Environmental and Social Impact Assessment for Bani Kenanah Water Supply System

Draft Environmental and Social Impact Assessment Report (ESIA)

September 2022

This publication was produced for review by the United States Agency for International Development. It was prepared by Arabtech Jardaneh under subcontract with CDM Smith.

Document Title:	Draft Environmental and Social Impact Assessment (ESIA) Report
Project:	Environmental and Social Impact Assessment (ESIA) for Bani Kenanah Water Supply System
Code	AW051
Client:	USAID/WAJ

Project Code: AW051		**Document No:2**		**Controlled Copy No: 1**	
Revision No	**Date**	**Description/Amendment**	**Checked**	**Reviewed**	**Authorized for Issue**
01	**06/09/2022**		**WD**	**ID**	**MM**
02	**20/09/2022**		**WD**	**ID**	**MM**

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ABBREVIATIONS

A	**Area**
AJWE	**Arabtech Jardaneh Water & Environment**
ALARP	**As Low as Reasonably Practicable**
BGR/GIZ	**The German Federal Institute for Geosciences and Natural Resources/the Deutsche Gesellschaft für Internationale Zusammenarbeit**
BS	**Basin slope = ΔH/L (dimensionless: H is in meters and L is in meters).**
CAD	**Computer-Aided Design**
CDM	**CDM Smith Company**
CEMP	**Construction Environmental Management Plan**
CITES	**Convention on International Trade in Endangered Species of Wild Fauna and Flora**
CO	**Carbon Monoxide**
dBA	**A-Weighted Decibel**
DLS	**Department of Land and Survey**
DoA	**Department of Antiquities of Jordan**
DoS	**Department of Statistics**
EF	**Emission Factor**
EIA	**Environmental Impact Assessment**
EIB	**European Investment Bank**
EPRP	**Emergency Preparedness Response Plan**
ESIA	**Environmental and Social Impact Assessment**
ESMS	**Environmental and Social Management System**
ESMP	**Environmental and Social Management Plan**
GHG	**Greenhouse Gas**

GIS	**Geographic Information System**
GOJ	**Government of Jordan**
HEC-HMS	**Hydrologic Engineering Center's Hydraulic Modeling System**
HSE	**Health, Safety, and Environment**
IBA	**Important Bird Area**
IDF	**Intensity-Duration-Frequency**
IEC	**International Electrotechnical Commission**
ISO	**International Organization for Standardization**
JMD	**Jordan Meteorological Department**
JOD	**Jordanian Dinar**
JS	**Jordanian Standard**
JSMO	**Jordan Standards and Meteorology Organization**
JVA	**Jordan Valley Authority**
km	**Kilometers**
km^2	**Square Kilometers**
kwh/m^3	**Kilowatt Hours per Cubic Meter**
LAL	**Land Acquisition Law**
l/c/d	**Liters per Capita per Day**
m	**Meters**
$\mu g/m^3$	**Micrograms per Cubic Meter**
mg/m^3	**Milligrams per Cubic Meter**
m/s	**Meters per Second**
m^3	**Cubic Meters**
$m^3/ca/yr$	**Cubic Meters per Capita per Year**
m^3/day	**Cubic Meters per Day**
m^3/hr	**Cubic Meters per Hour**
MCM	**Million Cubic Meters**

MEMR	**Ministry of Energy and Mineral Resources**
MFD	**Maximum Flow Distance**
mm	**Millimeters**
mm/h	**Millimeters per hour**
MoA	**Ministry of Agriculture**
MoE	**Ministry of Environment**
MWI	**Ministry of Water and Irrigation**
NO_2	**Nitrogen Dioxides**
NRW	**Nonrevenue Water**
OHS	**Occupational Health and Safety**
O&M	**Operation and Maintenance**
PA	**Protected Area**
PM_{10}	**Particulate Matter 10 mm**
ppb	**Parts per Billion**
PPE	**Personal Protective Equipment**
ppm	**Parts per Million**
PS	**Pump Station**
RAP	**Resettlement Action Plan**
RFP	**Request for Proposal**
ROW	**Right-of-Way**
RSCN	**Royal Society for the Conservation of Nature**
SCADA	**Supervisory Control and Data Acquisition**
SDS	**Safety Data Sheet**
SO_2	**Sulfur Dioxide**
tCO_{2eq}	**Tons of Carbon Dioxide Equivalent**
tCO_{2eq}/MWh	**Tons of Carbon Dioxide Equivalent per Megawatt Hour**

TNC	**Third National Communication to the United National Framework Convention on Climate Change**
ToR	**Terms of Reference**
TRIR	**Total Recordable Incident Rate**
TSP	**Total Suspended Particles**
TxDOT	**Texas Department of Transportation**
UNFCCC	**United National Framework Convention on Climate Change**
UH	**Unit Hydrograph**
USAID	**United States Agency for International Development**
USEPA	**U.S. Environmental Protection Agency**
USGS	**U. S. Geological Survey**
UV	**Ultraviolet**
VOC	**Volatile Organic Compounds**
WAJ	**Water Authority of Jordan**
°C	**Degrees Celsius**

1 EXECUTIVE SUMMARY

Jordan has attained high standards for water supply, providing citizens with high-quality water; however, availability is adversely affected because of intermittent supplies. The current water supply available to the Jordanian population is around 126 liters per capita per day (l/c/d), but only 61 l/c/d is delivered to the population. 65 l/c/d is wasted because of wear and tear of the water supply network (the non-revenue water [NRW] that is lost before reaching the Jordanian population). Since the arrival of Syrian refugees in 2011, per capita consumption in some parts of the north has dropped from above 88 to below 66 liters per capita because of the strain placed on water supplies by the increase in population.

The United States Agency for International Development (USAID) Jordan Water Infrastructure project works with the Ministry of Water and Irrigation (MWI) and water utilities to increase water supply, improve sanitation services, expand treated wastewater reuse, build the capacity of water sector utilities, and attract investments to the sector. It provides architectural, engineering, and construction management services, including assessments, feasibility studies, designs, tender documents, capacity building, operations and maintenance, customer service, and financial support.

MWI and the Water Authority of Jordan (WAJ) propose to rehabilitate infrastructure and replace the water supply system for the Bani Kenanah District through improvements to drinking water treatment and delivery systems, the rehabilitation of degraded assets across the water service cycle, and a reduction of NRW in locations where the water system suffers from a high NRW percentage. Some portions of the system are estimated at 40 to 50 percent NRW, which reduces the supply available to the public.

Task 7 of the USAID Jordan Water Infrastructure program is intended to improve Bani Kenanah's water supply system based on a feasibility study completed by Atkins Acuity, HCL, and Engicon under a European Investment Bank (EIB)-funded program. The work entails reviewing the feasibility study prepared by others, preparing detailed design and tender documents, providing support during procurement, and preparing a comprehensive Environmental and Social Impact Assessment (ESIA) study for the proposed Bani Kenanah water supply and distribution systems.

CDM Smith and Arabtech Jardaneh for Water & Environment (AJWE) have been commissioned by USAID to assist the Jordan Water Infrastructure project. Task 7 of the project is related to the Bani Kenanah District and includes the review of the feasibility study prepared by others, preparation of detailed design and tender documents, and preparation of the ESIA for the preferred alternative for water supply and distribution systems. The ESIA will be prepared in accordance with the requirements of the Jordanian environmental licensing and permitting regulation no. 69, year 2020, and EIB environmental and social standards. According to the Jordanian ESIA Regulation no. 69, year 2020, this project is classified as a Category 1 project.

1.1 Project Description

The current population of Bani Kenanah is about 147,000. The population is projected to reach approximately 277,000 by the project design horizon year of 2050. The Bani Kenanah project would serve 23 localities with water systems including Hibras, Aqraba, Saham, Rafid, Yarmouk, Harta, Kufur Soum, Malka, Samar, Brishta, Um Qais, Ibdir, Sama, Kufur Jayez, Harima, Abu Al-llogus, Qasfah, Yibla, Kharja, Hatem, Khraibeh, Khirbet Ezrit, and Berz.

1.2 Existing Bani Kenanah Water Resources

Currently, the main water resources available for the Bani Kenanah District consist of 10 wells in three local groundwater wellfields including the following:

- Harima Wellfield (4 wells)
- Kufur Asad Wellfield (5 wells)
- Quailba Wellfield (1 well)

A new wellfield near Wehda Dam is proposed by the Yarmouk Water Company. The company planned to drill three wells for an estimated production capacity of 100 cubic meters per day (m^3/day) for each well. The first well has been drilled and its water was delivered to the Quailba Pump Station (PS) through a newly constructed 300-millimeter (mm) diameter pipeline.

1.3 Existing Water Supply and Distribution Systems

The existing water supply system includes six PSs that supply water to the different localities by direct pumping (i.e., Harima, Kufur Asad, Syfeen, Malaka, Quailba, and Mukhabeh Al Fawqa PSs) and about 690 kilometers (km) of pipelines of various diameters ranging from 20 mm for house connections to 400 mm for main pipelines.

More than 64 percent of the network was installed before 2000, making it over 20 years old. Direct pumping to the network on intermittent supply mode is the norm in the Bani Kenanah water supply system. Each locality receives its supply for 1 or 2 days, and sometimes for only a few hours. Occasionally, Bani Kenanah receives additional supply from Zabda Reservoir via Bait Ras Reservoir. The water system suffers from a high NRW percentage, estimated to be 40 to 50 percent. There are some localities where most of the distribution system has been rehabilitated recently, while only a small percentage of the distribution system of other localities has been rehabilitated.

1.4 Proposed Bani Kenanah Water Supply Source

The main water supply for the Bani Kenanah District will be from Zabda Reservoir in Irbid City in addition to the newly developed Wehda Wellfield. Supply from the Zabda Reservoir to the Bani Kenanah District is planned for 4 days a week. The weekly demand would be delivered to a proposed 16,000 cubic meter (m^3) reservoir in the Sama area at an average rate of 40,000 m^3/day. Another new reservoir is proposed to be constructed in the Hibras area with a total capacity of 1,000 m^3 to supply the northern villages by gravity, including Harta, Aqraba, Rafid, Yibla, Kufur Soum, Samar, and Saham. This reservoir would collect the production of the Wehda Wellfield through the Quailba PS. Also, this reservoir would be supplied from the main Bani Kenanah Reservoir by gravity. Distribution from this reservoir to the localities would be based on an intermittent supply for 2 or 3 days per locality.

1.5 The Bani Kenanah Project Proposed Components

Primary Pipeline

The proposed primary pipeline would be 700 mm in diameter and 15 km long from the Zabda Reservoir to the proposed Bani Kenanah Reservoir in the Sama area. This main pipeline route would follow a low-traffic road outside the center of the city of Irbid. Construction of the pipeline would have a minor impact on the traffic and existing utilities. There would be only one critical section that includes crossing Highway No. 10 from the city of Irbid to North Shouneh that would be constructed using trenchless technology (jacking) to avoid impacting traffic.

The pipeline would traverse adjacent to a variety of environments, including residential areas, schools, mosques, dispersed stores, olive tree farms, and uninhabited landscapes, as well as the valley stream. The pipeline is expected be located within road rights-of-way (ROW) for the entire length of the route.

Proposed Bani Kenanah Storage Reservoir

A 16,000 m^3 storage water tank would be built in the Sama area at a level high enough to supply most of the localities by gravity, while also being low enough to be supplied by gravity from the Zabda Reservoir to save pumping costs.

The Sama Reservoir would be constructed on “9 donums (less than 1 acre).” of privately owned land currently planted with trees. Residential buildings surround the property. WAJ has started the land acquisition process and the Cabinet of Jordan has approved the land acquisition.

Pump Station

A small PS with a capacity of 300 cubic meters per hour (m^3/hr) would be constructed to supply the high areas in Harima, Kufr Jayez, and Sama that could not be supplied via gravity from the proposed Sama Reservoir. This PS would be near the Sama Reservoir and would be equipped with two pumps (one duty and one standby), each with a capacity of 300 m^3/hr at 50 m head.

Proposed Hibras Reservoir

The proposed reservoir would be 1,000 m^3 and it would receive water from the Quailba PS and from the Bani Kenanah Reservoir. It would supply the northern villages by gravity including Harta, Aqraba, Al-Rafid, Yibla, Kufur Soum, Samer, and Saham. The site would include a small guard room and an electrical and supervisory control and data acquisition (SCADA) room. The Hibras Reservoir would be constructed on 3.5 donums of privately owned land currently planted with trees. The only location where a residential building is present is on the plot's northern edge. The land acquisition procedure was launched by WAJ.

Secondary Pipelines

Secondary pipelines with diameters of 180 to 600 mm would replace old and deteriorated existing pipelines or reinforce existing small-size pipelines over a total length of 48 km. These pipelines would convey water from the storage reservoir, or PSs, to the entry of the district zones. These pipelines are mainly gravity pipelines except for localized areas within the distribution zone that would need to be supplied via the proposed PS. No service connections would be allowed on the secondary pipelines. The secondary pipelines are expected to follow road ROW for the entire length.

Tertiary Pipelines

Tertiary pipes with diameters ranging from 63 to 300 mm would be built to replace old, deteriorating pipelines or to reinforce existing small pipelines over a total length of 435 km. These pipelines would transport water from the secondary pipeline to the different districts within the project area. All distribution pipelines are gravity pipelines. Service connections would be permitted on tertiary pipelines.

Elimination of Existing Pump Stations

There are now six PSs fully operational for the Bani Kenanah water supply system. The proposed project plan would eliminate four PSs (i.e., Harima PS, Malka PS, Syfeen PS, and Kufur Asad PS). The Wehdah Dam system (PS0 and PS1) will continue to operate to serve the new Hibras Reservoir.

Description of the Proposed Water Networks

The following list enumerates the primary tasks that would be carried out as part of the Bani Kenanah project:

- The diameters of the water pipes vary from 63 mm to 700 mm, and their projected length in the construction zone is approximately 500 km.
- The depth of installation would vary from 0.65 meters (a minimum depth) to 1.3 meters, depending on the slope of the surface and to maintain gravity flows.

The project area is served by other existing utilities including the existing water and wastewater supply system, electricity, and telecommunications. Full coordination with utility providers would be needed to prevent utility supply disruption that might be caused by damage to existing pipelines from construction activities and/or making the pipeline connections. The design team reviewed the master plan together with town maps, land use maps, the existing water and wastewater networks operated by the Yarmouk Water Company, and other maps of the available utilities. These utility networks and services are to be taken into consideration throughout the project phases starting from the design stage through construction.

Construction Duration

The duration of construction of the water network, the reservoirs and the PS is expected to be no longer than 36 months (2023–2025).

1.6 Policy, Legal, and Institutional Framework

This section presents the national strategies and the national and international guidelines that apply to the Bani Kenanah project including EIB requirements. The project would be funded by EIB and thus will need to abide by its guidelines. This ESIA describes the national institutions related to this project, outlines the 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 national law.

The law considers the Ministry of Environment (MoE) to be the competent authority for the protection of the environment in the Kingdom, which is responsible for the evaluation of the environmental impacts of proposed projects and the issuance of associated approvals and permits. When the ESIA is approved, the proposed project would get a letter of approval and the proposed activities would commence, while adhering to the environmental mitigation and management systems specified and approved in the ESIA. Any deviation from those guidelines would be a violation subjected to the provisions of the law.

1.7 Environmental and Social Baseline Conditions

Physical Environment

Meteorology and Climate

Data related to meteorological conditions was collected and included detailed climate data averages over a 10-year time period (2010–2019) for the project area. Data was obtained from the Jordanian Department of Meteorology from the meteorological station falling within the Irbid Governorate (i.e., Al Yarmouk University Station). The data includes minimum and maximum temperatures, relative humidity, rainfall averages, and wind speed.

Air Quality

An air quality sampling program was conducted at the project site from August 18–21, 2022. The program covered the following emission parameters: particulate matter (PM_{10}), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO).

Real-time monitoring instruments were used to assess the ambient air quality. The instruments are U.S. Environmental Protection Agency (USEPA) approved and the test methods were conducted according to national and international standards.

According to Jordanian Standard 1140/2006, neither the hourly nor the daily limits for the various air pollutants (PM_{10}, SO_2, NO_2, and CO) were exceeded throughout the monitoring period.

Wind Monitoring

Results of wind monitoring in the project site (i.e., at the Sama Reservoir) during the monitoring period (August 18–21, 2022) showed that the prevailing wind direction was southeast with a frequency of 22.0 percent, followed by south with a frequency of 18.0 percent. The prevailing wind speeds were 3.6–5.7 meters per second with a frequency of 40.0 percent.

Temperature and Relative Humidity

The atmospheric temperature at the monitoring site ranged between 18.0 degrees Celsius (°C) and 36.0°C with a mean value of 28.8°C during the monitoring period. Time series of relative humidity were measured and values fluctuated between 36 percent and 88 percent, with a mean value of 56 percent.

Ambient Noise

Monitoring was conducted from August 18–21, 2022. The maximum average noise daytime and nighttime levels recorded within the site were 61.5 A-weighted decibels (dBA) and 52.4 dBA, respectively. Because the area is classified as a residential area with commercial activities, services, light handcrafts, and city center, the recorded averages were found to be lower than the maximum allowable noise limits of 65 dBA for daytime and 55 dBA for nighttime as provided by the Jordanian guidelines for prevention of noise (MoE 2003).

Topography and Land Region

Most parts of the proposed project are in a gentle rolling terrain with major urbanized areas. The elevations of the site and the adjacent areas range from approximately 431 m to approximately 699 m above sea level. The project area falls within the Northern Highlands Dissected Limestone land region (i.e., Land Region No. 8). It is typically Mediterranean in climate and has a xeric moisture regime, with a range in precipitation of between 250 mm and 500 mm per year. Soils of this region are mainly clay and considered to be the most productive rain-fed soils in Jordan, particularly in the Irbid plains.

Geology

The bedrock outcropping in this region is upper Cretaceous sedimentary in nature (i.e., Campanian to early Tertiary). The bedrock is covered in certain areas by superficial deposits extending from the Pleistocene to the present day. The Balqa group of formations, which are prevalent in the Cretaceous and Tertiary systems, encompasses most of the Bani Kenanah area. These formations are composed of sedimentary rocks such as chalk, chert, limestone, and marl, with the B3 formation being bituminous in some areas. The Bani Kenanah area is distinguished by its geological diversity. Basalt, calcrete, and travertine are the rocks that make up these formations.

Tectonic Setting

The project area lies within an area of low potential magnitude seismic hazards according to the Richter scale. Therefore, if an earthquake were to occur in the area, it is anticipated that the intensity would fall between 3.0 to 3.9 magnitude, which is barely felt on the ground and has minor to no destructive effects.

Water Resources

Surface Water Runoff

There are 16 wadis' catchments that drain in the project area. A hydraulic study was conducted to estimate the wadis' flows, and the intensity-duration-frequency (IDF) curves for the Irbid school's rainfall station, which is the nearest rainfall station for the project region, were used to calculate rainfall intensities for 50- and 100-year rain event frequencies. The rational formula was used to estimate peak discharges from areas with a relatively low time of concentration: a few minutes to 20 minutes (Wanielista 1990). Rainfall intensity of 25, 50, or 100-year return periods were used in the estimation of flood flows. This station has 23 years of data that can be accepted as representative of the rainfall existing in the region.

The design team should consider (1) all that is prescribed in this hydrology section for the culverts' design, giving special attention to cases A and B below for the minimum fill thicknesses and (2) any further protection measures to protect the pipes.

A. If the pipeline crosses a hydraulic structure such as a pipe or a box culvert, then the fill between the crown of the one located below and the bottom of the other will be at least 0.3 m.
B. If the pipeline is above the culvert, then the fill between the crown of the pipe and the asphalt should be 0.6 m or more; otherwise, encasement with reinforced concrete should be applied to the water pipeline.
C. If the pipeline passes along or across an open channel or a wadi, then the pipe should be protected with reinforced concrete for the parts passing across the channel.
D. If the pipeline passes along a culvert, depending on the sizes of both, the pipeline can be constructed either in or beside the culvert.

Groundwater

Groundwater flow is influenced by faults, hidden structures, or divides where faults and joints act as conduits through which groundwater flows. The groundwater flows from elevated regions (i.e., the Ajloun area in the south) to low-lying discharge areas in the northern part of the project area. Joints trending north to south may facilitate this movement. Flow in the northern side of the project area occurs laterally (i.e., to the northeast and northwest).

The average aquifer depth is 130 m below the ground surface. The aquifers that yield more than 20 m^3/hr are in the southern part of the project area and are those immediately close to joints and faults. The discharge regions to the north have low yields, less than or equal to 5 m^3/hr, except in very few areas with anomalous high yield ranging between 5 m^3/hr and 10 m^3/hr. All wells with low yield are located on the down-thrown block of the main faults. Aquifers close to fault zones have a mean yield of 46 m^3/hr.

Aquifers yielding more than 50 m^3/hr of water are only located on or near fault zones in the study area. Such aquifers occur in the central part of the study area where jointing and faulting are dominant. The water yield from aquifers in the Irbid area, therefore, depends on the location of the aquifer, whether on the up-thrown or down-thrown block of the faults and its proximity to fault zones.

Biological Environment

The current study was conducted through a combination of desktop (literature review) studies and ground truthing the data in the field. These studies were aimed at defining the biogeographical regions that influence biodiversity in the proposed development area and accordingly defining the general vegetation types and species diversity of both flora and fauna occurring in the study area.

Mediterranean Biogeographic Zone

The project area is in the Mediterranean Biogeographic Zone. This area is the most humid and has the highest altitude in the country. Altitudes in this habitat range from 700 m to 1,700 m above sea level. The northern part receives more precipitation than the southern part, and the annual rainfall ranges from 400 to 700 mm. The differences in rainfall between the northern and southern portions means that the northern mountains have more diverse vegetation types and densities. The soil types are the richest in the country and support the most diverse vegetation. The forest climate vegetation community in the north includes *Pinus halepensis*, *Quercus coccifera*, *Q. ithaburensis*, *Ceratonia siliqua*, and *Pistacia* spp. The vegetation is mostly dominated by chamaephytes.

Vegetation Types

Out of 13 vegetation types recognized in Jordan, the project area has three vegetation types: Mediterranean nonforest, deciduous oak forest, and water vegetation.

Zoogeographic

The Mediterranean Biogeographic Zone is characterized by the availability of microhabitats and richness of vegetation that combined with the topography of the area along with other abiotic factors allow for a high carrying capacity to sustain a large diversity of species.

The Mediterranean Biogeographic Zone harbors the highest numbers of amphibians, lizards, and snakes of any biogeographic zone in Jordan.

Mammals

No mammals were recorded during the field visits. The ESIA study shows the important mammals that are reported to occur in the Mediterranean biogeographic zone and the mammal species that have been recorded in the area from previous studies.

Birds

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 continued research.

The sensitivity map tool developed by Birdlife International (Birdlife 2022) was used to assess the importance of the project area for migratory soaring birds. The field study observed 20 soaring bird species while another 19 soaring bird species are thought to occur in the study area. Most of these species have no conservation status.

Protected Areas

The part of the work that includes secondary and tertiary pipelines would take place in Malka, Almansoura, and Um Qais villages, which are part of the Yarmouk Protected Area. Given the nature of the proposed project activities, the project would have no significant negative impact on the protected area, if the mitigation measures proposed in the Environmental and Social Management Plan (ESMP) are followed.

Rangeland Reserves

The proposed project is not close to any of the rangeland reserves. The closest rangeland reserve is Al-Khanasry, which is more than 40 km from the proposed site. In addition, because of their nature, the project activities would be limited to a small area, which decreases the potential for negative impacts on any sensitive habitat, including rangeland reserves.

Important Bird Areas

The proposed project site is close to Wadi Yarmouk Important Bird Area (IBA). Wadi Yarmouk is a steep-sided valley with a small river surrounded by *Nerium* and *Salix* thickets. There are remnant stands of deciduous oak on the slopes, which are generally covered by low shrubs and used as farmland. Some bird species are winter visitors to the site. The proposed project activities would be limited to small areas inside urban areas and are not expected to have negative impacts on IBAs.

Socioeconomic Conditions

The project area is located in the Bani Kenanah District, which falls in the north western part of the Irbid Governorate. It is a prominent center in the agricultural sector because of the vastness of its fertile lands, the red soil of the district, and the mild climate. It is 15 km away from the city center.

Bani Kenanah District is considered one of the largest areas in the Irbid Governorate in terms of population, and most of its population work in the government, agriculture, and trade sectors. The Bani Kenanah District includes five municipal councils: the Municipalities of Kaffarat, Saru, Shula, Yarmouk, and Khaled bin al-Walid.

The villages in the area include Sama Rusan, Harima, Hibras, Harta, Aqraba, Kufur Soum, Rafid, Yibla, Samar, Kaffarat, Saham, Kaffarat, Kharja, Yarmouk, Qasfah, Sayla, Khuraiba, Brishta, Qaraqosh, Hatim, Badr, Malka, Um Qais, Abu Al-llogus, and others.

The area of Irbid is 1,572 square kilometers, composing 1.8 percent of the total area of Jordan, with a population density of 1,216.2 people per square kilometer. The administrative center of the Bani

Kenanah District has the following relative advantages that contribute to a diverse economic environment.

The district contains three different terrains (i.e., a plain, a mountain, and a valley). The district's fields are among the most fertile agricultural lands in the region, with ideal conditions for growing grains, trees, and fruits. The district has two frontier borders (i.e., Syria borders the north, and the occupied Palestinian territories border the west). There is a historic area (i.e., the site of the Yarmouk battle) and a tourist district, in which there are many tourist and archaeological sites, the most important of which are Um Qais, Quailba, Al-Himma, Al-Ordoniyah, and Al-Asha.

The Bani Kenanah population was estimated to be 149,190, which composes 2 percent of the total population of Jordan.

Involuntary Resettlement/Land Acquisition

The land acquisition requirement for the project is primarily for the construction of a new reservoir and pumping station in the Sama area and another reservoir in Hibras area. The proposed project would affect land in the Sama region and in the Hibras region, affecting a total calculated area of 11 and 3.5 donum, respectively. The proposed project land acquisition is estimated to affect a total of nine project-affected parties, and as previously noted, the area is mostly planted with olive trees. On the other hand, because all of the water supply pipes are designed to be in the road ROWs, there would be no resettlement sites needed for the proposed work in ROWs.

Climate Change and Carbon Footprint

According to Jordan's Third National Communication to the United Nations Framework Convention on Climate Change (MoE 2014), climate change is expected to have a negative impact on the water sector, with reduced groundwater recharge, degraded groundwater quality, reduced streamflow, and rising water demand. Furthermore, according to the German Federal Institute for Geosciences and Natural Resources/the Deutsche Gesellschaft für Internationale Zusammenarbeit (BGR/GIZ) study for the Bani Kenanah Wellfields, all wells will be nearly depleted by 2025, and water will be sourced mostly from the Wehda Wellfield and the Zabda Reservoir. Throughout the year 2035 design horizon, the estimated annual production capacity of the indicated wellfields will not be sufficient to supply the expected demand of Bani Kenanah areas. As a result, it is expected that by implementing this proposed water supply project, the Zabda Reservoir will be able to cover the predicted gap between demand and available quantities from local resources. In addition, the new design would remove four PSs (i.e., Harima PS, Malka PS, Syfeen PS, and Kufur Asad PS). The Wehdah Dam system (PS0 and PS1) would keep running to supply the new Hibras Reservoir. Currently, energy accounts for half of all water costs. Power consumption for water operations will rise as groundwater levels fall, necessitating higher pumping energy consumption while lowering well production. Considering Jordan's power emission factor of 0.67 tons of carbon dioxide equivalent per megawatt hour (tCO_2eq/MWh), in Jordan's second national communication (MoE 2009), eliminating the four PSs in the proposed project would lower energy consumption and lower the annual greenhouse gas emissions by 7,311.5 tCO_2eq as well as lowering the pumping costs for the Bani Kenanah water supply system over the project lifetime.

Cultural Heritage Resources

The proposed pipeline routes along the road alignments were reviewed for published literature and previous filed field investigation reports to identify any potential existing cultural heritage materials or sites. The team found that there were no known remains except modern refuse dumps that have accumulated in areas above the old water pipeline routes. During the construction phase, the team should determine a procedure for action needed after a cultural heritage find.

1.8 Stakeholder Identification and Engagement

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

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., EIB), stakeholder engagement activities have been an ongoing process throughout this ESIA process.

The stakeholder engagement activities carried out during this ESIA include the following:

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

1.9 Environmental and Socioeconomic Factors

Environmental and socioeconomic factors in relation to this project have been identified, which includes factors within the physical, biological, and socioeconomic environments. In addition, the possible interaction between the environmental factors relevant to this project have been identified. This includes the main project activities, environmental and socioeconomic aspects, and the potential environmental impacts associated with each activity related to the project. The impacts are mainly generated from construction, operation, and decommissioning activities. After identifying all project-related receptors and preparing of the project description, the project-related environmental aspects can then be identified. The definition of environmental aspects adopted for this ESIA is the one defined by International Organization for Standardization (ISO) 14001 Environmental Management. An environmental factor can be considered to occur where an activity has the potential to interact with the environment. A socioeconomic factor can be considered to occur when an activity has the potential to interact with the social or economic environments.

To identify environmental, health, and socioeconomic internal factors for this project, activities have been identified through the following:

- Project feasibility study documentation

- Consultation with project proponents

The key input for the identification of external factors includes the following:

- Policy and legal framework
- Environmental, health and safety, and socioeconomic baselines

1.10 Analysis of Proposed Project Alternatives

This analysis for this project contains four options or alternatives:

- The “no project” alternative: although the construction phase of the proposed project would include disruptions to air quality, noise levels, and traffic within the project areas, these will be temporary impacts limited to the construction phase of the project and would be eliminated once the proposed project is in its operation phase.
- Water supply options: A number of options were analyzed (i.e., Supply Option 1: 7 days of supply from Zabda Reservoir, Supply Option 2: 4 days of supply from Zabda Reservoir, and Supply Option 3: 2 days of supply from Zabda Reservoir) using specific criteria such as the least capital investment, the best use of the primary and secondary pipelines, the optimum value for investment, system flexibility, ease of response to emergencies, and a minimum storage for emergency use. Option 1 was the best option financially. However, this option was not practical from the operational aspect. Zabda Reservoir is used to supply different areas in Irbid Governorate, and it would be difficult to allocate 7 days a week to supply Bani Kenanah. Therefore, WAJ selected Supply Option 2 as the most practical option.
- Routing alternatives: The water pipelines are located inside road ROW, footpaths, and wadis. The routing alternatives were assessed by the design team, considering the following technical considerations.

  Topography (preference was given to flow by gravity, where possible), stream geomorphology in terms of pipe protection and bank stability issues, ease of construction, conflicts with proposed and existing utilities (though it is the contractor’s responsibility to undertake a detailed survey of these utilities), impacts on potential development, and land acquisition and ROW considerations
- The reservoirs’ location alternatives: The proposed locations of the reservoirs were chosen to improve the design of the water networks that are supplied by these reservoirs. Important considerations were to decrease the technical losses and electrical energy consumption associated with pumping by using gravity to supply the networks.

  Two locations were chosen for the reservoir land. The primary factors for choosing the reservoir land were the availability of undeveloped land with a large enough area for the purpose, the elevation of the site to generate enough pressure to supply the targeted locations, and the position of the land with relation to the supplied places. Using these criteria made it possible to choose the best option.

1.11 Impact Assessment

The main impacts of constructing the water supply system would be the nuisance to the local communities, air emissions, noise, stress on infrastructure, disruption to commercial entities, traffic disruption, temporary visual impacts, and the increased risk of accidents.

There would be a temporary negative visual impact from the existence of spoil heaps above the ground level along the pipeline route. There may be temporary negative impacts on existing infrastructure and services such as paved streets and services. The potential impacts on air, noise, land, water, and aesthetic environments would be temporary impacts in the construction phase.

An identification and assessment of environmental, socioeconomic, and health issues potentially arising from the project has 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 ESMP has been developed to ensure that potential impacts are sufficiently monitored and mitigation measures are implemented.

1.12 Environmental and Social Impact Assessment Conclusions

Although there would be several negative impacts affecting people's daily lives during the construction phase, it is expected if proper mitigation measures are taken by the contractor, people would be willing to bear those temporary and expected impacts for the sake of larger benefits to be achieved once the project is in operation.

The following are identified potential impacts during the construction phase:

- Noise pollution due to construction activities and the use of heavy machinery, vehicles, and equipment
- Land acquisition
- Risks to public and occupational health and safety from different construction activities, including maneuvering of equipment and machinery
- Limitations on customers' access to businesses due to road closures
- Degraded air quality, degraded topography, geomorphology and soils, and impacts on water resources
- Visual intrusions due to solid waste generation and disposal
- Potential traffic impacts due to vehicles and equipment operation and the associated vehicle collisions as well as impacts due to solid waste (spoils) generation and disposal
- Potential disturbance of some roads and areas during excavation of trenches during construction activities. This would be a temporary issue, given that the contractor is obliged to restore the pavement to be compatible with adjacent undisturbed pavement
- Disruption to utilities due to trenching and excavation work, vehicles and equipment operation, and accidental fires

- Impact on land use due to equipment operation and spills of chemicals and liquid fuels, which could cause fires.

The general nuisance to the local community by the construction work would be short term in nature and the end product of a water supply system would have significant benefits. However, the contractor must take precautionary measures and commit to project schedules, such as cleanups after construction, electricity blackouts, water supply interruption, disruption of wastewater sewers, road closures, and noise and dust emissions associated with the construction phase.

2 INTRODUCTION

CDM Smith and Arabtech Jardaneh Water & Environment (AJWE) have been commissioned by the United States Agency for International Development (USAID) to fulfill the Jordan Water Infrastructure project. Task 7 of the project is related to the Bani Kenanah District and includes a review of a feasibility study prepared by others, preparation of detailed design and tender documents, and conducting the Environmental and Social Impact Assessment study (ESIA) for the preferred alternative for the proposed water supply and distribution systems. The ESIA will be prepared in accordance with the requirements of the Jordanian environmental licensing and permitting regulation no. 69, year 2020, and European Investment Bank (EIB) environmental and social standards. This report presents the ESIA for the proposed project.

The subsections below describe the consultant's understanding of the project and the ESIA objectives, as well as define the project proponent and the consultant team representatives.

2.1 Project Understanding

Jordan is characterized as being an arid to semiarid country with an average annual rainfall of less than 200 millimeters (mm) a year over 90 percent of the country. It is the second-most water-scarce country in the world, with demand exceeding available water resources. Both surface and groundwater resources used in Jordan are fed by rainfall, which is highly variable in space and time. Internal long-term traditional water resources are currently available at 65 cubic meters per capita per year (m^3/ca/yr). Climate change and population growth will reduce availability to 46 m^3/ca/yr by 2035, with rainfall projected to decline by 13.6 percent or 12.9 mm per year. Temperatures are expected to rise by 1.6 degrees Celsius (°C) (MWI 2025). This water scarcity is the single most important natural constraint to Jordan's economic growth and development. Hence, the country's water sector strategy stresses the need for improved water resource management.

Jordan has attained high standards for water supply, providing citizens with high-quality water; however, availability is adversely affected because of intermittent supplies. On average, the current water supply available to the population is around 126 l/c/d, but only 61 l/c/d is delivered to the population. 65 l/c/d is wasted because of wear and tear of the water supply network (the non-revenue water [NRW] that is lost before reaching to population). In addition, since the arrival of Syrian refugees in 2011, per capita consumption in some parts of the north has dropped from above 88 to below 66 liters per capita because of the strain placed on water supplies by the increase in population. (MWI 2025).

Water Authority of Jordan (WAJ) propose to rehabilitate infrastructure and replace the water supply system for the Bani Kenanah District through improvements to drinking water treatment and delivery systems, the rehabilitation of degraded assets across the water service cycle, and the reduction of NRW, where the water system suffers from a high NRW percentage. Some portions of the system are estimated at 40 to 50 percent NRW, which does not (legally) benefit the public.

2.2 Environmental and Social Impact Assessment Objectives

The ESIA study will be used for these objectives:

- Support the application for environmental approval from the MoE in line with the Environmental Classification and Licensing ESIA Regulation no. 69, year 2020.
- Comply with the EIB guidelines and requirements.
- Evaluate the likely environmental and social impacts that may be generated from the project.
- Minimize or eliminate negative impacts and maximize positive impacts.
- Evaluate the sustainability of the proposed Bani Kenanah project socially and environmentally.
- Inform the public about the project.

2.3 Environmental and Social Impact Assessment Process

In accordance with the MoE and EIB requirements, the ESIA assignment consists of the following phases:

- Prepare the ESIA preliminary Terms of Reference (ToR) and submit to the MoE for review. This step was completed in Stage I of the project's consultancy services.
- Organize and attend a scoping session with project stakeholders and document deliberations in a scoping statement, which includes a list of all attendees, a copy of the presentations provided, and a list of all the feedback and comments received from stakeholders. An online scoping session was conducted on July 20, 2022.
- Finalize the ToR and incorporate input from MoE and the scoping session attendees and append the Scoping Statement Report. The Final ToR and the Scoping Statement Report are included as **Annex A** to this report.
- Perform a full ESIA study and prepare the report.
- Prepare an ESMP, which is a part of this ESIA report.
- The Draft ESIA Report is expected to be submitted to MoE for approval. MoE will review and provide comments on the Draft Final ESIA Report, which when approved will form the basis of the environmental approval. AJWE will review and respond to any comments received from MoE prior to approval of the ESIA.
- The Final ESIA Report will incorporate any feedback from WAJ, USAID, and EIB, in addition to MoE and the project stakeholders. All of the reports will be prepared in English and Arabic.

2.4 Environmental and Social Impact Assessment Approach and Methodology

The approach and methodology used to describe and assess impacts to the environment and socioeconomic conditions due to the project are described in the final ToR report, which was approved by the MoE. The Final ToR is presented as **Annex A** of this report.

2.5 Project Proponent

USAID, on behalf of MWI/WAJ, is the proponent for the proposed Bani Kenanah water supply system project. The primary contact for USAID is the following:

Eng. Akram Al-Qhaiwi
Project Management Specialist
Office of Water Resources and Environment
United States Agency for International Development
Tel: +962 6 5906462
Fax: +962 6 5920143

2.6 The Consultant

CDM Smith is the engineering consultant preparing the detailed design and tender documents for the proposed Bani Kenanah project. The primary contact for CDM Smith is the following:

Bader H. Kassab
Project Manager
CDM Smith - Jordan
Al Mutanabi St. 73 (4th Circle)
Amman, Jordan
Office: +962 6.4642720
Email: kassabbh@cdmsmith.com

AJWE (as a subconsultant for CDM Smith) has prepared this ToR on behalf of the Bani Kenanah project donor in accordance with MoE guidelines and EIB standards. The primary contact for AJWE is the following:

Iyad Dahiyat
Director of Operations
Amman, Jordan
Office: +962 6.5857167
Email: Iyad_Dahiyat@aj-group.com

2.7 Report Structure

This report consists of the following sections:

1. Executive Summary	Summary of the project, main findings, and recommendations.
2. Introduction	Overview and purpose of the project and scope of the ESIA.
3. Project Description	A clear and concise description of the assessment phase over the life of the project from mobilization, construction, operation through to decommissioning. The description should be sufficient to allow the risks and impacts to be identified, described, and evaluated.
4. Policy and Legal Framework	Details of the applicable policy, legislation, and regulations in Jordan and EIB standards with potential implications to the project.
5. Environmental and Social Baseline Conditions	Assessment of the baseline conditions against which the impacts of the project can be assessed based on desktop studies and field work.
6. Environmental and Social Impacts	Assessment of the impacts of the project and a discussion of the possible negative and positive impacts of the project on the environment and social fabric, including socioeconomic effects.
7. Analysis of Project Alternatives	A comparison of the project alternatives considered and their potential impacts.
8. Environmental and Social Management Plan	The main ESMP components are presented in this section. Details of specific activities to be carried out during different phases of the project to ensure the identified mitigation measures are implemented are provided through the ESMP.
9. Stakeholder Identification and Engagement	Summary of the stakeholder engagement process, which identifies the affected parties and details how the project will communicate, inform, and discuss the substantive issues with all interested and affected parties.
10. References	A listing of all the references used in the ESIA study.

