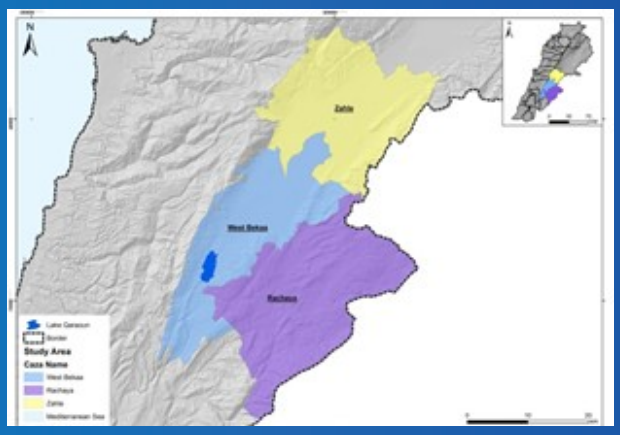


UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)

EXTENSION OF WASTEWATER COLLECTION NETWORKS DRAINED TOWARD EL MARJ WASTEWATER TREATMENT PLANT

SAFEGUARD STUDIES FOR LAKE QARAOUN POLLUTION PREVENTION PROJECT

EL MARJ WASTEWATER SYSTEM

ADDEDNUM NO. 2 TO THE ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

September 16, 2021

ADDENDUM TO THE ESMP REPORT FOR EL MARJ WASTEWATER SYSTEM

Project History:

1. An ESMP was submitted by ELARD for the extension networks in El Marj and Aitanit areas under the number 275/B/2018 on 17/1/2018; the MoE review committee requested an Addendum on 19/3/2018.
2. A draft of Extension of wastewater collection networks drained toward El Marj wastewater treatment plant ESMP was submitted on 26/3/2019 for MoE approval under the same number: 275/B/2018. This report **obtained approval on 16/7/2019.**
3. Once new data was available, an addendum ESMP for Extension of wastewater collection networks drained toward El Marj wastewater treatment plant under Safeguard Studies for Lake Qaraoun Pollution Prevention Project was submitted on 5/1/2020 under the new number 3384/B/2020 linked to 275/B/2018.
4. In parallel, an EIA report prepared by BTD consultants for the Wastewater treatment plant in El Marj and sewer lines connected to it was submitted to MoE by the number 2850/B/2018 on 17/5/2018 and it **obtained approval on 17/6/2019** (after several addenda submission).

Following the receipt of the Ministry of Environment's comments (dated May 6, 2021) on Addendum 1 Tilted "Extension of wastewater collection networks drained toward El Marj wastewater treatment plant Safeguard Studies for Lake Qaraoun Pollution Prevention Project" reference number 3384/B/2020, this report was prepared to answers the comments relating to project partitioning raised by the Ministry.

Given that the EIA Report for the WWTP in El Marj (2850/B/2018 approved on 17/6/2019) and a first draft ESMP report for the extension network (275/B/2018 approved on 16/7/2019) have already been approved, it is important to note that the scope of this report includes giving an overarching picture and detailing the comprehensive environmental and social management plan (including the mitigation plan, monitoring plan and emergency response plan) for the entire project.

This Addendum no. 2 is considered an integral part of the ESMP report number 275/B/2018 and 3384/B/2020.

1. COMPREHENSIVE PROJECT DESCRIPTION

The proposed project consists of the construction and operation of a complete wastewater management system serving villages that fall within the Bekaa plain. The project covers the villages from the West Bekaa caza and from Zahle caza namely: Aanjar, Majdel Aanjar, Saouiri, Barr Elias, El Marj, El Raouda, Bouerij, Chtaura, El Mraijat, Jdita, Jlala, Makse, Qabb Elias, Taalabaya, Taanayel, Wadi Ed Delem, and Zebdol. The location of the project area is shown in Figure 1-1 and Figure 1-2. This proposed project is comprised of the construction and putting into service of wastewater conveyance networks with gravity wastewater collectors, wastewater force mains, pumping stations, lift lines, sewer lines, a wastewater treatment plant, and a discharge system. The wastewater treatment plant is located between El Marj and Qabb Elias localities with its centre having the approximate following coordinates: X -306100, Y -45600 and Z 865 m.

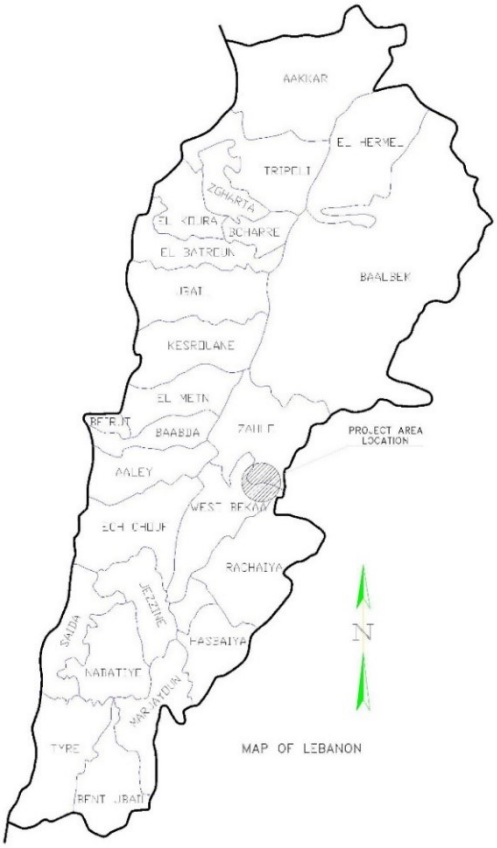


Figure 1-1: Project Area Limits

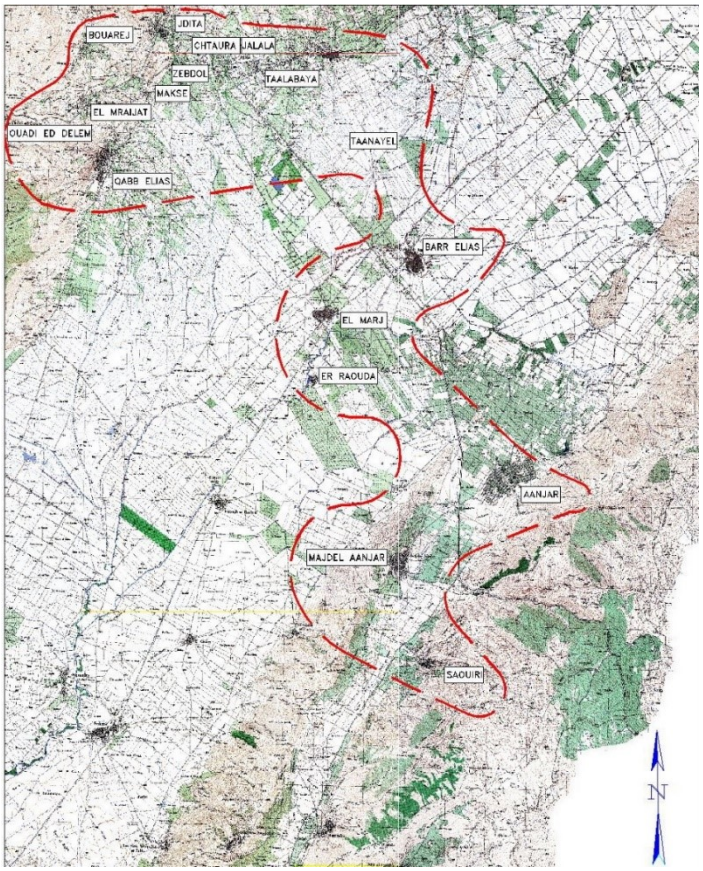


Figure 1-2: Project area location

Appendix A depicts the above-mentioned comprehensive view of the proposed project with the conveyance networks (gravity wastewater collectors), wastewater force mains, pumping stations, lift lines, wastewater treatment plant, and the discharge system.

Currently raw sewage in the project areas is discharged into the Litani River or Ghzayel River without any prior treatment, resulting in both environmental and health deterioration along the Litani basin. The objective of implementing this system is to protect public health, safeguard the environment, and at the same time provide clean treated water to be discharged to the surface watercourses.

In designing the El Marj area wastewater project, the following criteria were adopted:

- Design year 2040;
- Collection and conveyance of wastewater shall be by gravity as much as practically possible;
- The treatment plant is to be designed so that the treated effluent is in compliance with Lebanese and International standards for discharge to surface water; and

- The residual solids from the treatment plant (sludge) are to be stabilized and dewatered.

1.1 EXISTING WASTEWATER MANAGEMENT SYSTEM

With the exception of Saouiri village that discharges its wastewater into cesspools, the 16 remaining localities are connected to the municipal wastewater network which covers between 40% and 90% of the building units. Collected wastewater is mostly discharged into water bodies and diverted downstream to irrigation canals. Moreover as seen in the Table 1-1, the current networks are not connected to any WWTP.

Table 1-1 Current Wastewater Network Coverage and Discharge Location in the 17 Localities

Locality	Wastewater Network Coverage (%)	Discharge location
Anjar	100	Ghzaiyel River
Barr Elias	100	60% conveyed by a main collector that services some parts of El Marj as well, and this main collector discharges into the Ghzaiyel river. 40% of the collected wastewater of Barr Elias discharges directly into the Ghzaiyel river
Bouerij	51	Makse River
Chtaura and Jlala	93	Chtaura River
El Marj	95	80% Litani river 20% into a main collector (that also services part of Barr Elias) that discharges into the Ghzaiyel River
El Mraijet	87	Makse River
El Raouda	100	Ghzaiyel River
Jdita	80	Chtaura River
Makse	59	Makse River
Majdel Anjar	95	Ghzaiyel River
Qabb Elias and Wadi Ed Delem	85	El Siyade River
Saouiri	0	Cesspools
Taalabaya	90	Berdaouni River
Taanayel*	-	-
Zebdol	43	Chtaura River

*No information has been available about Taanayel

The following table shows the full project components including:

- The ones that were already approved by the EIA of BTD (2850/B/2018) whose execution is funded by an Italian fund and consists mainly of the WWTP and some sewer lines and pumping stations.

- The proposed extensions included in the current report (3384/B/2020) whose execution will be funded by the World Bank and includes gravity collectors and one pumping station.

Table 1-2 Summary of all components of the Marj Wastewater System

Locality	Existing Wastewater Network Coverage (%)	New Components	Current Status Constructed/ Under construction/ Not constructed	Funding	Falls into Scope of BTD's EIA/ ELARD's ESMP
Anjar	100	New Sewer Line	Under Construction	Italian Fund	BTD Approved EIA
Barr Elias	100	New Sewer Line	Under Construction	Italian Fund	BTD Approved EIA
		New Pumping station	Under Construction	Italian Fund	BTD Approved EIA
Bouerij	51	New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision
Chtaura & Jlala	93	New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision
El Marj	95	New Sewer Line	Under Construction	Italian Fund	BTD Approved EIA
		New WWTP	Under Construction	Italian Fund	BTD Approved EIA
El Mraijet	87	New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision
El Raouda	100	New Sewer Line	Under Construction	Italian Fund	BTD Approved EIA
		New Pumping station	Under Construction	Italian Fund	BTD Approved EIA
Jdita	80	New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision
Makse	59	New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision
Majdel Anjar	95	New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision
		New Sewer Line	Under Construction	Italian Fund	BTD Approved EIA
		New Sewage Forcemain	Under Construction	Italian Fund	BTD Approved EIA

Locality	Existing Wastewater Network Coverage (%)	New Components	Current Status Constructed/ Under construction/ Not constructed	Funding	Falls into Scope of BTD's EIA/ ELARD's ESMP
Qabb Elias and Wadi Ed Delem	85	New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision
		New Sewer Line	Under Construction	Italian Fund	BTD Approved EIA
		New Sewage Forcemain	Under Construction	Italian Fund	BTD Approved EIA
		New Pumping station	Under Construction	Italian Fund	BTD Approved EIA
Saouiri	0	New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision
Taalabaya	90	New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision
Taanayel		New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision
Zebdol	43	New Gravity Collector	Not constructed	WB Fund	ELARD ESMP Under Revision

1.2 PROJECT SCHEDULE

Table 1-3 summarizes the schedule of construction, testing and commissioning of the various project components.

Table 1-3 Schedule of the Construction, Testing and Commissioning of the various Marj Wastewater System Components

Elements	Scheduled Construction Beginning	Scheduled Construction End	Testing, Operation and Maintenance
AL Marj WWTP	May-2021	Jan-2023	Jan- 2023 till Jan 2025
Pumping Stations	May-2021	Jan- 2023	Jan- 2023 till Jan 2025
Sewer Lines under Italian Fund	June- 2021	August-2022	October-2022 till Jan-2025
Sewer lines under the World Bank Fund	December- 2021	March-2023	March-2023 till Jan-2025

1.3 AL MARJ WWTP THAT WAS PREVIOUSLY APPROVED

The proposed El Marj WWTP is located between El Marj and Qabb Elias localities, with approximate coordinates of 33°44'38.79"N and 35°50'46.41"E, as shown in Figure 1-3. The WWTP is designed to operate at an average flow of 43,200 m^3/day and on a peak flow of 86,400 m^3/day (the flow was calculated based on a detailed projection in the EIA report for El Marj WWTP). The treated effluent will be discharged into the Litani River.

