Environmental and Social Impact Assessment Expansion of Ramtha Wastewater Treatment Plant

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Abbreviations

AADF	Average annual daily flow
AFD	Agence Française de Développement
AJWE	Arabtech Jardaneh Water & Environment
ASL	Amman Silicified Limestone
BOD_5	Five-Day Biological Oxygen Demand
BNR	Biological Nutrient Removal
CH_4	Methane
CHP	Combined Heat and Power
Cm	Centimeters
DBO	Design-build-operate
DLS	Department of Land and Survey
DoA	Department of Antiquities
EBPR	Enhanced Biological Phosphorus Removal
EBRD	European Bank for Reconstruction and Development
ESIA	Environmental and Social Impact Assessment
EMP	Environmental Management Plan
EMRC	Energy and Minerals Regulatory Commission
ESMP	Environmental and Social Management Plan
ESSF	Environmental Social Safeguards Framework
E&S	Environmental and Social
FIDIC	Federation Internationale des Ingenieurs - Conseils
GAM	Greater Amman Municipality

GIS	Geographic Information System
H_2S	Hydrogen Sulfide
IBA	Important Bird Area
IDECO	Irbid District Electric Company
IDF	Intensity duration frequency
IFC	International Finance Corporation
ISO	International Organization for Standardization
JD	Jordanian Dinar
JSMO	Jordan Standards and Meteorology Organization
JVA	Jordan Valley Authority
kg/d	Kilogram per Day
km	Kilometer
km^2	Square kilometers
kW	Kilowatt
lpcd	Liter per capita per day
m	meter
m^2	Square Meters
m^3/d	Cubic Meters per Day
m^3/h	Cubic Meters per Hour
m^3/s	Cubic Meters per Second
mg/kg	Milligram/kilogram
m/s	Meters per Second
mm	Millimeter
MCM	Muwaqqar Chalk-Marl

MEMR	Ministry of Energy and Mineral Resources
MoE	Ministry of Environment
MoH	Ministry of Health
MoL	Ministry of Labor
MWh	Megawatt hour
MWI	Ministry of Water and Irrigation
NGO	Nongovernmental Organization
NH_3	Ammonia NH_3
NO_2	Nitrogen dioxide
NRA	Natural Resources Authority
OHS	Occupational Health and Safety
PAO	Phosphate Accumulating Organisms
PHS	Physical Health and Safety
PM10	Inhalable particulate matter
RAS	Return Activated Sludge
RSCN	Royal Society for the Conservation of Nature
SWD	Side Water Depth
SVI	Sludge Volume Index
SLM	Sound Level Meter
SO_2	Sulphur dioxide
ToR	Terms of Reference
TSS	Total Suspended Solids
URC	Umm Rijam Chert-Limestone
USAID	United States Agency for International Development

YWC	Yarmouk Water Company
WAJ	Water Authority of Jordan
WAS	Waste Activated Sludge
WG	Wadi Umm Ghudran
WHO	World Health Organization
WMP	Waste Management Plan
WS	Wadi Shallalah
WSL	Wadi Es-Sir Limestone
WWTP	Wastewater Treatment Plant

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1 EXECUTIVE SUMMARY

1.1 Introduction

CDM International (CDM Smith) was retained by the United States Agency for International Development (USAID) to undertake the USAID Jordan Water Infrastructure for the purpose of improving the utilization of limited water resources in Jordan and bring about urgently needed enhancements to the water and wastewater systems. Water and wastewater infrastructure improvements are needed throughout Jordan to alleviate water supply shortages, public health issues, and impacts on industry and the economy. The USAID Jordan Water Infrastructure will serve as an umbrella contract for USAID/Jordan's water, wastewater, and environment sectors and will cover multiple tasks specifically designed to achieve the paired objectives of delivering needed water infrastructure and capacity building to the Water Authority of Jordan (WAJ) and water companies throughout Jordan.

CDM Smith and Arabtech Jardaneh Water & Environment (AJWE) have been commissioned by the USAID to fulfill Task 5 that will examine the requirements for expansion of the Ramtha Wastewater Treatment Plant (WWTP) to the design horizon of 2045, including consideration of new areas that may be added to the plant's catchment area as identified by the Ministry of Water and Irrigation/Water Authority of Jordan (MWI/WAJ). Task 5 is limited to the study and design of the expansion of the Ramtha WWTP within the existing plant site. The proposed expansion would include upgrading and / or replacing of existing plant infrastructure and the transmission pipeline from the Ramtha WWTP to Shallalah WWTP per the identified requirements including complying with Jordanian Standards (JS) for effluent and solids disposal. In addition this Environmental and Social Impact Assessment (ESIA) will be prepared in accordance with the requirements of the Jordanian Environmental Impact Assessment (ESIA) Regulation no. 37/2005, and the World Bank and the Agence Française de Développement (AFD) environmental social safeguards framework (ESSF) standards, in order to support the application for an environmental permit from the Ministry of Environment (MoE).

1.2 Project Description

The Expansion of the Ramtha WWTP (the Project) would be located at Ramtha City in Irbid Governorate and is about 70 km north of Amman city. The Ramtha WWTP is located approximately 5 kilometers (km) northwest of Ramtha city center.

The Ramtha WWTP site has an area of 180,000 square meter (m^2) occupied by the current facility with a capacity of 5,400 cubic meters per day (m^3/d) average annual daily flow (AADWF) to serve Ramtha city. Adjacent to the plant site to the northwest side, WAJ owns an additional 100,000 m^2 parcel for expansion of the WWTP.

The Sahel Horan wastewater system study and design proposed to expand wastewater collection networks to unsewered areas of Ramtha city and the villages of Shajarah, Torrah, Emrawah and Dnaibeh and connect them to Ramtha WWTP which would also be expanded.

According to the feasibility study by CDM Smith, the expansion to the Ramtha WWTP for the design horizon 2045 will have a design capacity average annual daily flow (AADF) of 22,000 m^3/d. Based on MWI/WAJ decision on July 8, 2019, chose the option for a phased expansion of the Ramtha WWTP, starting with Phase 1 expansion to 11,000 m^3/d AADF, expandable to 22,000 m^3/d with conventional anaerobic digesters and a combined heat and power (CHP) system to generate power from digestor gas produced at the WWTP.

Other project components include a pump station for pumping excess treated effluent to Shallalah WWTP via a conveyance pipeline from the Ramtha WWTP (effluent storage pond) to the large effluent storage reservoir at the Shallalah WWTP. From Shallalah WWTP the effluent would enter the reuse system for pumping effluent to the Jordan valley for use as agriculture crop irrigation. This option would transfer up to 8,250 m^3/d of Ramtha WWTP treatment effluent for agriculture use in the Jordan valley in the short term, and can be expended to pump 22,000 m^3/d.

The pipeline would be 8.5 km long with diameter 600 millimeter (mm) buried HDPE or ductile iron pipe in the roadway right-of-way.

1.2.1 Project Components

The liquid stream components

Biological Nutrient Removal (BNR) with Primary Clarifiers

This new plant would replace the existing aeration and secondary clarifiers with a new BNR system (five-stage Bardenpho with plug flow reactors called biological nutrient removal (a type of conventional activated sludge). Phase 1 will be two liquid treatment trains of 5,500 m^3/d each, for a total average plant capacity of 11,000 m^3/d, and a five-day biological oxygen demand ($BOD_{5)}$ load of 8,940 kilograms per day (kg/d).

Septage Unloading Station

A new septage unloading station is required for the proposed expansion.

Rock Trap

A new rock trap would be installed upstream of the influent screens

Bypass to Wadi

The expanded WWTP would maintain use of an existing bypass to wadi to convey peak influent flows in excess of the WWTP hydraulic capacity directly to the wadi.

Stormwater Storage Ponds

During wet weather rainwater can enter the sewer collection system which results in very high and influent flow at the WWTP that could overload the WWTP and damage the biological treatment processes. To prevent this influent flow in excess of the peak capacity of the WWTP (27,500 m^3/d for Phase 1) are diverted to the stormwater ponds for temporary storage. After the storm has passed and

the influent flow returns to normal that diluted wastewater in the stormwater ponds is pumped to the WWTP headworks for treatment.

Influent Pump Station

During preliminary design it was determined that the influent pump station could be deleted and no longer necessary for this project.

Grit Removal

Suitable grit removal technology will be designed.

Headworks Odor Control

Hydrogen sulfide (H_2S) is typically the primary odor components at the head of a wastewater treatment plant. The project would design suitable odor control technology to remove odors successfully up to 90 percent (%).

Primary Clarifiers

Primary clarifiers are proposed for the plant expansion to reduce the loading to downstream biological treatment processes and for the primary sludge for the anaerobic digester for sludge stabilization. Therefore, the liquids treatment trains will be less energy intensive and the primary solids can be treated with biosolids treatment processes that are also less energy intensive.

Primary Sludge Truck Filling Station

WAJ and the Yarmouk Water Company (YWC) would like to have the ability to truck primary sludge to the Shallalah WWTP for digestion to produce more gas to produce electricity to offset costs at that facility.

Secondary Clarifiers

A total of two circular secondary clarifiers each 22.5 meters (m) in diameter are proposed for phase 1, while the two existing secondary clarifiers will be taken out of service and abandoned in place.

RAS and WAS Pump Stations

Dry pit return activated sludge/waste activated sludge (RAS/WAS) pump stations are proposed for a total of two secondary clarifiers to convey RAS to the BNR process and WAS to sludge processing.

Disinfection System

A chlorination system with chlorine gas would be used for disinfection.

Treated Effluent Storage Pond

The effluent storage pond is short term post disinfection store and pump effluent wet well for the local irrigation pump station and for pumping treated effluent to Shallalah WWTP. The effluent storage pond would provide 44,000 m^3 of two days usable storage at design horizon AADF. Additionally, the basin will have a floating cover to reduce algae growth and evaporation.

Additional Effluent Storage

Additional effluent storage could be provided by pumping treated effluent to the existing polishing ponds. Excess effluent from the secondary clarifiers or the effluent storage ponds could be pumped to the existing polishing ponds for storage. When water in the ponds is needed for crop irrigation it would be channeled through the existing chlorine contract tank for disinfection and into the effluent storage pond to the effluent reuse pump stations.

Effluent Reuse Pump Stations

A pump station to pump treated effluent to the nearby farms for irrigation and the excess effluent to the Shallalah WWTP effluent reservoir for reuse in the Jordan valley would be constructed as part of the project.

Effluent Reuse Pipeline

A new 8.5 km long, 600 mm diameter transmission pipeline of HDPE or ductile iron would be part of the project and buried in the roadway right-of-way to transmit the effluent to Shallalah WWTP reservoir for use in Jordan Valley crop irrigation.

The Solid Stream Components

Sludge Stabilization

Conventional anaerobic digestion is the technology that would be used for stabilization (pathogen and odor reduction) of biosolids. This process involves heating sludge to mesophilic temperatures under anaerobic conditions to biologically reduce volatile solids.

Digester Gas System

The digesters used to stabilize the sludge and a digestion by produce is digester (methane) gas that will be used to power the boiler for heating the digester tanks and to produce electricity with the CHP energy recovery system, excess gas is flared off for safety and environmental reasons. The CHP energy recovery system would generate electricity from the digester gas that could be used for other WWTP operations. This is an expensive system with complex O&M that requires highly trainer and interested operators to operative safely and efficiently.

Biosolids Dewatering

The Ramtha WWTP currently has 114 drying beds which provide a total drying area of 17,100 m^2. Thickened biosolids (sludge) is conveyed to the drying beds via distribution channels. With the proposed WWTP expansion to an influent volume of 22,000 m^3/d by 2045, the plant would need additional drying bed area. Additionally, mechanical biosolids dewatering would be installed for use during the winter months with the performance of the drying beds is poor due to the cool wet weather.

Civil Works

General site civil requirements of the WWTP include:

Plant support structures

- Administration building for manager and staff offices, operations room, public reception and meeting rooms, locker rooms, and laboratory.
- Electrical and generator building for plant wide electrical equipment and emergency standby diesel generator.
- Maintenance building for working of plant equipment and storage of spare parts and equipment.

Site roads

- Plant entry and service roads, site entry road to administration building and to main process areas, secondary site roads, such as roads around ponds and plant boundary road. Existing roads to be checked and improved as necessary new site roads to be paved or gravel based.

Miscellaneous requirements

- Yard lighting and upgrade of the electrical service connection at the plant site necessary to meet the requirements of the plant expansion.
- Boundary fencing: to provide full site fencing, repair and replace as needed.
- Electrical and instrumentation conduits.
- Plant water system,
- Fire protection and alarm, lightening system, and safety and security systems.
- Transmission pipeline roadway restoration works (USAID, 2019)

Site grading

- The area for WWTP expansion liquid steam treatment system is located would be regraded and lower to allow gravity flow through the new WWTP expansion without making the process tanks too deep in the ground. Do this allows the influent pump station to be deleted and reduces the energy needs and operation cost of the WWTP.
- Regarding of site roads to allow vehicle access from the existing WWTP area to the new areas.

The construction period is expected to be of 24 months depending upon contractor's capability. Approximately 36 people would be employed during the peak of construction period. During the operational period that would be extended to 2045, approximately 19 people would be employed full-time to operate and maintain the WWTP plant.

During construction, workers would likely be accommodated in temporary onsite accommodations provided by the construction contractor. However, worker accommodation options are determined by the construction contractor. If the project opted to include worker accommodation facilities on site, these shall be established in accordance with the specifications of the International Labour Organisation (ILO) standards and guidance published by the European Bank for Reconstruction and Development (EBRD) and the International Finance Corporation (IFC) and shall adhere to all measures needed to prevent potential occupational hazards on site.

The most likely activities to be undertaken during the complete development and operation of the project can be divided in to following main three phases,

- **Planning and Design Phase**: Typical activities includes:
  - Feasibility study,
  - Design,
  - Permits,
  - Project partners participation,
  - Tendering.

- **Construction and Commissioning Phase:** Typical activities include
  - Transportation of all project components to the site
  - Civil, mechanical and electrical construction/installation of project according to design
  - Commissioning of the project including mechanical, electrical and performance tests.

- **Operation Phase:** Typical activities include:
  - Operation and maintenance of the WWTP after commissioning, daily physical inspections of the WWTP components and site conditions; monitoring and evaluation of plant performance measurements and repairs.
  - Corrective maintenance in case of defect or failure of WWTP components.

1.3 Legislative Framework

The competent authority approving ESIA studies in Jordan is the Ministry of Environment (MoE), which is responsible for the evaluation of the environmental impacts of the project and the issue of associated permits and licenses.

According to the Environmental Protection Law no. 6/2017, the ESIA study should be done before the project is initiated and sent to the Ministry of Environment where it will be reviewed.

Regulation no. 37/2005 sets out the process for conducting an ESIA study, the items to be included in the study, and the procedure for obtaining an environmental clearance.

If the impact assessment is approved, the project will get a license and be able to start construction and operation as long as it adheres to the environmental mitigation and management systems specified and approved in the study. Any deviation from those guidelines would subject the project to violations. In addition to local requiremnts, AJWE is committed to deliver this ESIA in accordance with the World Bank and AFD ESSFs, in order to support the application for an environmental permit from the MoE.

1.4 Baseline Conditions

1.4.1 Physical Environment

Meteorology and Climate

The project area falls within the warm semi-arid Mediterranean climatic zone. The project area meteorological characteristics were obtained from the Jordan Department of Meteorology for the last 34 years. The data shows that the monthly average high temperature is 33 degrees centigrade (°C) in August, while the monthly average low temperature is 4.1 °C in January. The average mean monthly temperature is 18.6 °C, and the average relative humidity is 46.4 - 73.4 percent, the average annual rainfall is 225.7 mm and the average mean wind speed is 6.0 knots (11 kilometer per hour).

Air Quality

An air quality sampling program was conducted at the project site for 7 consecutive days, the programme covered the following emission parameters: Inhalable particulate matter (PM10), sulphur dioxide (SO_2), hydrogen sulphide (H_2S), nitrogen dioxide (NO_2), ammonia (NH_3) and methane (CH_4).

The monitoring of the ambient air quality (PM_{10}, SO_2, NO_2, H_2S, NH_3, and CH_4) near the proposed project (Ramtha WWTP) during the period of sampling showed that the hourly and daily average concentrations were far below the relevant limits in the Jordanian ambient air quality standard (JS 1140/2006).

Noise Levels

Noise measurements were collected at the project site for three consecutive days and were performed according to American National Standards Institute (ANSI) S1.13 requirements using a digital data logging Sound Level Meter (SLM), Model HD600

The recorded averages were found to be lower than the maximum allowable noise limits of 55 dBA for daytime and 45 dBA for night-time provided by the Jordanian guidelines for prevention of noise pollution (2003).

The noise levels that were recorded were due to a traffic activity primarily from farmer's vehicles, and from the irrigation pumps that are at the nearby farms, which may also operate at night-time.

Physiography and Soil

The project area falls within land region namely the Northern Highlands Dissected Limestone. The most predominant characteristics are typically Mediterranean, with a range in precipitation between 250 mm and 500 mm. The dominant soil subgroups in the study area are Vertisols/Chromoxerent which are red clays with low carbonate content.

A topographic survey was conducted for the project area. The results of this survey have shown that the approximate center of the existing plant site is at Latitude 32°35'36" North and Longitude 35°59'19" West with an elevation of about 480 meters. The plant site is in an area of agricultural use with little topographic relief. Surface drainage is towards the north.

Geomorphology and Geology

The project site geology belongs to the Balqa and Ajlun group within the (B5/B4/B3(B2/A7)/(A1/A6) formations, which fall within the Cretaceous and Tertiary systems. These sedimentary rock formations consist of chalk, chert, limestone and marl, the B3 formation is sometimes bituminous.

Tectonic Settings

The project site lies within the light magnitude range of Richter's scale. Therefore, if an earthquake occurred in the project area, it is anticipated that the intensity would fall between the 4.0 to 4.9 magnitudes according to Richter's scale. Earthquakes in this light magnitude range are often felt with rattling and shaking noises, but usually causes no significant structural damage.

Surface water

The project area is located within Yarmouk basin. There are no major wadis crossing the Ramtha WWTP site. Wadi Shoumar, a major wadi, is passing adjacent to the outer fence of the project area from the east and northeast and continues adjacent to the plot selected for the expansion of the project from the northeast.

The proposed route of the transmission pipeline passes in the roadway right-of-way (underground at a depth around 120 centimeters [cm]) where some wadis are crossing through the culverts. Along the proposed route there are 7 culverts; 5 of which are pipe culverts and the other 2 are box culverts. A surface hydrology study was conducted for the project area during September 2019, which studied stormwater based on the existing topographic conditions, the study results are discussed in detail under the baseline section.

Groundwater

The project area is located within Yarmouk groundwater basin. The Shallow and Upper Cretaceous Aquifer Systems are the principal aquifer systems providing water to almost all households in the Yarmouk basin. The B4/5 aquifer system is recharged along the elevated areas of Jabel Al-Arab, Golan Heights and Ajlun Highlands, which are believed to have great water-bearing potential. Groundwater levels in this basin vary from zero at the Mukheiba area, where aquifers are under water table conditions, to 250 m below the ground surface near Irbid, where the aquifers are confined. Water table fluctuation between the wet and dry seasons is high; with a mean variation of about 9 m. Directions of groundwater flow are to the north and northwest.

According to a previous study for the groundwater vulnerability map of the Ramtha WWTP using the modified DRASTIC model, it was found that the proposed site lies within the high vulnerability class.

This is due to the fact that depth to groundwater is shallow, with high net recharge value, high aquifer permeability, low slope, soil texture, high hydraulic conductivity, and high lineament density and land use (agriculture). (Awawdeh, M., Obeidat, M. & Zaiter, G. Appl Water Sci, 2015)

1.4.2 Biological Environment

The biological environment baseline was collected based on literature review, and site visits to the project area and its surroundings and the transmission pipeline to Shallalah WWTP.

Flora

Biogeographic Zones

The project area is located in Mediterranean biogeographic zone This area is the most humid and has the highest altitude in Jordan. It extends from Um Qais in the North to Ras Alnaqab mountains in the south and may extend to Wadi Rum.

Vegetation Types

The project area is characterized by Mediterranean Non-Forest Vegetation. This vegetation type also called Batha Mediterranean vegetation. It is found in all Mediterranean region except the forest and cultivated areas. This vegetation type is characterized with shrubs and bushes and stretches across the Jordanian ridge between Irbid and Tafilah.

Fauna

Reptiles

The richness of vegetation, and diversity of topography in the Mediterranean zone creates a microhabitat that allow for high carrying capacity and sustain a large number of species. Herpetofaunal species limited to this zone are recorded in this report. During the field visits no herpetofaunal species were observed on the site which can be explained by high disturbance and intensive agricultural activities.

Mammals

The mammals of the project area belong to the group that are found in this distinct sub region within the Palearctic region (European Origin). It includes mountain areas that extend from the north of Jordan to the Al Naqab Mountains in the south.

Birds

Birdlife International Soaring Birds Sensitivity Mapping Tool has been applied to the project site as an additional guidance regarding the importance of the area for soaring birds. The tool shows 34 avifaunal species may occur on the site, most of them have no conservation status. The bird species that were recorded during the field visits are all common to the similar habitat and has no conservation status.

Protected Areas

The project site is not close to any protected areas, the closest protected area is Yarmouk which is about 25 km from the proposed project. Given the distance from the closest protected area and the nature of the proposed project activities, the project will have no significant negative impact on the protected area.

Rangeland Reserves

The proposed project is not close to any of the rangeland reserves. The closest rangeland reserve is Alkhanasry which is about 23 km from the proposed site. In addition, the nature of the project activities is limited to a small area which decreases the negative impact on any sensitive habitat including rangeland reserves.

Important Birds Areas

Part of the expansion of Ramtha WWTP in addition to the transmission pipeline to Shallalah WWTP lies within the Important Bird Areas (IBA) which is agricultural plains between Irbid, Ramtha and Mafraq. The area is largely in agricultural cultivation mainly with dry cultivation of cereals. Natural steppe vegetation occurs only as small remnant patches between fields. The habitats are currently threatened by urban expansion and industrial developments. Resident and breeding birds include Long-legged Bussard, Little Owl, Calandra and Short-toed Lark, while Lesser Kestrel has been reported as migrant and possible breeder and the Griffon Vulture as frequent visitor. Imperial Eagle and Corncrake are scarce migrants and several species visit the area in winter, including Crane, Sociable Plover (rare), Lapwing, Finsch's Wheatear and Syrian Serin (rare). The proposed project could have positive impact on birds specially waders and waterfowls. where the sewage treatment plants are artificial habitat that is suitable for waterfowls and waders as they have open water bodies that rich with insects and phytoplankton that is considered a good source of food for them. In addition, the existing pools are suitable habitat for waders as waders prefer shallow water and muddy habitat.

1.4.3 Socio-Economic Conditions

Population

The project site is located in Ramtha district, which falls in northeastern portion of Irbid Governorate. The Ramtha District includes the area of Al Buwaidah, the municipality of Horan Plain, and the villages of Shajarah, Torrah, Emrawah and Dnaibeh. The Ramtha district is adjacent to the Syrian border on the north, with a border length of 37 km.

The area of Irbid is 1572 km^2, comprising 1.8 percent of the total area of Jordan, this would result in a population density of 1216.2 capita/km^2.

In 2018 Ramtha population was estimated to be 257,560, which comprises 2 percent of the total population of Jordan. and is composed of 133830 males and 123730 females. (DOS, " Household Expenditure & Income Survey", 2018)

Project Support to Jordanian Government in Hosting Refugees

As of March 2016, there are approximately 636,000 Syrians (6.7 percent of Jordan's population) formally registered by the United Nations High Commission for Refugees (UNHCR) although the Jordanian government considers a more realistic number to be 1.27 million Syrians. According to government statistics residential consumption rose by 9.44 percent from 2011 to 2012, compared to just 5.9 percent between 2010 and 2011.

Increasing numbers of Syrian refugees causes increasing demand for water in various governorates, putting significant pressure on water resources. Potential solutions may include the expansion of existing plant, the establishment of new plant, the extension of new major tanker sanitation lines and sub-lines and/or establishment of new fountains in different regions. (UNHCR, 2016).

Land Use

The project area falls within the warm semi-arid Mediterranean climatic zone, with a range in precipitation between 250 mm and 500 mm. The dominant soil subgroups in the study area are Vertisols /Chromoxerent as red clay with low content of carbonates.

The Ramtha WWTP is surrounded by agricultural land, most of which is highly suitable for agriculture. The surrounding agricultural lands are regularly cultivated with fodder crops (ryegrass, alfalfa, barley and corn). Some of uncultivated areas (vacant) or undeveloped land exist throughout the proposed project area, but the cultivated areas are widespread over the surrounding areas.

Crops nearby and surrounding Ramtha WWTP are irrigated with treated effluent are summarized as follows:

- The total planted area of irrigated fodder crops using treated effluent from Ramtha WWTP is 737.7 dunum.
- There are 16 agreements between farmers and the Ministry of Water and Irrigation.
- Planted crops include alfalfa (annual and perennial), ryegrass, barley and corn.

Infrastructure and Utilities

The site is easily accessible through a paved road leading to the WWTP; connecting from Ramtha city. However, this existing road is a relatively narrow two-way street (5m wide) and could be a nuisance for residents because of noise, dust, and odors. Another secondary road exists adjacent to the Ramtha WWTP, but it is not used by the WWTP operations.

Electrical power is provided to the plant by Irbid District Electricity Company (IDECO), and water supply would be available during the project's construction phase.

1.5 Archaeological and Cultural Heritage Resources

An archaeological survey was carried out by AJWE consultants. The study team investigated the project area and the surrounding zone and the transmission pipeline route from Ramtha to Shallalah.

The field study and investigations revealed no archaeological or cultural heritage sites existed in the proposed expansion area of Ramtha wastewater treatment plant and along the pipeline route toward Shallalah WWTP. The study revealed the presence of scattered flints approximately 100 meters to the north side of the proposed expansion area. This area would not be threatened by project activities.

1.6 Stakeholder Identification

Stakeholders should play a vital role in providing advice to the project management, therefore, in compliance with local ESIA regulations, and international standards, i.e. AFD / World Bank, stakeholder engagement has been an ongoing process throughout the ESIA process in order to ensure transparency with all stakeholders that may be affected by or have influence on the project.

The stakeholder engagement activities carried out during this ESIA are as follows:

- Identification of project stakeholders and all parties affected or related to this project
- Conducting a scoping session and documenting its results in a scoping session report as part of the Final Terms of Reference (ToR).
- Conducting site visits to meet with community representatives.

The details of the above-mentioned activities are further elaborated in the ESIA report.

1.7 Identification of Environmental and Socio-economic Aspects and Receptors

The ISO 14001:2004 Environmental Management Systems - Specification with Guidance for Use was adopted to provide a definition of environmental aspects for this ESIA. An environmental aspect is denoted where a proposed activity has the potential to interact with the environment. A socio-economic aspect can be considered to occur when an activity has the potential to interact with the social or economic environments within or at the vicinity of a specific project area.

To identify environmental and socio-economic aspects for this project, project activities, that may affect environmental and socio-economic receptors, require identification. This was achieved through:

- Project-related studies and documentation;
- Consultation with project proponent i.e. USAID / WAJ
- Consultation with MoE during the scoping session and ToR in addition to gathering input from relevant stakeholders.

Environmental and Socio-economic receptors for this project have been identified and include: Physical Environment, Biological Environment and Socio-economic Environment. In addition, the possible interaction between the environmental aspects and receptors relevant to this project have been also identified and presented. This includes the main project activities/environmental & socio-economic aspects and the potential environmental impacts associated with each project activity. The impacts are mainly generated from construction, operation and decommissioning activities.

1.8 Analysis of Proposed Project Alternatives

The alternative analysis examined all alternatives including the 'project' versus 'no project' alternative and alternative wastewater treatment technologies. It was determined that the proposed project alternative is considered the best possible option as opposed to 'No Project' alternative. The proposed project would reduce the environmental degradation due to untreated wastewater, and the effluent is considered a good source to satisfy the nearby agricultural area water demands, as long as it is adequately treated to ensure water quality appropriate for cropping.

The existing Ramtha WWTP ability to accommodate rising influent demand is constrained by the plant's capacity of 5,400 m^3/d. If the no project alternative is selected, projections indicate the increase from 4,970 m^3/d (27 percent of service area) in year 2025 to 16,689 m^3/d (76 percent of service area) by year 2045. This would result in the discharge of untreated wastewater into the environment causing the pollution of surface water, soil and groundwater.

Other project technologies were evaluated. The most sustainable and cost-effective alternative according to this evaluation is Alternative C.2 which consists of biological nutrient removal (five-stage Bardenpho with plug flow reactors) with primary clarifier and solids treatment with CIGAR. However, MWI/WAJ has no experience with the CIGAR system and has concerns about the system. On August 2, 2019, MWI/WAJ decided that a phased expansion of the Ramtha WWTP to the 2045 design horizon was the preferred option. Phased expansion to the projected flow of 22,000 m^3/d, would start with Phase 1 expansion of 11,000 m^3/d AADF. The selected expansion of Ramtha WWTP is Alternative C1–Phase 1, which has an AADF of 11,000 m^3/d (expandable to 22,000 m^3/d) with conventional anaerobic digesters and CHP system to generate electricity from digester gas (biogas). The CHP system cost-benefit analysis showed that the electricity produce by the system was not sufficient to pay back the initial capital investment in CHP system and its operational cost but it was decided to keep the system in the Phase 1 expansion.

The Ramtha WWTP site has an area of 180,000 m^2 occupied by the current facility. Adjacent to the plant site on the northwest side, WAJ owns an additional 100,000 m^2 parcel for expansion of the WWTP.

The rationale for choosing the selected site is the original Ramtha WWTP was built in the 1980s, it was expanded and updated starting in the late 1990s to an extended aeration system that became operational in 2005. Portions of the existing facility, following Phase 1 expansion, may be used in future expansions. Additionally, the existing site is a WWTP and it is extremely difficult to identify a new site due to public sentiment. The land acquisition procedures associated with a new site requires an extended time period and the procurement of the land for a new site is a costly proposition.

1.9 Impact Assessment

An identification and assessment of environmental, socio-economic and health and safety issues potentially arising from the project have been undertaken, and mitigation measures were proposed to reduce the potential impacts that may result from the project.

Details of impact assessment and impact significance are provided in Section 9 of this ESIA. In addition, an Environmental and Social Management Plan (ESMP) have been developed to ensure that potential impacts are sufficiently monitored, and mitigation measures are implemented.

The key potential impacts and their corresponding mitigation measures and monitoring requirements are presented in the ESMP tables in the ESIA report.

1.10 Decommissioning of the New WWTP

The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be similar to those identified for the construction phase. However, it is recommended that before any decommissioning activities take place a disposal plan for all materials and equipment's must be prepared by the responsible entity undertaking decommissioning activities.
The disposal plan must consider the reuse and recycling of any components of the WWTP where suitable; reuse in other technologies; and disposal of the other components that cannot be reused or recycled at existing hazardous or solid waste facilities in Jordan through coordination with the Ministry of Environment and with Ministry of Local administration (MoLA) to identify the nearest landfill.

1.11 Decommissioning of the Existing WWTP

To decommission the existing plant, following completion and placing the new expanded WWTP into operation, wastewater from the existing WWTP process units, equipment, and pipelines would be transferred to the new WWTP for treatment by the construction contractor. Sludge remaining in the old process units would be dewatered and delivered to an approved landfill along with equipment and piping that cannot be reuse or recycled.

All dismantled (salvaged) mechanical and electrical items would be cleaned, crated and delivered to a location as selected by the client. The list of items to be dismantled and the location to be delivered will be agreed with the client and included in the tender documents.

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2 INTRODUCTION

2.1 Overview

CDM International (CDM Smith) was retained by the United States Agency for International Development (USAID) to undertake the USAID Jordan Water Infrastructure for the purpose of improving the utilization of limited water resources in Jordan and bring about urgently needed enhancements to the water and wastewater systems. Water and wastewater infrastructure improvements are needed throughout Jordan to alleviate water supply shortages, public health issues, and impacts on industry and the economy. The USAID Jordan Water Infrastructure will serve as an umbrella contract for USAID/Jordan's water, wastewater, and environment sectors and will cover multiple tasks specifically designed to achieve the paired objectives of delivering needed water infrastructure and capacity building to the Water Authority of Jordan (WAJ) and water companies throughout Jordan. The USAID Jordan Water Infrastructure covers engineering infrastructure improvements identified by USAID in cooperation with the Ministry of Water and Irrigation (MWI), the WAJ, public sector water companies such as Miyahuna, Yarmouk, and the Aqaba Water Company, various municipalities, and the MoE. The program provides engineering services for assessments, studies and design and construction management for water, wastewater and environmental projects.

As a result of the above requirements, CDM Smith and Arabtech Jardaneh Water & Environment (AJWE) have been commissioned by the USAID to fulfill Task 5 that will examine the requirements to expansion the Ramtha WWTP to the design horizon of 2045, including consideration of new areas that may be added to the plant's catchment area as identified by MWI/WAJ. Task 5 is limited to the study and design of the expansion of the Ramtha WWTP within the existing plant site. The proposed expansion would include upgrading and / or replacing of existing plant infrastructure and the transmission pipeline from the Ramtha WWTP to Shallalah WWTP per the identified requirements including complying with Jordanian Standards for effluent and solids disposal. In addition this Environmental and Social Impact Assessment (ESIA) will be prepared in accordance with the requirements of the Jordanian Environmental Impact Assessment (ESIA) Regulation no. 37/2005, and the World Bank and the AFD environmental social safeguards framework (ESSF) standards.

The project is categorized as Category "1" with respect to the classification of the Ministry of Environment (MoE), and as per the Environmental and Social Impact Assessment (ESIA) Regulation No. 37/2005, where Category "1" projects shall undergo a full ESIA study.

The ESIA will be carried out to meet the following requirements:

- Applicable local, Jordanian/national and regional requirements, including those related to environmental and social impact assessments.
- The World Bank ESSF (2017) and environmental and social operational standard requirements where applicable.
- Relevant international conventions and protocols relating to environmental and social issues, as transposed into national legislation.
- This full ESIA is consistent with applicable requirements in the ESIA regulation no. 37/2005.

2.2 Scope of Work

Arabtech Jardaneh Water & Environment (AJWE) was appointed by CDM Smith to prepare the Comprehensive ESIA study for the project activities during the three project phases: construction, operation and decommissioning. The ESIA will be prepared in accordance with the requirements of the Jordanian ESIA Regulation no. 37/2005, and the World Bank standards as adopted by AFD in order to support the application for an environmental permit from the Ministry of Environment (MoE).

In accordance with MoE's requirements, the ESIA assignment will consist of the following phases:

- Preparation of preliminary ToR.
- Attend and document scoping session with stakeholders.
- Finalize and submit ToR following input from MoE along with scoping report.
- Perform ESIA study and prepare ESIA report - including the Environmental & Social Management Plan (ESMP).
- Finalize and submit ESIA study following input from MoE and obtain the environmental permit.

2.3 ESIA Objectives

The AJWE team has provided a comprehensive ESIA study for developing the expansion of the Ramtha WWTP plant located in Ramtha District.

This ESIA aims to:

- Identify and assess the potentially significant existing and future environmental and social impacts resulting from project activities during the three phases of the project;
- Determine the measures needed to avoid and/or minimize potential environmental and social impacts, and identify mitigation measures and opportunities for the project that;
  - Ensure that the project is socially and environmentally sustainable;
  - The project respects the rights of affected workers/personnel on site and in communities; and
  - Ensure that the project is designed and operated in compliance with the AFD and World Bank standards and applicable local and national regulatory requirements and good international practice,
- Support the application for environmental approval from the MoE in line with the ESIA regulation no. 37/2005.

2.4 The Project Proponent

The USAID on behalf of MWI/WAJ is the proponent for the proposed expansion of the Ramtha WWTP project. CDM Smith is the consultant preparing the feasibility study for the proposed project, and may be contacted at:

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Project Manager
CDM Smith - Jordan
73 Al Mutanabi St. (4th Circle)
Amman, Jordan
Jordan Mobile: +962 79.8997904
Jordan
Office:+9626.4642720
E-mail: MinkwitzRE@CDMSmith.com

2.5 The Consultant

AJWE (as a sub consultant for CDM Smith) has prepared this ESIA report on behalf of the project proponent in accordance with the MoE guidelines and AFD and World Bank standards. The primary contact for AJWE is:

Jihad Abu Jamous
Director General
Amman, Jordan
Telephone: 0796434414
E-mail: Jihad_Abujamous@AJ-Group.com

2.6 ESIA Reporting

This draft ESIA report has been prepared in compliance with the requirements stated in the Jordanian ESIA regulation no. 37/2005, and World Bank standards and are included in **Table 1**:

ESIA Section	Description
Executive Summary	Summary of the project, main findings and recommendations
Introduction	Overview and purpose of the project and scope of the ESIA
Review of Legislation and Standards	Details of the applicable legislation and regulations and other standards in Jordan with potential implications to the project
Project Description	A clear and concise description of different activities over the life of the project. The description should be sufficient to allow the risks and impacts to be identified, described and evaluated
Environmental and Social Baseline	Assessment of the baseline conditions against which the impacts of the project can be assessed
Assessment of Impacts	Assessment of the impacts of the project (and methodology used), which shall include a listing, description, assessment (including quantification of impact), and discussion of the possible negative and positive impacts of the project on the environment and social fabric, including socio-economic context – in addition to consideration of cumulative impacts.
Stakeholder Identification and Engagement	Summary of the stakeholder engagement process which will identifies the related and parties and stakeholders influencing the project and details how the project will communicate, inform and discuss the substantive issues with all interested and effected parties
Analysis of Alternatives	A comparison of the project alternatives considered and their anticipated potential impacts
Mitigation and Monitoring measures	Recommendations for mitigation measures to minimize the identified impacts and any ongoing monitoring requirements
Environmental and Social Management Plan	Details of specific activities to be carried out during different phases of the project and project activities to ensure the identified mitigation measures are implemented

Table 1: ESIA Sections

3 PROJECT DESCRIPTION

3.1 Existing Situation

Ministry of Water and Irrigation (MWI) is the official body responsible for the overall monitoring of the water sector, including water supply and wastewater systems and the related projects planning and management, the formulation of national water strategies and policies, research and development, information systems and procurement of financial resources. WAJ strategic objectives include improving water and wastewater systems through further development of the water and wastewater treatment and networks, optimizing the use of energy, reducing nonrevenue water, and continuing to produce water of the highest quality. According to water strategy (2016-2025) and the wastewater master plan (WWMP), the expansion of the Ramtha WWTP is one of the planned projects to increase amounts of treated wastewater.

AFD has expressed interest in funding the construction of this project using contracting method design-build-operate (DBO) (FIDIC 2008 Gold Book) procedures and the requirements of AFD and MWI/WAJ.

Ramtha City is in Irbid Governorate and located about 70 km north of Amman city. The Ramtha WWTP is approximately 5 km northwest of Ramtha city center as shown in **Figure 1**. The original WWTP built in the 1980s was originally a lagoon-based system. The plant was expanded to 5,400 m^3/d AADF and updated to extended aeration process and started operating in 2005. Ramtha district is adjacent to the Syria boarder and many Syrian refugees reside in the area.

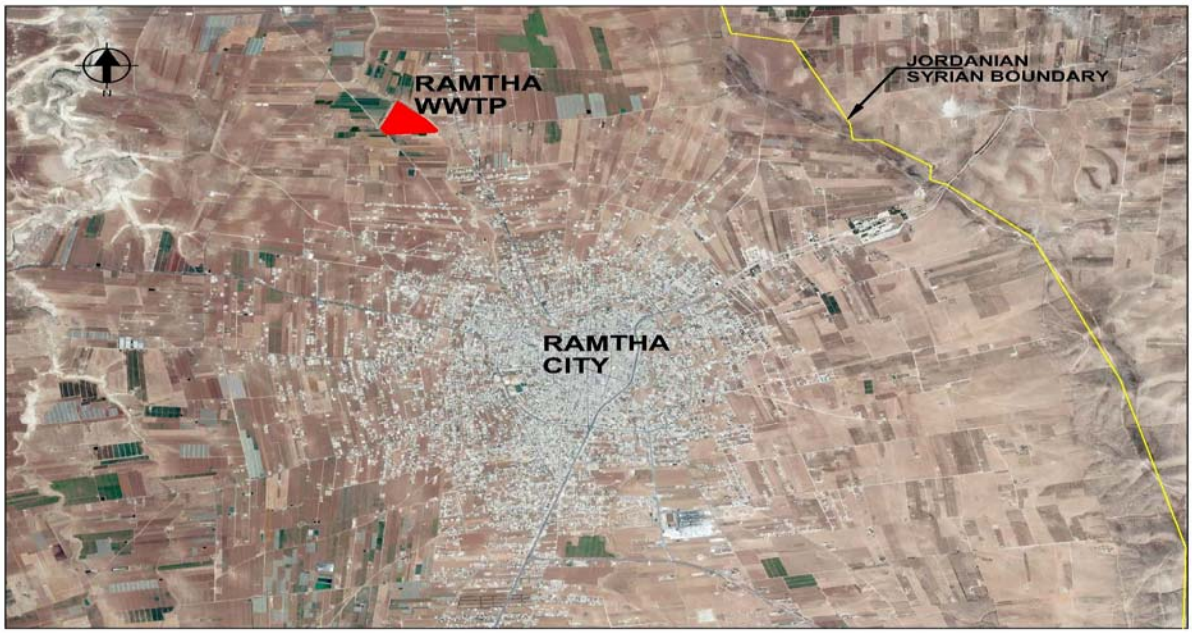

Figure 1: Ramtha WWTP Location

The Wastewater Treatment Plant Surroundings

- The Ramtha city is approximately 5 km southeast of the Ramtha WWTP.
- The nearest residential area is approximately 1 km south of the Ramtha WWTP.
- A chicken farm is located about 190 meters to the west.
- The Feed Factory is approximately 200 meters northeast of the Ramtha plant.
- The nearest major road network is around 220 m to the east.
- Farms adjacent to the project area (an estimated area of 737.7 dunums are irrigated with treated water for the existing Ramtha WWTP)
- The nearest sub-road network is adjacent to the project area.
- Al-Ekaider landfill is located about 17 km from the plant site to the southeast.

The Ramtha WWTP site occupied by the current facility has an area of 180,000 m^2 as shown in **Figure 2**. Adjacent to the plant site on the northwest side, WAJ owns an additional 100,000 m^2 parcel for expansion of the WWTP. The existing Ramtha WWTP site plan is shown in **Figure 3**.

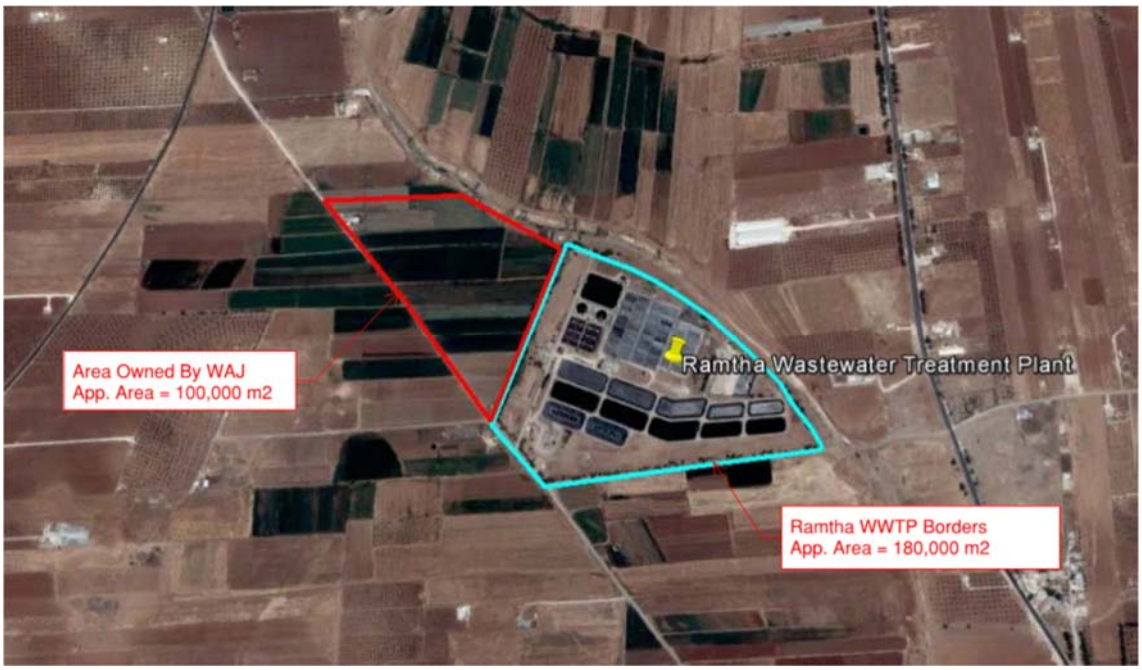

Figure 2 : Ramtha WWTP Site and Area Available for Expansion

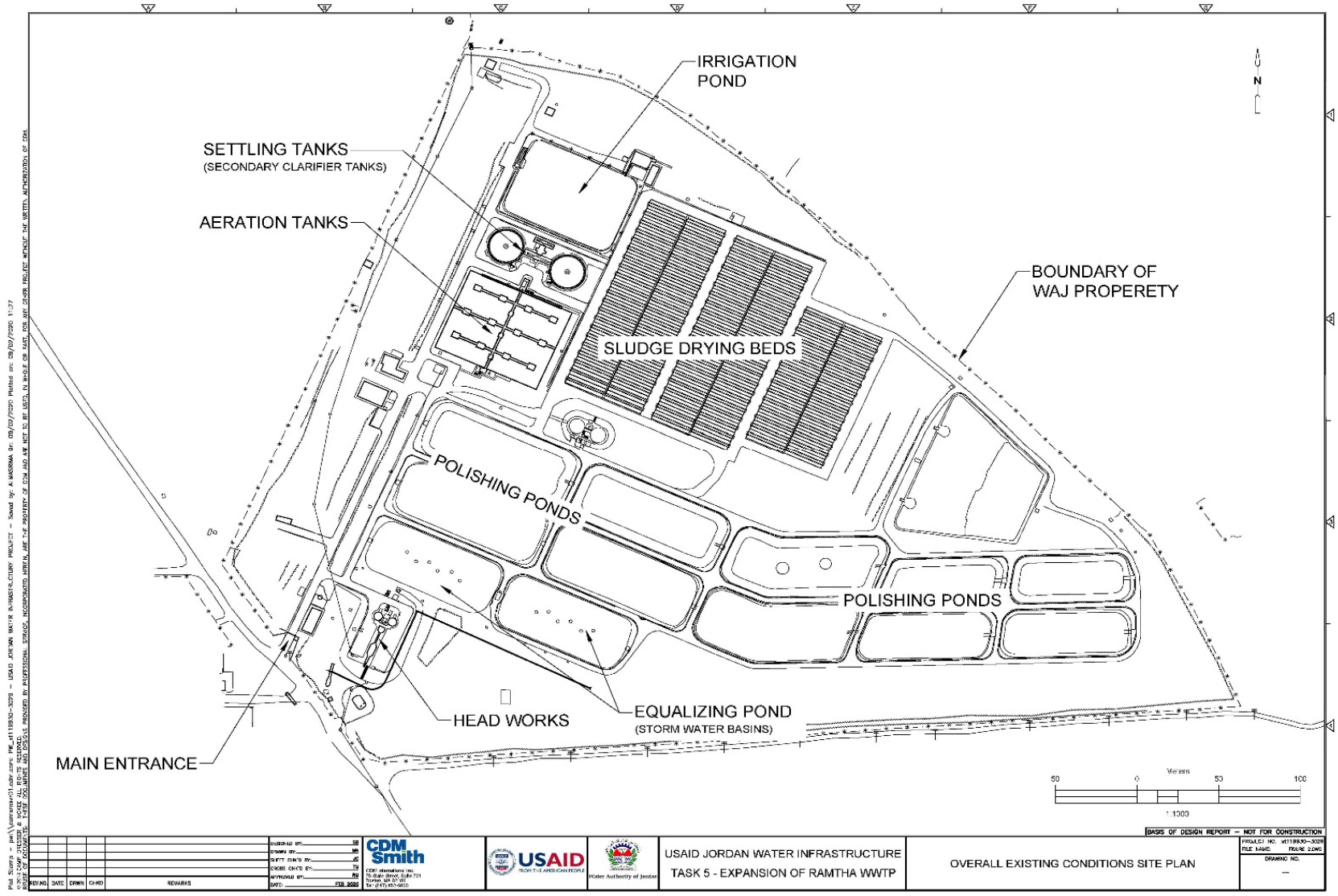

Figure 3 : Existing Ramtha WWTP Site Plan

The original Ramtha WWTP was a lagoon-based treatment system built in the 1980s. The plant was expanded and updated starting in the late 1990s to an extended aeration system that became operational in 2005 as shown in **Figure 4**. The Ramtha WWTP secondary treatment consists of a biological nutrient removal (BNR) process to achieve organic matter, nitrogen, and phosphorus removal. The BNR process consists of two identical treatment trains. In each train, influent first passes through a two-stage anaerobic zone where screened and degritted influent wastewater is mixed with return activated sludge (RAS).

The anaerobic zone allows phosphate accumulating organisms (PAOs) to take up and store soluble substrate. This anaerobic zone is provided for the enhanced biological phosphorus removal (EBPR) and to limit the growth of filamentous bacteria for better settling sludge which would be measured with lower sludge volume index (SVI).

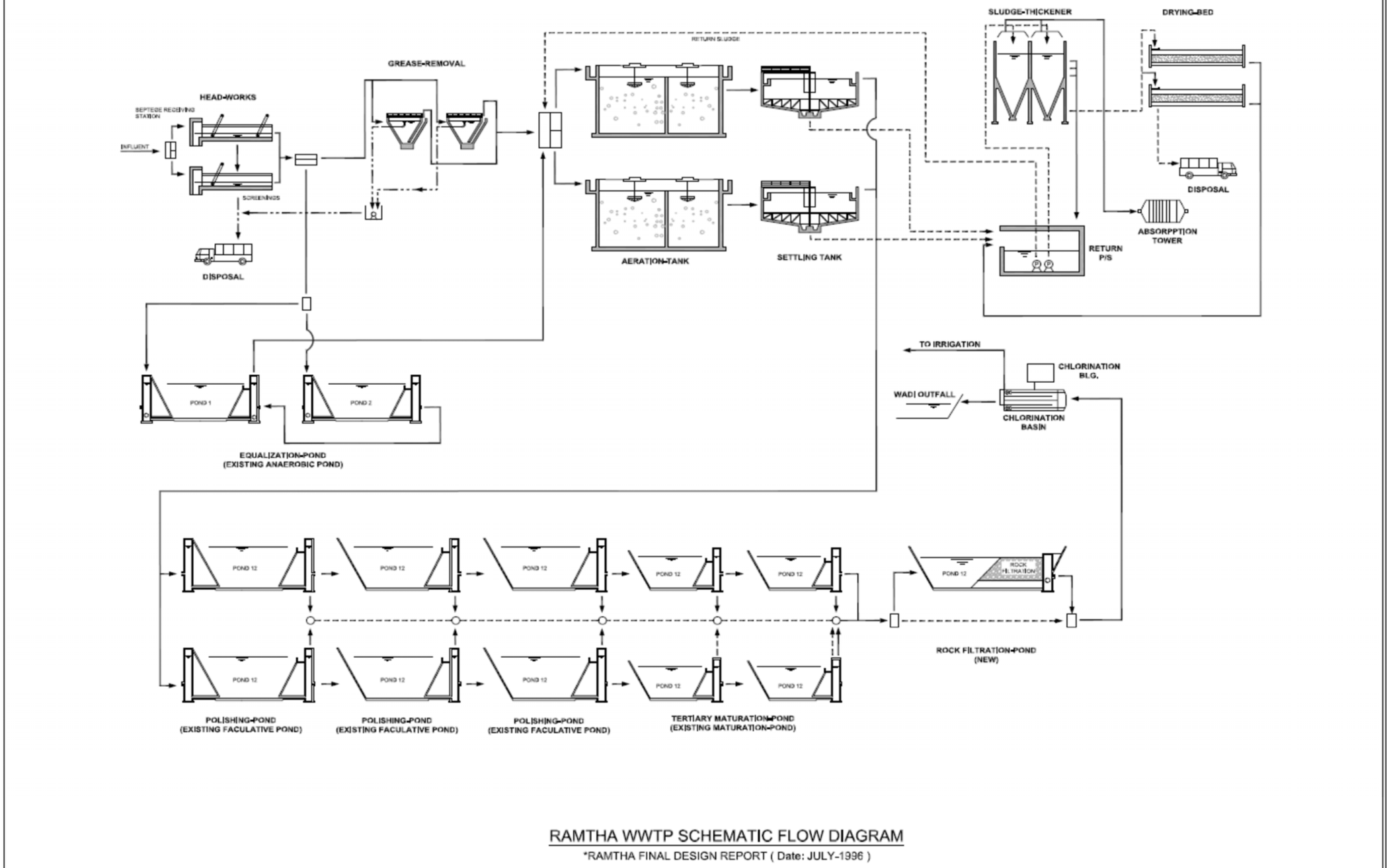

Figure 4: Existing Ramtha WWTP Schematic Flow Diagram

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The rest of activated sludge tank is equipped with a total of twelve platform mounted vertical surface aerators. Each of the two aeration tanks is equipped with six vertical surface aerators. Each aerator is 30 kW to provide 1.8 kg O_2/kWh (kilograms of oxygen per kilowatt-hour). The BNR process is followed by two 22-m diameter circular secondary clarifiers with a side water depth (SWD) of 3.1 m. The RAS is pumped from the secondary clarifiers to the anaerobic zones by the RAS pumps which can provide flows up to 1.5 AADF.

The waste activated sludge (WAS) is first pumped to a gravity thickener unit. The thickened WAS is then transferred to one of the 128 sludge drying beds for sludge drying and stabilization before disposal. The ponds remaining from the original plant construction are primarily used for effluent storage with the rock filter aiding in the removal of algae prior to chlorination.

3.2 Existing WWTP Flows and Loads

The 2005 plant expansion capacity was 5,400 m^3/d AADWF to serve Ramtha city. As of October 2018, approximately 60 percent of Ramtha city was connected to the WWTP.

As of October 2018, the Ramtha WWTP was operating at 83 percent of the design hydraulic capacity and 82 percent of the design organic load with influent BOD_5 of averaging 1,002 mg/l, which is a normal organic concentration in Jordan. The high loading month is August and in 2018 the influent flow was 88 percent of the hydraulic design capacity and the organic loading was expected to have been similar. (Ramtha WWTP Expansion Condition Assessment Report, April 2019)

3.3 WWTP Catchment Area

Currently only part of Ramtha city has a sewage collection system and is connected to the Ramtha WWTP. MWI/WAJ has plans to extend the wastewater collection system to new areas of Ramtha city and to villages north of Ramtha WWTP under the Sahel Horan project. Based on data extracted from the recent (December 2018 update) GIS database provided by Yarmouk Water Company, the existing wastewater collection network is 140 km long with 5,291 house connections and services a population between 68,000 and 82,000. The uncertainty in the served population is due to the influx of Syrian refugees. The existing sewage collection system connection to the Ramtha WWTP are shown in black in **Figure 5**.

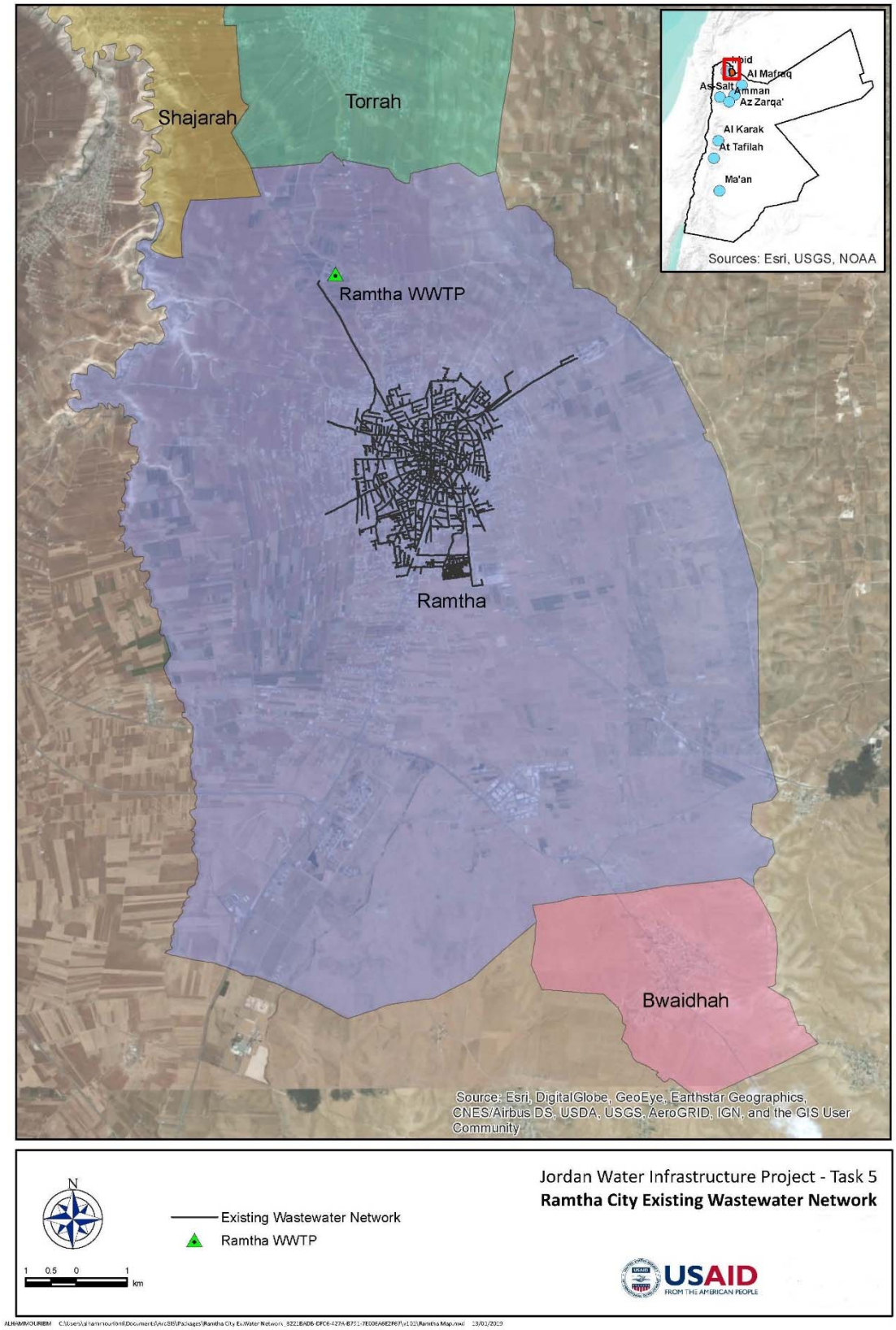

Figure 5: Ramtha City Existing Wastewater Network

3.4 Effluent and Solids Reuse

The Ramtha WWTP effluent and biosolids reuse study prepared by Ahmad Abu-Awwad, Ph.D for USAID Jordan Water Infrastructure indicates that in 2018, all treated effluent from Ramtha WWTP was used to supply the farmers on a daily basis to irrigate their fodder crops (ryegrass, alfalfa, barley, and corn), through 16 signed agreements between local farmers and the MWI. The total irrigated cultivated area was 737.7 dunum (1 dunum = 1,000 m^2) in 2018, which represents the total irrigated area permitted in the agreements.

