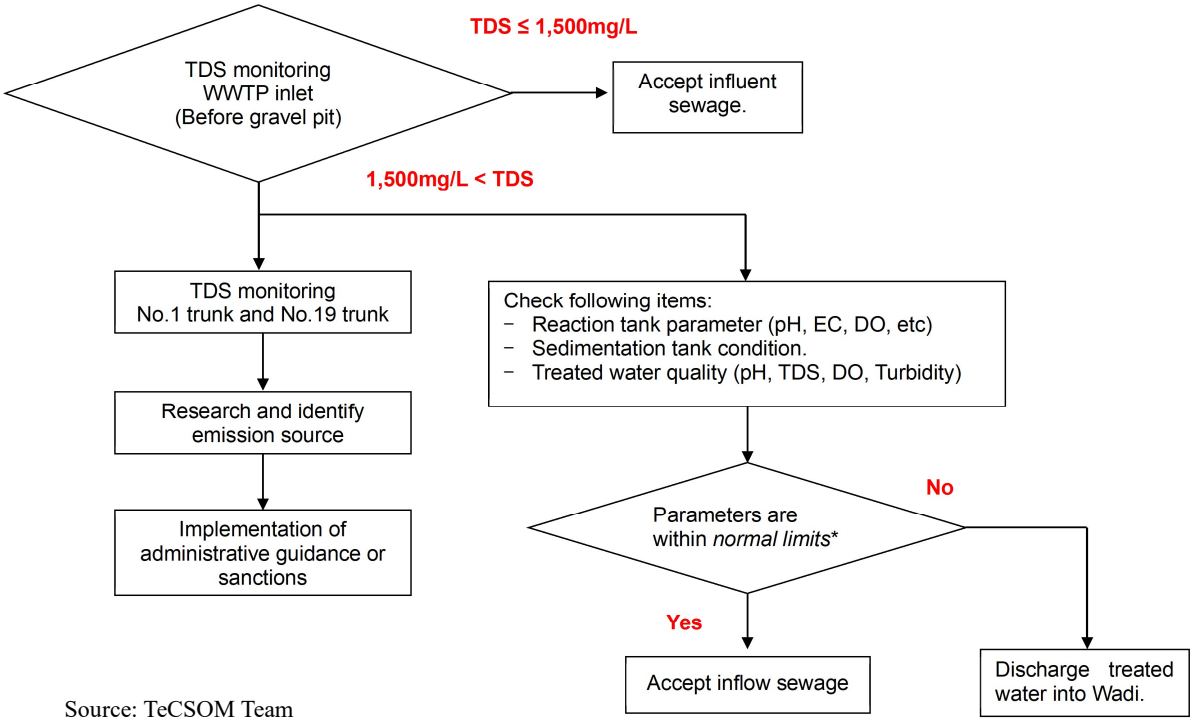
Open (Emergency)

Photo 2.2.4 Discharge By-pass Gate



Source: TeCSOM Team

Figure 2.2.7 Response Procedures for Unusual Sewage Inflow (pH)



Source: TeCSOM Team

Figure 2.2.8 Response Procedures for Unusual Sewage Inflow (TDS)

4) Procurement of water quality testing reagents

- As the cost of reagent purchases exceeded the municipal budget, the Water and Wastewater Department Director discussed the matter with the Mayor in order to secure the budget in June 2022. As a result, the partial budget for the purchase of reagents was agreed upon by the Mayor.
- Reagents (for water quality tests and instrument calibration) ordered by Jericho Municipality have been procured. This allowed the scope of on-the-job training by an expert to be extended from February 2023. The water quality parameters added are total nitrogen, nitrate-nitrogen, ammonia nitrogen, phosphate, CODcr and TSS (which is filter paper).

5) Other observations

- Water quality analysis SOPs were revised, and a water quality analysis monitoring plan was developed. The implementation of water quality monitoring according to these documents has ensured that the quality and process control of influent sewage, sewage treatment processes and treated wastewater is better managed. In addition, a response procedure for unusual inflow sewage has been developed. By this document, the procedure to determine the unusual sewage inflow and the response to keep treated wastewater for agricultural re-use were shown clearly.

2.2.2 Conduct Training on Testing the Influent Sewage Quality for Operatives at the WWTP (Activity 2-2)

On-The-Job Trainings (OJT) had been implemented to improve the capacity of water quality laboratory technicians under the Activity 2-2. The technicians have learned 1) the importance of equipment calibration and 2) accuracy data control by performing water quality measurements, as basic knowledge for acquiring reliable data. The expert carried out 1) daytime water quality measurements in the reactor tank; and 2) a drinking water factory inspection to improve the technicians' water analysis knowledge. In addition, a procurement plan for reagents and consumables was developed for sustainable management of the water quality laboratory.

a) Activities

1) OJT on water quality analysis

- In the beginning of this Project, the water quality laboratory technician in the WWTP laboratory was Technician A. In addition, Technician B was newly recruited at the end of August 2022. Technician B then became a full-time water quality laboratory technician in the sewerage laboratory. Therefore, records and results of the OJT training conducted for these two staff members are therefore noted respectively.

i) Outline of OJT

- At the implementation of his OJT (May - June and August 2022), Technician A was working three days a week (Tuesday, Thursday, Sunday) in the WWTP water quality laboratory because he had an additional post of drinking water quality laboratory.
- Therefore, considering the working days of Technician A, the sampling points and monitoring schedule were established. The monitoring points and monitoring schedule are shown in Table 2.2.11. The measurement items were determined with reference to PS742-2015 agricultural treated wastewater effluent.

Table 2.2.11 Monitoring Point and Monitoring Schedule

Monitoring item	Schedule	JAIP effluent	WWTP inflow	Reactor tank	Treated water
Water temperature, pH, EC, TDS	3 times/ week	✓	✓	✓	✓
Turbidity			✓		✓
DO			✓	✓	✓
Residual chlorine					✓
MLSS, SVI	2 times / week			✓	
BOD_5	Weekly		✓		✓
CODcr		✓	✓		✓
TSS			✓		✓
T-N, NO_3-N, NH_4-N, PO_4-P					✓

Source: TeCSOM Team

- This OJT was focused on the following issues:
  - ➢ Implement analytical operations according to manuals and SOPs.
  - ➢ Calibrate equipment prior to measurement.
  - ➢ Perform at least two measurements on one sample to check the precision of data.

ii) Orientation: OJT to technician B (conducted in August 2022 to June 2023)

- Technician B was recruited as a new water quality analysis staff at the end of August 2022. Prior to the start of the water quality analysis work, an orientation was conducted on the Project and the Jericho WWTP. The orientation material is presented in Appendix 2.2.4.


Photo 2.2.5 Orientation for Technician B

iii) OJT on water quality monitoring

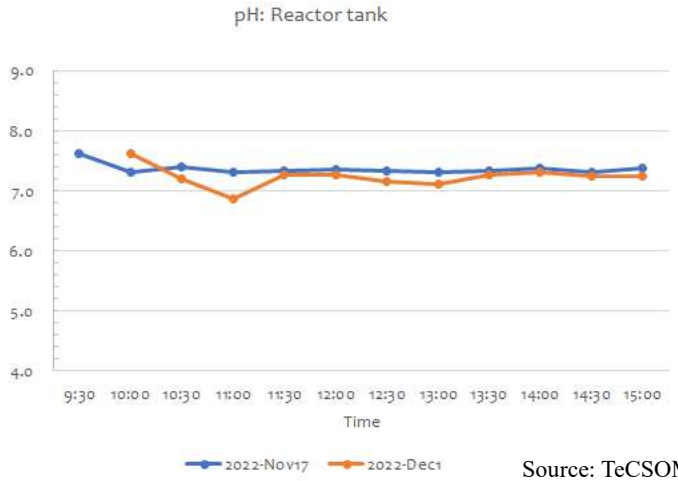
- Technician B had experience of working in an analytical laboratory and had basic knowledge of chemical analysis. Therefore, the OJT for Technician B was conducted focusing on the

establishment of a water quality monitoring plan, an unusual water quality response procedure, and considered a procurement plan for water quality analysis reagents.

- In addition, conduct water quality analysis according to the adopted monitoring plan, and train the process of data analysis and utilization.

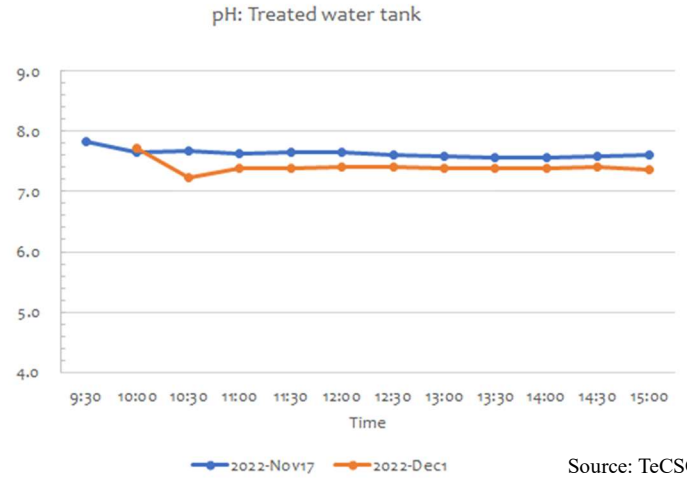
2) Daytime water quality measurements of the reactor tank and treated wastewater

- In the WWTP water quality laboratory, daily monitoring of reaction tanks condition and treated wastewater quality has been conducted. However, monitoring work is done at around 10:00 AM only and the variation during the daytime was not clear. Thus, it was not clear whether the water quality monitoring data obtained in the morning represents the day's water quality.
- Therefore, pH and TDS measurements were conducted at 30-minute intervals between 9am and 3pm (during staff working hours) on 17 November and 1 December 2022 to observe water quality change in reaction tank and treated wastewater. The measurement results are shown in Figures 2.2.9 to 2.2.12.
- The results from the two investigations confirm that the water quality change during the daytime (9:00-15:00) is relatively constant. This indicates that the treated wastewater measurement data in the morning can be used as representative of the day's water quality.



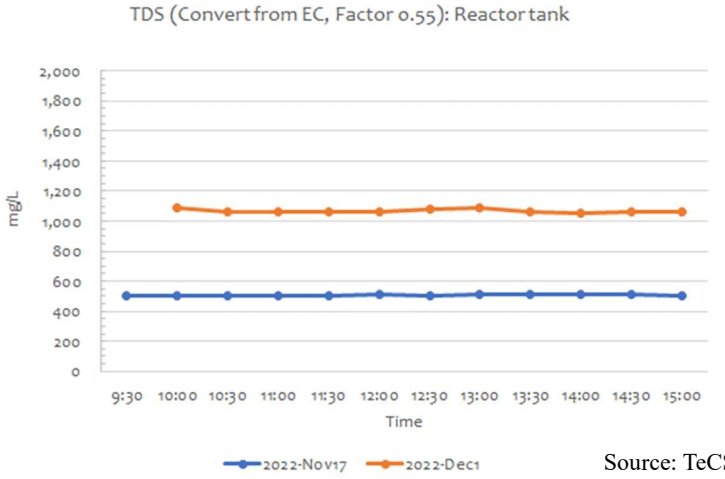
Source: TeCSOM Team

Figure 2.2.9 pH Daytime Data (Reactor Tank)



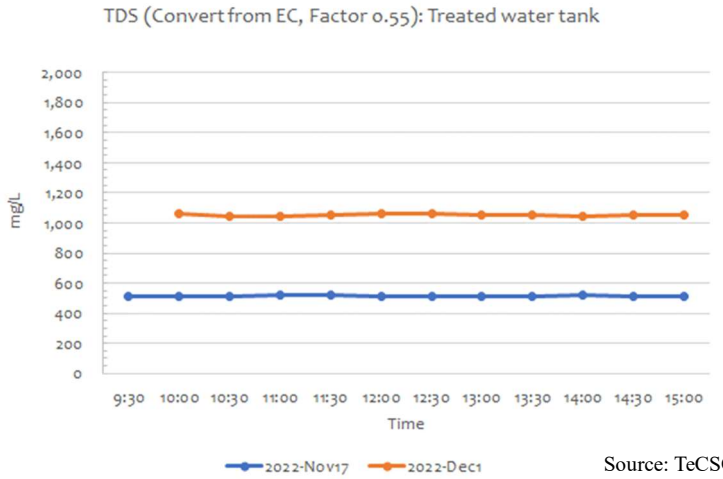
Source: TeCSOM Team

Figure 2.2.10 pH Daytime Data (Treated Water)



Source: TeCSOM Team

Figure 2.2.11 TDS Daytime Data (Reactor Tank)



Source: TeCSOM Team

Figure 2.2.12 TDS Daytime Data (Treated Water)

3) Soft drink factory inspection

- As of May 2023, the soft drink factory near JAIP is discharging sewage into the sewer. Site visits and wastewater sampling were conducted on 11 March 2023. The results of the visit are presented in Appendix 2.2.5.
- In the office of soft drink factory, an explanation and discussions about the plant's processes and the source of the wastewater generation were given, and an understanding of the plant's effluent was gained. This plant uses deep-well groundwater on site after Reverse Osmosis Membrane (RO) treatment. The water is used for beverage preparation and bottle washing. The effluent generated contains highly concentrated brine from the RO process and washing effluent from the bottles and bottling equipment.