3 PROJECT DESCRIPTION

The sections below present a detailed description of the project area and activities of the proposed project.

3.1 Project Objective

The USAID Jordan Water Infrastructure project works with MWI and water utilities to increase water supply, improve sanitation services, expand treated wastewater reuse, build the capacity of water sector utilities, and attract investments to the sector. It provides architectural, engineering, and construction management services including assessments, feasibility studies, designs, tender documents, capacity building, operations and maintenance, customer service, and financial support.

Task 7 of the USAID Jordan Water Infrastructure activity is intended to improve Bani Kenanah's water supply system based on a feasibility study completed by Atkins Acuity, HCL, and Engicon under an EIB-funded program. The work entails reviewing the feasibility study prepared by others, preparing detailed design and tender documents, providing support during procurement, and preparing a comprehensive ESIA study for the proposed Bani Kenanah water supply and distribution systems.

Under this proposed project, the USAID Jordan Water Infrastructure project would rehabilitate the Bani Kenanah water system only (i.e., wastewater is not included in this scope) by adopting restructured network designs, modifying pressure zones to optimize network pressure, and reducing NRW. The new water system would generate additional water sources while also reducing Yarmouk Water Company's power consumption and costs.

3.2 Bani Kenanah Overview

The Bani Kenanah District is situated in the northwest part of Jordan, approximately 15 kilometers (km) from the Irbid Governorate center. The Bani Kenanah District is one of Irbid Governorate's nine districts. Bani Kenanah is considered one of the largest areas in Irbid Governorate in terms of population, and most of its residents work in the government, agriculture, and trade sectors. The Syrian refugee crisis has put increased demand on the district's already stressed water supply system. An increasing number of residents suffer from insufficient supply. The Bani Kenanah District contains five municipalities: Kaffarat, Saru, Shula, New Yarmouk, and Khaled Bin Al Waleed.

The district contains three different terrains (i.e., plains, mountain, and valley). The district's lands are among the most fertile agricultural lands in the region and are suitable for growing grains, trees, and fruits. Bani Kenanah is a border region in Jordan with Syria to the north and the occupied Palestinian territories to the west. In addition, it is a tourist district in which there are many tourist and archaeological sites, the most important of which are Um Qais, Quailba, Al-Himma, Al-Ordoniyah, and Shula.

The 2020 population of Bani Kenanah was estimated at around 147,000 (**Table 1** provides population by locality in the study area). The population is projected to reach approximately 277,000 by the project design horizon year of 2050. The Bani Kenanah project would serve 23 localities with water systems including Hibras, Aqraba, Saham, Rafid, Yarmouk, Harta, Kufur Soum, Malka, Samar, Brishta, Um Qais, Ibdir, Sama, Kufur Jayez, Harima, Abu Al-llogus, Qasfah, Yibla, Kharja, Hatem, Khuraiba, Khirbet Ezrit, and Berz as shown in **Figure 1** below.

Table 1: Bani Kenanah Population

Locality	Total Population (Jordanian and Non-Jordanian)
	2020
Hibras	6,476
Aqraba	4,562
Saham	10,986
Rafid	3,336
Yarmouk	924
Harta	7,596
Kufur Soum	12,745
Malka	19,326
Samar	6,276
Brishta	879
Um Qais	6,877
Ibdir	4,770
Sama	8,521
Kufur Jayez and Al Berz	6,139
Harima	7,120
Abu Al-llogus	2,012
Qasfah	1,554
Yibla	8,348
Kharja	12,009
Hatem	10,586
Khuraiba	3,960
Khirbet Ezrit	1,922
Total	146,924

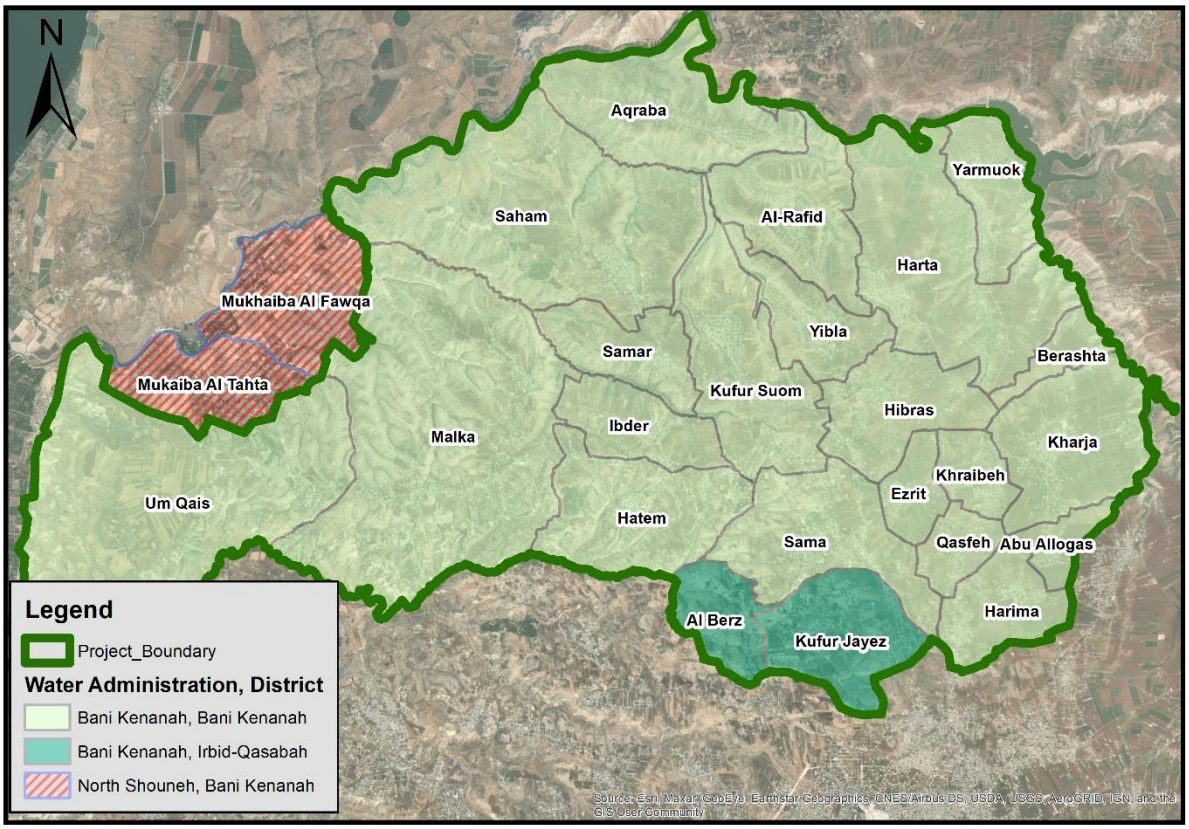


Figure 1: Bani Kenanah Project Area

The following are the main assumptions that serve as the foundation for the Bani Kenanah project's design. The assumptions are based on the recommendations of the CDM Smith/AJWE feasibility study as approved by WAJ:

- Census data from 2015 was adapted and projected over the design horizon of 2050 using the Department of Statistics (DoS) high growth rate scenario.
- Total water demand was assumed at 100 l/c/d, including 20 percent as NRW.
- All local wellfields currently used to supply Bani Kenanah District will be considered depleted by 2025 based on a study conducted by BGR/GIZ.
- A new wellfield is planned to be constructed by the Yarmouk Water Company near the Wehda Dam. The project includes drilling and operating three new wells for a total estimated production capacity of 300 cubic meters per hour (m^3/hr) by 2025. The first well was drilled, and a project to treat and deliver its water to Bani Kenanah was tendered, with construction set to end in early 2022.
- The main source of water supply will be from Zabda Reservoir, which receives its supply from several different sources as well as from Wehda Wellfield.

3.3 Existing Water Resources

Currently, the main water resources available for the Bani Kenanah District consist of 10 wells in three local groundwater wellfields as shown in **Figure 2**:

- Harima Wellfield (four wells)
- Kufur Asad Wellfield (five wells)
- Quailba Wellfield (one well)

The wells of Harima, Kufur Asad, and Quailba are entirely used for Bani Kenanah District. Each wellfield delivers water to different localities by direct pumping to the distribution networks from main PSs located at each wellfield.

A new wellfield near Wehda Dam is proposed by the Yarmouk Water Company. The company planned to drill three wells at an estimated production capacity of 100 cubic meters per day (m^3/day) for each well. The first well has been drilled and its water is delivered to the Quailba PS through a newly constructed 300 mm diameter pipeline.

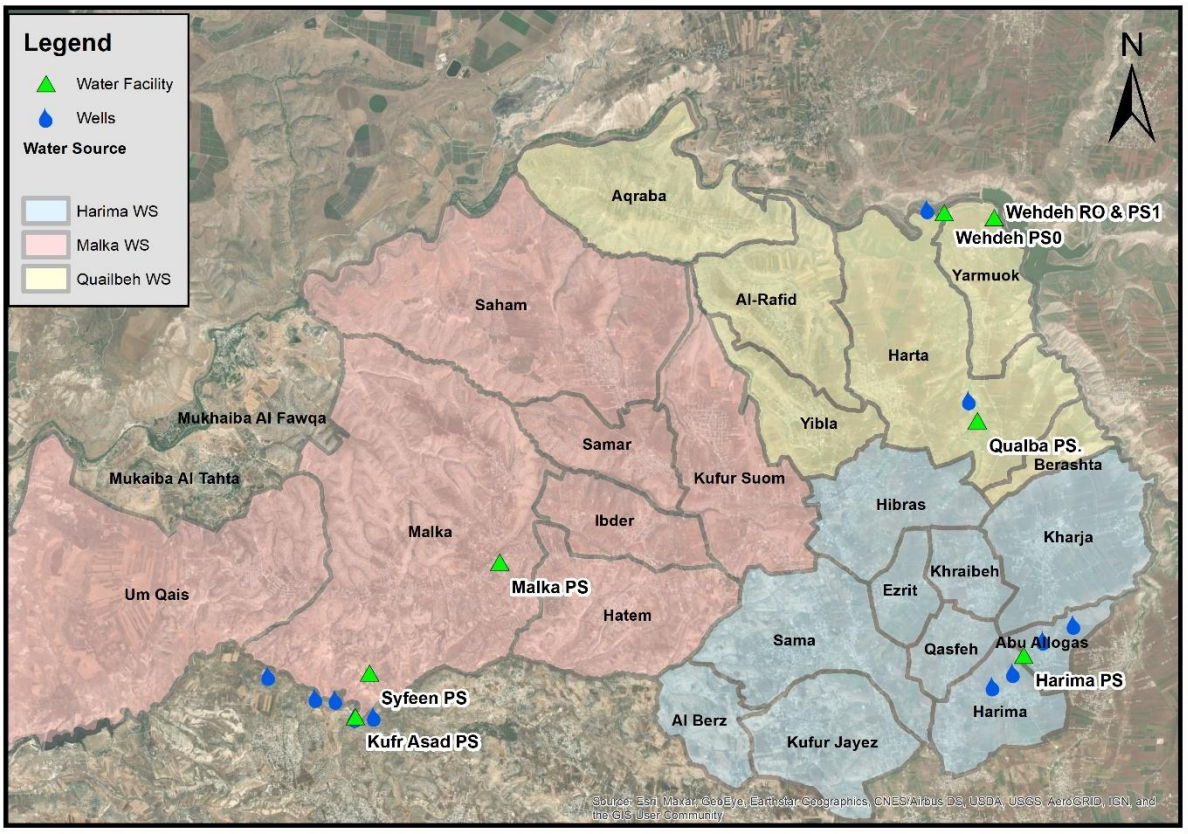


Figure 2: Main Water Resources Available for Bani Kenanah District

3.4 Existing Water Supply and Distribution Systems

The existing water supply system includes six PSs that supply water to the different localities by direct pumping (i.e., Harima, Kufur Asad, Syfeen, Malaka, Quailba, and Mukhabeh Al Fawqa), and approximately 690 km of pipelines of various diameters ranging from 20 mm for house connections to 400 mm for main pipelines.

More than 64 percent of the network was installed before 2000, making it over 20 years old. Direct pumping to the network on intermittent supply mode is the norm in the Bani Kenanah water supply system. Each locality receives its supply for 1 or 2 days, and sometimes for only a few hours. Occasionally, Bani Kenanah receives additional supply from Zabda Reservoir via Bait Ras Reservoir. The water system suffers from a high NRW percentage, estimated to be 40 to 50 percent. There are some localities where most of the distribution system has been rehabilitated recently, while only a small percentage of the distribution systems of other localities have been rehabilitated.

3.5 Proposed Bani Kenanah Water Supply Source

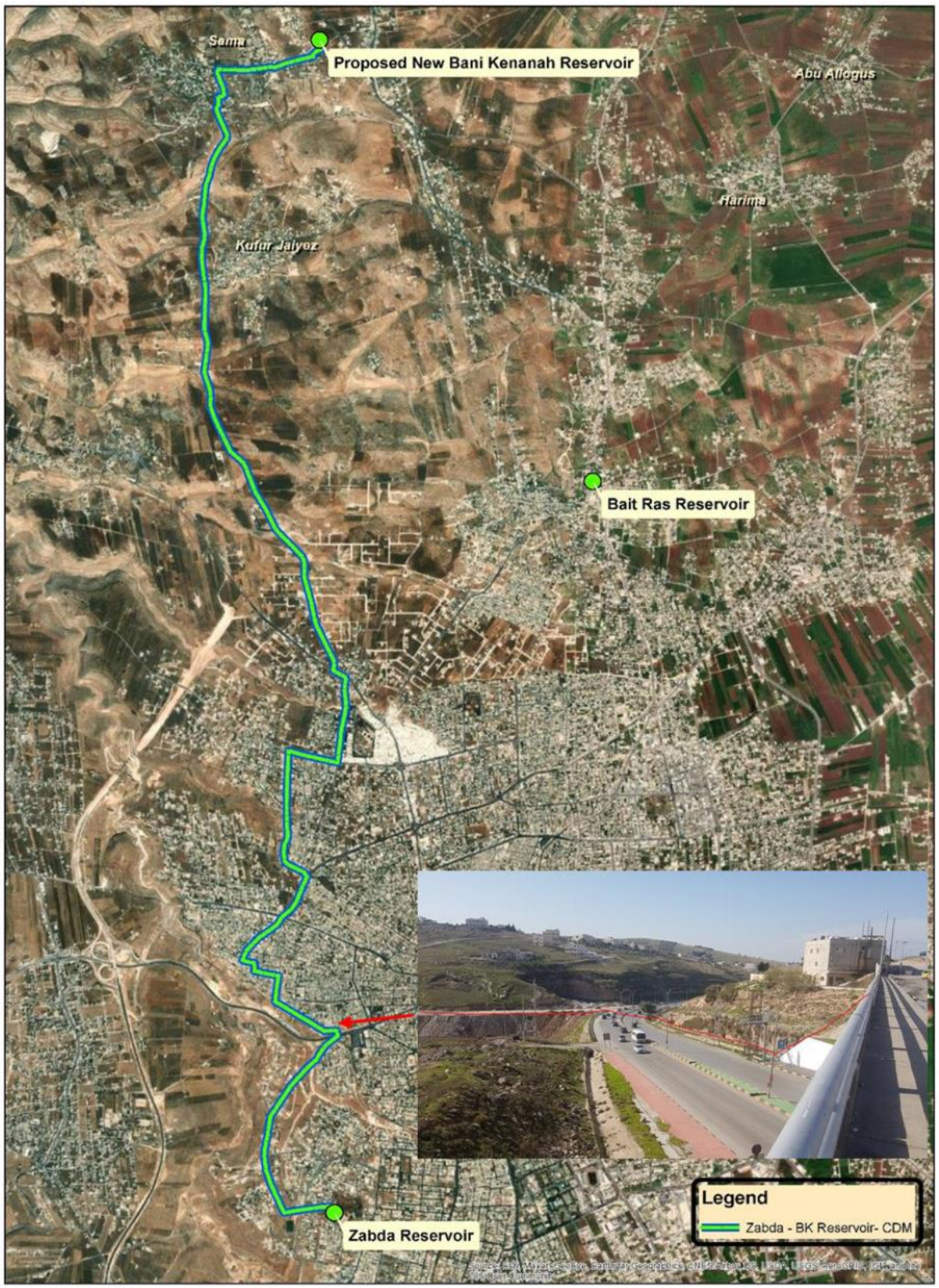
The main water supply for the Bani Kenanah District will be from the Zabda Reservoir in the city of Irbid in addition to the newly developed Wehda Wellfield. Supply from the Zabda Reservoir to the Bani Kenanah District is planned for 4 days per week. The weekly demand would be delivered to a proposed 16,000 m^3 reservoir in the Sama area at an average rate of 40,000 m^3/day. Another new reservoir is proposed to be constructed in Hibras area with a total capacity of 1,000 m^3 to supply the northern villages by gravity including Harta, Aqraba, Rafid, Yibla, Kufur Soum, Samar, and Saham. This reservoir would collect the production of the Wehda Wellfield through the Quailba PS. Also, this reservoir would be supplied from the main Bani Kenanah Reservoir by gravity. Distribution from this reservoir to the localities would be based on an intermittent supply for 2 or 3 days per locality.

3.6 The Bani Kenanah Project Proposed Components

Primary Pipeline

The proposed primary pipeline would be 700 mm in diameter and 15 km long, from the Zabda Reservoir to the proposed Bani Kenanah Reservoir in the Sama area. This main pipeline route would follow a low-traffic road outside the center of the city of Irbid. Construction of the pipeline would have a minor impact on the traffic and existing utilities as shown in **Figure 3.** There would be only one critical section that includes crossing Highway No. 10 from the city of Irbid to North Shouneh that would be constructed using trenchless technology (jacking) to avoid impacting traffic.

The pipeline would traverse adjacent to a variety of environments including residential areas, schools, mosques, dispersed stores, olive tree farms, and uninhabited landscapes, as well as the valley stream, The pipeline is expected be located within road ROW for the entire length of the route. Street widths in the project area range from 5 to 15 m; typical road ROW as shown in **Figure 4**.



Source: U.S. Geological Survey (USGS) (2021)

Figure 3: Alignment of Proposed Primary Pipeline


مسجد نور الهدى

Figure 4: Photographs of Planned Primary Pipeline Locations

Proposed Bani Kenanah Storage Reservoir

A 16,000 m^3 storage water tank would be built in the Sama area at a level high enough to supply most of the localities by gravity, while also being low enough to be supplied by gravity from the Zabda Reservoir to save pumping costs. The site plan for the Sama Reservoir is shown in **Figures 5 through 7.**

The Sama Reservoir would be constructed on 9 donums (a donum is less than 1 acre) of privately owned land currently planted with trees, as shown in **Table 2.** Residential buildings surround the property. WAJ has started the land acquisition process and the Cabinet of Jordan has approved the land acquisition.

Table 2: Trees Planted on Private Land Proposed for Sama Reservoir

Trees	Number of Trees
Olive trees	77
Cypress trees	6
Almond trees	5

Figure 5: Trees Planned to Be Removed for the Proposed Sama Reservoir

The area surrounding the proposed Sama Reservoir includes the following features:

- The civil defense building is approximately 394 m east of the proposed reservoir.
- The Yarmouk hospital is approximately 251 m east of the proposed reservoir.
- The Saru municipality is approximately 70 m south of the proposed reservoir.
- The nearest residential areas are approximately 73 m to the north, 10 m to the south, 87 m to the west, and 40 m to the east of the proposed reservoir.
- The reservoir would be located near the major road network.
- The Toqbol transfer station is approximately 3.6 km to the west.
- The nearest school is approximately 440 m west of the proposed reservoir.

Figure 6: Area Surrounding the Proposed Sama Reservoir

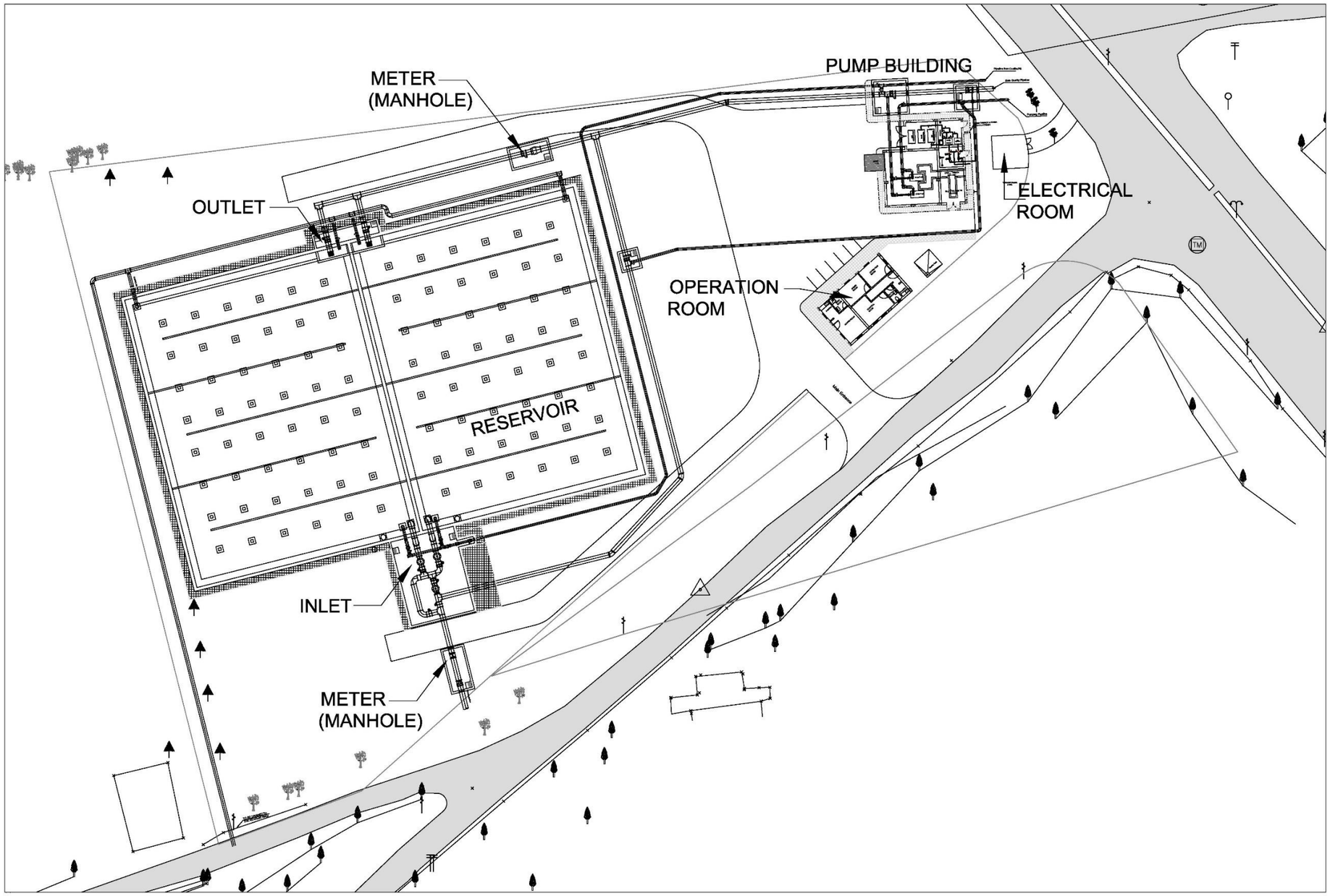


Figure 7: The Proposed Sama Reservoir Layout

Pump Station

A small PS with a capacity of 300 m^3/hr would be constructed to supply the high areas in Harima, Kufr Jayez, and Sama that could not be supplied via gravity from the proposed Sama Reservoir. This PS would be near the Sama Reservoir and would be equipped with two pumps (one duty and one standby), each with a capacity of 300 m^3/hr. at 50 m head.

Proposed Hibras Reservoir

The proposed Hibras Reservoir would be a 1,000 m^3 reservoir that would receive water from the Quailba PS and from the Bani Kenanah Reservoir and would supply the northern villages by gravity including Harta, Aqraba, Rafid, Yibla, Kufur Soum, Samar, and Saham. The site would include a small guard room and an electrical and SCADA room.

The proposed Hibras Reservoir would be constructed on 3.5 donums of privately owned land currently planted with trees, as shown in **Table 3** below**.** The only residential building near the proposed reservoir is at the north side of the plot boundary. WAJ has started the land acquisition process.

Table 3: Trees Planted on Private Land Proposed for the Hibras Reservoir

Trees	Number of trees
Olive trees	40

Source: Google Earth

Figure 8: The Proposed Hibras Reservoir

Secondary Pipelines

A total of 48 km of secondary pipelines with diameters of 180 to 600 mm would replace the old deteriorated existing pipelines or reinforce existing small-size pipelines as shown in **Figure 9.** These pipelines would convey water from the storage reservoir, or PSs, to the entry of the district zones. These pipelines would be mainly gravity pipelines except for localized areas within the distribution zone that would need to be supplied via the proposed PS. No service connections would be allowed on the secondary pipelines.

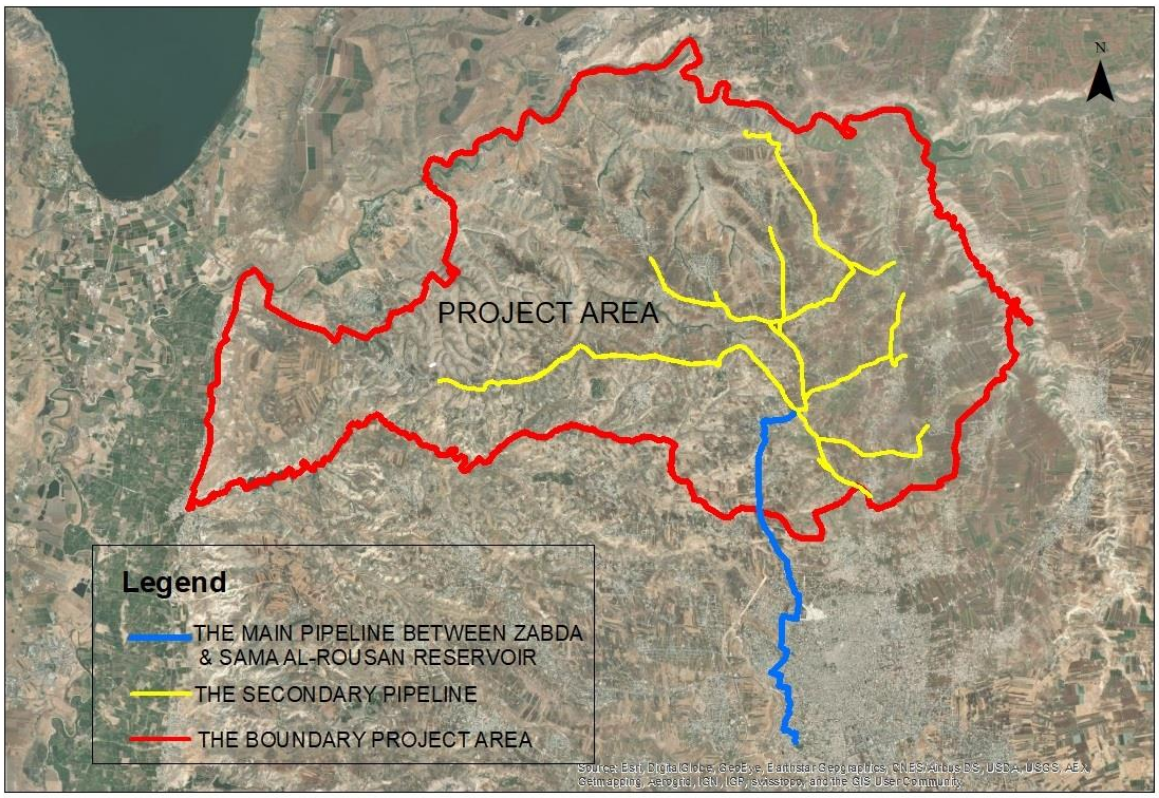
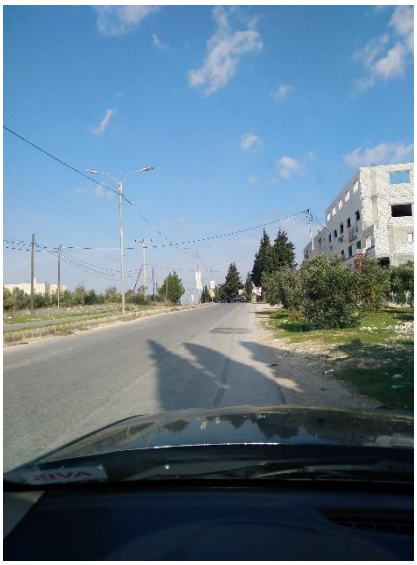


Figure 9: Proposed Secondary Pipelines Layout

The secondary pipelines are expected to follow the road ROW for the entire length, which have street widths ranging from 3 to 15 m. Several farms are located adjacent to these roads. The secondary pipelines would pass through a variety of environments, as shown in the following photographs:

1. Residential Areas:



2. Municipalities (Saru, Shula, Kaffarat):

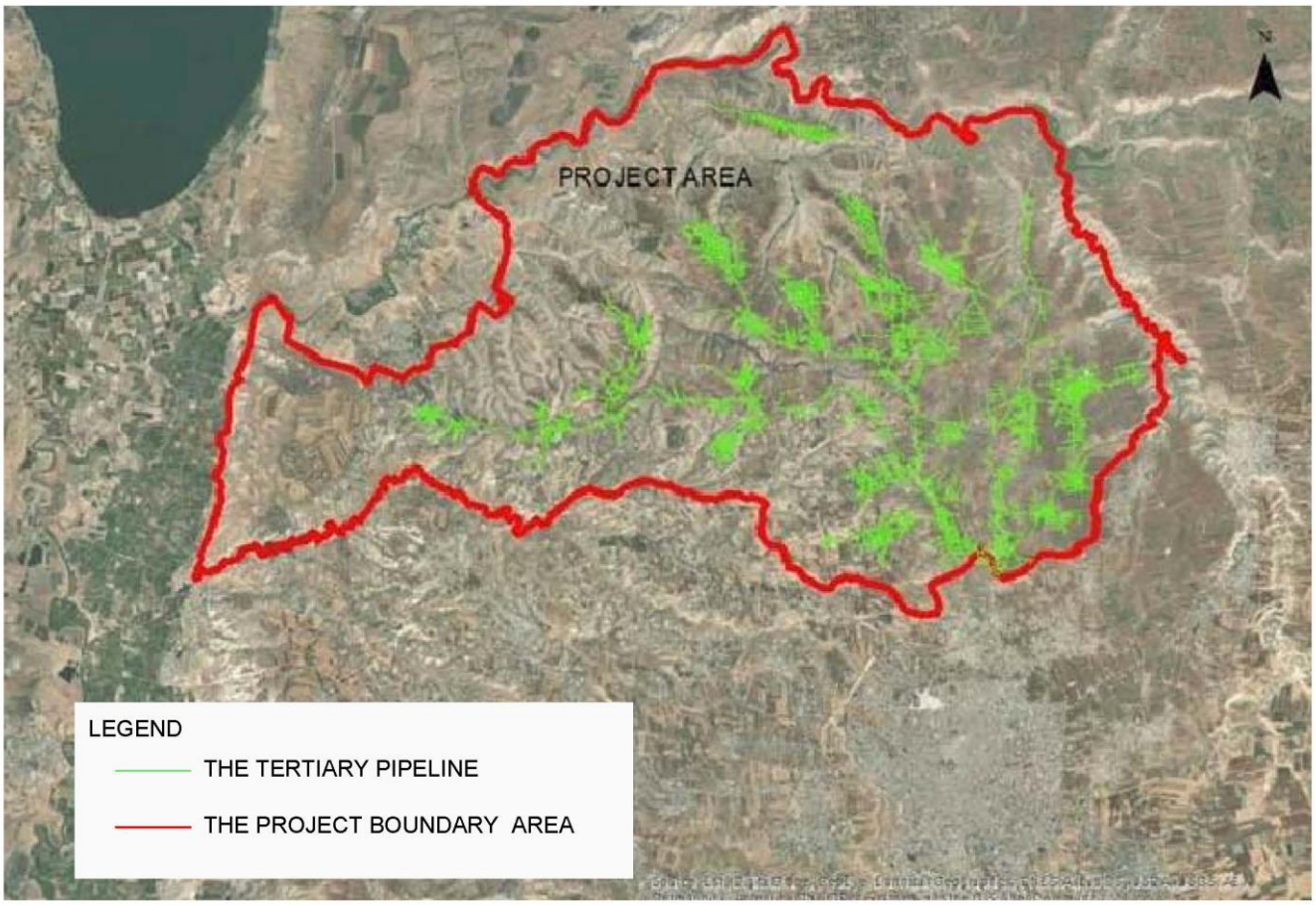
3. Schools:

4. **Commercial Streets:** The pipeline would pass inside the main markets of Bani Kenanah, Saru, and Shula.

5. Olive Tree Farms:

Tertiary Pipelines

A total of 435 km of tertiary pipes with diameters ranging from 63 to 300 mm would be built to replace old, deteriorating pipelines or to reinforce existing small pipelines, as depicted in **Figure 10.** These pipelines would transport water from the secondary pipeline to the different districts within the project area. All these distribution pipelines would be gravity pipelines. Service connections would be permitted on tertiary pipelines including houses, commercial areas, schools, hospitals, health centers, and any other current customer.



Source: USGS (2021)

Figure 10: Proposed Tertiary Pipelines Layout

The tertiary pipelines would pass through a variety of environments, as shown in the following photographs:

1-Residential Areas:



2-Schools:

3-Mosques:

4-Commercial Streets:

5-Olive Tree Farms:

Description of the Proposed Water Networks

The design team has followed certain design considerations in developing the proposal for the upgraded and new water networks. The following points summarize the major work that would be constructed through this Bani Kenanah project:

The estimated length of pipes for the construction area would be nearly 500 km of water lines with diameters that range from 63 mm to 700 mm. The depth of the pipes would range between 0.65 m (the minimum depth) to 1.3 m, depending on the slope of the surface, given that they are dependent on gravity flows.

Table 4 below shows the typical trench width for each diameter of pipe and the total length of water pipes for each diameter.

Table 4: Typical Trench Width for Each Diameter and Length of Pipe

Project Area	Diameter	Total Length (m)	Typical Trench Width (mm)
Bani Kenanah Water Supply System	Ductile Iron 700	14,848	1,300
	Ductile Iron 600	749	1,200
	Ductile Iron 400	4,689	1,000
	Ductile Iron 300	18,566	900
	Ductile Iron 250	13,117	850
	Ductile Iron 200	15,410	800
	Polyethylene 180	17,381	750
	Polyethylene 125	71,072	700
	Polyethylene 63	342,578	650
	Total Length	498,410	-

Table 5 below shows the depth of trenches in relation to the total lengths of pipes with the time required to complete construction and restore the trenches, based on depth of excavation.

Table 5: Depth of Trenches in Relation to Total Length of Pipes

Depth of Trench	Total Length (km)	Percent Of Total Quantities	Average Duration to Construct and Restore Trenches (at 150 m/day) *	Expected Width of Excavation (m)
Less than 1.0 m	34	7%	2–4 days	0.6
From 1.0 to less than 2.0 m	460	92%	3–5 days	0.7–2.0
More than 2.0 m	6	1%	4–7 days	2.0

*: The maximum amount of open trench permitted in any one location must be 150 m, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is lesser.

Description of Project Area during Construction

- The area that would be disturbed during construction depends on the length of the street/road, the type of neighborhood or area (i.e., current land uses), and the type of street (i.e., whether it is a main road or a branching road).
- Trenches would be opened in some roads that serve public service providers such as clinics or hospitals, schools, utility providers, and mosques.
- Most of the roads within the project area are around 5 to 10 m wide with two-way traffic, while the major main roads are between 12 to 20 m in width.

The project area is served by other existing utilities such as the existing water and wastewater supply system, electricity, telecommunications, etc. Full coordination with other utility providers is needed to avoid and minimize the potential for disruption of other utilities' supply. Disruption might result if construction activities damage existing pipelines and services. In developing the proposed water system network, the design team reviewed town maps, land use maps, the existing water and wastewater networks from the Yarmouk Water Company, and other maps of the available utilities to be considered during construction.

Key Project Activities

The key project activities for the expansion and rehabilitation of the water networks in the project area would include the following:

- Mobilization to the site, which would include obtaining all site permits; moving all equipment onto the site; furnishing and erecting temporary buildings and other construction facilities; implementing security requirements; and installing equipment for the site offices, the contractors, and other engineers and employees on-site.
- Supply of materials.
- Storage of materials.
- Topographical survey to check and verify survey data.

- Scheduling and planning.
- Coordination with other utility providers.
- Construction of new water networks would include the following main activities on-site:
  - ❖ Excavation, trenching, pipe laying, testing, backfilling, restoration, construction of house connections, and connection and disconnection to the existing system and service.
  - ❖ The major work within the PS and the reservoirs would include the construction of civil works and the supply and installation of electromechanical works. Special care must be taken during the connection and disconnection of existing systems.
- Continuance of existing water networks operation during the construction work, which is critical. Therefore, contractors must carefully examine all work to be done in, on, or adjacent to existing networks. Work must be scheduled to minimize required existing water networks disconnection time. Contractors are expected to take all necessary precautions for the health and safety of their employees and for the local communities.

The primary types of equipment that are expected to be used by contractors during the construction phase of the project are summarized in **Table 6** below.

Table 6: Key Equipment to be Used in the Water Network Construction

No.	Equipment Type	Number of Equipment Type
1	Excavator/Jackhammer	8
2	Loaders	7
3	Compactors	7
4	Trucks	8
5	Pickup trucks	20
6	Trailers	2
7	Crane	3
8	Concrete Mixer	As needed
9	Asphalt Finisher	As needed
10	Vehicles	30

Construction Duration

The duration of construction for the water network, the reservoirs, and the PS are expected to be no longer than 36 months and would occur from 2023 to 2025.

Labor Conditions

The peak number of personnel on-site during construction may range up to 256. These personnel would include engineers, technical specialists, project partners and their representatives, suppliers, and construction workers as shown in **Table 7**.

Table 7 : Number of Personnel during Construction

Position	Number
Project Manager	6
Site Engineer	12
Mechanical Engineer	3
Electrical Engineer	3
Inspector	16
Surveyor	8
Quantity Surveyor	8
Heavy Equipment	20
Driver	20
Technician	20
Skilled Labor	20
Unskilled Labor	100
Administrator	20
Total	256

During operation, the peak number of personnel on-site may range up to 32. These personnel would include skilled labor such as operators and electrical and mechanical technicians, as shown in **Table 8**.

Table 8: Number of Personnel during Operation

Position	Number
Manager	1
Operation Engineer	2
Maintenance Engineer	2
Administration and Finance	3
Labor	12
Operation and Maintenance Staff	12
Total	32

During construction, workers would likely be housed in the accommodation facilities nearest to the site. If the project management team opts to include worker accommodation facilities on-site, these must be established in accordance with the specifications of the International Labor Organization standards and guidance and must adhere to all measures needed to prevent potential occupational hazards on-site.

Labor camps on-site would be installed temporarily according to good utility practices (practices to ensure safety and health in the provision of utilities such as water, gas, and electricity), and would include a kitchen with catering facilities, common recreational space, and offices for the contractor, as necessary.