The treated effluent is sold to the farmers under the direction of the MWI/JWA. Based on the agreements between the farmers and the MWI, the sale price is JD 0.05 per cubic meter per dunum on daily basis for 365 days per year. The total cost is JD 54.75 per 1,095 m^3 per dunum (JD 0.05 x 3 x 365) of treated effluent per year. The effluent is supplied (at 3 m^3 per day per dunum) to the farms on daily basis, regardless of crop types and its needs. Sludge (WAS) from the extended aeration process are thickened in a gravity thickener and dried in on site sludge drying beds. Once the solids are sufficiently dried, they are hauled to a landfill for disposal. Currently, there is no market for use of sludge as a fertilizer for soil amendment due to the perceived risk by the local population and tight restriction on it use by the Jordan Ministry of Agriculture.

3.5 Expansion of Ramtha WWTP Proposed Phase 1

The Sahel Horan wastewater system study and design were completed in May 2012 but has not yet been constructed. That project planned to expand wastewater collection networks to unsewered areas of Ramtha city and the villages of Shajarah, Torrah, Emrawah and Dnaibeh and connect them to Ramtha WWTP which would also be expanded as shown in **Figure 6**.

Wastewater Flow Projections Based on Domestic Demand of 100 lpcd				
Irbid (Ramtha)	Wastewater Flow projections with 80% of localities connected to collection system (m^3/d)			
Locality	2015	2025	2035	2045
Ramtha city	4,953	12,116	13,549	14,419

Table 2: Wastewater Flow Projections Based on Domestic Demand of 100 lpcd

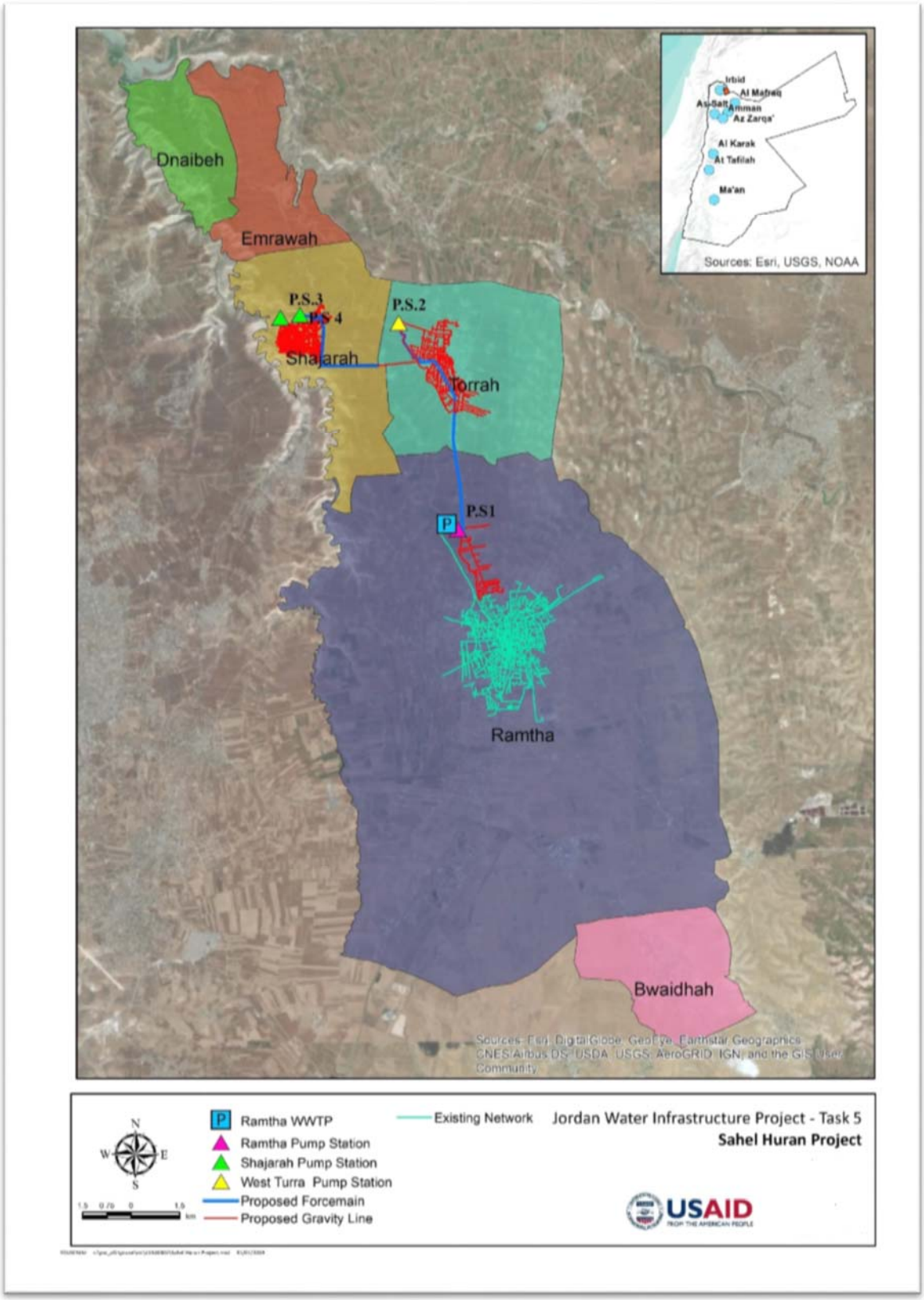

Figure 6: Sahel Horan Planned Wastewater Network Expansion

CDM Smith prepared a feasibility study report for the proposed project and based on that analysis, the expansion to the Ramtha WWTP for the design horizon 2045 would need to have a design capacity AADF of 22,000 m^3/d. On July 8, 2019, MWI/WAJ choose the option for a phased expansion of the Ramtha WWTP to the 2045 design horizon projected flow of 22,000 m^3/d. Phase 1 would expand the WWTP to a design capacity of 11,000 m^3/d AADF. The proposed WWTP expansion is "Alternative C1-Phase 1" has AADF of 11,000 m^3/d expandable to 22,000 m^3/d and with a conventional anaerobic digesters and CHP system. This alternative (C1-Phase 1) includes primary clarifiers and conventional activated sludge process with five-stage plug flow Bardenpho for BNR as shown in **Figure 7**.

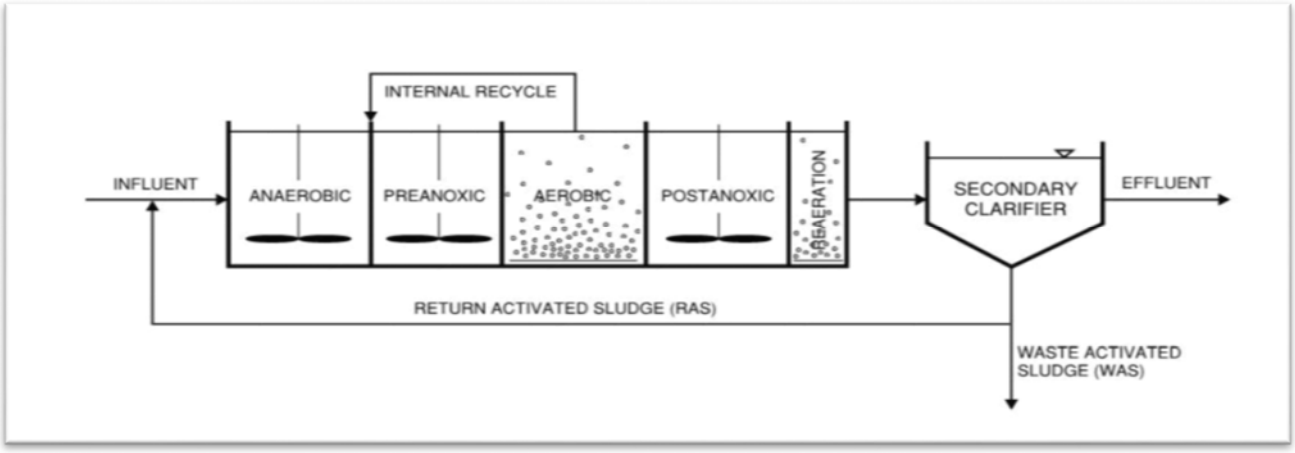

Figure 7: Five-Stage Bardenpho BNR Process

The existing plant capacity is 5,400 m^3/d. This plant expansion will add new parallel treatment process with a capacity of AADF 11,000 m^3/d and BOD_5 biological load of 8,940 kg/d. Treated effluent from the expanded plant would achieve the required JS893/2006 category 3A for the irrigation of cooked vegetables. and allows for of the existing plant would continue operations during construction of the new facility and would be decommissioned once the new expanded plant is operational. In addition, the expansion would include a proposed treated effluent transmission pipeline from Ramtha WWTP to Shallalah WWTP effluent reservoir. The new WWTP expansion schematic layout and proposed project plans are shown in **Figures 8 and 9**

Coordinates in Decimal Degrees of the Site	E	N
A- Ramtha WWTP	780489.74°	3610215.9°
B –Shallalah WWTP	775348.17 °	3607130.79°

Table 3: Project Coordinates

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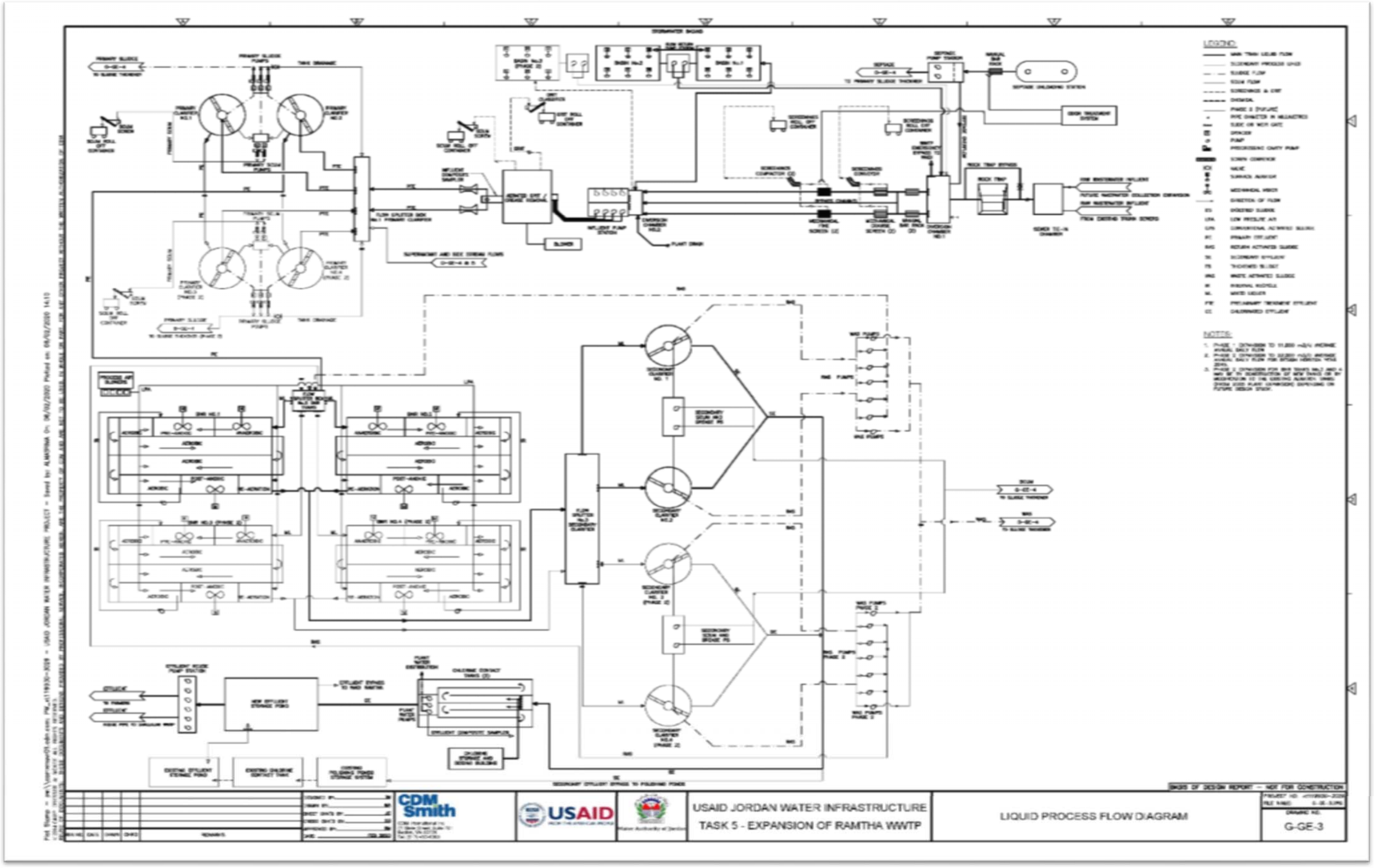

Figure 8: New Expansion Layout (Alternative C1- Phase 1)

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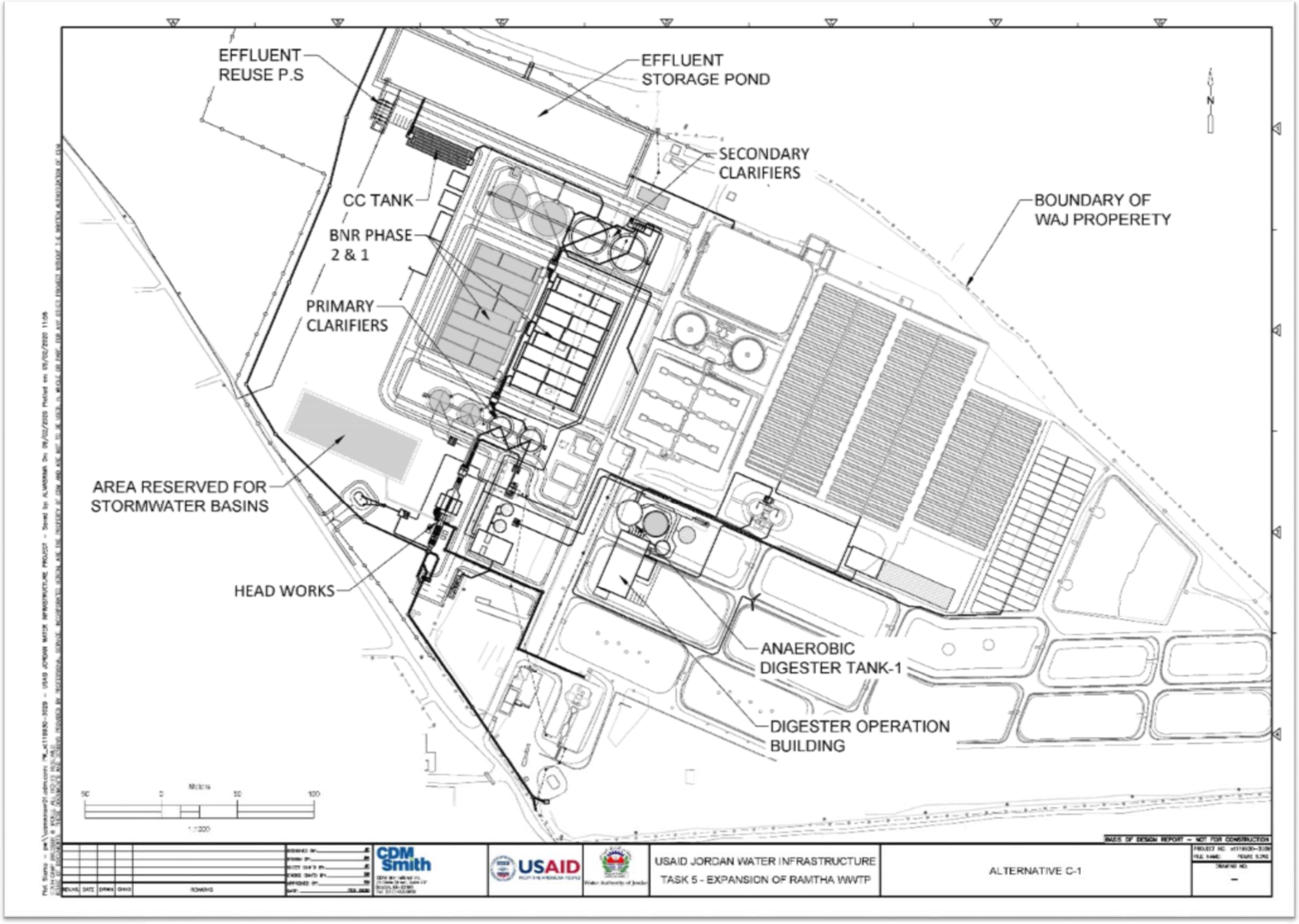

Figure 9: Proposed Project Site Plan (Alternative C1 – Phase 1)

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3.5.1 Proposed Phase 1 Expansion Components (Liquid Stream Treatment)

3.5.1.1 Biological Nutrient Removal with Primary Clarifiers

This new plant would replace the existing aeration and secondary clarifiers with a new BNR system (five-stage Bardenpho with plug flow reactors called conventional activated sludge in the feasibility study report) and primary clarifier system. Phase 1 would include two liquid treatment trains with a capacity of 5,500 m^3/d each, for a total average plant capacity of 11,000 m^3/d, and BOD_5 biological load of 8,940 kg/d.

Phase 1 expansion would include the following:

- Installation of new primary clarifiers.
- Installation of two BNR trains complete.
- Installation of two new secondary clarifiers
- Installation of new primary, RAS and WAS pump stations and piping.
- Decommissioning of existing process tanks.

Plant Hydraulics

Due to the depth at which the sewer enters the plant site and the level of topography of the plant site an influent pump station would be required to avoid having very deep process structures.

Septage Unloading Station

A new septage unloading station would be required for the proposed expansion.

Rock Trap

A new rock trap would be installed upstream of the influent screens. The rock trap would include the following features:

- Rock pit for the collection of gravel and rock
- Small clamshell bucket with electric hoist mounted on a monorail for removing the gravel and rocks from the pit
- Rock draining pad
- Dry weather bypass
- Rock trap tank overflow to headwork.

Emergency Bypass to Wadi

The expanded WWTP will not maintain the existing bypass to wadi but instead provide a new emergency bypass to wadi from the stormwater ponds and should reduce the risk of accidental diversion of raw wastewater. A stormwater diversion chamber would divert stormwater flow in excess of the peak hydraulic capacity for the new WWTP [27,500 m^3/d (2.5 x AADF)] to the stormwater pond for temporary storage. The emergency bypass to the wadi is connected to the stormwater pond overflow, so only with the stormwater pond is full and overflowing will water be bypassed to the wadi. Additionally, the overflow from the new headworks drains to the stormwater pond to capture the flow so it may be returned to the WWTP for treatment.

Influent Screening

Two types of screens would be used in series; a manual bar screen located directly downstream of the rock trap followed by mechanical bar screens. For each screen type, two screening channels are proposed. A bypass channel would also be provided around the mechanical screens, equipped with an upstream slide gate to allow for a passive overflow into the bypass channel in the event the mechanical screens malfunction. This provides firm capacity at peak flow, while providing a means to take a screen out of service for maintenance during dry weather periods.

Stormwater Pond

The influent stormwater pond would temporarily store wet weather flow that often exceeds the treatment capacity of the WWTP and avoids bypassing the excess flow to the wadi. After the peak wet weather flows pass, the raw wastewater in the stormwater pond is pumped back to the headworks for treatment. The existing equalization basins would be rehabilitated and expanded as necessary to be used as stormwater storage ponds.

Influent Pump Station

The existing WWTP has an influent pump station to lift the wastewater up in to the aeration process tanks. WAJ has elected to not have an influent pump station for the new WWTP expansion to save the operation cost and instead regrade the site to allow for the process tanks be lower. Therefore, the expanded WWTP will not have an influent pump station.

Grit Removal

The grit removal process to remove grit and fine sand prior to entering the process tanks.

Headworks Odor Control

H_2S is typically the primary odor component at the head of a wastewater treatment plant. The WWTP would include appropriate technology to remove approximately 90 percent of the odors at the headworks. A bio trickling filter is proposed to handle spikes of H_2S concentration and to treat high H_2S streams.

Primary Clarifiers

Primary clarifiers are proposed for the plant expansion to reduce the loading to the downstream biological treatment processes and to concentrate the primary sludge for the anaerobic digester. The liquids treatment trains would be less energy intensive with less loading. The primary solids would be directed to the anaerobic digestors for sludge stabilization. It is assumed that primary clarification will remove 50 percent of influent TSS and 30 percent of influent BOD_5 at the Phase 1 average day maximum month flow (ADMM) of 13,150 m^3/d. Flow splitting prior to the clarifiers would ensure that influent flow is evenly distributed among units and allow for any of the units to be taken off-line.

Primary Sludge Truck Filling Station

WAJ and YWC propose to have the flexibility to send sludge to the Shallalah WWTP for digestion to produce more digester gas and generate more electricity to offset operations costs at that facility. Pumping sludge 8.5 km is not practical, so a truck filling station is the only viable option for delivering primary sludge to Shallalah WWTP anaerobic digestion and CHP system. Only screened primary sludge would be made available at the sludge truck filling station since WAS has lower VSS/TSS ratio and would not yield much biogas and the supply of septage is unreliable.
This option will be used if there is an issue with the Ramtha WWTP digester or CHP system and it is offline then the sludge will be hauled to feed the Shallalah WWTP digester and CHP system to generate more power.

Secondary Clarifiers

A total of two circular secondary clarifiers each 22.5 m in diameter are proposed for Phase 1. The two existing secondary clarifiers will be taken out of service once the new plant is operational.

RAS and WAS Pump Stations

Dry pit RAS/WAS pump stations are proposed to convey RAS to the BNR process and WAS to sludge processing. Each RAS/WAS pump station would have five RAS and two WAS pumps to serve the pair of secondary clarifiers. Each clarifier would be provided with two duty dry pit centrifugal RAS pumps while sharing a standby RAS pump with the other secondary clarifier served by the same pump station.

Disinfection System

A chlorination system that uses chlorine gas would be used for disinfection. Chlorinators will create a solution, which will be conveyed to the injection point at the new chlorine contact tanks (CCTs). Two CCTs would be used to provide 15 minutes of contact time at the design horizon (2045) peak hourly flow of 55,000 m^3/d.

Treated Effluent Storage Pond

The effluent storage pond is short term post disinfection store and effluent pump wet well for the effluent reuse pump station for pumping effluent to local farms for irrigation and the excess to the Shallalah WWTP. The effluent basin would be an earthen basin with HDPE liner with 44,000 m^3 of usable storage to provide two days storage at design horizon AADF. Additionally, the basin would have a floating cover to reduce algae growth and evaporation.

Additional Effluent Storage

Additional effluent storage could be provided by the existing polishing ponds. Excess effluent from the secondary clarifiers could be pumped to the existing polishing ponds for storage. When the water in the ponds is needed for crop irrigation it would be channeled through the existing chlorine contract tank for disinfection and into the effluent storage pond and to the effluent reuse pump station. Use of the polishing ponds would only be for short term storage because algae growth would degrade the quality of effluent stored in these ponds and would no longer comply with the Jordanian Standard for the WWTP effluent.

3.5.2 Effluent Reuse Pump Station and Pipeline to Shallalah WWTP

A new effluent reuse pump station will replace the existing effluent pump station for pumping treated effluent to local farmer for irrigation and for pumping the excess effluent to the Shallalah WWTP through the new effluent reuse pipeline. The new effluent reuse pipeline would conveyance excess treated effluent to the 15,000 m^3 effluent storage tank at the southwest corner of the Shallalah WWTP.

The effluent reuse pipeline to Shallalah WWTP involves the construction of a new 8.5 km long conveyance pipeline from new Ramtha WWTP effluent reuse pump station to the large effluent storage reservoir at the Shallalah WWTP. From Shallalah WWTP the effluent would enter the reuse system for pumping effluent to the Jordan valley for use on agriculture crop irrigation. The project would transfer up to 8,250 m^3/d of Ramtha WWTP treatment effluent for agriculture use in the Jordan valley during 11 hours of operation per day (with the option for expansion to convey 22,000 m^3/d when operating for 22 hours per day). Due to hydraulic capacity constraints in the effluent reuse conveyor from Shallalah WWTP to the Jordan valley pumping from Ramtha is limited to 11 hour per day from midnight to 11:00 AM. The effluent reuse pipeline follows existing roadways that pass mostly through rural agriculture areas as seen in **Figure 10**. Ramtha WWTP is at a higher elevation than the Shallalah WWTP but the effluent is pumped over a high point in the pipeline alignment. From the pipeline high point, the effluent can flow by gravity to Shallalah WWTP site.

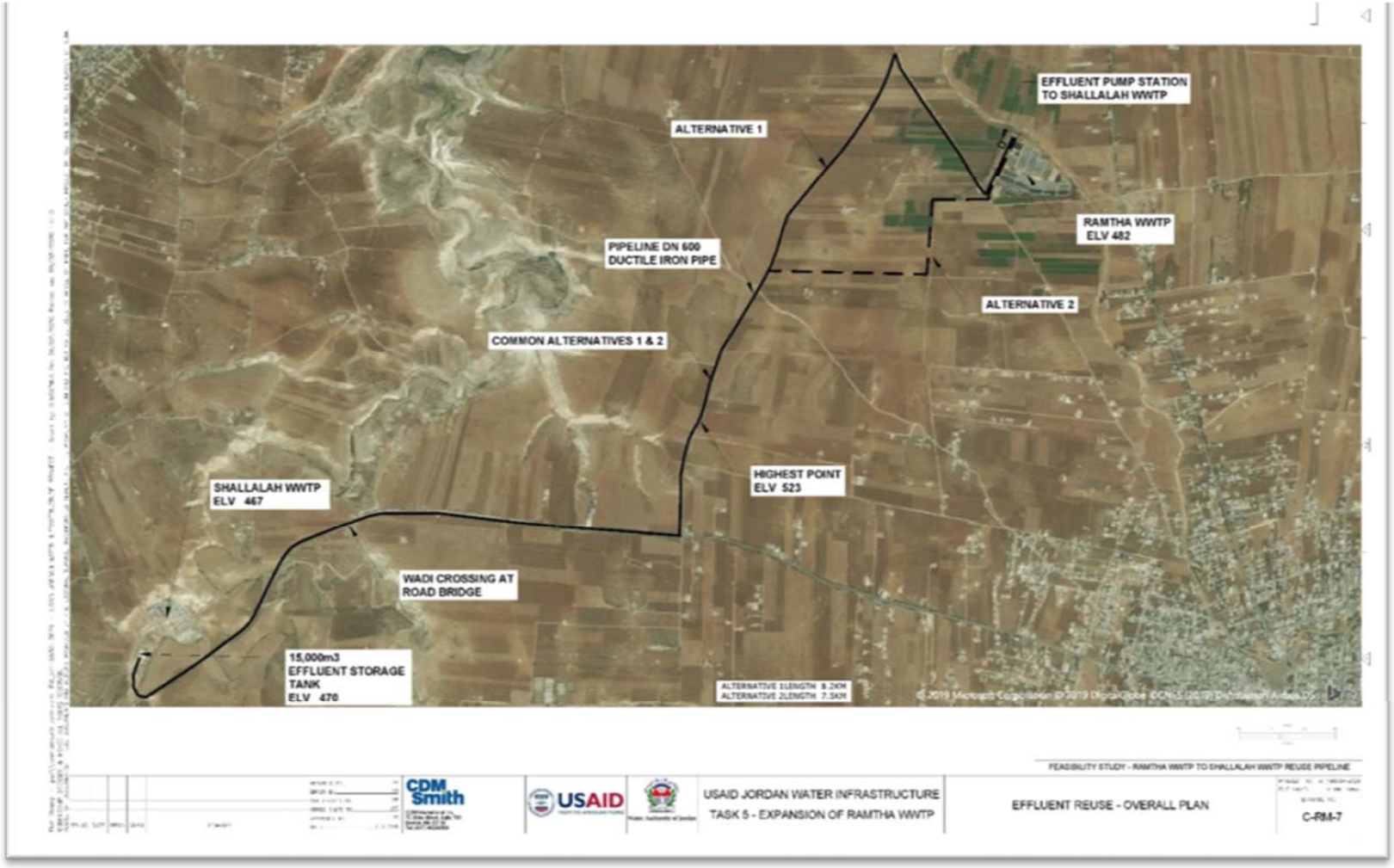

Figure 10: Transmission Pipeline Route

The effluent reuse pipeline diameter would be 600 mm in diameter and would be HDPE or ductile iron pipe buried in the roadway right-of-way. This pipeline would cross Wadi Shallalah and a secondary wadi just to the west. Due to a high point in the pipeline, the effluent gravity flow into the Shallalah WWTP effluent reservoir may cause surges therefore a pressure sustaining valve would be added to the pipeline at the Shallalah effluent reservoir. Additionally, a motorized isolation valve would also be required to allow the Shallalah plant to shut off flow from Ramtha WWTP in case of an emergency at the plant.

A summary of infrastructure that would be required for the transfer of effluent to Shallalah WWTP for effluent reuse includes:

- Connection to the new effluent reuse pump station at Ramtha WWTP with a Phase 1 firm pumping capacity of 750 m^3/h and expandable to 1,100 m^3/h in Phase 2 expansion, pipeline surge protection system, and civil works.
- An 8.5 km long pipeline would be 600 mm in diameter of HDPE or ductile iron pipe with air valves, pipeline washouts and roadway crossing where required.

Station	Coordinate (N)	Coordinate (E)
0+000.00	1,222,666.6989m	242,798.3445m
0+200.00	1,222,538.5022m	242,655.4078m
0+400.00	1,222,699.8402m	242,537.3646m
0+600.00	1,222,863.1512m	242,421.9684m
0+800.00	1,223,028.9804m	242,310.2396m
1+000.00	1,223,009.0386m	242,239.0204m
1+200.00	1,222,827.2919m	242,156.4605m
1+400.00	1,222,655.3658m	242,054.4810m
1+600.00	1,222,491.2629m	241,940.2725m
1+800.00	1,222,339.0901m	241,810.6276m
2+000.00	1,222,181.8794m	241,687.0050m
2+200.00	1,222,010.0862m	241,590.4037m
2+400.00	1,221,818.8426m	241,531.8812m
2+600.00	1,221,638.6258m	241,445.8212m
2+800.00	1,221,465.4059m	241,345.9175m
3+000.00	1,221,291.9148m	241,246.4373m
3+200.00	1,221,107.1122m	241,171.7043m
3+400.00	1,220,914.8792m	241,117.2597m
3+600.00	1,220,731.2503m	241,041.5067m
3+800.00	1,220,540.2486m	240,986.9418m
4+000.00	1,220,341.3216m	240,973.5964m
4+200.00	1,220,141.3231m	240,974.3579m
4+400.00	1,220,089.7235m	240,832.6962m
4+600.00	1,220,101.1028m	240,633.0400m

Station	Coordinate (N)	Coordinate (E)
4+800.00	1,220,109.5433m	240,433.2306m
5+000.00	1,220,121.6200m	240,233.6248m
5+200.00	1,220,143.1597m	240,034.7958m
5+400.00	1,220,166.2950m	239,836.1400m
5+600.00	1,220,185.9903m	239,637.1172m
5+800.00	1,220,200.2905m	239,437.6562m
6+000.00	1,220,199.8956m	239,237.6601m
6+200.00	1,220,184.6323m	239,039.1882m
6+400.00	1,220,109.2527m	238,854.2061m
6+600.00	1,220,028.0256m	238,671.4436m
6+800.00	1,219,916.0056m	238,510.2446m
7+000.00	1,219,739.5664m	238,417.2825m
7+200.00	1,219,557.8577m	238,333.7308m
7+400.00	1,219,405.7927m	238,208.5149m
7+600.00	1,219,287.5964m	238,047.1780m
7+800.00	1,219,169.3494m	237,885.8781m
8+000.00	1,219,056.1790m	237,721.0653m
8+200.00	1,219,035.8226m	237,573.8437m
8+400.00	1,219,232.6820m	237,547.0609m
8+495.58	1,219,286.5823m	237,592.6008m

Table 4: Transmission Pipeline Coordinates from Ramtha WWTP to Shallalah WWTP

3.5.3 Solids Stream Treatment

MWI/WAJ selected the alternative for "conventional anaerobic digestion with CHP for electric power generation" for the Ramtha WWTP expansion, which is an expensive and complex biological process and requires highly trained operators that understand the process and can troubleshoot biological process and mechanical problems.
The system is constructed electricity generated from this system would be used to cover part of the WWTP energy consumption. The components of the solids processing are shown in **Figure 11** and described in the following subsections.

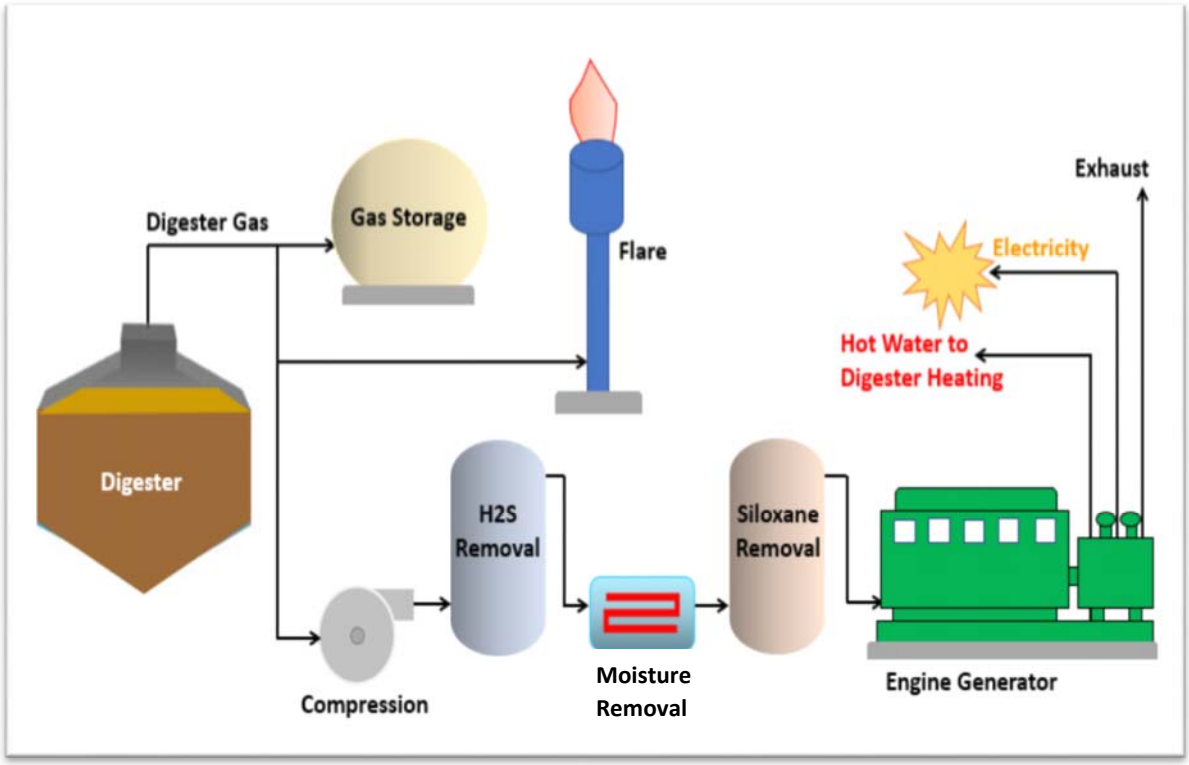

Figure 11: Digester Gas Utilization Schematic

3.5.3.1 Sludge Stabilization

Conventional anaerobic digestion is one of the most common and proven technologies used for stabilization (pathogen and odor reduction) of biosolids, which involves heating sludge to mesophilic temperatures under anaerobic conditions to biologically reduce volatile solids. Although sludge stabilization is not required for third class biosolids it is a side benefit of energy recovery from biosolids.

Phase 1 expansion would have 2 concrete cylindrical anaerobic digesters (with additional tanks constructed during Phase 2 expansion) with fixed steel covers would be constructed to provide conventional anaerobic digestion. Each digester would include a mechanical mixing system and an external heat source.

Parameter	Unit	2023 Average Daily	2045 Average Daily	2045 Maximum Month	2045 Peak Week
Thickened Primary Sludge					
Flow	m^3/day	56	112	130	163
Dry Solids Load	dry kg/day	3,436	5,784	6,509	8,155
Solids Concentration	percent	6.1	5.1	5.0	5.0
Thickened WAS					
Flow	m^3/day	22	89	118	119
Dry Solids Load	dry kg/day	1,260	5,041	7,061	7,107
Solids Concentration	percent	5.6	5.6	5.9	5.9

Table 5: Thickened Sludge Flows and Loads

3.5.3.2 Digester Gas System

The Phase 1 expansion of Ramtha WWTP has a CHP system to generate electrical power from the digester gas produced by the anaerobic digesters. A key driver for the implementation of anaerobic digestion systems is the production of biogas and its beneficial reuse for renewable energy

Parameter	Unit	2023 Average	2045 Average Daily	2045 Maximum Month	2045 Peak Week
Biogas Fuel	kW	433	940	1,167	1,336
Generated Electricity	kW	169	367	455	521
Annual Electricity	MWh	1,478	3,212	-	-
Generated Heat	kW	202	439	545	624

Table 6: Digester Gas Production

Parameter	Unit	2023 Average Daily1	2045 Average Daily	2045 Maximum Month	2045 Peak Week	2045 Maximum Day
Gas Production	m^3/h	70	151	188	215	224
Gas Production	m^3/day	1,672	3,634	4,509	5,165	5,385

Table 7: Digester Gas Electrical and Heat Generation

The biogas capture system shown in **Figure 11** would include a backup boiler and gas flare. Excess gas flares provide a means for releasing waste biogas safely into the atmosphere in a controlled manner. While 100 percent of the digester biogas is expected to be utilized by the CHP system to produce electricity and process heating, if the CHP system goes down, the backup boiler and flare provide avenues for using and releasing biogas, respectively.

3.5.3.3 Digester Gas Energy Recovery System

Biogas can be turned into electricity and process heat, the produced biogas will be routed through a digester gas cleaning to condition the gas for use at the engine generators and backup boiler.

3.5.3.4 Biosolids Dewatering

The Ramtha WWTP currently has 114 drying beds which provide a total drying area of 17,100 m^2. Drying is achieved from exposing the biosolids (sludge) to sun heating and evaporation at ambient conditions. Thickened biosolids are conveyed to the drying beds via distribution channels and allowed to spread-out in the beds. Filtrate from the drying beds is returned to the head of the WWTP for treatment in biological treatment processes. Biosolids drying time is dependent on weather conditions with an average drying time of approximately three weeks during the dry season. With the plant expansion to an influent of 22,000 m^3/d by 2045, the plant will need additional drying bed area.

Mechanical biosolids dewatering would be installed for use during the winter months with the performance of the drying beds is poor due to the cool wet weather to be able to dewater biosolids year around.

3.5.3.5 Biosolids Disposal

Dried biosolids (sludge) is temporarily stored on the plant site until there is sufficient quantity for YWC to issue a contract for a hauler to take the sludge to the Al-Ekaider landfill.

3.5.4 WWTP Expansion Summary

In summary, the infrastructure constructed for this Phase 1 expansion would include the following:

- New liquid treatment train with capacity of BOD_5 biological loading of 9,025 kg/d and AADF 11,000 m^3/d (expandable to 17,883 kg/d and 22,000 m^3/d) built in parallel to the existing 5,400 m^3/d facility.
- The existing WWTP process tanks will remain in service throughout construction and after the new WWTP processes are commissioned and operational the old process tanks will be decommissioned, but not dismantled.
- Completely new headworks with AADF capacity for the 22,000 m^3/d for the 2045 design horizon.
- Septage truck unloading station with the septage discharged to the WWTP headworks and mixed with the influent flow. Design will allow for the septage to be sent to the conventional anaerobic digesters with pumps.
- Conversion of the existing equalization basins to stormwater storage ponds. .
- Two primary clarifiers, with full flow splitter box with connections for two additional future clarifiers; circular type clarifier is assumed.
- Two BNR treatment trains each with an AADF capacity of 5,500 m^3/d in new concrete structures, including flow splitter box with connection for two additional future treatment trains.
- Two conventional anaerobic digester tanks expandable to three tanks in Phase 2, and the CHP system for energy recovery.
- RAS/WAS pump station for the two treatment trains.
- Two new secondary clarifiers and splitter box with connections for two future clarifiers.
- New chlorine contact tanks and chlorine gas storage and chemical injection equipment and building.
- New effluent storage pond with approximately 44,000 m^3 capacity, which also functions as the wet well for the effluent pump station.
- New effluent reuse pump station for pumping treated effluent to local farmers and to the Shallalah WWTP effluent reservoir.
- Reuse of existing sludge thickeners for primary sludge and septage thickening.
- Primary sludge screening prior to the anaerobic digestion process.
- Primary sludge truck loading station to allow for the option to haul untreated sludge to Shallalah WWTP for digestion to generate power.
- Rehabilitation of existing drying beds as needed and additional new drying beds for dry season sludge dewatering.
- New mechanical sludge dewatering facility for wet season sludge dewatering.
- New plant water system to distribute chlorinated effluent around the WWTP for O&M operations, and plant fire water system.
- New plant administration building with laboratory facilities, similar to that at the East Jerash WWTP.
- New maintenance building similar to that at the East Jerash WWTP.
- New electrical and generator building built to contain equipment for the full plant design capacity but only equipment required for Phase 1 installed.
- Site grading and paving in areas disturbed.
- New plant boundary fencing on west side.
- Rehabilitation of the existing polishing ponds and rock filters is not included, but they will remain for effluent storage except for area needed for the plant expansion

Plant Support Facilities

Buildings

Plant support structures for the site include:

- Administration Building for manager and staff offices, operations room, public reception and meeting rooms, locker rooms, laboratory.
- Electrical and generator building for plant wide electrical equipment and emergency standby diesel generator.
- Maintenance building for working of plant equipment and storage of spare parts and equipment.

General Site Civil

General site civil requirements of the proposed WWTP expansion under Phase 1 include:

- Site roads including:
  - plant entry roads and service roads,
  - site entry road to administration building and to main process areas,
  - secondary site roads, like roads around ponds and plant boundary road, all to checked and improved and paved as necessary.
- Miscellaneous requirements
  - Yard lighting and upgrade of the electrical service connection at the plant site necessary to meet the requirements of the plant expansion.
  - Boundary fencing: to provide full site fencing, repair and replace as needed.
  - Electrical and instrumentation conduits.
  - Plant water system,
  - Fire protection and alarm, lightening system, safety and security systems
  - Transmission pipeline roadway restoration works. (USAID, 2019)
  - Regrading to lower the site to enable deletion of the influent pump station

Main roads

One paved main road connects to the Ramtha WWTP as shown in **Figure 12**. The main road is 5m wide and is 3 Km away from sub Ramtha road, many new residential buildings, and agricultural lands are along the road. The WWTP uses this road to dispatch the sludge to Al-Ekaider landfill.

Figure 12: Main and Sub Roads on Project Area

3.5.5 Workforce (Labor and Management Staff)

The number of peak construction personnel during construction phase highly dependent upon the approach that will be considered by the construction contractor.

During construction the estimated peak number of personnel on site may be as high as 36. However, such numbers are not expected for all time during construction phase only peak work periods. These personnel include engineers, specialists, project partner and representatives, suppliers as well as unskilled construction workers.

During construction, workers will likely be accommodated in temporary onsite accommodations provided by the construction contractor. However, worker accommodation options are determined by the construction contractor. If the construction contractor opted to include worker accommodation facilities on site they would include kitchen with catering facilities, and common recreational space. The accommodations would be established in accordance with the specifications of the International Labor Organization (ILO) standards and guidance published by World Bank and shall adhere to all measures needed to prevent potential occupational hazards on site.

The construction contractor's temporary onsite facilities would include offices for the construction contractor and engineer as necessary, workshop facilities, and material lay down areas. All temporary facilities will be removed at the end of construction.

During the WWTP operation, the estimated number of personnel on site would be 19 as it relates to a 24/7 operation. This estimate includes all WWTP operation staff such as the plant manager, operators, laborers, and support staff.

3.5.6 Implementation Schedule

Project Specific Assumptions:

- Start of construction early 2021.
- Construction completion is mid-2023.
- Existing WWTP to remain operations throughout construction.
- Decommissioning of existing plant cannot start until after new plant startup and
- commissioning.
- Two-year operations and maintenance (O&M) program to start after new WWTP commissioning and acceptance.

Overview of Project Phases:

The common project develop phases are:

- **Planning and Design Phase**: Typical activities include:
  - Feasibility study,
  - Design,
  - Permits,
  - Project partners partipipation,
  - Tendering.
- **Construction and Commissioning Phase**: Typical activities include:
  - Transportation of all project components to the site.
  - Civil, mechanical and electrical construction according to the design.
  - Commissioning of the WWTP includeing process, mechanical, electrical systems and performance testing.
- **Operation Phase:** Typical activities include:

- Operation and maintenance of the WWTP after commissioning, daily physical inspections of the WWTP components and site conditions; monitoring and evaluation of plant performance measurements, repairs and upkeep.
- Corrective maintenance in case of defect or failure of components.

Construction Schedule:

The WWTP expansion construction duration is anticipated to take about two years followed by the two year construction contractor's O&M period. It will employ approximately 36 people during the peak of construction period. During operational period that will extend until 2045, approximately 19 people will be employed to operate and maintain the WWTP. (an organization chart for the Ramtha WWTP showed 17 employees dedicated to the Ramtha WWTP in the present situation). The following **Table 7** summarizes the expected Project Implementation Schedule

Milestone	Expected Start Date	Expected Period
Construction Phase	2021	24 months depending upon contractor's capability
Commissioning	Mid 2023	
Operation	Mid 2023	2045

Table 8: Project Implementation Schedule

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4 REGULATORY FRAMEWORK

This section outlines regulations relevant to the natural environment of the Hashemite Kingdom of Jordan and describes relevant international conventions and treaties signed and ratified by Jordan and incorporated into the national law.

Specifically, the legislative framework presented in this section is relevant to the WWTP project. and describes the World Bank and AFD performance requirements and relevant USAID directives that the project is required to comply with during its life cycle.

4.1 Relevant Environmental-Related Institutions

A selection of the main ministries, institutions and authorities that are directly related to environmental issues are as follows:

4.1.1 Ministry of Environment

The Jordanian Ministry of Environment (MoE) is the principal environmental institution in Jordan and responsible for the evaluation of the environmental impacts of the project and issue of associated project licenses and clearance.

MoE was established in 2003, and its mission is maintaining and improving Jordan's environmental quality through sustaining and conserving the environmental resources thus contributing to sustainable development. MoE develops environmental policies that are implemented and enforced throughout the Kingdom, moreover, it is dedicated towards ensuring that legislation is enforced; raising public awareness, inspection and monitoring, encouraging co-operating with national, regional and international bodies.

The Ministry of Environment has the legal strength of the environmental law that provides the Ministry with the tool to perform their duties. The Environmental Protection Law was one of the temporary laws issued in 2003 and was officially endorsed by the Jordanian Parliament in 2006 and amended in 2017 and issued as the Law No. 6 for the Year 2017.

The law considers the Ministry of Environment to be the competent authority for the protection of environment in the Kingdom, and the official and national authorities shall be bound to implement the instructions and resolutions issued under the provisions of this law which give the Ministry all the judicial powers it requires for implementing the law.

Law No. 6 provides the Ministry with the legal power to inspect any facility, and according to the findings of the audit, gives the Ministry the right to order a facility shutdown until the proper mitigation and control measures are implemented and the environmental violation eliminated. This inspection system was further strengthened with the establishment of the Environmental Police in 2007 where the police are now acting as an implementation tool and a full-fledged partner in the implementation of the environmental law.

The Environmental Protection Law has also introduced a system of an environmental "pre-emptive" assessment of all economic and developmental projects to be established in Jordan. This process is

known as the Environmental and Social Impact Assessment (ESIA) where any developmental or economic project should carry out a detailed assessment of the expected environmental impacts potentially arising from the implementation of the project, and how these impacts can be mitigated through remedial action at the technical, legislative and public levels.

According to the Environmental Protection Law, the ESIA study should be done before the project is initiated and sent to the Ministry of Environment where it will be reviewed. Please refer to ESIA Regulation No. (37) / year 2005 classifies projects into three categories according to their environmental impacts:

- **Category 1:** Projects that require comprehensive ESIA
- **Category 2:** Projects that require PEA
- **Category 3:** Projects that don't require an ESIA

However, upon the MoE's decision, a comprehensive ESIA may be required based on the findings of the preliminary stage if major impacts are expected from the project. If not, then the preliminary ESIA will be finalized by the consultant based on the MoE's comments. The MoE will approve the study, which means the project will obtain the license and commence its activities while adhering to the environmental mitigation and management systems specified and approved in the preliminary ESIA study. Any deviation from these guidelines would cause project violations.

This regulation sets out the process for conducting an ESIA study and the items to be included in the Study, procedure for obtaining an environmental clearance. In addition, it lists the projects that require a full ESIA or a preliminary ESIA. Any project which may pose potentially significant impacts on the environment must have a full ESIA carried out and will be classified as a Category 1 Project according to the ESIA regulation, the study must be conducted prior to obtaining environmental clearance from MoE for construction and operation activities. This will apply to this project.

The project proponent is responsible for submitting the ESIA study to MoE. upon an agreement with AJWE (the ESIA Consultant) who will be conducting an ESIA Study for the project in compliance with all Jordanian legislation mentioned in the following sections, in addition to all regional and international laws and regulations (AFD / World Bank guidelines).

If the impact assessment is approved, the project will get the license and start its activities while adhering to the environmental mitigation and management systems specified and approved in the study. Any deviation from those guidelines would render the project to violations.

4.1.2 ESIA Regulation in Jordan

According to the Jordanian ESIA Regulation no 37/2005, this project is classified as Category (1), i.e. it needs a comprehensive ESIA study. In accordance with Article (9), the Project Developer, submitted preliminary Terms of Reference (ToR) for the ESIA Study prior to holding the scoping session, MoE shall call the project owner and any concerned individual or representative of a public or private party that may be potentially affected by the project to participate in investigating the preliminary ToR to identify the Significant Impacts of the project on the environment. As a result, this has been carried out through the Scoping Session, which was held on Tuesday, October 19, 2019. CDM Smith and its

ESIA Consultant (AJWE) provided all the available information on the project and its surrounding environment and social conditions to all concerned entities within an appropriate time prior to the date of the Scoping Session.

After the Scoping Session, AJWE submitted a summary of the scoping session's discussions and deliberations as well as a list of the parties/stakeholders who attended, and the key issues of concern/comments that were raised during the session (scoping session report – provided as **APPENDIX A** of this ESIA report), which was then attached to the Final ESIA Terms of Reference (ToR) and submitted to MoE. The Final ToR was reviewed by the technical committee at the MoE which will make recommendations to the project developer (if deemed necessary). If the Minister approves the Final ToR of the project ESIA, the project developer shall advise the consultant team to prepare the draft of the ESIA document. For this project, the Final ToR and Scoping Report were approved by the MoE. on March 12, 2020 via an official approval letter (Ref. No.4/7/2454).

Relevant to this project and upon submission of the Draft ESIA, the MoE's technical committee will be responsible for review. If the document fulfils the requirements of this regulation, then the ESIA will be considered the final document.

If the committee decides that the Draft ESIA does not fully cover the requirements, it shall require WAJ and its Consultant (CDM Smith and AJWE) to provide any additional information needed to complete its analysis of the draft.

The decision related to the ESIA study shall be announced to the public in the manner that MoE deems appropriate. When the ESIA approval letter is issued, the project is considered to have obtained environmental clearance.

4.2 Other Relevant Ministries and Governmental Entities

4.2.1 Ministry of Energy and Mineral Resources

Ministry of Energy and Mineral Resources (MEMR) was established in 1984 and entrusted with administering and organizing the energy sector in a way that achieves the national objectives. The responsibilities of the Ministry were amended to include the comprehensive planning process of the energy sector and setting the general plans and ensuring their implementation in a way that achieves the general objectives of the energy sector. The most important objective is providing energy, in its various forms, for the development process, organizing its affairs, exchanging electric power with neighboring countries, and attracting international capital for investment in this field, especially the generation of electric power, the production of oil derivatives, transportation of oil and gas, and utilizing local energy sources.

The Natural Resources Authority (NRA) was established in 1965. In 1968 law number 12 was ratified to regulate tasks, responsibilities and management of NRA. NRA was formed then, from many Directorates amongst are Mining, Geology, Water and Irrigation. Since 1985, MEMR was assigned as the President of NRA. Water and Irrigation Directorates were transferred to form an essential component of MWI.

However, based on recent restructuring, law No. 17/2014 relating to the restructuring of institutions and governmental organizations, is the legal successor for the NRA was formed, which is the Energy and Minerals Regulatory Commission (EMRC) –the EMRC is also the legal successor for Electricity Regulatory Commission (ERC) and the Jordan Nuclear Regulatory Commission (JNRC).

The main strategic objectives of the ministry are to ensure energy efficient practices in all sectors, promote energy efficiency projects, development and efficient exploitation of local energy sources such as renewable energy.

4.2.2 Ministry of Agriculture

The Ministry of Agriculture (MoA) is responsible for managing public rangelands and forests, protecting soil, pasture-land and flora, provision of agricultural loans, support farmers, the granting of permits for import and export of agricultural products of plant, animal and veterinary medicines and vaccines, and live birds, the establishment and renewal of licenses for companies, factories, shops, galleries, nurseries and agricultural farms and olive presses, provide training for farmers, protecting and managing wildlife, issuing fishing and hunting licenses and regulations. Some wildlife protection and permitting tasks are the responsibility of the Royal Society for the Conservation of Nature (RSCN).

4.2.3 Ministry of Water and Irrigation / Water Authority of Jordan

As mentioned earlier, MWI is the official body responsible for the overall monitoring of the water sector, water supply and wastewater system and the related projects, planning and management, the formulation of national water strategies and policies, research and development, information systems and procurement of financial resources. Its role also includes the provision of centralized water-related data, standardization and consolidation of data.

Units for public relations, internal monitoring and water security and protection are directly subordinate to the Minister of Water and Irrigation with responsibilities overarching MWI, WAJ and Jordan Valley Authority (JVA).

The Ministry of Water and Irrigation embraces the two most important entities dealing with water in Jordan:

- The WAJ: in charge of water and sewage systems.
- The JVA: responsible for the socio-economic development of the Jordan Rift Valley, including water development and distribution of irrigation.

According to Article 3 of Water Authority Law No.18 of 1988, WAJ was established as an autonomous corporate body that carries full responsibility for the public water supply, wastewater services and related projects as well as for the overall water resources planning and monitoring, construction, operations and maintenance. The responsibilities of WAJ are defined in the said law and are briefly described hereafter:

- Survey the different water resources, conserve them, and determine ways, means and priorities for their implementation and use.

- Develop potential water resources in the Kingdom and put forth programs and plans to meet future water needs by providing additional water resources from inside or outside the Kingdom.
- Regulate and advise on the construction of public and private wells, investigate groundwater resources, drill exploratory, reconnaissance, and production wells, and license well-drilling rigs and drillers.
- Study, design, construct, operate, maintain, and administer water and wastewater projects including collecting, purifying, treating, disposing and using any other methods of dealing with water.
- Draw terms, specifications and special requirements in relation to the preservation of water and water basins.
- Carry out theoretical and applied research and studies regarding water and wastewater to achieve the Authority's objectives.
- Issue permits to engineers and licensed professionals to perform public water and wastewater works and participate in organizing special training courses to enhance their qualifications and consequently reduce water loss and pollution.
- Regulate the use of water, prevent its waste, and limit its consumption.
- Plan, allocate, permit, monitor and regulate wastewater reuse activities.
- WAJ Program Management Unit (PMU) regulates water supply and wastewater utilities under private management.

These organizations work collectively in order to determine the national water policies and regulations in order to protect water from contamination. In addition, the ministry is responsible for water protection and monitoring studying irrigation patterns and sewerage. Moreover, groundwater, aquifer management and abstraction monitoring and licensing are the responsibility of WAJ.

Generally, WAJ is responsible for the public water supply and wastewater services, as well as for the overall water resources planning and monitoring, while JVA is responsible for management and protection of water and land resources, including their supporting infrastructure.

4.2.4 Ministry of Health

The Ministry of Health (MoH) undertakes all health affairs in the Kingdom, and its tasks and duties include: maintaining public health by offering preventive treatment and health control services; organizing and supervising health services offered by the public and private sectors; providing health insurance for the public within available means; establishing and controlling the management of health educational and training institutes and centers according to relevant provisions of the legislations enacted; and working, in coordination with concerned parties, to raise public health standards.

In terms of this project, the Ministry of Health will have a supervisory and monitoring role through enforcing all applicable legislation to ensure WAJ's contractor compliance with all relevant aspects and provisions of the General Health Law, no. 47 for the year 2008 (in particular chapters 8 to 10 and 13). In summary, the ministry's roles will include but not limited to the following:

- Chapter 8, Drinking Water: Monitoring of drinking water quality and its sources to prevent any potential contamination;
- Chapter 9, Chemicals: Monitoring and supervising of chemicals imported into the country, handling methods and chemicals used in industries, through screening chemical types and categorizing them into a list with permitted chemicals and prohibited types depending on the degree of hazard. Chemicals used in industries are to abide by the list of permitted chemicals proposed by the Ministry to ensure public health protection.
- Chapter 10, Health Hazards: Compliance with the Instruction No. 1/2011 for the prevention of occupational hazards related to health hazards resulting from labour housing units' onsite to avoid any health hazards to workers or others such as, dust, odor, and noise and ensure proper disposal of generated wastes and wastewater.
- Chapter 13, Trade and Industries: The Ministry will ensure compliance with the Trade, Industry and Occupational Safety Law No. 16/1953. This can be done through inspections in order to prevent any potential health or occupational hazards.

4.2.5 Ministry of Local Administration

The Ministry is taking up the supervisory role over the activities of the Municipalities and the Joint Services Councils (JSC) operating in all over the Kingdom with a total of (93) Municipalities and 22 JSCs. The main duties are:

- Provide the various facilities to the municipalities to enable them to perform their functions and support them in improving the services efficiency; oversee, coach and monitor the financial, administrative and organizational performance of the municipalities;
- Enhance the institutional capabilities of the sector;
- Manage the financial transactions and arrange with the relevant parties to provide the necessary funding for the programs and projects;
- Set, develop and implement the legislative, administrative, financial and institutional framework that are effective for the Municipal operations;
- Prepare the regional, organizational and detailed construction plans for the municipalities;
- Monitor and control the implementation of the regulations, policies and instructions of the municipalities and joint services councils and
- Draw up the regulatory bills of the municipal affairs sector

- Review and supervise the infrastructure projects of the municipal councils and develop the designs, technical specifications and tender documents in addition to sustaining and developing the inhabited clusters that have no municipal councils.

4.2.6 Ministry of Public Works and Housing

The Ministry of Public Works and Housing aims to develop a network of public roads in the kingdom, linking towns, villages and communities and sites of industrial production, agricultural and tourist areas and archaeological sites; and to link the Kingdom and neighboring countries and sustain this network and keep it in a good technical level.

The Ministry is also working on upgrading the quality of the roads and the promotion of safety requirements in addition to keeping abreast of the latest updates and techniques of modern roads and lighting.