	
RO plant in the factory	Water quality Labo. in the factory

Photo 2.2.6 Site Visit (Soft drink factory)

b) Achievements

1) OJT outputs of technician A

Technician A learnt the following through OJT:

- Make water quality measurements correctly according to the manual and SOPs. Pay particular attention to the range of quantification.
- Correctly use measuring instruments (measuring flasks, measuring cylinders).
- Understand the properties of the sample and the analyte and carry out appropriate dilution, stirring and pre-treatment.
- Perform at least two measurements on one sample and assess data precision.
- Always calibrate measuring equipment and materials.
- Use reagents that are within their expiry date.
- Use reagents that match the measuring equipment (reagents specified by the manufacturer of the measuring equipment).

2) OJT Outcomes of Technician B

- At the weekly meeting, the new water quality laboratory technician presented measurements of treated wastewater and explained compliance with reuse standards. The laboratory technician was considering not only the measurement items, but also their relationship to other items such as TSS and Electricity Conductivity (EC). The technician understood that data accumulation and correlation studies are important. For example, since the MLSS concentration in the reaction tank changes with excess sludge withdrawal (sludge transfer to the thickened sludge tank), it is important that water quality data be shared with the WWTP operator.

3) Procurement of reagents for water quality analysis

- At the end of August 2022, when Technician B was recruited, there was a lack of stock of reagents required for water quality analysis. Therefore, a survey of suppliers of chemical analysis equipment and reagents within Palestine was conducted, and a list of required reagents was prepared and procured in accordance with the procurement system of Jericho Municipality. officer and the first procurement was not completed until the end of January 2023.
- Based on this experience, it becomes clear to consider sufficient time for the next and subsequent procurements. Therefore, a procurement plan for reagents for one year was developed in advance. This plan considers the measurement items and number of measurements according to the newly established water quality monitoring plan. The procurement plan is shown in Appendix 2.2.6, and relevant research is described in Appendix 2.2.7. The developed procurement plan was approved by the Water and Wastewater Department in February 2023.

4) Water quality analysis data

- In this OJT, water quality monitoring of influent sewage (WWTP inlet and influent pipes No. 1 and No. 19), reaction tanks and treated wastewater were conducted according to the monitoring plan. The measurement results for each item are presented below (note: data from 2 February - 30 May 2023).
- A comparison of treated wastewater quality and the water quality criteria for agricultural reuse (PS742-2015, Category High quality (A) is shown in Table 2.2.10.
- Turbidity, BOD_5, total nitrogen (T-N) and ammoniacal nitrogen (NH_4-N) exceeded criteria on some occasions. In addition, a temporary decrease in Dissolved Oxygen (DO) was also observed. Other than these, the standard values were mostly satisfied. Water quality monitoring data record and data analysis in this OJT are shown in Appendix 2.2.8.

Table 2.2.12 Treated Water Quality

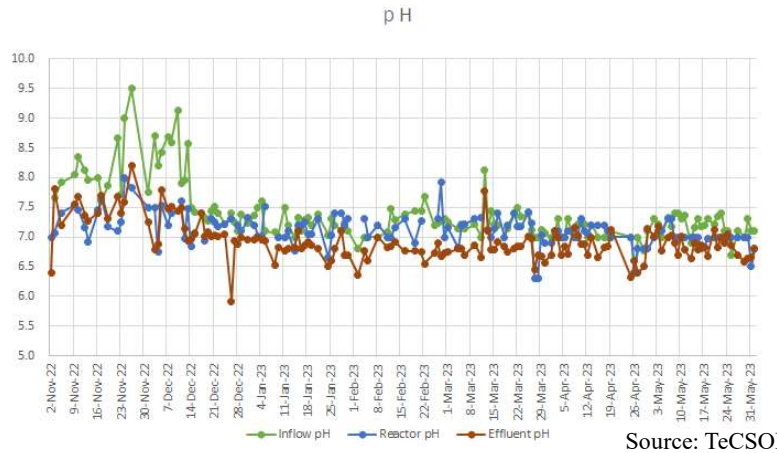
Item	PS742-2015 High quality(A)	Monitoring data			Assessment
		Max	Average	Min	
pH	6-9	8.2	6.9	5.9	Good
TDS	1,200 mg/L	1,200	959	509	Fair
DO	1 mg/L <	4.5	2.2	0.1	Good
Turbidity	5 – 10 NTU	33.0	5.0	1.2	Fair
CODcr	50 mg/L	22.0	10.7	3.0	Good
BOD_5	20 mg/L	23.0	8.4	4.0	Fair
T-N	30 mg/L	55.0	22.9	5.7	Fair
NO_3-N	20 mg/L	1.2	0.7	0.4	Good
NH_4-N	5 mg/L	9.9	2.9	0.3	Fair
PO_4-P	30 mg/L	7.8	3.4	1.2	Good
TSS	30 mg/L	10.0	6.5	3.5	Good

Source: TeCSOM Team

Photo 2.2.7 Sharing Water Quality Data with Operator

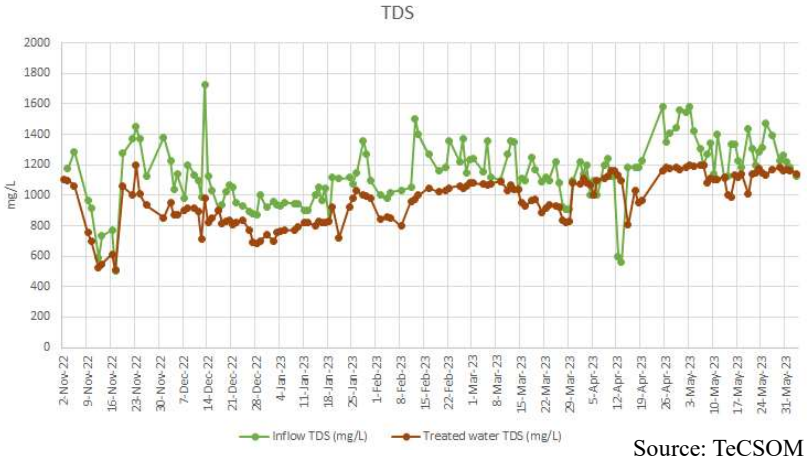
- Daily changes in pH, TDS, DO and Turbidity are shown in Figures 2.2.13 to 2.2.16. There was an inflow of very high alkaline (high pH) sewage in November 2022. However, it can be seen that the pH has been neutralized through biological treatment. The pH of the treated wastewater is generally in the range 6.5 - 7.5.

- TDS has shown an increasing trend since October 2022, but remains below 1,200 mg/L. Turbidity was usually below 10 NTU (Nephelometric Turbidity Unit), but occasionally exceeded 10 NTU. This could be due to incomplete sludge withdrawal or sludge flotation phenomenon. A possible reason of sludge flotation is the occurring of the delay of nitrification and denitrification process caused by excessive blower operation times and generation of nitrogen gas in the settling tank due to this delay.



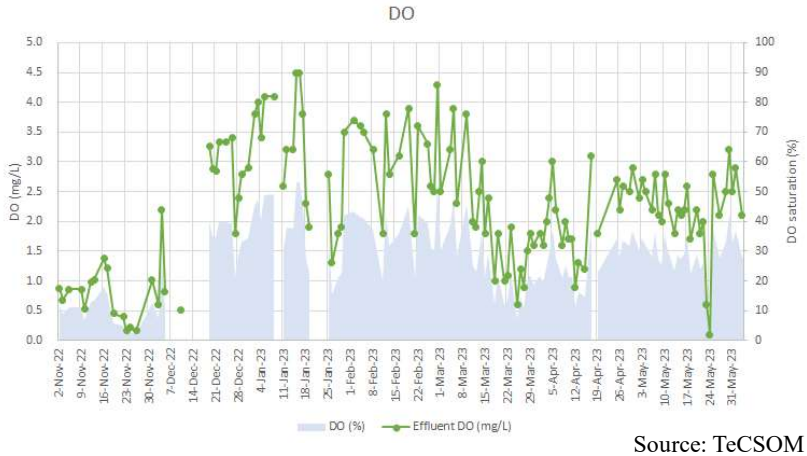
Source: TeCSOM Team

Figure 2.2.13 pH Data



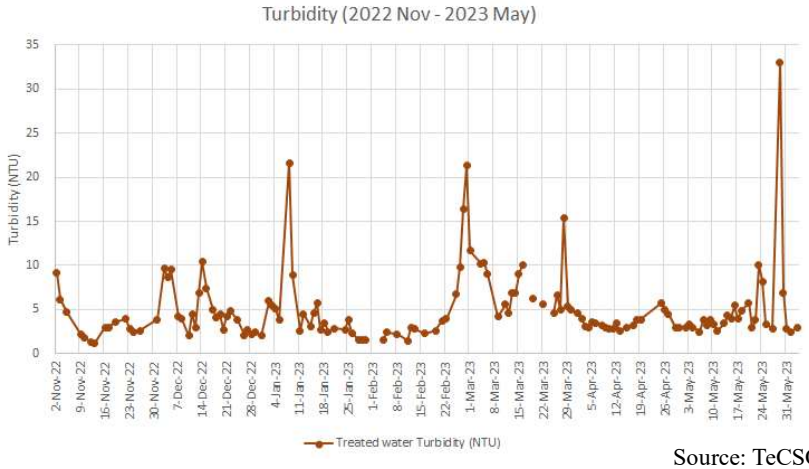
Source: TeCSOM Team

Figure 2.2.14 TDS Data



Source: TeCSOM Team

Figure 2.2.15 DO Data



Source: TeCSOM Team

Figure 2.2.16 Turbidity Data

2.2.3 Conduct a Seminar on How to Evaluate and Deal with Water Quality Test Results for the Water and Wastewater Department (WWD) in Jericho municipality (Activity 2-3)

The water quality laboratory technicians have performed the following activities in the Activity 2-3.

1) Sharing and explaining water quality monitoring data at weekly meetings;
2) Presentation of water quality data and management to the Ministry of Agriculture and palm famers at workshops on treated wastewater and treated sewage sludge reuse.

The technicians have developed their documentation and presentation skills through this activity, and voluntarily started sharing water quality monitoring data within the Water and Wastewater Department of the Jericho Municipality, especially with the WWTP operator, and have been carrying out the operation based on the water monitoring data. Furthermore, it was noteworthy that the usefulness of treated water and dried sludge reuse is understood by the participating treated wastewater users and the palm farmers.

a) Activities

1) Sharing of water quality monitoring data

- The water quality monitoring data obtained during this OJT is processed by Technician B and the information is shared within the Jericho Municipal Water and Sewerage Department through presentations and discussions at the Weekly Meeting. The presentation material in the weekly meeting is shown in Appendix 2.2.9.

Photo 2.2.8 Presentation and Discussion in the Weekly Meeting（September 2022）

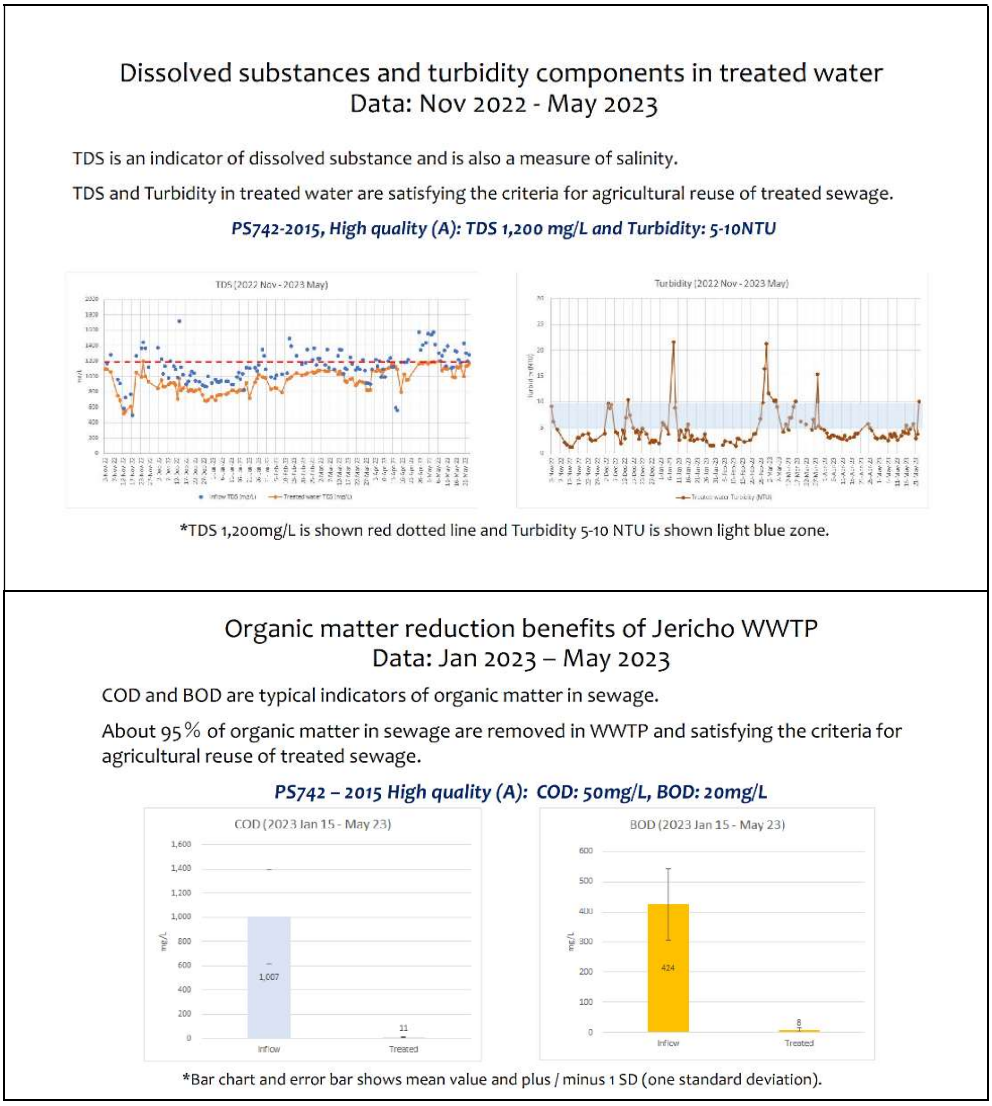
b) Achievements

1) Presentation on water quality data/information

- Data obtained from routine water quality monitoring is presented in an easy-to-understand graphical form. The continuous accumulation of water quality data has made it easier to detect

unusual values by understanding the parameters shown by normal data, range of fluctuations, etc.