The WWTP consists of the following units:

- Two mechanically-operated fine screens, and one by-pass manually-operated fine screen where large solids are retained and collected manually to garbage bags;
- Two Sand/grit/grease and oil removal tanks;
- Influent lift station with seven (six duty and one standby) submersible pumps in phase 1, and another seven (six duty and one standby) submersible pumps in phase 2;
- Four primary clarifiers;
- Four anaerobic tanks with two submersible mixers per tank, eight anoxic tanks with two submersible mixers per tank, and four Aerobic tanks. These biological tanks are utilized to maintain a desired bacterial mass;
- Four secondary clarifiers;
- Two chlorine contact tanks;
- Four raw sludge thickeners;
- Four aerobic sludge digesters;
- Four belt filter presses;
- Four Granular Activated Carbon (GAC) filters to eliminate the odor emissions: two will be installed in the pretreatment building, and two in the sludge dewatering building.

Figure 1-3 El Marj WWTP Proposed Location – Aerial View

Figure 1-4: A Picture of the empty lot where El Marj WWTP is to be constructed

1.3.1 Adopted influent wastewater characteristics

As per the EIA for El Marj WWTP the consultant adopted the following influent wastewater characteristics for the dimensioning of the wastewater treatment plant:

- BOD_5: 400 mg/l;
- TSS: 440 mg/l;
- TN: 60 mg/l; and
- TP: 15 mg/l.

1.3.2 Wastewater Treatment Plant Process Description

A simple overall description of the wastewater treatment plant is as follows:

Wastewater Treatment

- Fine screens
- Sand/Grit/Grease/Oil removal tanks
- Parshall Flume inlet flow meter
- Influent lift station
- Primary clarifiers
- Anaerobic biological treatment tanks
- Anoxic biological treatment tanks
- Aerobic biological treatment tanks
- Secondary clarifiers
- Parshall Flume outlet flow meter
- Chlorine contact tanks

Sludge Treatment

- Grit/Sand classification
- Primary sludge pumping station
- Return/Waste activated sludge pumping station
- Raw sludge thickeners
- Thickened sludge transfer pumps
- Aerobic sludge digesters
- Sludge dewatering by belt filter presses

Odors Treatment

- Granular Activated Carbon (GAC) filters to service the preliminary treatment building
- Granular Activated Carbon (GAC) filters to service the sludge dewatering building

The plant is designed to achieve carbon removal, nitrification, denitrification, phosphorus removal and aerobic sludge stabilization. The treated effluent will be disinfected by chlorination before its disposal to the receiving natural water course (Litani River).

The raw sludge will be thickened, aerobically, stabilized then dewatered mechanically using belt filter presses. The dewatered sludge is expected to be evacuated regularly by trucks. A storage area for the dewatered sludge is provided.

Other works are also part of the plant, namely:

- Plant by-pass pipe system
- Plant storm water drainage system
- Plant internal sewerage system
- Supernatant/Filtrate pumping station
- Wash water storage reservoir

- Wash water supply system including pumps and pipes
- Emergency sludge drying beds.

The plant layout also encompasses several buildings, namely:

- Preliminary treatment works building
- Chlorination building
- Sludge dewatering building
- Air blowers' buildings
- Power supply building
- Electrical transformer building
- Workshop building
- Administration building
- Guard house building
- Alum building.

Figure 1-5 shows the layout of the proposed wastewater treatment plant.

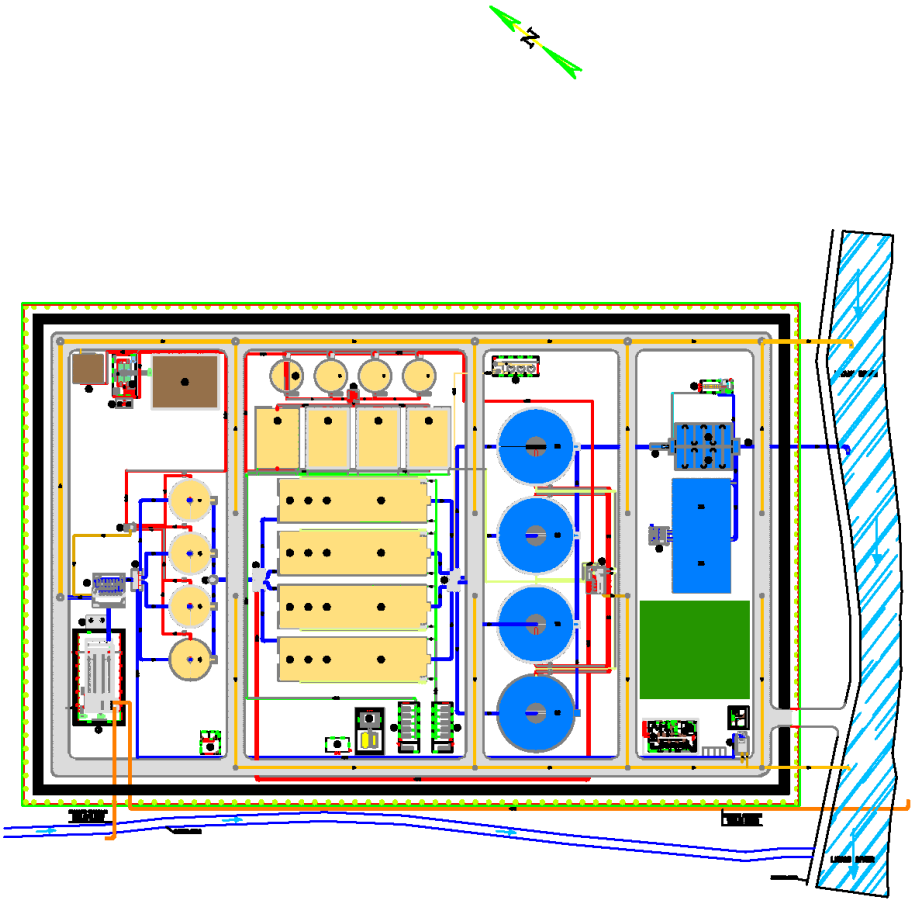


Figure 1-5: The full wastewater treatment plant layout

1.3.3 Wastewater Treatment Plant Process Description

The process flow diagram for the proposed wastewater treatment plant is given in Figure 1-6.

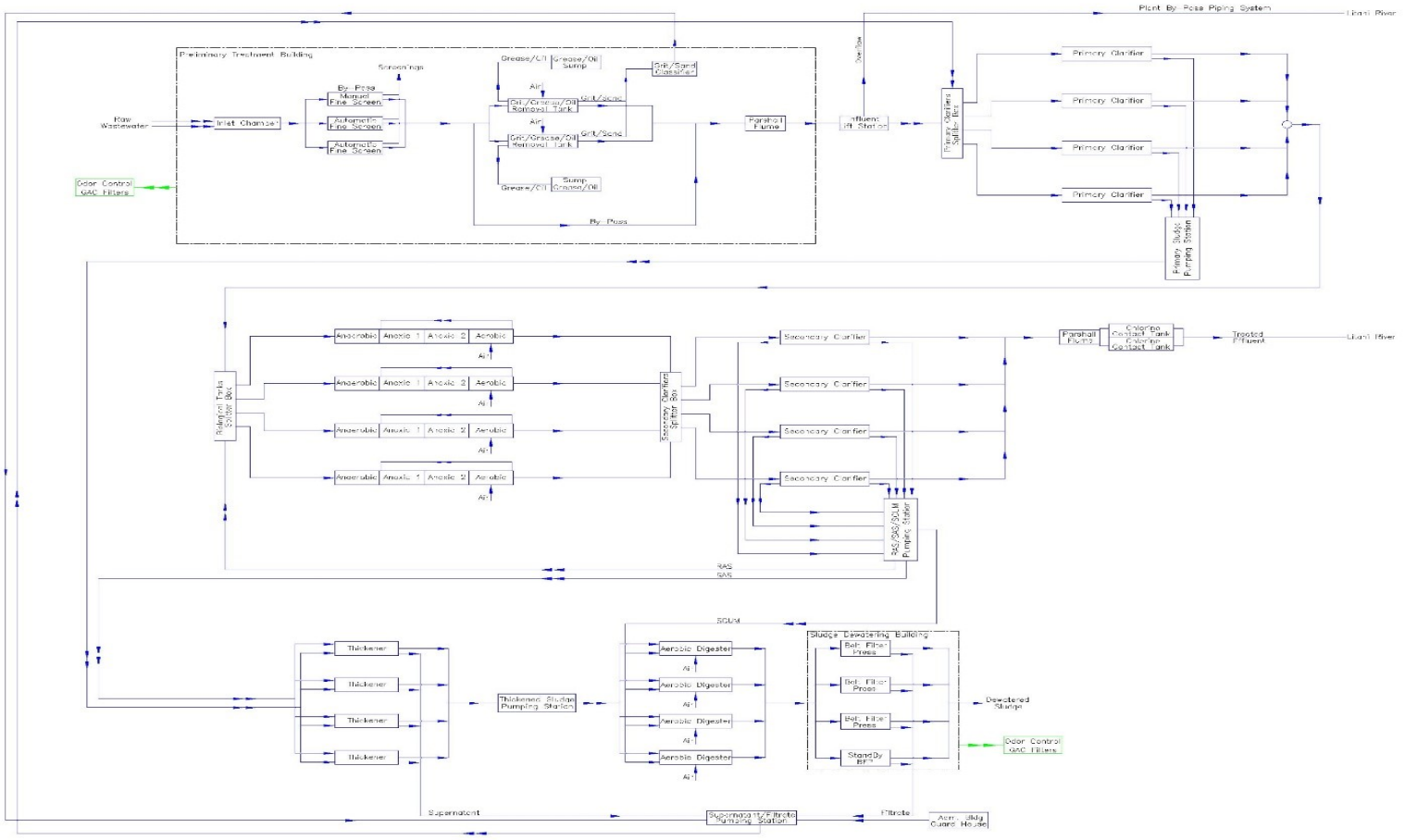


Figure 1-6 Process Flow Diagram

The description of the wastewater treatment plant processes is given hereafter.

Preliminary Treatment

The preliminary treatment works are housed in the Preliminary Treatment Building. The incoming pumped flows are received in an inlet chamber to dissipate the energy.

After passing through the inlet chamber, the raw wastewater is conveyed to automatic fine screens. The automatic fine screen would have a 3 mm spacing between the bars. This fine opening would allow the retention of fine materials that could cause clogging. The function of the proposed screens is to protect equipment downstream of the screens. In order to allow the maintenance of the fine screens when necessary, one (1) manual fine screen is fitted in a by-pass channel. The duty and the by-pass screens are each sized for half the plant ultimate peak flow. The screens outlet channel is fitted with a by-pass stop log allowing the diversion of the incoming wastewater directly to the influent lift station.

The removal of sand/grit/grease and oil is achieved via longitudinal type aerated sand/grit/grease/oil removal tanks. A sluice gate is proposed at the inlet of each tank to permit ease of maintenance. The tanks could be by-passed by closing the tanks inlet sluice gates and opening a proposed by-pass stop log. Each sand/grit/grease/oil removal tank is composed of two sections with one section for the floatation of grease/oil and the other section for the settlement of sand/grit. The sand/grit removal section is fitted with a diffused aeration system consisting of coarse-bubble tube diffusers installed along the tank length. This aerated section has a sloped bottom and a central collection pit spanning its total length. The sand accumulates in this central pit. A travelling bridge spans the whole tank width. This travelling bridge is fitted with a grease/oil skimmer placed over the non-aerated section and an air-lift pump placed over the pit of the aerated section. The grease/oil skimmer pushes the floated grease/oil towards a pit placed at one end. The air-lift pump sucks the sand/grit deposited in the central pit and discharges it into a collection channel located above the common wall of the sand/grit/grease/oil removal tanks. The collected sand/water mixture is conveyed by the channel to the inlet of a sand/grit classifier.

The sand/grit classifier separates the sand from the water discharging the sand into a container and returning the water via a pipe to the plant internal sewerage system. The collected grease/oil is conveyed from the grease/oil pit to the outside of the preliminary treatment building via a submersible pump installed in the pit.

The preliminary treatment works are proposed to be housed in a dedicated building in order to eliminate odorous emissions. A Granular Activated Carbon (GAC) odor

treatment system is proposed to treat the extracted air from the preliminary treatment building.

Influent Lift Station

The influent lift station is composed of a wet well where submersible pumps are installed and a dry pit where valves and equipment are installed. The pumps are proposed to be of the submersible type. The pumps would be installed in the wet well of the influent lift station. The discharge side of each pump would incorporate a check valve and an isolating gate valve. A washout is provided to allow the drainage of the pipes when needed. An overflow is also provided for the wet well. The overflow pipe is connected to the plant by-pass piping system.

Primary Treatment

The degritted and grease/oil free wastewater is lifted to the splitter box of the primary sedimentation tanks where settlable suspended solids are removed by gravity settling. The settled suspended solids (primary sludge) are slowly conveyed by means of a travelling bridge and a scraper to a sludge hopper. The primary sludge is then conveyed to a wet well, located in the primary sludge pumping station, from where it is pumped to the raw sludge thickeners. The treated wastewater is collected at the periphery of the tank, where it falls over a weir into a collection channel, from the channel to a collection manhole and from the manhole to the distribution chamber feeding the biological tanks.

Biological treatment

In the anaerobic tanks, microorganisms release phosphorus. The released phosphorus is subsequently assimilated in the aerobic stage (aeration tanks) resulting in biological phosphorus removal. A small amount of nitrogen is removed in this anaerobic treatment stage.