4 POLICY AND LEGAL FRAMEWORK

This section presents the national strategies and the national and international guidelines that apply to the Bani Kenanah project including EIB requirements. The project would be funded by the EIB and thus will need to abide by its guidelines. This section also describes national institutions related to this project and 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 national law.

4.1 Relevant National Strategies

Jordan is characterized as being an arid to semiarid country with an average annual rainfall of less than 200 mm a year over 90 percent of the country. It is the second-most water-scarce country in the world, with demand exceeding available water resources. Both surface and groundwater resources used in Jordan are fed by rainfall, which is highly variable. Internal long-term traditional water resources are currently available at 65 m^3/ca/yr. Climate change and population growth are expected to reduce availability to 46 m^3/ca/yr by 2035, with rainfall projected to decline by 13.6 percent or 12.9 mm/yr. Mean temperature is expected to rise by 1.6°C by 2100 (MWI 2025).

The municipal water supply deficit in 2040 is expected to be about 531 million cubic meters (MCM) per year. According to current projections, new projects may provide up to 297 MCM. Just around 234 MCM will be required to fill the supply gap. However, the implementation and timing of these programs are contingent on the availability of relevant funds. As a result of the significant impact of climate change on projected rainfall and temperature distribution and the resulting reduction in water supplies, climate change adaptation must be included in all relevant planning according to the MWI Water Master Plan.

The proportion of water used for domestic purposes may increase by 50 to 60 percent as Jordan's population is estimated to nearly double by 2050. Earlier migration influxes and the rapidly increasing population of Syria’s refugees have put additional strains on the limited water resources in Jordan. Jordan’s development plans were reviewed by MWI to (1) ensure better preparation and planning for future water scarcity issues and (2) improve sanitation coverage through the preparation of the National Water Strategy in 2016–2025 (MWI 2025).

The Jordanian government addressed water security and climate change resilience in the following key documents that govern the water sector:

Jordan Vision 2025

In the national vision document titled *Jordan 2025: A National Vision and Strategy* (Government of Jordan 2015), , the provision of safe water is considered a critical factor for poverty reduction and economic empowerment. The assessment of Jordan's water sector suggests that the government is attempting to achieve substantial structural reform in the sector. The government hopes to improve water use efficiency and enhance conservation to ensure an adequate water supply for Jordan for the long term.

National Water Strategy (2016–2025)

The National Water Strategy 2016–2025 is a plan for ensuring a resilient and sustainable water sector within the 10-year period of Jordan's 2025 vision document. The strategy takes a comprehensive approach to incorporating social, economic, and environmental sustainability in the development of Jordan's water sector. The strategy has key objectives of achieving sustainability of the current sources, reducing over pumping of groundwater, and expanding sanitation and reuse services.

Water Sector Capital Investment Program (2016–2025)

The objectives of the Water Sector Capital Investment Plan 2016–2025 are securing water supply, developing new water resources, providing access to improved water supply, and expanding wastewater services and coverage across Jordan. The strategy aims to obtain 105 l/c/d of metered water, reduce NRW to 30 percent, reduce energy use to 3.66 kilowatt hours per cubic meter of water pumped, and expand the coverage of wastewater services to 80 percent, all by 2025.

Water Demand Management Policy

The objective of the policy is to conserve water resources though minimizing water losses. The strategy promotes efficient water use by relying on nonconventional water resources such as gray water reuse. The policy encourages buildings such as new commercial and residential developments or residences not connected to a central sewer system to use gray water for gardening. The policy provides new regulations to address any health or environmental issues that may be associated with gray water reuse.

Water Substitution and Reuse Policy

This policy intends to manage scarce water resources efficiently, maximize benefits and returns, and proposes implementation actions. The policy aims to enhance economic opportunities while preserving freshwater resources and protecting the environment.

Water Reallocation Policy

This reallocation policy aims to set action plans for redistributing water between sectors and governorates. It will employ a conveyance system for water to connect the southern and northern regions. The reallocation policy plans to use treated wastewater for irrigation within the Jordan Valley to increase the amount of freshwater for domestic purposes.

Surface Water Utilization Policy

The objective of this policy is to promote the efficient use of surface water. The policy aims to protect and manage surface water.

Climate Change Policy for a Resilient Water Sector

The aim of this policy is to strengthen water sector resilience and add more environmental protections into the existing institutional framework to promote climate change mitigation efforts.

The National Climate Change Policy of the Hashemite Kingdom of Jordan 2013–2020 (MoE 2013)

The long-term goal of this policy is to achieve a climate risk–resilient Jordan. The policy aims to keep Jordan's carbon footprint low while growing the economy. The policy envisions healthy, sustainable, resilient communities with protected water and agricultural resources. The policy also aims to increase the resilience of water resources to climate change, among many other sectors.

The Jordan Nationally Determined Contributions (MoE 2021)

Among the many adaptation measures and programs for the water sector recommended in the Jordan Nationally Determined Contributions are measures to enhance the residential water supply by reducing water losses, installing water saving technologies, and promoting water harvesting. Improving the adaptive capacity of water utilities (wastewater treatment plants, water desalination plants, and water distribution utilities) constitutes a major element of the water resource management scope in Jordan. Enhancing the effective performance and resilience of these water utilities to climate change impacts will strengthen the adaptive capacity of the whole sector. Protecting water utilities from adverse impacts of climate change and reducing their environmental impacts are major objectives to enhance the sustainability of water infrastructure. This can be achieved by enhancing performance and efficiency of water utilities through technological improvements and capacity development for reducing water loss.

5 LEGISLATIVE FRAMEWORK

AJWE have identified the main ministries, institutions, and authorities that are directly involved with environmental monitoring, protection, and regulation within the Bani Kenanah project's study area. These different entities are described in the following sections.

5.1 Relevant Environmental-Related Institutions

Ministry of Environment

The Jordanian MoE is the principal environmental institution in Jordan and is responsible for the evaluation of the environmental impacts of the project and the issuance of associated project licenses and clearance.

MoE was established in 2003, with the mission to maintain and improve 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 Jordan. Moreover, MoE is dedicated to ensuring that legislation is enforced through raising public awareness, implementing inspection and monitoring programs, and encouraging cooperation with national, regional, and international bodies.

MoE is legally strengthened by the Environmental Protection Law, which provides the MoE with the tools to perform its duties. The Environmental Protection Law was a temporary law issued in 2003 and was officially ratified by the Jordanian Parliament in 2006. In 2017, the Environmental Protection Law No. 6 was issued.

The law considers MoE to be the competent authority for the protection of the environment in Jordan. Official and national authorities are bound to implement the instructions and resolutions issued under the provisions of this law that gave the MoE all the judicial powers it requires for implementation.

Environmental Protection Law No. 6 provides the MoE with the legal power to inspect any facility, and according to inspection findings, gives the MoE 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. The police now act as an implementation tool and a 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 ESIA where any development or economic project should include 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 submitted to MoE, where it will be reviewed. The Classification and Permitting Regulation No. 69 year 2020 classifies projects into four categories according to their environmental impacts as follows:

- **Category 1:** Projects of high risk that require a comprehensive environmental impact assessment
- **Category 2:** Projects of medium risk and potential damage that require an initial environmental impact assessment
- **Category 3:** Projects of low risk that require environmental approval
- **Category 4:** Projects of low risk that are not required to apply for environmental approval or any other permits.

The Bani Kenanah project is categorized as Category 1 as classified by MoE in their letter dated November 24, 2021, and in accordance with the Classification and Permitting Regulation No. 69 year 2020. Category 1 projects must undergo a full ESIA study. This assignment will be carried out considering the following requirements:

- Applicable local, national, and regional requirements, including those related to environmental and social impact assessments
- EIB environmental and social standards
- Relevant international conventions and protocols relating to environmental and social issues, as transposed into national legislation
- Applicable requirements in the ESIA Regulation no. 69 year 2020.

If the impact assessment is approved, the project will obtain the proper license and start its implementation program while adhering to the environmental mitigation and management systems specified and approved in the study. Any deviation from those guidelines would render the project in violation of laws and regulations.

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, wastewater systems, and related projects. MWI is responsible for 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 and standardized water-related data.

Units for public relations, internal monitoring, and water security and protection are directly subordinate to the Minister of Water and Irrigation, whose responsibilities encompass MWI, WAJ, and Jordan Valley Authority (JVA) (Ministry Bylaw No. 52 year 1992).

MWI encompasses the two most important entities that deal with water in Jordan:

- WAJ: responsible for water and sewage systems.
- JVA: responsible for the socioeconomic development of the Jordan Rift Valley, including water development and distribution of irrigation water.

According to Article 3 of the permanent Water Authority Law No. 18, year 1988, WAJ was established as an autonomous corporate body that carries full responsibility for public water supply, wastewater services, and related projects as well as for overall water resources planning and monitoring, construction, operations, and maintenance. The responsibilities of WAJ are defined in 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 Jordan and put forth programs and plans to meet future water needs by providing additional water resources from inside or outside Jordan.
- 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 managing water resources.
- Develop 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 WAJ'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.
- Regulate water supply and wastewater utilities under private management (WAJ Program Management Unit).

5.2 Other Relevant Institutions

Ministry of Health

The Ministry of Health undertakes all health affairs in Jordan. The Ministry's tasks and duties include the following:

- 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 legislation enacted
- Working in coordination with concerned parties to raise public health standards by fighting diseases resulting from malnutrition

In terms of this project, the Ministry of Health will have a supervisory and monitoring role through enforcement of all applicable legislation to ensure WAJ's contractor compliance with all relevant aspects and provisions of the General Health Law No. 47, year 2008 (Chapters 8 to 10 and 13). In summary, the Ministry of Health's roles will include but are 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 and prohibited chemicals depending on the degree of hazard. Chemicals used in industries are to abide by the list of permitted chemicals proposed by the Ministry of Health to ensure public health protection.
- **Chapter 10**, Health Hazards: Compliance with Instruction No. 1 year 2011 for the prevention of occupational hazards related to exposure to dust, odor, and noise. The stipulation requires proper disposal of generated wastes and wastewater.
- **Chapter 13**, Trade and Industries: The Ministry of Health will ensure compliance with the Trade, Industry, and Occupational Safety Law No. 16, year 1953. This can be done through inspections to prevent any potential health or occupational hazards.

Ministry of Local Administration

The Ministry of Local Administration has a supervisory role over the activities of the municipalities and the Joint Services Councils operating across Jordan. There are a total of 93 municipalities and 22 Joint Services Councils. The main duties of the Ministry of Local Administration are the following:

- Provide the various facilities to the municipalities to enable them to perform their functions and support them in improving the efficiency of service provision.

- Oversee, coach, and monitor the financial, administrative, and organizational performance of the municipalities.
- Enhance the institutional capabilities of the sector.
- Manage financial transactions and arrange with the relevant parties to provide the necessary funding for programs and projects.
- Set, develop, and implement the legislative, administrative, financial, and institutional frameworks that are effective for municipal operations.
- Prepare the regional, organizational, and detailed construction plans for the municipalities.
- Monitor and control the implementation of regulations, policies, and instructions of the municipalities and Joint Services Councils. 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.
- Sustain and develop the inhabited clusters that have no municipal councils.

Ministry of Public Works and Housing

The Ministry of Public Works and Housing aims to develop a network of public roads in Jordan, linking towns, villages, and communities, sites of industrial production, agricultural and tourist areas, and archaeological sites. The Ministry of Public Works and Housing also aims to link Jordan to neighboring countries. The ministry is upgrading the quality of roads and promoting safety requirements. They are staying up to date with the latest technologies used in modern road construction and lighting.

Department of Land and Survey

The Department of Land and Survey (DLS) is responsible for maintaining, documenting, preserving, and facilitating the use of land property rights and providing the database necessary to build the national geographic information system. This department will be consulted for issues relating to land acquisition and resettlement, if needed.

Ministry of Transport

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

- Devising the general policy for transportation and overseeing its implementation in coordination with all related parties
- Regulating and monitoring the road freight transport sector and its services, as well as issuing 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 issuing necessary permits for operating in the sector and other responsibilities

Public Security Directorate/Traffic Department

The Traffic Department of the Public Security Directorate is responsible for coordinating any changes in road traffic due to construction work. The department's duties include the following:

- Participate in the general policy of traffic control and transportation in Jordan in cooperation with other involved entities.
- Enforce traffic control law and all regulations and instructions issued based on that law.
- Monitor and organize traffic movement within cities.
- Monitor road conditions within and outside cities and determine technical problems in cooperation with related entities to reach suitable solutions.
- Institute plans and procedures to monitor and control roads used by official envoys.
- Issue tickets and collect fines for issued tickets.
- Participate in the implementation of public transport policy in coordination with all relevant public transport regulatory commissions.
- Monitor the work of traffic safety volunteers and activate the role of the volunteer social police from the local community.
- Prepare public awareness campaigns to increase traffic awareness across all social groups.
- Track and find stolen and wanted vehicles.
- Conduct traffic studies and research to determine root causes of traffic problems and present solutions.

Ministry of Tourism and Antiquities/Department of Antiquities

The Ministry of Tourism and Antiquities (DoA) works toward developing tourism using a comprehensive and integrated approach to express the nation's legacy, culture, history, heritage, inheritance, successive civilizations, and economic prosperity. The Ministry aims to develop an advanced tourism industry capable of using its comparative and competitive advantages to grow.

The Department of Antiquities of Jordan (DoA) is the official institutional authority mandated by law to be responsible for the protection, conservation, and preservation of antiquities.

The first unit that took the role of DoA in Jordan was founded in 1924. Its main job was to supervise fieldwork, in cooperation with foreign expeditions and archaeological missions, and to implement salvage excavations and limited consolidation and preservation work. The official DoA of Jordan was established in 1928.

There are two institutional policies of the DoA:

- The principal policy of the DoA is the protection of antiquities, preferring conservation measures that do not require physical intervention to the remains as the first choice where possible.
- The second policy is for the preservation of antiquities, including research, survey, excavation, and site management.

The DoA would be involved in the program if artifacts were found during excavation activities. The Law of Antiquities No. 21, year 1988 calls for any remains found to be immediately reported. Article 21 of this law indicates that all antiquities discovered during excavations carried out by any party must be considered the property of the state. The DoA then has the right to assess the significance of any discovered remains/antiquities and institute its recommendations accordingly.

Ministry of Agriculture

The Ministry of Agriculture (MoA) is responsible for managing public rangelands and forests; protecting soil, pastureland, and flora; providing agricultural loans; supporting farmers; and granting permits for the import and export of agricultural products of plants and animals, veterinary medicines and vaccines, and live birds. MoA is also responsible for the establishment and renewal of licenses for companies, factories, shops, galleries, nurseries and agricultural farms, and olive presses, providing training for farmers, protecting and managing wildlife, and issuing fishing and hunting licenses and regulations.

However, the most relevant task of the MoA is that mentioned in Article 34 of its Interim Agriculture Law No. 44, year 2002, which indicates that it is prohibited to cut down trees, bushes, or wild plants without license from the Minister of Agriculture. Therefore, the project manager will coordinate with the MoA if the project requires the removal of trees as part of the construction phase.

Some wildlife protection and permitting tasks are also the responsibility of the Royal Society for the Conservation of Nature (RSCN).

Ministry of Labor

Since its emergence, the Ministry of Labor 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, Labor Law No. 8, year 1996 was issued and the administrative regulation No. 38, year 1994 was established, along with its amendments.

The tasks of the Ministry of Labor include:

- Organizing the labor sector, as well as updating labor legislation to meet the needs of the labor market
- Maintaining production parties' rights and encouraging foreign investments
- Developing the workforce through the Vocational and Technical Training and Educational Council
- Collaborating in human resources and workforce development projects

- Applying the law of vocational work organization
- Organizing foreign labor in the Jordanian labor market
- Maintaining available job opportunities to employ Jordanian labor
- Restructuring and reorganizing the Ministry of Labor to promote efficient operation
- Building up labor market databases
- Consolidating cooperation and partnership with the private sector
- Consolidating regional and international cooperation and partnerships
- Consolidating partnerships and cooperation with corporations concerned with preparing and developing human resources

Jordan Standards and Meteorology Organization

Jordan Standards and Meteorology Organization (JSMO) plays a proactive role in protecting the interests, health, and safety of citizens and the environment and enhancing the competitiveness of Jordanian products in national, regional, and international markets.

JSMO prepares, approves, revises, amends, and monitors the implementation of standards and technical regulations covering all services and products (except for pharmaceutical products, medicines, veterinary medicines, serums, and vaccines).

JSMO fulfills its mandate to build, implement, and update systems compatible with international practices, in the fields of standardization, metrology, conformity assessment, market surveillance, accreditation, information, and related areas through providing an internal supportive working environment and developing all needed human, knowledge, material, technological, and financial resources.

Yarmouk Water Company

Yarmouk Water Company was established as a company for the management of water in the North Sector on July 26, 2010, as a limited liability company. In accordance with the provisions of the Jordanian Companies Law No. 22, year 1997, it is wholly owned by WAJ. The company is managed and supervised by a board of directors consisting of seven members, which reports to the General Assembly. The company 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 high-quality services in the water and sewage sector with efficiency and excellence. The company works in the service areas of Irbid, Mafraq, Ajloun, and Jerash. They implement strategic initiatives to reduce water losses and energy consumption. The company improves financial performance by increasing revenues, reducing expenses, and building technical and administrative capacities. The company is 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 structures consist of the following:

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

The company relies on groundwater from wells, Wadi Al Arab, Hakma, Ramtha, a group of springs, and various water sources. The annual supply amounts to about 90 MCM.

5.3 Principal National Legislation

Laws

- Industry and Handicraft Law No. 16, year 1953
- Management of Natural Resources Law No. 19, year 2018
- Land Acquisition Law No. 13, year 2019
- Water Authority Law No. 18, year 1988 and its amendments, in addition, Law No. 22, year 2014
- The Antiquities Law No. 21, year 1988 and its amendments
- Law for Protection of Cultural Heritage and Sites No. 5, year 2005
- Labor Law No. 8, year 1996 and its amendments
- Civil Defense Law No. 18, year 1999
- Agricultural Law No. 7, year 2018 and its amendments
- General Electricity Law No. 64, year 2002 and its amendments
- Transportation Law No. 89, year 2003 and its amendments
- The Environment Protection Law No. 6, year 2017
- Local Administration Law No. 22, year 2021
- The Free and Development Zones Law No. 38, year 2017
- Public Health Law No. 47, year 2008 and its amendments of 2017
- Traffic Law No. 49, year 2008
- Roads Law No. 24, year 1986
- Land Transport Regulatory Commission Law No. 4, year 2011
- The Waste Management Framework Law No. 16, year 2020
- Renewable Energy and Energy Efficiency Law No. 33, year 2014
- Law of Professional Licenses and its Amendments No. 28, year 1999
- Monitoring and Inspection of Economic Activities Law No. 33, year 2017
- Real Estate Ownership Law No. 13, year 2019

Regulations

- Environmental Classification and Licensing Regulation No. 69, year 2020
- Regulations for Protection of Birds and Wildlife and Rules Covering Their Hunting No. 13, year 1973
- Regulation of Protection and Safety from Industrial Tools and Machines and Worksites No. 43, year 1998 – Issued by the virtue of the provisions of paragraph (c) of Article 85 of the Labor Law No. 8, year 1996 and its amendments
- Regulation for the Establishment of Occupational Health and Safety Committees and Supervisors No. 7, year 1998; issued in accordance with Article 85 of the Jordanian Labor Law No. 8, year 1996 and its amendments
- Groundwater Control Regulation No. 85, year 2002; issued pursuant to Articles 6 and 32 of Water Authority Law No. 18, year 1988
- Regulation of Harmful and Hazardous Waste Management, Transfer and Handling No. 68, year 2020.
- Soil Protection Regulation No. 25, year 2005
- Regulation for the Protection of the Environment from Pollution in Emergency Situations No. 26, year 2005
- Buildings, Towns, and Villages Planning Regulation No. 1, year 2022
- The Joint Services Councils Bylaw No. 113, year 2016
- Air Protection Regulation No. 28, year 2005
- Land Use Planning Regulation No. 6, year 2007
- Regulation for the Licensing and Permitting of Excavation and Infrastructure Network Projects No. 112, year 2007
- Natural Reserves and National Parks Regulation No. 29, year 2005
- Regulation for Trade Regulatory System No. 94, year 1998
- The Regulation of Preventing Dust and Waste Collection Fees within Municipal Areas and its amendments No. 68, year 2016
- Regulation of Non-hazardous Solid Waste Management System No. 44, year 2022

Instructions

- Instructions for the Management and Handling of Hazardous Waste, year 2020
- Instructions for Recycling and Handling of Consumed Oils, year 2014 and amendments
- Instructions for the Limitation and Control of Noise, year 2003
- Instructions for the Selection of Locations for Development Activities, year 2018, issued in accordance with paragraph (d) of Article 4 of the Environmental Protection Law No. 52, year 2006
- Instruction for the Prevention of Occupational Hazards Related to Health Hazards Resulting from Labor Housing Units On-Site No. 1, year 2013, issued in accordance with Article 49 of the temporary Public Health Law No. 49, year 2008. Modified Instruction for the Protection of Water Resources, year 2019
- Instructions for the Protection of Water Resources, year 2019 and its amendments
- Instructions for the Protection of Birds and Wildlife, year 2021 No. (Z/2) of the Agriculture Law

Standards

- Jordanian Standard (JS) 286/2015 requirements for drinking water and its amendments
- Standard for storage – general precautionary requirements for storage of hazardous materials (JS 431/1985)
- Standard for heat levels allowed to be exposed to in work environment (JS 525/1987)
- Standard for maximum allowable limits of air pollutants emitted from the stationary sources (JS 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)
- Standard for ambient air quality (JS 1140/2006)
- Microbiological standards for the quality of raw water for drinking water sources and the minimum requirements for treatment to exploit those sources/Supreme Steering Committee for Water Quality

5.4 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 ratification are noted in parentheses):

- International Plant Protection Convention (April 24, 1970)
- Convention Concerning the Protection of the World Cultural and Natural Heritage (December 17, 1975)
- Convention on Wetlands of International Importance especially as Waterfowl Habitat (May 10, 1977)
- Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) (March 14, 1979)
- Protocol to amend the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) (October 1, 1986)
- Amendment to the Convention of International Trade in Endangered Species of Wild Fauna and Flora (Article XI) (April 13, 1987)
- Protocol on Substances that Deplete the Ozone Layer (August 30, 1989)
- Convention for the Protection of the Ozone Layer (August 31, 1989)
- Convention on Biological Diversity (February 10, 1994)
- Convention on the Conservation of Migratory Species of Wild Animals, Bonn Convention — 2000.
- Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer (February 10, 1994)
- Framework Convention on Climate Change (March 21, 1994)
- Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer (September 28, 1995)

- International Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa (December 26, 1996)
- Constitution of the Food and Agriculture Organization of the United Nations (January 23, 1951)

5.5 Specific Relevant Government of Jordan Standards and Guidelines

All projects undertaken in Jordan are governed by specific project design requirements and applicable agreements with environmental permitting authorities. Specific requirements relating to the following are provided below:

- Ambient air quality
- Ambient noise
- Waste management
- Soil and groundwater quality
- Expropriation and resettlement

Ambient Air Quality

Ambient air quality limits provided by the Ambient Air Quality Standards (JS 1140/2006) are enforced in Jordan. A summary of these standards is presented in **Table 9.**

Table 9: Relevant Ambient Air Quality Standards

Air Pollutant	Average Time	Maximum Allowable Concentration in the Ambient Air	Number of Allowed Exceedances
Sulfur Dioxide (SO_2)	1 Hour	0.30 mg/m^{3*}	3 times within a given month in 1 year
	24 Hours	0.14 mg/m^3	Once per year
	1 Year	0.04 mg/m^3	–
Carbon Monoxide (CO)	1 Hour	26 mg/m^3	3 times within a given month in 1 year
	8 Hours	9 mg/m^3	3 times within a given month in 1 year
Nitrogen Dioxide (NO_2)	1 Hour	0.21 mg/m^3	3 times within a given month in 1 year
	24 Hours	0.08 mg/m^3	3 times within a given month in 1 year
	1 Year	0.05 mg/m^3	–
Hydrogen Sulfide (H_2S)	1 Hour	0.03 mg/m^3	3 times within a given month in 1 year
	24 Hours	0.01 mg/m^3	3 times within a given month in 1 year
Ozone (O_3)	1 Hour	0.08 mg/m^3	–
	8 Hours	0.12 mg/m^3	–
Ammonia (NH_3)	24 Hours	270 mg/m^3	3 times within a given month in 1 year
	1 Year	8 mg/m^3	–
Total Suspended Particles	24 Hours	260 $\mu g/m^3$	3 times within a given month in 1 year
	1 Year	75 $\mu g/m^{3+}$	–
PM_{10}	24 Hours	120 $\mu g/m^3$	3 times within a given month in 1 year
	1 Year	70 $\mu g/m^3$	–
$PM_{2.5}$	24 Hours	65 $\mu g/m^3$	3 times within a given month in 1 year
	1 Year	15 $\mu g/m^3$	–
Lead (Pb)	Seasonal	1 $\mu g/m^3$	–
	1 Year	0.5 $\mu g/m^3$	–

Air Pollutant	Average Time	Maximum Allowable Concentration in the Ambient Air	Number of Allowed Exceedances
Phosphate (P_2O_5)	24 Hours	100 µg/m^{3+}	3 times within a given month in 1 year
	1 Year	40 µg/m^3	–
Cadmium (Cd)	1 Year	0.005 µg/m^3	–

+µg/m^3: microgram per cubic meter

*mg/m^3: milligram per cubic meter

Ambient Noise Limits

The Jordanian Instruction for the Prevention and Elimination of Noise, year 2003 sets the maximum allowable noise limits that all projects and noise producing facilities should comply with. Article 5 of the same standards established a list of activities that are prohibited by law. Project activities that would be affected are the following:

- All construction activities using noise producing plants and equipment (e.g., mixers and vibrators) must cease between 8:00 p.m. and 6:00 a.m., unless a permit is granted by the MoE.
- Work activities within light industrial areas with residential dwellings are prohibited to continue between 9:00 p.m. and 7:00 a.m. (summer) and between 8:00 p.m. and 6:00 a.m. (winter).
- The project area encompasses residential, commercial, and industrial uses where these standards would apply.

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

Table 10: Maximum Allowable Noise Limits

Area	Allowable Limits for Noise Levels (dBA)	
	Day	Night
Residential areas within the city	60	50
Commercial areas	65	55
Industrial areas (heavy industry)	75	65

Soil and Groundwater Quality

Soil

The Soil Protection Regulation No. 25, year 2005 covers requirements to protect soils and prevent soil contamination through proper management and monitoring.

Groundwater

The general rules of the Groundwater Control Regulation No. 85, year 2002, issued pursuant to Articles 6 and 32 of Water Authority Law No. 18, year 1988, are the following:

“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 of usage and the quantities of pumped-out water and any other conditions should be identified in the license.”

Owning land does not include ownership of water stored underground. A license is required for drilling wells. In addition, supervision by the authority is required, and a pumping test must be conducted before utilization.

“Anyone who is granted a license to extract groundwater must 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 for private well owners.

Waste Management

Solid Waste Management

Instructions of Solid Waste Management (2019) According To Regulation No. 27, Year 2005

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

It lists details, responsibilities, and tasks to be undertaken including monitoring, collection 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 for storage, collecting, sorting, recycling, treating, and conducting training and awareness programs, in addition to dealing with compliance, offenses, punishments, and fines. The regulation requires the development of plans for occupational safety and health in solid waste management facilities.

Handling of Hazardous Waste

Instructions for Managing and Handling Hazardous Wastes, Year 2020 Issued Pursuant to the Provisions of Article 10 of the Regulations for the Management of Hazardous and Hazardous Substances, Transport, and Handling No. 68, Year 2020

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. The regulation covers hazardous waste materials used 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 to prevent fire and other accidents. There are special restrictions for safety and health of the employees in the site including emergency plans.

Handling of Consumed Oils

Instructions for Recycling and Handling of Consumed Oils, Year 2014 and Amendments

The handling of spent oils must follow the Instructions for Recycling and Handling of Consumed Oils, year 2003. These instructions provide definitions of consumed oils as oils refined from raw petrol or industrial oils that have been used, and are as a result, transferred into polluted waste together with chemicals or physical pollutants that should be disposed of, treated, or recycled. Examples are machine oils, engine oils, hydraulic oils, energy transfer and movement oils, heat exchange oils, 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. They describe how these instructions should be implemented by 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 the following:

- Discharge of oil into sewage networks, septic tanks, surface and groundwater resources, or the environment is prohibited.
- All parties mentioned in Article 3 must obtain a license from the Public Institution for Environmental Protection.
- Oil mixing with solid residential waste and disposal into the municipal dump for residential 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 prior approval is granted.
- 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. The general conditions for oil carriers include having an identification number (license), submitting comprehensive information about the company with the license request, and transferring the oil into a licensed collection station only. Other articles list the conditions for oil recycling and treatment units.

Expropriation and Resettlement

Jordan has an established system for expropriation of land and property in the public interest. This section outlines Jordan's existing legal and policy framework relating to the expropriation of any private land.

Legal Provisions for Expropriation and Compensation of Private Land and Property

Legal Instrument

Land acquisition is done under a single piece of legislation, law No. 12, year 1987, commonly referred to as the Land Acquisition Law (LAL). The LAL applies in all cases and to all concerned institutions. The key articles of the LAL are discussed in this section in the context of EIB guidelines for land acquisition and resettlement, respectively. Appropriate provisions would apply to the proposed Bani Kenanah water supply system project.

Land Owners

The LAL specifies (Article 7) that the owner of the property is the person in whose name the property is registered at the Land Registry. If the property is not registered, the person seizing the land on the day of issuance of the Council of Ministers' Resolution to acquire will, for the purposes of compensation, be considered the owner. This stipulation does not preclude anyone else from claiming ownership through the courts. The entitlements of legally established renters are also confirmed.

In the case of multiple ownerships, it is the general practice of the government to deal with the owners as a body and to ask them to select a representative to act and negotiate on their behalf. Nonetheless, all owners (shareholders) will be entitled to property compensation according to their shares.

Compensation for Improvements and Rights

The LAL in Article 10 states clearly that compensation should be fair to all project-affected parties including both owners and renters. Owners should be compensated for their properties including land, buildings, improvements, trees, etc. at full replacement cost. Judgments on the LAL in 1996 confirm this position: "The property appropriated is the land and the buildings, trees, and other fixtures on it including the water tank built in the land. Claiming for equitable compensation includes all that is in the property."

Crops and Trees

Under the LAL, trees and annual crops are subject to compensation but no guidelines are defined except that the expropriation must be in consideration of an equitable compensation.

Under past practice, tree crops have been compensated based on a flat-rate single payment defined according to a schedule developed for this purpose based on the type and age of tree. This schedule is outdated and is widely believed to lead to the underestimation of asset values. The courts have often increased compensation substantially after receipt of independent valuation reports.

Amount of Compensation Payable to Renters

The LAL caps the awards to renters proportionately as a percentage of the compensation for the plot. The maximum is:

- 15 percent of the compensated value for the property/land expropriated if the compensation is for occupation for industrial or commercial purposes
- 5 percent of the compensated value for the property/land expropriated if the property is occupied for any other purpose

The LAL does not preclude private agreements between renters and owners. In conjunction with other laws, a settlement without the agreement of the renter is extremely unlikely.

5.6 European Investment Bank Environmental and Social Standards

The EIB is a public entity that is guided by the European Union's policy goals and principles of sustainable development, public engagement, and accountability. It aims to promote sustainable and inclusive growth while safeguarding the natural and social environment in a comprehensive manner, ensuring that environmental and human well-being requirements are included in the definition, preparation, and implementation of all EIB-financed activities.

The EIB also recognizes the need for a proactive approach to guarantee that environmental and social factors are considered early in the strategic decision-making process by promoters to have a real impact on the development options available. To that end, the EIB encourages the use of the strategic environmental assessment as a tool for identifying and analyzing prospective plans and program impacts.

The EIB environmental and social elements that must be evaluated (version February 2022) include:

- Environmental and social impacts and risks
- Stakeholder engagement
- Resource efficiency and pollution prevention
- Biodiversity and ecosystems
- Climate change
- Involuntary resettlement

- Vulnerable groups, indigenous peoples, and gender
- Labor rights
- Health, safety, and security
- Cultural heritage

5.7 European Investment Bank Involuntary Resettlement Policy

Land acquisition and resettlement is, and will remain, an unavoidable potential side effect of development projects. To limit unfavorable impacts that might occur because of the implementation of the project, tools were designed through a Resettlement Policy Framework and a Resettlement Action Plan (RAP) to mitigate the potential impacts of land acquisition and other related impacts. The fundamental goals and procedures that must be considered during the development of any land acquisition and resettlement operation for the EIB-assisted project are specified in the EIB Involuntary Resettlement Standard. The main goals of the RAP can be summarized as follows:

- Involuntary resettlement should be avoided or minimized where feasible through exploring all viable alternative project designs; where it is unavoidable, the resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable displaced persons to share project benefits.
- Displaced persons should be meaningfully consulted and should have opportunities to participate in planning and implementing resettlement programs.
- Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living, or at least to restore them, in real terms, to predisplacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.

6 ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

As required by the ESIA ToR (**Annex 1**), environmental and social baseline field surveys and investigations were conducted and relevant documents were reviewed to study and establish an environmental and social baseline for the proposed project. This section of the ESIA presents an overview of the findings of the data collection, field investigations, and review of the baseline physical, biological, and socioeconomic conditions in the project area.

6.1 Physical Environment

The characterization of the physical environment baseline conditions was achieved through data collection, field visits, and review of available reports.

Data related to meteorological conditions were collected and included detailed climate data averages over a 10-year period (2010 to 2019) for the project area. Data was obtained from the Jordanian Department of Meteorology from the meteorological station falling within the Irbid Governorate (i.e., Al Yarmouk University Station). This data is presented below and includes minimum and maximum temperatures, relative humidity, rainfall averages, and wind speed.

Field investigations involved several field visits made by various environmental team members including the ecology expert. Photographs of the project area were taken during those field visits.

Air quality sampling was conducted at the proposed Sama Reservoir location from August 18 to 21, 2022. In addition, noise level monitoring was conducted for the same location. The air quality and noise level monitoring are discussed in the sections below.

Meteorology and Climate

The meteorological characteristics of the proposed project area have been obtained from Al Yarmouk University weather station, which is the closest to the proposed project area. **Table 11** below summarizes the average annual temperature, rainfall, humidity, and wind speed readings over a period of 10 years.

Table 11: Averages of Annual Climate Data for Years 2010–2019

Climatic Parameter	Irbid Weather Station
Average Maximum Temperature (°C)	24.5
Average Minimum Temperature (°C)	13.8
Average Mean Temperature (°C)	19.15
Average Monthly Rainfall Amount (mm)	36.08
Average Total Annual Rainfall Amount (mm per year)	433
Average Relative Humidity (xxx)	63.8
Average Mean Wind Speed (knot)	2.9

Source: Jordan Meteorological Department (2019)

Figure 11 below shows the mean monthly rainfall pattern for Irbid, from measurements taken for the years 2010 through 2019. A maximum average of about 9 mm rainfall is observed in November, while no rainfall occurs in the drier months from June to September.

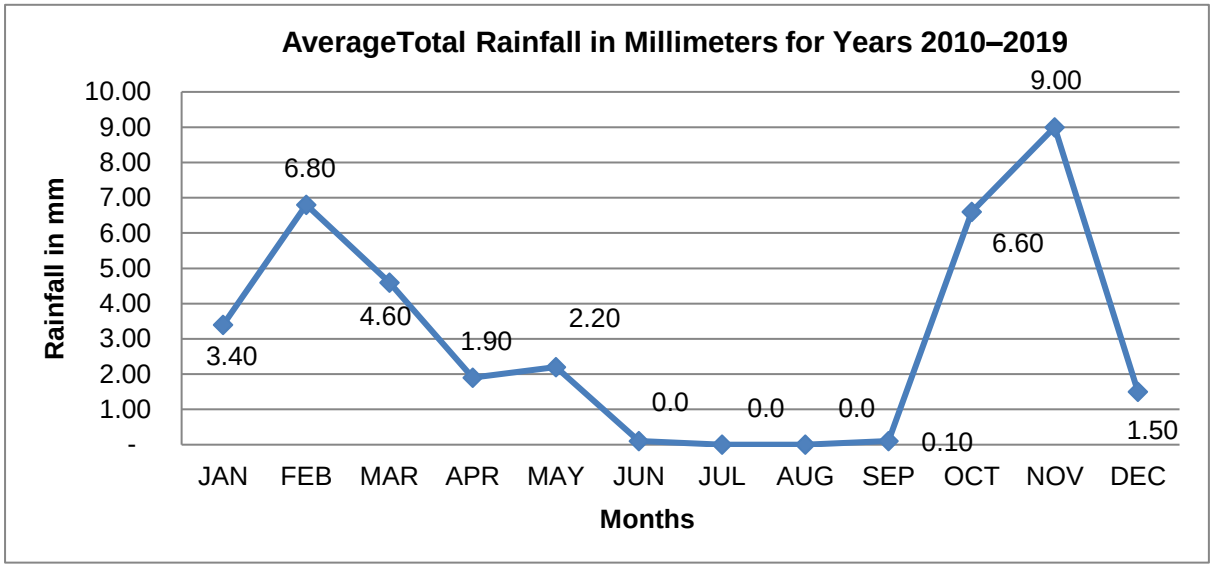


Figure 11: Irbid Mean Monthly Rainfall Amount 2010–2019

Air Quality

The baseline assessment of air quality presents the existing conditions within the project study area to document the existing environment before starting proposed project activities. Existing physical conditions related to air quality and ambient noise are presented. The information was obtained from a combination of field surveys and real-time measurements at the proposed project area.

Instrumentation and Measurement Site

An air quality sampling program was conducted at the project site from August 18 to 21, 2022. The program covered the following emission parameters: particulate matter (PM_{10}), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO). **Figure 12** shows the location of the air quality monitoring location.

Figure 12: Location of Air Quality Monitoring

Real-time monitoring instruments were used to assess the ambient air quality, as shown in **Table 12**. The instruments are USEPA-approved, and the test methods were conducted according to national and international standards.

Table 12. Monitored Parameters, Principles, and Standards

#	Parameter	Test Method	Principle
1	Particulate Matters (PM_{10})	Beta ray attenuation	JS 1140/2006
2	Sulfur Dioxide (SO_2)	Ultraviolet (UV) fluorescence	
3	Nitrogen Dioxide (NO_2)	Chemiluminescence	
4	Carbon Monoxide (CO)	Infrared	

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. The monitoring results of pollutants were compared to JS 1140/2006 to verify compliance with its limits.

Results

A. Meteorological Parameters

Results of wind monitoring (**Figure 13**) at the project site during the monitoring period (August 18 to 21, 2022) showed that the prevailing wind direction was southeast, with a frequency of 22.0 percent, followed by south, with a frequency of 18.0 percent. Regarding wind speed, the prevailing wind speeds were 3.6 to 5.7 meters per second (m/s), with a frequency of 40.0 percent. The hourly records for the meteorological parameters are in **Annex D**.