- The accumulation of water quality data is useful for understanding not only the current water quality, but also the variation of water quality with respect to seasonal variations. This data is shared with the WWTP operators so that proper wastewater treatment can be maintained.
- The content, organization and message of the presentation can now be structured in the forms of figures and tables. Presentation skills have also improved to keep presentations within the timeframe in English and Arabic.



Source: TeCSOM Team

Figure 2.2.17 Water Quality Briefing Material

2) Presentation on water quality management

- A presentation on the topic of water quality management was also given at the 3rd JCC/Workshop on 6 December 2022.

- In addition, a workshop on 7 June 2023 on the reuse of treated wastewater & treated sewage sludge in cooperation with the Jericho Municipality and PFCA on water quality management operations.
- The presentation materials from the 3rd JCC/Workshop and the PFCA workshop are shown in Appendix 2.2.10.

3rd JCC Workshop

PFCA workshop

Photo 2.2.9 Presentation at Workshops

2.3 Output-3: Potential for Sewage Sludge Reuse from the Jericho Wastewater Treatment Plant is Studied.

2.3.1 To Evaluate Options for Treatment of Sludge Discharged from the Jericho Wastewater Treatment Plant (Activity 3-1)

The TeCSOM team confirmed that the sludge treatment has been carried out appropriately by evaluating the sludge treatment (from thickened sludge to dried sludge on drying beds) and the rotation of the sludge drying process on the sludge drying beds in the Activity 3-1.

Analysis of the heavy metal content of the dried sludge, the final form of the sludge, has shown that it is safe, with levels well below the Palestinian standard . Since the compositional analysis for the dried sludge indicated that the moisture content of the solar dried sludge is approximately 10%, the total fecal coliform is not detected, and the nitrogen content is higher than general soil in the land owned by Jericho Municipality, it appeared that the treated sludge can be utilized as a soil conditioner.

Given the fact, Jericho Municipality has recently developed two pilot plants and initiated the reuse of dried sludge as a soil conditioner on municipal land.

a) Activities

- The dried sewage sludge is currently piled up near the sludge drying beds in the WWTP. It has not been carried off-site or disposed of. In the current operation of the drying bed, dried sludge is carried out (piled up in the field) when the bed is full, and the amount of generated sludge is not large enough to consider the dry beds rotation. Therefore, the drying time is not specifically measured.
- As a practical issue at the site, the thicker the dried sludge becomes, the more difficult it is to remove the dried sludge by hand, so it is necessary to introduce heavy machinery (e.g. tractor) for removal. In fact, the plant manager has requested the purchase of heavy machinery.
- Dried sludge was sampled three times for component analysis on 23 November, 2021, 2 November 2022, and 3 April 2023.

Photo 2.3.1 Sludge Sampling (1)

Photo 2.3.2 Sludge Sampling (2)

- The residence time in the sludge drying bed was estimated based on Japanese literature, but the high temperature in Jericho City is favorable for drying treatment. As a result, the moisture content of the dried sludge generated at the Jericho WWTP is approximately 10%. In other cities (such as Nablus), the moisture content is as high as 82.2% (according to An-Najah National University Report, 2020) due to mechanical dewatering in the form of cake, making it difficult to handle as reuse sludge.
- With the help of the university, the moisture content of the dried sludge, fecal coliform, EC, and Na salinity related content were measured.
- The TeCSOM team visited the Arab Development Society on November 17, 2021 and confirmed about soil composition in Jericho and testing of sewage sludge as a fertilizer. The experimental fields are approximately 6 hectares (out of the approximately 30 hectares in total) of fodder (grass millet Panicum, because of its tolerance to salinity). The reasons for not using the whole experimental fields include lack of irrigation water and high salt-related concentration in the soil. The Arab Development Society has not tested sewage sludge as a fertilizer.

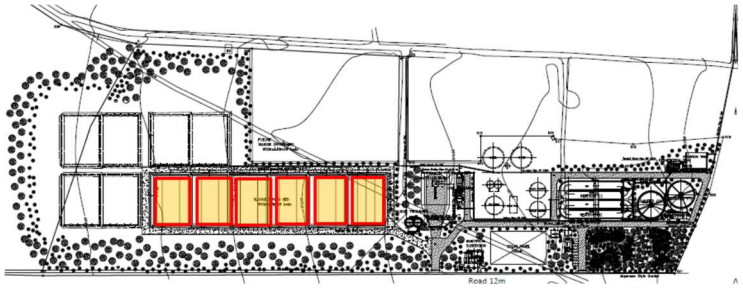
Photo 2.3.3 Experimental Farm

Photo 2.3.4 Sewage Sludge (Not used)

b) Achievements

1) Generated dried sludge

- The final sludge form at the Jericho WWTP is dried sludge. The sludge is dried in the 6 existing sludge drying beds taking advantage of the climate of Jericho. The capacity of the drying and disposal system and the treatment cycle were studied to cope up with the increase in the volume of sewage inflow in the future.



Source: TeCSOM Team

Figure 2.3.1 Drying Beds at Jericho WWTP

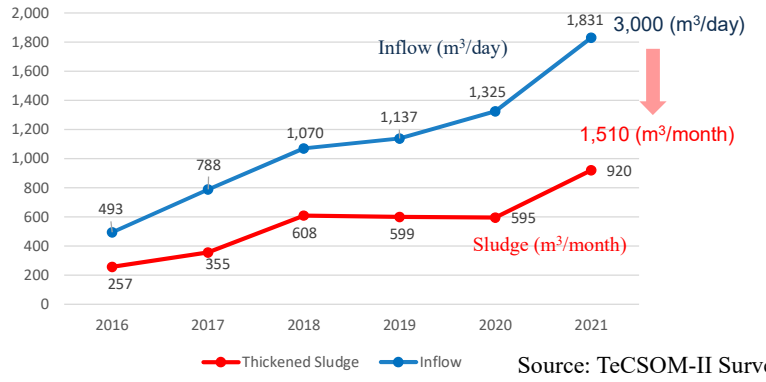
- In the current wastewater treatment operation, excess sludge is pumped from the reactor (aeration tank)/clarifier (final sedimentation tank) to the sludge thickening tank in order to maintain a constant Mixed Liquor Suspended Solids (MLSS) concentration in the reactor. Since only the operation time of the pump is recorded by Supervisory Control and Data Acquisition (SCADA), the amount of sludge pumped to the drying bed was estimated based on the pump capacity and operation time.
- Since the concentration of the thickened sludge was not measured, it was calculated based on the general value of 10,000 mg/L (1% sludge concentration) after checking the thickening facility structure.

Photo 2.3.5 Drying Beds (1)

Photo 2.3.6 Drying Beds (2)

- As a result of the study, it was estimated that the monthly average amount of thickened sludge in 2021 would be approximately 920 m^3/month (the daily average of the inflow water volume in the same year was 1,831 m^3/day). When sewage inflow reaches 3,000 m^3/day, approximately 1,510 m^3/month of thickened sludge is estimated to be generated. This is equivalent to a sludge thickness designed of approximately 26 cm per bed.
- The average generated dried sludge in 2021 is estimated to be approximately 9.2 dry-tons/month (approximately 300 dry-kg/day).

- The design value is 30 cm, but theoretically it could be up to 40 cm. This means that even if the inflow sewage reaches the planned inflow water volume (daily average of 6,600 m^3/day), the drying bed facility can accept drained thickened sludge per week with one bed. Trends and forecasts of the volume of influent sewage and thickened sludge and the capacity of the dry bed to accept the sludge are shown in Figure 2.3.2.



Source: TeCSOM-II Survey Results, 2023

Thickness (cm)	20	25	30	40
Sludge Volume (m^3/month)	1,728	2,160	2,592	3,456

Figure 2.3.2 Inflow Amount and Thickening Sludge Volume

- Rotation of drying beds was examined. In the literature survey, the only literature that showed detailed data was from Japan, and calculations were made based on this, although the temperature and humidity differed. The average temperature in Jericho is approximately 28°C in May-October and 18°C in November-April. As a conclusion, the drying bed facility can be operated with a drying time of 35 days per bed, and the existing six beds can be rotated.

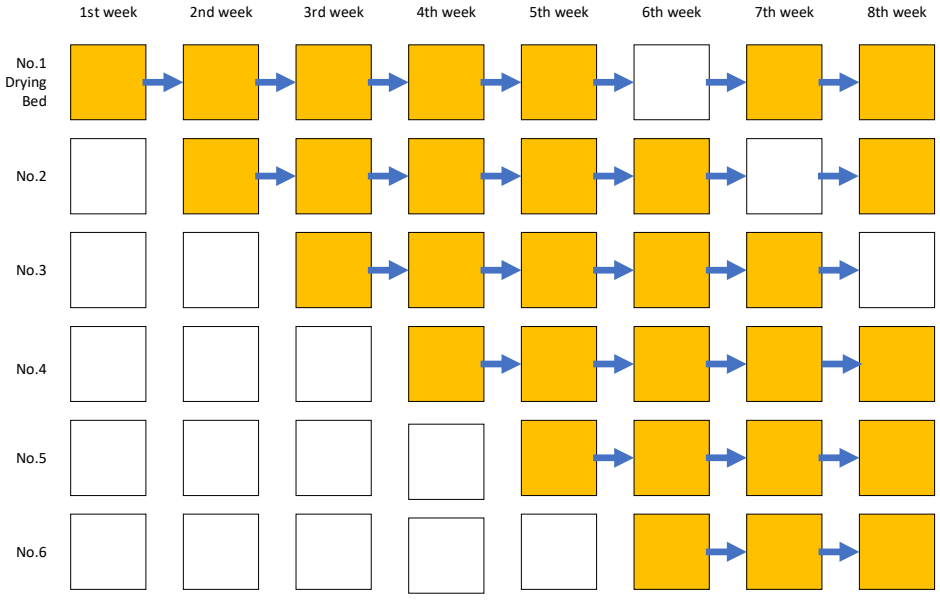


Figure 2.3.3 Drying Beds Rotation

Source: TeCSOM Team

2) Results of heavy metal content and compositional analysis of dried sludge

- The results of the 3-times component analysis of sewage sludge were obtained. The results show that the heavy metal content (7 parameters) is much lower than the standard value, and the sludge as a fertilizer/soil conditioner complies with the standard value. The heavy metal content was compared not only with Palestinian standards, but also with the heavy metal content shown in the Land Application of Sewage Sludge by the United States Environmental Protection Agency (EPA) for reference purposes, and found to be within the standard values.

- The third measurement shows that the heavy metal content has increased by approximately 100 times or more compared to the previous measurements. However, no inflow of industrial effluents or other substances has been identified. The content should continue to be monitored in the future. The results for heavy metal content are shown in Table 2.3.1. The results of the sludge analysis are included as Appendix 2.2.2.

Table 2.3.1 Heavy Metal Content in Dried Sludge

Parameters	Palestine[1)]	EPA[2)]	Soil (2014)	Sludge (2014)	Sludge (2015)	Sludge (2021)	Sludge (2022)	Sludge (2023)
Cadmium	**20**	85	ND[3)]	3.2	1.94	ND	ND	1.2
Copper	**1,000**	4,300	33.6	279.5	153.3	0.179	1.81	230.7
Nickel	**300**	420	39.5	30.2	31.9	0.026	0.15	24.8
Lead	**750**	840	ND	29.7	15.7	0.018	0.15	22.99
Zinc	**2,500**	7,500	100.4	1,258	1,029	0.55	3.59	518.9
Mercury	**16**	57	0.0133	2.969	1.67	ND	ND	ND
Chromium	**400**	3,000	42.4	ND	43.45	0.039	0.28	31.36

Unit: mg/kg of dry matter

1) Certification of Obligatory Technical Instructions, Treated Sludge for Agricultural Reuse, 59 for year 2015
2) United States Environmental Protection Agency, Land Application of Sewage Sludge, A Guide for Land Appliers on the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR Part 503
3) ND: Not Detected

Data Source: JICA, TeCSOM Project Completion Report, 2018, TeCSOM-II Survey Results, 2023

1) Refer to Appendix 2.3.4

- The moisture content of solar dried sludge is lower at 9.9% to 14.4% in the Jericho WWTP, making it easy to handle. In other cities, the moisture content of dewatered sludge cake (not dried sludge) is considered to be over 70%. The total fecal coliform count in the dried sludge was not detected (0 CFU/100mL), indicating that the fecal coliform has been killed.