In the anoxic (denitrification) tanks, nitrates are converted to nitrogen gas. The nitrates are continuously returned from the aeration tanks to the anoxic tanks via internal return pumps installed in the aeration tanks.

In the aeration tanks, an aerobic bacterial culture referred to as activated sludge carries out the biological degradation of the wastewater to stable end-products such as water and carbon dioxide. The non-settlable suspended, colloidal and dissolved organic substances are taken up by the bacterial culture. As a result, the organic matter present in the wastewater is converted to bacteria. Because of the continuous

conversion of organic matter to bacteria, the bacterial mass increases substantially. Biological tanks are usually designed in order to maintain a desired bacterial mass. As such the amounts of bacteria exceeding the desired bacterial mass are daily wasted (applied to sludge processing units). The biologically treated wastewater which contains a high concentration of bacteria is carried to final sedimentation tanks (also known as secondary sedimentation tanks or secondary clarifiers).

The biological treatment process would achieve some 50% biological phosphorus removal. Thus, the phosphorus concentration reduces from 15 to about 7 mg/l through the biological treatment process. To reduce the phosphorus effluent concentration to 1 mg/l, a chemical precipitant (alum) is injected to the effluent from the aeration tanks. The alum binds with the phosphorus resulting in the settlement of the chemically removed phosphorus inside the final sedimentation tanks.

Final Sedimentation (Secondary Clarifiers)

The effluent leaving the aeration tanks is laden with bacterial flocs having a specific gravity slightly higher than water. The effluent is allowed into final sedimentation tanks (secondary clarifiers) where the bacterial flocs (sludge) settle by gravity to the bottom of the tank. The settled flocs are collected to the central sludge hopper by means of several curved scraper blades suspended from a slowly revolving bridge. The sludge collected in the central sludge hopper of each tank flows towards the return activated sludge pumping station. The treated wastewater is collected at the periphery of the tanks, where it falls over a weir into a collection channel and flows to the discharge channel. The performance of the final sedimentation tanks is most crucial for the overall efficiency of the activated sludge process and hence the performance of the treatment plant. If the final sedimentation tanks fail to separate the activated sludge flocs from the wastewater, the effluent will show high turbidity with BOD5 values exceeding the desired effluent quality.

The effluent leaving the final sedimentation tanks is devoid of organic matter but still contains pathogenic microorganisms. This secondary biological treatment process would result in the removal of 90% of the Fecal Coliforms. As such the 10% remaining Fecal Coliforms, amounting to 1,000,000 #/100ml, would require further reduction by disinfection.

Return/Waste Activated Sludge Pumping Station

Part of the settled bacterial flocs (sludge) drawn from the final sedimentation tanks is pumped back to the biological tanks in order to maintain the desired bacterial

concentration in the tanks. This sludge is referred to as return activated sludge (RAS). The remaining part, surplus activated sludge (SAS) or waste activated sludge (WAS), is pumped to sludge processing units for treatment.

Effluent Disinfection

Effluent disinfection would be required for a treated effluent that could be re-used for irrigation. Disinfection by UV is not recommended due to high cost and the requirement to filter the effluent in order to achieve the desired log inactivation by UV light. The Consultant proposes to disinfect the effluent by chlorination. A cost comparison was undertaken to compare the capital and operation/maintenance costs between the provision of either a UV disinfection system or a chlorination system. It was considered that the effluent is not filtered before UV disinfection and therefore the filtration system cost was not included. Over 25 years (Year 2015 – Year 2040) economic period, the present value of the investment required for the UV system was found equal to US$ 3,430,000 whereas the present value for the chlorination system was found equal to US$ 1,800,000. The higher cost related to the UV system is resulting from a 3 times higher investment cost, UV lamps replacement cost every 5 years and 31 times higher electrical energy cost. The power required for the UV modules is 126 kW while the chlorination system requires only 3 kW. Although, with the chlorination system, cost of chlorine is recurring, the calculations show that the chlorination system would be cheaper than the UV disinfection system by US$ 1,630,000 over a 25-year economical period.

A serpentine flow pattern tank is provided. At the head of the tank, chlorine is injected into the incoming flow. The serpentine flow pattern allows the homogeneous mixing of the chlorine and the water. The necessary contact period for efficient disinfection is ensured by providing the appropriate tank volume.

Sludge Processing

The sludge produced from the primary and secondary sedimentation tanks is pumped to raw sludge thickeners. The thickeners play the function of reducing the sludge volume by separating a portion of the water present in the sludge. This is achieved by allowing the sludge to settle by gravity with the assistance of mechanical stirrers. As the sludge fills in the thickeners bottom, it becomes more condensed and therefore its dry solids content increases.

The sludge is then transferred from the raw sludge thickeners to aerobic sludge digesters. The thickened raw sludge is stabilized aerobically in the digesters where the organic matter is converted to stable end products and carbon dioxide. During digestion, the pathogenic germs and the volatile organic matter are reduced and the colloidal water-binding structure of the sludge is destroyed.

The digested sludge volume is further reduced by dewatering. The sludge is mechanically dewatered using belt filter presses. The belt filter press was favored over the centrifuge due to the power savings related to the same. Each centrifuge with related equipment would require 58 kW, whereas the belt filter press with related equipment requires only 8 kW. The yearly energy costs related to the centrifuges with related equipment would be US$ 58,000. The yearly energy costs related to the belt filter presses with related equipment would be US$ 7,000.

Emergency sludge drying beds are also proposed. These emergency beds can be used in case of shut-down of the belt filter presses for maintenance during a short period of time.

Odor Treatment

An odor control system is proposed to curtail and eliminate the odor emissions from the preliminary treatment building. The odor control system consists of two (2) granular activated carbon (GAC) filters.

An odor control system is proposed to curtail and eliminate the odor emissions from the sludge dewatering building. The odor control system consists of two (2) granular activated carbon (GAC) filters.

Gas-phase dry scrubber type odor control units for the removal of hydrogen sulfide are proposed. The media utilized for scrubbing the hydrogen sulfide from the air are granular activated carbon.

1.4 PROPOSED EXTENSION OF THE WASTEWATER NETWORK

The aim of the proposed extension of the network (the main scope of this report) is to connect the existing network to El Marj WWTP and service unconnected areas. Therefore, the proposed El Marj extension of wastewater network includes the construction of 321.52 km of additional sewer lines (gravity lines and one force main). The additional sewer lines in Bouerij, Chtaura, El Mraijet, Jdita, Jlala, Makse, Taalabaya, Taanayel, Wadi Ed Delem, Zebdol, and the lower part of Qabb Elias and part of Saouiri will be constructed within the public domain along the existing roads Right-of-Way. The

following sections present the proposed extension of wastewater network specific to each of the above-mentioned localities.

Construction works in 12 villages will comprise of:

- A total length of 319.42 km sewer lines (including house connections) made up of either unplasticized Polyvinyl Chloride (uPVC), Glass Fiber Reinforced Plastic (GRP), Glass Reinforced Epoxy (GRE), or concrete as gravity sewer lines with a diameter ranging between 150 mm and 1,000 mm.
- A force main laid over a 2.1 km asphalt road, constructed from either Ductile Iron (DI) lines or GRP lines of 300 mm in diameter. .

1.4.1 Gravity Wastewater Collectors Design Criteria

For the design of the gravity wastewater collectors, the following design criteria are adopted:

The hydraulic design of the gravity sewers is carried out using Manning's equation:

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

where,

n: Manning's roughness coefficient;

R: hydraulic radius (m); and

S: pipe slope (m/m).

The design roughness coefficient n is set at 0.013.

The minimum sewer pipe diameter shall be 200 mm.

Minimum self-cleaning velocity of 0.3 m/s occurring at least once per day.

Minimum velocity = 0.75 m/s at full flow.

Maximum velocity = 3.00 m/s.

Maximum flow in the sewer shall not exceed 75% of the sewer capacity.

The minimum soil cover to the top of the sewer pipes shall not be less than 1.20 meters.

Manholes shall be provided for inspection and maintenance purposes on all gravity sewers. They shall be placed at all junctions and drops, at changes in direction, gradient and diameter, and at regular intervals to accommodate cleaning equipment. Spacing between manholes shall not exceed 75 meters.

1.4.2 Wastewater Pumping Stations

Three wastewater pumping stations were proposed in the Italian Fund project and included in the BTD report, namely:

- Er Raouda PS1;
- Qabb Elias PS2;
- Barr Elias PS3.

The proposed wastewater pumping stations are composed of a wet well where submersible pumps are installed and a closed building above the wet well

encompassing rooms for required equipment such as hydraulic accessories, pumps control panels and the ancillary electromechanical works. A dedicated room is foreseen for the electrical transformer. The standby power generator for the pumping station would be installed outside of the pumping station building.

The wastewater pumps are proposed to be of the submersible type. Three (3) pumps are proposed for each pumping station with two (2) duty and one (1) standby pump.

The number of pumps and their type are defined taking into consideration the following:

- Ensuring flexibility in the system operation by the provision of multiple pumps;
- Providing a minimum of one additional pump as stand-by unit;
- Providing pumps with identical type and characteristics. Thus, making easy the preventive maintenance and the load repartition control;
- Eliminating the emission of noise; and
- Using low voltage motors.

The discharge side of each pump would incorporate a check valve and an isolating gate valve. An isolating gate valve is proposed for the pumping station force main.

A washout composed of a gate valve and a drain pipe is proposed for the wastewater force main of the pumping station.

The proposed pumping stations will be equipped with odor control units.

1.4.3 Pumps Odor Control System

The gases released from the flows are anticipated to be those consistent with raw sewage and will include various sulphides, marcaptants, amines, nitrides, skatoles, acid compounds, and methane. The air purification plant shall reduce the levels of odors and gas emissions such that the air is effectively odorless when measured at a boundary, 15 m away, at all times.

To achieve the required performance, the following estimated values of hydrogen sulphides (H2S) may be used as guidelines:

Maximum concentration of H_2S from any source – 10 ppm.

Maximum concentration of H_2S to be achieved in treated air at discharge to atmosphere – 0.03 ppm.

Maximum concentration of H_2S to be achieved in diluted treated air at the boundary fence 15 m away – 0.00047 ppm.

The equipment shall also be capable of withstanding short periods of high contaminant (shock loads) and long periods of low contaminant without detriment to the short- or long-term performance of the equipment.

Water mist shall be removed from the air to be treated in an axial demister where the water is separated from the air by centrifugal force.

The air shall then be filtered over a foam type or fiber type regenerable pre-filter grade EU 3 or better. The pre-filter shall have a separate pressure gauge with a range of 0 – 500 Pa. The filter body and internals shall be in 316 stainless steel. The odorous air shall be blown through the unit with a dynamically balanced 316 stainless steel fan, which shall have a drain connection and inspection door. The fan shafts shall have double

ball bearing and dynamic shafts seal to prevent odor leakage. The motor shall be protection class IP 55 and shall be tropicalized.

After the pre-filter the air shall be discharged via a stainless-steel pipe to the absorber vessel. The flow shall be controlled by an integral airtight an externally lockable stainless-steel damper. The odorous air shall be blown through two beds of non-impregnated granular activated carbon. The beds shall be at least 900 mm deep and shall operate in parallel. The air shall stay in the bed at least 2.25 seconds and the maximum filtration rate shall not exceed 25 m per minute.

The activated carbon shall be bituminous coals based, non – impregnated granular and able to convert H_2S to an odor-free form. When saturated, the carbon shall be regenerable using potable water only. The maximum water requirement shall not exceed 10 times the weight of carbon and the regeneration operation shall be completed within 24 hours. All water piping and valves for the inlet, outlet and overflow shall be provided with the adsorption system.

The granular carbon shall be US mesh size 4 × 7 and steam activated. The supplier shall guarantee that the carbon is non-impregnated in situ and has a 16% W/W capacity for H_2S. The supplier must guarantee that he will take back the saturated carbon after several regenerations and supply reactivated carbon with the same adsorption properties as the initials fill.

Appropriate supports shall be provided to support the carbon beds and distribute the air evenly. Provision shall be made to take air at 30, 60 and 90% bed depth and a H_2S detection system with colorimetric sensitive paper shall inform where the saturation front in the absorber has moved to the amount of air treated. An outlet shall be provided for each bed and shall be fitted with a stainless-steel airtight butterfly valve mounted in an outlet pipe complete with a rain cap.

A bulk carbon regenerable odor control unit shall be provided to deodorize the air extracted from the wet well. The extraction rate shall be sufficient to provide 12 air changes per hour in the wet well when empty of sewage. The odor control unit shall be provided with a bypass with provision of relief device to prevent the buildup of pressure in the sump under unusual operating conditions. The unit shall be located inside the building, sealed to prevent gas leakage and vented externally to a high level.

1.4.4 Wastewater Force Mains

Force mains are proposed namely from Ductile iron pipes of diameters ranging from 500mm to 800mm with a total length of 5,049m.

1.4.5 Construction Phase

1.4.5.1 Main Construction Activities

Activities involved in the site preparation and construction works of the proposed additional sewer lines in the 12 localities are:

- Site clearance
- Excavation
- Backfilling

- Pipe works
- Concrete works
- Plastering
- Waterproofing
- Metal works
- Testing and commissioning
- Road reinstatement.

Activities involved in the site preparation and construction works of the proposed wastewater pumping stations:

- Civil Engineering Works
  - Site clearance
  - Excavation
  - Concrete works
  - Plastering
  - Waterproofing
  - Metal works
  - Pipe works
- Mechanical works
- Electrical works
- Instrumentation and Control equipment works.