4.2.7 Ministry of Transport

The Ministry of Transport assumes the following responsibilities under the Transport Law No. 89/year 2003 and authorizations needed in order to carry out its mission such as:

- Devising the general policy for transport and overseeing its implementation in coordination and
- Cooperation with all related parties;
- Regulating and monitoring the road freight transport sector and its services;
- Issuance of necessary permits for individuals and companies operating in the sector;
- Regulating and monitoring the freight transport by rail sector and its services, as well as issuance of necessary permits for operating in the sector and many other responsibilities.

4.2.8 Jordan Standards and Metrology Organization

Jordan Standards and Metrology Organization (JSMO) plays a proactive role in protecting the interests, health and safety of citizens and environment and enhancing the competitiveness of Jordanian products in the national, regional and international markets in keeping with the national goals and contributing to achieving them within the defined priorities. JSMO prepares, approves, revises, amends and monitors the implementation of standards and technical regulations with regard to all services and products (with the exception of pharmaceutical and food products, medicines, veterinary medicines, serums and vaccines).

The main objectives of JSMO are:

- Adoption of a national system for standardization and metrology based on accepted international practices.
- Keeping pace with scientific and technical developments in the fields of standards, metrology, conformity assessment and laboratory accreditation.
- Ensuring the health and safety of the Jordan's citizenry and protection of the environment by making sure that products are in compliance with the technical regulations adopted by the Organization for the purpose.
- Raising the quality of local products through the adoption of appropriate Jordanian Standards in order to enhance their competitiveness in the local and international markets and thus support the national economy.

4.2.9 Department of Antiquities

Department of Antiquities (DoA) was established in 1928 as the official institutional authority mandated by law to be responsible for the protection, conservation and presentation of antiquities.

The two main policies are:

- For the protection of antiquities, conservation measures that do not require physical intervention to the remains are preferred as the first choice where possible.
- For the presentation of antiquities, including research, survey, excavation and site management.

4.2.10 Department of Land and Survey

The Department of Land and Survey (DLS) plays a vital role in preserving land property rights and solving any conflicts concerning rights in land or water. DLS represents Jordan's land information bank.

Among its numerous duties and tasks, the DLS is responsible for the registration of land property rights, maintaining them and facilitating their use, furthermore, DLS administers, protects, rents, accredits, and updates records of state land, as well as expropriation of land for public interest. In addition, the DLS is responsible for establishing a comprehensive land valuation system and maintaining its records for the purposes of registration transactions and archiving and maintaining land registry records.

4.2.11 Yarmouk Water Company

Yarmouk Water Company was established as a company for the management of water in the North Sector on 26/7/2010 as a limited liability company in accordance with the provisions of the Jordanian Companies Law No. 22/1997, which is wholly owned by the Jordan Water Authority. The company is managed and supervised by a board of directors consisting of (7) members, which is responsible to the General Assembly and before others and has the right to appoint the general manager of the company and grant him the necessary powers to manage the company.

The Yarmouk Water Company seeks to provide optimal services in the water and sewage sector with high efficiency and excellence to improve the level of services provided within the service areas of the company (Irbid, Mafraq, Ajloun and Jerash) and implement strategic initiatives to reduce the burden on the state treasury by reducing water losses and reducing Energy consumption and thus improve financial performance by increasing revenues, reducing expenses, building technical and administrative capacities, and addressing the problem of water scarcity to meet the requirements of natural and forced growth, in a manner that builds trust between the company and the service recipient.

The company's main organization consists of the following:

- Irbid Water Management
- Water Management in Mafraq Governorate.
- Water Department of Ajloun Governorate.
- Water Department of Jerash Governorate

In addition to a number of departments for technical, administrative, financial and commercial services and participants. The company provides its services in the water and sewage sectors in the four governorates. The company relies on the water supply on ground water in the basic form of the wells, Wadi Arabs, Hakma and Ramtha and a group of springs and various water sources and the annual supply of about (90) million cubic meters.

4.2.12 Energy and Minerals Regulatory Commission

The Energy and Minerals Regulatory Commission (EMRC) is a governmental body that possess a legal personality with financial and administrative independence and is considered the legal successor of the Electricity Regulatory Commission (ERC) and the Jordan Nuclear Regulatory Commission (JNRC) and the Natural Resources Authority (NRA) in relation to its regulatory tasks according to law No. 17/2014 regarding the restructuring of institutions and governmental organizations.

4.2.13 Irbid District Electric Company

The Irbid District Electric Company (IDECO) concession area includes Irbid, Mafraq, Jerash, Ajloun and some parts of Balqa governorate, where the area of excellence is about 23,000 km^2, accounting for 26 percent. of the area of the kingdom.

The company's tasks include:

- Increase the reliability of electric power by ensuring the continuity of the supply of electricity
- Improving technical and organizational performance by adhering to the performance standards code issued by the Energy and Minerals Regulatory Commission.
- Insurance - capital spending and reducing electricity loss to the lowest levels
- Excellence in the company's services through the development of a smart electrical network through the introduction of advanced technology and smart systems to ensure the adoption of rational investment decisions high efficiency and provide better service at a lower cost

4.2.14 Ministry of Labor

Ministry of Labor (MoL) has undertaken the responsibility of accomplishing the general objectives of labor and laborers affairs and issues in Jordan. To keep pace with social and economic development, the Labor Law No. (8) and its amendments for the year 1996 was issued and the administrative regulation No. (38) of the year 1994 was established, along with its amendments.

The tasks of the Ministry include:

- Organizing the labor sector, as well as updating labor legislation so as to meet the needs of the labor market in light of the social and economic developments within a framework that maintains the production parties' rights and contributes in encouraging the foreign investments.
- Contribution to the development of workforces through the Vocational and Technical Training and Educational Council.
- Collaboration in human resources and workforce's development projects.
- Organizing the foreign labor in the Jordanian Labor Market.
- Maintain available job opportunities to employ Jordanian Labor.
- Building up labor market databases.
- Consolidating cooperation and partnership with the private sector.
- Consolidating regional and international cooperation and partnership.
- Consolidating partnership and cooperation with corporations concerned with preparing and developing Human Resources

4.3 Principal National Legislation

4.3.1 Laws

- Industry & handicraft law (No. 16, 1953)
- Management of Natural Resources Law (No. 12, 1968)
- Land Acquisition Law (No. 13, 2019)
- Water Authority Law (No. 18, 1988) and its amendments
- The Antiquities Law (No. 21, 1988) and its amendments
- Labor Law (No. 8, 1996) and its amendments
- Civil Defense Law (No. 18, 1999)
- Agricultural Law (No. 7, 2018) its amendments
- General Electricity Law (No.64, 2002) its amendments
- Transportation Law (No. 89, 2003) and its amendments
- The Environment Protection Law (No. 6, 2017)
- Municipalities Law (No. 13, 2011)
- The Free and Development Zones Law (No.2, 2008)
- Public Health Law (No.11, 2017)
- Traffic Law (No. 49, 2008)
- Land Transport Regulatory commission law (No.4,2011)
- Renewable Energy and Energy Efficiency Law (No. 33, 2014)
- Energy and Minerals Regulatory commission law (No. 8, 2017)

4.3.2 Regulations

- The Environmental Impact Assessment Regulation (No. 37, 2005)
- Regulations for Protection of Birds and Wildlife and rules covering their hunting (No. 13, 1973)
- Regulation of Protection and Safety from Industrial Tools and Machines and Worksites (No.7,1998) – Issued by the virtue of the provisions of Paragraph (c) of Article (85) of the Labor Law No. (8) Of 1996 and its amendments.
- Regulation for the establishment of Occupational Health and Safety Committees & supervisors (No. 7, 1998), issued in accordance to Article (85) of the Jordanian Labor Law no. 8 /1996 and its amendments.
- Groundwater Control Regulation (No. 85, 2002), Issued pursuant to Articles 6 and 32 of Water Authority Law No. 18 for the year 1988.
- Regulation of Harmful and Hazardous Waste Management, Transfer & Handling (No. 24, 2005).
- Soil Protection Regulation (No. 25, 2005)
- Regulation for the Protection of the Environment from Pollution in Emergency Situations (No. 26,2005)
- Regulation of Solid Waste Management (No. 27, 2005)
- Air Protection Regulation (No. 28, 2005)
- Land use planning Regulation (No. 6, 2007)
- Environmental Protection Regulation (No. 37, 2018)

4.3.3 Instructions

- Instructions for Disposal of Industrial and Commercial wastewater into the sewage network, issued in accordance with Water Authority Law No. 18 for year 1998 and Article No. 23 of the Sewage System Law No. 66 for the 1994.
- Instructions for the Solid Waste management for the year 2019.
- Instructions for the Management and Handling of Hazardous Waste of the year 2019.
- Instructions for Recycling and Handling of Consumed Oils of the year 2014 and amendments.
- Instructions for the Limitation and Control of Noise for the year 2003.
- Instruction for Controlling the Use of Substances that Deplete the Ozone Layer for the year 2003, issued in accordance with the Protection of the Environment Law No. 1/2003 Articles 9-15.
- Instructions for the Selection of locations for Development Activities for 2012 issued in accordance with paragraph (d) of Article (4) of the Environmental Protection Law no. 52 for 2006.
- Instructions for licensing procedures and issuing permits for excavation projects and infrastructure networks in the Aqaba Special Economic Zone No. 112 of 2007
- Instructions No. (1) for the year 2011 for the prevention of occupational hazards related to health hazards resulting from labour housing units onsite, issued in accordance to article (49) of the temporary Public health law No. (49) For the year 2008.

4.3.4 Standards

- Standards for uses of treated Sludge and Sludge Disposal (JS1145/2016)
- Standard for the Requirements for Discharges of Industrial Effluents (JS 202/1991).
- Standard for Storage – General precautionary requirements for storage of hazardous materials (JS 431/1985).
- Standard for lighting levels in work environment (No. 524/1987)
- Standard for heat levels allowed to be exposed to in work environment (No. 525/1987)
- Standard for maximum allowable limits of air pollutants emitted from the stationary sources (No. 1189/1998)
- Standards for Motor Emissions (JS 1052/1998)
- Standards for Motor Vehicle Emissions – Diesel Engines (JS 1053/1998)
- Standards for Motor Vehicles (Noise Levels) (JS 1059/1998)
- Standards for reclaimed domestic wastewater (No. 893/2006)
- Ambient Air Quality Standard (No. 1140/2006)
- Standards for industrial reclaimed wastewater (No. 202/2007)
- Drinking Water Standards (No.286/2015).

4.4 Regional and International Agreements and Protocols

The Kingdom of Jordan has signed and ratified (that is, placed into national law) the following international protocols and agreements relevant to this project (dates of entry into force noted in parentheses):

- International Plant Protection Convention (24/4/1970);
- Convention Concerning the Protection of the World Cultural and Natural Heritage (17/12/1975);
- Convention on Wetlands of International Importance especially as Waterfowl Habitat (10/5/1077);
- Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) (14/3/1979);
- Protocol to amend the Convention on Wetlands of International Importance especially as Waterfowl Habitat (RAMSAR Convention) (1/10/1986);
- Amendment to the Convention of International Trade in Endangered Species of Wild Fauna and Flora (art. XI) (13/4/1987);
- Protocol on Substances that Deplete the Ozone Layer (30/8/1989);
- Convention for the Protection of the Ozone Layer (31/8/1989);
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (5/5/1992);
- Convention on Biological Diversity (10/2/1994);
- Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer (10/2/1994);
- Framework Convention on Climate Change (21/3/1994);
- Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer (28/9/1995);
- International Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (26/12/1996).
- Constitution of the Food and Agriculture Organization of the United Nations (23/1/1951)

4.5 AFD Environmental and Social Policy

AFD uses as a reference number of rules, good practices and directives produced by international standard-setting organisations, this mainly concerns:

- The World Bank Safeguard Policies for public sector financing;
- The UN Principles for Responsible Investment (UNPRI);
- The IFC Performance Standards.

All 9 environmental and social standards (ESSs) refer to the topics listed below, which AJWE team will consider during the ESIA process:

- **ESS1** – Assessment and Management of Environmental and Social Risks and Impacts
- **ESS2** – Labour and Working Conditions
- **ESS3** – Resource Efficiency, Pollution Prevention and management
- **ESS4** – community Health and Safety
- **ESS5** – Land Acquisition, Restrictions on land use and involuntary Resettlement
- **ESS6** – Biodiversity Conservation and Sustainable Management of Living Natural Resources
- **ESS7** – Indigenous Peoples
- **ESS8** – Cultural Heritage
- **ESS9** – Informational Disclosure and Stakeholder Engagement

4.6 Specific Relevant Standards and Guidelines

All projects within Jordan depend on the specific project design requirements and applicable agreements with environmental permitting authorities. Specific requirements relating to the following are provided below:

- Ambient air quality;
- Air emission limits from stationary sources;
- Ambient noise;
- Soil and Groundwater Quality; and
- Waste Management.

4.6.1 Ambient Air Quality

Ambient air quality limits recommended by the Ambient Air Quality Jordanian Standards (JS No. 1140/2006) and the World Health Organization (WHO) guidelines are summarized and presented in **Table 9** below:

Air Pollutant	JS No. 1140/2006			WHO Guidelines ($\mu g/m^3$)
	Average Time	Maximum Allowable Concentration in the Ambient Air	Number of Allowed Exceedances	
Sulphur Dioxide (SO_2)	1 Hour	0.3 mg/kg 244.9 $\mu g/m^3$	3 times within a given month in one year	--
	24 Hour	0.14 mg/kg 114 $\mu g/m^3$	Once a year	125 (IT 1) intermediate target 50 (IT 2)
	1 Year	0.04 mg/kg	--	--
Carbon Monoxide (CO)	1 Hour	26 mg/kg	3 times within a given month in one year	--
	8 Hour	9 mg/kg	3 times within a given month in one year	--
Nitrogen Dioxide (NO_2)	1 Hour	0.21 mg/kg 171.4 $\mu g/m^3$	3 times within a given month in one year	200
	24 Hour	0.08 mg/kg	3 times within a given month in one year	--
	1 Year	0.05 mg/kg 40.8 $\mu g/m^3$	--	40
Total Suspended Particles (TSP)	24 Hour	260 $\mu g/m^3$	3 times within a given month in one year	--
	1 Year	75 $\mu g/m^3$	--	--

Air Pollutant	JS No. 1140/2006			WHO Guidelines ($\mu g/m^3$)
	Average Time	Maximum Allowable Concentration in the Ambient Air	Number of Allowed Exceedances	
PM_{10}	24 Hour	120 $\mu g/m^3$	3 times within a given month in one year	150 (IT 1)
	1 Year	70 $\mu g/m^3$	--	70 (IT 1)
$PM_{2.5}$	24 Hour	65 $\mu g/m^3$	3 times within a given month in one year	75 (IT 1)
	1 Year	15 $\mu g/m^3$	--	35 (IT 1)
H_2S	1 Hour	0.03 mg/kg	3 times within a given month in one year	--
	24 Hour	0.01 mg/kg	3 times within a given month in one year	--
NH_3	24 Hour	270 $\mu g/m^3$	3 times within a given month in one year	
	1 Year	8 $\mu g/m^3$	--	

Table 9: Ambient Air Quality Standards

4.6.2 Ambient Noise Limits

Article (4) of the Standards for the prevention and elimination of noise (2003) indicated that all projects and noise producing facilities should comply with International Noise Standards (No. 2204) and related amendments for issues related to measurement of noise and other associated technical issues.

Article (5) of the same standards established a list of activities is prohibited by law. Those relevant to the proposed Project are:

- All construction activities utilizing noise producing plants and equipment (e.g. rigs, mixers and vibrators) must cease between 8:00 pm and 6:00 am, unless a permit is granted by the MoE;
- Work activities within light industrial areas with residential dwellings are prohibited to continue between 9:00 pm and 6:00 am (summer) and between 8:00 pm and 7:00 am (winter).

Article (6) of the noise standard specifies the maximum allowable noise level in decibels (dBA) for specific times and areas. The maximum allowable noise levels applicable to this project are detailed in **Table 10** below.

Area	Allowable Limits for Noise Levels (dBA)	
	Day	Night
Residential areas within cities	60	50
Residential areas within suburbs	55	45
Residential areas within villages	50	40
Residential areas with commercial activities, services, light handcrafts, and city centre	65	55
Industrial areas (Heavy Industry)	75	65
Places of education, worship, treatment and hospitals	45	35

Table 10: Maximum Allowable Noise Limits

Quality of Effluent for Reuse

WWTP effluent quality limits recommended by the reclaimed domestic wastewater Standards (JS No. 893/2006) and the IFC EHS guidelines are summarized and presented in **Table 11** below:

Parameter	Unit	(Cat1) Discharge to Wadi	(Cat2) Artificial Recharge of Ground water Aquifer	(Cat3) Irrigation				
				Group A Cooked vegetable parks, and playground	Group B Fruit Tree, Green Areas	Group C Field Crops, Industrial products forestry	Cut Flowers	IFC EHS Guidelines mg/l
BOD5	mg/l	60	15	30	200	300	15	30
COD		150	50	100	500	500	50	125
DO		>1	>2	>2	-	-	>2	-
TSS		60	50	50	200	300	15	50
NO_3 as NO_3		80	30	30	45	70	45	-
NH_4		-	5	-	-	-	--	-
TOTAL- N		70	45	45	70	100	70	10
PO_4 as PO_4		15	15	30	30	30	30	-
FOG		8	8	8	8	8	2	-
E. coli	MPN/10 OMl	1000	<2.2	100	1000	-	<1.1	400
pH	-	6 to 9	6 to 9	6 to 9	6 to 9	6 to 9	6 to 9	6-9
Turbidity	NTU	-	2	10	-	-	5	-
Nematodes	Eggs/l	<0.1	<1	<1	<1	<1	<1	-

Table 11: Reclaimed Domestic Wastewater JS 893/2006

4.6.3 Occupational Noise

The instructions for the protection of workers and institutions from occupational hazards/risks issued by the virtue of Article (79) of the Labor Law no.8 of 1996 discuss the provision of workers with necessary personal protective equipment, rest areas and other facilities in addition to lifting limits and other occupational health and safety considerations. Furthermore, Article (16) mentions that each company or establishment must ensure to prevent or minimize noise generation so as to prevent any occupational risk on workers, which should not exceed the intensity mentioned below in **Tables 12 and 13.**

Noise Intensity (dBA)	Acceptable exposure during that day (in Hours)
80	16
85	8
90	4
95	2
100	1
105	1/2
110	1/4
115	1/8

Table 12: Acceptable Noise Exposure

As for Intermittent noise in the form of strong quick strikes can be calculated as per the below:

Noise Intensity (dBA)	Number of times acceptable per day
140	100
130	1,000
120	10,000

Table 13: Daily Acceptable Noise Exposure

4.6.4 Soil and Groundwater Quality

Soil

The Soil Protection Regulation No. 25 for the year 2005 states the requirements to protect soils and prevent its contamination through proper management and monitoring.

Groundwater

The general rules of the Groundwater Control Regulation No (85) of 2002, issued pursuant to Articles 6 and 32 of Water Authority Law No. 18 of 1988 are that "the groundwater is state-owned and subject to its control. It is not permissible to pump out or utilize underground water without obtaining a license issued according to the provisions of the law. The purpose usage and the quantities of pumped-out water and any other conditions should be identified in the license". Owning land does not include water ownership that is stored underground. The license is required for drilling wells; in addition, supervision from the authority is required, plus a pumping test before utilization. "Anyone who is granted a license to extract groundwater shall be committed not to cause water pollution or depletion and to strictly comply with the conditions of the license". The regulation also covers licensing rules and fees as well as water prices, pollution control, and requirements from private well owners.

4.6.5 Waste Management

Hazardous Waste Management

Instructions for managing and handling hazardous wastes for the year 2019 issued pursuant to the provisions of Article 10 of the Regulations for the Management of Hazardous and Hazardous Substances, Transport and Handling No. 24 of 2005:

This regulation focuses mainly on setting the general procedures for hazardous waste producers in terms of storing, handling, collection and disposal procedures for hazardous waste in preparation for recycling and treatment inside the facility or transport and cleaner production and empty hazardous waste containers, including emergency plans, precautions and setting general procedures before transferring to those who are responsible for transporting this type of waste.

The regulation also deals with special conditions and general procedures for owners or managers of the specified site for storing, treating and disposing of hazardous waste in terms of receiving and registering the waste, ensuring the implementation of safe procedures in order to prevent fire and other accidents, since there are special restrictions for safety and health of the employees in the site including emergency plans.

Solid Waste Management

Instructions of Solid Waste Management for the year 2019 according to regulation No.27 for the year 2005:

The objective of the Regulation is to ensure the management of solid waste in a way that maintains environment protection and public health.

It lists details, responsibilities and tasks to be undertaken including observing and collecting operations, transportation of wastes, permitting, supervising, scheduling, archiving and outlining the responsibilities and tasks for the Ministry of Local Administration. In addition, it sets the duties to be fulfilled by the Ministry of Local Administration in cooperation with the related bodies. These duties include picking up the waste, defining stipulations of storage, collecting, sorting, recycling, treating, and training and awareness programs, in addition to dealing with compliance, offences, punishments

and fines and develop plans for occupational safety and health in the solid waste management facilities.

Handling of Oils

Instructions for Recycling and Handling of Consumed Oils for the year 2014 and amendments:

The instructions provide definitions of consumed oils as oils refined from raw petrol or industrial oils that have been used, and which as a result are transferred into polluted waste together with chemicals or physical pollutants and which should be disposed of or treated or recycled. Examples are machine oils, engines oils, hydraulic oils, energy transfer and movement oils, heat exchange or any other oils that are used for lubrication. Other definitions are given for underground tanks used as storage tanks to store and treat oil, oil containers and oil collecting licensed stations.

The instructions state implemented measures for oil producers, parties that transport oil, collecting stations, treatment units, oil combustors, and all directly or indirectly related parties in the stages of oil use and recycling.

Definitions of general requirements are also included such as:

- Prohibition of discharge of oil into sewage networks or septic tanks or surface and ground water resources or the environment
- All parties mentioned in Article 3 must obtain a license from the MoE.
- Oil mixing with solid domestic waste and disposal into the municipal dumping sites for domestic waste is prohibited
- Oil use for energy production is prohibited in food producing institutions
- Use of raw oil for energy production is prohibited in institutions, factories or houses unless an approval is given
- Mixing of oils with hazardous waste and chemicals is prohibited

In addition, general conditions for oil producers, oil collection stations and oil carriers are set and the general conditions for oil carriers include having an identification number (license), submitting of full information about the company with the license request, transferring the oil into a licensed collection station only. Other articles list the conditions for oil recycling and treatment units.

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5 BASELINE CONDITIONS

Following is an overview of the findings of the data collection and literature review work. A listing of the data obtained, and reports reviewed is presented in the section below, and the overview of the physical, biological, socio-economic and archaeological baseline conditions is described below:

5.1 Data Sources and Literature Reviews

All available information sources have been reviewed and relevant information extracted, analyzed and presented in the context of this study. A detailed references list of reports and documents reviewed for information is presented in **Section 12– References** of this report. A literature reviews together with a field survey of the project area and its surroundings has been conducted in order to summarize the most up to date data needed for preparation of the project description, the environmental baseline as well as documents of a more technical nature to better understand the potential impacts and to propose mitigation measures of the project's activities.

Information has been collected from various sources, to the extent possible. Some sources include relevant government institutions such as the Jordanian Department of Statistics (DoS), Jordan Meteorological Department (JMD), MOA, MWI & WAJ and DoA.

Some of the major topics reviewed as part of the literature review included:

- Hydrological, hydrogeological and water resources studies;
- Ecological studies and reports on the Flora and Fauna;
- Archaeology; and
- Geology of the Area

5.2 Physical Environment

5.2.1 Meteorology and Climate

Jordan's climate varies from Mediterranean in the west, to desert in the east and south, but the land is generally arid. The proximity of the Mediterranean Sea is the major influence on Jordan's climate, although continental air masses and elevation also modify it. The prevailing winds throughout the country are westerly to north-westerly, but spells of hot, dry, dusty winds blowing from the southeast off the Arabian Peninsula frequently occur providing the country with its most uncomfortable weather (The Khamsin is an oppressive, hot, dry and dusty south or south-east wind occurring in N. Africa, around the E Mediterranean and the Arabian Peninsula intermittently in late winter and early summer, but most frequently between April and June.)

The country's climate is a result of both its geographical location in the eastern Mediterranean region and its relief, which ranges from 416 m below sea level at the Dead Sea shoreline to 1800 m above sea level in the southern highlands. (GTZ, Water Resources in Jordan, , 2004)

Jordan is vulnerable to the potential impacts of climate change, since ecosystems and water resources are affected by changes in the hydrological cycle (MoE, Environmental Profile of Jordan, 2006)

Figure 13 is showing the bioclimatic zones of Jordan. The map indicates that the project area falls within the warm semi-arid Mediterranean climatic zone. The project area meteorological characteristics were obtained from the Jordan Department of Meteorology for the last 34 years.

Climatic Parameter	Meteorological Department Ramtha Station
Avg. Max Monthly Temp (°C)	33
Avg. Min Monthly Temp (°C)	4.1
Avg. Mean Temp (°C)	18.6
Max. Month Avg. Rainfall Amount (mm)	53.1
Avg. Annual Rainfall Amount (mm/year)	225.3
Avg. Relative Humidity (%)	46.3-73.4
Avg. Mean Wind speed (km/day)	267

Source: Jordanian Department of Meteorology

Table 14: Averages of annual climate data for the last 34 years

The mean maximum and minimum temperatures recorded by the Hashemite Kingdom of Jordan Meteorological Department Ramtha weather station indicate mild wet winters and dry hot summers. The relative humidity in Al Ramtha area is around 46.3 percent and the annual precipitation rate is around 225.3 mm are shown in **Table 15** and **Figure 14**

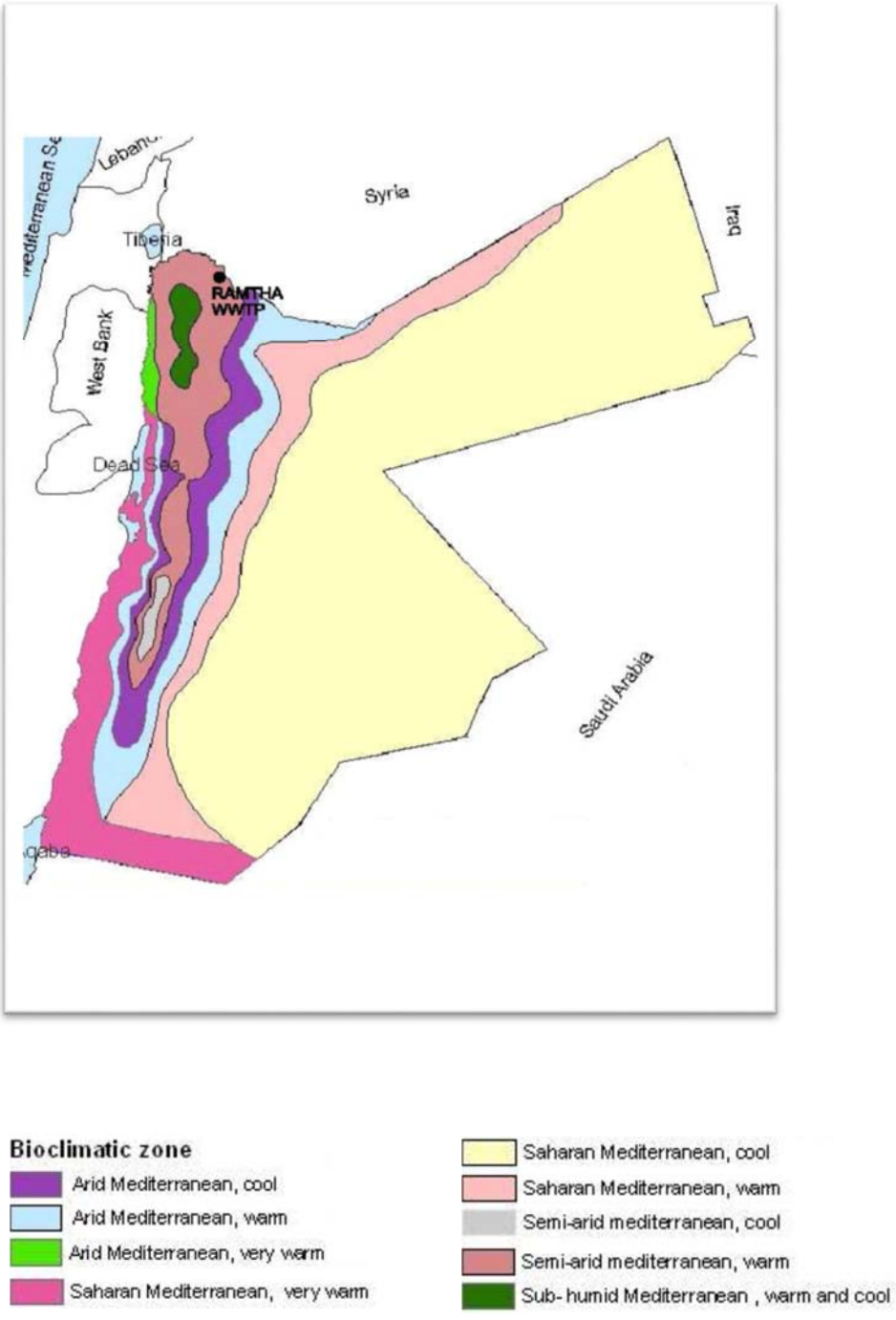


Figure 13: Bioclimatic Zones of Jordan

Latitude: 32°29'20" N
Longitude: 35°58'50" E
Elevation: 590 m

Month	Minimum Temperature	Maximum Temperature	Relative Humidity	Wind Speed	Actual Sunshine (1998-2013)	Rainfall	Radiation	Class A Pan Evaporation (1989-2013)	ETo (*)
	°C	°C	%	Km/day	hours	mm	MJ/m²/day	mm/day	mm/day
January	4.1	13.4	73.4	245	5.8	53.1	10.7	2.26	1.69
February	4.5	14.5	69.0	276	6.2	52.1	13.2	2.83	2.21
March	6.2	18.1	64.7	285	7.8	34.4	17.8	4.25	3.17
April	9.5	23.7	54.5	267	8.4	10.0	21.0	6.56	4.63
May	12.9	28.6	46.3	267	10.4	3.0	25.2	9.47	6.29
June	15.6	31.2	50.2	307	11.7	0.8	27.5	11.24	7.18
July	17.9	32.7	53.9	342	11.4		26.8	11.61	7.42
August	18.3	33.0	56.8	320	10.8		24.8	10.61	6.89
September	16.6	31.1	56.5	258	9.9	0.2	21.3	9.05	5.63
October	13.8	27.3	56.7	213	8.4	7.1	16.4	6.49	4.1
November	9.3	20.9	60.6	218	7.1	24.3	12.4	3.78	1.55
December	5.6	15.4	67.8	236	6.1	40.4	10.3	2.41	1.92
Average	11.2	24.2	59.2	267	8.7		19.0	6.71	4.39

(*) ETo means grass reference evapotranspiration, calculated by using CROPWAT 8 software.

Table 15: Climatic Data for Ramtha Weather Station (1984-2013)

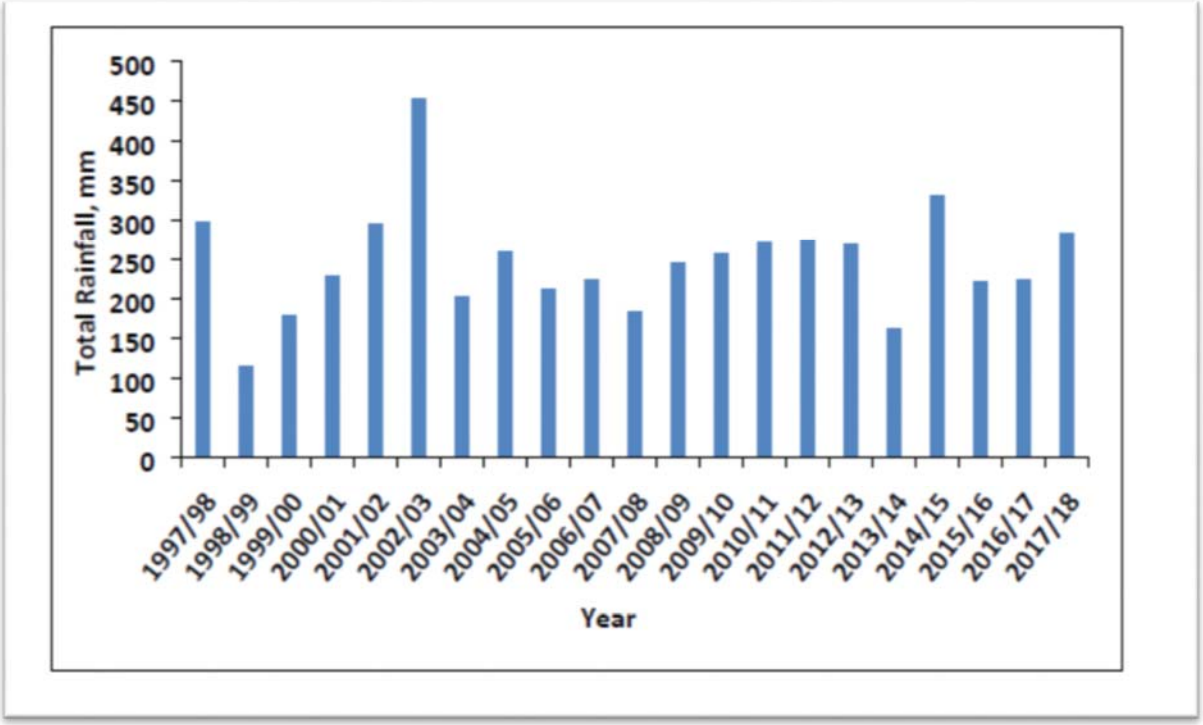


Figure 14: Annual total rainfall from Ramtha Agricultural Directorate (1997-2018)

5.2.2 Air Quality

This air quality analysis describes the baseline conditions within the project's study area with the aim of documenting the existing environment prior to commencement of project activities. The information was obtained from a combination of field surveys and real measurements at the proposed project site.

Objectives:

The general objectives of the air quality data collection effort are:

- To assess the ambient concentrations of selected air pollutants in the immediate vicinity of the identified project site.
- To determine if the Jordanian ambient air quality standards (JS 1140/2006) were violated or exceeded at the project site
- To establish ambient air quality baseline data within the project site.
- To ensure that possible adverse impacts are identified and avoided or minimized.

5.2.2.1 Instrumentation and Measurement Site

Air quality sampling program was conducted at the project site from Feb. 27th to March 5th, 2020. The program covered the following emission parameters: Inhalable particulate matter (PM_{10}), sulphur dioxide (SO_2), hydrogen sulphide (H_2S), nitrogen dioxide (NO_2), Ammonia (NH_3) and Methane (CH_4). Real-time monitoring instruments were used to assess the ambient air quality as shown in **Table 16**. The instruments (screen view ™ Version 4.0.1 by lakes Environmental Software Screen 3) were United States Environmental Protection Agency (USEPA) approved and the test methods were conducted according to the Jordanian Standard JS1140/2006.

#	Parameter	Principle	Test Method
1	Particulate Matters (PM_{10})	Beta ray attenuation	JS1140/2006
2	Sulfur Dioxide (SO_2)	Ultraviolet (UV) fluorescence	
3	Nitrogen Dioxide (NO_2)	Chemiluminescence	
4	Hydrogen Sulphide (H_2S)	Ultraviolet (UV) fluorescence	
5	Ammonia (NH_3)	Chemiluminescence	
6	Methane (CH_4)	Back-flush gas chromatography (GC)	---

Table 16: Monitored Parameters, Principles and Modes of Operation

The air quality monitoring instruments were installed at the west border of the WWTP in Figure **15**. The latitude and longitude coordinates of the monitoring site are at 32°35'37.21"N and 35°59'13.41"E, respectively.

Figure 15: Air Quality Monitoring Site

5.2.2.2 Standards and Regulations

Ambient air quality standards have been established in Jordan for certain pollutants considered harmful to the public and the environment. These standards define the maximum allowable concentrations and number of exceedances for pollutants over a given averaging period. A summary of these standards (JS 1140/2006) is shown in **Table 17.** The monitoring results of pollutants were compared to the JS 1140/2006 to verify compliance with its limits. Complete air quality test results are shown in **Appendix B**.

Pollutant	Averaging time	Units		Number of permissible exceedances/year
		ppm	µg/m³	
Sulfur Dioxide (SO_2)	1-hour	0.31	---	3
	24-hour	0.14	---	1
	Annual	0.04	---	---
Carbon Monoxide (CO)	1-hour	26.00	---	3
	8-hour	9.00	---	3
Nitrogen Dioxide (NO_2)	1-hour	0.21	---	3
	24-hour	0.08	---	3
	Annual	0.05	---	---
Hydrogen Sulphide (H_2S)	1-hour	0.03	---	3
	24-hour	0.01	---	3
Ammonia (NH_3)	24-hour	---	270	3
	Annual	---	8	---
Particulate Matter (PM_{10})	24-hour	---	120	3
	Annual	---	70	---

Table 17: Jordan ambient air quality standards (JS1140/2006)

Meteorological Parameters

Results of wind monitoring (**Figure 16**) at the project site during the monitoring period (February 27 – March 5, 2020).

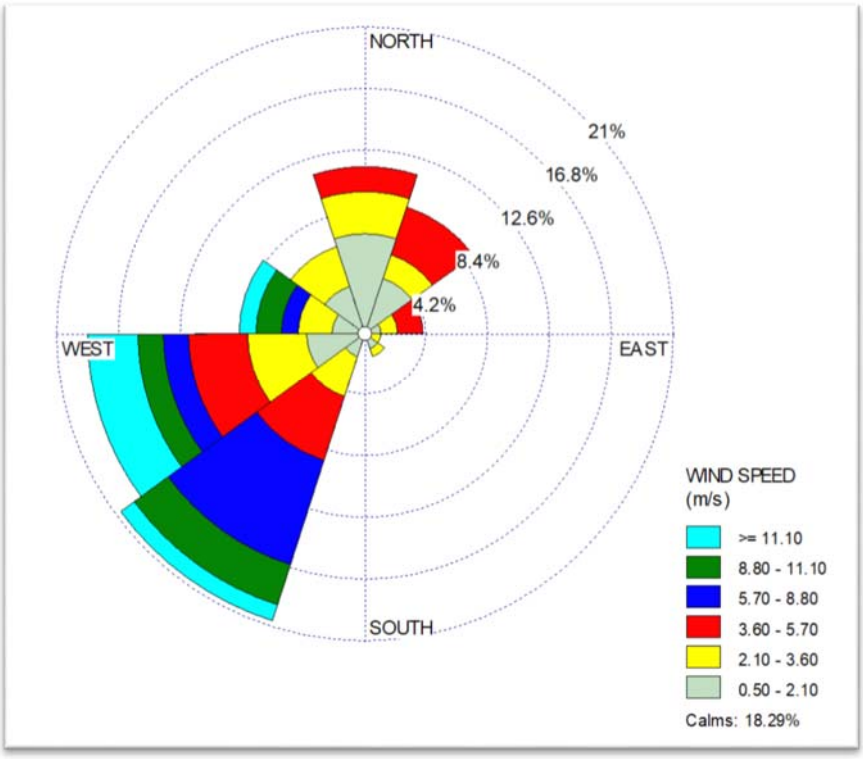


Figure 16: Wind Rose at the monitoring location during February 27 – March 5, 2020

The atmospheric temperature at the monitoring site ranged between 2.00°C and 22.0°C with a mean value of 11.0°C. Time series for atmospheric temperature is presented in **Figure 17.** Time series of relative humidity is presented in

Figure 18, where values fluctuated between 27.0 percent and 94.0 percent with a mean value of 68.0 percent.

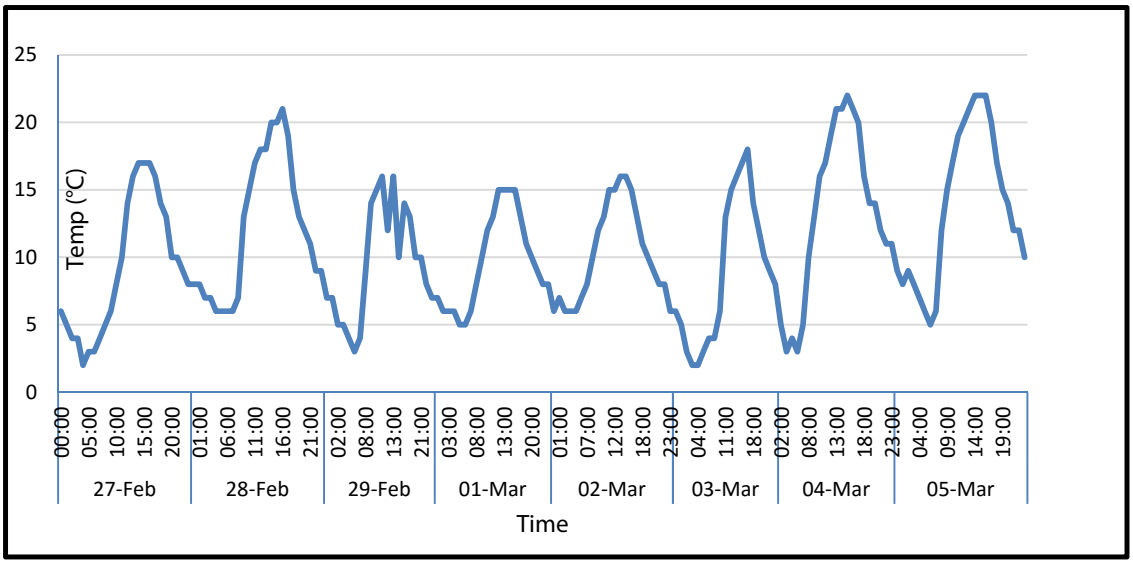


Figure 17: Time series for atmospheric temperature during February 27 –March 5, 2020

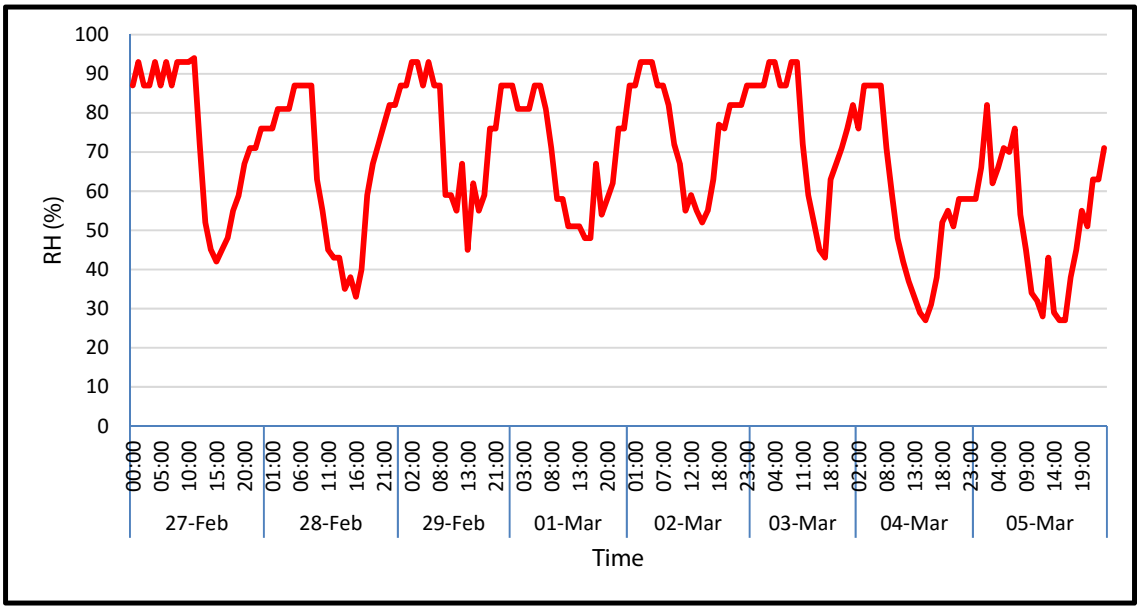


Figure 18: Time series for relative humidity February 27 –March 5, 2020

Particulate Matters (PM10)

It can be seen from the obtained results that the maximum daily average of PM_{10} reached a value of 42.3 µg/ m^3 throughout the whole monitoring period. Therefore, no exceedances were recorded to the daily limit of 120 µg/m^3 specified in Jordanian standards were recorded. The Jordanian standards for this and other parameters are included in **Table 17**.

Sulfur Dioxide (SO_2)

It can be seen from the obtained results that the maximum hourly average of SO_2 reached a value of 0.031 ppm, while the daily average concentration had a maximum value of 0.016 ppm throughout the whole monitoring period. Therefore, neither exceedances were recorded to the hourly limit of 0.300 ppm nor to the daily limit of 0.140 ppm specified in Jordanian standards.

Nitrogen Dioxide (NO_2)

The maximum hourly of NO_2 average concentrations was 0.018 ppm, while the maximum daily of NO_2 average concentrations was 0.008 ppm. Thus, no exceedances for NO_2 concentrations were recorded according to JS 1140/2006 during the monitoring period.

Hydrogen Sulphide (H_2S)

It can be seen from the obtained results that the maximum hourly average of H_2S reached a value of 0.020 ppm, while the daily average concentration had a maximum value of 0.007 ppm throughout the whole monitoring period. Therefore, no exceedances were recorded to the hourly limit of 0.030 ppm nor to the daily limit of 0.010 ppm specified in Jordanian standards JS 1140/2006.

Ammonia (NH_3)

Low NH_3 levels were observed during the monitoring period. The maximum daily average was 81.6 $\mu g/m^3$, which is far below the limit of 270 $\mu g/m^3$ specified by JS 1140/ 2006. It should be mentioned here that there is no hourly average limit of NH_3 in the Jordanian standard JS1140/2006.

Methane (CH_4)

Methane emits to the atmosphere due to human activities, where it traps the sun's heat causing global warming or which is called the climate change. However, there is no Jordanian standard or guideline about the levels of CH_4 in the ambient air.

During the monitoring period, the hourly concentrations of CH_4 varied between 0.552 and 0.820 ppm at the monitoring site. The average concentration throughout the entire period was 0.674 ppm, with a maximum daily concentration of 0.707 ppm.

Conclusions

The monitoring of the ambient air quality (PM_{10}, SO_2, NO_2, H_2S, NH_3, and CH_4) near the proposed project (Ramtha WWTP) during the period February 27 – March 5, 2020 showed that the hourly and daily average concentrations of pollutants were far below the relevant limits stated in the Jordanian ambient air quality standard (JS 1140/2006).

Results of wind speed and wind direction monitoring showed that the prevailing wind direction was southwest (SW) with a frequency of 20.6 percent, followed by west-southwest (WSW) with a frequency of 18.9 percent. While the prevailing wind speeds were those speeds of 0.50 – 2.10 m/sec with a frequency of 21.4 percent.

5.2.3 Ambient Noise

5.2.3.1 Instrumentation and Measurement Site

Noise measurements were performed according to ANSI S1.13 requirements and using a digital data logging Sound Level Meter (SLM), Model HD600. The SLM is a Type 2 data-logger with free-field microphone that meets the standards of the International Electro technical Commission (IEC); IEC61672-1: 2002 Class 2; IEC60651: 1979 Type 2; and the ANSI S1.4:1983 Type 2.

Positioning of the SLM must meet the following guidelines:

- Microphone must be placed 1.2 -1.5m above the ground level and no closer than 3 m to any reflecting surface. Hand-held monitoring should be avoided;
- In dry conditions with a wind speed of less than 5 m/s;
- Noise measurements should not be made in fog and rain;
- Cover the microphone with the supplied windscreen; and
- Isolate the instrument from strong vibration and shock.

5.2.3.2 Standards and Regulations

Allowable noise limits are governed by the 2003 Jordanian instructions for prevention of noise, which defines the maximum allowed noise limits for the different land-use types during daytime and night-time as listed in **Figure 18**. These limits are applicable for ambient noise outside workplace. For noise limits within workplace, the instructions issued by Ministry of Labor are adopted for this project.

Area	Allowable Limits for Noise Levels (dBA)	
	Day	Night
Residential areas within cities	60	50
Residential areas within suburbs	55	45
Residential areas within villages	50	40
Residential areas with commercial activities, services, light handcrafts, and city center	65	55
Industrial areas (Heavy Industry)	75	65
Places of education, worship, treatment and hospitals	45	35

Table 18: Allowable Limits for Noise Levels (dBA)

5.2.3.3 Conclusions

The proposed location is within rural and farming areas which generally experience noise levels from the existing practices of water pumping for irrigation at private farms and vehicle use. Vehicle use is higher for domestic travel at daytime, and higher at night-time for transporting of agriculture crops.

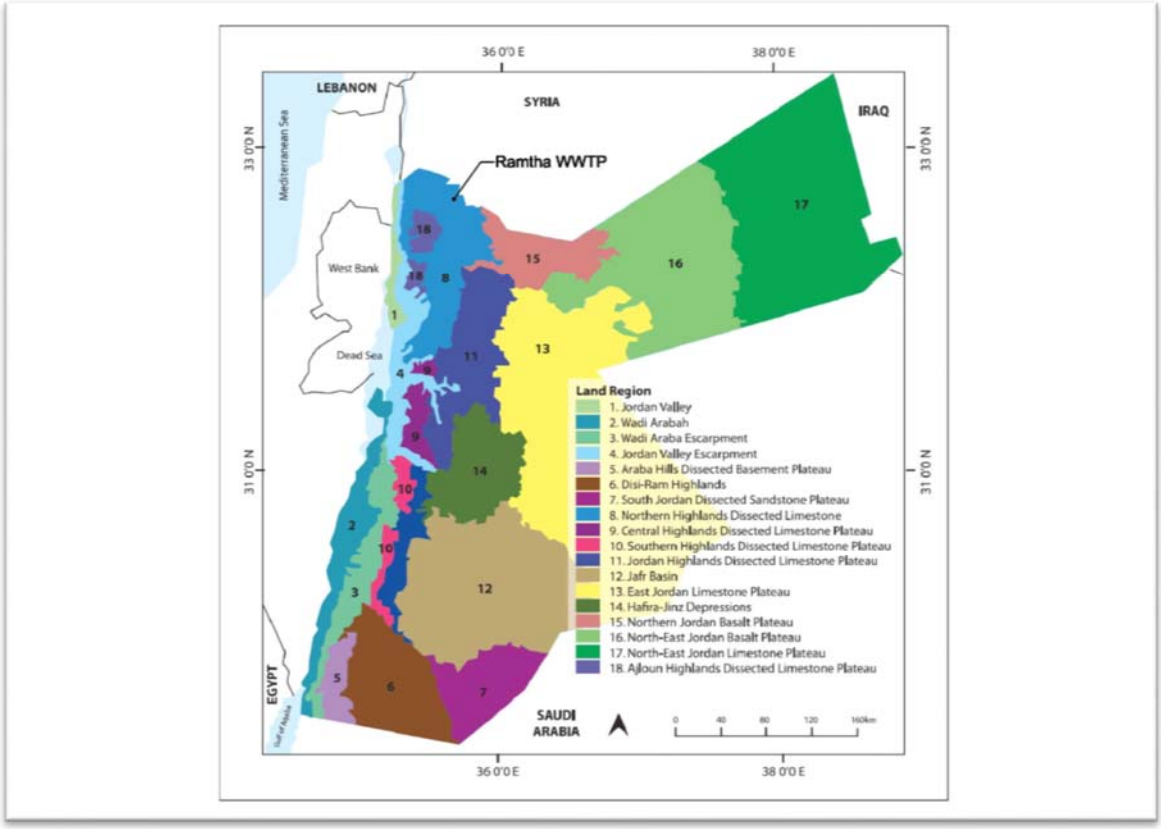
5.2.4 Topography and Soil

Jordan is located about 80 km east of the Mediterranean Sea, bounded by Syria to the north, Saudi Arabia and the Gulf of Aqaba to the south (which is Jordan's only outlet to the sea), Iraq to the east and Palestine to the west. The area of landmass is approximately 88,778 km^2, while the area of water bodies is approximately 482 km^2 which includes the Jordanian portion of the Dead Sea and the Gulf of Aqaba. Topography, morphology and soil are interrelated physical characteristics which are described in the following paragraphs (MOE, 2006).

Jordan is divided into three main topographic regions. These three regions, from east to west, are:

- **The Jordan Rift Valley:** A fault that extends from Lake Tiberias in the north to the Gulf of Aqaba in the south. The Jordan Valley, the Dead Sea and Wadi Araba are located in this zone (MOE, 2006).
- **The Mountainous Region:** The region forms the eastern boundary of the Rift Valley and extends from Lake Tiberias to the Gulf of Aqaba. Mountains in this zone have elevations ranging from 1,200 to 1,500 meters above sea level. The region has a relatively mild climate with winter rains. The higher elevations receive occasional winter snows. Average annual precipitation in the zone varies from 600 mm in the north, to 100 - 300 mm in the south. Ninety percent of Jordan's population live in this zone (MOE, 2006)
- **The Eastern Desert:** The desert region (also known as the Badia) lies east of the Mountainous Region and covers 80 percent of the land area of Jordan. This region is characterized by a dry, hot climate. Most of the zone is flat or hilly, but in the south lays the two highest mountains in Jordan, namely Rum Mountain (1,753 m) and Umm ad Dami (1,854 m) (MOE, 2006) .

Jordan is split into 18 land regions as shown in **Figure 19**, where each land region is characterized by altitude, physiography, dominant soil type, vegetation and land use. According to the **Figure 19**, the project area falls within land region: namely the Northern Highlands Dissected Limestone (land region no. 8). However, the most predominant characteristics are seen from land region no.8 which has a Mediterranean characteristic, with a range in precipitation between 250 mm and 500 mm. The natural vegetation includes mixed woodland, with tall grass steppe on the eastern margins. The dominant soil subgroups in the study area are Vertisols /Chromoxerent which are red clay with low content of carbonates. This type of soil is deep cracking soils, mostly red, with a very high clay content, that shrinks and swell with moisture variations (mixing the solum layer). ((Soils of Jordan Al Qudah B.in Zdruli P. (ed.), Steduto P. (ed.), Lacirignola C. (ed.), Montanarella L. (ed.). Soil resources of Southern and Eastern Mediterranean countries Bari : CIHEAM Options Méditerranéennes : Série B. Etudes et Recherches; n. 34))



Source: MoE, 2014

Figure 19: Land regions distribution in Jordan

A topographic survey was conducted for the project area. The results of this survey have shown that the approximate center of the existing plant site is at Latitude 32°35'36" North and Longitude 35°59'19" West with an elevation of about 480 m. The plant site in an area of agricultural use with little topographic relief. Surface drainage is towards the north.

The topography of the catchment is characterized by a considerably low to moderate slopes in the upper parts of the catchments and more gentle slopes in the lower parts which are almost rolling to flat in most of the project area. **Table 19** shows the general slope of the catchment is 1.4 percent which is a very low slope. **Figure 20** shows the flat irrigated lands located around the Ramtha WWTP.

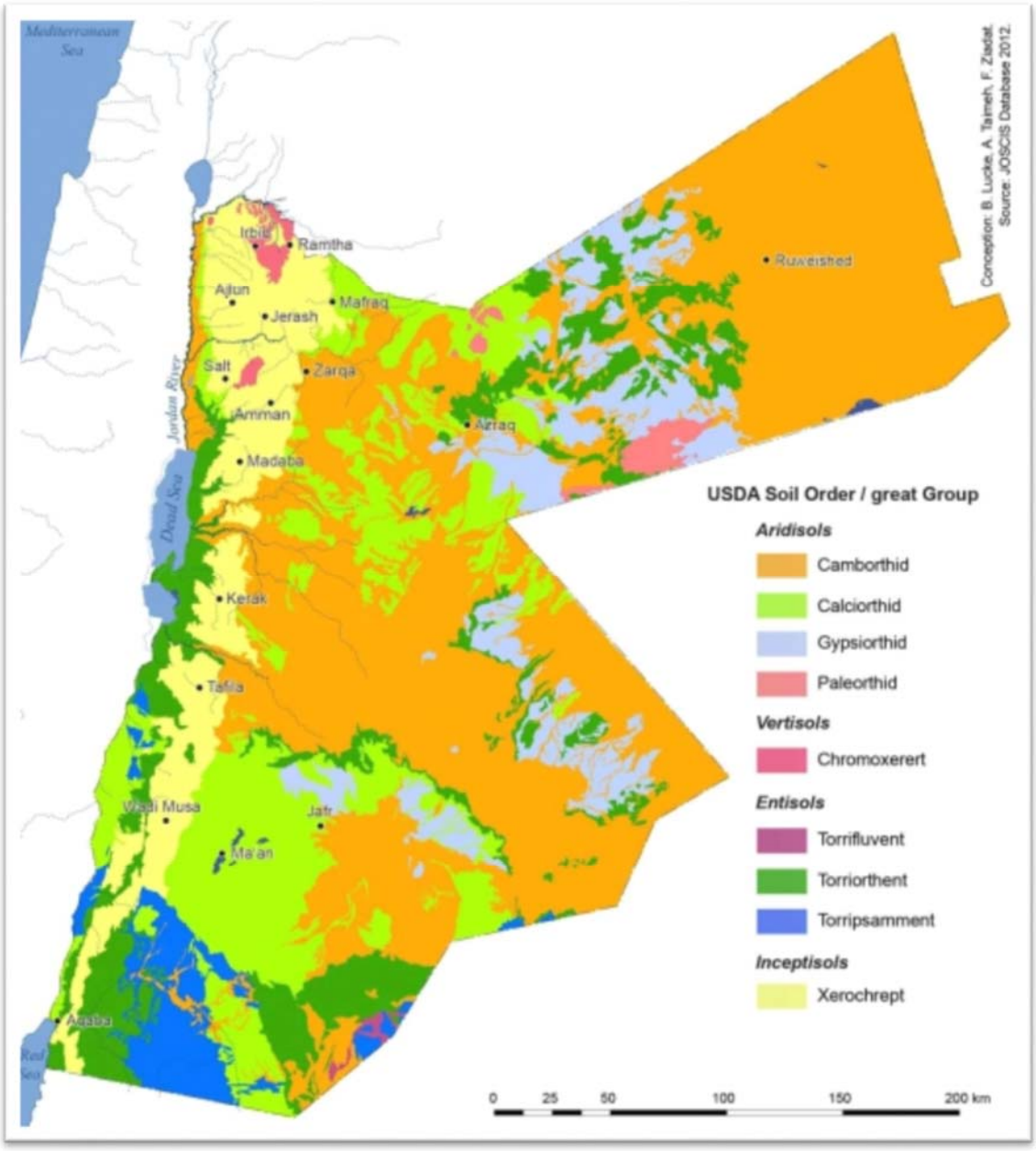
Figure 20: Flat irrigation lands located around the Ramtha WWTP (southward)

Ramtha Soil

Taxonomy Order: Vertisols

Great Group: Chromoxererts

These are the Vertisols developed under a xeric soil moisture regime. They are deep, clayey soils, developed on hard limestone and basalt, and are distributed on level to nearly level areas in the Irbid basin in the North, and Madaba and Karak in the South. The Chromoxererts are well represented by subgroups such as Typic and Entic Chromoxererts. These soils are inherently fertile, have a high water-holding capacity and are well suited for all cereal crops. When fruit trees are planted in these soils, their root systems might be damaged because of the moderately wide cracks, which develop during the dry season. Other soils such as Xeralfs, Xerolls and Xerorthents have a limited occurrence and distribution. These can be found in the mountains of Ajloun, Blaqaía and Shoubak. Major constrains to these soils are shallowness, stoniness and steep slopes. A simplified nation-wide soil map has been drawn in **Figure 21** by that presents the dominating soil suborders of the respective areas, which we consider the most accurate, though simplified, nation-wide soil map of Jordan that is now available.