- The U.S. Environmental Protection Agency has established standards for the use of sewage sludge. As a safety standard for agricultural use of sludge without limitation of use, the number of fecal coliforms should be less than 1,000 per gram of dried sludge weight.

- The results of the compositional analysis of treated sewage sludge are shown in Table 2.3.2.

Table 2.3.2 Results of the Compositional Analysis of Treated Sludge

Parameters	unit	Sludge[1] (2021)	Sludge[1] (2022)	Sludge[1] (2023)	Samed[1] Soil (2022)	Soil Conditioner Standard[2]	Improvement of Soil[4]
Nitrogen (N)	%	2.855	4.0	4.4	0.085	>1.5	
Phosphate (P_2O_5)	mg/kg	219	215	205	22.6		
Kalium (K_2O)	mg/kg	323	326	320	32.5		
pH		6.8	6.9	6.9	7.26	<7.5	5.0-8.5
EC	dS/m	7.7	7.5	8.7	1.32	<15	
Moisture Content	%	9.9	8.9	14.4	9.4	<20	25-40
Total Fecal Coliform[3]	CFU/100mL	Nil	Nil	Nil	Nil	<10	
Total Organic Matter	%	62.83	63.76	59.9	8.43	>50	>25
Carbon-Nitrogen ratio (C:N)		11:1	8:1	13:1	99.2	<15:1	<25:1

1) TeCSOM-II, Sewage analysis by An-Najah National University, TeCSOM-II Survey Results, 2023
2) Palestine Standard PS609-2014, Organic fertilizers and soil conditioners
3) U.S. EPA, 1999, Environmental Regulations and Technology, EPA stipulates Class A less than 1,000 MNP per 1 gram
4) Palestine Standard PS 2652-2011, Organic Fertilizer (Humus) Compost

2) Refer to Appendix 2.3.6

3) Solar-dried sludge treatment

- According to Palestine's "Technical Instructions, 59 for 2015, Treated Sludge for Agricultural Reuse"(Refer to Appendix 2.3.4), appropriate sludge treatment includes biological, chemical and thermal methods. In the Jericho WWTP, sludge has been treated based on a solar drying system, which is in line with these Technical Instructions.

- The Ministry of Agriculture, in discussions with the Jericho Municipality, advised that the treated sludge from solar drying at the Jericho Wastewater Treatment Plant is of high quality (equivalent to PS 898-2010 classification Class I, refer to Appendix 2.3.5) and therefore the treated sludge can be considered for use as a soil conditioner. The Ministry of Agriculture verbally mentioned that dry sludge treatment of sludge at the Jericho Wastewater Treatment Plant is appropriate.

- Therefore, based on the results of the component analysis of the dried sludge, it can be stated that solar drying treatment, which is the treatment of sludge at the Jericho WWTP, is appropriate.

2.3.2 Conduct Training on How to Reuse the Sewage Sludge and Support the Exchange of Opinions between the Ministry of Agriculture and the Project Implementing Agency. (Activity 3-2)

The Water and Wastewater Department of the Jericho Municipality and the TeCSOM team explained to the Ministry of Agriculture the reuse options of the dried sludge produced by the Jericho WWTP, the possibility of using the treated sludge as a soil conditioner based on the heavy metal and compositional analyses, and a planned pilot plant on the Jericho Municipality site i

n this Activity 3-2.

Jericho Municipality held workshops for treated wastewater users and the palm farmers on the reuse of treated wastewater and treated sewage sludge, and achieved compliance with the Palatine standards for heavy metal content and effectiveness for reuse as a soil conditioner.

For the time being, the reuse of the treated sewage sludge as a soil conditioner is continued at the pilot plants managed by Jericho Municipality.

a) Activities

1) Study of dried sludge reuse

- Regarding the use of sewage sludge, users are concerned about the moisture content and filthiness. However, as long as the sludge is in good dry condition or has been treated with chemicals, there is no problem. This can be said not only for human waste, but also for animal waste.
- The latest version of the Ministry of Agriculture's standards for the use of sewage sludge fertilizer was obtained via the JICA Palestine office, and the standards for heavy metal content were confirmed. These standard values have not been changed since the TeCSOM-I.
- It has been confirmed that there is no industrial sewerage discharge in the water supply area in the waterworks of Jericho City, and the possibility of factory wastewater inflow is low. However, the heavy metal contents of the dried sludge were investigated to ensure safety. (Refer to Activity 3-1)
- The Director of the Water Supply and Wastewater Department considered that it is appropriate to follow the same procedure for promoting the reuse of sewage sludge as for the reuse of treated wastewater, and suggested that a pilot plant inside and outside the plant should be used for verification experiments. The expert team used its experience in the sale of treated wastewater for reuse and the survey procedure is illustrated in Figure 2.3.4.

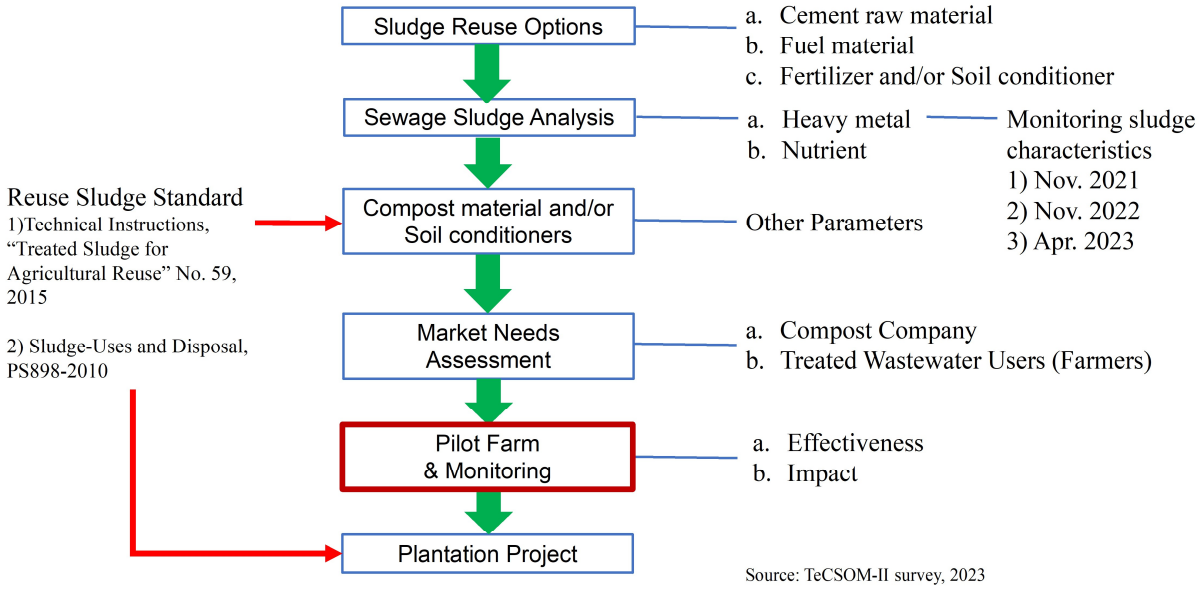


Figure 2.3.4 Study on Treated Sludge Reuse

- Use restrictions for sewage sludge were identified from the Palestine Standard (PS). The restrictions on the sludge reuse are as follows.

Table 2.3.3 Restrictions on Sewage Sludge Reuse

Palestine Standard	Reuse Conditions/Restrictions
Technical Instructions, "Treated Sludge for Agricultural Reuse" No. 59, 2015[1)]	1) Prevent reuse of treated sludge a. Grassland or fodder crops b. Fruits and vegetables, but except a fruit tree c. Direct contact with soil
Sludge-Uses and Disposal, PS898-2010[2)]	1) Not permitted to use Treated sludge a. Vegetables b. Park, home gardens, green spaces near public sites (not less than 250 m) c. Root crops (radish, potatoes) 2) Treated sludge package for sale purpose d. Approval of the competent regulatory authorities is required.

1): Refer to Appendix 2.3.4.
2): Refer to Appendix 2.3.5.

- An-Najah National University's advice on the effective use of sewage sludge has to do with the following: i) soil conditioner and ii) raw material for compost (mix with other fertilizers). Regarding ii), sewage sludge is not suitable for use as a fertilizer by itself due to its low phosphorus and potassium content. The Ministry of Agriculture expressed disapproval of the utilization of dried sludge of which a quality control is not possible. The details are shown on the following chapter 2) Discussions with the Ministry of Agriculture

2) Discussions with the Ministry of Agriculture

- The TeCSOM team visited PWA and the Ministry of Agriculture to explain the plan to reuse the sewage sludge (dried sludge) generated from the Jericho WWTP as fertilizer and/or soil conditioner. Both parties expressed the view that there is no problem in reusing the sludge as a soil conditioner since there is no factory wastewater in Jericho city (except JAIP) and the moisture content of the sludge is low.

- The Director of the Ministry of Agriculture is concerned about the large amount of sewage sludge that will be generated in Palestine in the future, and hopes to reuse it and share the experience of this Project.

- The experts discussed the re-use of sludge with the Ministry of Agriculture on 8 September 2022. The main reuse options of dried sludge are 1) fertilizer/soil conditioner, 2) cement raw material and 3) fuel for incineration. Options 2 and 3 were not adopted due to lack of cement plants and incineration facilities in Palestine/West Bank.

- The results of the compositional analysis of lemons in the pilot plant at TeCSOM-I were shared with the Ministry of Agriculture. It was explained that no significant differences were found in the composition of fruit grown in water supply and treated wastewater.

- The Palestine Standard (PS) states that soil conditioner or compost should use organic matter of animal or plant origin and prohibits the use of sludge of human waste origin. While, PS 59-2015 states that sewage sludge must be treated before it can be reused as a soil conditioner. The Ministry of Agriculture's position on the reuse of sludge in Jericho is that dried sludge can be reused, since the Jericho WWTP carries out the sludge treatment process of thickening the excess sludge and then drying out the sludge under the sun.

- The treatment and disposal of sewage sludge is becoming a problem in other cities. It is being considered to bring the sludge to Jericho, where the climate allows solar drying sludge treatment, but the following three problems need to be solved: 1) Jericho Municipality must accept sludge from other cities; 2) a storage site for the sludge must be secured; and 3) the sewage sludge must be reused (otherwise the sludge will accumulate and the storage site will become a disposal site).

- On 4 March 2023, discussions were held with the Director of the Ramallah Branch of the Ministry of Agriculture regarding the reuse of treated sewage sludge. It was found that the Arab Development Society located in Jericho has machinery for composting, but the equipment is outdated and is currently not in use. The results of the compositional analysis of the dried sludge generated from the Jericho WWTP (November 2021 and November 2022) noted the following: 1) organic matter, nitrogen content and moisture content are good; 2) approximately 1.1 m^3/1000 m^2 is appropriate for the amount applied as a soil conditioner.

- The sludge reuse plan was discussed with the Ministry of Agriculture on 13 March 2023. Using presentation materials, the Director of the Water and Wastewater Department explained the

characteristics of the dried sludge being treated at the Jericho WWTP and the policy for its reuse as a soil conditioner. Meanwhile, sludge composition analyses results showed that the content of nitrogen, phosphorus and potassium was 10 to 40 times higher than that of ordinary soil (Samed Land owned by Jericho Municipality), indicating the effectiveness of dried sludge as a soil improvement material. The explanatory material is shown in Appendix 2.3.1.

- The Ministry of Agriculture commented that: 1) the heavy metal content and moisture content, etc., meet the standard values; 2) the use of dried sludge as a soil amendment is agreed; and 3) the reuse of treated sludge in the pilot plant in the WWTP and in the city-owned Samed Land is approved.
- However, the Ministry of Agriculture was reluctant to allow the distribution of dried sludge to ordinary farmers. The reasons for this are as follows:
  - Treated sewage sludge should be used under conditions that can be monitored and controlled for the time being. The use of dried sludge where it cannot be controlled is not permitted.
  - When treated dried sludge is distributed, regardless of whether it is distributed free of charge, the sludge composition must be verified by the Ministry of Economy.
  - When treated sludge is reused as a soil conditioner, soil composition and plant growth are monitored in the pilot plants for a period of at least three years.
- The Director of the Water and Wastewater Department intends to continue with the test plots and to use them as soil conditioners for afforestation within the WWTP.

3) Discussion with fertilizer companies

- The TeCSOM team visited two fertilizer companies in Jericho to find out how to reuse the treated sludge, and conducted an interview survey in October 2021. The results of the survey are shown below.