Activities involved in the site preparation and construction works of the proposed wastewater treatment plant:

- Civil Engineering Works
  - Site clearance
  - Excavation
  - Concrete works
  - Plastering
  - Waterproofing
  - Metal works
  - Pipe works
- Mechanical works
- Electrical works
- Instrumentation and Control equipment works.

1.4.5.2 Main Construction-related Materials

The main potential construction-related materials associated with the construction of the proposed additional sewer lines are listed in Table 1-4. These have been extracted from the Bill-of-Quantities prepared by the Engineering Consultant.

Table 1-4 Main Construction-related Materials Associated with the Sewer Lines Construction Activities

Construction-related Materials Associated with the Sewer Lines Construction Activities	Quantity (Unit of measurement)
Pipeworks	321,520 m*
Sand or gravel bedding and surrounds	210,327 m*
Reinforced concrete bedding and surrounds	15,732 m*
Concrete manholes	6,299 units
Manhole covers and frames	6,303 units
Concrete works	255 m^3
Asphalt for reinstatement of paved roads including base, sub-base and wearing courses	270,549 m^2

* As per BoQ, materials provided in linear meters and not quantities or volumes

Table 1-5 Main Construction-related Materials Associated with Project Activities

Construction-related Materials Associated with the Project Activities	Quantity (Unit of measurement)
For wastewater gravity collectors and wastewater forcemains	
Pipeworks	73,163 m*
Sand or gravel bedding and surrounds	68,663 m*
Reinforced concrete bedding and surrounds	1,630 m*
Concrete manholes	1,865 units
Manhole covers and frames	1,865 units
Concrete works	205 m^3
Asphalt for reinstatement of paved roads including base, sub-base and wearing courses	95,550 m^2
For 3 wastewater pumping stations	
Civil engineering works	Lump Sum
Mechanical works	Lump Sum
Electrical works	Lump Sum
Instrumentation and Control equipment works	Lump Sum
For one wastewater treatment plant	
Civil engineering works	Lump Sum

Construction-related Materials Associated with the Project Activities	Quantity (Unit of measurement)
Mechanical works	Lump Sum
Electrical works	Lump Sum
Instrumentation and Control equipment works	Lump Sum

Sourcing of raw materials will be from duly permitted sites; these have not yet been defined and will be defined once the contractor is selected.

1.4.5.3 Construction Schedule of Main Activities

The overall duration of construction activities for the proposed Project is 30 months, and is detailed per activity in Table 1-3.

1.4.5.4 Construction Equipment

Equipment and machinery employed at a typical construction site where the proposed works are executed are presented in Table 1-5 below. Nevertheless, the count of equipment and machinery to be used is not available at this stage. The awarded Contractor shall provide this at a later stage.

Table 1-5 List of Construction Equipment and Machinery

Equipment/Machinery
Air compressor
Asphalt spreader/paver
Backhoe loader
Bench Saw
Bulldozer
Circular Saw
Compressor
Concrete mixer truck
Drill
Dump truck
Excavator Truck (Poclain)
Fuel tanker
Grinder
Ground excavation dozer
Hole Cutter
Jack hammer

Equipment/Machinery
Leveling ground grader
Mobile Concrete pump
Mobile Crane
Pick Up
Plate compactor
Pneumatic breaker (Breaking hard ground)
Rock Breaker (Jack Hammer)
Roller compactor
Shovel Truck
Water tanker
Welding machine

1.4.5.5 Power Supply and Energy Consumption

For each construction site, the needed electricity will be supplied by Electricité Du Liban (EDL), if possible and private generators as needed. Details regarding the capacity of the generators, fuel consumption for the generators, equipment and machinery, and construction site fuel storage tanks are not available at this stage.

1.4.5.6 Water Supply

Water during construction will be needed for concrete batching activities, hydro-testing, compaction, dust suppression, and daily domestic use of workers. Water tankers will supply water from providers in the area. Water will be stored in plastic tanks onsite. Water consumption quantities are not available at this stage and will be estimated by the selected Contractor at a later stage.

1.4.5.7 Wastewater Generation

Wastewater generated during the construction phase will consist mainly of hydro-test water (for the hydraulic testing of pipes), concrete washout water, and domestic wastewater (onsite temporary toilets, lavatories, etc.). Wastewater will be either collected and discharged at the nearest existing manhole connected to the sewage network, or collected into an onsite temporary septic tank that will be regularly emptied by service providers in the area.

1.4.5.8 Solid Waste Management

Domestic solid waste generated during this phase will be disposed of along with the municipal solid waste stream generated in the Project area, collected by the municipalities of the 12 concerned localities.

Construction and demolition waste that cannot be reused onsite will be appropriately disposed of at a location approved by the involved municipalities and MoE. Hazardous

wastes (oil, grease, bitumen, chemicals, etc.) will be stored and disposed in coordination with the concerned municipalities and the MoE. No waste will be left on-site after the completion of construction works, and onsite waste burning will be prohibited.

1.4.5.9 Manpower, Transportation, and Security

The number of workers needed varies depending on the construction activities. The average manpower forecast required for the execution of works is not available at this stage. The selected contractor shall decide on the team size, number of workers of different categories, their functions/ roles, and the schedule and shifts.

There is still a lack of data on the location of the labor camp – if any – at this design stage. Due to the considerable number of foreign nationals living in the Bekaa region who already work in the construction sector, it is likely that workers will be already living near the project areas, and thus no labor camp will be needed. However, two site offices, including a meeting room, a kitchen and a restroom will be set up at the project site for site engineers and supervisors (contractor/ consultant), as well as space for parking equipment and vehicles. Additionally, access to restrooms will be provided for workers during the construction phase. Occupational Safety and Health Administration (OSHA) recommends providing one (1) unit for every 20 workers on site.

Transportation of construction materials and wastes, and laborers, will be carried out by the awarded Contractor in conformance with the applicable laws and regulations related to road and public safety.

Construction sites will be secured from public access and trespassing by proper fencing and delineation of sites, installation of warning boards, and appointment of onsite guards. Additionally, a Project sign will be installed on site upon commencement of works displaying the Project name, implementing agency, assigned contractor, funding organization, and information on the GRM.

1.4.6 Operation Phase

During the operation phase, operation and maintenance teams of the BWE will carry out day-to-day activities of the:

- Wastewater network
- Wastewater Gravity Sewers and Forcemains
- Wastewater Pumping Stations
- WWTP.

1.4.6.1 Wastewater Management

Under the normal operating and maintenance conditions of the sewage networks, no wastewater is expected to be generated. Nevertheless, faulty operation and maintenance practices or sudden malfunctioning in the sewage collection lines is

expected to result in raw wastewater overflows. This might result in the generation of foul odors and bases for vector breeding – if not promptly resolved.

Wastewater generation at the pumping stations will be negligible, except in cases where cleaning activities inside the pumping stations are conducted.

The generated wastewater from workers as well as the additional wastewater generated from the plant from cleaning activities as well, will be diverted to the pretreatment plant along with the rest of the sewage received by the plant.

1.4.6.2 Solid Waste Management

Solid wastes will be generated during maintenance works involving the repair of sewer pipelines – mainly wastewater/ sludge residues. Such wastes will be disposed of in El Marj WWTP in coordination with the concerned municipalities and the BWE.

Sludge will not be produced from the pumping stations, since the wastewater will be thoroughly grinded and mixed with the wastewater by the submersible pumps before being pumped.

The majority of waste generated from the pretreatment headworks plant will be from pretreatment processes, namely the debris and material trapped by the coarse and fine screens, sand, grit, and grease.

In addition, domestic waste generated by the workers will largely include organic food waste and common office waste such as paper and cardboard waste.

1.5 WASTEWATER FLOWS

The total wastewater flow is the sum of three flows: domestic, non-domestic, and infiltration/inflow. Based on the adopted figures of population and on the following assumptions, the wastewater flows were estimated:

- Water consumption equal to 120 l/d/capita was examined;
- The non-domestic demand of water is estimated at about 15% of the domestic demand; and
- Wastewater flow is taken as 80% of the water consumption.

Wastewater flows are determined for two periods of the year, the summer and the winter seasons since water consumption rates vary between the seasons. Domestic wastewater flows are determined as 80% of the water consumption rates. Non-domestic wastewater flows are taken as a percentage of the average domestic wastewater flow. The percentages of non-domestic flows have been determined by BTD from the field survey conducted during the preliminary studies. These percentages

were found to vary from one village to the other (which is something expected knowing the difference in population between the villages). In addition, based on the Consultant's meetings with municipal officials, non-domestic water users represent about 15% of the total users. Non-domestic users include commercial users, institutions such as schools and government buildings.

In addition to the generated wastewater flows (Domestic and non-domestic flows), an infiltration rate is also taken into consideration. The infiltration/inflow is calculated as 10% of the average daily flow.

In summary, Table 1-6 gives the calculated wastewater flows.

Table 1-6 Projected Wastewater Flows and Loads – Project Area

Description/Year	Unit	2010	2015	2020	2025	2030	2035	2040
Total Population	capita	191,200	211,309	233,532	258,093	285,237	315,236	348,389
Grade of Connection	%	100	100	100	100	100	100	100
Population Connected	capita	191,200	211,309	233,532	258,093	285,237	315,236	348,389
Water Consumption L/cap.d	L/cap/d	120	120	120	120	120	120	120
Wastewater/Water	%	80	80	80	80	80	80	80
Commercial/Domestic Wastewater	%	15	15	15	15	15	15	15
(Infiltration/Inflow)/(D + ND)	%	10	10	10	10	10	10	10
Peak Factor Domestic	-	2.08	2.05	2.01	1.98	1.95	1.91	1.88
Peak Factor Non-Domestic	-	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Peak Factor Infiltration/Inflow	-	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Influent BOD_5	mg/l	400	400	400	400	400	400	400
Influent TSS	mg/l	440	440	440	440	440	440	440
Influent TP	mg/l	15	15	15	15	15	15	15
Influent TN	mg/l	60	60	60	60	60	60	60
DWW Generation	m^3/d	18,355	20,286	22,419	24,777	27,383	30,263	33,445
NDWW Generation	m^3/d	2,753	3,043	3,363	3,717	4,107	4,539	5,017
WW Generation	m^3/d	21,108	23,328	25,782	28,493	31,490	34,802	38,462
Infiltration/Inflow	m^3/d	2,111	2,333	2,578	2,849	3,149	3,480	3,846
Total WW Flow	m^3/d	23,219	25,661	28,360	31,343	34,639	38,282	42,308
Population Equivalents	capita	210,320	232,440	256,885	283,902	313,761	346,759	383,228
Peak Hourly Flow	m^3/h	2,023	2,206	2,407	2,625	2,864	3,125	3,409
Peaking Factor	-	2.09	2.06	2.04	2.01	1.98	1.96	1.93
BOD_5 Load	kg/d	9,288	10,265	11,344	12,537	13,856	15,313	16,923
TSS Load	kg/d	10,217	11,291	12,478	13,791	15,241	16,844	18,616
TP Load	kg/d	348	385	425	470	520	574	635
TN Load	kg/d	1,393	1,540	1,702	1,881	2,078	2,297	2,539

2. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

A number of measures are recommended in order to mitigate the adverse impacts associated with the construction or operation of the extension of wastewater collection networks drained toward El Marj wastewater treatment plant and the WWTP itself. Some of these measures shall be included as requirements in the tender documents for the Construction and later for the Operation of works. Other measures should be evaluated for effectiveness and modified as necessary based on the implementation results of the Environmental Management Plan.

Most of the identified environmental **impacts** during **construction** can be mitigated if proper plans are drawn and implemented under the supervision of the concerned authorities.

Mitigation of **impacts** related with the **operational** phase of the project is based on provisions made at the **design** stage of the project, such as provision of odour control facilities for the WWTP.

Furthermore, mitigation of impacts related with the operation of the El Marj wastewater plant could also be achieved by improving the management of the facilities. This involves allocation of the necessary resources, human and financial to ensure that the facilities are well-operated, properly maintained and regularly monitored.

The foreseen mitigation measures are presented in the following sections followed by the necessary environmental monitoring plan and the institutional arrangement needs.

2.1 MITIGATION PLAN*

*It is important to note that it is very difficult to provide cost estimation at the moment because of the instable cost of services in Lebanon and the varying prices.