Source: Ministry Agriculture

Figure 21: Soil Map of Jordan

Figure 22 presents the soil map for Ramtha area, where Ramtha city is located at the northern part and few kilometers far from the Jordan- Syria border.

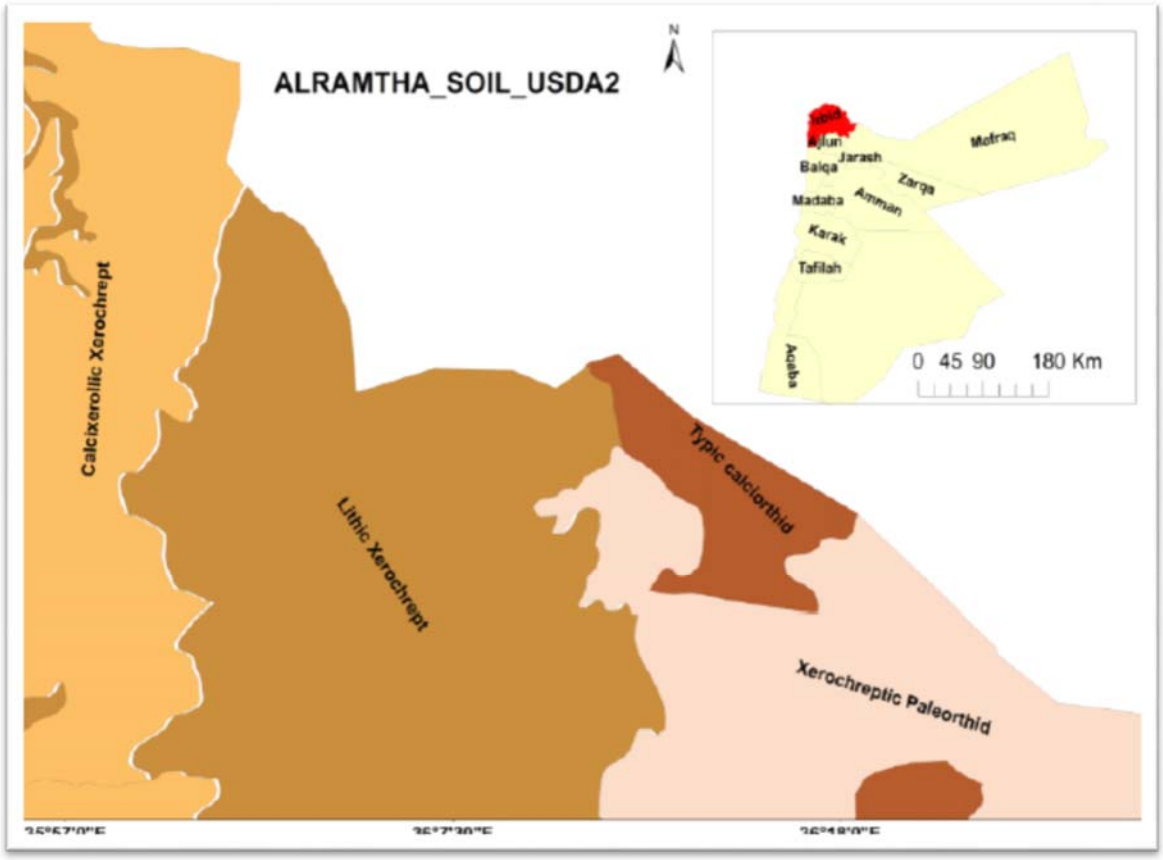


Figure 22: Soil Map of Ramtha Area

Figure 23: Soils of the Project Area

Figure 24 presents the mixing solum in different areas in the world. ((Bernhard Lucke, Feras Ziadat et Awni Taimeh.), 2012)

source: https://en.wikipedia.org/wiki/Solum

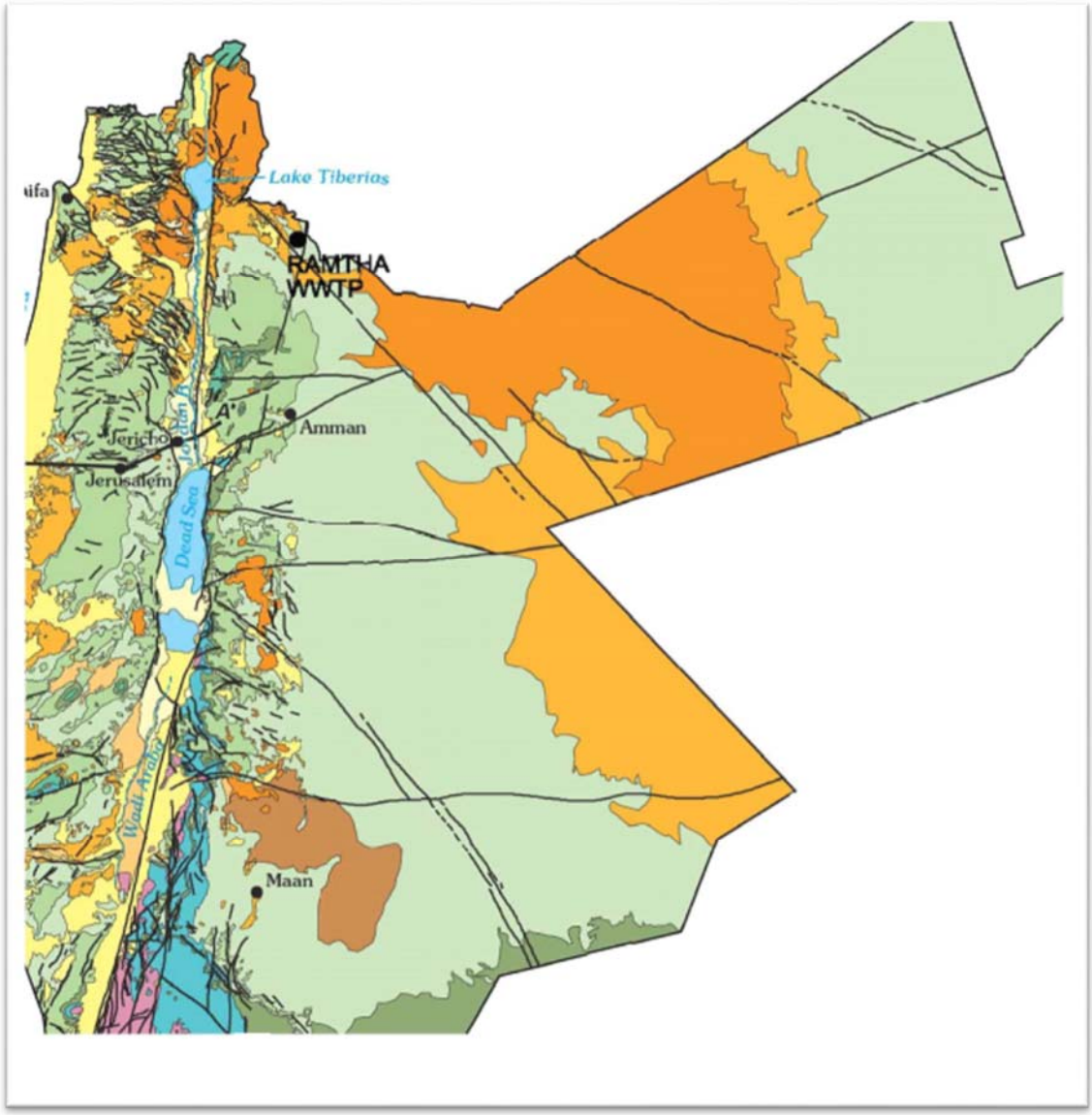
Figure 24: Mixing Solum in Different Areas in the World

5.2.5 Geomorphology and Geology

Jordan occupies the north-west part of the Arabian plate where most of the country is located within the stable shelf part of the plate (Petroleum and Oil shale Directorate, NRA, 2006). The geology in Jordan includes basalt, sandstone, limestone, chalk, marl and chert and various other Pleistocene and Holocene deposits of alluvial and Aeolian deposits.

The oldest rocks in Jordan are Precambrian in age and crop out around Aqaba and Wadi Arabah. Magnificent outcrops of the Palaeozoic sandstone in southern Jordan are present along the eastern shoulder of Wadi Arabah until the north-east tip of the Dead Sea.

The geologic map presented in **Figure 25** shows the differing geologic features, landforms and hydrologic conditions from one part of the country to another. The detailed legend of the geologic map is also shown in **Figures 26 and 27** explaining the rock units, their age, lithology and water bearing properties.



Source: U.S Geological Survey, 1998

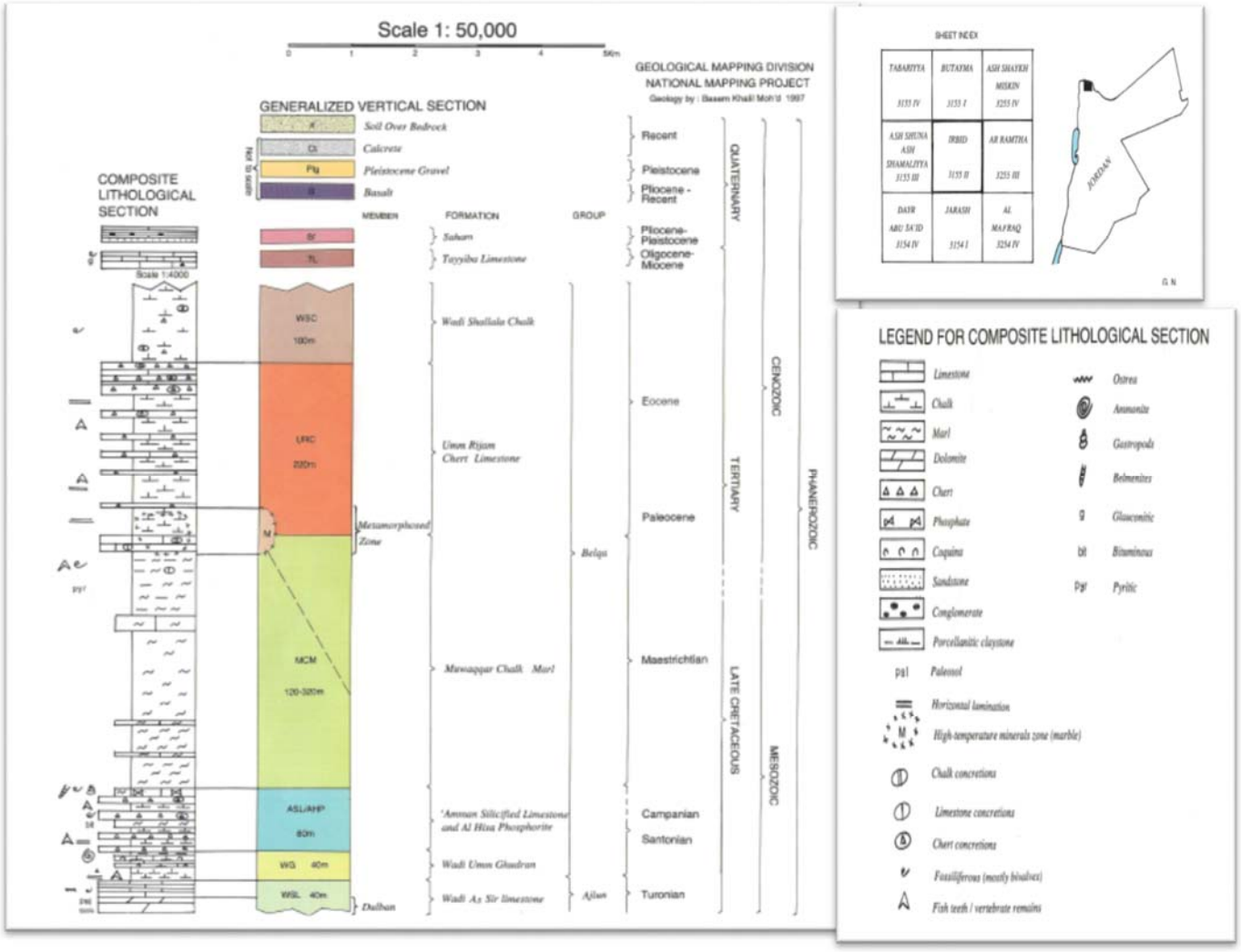
Figure 25: Geology of Jordan

System/ Series		Stage	West of Jordan River and Wadi Araba Group	West of Jordan River and Wadi Araba Unit	East of Jordan River and Wadi Araba Group	East of Jordan River and Wadi Araba Unit	This report	SEDIMENTARY ROCKS Unit description
Quaternary	Holocene		Kurkar	Qa	Jordan Valley	Alluvium and Lisan Series		Soil, sand, gravel, sandstone, and conglomerate. Comprise prolific aquifer in Coastal Plain Basin. In Jordan Valley Floor Basin, alluvial fan deposits along flanks form aquifers that contain most of the freshwater of the basin.
	Pleis-tocene			Qd				
				Qk				In Jordan Valley Floor Basin, upper part includes marl, clay, and evaporites that inhibit groundwater flow. Lower part consists of water-bearing conglomerate, sand, and gravel.
Tertiary	Pliocene		Sadiye	Ql		Absent		
				Qs				
				Tp				In Coastal Plain Basin, consists mainly of clay and marl, that inhibit groundwater flow.
	Miocene			Ts				Marl, limestone, sandstone, conglomerate. Generally an aquitard; limestone and sandstone layers are water bearing.
	Oligocene							
	Eocene		Advat	Ta	Belqa	B5	Undifferentiated	Chalk, limestone, chert, marl. Generally aquitard; limestone layers are water bearing.
	Paleocene		Mount Scopus	Ks		B4		Chalk, chert, limestone, marl. Limestone and chert layers are prolific aquifers in much of Jordan. Well yields are highly variable and are controlled largely by cavernous zones in the limestone that are affected by geologic structure. Flowing wells common in areas of low elevation. Salinity increases in an eastward direction in Jordan.
Cretaceous	Upper	Seno-nian				B3 B2/A7		
		Turo-nian	Judea	Kj	Ajlun	A1/A6		Limestone, dolomite, marl, shale. Limestone and dolomite layers are prolific aquifers in Eastern and Western Mountain Basins.
		Ceno-manian		Kc				
	Lower	Albain	Kumub	Kk	Kumub	K		Sandstone, dolomite, marl, sand, shale, clay, sandy lime-stone. Upper part mostly consists of shale and carbonates forming aquiclude; lower part mostly consists of water-bear-ing sandstone. High salinity in vicinity of Jordan Rift Valley.
		Aptian						
Jurassic			Arad	Ja	Zarqa	Z		Limestone, dolomite, sandstone, marl, shale. Limestone, dolomite and sandstone layers water bearing. Important source of water in Negev, north and south Wadi Araba, and south Jordan Desert Basins. High salinity in parts of region. Groundwater development is limited by drilling depths, high pumping lifts, and mineralization of groundwater.
Triassic			Ramon	Tr		Absent		
				Pn				Limestone, sandstone, shale, clay, dolomite, gypsum. Limestone, dolomite and sandstone layers water bearing. Important source of water in Negev, north and south Wadi Araba, and south Jordan Desert Basins. High salinity in parts of region. Upper part largely aquiclude. Groundwater development is limited by drilling depths, high pumping lifts, and mineralization of groundwater.
Paleozoic			Negev and Yam Suf	Py	Khreim and Disi	R		

System/ Series		Stage	West of Jordan River and Wadi Araba Unit	East of Jordan River and Wadi Araba Unit	This report	IGNEOUS AND META-MORPHIC ROCKS Unit description
Quaternary	Holocene		B4	BA		Basalt, tuff, and alkaline magmatic rocks. Major source of water in northern and northeastern part of region. Basalt is hydraul-ically connected with conglomerate, sandstone, marl, and chalk. Basalt and coarse grained clastics form aquifers that are separated by layers of marl and chalk. Water is generally of very good quality and high well yields are common.
	Pleis-tocene					
Tertiary	Pliocene					
	Miocene					
Cretaceous	Upper	Senonian	B3	Absent		
		Turonian				
		Cenoma-nian				
	Lower	Albain	B2			
		Aptian				
Jurassic			B1			
Triassic						
Precambrian			p€3			Metamorphic rocks, volcanic intrusives. Water occurs in fractures in crystalline bedrock. Generally not utilized as water source.
			p€2	G		
			p€1	Absent		

Figure 26: Generalized Geologic Units and Water-Bearing Properties

The project site belongs to the Balqa and Ajlun group within the (B5/B4/B3(B2/A7)/(A1/A6) formations, which fall within the Cretaceous and Tertiary systems. In terms of sedimentary rocks these formations consist of chalk, chert, limestone and marl, the B3 formation is sometimes bituminous. Limestone and chert layers contain prolific aquifers in much of Jordan. Groundwater well yields are highly variable and are controlled largely by cavernous zones in the limestone that are affected by the geologic structure. Flowing wells are common in areas of low elevation (U.S Geological Survey, 1998)



Source: Ministry of Energy and Mineral Resources (MEMR)

Figure 27: Geological Mapping for Irbid

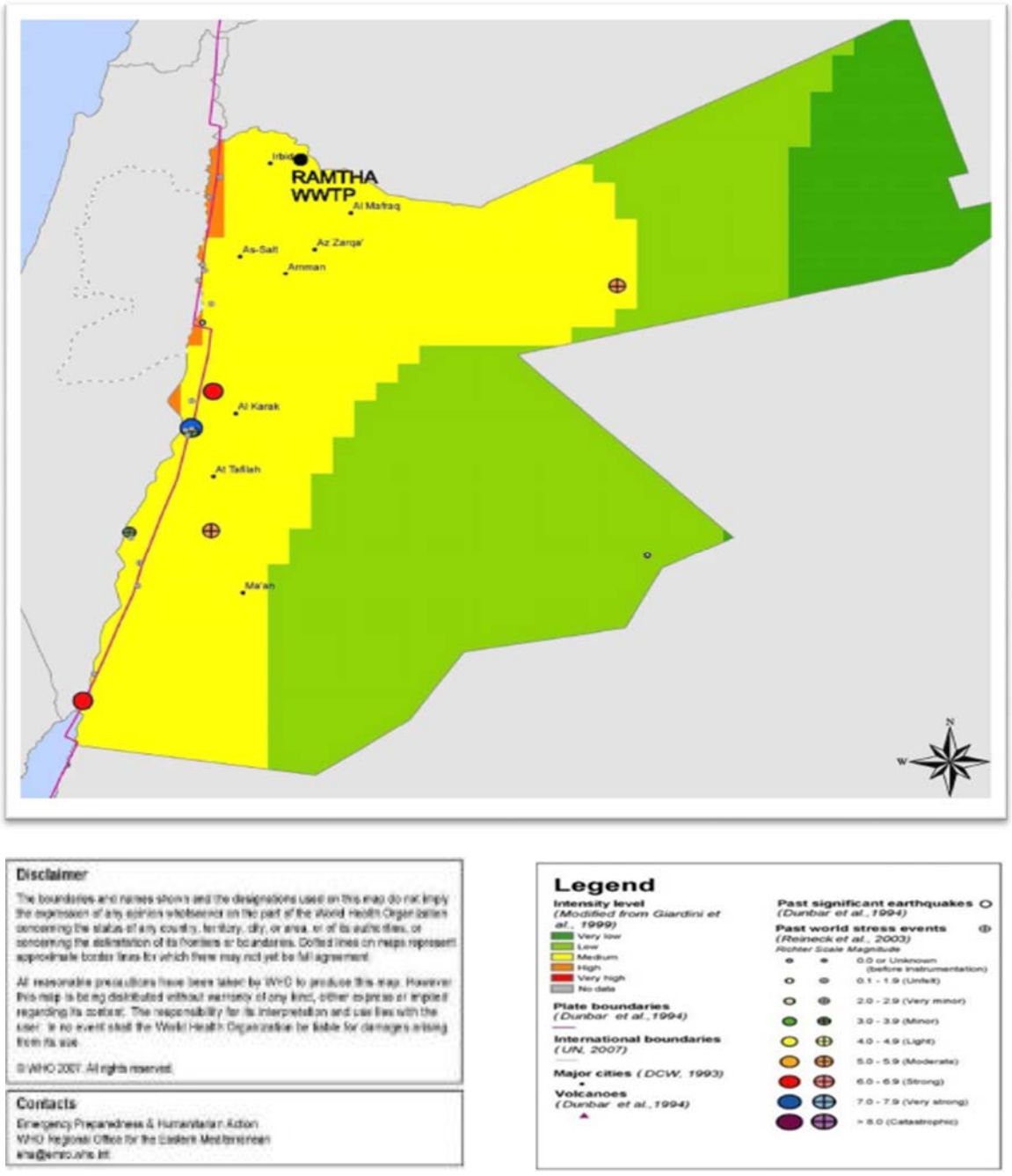
5.2.6 Tectonic Settings

The geological structure of Jordan shows the effect of several phases of deformation since the Cambrian period. The crustal movement that affected the country has resulted in gentle, regional tilting, uplift and subsidence and a combination of faulting and folding (Petroleum and Oil shale Directorate, NRN-2006).

Jordan occupies the northwest part of the Arabian plate where most of the country is located within the stable shelf part of the plate. The late Proterozoic (approximately between 2500 million years ago to 542.0 ± 1.0 million years ago) was characterized by Arabian Shield cratonization and island arcs accretions with basement sutures indicating east-west compressional forces (Petroleum and Oil shale Directorate, NRN-2006).

Overall, the rate of current seismic activity in Jordan, including the project area, is minor with many of the strong seismic events located along the axis of the Dead Sea Rift.

As shown in **Figure 28** the project site lies within the light magnitude of Richter's scale. Therefore, if an earthquake was induced in that area, it is anticipated that the intensity will fall between the 4.0 to 4.9 magnitudes according to Richter's scale. The light magnitude seismic event is often felt with rattling and shaking noises, but usually causes no significant damage (Richter Scale Explained, 2011)



Source: Atlas of Jordan. 2014

Figure 28: Seismic Hazard Distribution Map of Jordan

5.2.7 Water Resources

Jordan is classified as a country with scarce water resources. The available renewable water resources per capita are falling due to population growth and are anticipated to fall from less than 100 m^3/capita/year in 2016 to about 90 m^3/capita/year by 2025, putting Jordan in the category of absolute water shortage. (water sector capital investment plan, (2016-2025))

Highly variable seasonal rainfall is the main source of water in the country. Significant amounts of rainfall (i.e. above 200 mm) are limited to the highlands in the north-western part presenting the long-term average of annual precipitation. Around 5 percent of rainwater infiltrates into the ground, thereby replenishing groundwater aquifers. The amount transformed into direct flow is slightly smaller. The largest share of over 90 percent of annual rainfall is lost to evapo-transpiration.

Due to the limited water resources in Jordan, the demands and uses of water are exceeding renewable water supply, as a result of major contributing factors, such as the unsustainable use of groundwater through overdrawing of highland aquifers which leads to the gradual depletion of groundwater resources (MOE, 2006) .

The water uses in Jordan are divided into three main uses, with the percentage of usage from the total available quantity of water resources:

- Irrigation, 51.9 percent
- Municipal, 44.1 percent
- Industrial, 4 percent

In terms of renewable water resources; groundwater, base flow and flood flow are considered conventional resources while treated wastewater, brackish and desalinated water are considered non-conventional resources.

Besides the indigenous water resources, the country's renewable water resources are replenished through regional watercourses and trans-boundary groundwater flow (GTZ, National Water Master Plan, 2004, 2004). Water desalination, on the other hand, could be considered a future source of water supply.

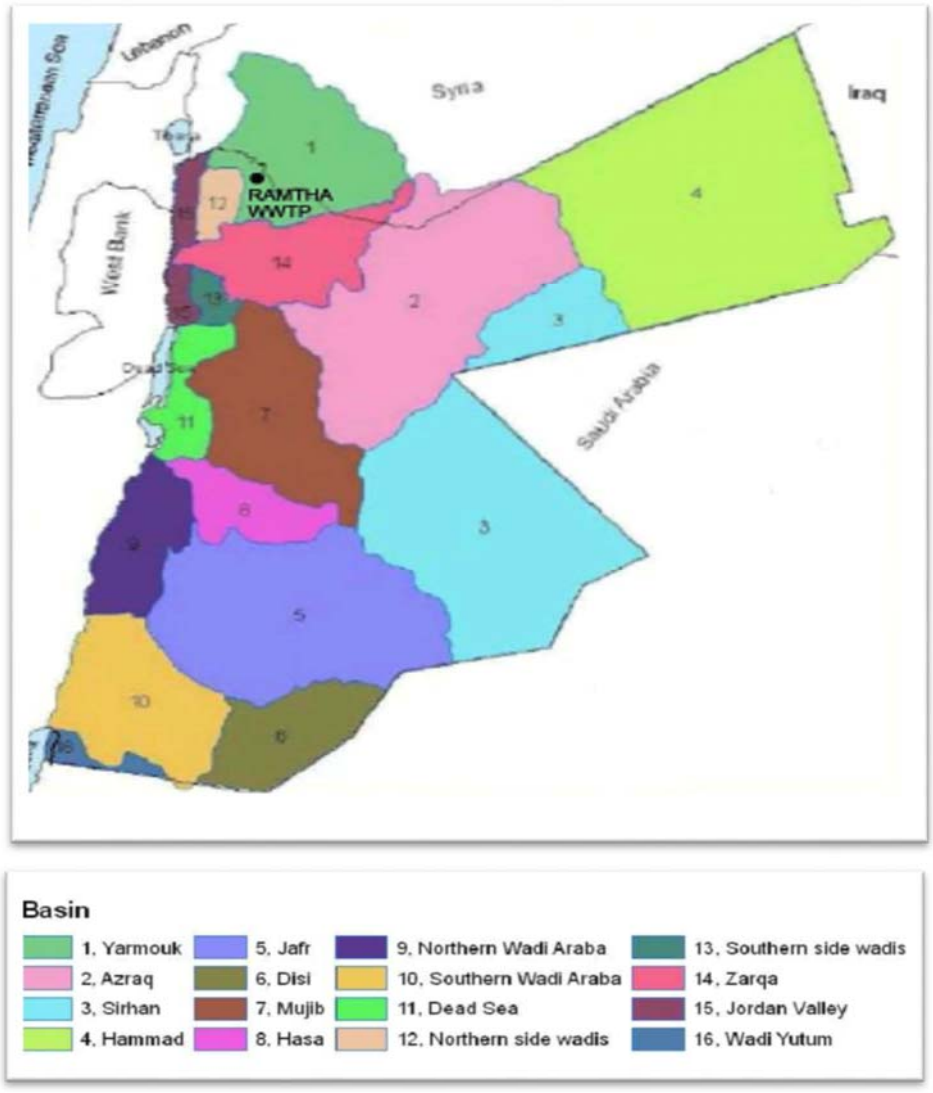
Below is a description of surface and groundwater hydrology, existing water pollution discharges, and receiving water quality for water resources related to location of the project.

5.2.7.1 Surface Water

Surface water basins in Jordan are depicted in **Figure 29**. According to this figure, the project area is located within Yarmouk basin.

The groundwater resources of the Yarmouk basin, Jordan were evaluated and studied to aid in planning, development and management. The principal sources of groundwater in this basin are classified as Shallow and Upper Cretaceous Aquifer Systems. Groundwater levels in this basin vary from zero to 250 m below the ground surface. Water table fluctuation in the wet and dry seasons is

high; with a mean of about 9 m that reflects the response of the rainfall water percolation to the groundwater to the upper aquifer B4/5 during rainy season. Directions of groundwater flow are due north and northwest. The chemical quality of groundwater in this basin is good, with low mineralization. (Groundwater Quality, Yarmouk Basin, North Jordan" Ta"any, Batayneh, and Jaradat, ; Article in Journal of Environmental Hydrology , November 2007).



Source: MoE, 2006

Figure 29: Surface Water Basins Distribution in Jordan

Figure 30: Yarmouk River

A surface hydrology study was conducted for the project area during September 2019, which studied the stormwater runoff based on the existing topographic condition. The following are the study findings:

Catchment Characteristics

The catchments of the wadis draining in the study area consist of two major wadis; the first one is Wadi Shoumer that passes adjacent the north eastern fence of the Ramtha WWTP and Wadi Tilala that passes near the eastern side of the Shallalah WWTP where some of the treated wastewater will be sent from Ramtha WWTP to Shallalah WWTP through a transmission pipeline.

For the delineation of the catchment areas related to the drainage of the two wadis, digital version of the topographic maps at the available scale have been used. The drawn catchments on 1:50,000 scale is drawn on the topographic map **Figure 31.**

Using the AutoCAD software, the areas of these catchments were measured. The characteristics of the catchments will include the highest elevation (H1), lowest elevation (Ch_4), longest wadi course (L), distance between the nearest point located on the main wadi course to the centroid of the catchment and the outlet of the catchment (Lc) and the general slope (S) of the catchment itself. in **Table 19.**

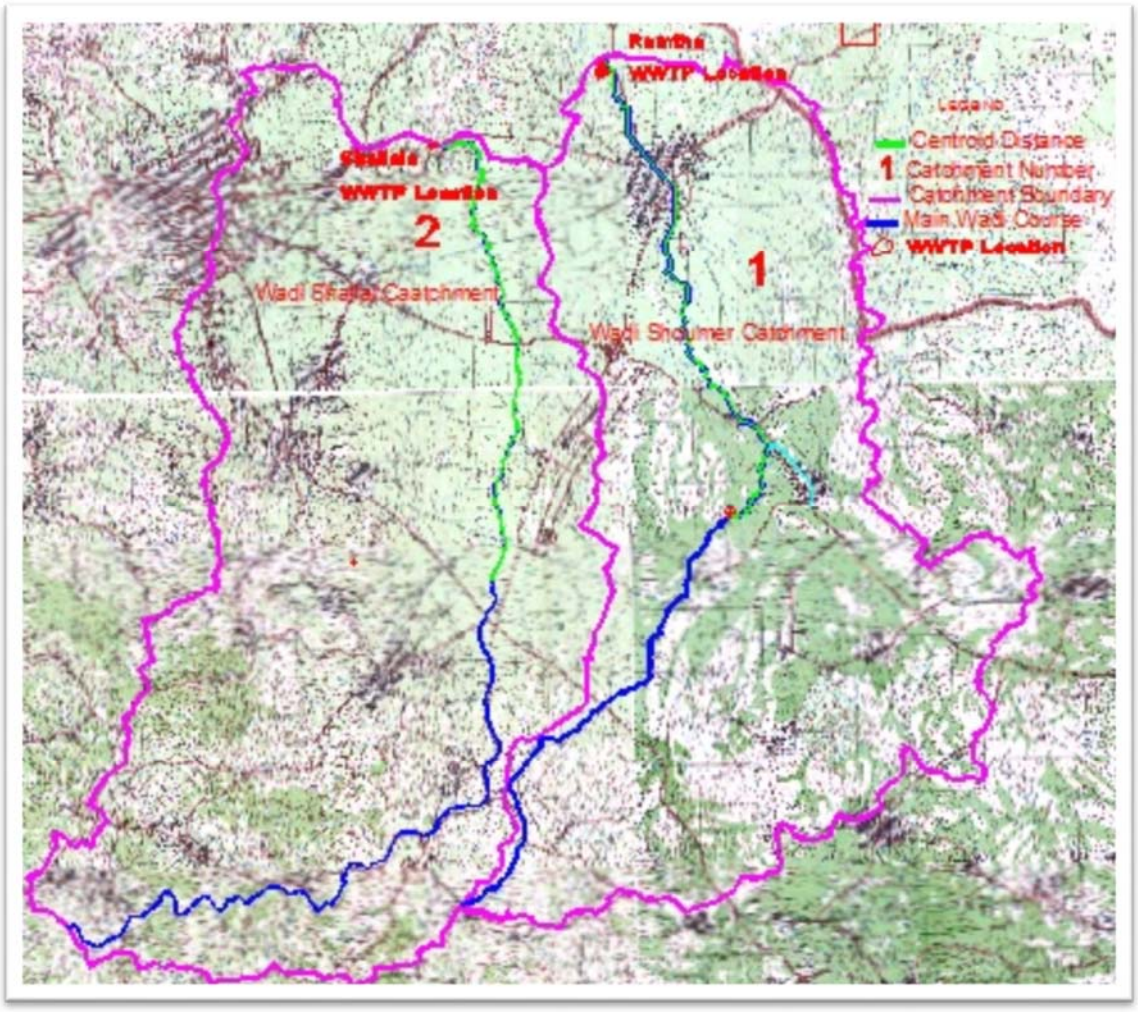


Figure 31 : Map of Catchment Areas

Wadi	Area	Longest Wadi	Centroid distance	Highest elevation	Lowest elevation	Elevation difference	Slope
	Km^2	km	km	m	m	m	%
Shoumer	284.18	36.89	19.14	985	475	510	1.38
Tilala	342.51	43.72	17.28	1182	445	737	1.69

Table 19 : Hydrological Characteristics of the Catchments

In order to carry out the hydraulic study, the intensity, duration and frequency (IDF) curves for Ramtha rain fall station have been used to calculate the rain fall intensities for 50- and 100-years' frequencies.

Methodology of Hydrological Study

There are no major wadis crossing Ramtha WWTP. Wadi Shoumar, a major wadi, is passing adjacent to the outer fence of the project from the east and northeast and continues adjacent to the plot selected for the extension of the project from the northeast. The flows in wadi passing adjacent the project where computed, in order to calculate the optimum sizes of the flood protection and drainage elements. Near Shallalah WWTP another wadi is passing which is Wadi Tilala. **Figure 32** shows the expansion of Ramtha WWTP**. Figure 33** is a photo of Wadi Shoumar passing adjacent to fence of Ramtha WWTP.

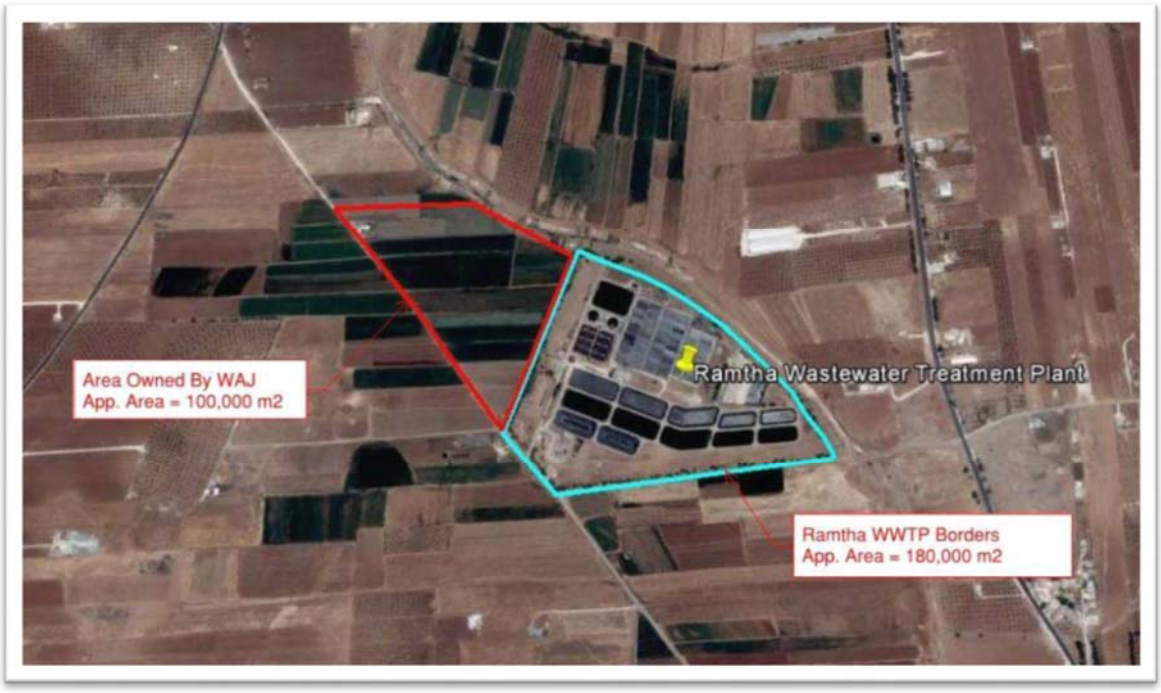


Figure 33: Ramtha WWTP and the Expansion Plot

Figure 32: Wadi Shoumar Adjacent to the Northeastern Side of Ramtha WWTP

Rational formula can only be used to estimate the peak discharges from areas with a relatively low time of concentration that is few minutes to 20 minutes. (Wanielista, Martin P., University of Florida, ,, 1990). Because the project area is in a larger catchment, the Snyder's synthetic unit hydrograph was used in this project. This method needs the derived and drawn IDF representative curves developed from knowing the rainfall intensities needed for the hydrological study. Snyder's synthetic unit hydrograph approach was used for estimating the floods of Wadi Shoumar at the outlet point located near Ramtha WWTP

The SCS (Soil Conservation Service) peak flow method calculates peak flow as a function of drainage basin area, potential watershed storage, and the time of concentration. The curve number is related to the soil moisture retention (S) where the empirical studies found that S is related to soil type, land cover, and antecedent moisture condition of the basin, where these are represented by the runoff curve number (CN) which is used to estimate the S value.

The concept behind this approach is that only part of the rainfall will contribute directly to runoff (i.e. will be effective). Either the initial loss or the continuing loss is much dependent on the soil structure, soil texture and its permeability, the land development and land use conditions are also playing an important role in producing the runoff, in addition to land slope. Since this method is having a lot of limitations, this method was not used in this study.

Flood Determination

The methodology used in the computation of the flows was the Snyder's synthetic Unit Hydrograph since the areas of two concerned catchments are considerably large.

The derived and drawn IDF curves were used in knowing the rainfall intensities needed for the calculations, which is applicable in computing the design floods that might occur in such catchment areas.

The annual data series of the short duration precipitation for Ramtha were collected from the Ministry of Water and Irrigation as shown in **Table 19**. The statistical analysis of these short duration annual data series of precipitation are presented in **Table 20.**

Water Year	Duration (min)									
	5	10	15	20	30	60	120	360	720	1440
1987	3.46	4.43	4.67	4.67	4.67	6.6	10.38	16.83	21.44	40.56
1988										
1989	3.44	3.44	3.54	3.65	3.68	6.1	9.34	16.13	17.36	26.6
1990	4.37	5.21	5.94	6.23	7.45	12.5	15.49	35.97	53.4	73.8
1991	4.22	4.86	4.86	4.86	5.25	6.38	10.66	15.02	21.83	35.08
1992	3.69	3.99	4.28	4.58	4.71	5.79	10.05	19.52	23.57	29.63

Water Year	Duration (min)									
	5	10	15	20	30	60	120	360	720	1440
1993	2.88	3.85	4.24	4.51	4.89	6.63	8.5	14.08	18.67	21.1
1994	8.94	8.94	8.94	8.94	10.18	11.8	15.69	19.9	29.64	35.61
1995	11.2	13.84	15.93	15.93	17.43	21.48	29.75	30.89	30.89	31.19
1996	12.2	14.2	17.65	18.08	20.04	28.7	30.97	34.67	35.32	38.47
1997	3.2	4.44	4.44	4.44	6.98	8.17	12.83	19.08	22.09	28.98
1998	5.39	6.4	8.23	8.8	10.13	10.54	10.96	16.7	21.6	27.24
1999	2.85	3.85	4.36	4.86	5.23	6.86	8.52	14.4	18.36	19.82
2000	3.00	3.35	4.07	4.47	5.37	8.58	14.39	28.79	28.79	28.79
2001	3.43	4.58	5.20	5.65	6.52	9.42	15.36	17.02	17.23	17.23
2002	8.5	9.68	9.82	10.77	17.34	20.39	20.39	20.39	21.12	27.97
2003	5.5	6.4	6.93	9.08	9.08	9.46	16.45	36.14	43.39	47.02
2004	7.68	9.01	10.74	12.89	15.52	18.19	18.19	18.19	26.39	32.2
2005	6.2	9.53	11.4	14.24	17.05	24.76	26.24	26.24	26.24	34.36

Table 20: Annual Data Series of the Short Duration Precipitation at Ramtha

Water Year	Duration (min)									
	5	10	15	20	30	60	120	360	720	1440
Count	18	18	18	18	18	18	18	18	18	18
Mean	5.56	6.67	7.51	8.15	9.53	12.35	15.79	22.22	26.52	33.09
S.D.	2.95	3.43	4.19	4.50	5.44	7.15	7.00	7.74	9.54	12.54
Reduced (Sn)	1.0493	1.0493	1.0493	1.0493	1.0493	1.0493	1.0493	1.0493	1.0493	1.0493
Reduced (Yn)	0.5202	0.5202	0.5202	0.5202	0.5202	0.5202	0.5202	0.5202	0.5202	0.5202

Table 21: Statistical Analysis of Short Duration Annual Data series of Precipitation at Ramtha

The Gumbel's double exponential distribution was applied to calculate the IDF information and draw the IDF curves as shown in **Table 22, Table 23** and **Figure 34**.

Water Year	Duration (min)									
	5	10	15	20	30	60	120	360	720	1440
2	5.13	6.16	6.90	7.49	8.73	11.31	14.76	21.09	25.12	31.25
3	6.64	7.92	9.04	9.79	11.51	14.96	18.34	25.04	30.00	37.66
5	8.32	9.87	11.43	12.35	14.61	19.03	22.32	29.44	35.42	44.80
10	10.42	12.33	14.42	15.57	18.51	24.14	27.32	34.98	42.25	53.77
25	13.09	15.43	18.21	19.64	23.43	30.61	33.65	41.97	50.86	65.10
50	15.06	17.73	21.02	22.66	27.08	35.40	38.34	47.15	57.26	73.51
100	17.02	20.02	23.81	25.66	30.70	40.16	42.99	52.30	63.60	81.85
200	18.98	22.29	26.58	28.64	34.31	44.90	47.63	57.43	69.93	90.17

Table 22: Rainfall [mm], Duration [min.] and Frequency [year] at Ramtha

	Duration (min)									
	5	10	15	20	30	60	120	360	720	1440
I2	61.59	36.98	27.60	22.46	17.46	11.31	7.38	3.51	2.09	1.30
I3	79.66	47.51	36.16	29.37	23.03	14.96	9.17	4.17	2.50	1.57
I5	99.79	59.24	45.70	37.06	29.22	19.03	11.16	4.91	2.95	1.87
I10	125.09	73.97	57.69	46.72	37.01	24.14	13.66	5.83	3.52	2.24
I25	157.05	92.59	72.83	58.92	46.85	30.61	16.82	6.99	4.24	2.71
I50	180.76	106.40	84.07	67.98	54.15	35.40	19.17	7.86	4.77	3.06
I100	204.30	120.11	95.22	76.97	61.40	40.16	21.50	8.72	5.30	3.41
I200	227.75	133.76	106.33	85.92	68.61	44.90	23.82	9.57	5.83	3.76

Table 23: Rainfall Intensity [mm/hr], Duration [min.] & Frequency [year] at Ramtha

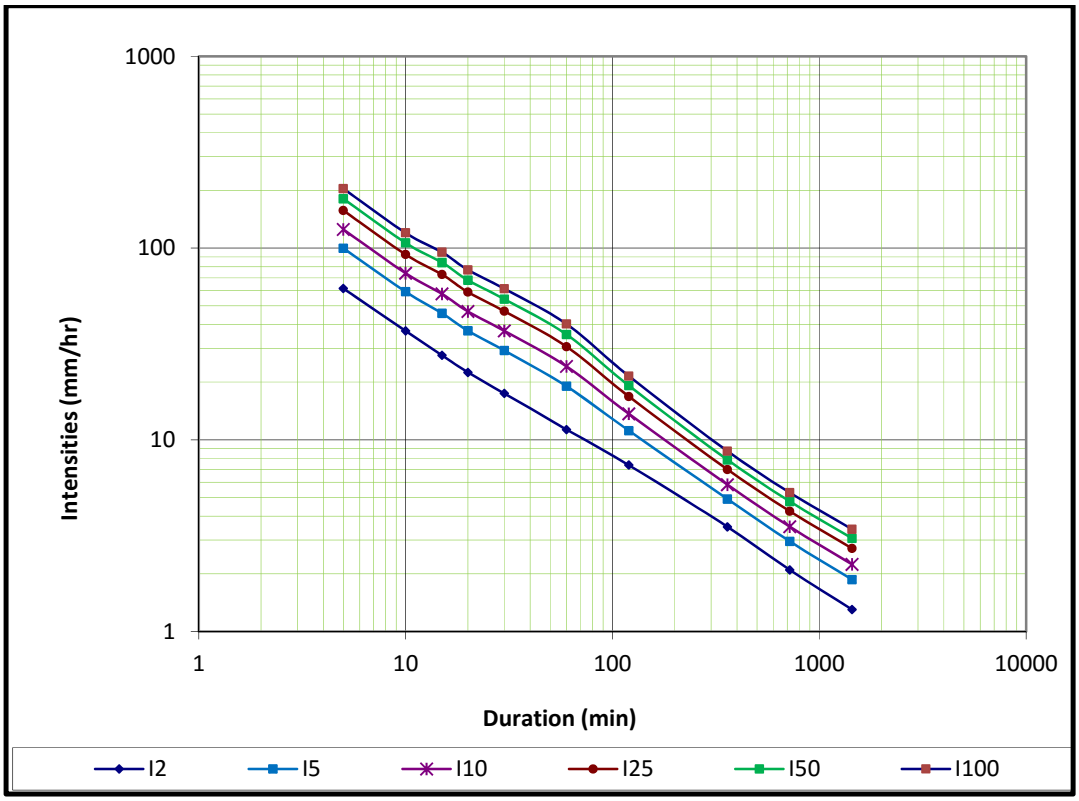


Figure 34: Rainfall Intensity [mm/h], Duration [min.] & Frequency [year] (IDF) Curves at Ramtha

Using **Table 23** and/or **Figure 35**, the best fit trend lines can be drawn for the rainfall intensities to find the equation and regression coefficient as in **Figure 35**. The trend line equations can be used in the derivation of the rainfall intensities relevant to any time of concentration.

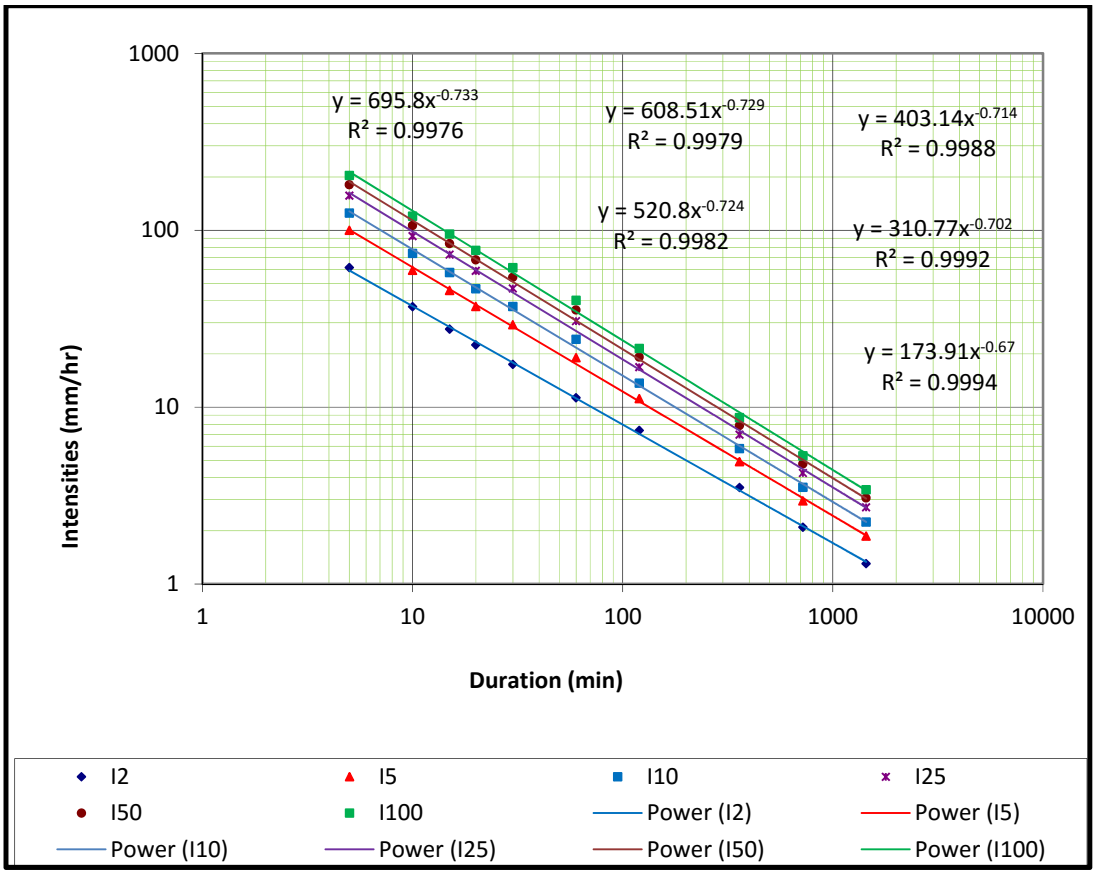


Figure 35: Best Fit Distribution (Power Trend Line) for the IDF Curves of Ramtha.

The hydrological calculation for the available catchment areas within the project was computed, to provide cost effective design. For designing the protection measures, if required, the design flood of 25-year, 50-year and 100-year return periods are determined.

The effective rainfall and design floods have been computed for 25-year standard return period for Wadi Shoumar as shown in the following **Table 24** and **Table 25.**

Time (hours)	Rain intensity P(mm/hr)	Cumulative Rainfall (mm)	Areal Reduction Factor	Cumulative Areal Rain (mm)	P Increment (mm)	Nested Profile (mm)	Cumulative storm rain (mm)	P - Ia	Profile P - Ia	Effective** Rain (mm)
0										
1	26.9	26.871	0.535	14.388	14.388	0.823	0.823	0.000	0.000	0.000
2	16.3	32.537	0.643	20.910	6.522	0.887	1.711	0.000	0.000	0.000
3	12.1	36.389	0.696	25.332	4.422	0.964	2.674	0.000	0.000	0.000
4	9.8	39.397	0.729	28.730	3.398	1.058	3.732	0.000	0.000	0.000
5	8.4	41.899	0.752	31.516	2.787	1.177	4.910	0.000	0.000	0.000
6	7.3	44.061	0.769	33.894	2.378	1.333	6.242	0.000	0.000	0.000
7	6.6	45.977	0.783	35.978	2.084	1.547	7.790	0.000	0.000	0.000
8	6.0	47.703	0.793	37.840	1.862	1.862	9.652	0.000	0.000	0.000
9	5.5	49.279	0.802	39.528	1.688	2.378	12.030	0.000	0.000	0.000
10	5.1	50.733	0.810	41.075	1.547	3.398	15.427	0.000	0.000	0.000
11	4.7	52.085	0.816	42.506	1.431	6.522	21.950	0.178	0.178	0.000

Time (hours)	Rain intensity P(mm/hr)	Cumulative Rainfall (mm)	Areal Reduction Factor	Cumulative Areal Rain (mm)	P Increment (mm)	Nested Profile (mm)	Cumulative storm rain (mm)	P - Ia	Profile P - Ia	Effective** Rain (mm)
12	4.4	53.351	0.822	43.839	1.333	14.388	36.338	14.566	14.388	12.888
13	4.2	54.543	0.827	45.088	1.249	4.422	40.759	18.988	4.422	2.922
14	4.0	55.670	0.831	46.266	1.177	2.787	43.546	21.774	2.787	1.287
15	3.8	56.740	0.835	47.379	1.114	2.084	45.630	23.859	2.084	0.584
16	3.6	57.760	0.839	48.437	1.058	1.688	47.318	25.546	1.688	0.188
17	3.5	58.735	0.842	49.446	1.008	1.431	48.749	26.977	1.431	0.000
18	3.3	59.668	0.845	50.410	0.964	1.249	49.998	28.227	1.249	0.000
19	3.2	60.566	0.848	51.333	0.924	1.114	51.112	29.340	1.114	0.000
20	3.1	61.429	0.850	52.220	0.887	1.008	52.120	30.349	1.008	0.000
21	3.0	62.262	0.852	53.074	0.854	0.924	53.044	31.272	0.924	0.000
22	2.9	63.066	0.855	53.898	0.823	0.854	53.898	32.126	0.854	0.000
23	2.8	63.845	0.857	54.693	0.795	0.795	54.693	32.922	0.795	0.000

Time (hours)	Rain intensity P(mm/hr)	Cumulative Rainfall (mm)	Areal Reduction Factor	Cumulative Areal Rain (mm)	P Increment (mm)	Nested Profile (mm)	Cumulative storm rain (mm)	P - Ia	Profile P - Ia	Effective** Rain (mm)
24	2.7	64.599	0.859	55.463	0.770	0.000	54.693	32.922	0.000	0.000
*Ia= Initial abstraction		Ia=	21.77						Total	12.89
**Effective Rain= P-Ia-Infiltration		24-hr intensity	2.7							

Table 24: Effective rainfall calculation at Ramtha (25-Year) For Wadi Shoumer

One-Hourly UH for 1mm		One-Hourly Effective Rainfall Distribution (mm)					Q_{25}
T(hr)	Q(m^3/s)	12.89	2.92	1.29	0.58	0.19	m^3/s
0	0.000	0.000					0
1	0.168	2.159	0.000				2.159
2	0.562	7.241	0.490	0.000			7.730
3	1.153	14.862	1.641	0.216	0.000		16.719
4	2.050	26.422	3.369	0.723	0.098	0.000	30.612
5	3.055	39.379	5.990	1.484	0.328	0.031	47.212
6	4.258	54.877	8.927	2.638	0.674	0.106	67.220
7	5.214	67.199	12.440	3.931	1.198	0.217	84.984
8	5.884	75.837	15.233	5.478	1.785	0.385	98.718
9	6.209	80.028	17.191	6.708	2.487	0.574	106.989
10	6.170	79.520	18.142	7.570	3.046	0.800	109.078
11	5.815	74.947	18.027	7.989	3.437	0.979	105.379

One-Hourly UH for 1mm		One-Hourly Effective Rainfall Distribution (mm)					Q_{25}
T(hr)	Q(m^3/s)	12.89	2.92	1.29	0.58	0.19	m^3/s
12	5.322	68.596	16.990	7.938	3.627	1.105	98.256
13	4.721	60.847	15.550	7.482	3.604	1.166	88.649
14	4.100	52.844	13.793	6.847	3.397	1.159	78.041
15	3.430	44.206	11.979	6.074	3.109	1.092	66.461
16	2.977	38.363	10.021	5.275	2.758	0.999	57.417
17	2.563	33.028	8.697	4.413	2.395	0.887	49.419
18	2.208	28.455	7.487	3.830	2.004	0.770	42.545
19	1.873	24.136	6.450	3.297	1.739	0.644	36.266
20	1.616	20.833	5.471	2.840	1.497	0.559	31.201
21	1.390	17.911	4.723	2.409	1.290	0.481	26.814
22	1.173	15.116	4.060	2.080	1.094	0.415	22.765
23	1.015	13.084	3.427	1.788	0.944	0.352	19.595
24	0.828	10.670	2.966	1.509	0.812	0.304	16.261
25	0.729	9.400	2.419	1.306	0.685	0.261	14.071

One-Hourly UH for 1mm		One-Hourly Effective Rainfall Distribution (mm)					Q_{25}
T(hr)	Q(m^3/s)	12.89	2.92	1.29	0.58	0.19	m^3/s
26	0.631	8.130	2.131	1.065	0.593	0.220	12.139
27	0.562	7.241	1.843	0.938	0.484	0.191	10.696
28	0.503	6.478	1.641	0.812	0.426	0.155	9.513
29	0.444	5.716	1.469	0.723	0.368	0.137	8.413
30	0.384	4.954	1.296	0.647	0.328	0.118	7.343
31	0.335	4.319	1.123	0.571	0.294	0.106	6.412
32	0.286	3.684	0.979	0.495	0.259	0.094	5.511
33	0.256	3.303	0.835	0.431	0.225	0.083	4.877
34	0.207	2.668	0.749	0.368	0.196	0.072	4.052
35	0.187	2.414	0.605	0.330	0.167	0.063	3.578
36	0.168	2.159	0.547	0.266	0.150	0.054	3.176
37	0.138	1.778	0.490	0.241	0.121	0.048	2.678
38	0.118	1.524	0.403	0.216	0.109	0.039	2.291
39	0.099	1.270	0.346	0.178	0.098	0.035	1.926

One-Hourly UH for 1mm		One-Hourly Effective Rainfall Distribution (mm)					Q_{25}
T(hr)	Q(m^3/s)	12.89	2.92	1.29	0.58	0.19	m^3/s
40	0.079	1.016	0.288	0.152	0.081	0.031	1.568
41	0.059	0.762	0.230	0.127	0.069	0.026	1.214
42	0.049	0.635	0.173	0.101	0.058	0.022	0.989
43	0.039	0.508	0.144	0.076	0.046	0.019	0.793
44	0.030	0.381	0.115	0.063	0.035	0.015	0.609
45	0.020	0.254	0.086	0.051	0.029	0.011	0.431
46	0.010	0.127	0.058	0.038	0.023	0.009	0.255
47	0.000	0.000	0.029	0.025	0.017	0.007	0.079
48			0.000	0.013	0.012	0.006	0.030
49				0.000	0.006	0.004	0.009
50					0.000	0.002	0.002
51						0.000	0.000

Table 25: Design flood hydrograph of 25-year return period at Wadi Shoumer

Figure36 shape and the distribution of the 25-year design hydrograph for Wadi Shoumer.

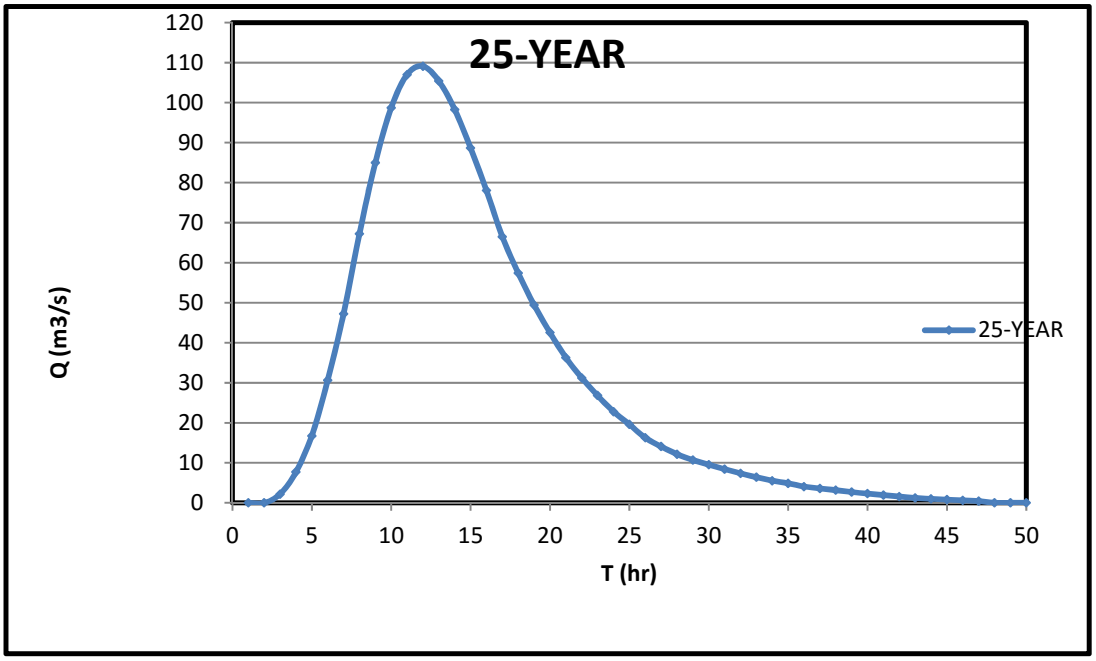


Figure 36: 25-year design hydrograph for Wadi Shoumer

The same steps were applied to calculate the effective rainfall for the 50-year and 100-year return periods for Wadi Shoumar

Following the same steps applied for the 25-year flood of Wadi Shoumar, the design flood of the three mentioned return periods for Wadi Tilala were also estimated. These floods have been included in **Table 26** that shows the summary for the estimated floods for both wadis and **Figures 37 and 38** present the hydrographs of the estimated design floods for both wadis.