Table 2.3.4 Interview Results

	Company A	Company B
1.Price	54 NIS/m^3	7.15 NIS/25L Israeli-made fertilizers are on the market at 4.6-6.0 NIS/25L, and struggling in terms of price.
2.Purchase	Removal by truck	Purchaser visits in Jericho city. Delivery service is available outside of Jericho.
3. Availability of licenses for sale	No license	Licensed. In Palestinian university, fertilizers are tested for heavy metal content according to Ministry of Agriculture standards.
4. Guaranteed composition as a fertilizer	None in particular	Display (disclosure) component analysis of fertilizer
5. Advertising for sale	None in particular	Introduced on the company's website Display products at the Ministry of Agriculture
6. Customer complaints	None in particular	Israeli products are cheaper (but according to the company, the quality is inferior).

7. Sales considerations	None in particular	Explain quality guarantee, correct use as fertilizer, benefits to farmers

TeCSOM-II Survey Results, 2023

- The main business of Company A is dairy farming (dairy cows), and as a side business Company A sells cow dung as compost. Company B is mainly selling fertilizer and dates. Company B is considering withdrawing from fertilizer sales due to the low prices of Israeli products. Comparing the two companies, Company B is more focused on fertilizer quality and sales. Additional interviews were conducted to identify possibilities for collaboration with Jericho Municipality.
- The TeCSOM team visited Company B and interviewed them again on December 5, 2021, about the fertilizer market in Palestine. The information obtained from the interview was as follows.
  - Israeli-made fertilizers are coming into the market and are cheaper by 1.1-2.5 NIS per pack (25 L), which has slowed down sales of Company B's products.
  - Israeli-made products are distributed within Palestine, but Palestinian-made products are not allowed to be sold to Israel (Paris Protocol 1994).
  - Company B's fertilizer is 40% animal compost and the rest is made from plant leaves.
  - If the content of heavy metals in the dried sludge is less than the standard value and it is shown to be safe, can it be used as part of fertilizer? The TeCSOM team asked if it would be possible to reduce the price by mixing dried sludge. Company B responded as follows: (1) It is a good idea, but the company has stopped production of fertilizer; (2) It needs to ask for the decision of the company's higher management to resume production and mix the sludge.
- The TeCSOM team visited a fertilizer company, Company B, located near the Jericho WWTP, to discuss the reuse of sewage sludge with the company manager and engineer on 29 May 2022.
  - At the previous company visit in October 2021, the company was considering withdrawing from fertilizer sales. At the last visit in May 2022, when the TeCSOM team reconfirmed fertilizer sales, it was found that the company accepts individual orders and manufactures and sells fertilizers on an order basis. At present, the company is not withdrawing from the market.
- Discussions have been held with the date production and fertilizer manufacturing company in Jericho regarding the use of sewage sludge. However, the company representatives have decided not to utilize sewage sludge for the following reasons: 1) the demand for their products is declining due to the entry of low-cost Israeli products; 2) Concerned that the use of treated sludge will create a negative image among date buyers and that the company's own dates will be avoided.

4) Discussions with cooperative farm owners

- In promoting the reuse of sewage sludge, the procedure for implementing the ~~successful~~ reuse of treated wastewater was reviewed. An important ~~critical~~ point in the procedure was to accumulate

water quality data and present the results of safety and effectiveness verification to the stakeholders and obtain agreement. (Refer to Figure 2.1.4.)

- Five of the nine farm owners who use treated wastewater were interviewed to follow up on their use. The farmers were interviewed about: 1) the amount of water used annually; 2) whether the farmer needs more water; 3) the type of crops; 4) the area covered; 5) direct use or mixed with groundwater; 6) plans to expand farmland; and 7) what fertilizers are used. (Refer to Table 2.1.1.)

- All farm owners use treated wastewater to irrigate palm farms and need more water. Respondents would be willing to buy treated wastewater supplies if it is available. The fertilizers currently used are organic fertilizers from cattle manure and chemical fertilizers (potassium and ammonia).

- The TeCSOM team selected cooperative farmers from among eight farmers using treated wastewater and approached them for the treated sewage sludge reuse as a soil conditioner. As a result, one cooperative farmer has agreed on using it as a pilot farm in his palm fields.

- However, the implementation of the pilot farm with a cooperative farmer was cancelled by a Jericho Municipality decision. The TeCSOM team visited the cooperative farmer, who was scheduled to provide the pilot farm, and informed the farmer of the Municipality's intentions and obtained his understanding. The team asked for his opinion on what problems there would be in using sewage sludge as a soil conditioner. If –for any reason - the size, shape, color, and yield of dates were to deteriorate, the view is that producers and purchasers/consumers would link dates deterioration to the effects of sewage sludge, even if there is no causal link to sewage sludge. These opinions are very helpful and provided significant hints for the dissemination of the reuse of sewage sludge.

  - The following measures are considered necessary to address this concern: 1) continue the demonstration for at least three years; 2) target seedlings rather than mature trees from which dates will be harvested.
  - The amount of commercial fertilizer applied is approximately 100 L per date tree each year. This information should be used as a reference for the reuse of soil conditioners.

5) Experimental farm led by Jericho Municipality

- The implementation of the pilot farm with a cooperative farmer was cancelled by a Jericho Municipality decision. Instead, it was decided that Samed Land (approximately 2,000 m^2) owned by the Jericho Municipality should be used as a pilot. This policy change was due to the Mayor's insistence that the Municipality be responsible for and lead the monitoring and management of the experimental farm. Samed Land was a candidate from TeCSOM-I, but the decision was made just when the pilot was unable to make progress and had to abandon the pilot.

[The 1st Workshop on Reuse of Treated Wastewater and Sewage Sludge]

- A workshop on the reuse of treated wastewater and treated sewage sludge was held on 6 December 2022 after the 3rd JCC. Topics discussed at the workshop included WWTP operation and maintenance, water quality management and reuse of treated wastewater and sewage sludge. The workshop was mainly aimed at users of treated wastewater, but only two of the nine invited farm owners attended. The subject matter should have been more interesting.

  i) Water quality management

  - To improve the reliability of water quality management, not only treated wastewater but influent sewage and sewage in reaction tanks should also be monitored.

  ii) Reuse of treated wastewater

  - The participating farm owners commented on treated wastewater as follows: (i) lower selling prices during off-season/low water demand periods would increase the amount of water purchased; and (ii) there was a strange odor, albeit a temporary occurrence, from the treated wastewater purchased.

  - Regarding (i), it is worth considering. Regarding (ii), it is very valuable to receive direct feedback from the users. Suppliers are often unaware of the opinion because the Jericho Municipality focuses on water quality compliance and usage ratio. In reaction to this opinion, the Jericho Municipality has cleansed irrigation Tanks. (Refer to Activity 1-1)

  iii) Reuse of sewage Sludge

  - The presentation included dates harvested at the pilot plant. The effectiveness of sewage sludge can be demonstrated not only by showing the heavy metal content and nutrient (nitrogen, phosphorus and potassium) composition, but also by showing the actual harvested dates. At the workshop, dried sludge was brought along to show the farm owners how odorless it is and how easy it is to handle.

[The 2nd Workshops on the Reuse of Treated Wastewater and Treated Sewage Sludge]

- A workshop on the reuse of treated wastewater and treated sewage sludge was held at the Palm Farmers' Cooperation Association (PFCA) on 7 June 2023. The total number of participants was 25 (PWA: 1, Ministry of Agriculture: 2, PFCA: 12, Jericho Municipality: 6, TeCSOM team: 4). The previous workshop (held on 6 December 2022) was held in the Jericho Municipality conference room and was attended by only two farmers (users of treated wastewater), whereas this time, with the PFCA as the venue, there was more participation from the farmers' side. The presentation materials are shown in Appendix 2.3.2.

- The following matters were explained by the C/Ps in the workshop. The language of the

explanations was Arabic.

- Reuse of treated wastewater
- Reuse of treated sewage sludge
- Water quality management

- Prior to the workshop, the PFCA chairperson had been skeptical about the effectiveness of the treated wastewater reuse, despite the fact that it has been used for more than eight years. There was also unacceptance to reuse treated sewage sludge as a soil conditioner. However, after the workshop, the chairperson and participants expressed understanding of the reuse of treated wastewater and sewage sludge (dried sludge) and hoped that treated wastewater could be used as a source of irrigation water. The chairperson expressed the view that treated sewage sludge could be mixed with the topsoil in the field (approximately 1.5 m deep) as a soil conditioner, which would mitigate the salinity of the soil.

- In addition, the following comments were made:

  - Establishment of a liaison network between the PFCA and Jericho Municipality to share information on treated wastewater and treated sewage sludge;
  - Construction of central irrigation water distribution facilities within the Jericho WWTP to facilitate water distribution. Elimination of individual pumps;
  - The PFCA distributes groundwater at 0.9 NIS/m^3 including electricity. Jericho Municipality is requested to maintain 0.6 NIS/m^3 (treated wastewater: 0.5 NIS/m^3, electricity: approx. 0.1 NIS/m^3);
  - The pilot plants will have a monitoring period of at least three years; (Ministry of Agriculture)
  - Several treated wastewater users expressed the hope that the water supply would be increased in the future, since treated wastewater is a valuable source of water.

6) Interviews with palm farm owner

- Since palms are one of the target plants for the treated sludge reuse, the farm owner was interviewed about the cultivation of dates.

  i) Palm date seedlings can be taken from mature trees or purchased from nursery fields. When taking from mature trees, the survival ratio of seedlings is approximately 80%, with 20% failing to thrive and dying, a ratio similar to that in the pilot plant on site (approximately 30% died).

  ii) Palm dates take approximately 4 years from seedlings to bear fruit and require pollination. Pollination takes place in February-March.

  iii) Mature date trees require approximately 100 m^3/vine/year of water. Seasonal water demand is approximately 50% due to cooler temperatures and rainfall in November-February after harvest, 100% until August just before harvest, and decreases to 40% in September-October at harvest. This variation in water demand almost corresponds to the amount of treated wastewater delivered from the WWTP.

  iv) Removal (washing) of salts accumulated on the soil surface was proposed due to the surplus

of treated wastewater during the period of reduced water demand for dates (November-February). The farmer suggested that two problems could occur: 1) large amounts of weeds would grow near the watering area; and 2) even if the soil surface could be temporarily cleaned, salts would again be accumulated on the soil if there was no drainage system. The farmer, who is considering expanding his date fields, indicated that he would be willing to purchase water throughout the year if the Jericho Municipality would guarantee the distribution of 500 m^3 of water per day.

This was valuable information and helped to consider the cultivation of dates and the use of surplus water.

b) Achievements

1) Reuse treated sludge as a soil conditioner

- In order to examine the possibility of reusing sewage sludge for building materials and energy, the TeCSOM team confirmed cement plants and incineration facilities in Jericho and its suburbs, but none of these facilities is located in the West Bank in Palestine. All waste in the West Bank is disposed of in landfills. On the other hand, it was confirmed that there are three cement factories in Israel.

- Although there are many issues to be solved to transport the dried sludge from the Jericho WWTP to the cement plants in Israel, the TeCSOM team estimated the demand based on the cement production capacity and the dried sludge supply. As a result, it was found that the demand for dried sludge as a raw material for cement is expected to be approximately 44 times the amount of dried sludge generated from the Jericho WWTP. However, the reuse for the raw material for the cement was rejected due to its low feasibility.

- The dried sludge can be utilized as a soil conditioner for the reasons that 1) heavy metal content is lower than standards, 2) Nitrogen content is higher than the general soil (at Samed Land) and that 3) handling will be easier due to its low moisture of approximately 10%.

2) Operation of on-site experimental farm

- The pilot plant (on-site experimental farm) located in the Jericho WWTP has been re-established and started to operate using sewage sludge as soil conditioner (December 16, 2021). The pilot plant was divided into two groups: commercial fertilizer and sewage sludge, and a verification experiment were conducted to observe whether there is any difference in the growth of plants. The target plants were palm trees, lemons, and oranges, as in TeCSOM-I (which have continued to grow since TeCSOM-I).

Photo 2.3.7 Pilot Plant (1)

Photo 2.3.8 Pilot Plant (2)

- Discussions were held with the An Najah National University on the reuse of sewage sludge as fertilizer. Sewage dried sludge by itself does not contain enough phosphorus, nitrogen and potassium to be used as fertilizer. Therefore, it is appropriate to use it as compost material or soil conditioner.
- Mixing with commercial fertilizers at: dried sludge = 1:1 to 1:3 is considered appropriate.
- The opinion of the An-Najah National University professor is that the first analysis of sewage sludge (dried sludge) shows that it is not suitable for fertilizer due to its low phosphorus and potassium content (<2%). When dry sludge (with a moisture content of approximately 10%) is reused as a composting material or soil conditioner, it is dry and needs to be watered.
- Following this decision, the Water and Wastewater Department, the Garden Division, and the TeCSOM team worked together to develop the pilot farm (Samed Land). Samed Land has an area of approximately 2,000 m^2 and consists of 2 date and 17 lemon/citrus trees.
- Jericho Municipality will continue to cooperate with An-Najah National University to conduct water quality measurements and heavy metal content and composition analysis of the dried sludge. Therefore, it is important to secure a budget for the analysis. At the 4th JCC held on 22 June 2023, Jericho Municipality agreed to secure the budget for the analysis.