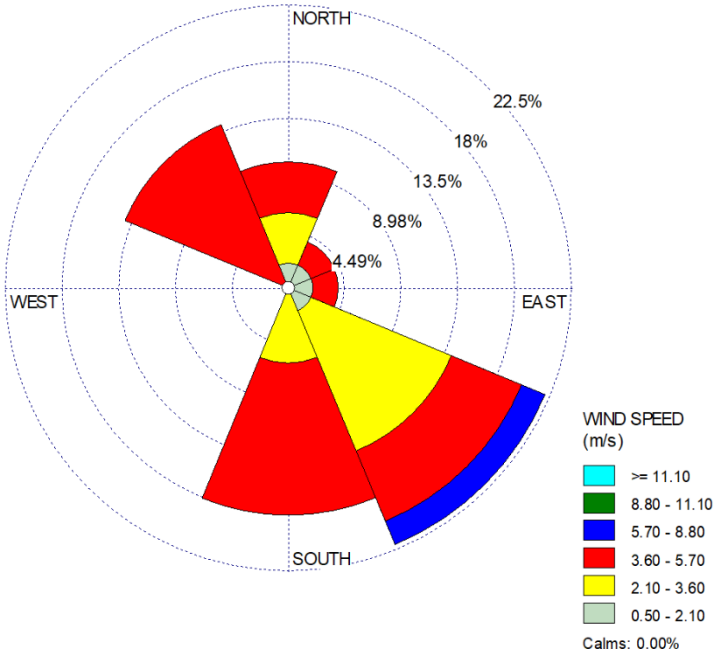


Figure 13: Wind Rose at the Monitoring Location (Sama Reservoir) during August 18 to 21, 2022

The atmospheric temperature at the monitoring site as shown in **Figure 14** ranged between 18.0°C and 36.0°C, with a mean value of 28.8°C, during the monitoring period. Time series of relative humidity is presented in **Figure 15**, where values fluctuated between 36 percent and 88 percent, with a mean value of 56 percent.

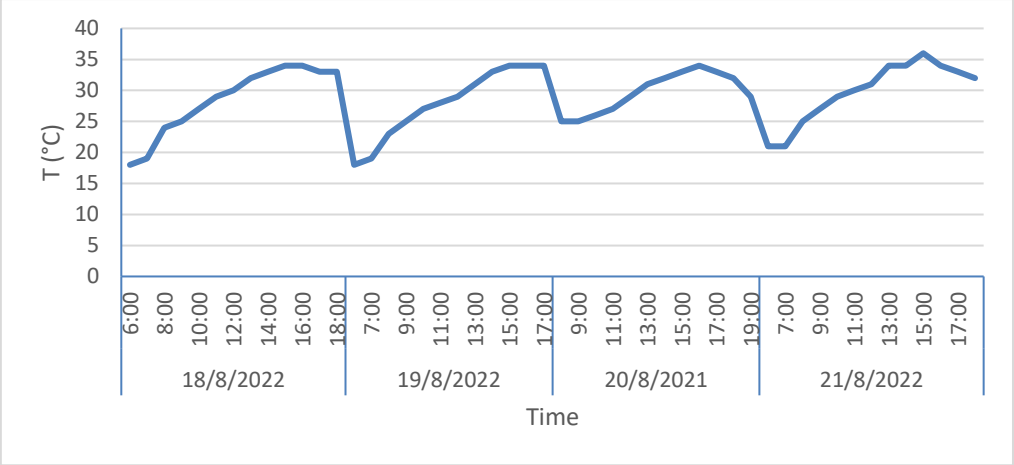


Figure 14:Time Series for Atmospheric Temperature during August 18–21, 2022

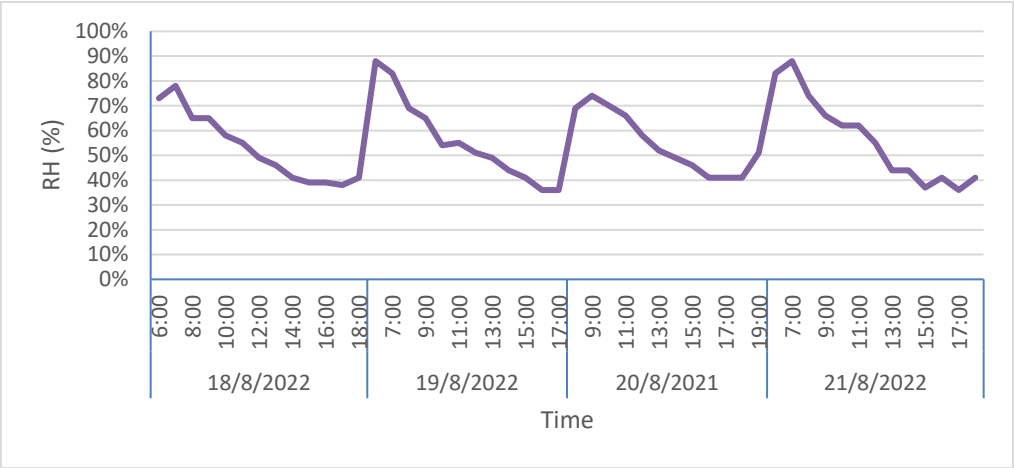


Figure 15: Time Series for Relative Humidity during August 18–21, 2022

B. Air Pollutants

Air quality monitoring results during the monitoring period (August 18 to 21, 2022) will be discussed in detail within this section. However, the hourly records for the air quality monitoring results are presented in **Annex D.**

Table 13: Carbon Monoxide Measurements

Element	Date	Time	Result	Legal Limits (JS 1140:2006)	Test Method
Carbon Monoxide Measurements	August 18, 2022	17:00–00:00	3.21	10.3 mg/m^3 (9 parts per million [ppm])	Infrared (JS 1140:2006)
	August 19, 2022	01:00–08:00	2.08		
		09:00–16:00	2.04		
		17:00–00:00	1.9		
	August 20, 2022	01:00–08:00	1.71		
		09:00–16:00	2.2		
		17:00–00:00	2.1		
	August 21, 2022	01:00–08:00	1.92		
		09:00–16:00	2.95		

Table 14 : PM_{10}, SO_2, and NO_2 Results

Date/Time	Parameter	Result (Daily Average)			Legal Limits (JS 1140:2006)	Test Method
		Day 1	Day 2	Day 3		
18-21/02/2022	Pm_{10} (Mg/m^3)	26.5	38.4	47.9	120(mg/m^3)	Beta ray attenuation (JS 1140:2006)
	SO_2(Mg/m^3)	0.028	0.027	0.032	0.367(mg/m^3) (0.14 ppm)	UV Fluorescence **(**JS 1140:2006)
	NO_2(Mg/m^3)	0.08	0.06	0.058	0.151(mg/m^3) (0.08 ppm)	Chemiluminescence (JS 1140:2006)

Notes:

- Legal limits are the maximum allowable limits.
- The scope of accreditation includes the measurements of SO_2, NO_2, and noise.
- The test results relate only to the items tested.

Particulate Matters (PM_{10})

Table 14 shows that the maximum daily average of PM_{10} reached a value of 47.9 µg/m³ throughout the monitoring period. Therefore, no exceedances were recorded to the daily limit of 120 µg/m³ specified in Jordanian standards.

Sulfur Dioxide (SO_2)

Table 14 shows that the maximum hourly average of SO_2 reached a value of 0.023 ppm, while the daily average concentration had a maximum value of 0.012 ppm throughout the monitoring period. Therefore, exceedances were not recorded to the hourly limit of 0.300 ppm nor to the daily limit of 0.140 ppm as specified in Jordanian standards.

Nitrogen Dioxide (NO_2)

The maximum hourly average concentration of NO_2 was 0.071 ppm, while the maximum daily average concentration of NO_2 was 0.043 ppm. Thus, exceedances for NO_2 concentrations were not recorded to the hourly limit of 0.21 ppm nor to the daily limit of 0.08 ppm according to JS 1140/2006 during the monitoring period.

Carbon Monoxide (CO)

By comparing the hourly average results with the JS 1140/2006 it is evident that the results are significantly lower than the maximum allowable limit. The maximum hourly average value recorded during the monitoring period was 3.7 mg/m^3, which represents about 14 percent of the allowable limit within the JS 1140/2006, whereas the highest recorded amount over 8 hours was 2.8 ppm, which represents about 31 percent of the maximum allowable limit stipulated in the JS 114/2006.

Ambient Noise

Instrumentation and Measurement Site

Noise measurements were performed from August 18 to 21, 2022 according to ANSI/ASA S1.13:2020 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 Electrotechnical Commission (IEC) IEC61672-1: 2002 Class 2 and IEC60651: 1979 Type 2, as well as the ANSI S1.4: 1983 Type 2.

Positioning of the SLM must meet the following guidelines:

- Place the microphone 1.2 to 1.5 m above the ground level and no closer than 3 m to any reflecting surface. Handheld monitoring should be avoided.
- Do not take noise measurements in fog and rain.
- Cover the microphone with the supplied windscreen.
- Isolate the instrument from strong vibration and shock.

Standards and Regulations

Allowable noise limits are governed by the Instructions for the Limitation and Control of Noise, year 2003, which defines the maximum allowed noise limits for the different land use types during daytime and nighttime as listed in **Table 15**. These limits are applicable for ambient noise outside a workplace. For noise limits within workplaces, the instructions issued by the Ministry of Labor are adopted. The project area is categorized as a residential area; therefore, the measured noise level was compared with limits set for this category.

Table 15: Maximum Allowable Noise Limits

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

Results

Monitoring was conducted from August 18 to 21, 2022. The results will be discussed in detail within this section. The hourly records for ambient noise results are presented in **Table 16.**

Table 16: Noise Measurement

Date/Time	Result (Daily average – dBA)					Legal Limits[1]	Test method
	Parameter	August 18, 2022	August 19, 2022	August 20, 2022	August 21, 2022		
18-21/02/2022	Noise – daytime	57.7	61.5	61.6	61.5	65 dBA daytime average	ANSI/ASA S1.13: 2020
	Noise – nighttime	–	48.8	52.4	51.1	55 dBA nighttime average	

[1] Jordanian Guidelines for Prevention of Noise, year 2003 – Residential areas with commercial activities, services, light handcrafts, and city center

The maximum average noise for both daytime and nighttime recorded within the site were 61.5 dBA and 52.4 dBA, respectively. Because the area is classified as a residential area with commercial activities, services, light handcrafts, and city center, the recorded averages were found to be lower than the maximum allowable noise limits of 65 dBA for daytime and 55 dBA for nighttime provided by the Jordanian guidelines for prevention of noise, year 2003.

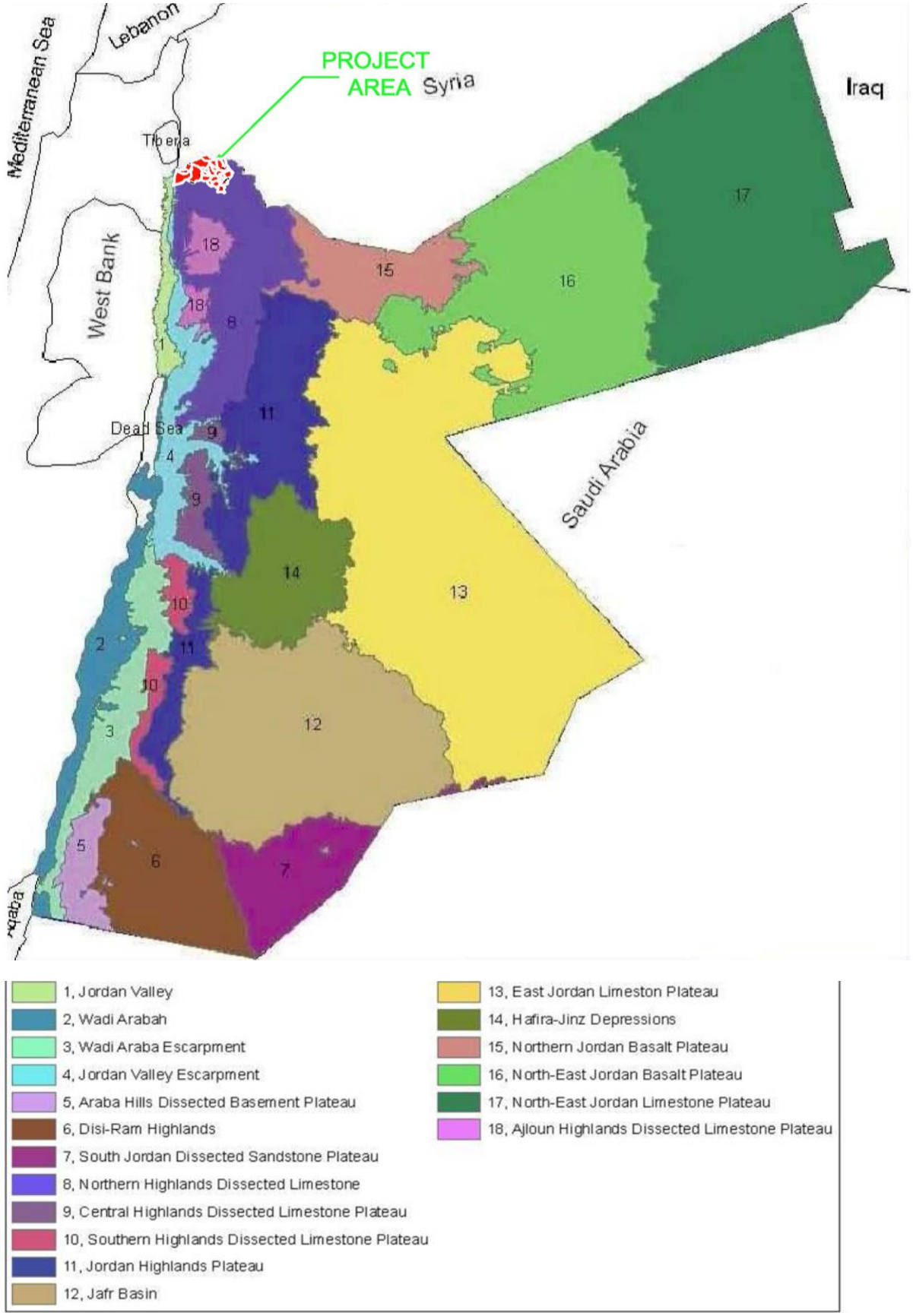
Any additional noise generated from the project activities must be considered, and appropriate mitigation of adverse health impacts should be done, especially for the project workers, such as wearing protective earmuffs or earplugs during construction.

Topography and Soil

The project area falls within the Northern Highlands Dissected Limestone region (Land Region No. 8). It is typically Mediterranean in climate and has a xeric moisture regime, with a range in precipitation of between 250 mm and 500 mm per year. The region contains a wide range of soil types, reflecting the wide range of physical characteristics throughout the area. Xerochrepts and chromoxererts are the major soils with typic subgroup occurring predominantly in the western half of the region and calcixerollic in the eastern half. Lithic subgroups occur on the shallow eroded areas of the steeper slopes and the hilltops and upper slopes from which most of the residual soils have eroded.

This agriculturally important region extends from the Yarmouk River in the north to Wadi Wala in the south, with an altitude range that varies from sea level to 1,050 m.

Soils of this region are mainly clay and are the most productive rain-fed soils in Jordan, particularly in the Irbid plains (MoA 2006).

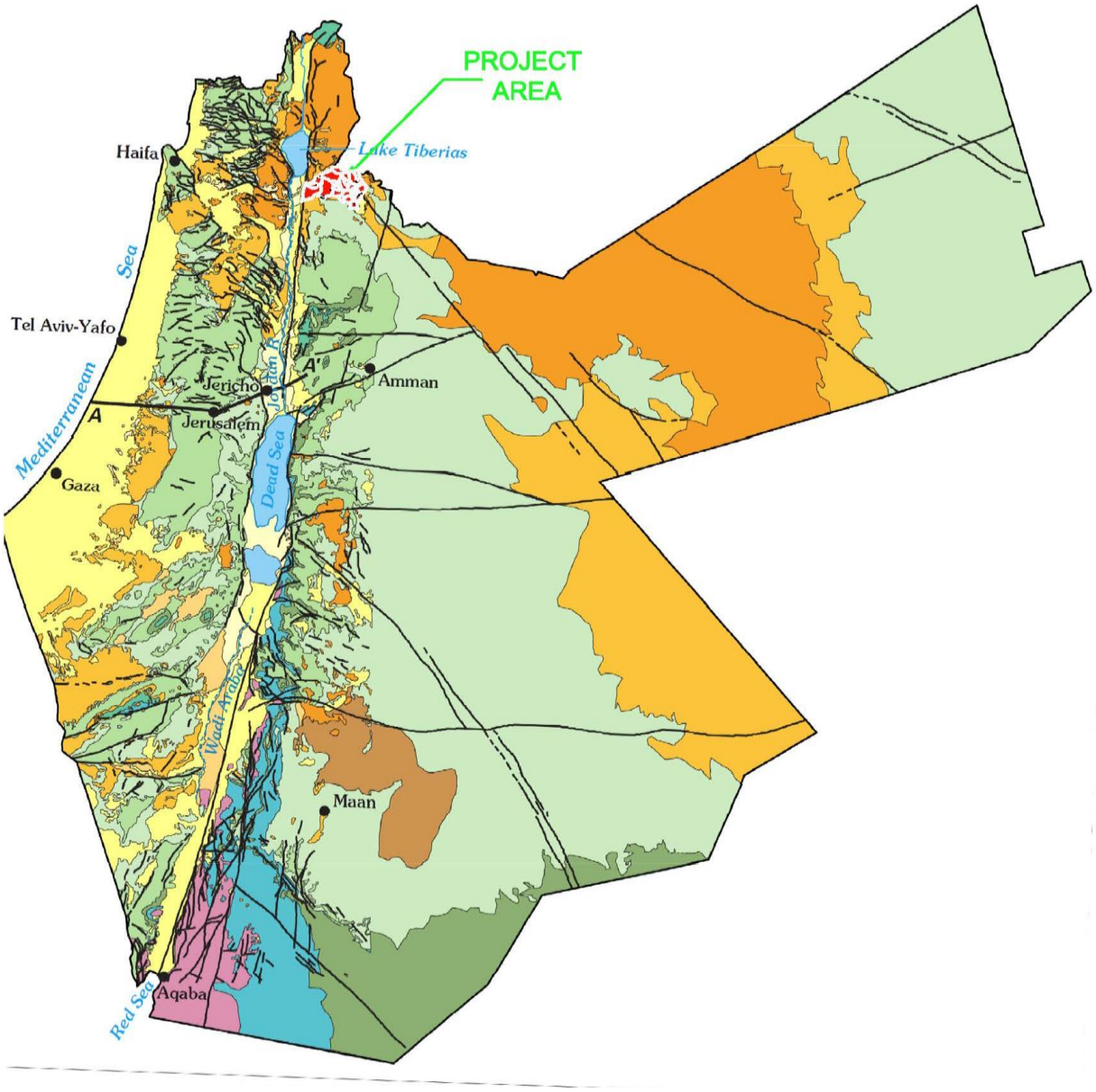


Source: MoA (2006)

Figure 16: The Study Area with Respect to Land Regions in Jordan

Geology

The geologic map presented below shows the different 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 **Figure 17** explaining the rock units, their age, lithology, and water-bearing properties.



Source: USGS (1998)

Figure 17: 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		Saqiye	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.
						B3 B2/A7		
Cretaceous	Upper	Seno-nian						
		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 METAMORPHIC 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 hydraulically 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		

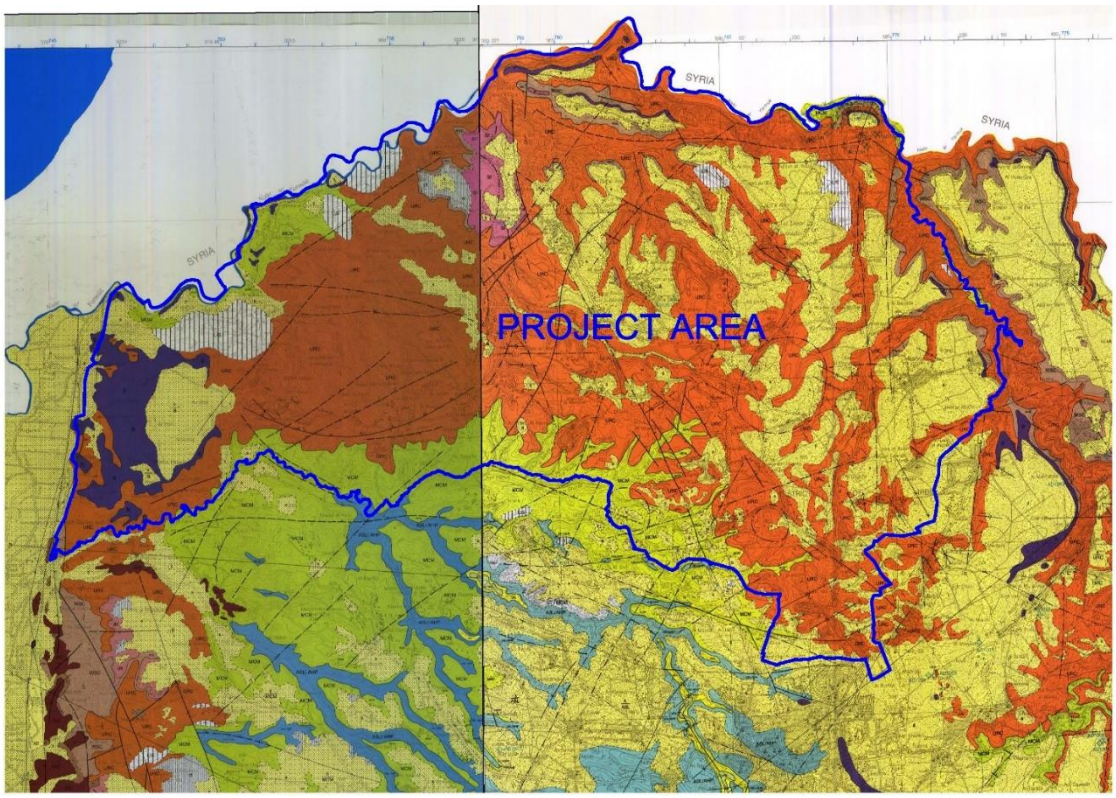
Source: USGS (1998)

Figure 18: Generalized Geologic Units and Water-Bearing Properties

As depicted in **Figure 17**, The bedrock outcropping in the study area is upper Cretaceous sedimentary in nature (i.e., Campanian to early Tertiary). The bedrock is covered in certain areas by superficial deposits extending from the Pleistocene to the present day. A table of the detailed legend and the detailed legend of the geologic map is shown in **Figure 18** describing the rock units, their age, lithology, and water-bearing properties (Geology Department 2020).

The Balqa group of the B5,B4,B3,and B2/A7 formations, which are prevalent in the Cretaceous and Tertiary systems, encompasses most of the project area. These formations are composed of sedimentary rocks such as chalk, chert, limestone, and marl, with the B3 formation being bituminous at times. In much of Jordan, aquifers are found in the limestone and chert layers. Groundwater well yields are highly varied, owing to cavernous zones in the limestone that are influenced by geologic structure. In Jordan, the salinity of flowing wells, which are abundant in low-elevation areas, increases eastward.

The Bani Kenanah area is distinguished by its geological diversity. Basalt, calcrete, and travertine are the rocks that make up these formations.

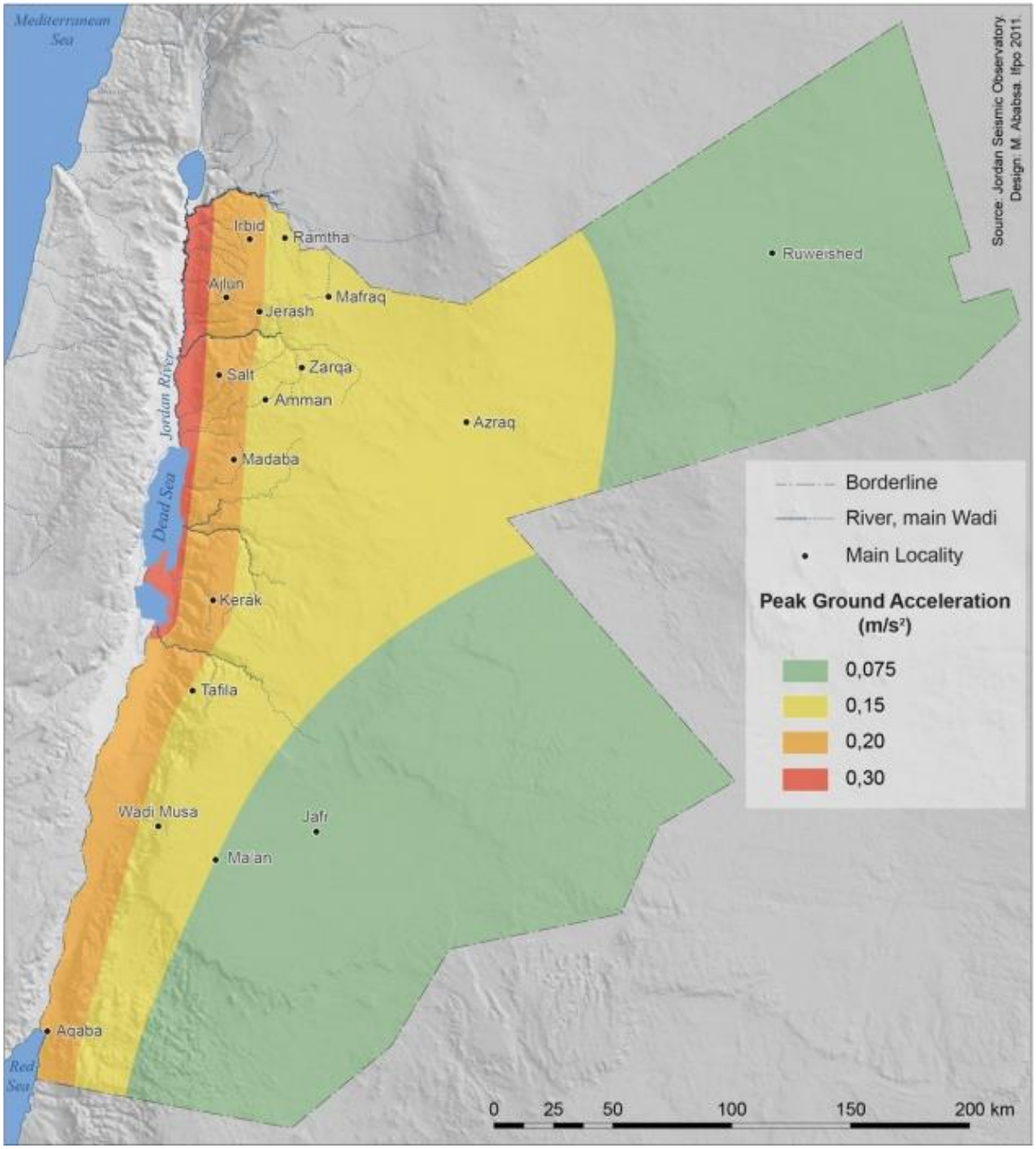


Source: Geology Department (2020)

Figure 19: Geological Map of the Bani Kenanah Area

Tectonic Setting

As shown in **Figure 20,** the project area lies within an area of low potential magnitude seismic hazards according to the Richter scale. Therefore, if an earthquake were to occur in that area, it is anticipated that the intensity would fall between 3.0 to 3.9 magnitude (yellow color), which is barely felt on the ground, and has minor to no destructive effects (Ministry of Energy and Mineral Resources 2011).



Source: Ministry of Energy and Mineral Resources (2011)

Figure 20: The Seismic Distribution Hazard Map of Jordan

Water Resources

The proposed project area is in the northern region of Jordan, northeast and northwest of the city of Irbid. Most parts of the proposed project are in a rolling terrain with major urbanized areas covering some parts of the catchments. The elevations of the project area and the adjacent areas range from about 431 m to about 699 m above sea level. The project area encompasses many large and diverse urban, residential, and agricultural areas as shown in **Figure 21.**

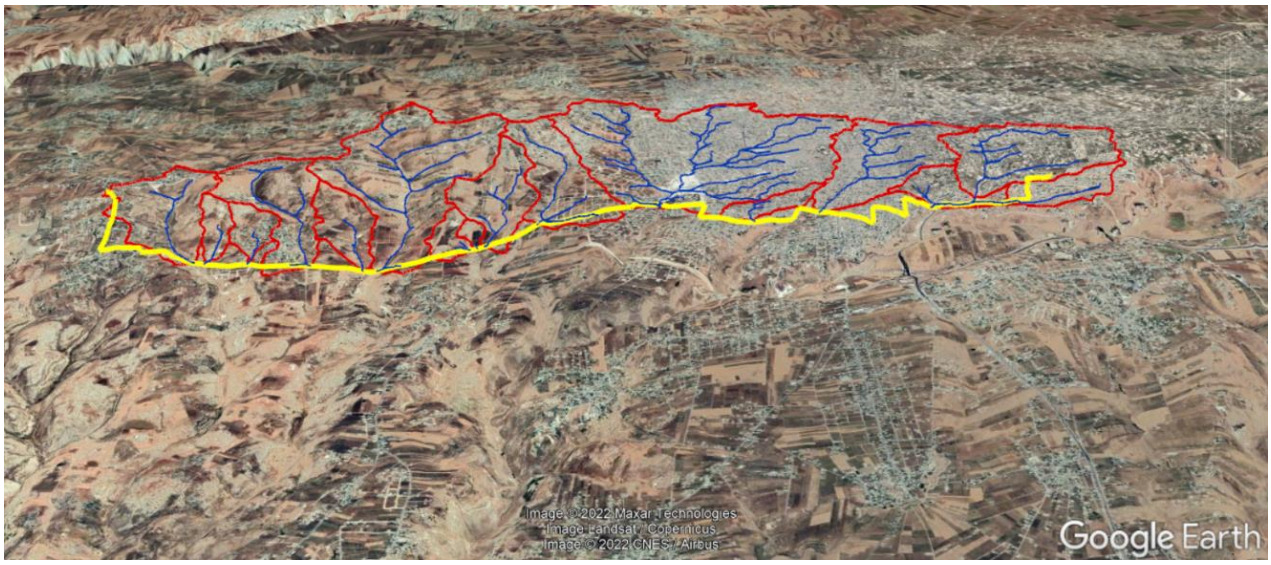


Figure 21: Site Location

The monthly rainfall and temperature averages of the region are presented where the annual rainfall average is 433 mm.

Catchment Characteristics

The catchments of 16 wadis drain into the proposed project area. The U.S. Army Corps of Engineers' Hydrologic Engineering Center's Hydraulic Modeling System (HEC-HMS) software was used to delineate the catchment areas related to the drainage of the wadis. On the Google Earth map in **Figure 22,** the catchments are depicted at a scale of 1:50,000.

The catchment areas were measured using Google Earth software. The characteristics of the catchments, as shown in **Table 17,** include the highest elevation, lowest elevation, longest wadi course, and the general slope of each catchment.

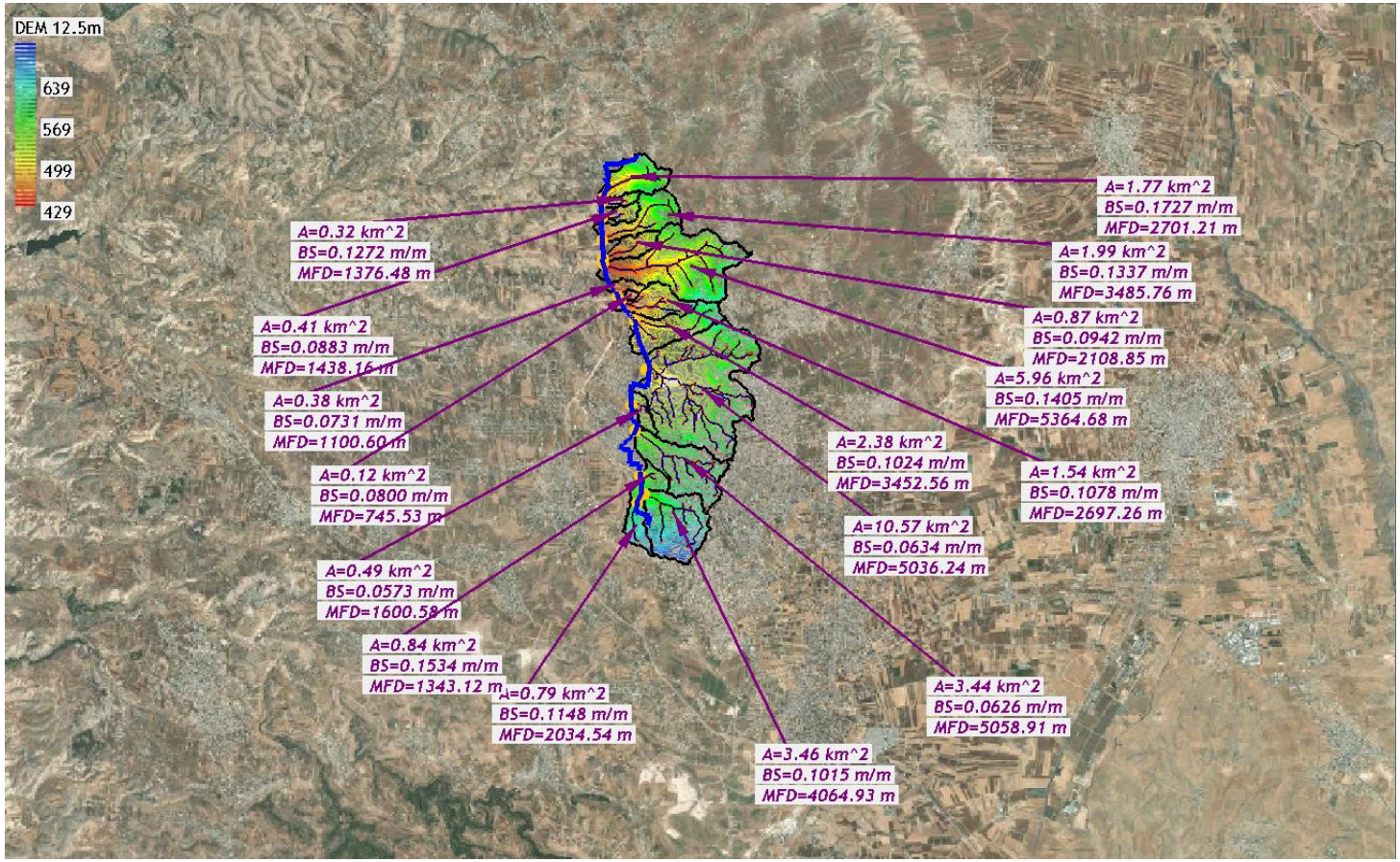


Figure 22: Map of Catchment Areas on Google Earth

Table 17: Hydrological Characteristics of the Catchments

Catchment Area No.	Catchment Area (square kilometers [km^2])	Highest Level (m)	Lowest Level (m)	Maximum Flow Distance (MFD)(m)	Maximum Flow Slope (MFS) (m/m)	Basin TC (min)
Catchment Area-1	0.79	685	559	2,034.54	0.0617	20.05
Catchment Area-2	3.46	699	536	4,064.93	0.0401	40.39
Catchment Area-3	0.84	601	541	1,343.12	0.0444	16.52
Catchment Area-4	3.44	629	528	5,058.91	0.0200	62.52
Catchment Area-5	0.49	573	515	1,600.58	0.0363	20.49
Catchment Area-6	10.57	601	488	5,036.24	0.0225	59.57
Catchment Area-7	2.38	615	466	3,452.56	0.0432	34.63
Catchment Area-8	1.54	629	509	2,697.26	0.0444	28.30
Catchment Area-9	0.12	489	468	745.53	0.0281	12.54
Catchment Area-10	0.38	503	463	1,100.60	0.0362	15.34
Catchment Area-11	5.96	615	459	5,364.68	0.0290	56.60
Catchment Area-12	0.87	559	467	2,108.85	0.0437	23.59
Catchment Area-13	1.99	573	431	3,485.76	0.0406	35.67
Catchment Area-14	0.41	559	484	1,438.16	0.0520	16.40
Catchment Area-15	0.32	587	477	1,376.48	0.0796	13.45
Catchment Area-16	1.77	601	485	2,701.21	0.0428	28.72

Time of Concentration (TC)

From the observation of the site visits and the catchment characteristics, the time of concentration can be computed by many formulas (e.g., Izzard's, Kerby's, Kirpich's, and Kinematics formulas), and they may give different values for the same conditions. The most commonly used formula is Kirpich's formula. For this reason, Kirpich's formula can be used in this study, which is as follows:

$$T_C = 0.0147 * \frac{(L^3)^{0.385}}{(H_1 - H_2)^{0.385}}$$

Where:

A = Catchment Area (km^2)

L = Longest Wadi (m)

H1 = Highest Elevation (m)

H2 = Lowest Elevation (m)

TC = Time of concentration (min)

For application of the Rational Method, Texas Department of Transportation (TxDOT 2019) recommends that tc should be less than 300 minutes (5 hours) and greater than 10 minutes. Other agencies may require that tc be greater than 5 minutes. The concept is that estimates of (i) become unacceptably large for durations less than 5 or 10 minutes.

For long durations (such as longer than 300 minutes), the assumption of a relatively steady rainfall rate is less valid (Thompson 2006). In this study the minimum value for the tc is 10 minutes.

Topography of the Catchment

The catchments are characterized by low to moderate slopes in the upper parts of the catchment and more gentle slopes in the lower parts of the catchment, which are virtually rolling to flat in most of the project area.

Availability of Hydrological Data

For the hydraulic study, the IDF curves for the Irbid school's rainfall station were used to calculate rainfall intensities for 50- and 100-year frequencies.

Methodology of Hydrological Study

❖ Rational Method

a) Method Description

The Rational Method is probably the most popular method for designing hydraulic structures. It is mostly preferable for design of storm drain systems in urban areas. It has been applied all over the world and many refinements of the method have been produced. Although the Rational Method incorporates some empirical aspects and its application requires judgment and experience, it has been shown that it is founded on a sound theoretical basis and is a well-accepted hypothesis. This has made the method transferable from one country to another.

The general formula can be written in the following form:

$$Q_p\ (T) = k.\ C.\ i_M\ (t_c, T).\ A.\ F$$

Where:

Q_p (T)	The peak runoff, for a return period T, at the design point in the drainage system
C	The runoff coefficient
i_M (t_c, T)	The mean rainfall intensity, with a return period T, for a duration equal to the time of concentration
A	The area of the watershed upstream of the design point
k	A unit conversion factor depending on the units used
F	A correction factor considering such effects as special rainfall distribution, storage in the water course or sewage, watershed shape and slope, etc. This correction factor is not used in all formulations of the Rational Method.

The Rational Method has been used to estimate the peak discharges from areas with a relatively low time of concentration (T_c) that is a few minutes to 20 minutes (University of Florida 1990).

In small homogeneous catchments, the most used method is the RationalMethod, which is related to the area, slope, time of concentration, and the runoff coefficient of the basin.

For the determination of peak flows, the Rational Method can have the following form:

$$Q_p = \frac{C * I * A}{3.6}$$

Where:

C	=	Runoff Coefficient	
I	=	Rainfall Intensity	(millimeters per hour [mm/h])
A	=	Catchment Area	(km^2)
Q_p	=	Peak Flow	

The derived and drawn IDF representative curves will be used in knowing the rainfall intensities needed for the Rational Method, which is applicable in computing the design floods that might occur in small catchment areas.

Jordan has no local regulatory practice for stormwater design; therefore, in their studies the hydrologists followed available international standards.

b) Runoff Coefficients

The runoff coefficient for rural watersheds is given by using **Tables 18** and **19**. In the project area the relief is gentle to medium, where the slopes range between 0.02 and 0.08. In this case, the weighted average runoff coefficients have been found for each catchment separately.