Wadi Name	Q (25-year)	Q (50-year)	Q (100-year)
	(m^3/s)	(m^3/s)	(m^3/s)
Ash Shoumer	109.08	137.74	173.81
Tilala	129.46	164.01	207.49

Table 26: Summary of the estimated flood peaks

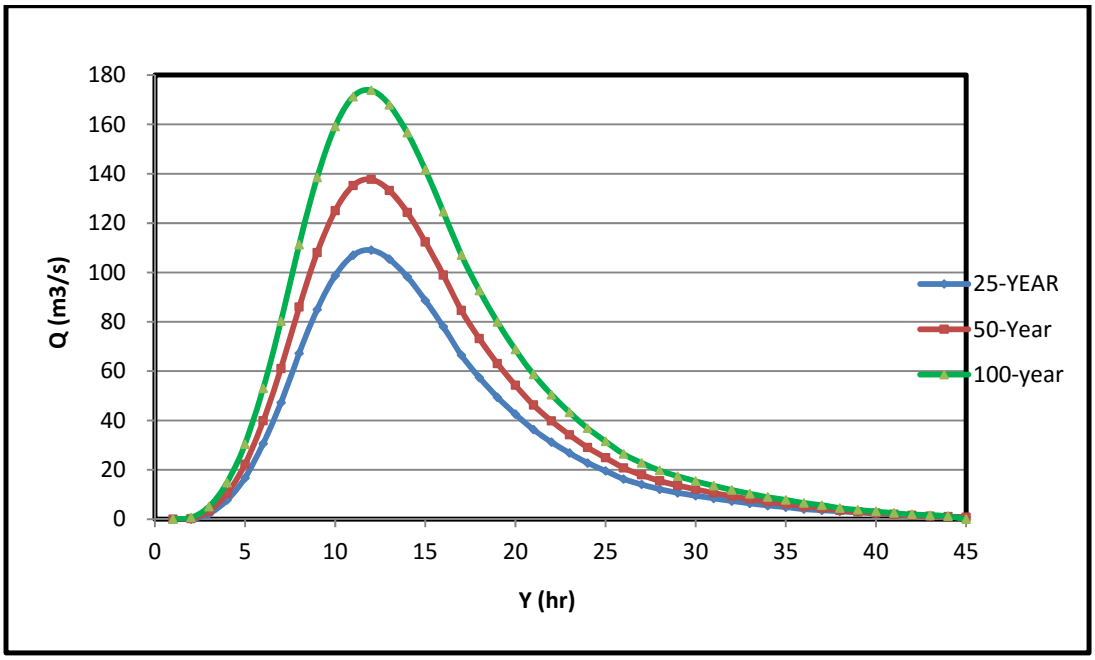


Figure 37: Constructed flood hydrographs for different return periods for Wadi Shoumer

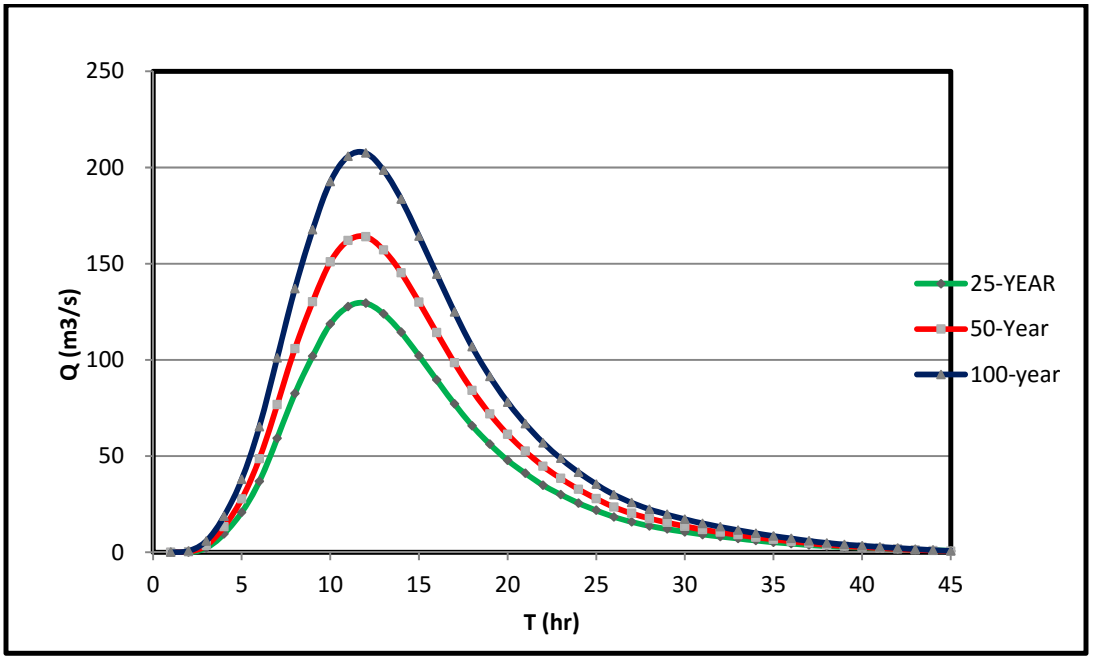


Figure 38: Constructed flood hydrographs for different return periods for Wadi Tilala

The main sewer lines in Ramtha are laid in the right and left slope of the Wadi Shoumer, which crosses the urban area. During rainfalls this leads very often to important penetration of stormwater into the sewerage system (planed as separate system) because of damaged manholes, opened manhole covers, etc. Stormwater overflow structures are not available in the collection network or at the treatment plant.

Treated Effluent Reuse Options (Shallalah Transmission Pipeline)

An effluent reuse conveyance pipeline would be constructed from Ramtha WWTP to Shallalah WWTP effluent reservoir for transmission to the Jordan valley and contribute to the scheme to send treated effluent from the Irbid Governate area WWTPs to the Jordan valley for agricultural irrigation.

If treated effluent from Ramtha WWTP is not efficiently used in agricultural irrigation around Ramtha WWTP, the excess effluent could be used in the Jordan valley where it is most needed. This would eliminate the negative impacts to the environment, Yarmouk River, and Wahdah Dam from excess treatment effluent discharge to the wadi downstream of the Ramtha WWTP.

The proposed effluent reuse conveyance pipeline is 8.5 km long to convey treated effluent to the Shallalah WWTP effluent storage tank. The conveyance pipeline is of Ø600mm diameter of HDPE or ductile iron and it passes in the roadway right-of-way (underground with a depth around 120 cm) that mostly pass through rural agricultural areas as in the following **Figure 39**

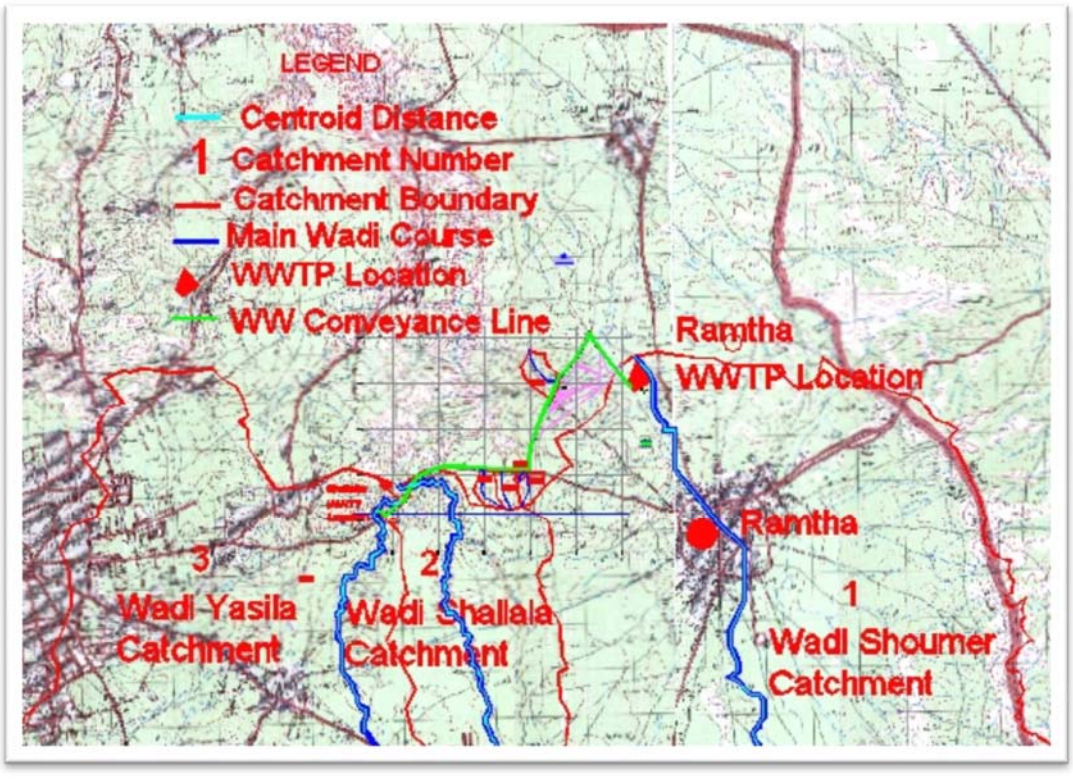


Figure 39: Effluent Conveyance from Ramtha WWTP to Shallalah WWTP

This conveyance pipeline will transfer up to 8,250 m^3/d of Ramtha WWTP treatment effluent. The Ramtha WWTP is at higher elevation than the Shallalah WWTP, but the effluent is pumped over a high point in the alignment. Then can flow by gravity to the effluent storage tank of the Shallalah WWTP site. A pressure sustaining valve on the pipeline is recommended to prevent excessive effluent of causing damages to the pipeline. In addition to a motorized isolation valve to allow the Shallalah WWTP to shut off the flow from the Ramtha WWTP in case of an emergency at the WWTP. (USAID, 2019).

The proposed route of the conveyance pipe passes adjacent to the existing roads where some wadis are crossing through the culverts as shown in the **Figure 40**. Along the proposed route there are 7 culverts; 5 of which are pipes and the other 2 are box culverts. The catchment characteristics of these wadis are described in **Table 27**.

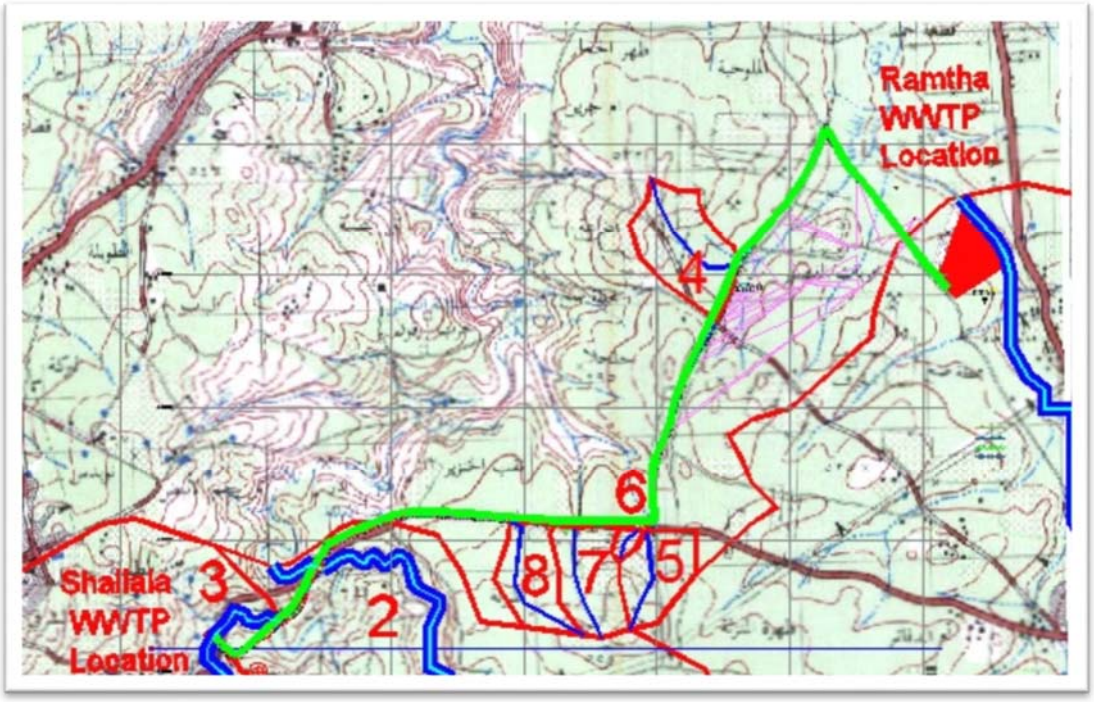


Figure 40: Effluent Conveyance from Ramtha WWTP to Shallalah WWTP (Zoomed)

Wadi	Area	Longest Wadi	Centroid Distance	Highest elevation	Lowest Elevation	Elevation Difference	Slope
	km^2	km	km	m	m	m	%
Tilala	342.51	43.72	17.28	1182.0	445.0	737.0	1.69
Yesila	109.01	19.81	6.84	886.0	465.0	421.0	2.13
4	0.493	1.04	NR	490.0	532.0	42.0	4.04
5	0.313	0.77	NR[1]	510.0	558.0	48.0	6.23
6	0.037	0.28	NR	512.3	530.0	17.7	6.31
7	0.370	0.86	NR	509.2	558.0	48.8	5.64
8	0.326	1.19	NR	509.0	555.0	46.0	3.85

Table 27: The catchment characteristics of these wadis

[1]:NR: Not Required

The time of concentration was found using Kirpich's formula and the intensities related were determined using Ramtha IDF curves as presented in **Table 28**.

Catchment ID #	Used Time of Concentration (min)	Actual Time of Concentration (min)	Rainfall Intensities (mm/h)				
			2-year	5-year	10-year	25-year	50-year
2- Tilala	351.06	351.06	3.43	5.08	6.14	7.48	8.49
3- Yesila	174.55	174.55	5.47	8.29	10.11	12.40	14.12
4	14.10	14.10	29.54	48.50	60.95	76.69	88.43
5	10.00	9.46	37.18	61.72	77.89	98.33	113.57
6	10.00	4.32	37.18	61.72	77.89	98.33	113.57
7	10.68	10.68	35.57	58.93	74.30	93.74	108.23
8	15.90	15.90	27.25	44.57	55.93	70.28	80.98

Table 28: Computed and Accepted Time of Concentration and Related Intensities

Figure 41shows a photo for the 2-cell box culvert discharging the floods coming from Wadi Yesila catchment while **Figure 42** shows a photo for the 3-cell box culvert discharging the floods coming from Wadi Tilala catchment.

Figure 41: Wadi Yesila 2-Cell Box Culvert

Figure 42: Wadi Tilala 3-Cell Box Culvert

In order to know the floods that might affect the treated effluent conveyer, the design floods were estimated for the return periods of 25-year and 50-year. The Snyder's synthetic unit hydrograph method was applied to estimate the design flood of Wadi Tilala that is being discharged through 3 cells of 3.5m x 3.5m size culvert and of Wadi Yesila that is being discharged through 2 cells of 3.0m x 3.0m size culvert. The estimate of the design floods for the 25-year and 50-year return periods for the pipe culverts were carried out using the Rational method.

Table 29 presents the estimated floods for 25-year and 50-year for all related culverts.

	Method of Calculation	25-yr Flood Q m3/s	50-yr Flood Q m3/s	No. of Existing Box Culvert	Size of Box Culvert	Size of Pipe Culvert Ø
Tilala	Unit Hydrograph	129.46	164.01	3	3.5m x 3.5m	
Yesila	Unit Hydrograph	47.40	58.5	2	3.0m x 3.0m	

	Method of Calculation	25-yr Flood Q m3/s	50-yr Flood Q m3/s	No. of Existing Box Culvert	Size of Box Culvert	Size of Pipe Culvert Ø
4	Rational	3.676	4.238	1		500
5	Rational	2.992	3.456	2		700
6	Rational	0.354	0.409	1		700
7	Rational	3.372	3.893	2		700
8	Rational	2.227	2.567	1		700

Table 29: Estimated Floods for 25-year and 50-year for All Related Culverts

The Flow Master program has been used to calculate the water depth and velocity that passes inside each culvert. In most cases, this depth is usually higher than the water height while flowing outside in the wider wadi, For Wadi Tilala, the 25-year flood for this wadi is 129.47m^3/s discharging in the 3-cell box culvert. So, when the flow of 1-cell as 43.2m^3/s is being analyzed, the resulted depth of water is 1.61m and the velocity is 7.65m/s when the slope is 1.25 percent.

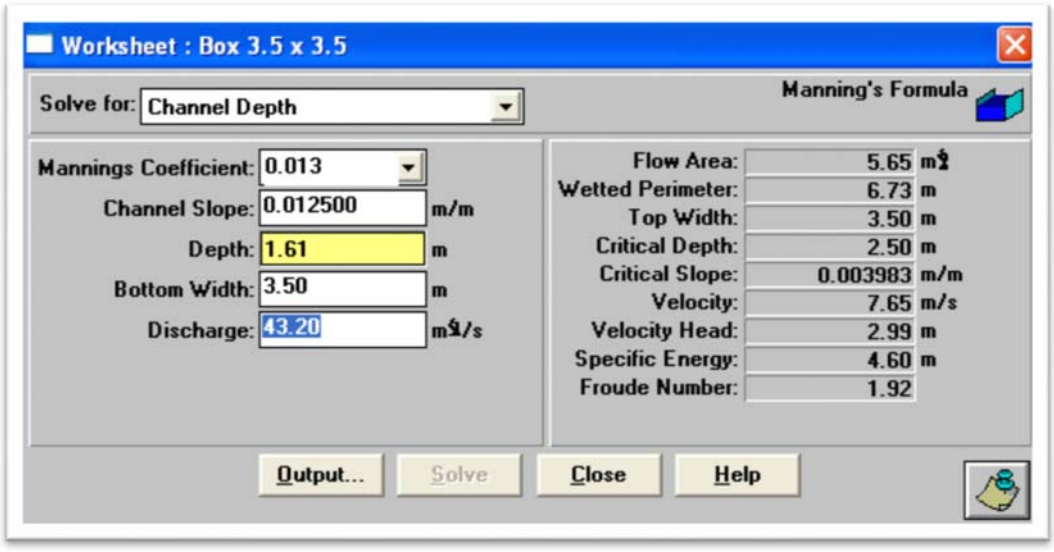


Figure 43: Hydraulic Analysis of 1-cell Box Culvert at Wadi Tilala

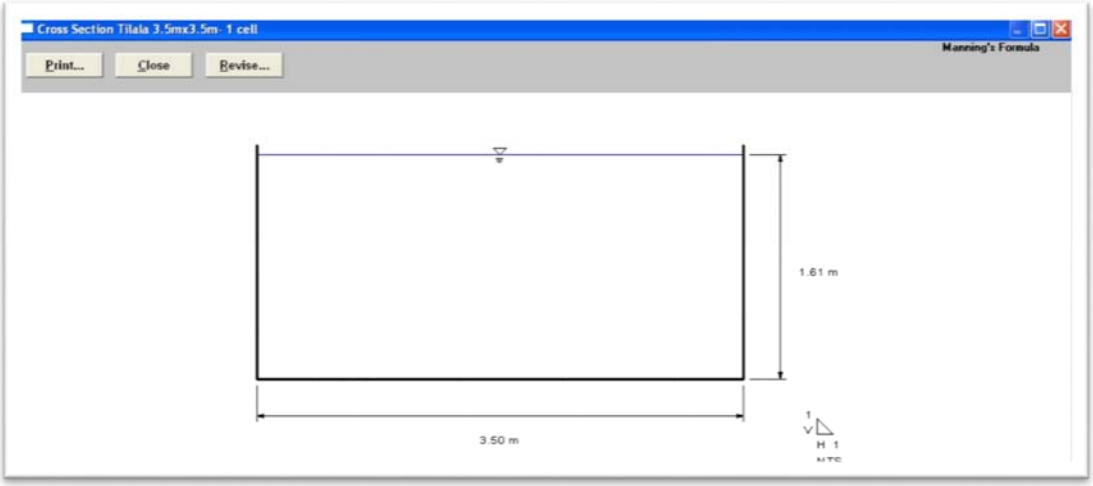


Figure 44: Hydraulic Section of Flow in 1-cell Box Culvert at Wadi Tilala

The Flow Master program was also used to calculate the water depth and velocity that passes inside the culvert at Wadi Yesila as in **Figures 43 and 44**. The 25-year flood for this wadi is 47.4m^3/s discharging in the 2-cell box culvert. So, the flow of 1-cell is about 16.0 m^3/s and the resulting depth of water is 0.98m and the velocity is 5.43m/s when the slope is 1.00 percent.

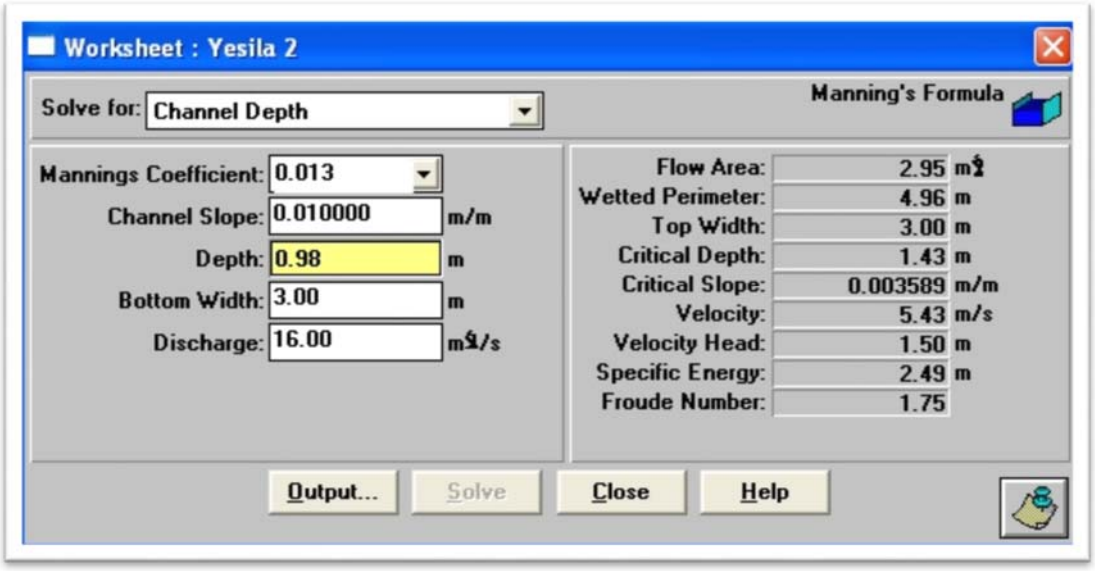


Figure 45: Hydraulic Analysis of 1-cell Box Culvert at Wadi Yesila

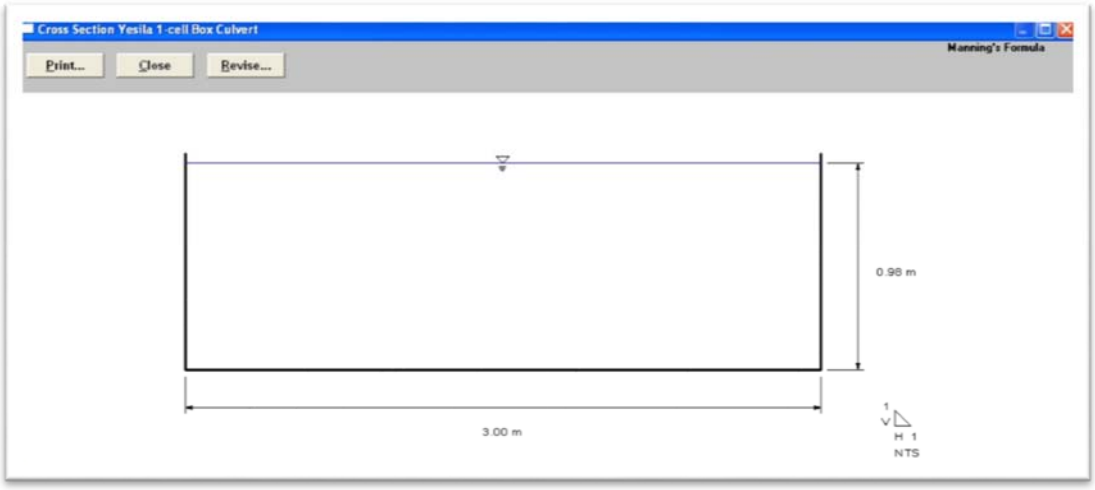


Figure 46: Hydraulic Section of Flow in 1-cell Box Culvert at Wadi Yesila

5.2.7.2 Groundwater

Groundwater is water that is stored underground in spaces of soil or rock. The water-bearing porous soil or rock strata yielding significant amounts of water to wells or springs are called aquifers. The groundwater aquifers in Jordan are classified into three main complexes:

- **The Deep Aquifer Complex**: This is formed from sandstone and is found as one unit in the south and two units in the north separated by thick limestone and marl layers.
- **The Middle Aquifer Complex** (the upper and middle cretaceous complex): This consists of limestone, dolomite, marl stone and chert beds.
- **The Shallow Aquifer Complex:** This is the most exploited and consists of two main systems; the basalt aquifer system and the sedimentary rocks and alluvial deposits of Tertiary and Quaternary ages system.

In Jordan, groundwater is recharged either by the seepage of a small percentage of total rainfall into the ground, or through groundwater inflow from Syria (referred to as "trans-boundary flow", in which water resources are shared with another country). Other inflows are the result of return flows from irrigation, leaks from pipes, reservoirs, and wastewater treatment plants. Groundwater outflows are from abstraction by pumping wells, spring and base flow discharge (GTZ, NWMP-Water Resources in Jordan, 2004).

Twelve groundwater basins are identified having a total renewable annual supply "safe yield" of about 280 million cubic meters. The distribution of the groundwater basins is shown in **Figure 50.**

The project area is located within Yarmouk groundwater basin. The Shallow and Upper Cretaceous aquifer systems are the principal aquifer systems providing the water requirements of almost all households in the Yarmouk Basin. The Shallow Aquifer System, namely (B4/5), consists of the Umm Rijam Chert-Limestone (URC), Wadi Shallalah (WS) and basalt (BS) formations, while the Upper Cretaceous Aquifer System, namely (B2/A7), consists of the Wadi Es-Sir Limestone (WSL), Wadi Umm

Ghudran (WG) and Amman Silicified Limestone (ASL) formations. The B4/5 aquifer system is recharged either along the elevated areas of Jabel Al-Arab, Golan Heights and Ajlun Highlands, which are believed to have great water-bearing potential (Hawi, 1990; Abderahman and Awad, 2002; Abu-Jaber and Ismail, 2003, 1990-2003)(Hawi, 1990; Abderahman and Awad, 2002; Abu-Jaber and Ismail, 2003), or due to local surface water infiltration through the URCand WS outcrops in the northern and northwestern parts of the basin. But their small outcrop area and steep slopes limit the amount of recharge. Accordingly, most groundwater that emerges from the B4/5 aquifer appears as spring discharge in several locations. A total of 46 springs, yielding about 491 m^3/ h are encountered throughout the basin.

Groundwater levels in this basin vary from zero at the Mukheiba area, where aquifers are under water table conditions, to 250 m below the ground surface near Irbid, where the aquifers are confined. Water table fluctuation between the wet and dry seasons is high; with a mean of about 9 m. Directions of groundwater flow are due north and northwest.

The B4/5 represents the upper aquifer north and northwest of the Yarmouk basin, with a maximum thickness of more than 200 m (Ta'any, R., A. Batayneh and R. Jaradat, 2007. , 2007). The aquifer is moderately fractured. The water table of B4/5 aquifer tends to be shallower in the north and northwest where it becomes deeper in the east and southeast of Yarmouk basin (Ta'any, R., A. Batayneh and R. Jaradat, 2007. , 2007). The majority of springs in the study area emerge from the B4/5 with a total average annual discharge of about 3.3 million cubic meters (Ta'any, R., A. Batayneh and R. Jaradat, 2007. , 2007). The second aquifer, which is separated from the upper B4/5 by the Muwaqqar Chalk-Marl (MCM) formation (B3) aquitard, is the B2/A7 (ASL/WSL formations). The aquifer's thickness varies from 300 m in the southern part to more than 500 m in the north and west of the study area.

Geologically, the rock formations of the study area are classified as the Ajlun Group, Balqa Group and Jordan Valley Group of Upper Cretaceous to Tertiary ages (Makhlouf et al.,, 1966) .

The oldest is the Wadi Es-Sir Limestone (WSL) formation of Turonian age belonging to the Ajlun Group, essentially composed of limestone and dolomitic limestone. In northern Jordan, and locally in the basin area, the upper 100 m thickness of the WSL formation is exposed on the southwestern part of the basin area (Figure 48). The WSL formation of the Ajlun Group is overlain by the rocks of the Balqa Group and include, in ascending order: Wadi Umm Ghudran (WG), Amman Silicified Limestone (ASL), Muwaqqar Chalk-Marl (MCM), Umm Rijam Chert-Limestone (URC) and Wadi Shallalah (WS) formations. The base of the Balqa Group, WG formation of Santonian age, comprises marl, marly limestone, chalk and chert, up to 40 m thick exposed in Wadi Umm Ghudran Ed Dibab, south Irbid (Figure 48). The overlying limestone, chert, chalk and phosphorite beds that are exposed in the southern part of the basin area are members the ASL formation (Campanian age). At the site this formation is about 60 m thick. Bituminous marl and clayey marl of the MCM formation of Maestrichtian age overlies the ASL formation and is exposed in the central part of the basin area. These are about 200 m thick (Makhlouf et al.,, 1966)). Alternating beds of limestone, chalk and chert of the URC formation of Paleocene age overlie the MCM formation. In the basin area, the URC formation outcrops at the north in **Figure 47**. The thickness of this formation is 200 m at the outcrop. At the site of Wadi Shallalah (northeast Irbid) it is 35 m thick.

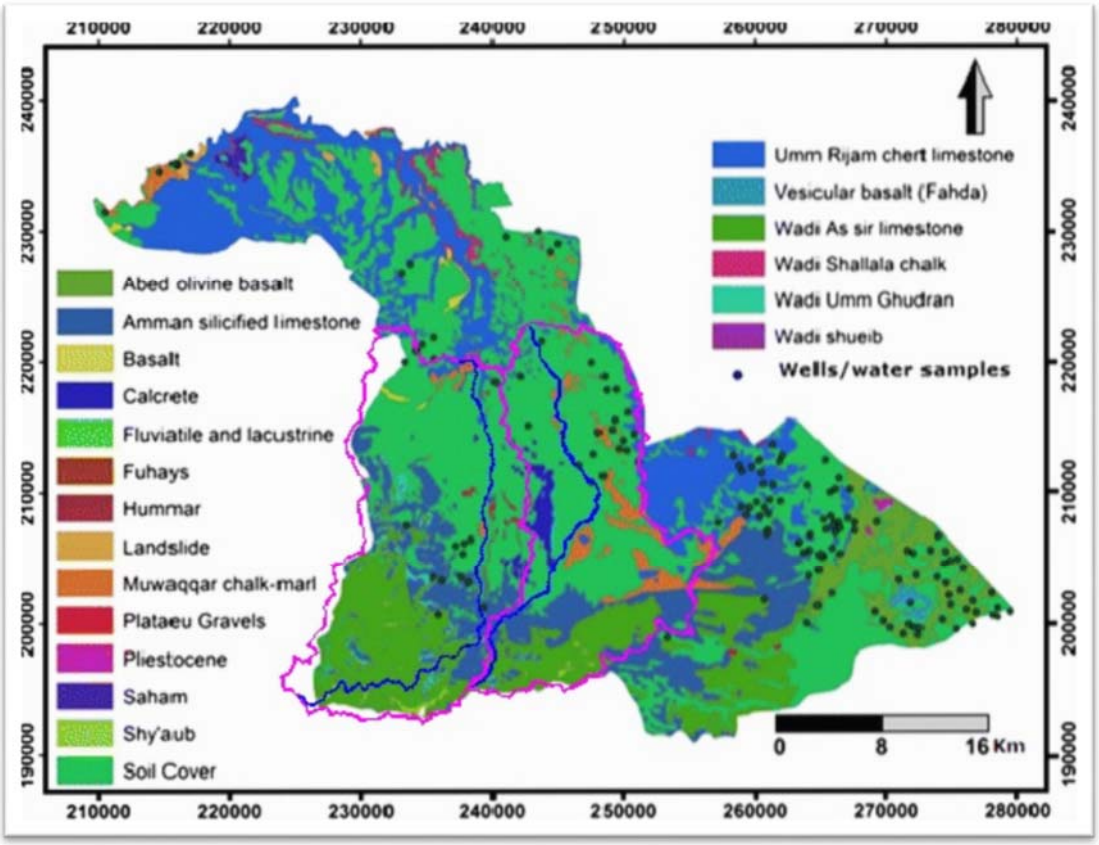


Figure 47: Geological Map of Yarmouk Basin

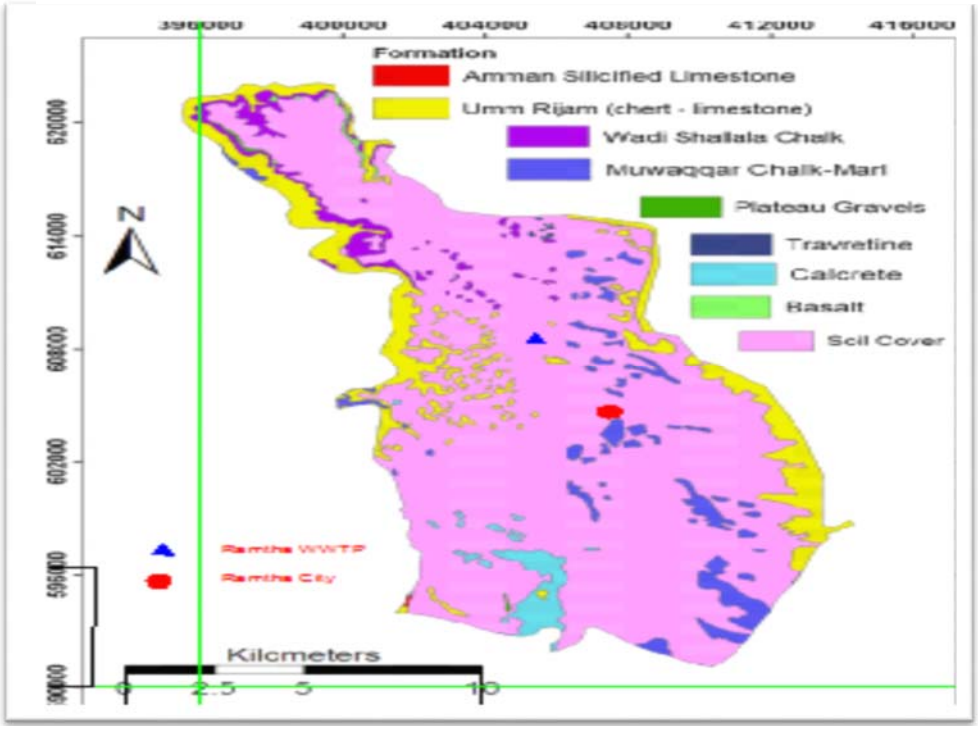
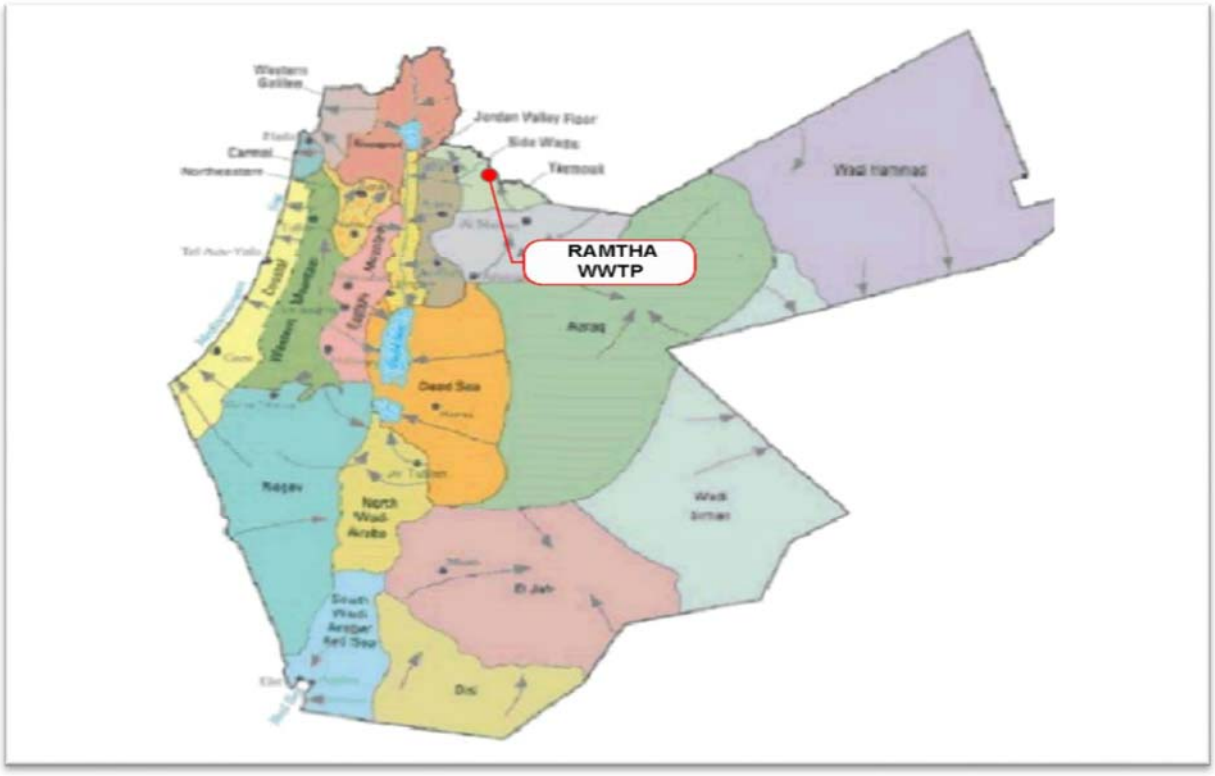


Figure 48: Geology map of the area located around and downstream the Ramtha WWTP



Source: Awad Nawafleh, Muheeb Awawdeh, Elias Salameh; "Assessment of Groundwater Vulnerability to Contamination in Irbid Governorate, North Jordan" a paper at Research Gate, 2014

Figure 49: Groundwater Basins in Jordan

According to a previous study for the groundwater vulnerability map of the Ramtha WWTP using the modified DRASTIC model, it was found that the plant lies within the high vulnerability class.

This is due to the fact that depth to groundwater is shallow, with high net recharge value, high aquifer permeability, low slope, soil texture, high hydraulic conductivity, and high lineament density and land use (agriculture). ((Awawdeh, M., Obeidat, M. & Zaiter, G. Appl Water Sci (2015) 5: 321.)

The DRASTIC model uses seven environmental parameters to assess groundwater vulnerability: depth to water table, net recharge, aquifer media, soil media, topography (slope), impact of vadose zone media (The zone above the water table which is unsaturated or discontinuously saturated), and hydraulic conductivity.

Wells in Irbid governorate

Potential well contaminant can be caused by both naturally occurring sources and by human activities such as the non-compliant effluent from the WWTPs, sewer lines and agricultural activities (fertilizer storage and use, animal feedlots, animal waste disposal, animal burial, manure stockpiles, manure spreading, pesticide storage and use) which are abundantly available at the Ramtha WWTPs surroundings". The most commonly found contaminants are microorganisms, nitrite and nitrate, and heavy metals.

5.2.8 Biological Environment

The biological environment baseline was collected based on literature review, site visits to the project area and its surroundings, and the transmission pipeline route to Shallalah WWTP. As well as the professional experience of AJWE ESIA team in the biodiversity of the project area. The findings are presented in the sections below:

5.2.8.1 Study Methodology

In order to assess and understand the potential impact of the project, the study has correlated the following target biological environment aspects with their physical environment units:

- Bio-geographical zones where the project area located.
- Flora of the project area.
- Fauna of the project area: the study selected the following groups to assess the status of fauna in the area. These groups are mammals, birds especially the conservation important resident species and conservation important reptiles.
- Sensitive Habitats: areas with biological importance such as Protected Areas, Range land Reserves, and Important Bird Areas.

Study methods included the following:

1-Literature Review: In this part, the survey team collected and reviewed the available data about the biological environment in the project area. Data collection was achieved through:

- Library search for the available reference on the biodiversity or any related biological aspects.
- References from institutions that are working in this field of specialty such as, Ministry of Environment (MoE), Royal Society for Conservation of Nature (RSCN) and University scientists and specialists.

The researchers reviewed the available data and information on:

- Flora, fauna species
- Habitat and typical species communities

2-Field Work Survey: To validate the literature review findings, a two day field visit was undertaken at the project site and the transmission pipeline during August,2019 to survey for terrestrial flora, fauna, and avi-fauna. Field observations were recorded while walking along the site and adjacent areas within 500m. Field observations examined for the presence of breeding and resident birds, animal signs and tracts, and plant species. All species observed were recorded and documented in the next section.

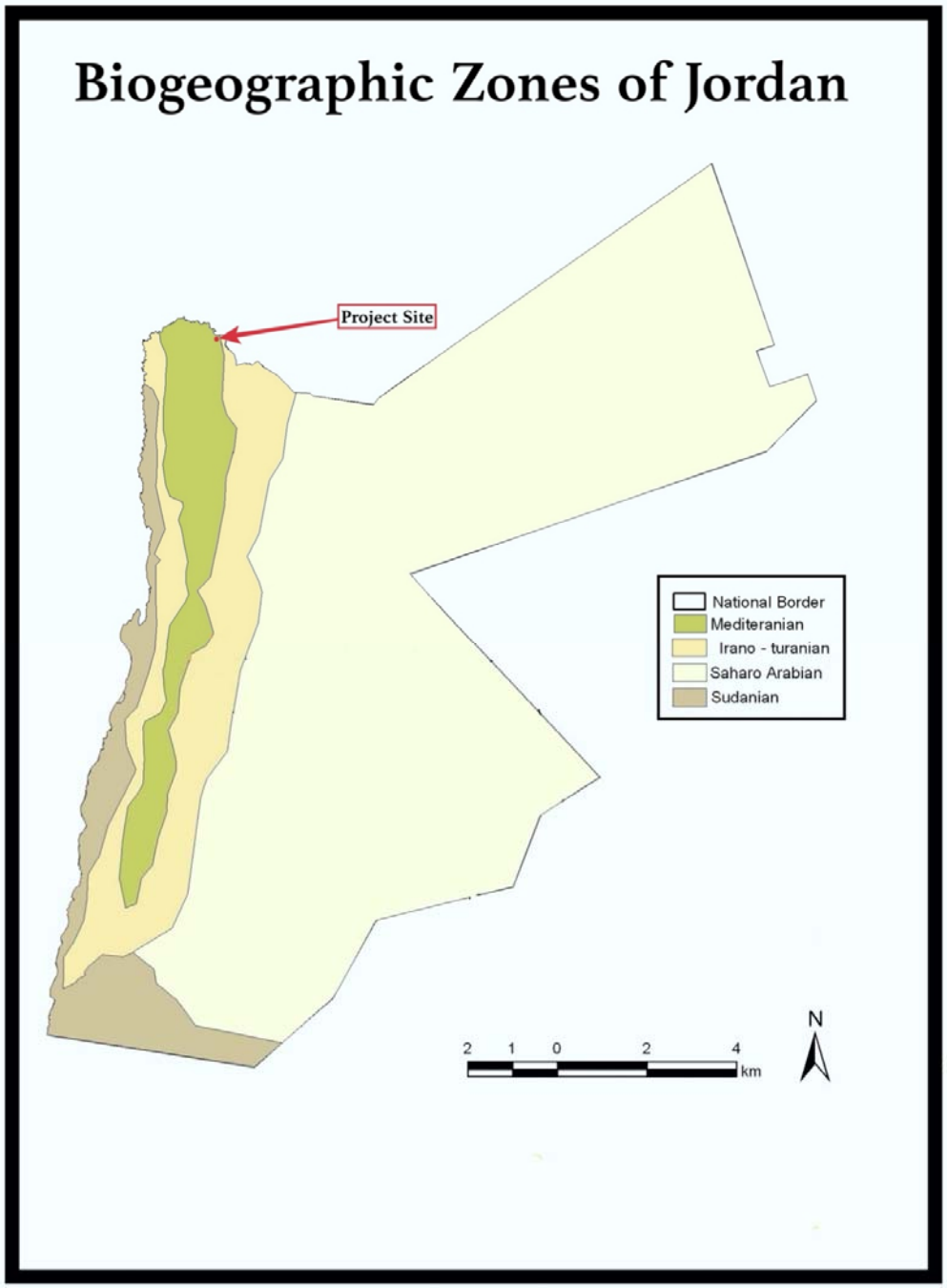
5.3 Baseline Conditions for Biological Environment

5.3.1 Biogeographic Zones

Four biogeographical regions are recognized in Jordan: Mediterranean, Irano-Turanian, Saharo-Arabian and Sudanian (Al-Eisawi, 1996). Limits between regions are indicative only, and some species can be found across several regions.

The project area is located in Mediterranean biogeographic zone in **Figure 50.** This area is the most humid and has the highest altitude in the country. It extends from Um Qais in the North to Ras Alnaqab mountains in the south and may extend to Wadi Rum. Altitudes in this biotope ranges from 700m to 1700 above sea level. The northern part receives more precipitation than the southern part, the annual rainfall ranges from 400-700mm. The differences in rainfall between north and south makes the northern mountains having more vegetation types and densities. (Disi, 2002)

The soil is of the types Terra Rossa and Rendzina which are the richest in the country and support the best vegetation especially the forest climax of *Pinus halepensis, Quercus coccifera, Q. ithaburensis, Ceratonia siliqua, and Pistacia spp.* (Al-Eisawi, 1996).

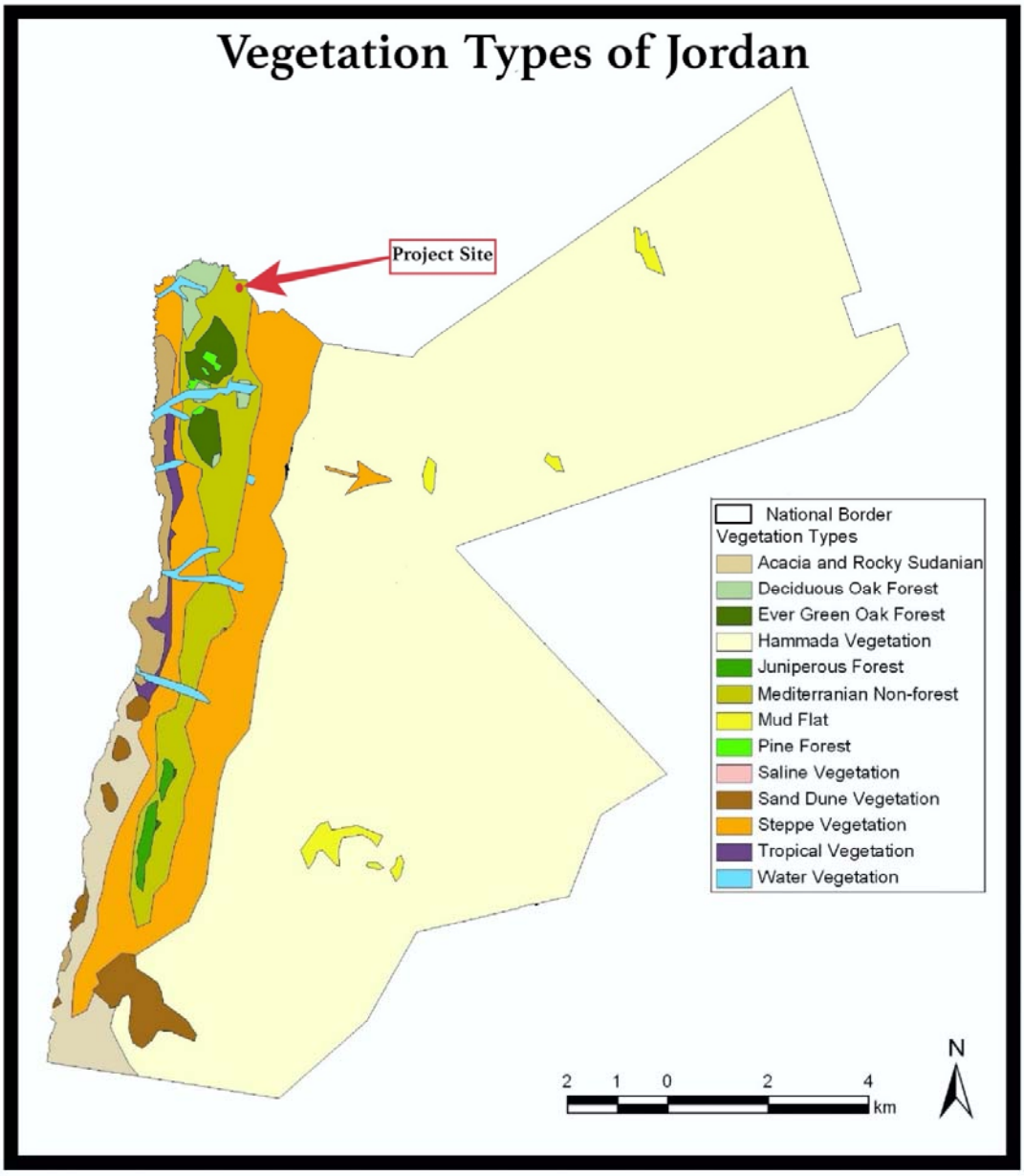


Source: (Al-Eisawi, 1996)

Figure 50: Biogeographical Zones of Jordan

5.3.2 Vegetation Types

The vegetation type of the project area is Mediterranean non-forest vegetation in **Figure 51:** Vegetation Types of Jordan This vegetation type also called Batha Mediterranean vegetation. It is found in all Mediterranean regions except the forest and cultivated areas. This vegetation type is characterized with shrubs and bushes. This type stretches across the Jordanian ridge between Irbid and Tafilah. The leading species of this vegetation type are:



Source: (Al-Eisawi, 1996)

Figure 51: Vegetation Types of Jordan

Rhamnus palaestinus	*Urginea maritima*
Calycotome villosa	*Asphodelus aestivus*
Sarcopoterium spinosum	*Ballota undulata*
Cistus villosus	*Thymus capitatus*
Ononis natrix	*Dactylis glomerata*
Varthemia iphionoides	*Hordeum glaucum*

Source: (Albert, Petutschnig, & Watzka, 2004)

Table 30: leading species of Mediterranean non-forest

Family	Species	Family	Species
Amaryllidaceae	Ixiolirion tataricum	Apocynaceae	Nerium oleander
Apiaceae	Ammi majus		Vinca herbacea
	Daucus carota	Berberidaceae	Leontice leontopetalum
	Lecokia cretica	Boraginaceae	Anchusa azurea
	Tordylium aegyptiacum		Anchusa milleri
Araceae	Biarum pyramid		Lappula spinocarpos
Asteraceae	Anthemis cotula	Brassicaceae	Anastatica hierochuntica
	Anthemis haussknechtii		Lepidium draba
	Centaurea hyalolepis		Alyssum simplex
	Centaurea verutum	Caryophyllaceae	Paronychia argentea
	Chrysanthemum coronarium		Silene coniflors
	Crepis sancta	Chenopodiaceae	Chenopodium album

Family	Species	Family	Species
	Filago contracta	Cucurbitaceae	Bryonia syriaca
	Phagnalon rupestre		Ecballium elaterium
	Picris amalecitana	Dipsacaceae	Cephalaria joppensis
	Rhagadiolus stellatus	Euphorbiaceae	Euphorbia cuspidata
	Silybum marianum		Euphorbia hierosolymitana
Fabaceae	Lathyrus gorgoni	Fumariaceae	Fumaria parviflora
Iridaceae	Iris grant-duffii	Hypericaceae	Hypericum triquetrifolium
Lamiaceae	Mentha longifolia	Liliaceae	Ornithogalum neurostegium
	Salvia verbenaca		Ornithogalum umbellatum
Malvaceae	Malva neglecta		Linum mucronatum
	Malva sylvestris	Poaceae	Aegilops searsii
Papaveraceae	Hypecoum procumbens		Bromus rubens
	Astragalus aleppicus		Bromus scoparius
	Astragalus guttatus		Dactylis glomerata
	Astragalus spinosus		Echinaria capitata
	Lens culinaris		Hordeum spontaneum
	Melilotus indicus		Phalaris brachystachys
	Onobrychis caput-galli		Phalaris minor
	Onobrychis ptolemaica		Parapholis marginata
	Ononis spinosa	Polygonaceae	Rumex vesicarius
	Trifolium arvense	Ranunculaceae	Adonis aestivalis
Ranunculaceae	Ranunculus asiaticus		Adonis annua
Resedaceae	Reseda luteola	Rubiaceae	Asperula arvensis
Solanaceae	Hyoscyamus aureus		Galium tricornutum

Source: (Taifour & El-Oqlah, 2014)

Table 31: Flora species recorded at the area

All the recorded plants species from field visit and previous studies are common plants and have no conservation status.

During the field visits it was noticed that the project area and its surroundings and the transmission pipeline route to Shallalah are heavily cultivated. Although, wild plants occur outside the farms and on road edges, all these plant species observed are common and have no conservation status according to the IUCN red list and Jordan red list.

5.3.3 Zoogeographic

5.3.3.1 Reptiles

The Mediterranean zone has the richness of vegetation, topography and microhabitat to allow for high carrying capacity and sustain a large number of species. Hence, the ecozone harbours the highest number of amphibians, lizards and snakes in comparison with other ecozones of Jordan. Northwest Jordan support 55percent of the recorded herpetofaunal species found in Jordan. (Disi, 2002). Herpetofaunal species limited to this zone are:

Pelobates syriacus (recently extinct),	*Laudakia stellio*
Mauremys rivulata	*Lacerta kulzeri ptraea*
Testudo Graeca terrestris	*Lacerta laevis*
Cyrtopodion kotschyi oreintalis	*Lacerta media israelica*
Eirenis decemlineata	*Ophiomorus latastii*
Malpolon monspessulanus	*Pseudopus apodus*
Chalcides guentheri	*Coluber schmidti*
Vipra palaestinae	*Coluber rubriceps*
Coluber jugularis asianus	*Telescopus nigriceps*

Table 32: Herpetofaunal Species from Jordan

Family	Species
Ranidae	Rana bedriagae
Gekkonidae	Hemidactylus turcicus
	Ptyodactylus puiseuxi
Agamidae	Laudakia stellio
	Trapelus ruderatus
Chamaeleonidae	Chamaeleo chamaeleon
Lacertidae	Ophisops elegans
Scincidae	Eumeces schneiderii
Boidae	Eryx jaculus
Colubridae	Coluber jugularis
	Coluber nummifer
	Coluber rogersi
	Coluber rubriceps
	Eirenis coronella
	Eirenis rothi
	Malpolon monspessulanus
	Psammophis schokari
Testudinidae	Testudo graeca

Source: (Disi, 2002)

Table 33: Herpetofauna Reported from the Area

During the field visits no herpetofaunal species were recorded on the site which can be explained by high level of disturbance and intensive agricultural activities.

5.3.3.2 Mammals

The_Mediterranean Zoogeographic Zone is a distinct sub region within the Palearctic region (European Origin). It includes mountain areas that extend from the north of Jordan to the Al Naqab Mountains in the south. During the field visit, no mammals have been recorded. **Table 34** shows the important mammals that are reported as occurring in this Mediterranean zone.

Family	Scientific Name	Common Name	Status
Erinaceidae	*Erinaceus concolor*	Common Hedgehog	Insufficient data
	Hemiechinus auritus	Long-eared Hedgehog	Insufficient data
Soricidae	*Corcidura suaveolens*	Lesser white-toothed shrew	Vulnerable
Canidae	*Canis aureus*	Golden jackal	Vulnerable
Felidae	*Felis caracal*	Caracal	Nationally Endangered
Herpestidae	Hepestes ichneumen	Egyptian mongoose	Vulnerable
Hyaenidae	*Hyaena hyaena*	Striped hyena	Nationally Threatened
Mustelidae	*Martes foina*	Stone Marten	Nationally Threatened
	Meles meles	Common Badger	Nationally Threatened
	Vormela peregusna	Marbled Polecat	Vulnerable
Procaviidae	*Procavia capensis*	Hyrax	Nationally Threatened
Spalacidae	*Spalax leucodon*	Mole Rat	Vulnerable
Hystricidae	*Hystrix indica*	Indian crested porcupine	Vulnerable

Source: (Amr, 2000)

Table 34: Important Mammals found in Mediterranean Zoogeographic Zone

5.3.3.3 Birds

Jordan has a wide diversity of bird habitat types due to its varied topography and climate and its biogeographical location. More than 434 bird species have been recorded in Jordan, of which more than 141 species are breeding birds and this number might increase with the continued research.

Jordan lies on the main bird migration route between Africa, Asia and Europe. Millions of birds migrate over Jordan each year, and the majority of the Jordanian avifauna belongs to this migration. The huge number of migrant birds that visit Jordan twice a year has made the country of great importance for the global avifauna. According to Birdlife International, at least 500 million migratory birds of over 230 species pass through Jordan twice a year and rest in Important Bird Areas (IBAs) in the Middle East. Jordan has 27 sites that are declared as Important Birds Areas (RSCN & Birdlife, 2000).

Birdlife International has developed a sensitivity map tool to assess the migratory soaring birds. This tool was used to assess the importance of the project location for migratory soaring birds. **Table 35** shows 34 avifaunal species that may occur on the site, most of them have no conservation status.