Photo 2.3.9 Location Map of Samed Land

Photo 2.3.10 Before Cleaning (Feb. 2023)

Photo 2.3.11 After Cleaning (Feb. 2023)

- Dried sludge has been used as a soil conditioner in Samed Land. The soil characteristics were measured before (November 2022) and after (April 2023) the use of dried sludge. The results are demonstrated in Table 2.3.5.
- It can be seen that sludge being applied to the soil resulted in an almost doubling of organic content and moisture, a 10-fold increase in N, and therefore a decrease in the C/N ratio. While P and K levels did not change significantly between 2022 (before application of the sludge) and in 2023 (after), both were not abundant in the sludge shown in Table 2.3.5, and so were not varied in the soil.

Table 2.3.5 Results of Soil from Samed Land, November 2022, and April 2023

No.	Parameter	Unit	Results Nov. 2022	Results Apr. 2023
1	Nitrogen (N)	mg/kg	850	8600
2	P as P_2O_5	mg/kg	22.6	22.5
3	K as K_2O	mg/kg	32.5	19.6
4	pH	-	7.26	7.2
5	EC	dS/m	1.32	1.065
6	Moisture content	%	9.4	16.5
7	Total Fecal Coliform	CFU/100 ml	Nil	Nil
8	Total Organic Matter (TOM)	%	8.43	13.56
9	C/N	-	99.2	15.86

TeCSOM-II Survey Results, 2023

3) Plantation planning in the WWTP

- One of the visions of the Jericho Municipality is to become a 'green city', and the 2023 Jericho Municipal Budget allocates 20,000 NIS for afforestation (greening) of WWTP sites. In discussions with the Mayor of Jericho, it was agreed to reuse treated wastewater for irrigation and treated sewage sludge as a soil conditioner for this greening, and to make the WWTP site the city's publicity area.

- A plan was developed to grow plants in the WWTP reusing treated wastewater and treated sewage sludge. The plantation plan has the following backgrounds.

  i) The Jericho Municipality has set the Green City as one of the visions of the Jericho Strategic Four-Year Plan, with a budget of 20,000 NIS.

  ii) The Ministry of Agriculture has not approved the distribution of treated sewage sludge (dried sludge) to general farmers at this time, although it is approved as effective for reuse as a soil conditioner. The Ministry of Agriculture is cautious about this. Therefore, a large-scale pilot will be set up at the Jericho WWTP and the treated wastewater and dried sludge will be reused to grow Jericho's specialty plants, using the budget of the Jericho Municipality.

  iii) Direct distribution of dried sludge outside the WWTP is difficult, but the sludge can be used indirectly by distributing produce (date saplings, flowers), making it safer and more effective. This insight was gained during the interviews with the palm farmers. Application to palm saplings and ornament plants is considered feasible, as the treated sludge does not directly affect on the products, or rather the concern of the users is removed by this approach.

  iv) The plantation uses the space next to the administration building and is easily visible from the meeting room, so that it can appeal to visitors at the WWTP, including donors, as part of a recycling-oriented society formulation. The proximity to the irrigation tank also makes irrigation easier.

  v) Target plants shall be popular trees in Jericho, such as Jericho rose, olives, seedling dates and Paulownia.

- The plantation plan has been agreed by the Jericho Mayor, and this time a more concrete plan was presented to the Jericho Municipal Council on 16 May 2023. After discussions, the municipal council members agreed to launch the plantation plan. The municipal council showed a high level of interest in the plan and increased the budget from 20,000 NIS to 50,000 NIS (approximately 2

million yen). The explanatory material is presented in Appendix 2.3.3.

- Following approval by the municipal council, a meeting of plantation plan stakeholders (comprising two municipal councilors, the director of the Health and Environment Department, the director of the Water and Wastewater Department and the TeCSOM team) was held.
- The vegetation was composed of 50 Paulownia, 15 date and 15 olive trees. The Jericho rose was withheld due to lack of easy access to seedlings.
- It was agreed that the plantations would use treated wastewater and dried sludge. The target area (approximately 7,000 m^2) was cultivated from 27 May 2023, and vegetation and irrigation pumps/pipes were subsequently prepared. The location and image of the plantation project are shown below. The photos 2.3.13 and 2.3.14 were captured on 5 July 2023.

Photo 2.3.12 Plantation Project Location

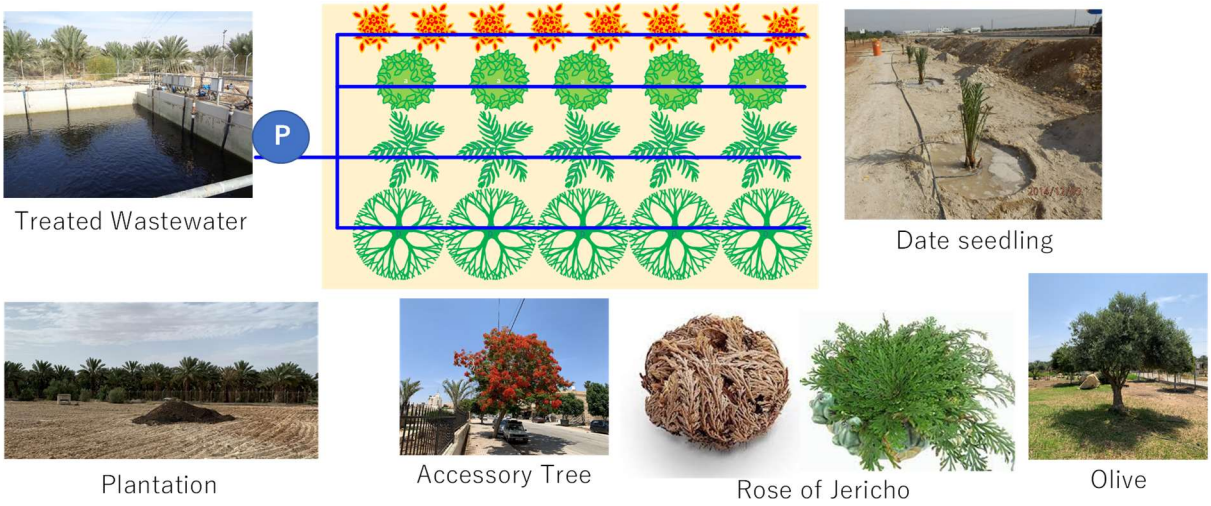


Figure 2.3.5 Image of the Plantation Project

Photo 2.3.13 Preparing Plantation (1)

Photo 2.3.14 Preparing Plantation (2)

Chapter 3 Terminal Self-evaluation of the Technical Assistance Project and Recommendations

3.1 Terminal Self-evaluation of the Project

This section evaluated the Project in terms of six evaluation criteria (relevance, coherence, effectiveness, efficiency, impact and sustainability) based on the Project inputs, activities, objectives and implementation arrangements.

Table 3.1 Perspectives on the Six Evaluation Criteria

Criteria	Perspectives of Evaluation
Relevance	Was the Project objective/purpose consistent with ・ Development policies of Palestine? ・ Development needs of target groups/beneficiaries? ・ Japan's ODA policy for recipient country?
Coherence	Was the Project consistent with ・ Interventions by the same organization/government? ・ Synergies and interlinkages of other interventions? ・ International norms and standards followed by the organization/government?
Effectiveness	・ Was the Project purpose achieved? ・ What were the major factors influencing achievement or non-achievement of the Project purpose? ・ Were the outputs produced by the Project contribute to the achievement of the Project purpose?
Efficiency	・ Were the outputs produced by using inputs resources efficiently?
Impact	・ Will the overall goal be achieved? ・ What are the positive and negative changes as a result of the Project (expected and unexpected effects)?
Sustainability	Are the effects of the Project likely to continue in terms of the following aspects? ・ Are there any policies to endorse activities to sustain project effects? ・ Are these necessary organizational arrangements? ・ Do the staff have adequate skills/knowledge? ・ Are the budgets sufficiently allocated for activities to sustain project effects?

(1) Relevance

The relevance of the Project is rated high since it remains consistent with the Palestinian sewerage project development policy, the Jericho Municipality's needs for support and Japanese ODA policy.

1) Development policy of the Palestinian Authority

"The National Policy Agenda of the Palestinian Authority (2017-22)" identifies the management and treatment of sewage and the expansion of its reuse as a priority. In its "National Water and Wastewater Policy and Strategy for Palestine (2013)", the Palestinian Water Authority (PWA) advocates 1) prevention of environmental pollution by sewage; 2) promotion of sewage system development; 3) agricultural use of treated wastewater as a new water source; and 4) proper sludge treatment and disposal.

2) Counterpart needs

Jericho Municipality is obliged to promote the development of sewerage facilities, control the quality of treated wastewater, collect sewerage fees and manage human and financial resources to keep the sewerage facilities in good condition. Jericho Municipality is developing a strategic four-year plan, with one of its visions being the creation of a recycling-oriented society. Specifically, Jericho Municipality aims to reduce Carbon dioxide (CO_2) emissions by installing solar power facilities (SDG target 7), reuse treated wastewater as a new water source in the face of limited water sources (SDG target 6), and promote plant growth by reusing treated sewage sludge as a soil conditioner (SDG target 2).

3) Japan's ODA policy

The Government of Japan has stated in its 'Corridors of Peace and Prosperity' initiative that it strengthens the economic and social infrastructure of the Jordan Valley. The Jericho WWTP plays a major role in the initiative and is a basic infrastructure for the socio-economic development of the region as a whole. The Project, which contributes in terms of improving sewerage management capacity and strengthening the financial base, is also consistent with Japan's ODA policy.

(2) Coherence

The coherence of the Project is rated high since the policy and donor support aims to promote sewerage development projects and increase sewerage coverage.

The aforementioned development policies of the Palestinian Authority, the needs of its counterparts and Japan's ODA policy are consistent with the objective of this Project. With donor support, JICA developed the WWTP and sewers (29.5 km in length) in 2014 and USAID constructed sewers (29.2 km in length) in 2018. In addition to the sewers, sewer house connections (Pilot Project) were installed with the support of JICA and PWA and increased connections to the sewerage system.

A survey and design were carried out by USAID to support the development of sewers in 2023. The design will include construction of approximately 30 km of sewers as well as sewer house connections. Once completed, the USAID project will contribute to a further increase in sewerage coverage.

(3) Effectiveness

The effectiveness of this Project is rated high.

1) Prospects for achieving the project purpose

All outputs have been achieved, and the Project purpose "A Sustainable Wastewater Management System is established in Jericho Municipality" is mostly achieved since ten activities were implemented to achieve three outputs.

2) Contributing factors for achieving the project purpose

Jericho Municipality has contributed to the effectiveness of the Project not only through the Water and Wastewater Department, which directly manages and supervises the sewage works, but also through information sharing and collaboration with the other departments, including the Finance Department, which carries out water and wastewater fee collection; the Public Relations Department, which publicizes activities and guides visitors to the WWTP; the Legal unit, which manages departmental functions and legal responsibilities; the Health and Environment Department, which manages pilot plants including Samed Land and carries out the plantation project.

3) Communication and ownership of the counterparts

Strong commitment and ownership on the part of Jericho Municipality was confirmed. Jericho Municipality has performed the following activities:

i) Establishment of a 'Special Account' to secure funding for the construction of a sewer house connection;

ii) Employment of a new water quality laboratory technician;

iii) Recruitment of a mechanical and electrical engineer/technician (budgeted for, but resulted in no applicants);

iv) Securing a budget to purchase reagents for water quality testing;

v) Specific financial resources for profits from sale of treated wastewater (outsourcing costs of WWTP maintenance);

vi) Promotion of integrated collection of water and sewerage fees;

vii) Promotion of prepaid water meter installation;

viii) Regulations for suspending water supply due to unpaid water bills;

ix) Collection of debt amounts of water supply fees from government institutions;

x) Securing financial resources through increased water tariffs for commercial users and villas;

xi) Implementation of pilot plots for reuse of treated wastewater and treated sewage sludge and budgetary measures.

The counterparts became aware of the importance of allocating and executing the necessary budget by reporting to the Jericho Mayor and the Council members through weekly meetings and the JCCs.

4) Impediment factors to achieving project purpose

The Project was trying to establish a cooperative relationship with An-Najah National University (resident in Nablus) on water quality analysis and sludge composition analysis. However, since the security situation became unstable, traffic has been restricted and opportunities for close interaction between the project side and the university side have been drastically reduced.

(4) Efficiency

The efficiency of the Project is rated relatively high.

a) Inputs

1) Japanese side

i) Experts

A total number of 3 experts (for 19.47 man-months in total) were fielded from the Project commencement through the completion (28 July 2023). The table below shows the number of experts and their inputs.

Table 3.2 Japanese Experts

Field	Number	Man-month
Chief Advisor/ Sewerage Management	1	10.77
Water Quality Management	1	6.5
Sewage Sludge Management	1	2.2

Due to the rapid increase in the number of Coronavirus cases in Israel from November 2021 to around March 2022, international travel restrictions were imposed on foreign nationals and mobilization of some experts was postponed.

ii) Equipment provided by Japan

Equipment provided by Japan included printers, water testing reagents and air purifiers.