Table 18: Runoff Coefficients for Rural Watersheds

Type of Surface	Return Period (Years)							
	2	5	10	20	25	50	100	500
Developed:								
Asphalt	0.73	0.77	0.81	0.85	0.87	0.90	0.95	1.00
Concrete/roof	0.75	0.80	0.83	0.87	0.89	0.92	0.97	1.00
Grass areas (lawns, parks, etc.) Poor condition (grass cover less than 50% of the area):								
Flat, 0–2%	0.32	0.34	0.37	0.40	0.41	0.44	0.47	0.58
Average, 2–7%	0.37	0.40	0.43	0.46	0.47	0.49	0.53	0.61
Steep, over 7%	0.40	0.43	0.45	0.49	0.50	0.52	0.55	0.62
Fair condition (grass cover on 50% to 75%of the area):								
Flat, 0–2%	0.25	0.28	0.30	0.34	0.35	0.37	0.41	0.53
Average, 2–7%	0.33	0.36	0.38	0.42	0.43	0.45	0.49	0.58
Steep, over 7%	0.37	0.40	0.42	0.46	0.47	0.49	0.53	0.60
Good condition (grass cover larger than 75%of the area):								
Flat, 0–2%	0.21	0.23	0.25	0.29	0.30	0.32	0.36	0.49
Average, 2–7%	0.29	0.32	0.35	0.39	0.40	0.42	0.46	0.56
Steep, over 7%	0.34	0.37	0.40	0.43	0.44	0.47	0.51	0.58
Undeveloped cultivated land:								
Flat, 0–2%	0.31	0.34	0.36	0.40	0.41	0.43	0.47	0.57
Average, 2–7%	0.35	0.38	0.41	0.44	0.44	0.48	0.51	0.60
Steep, over 7%	0.39	0.42	0.44	0.48	0.48	0.51	0.54	0.61
Pasture/range								
Flat, 0–2%	0.25	0.28	0.30	0.34	0.35	0.37	0.41	0.53
Average, 2–7%	0.33	0.36	0.38	0.42	0.43	0.45	0.49	0.58
Steep, over 7%	0.37	0.40	0.42	0.46	0.47	0.49	0.53	0.60
Forest/woodlands:								
Flat, 0–2%	0.22	0.25	0.28	0.31	0.31	0.35	0.39	0.48
Average, 2–7%	0.31	0.34	0.36	0.40	0.41	0.43	0.47	0.56
Steep, over 7%	0.35	0.39	0.41	0.44	0.45	0.48	0.52	0.58

Source: **Texas Department of Transportation(2019)**

Table 19: Runoff Coefficients for Single Residential Areas

Land Use	Impermeable Factor	
Low-Density Housing	0.15	0.20
Medium-Density Housing	0.20	0.25
High-Density Housing	0.25	0.35
High-Rise Housing	0.20	0.25

C. Rainfall Intensity, Duration, and Frequency

Rainfall intensity of 25-, 50-, or 100-year return periods were used in the estimation of flood flows. The nearest rainfall station for the project region is the Irbid school's rainfall station. This station has 23 years of records that can be accepted as representative of the different types of rainfall existing in the project area.

The IDF information and IDF curves for the Irbid school's rainfall station are shown in **Table 20** and **Figure 23** shows the developed IDF curves for the Irbid school's rainfall station data.

Table 20: IDF Curves at Irbid School's Rainfall Station

Intensity (mm/h)	Duration (min)								
Return Period	**5**	**10**	**20**	**30**	**60**	**120**	**360**	**720**	**1,440**
I2	52.84	35.17	24.14	18.97	12.31	8.32	4.34	2.88	1.87
I5	71.82	48.47	34.87	26.79	17.68	11.26	6.09	4.04	2.78
I10	84.39	57.28	41.98	31.98	21.24	13.21	7.26	4.81	3.38
I25	100.27	68.40	50.96	38.53	25.74	15.67	8.73	5.78	4.14
I50	112.05	76.65	57.62	43.38	29.08	17.50	9.82	6.50	4.70
I100	123.75	84.85	64.23	48.21	32.39	19.31	10.90	7.22	5.26

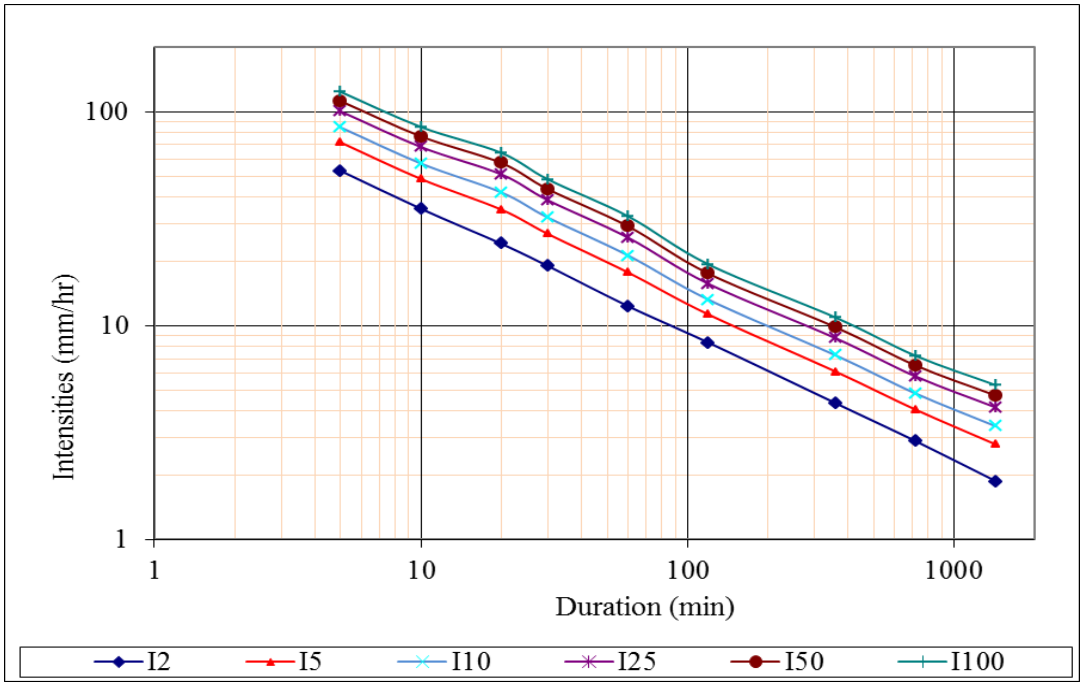


Figure 23: IDF Curves at Irbid School's Rainfall Station

Using the curves included in **Figure 23**, the best fit trend line can be drawn for the rainfall intensities to find the equation and regression coefficient that can be used in the derivation of the rainfall intensities relevant to any time of concentration. This is shown in **Figure 24.**

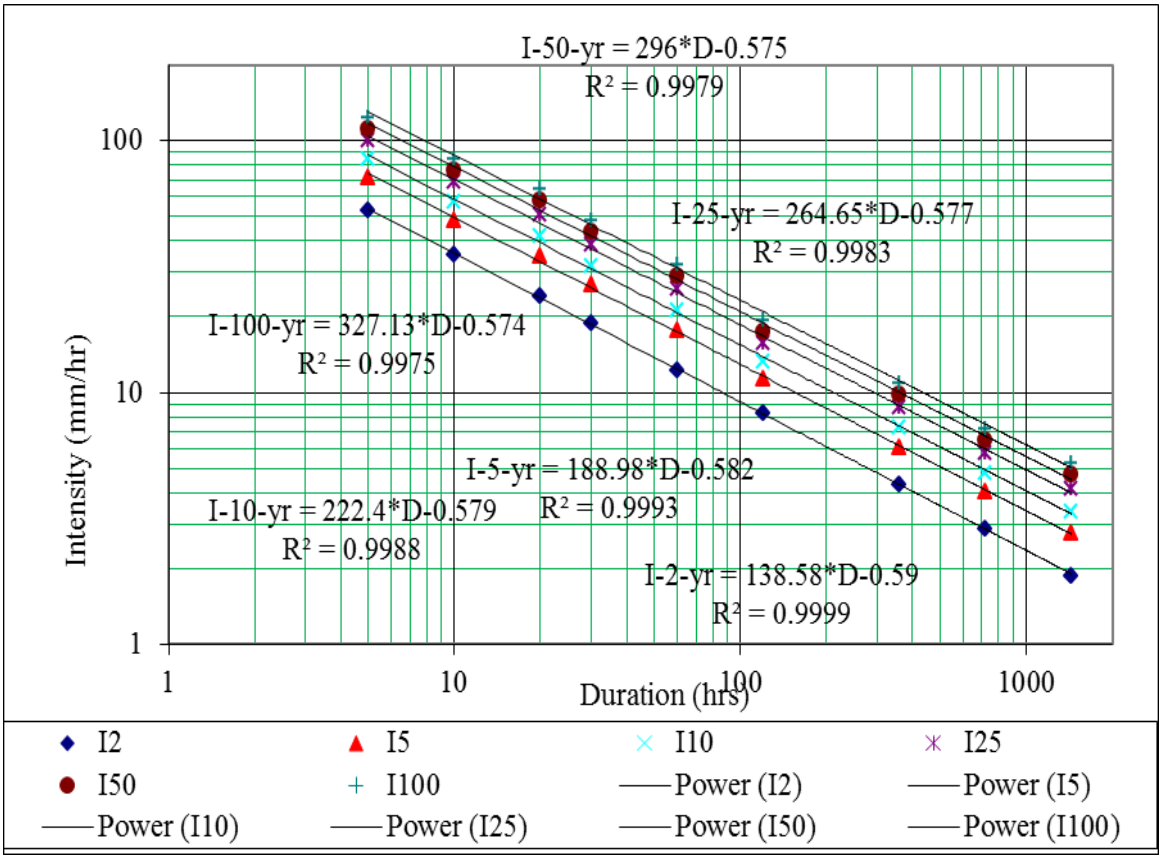


Figure 24: Best Fit Power Trend Line for Irbid School's Rainfall Station IDF Curves

Referring to the IDF curves included in **Figure 23**, the required intensities for the time of concentration for the available catchment areas within the project can be determined as in **Table 21**.

Table 21: Estimated Rainfall Intensities for the Catchments Related to the Project

Catchment	Concentration	Rainfall Intensities				
	TC	2-year	10-year	25-year	50-year	100-year
ID	min	mm/hr				
1	20.05	23.63	33.00	39.19	46.92	52.79
2	40.39	15.63	21.96	26.13	31.32	35.29
3	16.52	26.49	36.95	43.85	52.47	59.02
4	62.52	12.08	17.03	20.29	24.34	27.45
5	20.49	23.33	32.59	38.70	46.34	52.14
6	59.57	12.43	17.51	20.86	25.03	28.23
7	34.63	17.12	24.02	28.56	34.23	38.56
8	28.30	19.28	27.01	32.10	38.46	43.30
9	12.54	31.17	43.38	51.44	61.52	69.16
10	15.34	27.67	38.57	45.77	54.76	61.58
11	56.60	12.81	18.04	21.49	25.78	29.07
12	23.59	21.47	30.03	35.67	42.72	48.08
13	35.67	16.82	23.61	28.08	33.65	37.91
14	16.40	26.60	37.10	44.03	52.68	59.26
15	13.45	29.90	41.63	49.38	59.06	66.40
16	28.72	19.12	26.78	31.83	38.13	42.94

c) Design Floods of Small Catchments

There are 16 catchments affecting the occurrence of floods in the project area. Only two have an area greater than 5 km^2. The method used for estimating the design floods for the smaller 14 catchments was the Rational Method and for the other two catchments was the Snyder's Unit Hydrograph (UH).

Using the measured catchment areas from **Table 15**, the weighted average runoff coefficients from **Tables 18 and 19** and design intensities included earlier in **Table 21**, the design floods of 25-year, 50-year and 100-year return periods have been estimated and are shown in **Table 22**.

Table 22: Estimated Design Floods

Basin	Area A	Runoff Coef. C	25-Year Flood Q	25-Year Runoff Coef. C	50-Year Flood Q	100-Year Runoff Coef. C	100-Year Discharge Q
ID	km^2		m^3/s		m^3/s		m^3/s
1	0.79	0.60	**6.18**	0.65	7.53	0.70	8.35
2	3.46	0.54	**16.26**	0.58	19.67	0.62	21.82
3	0.84	0.60	**7.35**	0.65	8.95	0.70	9.92
4	3.44	0.60	**13.96**	0.65	17.05	0.70	18.92
5	0.49	0.60	**3.78**	0.65	4.61	0.70	5.11
6	10.57[1]	0.50	**36.75**	0.55	45.58	0.60	50.58
7	2.38	0.35	**7.92**	0.38	9.69	0.42	10.74
8	1.54	0.35	**5.76**	0.38	7.04	0.42	7.81
9	0.12	0.35	**0.72**	0.38	0.88	0.42	0.97
10	0.38	0.35	**2.02**	0.38	2.47	0.42	2.74
11	5.96[1]	0.35	**14.94**	0.38	18.29	0.42	20.29
12	0.87	0.35	**3.61**	0.38	4.42	0.42	4.90
13	1.99	0.35	**6.51**	0.38	7.96	0.42	8.83
14	0.41	0.35	**2.10**	0.38	2.56	0.42	2.84
15	0.32	0.35	**1.84**	0.38	2.24	0.42	2.49
16	1.77	0.35	**6.56**	0.38	8.02	0.42	8.90

1 This will be recalculated using Snyder's UH method.

D. Snyder's Unit Hydrograph

Method Description

The UH for a catchment defines the pattern of runoff for the catchment for a unit volume of rainfall in a specified duration (e.g., 1 hour). Where recorded rainfall and river flows are available, it is possible to derive the UH directly from the data, but for this study, empirical methods must be used. The SCS dimensionless UH was used, with the hydrograph peak and time to peak estimated using Snyder's UH method (1938).

The key parameters of the hydrograph are the unit storm duration, time lag, time to peak, and the time base (total duration). Various formulas have been proposed for determining these parameters from catchment characteristics. For large catchments (i.e., between 5 and 5,000 km^2) Snyder's UH method is generally recommended, but as the Rational Method is easier and often can fit catchments of less than 10 km^2, Snyder's UH method will be applied only to the larger catchments. This method can be summarized as follows:

For the lag time and the duration of the unit rainfall (time interval) of the hydrograph, the following equations are used:

$$t_L = C \times Ct \times (L \times L_C)^{0.3}$$

$$t_r = \frac{t_L}{5.5}$$

Where:

t_L	=	**lag time (middle of rainfall to UH peak)**
L	=	**length of main stream**
L_C	=	**length of stream from catchment centroid to outlet**
C	=	**factor equal to 1 in English units and 0.75 in International System of Units (SI) units**
C_t	=	**coefficient**
t_r	=	**unit rainfall duration**

The value of the coefficient Ct typically lies in the range 0.45 to 2.25, with lower values corresponding to catchments with steep slopes. For the study area, the range of coefficients (i.e., C × Ct) between 1.1 and 1.5 has been found to be acceptable. For this project, the value of C × Ct = 1.25 has been calibrated with the measurements of some wadis in Jordan that have hydrological conditions very similar to those in the proposed project area.

For ease of calculation, it is usual to adjust the unit duration to a convenient or standard time interval such as 1/2, 1, 2, or 3 hours. The modified time lag is then found as follows:

$$T_{LR} = t_L + \frac{t_R - t_r}{4}$$

Where:

t_{LR}	=	modified lag time
t_R	=	modified unit rainfall duration

The time to peak and peak flow of the UH are found as follows:

$$t_p = t_{LR} + \frac{t_R}{2}$$

$$q_p = C_p * \frac{A}{t_p}$$

Where:

t_p	=	time to peak of UH (hours)
qp	**=**	**peak of UH (m^3/s)**
A	**=**	**catchment area (km^2)**
Cp	**=**	**coefficient**

The value of the coefficient C_P is in the range of 4 to 5 to give the runoff in m^3/s for 1 inch of effective rainfall (or between 0.16 and 0.2 for 1 mm of effective rainfall). It is not easy to define the value of C_P precisely and it is subject to minor subsequent modification to ensure that the UH gives the correct volume of runoff. So, the common procedure is to assume that the coefficient is the maximum value (i.e., Cp = 0.20) and then correct the division of the volume under the hydrograph to the catchment area and check if the result is giving exact one-unit effective rainfall (i.e., 1 mm depth). If not, a correction factor is applied to the amplitudes of the UH accordingly. The overall volume of runoff indicated by this adjusted UH is calculated and the factored UH ordinates then represent the exact unit runoff required.

E. <u>The Key Parameters of the Unit Hydrograph</u>

To solve the synthetic UH parameters, Wadi 6 was used as an example. **Table 23** presents the results.

Table 23: Wadi 6 Synthetic Unit Hydrograph Parameters

Wadi Name	**Length L(km)**	**C × Ct**	**Lc L(km)**	**Lag Time (hr) t1= C × Ct(L × Lc)$^{0.3}$**	**Duration of Rainfall Tr (Hrs)**
Wadi 6	5.04	1.15	1.66	2.175	0.395
Modified Lag Time t'l (Hrs)	**Standard Time t'r (Hrs)**	**Area (Km^2)**	**Cp**	**UH Qp (m^3/s)**	**UH Tp (Hrs)**
2.20	0.50	10.57	0.20	0.95	2.45
Corrected Cp	**Corrected UH Qp**	**Highest Elev.**	**Lowest Elev.**	**ΔH (m)**	**Slope (%)**

	(m^3/s)	(m)	(m)		
0.1842	0.88	601	488	113.00	2.24

F. Rainfall Intensity Time Distributions

Because the duration of rainfall selected was 0.5 hour as mentioned **Table 24**, then the incremental time distribution of the rainfall intensities and the UH should be 0.5 hours.

As shown **in Table 24**, the half-hourly distribution of rainfall intensities was calculated using the power trend line equations presented earlier in **Figure 24.**

Table 24: Half-Hourly Distribution of Rainfall Intensities at Irbid

D (hr)	D (min)	25-year	50-year	100-year
0.5	30	37.19	41.87	46.44
1	60	24.93	28.11	31.19
1.5	90	19.73	22.26	24.72
2	120	16.71	18.87	20.95
2.5	150	14.69	16.60	18.44
3	180	13.22	14.95	16.60
3.5	210	12.10	13.68	15.20
4	240	11.20	12.67	14.08
4.5	270	10.47	11.84	13.16
5	300	9.85	11.14	12.38
5.5	330	9.32	10.55	11.72
6	360	8.87	10.03	11.15
6.5	390	8.47	9.58	10.65
7	420	8.11	9.18	10.21
7.5	450	7.79	8.82	9.81
8	480	7.51	8.50	9.46
8.5	510	7.25	8.21	9.13
9	540	7.02	7.95	8.84
9.5	570	6.80	7.70	8.57
10	600	6.60	7.48	8.32
10.5	630	6.42	7.27	8.09

D (hr)	D (min)	25-year	50-year	100-year
11	660	6.25	7.08	7.88
11.5	690	6.09	6.90	7.68
12	720	5.94	6.73	7.49
12.5	750	5.80	6.58	7.32
13	780	5.67	6.43	7.16
13.5	810	5.55	6.29	7.00
14	840	5.44	6.16	6.86
14.5	870	5.33	6.04	6.72
15	900	5.22	5.92	6.59
15.5	930	5.13	5.81	6.47
16	960	5.03	5.71	6.35
16.5	990	4.95	5.61	6.24
17	1,020	4.86	5.51	6.13
17.5	1,050	4.78	5.42	6.03
18	1,080	4.70	5.33	5.94
18.5	1,110	4.63	5.25	5.84
19	1,140	4.56	5.17	5.76
19.5	1,170	4.49	5.09	5.67
20	1,200	4.43	5.02	5.59
20.5	1,230	4.36	4.95	5.51
21	1,260	4.30	4.88	5.43
21.5	1,290	4.24	4.82	5.36
22	1,320	4.19	4.75	5.29
22.5	1,350	4.14	4.69	5.22
23	1,380	4.08	4.63	5.16
23.5	1,410	4.03	4.58	5.09
24	1,440	3.98	4.52	5.03

G. Unit Hydrograph Construction

Table 25 shows the calculation of the Snyder's UH for Wadi 6 derived from the catchment characteristics:

Table 25: Snyder's Unit Hydrograph of Wadi 6

1/5-Hourly T (hr)	1/5-Hourly UH Before Correction Q(m^3/s)	Corrected Q(m^3/s)
0	0.000	0.000
0.5	0.080	0.075
1	0.275	0.257
1.5	0.580	0.543
2	0.850	0.796
2.5	0.940	0.880
3	0.850	0.796
3.5	0.680	0.636
4	0.510	0.477
4.5	0.380	0.356
5	0.285	0.267
5.5	0.215	0.201
6	0.158	0.148
6.5	0.114	0.107
7	0.088	0.082
7.5	0.070	0.066
8	0.055	0.051
8.5	0.041	0.038
9	0.032	0.030
9.5	0.024	0.022
10	0.018	0.017
10.5	0.013	0.012
11	0.009	0.008
11.5	0.005	0.005
12	0.002	0.002
12.5	0.000	0.000

1/5-Hourly T (hr)	1/5-Hourly UH Before Correction Q(m^3/s)	Corrected Q(m^3/s)
Total	6.27	5.87
Average	0.24	0.23
Volume	11293.2	10570.0
Runoff Depth	1.068	1.000
Correction	0.936	
Corrected C_P	0.1842	

Figure 25 presents the UH for Wadi 6 in the Bani Kenanah area.

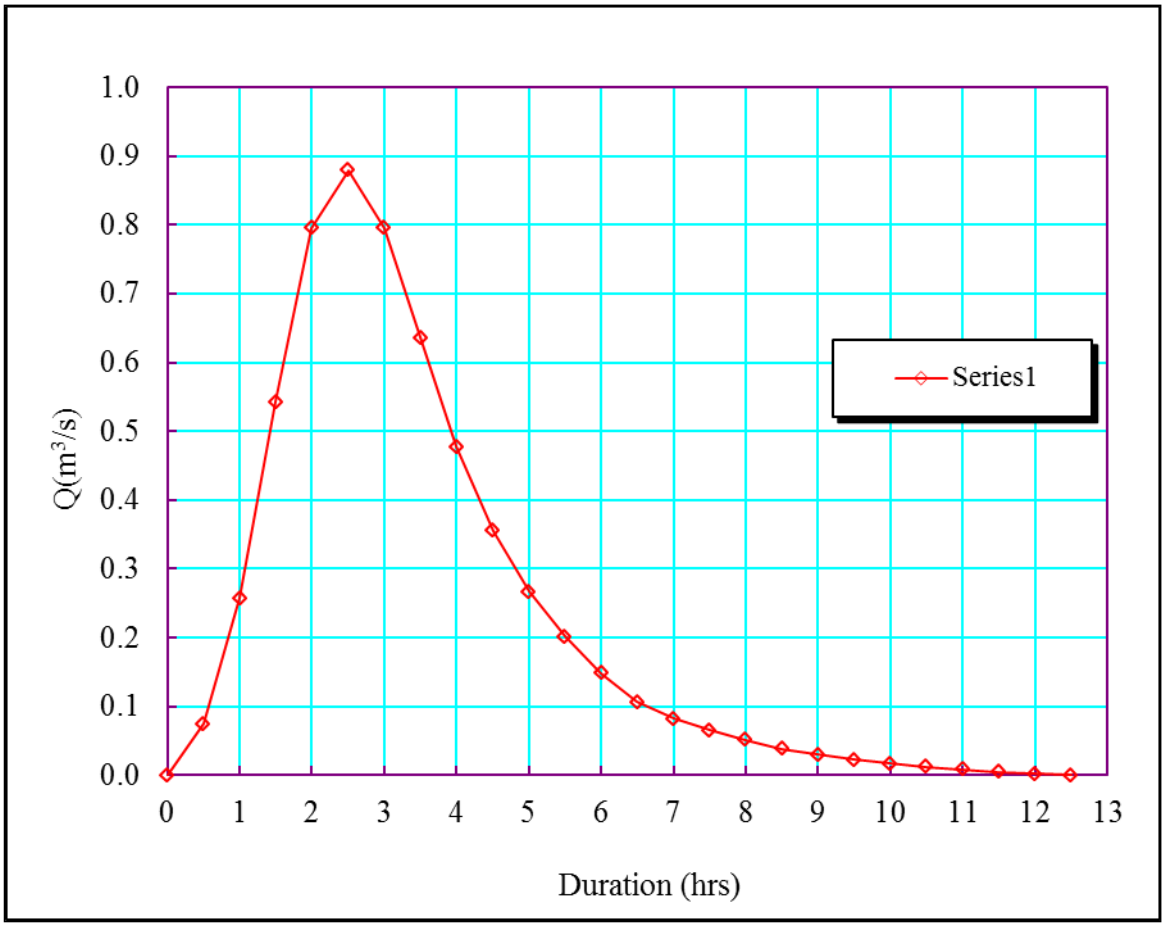


Figure 25: Unit Hydrograph of Wadi 6

By applying the same steps, **Table 26** shows the calculation of the Snyder's UH for Wadi 11 derived from the catchment characteristics:

Table 26: Snyder's Unit Hydrograph of Wadi 11

1/5-Hourly T (hr)	1/5-Hourly UH Before Correction Q(m^3/s)	Corrected Q(m^3/s)
0	0.000	0.000
0.5	0.030	0.028
1	0.108	0.102
1.5	0.235	0.223
2	0.367	0.348
2.5	0.438	0.416
3	0.457	0.434
3.5	0.404	0.383
4	0.333	0.316
4.5	0.254	0.241
5	0.195	0.185
5.5	0.153	0.145
6	0.118	0.112
6.5	0.091	0.086
7	0.069	0.065
7.5	0.053	0.050
8	0.042	0.040
8.5	0.035	0.033
9	0.028	0.027
9.5	0.022	0.021
10	0.017	0.016
10.5	0.013	0.012
11	0.010	0.009
11.5	0.008	0.008
12	0.006	0.006
12.5	0.004	0.004
13	0.002	0.002

1/5-Hourly T (hr)	1/5-Hourly UH Before Correction Q(m^3/s)	Corrected Q(m^3/s)
13.5	0.001	0.001
14	0.000	0.000
Total	6.27	5.87
Average	0.24	0.23
Volume	11,293.2	10,570.0
Runoff Depth	1.068	1.000
Correction	0.936	
Corrected C_P	0.1842	

Figure 26 shows the UH of Wadi 11 in the Bani Kenanah area.

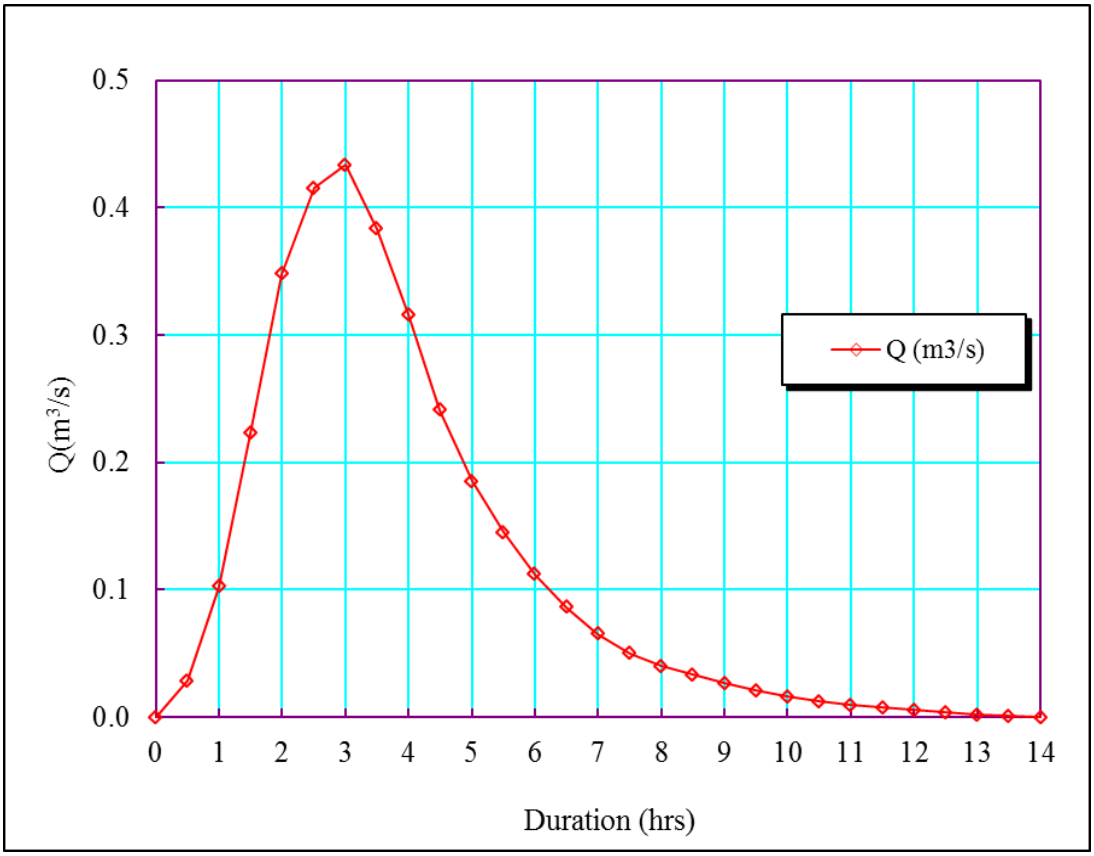


Figure 26: Unit Hydrograph of Wadi 11

H. Design Floods of Using Snyder's Unit Hydrograph

Using the information in **Tables 23, 24, 25, and 26**, the hydrograph amplitudes for the return periods of 25, 50, and 100 years can be derived as shown in **Tables 27** and **28** and in **Figures 27** and **28** for wadis 6 and 11, respectively.

Table 27: Hydrograph Amplitudes for Wadi 6

T (hr)	Q (m^3/s)	Q (m^3/s)	Q (m^3/s)
	25-year	50-year	100-year
0	0.00	0.00	0.00
0.5	0.00	0.00	0.03
1	0.00	0.03	0.16
1.5	0.00	0.15	0.45
2	0.04	0.41	0.93
2.5	0.17	0.83	1.53
3	0.43	1.37	2.19
3.5	0.85	1.96	2.87
4	1.39	2.59	3.56
4.5	2.02	3.26	4.32
5	2.73	4.03	5.17
5.5	3.57	4.95	6.19
6	4.64	6.14	8.04
6.5	6.20	7.89	12.10
7	9.19	11.25	18.88
7.5	13.86	16.51	27.15
8	19.59	22.96	33.57
8.5	24.19	28.13	35.63
9	25.79	29.93	43.69
9.5	24.40	28.36	37.96
10	21.46	25.05	31.31
10.5	18.07	21.24	25.76
11	15.08	17.86	21.31
11.5	12.55	15.01	17.62
12	10.40	12.58	14.57
12.5	8.59	10.53	12.09

T (hr)	Q (m^3/s)	Q (m^3/s)	Q (m^3/s)
	25-year	50-year	100-year
13	7.09	8.84	10.21
13.5	5.90	7.49	8.72
14	4.91	6.38	7.53
14.5	4.09	5.44	6.34
15	3.32	4.55	5.43
15.5	2.70	3.81	4.64
16	2.15	3.16	3.96
16.5	1.68	2.61	3.39
17	1.29	2.16	2.85
17.5	0.94	1.74	2.36
18	0.67	1.38	1.95
18.5	0.47	1.07	1.60
19	0.32	0.81	1.35
19.5	0.23	0.61	1.12
20	0.16	0.46	0.90
20.5	0.12	0.34	0.71
21	0.08	0.25	0.54
21.5	0.06	0.18	0.40
22	0.04	0.13	0.30
22.5	0.03	0.10	0.22
23	0.02	0.07	0.16
23.5	0.01	0.05	0.12
24	0.01	0.03	0.09
24.5	0.00	0.02	0.06
25	0.00	0.02	0.05
25.5	0.00	0.01	0.03
26	0.00	0.01	0.02
26.5	0.00	0.00	0.02
27	0.00	0.00	0.01
27.5	0.00	0.00	0.01
28	0.00	0.00	0.00

T (hr)	Q (m^3/s)	Q (m^3/s)	Q (m^3/s)
	25-year	50-year	100-year
28.5	0.00	0.00	0.00

Table 28: Hydrograph Amplitudes for Wadi 11

T (hr)	Q (m^3/s)	Q (m^3/s)	Q (m^3/s)
	25-year	50-year	100-year
0	0.00	0.00	0.00
0.5	0.00	0.00	0.02
1	0.00	0.02	0.11
1.5	0.00	0.10	0.30
2	0.00	0.27	0.62
2.5	0.02	0.57	1.05
3	0.14	0.97	1.56
3.5	0.42	1.47	2.12
4	0.93	2.04	2.74
4.5	1.65	2.72	3.48
5	2.59	3.61	4.46
5.5	4.11	5.19	6.20
6	6.36	7.66	8.93
6.5	9.18	10.82	12.42
7	11.79	13.76	15.68
7.5	13.29	15.46	17.56
8	**13.64**	**15.85**	**23.70**
8.5	12.73	14.82	22.06
9	11.27	13.18	19.47
9.5	9.60	11.30	16.32
10	8.12	9.64	13.67
10.5	6.88	8.24	11.57
11	5.79	7.00	9.74

T (hr)	Q (m^3/s)	Q (m^3/s)	Q (m^3/s)
	25-year	50-year	100-year
11.5	4.85	5.95	8.21
12	4.05	5.04	6.91
12.5	3.38	4.29	5.85
13	2.84	3.68	5.02
13.5	2.40	3.16	4.37
14	1.99	2.69	3.77
14.5	1.63	2.27	3.24
15	1.32	1.90	2.78
15.5	1.04	1.58	2.38
16	0.82	1.32	2.03
16.5	0.64	1.09	1.75
17	0.48	0.88	1.48
17.5	0.36	0.69	1.24
18	0.25	0.52	1.01
18.5	0.17	0.38	0.79
19	0.12	0.29	0.65
19.5	0.09	0.22	0.52
20	0.07	0.16	0.41
20.5	0.05	0.12	0.32
21	0.03	0.09	0.25
21.5	0.02	0.07	0.19
22	0.02	0.05	0.14
22.5	0.01	0.04	0.11
23	0.01	0.03	0.08
23.5	0.01	0.02	0.06
24	0.00	0.01	0.05
24.5	0.00	0.01	0.04
25	0.00	0.01	0.03
25.5	0.00	0.00	0.02

T (hr)	Q (m^3/s)	Q (m^3/s)	Q (m^3/s)
	25-year	50-year	100-year
26	0.00	0.00	0.01
26.5	0.00	0.00	0.01
27	0.00	0.00	0.01
27.5	0.00	0.00	0.00

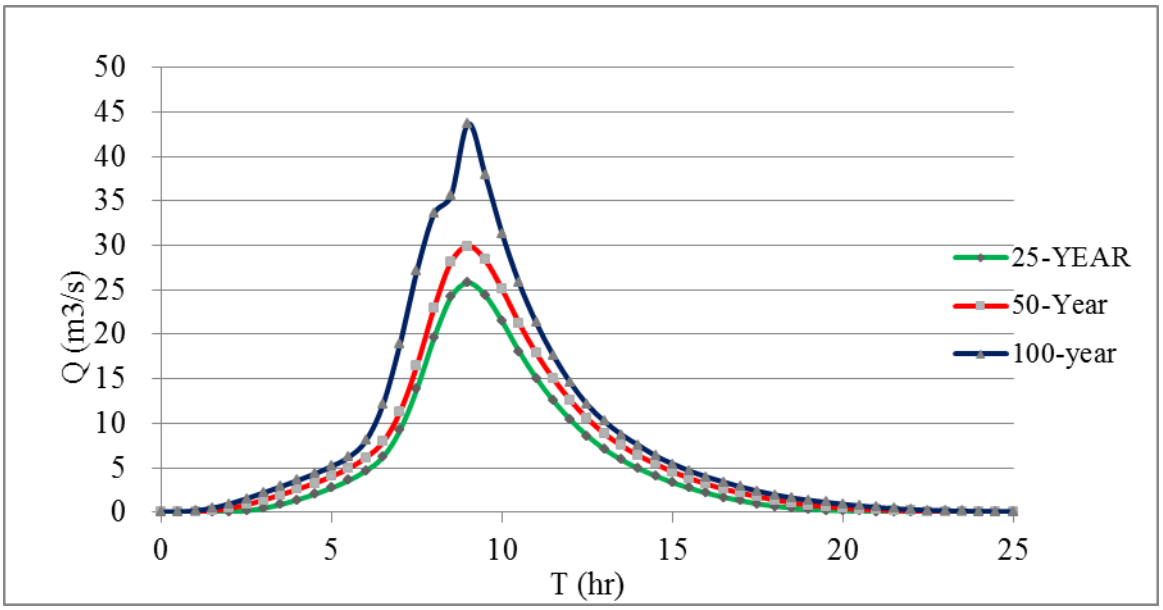


Figure 27: Hydrographs of Wadi 6

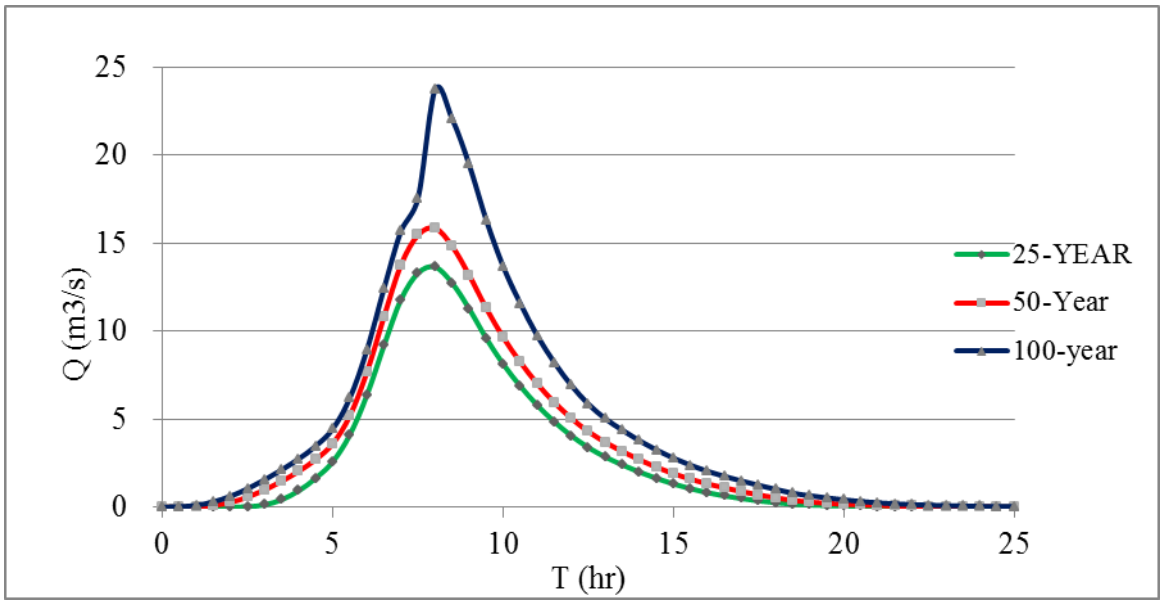


Figure 28: Hydrographs of Wadi 11

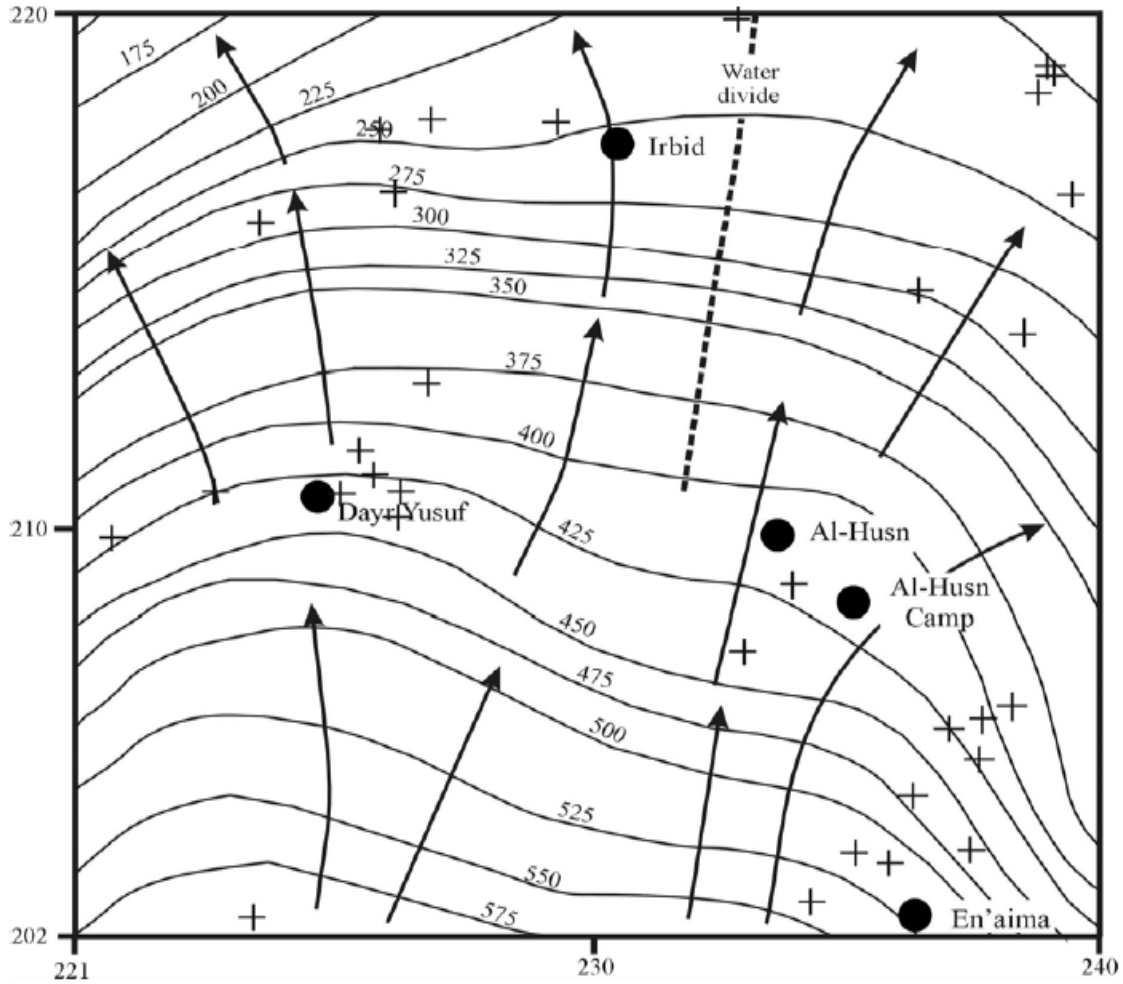
Hydrogeology

A. The Groundwater Flow Map

The groundwater flow map **(Figure 29**) was prepared based on the boreholes in the area and 25 m contour intervals. The map shows recharge and discharge zones in the area. It also shows how groundwater flow is influenced by divides **(Figure 29)** or faults, hidden structures (**Figure 30**)**.** This water divide coincides with the trend of some fold axes and it may be explained as resulting from a hidden fold. Moreover, the map shows that groundwater flows from elevated regions (Ajloun area in the south) to low-lying discharge areas in the northern part of the project area.