Species	Status	Species	Status
Eastern Imperial Eagle	Vulnerable	Northern Goshawk	Least Concern
Steppe Eagle	Endangered	Golden Eagle	Least Concern
Long-legged Buzzard	Least Concern	Black Stork	Least Concern
White Stork	Least Concern	Short-toed Eagle	Least Concern
Northern Bald Ibis	Least Concern	Greater Spotted Eagle	Endangered
Pallid Harrier	Near Threatened	Lesser Spotted Eagle	Least Concern
Montagu's Harrier	Least Concern	Saker Falcon	Endangered
Red-footed Falcon	Near Threatened	Peregrine Falcon	Least Concern
Booted Eagle	Least Concern	Common Kestrel	Least Concern
Honey Buzzard	Least Concern	Black Kite	Least Concern
Egyptian Vulture	Endangered	Griffon Vulture	Least Concern
Sparrowhawk	Least Concern	Merlin	Least Concern
Bonell's Eagle	Least Concern	Lesser Kestrel	Least Concern
Eurasian Buzzard	Least Concern	Common Crane	Least Concern

Species	Status	Species	Status
Great White Pelican	Least Concern	Glossy Ibis	Least Concern

Source: (Birdlife, 2019)

Table 35: Birds species may occur in the site

The bird species that were recorded during the field visit are summarized in **Table 36.** All of the bird species observed are common to the similar habitat and have no conservation status:

Species	Conservation Status
Black Kite	Least Concern
Long-legged Buzzard	Least Concern
Kestrel	Least Concern
Little Owl	Least Concern
House Martin	Least Concern
Palm Dove	Least Concern
Rock Dove	Least Concern
Hoopoe	Least Concern
Crested Lark	Least Concern
Yellow Wagtail	Least Concern
Swallow	Least Concern
Black-eared Wheatear	Least Concern
Blue Rock Thrush	Least Concern
Lesser White Throat	Least Concern
Blackcap	Least Concern
Chiffchaff	Least Concern
Southern Grey Shrike	Least Concern
House Sparrow	Least Concern

Table 36: Bird species recorded in the site

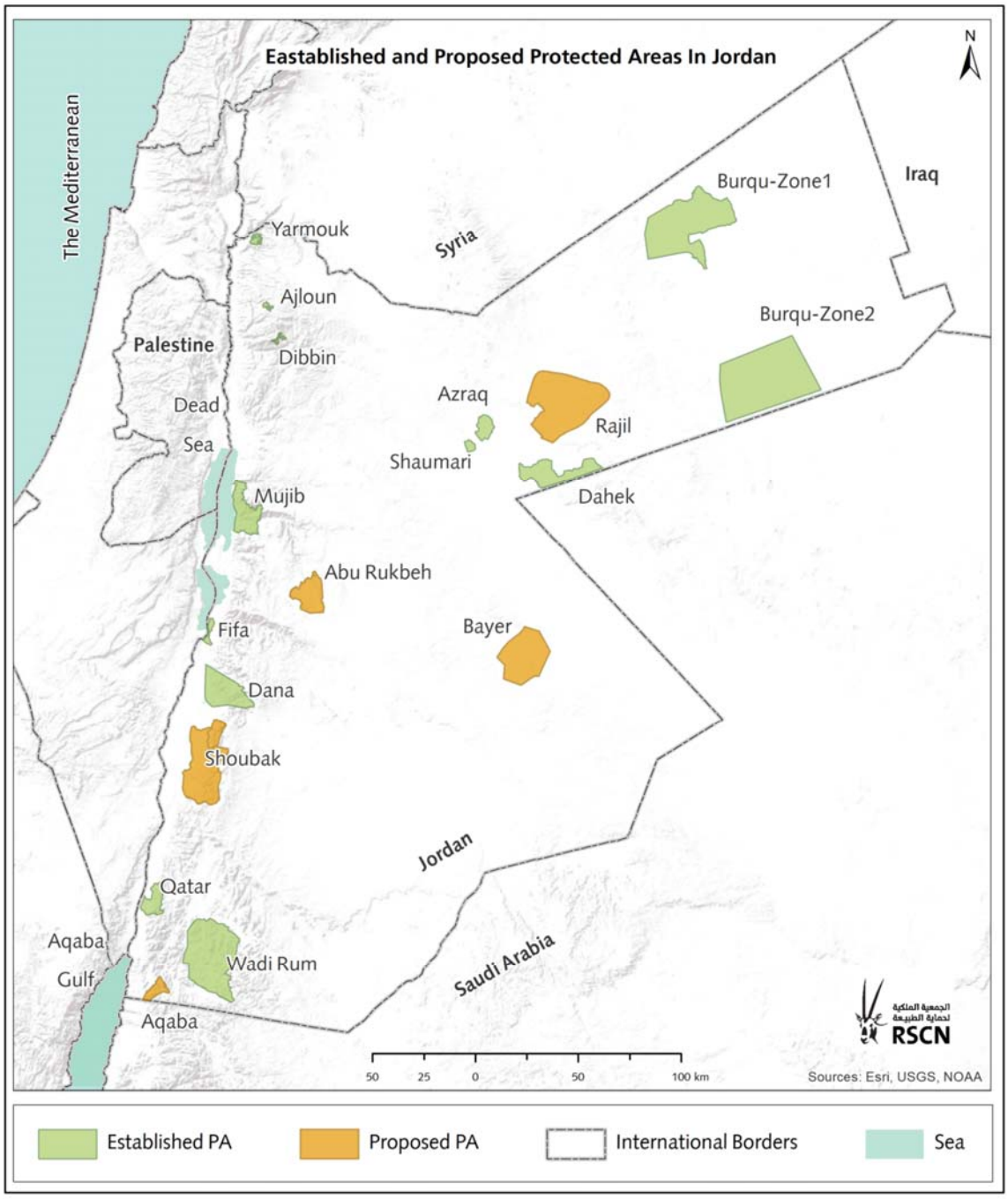
5.3.4 Sensitive Habitats

As mentioned in the study strategy, the study examined sensitive habitat included in or close to the proposed project's area. Identification of the sensitive habitats was started by the literature review and followed by the field visits to update collected data.

5.3.4.1 Protected Areas

During late seventies, an inventory was made by the Royal Society for Conservation of Nature (RSCN) and a network of sites where nominated as proposed protected areas. Some of these proposed protected areas were declared while others are still not. The protected areas representing important Jordan ecological systems.

Reference to the map of proposed and designated protected areas in **Figure 52** show that, the project site is not close to any of these protected areas. The closest protected area is Yarmouk which is about 25 km from the proposed project. Giving the distance from the closest protected area and the nature of the proposed project activities, the project will have no significant negative impact on the protected area.



Source: (RSCN, 2019)

Figure 52: Protected Areas of Jordan

5.3.4.2 Rangeland Reserves

The proposed project is not close to any of the rangeland reserves in Jordan in **Figure 53**. The closest rangeland reserve is Alkhanasry which is about 23 km from the proposed site. In addition, the nature of the project activities is limited to a small area which decreases the negative impact on any sensitive habitat including rangeland reserves.

5.3.4.3 Important Birds Areas

In 2000, Birdlife International and the Royal Society for the Conservation of Nature identified 27 important bird areas (IBAs) in Jordan. The sites were selected covering total area of approximately 7000 square kilometers, representing all habitat types, ecosystem and biogeographic zones existing in Jordan. These areas are home of a variety of resident and breeding birds, in addition to lying on one of the main migration routes for birds between Eurasia and Africa. These migrants include several globally endangered species that depend on the natural habitats of the rift and adjacent mountains for resting and feeding. (RSCN & Birdlife, 2000).

As can be noticed from **Figure 54**, part of the expansion of Ramtha WWTP in addition to the transmission pipeline to Shallalah WWTP lies within the Important Bird Area IBA which is agricultural plains between Irbid, Ramtha and Mafraq, mainly with dry cultivation of cereals. Natural steppe vegetation occurs only as small remnant patches between fields. The habitats are currently threatened by urban expansion and industrial developments. Resident and breeding birds in this area include Long-legged Bussard, Little Owl, Calandra and Short-toed Lark, while Lesser Kestrel has been reported as a migrant and possible breeder and the Griffon Vulture as a frequent visitor. Imperial Eagle and Corncrake are scarce migrants and several other species visit the area in winter, including Crane, Sociable Plover (rare), Lapwing, Finsch's Wheatear and Syrian Serin (rare).

The proposed project could have positive impact on birds specially waders and waterfowls, where the sewage treatment plants are artificial habitat that is suitable for waterfowls and waders as they have open water bodies that rich with insects and phytoplankton that is considered a good source of food for them. In addition, the existing pools are suitable habitat for waders as waders prefer shallow water and muddy habitat.

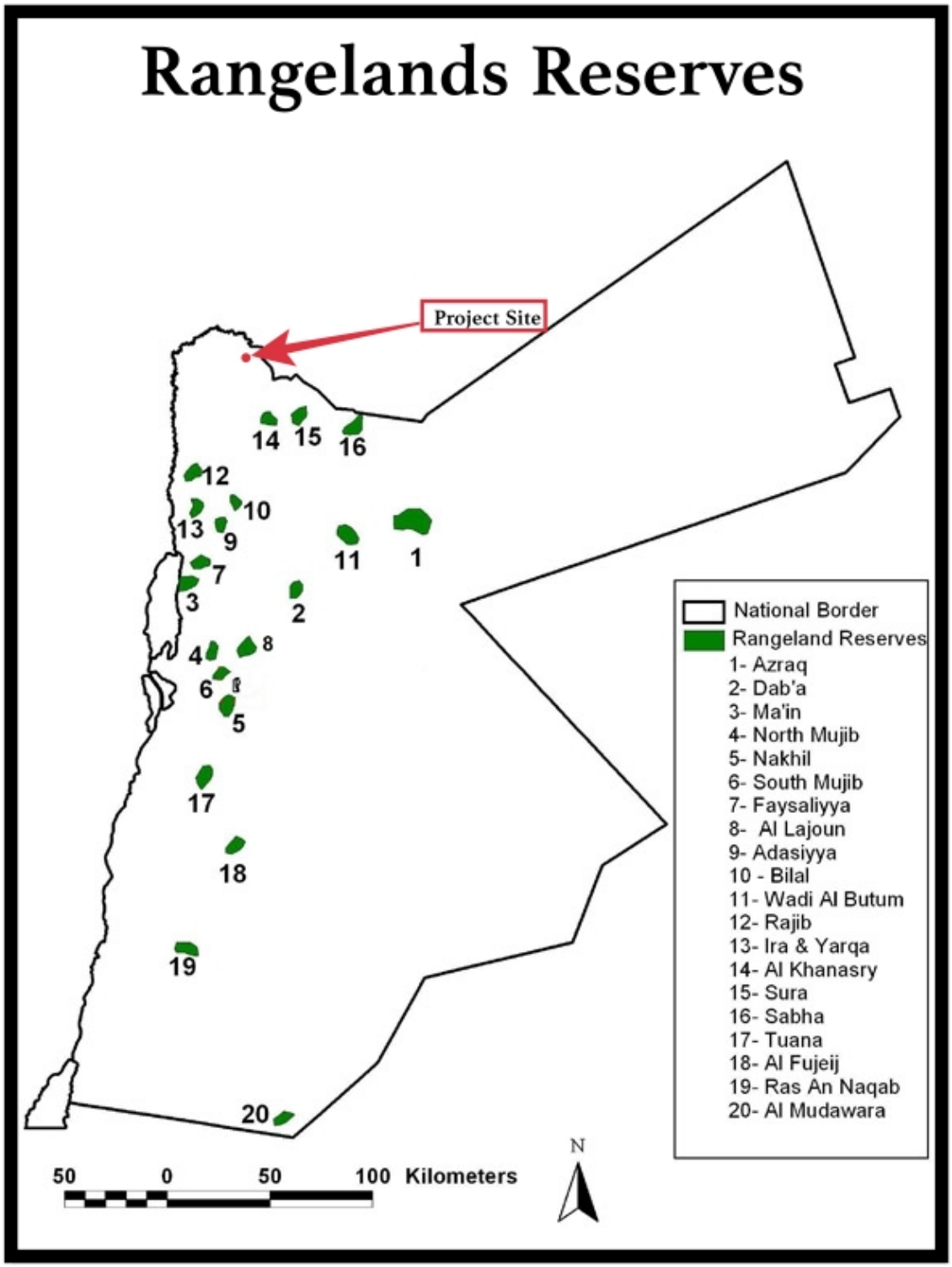
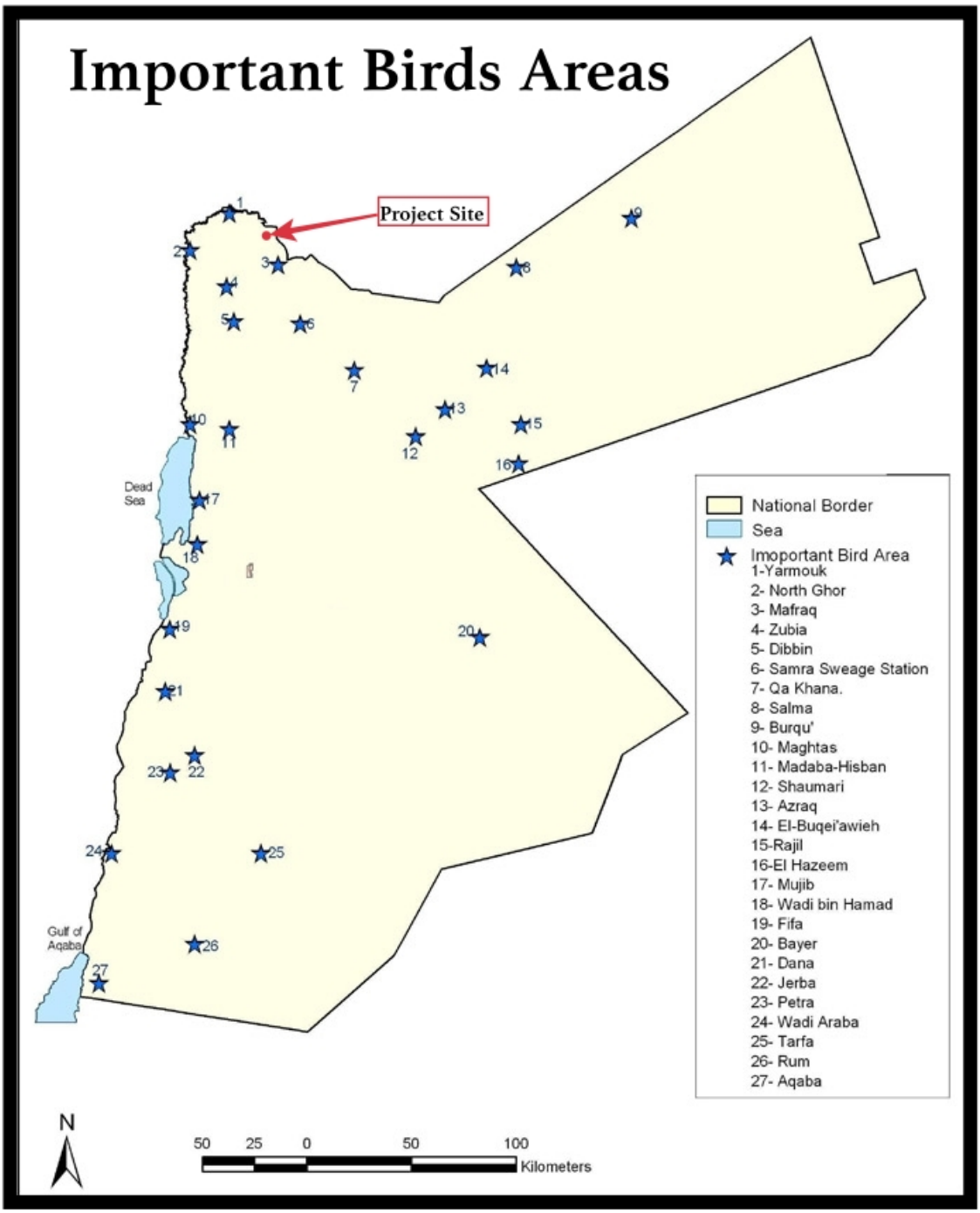


Figure 53: Rangelands Reserves of Jordan



Source: (RSCN & Birdlife, 2000)

Figure 54: Important Bird Areas of Jordan

5.4 Socio – Economic Conditions

Jordan faces a complex set of development challenges stemming from the chronic water scarcity. The situation is aggravated by climatic conditions, geography and, region's geopolitical environment including increasing demand due to high population growth, hosting several fluxes of refugees and economic development needs. Water scarcity poses a serious challenge that affects the wellbeing, security and economic future of all Jordanians.

Despite the severe challenges, Jordan is one of few countries in the world to have managed its meagre freshwater resources well. Jordan has one of the highest coverage rates in the region and almost 91 percent of treated wastewater is reused for agriculture. (National water strategy, 2016-2025)

Jordan's renewable water resources are limited and insufficient to meet national demand. There are growing signs of apparent overuse in an increasing number of watersheds and aquifers. Jordan's annual renewable resources of less than 100 m^3/capita/year are far below the global threshold of severe water scarcity of 500 m^3/capita/year. National water resources and water balance are facing negative impacts due to higher demand, over abstraction and the effects of climate change. There is severe competition among socio-economic sectors due to the exponential rise in water demand. The need for water for domestic, irrigation, industrial and environmental protection, coupled with the deterioration of water quality and control of water-borne diseases, pose serious water sustainability challenges. The economic development of the past two decades has further created enormous pressures on the quality of groundwater and surface water resources. The main challenge for the future, is meeting growing national water demand over the medium to long term. Alternative water resources management and efficiency strategies are therefore needed to optimize the use of this scarce resource. (MWI, 2016)

The country's major surface water resources, the Jordan River and the Yarmouk River, are shared with Israel and Syria who leave only a small amount for Jordan. The Disi Water Conveyance Project from the non-renewable Disi aquifer to the capital Amman, increases available resources by about 12 percent. It is planned to bridge the remaining gap between demand and supply through increased use of reclaimed water and desalinated sea water to be provided through the Aqaba Amman Water Desalination and Conveyance Project.

This section gives an overview of the type and number of people who live and work within the vicinity of project site and the surroundings, the surrounding land uses, existing infrastructure and utilities.

5.4.1 Population and Demographics in the Vicinity of the Project Area

The project site is located in Ramtha district, which falls in northeastern Irbid Governorate. The Ramtha District includes the area of Al Buwaidah, the municipality of Horan Plain, and the towns of Shajarah, Torrah, Emrawah and Dnaibeh. The Ramtha district is adjacent to the Syrian border from the north, with a border strip of 37 km.

The area of Irbid is 1572 km^2, comprising 1.8 percent of the total area of Jordan, with a population density of 1216.2 capita/km^2 (DOS, 2018).

Figure 55: Ramtha District

In 2018 Ramtha population was estimated to be 257,560, which comprises 2percent of the total population of Jordan. Among which 133,830 males and 123,730 females. (DOS, 2018)

District	Sub-District	Locality	2018			
			males	Females	Total	households
Ramtha	Ramtha	Ramtha	87719	80415	168134	31815
		Torrah	18486	17298	35784	6989
		Shajarah	15796	14336	30132	5602
		Emrawah	3888	3842	7730	1352
		Bwaidhah	5919	5760	11679	2289
		Dnaibeh	2022	2079	4101	777
Total			133830	123730	257560	48824

Table 37: Population Figure

Ramtha populations more than doubled in four years due to the influx of Syrian refugees, leaving the city struggling to cope with the growing number of residents. The incoming 308,939 Syrian refugees imposed additional pressure on the existing infrastructure and key services due to the sudden growth in population, which accounts for 21percent of the total served population and the same percentage of the generated wastewater flow. The proposed project would extend the served areas to include the natural population growth in addition to the incoming Syrian refugees.

In the vicinity of the Ramtha WWTP:

- The Ramtha city is approximately 5 km southeast of the Ramtha WWTP.
- The nearest residential area is approximately 1 km south of the Ramtha WWTP.
- A chicken farm is located about 190 meters to the west.
- The Feed Factory is approximately 200 meters northeast of the Ramtha plant.
- The nearest major road network is around 220 m to the east.
- Farms adjacent to the project area (an estimated area of 737.7 dunums are irrigated with treated water for the existing Ramtha WWTP)
- The nearest sub-road network is adjacent to the project area.
- Al-Ekaider landfill is located about 17 km from the plant site to the southeast.

It is anticipated that the population that will be present within project premises will be limited to project workers and employees.

Economic Profile

Unemployment

Per the Department of Statistics (DoS) yearbook for 2018, the unemployment rate in Irbid Governorate was 17.4 percent; the female unemployment rate was 34.8 percent versus 13.5 percent male unemployment.

The Irbid Governorate region has many agricultural, tourism, and industrial activities that, with the proper initiatives, could create immediate and decent jobs for Syrian refugees and Jordanian members of their host communities.

Household Size

According to a survey conducted by DoS for Irbid Governorate targeting nine districts—Qasabah Irbid, Ramtha, Koura, Tayiba, Almazar Alshamali, Alwasatia, Kinaanah, Bani Ubaid, and Northern Jordan Valley), the average household size is about 5.3 persons (DOS, " Household Expenditure & Income Survey", 2018).

Household Income

The average household income in Irbid Governorate is about 10,432 JD/year. Comparing household income by gender, the DoS survey shows average household income for males exceeded the females average income by 1.3 percent (DOS, " Household Expenditure & Income Survey", 2018).

Figure 56 shows the estimated annual household income in Irbid Governorate:

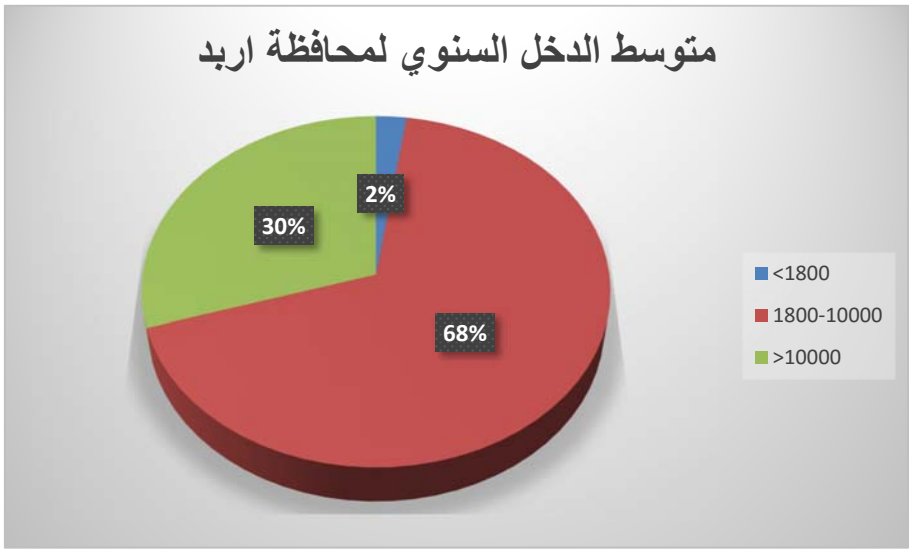
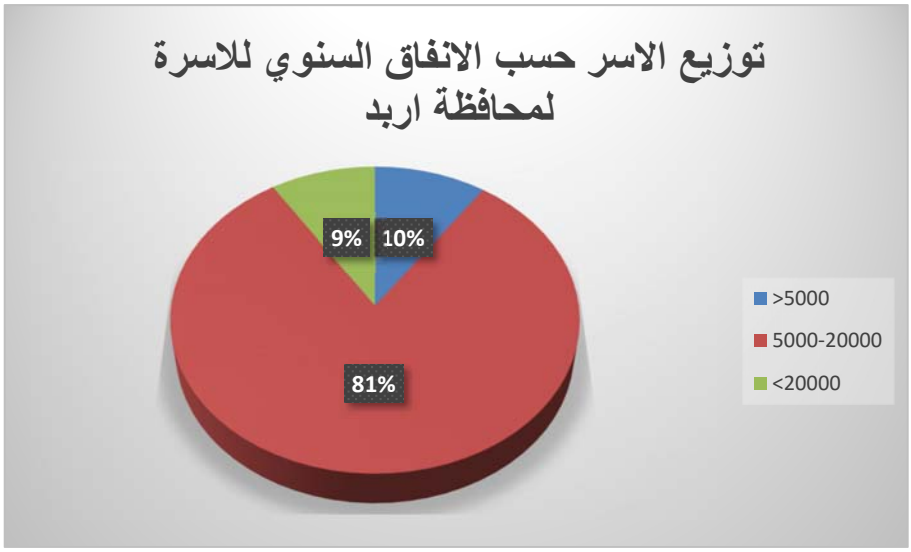


Figure 56: DoS Estimated Annual Household Income in Irbid Governorate

Household Expenditure

The average household expenditures in Irbid Governorate were 11,589.4 JD/year, with 81 percent of the families within the category between 5,000 and 20,000 JD annually in **Figure 57**.



Source: (DOS, " Household Expenditure & Income Survey", 2018)

Figure 57: Estimated Annual Household Expenditures in Irbid

Households Connected to Public Wastewater Networks

The DoS survey showed 36.2 percent of the total household in Irbid Governorate are connected to the public wastewater network and 63.8 percent have cesspits (DOS, 2013).

Distribution of Housing Units by Type of Sewage System and Governorate (2013)					
Governorate	Public Network	Cesspool	Without Connection	Population	Total
Irbid	36.2%	63.8%	0	214209	100%

Table 38: Distribution of Housing Units by Type of Sewage System and Governorate (2013)

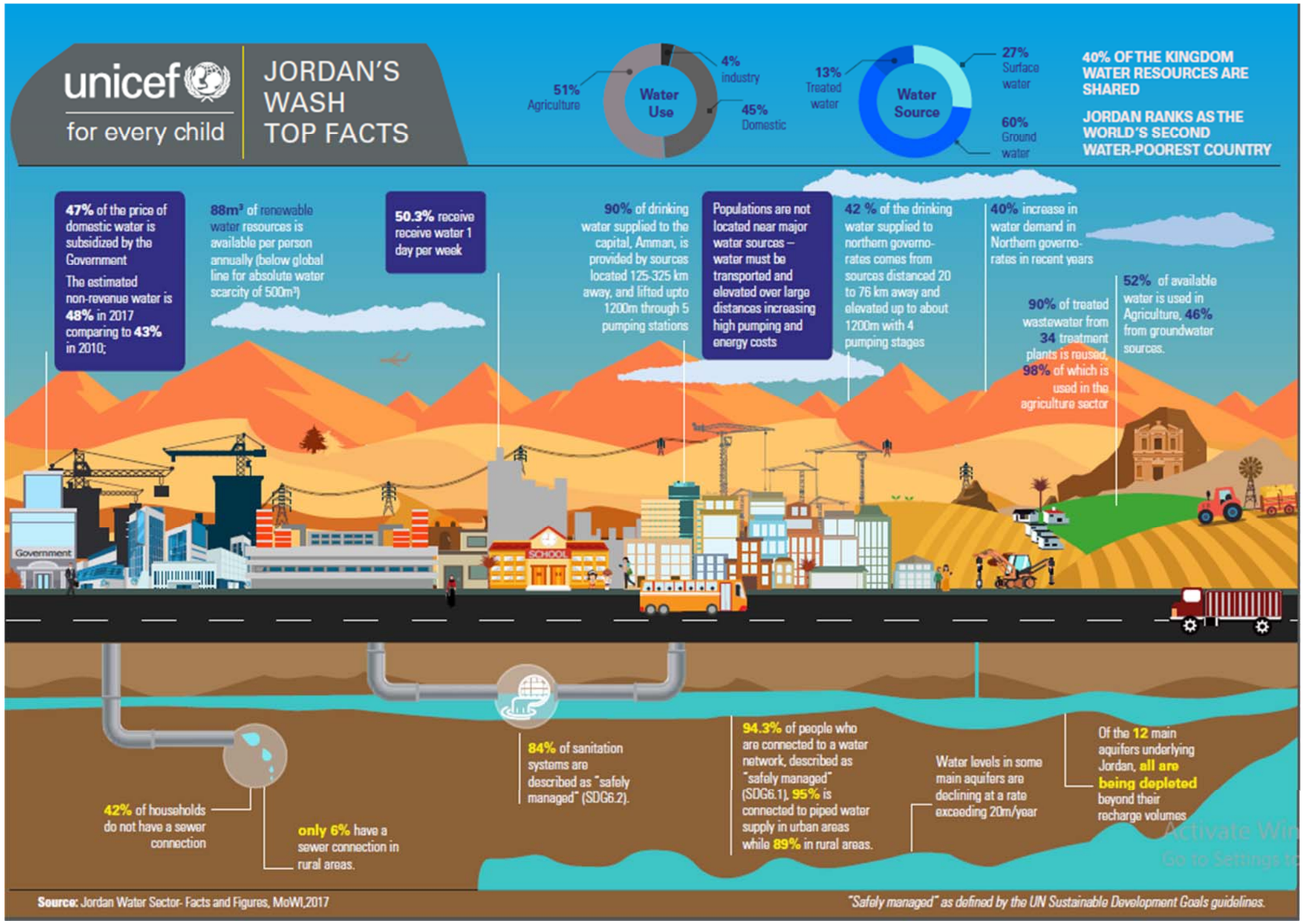
Households Connected to Public Water and Drinking Water Networks

The DoS survey showed 94.9 percent of the total household in Irbid Governorate are connected to the public drinking water network (DOS, 2013).

Health Services in Irbid Governorates

Access to water and sanitation is a fundamental human right and a necessity of life, health and dignity. Therefore, the timely and adequate provision of clean water and sanitation for specially displaced persons and citizens is particularly important given their vulnerability. Proper disposal of all wastes, as well as control of infectious disease vectors, such as mosquitoes, rats, mice and flies, is critical to mitigate health risks and prevent epidemics.

Some factors pose a major challenge for the health system to meet the growing expectations of the population, including the increased demand for health services due to population growth, the typical transformation of the diseases in Jordan, the presence of refugees, the expected rise in the proportion of young people and the elderly; and rising health care costs. The economic situation in which many face financial and economic crises add to these challenges.



Source:(MWI,2017) Jordan Water Sector, facts and figures

Figure 58: Jordan's Wash Top Facts

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Table 39 presents data on health statistics for both the public and private establishments In Irbid. Health statistics include number of employees, beds, health care centers, laboratory tests, Tuberculosis (T.B.) Center, and pharmacies. (Dos, 2016).

Governorate	Ministry of Health		Private Hospitals		Other Governmental		Total		Health Centers	T.B. Centers	No Employees at the Ministry of Heath	Number of Pharmcies
	No. of Beds	No. of Hospitals	No. of Beds	No. of Hospitals	No. of beds	No. of Hospitals	No. of Beds	No. of Hospitals				
Irbid	841	8	394	7	1024	2	2259	17	48	1	1271	392

Dos Yearbook 2016

Table 39: Health Care Services in Irbid Governorate

Based on the importance of preserving the water quality, the Yarmouk Water Company's Directorate of Laboratories monitors various water resources in Irbid (springs and wells, in addition to water supply systems including pumping stations,

reservoirs, public network, subscriber meter) to ensure that the water is free of chemical and bacterial contaminants according to Jordanian microbiological standards for 2017 and the Jordanian Standard for Drinking Water No. 286/2015.

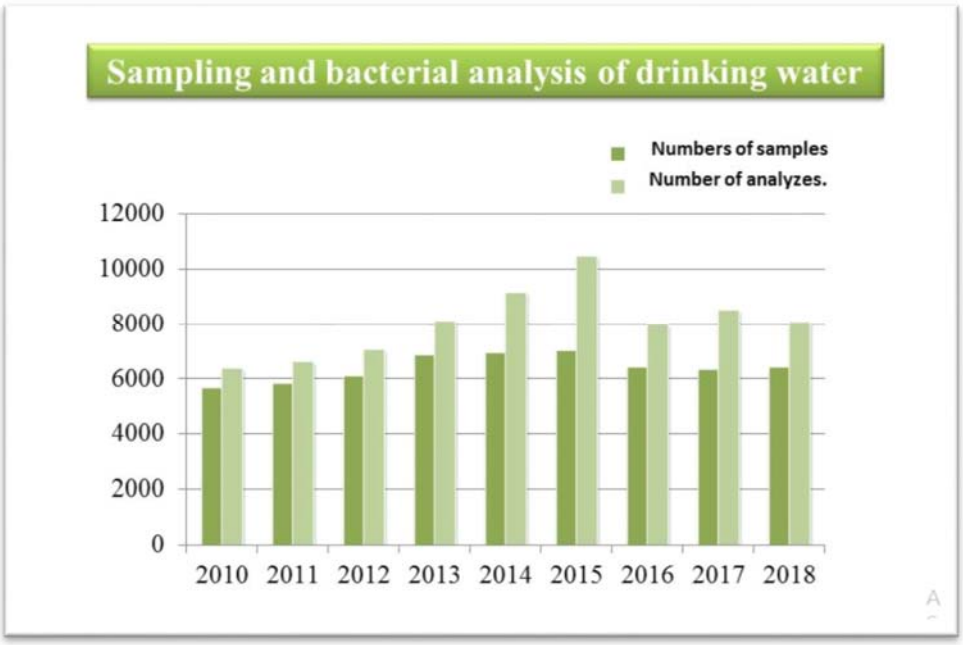

Figure 59: Sampling and Bacterial Analysis of Drinking Water

Directorate of Laboratories duty also is to preserve the environmental safety and public health, through monitoring the quality of reclaimed water in wastewater treatment plants for their conformity with Jordanian Standard No. 893/2015.

Project Support to Jordanian Government in Hosting Refugees in Water Sector

As of March 2016, there are approximately 636,000 Syrians (6.7 percent of Jordan's population) formally registered by UNHCR although the Jordanian government considers a more realistic number to be 1.27 million Syrians. According to government statistics residential water consumption rose by 9.44 percent from 2011 to 2012, compared to just 5.9 percent between 2010 and 2011.

Increasing numbers of Syrian refugees causes an increasing demand for water in various governorates, putting significant pressure on water resources.

The demand for water in Irbid governorate has doubled by 100,000 cubic meters per week, resulting in a 20 percent decrease in water availability per capita than in the past, pointing out that the Ministry of Water has implemented projects during the past years and set plans for many future water projects to confront the consequences of Syrian refugees such as the expansion Ramtha WWTP project which is intended to help address these consequences.

The stability of large numbers of Syrian refugees inside cities and villages in the northern governorates directly affected the level of services provided to citizens and refugees. For example the high number of complaints of sewage blockages in various networks in the northern governorates.as well as

increased pressure on the main treatment plants made it necessary to intervene to extend sanitation parallel connections and lines to reduce the pressure and burden on the existing networks. However, radical solutions require the expansion of existing plant, the establishment of a new plant, the extension of new major tanker sanitation lines and sub-lines and establishment of new fountains in different regions. (UNHCR, 2016).

5.4.2 Land Use

The project area falls within the warm semi-arid Mediterranean climatic zone, with a range in precipitation between 250 mm and 500 mm. The dominant soil subgroups in the study area are Vertisols /Chromoxerent as red clay with low content of carbonates. as shown in the **Figure 60**; which is considered as agricultural lands.

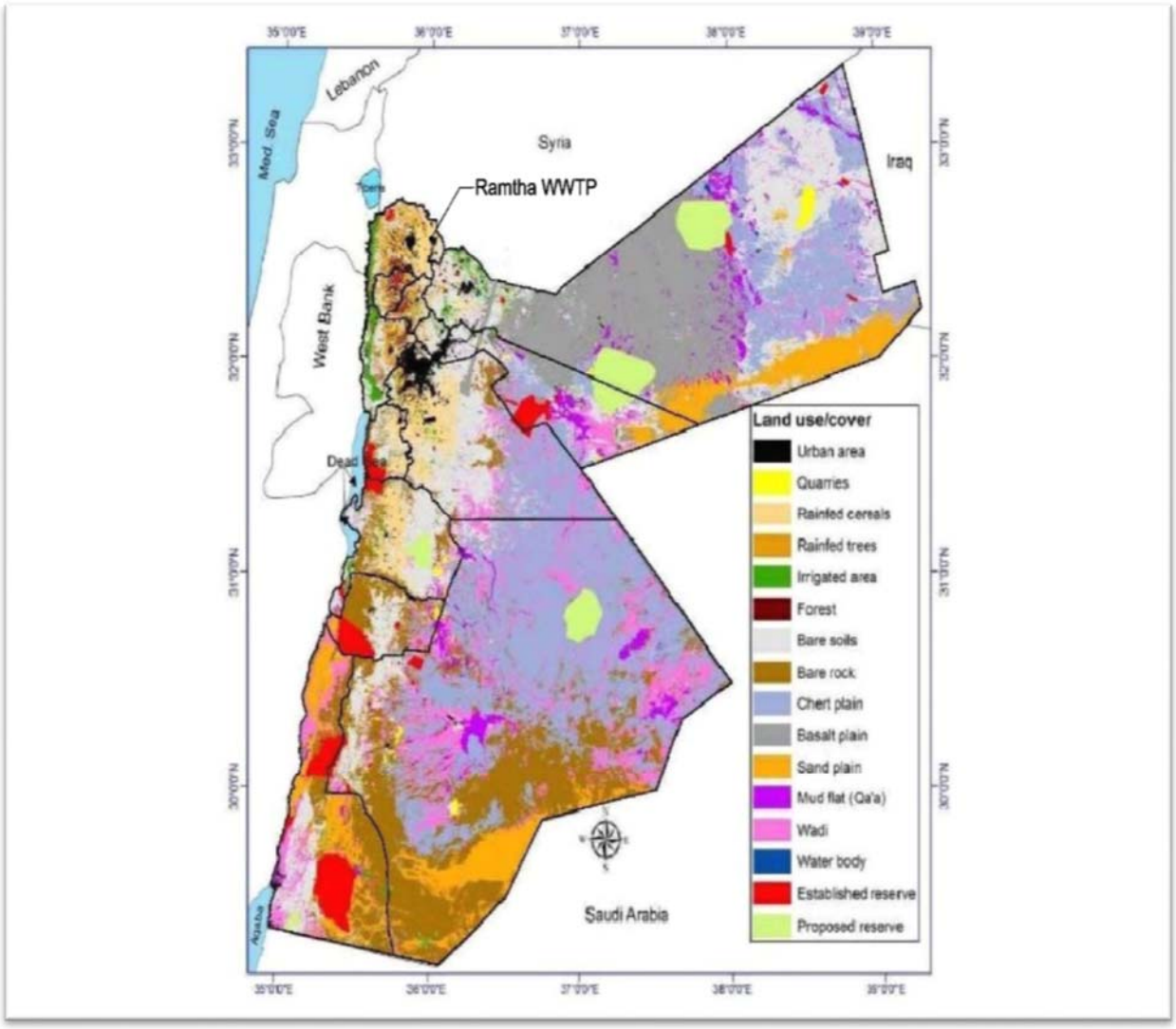

Figure 60: Land Use within Jordan

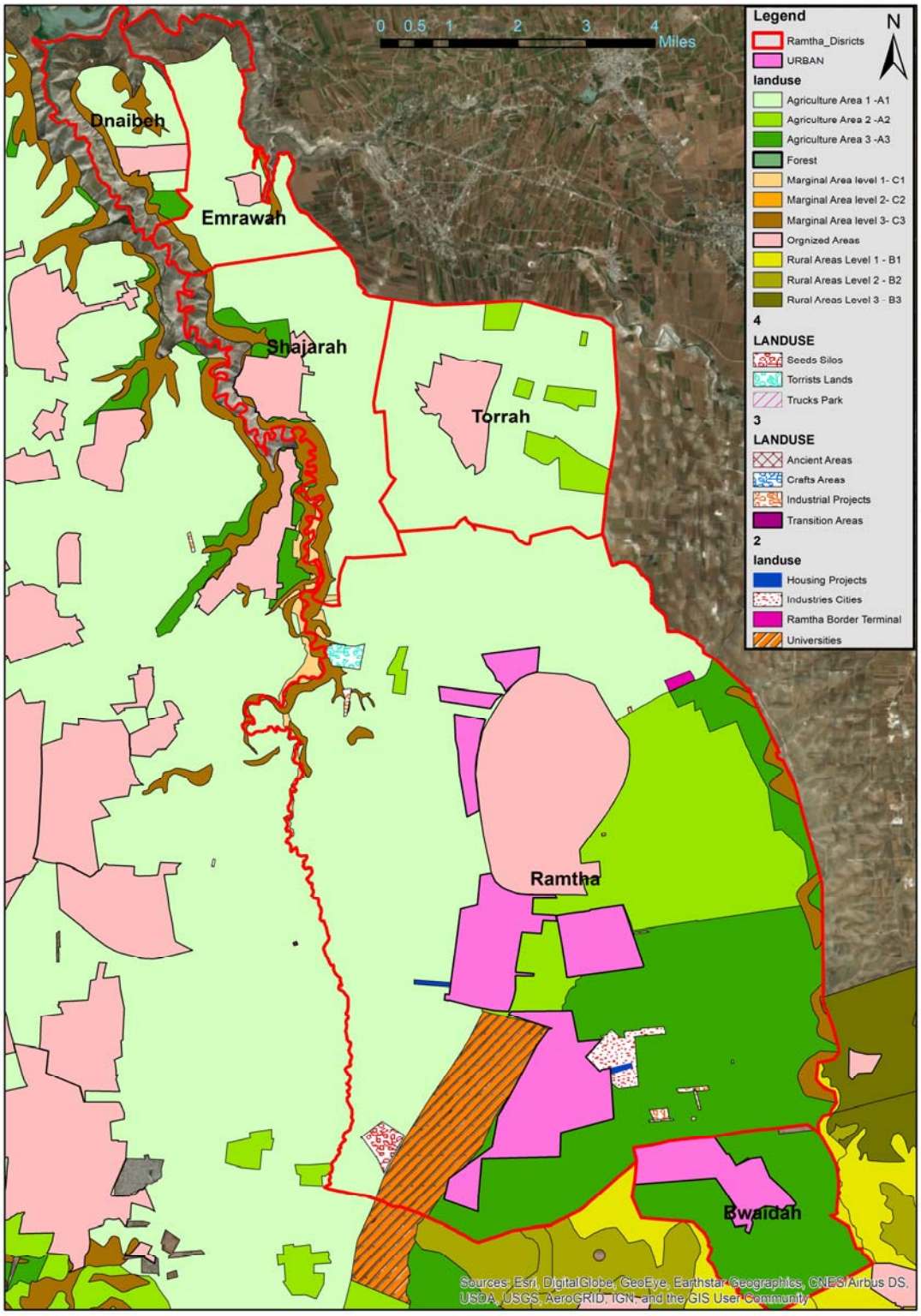

Figure 61: Land Use in Ramtha

In 2015, the total cultivated area in Irbid was 373,540 dunum, and varies from fruit trees, field crops, winter and summer vegetables. The most dominant crops are olives, wheat and barley which represent about 86.9 percent of the total cultivated area of all crops. The location of Ramtha WWTP is surrounded by agricultural land, most of which is highly suitable for agriculture, these lands nearby and surrounding Ramtha WWTP are regularly cultivated with fodder crops (i.e. ryegrass, alfalfa, barley and corn) in **Figure 62.** Some uncultivated areas (vacant) or undeveloped land exist throughout the proposed project area, but the cultivated areas are spread all over the WWTP surroundings.

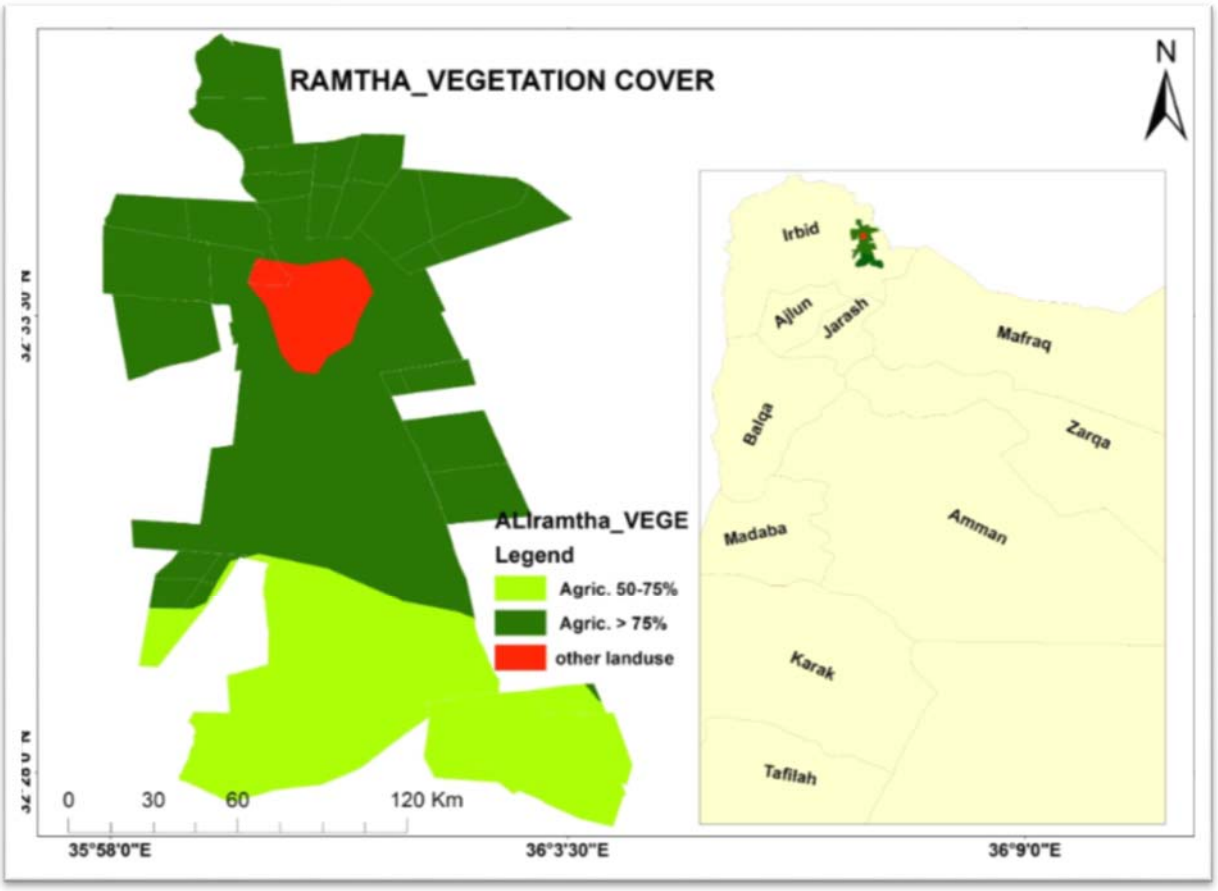

Figure 62: Vegetation Cover in Ramtha

Based on field visits, during the months of February and March 2019 (Dr. Abu Awwad), crops nearby and surrounding Ramtha WWTP were irrigated with treated effluent in **Figures 63 and 64**. Agricultural uses in the project vicinity are summarized as follows:

- The total planted area of irrigated fodder crops using treated effluent from Ramtha WWTP is 737.7 dunum.
- The number of agreements between farmers and the MWI is 16 agreements.
- Planted crops are alfalfa (annual and perennial), ryegrass, barley and corn.

Figure 63: Fodder Crops

Figure 64: Potato Crop

There are farmers currently growing crops on WAJ property on the west side of the plant that must be notified with WAJ's intent to use the land for expansion of the Ramtha WWTP.

5.4.3 Infrastructure and Utilities

The project site is easily accessible through a paved road leading to the WWTP; connecting from Ramtha city. However, this existing road is a relatively narrow two-way street (5m wide) and could prove to be a nuisance during construction for residents because of noise, dust, and odors. Another secondary road adjacent to the Ramtha WWTP but it is not used by the WWTP operations.
Electrical power is provided to the plant by Irbid District Electricity Company (IDECO), and water supply within the project area would be available during the project's construction phase.

5.5 Archaeological and Cultural Heritage Resources

As part of the investigation conducted for this project – an archaeological survey was carried out by AJWE consultants. The study team investigated the project area, the surrounding zone, and the transmission pipeline route from Ramtha to Shallalah WWTP. The study was conducted both by literature review and field visits. Through the site visits a thorough analysis and field investigation was conducted by the study team. Photographs were used to document the recorded data. The sites were registered, mapped and properly dated and evaluated. The documented data includes descriptions of the essential information for each site found during the field study. The major issues of concerns regarding archaeology and cultural heritage were:

- Potential damage to archaeological or heritage sites while landscaping and sites preparation activities.
- The discovery of any archaeological remains during excavation in the project sites for both the WWTP expansion and the pipeline route.

The field study and investigations revealed no archaeological or cultural heritage sites existed in the expansion area of Ramtha wastewater treatment plant or along the pipeline route toward Shallalah WWTP. The study revealed the presence of scattered flints to the north side located approximately 100 meters from the expansion area and would not be threatened by the project activities. In **Figure 65.**

The archaeological survey report consisted of one main recommendation:

- Follow the chance finds protocol if any artifacts are found on site during construction works or any other civil works related to the project. Minor and indirect impacts are not expected. The indirect impacts could be avoided by implementing the suitable mitigation measures.

Figure 65: Scattered Flints Found Outside the Project Area to the North

Shallalah Transmission Pipeline

The study team investigated the pipeline route and the surrounding zone from Ramtha to Shallalah WWTP using the same methodology as at the expansion area. The field assessment did not find any archaeological sites within or under direct threat by the proposed pipeline project activities. Still, precaution and management measures should be taken into consideration regarding the need to conserve any chance-found sites during construction activities.

6 STAKEHOLDER IDENTIFICATION AND ENGAGEMENT

6.1 Introduction

Stakeholders are identified as any individual and/or group that could be affected by the proposed project activities and has interest in their outcome. According to this definition, the stakeholders may include property owners, business owners, central government and local officials, special interest groups (farmers), and non-government organization.

Stakeholders should play a vital role in providing advice to the project management, therefore, in compliance with local ESIA regulations, and international standards, i.e. AFD & World Bank standards, stakeholder engagement activities were an ongoing process throughout the ESIA process.

The stakeholder engagement activities carried out during this ESIA are as follows:

- Identification of project stakeholders and all parties affected or related to this project
- Conducting a scoping session and documenting its results in a scoping session report as part of the Final ToR.
- Conducting site visits to meet with community representatives / relevant locals and farmers.

6.1.1 Identification of Project Stakeholders

Project stakeholder groups were identified and are presented in **Table 40** below.

Stakeholder Category	Stakeholders
Internal Stakeholders	
Employees	This includes relevant contractor female and male employees such as managers, engineers, technical staff, maintenance, secretaries, administrative personnel,
Workers	Temporary and permanent workers at project site.
Operators	Operators responsible for the daily operation and maintenance of the WWTP plant.
Contractors / Sub-contractors	Contractors and sub-contractors working on this project.

Stakeholder Category	Stakeholders
External Stakeholders	
National Government	Ministry of Environment, Ministry of Energy and Mineral Resources, Ministry of Local Administration, Ministry of Health, Ministry of Labor, Ministry of Transport, Ministry of Public Works and Housing, Ministry of Agriculture, Department of Antiquities, Jordan Standards and Metrology Organization…etc.
Local Government	Municipalities such as Ramtha Municipality
Community Members	Community leaders employed men and women, farmers, households' males and females, employed and unemployed labor force, youth and students.
Trade	Trade association groups, cooperatives, credit institutions, banks, businesses, business owners, tourism, agriculture, private health business, and public services companies
NGOs	This category includes local CBOs, local woman organizations, local cooperation societies, farmers society /association.
International Agencies	This includes international funding agencies that are funding projects in the area such as the Agency Francaise de Development (AFD).
Academic	Universities and research institutes.

Table 40: Identified Stakeholder Categories

6.1.2 Scoping Session

The Ministry of Environment sent invitations to all relevant stakeholders to attend the scoping session a week prior to the session's date. The list of stakeholders that attended the scoping session is presented in the scoping session report which is provided as **Appendix A.**

The main issues that were tackled during the session can be summarized as follows:

- Importance of acquiring all relevant governmental approvals such as Energy & Minerals Regulatory Commission (EMRC) and the electric company for the anaerobic digester and CHP system for electricity generation
- Importance of odor management;
- Importance of effluent monitoring to prevent pollution of surface and ground water sources.
- The positive impact on the local community and employment opportunity;

The overall aim of the scoping session was to take into consideration all issues of concern raised by stakeholders throughout different phases of the project. Thus, the above-mentioned issues were evaluated and assessed, where relevant, to ensure that the impacts are not significant, and no harmful effects will be caused during and after the project.

6.1.3 Consultation of Community Representatives in Ramtha City

In addition to conducting the scoping session, the ESIA team visited Ramtha city on Monday December 16, 2019, and attended the meeting hosted by Director of Ramtha Agricultural Directorate /MoA . **Table 41** below consists of consulted parties during the visit.

No	Consulted Party	Name of Party Representative	Date of Meeting
1	Agriculture research center	Eng. Ahmed Abu Dalu	16/12/2019
2	Farmer / Director of Ramtha agricultural directorate /MoA	Eng. Khalid Al-Shouqran	16/12/2019
3	Farmer	Ahmed Moh'd Khazaaleh	16/12/2019
4	Farmer	Ali Salim Al-Zoubi	16/12/2019
5	Farmer	Ahmed Rizeq Al-shboul	16/12/2019
6	Farmer	Dr. Tayseer Al-Masri	16/12/2019
7	Farmer	Eng. Khaled Yousef Bashabsheh	16/12/2019
8	The nearest resident to the south of the WWTP (1 km).	Khaleel Mahmoud Alu Aliqa wife	16/12/2019

Table 41: Consulted Stakeholders

Consultation with Ramtha Municipality

The AJWE team met with the farmers at the Ramtha Agricultural Directorate /MoA, by invitation of the director Eng. Khaled Al-Shouqran. Multiple topics were discussed concerning the project. Major topics discussed in this meeting were the main effects this project might have on local community especially the farmers. Farmer 's major demands and concerns about the project were:

- Decreasing of the land prices surrounding the new expansion of the WWTP.
- The burden of additional infrastructure cost (additional pipes for irrigation) that might be required due to the expansion of the WWTP.
- Commitment from WAJ and Miyahuna to continue supplying the treated wastewater during the construction phase.
- A concern of increasing the treated effluent prices by WAJ, since the new transmission pipeline to Shallalah WWTP will give WAJ an additional alternative for the treated effluent users. Farmers demand a decrease to the treated effluent prices.
- Agricultural research center (Eng. Ahmed Abu Dalu) emphasized the refusal of the society for consuming the cooked vegetables irrigated by the treated effluent due to psychological issues as well as the lack of trust of the community with effluent quality. Also emphasized on the expected refusal of the other countries (such as Emirates) importing Jordan agricultural products which will affect the whole sector.

Consultation with the farmers' leasing the 100 dunum from WAJ, Dr. Tayseer Al-Masri has been leasing the 100 Dunum for the last 25 years, his contract expires on August 1, 2022. The 100 Dunum is cultivated with annual and perennial trees, in addition to summer and winter crops. Dr. Al Masri stated that if the contract terminated before the expiration date WAJ must compensate him for the loss he might encounter.

Consultation with a local community resident (the nearest residence to the WWTP)

The house is the closest local resident to the project area (approximately 1 km away); hence, AJWE team determined that it is essential consult the resident. AJWE team met the housewife of Mr. Khaleel Mahmoud Abu Aliqa. The main points discussed were:

- Odor is not offensive to them, and the odor is not continuous and depends on the wind direction.
- Pest nuisance is very obvious.
- Concerned that the expansion would increase the noise level due to traffic passing by the road in front of the house.

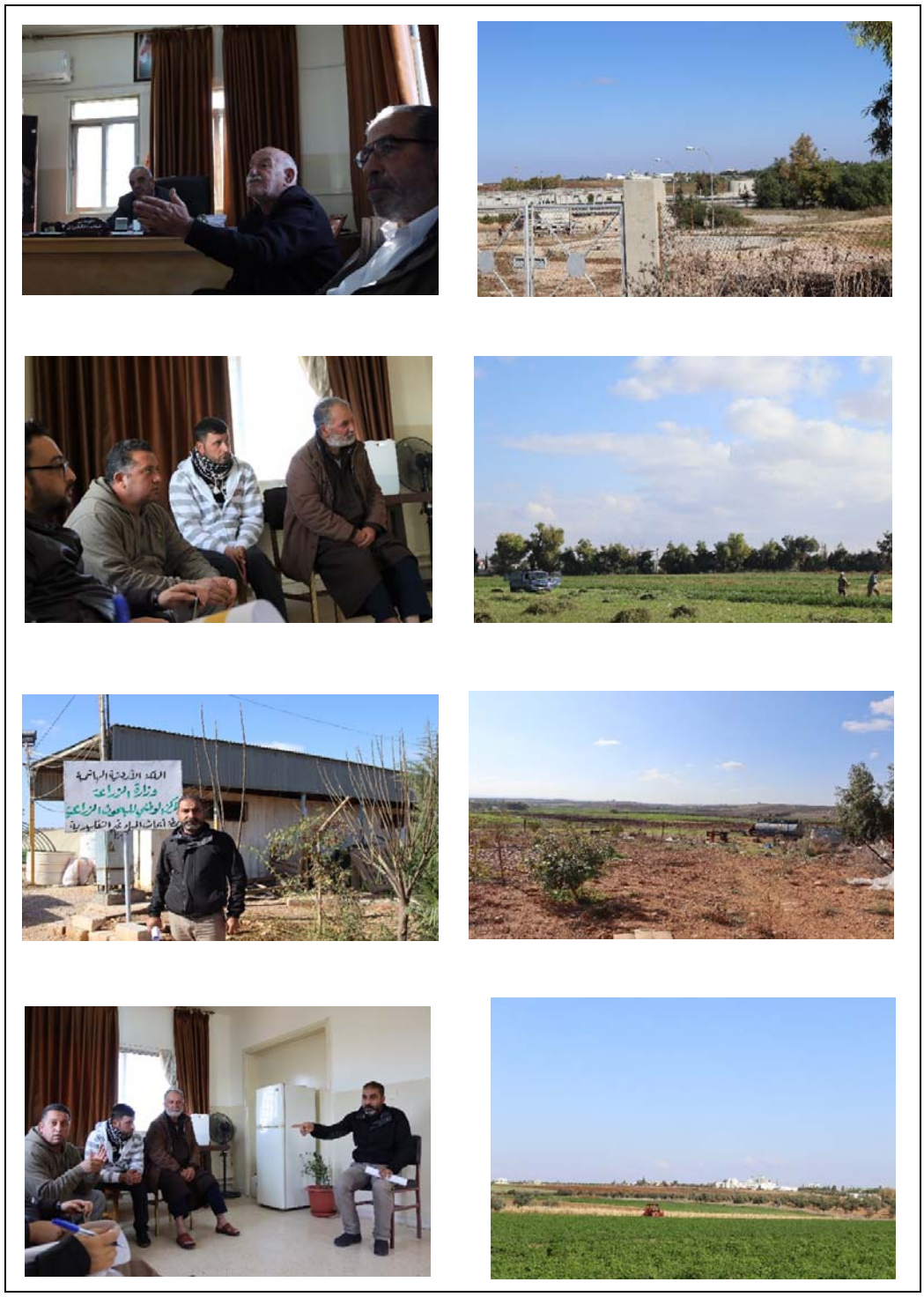

Figure 66: Photos from Consultation Activities

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7 IDENTIFICATION OF ENVIRONMENTAL AND SOCIO-ECONOMIC ASPECTS AND RECEPTORS

The environment covering physical, biological, socio-economic and occupational health and safety (OHS) aspects are identified for all proposed project activities which have the potential to:

- Interact with the physical, biological, occupational health and safety and socio-economic environment; and
- Breach the conditions of relevant national and international standards and guidelines.

The identified receptors are presented in **Table 42**.