2) Palestine side

i) Counterparts

A total number of 18 staff members were assigned from the departments/sections associated with the Jericho Municipality.

ii) Land and Facilities

Project office space was provided in Jericho Municipality by the Palestine side, included in utilities.

b) Joint Coordinating Committee (JCC)

The JCC was held every six months.
1st JCC held in December 2021
2nd JCC held in June 2022
3rd JCC held in December 2022
4th JCC held in June 2023

c) Weekly meeting

The relevant departments/sections of Jericho Municipality and the TeCSOM team held Weekly Meetings, in principle once a week, to review Project issues, measures and progress. Forty-nine (49) Weekly Meetings were held during the Project period. Minutes/memos of each meeting were prepared and distributed to the relevant parties to inform them of the proceedings.

d) Other meetings

Discussions and workshops were held with PWA, Ministry of Agriculture and relevant agencies. During the Project period, 76 meetings were held. Minutes/memos of each meeting were prepared and distributed to the relevant parties to inform them of the proceedings.

Communication and information sharing between the counterparts and the TeCSOM team has been adequate through the holding of JCC, weekly and other meetings and by circulating minutes/memos.

e) Ownership of the Project

As mentioned above, ownership by Jericho Municipality was observed with each commitment. Regular reporting of Project issues and initiatives by the TeCSOM team at weekly meetings, mayoral interviews and the JCC helped the counterparts to recognize the importance of allocating and executing the necessary budget. Regular and close communication between the TeCSOM team and the counterparts also contributed to the effectiveness of the Project.

(5) Impact

The impact is rated relatively high, considering the prospect for achieving the Overall Goal and other impacts.

1) Prospect for achieving the overall goal

The prospect to achieve the overall gal is rated moderate.

Nine (9) Key Performance Indicators (KPIs) were set in the Project to assess sewerage services

management. Although some progress has been made, including improvements in KPI values, the counterparts needs to continue monitoring sewerage management and implementing improvement measures against KPI values. The counterparts' regular reporting to the PWA of activities and improvements in sewerage services management, the PWA's participation in the JCC, which has resulted in a high evaluation of Jericho Municipality's commitments to sewerage services management, and the PWA's decision that it was worthy of additional investments, led to recommendations to other donors, in particular the EU.

The counterparts should report on the treated sludge reuse initiatives and progress to the Ministry of Agriculture, the Ministry of Economy and local agricultural associations to strengthen cooperation, which would contribute to the promotion of treated sludge reuse.

2) Other impacts

Other impacts include visitors from outside Jericho visiting the Jericho WWTP. The objectives of the visit were: 1) a visit to the Jericho WWTP; 2) a school social studies visit; 3) learning about the WWTP operation and maintenance; 4) dealing with treated wastewater discharges and sewage sludge generation in the surrounding environment; and 5) initiatives for reuse of treated wastewater and sludge. The Public Relations Department of Jericho Municipality has disseminated its activities on its website/social networking site, and positive impact was observed as a good practice.

No negative impacts have been identified.

(6) Sustainability

The sustainability of the Project is rated relatively high.

1) Policy aspect

Jericho Municipality is formulating a strategic four-year plan, which will include the expansion of further sewers in the next four years and in the future. Jericho Municipality has a green city as one of its visions, and treated wastewater generated from the WWTP is continuously effectively reused for irrigation. The treated sewage sludge is targeted for reuse as a soil conditioner.

2) Technical aspect

In water quality management, the counterparts' water quality measurement skills and analytical and assessment capacities were improved during the project period. The WWTP is properly operated on the basis of accumulated water quality data. In the maintenance of the WWTP, attempts were made to recruit an engineer/technician but there were no applicants, and the policy was changed to outsourcing to cover the shortage of engineers and equipment repairs and procurements.

3) Financial aspect

To promote sewer connections, the Water and Wastewater Department has started to accumulate funds in a newly established Special Account in order to secure funds for construction of sewer house connections. Profits from sale of treated wastewater are used to secure outsourcing costs for the WWTP.

In the water supply services, Jericho Municipality is increasing water tariffs for commercial users and new buildings, eliminating zero-reading (replacement of water meters) and installing prepaid water meters to secure financial resources.

Increased connections to sewerage systems with a donor support and Jericho Municipality are expected to increase the amount of wastewater and treated wastewater. The increase in sewerage users and treated wastewater is expected to be financed by revenues from sewer connection fees, increased sewerage fees, increased profits from sale of treated wastewater, and reduced electricity costs from installation of a new solar power generation facility.

(7) Conclusion

The effectiveness of the Project is rated high because it has improved the capacity of counterparts in Jericho Municipality to manage sewerage services, and the Project targets are expected to be achieved. The Project relevance and coherence are rated high and the efficiency is relatively high. Impact is relatively high. The Project sustainability of the is relatively high, and could be further enhanced if financial resources are secured and appropriate facility maintenance is continued.

3.2 Recommendations

1) Regular reports on activities to relevant authorities

The counterparts regularly report to the PWA on the activities and achievements of the Jericho sewerage services management. It is recommended that the counterparts report on their efforts to promote the reuse of treated wastewater and treated sewage sludge through proper WWTP operation and maintenance and water quality management.

2) Continuation of water quality management and sludge composition measurements

The counterparts shall carry out regular water quality measurements and secure reagents, as well as analyzing the composition of the sludge, in particular the heavy metal contents. Water quality and heavy metal parameters that cannot be measured in the water quality laboratory should be outsourced and budgeted for. The measured data shall be used to demonstrate safety and to monitor the pilot plants (including the status of tree growth).

3) Publicity for sewerage project activities

It is recommended that the operational status of the WWTP, water quality data and sludge composition be disclosed on a regular basis on the Jericho Municipality's website. To inform the public of the activities of the sewerage services, the information is published on the website.

4) Sewage received from JAIP

In receiving sewage from the JAIP, which plays a central role in the Japanese Government's "Corridor for Peace and Prosperity", an appropriate system should be established in full coordination with the relevant authorities for monitoring water quality, including the O&M of the pre-treatment plant constructed by the ROJ support. It is expected that the Jericho WWTP shall start receiving sewage from the JAIP.

Outline of Joint Coordinating Committee: JCC

In the project, JCCs were held every six months, where counterparts explained the progress of the project, challenges and measures taken, etc. The following is an overview of the four JCCs held.

【1st JCC】

a) Activity

- The first JCC in support of the TeCSOM-II was held on 1 December 2021. The titles of presentations and presenters are as follows.

Table -1 1st JCC Agenda

	Title	Presenter
1	Outline of the Project	Eng. Mohammad Fityani, Head of Water & Wastewater Department
2	Outline of the Jericho Wastewater Treatment Plant (WWTP)	Eng. Omran Khalaf, Operator of Jericho WWTP
3	Current Status of Municipality Finance	Mr. Abdul Fattah Haddad, Head of Collection Management Section
4	Challenges & Schedule of TeCSOM-II	Satoru Oniki, Project Chief Advisor

- In preparing for the JCC, each presenter attended the JCC with a thorough understanding of the topics covered in the weekly meetings, and added their own PowerPoint presentations and explanations. The PowerPoint materials are shown in Appendix 4.1.

Photo -1 1st JCC

Photo -2 C/P's Presentation

b) Achievements

- After the JCC, the presentations and remarks were summarized in the Minutes of Meeting, and signed by the main participants. The Minutes of Meeting are attached in Appendix 4.2. The main contents are as follows.

1) Establishment of water quality monitoring system

i) Need for replenishment of personnel for water quality analysis

ii) Importance of monitoring wastewater quality from factories including JAIP

iii) Importance of monitoring treated wastewater quality since treated wastewater is sold to farmers

iv) Transfer of technology related to water quality management at TeCSOM-II, increase in the number of trainees, and strengthening of the water quality monitoring system

v) Possibility of sewage sludge reuse as a result of its compliance with agriculture standards

2) Preventive maintenance

i) Assign a mechanical and electrical technician at the WWTP

ii) Periodic maintenance and repairs

iii) Extend the lifespan of equipment

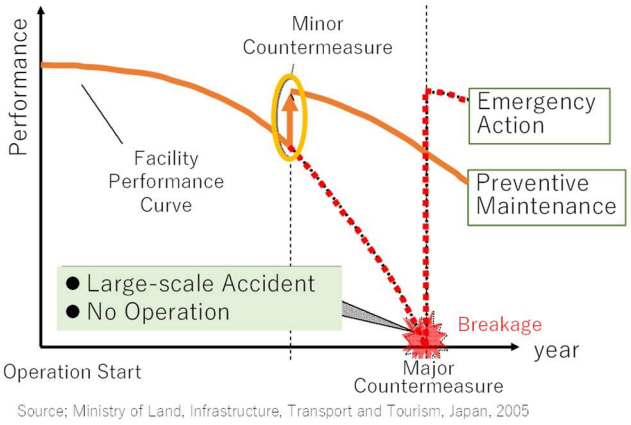


Figure -1 Conceptual Preventive Maintenance

3) Sound sewerage management

i) Collection of unpaid bills by introducing prepaid water meters

ii) Direct dialogue with ministries to collect fees from government buildings

iii) Focus on collection of unpaid fees and improvement of fee collection rate

iv) Donor support needed to expand sewer network and promote sewer house connections

v) Introduction of solar panels to reduce O&M costs

Photo -3 Solar Power Generation Facility

Photo -4 Generated Power Panel

4) PR materials for Jericho WWTP

i) Introduction of successful examples of Jericho sewerage project

ii) Explanations for visitors to the facility

The presentation materials used at the first JCC are shown in Appendix-3.

Photo -5 WWTP Visitors (1)

Photo -6 WWTP Visitors (2)

【2nd JCC】

a) Activity

・ The 2nd JCC was held on 21 June 2022. Activities and results were reported on the matters discussed at the 1st JCC held on 1 December 2021. This was the first JCC for the new Jericho Mayor (Mr. Abdul Karim Sidr, since April 2022). The titles and presenters are as follows. The PowerPoint materials are shown in Appendix 4.3.

Table -2 2nd JCC

	Title	Presenter
1	Project Progress	Eng. Mohammad Fityani, Head of Water & Wastewater Department
2	Outline of Jericho Wastewater Treatment Plant (WWTP)	Eng. Omran Khalaf, Operator of Jericho WWTP
3	Water Quality Management	Mr. Sobhi Yaghi, Water & Wastewater Department
4	Buildup of Sewer Database with GIS	Eng. Sarah Abu Sitteh, Planning & Project Department
5	Current Status of Municipality Finance	Mr. Abdul Fattah Haddad, Head of Collection Management Section
6	Challenges & Schedule of TeCSOM-II	Satoru Oniki, Project Chief Advisor

b) Achievements

・ After the JCC, the presentations and remarks were summarized in the Minutes of Meeting, and signed by the main participants. The Minutes of Meeting are attached in Appendix 4.4. The main contents are as follows.

・ The following four issues were discussed at the 1st JCC: i) Establish a water quality management system for the WWTP. For this purpose, Jericho Municipality increases the number of water quality laboratory technicians; ii) Implementation of Preventive Maintenance. Jericho Municipality increases the number of O&M technicians at the WWTP; iii) Collection of sewerage fees for sound management of sewerage services. Promote installation of prepaid water meters and collection of fees from unpaid customers, as well as collection of fees from government institutions; iv) Public Relations activities for sewerage services.

i) Establishment of a water quality management system

The Ministry of Local Government (MoLG) approved the FY2022 budget for Jericho Municipality to hire a water quality laboratory technician.
Jericho Municipality published a call for personnel in the local newspaper in June 2022 and received 19 applications as of June 28 before the deadline. In July, the application screening, examination (questions were prepared by PWA), and interview was conducted.

ii) Preventive maintenance

Jericho Municipality previously attempted to recruit a Maintenance Technician but received no application at that time. The Municipality was once again recruiting staff the technician

position. As one of the achievements, the Garden section in the municipality is dispatching a staff member daily to maintain the garden at the WWTP, where the trees are being cared for.

iii) Collection of sewerage fees

The collection ratio for water supply is 90% (2019) → 66% (2020) → 60% (2021), while the ratio for sewerage fee is 31% (2019) → 62% (2020) → 46% (2021). Therefore, Jericho Municipality makes efforts to improve the collection ratio.

iv) Public Relations

Jericho Municipality is focusing on public relations activities to interest donors and to help visitors to the WWTP understand the sewerage services of Jericho City. A tag for sewerage services in both English and Arabic has been placed on Jericho Municipality's website, and leaflets on sewerage services are posted on the website. Meetings and other activities are publicized through social networking sites.

New signboards have also been installed at the pilot plant in the WWTP to inform the public about the implementation of the experimental field.

Draft leaflets for children and water quality management implementation are under preparation and are being finalized in the Jericho Municipality.

v) Weekly meetings

The Jericho Municipality members and the TeCSOM team have held weekly meetings since the start of TeCSOM-II to share activities, achievements, and issues with the departments concerned and to advance the Project. After the meeting, the contents of the discussions are summarized in the minutes and distributed to the relevant members to remind them of the proceedings.

vi) TeCSOM presentation

The Chief Advisor organized the issues of TeCSOM-II as raised by each staff member and explained how these issues relate to each other. The main issues include the following seven items. i) Improvement of water and sewerage fee collection ratio; ii) Collection fees from unpaid customers; iii) Collection of sewerage connection fees and start of sewerage fee collection for Pilot Project 4 & 5; iv) Database for sewer networks; v) Public relations campaign to attract donors; vi) Water quality management to ensure treated wastewater quality; and vii) Study on sewage sludge reuse.