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
Construction Phase					
Ground Water	Construction of the Networks, WWTP and sewer lines	• **Fuel, oil and possible chemicals** shall be **stored** in designated areas on site, particularly on an impermeable base and within a suitably contained area; • Any **storage tanks** should be positioned to minimize the risks of damage by impact, and should be of sufficient strength and structural integrity • Drip trays should be installed underneath equipment such as diesel generators to contain leakages. Drip trays should be kept drained of rainwater; • Employees should be trained to be capable of dealing with small scale spill hazards; **oil spill** response kits to be available on the working area; • Collect all **used oils** generated on the construction site and send them to a licenced treatment/ disposal facility in compliance we Decree 5605/ 2019 • Promote "**good housekeeping**" practices; **Inspection** should be thoroughly practiced; • **Sewage** from construction camps will be treated by provision of chemical toilets or other suitable system on-site. In the case of a small spill (<10 L-100 L), containment of spill and contamination should be performed on site by adopting, at least, the following: • Immediate reporting of spill to contractor representative; • Stopping the source of spill (closing valve, seal pipe, seal hole or as appropriate); • Checking for hazards, flammable matters on site; • Immediate cleaning of the spill by removing affected top soil layer by trained employees; • Treating the removed soil as hazardous waste; • In-situ sampling of soil in the vicinity and underneath the spill for potential contamination; • Adopting dry cleaning techniques (to the extent - possible) to decrease resultant wastewater, and to avoid flushing of spills to deeper soil layers. In the case of an important spill (>100 L), the operator should request quick assistance from Contractors specialized in soil remediation.	Low	Implementation: Contractor Supervision: CDR	

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
Surface water	Construction of the Networks, WWTP and sewer lines	• To reduce the impacts on surface waters whenever a stream or a river is temporarily diverted during the construction of networks, the location of the diverted section should be selected in a manner to minimize the stretch disturbed. If the river runs dry during summer, then **works** should be **scheduled** in the summer season. • In case of disturbed areas during works, **rehabilitation** should be carried out progressively as soon as works in each area are completed. Rehabilitation will include reinstatement of soil, surface levelling, re-vegetation and mulching, and remediation of any locally caused erosion • To avoid pollution from possible oil spills (fuel/lubricants), contractor shall demonstrate preparedness to Oil Spills by having an Oil Spill Kit, Oil spill Management Plan, and trained employees. • In addition, routine inspection procedures and maintenance of equipment should apply for risk minimization. • Dumping of excavated or surplus materials in surface water must not be allowed. • Excavated material shall be disposed in an approved landfill site for construction material or an approved reclamation/ rehabilitation site agreed upon with CDR.	Low	Contractor + CDR to agree on disposal of excavated material Supervision: CDR	
Emissions					
Air Emissions	Combustion and exhaust emissions	• Ensure well designed, maintained, and operated equipment/vehicles. Precautionary control measures for emissions reduction could include proper engine fuel mixtures, regularly serviced exhaust emission systems, suitable engine tuning, and use of low sulfur content diesel, whenever available; • Ensure and regularly monitor compliance of stack emissions of generators with MoE Decision 8/1; • Use environmentally friendly equipment whenever possible (machinery with higher fuel efficiency or equipped with air pollution control devices to minimize exhaust emissions); • Keep a record of maintenance for all machinery, vehicles, and generators on site; • Report and monitor monthly fuel consumption records to keep track of consumption levels and identify overuse; • Avoid unnecessary idling of vehicles and equipment engines; and • Ensure that an effective Maintenance Plan and Schedule is in place for employed site machinery, vehicles, and power generators.	Medium	Implementation: Contractor Supervision: CDR	Part of construction activities cost
	Dust emissions	• Set physical barriers at site boundaries; • Ensure site roads are kept regularly damped down and compacted to minimize dust emissions; • Schedule deliveries of raw materials efficiently; • Wheel-washing of vehicles before departure from construction site; • Cover incoming and outgoing trucks with proper canopies; • Limit vehicular speed onsite to 20 km/h; • Maintain material stockpiles at minimum heights and adequate slopes and ensure that they are covered; • Surround the construction areas with scaffolding nets to control debris and dust from dispersing beyond the construction sites; and • Inform sensitive receptors of the scheduled construction works, ahead of time in conjunction with the concerned municipalities, especially for dust-generating activities.	Medium	Implementation: Contractor Supervision: CDR	Part of construction activities cost

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
Noise	Noise associated with site preparation, construction activities and operation of on-site generators, heavy machinery, equipment and vehicles	• Fit all machinery, equipment, and vehicles with exhaust silencers where possible; • Ensure proper inspection and maintenance of machinery, vehicles and generators; • Avoid idling and switch off engines when not in use; • Place noisy equipment away from sensitive receptors, behind stockpiles to provide acoustic barriers; • Control speed limits of vehicle movement on site and in the surrounding area; • Plan deliveries to and from the site during day time hours; • Respect scheduled working hours (7:00 am- 6:00pm) and avoid night-time work; • Avoid construction works on Sundays and public holidays; • Inform site staff and workers on the impact of noise and the applicable regulatory requirements; • Provide workers with noise protection equipment and enforce their use; • Conduct regular noise monitoring to ensure that noise emissions are compliant with national standards (Decision 52/1); • Notify the residents of the plans and expected duration prior to initiating the works, in conjunction with concerned municipalities; and • Establish a noise complaint grievance mechanism as a measure to allow implementation of timely and effective actions to minimize noise impacts on downwind receptors.	Medium	Implementation: Contractor Supervision: CDR	• Noise PPEs: Washable and reusable ear plugs: ~1.5 USD/piece or Ear Muffs: ~28 USD/piece • Noise monitoring: 400 USD/Event
Soil and Ground Water Resources	Temporary or permanent change in topography, soil erosion and collapse from grading, trenching, or excavation works	• Ensure international standards (i.e. ASTM Soil Compaction Standards) are met during any excavation works, compaction and grading activities, in order to minimize expected disturbance during the construction phase; • Manage fixed routes for equipment movement and avoid multiple routes; and • Re-use excavated/cut materials as general fill where considered suitable.	Medium	Implementation: Contractor Supervision: CDR	Part of construction activities cost
	Accidental spills of fuel, oil and chemicals	• Good housekeeping practices through handling and storage of chemicals, oil, fuels and lubricants within containment facilities (e.g. bunded areas, leak-proof trays) designed to prevent the release of spills/leaks to the soil and groundwater environment; • Maintenance schedule should be in place as part of the inspection procedures of all equipment/ generators/ machinery for risk minimization; • Maintenance of machines and equipment should take place off-site or onsite in a well-contained area with impermeable concrete pavement and drainage for vehicle washing and maintenance; • Oil spill response kits should be available wherever oils are being used/stored; • Promote awareness among workers on how to handle oil/lubricants; • Train workers how to clean up small-scale spills; • Ensure drip trays are present when re-fuelling; • Prepare a Spill Emergency Plan specific for the Project; and • In case of spill: - Immediately report incidents reporting to the concerned authorities; - Contain the source of spill (close valve, seal pipe, seal hole or as appropriate); - Check for hazardous flammable materials on site; - Prompt clean-up of the spill by removing affected top soil layer by trained employees who should be equipped with appropriate tools and Personal Protective Equipment (PPE); - Treat and contain the removed soil as hazardous waste; and - Adopt, to the extent possible, dry cleaning techniques to decrease resulting wastewater, and to avoid flushing of spills to deeper soil layers.	Low	Implementation: Contractor Supervision: CDR	Oil spill response kit: 80 USD Drip trays: 65 USD

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
	Inadequate solid waste management	• Segregate at source domestic-like wastes and construction wastes that can be reused onsite from those that need to be transferred for treatment or disposal; • Sort excavation waste resulting from construction activities into different types (bulky aggregates, fine aggregates, etc.); • Reuse part of the excavation waste in backfilling; and dispose of the rest (if any) in an adopted/authorized construction and demolition waste dump after obtaining a permit either from the municipality itself, the Union of Municipalities, or the Governor (Mohafez); • Material stockpiles should be of certain heights, slopes and be well covered and contained; • Schedule the works during dry season, when possible; • Progressively carry out rehabilitation of disturbed areas following completion of works at all construction sites (rehabilitation will include reinstatement of soil, surface leveling, re-vegetation and mulching, where applicable); and • Ensure that standards of "good housekeeping" are maintained (i.e., avoid littering, prevent storage of combustible waste for more than 24 hours to prevent attraction of pests and flies).	Low	Implementation: Contractor Supervision: CDR	Part of construction activities cost
	Inadequate wastewater management	• Ensure all connections are inspected and are not leaking through the regular inspection of septic/ holding tanks (if any) and connections to the wastewater sewage network; • Obtain a permit from the Municipality or the relevant Water Establishment to transport and discharge the domestic wastewater to an operating treatment facility if needed/ applicable; and • Restrict vehicle washing to contained maintenance areas offsite or onsite with impermeable concrete pavement and proper drainage.	Low	Implementation: Contractor Supervision: CDR	Part of construction activities cost
Waste Generation	Construction-related solid and liquid wastes generation	• All construction workers and personnel should be responsible for ensuring that standards of "good housekeeping" are maintained. This will include: - Clear all rubbish and work associated debris; - Sort domestic and general waste into combustible (paper, food, cardboard, and wood) and non-combustible waste (metals, glass, rubble) streams at source by means of suitably labeled containers for safe collection, segregation and handling of all waste streams generated; and - Avoid storage of combustible waste for more than 24 hours to prevent attraction of pests and flies. • Regularly inspect garbage bins; • Sort and collect hazardous wastes separately from domestic waste. All hazardous waste bags should be properly labeled and stored so as to prevent occupational health hazards; • Compile log sheets of hazardous wastes, including type, amount and disposal method, to track final destinations and identify opportunities for improvement; • Transport excavation and construction wastes in covered/closed trucks for disposal in currently available dumpsite locations until a permitted sanitary landfill is made available by the Government; the disposal location shall be approved by the concerned municipality, CDR and MoE; • Regularly inspect and maintain septic tanks (if any) to detect and prevent leaks; • Ensure that the quality of the hydro-test water is compliant with decision 8/1 for the discharge of wastewater into sewage network or surface water bodies; and • Collect the concrete wash water in a designated tank and allow for water to evaporate and the concrete to harden to dispose it off with construction waste.	Medium	Implementation: Contractor Supervision: CDR	Part of construction activities cost
Depletion of Resources					

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
Biological Resources	Excavation and construction activities	The biodiversity of the area will not be irreversibly affected as no endangered species are reported in the area. Impact on local flora and fauna will be due to construction works but will only be ***negligible to low***. Mitigation measures to minimize these impacts resulting from the construction of the networks, the WWTP and pumping stations include: • Minimize disturbance of natural land by excavating and constructing necessary areas of land only; • Stay away from the KBAs while transporting materials and equipment to and from the project's sites, i.e., use roads that are far away from the KBAs boundaries to minimize negative impacts on these areas • Prohibit unnecessary cutting or damaging of wild plants and trees, specifically the wild species; • Obtain the needed permissions and approvals from MoA upon initiation of construction works, before clearing trees; • Trees that will not be cleared should be separated from the construction area by a barrier placed at an appropriate distance from the tree trunk. It is generally recommended that the barrier is placed at a distance equal to the branch spread of the tree or half its height, whichever is greater. When branches are in the way, they should be pruned rather than removing the whole tree; • Olive and fig trees are sturdy, and usually respond well to transplanting especially in the fall season, when soil and air temperatures are still warm and thus the roots can become established. Thus, it is recommended to transplant all trees of these two species (67 olive trees and 21 fig trees; other tree species' survival chances following translocation are low) once they are cleared from the affected plots. For higher chances of successful transplantation of olive and fig trees, the following method is suggested: - Tree leaves should be removed off the top branches; - Dig the hole around the trunk as deep as possible to expose the main roots of the tree. Trees could be removed with the help of a JCB Backhoe, while keeping as much of the soil intact as possible. - Trees should be removed with their soil and each gently put in a big pot. Some humus or peat moss should be added at the bottom of each pot before placing the dug tree in it. The top of the pot should also be covered with a layer of humus soil or peat moss. The trees should be delivered to the Municipality and watered regularly. • Coordinate with the Municipality of Saouiri, before initiating construction works to ensure translocation of all olive and fig trees (total of 88 trees) upon their clearance within the shortest period of time to increase their chances of survival; • Avoid construction works during the bird migration seasons only within plots of Medium ecological value in Saouiri because this area falls on the migratory route of birds for both seasons. The peak spring migration season is from March to mid-May, whereas the fall one is during September and October; • Proper disposal of domestic and construction waste at designated sites; • Enclosing all fine earth materials during transportation to and from the site to prevent spillage and dusting; and • Proper storage and prompt transportation of construction material to prevent them from being washed away during rainfall or carried by wind. • Spreading excavated topsoil containing pollen and roots of the original vegetation at the peripheries around the WWTP upon completion of construction works in order to regenerate and reintroduce some of the native flora species present in the area; • With regard to treatment plant site, this will be planted with trees along the sites' borders and in selected places; and • Supervising the implementation of the proposed Waste Management and Spill Contingency plans.	Beneficial	Implementation: Contractor Supervision: CDR	Part of construction activities cost