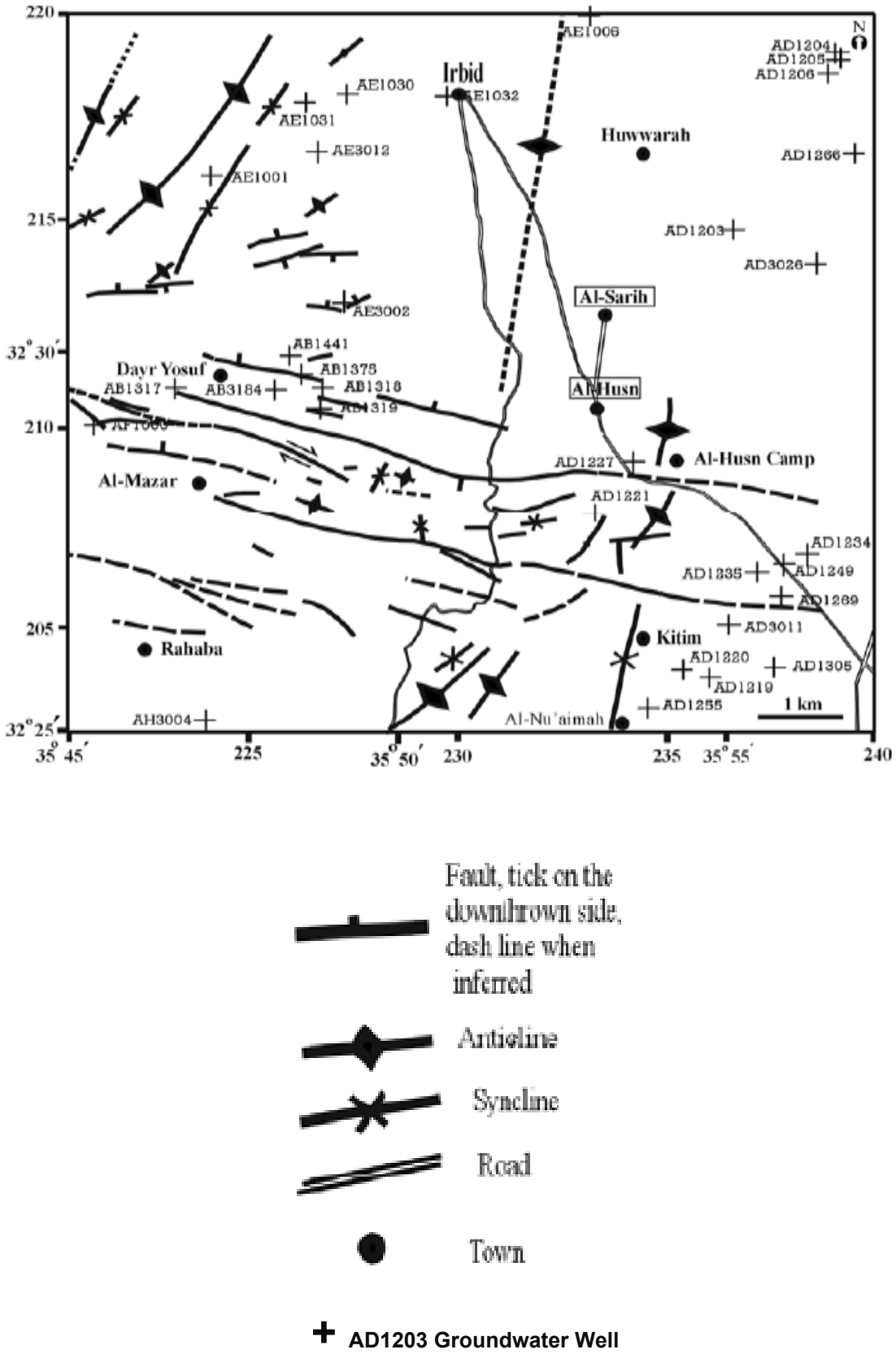
Joints trending north to south may facilitate this movement. Faulting is an outstanding phenomenon in the area, and the flow model is modified by the presence of major faults and folds. As a result, flow in the northern portion occurs laterally (i.e., to the northeast and northwest). A characteristic feature of aquifers tapped through boreholes located along or close to faults, which divert the lateral flow of groundwater, is that all of them have water yield exceeding 20 m^3/hr and can be considered a reasonably good yield. Such boreholes include AB1375, AD1219, AB1441, AD1234, AD1305, AD1221, AD1235, and AD1220 (**Figure 30**). Therefore, faults and joints act as conduits through which groundwater flows.

Contour lines represent the groundwater level and crosses represent borehole locations in **Figure 29.**



Source: JJEES (2008)

Figure 29: Groundwater Flow in the Irbid Area



Source: JJEES (2008)

Figure 30: Location of Boreholes and Their Relation to Structures in the Irbid Area

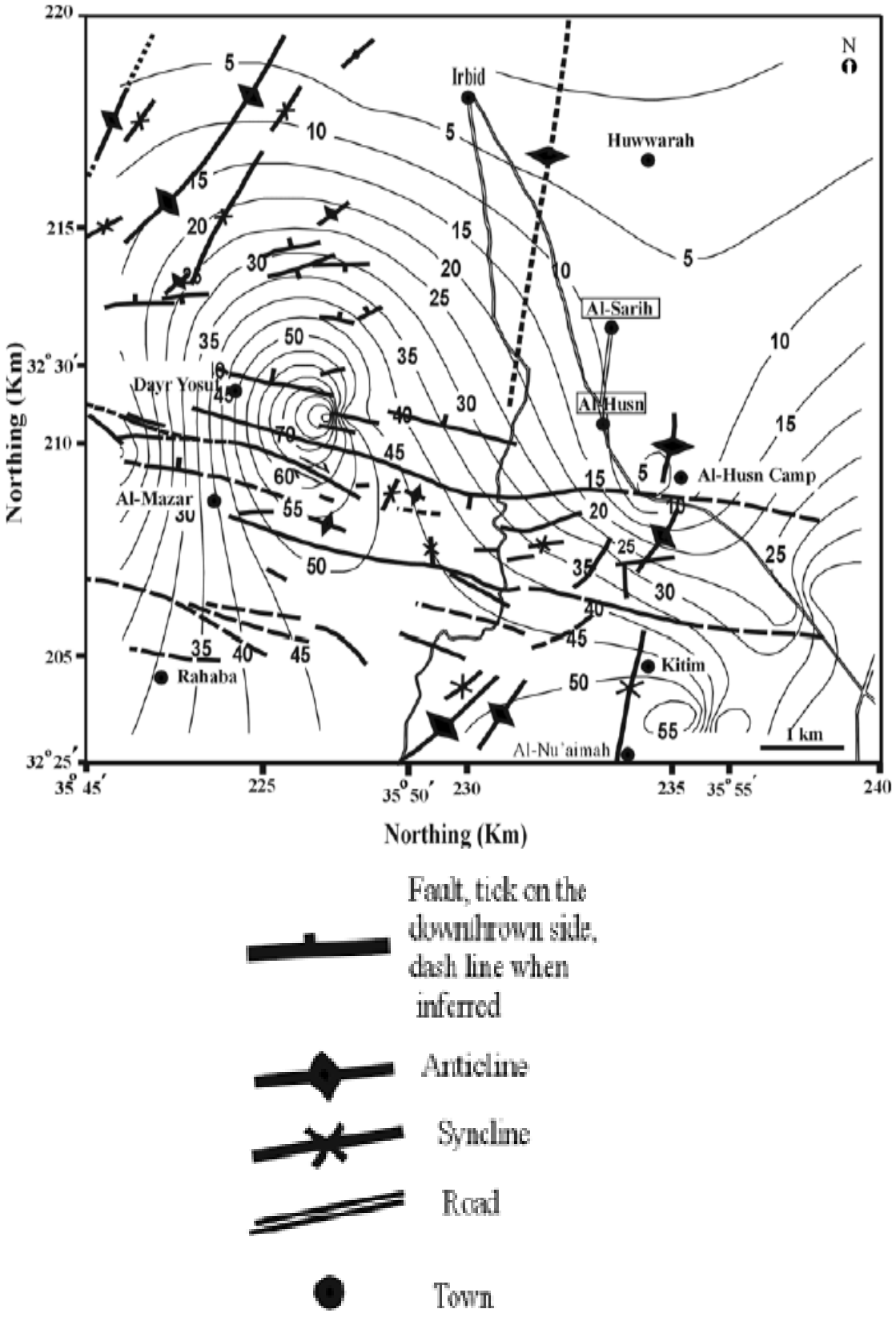
B. Aquifer Yields Map

A second map showing aquifer yields of boreholes was prepared by contouring the water yield at intervals of 2 m^3/hr (**Figure 31**). This map is important because it relates water yield from aquifers to geology and structures. The aquifers yielding more than 20 m^3/hr are in the southern region of the area, on the up-thrown block of the fault system **(Figure 30).** The high yield from these aquifers can be explained by a correlation of the location of wells and aquifer yield (**Figure 31**) maps. The regions with aquifers yielding over 20 m^3/hr are those immediately close to joints and faults. The discharge regions to the north have low yields, less than or equal to 5 m^3/hr except in very few areas with anomalous high yield ranging between 5 m^3/hr and 10 m^3/hr. All wells with low yields are located on the down-thrown block of the main faults.

Aquifers close to fault zones have a mean yield of 46 m^3/hr, and boreholes sited on such fault zones are quite deep, with an average total depth of 300 m. However, the respective (Amman–Wadi Es Sir Compounds) aquifers were struck at relatively shallow depths. The average aquifer depth in the project area is 130 m below ground surface. Aquifers yielding more than 50 m^3/hr of water are only located on or near fault zones in the project area. Such high yield aquifers are those tapped by boreholes such as AB1375, AD1219, and AB1441, which have a mean yield of 63 m^3/hr (**Figure 30**). These aquifers occur in the central part of the project area where jointing and faulting are dominant.

Therefore, the water yield in the Irbid area depends on the location of an aquifer, whether on the up-thrown or down-thrown block of the faults. However, the occurrence of multiple aquifers in boreholes does not always guarantee high water yield. Some boreholes associated with multiple aquifers have a low water yield (e.g., AD1266), whereas other boreholes that are associated with only a single aquifer have high water yield (e.g., AD1234).

Calcium and magnesium are the dominant ions in the groundwater in this basin, while bicarbonate is the most abundant of the anions. Concentrations of the major cations and anions are low compared with their permissible levels in potable water. The total dissolved solids are 1,069 mg/l and below, which indicates freshwater. The water has low to moderate electrical conductivity (424 to 1,670 mS cm-1) and a pH below 8.12. The concentration of total iron exceeds the recommended optimum limit for drinking water and some industrial uses but falls below the maximum permissible limit of 1 mg/l. The low sodium adsorption ratio (0.6 to 5.27) coupled with low electrical conductivity, gives the water low solidity and salinity hazards. Thus, the groundwater is generally of suitable chemical quality for domestic, agriculture, and most industrial uses (Ta Any et al. 2007).



Source: Ta Any et al. (2007)

Note: Numbers over dashed lines mean aquifer yield (m^3/hr)

Figure 31: Aquifer Yield Map of Irbid Area

Water Pollution

Human activities that lead to degradation of water quality include agricultural activities, mainly crop cultivation and application of fertilizers. This is indicated by the very significant correlation (r = 0.82) between nitrate and potassium in the water.

Treated/untreated wastewater is another major source of groundwater pollution, which is indicated by the presence of bacteriological contamination. Total coliform content up to 1,600 MPN/100 ml, and *E. coli* content of 500 MPN/100 ml were recorded (by MWI). Rock/soil-water interaction plays an important role in the modification of the groundwater chemistry, especially water hardness.

Design Criteria for Diversion Channels or Side Protection of the Supply Network Pipes:

The design of the supply network pipes should include the following situations to ensure protection of the pipelines and water quality:

A. If the pipe crosses a hydraulic structure such as a pipe or a box culvert, then the fill between the crown of the one located below and the bottom of the other will be at least 0.3 m.
B. If the pipeline is above the culvert, then the fill between the crown of the pipe and the asphalt should be 0.6 m or more; otherwise, encasement with reinforced concrete should be applied to water carrier.
C. If the pipeline passes along or across an open channel or a wadi, then the pipe should be protected with reinforced concrete for the parts passing across the channel.
D. If the pipeline passes along a culvert, depending on the sizes of both, the pipeline can be constructed either in or beside the culvert.

Results and Recommendations

The design team should consider all the prescribed hydrology section for the culverts' design, giving special attention to cases A and B above for the minimum fill thicknesses and consider any further protection measures.

6.2 Biological Environment

The biodiversity study provides ecological and biological baseline information at planned development areas so that development can mitigate any expected adverse impacts on species diversity and ecological integrity within the proposed project area.

The study objectives were the following:

- Conduct a rapid assessment to identify terrestrial flora and fauna species that inhabit and occur in the study area.
- Review and update records of terrestrial flora and fauna species in the study area and adjacent areas.
- Identify potential impacts on terrestrial fauna and flora species from project operation.
- Assess the project's direct and indirect impacts on biodiversity during the three phases of the project: construction, operation, and decommissioning.
- Propose mitigation measures where necessary to ensure protection for species and their habitats.

Biological Study Area

The proposed project area is located within the Highlands topographic region. **Figure 32** shows the project location in relation to topographic regions of Jordan. The Highlands region extends from Um Qais in the north, passes through the Ajloun Mountains, the hills of the Ammon and Moab regions, and the Edom mountains region. Many creeks and wadis drain from these hills from north to south and lead to the Jordan River, Dead Sea, and Wadi Araba. The southern highlands are higher than those in the north, while the reverse is true concerning the variety of vegetation types and their density.

Study Approach for Biological Environment

To assess and understand the potential impacts of the project, the study correlated the following target biological environment aspects with their physical environment units:

- Biogeographical zones where the project area would be 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 project area including mammals, birds (especially the conservation-important resident species), and conservation-important herpetofauna.
- Sensitive habitats: areas with biological importance such as protected areas, rangeland reserves, and IBAs.

To meet the objectives, scope, and the strategy of this study, different methods were used to assess the existing biological environment aspects at the project area and to evaluate the expected impacts on these aspects. Methods included the following:

Literature Review

The team reviewed all available information obtained previously from the study site and/or its adjacent areas. Information collected from previous environmental impact assessments, and other sources, if available, such as biodiversity assessment or other surveys.

A desktop research process reviewed the available data and identified information gaps to be further studied including:

- Flora and fauna species
- Habitat and typical species communities

Field Work Rapid Assessment

To validate the literature review findings, a 3-day field visit was undertaken at the project site during February 2022 to survey for terrestrial flora, fauna, and avifauna.

The field visit included random checks inside villages. The field observations were then recorded. Field observations included and examined for the presence of breeding and resident birds, animal signs and tracks, and plant species. All species observed were recorded and are reported in the next section.

Baseline Conditions for Biological Environment

The current study was conducted through a combination of desktop (literature review) studies and ground truthing the data in the field. These studies were aimed at defining the biogeographical regions that influence biodiversity in the proposed development area and accordingly defining the general vegetation types and species diversity of both flora and fauna occurring in the area. More details are given in the following sections on the status of species recorded or expected to occur in the area.

Biogeographic Zones

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

Mediterranean Biogeographic Zone

The Mediterranean biogeographic zone (**Figure 33**) is the most humid and has the highest altitude in the country. It extends from Um Qais in the north to the Ras Alnaqab mountains in the south and may extend to Wadi Rum. Altitudes in this biotope range from 700 m to 1,700 m above sea level. The northern part receives more precipitation than the southern part, and the annual rainfall ranges from 400 to 700 mm. The differences in rainfall between the northern and southern portions means that the northern mountains have more diverse vegetation types and densities (Disi 2002).

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

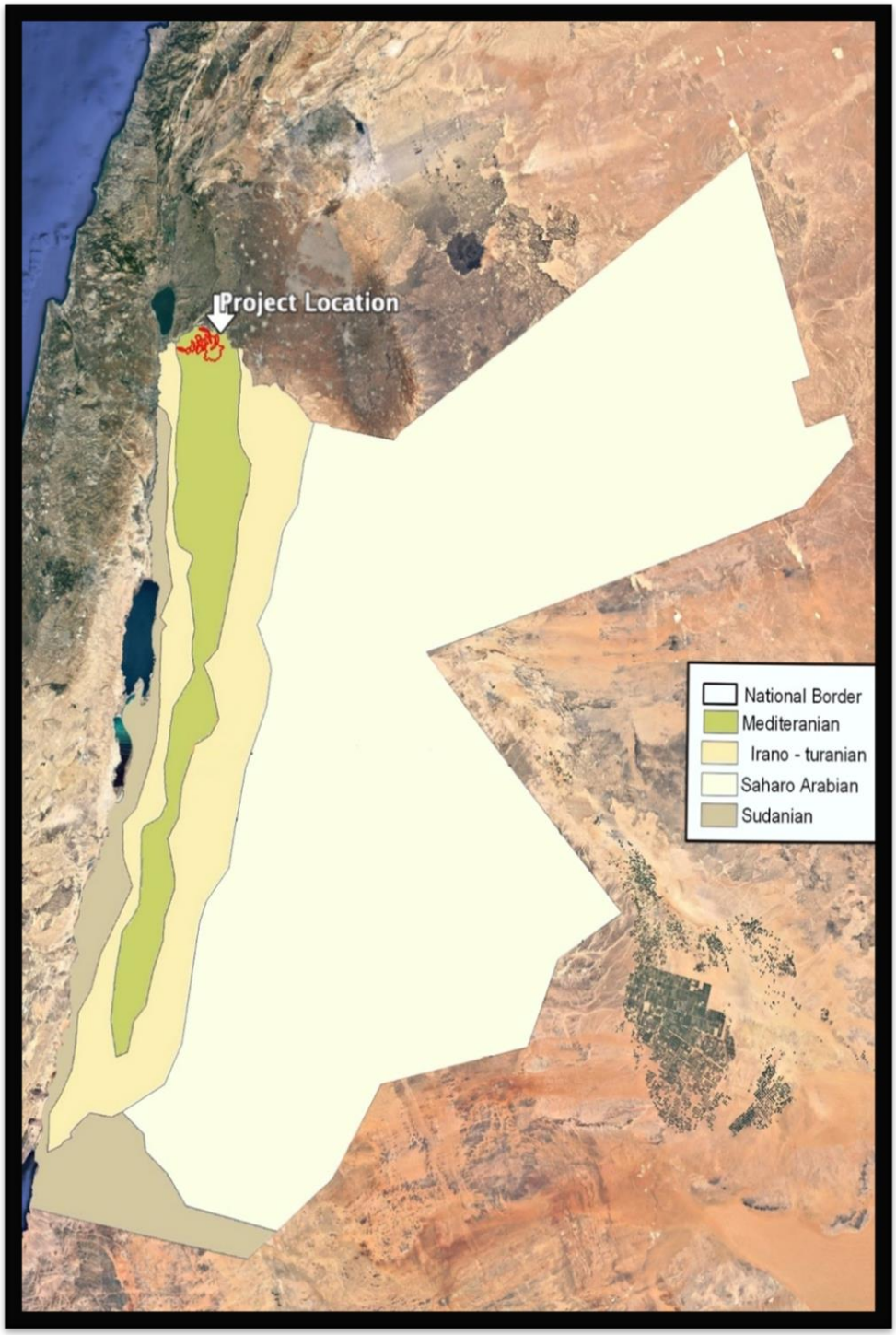
The maximum temperature ranges from 15 to 25°C. The soil is mostly calcareous or transported by wind. The vegetation is mostly dominated by chamaephytes. (Al-Eisawi 1996).

Vegetation Types

Out of 13 vegetation types recognized in Jordan, the project area has three vegetation types. These are Mediterranean non-forest, deciduous oak forest, and water vegetation. The following is a detailed description of each vegetation type:

Deciduous Oak Forest

About 80 percent of the project area lies within the deciduous oak forest vegetation type. Deciduous oak forest is an open forest in Jordan and is not as dense as evergreen oak forest, although the trees are wider in growth. The primary canopy species is the deciduous oak (*Quercus ithaburensis*), and it is associated with a lower layer composed of pistachio (*Pistacia atlantica*), or *Prunus dulcis* and *Crataegus azarolus*. The third vegetative layer is composed of small shrubs and bushes over the final herbaceous layer. This type of forest is generally subjected to animal grazing, especially by sheep and goats. (Al-Eisawi 2015).



Source: (Al-Eisawi 1996)

Figure 32: Biogeographic Zones of Jordan

The deciduous oak forest in Jordan occurs at a lower altitude than all other forest types and mostly grows on red and brown soil of hard limestone parental rock. Most of these types of forest are not well protected. Therefore, they are subjected to degradation. The deciduous oak forests are found at lower elevations than evergreen oak forests. The composition of deciduous oak forest varies in relation to the amount of humidity and temperature. The forests in Um Qais and Malka are associated with *Pistacia palaestina*, *Ceratonia siliqua*, *Styrax officinalis*, *Cercis siliquastrum*, and *Amygdalus communis* (Al-Eisawi 1996).

At the lower borders of the deciduous oak vegetation community, especially on the western slopes of Jordan mountains descending to the Jordan Valley, shrubs of *Ziziphus nummularia* will start to mix with oak trees. Then the vegetation becomes pure stands of *Ziziphus nummularia* until it reaches the Jordan Valley. This gradation in vegetation communities was observed clearly on the western slopes of Um Qais (Al-Eisawi 1996).

The dominant species in this vegetation type are the following (Al-Eisawi 1996):

Quercus ithaburensis	***Styrax officinalis***
Ceratonia siliqua	***Pistacia atlantica***
Olea europaea	***Tulipa* spp.**
Crataegus azarolus	***Calycotome villosa***
Amygdalus communis	***Retama raetam***
Rhamnus palaestinus	***Sarcopoterium spinosuinm***
Dactylis glomerata	***Euphorbia hierosolymitana***
Urginea maritima	***Poa bulbosa***
Carlina hispanica	***Salvia* spp.**

Mediterranean Non-Forest

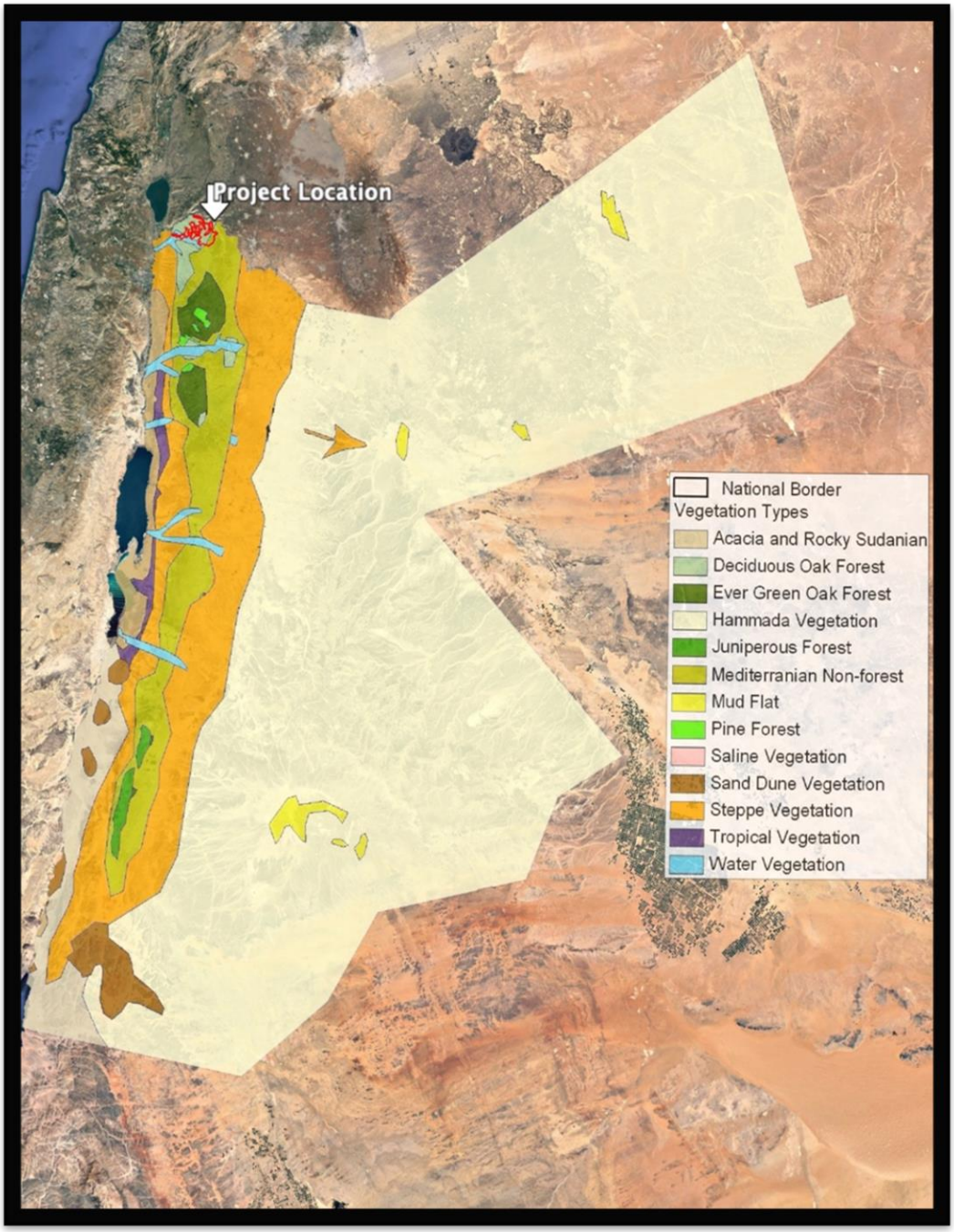
About 15 percent of the project area is in the Mediterranean non-forest vegetation type. This vegetation type also called Batha Mediterranean vegetation. It is found across the Mediterranean region except in the forested and cultivated areas. The Mediterranean vegetation type is characterized by shrubs and bushes. It stretches across the Jordanian ridge between Irbid and Tafilah. The dominant species of this vegetation type are the following (Albert et al. 2004):

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

Water Vegetation

A small part of the project area is located within the water vegetation type. The vegetation of this type is confined to water. This occurs around streams and riverbanks and around water pools. This vegetation type does not occur much in Jordan, but it does occur around the Jordan River, Yarmouk River, Zarka River, Wadi Shuaib, Wadi Mujeb, Wadi Al-Hasa, and in Azraq Oasis (Al-Eisawi 2000) and around Wadi Al Arab in the project area. The dominant species are the following:

***Salix* spp.**	***Phragmites australis***
Vitex angus-castus	***Cyperus longus***
***Tamarix* spp.**	***Typha domingensis***
Nerium oleander	***Juncus* spp.**



Source: Al-Eisawi (1996)

Figure 33: Vegetation Types of Jordan

Table 29 below shows the plant species that were recorded as occurring in or near the project area by previous studies (Al-Eisawi 1998; Taifour 2014). About 228 plant species have been reported from the area, of which 37 of them have conservation status as follows: 4 species are critically endangered, 12 species are endangered, 7 species are near threatened, and 14 species are vulnerable. Most of the recorded plant species from previous studies are common plants and have no conservation status.

Table 29: Flora Species Recorded at the Area

Species	Status	Species	Status	Species	Status
Acanthus hirsutus	Near Threatened	*Anthemis pseudocotula*	Least Concern	*Beta vulgaris*	Near Threatened
Achillea aleppica	Least Concern	*Anthriscus lamprocarpa*	Endangered	*Biscutella didyma*	Least Concern
Achillea falcata	Least Concern	*Apium graveolens*	Least Concern	*Briza maxima*	Least Concern
Adonis aestivalis	Least Concern	*Arbutus andrachne*	Vulnerable	*Bromus lanceolatus*	Least Concern
Adonis annua	Least Concern	*Aristolochia parvifolia*	Endangered	*Bromus madritensis*	Least Concern
Aegilops geniculate	Least Concern	*Artedia squamata*	Least Concern	*Bromus scoparius*	Least Concern
Aegilops kotschyi	Least Concern	*Arum palaestinum*	Endangered	*Bromus sterilis*	Least Concern
Aegilops peregrina	Least Concern	*Asparagus acutifolius*	Least Concern	*Bromus tectorum*	Least Concern
Ajuga iva	Least Concern	*Asperugo procumbens*	Least Concern	*Bryonia cretica*	Least Concern
Allium erdelii	Least Concern	*Asperula arvensis*	Least Concern	*Bryonia syriaca*	Least Concern
Amaranthus blitoides	Least Concern	*Asteriscus aquaticus*	Vulnerable	*Buglossoides arvensis*	Least Concern
Amaranthus retroflexus	Least Concern	*Astragalus callichrous*	Least Concern	*Bupleurum lancifolium*	Least Concern
Ammi majus	Least Concern	*Astragalus guttatus*	Least Concern	*Calendula arvensis*	Least Concern
Anabasis articulata	Least Concern	*Astragalus hamosus*	Least Concern	*Calendula palaestina*	Least Concern
Anacamptis laxiflora	Critically Endangered	*Astragalus pehuenches*	Vulnerable	*Calendula tripterocarpa*	Least Concern
Anchusa aegyptiaca	Least Concern	*Astragalus spinosus*	Least Concern	*Campanula rapunculus*	Least Concern

Species	Status	Species	Status	Species	Status
Anchusa milleri	Least Concern	*Atriplex leucoclada*	Least Concern	*Campanula strigosa*	Least Concern
Andrachne telephioides	Least Concern	*Avena sterilis*	Least Concern	*Capsella bursa-pastoris*	Least Concern
Anemone coronaria	Least Concern	*Ballota saxatilis*	Least Concern	*Carduus argentatus*	Least Concern
Anthemis palestina	Least Concern	*Bellevalia flexuosa*	Least Concern	*Carthamus tenuis*	Least Concern
Catananche lutea	Least Concern	*Crambe hispanica*	Least Concern	*Euphorbia arguta*	Vulnerable
Catapodium rigidum	Least Concern	*Crataegus azarolus*	Least Concern	*Euphorbia hierosolymitana*	Least Concern
Centaurea hyalolepis	Least Concern	*Crepis aspera*	Least Concern	*Euphorbia oxyodonta*	Endangered
Centaurea iberica	Least Concern	*Crepis sancta*	Least Concern	*Ferula communis*	Least Concern
Centaurea pallescens	Least Concern	*Crithopsis delileana*	Least Concern	*Foeniculum vulgare*	Near Threatened
Cephalaria setosa	Least Concern	*Crocus hyemalis*	Vulnerable	*Fumaria densiflora*	Least Concern
Cerastium dichotomum	Least Concern	*Crupina crupinastrum*	Least Concern	*Fumaria parviflora*	Least Concern
Ceratocephala falcata	Least Concern	*Cyclamen persicum*	Endangered	*Galium tricornutum*	Least Concern
Ceratonia siliqua	Least Concern	*Cynoglossum creticum*	Least Concern	*Geranium robertianum*	Endangered
Cercis siliquastrum	Vulnerable	*Dactylus glomerata*	Least Concern	*Geropogon hybridus*	Least Concern
Cerinthe palaestina	Least Concern	*Daucus carota*	Least Concern	*Gladiolus italicus*	Near Threatened
Chaetosciadium	Least Concern	*Diplotaxis erucoides*	Least Concern	*Glaucium corniculatum*	Least Concern
Chenopodium murale	Least Concern	*Echium glomeratum*	Least Concern	*Gundelia tournefortii*	Vulnerable
Chrozophora tinctoria	Least Concern	*Eminium spiculatum*	Vulnerable	*Hippocrepis unisiliquosa*	Least Concern
Chrysanthemum coronarium	Least Concern	*Ephedra alata*	Least Concern	*Hordeum bulbosum*	Least Concern
Cicer judaicum	Critically Endangered	*Eremostachys laciniata*	Least Concern	*Hordeum marinum*	Least Concern
Clematis cirrhosa	Least Concern	*Erodium gruinum*	Least Concern	*Hordeum spontaneum*	Least Concern

Species	Status	Species	Status	Species	Status
Convolvulus arvensis	Least Concern	*Erodium malacoides*	Least Concern	*Hymenocarpos circinnatus*	Least Concern
Conyza canadensis	Least Concern	*Erodium moschatum*	Least Concern	*Iris atrofusca*	Endangered
Coronilla scorpioides	Least Concern	*Erucaria hispanica*	Least Concern	*Isatis lusitanica*	Least Concern
Lagoecia cuminoides	Least Concern	*Medicago polymorpha*	Least Concern	*Paronychia argentea*	Least Concern
Lallemantia iberica	Vulnerable	*Medicago rotata*	Least Concern	*Phagnalon rupestre*	Least Concern
Lamium amplexicaule	Least Concern	*Medicago rugosa*	Least Concern	*Phalaris paradoxa*	Least Concern
Lathyrus aphaca	Least Concern	*Medicago scutellata*	Least Concern	*Phragmites australis*	Least Concern
Lathyrus hierosolymitanus	Least Concern	*Mentha longifolia*	Least Concern	*Pimpinella cretica*	Least Concern
Lathyrus pseudocicera	Least Concern	*Mercurialis annua*	Least Concern	*Pistacia atlantica*	Near Threatened
Legousia speculum	Endangered	*Micromeria nervosa*	Least Concern	*Pisum sativum*	Least Concern
Lens culinaris	Least Concern	*Nepeta curviflora*	Least Concern	*Platanus orientalis*	Critically Endangered
Lepidium draba	Least Concern	*Nerium oleander*	Least Concern	*Pluchea dioscoridis*	Least Concern
Linum pubescens	Least Concern	*Neslia paniculata*	Least Concern	*Poa bulbosa*	Least Concern
Lonicera etrusca	Vulnerable	*Olea europaea*	Vulnerable	*Poa sinaica*	Least Concern
Lotus halophilus	Least Concern	*Onobrychis caput-galli*	Least Concern	*Portulaca oleracea*	Least Concern
Lotus palaestinus	Least Concern	*Ononis spinosa*	Least Concern	*Prasium majus*	Least Concern
Lotus peregrinus	Least Concern	*Ononis viscosa*	Least Concern	*Quercus coccifera*	Vulnerable
Malva nicaeensis	Least Concern	*Origanum syriacum*	Vulnerable	*Quercus infectoria*	Endangered
Malva sylvestris	Least Concern	*Ornithogalum narbonense*	Least Concern	*Quercus ithaburensis*	Vulnerable

Species	Status	Species	Status	Species	Status
Medicago blancheana	Least Concern	*Ornithogalum umbellatum*	Least Concern	*Ranunculus asiaticus*	Least Concern
Medicago coronata	Least Concern	*Oxalis corniculata*	Least Concern	*Retama raetam*	Least Concern
Medicago laciniata	Least Concern	*Trifolium angustifolium*	Least Concern	*Rhagadiolus stellatus*	Least Concern
Medicago monspeliaca	Least Concern	*Trifolium argutum*	Least Concern	*Ruta chalepensis*	Least Concern
Salix alba	Near Threatened	*Trifolium campestre*	Least Concern	*Vicia ervilia*	Least Concern
Salvia dominica	Least Concern	*Trifolium clusii*	Least Concern	*Vicia galeata*	Endangered
Salvia indica	Critically Endangered	*Trifolium clypeatum*	Least Concern	*Vicia hybrida*	Least Concern
Salvia judaica	Endangered	*Trifolium pilulare*	Least Concern	*Vicia narbonensis*	Least Concern
Salvia spinosa	Least Concern	*Trifolium purpureum*	Least Concern	*Vicia palaestina*	Least Concern
Salvia verbenaca	Least Concern	*Trifolium scabrum*	Least Concern	*Vicia peregrina*	Least Concern
Sambucus nigra	Endangered	*Trifolium spumosum*	Least Concern	*Vicia sativa*	Least Concern
Scandix pecten-veneris	Least Concern	*Trifolium stellatum*	Least Concern	*Ziziphus spina-christi*	Least Concern
Scolymus maculatus	Least Concern	*Trifolium tomentosum*	Least Concern	*Scorpiurus muricatus*	Least Concern
Sedum hispanicum	Least Concern	*Trigonella caelesyriaca*	Least Concern	*Senecio flavus*	Least Concern
Senecio vulgaris	Least Concern	*Trigonella foenum-graecum*	Least Concern	*Trigonella arabica*	Least Concern
Sideritis pullulans	Least Concern	*Triticum dicoccoides*	Near Threatened	*Silybum marianum*	Least Concern
Silene aegyptiaca	Least Concern	*Turgenia latifolia*	Least Concern	*Umbilicus intermedius*	Least Concern
Silene conoidea	Least Concern	*Urospermum picroides*	Least Concern	*Thesium humile*	Least Concern
Tragopogon porrifolius	Least Concern	*Vaccaria hispanica*	Least Concern	*Urginea maritima*	Least Concern
Tribulus terrestris	Least Concern				

During the field visit, it was noticed that most of the project activities are proposed inside urban areas and the surroundings are heavily cultivated; the work would be along the road banks and inside villages and towns. Therefore, the project area suffers interference by people and continuous encroachment on vegetated areas for the uses of agriculture, urbanization, grazing, fire, and quarrying. The field visit recorded a few common plant species such as *Capparis spinosa*, *Silybum marianum*, *Ziziphus spina-christi*, and *Carthamus tenuis*.