The presentation materials used at the second JCC are shown in Appendix-4.

The Japanese experts were away from Jericho from 1 July to 12 August 2022, during which time Jericho Municipality member worked with the TeCSOM engineer. Weekly meetings were held every two weeks to review progress and issues. The Japanese experts participated online.

vii) Jericho Mayor remarks

The Mayor promised to focus on i) increasing the fee collection ratio; ii) promoting sewer connections; and iii) public relations activities. The Mayor also announced that in discussions between the Mayor and the PWA minister on 20 June 2022, the PWA committed to provide pipe materials for water pipes and sewers. This support is a factor in promoting strong sewer development as pipe materials are procured.

viii) JCC minutes of meetings

The Minutes of Meetings for the 2nd JCC contained the following six points and was signed by all parties involved (JICA, Jericho Municipality, PWA, TeCSOM): i) Increase collection ratio of water and wastewater tariffs; ii) collect sewer connection fees for Pilot Project 4 & 5; iii) establish a database of sewer information; iv) conduct public relations to attract donors; v) implement water quality management; and vi) study sewage sludge reuse.

【3rd JCC】

a) Activity

・ The 3rd JCC was held on 6 December, 2022. A workshop on the reuse of treated wastewater and sewage sludge was also held on the same day. The titles and presenters are as follows. The PowerPoint materials are shown in Appendix 4.5.

Table -3 3rd JCC

	Title	Presenter
1	Project Progress	Eng. Mohammad Fityani, Head of Water & Wastewater Dept.
2	O&M of Jericho Wastewater Treatment Plant	Eng. Omran Khalaf, Operator of Jericho WWTP
3	Water Quality Management	Ms. Arwa Abusroor, Water & Wastewater Dept.
4	Buildup of Sewer Database with GIS	Ms. Shirad Alsafadi, Head of GIS Sec.
5	Current Status of Municipality Finance	Mr. Abdul Fattah Haddad, Head of Collection Management Sec.
6	Challenges & Schedule of TeCSOM-II	Satoru Oniki, Project Chief Advisor

b) Achievements

・ It was decided in the JCC that the remaining Project period (six months) would tackle the following. Specific details were compiled in the Minutes of the Meeting. The Minutes of Meeting are attached in Appendix 4.6. The main contents are as follows.

1) Improvement of water and sewerage fee collection ratios; 2) investment in sewerage projects with sewer connection fees; 3) visualization of sewerage service improvements through the Key Performance Indicators (KPIs); 4) integrated sewer information utilization; 5) budgetary control for sewerage services; and 6) study on sewage sludge reuse.

1) Jericho Municipality shall raise public awareness to the residents not only by adapting penalties and installing Pre-Paid Water Meters (PPWMs) to increase the water and sewerage fee collection ratios.

2) Jericho Municipality shall inform the residents that the sewer connection fees collected are invested in sewerage projects.

   i) As a first step, the Water and Wastewater Department shall reserve 20% of the sewer connection fees to the Special Account authorized for the sewerage projects such as sewer connection, equipment repair and depreciation;

   ii) Jericho Municipality tries to gain publicity through information dissemination that a part of fees is used to improve sewerage services.

3) Jericho Municipality shall use the KPIs to measure improvements in the sewerage management.

   i) Jericho Municipality shall accumulate data related to the sewerage sector and shall calculate the KPIs periodically;

   ii) The KPIs are shared with the sewerage stakeholders and shall be used to improve sewerage services.

4) Jericho Municipality shall use the sewer data integrated in the GIS (information of sewer

geographic locations) to promote or enhance sewer connections and development.

i) Jericho Municipality uses the information on the sewer locations to quickly determine whether a connection to the sewer is possible and to promote sewer connections. Information on sewer locations contributes to reducing the workload of staff by reducing the work required to check sites.

ii) Jericho Municipality uses the information on sewer locations to identify houses that can be connected to sewers and to encourage house connections to sewers.

iii) Jericho Municipality can develop a sewer network plan by selecting priority sewer construction routes based on the information on existing sewers and building locations.

5) Jericho Municipality shall estimate and secure a budget required for sewerage services such as reagents for water quality testing and equipment repairs.

i) Jericho Municipality develops an annual plan for water quality measurements and estimate the quantity of reagents required with appropriate specifications for regular water quality testing. Jericho Municipality conducts water quality tests, and discloses the water quality data measured.

ii) The Jericho Wastewater Treatment Plant has been in operation for nine (9) years and repairs to equipment have occurred. Jericho Municipality endeavors to prepare a budget for equipment repairs and renewal under proper operation and maintenance.

6) Jericho Municipality shall demonstrate not only safety but also effectiveness for the sewage sludge reuse.

i) Jericho Municipality has initiated an experimental farm of dried sludge reuse as a soil conditioner at the municipality owned Samed Land. Jericho Municipality analyzes and evaluate soils and disclose information to stakeholders.

【4th/Final JCC】

a) Activities

・ The 4th/Final JCC was held on 6 December, 2022. The titles and presenters are as follows. The PowerPoint materials are shown in Appendix 4.7.

Table -4 4th/Final JCC

	Title	Presenter
1	Project Activities and Achievements	Eng. Mohammad Fityani, Head of Water & Wastewater Department
2	Reuse of Treated Wastewater and WWTP O&M	Eng. Omran Khalaf, Operator of Jericho WWTP
3	Water Quality Management	Ms. Arwa Abusrour, Water & Wastewater Department
4	Sewer Data Integration with GIS	Ms. Shirad Alsafadi, Head of GIS Section
5	Sewer Planning	Eng. Mohammad Fityani, Head of Water & Wastewater Department
6	Project Evaluation & Recommendations of TeCSOM-II	Satoru Oniki, Project Chief Advisor

b) Achievements

・ In the final JCC, presentations were made on each of the activities and their achievements. The Minutes of Meeting are attached in Appendix 4.8.

1) Presentation of counterpart activities and achievements

・ The counterparts presented 10 activities from Activity 1-1 to Activity 3-2 and their respective achievements. In the JCC, the Overall Goal and Project Purpose were introduced at the beginning of the meeting.

Output-1: Sewerage planning capacity improvement on sewer extensions

Activity 1-1: Analysis of sewerage service management

- Evaluation of the Jericho Municipal Sewerage Services Management using nine KPIs. The sewerage coverage, treated wastewater re-use ratio, WWTP operation ratio and sewerage fee collection ratio are graphed for changes over time from 2015 to 2023. Explanation of the state of improvement and identification of problems.
- Explanation of the current measures to improve sewerage services, such as collecting unpaid bills, improving water and sewerage collection ratios, eliminating unbilled fees (proper billing), securing sources of revenues from fees and public awareness through public relations activities.

Activity 1-2: Forecast of the sewage inflow volume into the WWTP

- Nine years after the WWTP started operation in June 2014, the amount of sewage inflow has

increased by approximately tenfold, from approximately 250 m^3/day at the beginning to 2,437 m^3/day in August 2022.

- Forecast inflow of sewage into the WWTP up to 2026, by considering factors such as population growth, tourist population, development plans, water use, connections to sewers, etc. This does not consider the support of other donors.
- According to the forecast, the WWTP's second reactor tank is expected to start operation in 2024.

Activity 1-3: Sewer network expansion plan

- Information on existing sewers (JICA, USAID, Pilot Project 1-5) is entered into the GIS to establish a centralized management system. Sewer information was categorized by each project and phase.
- Accumulated and improved analysis of sewer network data (location, extension, diameter, etc.) through the use of GIS.
- The latest sewer information is shared with relevant departments and sections.
- Identification of houses/buildings connected or unconnected to the sewerage system and identification of priority areas for development.
- Easily select priority areas/routes in sewer expansion plans. Effective use of sewer information using GIS during discussions with the USAID consultant.

Activity 1-4: Securing financial resources for sewerage services

- The Special Account was established in the Water and Wastewater Department to save 20% of the sewer connection fees. This was identified as a specific source of funding for sewer development costs. In addition, 100% of the revenues from the treated wastewater sale was to be saved in the Special Account to secure maintenance costs for the WWTP.
- House/building surveys in the pilot projects 4&5 have initiated the sewer connection fee collection and sewerage fee collection.
- Ensure integrated collection of water and sewerage fees in order to improve the sewerage fee collection ratio.
- Penalties in term of water supply suspension for unpaid water and sewerage fees.

Activity 1-5: Promotion of opinion exchanges between related organizations for the sewerage expansion by PWA

- Counterparts report on their activities and achievements towards improving the management of sewerage services to the PWA.
- The PWA joins the JCCs and commends Jericho Municipality for its commitment to sewerage services.
- The PWA informs other donors, such as the EU, of the additional investment value in Jericho Municipality.

Output-2: Water quality management capacity improvement

Activity 2-1: Preparation and revision of water quality monitoring manuals/SOPs.

- Development of water quality monitoring plans;
- Development and revision of 12 SOPs;
- Development of response procedures for unusual water quality inflows;
- Development of a procurement plan for water quality measuring reagents and securing a budget for Jericho Municipality;

Activity 2-2: OJT on water quality monitoring

- OJT on the correct use of water quality analytical equipment;
- OJT for water quality monitoring in accordance with the developed monitoring plan and SOPs;
- Data accuracy control through regular calibration of analytical equipment;
- Achievements include: improved water quality measurement capacity (knowledge, skills), data management and use of data related to water quality analysis;

Activity 2-3: Seminar on water quality monitoring results and unusual responses

- Explanation and presentation of water quality monitoring results;
- Improved data sharing and operational management between WWTP operators and laboratory technicians;
- Understanding the safety of treated wastewater through the publication of water quality data;

Output-3: Study on treated sludge reuse

Activity 3-1: Evaluation of sewage sludge treatment methods

- Identification of the amount of sewage dried sludge generated and planning of sludge drying cycles in drying beds;
- Verification of proper treatment of the sewage sludge from compositional analysis results of dried sludge, a moisture content of approximately 10% and undetected Total Fecal Coliform;

Activity 3-2: Discussions on the treated sewage sludge reuse

- Ensuring safety through compliance with standards for heavy metal content in sewage sludge;
- Proof of effectiveness as a soil conditioner and reuse of treated sludge from analysis of sludge components;
- Discussions with the Ministry of Agriculture, workshops held for Jericho farm owners (palm farmers), and promoting understanding of the treated sewage sludge reuse;

- Securing budgets and implementing a plantation project for Jericho Municipality's Green City Vision;
- Implementation of three pilot plants (Pilot Plant, Samed Land, Plantation Project) as a soil conditioner from treated sewage sludge;

2) Recommendations from the JICA/TeCSOM team

The three recommendations for counterparts are as follows:

- Implementation of regular water quality monitoring and ensuring the safety of treated wastewater and dried sewage sludge.
- Request for support from the PWA and other donors for continued sewerage development in order to increase sewage inflow to the WWTP (increase the facility operational ratio).
- Regular reports to the PWA on the activities of the Jericho Municipal sewerage service management. In particular, progress reports on the treated wastewater reuse and on the pilot farm using treated sewage sludge.
- Jericho Municipality shall advise to establish an appropriate system in full coordination with the relevant authorities for monitoring water quality, including the O&M of the pre-treatment plant constructed by the ROJ support.

The self-evaluation and recommendations of the Project were presented by the Chief Advisor and are described in Chapter 3.

3) Jericho Mayor comments

- The Jericho Mayor expressed his appreciation for the activities and achievements of the Project over the past two years. He referred to the future sewerage projects in Jericho as follows:

  i) In July 2023, 100% of the revenue from treated wastewater is saved in the Special Account to cover the maintenance costs of the Jericho WWTP (outsourcing costs). Preparations are currently ongoing for tendering for outsourcing.

  ii) Increase the sewerage connection ratio from 36% to 75% by the end of 2024.

  iii) Reduce electricity costs for treated wastewater distribution pumps when solar power is extended.

  iv) The Jericho Mayor intends to set up a meeting with the Minister of Agriculture to discuss promotion of the treated sewage sludge reuse.

  v) Consider insuring the use of treated wastewater and treated sewage sludge to compensate for any crop damages that may occur.

- The idea of compensating for crop damages through insurance was first presented at the JCC. At the previous interview with the Mayor, the city was reluctant to reuse treated sewage sludge. It is thought that the Mayor has changed his opinion to active use following the comprehensive explanations for reuse this time around.

- Insurance coverage is a good concept and the following should be considered:

  i) What conditions do insurers impose.

  - Data (parameters, frequency)

  ii) Compensated coverage

  - What conditions (yield, taste, size, color and wilting of dates)
  - Obligation to prove causality (on the part of the user) → an insurance company is evaluated and decided upon.
  - Related Departments/Sections in Jericho Municipality: WWD, Legal Unit, and so on
  - Three user categories (i) use of treated wastewater and treated sludge, (ii) treated wastewater only, (iii) treated sludge only
  - Insure sludge users for one year. After one year, if no harmful or adverse effects are observed, the insurance coverage is cancelled.