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
Water Resources Consumption	Water for construction activities and domestic use	• Adopt a water saving plan during the construction phase and limit the amount of water used for workforce daily uses.	Low	Implementation: Contractor Supervision: CDR	Part of construction activities cost
Energy Resources	Energy consumption during construction activities	• Use equipment with higher fuel efficiency • Adopt a periodic inspection and maintenance schedule for power generators and equipment engines, as per manufacturer specifications, and maintain maintenance logs; • Report and monitor monthly fuel and energy consumption records to keep track of consumption levels and identify overuse; • Avoid unnecessary idling of vehicles and equipment engines.	Medium	Implementation: Contractor Supervision: CDR	Part of construction activities cost
Other Impacts					
Traffic	Increase in traffic during construction	• Limit speed on the construction sites to 20 km/h unless otherwise advised, and adopt careful logistical and route planning; • Position any necessary traffic diversion signs and devices correctly. Signs and devices should be clearly displayed in the Arabic and English languages. Temporary traffic signals and signs should be employed to warn of hazards and provide directions, especially on narrow one-lane roads; • Coordinate with the concerned municipalities with respect to the planned road blockages, detours or diversion, and the scheduling of the construction works including material delivery, waste transfer, truck movement and other machinery operations in order to limit the disruption to the neighborhood from traffic inconveniences and traffic flow and to minimize noise and dust generation; • Follow a specific schedule for transport to avoid interference with peak traffic hours and minimize disturbance/delay to commuters at rush hours on the roads leading to the Project construction sites; and • Fill up all holes and trenches, and level all mounds and heaps of earth, and exposed surface reinstatement, which have been excavated or made in connection with the works immediately upon completion of any part of the works.	Medium	Implementation: Contractor Supervision: CDR	Part of construction activities cost
Archaeology	Potential damage to undiscovered archaeological features during excavation	• Coordinate with DGA for a survey to be conducted prior to the initiation of works, allowing to identify any possible prehistorical and archaeological remains on the different locations of the Project; and • Ensure that all crew members and site engineers are made aware of the laws and regulations related to archaeological findings and are capable of identifying any if encountered. • If any material were to be found during the survey, DGA is the only authority to determine the required operations and to give the approval to commence construction works. During construction, excavation and/or leveling works, excavation in sites of known archaeological interest should be avoided. Where this is unavoidable, prior discussions must be held with the DGA in order to undertake pre-construction excavation or assign an archaeologist to log discoveries as construction proceeds. Where historical remains, antiquity or any other object of cultural or archaeological importance are unexpectedly discovered during construction in an area not previously known for its archaeological interest, a "Chance-Find Procedure" should be applied. This procedure should be included in all sub-contractors' contracts under a "Protection of Prehistorical, Archaeological and Historical Sites" clause, developed in accordance with the Lebanese regulations (Decree 3057/ 2016) and the World Bank Guidance – OP 4.11. The following actions should be taken: • Stop construction activities. • Delineate the discovered site area. • Notify the responsible foreman/archaeologist who in turn should notify the DGA (within less than 24 hours). • Secure the site to prevent any damage or loss of removable objects. In case of removable antiquities or sensitive remains, a night guard should be present until the responsible authority takes over. • Responsible authorities would be in charge of protecting and preserving the site before deciding on the proper procedures to be carried out.	Medium	Implementation: Contractor Supervision: CDR, DGA	Part of construction activities cost Cost of additional works relating to the chance find procedure: to be determined

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
		• An evaluation of the finding will be performed by the DGA. The significance and importance of the findings will be assessed according to various criteria relevant to cultural heritage including aesthetic, historic, scientific or research, social and economic values. • Decision on how to handle the finding will be reached based on the above assessment and could include changes in the project layout (in case of finding an irrevocable remain of cultural or archaeological importance), salvage excavations, in situ conservation, preservation or restoration. • Implementation of the authority's decision concerning the management of the finding. • Construction works can resume only when permission is given from the DGA after the decision concerning the safeguard of the heritage is fully executed. In case of Archeological finds, the Contractor should refer to the Conditions of Contract (General Conditions of Contract (FIDIC); and CDR Safety, Health and Environmental Regulations). These include the following: • In case of delay incurred in direct relation to archaeological findings not stipulated in the contract (and affecting the overall schedule of works), the contractor may apply for an extension of time. However, the contractor will not be entitled for any kind of compensation or claim other than what is directly related to the execution of the archaeological findings works and protections. • The duration of any actions needed in case of Chance Finding cannot be determined ahead of time. As for the estimated price, it varies according to the needed manpower / time frame for the needed procedures, and can only be determined in accordance with the needed works.			
Socio-economic	Creation of new job opportunities	-	-	-	-
	Child Labor	• The assigned Contactor is bound to comply with laws prohibiting child labor and shall follow all applicable laws that recognize children's rights and minimum age of employment. • Maintain a record of labor registry and age verification. • Inform all workers of the internal GRM figuring in Section 6.2 of the ESMP report for the Marj sewage networks for reporting any problems or complaints they might have, and ensure it is properly implemented.	Low	Implementation: Contractor Supervision: CDR/ World Bank	Part of construction activities cost
	Social tension between foreign and local workers, and the host community	• The Project implementing agency – CDR- should ensure that the awarded Contractor is committed to adherence to the principles that define equal employment opportunity, while also complying with Decision 29/1 of 2018 restricting a number of jobs in the construction sector to Lebanese citizens. Therefore, equal employment opportunities will be provided to all qualified candidates regardless of color, citizenship status (when applicable), race, religion, gender, and marital status through clear selection criteria. Nonetheless, construction works in Lebanon have always been occupied by foreign labor, namely Syrian labor force. • Inform all workers of the internal GRM for reporting any problems or complaints they might have. • Inform local citizens of the external GRM in case they face problems with workers, or if they have any complaint.	Low	Implementation: Contractor Supervision: CDR/World Bank	Part of construction activities cost

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
	Labor- induced sexual abuse and exploitation/ harassment	• Conducting rigorous pre-employment checks of all candidates to avoid hiring any previous offenders; • The Contractor should have a Code of Conduct Policy that all hired labors should sign and follow the employee code of conduct policy; • All hired laborers should undergo mandatory training that coves sexual abuse and exploitation/harassment, and Gender-Based Violence. Sexual abuse and exploitation/harassment includes, but is not limited to: - Underage sexual activity; - Exchange of money, employment, goods, or services for sex or sexual favors; and - Engaging in sexual activities with sex workers. Gender-Based Violence can be broadly defined into five categories, and these include: - Sexual violence – rape, sexual assault, and sexual harassment; - Physical violence – hitting, slapping, and beating; - Emotional violence – psychological abuse; - Economic violence – denial of financial resources; and - Harmful traditional practices – forced marriages, and female genital mutilation. • Reporting allegations of sexual abuse and exploitation/harassment and Gender-Base violence through confidential reporting tools. All allegations should be investigated, and if these allegations are proven, strict disciplinary measures should be promptly taken.	Medium	Implementation: Contractor Supervision: CDR/World Bank	Part of construction activities cost
	Damage to the existing infrastructure	• Trial pits should be executed along the network route to locate the existing infrastructure components; • Sewer lines should be installed at least[1] 3 meters horizontally from and 0.3 meters lower than existing water main lines; • Where the separation requirements cannot be met due to topography, inadequate right-of-way easements, or conflicts with other provisions of these regulations, lesser separation is permissible if: - The water main and the sewer are located as far apart as feasible within the conditions listed above; - The water main and the sewer are not installed within the same trench; and - The sewer line is appropriately constructed to prevent contamination of the water in the main by sewer leakage. • No water main lines should pass through or come into contact with a sewer manhole; and • Ensure the community GRM figuring in the ESMP report for the Marj sewage networks is properly disseminated and implemented.	Low	Implementation: Contractor Supervision: CDR	Part of construction activities cost
	Property loss due to expropriation	• The CDR and PMU should ensure the proper implementation of the LAP and the grievance redress mechanism developed in the LAP Report for the Marj sewage networks in order to fairly compensate PAPs and address all complaints and grievances within an acceptable period of time and to the satisfaction of the plot owners; and • Ensure the community GRM figuring in the ESMP report for the Marj sewage networks is properly disseminated and implemented.	Medium	Implementation: CDR Expropriation Unit Supervision: CDR PMU/World Bank	Part of construction activities cost

[1]Separation distances specified should be measured from the nearest outside edges of the facilities.

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
	Disturbances to nearby sensitive receptors from noise and dust generation and traffic	• Properly implement the mitigation measures proposed for dust and noise emissions and traffic; and • Ensure the community GRM figuring in the ESMP report for the Marj sewage networks is properly disseminated and implemented.	Low	Implementation: Contractor Supervision: CDR	Part of construction activities cost
	Increased pressure on existing infrastructure	• The Project implementing agency – CDR - will ensure the compliance of the awarded Contractor with the proposed waste management plan (refer to Section 5.11.2 of the ESMP report for the Marj sewage networks); and • Ensure the community GRM figuring in the ESMP report for the Marj sewage networks is properly disseminated and implemented.	Low	Implementation: Contractor Supervision: CDR	Part of construction activities cost
Health and Safety Hazards	Potential risks to general health and safety of the sites' workers, nearby residents, commuters, and pedestrians	• Surround the construction areas with scaffolding nets; • Provide sufficient lighting; • Prohibit keeping trenches unnecessarily open and install barriers to avoid falling and tripping; • Fence off all construction sites to prevent unauthorized access; • Keep machinery and vehicles passages clear; • Implement a speed limit of 20 km/h for vehicles arriving to and leaving the construction sites; • Provide workers with the appropriate PPE (goggles, dust masks, helmets, hearing protection equipment, proper clothing, safety boots, etc.) and enforce their use; • Maintain the PPE (cleaning when dirty and replacement when damaged or worn out); • Ensure the availability of adequate loading and unloading space; • Prohibit smoking and littering; • Ensure that an easily accessible first-aid station is provided on-site; • Post adequate signs at visible locations throughout the construction area indicating type of operation, potential risks, and appropriate medical/emergency action response; • Perform staff training about the fundamentals of occupational health and safety procedures, and about handling hazardous material containers and related wastes; and • Implement the required air emissions and noise mitigation measures listed above.	Low	Implementation: Contractor Supervision: CDR	PPEs Prices/ person: Overall ~12 USD Boots ~100 USD Helmet ~ 5 USD PVC Gloves ~2 USD Welding Gloves ~ 4USD Goggles ~ 3 USD Mask ~8 USD Reusable ear plugs ~1.5 USD Ear Muffs ~28 USD First Aid Kit (for 100 workers) ~200 USD
Emissions					
Surface Water	Discharge of treated effluent water from the WWTP	• The treated effluent will be of high-quality meeting the standards for discharge to surface waters and this must be ensured through **continuous monitoring.** Main recommendations aiming to reduce the likelihood of occurrence of operational deficits include at least: • Proper **management** of the WWTP site coupled with continuous and effective monitoring and maintenance; • Keep **records** of wastewater quality at the entrance of the plant and of the produced effluent at the exit of the plant; • Ensure redundancy in the WWTP design; indeed, the selected processes show high tolerance in variations of flow and quality of the incoming wastewater; • Provide adequate **training** to plant operators to minimize the risks and effects of abnormal operating conditions; • Regular **inspections** of the WWTP by the competent authorities; and • Implement a **WWTP emergency response plan**, in case of abnormal operation.		BWE	Part of operation activities cost

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
Air	Foul odor emissions from the WWTP or pumping stations (Possible leaks and overflows in the pumping stations)	• Ensure proper construction of the sewage network; • Ensure that a regular inspection and maintenance schedule is in place for the sewage network and pumping stations to avoid blocked, broken or cracked pipes and proper operation of the pumping stations; and • Establish an odor complaint grievance mechanism as a measure to allow implementation of timely and effective actions to minimize impacts from odors on downwind receptors. • Proper engineering and adequate preventive measures for the system. The design of the WWTP foresees that odor producing units will be installed in close units equipped with odour control units. Specifically, the odour control unit will collect and treat the odours from: - The preliminary treatment building (screening, grit & oil removal), - The sludge dewatering building. • All malodorous solid waste (screenings, grit, etc.) will be stored in closed containers until their final disposal. • In the aerobic steps of the WWTP, adequate oxygen is provided to maintain constantly aerobic conditions of operation. The malodours are produced whenever anaerobic conditions are created. Thus, it is crucial that dissolved oxygen levels are continuously monitored and that the relevant air (oxygen) supply equipment of the WWTP is well and regularly maintained. • The Operator should also monitor odorous compounds at the fence of the WWTP to ensure that the corresponding limits (mainly H_2S and mercaptans) are met. • Proper landscaping (trees plantation) around the facility will also serve as a natural windbreaker, reducing any odour dispersion. Regarding GHG emissions, the WWTP is designed taking into consideration energy efficiency principles with low carbon footprint, resulting also in reduced operational costs. • During operation, the implementation of good operating practices and regular maintenance should ensure that the foreseen energy requirements at the design stage are not exceeded.	Low	BWE and concerned Municipalities	Part of operation activities cost
Noise	Noise from the WWTP and pumping stations' normal operation and maintenance activities	Noise during **WWTP operation** would arise from heavy machinery and equipment, when in use. Proposed noise mitigation measures include: • Selecting equipment that conforms with international standards on noise levels; • Placing air blowers and other noisy equipment in isolated (or noise proof) rooms to ensure that noise levels at the WWTP fence comply with the national standards; • Equipping all internal combustion engine driven equipment with intake and exhaust mufflers; • Keep equipment maintained in good working condition and in accordance with the manufacturer's instructions; and • Fencing and screening the site with a 'green belt' to muffle any residual noise generation. Noise from the network component operation is expected to arise mainly from the operation of the **pumping stations**. Properly enclosing the stations and keeping them well-maintained at all times would reduce any such impacts.	Low	BWE and concerned Municipalities	Part of operation activities' cost
Soil and Ground Water Resources	Potential contamination from wastewater overflows and/or leakages from the network and pumping stations, or failure of the WWTP	The treated effluent will be of high-quality meeting the standards for discharge to surface waters, which will in turn protect groundwater resources. This must be ensured through **continuous monitoring.** In order to reduce the risk of groundwater contamination from network leakages, the following shall be implemented as a minimum: • proper bedding, backfilling and compaction of soil during the construction of the network; • network pipes to be ideally of a material that is resistant and durable; • regular inspection and maintenance of electrical and mechanical components of the pumping stations;	Low	BWE and concerned Municipalities	Part of operation activities' cost