Zoogeographic

The Mediterranean biotope extends from Um Qais in the north through the Ajlun Mountains, the hilly regions of Balka, Madaba, Al Karak, and Al-Sharrah Mountains to Petra in the south and may extend to Wadi Rum. This ecozone is characterized by Terra Rosa soil associated with outcrops of big and crystalline rocks of Ajlun. Also, rendzina soils occur in the project area and they are restricted to outcrops of soft chalky limestone (Disi 2002).

The availability of microhabitats, richness of vegetation, and the topography of the area, along with other abiotic factors, allow for a high carrying capacity and sustain a large diversity of species.

Reptiles

The Mediterranean ecozone harbors the highest numbers of amphibians, lizards, and snakes in comparison with other ecozones of Jordan. Herpetofaunal species limited to this ecozone include (Disi 2002):

Triturus vittatus	***Pelobates syriacus (recently extinct)***
Mauremys rivulata	***Testudo graeca terrestris***
Cyrtopodion kotschyi orientalis	***Laudakia stellio***
Lacerta kulzeri petraea	***Lacerta laevis***
Lacerta media israelica	***Chalcides guentheri***
Ophiomorus latastii	***Pseudopus apodus***
Typhlops vermicularis	***Eirenis decemlineata***
Eirenis lineomaculata	***Eirenis rothii***
Coluber schmidti	***Coluber jugularis asianus***
Coluber nummifer	***Coluber ravergieri***
Coluber rubriceps	***Malpolon monspessulanus insignitus***
Rhynchocalamus melanocephalus	***Telescopus cf. nigriceps***
Micerlaps muelleri	***Vipera palaestinae***

Northwest Jordan composes 6 percent of the total area of Jordan, but harbors 55 percent of the recorded herpetofaunal species from Jordan. The species that occur in this limited area are divided as follows: amphibians 100 percent, Colubridae 70 percent, and Scincidae 60 percent, while the Gekkonidae, Agamidae, and Lacertidae contribute less to the species richness and do not exceed 30 percent of the reported species. Species with Palearctic origin form 54 percent of the total species in the project area, followed by species descended from Saharo-Arabian-Sindian regions (23 percent), and to a lesser degree from the Arabian (9 percent) and Afrotropical (4 percent) realms (Disi 2002).

Several Palearctic species that mainly occupy the Mediterranean biotope have extended their range into the Irano-Turanian biotope, such as *Bufo viridis*, *Malpolon monspessulanus insignitus*, *Eirenis rothii*, and *Ophisops elegans*. On the other hand, several species inhabiting the Badia have also expanded their distribution to this biotope including *Acanthodactylus boskianus*, *A. tristrami*, *Mesalina guttulatta*, *Spalerosophis diadema cliffordi*, and *Coluber rogersi*. The width of this zoogeographic region varies from year to year in relation to the amount of rain. (Disi 2002).

Table 30 shows some species that were reported from the area.

Table 30: Herpetofauna Reported from the Project Area

Reptilians and Amphibians	
Family Name: Buffonidae	
Buffo viridis	*Green Toad*
Family Name: Hylidae	
Hyla savignyi	*Tree Frog*
Family Name: Ranidae	
Rana bedriage	*Rana Frog*
Family Name: Gekkonidae	
Hemidactylus dawodi-azraqi	*House Gecko*
Ptyodactylus guttatus	*Spotted Fan-footed Gecko*
Family Name: Agamidae	
Laudakia stellio	*Starred Agama*
Trapelus ruderatus	*Syrian Agama*
Family Name: Chamaeleonidae	
Chamaeleo chamaeleon	*European Chameleon*
Family Name: Lacertidae	
Lacerta laevis	*Syrische Lizard*
Ophisops elegans	*Snake-eyed Lizard*

Family Name: Scincidae	
Ablepharus rueppelli	*Rueppell's Snake-eyed Skink*
Chalcides ocellatus	*Ocellated Skink*
Mabuya vittata	*Bridled Skink*
Family Name: Colubridae	
Coluber jugularis	*Large Whip Snake*
Eirenis coronella	*Crowned Peace Snake*
Eirenis rothii	*Roth's Dwarf Racer*
Hemorrhois nummifer	*Coin Snake*
Malpolon insignitus	*Montpellier Snake*
Family Name: Viperidae	
Vipera palaestinae	*Palestinian Viper*

Source: Disi (2001); RSCN (2009)

Mammals

Mediterranean Zoogeographic Zone

The project area is in a distinct subregion within the Palearctic region (European origin). It includes mountainous areas that extend from the north of Jordan to the Al Naqab mountains in the south. During the field visits, no mammals were recorded. **Table 31** shows the important mammals that have been reported from Mediterranean zone, and **Table 32** shows mammal species recorded in the project areas from previous studies.

Table 31: Important Mammals Found in the Mediterranean Zoogeographic Zone

Mammals	
Species Name	**Common Name**
Family Name: Soricidae	
Crocidura suaveolens	*Lesser White-Toothed Shrew*
Family Name: Erinaceidae	
Erinaceus concolor	*European Hedgehog*
Hemiechinus auritus	*Long-Eared Hedgehog*
Family Name: Pteropodidae	
Rousettus aegyptiacus	*Egyptian Fruit Bat*

Mammals	
Species Name	**Common Name**
Family Name: Rhinolophidae	
Rhinolophus blasii	*Blasius's Horseshoe Bat*
Rhinolophus euryale	*Mediterranean Horseshoe Bat*
Rhinolophus ferrumequinum	*Greater Horseshoe Bat*
Family Name: Rhinopomatidae	
Rhinopoma cystops	*Lesser Mouse-tailed Bat*
Family Name: Emballonuridae	
Taphozous perforatus	*Egyptian Tomb Bat*
Family Name: Molossidae	
Tadarida teniotis	*European Free-tailed Bat*
Family Name: Miniopteridae	
Miniopterus pallidus	*Pallid Bat*
Family Name: Vespertilionidae	
Barbastella leucomelas	*Eastern Barbastelle*
Myotis blythii	*Lesser Mouse-eared Bat*
Myotis emarginatus	*Geoffroy's Bat*
Myotis nattereri	*Natterer's Bat*
Pipistrellus kuhlii	*Kulh's Pipistrelle*
Plecotus christii	*Gray Big-eared Bat*
Family Name: Muridae	
Acomys dimidiatus	*Egyptian Spiny Mouse*
Acomys russatus	*Golden Spiny Mouse*
Dipodillus dasyurus	*Wagner's Dipodil*
Meriones crassus	*Silky Jird*
Meriones tristrami	*Tristram's Jird*

Mammals	
Species Name	**Common Name**
Apodemus mystacinus	*Broad-Toothed Field Mouse*
Family Name: Hystricidae	
Hystrix indica	*Indian Crested Porcupine*
Family Name: Spalacidae	
Spalax ehrenbergi	*Mole Rat*
Family Name: Canidae	
Canis lupus	*Arabian Wolf*
Vulpes Ehrenberg	*Red Fox*
Family Name: Felidae	
Felis silvistris	*Wild Cat*
Family Name: Herpestidae	
Herpestes ichneumon	*Egyptian Mongoose*
Family Name: Hyaenidae	
Hyaena Harpists	*Striped Hyaena*
Family Name: Mustelidae	
Martes foina	*Stone Marten*
Meles Fiona	*Eurasian Badger*
Vormela peregusna	*Marbled Polecat*

Source: Amr (2000)

Table 32: Mammals Reported from Yarmouk Protected Area

Mammals	
Species Name	**Common Name**
Family Name: Muridae	
Acomys cahirinus	*Cairo Spiny Mouse*
Apodemus mystacinus	*Broad-Toothed Field Mouse*
Family Name: Hystricidae	
Hystrix indica	*Indian Crested Porcupine*
Family Name: Spalacidae	

Mammals	
Species Name	**Common Name**
Nannospalax leucodon	*Palestine Mole Rat*
Family Name: Canidae	
Canis lupus	*Arabian Wolf*
Canis aureus	*Asiatick Jackal*
Vulpes Asiatic	*Red Fox*
Family Name: Felidae	
Felis chaus	*Jungle Cat*
Felis silvistris	*Wild Cat*
Family Name: Herpestidae	
Herpestes ichneumon	*Egyptian Mongoose*
Family Name: Hyaenidae	
Hyaena Asiatic	*Striped Hyaena*
Family Name: Mustelidae	
Martes foina	*Stone Marten*
Meles Asiatic	*Eurasian Badger*
Vormela peregusna	*Marbled Polecat*

Source: RSCN (2009)

Birds

Jordan has a wide diversity of bird habitat types because of 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 continued research.

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

A sensitivity map tool developed by Birdlife International was used to assess the importance of the project area for migratory soaring birds. **Table 33** shows 20 soaring birds that were observed and another 19 soaring bird species that are thought to occur in the area based on the sensitivity tool results. Most of these species have no conservation status.

Table 33: Soaring Bird Species That May Occur On-Site

Species	Status	Presence	Species	Status	Presence
Lesser Spotted Eagle	Least Concern	Observed	Montagu's Harrier	Least Concern	Expected
Levant Sparrowhawk	Least Concern	Observed	Peregrine Falcon	Least Concern	Expected
White Stork	Least Concern	Observed	Saker Falcon	Endangered	Expected
European Honey Buzzard	Least Concern	Observed	Steppe Eagle	Endangered	Expected
Black Stork	Least Concern	Observed	Osprey	Least Concern	Expected
Great White Pelican	Least Concern	Observed	Hen Harrier	Least Concern	Expected
Egyptian Vulture	Endangered	Observed	Red-Footed Falcon	Near Threatened	Expected
Greater Spotted Eagle	Vulnerable	Observed	Black-Winged Kite	Least Concern	Expected
Eastern Imperial Eagle	Vulnerable	Observed	Pallid Harrier	Near Threatened	Expected
Common Crane	Least Concern	Observed	Booted Eagle	Least Concern	Expected
Eurasian Spoonbill	Least Concern	Observed	Black Kite	Least Concern	Expected
Cinereous Vulture	Near Threatened	Observed	Long-Legged Buzzard	Least Concern	Expected
White-Tailed Sea-Eagle	Least Concern	Observed	Short-Toed Snake-Eagle	Least Concern	Expected
Griffon Vulture	Least Concern	Observed	Merlin	Least Concern	Expected
Western Marsh-Harrier	Least Concern	Observed	Eurasian Hobby	Least Concern	Expected
Lesser Kestrel	Least Concern	Observed	Glossy Ibis	Least Concern	Expected
Northern Goshawk	Least Concern	Observed	Northern Bald Ibis	Critically Endangered	Expected
Eurasian Buzzard	Least Concern	Observed	Golden Eagle	Least Concern	Expected
Common Kestrel	Least Concern	Observed	Bonelli's Eagle	Least Concern	Expected
Eurasian Sparrowhawk	Least Concern	Observed			

Source: Birdlife International (2020)

The bird species that were recorded during the field visits are summarized in **Table 34**: Bird Species Recorded in the Area The species that were observed are common species and they have no conservation status.

Table 34: Bird Species Recorded in the Area

Species	Conservation Status
Long-Legged Buzzard	Least Concern
Kestrel	Least Concern
Chukar	Least Concern
Sand Partridge	Least Concern
Rock Dove	Least Concern
Collared Dove	Least Concern
Palm Dove	Least Concern
Blackcap	Least Concern
Chiffchaff	Least Concern
House Martin	Least Concern
Hoopoe	Least Concern
Crested Lark	Least Concern
Swallow	Least Concern
Jay	Least Concern
House Sparrow	Least Concern
Palestine Sunbird	Least Concern
Spanish Sparrow	Least Concern
Blackstart	Least Concern
Blackbird	Least Concern

Sensitive Habitats

The study included examining any sensitive habitat that is within or close to the proposed project area. Identification of sensitive habitats was initiated in the literature review and followed by the field visits to update the published data.

Protected Areas

During the late 1970s, the RSCN inventoried and then nominated a network of sites as proposed protected areas. Some of these proposed protected areas were declared while others are still not protected. The protected areas that have been declared include representatives of Jordan's important ecological systems.

The part of the work that includes secondary and tertiary pipelines would take place in Malka, Almansoura, and Um Qais villages, which are part of the Yarmouk protected area (PA).

The Al-Yarmouk Nature Reserve is about 20.5 km^2 and dominated by deciduous oak (*Quercus ithaburensis*). The reserve includes four vegetation types including deciduous oak forest, planted pine forest, Mediterranean nonforest, and water vegetation types. Yarmouk was proposed as a PA by RSCN in 1999. The Yarmouk Valley has been identified as an IBA by Birdlife International and as a wetland of particular importance in the Directory of Wetlands of the Middle East. Yarmouk has a high diversity of species. The most important species are *Quercus ithaburensis*, *Salix alba*, *Platanus orientalis*, *Amygdalus communis*, *Rhamnus palaestina*, *Ferula communis*, *Orchis papilionacea*, and *Rosularia libanotica*. The PA has the largest deciduous oak forest in the region. The area is also considered to be of high importance because it is located in the flyways of large numbers of migratory species, including waterfowl and raptors.

Yarmouk PA has 59 plant species belonging to 30 families. Five species were identified as rare, in addition to five threatened species. It has 20 mammalian species, 11 of which are carnivores; 15 herpatofauna species; and a total of 58 bird species. Some globally threatened bird species occur in the PA, such as pygmy cormorant and the marbled teal, in addition to some regionally threatened species such as griffon vulture, honey buzzard, and lesser spotted eagle (RSCN 2009).

The PA faces several threats; loss of natural habitat due to land fragmentation is the most significant threat. The land fragmentation is caused by human activities, especially private agricultural land expansion.

Rangeland Reserves

The proposed project is not close to any of the rangeland reserves. The closest rangeland reserve is Al-Khanasry, which is more than 40 km from the proposed project. In addition, the nature of the project activities is limited to a small area, which decreases the potential negative impact on any sensitive habitat including rangeland reserves **(Figure 34).**

Important Bird Areas

In 2000, Birdlife International and the RSCN identified 27 IBAs in Jordan. The sites that were selected cover a total area of approximately 7,000 km^2 and represent all habitat types, ecosystems, and biogeographic zones that exist in Jordan. These areas are home of a variety of resident and breeding birds, in addition to lying on one of the main migratory bird routes 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 2000).

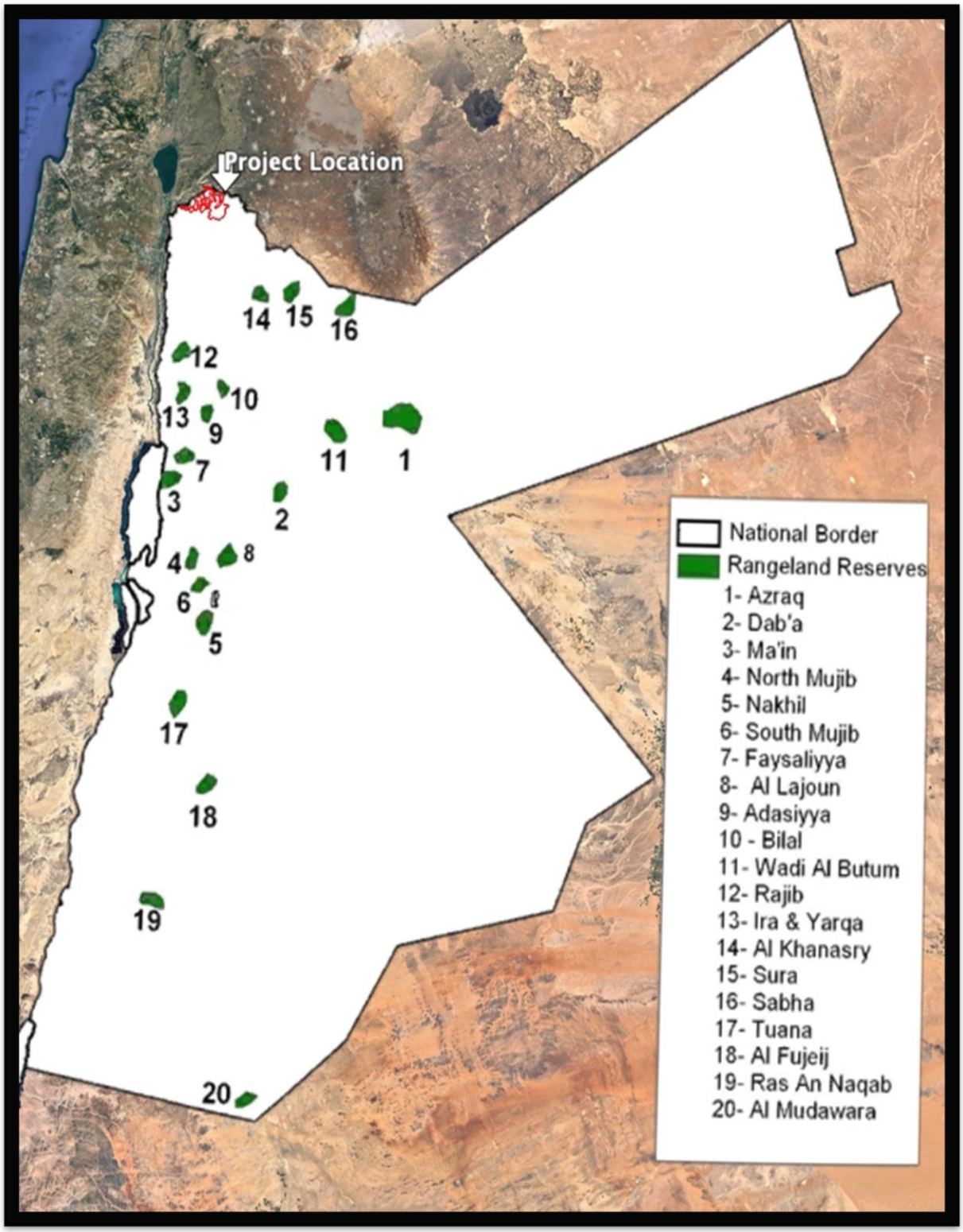
As can be seen in

Source: RSCN (2000)

Figure 35**,** the proposed project site is close to the Wadi Yarmouk IBA.

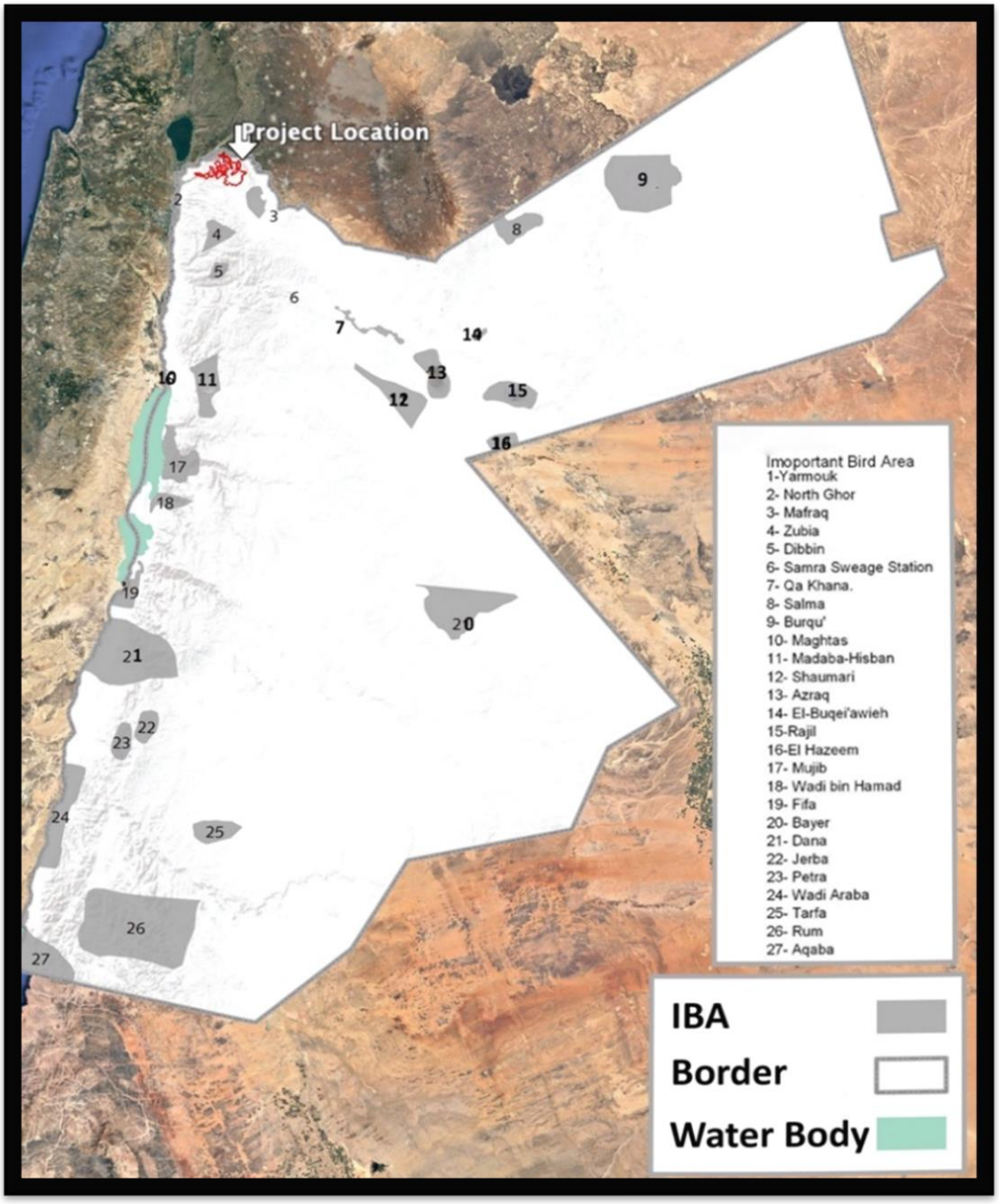
Wadi Yarmouk

Wadi Yarmouk is a steep-sided valley with a small river surrounded by *Nerium* and *Salix* thickets. There are remnant stands of deciduous oak on the slopes, which are generally covered by low shrubs and used as farmland. Located on the Syrian border, the Yarmouk River was one of the least disturbed valley systems in Jordan, but water pumping and agricultural expansion are increasingly threatening wildlife and habitats. Resident and breeding birds include marbled teal (possible), griffon vulture (nonbreeding resident), brown fish owl (possibly extinct), sand partridge (rare), Smyrna and pied kingfishers, Syrian woodpecker, hoopoe, Palestine sunbird, rufous bush robin, olivaceous and Sardinian warblers, and little swift. Migrating raptors include honey and steppe buzzards and lesser spotted eagle. Cormorant, pygmy cormorant, Finsch's wheatear, stonechat, and European serin are winter visitors to the site (RSCN 2000).



Source: RSCN (2000)

Figure 34: Rangeland Reserves of Jordan

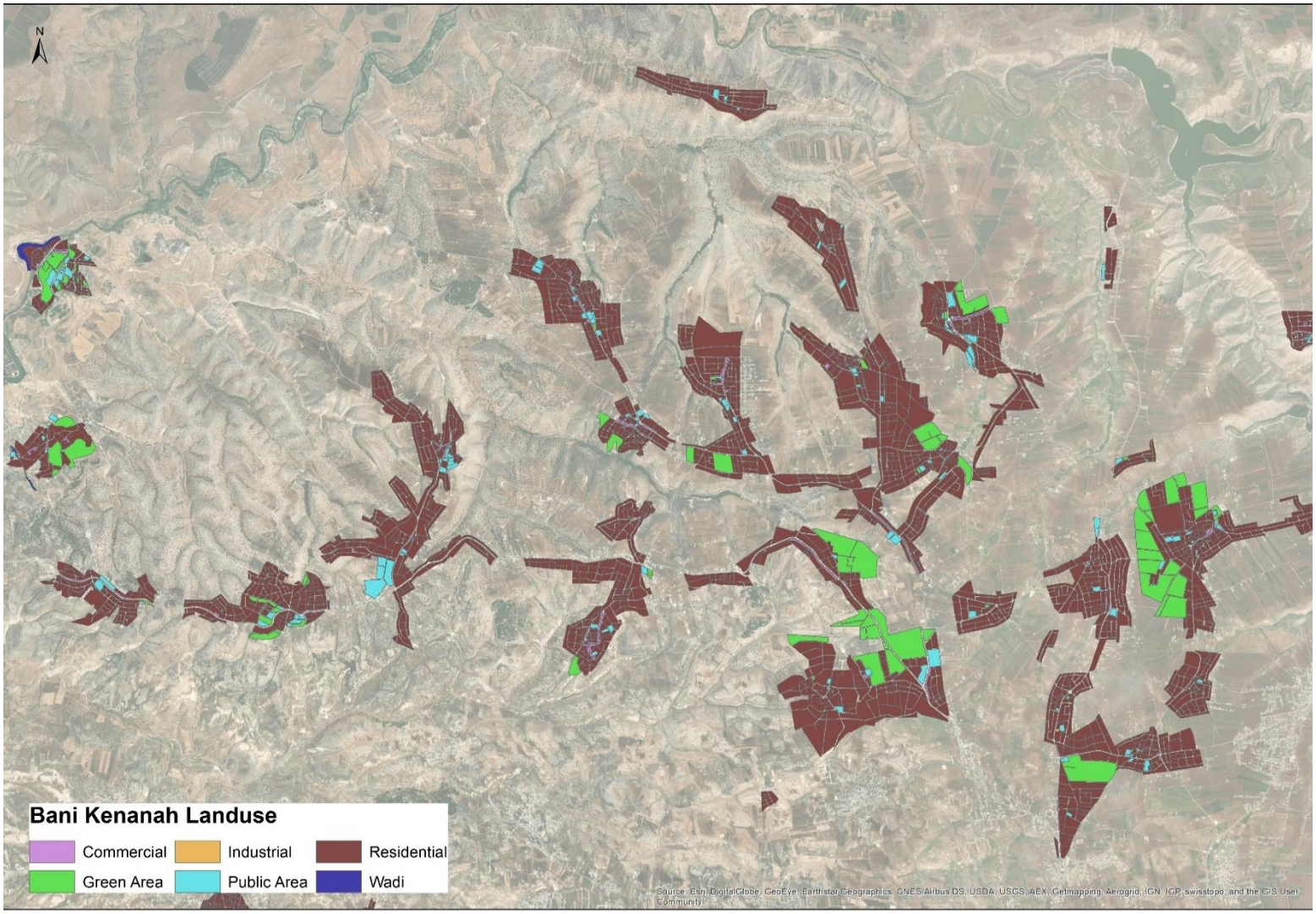


Source: RSCN (2000)

Figure 35: Important Bird Areas of Jordan

6.3 Land Use in the Study Area

Figure 36 depicts the various land use types that would be served by the project in the Bani Kenanah area. The population concentrations overlapping with the various land uses. Bani Kenanah's land use consists of agricultural, residential, commercial, and some industrial areas, as well as public and institutional areas.



Source: Yarmouk Geographic Information System (GIS) Department (2020)

Figure 36: Bani Kenanah Land Use

6.4 Socioeconomic Conditions

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

The Jordan Government continues to show a strong commitment to providing public services to the approximately 655,435 Syrian refugees registered in Jordan. These refugees are mainly in the northern governorates. (UNHCR 2020).

In high-density municipalities, municipal capacity for service delivery, including waste collection and wastewater treatment, has been overstretched in response to increased demands, which has been worsened by the inflow of Syrian refugees since 2011 (Ministry of Planning and International Cooperation 2022).

Furthermore, climate change adds to the stress experienced by the most vulnerable populations through water scarcity and land and air pollution. These major issues must be addressed to sustainably maintain the population.

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

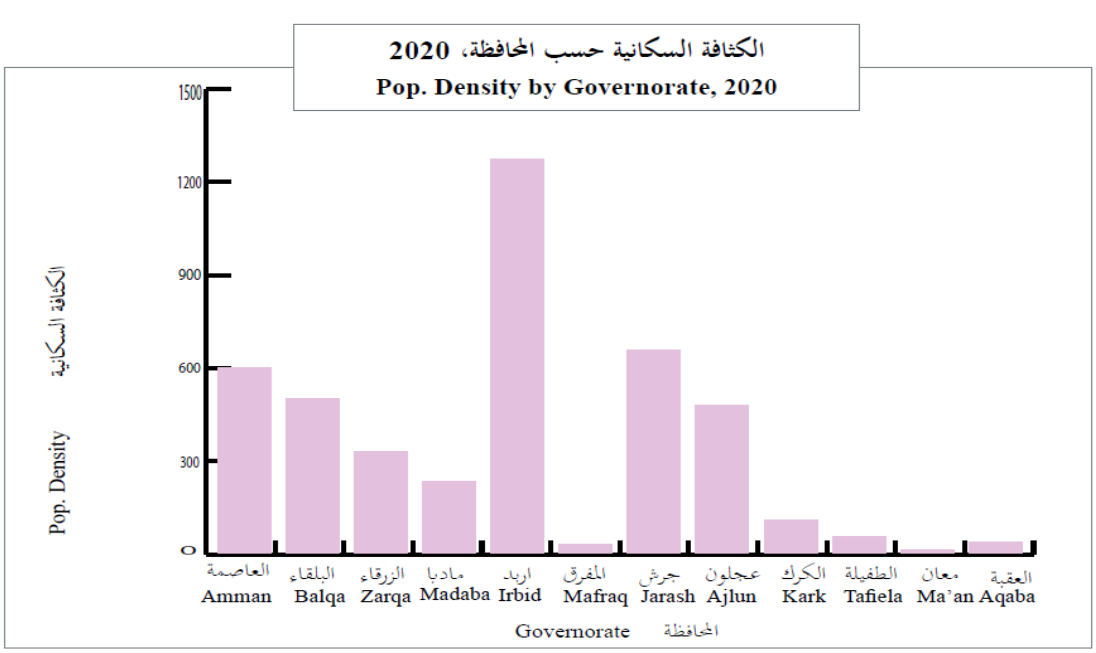
Population and Demographics in the Vicinity of the Project Area

The project site is in the Bani Kenanah District, which falls in northwestern Irbid Governorate. It represents a prominent center in the agricultural sector because of the vastness of its fertile lands, the red soil of the district, and the mild climate. It is 15 km from away the city center.

Bani Kenanah District is considered one of the largest areas in the Irbid Governorate in terms of population, and most of its population work in the government sector, agriculture, and trade sectors. The Bani Kenanah District was created in 1985 and includes five municipal councils: the municipalities of Kaffarat, Saru, Shula, Yarmouk, and Khaled bin al-Walid.

The villages in the area include Sama Al-Rusan, Harima, Hibras, Harta, Aqraba, Kufur Soum, Al Rafid, Yibla, Samar Al Kaffarat, Sahem Al Kaffarat, Kharja, Yarmouk, Al Qasfah, Al Sayla, Al Khuraiba, Brishta, Qaraqosh, Hatim, Ibdir, Malka, Um Qais, Abu Allogus, and others.

The area of Irbid is 1,572 km^2, composing 1.8 percent of the total area of Jordan, with a population density of 1,216.2 people per square kilometer (DoS 2018).



Source: DoS (2018)

Figure 37: Population Density by Governorate

Source: Ministry of Interior (2020)

Figure 38: Bani Kenanah District

The administrative center of the Bani Kenanah District has the following relative advantages that contribute to a diverse economic environment.

1. The district contains three different terrains (i.e., a plain, a mountain, and a valley). The district's fields are among the most fertile agricultural lands in the region, with ideal conditions for growing grains, trees, and fruits.
2. The district has two frontier borders (i.e., Syria borders the north, and the occupied Palestinian territories border the west).
3. A historic area (i.e., the site of the Yarmouk battle).
4. The tourist district, in which there are many tourist and archaeological sites, the most important of which are Um Qais, Quailba, Al-Himma, Al-Ordoniyah, and Al-Asha.

The Bani Kenanah population was estimated to be 149,190, which composes 2 percent of the total population of Jordan. The population is composed of 75,660 males (51 percent), 73,530 females (49 percent), and 31,238 households (DoS 2018). **Table 35** shows the breakdown of the population demographics by municipality.

Table 35: Breakdown of Population Demographics by Municipality

District	Subdistri	Municipality	2020			
			Males	Females	Total	Households
Bani Kenanah	Bani Kenanah	Kaffarat	22,389	21,900	44,289	9,134
		Saru	13,374	12,631	26,005	5,470
		Shula	8,656	8,744	17,400	3,786
		Yarmouk	14,169	13,628	27,797	5,617
		Khaled bin al-Walid	17,072	16,627	33,699	7,231
Total			75,660	73,530	149,190	31,238

Source: DoS (2020)

Economic Profile

Irbid is the second largest governorate in Jordan after Amman, in terms of economic enterprises in operation. Economic enterprises in Irbid account for up to 71 percent of all economic enterprises in the north and 16.7 percent of all economic enterprises in Jordan. Al Hasan Industrial City, located in Irbid Governorate, is Jordan’s second largest industrial city in terms of investment volume, having created 40,000 work opportunities through 617 functioning enterprises. (International Labor Organization 2018).

Unemployment

Despite the measures taken by the Jordanian government, the unemployment rate reached 16.5 percent during 2019.

Table 36 : Unemployment Rate for Jordanian

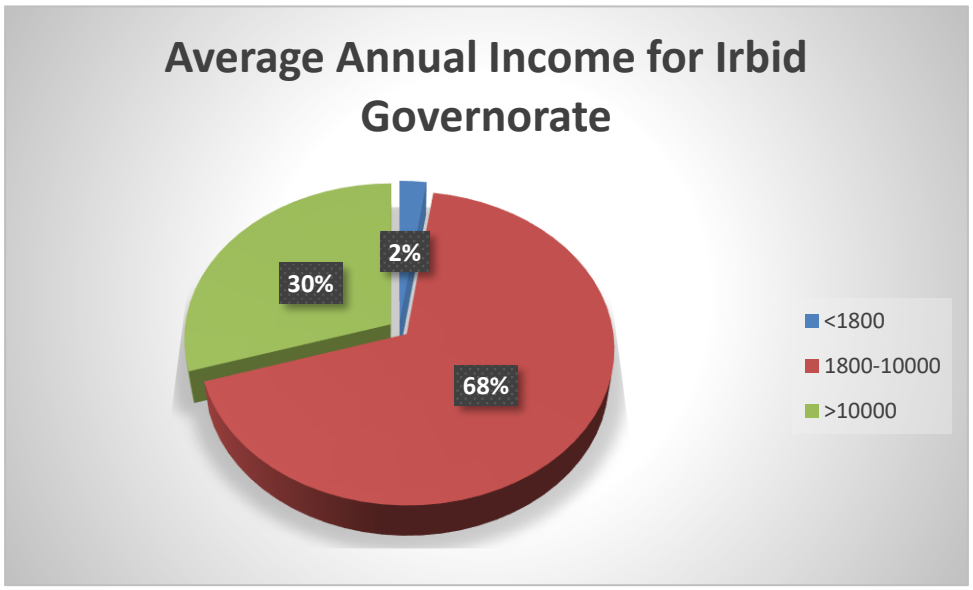
Unemployment rate for Jordanians, non-Jordanians, and Syrians, by Governorate and Gender						
Governorate	Jordanians			Syrians		
	Total (%)	Males (%)	Females (%)	Total (%)	Males (%)	Females (%)
Amman	18.7	17.4	24	30.5	29.9	47.7
Balqa	18.5	16.9	24	40.7	37.6	100
Zarqaa	20.3	18.9	28.4	39	39.2	35.9
Madaba	23.2	22.8	24.4	26.5	24.7	100
Irbid	16.5	12.6	30.7	25.5	24.1	64
Mafraq	18.9	16	28.7	39.5	40.6	28.7
Jerash	19.8	15.2	35.8	33.5	31.1	100
Ajloun	20	15	34.5	30.9	29	75.3
Karak	15.4	14.4	18	9.8	9.3	31.8
Tafilah	23.5	16.2	40.7	20.3	14.3	100
Maan	20.5	18.9	25.4	16.5	16.6	0
Aqaba	18.5	16.3	30.8	17.1	17.3	0

Source: DoS (2019)

Household Income

The average annual household income in the Irbid Governorate is approximately 10,432 Jordanian dinar (JOD). When comparing household income by gender, the DoS survey found that the average household income for males was 1.3 percent higher than for females (DoS 2020).

Figure 39 shows the estimated annual household income in Irbid Governorate:

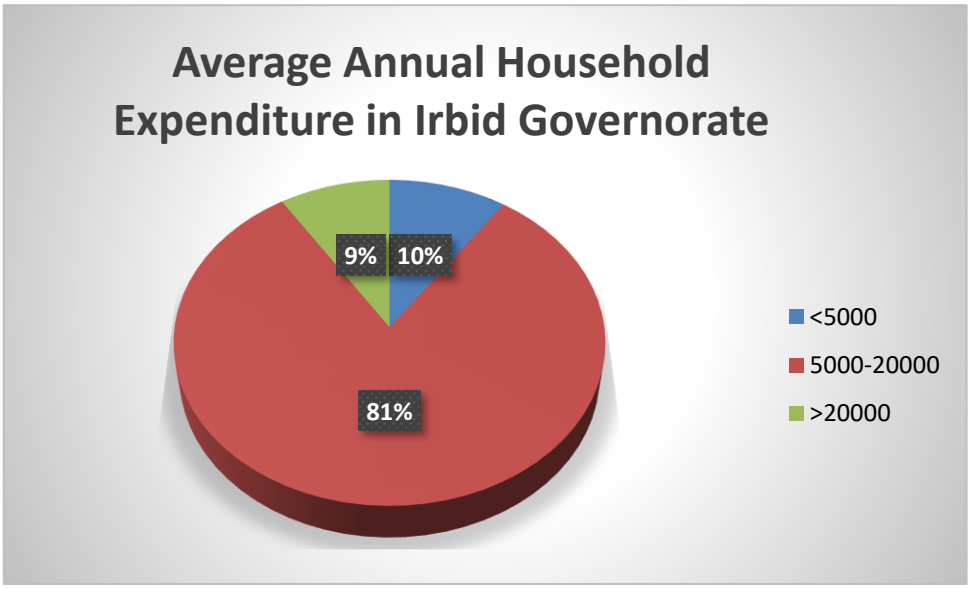


Source: DoS (2020)

Figure 39: Estimated Annual Household Income in Irbid Governorate

Household Expenditure

The average annual household expenditure in the Irbid Governorate was 11,589.4 JOD, with 81 percent of families spending between 5,000 and 20,000 JOD as shown in **Figure 40**.



Source DoS (2020)

Figure 40: Estimated Annual Household Expenditures in Irbid Governorate

Public Services

Households Connected to Public Wastewater Networks

The capacity of the existing wastewater treatment plants and sewer network systems has been exceeded because of the population growth in the northern governorates. This causes sewer overflows and clogs, as well as overloading at wastewater treatment plants. The state of the current infrastructure, as well as the pressures of increasing demands, necessitate considerable changes. Furthermore, Syrian refugees in camps, the most of whom are women and children, are dependent on the daily provision of life-saving water and sanitation facilities (Ministry of Planning and International Cooperation 2022).