Aspects/ Receptors	Details
1-Physical Environment	
Air Quality	The atmosphere at and around the project area.
Noise	The construction phase especially activity related to transportation and execution that might have a potential impact.
Soil	The soils of areas where project activities are to occur.
Hydrogeology	The hydrogeology (i.e. groundwater) of the area in and around where the project activities would occur.
Hydrology	Possible surface water within the project area. (Storm water)
Landscape / Visual Impact /Topography	The geomorphologic landforms and terrain at the project site.
2-Biological Environment	
Flora	Plant species that could occur in the area in which the construction and operational activities would occur.
Fauna	Fauna species that could potentially be affected by the project different activities in the area in which the construction and operational activities will occur.
Birds	Birds that rely on the area as a habitat and/or food source.
Reptiles	Reptiles that could be present within or in the vicinity of the project area that might be affected by construction and operation activities of the project.
Mammals	Mammals that occur in the environments in which construction activities are proposed to occur.

Aspects/ Receptors	Details
3-Occupational Health and Safety	
Construction Team Operations Team	Staff on the project site who will be subjected to occupational hazards/public health effects such as noise and dust.
Population in the vicinity of activity/land users	Residents and/or workers/land-users within or at the vicinity of the project sites that can be exposed to potential project operational hazards such as noise and dust and accidents, especially for vulnerable communities.
4-Socio-economic Environment	
Public Health and Safety – (PHS), including workers	Land users nearby the project boundaries that could be subject to hazards/public health and safety effects potentially arising from the project's activities.
Population	The population (people) that use the areas during construction activities and accessibility to main facilities or businesses (if any).
Land use, land ownership/acquisition, and potential decrease in land value	The project area is owned by the Government of Jordan (WAJ). Existing uses of the land areas in which the construction activities are to occur. Traditional boundaries, access issues, permit requirements and distribution of any private and/or government-owned lands. Possibility for need of land acquisition and/or potential economic resettlement/displacement.
Workforce and Employment	New work opportunities are expected mainly in the construction and operation phase.
Utilities and infrastructure	The utilities (e.g. power supply, water services) and infrastructure (e.g. commercial and industrial facilities) of areas in which the construction activities are proposed to occur.
Transport and Traffic	Road transport systems of the area in which the project activities are to occur during the construction phase, and minor during operation phase.
Archaeology / Cultural Property	Archaeological sites and artefacts that have cultural significance (if found within or in the vicinity of the project area, especially during construction).

Table 42: Identified Environmental and Socio-Economic Receptors

7.1 Interaction of Identified Aspects and Receptors

Based on the review of environmental aspects, project activities, and the project's environmental receptors, a summary of potential interactions between the environmental aspects and receptors relevant to this project were identified. This will allow for a preliminary assessment of the key environmental issues related to physical, biological, occupational health and safety, and socio-economic receptors, or 'key issues' associated with the project to be completed.

The interaction of aspects and receptors identified in the ESIA process are presented in **Table 43** for all planned and unplanned activities in addition to considering the potential effects in the event of a natural disaster:

Receptor / Activity		Physical						Biological			OHS	Socio-economic						
		Air Quality	Noise	Soil	Groundwater	Hydrology	Landscape / Topography	Flora (habitats)	Birds	Reptiles & Mammals		PHS	Population	Land Use	Workforce & Employment	Utilities & Infrastructure	Transport & Traffic	Cultural & Archaeology Heritage
Planned activities																		
Construction	Access road to site	●	●	●			●	●		●	●	●			●	●	●	●
	Accommodations	●	●	●			●	●		●	●		●		●	●	●	
	Haulage	●	●	●		●		●	●	●	●	●			●	●	●	
	Site survey	●	●					●							●		●	
	Site soil Investigation	●	●	●	●	●		●			●				●			●
	Clearing and grading	●	●	●		●	●	●	●	●	●	●			●	●		●
	Trenching & ditching	●	●	●			●	●		●	●	●			●	●		●
	Excavation & digging	●	●	●			●	●		●	●	●			●	●		●
	Earthworks & Civil works	●	●	●			●	●		●	●	●			●			
	Mobilization/demobilization of labor & equipment	●	●	●		●	●	●	●	●	●	●			●	●	●	
	Structures construction	●	●	●		●	●	●	●	●	●	●		●	●			●
	Waste generated from construction activities			●		●	●	●		●	●	●	●	●	●			
	Wastewater generated by site workers			●		●	●	●		●	●	●	●	●	●	●		

Operation	Wastewater discharge			●		●	●	●	●	●	●	●	●		●	●		
	Municipal solid waste handling	●		●		●	●	●	●	●	●	●	●	●	●			
	Hazardous/chemical waste storage and disposal	●		●		●	●	●	●	●	●	●	●	●	●	●		
	Sludge Treatment & Disposal																	
	Chemical / oil storage	●		●		●		●	●	●	●	●	●		●			
	Vehicles operation	●	●								●	●			●		●	
	Maintenance activities	●	●	●		●	●	●		●	●	●			●	●	●	
Decommissioning	Equipment Dismantling & disconnection of plant components		●	●			●	●		●	●	●	●		●		●	
	Demolishing	●	●				●	●	●	●	●	●	●		●		●	
	Fence Removal		●					●			●	●	●		●		●	
	Excavation & backfilling	●	●	●		●	●	●	●	●	●	●	●		●	●	●	
	Disposal		●	●			●				●				●	●		

Unplanned Project activities																		
Construction	Vehicle collision	●	●	●				●	●	●	●	●	●				●	
	Spill of chemicals or liquid fuels	●		●		●	●	●	●	●	●	●	●					
	Ignitions of flammable materials / accidental fires	●		●			●	●	●	●	●	●	●				●	
Operation	Vehicle collision	●	●	●				●	●	●	●	●	●				●	
	Spill of chemicals or liquid fuels	●		●		●	●	●	●	●	●	●	●					
	Ignitions of flammable materials / accidental fires	●		●			●	●	●	●	●	●	●				●	
Natural disasters																		
Construction	Earthquake "Seismic Activities"		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
	Flooding			●		●	●	●	●	●		●	●	●		●	●	
Operation	Earthquake "Seismic Activities"		●	●	●		●	●	●	●		●	●	●	●	●	●	●
	Flooding			●		●	●	●	●	●		●	●	●		●	●	

Table 43: Environmental and Socio-Economic Aspect Matrix

8 ANALYSIS OF PROPOSED PROJECT ALTERNATIVES

The analysis of project alternatives is one of the main tenets of environmental impact policy and procedures world-wide. A thorough, unbiased and transparent assessment of alternatives from an environmental, social, technical and economic standpoint is one of the most important contributions an ESIA can make to improve decision making.

The analysis for this project contains options or alternatives to treat the projected wastewater flow through the year 2045, new or upgraded wastewater treatment processes need to be selected to replace the existing process. This process should provide for nitrification/denitrification and produce an effluent that meets the Jordanian Standards for effluent discharge. A series of treatment process options were evaluated to provide a feasible, economical and simple method to generate second class sludge with some reuse potential. but since there is no reuse potential third class sludge is the objective.

By considering these alternatives prior to the commencement of project activities, environmental and social project benefits can be maximized, and potential challenges can be identified and addressed.

Table 44 presents the symbols that denote the various levels of environmental impact to aid in the comparison of alternatives. Each symbol indicates an overall evaluation of the specified environmental component and social aspect.

Symbol	Description
X	Denotes potential for impact, which is not considered significant
S-	Denotes potential significant adverse impact
S+	Denotes potential significant beneficial impact
*	Denotes no change to the existing situation

Table 44: Evaluation Symbols for Levels of Environmental and Social Impact

8.1 The 'Project' Vs. the 'No Project' Alternative

The "No Project" alternative considers the effects of not conducting the project at all. It is normally evaluated to assess the impacts if the project does not go ahead. This alternative is evaluated against the implementation of the proposed expansion of WWTP project.

The Sahel Horan wastewater system study and design were completed in May 2012, but the recommended project has not been constructed. This project planned to expand wastewater collection networks to unsewered areas of Ramtha City and the villages of Shajarah, Torrah, Emrawah, and Dnaibeh and to connect them to Ramtha WWTP, based on the analysis of the wastewater flow projections with 80 percent of localities connected to collection system, the expansion of Ramtha WWTP for the design horizon 2045 shall have a design capacity AADF of 22,000 m^3/d.

If "No Project" alternative is selected, with the existing Ramtha WWTP ability to accommodate rising influent demand is constrained by the existing capacity of 5,400 m^3/d, where the projections indicate the increase from 4,970 m^3/d (27percent of service area) in year 2025 to 16,689 m^3/d (76 percent of service area) by year 2045.

This demand that exceeds capacity would result in the discharge of untreated wastewater into the environment causing the pollution of surface water, soil and groundwater. The effects of releasing untreated wastewater would have the following impacts:

- adverse human health effects associated with reduced water quality;
- negative environmental effects due to the degradation of water bodies and ecosystems;
- potential effects on economic activities: because poor water quality constitutes an additional obstacle to economic development. The availability of freshwater is critical to sustaining the economic welfare of any human community, especially for the nearby agricultural areas.

However, the wastewater treatment plants (WWTPs) have been designed and operated to reduce the pollution due to wastewater and to minimize adverse impacts on environmental quality and human health, and the associated reclamation of water providing for reduced overall water demand through reuse. The project alternative will serve the increasing population and will increase water resources to be used for agricultural purposes, as it will annually reduce gross untreated wastewater by 1.81 million cubic meters in year 2025 and rises 234percent to about 6.06 million cubic meters by year 2045.
During their life cycle (operational phase) WWTPs have substantial environmental impacts due to energy consumption, chemical usage and gas emissions, as well as sludge generation which requires additional treatment.
During construction activities, the main adverse impacts introduced as a result of the project activities are mostly temporary impacts include disruptions to air quality, noise levels, and traffic within the area. However, these are limited to the construction phase of the project and would be eliminated or minimized once the proposed project is in its operational phase.

The implementation of anaerobic digestion at the proposed expansion would produce biogas (methane CH_4) that can be combusted to generate electricity. Combustion reduces methane to

carbon dioxide and water reducing the greenhouse gas load produced by the WWTP because methane has 25 times more global warming potential than carbon dioxide.

Table 45 presents an overview of the evaluation of the proposed project versus "No Project". Going forward with the proposed project alternative is considered the best possible option as opposed to 'No Project' since the proposed project will reduce the environmental degradation due to untreated wastewater, and the effluent would be a good source to satisfy the nearby agricultural area water demands, as long as it is adequately treated to ensure water quality appropriate for cropping.

Environmental Components	Project Options	
	Proposed Project	No-Project Alternative
Terrestrial Ecology	S+	S-
Air Quality	S+	S-
Green House Gas (GHG) Emissions	S+	S-
Noise Generation	*	*
Wastewater Generation	S+	S-
Waste Generation / Disposal	S+	S-
Soil & Groundwater	S+	S-
Health and Safety	S+	S-
Socio-economic Impacts	S+	*
Traffic Disturbance	*	*
Land Use	S+	S-
Archaeology / Cultural Property	*	*
Energy Production	S+	S-
Employment and Job Opportunity	S+	*

Notes:

X: Denotes potential for impact, which is not considered significant
S-: Denotes Potential Significant Adverse Impact
S+: Denotes Significant Beneficial Impact
*: Denotes no change to the existing situation

Table 45: Comparison of overall environmental and socio-economic impacts for the project Vs. 'no project' alternative

8.2 Site Selection Alternatives

The rationale for choosing the selected site is based on the following:

- The original Ramtha WWTP was built in the 1980s. The plant was expanded and updated starting in the late 1990s to an extended aeration system that became operational in 2005.
- The Ramtha WWTP site has an area of 180,000 m^2 occupied by the current facility. Adjacent to the plant site, WAJ owns an additional 100,000 m^2 parcel on the northwest side for expansion of the WWTP.
- The area of the current plant would provide sufficient space for the Phase 2 upgrades planned for the future to meet the demands of the 2045 design horizon.
- The existing site is a WWTP and it is extremely difficult to identify a new site due to public sentiment.
- The land acquisition procedures associated with a new site requires an extended time period and the procurement of the land for a new site is a costly proposition.

8.3 Project Technology Alternatives

Through the feasibility study process, several alternative technologies were evaluated including alternative liquid stream treatment alternatives, sludge treatment alternatives, and effluent reuse options. The best combination of these three process technologies form the proposed project. The alternatives for each process technology and the criteria for selection are described in this section.

The liquid stream treatment alternatives considered in the feasibility study are as follows:

- Alternative A – Modification of existing process tanks to biological nutrient removal [prior referred to as conventional activated sludge (CAS)] with primary clarifiers and addition of a new biological nutrient removal train
- Alternative B – Oxidation ditch with primary clarifiers
- Alternative C – Biological nutrient removal with primary clarifiers
- Alternative D – Oxidation ditch without primary clarifiers.
- Alternative E – Biological nutrient removal without primary clarifiers
- Alternative F – Sequencing Batch Reactor.

Wastewater solids or sludge treatment processes are used to stabilize and reduce the volume of particle (solid) organic matter in wastewater into safe organic and inorganic solids for offsite disposal of the remaining solids. Five solids stream treatment process options were evaluated as follows:

- Alternative 1 – Conventional Anaerobic Digestion with Digester Gas Utilization
- Alternative 2 – Covered In-Ground Anaerobic Reactor
- Alternative 3 – Sludge Lime Stabilization
- Alternative 4 – Aerobic Sludge Digestion
- Alternative 5 – Sludge Drying Beds

Effluent Reuse Options

- Reuse Alternative 1 - Nearby Utilization of Effluent
- Reuse Alternative 2 - Nearby and Along Pipe to Shallalah WWTP
- Reuse Alternative 3 - Shallalah WWTP Effluent Reservoir
- Reuse Alternative 4 - Jordan University of Science and Technology
- Reuse Alternative 5 - Ramtha Municipality

The feasibility study team considered the following assessment criteria to provide a qualitative method for ranking the treatment technologies and making recommendations. The assessment criteria have five main categories with subcategories as follows:

1. **Operational complexity**
   - Reliability
   - Flexibility
   - Maintenance complexity
   - Process complexity
   - Chemical requirement

2. **Material requirements**
   - Proprietary product required for construction phase
   - Proprietary product/consumables required for operation phase
   - Local fabrication opportunities
   - Reuse of existing structures

3. **Constructability**

4. **Meets Effluent Objectives**

5. **Operation and Maintenance Costs**
   - Energy
   - Chemicals
   - Labor

6. **Capital Costs**
   - Land acquisition required
   - Electrical service upgrade
   - Construction contract
   - Construction management
   - Two years of operation and maintenance by contractor

7. **Lifecycle costs from estimated plant startup in 2023 through the design horizon 2045.**

Each category was weighted to rank each category's importance within the seven categories with a total for all seven categories of 100 percent. A weight (points) is also applied to each subcategory to define a specific subcategory's importance within the category. The total points assigned to the subcategories within a given category totals 100.

According to this scoring system the alternative with the highest number of points is most favorable based on the sustainability score evaluation criteria and costs, while the alternative with the lowest total points is the least favorable.

The most sustainable and cost-effective alternative according to this evaluation system is Alternative C.2 from the feasibility study which consists of biological nutrient removal (five-stage Bardenpho with plug flow reactors) with primary clarifier and solids treatment with CIGAR. However, MWI/WAJ has no experience with the CIGAR system and has concerns about operating the system. MWI/WAJ's selected Alternative C1–Phase 1 for the expansion of Ramtha WWTP. This alternative uses the biological nutrient removal with primary clarifier and solids treatment with conventional anaerobic digesters and CHP system to generate electricity from digester gas (biogas). The selected alternative has an

AADF of 11,000 m^3/d expandable to 22,000 m^3/d to meet the demand projected for the 2045 design horizon.

The feasibility study evaluation showed that C.1 is not a favorable alternative as it scored substantially lower than Alternatives C.2, D, and E. The reasons for that are high capital costs, process and maintenance complexity, and chemical feed requirements. MWI/WAJ also expressed concern about the CIGAR process. Therefore, it was necessary to consider matching the most favorable liquids treatment alternative with most favorable solids treatment/disposal alternative. In addition to the screening criteria categories listed above, each of the alternatives was evaluated against potential environmental and socio-economic impacts as shown in **Table 46.**

Environmental Components	Project Scenario					
	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Terrestrial Ecology	S+	S+	S+	S+	S+	S+
Air Quality	S-	S-	S-	S-	S-	S-
GHG	S-	S-	S+	S-	S-	S-
Odor and Nausiance	S-	S-	S-	S-	S-	S-
Noise Generation	*	*	*	*	*	*
Surface Water	S-	S-	S-	S-	S-	S-
Soil & Groundwater	S-	S-	S-	S-	S-	S-
Health & Safety	S-	S-	S-	S-	S-	S-
Socio-economic	S+	S+	S+	S+	S+	S+
Traffic Disturbance	*	*	*	*	*	*
Land Tenure	*	*	*	*	*	*
Land Use	S-	S-	S-	S-	S-	S-
Visual Impacts / Aesthetics	*	*	*	*	*	*
Archaeology & Cultural Resources	*	*	*	*	*	*

Notes:
X: Denotes potential for impact, which is not considered significant
S-: Denotes Potential Significant Adverse Impact
S+: Denotes Significant Beneficial Impact
*: Denotes no change to the existing situation

Table 46: Comparison of Potential Environmental Impacts Between the Proposed Project Technology Alternatives

9 IMPACT ASSESSMENT

An impact assessment was undertaken following the full characterization of the environmental, social and health baseline, and identification of all project aspects. The scope of the assessment covers all project area and was undertaken in accordance with relevant MoE regulations and applicable local, national and international standards and guidelines (World Bank).

9.1 Approach and Methodology

Initially, project environmental, social and economic and health aspects were identified for the proposed activities. The activities were considered in terms of their potential to:

- Interact with the environment (physical, biological, socio-economic); and
- Breach the conditions of relevant national and international standards and guidelines or company policy.

The environmental, socio-economic and engineering information and data gathered, collated and reviewed during the baseline and aspect identification tasks were systematically developed to prepare matrices of key project activities and environmental, social, health and economic receptors. This allowed for a preliminary assessment of the key environmental and socio-economic issues, or 'key issues' associated with the project to be completed.

When assessing impacts, the following were considered:

- Both positive or negative impacts
- Impacts occurring directly or indirectly from project activities
- Magnitude of impact
- Public health and safety risks
- Geographical extent of the effect
- Duration and frequency of the impact
- Sensitivities of the receiving environment over the entire project area
- Potential significance
- Residual impacts.

Figure 67 below illustrates the ESIA process adopted during the ESIA study phases.

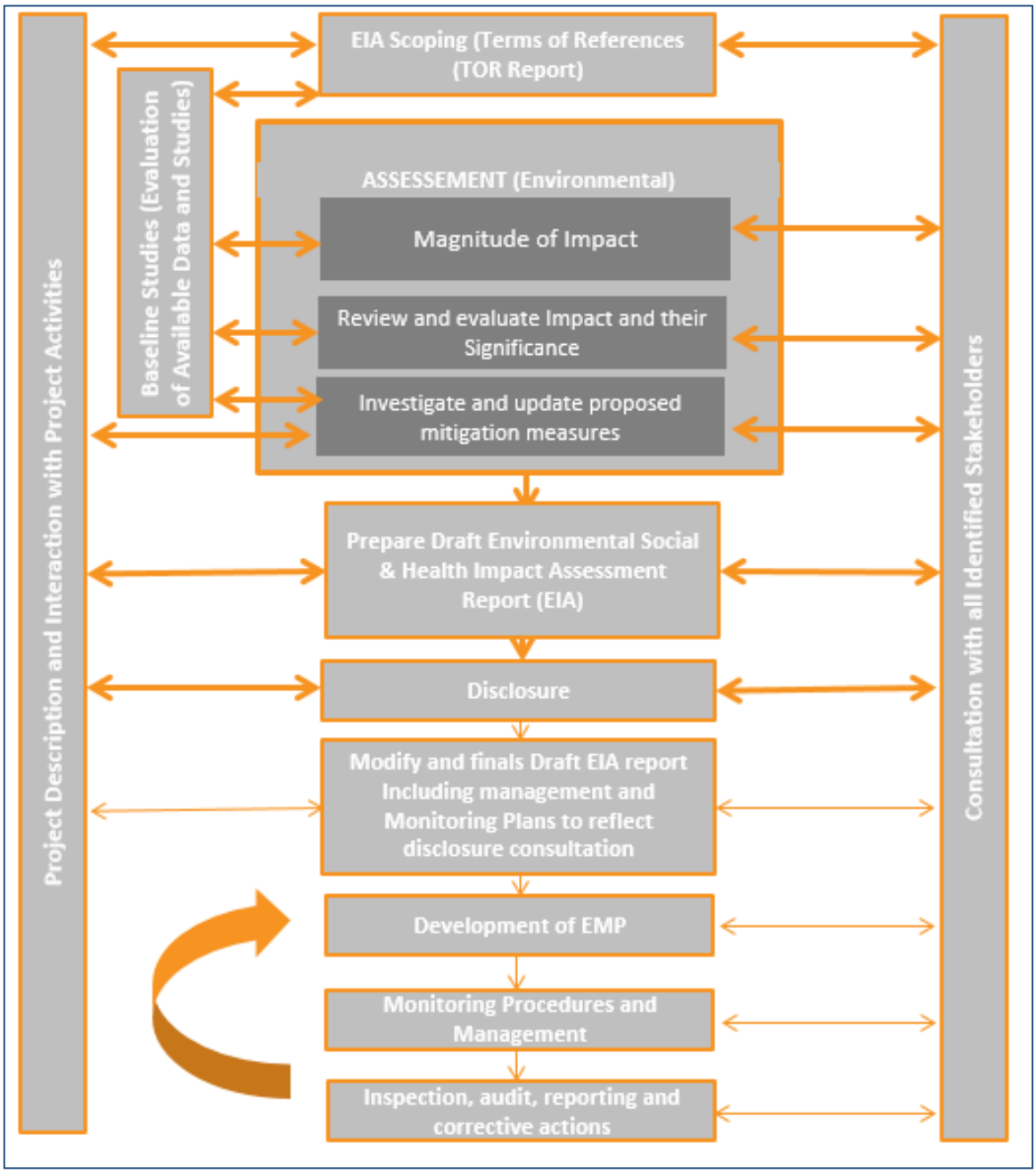

Figure 67: ESIA Process

As part of the assessment, the potential cumulative effects were considered, taking into account other developments (if any) in the local area.

Once all of the project environmental and socioeconomic impacts have been assessed, the significance of the impacts was ranked by considering the following elements:

- **The consequence of identified events:** the resulting effect (positive or negative) of an activity's interaction with legal, natural and/or socioeconomic environments; and
- **Likelihood:** the likelihood that an activity or event will occur.

Agreed criteria were defined for each level of consequence and each level of likelihood and the significance of the impact associated with each identified aspect is the product of the consequence and likelihood. It should be noted that the assessment has been conducted by considering the mitigation measures normally designed into / included in the project.

The following sections briefly describe the consequence, likelihood, and significance criteria.

9.1.1 Consequence

To assign a level of consequence to each environmental and social impact, criteria are defined for environmental and socio-economic consequence or severity. Legal issues are embedded in both criteria sets. The consequence categories and their ranking are presented in **Table 47**.

Consequence	Ranking	Description
Catastrophic	5	Massive effect – Persistent severe environmental damage or severe nuisance extending over a large area. In terms of commercial or recreational use or nature conservation, a major economic loss for the Company. Constant, high exceedance of statutory or prescribed limits, high profile community outrage.
Severe	4	Major effect – Severe environmental damage. The Company is required to take extensive measures to restore polluted or damaged environment to its original state. Extended breaches of statutory or prescribed limits, and serious community concern and complaints.
Critical	3	Localised effect – Limited discharges of known toxicity, considerable community concern and/or complaints. Repeated breaches of statuary or prescribed limit. Affecting neighborhood. Spontaneous recovery of limited damage within one year.
Marginal	2	Minor effect – Contamination. Damage sufficiently large to damage the environment, some community concern raised. Single exceedance of statutory or prescribed criterion. No permanent effect on the environment.
Negligible	1	Slight effect – Local environmental damage. Within the fence and within systems. Negligible financial severity.

Consequence	Ranking	Description
None	0	No impact
Positive	+	Beneficial impact – enhances the environment

Table 47: Consequence Categories and Rankings

It should be noted that it is often difficult to compare impacts consistently across different natural and socio-economic environments. When evaluating the environmental and socio-economic aspects, emphasis was placed on specific cause and effect relationships.

Scientific evidence as well as predictions based on observation of previous similar activities can and have been used in the impact assessment process. Where it has not been possible to fully quantify the effect that an activity may have on the environment or a component of the environment, or where there is a lack of scientific knowledge, qualitative judgment has been used. Such judgments are based on a full understanding of the project activities, and the team's knowledge of the environment, social structure and general health aspects of the region in which the project's activities will occur.

9.1.2 Likelihood

To assign likelihood to each activity, five categories are defined and ranked. The criteria for likelihood are shown in **Table 48**.

Category	Ranking	Definition
Certain	5	The activity will occur under normal operating conditions
Very Likely	4	The activity is very likely to occur under normal operational conditions
Likely	3	The activity is likely to occur at some time under normal operating conditions
Unlikely	2	The activity is unlikely to occur but may occur at some time under normal operating conditions
Very Unlikely	1	The activity is very unlikely to occur under normal operating conditions but may occur in exceptional circumstances

Table 48: Likelihood Categories and Rankings

9.1.3 Significance

The significance of the impact is expressed as the product of the consequence and likelihood of occurrence of the activity, expressed as follows:

Significance = Consequence x Likelihood

Figure 68 Illustrates all possible product results for the five consequence and likelihood categories.

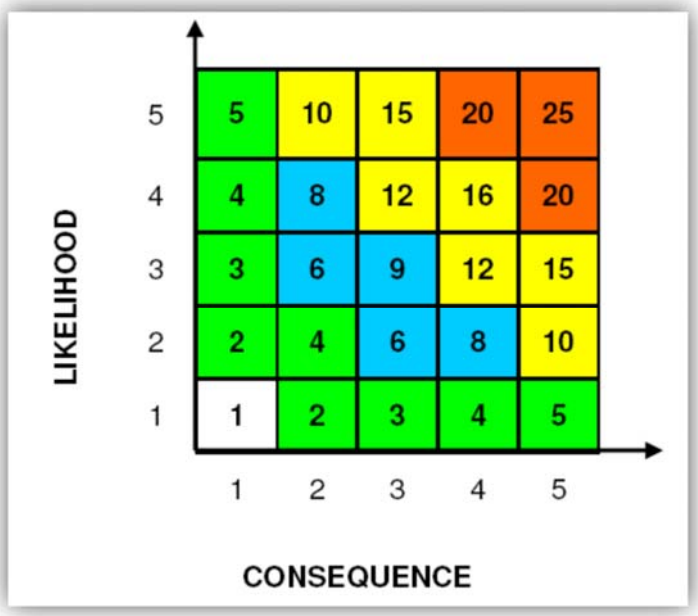

Figure 68: Product Results for Consequence & Likelihood Categories

Based on its consequence-likelihood score, each environmental aspect has been ranked into five categories by order of significance as illustrated in **Table 49.**

Ranking (Consequence X Likelihood)	Significance
>16	Critical
10-16	High
6-9	Medium
2-5	Low
<2	Negligible

Table 49: Significance Categories

To assist in determining and calculating the significance of an impact, impact assessment matrices were developed based on the aspect identification exercise.

9.1.4 Residual Impact

Residual impacts are impacts that remain after mitigation measures, including those incorporated into the project's base design and those developed to address specific impacts.

The residual impacts assessment identifies which project activities are likely to result in a semi-permanent to permanent change in the natural (i.e. physical, biological) and/or socio-economic environments. The significance of this change was also assessed.

9.2 Potential Environmental and Social Impact Assessment

This section identifies and, where appropriate, quantifies the primary biophysical effects expected to result from construction, operation and decommissioning of the Ramtha WWTP.

Every identified aspect was assessed in terms of its potential to cause an impact on natural and/or socio-economic receptors and was subsequently ranked in terms of consequence and likelihood, thus enabling the determination of the overall significance of the impact.

This section addresses the potential environmental and social impacts specific to this project.

The section is structured according to the main issues and effects resulting from the proposed project activities across the following project phases:

- **Construction Phase:** This involves all activities for the construction of the expansion of Ramtha WWTP.
- **Operation Phase:** This refers to the Ramtha WWTP operation processes.
- **Decommissioning Phase:** Following the operation phase, determination as to whether the WWTP can be retrofitted i.e. upgraded and new technology added. If retrofitting does not turn out to be feasible, then decommissioning activity would take place. Decommissioning activities are anticipated to be similar to construction; therefore, the potential impacts are anticipated to be relatively similar.

9.2.1 Physical Environment

9.2.1.1 Air Quality

Construction Phase

The main impacts associated with construction activities of the expansion of the WWTP or the transmission pipeline would be:

1) **Dust generation:** resulting from earthworks such as leveling, grading, excavation works and movement of vehicles along the roads, especially during windy conditions. The contractor shall be committed to control dust from such operations through the proposed dust emission control procedures described in the environmental and social management plan (ESMP) included in this report.

2) **Exhaust emissions:** Exhaust emissions of SO_2, NO_2, and PM_{10} would be attributed predominantly to the use of equipment and vehicles in plant construction operations and road vehicles such as movement of trucks and vehicles during construction works. These emissions will be localized to the project area and the concentrations from WWTP construction are predicted by the dispersion modelling results from demolition and WWTP construction are represented in **Table 50.**

Pollutant	Maximum Predicted Concentration		
	1-hour	24-hour	Annual
SO_2 (ppm)	0.005	0.002	0.0004
NO2 (ppm)	0.00013	0.00005	0.00001
TSP (µg/m^3)	8.346	3.338	0.668
PM10 (µg/m^3)	0.530	0.212	0.042

Source: Annex B air quality modelling report

Table 50: Air Emissions Modelling for Demolition and Construction Activities

The anticipated emissions SO_2, NO_2, TSP and PM_{10} would be generated in small concentrations that are far below the Jordanian standards. The maximum concentrations that appear near the project area would be found within about 1000 m. and they would be dispersed. Therefore, any deterioration in the air quality at the project location is considered to be **likely (3)** and **Marginal (2)** consequence with an overall **Medium (6)** Impact significance and is expected to be transient.

3) Odor emissions

At the construction phase the existing Ramtha WWTP will remain in service and emitting odorous gases due to its operations. The new treatment tanks would be built parallel to the existing tanks while the existing plant remains in service. Once the new plant is built and commissioned the existing treatment trains would be decommissioned.

Monitoring of the ambient air quality (PM_{10}, SO_2, NO_2, H_2S, NH_3, and CH_4) for 7 consecutive days near the proposed project (Ramtha WWTP) during the period February 27 to March 5, 2020, showed that the hourly and daily average concentrations were far below the relevant limits in the Jordanian Ambient Air Quality Standard (JS 1140/2006). Based on the above, local degradation of the ambient air quality and odor during construction is considered to be **likely (3)** but **Marginal (2)** in consequence with an overall **Medium (6)** impact significance.

Operation Phase

Air quality and odors are a major problem in the operation of WWTPs. Operations and heavy traffic generate a wide range of pollutants which are emitted to air and may be dispersed over vast areas including near residential areas causing odors and nuisance. The odors result from the anaerobic decomposition of organic matter containing sulfur and nitrogen. Inorganic gases produced from domestic wastewater decomposition commonly include hydrogen sulfide, methane, ammonia and carbon dioxide. Hydrogen sulfide (H_2S) is the most commonly known and prevalent odorous gas associated with domestic wastewater collection and treatment systems. The dispersion modelling results for each component of the WWTP that could be a source of odorous gases are shown in **Table 51**.

Source	Maximum Predicted Concentration					
	H_2S (ppm)		CH_4 (ppb)		NH_3 (ppm)	
	1-hour	24-hour	1-hour	24-hour	24-hour	1-yr
Headworks	0.0187	0.0075	NA	NA	17.72	3.54
Grit Removal	0.0047	0.0019			0.39	0.08
Effluent Storage Pond	0.0002	0.0001			59.24	11.85
Primary Clarifier	0.0096	0.0019			2.37	0.47
BNR Tanks	0.0008	0.0002			29.10	5.82
Secondary Clarifier	0.0003	0.0001			4.28	0.86
Anaerobic Digester Tank	0.0001	0.0000			0.58	0.12
Digester Sludge Tank	0.0004	0.0002	0.19	0.07	0.84	0.17
Drying Beds	0.0010	0.0004	2.20	0.88	158.24	31.65
Sludge Dewatering	0.0004	0.0002	0.81	0.33	4.96	0.99
All Sources	**0.0362**	**0.0124**	**3.20**	**1.28**	**277.72**	**55.54**

Table 51: Modeling Results of Odor Gases (H_2S, NH_3 & CH_4)

The air modelling results for the H_2S shows the maximum concentrations appear within 100 m of sources and the greatest contribution to the overall emissions from WWTP occurs from headwork unit with relatively minor contributions from other units.

The air modelling results for the NH_3 shows the maximum concentrations appear within 100 m of sources and the greatest contribution to the overall emissions from WWTP occurs from drying beds followed by the effluent storage pond unit with relatively minor contributions from other units.

The highest concentrations of CH_4 were predicted to occur from the drying beds unit for the hourly averages. The maximum concentrations appear within 100 m of sources and the greatest contribution

to the overall emissions from WWTP occurs from drying beds unit with relatively minor contributions from other units.

The selected technology for the expansion of Ramtha WWTP is conventional activated sludge technology which has low odor potential, and the conventional anaerobic digestion has been practiced for decades and is one of the most common technologies used for stabilization (pathogen and odor reduction) of biosolids, its advantage results in less odor for solids handling processes downstream than other technologies. Also having the digester cover to maintain anaerobic conditions in the tank, helps to contain and assist in collecting biogas produced during the digester process, thus further reducing odors.

Using drying beds at the Ramtha WWTP have some disadvantages including odors, visual nuisances, labor intensive sludge removal, and the process is dependent on climate. Drying beds are typically used in warmer climates.
At the existing septage receiving area, septage splashing during transfer creating odor problems, However, this plant expansion will replace the existing septage unloading station with a new facility that would cause less splashing septage and odor problems.
An odor control system would be added to the headworks, mechanical dewatering of biosolids and other processes that generate odors would be limited to the project area and would be generated in small concentrations and dispersed rapidly within the area.

Based on the above assessment, potential odor impacts from the WWTP is considered **likely (3)** with a **Critical (3)** consequence, with an overall impact significance of **Medium (9).**

There are no air emission sources expected to be associated with the effluent reuse conveyance pipeline from Ramtha WWTP to Shallalah WWTP effluent reservoir during the operation phase. Air emissions impacts of the transmission pipeline are considered **Very unlikely (1)** with a **Negligible (1)** consequence, thus an overall impact significance of **Negligible (1).**

Decommissioning Phase

Similar to construction, the decommissioning phase is anticipated to generate dust and exhaust emissions. Decommissioning activities would involve site preparation, dismantling and disassembling of the components of the WWTP plant, clearance of the site, and rehabilitation if needed.

Similarly, to the construction phase, local degradation of air quality is expected on a limited and temporary level. As a result, the impact is considered **likely (3),** with a **Marginal (2)** given the temporary nature of decommissioning, yielding an overall **Medium (6)** impact significance.

9.2.1.2 Energy Savings

The Energy Efficiency and Renewable Energy Policy issued by MWI, mandates improvements in the water sector's performance by improving energy efficiency in water facilities to decrease power consumption for water supply and introducing renewable energy technologies to protect the environment and reduce energy price volatilities in the water sector.
Sludge digesters is included in the expansion of Ramtha WWTP design to stabilize the primary and waste activated sludge and the methane produced is used to fuel the boiler for heating the anaerobic digester, the CHP system burns methane (digester gas) to power the generators for electricity production.

Table 52 summarizes the potential energy generation for the CHP engine.

Parameter	Unit	2023 Average	2045 Average Daily	2045 Maximum Month	2045 Peak Week
Biogas Fuel	kW	433	940	1,167	1,336
Generated Electricity	kW	169	367	455	521
Annual Electricity	MWh	1,478	3,212	-	-
Generated Heat	kW	202	439	545	624

Source: (USAID, 2019) Expansion of Ramtha WWTP feasibility study

Table 52: Digester Gas Electrical and Heat Generation

The annual average electrical production value is projected to range from approximately 1,478 MWh for 2023 to 3,212 MWh for 2045. The digesters themselves require electricity, but then produce additional electricity that can be used by other plant processes. The net electricity that would be available for other processes is estimated to be 718 MWh in 2023, increasing to 2,865 MWh in 2045.

The rate of energy generation to energy consumption for the years 2023 and 2045 will be lower by 38 percent and 42 percent respectively. However, the cost recover from the electricity production would not cover the initial capital cost and operation costs of the CHP system.

Green House Gas Emissions

Operation Phase

GHG emissions from the Ramtha wastewater treatment process

Based on the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines, the maximum methane generation capacity of municipal wastewater treatment processes is dependent on the organic content of influent wastewater and estimated as 0.6 kg per 1 kg of BOD or 0.25 kg per 1 kg of chemical oxygen demand (COD). **Table 53** indicates that projected yearly emissions of methane from the expansion of Ramtha WWTP would increase compared to the baseline.

Sector		Waste						
Category		Domestic Wastewater Treatment and Discharge						
Category Code		4D1						
Sheet		3 of 3 Estimation of CH_4 Emissions from Domestic Wastewater						
STEP 3								
		A	B	C	D	E	F	G
Income group	Type of treatment or discharge pathway	Fraction of population income group	Degree of utilization	Emission Factor	Organically degradable material in wastewater	Sludge removed	Methane recovered and flared	Net methane emissions
		(U i)	(T i j)	(EF j)	(TOW)	(S)	(R)	(CH_4)
		(fraction)	(fraction)	(kg CH_4/kg BOD)	(kg BOD/yr)	(kg BOD/yr)	(kg CH_4/yr)	(kg CH_4/yr)
				Sheet 2 of 3	Sheet 1 of 3			G = [(A x B x C) x (D -E)] - F
Rural								
Urban high income								
Urban low income	existing	1	1	0.48	2,042,631	125,108	0	920411.16
	Phase 1 (2025)	1	1	0.48	4,085,263	250,217	355,400	1485421.84
	Phase 2 (2045)	1	1	0.48	8,170,069	394,243	580,000	3152396.36
Total								

Source: 2006 IPCC guidelines, volume 6

Table 53: Estimation of CH_4 Emissions from Domestic Wastewater

The indirect GHG emissions - emissions from Ramtha WWTP energy requirements

The energy required to operate the wastewater treatment plant would contribute indirectly to an increase in greenhouse gas emissions. From an environmental point of view, treatment processes that have comparatively lower energy requirements than the existing conditions can be considered to have a lesser effect on global warming.

Table 54 shows the Ramtha WWTP power generation estimates.

2035		2015	2025	2035
Total population equivalent concerned	PE	136.565	172.052	216.762
Total energy consumption at WWTP	*MWh/a*	*4.008*	*4.698*	*6.607*
Power production at sludge digestors	*MWh/a*	*1.543*	*1.979*	*2.515*
Rate energy generation to energy consumption	%	38%	42%	38%

Source: (USAID, 2019) Expansion of Ramtha WWTP feasibility study

Table 54: Power Generation Estimates

Considering the expected GHG emissions from electrical energy consumption assuming Jordan emission factor 0.67tCO/MWh the predicted GHG emissions are shown in **Table 55,** (in tons of carbon dioxide equivalents). (UNDP, 2014)

Year	GHG emissions tCO2e	GHG emissions offset tCO2e	Offset %
2015	2685.36	-	-
2025	3147.66	1325.93	42%
2035	4426.69	1685.05	38%

Table 55: Predicted GHG Emissions

The project implementation would lead to a reduction of methane emissions due to the sludge digesters included in the Ramtha WWTP expansion to stabilize the primary sludge and WAS and produce CH_4 that would be captured and use to fuel the CHP system to generate electricity and any excess gas would be flared to prevent methane from escaping into the atmosphere.

This accounts also for 38 percent and 42 percent indirect GHG reduction, respectively, which is considered a significant improvement in WWTP carbon footprint. Therefore, the impact significance is assessed as **positive (+).**

9.2.1.2 Noise

Construction Phase

Construction activities for the WWTP plant would contribute to noise impacts. There are several noise generating activities such as earthworks, haulage activities, excavation, backfilling, and installation of the equipment within the plant in addition to noise sources generated from machinery and equipment on site.

The closest communities/activities to the project area are 1 km away to the south from the project site on the main road to the plant. Hence, it can be considered that the only human receptors who could potentially be impacted by the noise are the nearby residence and employees working within the project site during assigned working hours,

During construction, workers would likely be accommodated in the nearest accommodation places to the site (possibly in Ramtha and surrounding areas) and labor camps with kitchen facilities and offices will most likely be present on site for daily use during working hours. However, there is a possibility for having worker accommodation facilities on site; if this is the case, the facilities shall be established in accordance with the specifications of the International Labor Organization (ILO) standards and guidance published by EBRD and IFC; and workers would be working on site during the day within normal working hours and sleeping at night where all project activities and noisy operations would cease. Therefore, no noise impacts are expected during night time and the contractor shall be committed to adhere to such requirements.

These increased noise levels on site is considered occupational noises that require occupational health and safety measures and shall comply with the occupational noise exposure limits. In addition to this, some reptiles and mammals, within the project area can potentially be driven away from the site due to the sound levels.

However, these noise impacts are not considered to significantly harm animals nor cause impacts on a population level since they would be temporary.

Since the activities will occur under normal operating conditions and are expected to have only localized and temporary effects within the project area, the impact likelihood is **very likely (4)** with a **negligible (1)** consequence, thus the impact significance is **low (4**).

Operation Phase

The WWTP as a facility is not considered to exhibit any significant noisy operations, although the plant's pumps and mechanical equipment may produce some sound, but this is not considered a serious issue. The sound would not exceed the baseline condition and would be considerably less than noises produced during construction. In addition, there will be no close by sensitive receptors such as worker accommodation or residential dwellings within the project site during the operation phase.

Because sound attenuates and decreases with increasing distance from the source, the noises generated by plant operations would only be heard from close by and would not be expected to carry to off-site receptors.

As a result, the impact is **very likely (3),** with a **negligible (1)** consequence, thus, the overall significance is **Low (3).** Therefore, no mitigation measures are needed.

The transmission pipeline is not considered to exhibit any significant noisy operations, as a result, the noise impact is **very unlikely (1),** with a **negligible (1)** consequence, thus, the overall significance is **negligible (1).** Therefore, no mitigation measures are needed.

Decommissioning Phase

The decommissioning activities of dismantling the WWTP plant and removing the ancillary facilities are associated with potential increased noise levels.

However, as the only receptors will be the workers at the site and within the proposed facilities within the vicinity of the WWTP plant, these increased noise levels are considered occupational noises that require occupational health and safety measures. For any potential receptors other than the workers, the impact likelihood is **likely (3),** with a **negligible (1)** consequence, thus it is of **low (3)** significance and it would be considered temporary impact.

9.2.1.3 Soil

Construction Phase (The WWTP and the transmission pipeline)

To ensure soil sustainability during construction projects a soil management plan must be developed to eliminate risks such as a risk of losing, damaging or contaminating valuable soil resources, whether the soil will be retained for future landscaping on-site, or used or sold off-site.

This plan should include maps for soil types, method of excavations, soil erosion prevention, stockpiling, hauling routes, storage location, reuse purposes and finally whose responsible for soil management at site.

The other potential source of impact to soil is waste generation from construction material, accidental leakage of fuel, oil, or chemicals stored within the project area causing direct contamination to soil which may degrade lower layers of soil depending on the amount spilled.

Assuming that soil management plan and spill response plans shall be in place and implemented by the contractor, it is anticipated that impacts to soil resulting from these activities will be **likely (3),** with a **marginal (2)** consequence, yielding a **medium (6**) impact significance.

Operation Phase

Sewage sludge and effluent from wastewater treatment plants is a major environmental concern. Transport of contaminants or heavy metals from the effluent through the soils may eventually lead to the groundwater contamination and their accumulation in soils and crops.

Farmers nearby the Ramtha WWTP as well as the Jordan valley farmers after implementing the WWTP expansion and the effluent reuse pipeline may use wastewater for the irrigation of their crops. This practice presents both positive and negative effects with respect to agricultural use, as well as in the context of environmental contamination and toxicology. Although wastewater is an important source of essential nutrients for plants, many environmental, sanitary, and health risks are also associated with the use of wastewater for crop irrigation due to the presence of toxic contaminants and microbes if not treated properly. In addition to the risk of deteriorating the quality of the soil by irrigating with treated wastewater will depend on the water's mineral salt content, its salinity level, and the suspended solids it contains. (USAID, 2019)
However, with the improved effluent quality from the expansion of Ramtha WWTP, and complying with the JS 893/2006, the surrounding farmers will be able to grow high value crops and utilize more of the treated effluent.

Soil impacts during operation phase may include also accidental spillage of lubricant, fuel and other chemicals used in the wastewater treatment process that may potentially cause soil degradation. However, the impact is not considered significant given the spill response procedures and good site practice that is expected to be in place as a result, the magnitude of the spill is expected to be minimal during operation.

The proper monitoring programs and implementation of spill response procedures, and proper storage and handling of any chemicals on site, will reduce the probability of the impact.

Therefore, this impact is **likely (3**), with a **Critical (3)** consequence, yielding an overall **Medium (9)** impact significance.

The transmission (effluent reuse) pipeline is not considered to cause any soil impact during the normal operation, in emergency situations like pipeline rupture, the anticipated soil impact is considered of negligible significance since it is reclaimed water used for cooked vegetables.

Decommissioning Phase

During the decommissioning phase, the decommissioning activities are anticipated to have an impact of medium significance to soil. This is due to possible accidental leakage of fuel, oil, or chemicals during dismantling activities. Therefore, proper environmental protection measures should be followed to prevent or control the occurrence of such incidences. The impact is **likely (3)** to occur, with a **marginal (2**) consequence, resulting in a **medium (6)** impact significance**.**

9.2.1.4 Visual Amenity

Construction Phase

The civil works and site preparation activities that are likely to take place during construction of the project components such as primary and secondary clarifiers, different process tanks, pump stations, infrastructure, buildings and other ancillary facilities are anticipated to include materials lay down, site levelling, excavation, trenching works for underground cables, drainage works, foundations for structures, trenching for the transmission pipeline, access roads and internal roads, and backfilling.

The above activities are expected to create temporary visual intrusion on the site and its surroundings including the nearby farms. The visual environment during construction would include equipment and machinery and construction related vehicles such as trucks, compactors, excavators and loaders. However, the current visual context is agricultural land nearby and surrounding the existing Ramtha WWTP. The visual intrusions would be viewed by these farms and by employees. The visual effects of the construction would be of low significance within the project area.

The potential visual impact is **likely (3),** with a **negligible (1)** consequence, resulting in **low (3**) impact significance.

Operation Phase

The residential dwellings are present more than 1 km away from the immediate vicinity of the project area, Moreover, there is a large area of agricultural land nearby and surrounding the Ramtha WWTP.

However, it is expected that the project will have a negligible impact on the surrounding communities. The project area is not anticipated to cause visual impacts since it would be no different to the baseline condition.

Based on the above, the potential visual impacts from the operation phase is considered **unlikely (2)** with a **marginal (2)** consequence, resulting in an overall impact significance of **low (4).**

Decommissioning Phase

During the dismantling of the WWTP, removal of ancillary facilities, and the rehabilitation of the project area, visual intrusions would be likely, but the consequence would be negligible due to fact that such impact would be temporary and short term.

Therefore, the potential impact is **very unlikely (1)** given that there will be remediation procedures on site, with a **negligible (1)** consequence, yielding an overall **negligible (<2)** impact significance.

9.2.1.5 Water Resources

Surface Water

All Phases

Based on the surface hydrological study conducted for the project area; the topography of the catchment is characterized by a considerably low to moderate slopes in the upper parts of the catchments and more gentle slopes in the lower parts which are almost rolling to flat in most of the project area. The general slope of the catchment is 1.4 percent which is a low slope.

There are no major wadis crossing Ramtha WWTP site. Wadi Shoumar is a major wadi passing adjacent to the outer fence of the project site from the east and northeast and continues adjacent to the plot selected for the extension of the project from the northeast. The flow in wadi passing adjacent the project was computed in order to calculate the optimum sizes of the flood protection and flow drainage elements. Based on the Computed Design Floods Related Frequency – specifically for 25 years (**Table 26**) provided in the baseline section of this ESIA study, surveying works are required to the wadi passing adjacent to WWTP and its expansion in order to have cross sections to calculate hydraulically the water height during the floods and design proper protection measures for the plant. Another wadi exists and it is passing near Shallalah WWTP which is Wadi Tilala.

In addition, indirect runoff is contributing to the wastewater volumes during rainfall because of inside broken line or broken or uncovered manholes at Wadi Shoumar, this leads very often to important penetration of storm water into the sewerage system (planned as separate system) due to damaged manholes, opened manhole covers.

According to the feasibility study for the proposed project, the calculated flow in excess of the proposed design peak hourly flow of 55,000 m^3/d will be diverted to the plant's stormwater ponds. After the stormwater ponds are full, flows would bypass the plant to the wadi. Since this would only happen during a storm with heavy precipitation, the bypass flow would be diluted with rainwater reducing potential environmental impacts on surface waters.

As a result, the impact on surface water are considered **likely (3)** with a **Critical (3)** consequence, yielding a **Medium (9)** impact significance.

Transmission pipeline

The excess treated effluent from Ramtha WWTP could be used in the Jordan valley where it is most needed. This would eliminate the potential negative impacts to the environment, Yarmouk River, and Wahdah Dam from the discharge of excess effluent to the wadi downstream of the Ramtha WWTP.

In order to avoid any damage to the pipeline by floods and to let the conveyance pipe cross the wadi safely, it is recommended to fix the pipe with the ceiling of the box culverts from outside (inlet or outlet).

A motorized isolation valve to allow the Shallalah WWTP to shut off the flow from the Ramtha WWTP in case of an emergency at the Shallalah WWTP. This would prevent impacts on surface waters near Shallalah WWTP from the overflow of excess effluent from Ramtha WWTP.

Through the implementation of the design features described above, the potential impact would be greatly minimized. As a result, the impact of the transmission pipeline on surface waters is considered **unlikely (2)** with a **Marginal (2)** consequence, yielding a **Low (4)** impact significance.

Groundwater

All Phases

According to a previous study for the groundwater vulnerability map of the Ramtha WWTP using the modified DRASTIC, it was found that the plant lies within the high vulnerability class. This is due to the fact that depth to groundwater is shallow, with high net recharge value, high aquifer permeability, low slope, soil texture, high hydraulic conductivity, and high lineament density and land use (agriculture). ((Awawdeh, M., Obeidat, M. & Zaiter, G. Appl Water Sci (2015) 5: 321.)The existing WWTP would be functioning until the commissioning the new expansion treatment plant and, it is anticipated to continue to impact the groundwater negatively until it is shutdown.

During the operation phase of the new expansion, the effluent would be reused for the irrigation of cooked vegetables in the nearby farms and transmitted to Shallalah reservoir for Jordan valley irrigation. The use of treated effluent for irrigation shall be in compliance with the Jordanian Standard for reuse for irrigation of cooked vegetables (JS893/2006 category 3(A)) and would allow the farmers to grow high value crops. A large part of the effluent would be stored in large ponds until needed by the local farmers, so the effluent is not discharged to the wadi and wasted.

This would allow for 100 percent of the annual treated effluent to be reused for crop irrigation until 2025, but the percent utilization decreases as influent flows to Ramtha WWTP increase over time. By 2045, reuse of the annual effluent production would drop to 88 percent in 2045.

Update the effluent reuse every few years with the new flow projections will identify the additional storage needs for full utilization of the effluent for irrigation. ((USAID, . Dr. Abu Awwad), 2019)

As a result, no groundwater contamination is anticipated from project activities.

The impact is assessed as **unlikely (1),** with a **Critical (3)** consequence, yielding a **Low (3)** impact significance.

9.2.2 Biological Environment

Based on the result of the biodiversity study, the potential impacts of the construction and operation phases of the project have been identified. Generally, all recorded species were common in similar habitats in the country. Furthermore, the project activities would not have a major adverse impact on biodiversity aspects on the site especially if the mitigation measures mentioned below are implemented and maintained. The mitigation measures are expected to decrease potential negative impact to the minimum.

Construction Phase

9.2.2.1 Flora

The recorded flora species at the proposed site for the project are considered of common species at similar habitats in other parts of the country. Due the limited area of the project activities, and the current agricultural activities of the proposed site, it is expected the potential negative impact on the flora species would be very limited. Construction phase will involve clearance of vegetation for both the permanent or temporary project structures. Some vegetation would be permanently lost, but as the proposed site is currently used for farming the impact on wild plant species would be very limited and no significant negative impact is anticipated.

9.2.2.2 Terrestrial Fauna

No significant impact is expected on fauna species except disturbance that would occur because of construction activities. Disturbance of wildlife communities from the increased activity resulting from the construction, will come in the form of noise. Some fauna species will tend to leave the area due to disturbance resulted from construction activities, however, such activities would be in a limited area and will not affect large number of fauna species. Due to machineries movement an accidental killing of fauna species is also expected.

9.2.2.3 Sensitive Habitats

The site is close to the Irbid-Mafraq Plains IBA. The construction of the WWTP expansion is expected to have high level of disturbance at the WWTP site that would negatively affect the birds using the site, but due to short period of construction phase and small area of operation the negative impact will not be significant. To decrease this potential impact to the minimum it is recommended to perform the construction activities outside the migration and breeding season. The bird migration and breeding seasons are from November to January and from May to August.

The alternate method for minimalizing the potential impact is by screening around the existing ponds can be used to block the bird's view (bird's eyesight) of the construction work areas; this screening would be maintained throughout the migration and breading seasons. Additionally, construction work should be avoided during the early morning (before 8:00 am) and late afternoon (after 5:00 pm) in the bird migration and breading season, work may proceed as normal between 8:00 am and 5:00 pm.

The project will implement the alternative method with screening to mitigate these construction impacts.

No significant impact terrestrial ecology is expected; therefore, it is assessed as unlikely (2), with a marginal (2) consequence, therefore, the impact significance is low (4).

Operation Phase

9.2.2.4 Flora

No significant impact is anticipated during operation phase. Therefore, the impact significance is **negligible.**

9.2.2.5 Terrestrial Fauna

Terrestrial fauna in Jordan have a very wide distribution. The project activities during operation phase is not considered to have a measurable adverse impact on fauna species, most of the species reported from the site also occur in other areas and the project site is not considered a critical habitat for any faunal species. However, none of the reported fauna species from the site are confined to the project area, and these species can move to other suitable habitats. In contrast the project could have positive impact on waders and waterfowls as the ponds will form a good habitat for them. where the sewage treatment plants are artificial habitat that is suitable for waterfowls and waders as they have open water bodies that rich with insects and phytoplankton that is considered a good source of food for them. In addition, the existing pools are suitable habitat for waders as waders prefer shallow water and muddy habitat.

9.2.2.6 Sensitive Habitats

No significant negative impact is expected on the sensitive habitats during the operation phase. The existing ponds and associated effluent transportation systems would constitute an enhancement of habitat for certain species including waterfowls and waders.

However, the beneficial effect is considered minimal; as a result, the impact is **unlikely (2)** with a **negligible (1)** consequence yielding **low (2)** impact significance.

Decommissioning Phase

The activities associated with decommissioning would involve dismantling of the WWTP and removal of its facilities.

This is a short-term phase that could result in some additional noise and dust disturbances. These activities are not anticipated to harm any flora or fauna elements provided dust suppression measures and other procedures are followed. On the other hand, decommissioning activities may cause disturbance to bird species similar to what was discussed during construction.

The impact is **unlikely (2)** to occur with a **marginal (2)** consequence**,** thus the impact significance is considered to be **low (4).**

9.2.3 Pest Nuisance

The best climatic condition for most pests is the availability of warmth which enhance the breeding. The most probable sources of such insect pests would be agricultural activities, waste dumping of dead poultry and animals which observed abundantly in the WWTP surrounding area, and the existing WWTP operations specifically the sludge disposal around the proposed expansion of Ramtha WWTP which will allow flies, mosquitoes and other insects to breed. Under the proposed project, the digestion and stabilization of sludge would reduce the volatile organic content of the sludge; which makes the treated sludge less odorous and reduces the risk of insect's growth and disease.

However, during the operational phase of the treatment plant, a floating cover will be added to the effluent storage pond to reduce algae growth and water loss due to evaporation, which will prevent the pest breeding, but also, pest management will need to be regularly carried out, even though it is not likely to eliminate these insects totally, adequate efforts must be made to at least keep it to a minimum. This floating cover will be installed only on the new effluent storage pond, if the existing polishing ponds will not have covers if they used for additional effluent storage.

Therefore, the impact is **likely (3)** given that there will be remediation procedures on site, there would be a **Marginal (2)** consequence, yielding an overall **Medium (6)** impact significance.

9.2.4 Waste Management

Construction Phase

Improper management of non-hazardous and hazardous waste generated during construction may lead to impacts on soil, water, visual environment, in addition to health and safety of workers.

Non-hazardous waste includes paper, wood, plastic, scrap metals, and glass. Hazardous waste includes but is not limited to absorbent material, batteries, tires, metal drums, chemicals and empty chemical containers, and waste oil from machinery lubricants.

All waste generated at the construction site would be segregated, handled, stored and managed as per contractor's waste management procedures. Domestic wastewater generated at site would be directed to the WWTP, and solid waste shall be disposed in a secured area for trash at the nearest landfill.

The impact is **likely (3)** to result in impacts related to the generation and disposal of wastes, but with proper management the consequence would be **marginal (2),** therefore, the impact significance is assessed as **medium (6).**

Operation Phase

Waste generated during operation phase would include domestic waste (due to workers' domestic activities). Also, domestic wastewater and liquid effluent generated from site activities, such as toilets and sanitation facilities during operation phase, would be directed to the WWTP. The end products of a wastewater treatment plant are sludge and treated wastewater.

The wastewater treatment operation would generate large quantities of sludge that may result in a large negative impact on many environmental aspects (soil, groundwater, air, etc.) if not treated properly. Applying the conventional anaerobic digester technology will decrease the sludge quantities dramatically

Ramtha Phase 1 Cake Production		Ramtha Phase 2 Cake Production	
Ave Day		**Ave Day**	
Dry solids	5,474 kg/d	Dry solids	9,185 kg/d
At 50% Solids		**At 50% Solids**	
Wet Weight	12,591 kg/d	Wet Weight	21,126 kg/d
Wet Volume	11 m^3/d	Wet Volume	18 m^3/d
Peak Month		**Peak Month**	
Dry Solids	6,782	Dry Solids	11,309
At 50% Solids		**At 50% Solids**	
Wet Weight	15,599 kg/d	Wet Weight	26,012 kg/d
Wet Volume	14 m^3/d	Wet Volume	23 m^3/d

Table 56: Ramtha WWTP Sludge Production

Using the drying beds as the final step of the process, drying is achieved from sun exposure and ambient conditions. Filtrate from the drying beds is sent to the excess water tank before ultimately returning to biological treatment processes. Dried sludge is temporary stored on the plant site until there is sufficient quantity for YWC to issue a contract for a hauler to take the sludge to the Al-Ekaider landfill. This process would produce a second-class sludge. However, sludge may be subject to fire and explosions if it is not properly disposed of, the proposed project would apply digestion and stabilization of the sludge which reduces the volatile organic content reducing the risk fire or explosion in the treated sludge. The potential impact during operation includes the risk of spills from chemicals used in the treatment processes. WWTP use a lot of chemicals and they need to be managed, stored, handled, used, and disposed of properly to avoid impacts on workers and the environment.