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
		• installation of pressure monitors on pressure mains to allow for early detection of leaks in the network; • installation of an emergency flow line or bypass chambers to allow for sewage flow to be diverted in case repairs to the sewer are needed; • in case of complete pump failure, wastewater storage within the collection system itself will be an option to avoid uncontrolled discharge to the environment; • provision of stand-by generator, with sufficient capacity, to start-up and maintain the firm capacity of the pumping stations, to ensure their continued operation in case of generator failure during power blackouts, and to avoid wastewater overflows, • regular testing (monthly) of back-up power (generator) at pumping stations; • implementation of a flow monitoring program to record changes in flow patterns; • undertake a regular monitoring program within the wastewater collection system to evaluate the levels of H_2S within the system in order to avoid corrosion; • carry out flushing and a CCTV program to observe gravity sewer condition and monitor changes every 5 years; • register locations where sediment accumulation or other issues of concern have been noted to increase maintenance activities; • periodically swab pressure mains, if possible; • install an alarm system at the pumping stations, monitoring operational parameters of the pumping stations and the status of the standby generator system; • immediately report any leakages to municipal/governmental representatives; and • Stopping the source of leak (close valve, seal pipe, seal hole or as appropriate) as soon as possible. • Proper operation and maintenance procedures for the sewage network including replacing network portions with an expired design life; • Ensure sewage network manholes are closed with proper lids to prevent blockages from fallen bulky objects; • Prepare an Emergency Response Plan in case of sewer overflows due to clogs in sewer lines or ground subsidence. The Emergency Response Plan will most likely consist of diverting the existing sewage flow to ensure uninterrupted service during maintenance activities, by installing a temporary bypass using flexible pipes, and a sump pump. An Emergency Response team assigned by BWE (operator) must follow the established Emergency Response Plan, and must have access to all sewer facilities, in order to repair any component due to contingencies related to sewer overflows. In case of overflow: - Clean the sewer line to remove grease, grit, and other debris that may lead to sewer overflow (in case of overflow due to clogging); or - Replace sewer line and backfill around the manhole equally to prevent tipping, and compact the fill (in case of ground subsidence). In the case of a breakage in a network pipe within the WWTP area, containment of spill and contamination should be performed on-site by adopting the following: - Ensuring the proper insulation of pipes and tanks during WWTP construction; - Stopping the source of leak (close valve, seal pipe, seal hole or as appropriate); and - Immediate cleaning of the spill by trained employees. • Proper **management** of the WWTP site coupled with continuous and effective monitoring and maintenance.			

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
Waste Generation	Operation- and maintenance-related solid and liquid wastes generation	• Generated sludge should be tested for suitability of use as a soil conditioner as per FAO guidelines. • If the resulting sludge cannot be used as a soil conditioner it will be thickened, dried using a filter press, stabilized with lime and tested (leaching test) to check its suitability for landfilling. If landfilling is not possible, and in case results showed it contains heavy metals beyond standards it shall be treated as a hazardous waste and be sent to a hazardous waste landfill or safely stored in a 5,000 L tank next to the wastewater treatment plant until such a landfill becomes available. • Provide as practicably possible low toxic or environment-friendly (biodegradable) detergents for general cleaning purposes.	Low	BWE and concerned Municipalities	Part of operation activities' cost
Depletion of Resources					
Biological Resources	Normal operation of the system	The project's operation will have an overall positive impact on biodiversity mainly as a result of the reduction of uncontrolled wastewater discharges in the area. Nevertheless, localized negative impacts may result from leaks in networks, or from abnormal operation of the pumping stations and/or WWTP. To eliminate the risk of these impacts, the following measures are foreseen: • Proper engineering and adequate preventive measures, as discussed in previous sections; • Implementation of the Network Leakage Prevention; • Double number of spare power generators to allow for WWTP Operators to bring back to normal the operating conditions of the plant and prevent any uncontrolled discharges to occur. • Proper management of liquid and solid waste generated by maintenance activities; • Prevention of littering in the area;	Beneficial	BWE and concerned Municipalities	Part of operation activities' cost
Energy Resources	Energy consumption during maintenance activities	• Adopt a periodic maintenance schedule of power generators, as per manufacturer specifications, and maintain maintenance logs; • Upgrade machines/equipment used for maintenance activities to more energy-efficient technology for the purpose of reducing consumption; and • Switch off all machines/ equipment or any other energy consuming appliances when not in use.	Low	BWE and concerned Municipalities	Part of operation activities' cost
Other Impacts					
Traffic	Increase in traffic during maintenance works	• Avoid maintenance works during peak traffic hours; • Display temporary traffic signals and signs to warn of hazards and provide directions especially on narrow one-lane roads; and • Coordinate with municipal police in case of need for road closure and rerouting to be able to carry out specific maintenance activities, preferably ahead of time.	Low	BWE and concerned Municipalities	Part of operation activities' cost
Socio-economic	Improvement of overall socioeconomic and environmental conditions of serviced communities, and receiving environment from contamination with wastewater		-	-	-
Health and Safety Hazards	Potential health and safety risks to operation and maintenance	• Provide maintenance workers with the appropriate PPE (goggles, dust masks, helmets, hearing protection equipment, proper clothing, safety boots, etc.) and enforce their use; • Post adequate signs at visible locations throughout the maintenance areas indicating type of operation, potential risks, and appropriate medical/emergency action response;	Low	BWE and concerned Municipalities	PPEs Prices/ person: Overall ~12 USD Boots ~100 USD

Source of Impact	Project Activities	Mitigation Measures	Residual Impacts	Institutional Responsibility	Cost Estimation*
	workers and nearby receptors, pedestrians, and commuters from maintenance works or from sudden overflows or leakages in the system	• Prohibit keeping trenches unnecessarily open and install barriers to avoid falling and tripping; • Fence all maintenance sites to prevent unauthorized access; • Store and handle chemicals (if any) as directed by their material safety data sheets and use the required PPEs; • Conduct regular training for workers about health and safety requirements; • Implement the required ambient air emissions and noise mitigation measures listed above respectively. • An appropriate number of site personnel are trained in First Aid. On all construction sites, first aid facilities are provided in an accessible location; • Establish a fire protection & prevention program; Fire-fighting equipment is available at the working sites as appropriate; The following mitigation measures will be undertaken to safeguard occupational health and safety due to the operation of the WWTP: • The BWE/MoEW will ensure that operation and maintenance personnel of the WWTP are fully aware of the hazards involved in the running of a system of this nature. • All site employees will be **trained** in hygienic procedures designed to avoid infection from wastewaters and sludge**;** • In particular, **emergency procedures** will be developed in the event of the **release of chlorine gas**. A warning device for the detection of chlorine gas will be provided where chlorine is to be used; • Providing appropriate safety equipment, fire protection measures, and monitoring instruments (e.g. gas detectors); • **Proper labelling and storage of chemicals** (Chlorine gas or powder), oils, and fuel to be used on-sites will be ensured; • Unattended **public access** to the wastewater treatment plants will be **restricted** by proper fencing and guarding; • Movement of equipment and vehicles within the WWTP site will be controlled and **low speed limits** will apply; • Properly **rating electrical installations and equipment** and, where applicable, protecting them from flammable atmosphere; and • Providing sufficient **lighting** that should comply with zoning requirements.			Helmet ~ 5 USD PVC Gloves ~2 USD Welding Gloves ~ 4USD Goggles ~ 3 USD Mask ~8 USD Reusable ear plugs ~1.5 USD Ear Muffs ~28 USD First Aid Kit (for 100 workers) ~200 USD
	Improved public health conditions from the proper management of wastewater	-	-	-	-

2.2 MONITORING PLAN*

*It is important to note that it is very difficult to provide cost estimation at the moment because of the instable cost of services in Lebanon and the varying prices.

Phase	Impact	Parameters to Monitor	Frequency	Monitoring Location	Number of Samples/Monitoring Points	Standards/Guidelines National/International	Institutional Responsibility	MoE Ref.
Construction	**Emissions**							
	Air Pollutants	• Recorded respiratory health problems among workers • Color of fumes from equipment and construction generators • Emissions of Generators and construction equipment	• Workers' respiratory problems: monthly • Color of fumes from equipment and generators: daily (visual) • Generators' and equipment's emissions: before starting construction works and monthly afterward	• Workers' respiratory problems: workers' health records • Color of fumes from equipment and generators: stacks • Generators' and equipment's emissions: stacks	• Generators and equipment stacks for color of fumes • Emissions at generators and equipment stacks for air emissions, and ambient air quality at nearest receptors	• MoE Decision 8/1, dated 2001 (National Standards for Environmental Quality (NSEQ)- Appendix 2-9 for stack emissions • MoE Decision 52/1 – Section 14 for ambient air quality (at receptors)	Site officer HSE	Construction Manager/ Contractors
	Noise	L_{eq}, L_{max}, L_{min}, L_{90} dB(A)	• Three times daily during grading and excavation • Once daily during concrete pouring, pipes laying, WWTP and pumping stations construction	Nearest sensitive receptors	Depending on number of receptors	MoE Decision No. 52/1 (Section 10 (Noise Standards)	Site officer HSE	Construction Manager/ Contractors
	Wastewater Generation	Leakages	Daily	Networks (if applicable) and labor sanitary facilities	Visual inspection	Decree No. 2761of 1933 (Provides guidelines related to wastewater management and disposal; related to the pollution caused by the discharge of liquid waste, emphasizes the prohibition of direct or indirect wastewater discharges and waste disposal into water streams)	Site officer HSE	Construction Manager/ Contractors
	Solid Waste Generation	• Waste types • Waste generation rates (kg or tons/day) • Waste reused • Waste transported for offsite reuse/recycling • Waste disposed of • Method and location of disposal	Daily	Construction sites (waste storage)	Daily records	Law 80/2018 (ISWM Law) Law No. 973 dated 1974 (Related to solid waste pollution; followed by the application of Decree No. 8735)	Site officer HSE	Construction Manager/ Contractors
	Depletion of Resources							
	Energy Resources	Fuel bills and fuel quantities consumption follow up	• Daily records • Monthly report	Construction sites	Fuel and electricity bills	-	Contractor	Construction Manager/ Contractors
	Water Resources	Water consumption (m^3/day) (install water meters to calculate volume consumed per week if applicable)	• Daily records • Monthly report	Construction site	Water bills	-	Contractor	Construction Manager/ Contractors
	Other Impacts							
	Socio-economic	Number/ percentage of local workers	Before commencement and during construction works (monthly)	Construction sites	Employee records	-	Contractor	Contractors

Phase	Impact	Parameters to Monitor	Frequency	Monitoring Location	Number of Samples/Monitoring Points	Standards/Guidelines National/International	Institutional Responsibility	MoE Ref.
	Health and Safety Hazards	• Proper PPE use • Good housekeeping practices • Number, type and cause of accidents and injuries	Continuous	Construction sites	Accidents records	National Decree No. 11802 dated 2004 (Organizing prevention, public safety and occupational health in all institutions subject to the Labor Law)	Site HSE Officer	Contractors
	Archaeology	Monuments/objects found during the works, and measures taken	Daily	Construction sites	Visual inspection	National Decree No. 3057 dated 2016 which defines and regulates the procedures followed by the DGA for preventive and rescue excavations.	Workers, Site HSE Officer, Contractor and Supervision Consultant	Contractors
Operation	**Emissions**							
	Influent Wastewater in WWTP	Influent Flow Rate, Temperature, pH, TSS,VSS, BOD, COD, TN, Ammonia, Nitrates, Phosphates, TP	Daily	WWTP	One during commissioning, Monthly once WWTP operation has stabilized and is achieving compliance with applicable standards	MoE Decision 8/1	Operator	BWE
	Effluent discharge from WWTP to be discharged to Litani River	Flow rate, pH, TSS, VSS, Temperature, pH, TSS,VSS, BOD, COD, TN, Ammonia, Nitrates, Phosphates, TP, Heavy Metals, TC, FC	Daily	WWTP effluent point	One during commissioning, Monthly once WWTP operation has stabilized and is achieving compliance with applicable standards	MoE Decision 8/1	Operator	BWE
	Wastewater leakages/ overflow	Leakages/ overflow from network/ pumping stations and WWTP	Daily	Networks, pumping stations and WWTP	Visual inspection	Decree No. 2761of 1933 (Provides guidelines related to wastewater management and disposal; related to the pollution caused by the discharge of liquid waste, emphasizes the prohibition of direct or indirect wastewater discharges and waste disposal into water streams)	Operator	BWE
	Sludge from WWTP	Dry Solid Content, Sludge Density, Lead, Cadmium, Chromium, Copper, Nickel, Mercury, Zinc, leaching test	Monthly	WWTP	1	Wastewater reuse and Sludge Valorisation and reuse: Proposition for Lebanese Guidelines on Sewage Sludge Use in agriculture UN-FAO 2010	Operator	BWE
	Air pollution around WWTP	Gases emitting odour: • Mercaptans • Hydrogen Sulfide • Ammonia	Upon reception of complaints relating to odors	WWTP fence/ receptor where odors are reported to be perceived	1	Y. Nagata, Measurement of Odor Threshold by Triangle Odor Bag Method In Odor Measurement Review (Japan: Office of Odor, Noise and Vibration Environmental Management Bureau, Ministry of the Environment, Government of Japan, 118–12, 2003)**	Operator	BWE
	Solid Waste Generation	• Quantity of sludge generated • Quantity of maintenance waste and parts generated • Method of disposal	During networks, WWTP and pumping stations' maintenance activities	Maintenance locations	Records of waste generation and management	Law No. 973 dated 1974 (Related to solid waste pollution; followed by the application of Decree No. 8735)	Operator	BWE