Therefore, the potential impact from operation is **likely (3),** with a **Critical (3)** consequence, yielding a **Medium (9)** impact significance.

Decommissioning Phase

Waste generated during decommissioning limited to non-hazardous and inert wastes such as scrap metals, paper, wood, plastic, given that the contractor will adhere to the set waste management procedures.

Similar to the construction phase, potential generation of hazardous waste includes absorbent material, batteries, used pumps, tires, metal drums, empty chemical containers and / or unused chemicals, waste oil from machinery lubricants.

In addition, there may be remnants of treated or untreated sludge from the old WWTP processes. Decommissioned equipment may contain oils or other chemicals that would need to be drained and contained before the equipment could be dismantled and moved.

To avoid the generation of hazardous wastes from dismantling the WWTP and disconnection of the plant components, it is recommended that these materials and components are evaluated to determine whether they are suitable to extend their life or return them the manufacturer for recycling or to be reused in other facilities depending on their efficiency and feasibility.

The impact of waste generation is considered **likely (3),** with a consequence of **marginal (2)** during to this short-term phase, given that specific waste management procedures would be implemented on site, yielding an overall impact significance of **Medium (6).**

9.2.5 Health and Safety

Construction Phase

The construction activities include site preparation, infrastructure and utilities installation, and building structures. As a result, there would be potential impacts on workers' health and safety due to exposure to risks through construction activities that lead to accidents cause injuries or death. The most frequent risks that cause accidental death and injury are:

Safety risks such as: tripping; falling due to working at heights; potential fire due to hot work, smoking, failure in electrical installations; and electric shocks.

Health risks: Injuries such as: lifting, lowering, pushing, pulling and carrying; temporary or hearing loss which usually comes from noise generated from machinery used for excavation or piling work and from compressors and concrete mixers.; heat stress and working during high temperatures; dermatitis that can arise from contact with substances that cause dermatitis such as wet cement, asphalt, solvents used in paints, glues or other surface coatings.

The contractor will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of nonconformance events – this is associated with the application of effective Environmental, Health and Safety (EHS) policies by the contractor. The contractor shall ensure all potential risks during construction phase are assessed and all prevention and mitigation measures are in place accordingly. The contractor shall ensure all workers during construction comply with safety procedures through training, awareness and supervision in addition

to the adherence to the Occupational, Health, and Safety and Environmental procedures and emergency response procedures on site and issuing relevant procedures for different types of work.

Moreover, the contractor shall provide all appropriate resources (Personal Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

It is worth noting that the Jordanian Labor Law No. 8 for the year 1996 and its amendments mentions that when an employee is affected with one of the occupational diseases, disabilities or death due to working practices and a medical authority report is submitted stating the condition, the employer is then obliged to pay the compensation payment according to the law. Moreover, the provisions of the 'General Safety Code of Construction Projects Implementation', as part of the Jordanian National Building Law must be observed carefully by the assigned contractor, in addition to the fire protection code. The occurrence of occupational health and safety impacts such as death and serious injuries is considered irreversible and highly significant since human receptors are adversely affected.

Given the health and safety systems and precautions that are expected to be applied by the contractor, the impact is considered to be **Likely (3)** with a **Critical (3)** consequence, yielding a **Medium (9)** impact significance.

Operation Phase

Wastewater treatment plant operators may be exposed to a variety of hazardous chemical agents, contained within the effluents and the reagents used in the wastewater processing, these chemical agents may cause acute poisoning, chemical accidents (e.g., skin burns, injury to the eyes, etc.) damage to the respiratory system, allergies, dermatitis, or chronic diseases. Wastewater treatment plant operators may be injured by slips, trips and falls on wet floors; by falls into treatment ponds, pits, clarifiers or vats and by splashes of hazardous liquids; they may suffer cuts and pricks from sharp tools, diseases caused by infectious agents (bacteria, viruses), diseases caused by insects or rodents proliferating in the sludge drying beds or other parts of the WWTP. Workers exposed to hazards related to work in confined spaces. Other common hazards include electric shock, explosions, and entanglement in moving machinery.

Therefore, the project developer (WAJ) shall ensure all risks from operation activities to be assessed and to establish specific work procedures for tasks and developing Occupational, Health, Safety and Environmental procedures for the operation phase to prevent and reduce the incidence of health and safety risks and avoid non-conformance events.
(ILO/CIS, 1999) updated 2012.

As a result, the potential impact is considered **Likely (3)** with a **Critical (3)** consequence, yielding a **Medium (9)** impact significance.

No health and safety impacts are anticipated from the operation of the transmission pipeline to Shallalah WWTP.

Decommissioning Phase

The decommissioning activities would include equipment dismantling and possibly demolishing facilities at project site. As all project components will be assessed for reuse or recycling after decommissioning, the prospect risks from decommissioning phase will be limited to dismantling and demolishing activities including moving all components to their final destination. There will be potential impacts on workers' health and safety due to exposure to risks through decommissioning activities as following:

Safety risks such as: tripping; falling due to working at heights; potential fire due to hot work, smoking, failure in electrical installations; electric shocks.

Health risks: Injuries such as: lifting, lowering, pushing, pulling and carrying; temporary or hearing loss which usually comes from noise generated from machinery used for excavation or piling work and from compressors and concrete mixers etc.; heat stress and working during high temperatures; dermatitis that can arise from contact with substances that cause dermatitis such as wet cement, asphalt, solvents used in paints, glues or other surface coatings.

Therefore, the project developer (WAJ) will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The developer shall ensure all prospect risks during decommissioning phase are assessed and all prevention and mitigations measures are in place accordingly.

As a result, the potential impact is **Likely** (**3**) with **Critical** (**3**) consequence, resulting in a **Medium** (**6**) impact significance.

9.2.6 Socio-economics

Construction Phase (WWTP and the transmission pipeline)

Employment Opportunities

Positive benefits of the project may arise from short-term job opportunities during construction which may range up to 36 jobs at peak. Peak construction is expected for 18 months of the project. These personnel include engineers, specialists, project partner and representatives, suppliers as well as unskilled construction workers. The project developer (WAJ) shall ensure that the majority of project's jobs to be dedicated for Jordanian workforce, with prioritizing locals for these job opportunities, should their qualification match the needed requirements.

In terms of gender issues, the job opportunities during construction is mainly limited to men due to required physical efforts and other cultural considerations, therefore jobs available to local men can benefit women indirectly through support services such as a) renting homes; b) selling goods and products indirectly through benefiting from income from the job provided for the spouse or head of the household.

The impact is assessed as **positive (+);** however, it would be short-time during the construction period. Maximizing the impact can be through selecting local staff as much as possible or sourcing goods and services from locals.

Traffic

During the construction phase traffic is expected to increase to a certain degree due to the nature of activities that will take place such as the transport of equipment and materials to and from the site through the surrounding road network. Additional traffic load would be evident at certain times during the day, especially if there are slow moving heavy vehicles transporting material to and from the site.

Vehicle traffic can cause congestion on road networks around and within the site and thereby leading to potential accidents. In addition, anticipated traffic congestion due to the construction of the transmission pipeline route.

The potential traffic impacts can possibly occur during the duration of construction, especially during working hours. However, this is considered a short-term impact.

During construction, workers would likely reside in the nearest accommodation facilities to the site (possibly in Ramtha and surrounding) and labor camps with kitchen facilities and offices will most likely be present on site for daily use during working hours. As a result, it is anticipated that a number of vehicles (buses, cars) will be used to transport personnel to and from the project area. However, there is still a possibility for having worker accommodation facilities on site; if this is the case, daily transportation of workers to and from the site would be minimal. Furthermore, the workers will likely adhere to a special shift system under the direction of the construction contractor; and may not all be present on site at once. Such options are still being explored and the exact details would be determined once the construction contractor is appointed.

Traffic impacts are likely to happen but is not anticipated to cause any permanent effect on the receiving environment, also the number of vehicles provided during construction is not anticipated to cause significant traffic impacts to the area

This impact is likely to happen but is not anticipated to cause any permanent effect on the receiving environment. Hence, the impact is **Likely (3),** with a **marginal (2)** consequence, resulting in a **medium (6)** impact significance.

Potential Implications on Local Community Groups

The project area is government owned land. As mentioned in the baseline section, there is a farmer currently growing crops on WAJ property on the west side of the WWTP, where the expansion of the Ramtha WWTP is proposed. The land user were consulted and he asked for compensation for his loss if the contract is terminated before the expiry date.

The transmission pipeline is proposed to be in the roadway right-of-way under the authority of Ministry of Public Works and Housing which should be notified for the required approvals before construction.

The potential for impacts relating to World Bank's ESSFs with regards to Land Acquisition and Involuntary resettlement have been considered through the ESIA. This assessed the situation with regards to the two main categories:

Category 1: Physical Displacement

The project will be developed on government land that is currently occupied by farmers growing crops on WAJ property on the west side of the WWTP. It is WAJ's intention to use the land for the expansion of the Ramtha WWTP. These farmers were notified during scoping and before construction work.

Category 2: Economic Displacement

The project area is government owned land which indicates there is no land ownership conflicts, The AJWE team met with the farmers (PAPs) at the Ramtha Agricultural Directorate. The overall goal of the consultation with PAPs is to consult the project affected people about the project-anticipated physical or economic impacts.

The consultation reveals no Resettlement Action Plan (RAP) is required, but only one person is affected by the project Dr. Tayseer Al-Masri who has been leasing the 100 Dunum for the last 25 years, and the agreement will expire by August 1, 2022, therefore, the development of the project at the proposed location would affect economically this farmer. The 100 Dunum is cultivated with annual and perennial trees, in addition to summer and winter crops. Dr. Al Masri stated that if the contract terminated before the expiration date WAJ must compensate him for the loss he might encounter.

After consultation with Dr. Almasri, he showed his w illingness to negotiate the compensation with an . estimation of xxxx-xxxxJD/year if the contract terminated before 1 August 2022

Therefore, the project is in compliance with ESSFs and not expected to cause any serious impacts to such local communities. As a result, the impacts are considered **Unlikely (2)** to occur with **a Marginal (2)** consequence, yielding a **Low (4)** impact significance.

Community, Health, Safety and Security

The closest community to the project area is 1 km and closest commercial activity is an animal feed factory located around 3.5 km away from project boundary. The project area is not expected to cause any serious or long-term impacts to such communities. All safety and controlling measures would be in place prior to commencement of construction activities, and the project site will eventually be secure and access will be controlled. Any potential public risks during construction would be avoided. No direct community residents/locals/vulnerable groups are expected to be significantly affected by project activities. The nuisances that they may be exposed to on a short-term basis during construction are traffic congestion at certain times, noise and dust and general disturbance from construction activities.

The potential for labor influx into the site, especially during construction, is not expected to negatively impact the local communities, and communities may even benefit economically in terms in income generation if such workers decided to be accommodated in nearby areas. The construction phase is expected to provide opportunity for skill transfer and increased sales for local retail and service industries which will benefit the community.

The potential impact to community, health, safety and security is not expected therefore is considered **Likely (3)** with a **Critical (3)** consequence, yielding a **Medium (9)** impact significance. Even for the project operation phase, such impact is not expected.

Labor and Working Conditions

Common activities during construction such as excavations, lifting, movement of heavy machinery, or handling chemicals, can introduce occupational health and safety risks to workers as mentioned under health and safety impacts described above. Other risks are also associated with child labor and forced labor.

Effective systems in line with the World Bank ESSF2: Labor and Working Conditions, World Bank EHS guidelines and International Labor Organisation (ILO) requirements and good site practices in terms of site services and facilities shall be designed and implemented to manage such potential risks. Such systems include a set of Human Resources policies that will comply with Jordanian Labor Law and required international guidelines (i.e. World Bank, ILO). The contractor shall also take reasonable steps to develop a workers' grievance mechanism to be implemented during construction to receive and follow up on worker grievances.

The construction phase shall be managed by the contractor and supervised by the project operator and developer (YWC and WAJ) to ensure that such incidents do not take place – competent persons shall be appointed by the contractor on site to oversee all activities and carry out relevant audits and inspections. Such practice shall not be limited to direct contractor staff only, they shall also be applied other employment relationships such as workers engaged by third parties and the supply chain (vendors/suppliers) that the contractor deals with.

During construction, workers would likely be accommodated in the nearest accommodation facilities to the site (possibly in Ramtha and surrounding areas) and labor camps with kitchen facilities and offices will most likely be present on site for daily use during working hours. However, there is a possibility for having worker accommodation facilities on site; if this is the case, the facilities shall be established in accordance with the specifications of the International Labor Organisation (ILO) standards and guidance published by EBRD and IFC.

A grievance mechanism during the operation phase shall also be developed and will under the responsibility of the project developer and/or the operation and maintenance contractor.

The implementation of an effective system, development of relevant plans and contracting with suppliers and sub-contractors that satisfy World Bank requirements will reduce the risks of labor and working conditions throughout the project phases. As a result, the potential impact is considered **Unlikely (2)** with a **Marginal (2)** consequence – yielding an overall **Low (4)** impact significance**.**

Operation Phase (WWTP and the transmission pipeline)

Employment Opportunities

The long-term operation of the WWTP would provide specialized employment and training for a small local workforce (up to 19 people) to be hired as part of the operation and maintenance contractor team. However, these opportunities are assumed to be limited in number and require people with certain technical qualifications. Also to manage local community expectations and to maximize this impact a Corporate Social Responsibility plan would be developed and implemented by WAJ or the operator to ensure a certain budget will be allocated for community development activities. No female is currently working at the WWTP and it was declared by the local community (farmers) it is not accepted socially in the area.

The impact significance of employment opportunities is assessed as **positive (+).**

Traffic

Impacts from traffic are not expected to occur during the operation phase due to the low number of personnel present within the project site. Furthermore, a new septage unloading station will be provided for two truck unloading. Therefore, increased traffic loads are not considered a significant impact during operation. As a result, the potential impact is **Unlikely (2)**, with a **Marginal (2)** consequence, yielding an overall **Low (4)** impact significance.

Economy and Society

Four benefit types associated with the proposed Ramtha WWTP expansion are based on expanded population served and agriculture use.

Influent related:

- Environmental – reduce environmental degradation of water supply. The increase in wastewater treatment capacity will lead to a reduction in raw wastewater discharges to the environment. The WWTP expansion will decrease untreated wastewater discharges from as estimated 1.81 million m^3 in 2025 to 6.06 million m^3 in 2045. The increase quantity of treated wastewater available for agriculture uses would decrease pressure to use clean potable water that can be used for human consumption. In the localities surrounding Ramtha the estimated price of water saved would be ($0.95) per m^3 in 2019 according to the Ramtha WWTP expansion 2019 feasibility study.
- Health – reduce water-related diseases (e.g., cholera outbreak). Building upon the Nevsehir and EU experience, annual per person benefits associated with the Ramtha WWTP expansion are estimated at $15.

Effluent related (agriculture use):

- **Irrigation –** reduce aquifer water use (substitution-effect). The net change in effluent agriculture use associated with the plant expansion and storage/pumping reuse option indicates annual water savings ranging from 2.11 million cubic meters in year 2025 to 5.38 million cubic meters by year 2045 Again, the price of water ($0.95) was applied to the net water savings.

- **Fertilizer –** reduce fertilizer use (if permitted). The mineral fertilizer cost savings of using WWTP effluent ($0.38) applied to the water savings.

Type	Description	Estimation
Environmental	reduce water supply degradation	Treated WW savings * water shadow price ($0.95 /$m^3$)
Health	reduce water-related diseases	Net new population served * per capita cost ($15.00)
Irrigation	reduce aquifer water use	Net agriculture use * water shadow price ($0.95 /$m^3$)
Fertilizer	reduce fertilizer use	Net agriculture use * fertilizer cost ($0.38 /$m^3$)

Source: (USAID, 2019) expansion of Ramtha WWTP feasibility study

Table 57: Benefit Types and Estimation

The impact significance to the economy and society from operation is assessed as **positive (+).**

Project Support to Jordanian Government in Hosting Refugees

As of March 2016, there were approximately 636,000 Syrians (6.7 percent of Jordan's population) formally registered by UNHCR although the Jordanian government considers a more realistic number to be 1.27 million Syrians. According to government statistics residential consumption rose by 9.44 percent from 2011 to 2012, compared to just 5.9 percent between 2010 and 2011.

Increasing numbers of Syrian refugees causes an increasing demand for water in various governorates, putting significant pressure on water resources.

The key point is that there is a large stable population of refugees in the northern part of Jordan that is stressing existing water resources and sanitary systems. The proposed project addresses that need by expanding the treatment capacity and the volume of treated effluent available for irrigation for agriculture. Therefore, positive benefit.

Therefore, the proposed project addresses the need to provide services to the large refugee population in Irbid Governorate and the impact significance is assessed as **positive (+).**

Decommissioning

Employment Opportunities

Short-term job opportunities may arise during decommissioning; however, it is not expected to negatively impact permanent personnel at the WWTP since the new facility would commence operations, and existing permanent staff would move to the new facility.

Although this impact is **Very unlikely (1)** given that fact that an upgrade is expected for the facility**,** however, the consequence is considered with a **Marginal (2)** since current permanent operating personnel will move to the new facility while decommissioning is ongoing, yielding a **Low (3)** impact significance.

Traffic

The anticipated impacts during decommissioning are similar to those described for the construction phase, where the heavy machinery that transports disassembled parts of the WWTP might be of more significant than normal vehicles and pickups.

Proper management actions with adequate mitigations can reduce significantly such anticipated impacts.

The potential traffic impact is **Likely (3),** with a **Marginal (2)** consequence, thus the impact significance is considered to be **Medium (6).**

9.2.7 Archaeology and Cultural Resources

Construction & Decommissioning Phases

Based on the archaeological survey performed by the AJWE team; the survey determined that there are no important archaeological and cultural heritage sites within the project area. If any archaeological remains are found during project implementation; site works must cease and the DoA must be informed of this in order to assess the find.

The consequence of finding such remains would be minor if construction was coupled with effective monitoring during site activities and paying attention to the identified sites. If such similar remains are found early coordination with the Jordanian Department of Antiquities and proper chance find procedures are implemented in accordance with the Jordanian Antiquities Law would minimize adverse impacts.

It is concluded that there is no anticipated impact from construction or decommissioning on these receptors; therefore, the impact assessment process for this receptor has yielded a low significance.

The chance find site impact is **very unlikely (1),** with a **Critical (3)** consequence if archaeological remains happen to be discovered, therefore, the overall impact significance is considered to be **low (3).**

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10 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The project developer (WAJ) is committed to achieving and maintaining environmental standards, such that Jordanian environmental regulations and World Bank ESSF are met, and potential adverse environmental impacts resulting from the project activities are minimized as practicably as possible. This would be achieved through appropriate project planning and methods of project operation.

Implementation of on-going environmental monitoring programs will enable the assessment and modification, if required, of the Environmental and Social Management Program.

10.1 Objectives

This Environmental and Social Management Plan (ESMP) aims at ensuring the application of the mitigation and monitoring measures needed to reduce and control the various environmental and social impacts associated with the implementation of the proposed project.

The key objectives of the ESMP are summarized below:

- Minimizing any adverse environmental, social and health impacts resulting from the project activities;
- Conducting all project activities in accordance with relevant Jordanian legislation and applicable World Bank and AFD guidelines.
- Implementation of on-going environmental and social monitoring program;
- Include an Environmental and Social Safeguards Framework (ESSF) embedded in the ESMP to monitor the implementation of mitigation measures and propose relevant performance indicators.
- Periodic review of the environmental and social management programs to allow for iterative improvement;
- Ensure that all stakeholder concerns are addressed.

Overall, this ESMP aims at ensuring the application of the mitigation and monitoring measures needed to reduce and control the various environmental and social impacts associated with the implementation of the proposed project as presented in **Table 58, 59 and Table 60**.

10.2 Mitigation and Monitoring

Further to the impacts assessed in the previous section, this section presents more detailed mitigation measures and monitoring requirements (included in the following tables) that correspond to the impacts described in the previous section.

Mitigation measures aim to offset negative impacts that may result from the project, and monitoring is the process of measuring the success of mitigation measures in order to assess their effectiveness. Reporting is the process of measuring actual performance or how well the mitigation measures have been implemented, including the format, timing and responsibility for reporting of the monitoring results.

Although the ESIA process did not reveal any impacts with a high or critical significance (the highest was found to be medium), this section provides measures that further reduce those impacts considered to be medium as well as those considered to be low.

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Pre-construction phase		Rented land where the expansion of WWTP will take place, WAJ to compensate the farmer if construction started before the contract expiry date.	Once		Agreement with the Farmer	WAJ	Pre-construction phase
		renewable energy with a capacity of more than 1 megawatts should seek the required permits before project commencement in accordance with the provisions of Article (7) of the Renewable Energy and Energy Conservation Law No. (13) of 2012 and in accordance with the provisions of Article 28 of the Temporary General Electricity Law No. 64 of 2002.		Once		License approved	WAJ

Table 58: Environmental and Social Management Plan during Pre-construction phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Physical Environment							
Air Quality	Dust generation due to construction activities	• Setting an appropriate site speed limit to reduce dust generation from vehicles travelling over unmade surfaces. • Unnecessary handling of dusty materials will be avoided such as minimising drop heights when loaders dump soils into trucks. • Train workers to handle construction materials and debris during construction to reduce fugitive emissions. • Cover trucks when transferring fine and dusty materials outside the project location. • Vehicle and machinery movements during construction shall be restricted to designated routes at all times where practicable. • No stockpiling of fine material is allowed within the construction sites. • The contractor shall use dust suppression measures on unpaved roads, excavations, stockpiles, and for transport of excavated material to reduce airborne particulates near sensitive receptors, especially during windy conditions.	Visual monitoring of emissions from vehicles and equipment Visual monitoring of dust generated from construction activities, construction vehicle movement, stockpiles, storage of construction materials, etc. Visual monitoring of the implementation of dust suppression	Daily At construction site and at boundaries of the nearest public receptor	Contractor shall prepare and submit monthly report to Supervising Engineer who will in turn communicate it to WAJ.	Compliance with Jordanian ambient air quality Standards JS 1140/2006 Complete records of monitoring activities. Regular vehicle maintenance records. No visible dust plumes originating from construction sites.	Construction Contractor
	Exhaust emissions due to operation of construction plant and machinery	• Ensure adequate maintenance and inspection of vehicles to minimize exhaust emissions. • Not running engines for longer than is necessary.					

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Noise	Increased noise levels due to constrcution & machinery	• The contractor shall use heavy equipment, machinery, and fuels in compliance with national regulations. The contractor shall perform regular maintenance on all equipment, vehicle and machinery to prevent noise emissions. • The contractor shall limit idling of engines when not in use to reduce its contribution to noise emissions. • Contractor shall restrict work activities to be between 8 am to 5 pm on weekdays with coordination and approval of WAJ and/or supervising Engineer and shall avoid work on Fridays (weekend) in residential areas. If work was initiated at nighttime, approvals must be obtained by WAJ. • The contractor shall provide 24 hours advance notification of construction schedule and activities with potential disturbance to nearest residences and sensitive receptors which are adjacent to the Ramtha WWTP.	Noise measurements At boundaries of the nearest public or sensitive receptor	One month after start up every quarter after that., after receiving any complaints from workers or third parties.	Contractor shall prepare and submit quarterly report to supervising engineer who will in turn communicate it to WAJ.	Compliance with MoE and national guideline limits for environmental noise at sensitive receptors: Noise instruction for year 2003 Complete records of monitoring activities	Construction Contractor
Soil	Soil contamination at the WWTP plant and along the transmission pipeline	• A spill prevention and response plan shall be prepared by the contractor in order to control any inadvertent leakage or spillage. • Machineries and equipment shall be checked by the contractor on daily basis to ensure that there is no leak of oil, fuel, greases or other liquids. If leaks are detected, machineries and equipment shall not be operated until repaired. • Construction of bunds around relevant work and storage areas. Bunds in areas of hazardous chemical storage (including temporary storage) should be lined to contain accidental spillage and minimize the potential for migration to the underlying soil. • Any spilled chemical shall be immediately collected and disposed of in accordance with Spill Prevention and Response Plan and Saftery Data Sheets (SDS). • Contractor shall ensure that a spill kit and adequate PPE is available at the site for emergency cleanup activities in case of chemical/oil spillage.	Visual Inspection of storage area, and machinery through conducting regular audits of on-site activities and incident reporting forms. Visual Inspection of any temporary soil storage and run-off controls	Daily	Contractor shall prepare and submit monthly report to supervising engineer who will in turn communicate it to WAJ. for accidental spillage. All unplanned incidents/accidents must be recorded by the contractor.	Number of spills or incidents to be recorded Up-to-date. complete records as required by spill prevention and response procedures. Training records of personnel on spill prevention and response procedures.	Construction Contractor
	Soil disrtubance	• The contractor shall adopt soil conservation methods all sides of the entire project to reduce the area of destruction during excavation works. • Removed topsoil shall be stored separately in order to spread over restored areas when applicable. • Upon completion of excavation works, the contractor shall restore disturbed areas to their original condition. • Roadway restoration works after completion of transmission pipeline erection. • To control soil erosion, surface run-off should be collected from all paved working areas into retention ditches to restrict concentration of flows	Visual inspection of disturbed area in and around construction site for erosion. Visual inspection of waste storage area, chemical storage area and fuel storage area for spills and leaks. Visual inspection of vehicles, machinery and equipment for leaks of oils, grease, etc.	Daily	Contractor shall prepare and submit monthly report to supervising engineer who will in turn communicate it to WAJ. All unplanned incidents/accidents must be recorded by the contractor. Corrective actions reporting	No. of unplanned incidents/accidents (soil erosion) recorded by the contractor. Up-to-date and complete records.	Construction Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Visual Amenity	Visual impacts from construction activities such as materials lay down, excavation, backfilling	• The contractor shall ensure general cleanliness and good housekeeping practice at the project site at all times. • Prohibit the disposal of solid waste into the surrounding land during construction activities. All inert material surpluses shall be managed within the limit of the project site. • The contractor shall restore disturbed areas back to their original conditions after excavation works have been completed.	Visual inspection of general housekeeping and cleanliness at site in addition to waste management on site.	Daily	Contractor shall prepare and submit monthly waste report to WAJ.	Good housekeep-ing practices and tidiness of work areas within the project site.	Construction Contractor
Waste Generation	Hazards presented by improper management and handling of hazardous and non-hazardous waste during construction.	• The contractor shall segregate storage for different types of wastes, such as hazardous, non-hazardous, recyclable, construction material, plastic, paper, etc. to facilitate proper disposal. • The contractor shall provide a separate storage area for hazardous materials. The hazardous materials/products must be labeled with proper identification of its hazardous properties. • Chemical waste shall be stored in accordance with the provisions of Safety Data Sheets (SDS). The contractor shall keep SDS onsite. • Littering in the project area and surrounding areas shall be prohibited. Contractor shall provide trash bins within each construction site so as to prevent littering in the project area and surrounding areas. • All inert and domestic waste generated during construction must be removed from site and disposed in accordance with the requirements of landfills approved by the local municipality. • Hazardous wastes generated shall be disposed off-site in coordination with MoE to an approved waste facility. (Swaqa) • The contractor shall establish regular intervals for waste collection and disposal as per contractor's waste management procedures.	Visual monitoring of site cleanliness and proper storage and handling of hazardous waste. Inspect that segregated waste disposal or storage areas are clearly marked.	Daily	Contractor shall prepare and submit monthly waste report to WAJ.	Compliance with waste management procedures. Current and complete records of regular waste pickup and disposal.	Construction Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Water Resources	Potential surface water runoff / potential flood risks.	• To minimize risks from high rainfall and potential flooding the following measures have been proposed as per the surface hydrology study conducted for the project area: surveying works are required to the wadis passing adjacent to WWTP and its expansion in order to have cross sections to calculate hydraulically the water height during the floods and design of diversion channels & proper protection measures for the plant. • All chemicals shall be stored in dedicated areas in tightly closed containers and shall be protected from adverse weather condition. • A spill prevention and response plan shall be prepared by the contractor in order to control any inadvertent leakage or spillage. Spill response measures shall be implemented (as necessary) to contain and clean up any contaminated soil. • Any spilled chemical shall be immediately collected and disposed of in accordance with spill prevention and response plan and Safety Data Sheet (SDS). • Contractor shall direct contaminated wastewater from washing/maintenance to a drain pit in the construction workshop, collected and directed to treatment basins. • Contractor shall ensure sediment and any contaminants present do not come into contact with, or are transported off-site in, surface water run-off. • to avoid any damage of the pipe by floods and to let the conveyance pipe crosses the wadi safely, it is recommended to fix the pipe with the ceiling of the box culverts from outside (inlet or outlet). • Proper design and supervision of concrete structure at the Ramtha WWTP to ensure reliable infrastructure to prevent wastewater infiltration to the groundwater.	Visual inspection of drainage features during the rainy season. Visual inspection of any erosion from construction area Visual inspection of any spills	Daily during rainy seasons At construction site and along wadis	Contractor shall prepare and submit monthly report to WAJ for Inspection and Incidents in case of flood from high precipitation events.	Runoff from constructions site should be clear of heavy particulates, oils/chemicals, or trash. Complete records as required by spill prevention and response procedures.	Construction Contractor
	Two existing monitoring wells within the expansion of ramtha WWTP.	• Contractor shall ensure all safety measures are in place to protect the monitoring wells from any damaging during construction phase.	Visual inspection	daily	Contractor shall prepare and submit monthly report to WAJ for any Incidents for the monitoring wells		
Biological Environment							
Terrestrial Ecology	Potential disturbance to flora	• Prohibit removal of existing natural plant if not necessary for construction. • In the case of damage to a flora during construction in natural areas, the supervising engineer and/or WAJ in addition to Ministry of Agriculture shall be notified to decide whether replacement is necessary. • Prohibit workers from cutting natural plants in the surrounding area • for fire. • Prohibit machinery from using surrounding area of the proposed site as parking or maintenance area for machinery. • Plant native species around the WWTP and ponds.	Visual inspection for any case involving vegetation removal or disturbance to fauna.	Daily	Contractor shall prepare and submit monthly report to WAJ	Records of cleared vegetation and translocated trees.	Construction Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	Potential Disturbance to fauna and Migratory birds disturbance	• Prohibit workers from hunting, killing animals as well as destroying ground nests for birds inside the proposed site and the surrounding area. • Replace any found ground nests inside the proposed site in coordination with the Royal Society for Conservation of Nature (RSCN) • Decrease the construction activity to the minimal during night time to decrease potential disturbance. • Where possible, animals that fall into the excavations during construction will be removed and ladders or branches placed in open excavations to assist fauna to escape. • Report any killing accidents for wild life to the Ministry of Environment and RSCN. • Using screening around the existing ponds to block the bird's view (bird's eyesight) of the construction work areas; this screening would be maintained throughout the migration and breading seasons. • construction work should be avoid during the early morning (before 8:00 am) and late afternoon (after 5:00 pm) in the bird migration and breading season, work may proceed as normal between 8:00 am and 5:00 pm. • Insulate the electrical towers to prevent bird electrification	Visual inspection for any case involving any disturbance to fauna. Coordination with RSCN when needed.	Daily	Contractor shall prepare and submit monthly report to WAJ	Records of hunting or killing accidents to fauna	Construction Contractor
Health and Safety							
Health and Safety	Potential of exposure to safety events such as tripping, working at height activities, fire from hot works, smoking, failure in electrical installations, mobile plant and vehicles, and electrical shocks	• Occupational Health & Safety: • A hazard assessment of the work site shall be completed by the contractor prior to construction. • Presence and compliance with Environmental, Health & Safety (EHS) related policies and procedures on site. • Allocate specific personnel responsible for health & safety management on site. • Adequate and appropriate training of all workers of the contractor's EHS policies and procedures before they are permitted to undertake a task. • All construction equipment used for the execution of the project works shall be fit for purpose and carry valid inspection certificates and insurance requirements. • Risk assessment shall be prepared and communicated prior to commencement of work for all types of work activities on site. • Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. • Signpost any slippery areas, ensure proper footwear with a good grip is worn for personnel working within slippery areas. • As far as reasonably practical, use cordless tools that may not need to use cables. Where cables for temporary lighting or mains-powered tools will be used, all cables shall be run through designated corridors. • Avoid work at height where it reasonably practicable to do so, e.g. by assembly at ground level. • Prevent any person falling a distance liable to cause personal injury e.g. by using a scaffold platform with double guard-rail and toe boards;	Visual inspection of compliance with health and safety procedures Vehicle and Residents Safety through visual spot checks and inspection Maintain proper housekeeping for the project site Routine facilities' and site inspection Inspection of equipment and tools used during working at height activities	Daily Continuously Continuously Monthly Monthly	Contrctor shall prepare and submit monthly H&S report to WAJ considering all H & S performance indicators	Total Recordable Incidence Rate (TRIR) Lost Time Incidence Frequency of incidence Fatal accident rate Number of safety training performed Number of non-conformance events. reports. Training records of workers on EHS	Construction Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Arrest a fall with equipment to minimise the distance and consequences of a fall, e.g. safety nets, where work at height cannot be avoided or the fall prevented. • Carry out fire risk assessment for the construction areas, identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. • Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. • Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. • Establish and communicate emergency preparedness response plan (EPRP) with all parties, the EPRP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel and drills to test the plan. • Ensure all plant machines and vehicles are regularly inspected, serviced and maintained; ensure all staff assigned is trained and competent to operate plant machines and vehicles. • Ensure all routes are suitable and wide enough for the vehicles, routes should be planned by minimising bends/junctions, steep gradients and the need for reversing, clearly designate areas for pedestrian walkways and crossing points. • Ensure clear signages are in place, such as Warning of speed limits, obstructions, allowable widths/heights...etc. • Electrical equipment must be safe and properly maintained; works shall not be carried out on live systems. • Only competent authorised persons shall carry out maintenance on electrical equipment, adequate Personal Protective Equipment (PPE) for electrical works must be provided to all personnel involved in the tasks. • Lock-Out / Tag-Out (LOTO) system shall be implemented during any electrical works. • Adequate number of staff and first aiders shall be on site in accordance with Jordanian Labor Law requirements. • First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site. • Emergency evacuation response shall be prepared by the contractor and relevant staff shall be trained through mock-up drills.	Fire Emergency Response Drills Inspection for fire extinguishers, testing for fire detection system, and other fire fighting equipment. Maintenance for fire extinguishers, testing for fire detection system, and other fire fighting equipment. Monitor work areas and activities to identify fire and explosions hazards. Preventive maintenance and patrol inspections for all vehicles and mobile plant Vehicles and mobile plants inspection	Based on fire risk assessment Monthly Monthly Monthly Monthly Monthly		policies and procedures	

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	Exposure to health events during construction activities such as manual handling, electrical shocks and burns, hand-arm vibration, temporary or permanent hearing loss, heat stress, and dermatitis	• Adequate and appropriate training of all workers of the contractor's EHS policies and procedures before they are permitted to undertake a task. • Ensure that operations, which involve manual handling, are eliminated so far as reasonably practicable, provide mechanical aids such as forklifts, trolleys, cranes, hoists etc. • Ensure all equipment are suitable for jobs (safety, size, power, efficiency, ergonomics, cost, user acceptability etc), provide the lowest vibration tools that are suitable and can do the works. • Ensure all tools and other work equipment are serviced and maintained in accordance with maintenance schedules and manufacturer's instructions. • Regular noise exposure assessments and noise level surveys of noisy areas, processes and equipment shall be carried out in order to form basis for remedial actions when necessary. • As far as reasonably practical, all steps to reduce noise exposure levels of employees by means other than that of personal protective equipment shall be taken, such as reducing exposure times, enclosures, silencers, machine covers…etc. • Provide suitable and effective hearing protection to employees working in high noise levels. • Designate and clearly mark hearing protection zones, which may include particular areas, operations or pieces of equipment. All personnel entering these zones shall be required to wear hearing protection inside these areas. • Awareness training sessions should be established and provided to all personnel involved during the construction phase in order to highlight the heat related illnesses of working in hot conditions such as heat cramps, heat exhaustion, heat stroke, dehydration. • Ensure adequate quantities of drinking water are available at different locations within the site, • Ensure proper planning of works to consider the time of peak temperatures during the day, provide rest breaks during the peak times. • Provision of sun shades at different locations within the site. • Eliminate the risk of exposure whenever possible, provide proper PPE wherever necessary and to ensure that there are satisfactory washing and changing facilities. • Ensure that all workers exposed to a risk are aware of the possible dangers. They should be given thorough training in how to protect themselves and there should be effective supervision to ensure that the correct methods are being used. • Public Health & Safety: • The contractor will ensure workers are properly trained on public health and safety concerns. • Rigid barriers must be used to mark any temporary footway and to protect pedestrians from traffic, excavations, plant and materials. Road danger lamps must be placed at the ends of the barriers at night. • Vehicular movement to and from the project area shall be minimized to the extent possible.	Monitor the health of workers Monitor work areas and operations to identify noise hazards. Inspection for use hear protection equipment Fit Testing Maintenance & care for hear protection equipment.	Prior to employment And every 6 months contineously contineously every 6 months Monthly	Contrctors shall prepare and submit monthly H&S report to WAJ	Total Recordable Incidence Rate (TRIR) Lost Time Incidence Frequency of incidence Fatal Accident Rate Medical Treatment Case(MTC) No. Restricted Work Day Cases (RWDC) HSE training hours Number of non-conformance events.	Construction Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Socio-economics							
Nuisance and mobility impacts:	Naisance due to dust and noise	The contractor shall coordinate with local authorities, utility providers, etc. conducting or planning construction work in the same project area in order to reduce public disruption. The public located in close proximity to the project must be notified prior to noisy activities taking place on site. Dust suppression measures shall be implemented as necessary to avoid nuisance to the public. The contractor to establish a grievance mechanism for the local community.	Inspection of mobility and access facilitation procedures	Daily	Contractor shall prepare and submit monthly report to Supervising Engineer who will in turn communicate it to WAJ.	Up-to-date records of complaints, and corrective actions. Records of public consultations/stakeholder engagement where needed.	Construction Contractor
Traffic	Additional traffic load due to transport of equipment and materials to and from the site through the surrounding road network, including the constrction of the transmission pipeline to Shallalah	The contractor to ensure that all trucks and vehicles accessing the facility are operated by licensed operators. Pedestrians Safety: All project vehicles and trucks shall comply with the proposed speed limits Ensure adequate maintenance and inspection of vehicles Presence of flagman at the entrance and exit of the project site in order to control vehciles and truck movement. Every employee working on the project site shall make sure that all needed signs and preventive measures are implemented when starting any activity. Number of traffic signs, their characteristics and distance among them will be placed according to local legal requirements and an on-site HSE assessment that will conducted prior to any construction activity starts. Signs shall always be in good conditions and be visible to every road user. Vehicle transit across any restricted area and/or limited to working activities is prohibited. Vehicle repairmen and/or maintenance activities are not allowed within the project area. They shall only be carried out within the especially dedicated areas. The contractor shall establish adequate coordination system with other contractors working in the project area to minimize traffic disruption to local residents and visitors and ensure that all traffic hazards are kept to a minimum. It is recommended that the contractor prepares a traffic management plan to address safe and efficient movement of traffic around the construction area, reversing vehicles, movement of plant / materials, and interface with site pedestrians / members of the public. Contractor shall provide, place and maintain all necessary barricades, traffic cones, warning signs, lights and other safety devices in accordance with the Jordanian Traffic Directorate to protect traffic in public or private streets.	Monitor vehicle movement to and from the project area. Monitor road condition and signage and traffic calming needs.	Continuously	Contractor shall prepare and submit monthly report to Supervising Engineer who will in turn communicate it to WAJ.	No complains or concerns from traditional users of the area's roads routes are received during the construction activities. No incidents or accidents (collisions) are recorded	Construction Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Local communities	Potential implications of local community groups.	Preparation of a community grievance mechanism and a Stakeholder Engagement Plan (SEP) prior to construction in complicance with WB guidelines. no land ownership conflicts, but it is leased to a farmer until 1st August 2022, as a result, a fair compensation to the farmer must be considered if the agreement ended by WAJ before the expiration date. Commitment to the farmers to continue supplying their farms with the treated wastewater during the construction phase. Contractor to repair any farmer's infrastructure damages (irrigation pipes) that might occure during the construction phase.	Monitor grievance mechanism and a Stakeholder Engagement Plan (SEP) implementation.	Monthly	Contractor shall prepare and submit monthly report to supervising engineer who will in turn communicate it to WAJ.	Grievance mechanism and a stakeholder engagement plan (SEP) are prepared in compliance with WB guidelines Number of stakeholder engagement and grievances and corrective actions	Construction Contractor
	Community Health, Safety and Security	Appoint a Community Liaison Officer (CLO) whose responsibility shall include the management of all community related matters for the project. The CLO role shall also be relfected in the SEP. Implementation of approproate security management on site.	Project area is secured and access is well monitored	Daily	Contractor shall prepare and submit monthly report to supervising engineer who will in turn communicate it to WAJ.	CLO appointed implementation of community grievance mechanism and SEP. Number of grievances and corrective actions	Construction Contractor
Worker Community	Labor and Working Conditions	The contractor shall take all reasonable steps to ensure that all national legislation on labor and health and safety, the requirements of WB guidelines ESSF2 (Labor and Working Conditions), the World Bank general EHS guidelines, relevant standards and procedures as developed and implemented by WAJ, and any other relevant standards identified by WB are complied with. The contractor shall provide a grievance mechanism for all workers and employees. The contractor will ensure that all workers are informed about the grievance mechanism and that information about the mechanism is posted in relevant areas of the project site. The contractor ensure that hiring, recruitment and training plans satisfy the requirements of the provisions of ESSF2, and the HR procedures are well tailored to comply with local Jordanian Laws, WB requirements and WAJ's HR policy and procedures. The contractor shall ensure that a safe and healthy working environment is provided for all workers on site and that good international practice on occupational health and safety is followed in line with policies developed by the contractor. The contractor shall not under any circumstance employ workers under the minimum age for employment, as defined in national legislation. children under the age of 18 will not be employed in hazardous work and a risk assessment will be carried out in respect of any work carried out by such employees. The contractor shall ensure that there shall be no use of forced or compulsory labor. If workers accommodation will be established on site, it is essential to ensure that the camp is established in accordance with the specifications of the International Labour Organisation (ILO) standards and guidance published by EBRD and IFC. Also is is reocmmended to implement an induction program for all workers' resident in the camp to be aware of their rights, and safety measures.	Monitor compliance with labor and health and safety standards. Appointment of a manager on site to be responsible for ensuring that labor and health and safety legislation is complied with, monitoring suppliers and sub-contractors performance. This shall be conducted through Internal audits and/or inspections for compliance.	monthly Every 6 months	Contractor shall prepare and submit quarterly report to supervising engineer who will in turn communicate it to WAJ.	Compliance with WAJ and WB guidelines. Number of grievances reported by workers/employees and corrective actions	Construction Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Archaeological Resources & Cultural Heritage							
Archaeology & Cultural Resources	Only potential concern can be impacts on possible unseen archaeological sites/remains (chance finds)	• Based on the Archaeological Survey report docuncted for the project. the following recommendations are proposed: • Adherence to the project area allocated for the project and not exceed it; and • Impementation of chance find procedures as per the Jordanian Antiquities Law. This is described as follows: • Construction works shall be ceased if any historical/ culturally sensitive or archaeological sites / remains are chance found during construction activities. • If any known sites were found during construction and may potentially be threatened by construction, the area with the newly discovered remains/sites shall be fenced and the DoA shall be notified immediately and invited for consultations and assessment of the finding and agreement must be reached with the DoA in order to minimize damages to the sites. It shall also be the Contractor's responsibility to notify the supervisor of the Cultural resources Management Office of the DoA are encountered in any area during construction and also specifications set in Article 15 of the Antiquities Law No. 21 (1988). • The DoA will assess the discovered remains and may carry out an emergency salvage excavation (i.e. archaeological excavation conducted during the construction phase, which should be conducted only when an archaeological site is accidently found (chance found)). • The available short time for salvage excavations cannot be considered an authorization to destroy the discovered remains or site. Each site must be given proper consideration and analysis before its destruction. • Construction work shall be resumed within the newly discovered area only after archaeological experts from DoA and official authorities are consulted and appropriate mitigation measures are implemented, however construction activities can continue at other parts of the site after coordination with DoA. • WAJ / Yarmouk Co. shall employ specialized personnel to oversee and supervise the implementation of mitigation measures.	Minimum of one site inspection immediately after chance find.	One site inspection after chance find	Contractor shall prepare and submit immediate report to to WAJ and to Department of Antiquities (DoA) in case of chance finds.	No. of chance findings at the project location	Construction Contractor

Table 59: Environmental and Social Management Plan during Construction Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Physical Environment							
Air Quality	Potential Odors from WWTP operations, Pump Stations Operation, or power failure / malfunction problems	air dispersion modelling assessment of odor releases from the WWTP should be done after detailed design is completed, to ensure that the design, will meet the odor compliance criteria. Appropriate preventive maintenance, inspection program shall be developed and implemented. Where practicable proper landscaping, tree planting around the facility may serve as a natural windbreaker and minimize potential odor dispersions.	Complinance with relevant Jordanian Standards (JS 1140:2006) ambient air quality preventive maintenance, inspection program.	Once Monthly	Operator shall prepare and submit air dispersion modelling assessment report to WAJ.	Up-todate monitoring records and corrective actions. Compliance with Jordanian Standards for controlling vehicular exhaust gas emissions Number of community complaints in relation to project-generated dust.	Operator (Yarmouk Co.)
	Exhaust emissions and noise due to operation machinery at septage and sludge loading & unloading	*Ensure adequate maintenance and inspection of vehicles to minimize exhaust emissions. *Not running engines for longer than is necessary. *Compliance with MoE and national guideline limits for ambient air quality JS 1140/2006 *Compliance with Jordanian Standards for controlling vehicular exhaust gas emissions JS 1140/2006	Monitor levels of the following air quality SO2, NO2, PM10, H2S, NH3, CH4, with comparison to the JS 1140/2006 limits	Twice a year for three consecutive days	Operator shall prepare and submit report t**wice a year** to WAJ.		
Pest Nuisance	Nearby resident's nuisance due to pests breeding at Ramtha WWTP	*pests in the availability of warmth will enhance the breeding. The most probable sources of such insects may be agricultural activities, waste dumping, sludge disposal of the proposed expansion of Ramtha WWTP. The proposed digestion and stabilization of sludge in the Ramtha WWTP will reduce the volatile organic content of the sludge; which makes the treated sludge less odorous and reduces the risk of insect's growth and disease. *A floating cover will be added to the effluent storage pond to prevent the pest breeding. *Pest management will be regularly carried out, even though it is not likely to eliminate these insects totally, adequate efforts must be made to at least keep it to a minimum.	Visual inspection of the pest breeding within the Ramtha WWTP and surrounding area. Inspect the pest management procedures effectiveness and maintaining records.	Daily Twice a year	Operator shall prepare and submit report t**wice a year** to WAJ.	Number of community complaints in relation to project-pest nuisance.	Operator (Yarmouk Co.)

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Soil	Soil Contamination	Appropriate preventive maintenance, inspection program shall be developed and implemented. *the treated effluent must be disinfected to meet the Jordanian Standards described in JS893/2006 for category 3(A) effluent suitable for the irrigation of cooked vegetable crops. Chlorine gas is used for the disinfection of the effluent from the secondary clarifiers to inactivate E. coli and harmful bacteria. *Soil sampling of surrounding area for accumulation of soil salinity, sodium, and chloride. In addition to proper crop selection. *Adequate provisions should be made to seal the sludge storage bottoms and embankments to prevent leaching into adjacent soils or groundwater.	*Inspect the presence of any disturbed areas in and around the project site for erosion *Visual inspection of oil storage tanks, waste storage area and fuel storage area for spills and leaks Monitoring the wastewater effluent quality to comply the Jordanian standard. JS893/2006 Frequent Sampling of soils preventive maintenance, inspection program.	Post rainfall event Weekly Every 3 months Annual	Operator shall prepare and submit a quarterly report to WAJ. WAJ/MoA/JVA	Up-to date monitoring records. all worker straining on spill response procedures. Up-to date monitoring records and corrective actions. Awareness campaigns No's conducted to the farmers	Operator (Yarmouk Co.) Operator Yarmouk Co. WAJ in cooperation with MoA
Water Resources	Surface & groundwater pollution	The treated effluent must be disinfected to meet the Jordanian Standards described in JS893/2006 for category 3(A) effluent suitable for the irrigation of cooked vegetable crops. *Appropriate preventive maintenance, inspection program shall be developed and implemented. Monitor the sludge storage bottoms and embankments to prevent leaching into adjacent soils or groundwater. *Update the effluent reuse study after 2025 with the new flow projections to identify the additional storage needs for full utilization of the effluent for irrigation. (USAID, 2019) Monitor the nearest groundwater source downstream.	Monitoring the wastewater effluent quality to comply the Jordanian standard. JS893/2006 for category 3(A)	Every three months Once by 2025 annually	Operator shall prepare and submit a quarter report to WAJ. Effluent reuse study by third party.	Up-to date monitoring records and corrective actions.	Operator Yarmouk Co.

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Waste Management	Water and soil contamination due to wastewater effluent characteristics and sludge treatment and disposal	* Appropriate preventive maintenance, inspection program shall be developed and implemented to ensure the WWTP effluent standard is per Jordanian Standard JS893/2006 category 3(A) for effluent reuse of the irrigation of cooked vegetables. *and WWTP biosolids (sludge) complies with Jordanian Standard JS1145/2016 treated sludge and Sludge disposal as Third Class biosolids for landfill only.	Jordanian Standard JS893/2006 category 3(A) Jordanian Standard JS1145/2016 treated sludge and sludge disposal as third class biosolids for landfill only.	Every three months Every three months	Operator shall prepare and submit a quarter report to WAJ.	Compliance with relevant Jordanian Standards (JS 893:2006) Reclaimed Domestic Wastewater and JS1145/2016	
	Hazards presented by improper management and handling of hazardous and non-hazardous waste during construction.	• The contractor shall segregate storage for different types of wastes, such as hazardous, non-hazardous, recyclable, construction material, plastic, paper, etc. to facilitate proper disposal. • The contractor shall provide a separate storage area for hazardous materials. The hazardous materials/products must be labeled with proper identification of its hazardous properties. • Chemical waste shall be stored in accordance with the provisions of Safety Data Sheets (SDS). The contractor shall keep SDS onsite. • Littering in the project area and surrounding areas shall be prohibited. Contractor shall provide trash bins within each construction site so as to prevent littering in the project area and surrounding areas. • Hazardous wastes generated shall be disposed off-site in coordination with MoE to an approved waste facility. (Swaqa) • The contractor shall establish regular intervals for waste collection and disposal as per contractor's waste management procedures.	Visual monitoring of site cleanliness and proper storage and handling of hazardous waste. Inspect that segregated waste disposal or storage areas are clearly marked.	Daily	Contractor shall prepare and submit monthly waste report to WAJ.	Compliance with waste management procedures. Current and complete records of regular waste pickup and disposal.	Construction Contractor
Terrestrial Ecology							
Terrestrial Ecology	Potential disturbance and harm to Fauna and birds	*Minimize human and vehicular contact with faunal species present on site. *Any ground nests found on site shall be translocated outside the project boundary. *Apply manual plant removal if needed. Prohibit workers from hunting, killing animals as well as destroying ground nests for birds inside the proposed site and the surrounding area.	Visual inspection within project site.	Daily	Operator shall prepare and submit a monthly report to WAJ.	No reported harm to any faunal species.	Operator Yarmouk Co.

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Health and Safety							
Safety risks	Potential of exposure to safety events during operation activities such as slipping and tripping, working at height activities, and fire	*Adopt specific Occupational Health & Safety policies to be complied with during operation. *Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. Signpost any slippery areas, provide proper footwear during working within slippery areas. Avoid work at height where it reasonably practicable to do so, e.g. by assembly at ground level. *Prevent any person falling a distance liable to cause personal injury e.g. by using a scaffold platform with double guard-rail and toe boards. *Ensure all works and storage areas are tidy, all material deliveries shall be planned to minimize accumulated materials at project site. *Carry out fire risk assessment during operation to identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. *Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. *Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. *Establish and communicate emergency preparedness and response plan with all parties, the EPRP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel and drills to test the plan. *Adequate first aiders shall be on site in accordance with Jordanian Labour Law requirements. *First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site. *Emergency evacuation response shall be prepared by the contractor and relevant staff shall be trained through mock-up drills.	Inspection of equipment and tools used during working at height activities Facilities and site inspection. Maintain proper housekeeping for the project site Monitor work areas and activities to identify fire hazards. Maintenance check for fire extinguishers, testing for fire detection system, and other firefighting equipment. Fire emergency response drills	Monthly Monthly Continuously Based on fire Assessment Monthly Twice a year	Operator shall prepare and submit a Monthly report to WAJ. Operator shall prepare and submit a Monthly report to WAJ.	Total Recordable Incidence Rate (TRIR) Lost Time Incidence Frequency of incidents Number of non-conformance events. Total Recordable Incidence Rate (TRIR) Lost Time Incidence Frequency of incidents Number of non-conformance events.	Operator Yarmouk Co. Operator Yarmouk Co.

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Socio-economics							
Traffic	Potential minimal increase of traffic load	Implementation of a regulated entrance and exit into the facility.	Monitoring of access roads around site Record complaints received from locals or authorities.	Daily Continuously	Operator shall prepare and submit a Monthly report to WAJ	Number of complaints from road users. Number of traffic incidents due to vehicle movement.	Operator Yarmouk Co

Table 60: Environmental and Social Management Plan during Operation Phase

Aspect	Potential Impact	Monitoring Requirements	Frequency	Responsibility
Air Quality	• potential odors resulted from WWTP operations, pump stations and malfunctions • noise and vehicles emissions during loading, unloading of WW or sludge.	compliance with JS 1140/2006 for ambient air monitoring to the following parameter: SO2, NO2, PM10, H2S, NH3, CH4	• every six months for three consecutive days	Operator (Yarmouk Co.)
Soil	Soil salinity due to using the treated wastewater in irrigation in the farms	Repeated soil samples to monitor the electrical conductivity (EC) and SAR sodium absorption percentage. No Jordanian standard is available, international standards can be used	annually	Ministry of Agriculture Jordan Water Authority Jordan valley Authority
Water Resources	Surface and Groundwater Pollution	The treated effluent to meet the Jordanian Standards described in JS893/2006 for category 3(A) effluent suitable for the irrigation of cooked vegetable crops. (BOD5, COD, DO, TSS, NO3, NH4, TOTAL-N, PO4, E. coli, PH, turbidity, nematodes) Monitor the nearest groundwater source downstream. Compliance with JS286/2015 if used as drinking water. Compliance with MoA instructions (7/ز) for the year 2016 if used for irrigation for the following parameters. EC, PH, TDS, Temp., heavy metals	Every three months annually	Operator (Yarmouk Co.)
Waste management	Treated sludge produced	treated sludge monitoring and compliance with JS1145/2016 category 3	According to JS 1145/2016 and sludge quantity produced (metric ton/yr.).	Operator (Yarmouk Co.)

Table 61:periodic monitoring

10.3 Decommissioning

The design life of the expansion of Ramtha WWTP will extend for a period of approximately 25 years and might be renewed upon mutual consent between project stakeholders.

The post-design life is expected to involve the following two options:

- Rehabilitation, upgrading and modernization of the WWTP, with a possible expansion (retrofitting and addition of new technology). As a result, impacts from decommissioning are not expected to arise in the near future.

- Decommissioning in case there was a need for the Ramtha WWTP to be dismantled and end its operations.

A decommissioning plan would be prepared by the Ramtha WWTP operator to ensure the environmental safety, the plan should identify all potential hazards and contamination points due to decommissioning activities and ensure the appropriate measures were in place to eliminate any environmental pollution and ensure site rehabilitation as appropriate.

The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be similar to those identified for the construction phase. However, it is recommended that before any decommissioning activities take place a disposal plan for all materials and equipment's shall be prepared by the responsible entity undertaking decommissioning activities.

The disposal plan shall consider the following options at a minimum and compare the feasibility and applicability of each:

1) Recycling of any components of the WWTP where suitable;

2) Reuse of components in other technologies;

3) Disposal of the other components that cannot be reused or recycled at existing hazardous or solid waste facilities in Jordan through coordination with the Ministry of Environment and with Greater Amman Municipality for the nearest landfill.

More certainty with regards to disposal methods will be clarified by then depending on new available technologies and reuse/recycling options and other appropriate disposal facilities.

Therefore, to avoid repetition, please refer to **Table 59** for detailed mitigation measures that overlap with decommissioning as well.

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11 Overview of ESMP and Auditing Protocol

11.1 Environmental and Social Management System Framework

After the identification and assessment of environmental and social risks/impacts generated by the project (throughout the ESIA stage), the project developer will be obliged to manage such risks during the project lifecycle i.e. Construction, Operation and Closure/Decommissioning.

The main tool to manage such risks is through developing an Environmental and Social Management System (ESMS) that are commensurate to the level of risks/impacts identified and as per the requirements of *World Bank Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.*

The ESMS developed by the project developer shall apply to the contractor and operator. The ESMS documentation shall be in place prior to construction and may include plans relevant to the project's identified risks and impacts - mainly related to the following:

- Requirements for environmental and social management;
- Requirements for stakeholder engagement;
- Requirements for management of labor and working conditions;
- Requirements on emergency preparedness and response.
- Requirements for other relevant plans. – as requested.

11.2 Monitoring and Reporting

After the preparation of the relevant ESMS plans and procedures, the WAJ will be required to establish procedures to monitor and measure the effectiveness of the management program during project implementation, as well as compliance with any related legal and/or contractual obligations and regulatory requirements.

Regular reporting from the contractor and operator (at a later stage) shall be submitted to the project developer i.e. WAJ. The issued reports shall include information and indicators consistent with the World Bank environmental and social reporting requirements.

11.3 Auditing

Environmental and social audits will assess a projects performance against its project specific ESMS should the need arise.

The audit may be required during the project implementation to review the current operational performance of Yarmouk's existing operations i.e. the expansion of Ramtha WWTP project. For this project, the audit shall be conducted during the **construction phase** and the **operation phase**, usually by an environmental and social experts as independent third-party consults.

Key issues that are recommended to be covered under the environmental and social audit may include, but not be limited to:

- A review of the company's existing and approved environmental and social management system (ESMS), policies and practices;
- Organizational capacity and resources;
- Human Resources and employment policies (e.g. child labor, forced labor, non-discrimination and equal opportunity, workers' organizations, contractor management, retrenchment and employment);
- Occupational health and safety (national requirements, key health and safety issues, control and major accident hazards, current health and safety monitoring program, summary of regulatory compliance status, emergency response practices and procedures);
- Pollution prevention measures available at the WWTP and regulatory compliance with national requirements including applicable Best Available Techniques.
- Community health, safety and security as it relates to the Company's existing operations;
- Management of potentially hazardous works;
- Waste management procedures on site during all project phases;
- Noise generation during construction and operation;
- Identification of potential environmental liabilities (e.g. potential contamination as a consequence project operations);
- Overview of the supply chain (e.g. suppliers, contractors, sub-contractors of main materials and resources) and identification of relevant environmental, social, labor and/or reputation issues; and
- Public interaction, including responsiveness to public comments, complaints and questions. The audit should also identify the main stakeholder groups and current stakeholder engagement activities in line with World Bank guidelines. A check on grievance mechanism and its records and frequency of response shall be conducted,
- Updating Environmental and Social Management Plan accordingly.
- The successful implementation of the ESMP will require detailed training of employees and some training of other stakeholders to ensure that they are aware the main objectives and purpose of the ESMP and its benefit to the project.

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