Phase	Impact	Parameters to Monitor	Frequency	Monitoring Location	Number of Samples/Monitoring Points	Standards/Guidelines National/International	Institutional Responsibility	MoE Ref.
	Other Impacts							
	Public health and safety	Number and cause of accidents among workers during operation and maintenance works	During operation and maintenance activities	Maintenance locations	Accidents records	National Decree No. 11802 dated 2004 (Organizing prevention, public safety and occupational health in all institutions subject to the Labor Law)	Operator	BWE

** Another reference standard could be used: the Indian: https://cpcb.nic.in/openpdffile.php?id=UmVwb3J0RmlsZXMvTmV3SXRlbV8xNDFfcGFja2FnZV9vZG91cnJlcG9ydF8yLjEyLjA4LnBkZg

2.3 EMERGENCY PLAN

Contingency measures and plans in case of emergency have been addressed throughout the EMP; however, this section is to recall the most important steps to be taken in case of emergencies:

In case of sewer overflows due to clogs in sewer lines or ground subsidence, the Emergency Response Plan will consist of diverting the existing sewage flow to ensure uninterrupted service during maintenance activities, by installing a temporary bypass using flexible pipes, and a sump pump. An Emergency Response team assigned by BWE (operator) must follow the established Emergency Response Plan, and must have access to all sewer facilities, in order to repair any component due to contingencies related to sewer overflows. In case of overflow:

- Clean the sewer line to remove grease, grit, and other debris that may lead to sewer overflow (in case of overflow due to clogging); or
- Replace sewer line and backfill around the manhole equally to prevent tipping, and compact the fill (in case of ground subsidence);
- The installation of an emergency flow line or bypass chambers also allows to divert sewage flow in case repairs to the sewer are needed;
- An emergency storage pond can be constructed near lifting stations for storage of wastewater in case of pump failure;
- In case of complete pump failure, wastewater storage within the collection system itself is a preferable solution to a discharge to the environment;
- A standby generator with sufficient capacity to start-up and maintain the firm capacity of the station is needed to ensure the continued operation of lifting stations in case of generator failure during power blackouts, and to avoid flooding in such cases;
- Regular testing (monthly) of back-up power (generator) at pumping stations.

Pumping station Contingency measures and plans in case of emergency:

- Stand-by equipment (pumps, WWTP equipment, etc.)
- Back-up power supply (electrical generators) maintaining the operation of the WWTP and pumping stations in case of any local power failure;
- Overflows for the WWTP and pumping stations in case of plant failure (at the various stages of treatment);
- Regular checkups and preventive maintenance;
- Corrective maintenance;
- Process operational procedures;
- Leakage detection system at the main collector where needed;
- Pumping stations retention basins;
- Fire fighting system.

Throughout the limited remaining phases of the construction and throughout the operation of the project, the workforce is to be continuously informed of any hazardous issues that may materialize during these periods. Moreover, residents of the project during the operational period should in turn be informed accordingly should a hazard persist. Stringent emergency procedures are to be assigned that will intercept any pollution that may occur as a result of structural damage due to any natural disaster occurrences. A requirement should be set in the tender document that forces the awarded contractor to perform regular and frequent maintenance checkups of the facility. These preventive measures and design considerations will ensure a continuous and uninterrupted operation of the system.

2.4 INSTITUTIONAL STRENGTHENING

A main objective of the Al Marj Region wastewater project is to improve public health and safeguard water quality in the Project Area. The beneficiaries from the Al Marj Region wastewater system services should be aware of their responsibilities and of the advantages provided by the system. In this respect, it is recommended to carry out public relation campaigns. These campaigns should focus on informing the public about water sanitation hygiene as well as about tariff-related subjects.

An appropriate information policy of a company or organization increases the transparency of its activities, and therefore enhances the understanding of the public for undertaking the necessary measures. This improves the contentment of beneficiaries with the provided services. It also affects the willingness to pay in a positive way and consequently helps to minimize the outstanding of unpaid fees.

The information given to the public should include subjects such as the tariff and investment policy of the owner/operator. Furthermore, it is recommended to inform the public about activities undertaken to ensure cost and service effectiveness. Changes in the tariff structure and tariff increases should be announced in advance, so that private households as well as commercial customers and industries are able to adjust their budget planning to the new level of fees. In this context, the importance of "continuity" has to be highlighted. Continuity of the policy followed by the owner/operator should be obligatory in the short term, e.g. in keeping the tariffs unchanged for a period of several years, and also in the long term. The latter is reflected in the tariff and investment policy and is fundamental for customers.

For functional and sustainable networks and sewage treatment it would be necessary to instruct people how to operate their sewage connection properly. This refers especially in restricting the matters which can be disposed of to sewers. Not to be disposed are toxic substances and liquids, fuel, household garbage and all kinds of solid waste.

All information should be provided in a simple and comprehensive manner and designed individually for the targeted group of customers. Communication media might include:

- Advertisement in regional newspapers, magazines as well as on panels installed in public places and municipal boards;
- Information brochures;
- Brochures or books for school lessons;
- Information on water bills;
- TV and radio spots; and
- Arranging of seminars and activities in local cultural centres.

A general, country-wide public awareness campaign for the purpose of protecting water resources, rationalizing water consumption, improving hygiene and public health might also be carried in cooperation with all organizations and ministries engaged in the field of water supply, wastewater sanitation as well as public health.

2.5 TRAINING REQUIREMENTS

It is very probable that a private company would be in charge of operation and maintenance of the Al Marj wastewater treatment plant. The Bekaa Water Establishment should impose the recruitment of at least one selected employee from its staff to assist in the operation of the wastewater treatment plant so that the transfer of the technology is somehow guaranteed. Therefore, personnel training should be provided to ensure a sustainable and successful project operation and future expansion.

The training should be designed to pass necessary skills and knowledge in the fields of:

- Operation, equipment performance, safety measures, laboratory procedures, treatment process, automation of operation; and
- Maintenance management for routine and preventive maintenance.

Within the Bekaa Water Establishment, it is also recommended to design training measures in fields such as financial and personnel management, accounting and computer applications. The training of the operation personnel is necessary for the whole project but with a special emphasis on the wastewater treatment plant which by its complexity requires more know-how and skills. The training of the operation personnel should especially address the skilled and specialized staff assigned to assist in the plant operation. This training should be initiated during the testing and commissioning period.

The training program should, in principle, comprise the following:

- Organization of the plant operation;
- Monitoring of the plant operation;
- Estimation, analysis and judgment of laboratory tested parameters and all other measured parameters;
- Recognizing the faults or shortcomings during operation of the wastewater and of the sludge treatment unit processes; and
- General maintenance instructions and training for the actual equipment.

Other complementary training should include:

- General knowledge and application of physics, chemistry and basic biology;
- Wastewater, types of wastewater, wastewater production, wastewater characteristics;
- Influence of the operation of the sewerage system on the treatment plant;
- Wastewater treatment process units: mechanical, biological, chemical;
- Equipment used for the wastewater treatment: general aspects, screens, grit removal units, sedimentation tanks, activated sludge tanks, nutrients removal reactors, disinfection, sludge thickeners and sludge dewatering units;
- Sludge: general aspects, types of sludge, amount of sludge and characteristics of sludge;

- Processes and equipment for sludge treatment;

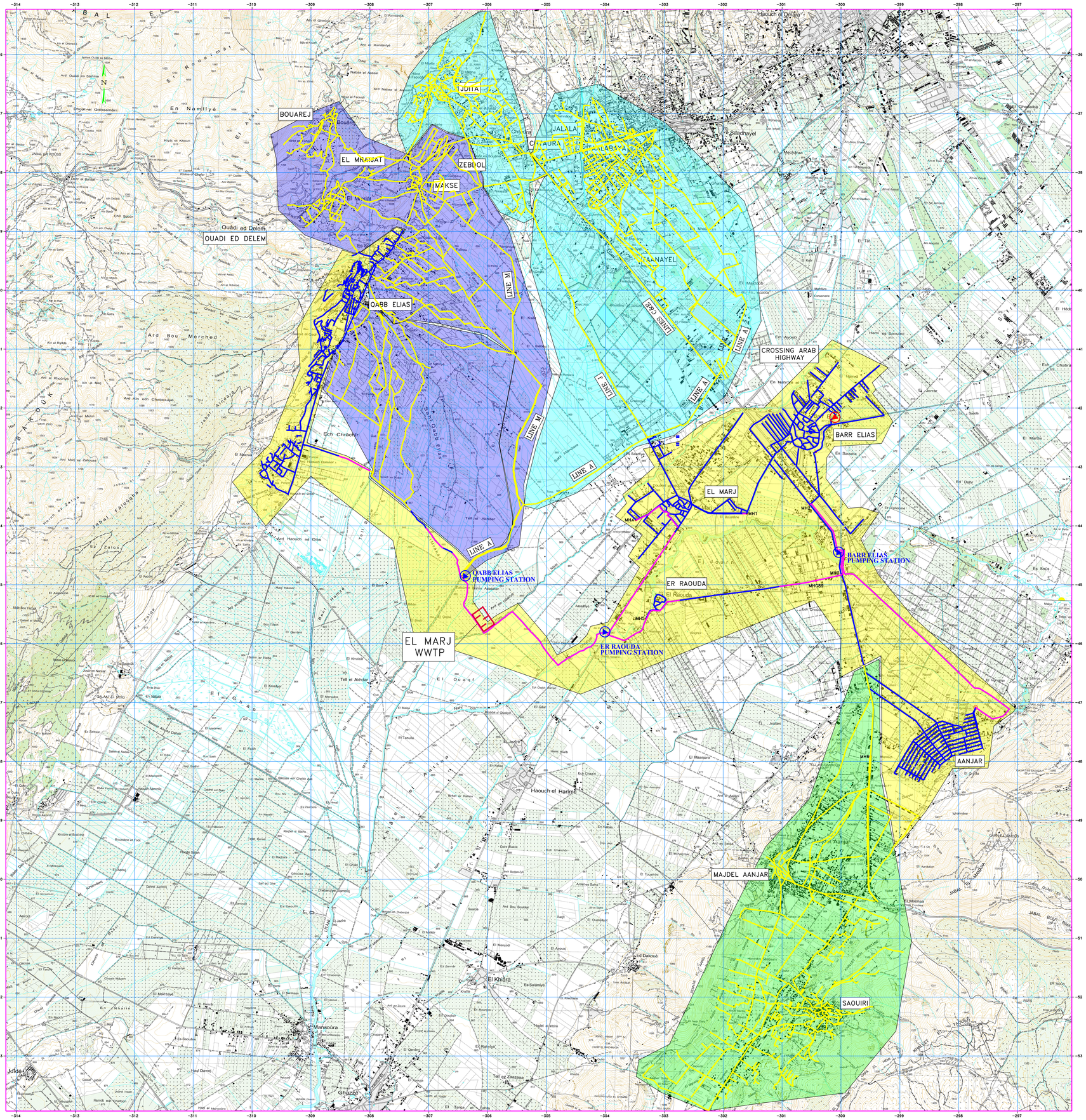
- Mechanical equipment: general aspects, pumps, blowers, compressors, aerators, scrapers, fittings and pipes, motors, sludge dewatering equipment, conveyor belts, electrical equipment, PLCs, monitoring/control equipment, gauges and samplers;

- Operation supervision: daily operation journal, special operation situations, data preparation, interpretation and processing;

- Training in laboratory activities to cover in principle the determination of the physical, chemical and biological values with the equipment provided for the laboratory. The trainees should be able to test the following main parameters: BOD_5, COD, NH_4-N, NO_3-N, Total N, PO_4-P, Total P, total suspended solids, settleable solids, dry solids and volatile solids.

The staff to be trained should have a technical education suitable for working in a wastewater treatment plant or to be educated as chemists and have experience in working in a laboratory. Knowledge of English is deemed necessary.

Appendix A – Map showing the Comprehensive Marj Wastewater System (WWTP, Sewage Networks and Pumping Stations)



LEGEND:

- EXTENSION OF WASTEWATER COLLECTION NETWORKS DRAINED TOWARD EL MARJ WWTP – LOT 1 (WORLD BANK FUND)
- EXTENSION OF WASTEWATER COLLECTION NETWORKS DRAINED TOWARD EL MARJ WWTP – LOT 2 (WORLD BANK FUND)
- EXTENSION OF WASTEWATER COLLECTION NETWORKS DRAINED TOWARD EL MARJ WWTP – LOT 3 (WORLD BANK FUND)
- ANJAR / MAJDEL ANJAR WASTEWATER TREATMENT PROJECT (ITALIAN FUND)
- EXISTING WASTERWATER LINES
- WASTEWATER LINES Under Construction
- WASTEWATER LINES Not Awarded Yet
- WASTEWATER Treatment Plant
- PROPOSED PUMPING STATION
- EXISTING PUMPING STATION

Rev.	Date	Dsgn.	Drwn.	Chk'd	Appr'd

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EXTENSION OF WASTEWATER COLLECTION NETWORKS DRAINED TOWARD EL MARJ WASTEWATER TREATMENT PLANT

WASTEWATER PROJECT	GENERAL LAYOUT

FILE	DESIGNED BY	DRAWN BY	CHECKED BY
473W-000P03	B.T.D	B.T.D	B.T.D

DATE	SCALE	SHEET No.	DRAWING No.
AUGUST 2021	1/25000	1/1	473W-000P03