The DoS survey showed that 45 percent of the households in the Irbid Governorate are connected to the public wastewater network and 54.9 percent have cesspits (DoS 2017).

Water Supply

Jordan's water crisis is a strategic concern that must be addressed. Jordan must achieve a balance between the needs for drinking water and industrial and irrigation water. Because Jordan is the world's second-poorest country in terms of water resources, drinking water remains the most important and greatest priority. Water vulnerability has increased because of the Syrian refugee crisis, especially in Jordan's northern and central governorates. In the northern governorates most affected by the Syria crisis, annual water demand has grown by 40 percent, while demand elsewhere in Jordan has only increased by 21 percent. In some areas, water delivery has been reduced from once per week to once every four weeks (MWI 2021).

Table 37: Water Supply for Household and Municipal Purposes for Irbid

Water Supply 2020			
Governorate	Water Supply (MCM)	Population (1,000)	Per Capita Water Supply (Liter/day)
Irbid	58.0	1,867.0	75.4

Source: DoS (2019)

Education

Progress is taking place on the national level; however, the Syrian crisis continues to have a negative impact on access, equity, and education. Increased demand for education has created issues, such as the need for more school repairs. With respect to education, 96.6 percent of Jordanians and 86.6 percent of Syrians attend grades 1 through 10 and 74.4 percent of Jordanians and 30 percent of Syrians attend grades 11 through 12 (DoS and ICF 2019).

Table 38: Schools and Students in Bani Kenanah by Gender

Number of Schools and Students				Total
Governorate	Male	Female	Mixed	
Bani Kenanah Schools	38	17	70	125
Bani Kenanah Students	14,509	14,024		28,533

Source: DoS and ICF (2019)

Health Care Services

With population growth, changing demographics, and disease epidemiological transitions, health needs are increasing. Approximately one-third of Jordan's population is without health insurance. Furthermore, the Syrian crisis has been ongoing for several years, and the evolving humanitarian situation imposes new demands on Jordan's health care system. The health demands of Syrian refugees in Jordan continue to put extra strain on Jordan's national health care system and its ability to respond.

Table 39: The Number of Hospitals and Beds in Irbid

Number of Hospitals and Beds in Irbid							
Ministry of Health Hospitals		Private Hospitals		Other Gov.		Total	
No. of Hospitals	No. of Beds	No. of Hospitals	No. of Beds	No. of Hospitals	No. of Beds	No. of Hospitals	No. of Beds
8	869	7	399	2	1,006	17	2,274

Source: DoS and ICF (2019)

Tourist Services

The city of Irbid is considered one of the most beautiful governorates in northern Jordan and is called the Bride of the North. It is located 71 km north of the capital Amman, and its simplicity with its fertile soil and green areas is a destination for picnics and trips during the spring.

Irbid is the third largest city in Jordan, considered one of the oldest cities in Jordan, and it contains traces of settlement that dates back to the Bronze Age and the Iron Age. Some of the most beautiful tourist destinations include the Bani Kenanah District *liwa*, or administrative centers, in the city of Irbid and Sama Rousan, a beautiful area in the north of the Irbid Governorate. The Sama Rousan area includes many attractive villages including Harima, Hibras, Harta, Aqraba, and Samar.

Table 40: Hotels in Irbid Governorate

Hotels in Irbid Governorate				
Hotels	Rooms	Suites	Beds	Employees
8	176	77	536	50

Source: DoS and ICF (2019)

Table 41: Distribution of Tourist Group Reservations

Tourism in Irbid Governorate		
Tourists	Tourist Nights	Average Stay (nights)
272	**770**	**3**

Source: DoS and ICF (2019)

Solid Waste Management

The Syrian conflict is weighing heavily on municipal services. One of the most visible effects on municipalities is the increase in solid waste generated, which has increased by 12.15 percent in the northern governorates (Ministry of Planning and International Cooperation 2022).

Table 42: Waste Collection in the Governorates

Per Capita Waste Collection by Governorate			
Governorates	**Per Capita Collected Waste (gm/day)**	**Population**	**Collected Waste (ton)**
Amman	1.15	4,430,700	1,867,609.2
Balqa	1.01	543,600	200,784
Zarqaa	0.55	1,509,000	301,248
Madaba	0.12	209,200	8,862
Irbid	0.44	1,957,000	313,318.8
Mafraq	1.31	608,000	291,474
Jerash	0.91	262,100	87,396
Ajloun	1.46	194,700	103,806
Karak	0.86	350,000	109,232.4
Tafilah	1.93	106,500	75,193.2
Maan	0.9	175,200	57,546
Aqaba	0.27	208,000	20,620.8
Jordan	0.89	10,554,000	3,437,090

Source: DoS (2020)

Involuntary Resettlement/Land Acquisition

The land acquisition requirement for the proposed project would be primarily for the construction of a new reservoir and pumping station in the Sama area and another reservoir in the Hibras area. This section will include the legal framework of the land acquisition and the project-affected parties due to involuntary resettlement.

The proposed project would affect two plots, one in the Sama region and one in the Hibras region, with a total calculated area of 11 and 3.5 donum, respectively. The proposed project land acquisition is estimated to affect a total of nine project-affected parties, and as previously noted, the areas are mostly planted with olive trees. On the other hand, all water supply pipes are designed to be in the road ROWs; therefore, there would be no resettlement required for the ROW sites for the proposed project.

Legal Framework for Involuntary Resettlement by the Project

The legal framework and entitlement policies for the land acquisition to be implemented by WAJ for the proposed project are derived from the provisions of the LAL of Jordan. Enforced national legislations concerning resettlement in Jordan are governed by LAL No. 12, year 1987; WAJ Law; and the provisions of the Management of Government Law.

Land Acquisition Law

The LAL No. 12, year 1987 provides the Government of Jordan the right to acquire any piece of land or property to develop a project for public benefit. However, the government must compensate the owner(s) fairly. If the owner(s) are not satisfied with the compensation, they can present the matter in court. Such matters are considered of high urgency and are handled by the court system as quickly as possible.

WAJ Procedures Related to Resettlement

According to the WAJ Department of Property and Acquisition, land acquisition for WAJ projects goes through the following steps after delivering the required documents:

1. The required documents to be submitted to the Water Authority are the following:
   a. Land registration certificate (landlord certificate)
   b. Municipality organization chart
2. The Water Authority sends a letter to DLS requesting the acquisition of the required plot.
3. A surveyor from DLS is assigned to determine the plot (or piece of land) required for acquisition.
4. DLS announces in at least two daily newspapers about the intention to acquire the required plots.
   a. The announcement must mention the name of the expropriator; land (plot) registration number and location details; purpose of the acquisition, which should include the name and objective of the project/activity for which the acquisition is being proposed and the public benefit purpose; and a statement that the expropriator intends to submit the land acquisition request to the Cabinet of Ministers 15 days after the date of the announcement of land acquisition of the described land plot (or property).

b. The acquisition request is then submitted to the Cabinet of Ministers, no sooner than 15 days from the date of the announcement, requesting the acquisition of the required plots for the project/activity purpose that is for public benefit.
c. Not noticing the advertisement by landowner in the newspapers will not be an obstacle in the way of the acquisition process even if an objection is made afterward.

5. Usually, the Cabinet of Ministers arrives at a positive response to the acquisition request as long it is perceived to be for public benefit.
6. DLS, who is responsible for the land acquisition, assigns a mark on the plot registration sheet saying that it is intended to be acquisitioned to the name of the expropriator. This note is also made to acquired plots on DLS maps and land ownership database, and DLS puts any action of selling or mortgage on hold.
7. A committee for assessing the land value is formed, which is called the Origin Committee, and in turn the committee calls the landowner and informs him of the estimated price for the plot. If the owner disagrees on the estimated price, another committee called the Negotiation Committee is formed and the case is brought to them.
8. The committee to evaluate the plot is formed from the following members:
   a. A representative of the project owner (e.g., WAJ).
   b. A representative of the Ministry of Finance.
   c. A representative of DLS.
9. The Committee of Damage estimates the damage may be caused by the project (e.g., tree removal or house cracks from vibration). This committee is formed by the governorate itself and includes local parties of Irbid. It evaluates the potential for damage and compensates owners. The local parties include a representative of the Bani Kenanah municipality, a representative of the Irbid Governorate, a representative of DLS, and a representative of the Audit Bureau (control body).
10. If the owner goes to the court in case where the price evaluation negotiations fail, the court does not have the right to cancel the acquisition process but rather continues the negotiation process until a price is agreed upon. Meanwhile, the project continues.
11. If any damage occurs through the project execution, a fair compensation is offered, or the damaged property is fixed back to its condition at the start of the project by the contractor.
12. Usually, the contractor coordinates with the service providers in the area where the proposed line is intended to pass through or where the project is going to be constructed (e.g., the contractor would communicate and coordinate with the electricity service provider or the Ministry).
13. There is no follow-up required for cases that are fully compensated as soon as the acquisition process is finished and the payment to the owner is made.
14. If a third party depends on the property for their livelihood, no compensation is made for that user and the Ministry does not usually deal with the third party at all. All negotiations are made with the landowner; however, the land user, whose livelihood is from that land, has the right to ask for fair compensation through the governor or the Minister.

For the purpose of this proposed Bani Kenanah project, WAJ sent a letter to DLS asking for the acquisition of the required plots for the proposed Sama and Hibras Reservoirs. A surveyor from DLS was assigned to identify the plots required for acquisition. DLS announced the intention to acquire the required plots in the newspapers. The acquisition request was submitted to the Cabinet of Ministers and it was approved by the Cabinet for the two plots. A committee for assessing the land value was formed, and the committee identified the compensation value for the land. Another committee, called the Committee of Damage, estimated the damage potentially caused by the project (e.g., tree removal in this case) and estimated the necessary compensation for the trees. This committee included a member from MoA to evaluate the compensation proposed for the trees.

The project-affected parties affected by the land acquisition are shown in the **Table 43.**

Table 43: Identified Landowners in the Project Area

Name	Name of Land	Contact
Mr. Saeed Al-Rousan	Sama Rousan	0799043529
Mr. Mowafaq Al-Rousan		
Mr. Rami Al-Rousan		
Ms. Suhad Al-Rousan		
Ms. Ruba Al-Rousan		
Mr. Ali Al-Rousan		
Ms. Basma Al-Rousan		
Ms. Sahar Al-Rousan		
Ms. Rashdeh Al-Rousan		
Mr. Fayez Obeidat	Hibras	-

Climate Change and Carbon Footprint

According to Jordan's Third National Communication (TNC) to the United Nations Framework Convention on Climate Change, more intense heat waves are expected, with certain temperature thresholds being crossed, especially during the summer. Drought is anticipated during the years 2070–2100, with dry days lasting more than 30 days. However, annual values suggest that, despite a general decrease in precipitation, heavy rainy years at the end of the century are still expected to partially alleviate droughts. The evaporation rate will almost certainly rise. Finally, the most valuable points from climate change projections and trends are expectations for a warmer and drier climate, warmer summers, drier falls, and drier winters. More heat waves and drought, are expected but significant rains or winds are not expected.

Climate change is expected to have a negative impact on the water sector, with reduced groundwater recharge, degraded groundwater quality, reduced streamflow, and rising water demand. The average sensitivity level was rated high according to the TNC report (MoE 2014). **Figure 41** shows the vulnerability assessment for the water sector in Jordan.

Climate Change Hazards	Sensitivity Factors Indicators	Exposure level		Sensitivity level	Impact level		Adaptive capacity level	Overall vulnerability assessment	
		RCP 4.5	RCP 8.5		RCP 4.5	RCP 8.5		RCP 4.5	RCP 8.5
Precipitation decrease	Groundwater level decline	High (average score = 3.67)	Very High (average score = 4.33)	High (average score = 3.67)	High (average score = 3.67)	High (average score = 4.0)	1.5	High	High
	Groundwater quality deterioration						1.5		
	Stream flow reduction						2.5		
Temperature increase	Groundwater recharge decrease	Very High (average score = 5)	Very High (average score = 5)	High (average score = 3.50)	Very High (average score = 4.75)	Very High (average score = 4.75)	2.0	Very High	Very High
	Stream flow reduction						2.0		
Drought	Increased water demand	High (average score = 3.67)	Very High (average score = 4.33)	High (average score = 4.0)	High (average score = 3.83)	High (average score = 4.0)	1.5	High	High
Evaporation	Stream flow reduction	High (average score = 3.67)	Very High (average score = 4.33)	High (average score = 4.0)	High (average score = 3.83)	High (average score = 4.0)	1.5	High	High

Source: MoE (2014)

Figure 41: Vulnerability Assessment Matrix for Water Sector

The decrease in precipitation and drought intervals and the increase in temperature and evaporation rates are considered the climate change hazards that will lead to groundwater level decline and quality deterioration, as well as increased water demand.

According to a BGR/GIZ study for the Bani Kenanah Wellfields, all the wells will be nearly depleted by 2025, and water will be sourced mostly from the Wehda Wellfield and the Zabda Reservoir. Throughout the year 2035 design horizon, the estimated annual production capacity of the indicated wellfields will not be sufficient to supply the expected demand of the Bani Kenanah areas. As a result, it is expected that by implementing this proposed water supply project, the Zabda Reservoir will cover the predicted gap between demand and available water quantities from local resources. In addition, the new design will eliminate the need for four PSs: Harima, Malka, Syfeen, and Kufur Asad. The proposed project design will depend on gravity supply for the water system.

The Wehdah Dam system (PS0 and PS1) would keep running to supply the new Hibras Reservoir. Currently, energy needs account for half of all water costs. Power consumption for water operations will rise as groundwater levels fall, necessitating higher energy consumption for pumping, while lowering well production.

6.5 Cultural Heritage Resources

To establish the archaeological and cultural heritage baseline for the environmental impact assessment study, an archaeological study was carried out by a team of specialists.

The methodology adopted for this study included a literature review, field investigation and documentation, data analysis, report preparation, and final report with recommendations.

Field Work Study

The study team investigated the whole project area in Bani Kenanah and the surrounding zone from all sides.

The study was conducted on foot, and study members walked at a distance of 5 to 10 m from each side of the proposed pipeline routes.

Literature Survey

Available references, databases, and information that are related to the study area were reviewed, including:

- Jordan Antiquities Database and Information System (Mega and former JADIS)
- DoA archives
- Library of American Center for Oriental Research and British Council for Research in Levant

Photographic Documentation

A photographic technique was used to document the recorded data.

The project areas were registered, mapped, properly dated, and evaluated. During the study the following activities were conducted:

- Field investigation of the whole project area and the surrounding areas especially in Umm Qais and Abila.
- Registration of the results even if found outside of the project borders (i.e., in the surrounding zone) on a suitable registration form.

- Mapping of all features even found outside of the project borders (i.e., pipeline route) on 1:25,000 map scale series k737 maps.
- Definition of the mitigation measures necessary to avoid and minimize the project threats and impacts to national and local archaeological and cultural resources.
- The documented data includes descriptions of the essential information for each site found during field study. The information includes the following:
    - ❖ Site number assigned in the field
    - ❖ Site location and UTM coordinates
    - ❖ Modern Arabic name of site (if known)
    - ❖ Brief descriptions of the discovered remains
    - ❖ Recommended actions

The pipeline routes along the road alignments were subjected to literature study and a review of records of previous investigations to protect any existing or known cultural heritage resources. The team found no remains along the proposed pipeline routes except modern dumps that have accumulated occasionally above the old water pipeline routes (see **Figure 42**).

The field investigations were conducted in accordance with the Antiquities Law No. 21, year 1988, as directed in Article No. 31 (i.e.., “No permit should be granted for any construction project including buildings and fences, unless a distance of 5-50 meters is left between them and any antiquity according to directors’ decision”).

The following section presents the details of the field investigations.

Site No: 1
Site name: khirbet ain lahiyah/Approved
MIGA Number: 3154
Site location: Irbid – Bani Kenanah
Date: 9042 (Nabataean, Late); 9046 (Roman, Unspecified)
Site Recommendation: The site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase

Site No: 2
Site name: khirbet al zawiyah al janoobiyah
MIGA Number: 3162
Site location: Irbid – Bani Kenanah
Date: 9044 (Roman, Early)
Site Recommendation: The site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase

Site No: 3
Site name: khirbet al massarra
MIGA Number: 2920
Site location: Irbid – Bani Kenanah
Date: 9046 (Roman, Unspecified)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase

Site No: 4
Site name: SAHEM JADIS: 2223021, saham khirbethaielhessen
MIGA Number: 2814
Site location: Irbid – Bani Kenanah
Date: 9022 (Early Bronze III); 9060 (Modern [1915–1950]); 9999 (Unspecified/Unknown Period)
Site Recommendation: The site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase

Site No: 5
Site name: ain saham
MIGA Number: 3156
Site location: Irbid – Bani Kenanah
Date: 9044 (Roman, Early)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 6
Site name: saham al kaffarat
MIGA Number: 2783
Site location: Irbid – Bani Kenanah
Date: 9053 (Islamic, Ayyubid)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 7
Site name: Aqraba/Mittmann Site 34 JADIS: 2223029, AQRABA/ MITTMANN SITE 34
MIGA Number: 11611
Site location: Irbid – Bani Kenanah
Date: 9048 (Byzantine, Late); 9050 (Islamic, Umayyad)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 8
Site name: Aqraba JADIS: 2223003
MIGA Number: 11591
Site location: Irbid – Bani Kenanah
Date: 9019 (Early Bronze I); 9020 (Early Bronze II); 9046 (Roman, Unspecified); 9060 (Modern (1915-1950))
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 9
Site name: NN/MELLAART Site 6 JADIS: 2223001
MIGA Number: 11590
Site location: Irbid – Bani Kenanah
Date: 9024 (Early Bronze, Unspecified); 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 10
Site name: RAFID JADIS: 2223006, Rafid
MIGA Number: 2872
Site location: Irbid – Bani Kenanah
Date: 9048 (Byzantine, Late); 9049 (Byzantine, Unspecified); 9053 (Islamic, Ayyubid); 9054 (Islamic, Mamluk); 9059 (Ottoman, Unspecified); 9999 (Unspecified/Unknown Period).
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 11
Site name: HARTHA JADIS: 2223004
MIGA Number: 11592
Site location: Irbid – Bani Kenanah
Date: 9048 (Byzantine, Late); 9054 (Islamic, Mamluk); 9060 (Modern (1915-1950))
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 12
Site name: YUBLA JADIS: 2223009
MIGA Number: 11595
Site location: Irbid – Bani Kenanah
Date: 9031 (Iron Age I); 9038 (Hellenistic, Late); 9048 (Byzantine, Late);9050 (Islamic, Umayyad); 9053 (Islamic)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 13
Site name: KUFR SOM JADIS: 2223010
MIGA Number: 11596
Site location: Irbid – Bani Kenanah
Date: 9048 (Byzantine, Late); 9051 (Islamic, Abbasid); 9052 (Islamic, Fatimid); 9054 (Islamic, Mamluk); 9055 (Islamic, Unspecified); 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 14
Site name: No Name
MIGA Number: 5977
Site location: Irbid – Bani Kenanah
Date: 9019 (Early Bronze I); 9020 (Early Bronze II); 9031 (Iron Age I); 9044 (Roman, Early); 9048 (Byzantine, Late); 9050 (Islamic, Umayyad); 9051 (Islamic, Abbasid); 9052 (Islamic, Fatimid); 9054 (Islamic, Mamluk); 9057 (Ottoman, Early); 9058 (Ottoman, Late).
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 15
Site name: HEBRAS JADIS: 2223007, Ain Hibras 1, Hibras
MIGA Number: 2828
Site location: Irbid – Bani Kenanah
Date: 9045 (Roman, Late); 9049 (Byzantine, Unspecified); 9051 (Islamic, Abbasid); 9054 (Islamic, Mamluk); 9055 (Islamic, Unspecified); 9060 (Modern [1915–1950]); 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 16
Site name: HEBRAS JADIS: 2223007, Ain Hibras al Mqataneh, Hibras
MIGA Number: 2843
Site location: Irbid – Bani Kenanah
Date: 9045 (Roman, Late); 9049 (Byzantine, Unspecified); 9051 (Islamic, Abbasid); 9054 (Islamic, Mamluk); 9055 (Islamic, Unspecified)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 17
Site name: HEBRAS JADIS: 2223007, Ain Hibras 2, Hibras
MIGA Number: 2829
Site location: Irbid – Bani Kenanah
Date: 9049 (Byzantine, Unspecified); 9051 (Islamic, Abbasid); 9054 (Islamic, Mamluk); 9055 (Islamic, Unspecified); 9060 (Modern (1915-1950)); 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 18
Site name: Khirbet Ezrit JADIS: 2322019
MIGA Number: 2852
Site location: Irbid – Bani Kenanah
Date: 9038 (Hellenistic, Late); 9044 (Roman, Early); 9046 (Roman, Unspecified); 9047 (Byzantine, Early);9048 (Byzantine, Late); 9051 (Islamic, Abbasid); 9054 (Islamic, Mamluk); 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 19
Site name: Gadara/Um Qais - Hinterland- Survey Yarmouk Forest Reserve
MIGA Number: 68702
Site location: Irbid – Bani Kenanah
Date: 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 20
Site name: Gadara/Um Qais - Hinterland- Survey Yarmouk Forest Reserve
MIGA Number: 68702
Site location: Irbid – Bani Kenanah
Date: 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 21
Site name: khirbet al areeth
MIGA Number: 3122
Site location: Irbid – Bani Kenanah
Date: 9044 9046 (Roman, Unspecified)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken, and a chance find procedure should be adopted during construction phase.

Site No: 22
Site name: QABU JADIS: 2122083
MIGA Number: 10640
Site location: Irbid – Bani Kenanah
Date: 9046 (Roman, Unspecified); 9049 (Byzantine, Unspecified); 9060 (Modern [1915-1950]); 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precautions should be taken and a chance find procedure should be adopted during construction phase.

Site No: 23
Site name: NN/WADI ARAB SURVEY SITE 038 JADIS: 2222021, al hujajmalk Approved
MIGA Number: 2776
Site location: Irbid – Bani Kenanah
Date: 9049 (Byzantine, Unspecified); 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 24
Site name: NN/WADI ARAB SURVEY SITE 038 JADIS: 2222021
MIGA Number: 10640
Site location: Irbid – Bani Kenanah
Date: 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 25
Site name: NN/WADI ARAB SURVEY SITE 037 JADIS: 2222020 Approved
MIGA Number: 5919
Site location: Irbid – Bani Kenanah
Date: 9060 (Modern [1915–1950])
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 26
Site name: BALAD EL-MANSURA JADIS: 2122094
MIGA Number: 10646
Site location: Irbid – Bani Kenanah
Date: 9060 (Modern [1915–1950])
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 27
Site name: Hatem JADIS: 2222049
MIGA Number: 11581
Site location: Irbid – Bani Kenanah
Date: 9051 (Islamic, Abbasid); 9052 (Islamic, Fatimid); 9054 (Islamic, Mamluk)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 28
Site name: HARIMA JADIS: 2322017, khirbet Harima
MIGA Number: 2853
Site location: Irbid – Bani Kenanah
Date: 9046 (Roman, Unspecified); 9048 (Byzantine, Late); 9054 (Islamic, Mamluk);9059 (Ottoman, Unspecified); 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 29
Site name: SAMA ER-ROUSAN JADIS: 2222039, SAMA
MIGA Number: 11577
Site location: Irbid – Bani Kenanah
Date: 9032 (Iron Age IIa-b); 9033 (Iron Age IIc); 9048 (Byzantine, Late); 9050 (Islamic, Umayyad); 9051 (Islamic, Abbasid); 9052 (Islamic, Fatimid); 9054 (Islamic, Mamluk); 9059 (Ottoman, Unspecified); 9060 (Modern [1915–1950])
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 30
Site name: No Name
MIGA Number: 3176
Site location: Irbid – Bani Kenanah
Date: 9045 (Roman, Late)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 31
Site name: khirbet Hod al Qadi
MIGA Number: 3124
Site location: Irbid – Bani Kenanah
Date: 9055 (Islamic, Unspecified)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 32
Site name: al mzereeb
MIGA Number: 58402
Site location: Irbid – Bani Kenanah
Date: 9048 (Byzantine, Late); 9050 (Islamic, Umayyad)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 33
Site name: KOM SAMA JADIS: 2222061, Mzereeb
MIGA Number: 2765
Site location: Irbid – Bani Kenanah
Date: 9034 (Iron Age III [Persian]); 9035 (Iron Age, Unspecified); 9046 (Roman, Unspecified); 9049 (Byzantine, Unspecified); 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 34
Site name: Milh
MIGA Number:3167
Site location: Irbid – Bani Kenanah
Date: 9999 (Unspecified/Unknown Period)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 35
Site name: khirbet tall al Dairy JADIS: 2222038
MIGA Number: 3178
Site location: Irbid – Bani Kenanah
Date: 9046 (Roman, Unspecified)
Site Recommendation: Field operations and assessment revealed that the site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 36
Site name: ZAFARAN /Approved
MIGA Number: 5965
Site location: Irbid – Bani Kenanah
Date: 9029 (Late Bronze IIa-b); 9031 (Iron Age I); 9032 (Iron Age IIa-b); 9047 (Byzantine, Early); 9999 (Unspecified/Unknown Period)
Site Recommendation: The site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 37
Site name: KUFR JAYIZ JADIS: 2222040, kufur Jayez
MIGA Number:2820
Site location: Irbid – Bani Kenanah
Date: 9044 (Roman, Early); 9049 (Byzantine, Unspecified); 9050 (Islamic, Umayyad); 9051 (Islamic, Abbasid); 9054 (Islamic, Mamluk); 9055 (Islamic, Unspecified); 9999 (Unspecified/Unknown Period)
Site Recommendation: The site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 38
Site name: KHARJA Approved JADIS: 2322021, kharja
MIGA Number: 2789
Site location: Irbid – Bani Kenanah
Date: 9046 (Roman, Unspecified); 9049 (Byzantine, Unspecified); 9051 (Islamic, Abbasid); 9054 (Islamic, Mamluk); 9055 (Islamic, Unspecified); 9059 (Ottoman, Unspecified); 9999 (Unspecified/Unknown Period)
Site Recommendation: The site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 39
Site name: KHREIBE Approved JADIS: 2322020, khuraiba
MIGA Number: 2842
Site location: Irbid – Bani Kenanah
Date: 9001 (Paleolithic, Lower); 9044 (Roman, Early); 9046 (Roman, Unspecified); 9051 (Islamic, Abbasid); 9053 (Islamic, Ayyubid); 9054 (Islamic, Mamluk); 9060 (Modern [1915–1950]); 9999 (Unspecified/Unknown Period)
Site Recommendation: The site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 40
Site name: Khirbetain Khuraiba/Approved
MIGA Number: 3190
Site location: Irbid – Bani Kenanah
Date: 9033 (Iron Age IIc)
Site Recommendation: The site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 41
Site name: Umm Arrujman
MIGA Number: 3173
Site location: Irbid – Bani Kenanah
Site Recommendation: The site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 42
Site name: ABU EL-LOQAS JADIS: 2322016
MIGA Number: 12638
Site location: Irbid – Bani Kenanah
Date: 9051 (Islamic, Abbasid); 9052 (Islamic, Fatimid); 9054 (Islamic, Mamluk)
Site Recommendation: The site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 43
Site name: IBDAR JADIS: 2223013, Khirbet Ibdir
MIGA Number: 2799
Site location: Irbid – Bani Kenanah
Date: 9047 (Byzantine, Early); 9049 (Byzantine, Unspecified); 9054 (Islamic, Mamluk); 9999 (Unspecified/Unknown Period)
Site Recommendation: The site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

Site No: 44
Site name: Malka JADIS: 2223016
MIGA Number: 11600
Site location: Irbid – Bani Kenanah
Date: 9044 (Roman, Early); 9047 (Byzantine, Early); 9048 (Byzantine, Late); 9049 (Byzantine, Unspecified); 9051 (Islamic, Abbasid); 9052 (Islamic, Fatimid); 9054 (Islamic, Mamluk); 9999 (Unspecified/Unknown Period)
Site Recommendation: The site is not threatened by project activities. Still, precaution should be considered and a chance find procedure should be adopted during construction phase.

7 STAKEHOLDER IDENTIFICATION AND ENGAGEMENT

7.1 Introduction

Stakeholders are identified as any individual and/or group that could be affected by the proposed project activities. According to this definition, stakeholders may include property owners, business owners, central government and local officials, special interest groups, local community and nongovernmental organizations.

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., EIB standards), stakeholder engagement activities have been an ongoing process throughout the ESIA process.

The stakeholder engagement activities carried out during this ESIA include:

- Identifying 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 relevant local communities

7.2 Identification of Project Stakeholders

The project stakeholder groups were identified and are presented in **Table 44**.

Table 44: Identified Stakeholder Categories

Stakeholder Category	Stakeholders
Internal Stakeholders	
Employees	This includes relevant WAJ female and male employees such as managers, engineers, technical staff, maintenance workers, secretaries, administrative personnel, etc.
Workers	Temporary and permanent workers at the project.
Operators	Operators responsible for the daily O&M of the water supply system.
Contractors/Subcontractors	Contractors and subcontractors working with WAJ on this project.
External Stakeholders	

Stakeholder Category	Stakeholders
National Government	MoE, Ministry of Energy and Mineral Resources, Ministry of Municipal Affairs, Ministry of Health, Ministry of Labor, Ministry of Transport, Ministry of Public Works and Housing, MoA, DoA, Jordan Standards and Metrology Organization
Local Government	Municipalities such as the Bani Kenanah municipalities.
Community Members	Community leaders employed men and women, farmers, males' and females' households, employed and unemployed labor force, youth, and students.
Trade	Trade association groups, cooperatives, credit institutions, banks, businesses, business owners, tourism, agriculture, private health businesses, and public services companies
Nongovernmental Organizations	This category includes local community-based organizations, local woman organizations, local cooperation societies.
International Agencies	This includes international funding agencies such as the EIB that are funding projects in the area.
Academic	Universities and Research Institutes.

7.3 Conducting a Scoping Session

The MoE sent invitations to all relevant stakeholders to invite them 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 **Annex A.**

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

- Actions to be taken to protect archaeological and tourism locations while taking into account the Urban Heritage Protection Law (5/2005) and the Antiquities Law, year 1988 and its revisions.
- Measures to assure that the project would be finished by a certain date to reduce the harm that could occur to a neighborhood as a result of the dust and noise caused by project activities.
- To provide the ESIA committee with a shapefile of all of the project's boundaries, as well as to provide more information and clearance distances for significant areas, particularly the Yarmouk Reserve.
- Develop a plan to remove trees present on the Sama and Hibras Reservoir plots and ensure MoA approval of the plan before construction begins.

The overall goal of the scoping session was to incorporate any concerns expressed by stakeholders into the various project phases. To ensure that the impacts are minimal and that no negative effects arise during or after the project, the aforementioned issues were analyzed and included in the assessment, where appropriate.

7.4 Consultation of Community Representatives in Bani Kenanah

The ESIA team made several visits to the Bani Kenanah area, in addition to holding the scoping session. The ESIA team developed a short questionnaire and reached out to local residents in various settings (e.g., commercial, educational, religious). Additionally, the team approached the landowners of the Sama and Hibras plots to get their opinions on the proposed project; however, the Sama Reservoir area owners were quite upset and refused to speak with the team. **Annex C** shows the questionnaire results.

7.5 Environmental and Socioeconomic Aspects and Receptors

After identifying all project-related receptors and preparation of the project description, the project-related environmental aspects can then be identified. The definition of environmental aspects adopted for this ESIA uses the definitions in International Organization for Standardization (ISO) 14001 Environmental Management. An environmental aspect is denoted where an activity has the potential to interact with the environment. A socioeconomic aspect can be considered to occur when an activity has the potential to interact with the social or economic environments.

To identify environmental, health and socioeconomic aspects for this project, project activities were identified through:

- Review of project feasibility study documentation
- Consultation with project proponents

The key input for the identification of receptors included:

- Policy and legal framework
- Environmental, health and safety, and socioeconomic baselines

7.6 Identification of Environmental and Socioeconomic Receptors

Table 45 provides a summary of the identified environmental and socioeconomic receptors within and in the vicinity of the project area.

Table 45: Identified Environmental and Socioeconomic Receptors

RECEPTOR	DEFINITION
Physical Environment	
Air Quality	The air quality at and around the project area.
Soil	The soils of areas in which project activities would occur.
Hydrogeology	The hydrogeology (i.e., groundwater) in the area in and around where the project activities would occur.
Hydrology	Possible surface water within the project area.
Landscape/Visual Impact /Topography	The geomorphologic landforms and terrain at the project sites.
Biological Environment	
Flora	Plant species that could potentially inhabit the areas in which the construction and operational activities would occur.
Fauna	
Birds	Birds that rely on the area as a habitat and/or food source.

RECEPTOR	DEFINITION
Reptiles	Reptiles that could potentially be present within or in the vicinity of the project area which might be affected by construction and operation activities of the project.
Mammals	Mammals that inhabit the environments in which construction activities are proposed to occur.
Health & Safety	
Workers	Construction and operation staff on the project site who will be subjected to occupational hazards and/or public health effects such as noise, dust, etc.
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 hazards such as noise, dust, etc. and accidents especially for children. This will be evaluated in light of the local social situation.
Socioeconomic Environment	
Population in the Vicinity of Activity	The population (people) that use the project area during construction activities and who require accessibility to community facilities (e.g., schools, hospitals). This will be evaluated considering the local social situation.
Land Use, Land Ownership/ Acquisition	Existing uses of the land areas in which the construction activities would occur. Traditional boundaries, access issues, permit requirements and distribution of any private and/or government-owned lands. Possibility for land acquisition for network expansion or building of new PSs.
Utilities and Infrastructure	The utilities (e.g., power supply, water services) and infrastructure (e.g., commercial, industrial, and leisure facilities) of areas in which the construction activities are proposed to occur.
Workforce	Impacts of new workforce on the project area during the construction and operation phases.
Transport	Road transport systems of the area in which the construction activities would occur.
Archaeology/Cultural Property	Archaeological sites and artifacts that have cultural significance (if found in within or in the vicinity of the project area).

7.7 Summary of Environmental and Socioeconomic Aspects

Based on the review of environmental and social aspects, project activities, and the project's environmental receptors, potential environmental impacts were identified. **Table 46** presents possible interactions between the environmental aspects and receptors relevant to this project.

Table 46: Summary of Environmental and Socioeconomic Aspects

Project Activity	Environmental Receptor/Potential Environmental Impact
Planned Project Activities	
Construction Phase	
Land Use and Land Acquisition	• Potential to occupy land, preventing its use for economic purposes by locals (e.g., olive trees). • Potential for public health and safety concerns.
Trenching and Excavation Works	• Potential for dust emissions and noise emissions. • Potential for spillage of fuel, oil, or waste with consequent risk to water resources and for aquifer contamination. • Landscape modification. • Potential for topsoil disturbance and erosion processes. • Visual/aesthetic impacts. • Potential impact on flora, fauna, terrestrial habitats, and/or IBAs (if present) within the project area. • Potential public health and safety impacts. • Potential disruption to businesses. • Potential traffic disruption. • Potential impact on existing utilities/infrastructure during construction work. • Potential employment opportunities in construction work. • Potential impact on archaeological and cultural heritage sites.
Solid waste (Spoil) Generation/Disposal	• Potential for soil disruption and impacts of surface water resources if present. • Potential for visual impacts. • Potential risk to flora and fauna if using unplanned disposal methods. • Potential risk of traffic accidents during transport. • Potential public health risk to project area residents. • Potential impact on archaeological and cultural heritage sites (if present).
Material and Chemical/oil storage	• Potential for air emissions • Potential impact on surface water resources if present • Potential for disturbance of shallow groundwater due to risk of fuel/oil spill • Potential for soil quality degradation • Potential of visual impacts • Potential for flora and fauna disturbance • Potential impact on public health and safety
Vehicle operation	• Potential increases in exhaust emissions from vehicles • Noise and vibration when in the proximity of environmental and social receptors • Potential for spillage of fuel, oil, or waste with risk to water resources • Potential for topsoil disturbance and erosion processes • Potential impact on flora, fauna, terrestrial habitats, and/or IBAs (potentially present) within the project area • Potential of impact on existing traffic within the project area • Potential impact on archaeological and cultural heritage sites (if present) • Potential impact on infrastructure/utilities in case of accidents • Potential impact on public health and safety

Project Activity	Environmental Receptor/Potential Environmental Impact
Equipment operation	• Potential increases in exhaust emissions from equipment use • Noise and vibration when in the proximity of environmental and social receptors • Potential for spillage of fuel, oil, or waste and consequent risk to soil and groundwater • Potential for topsoil disturbance and erosion processes • Landscape modification • Potential of visual impacts • Potential impact on flora, fauna, terrestrial habitats, and/or IBAs (potentially present) within the project area • Potential to occupy land, preventing its use for economic purposes by locals • Potential of impact on existing traffic within the project area • Potential impact on archaeological and cultural heritage sites (if present) • Potential impact on infrastructure/utilities in case of accidents • Potential impact on public health and safety
Access Roads (if needed)	• Potential for dust emissions and noise during use of access roads • Potential for topsoil disturbance • Potential increase in impacts on ground transport to newly accessed areas for construction activities • Potential impact on flora, fauna, terrestrial habitats, and/or IBAs (potentially present) within the project area • Potential for public health and safety implications • Potential impact on archaeological and cultural heritage sites (if present)
Operation Phase	
PSs	• Potential for noise • Potential for air emissions.
New Water Pipelines (Network)	• Reduce NRW, then reduce energy costs and increase water delivery efficiency • Adapt to climate change through water resources conservation • Increase served population • Positive impact on public health and living standards
Potential Accidental Events (Unplanned)	
Construction Phase	
Vehicle collisions and accidents with other infrastructure	• Potential for spillage of fuel, oil, or waste and consequent impact on soil and water resources • Potential disturbance to flora and fauna. • Health and safety risk for project area residents and workers • Potential impact on infrastructure and transport system • Potential impact on archaeological and cultural heritage sites (if present)
Spill of chemicals or liquid fuels	• Potential air emissions • Potential for disturbance of surface water and shallow groundwater • Potential for soil quality degradation, preventing its use for economic purposes by locals • Potential risk to public health • Potential for flora and fauna disturbance • Potential impact on existing infrastructure

Project Activity	Environmental Receptor/Potential Environmental Impact
Ignition of flammable materials/accidental fires	• Potential for hazardous emissions • Potential for noise generation and disturbance of environmental and human receptors • Potential disturbance to flora and fauna • Potential risk to workers and project area residents • Potential of damage to transport, machinery, and general equipment • Potential impact on archaeological and cultural heritage sites (if present)
Operation Phase	
PS power failure/malfunction problems/emergency overflow	• Potential risk to public health and employee safety
Water pipeline rupture and leakage	• Potential damage to adjacent structures • Potential subsidence of roads • Potential risk to public health

7.8 Identifying Environmental, Social, and Health Aspects

Identified project activities and legal, environmental, and socioeconomic receptors have been integrated into matrices with the activities on the y-axis and receptors on the x-axis. Each matrix was subsequently assessed to identify every possible case of potential activity-receptor interaction. A summary list of project activities and their potential environmental and socioeconomic impacts are presented in **Table 47**.

Table 47: Environmental and Socioeconomic Aspects and Receptor Matrix

Activity \ Receptor		Physical					Biological			Health and Safety	Socioeconomics					
		Atmosphere	Noise	Soil and Groundwater	Hydrology (Surface Water)	Visual Amenity and Landscape /Topography	Flora / Habitats	Birds	Reptiles and Mammals	Workers/Area's Residents and Land users	Population/ Resettlement	Workforce and employment	Land Use/ Ownership	Utilities / Infrastructure	Transport	Archaeology / Cultural Property
Planned Project Activities																
Construction	Land Use and Land Acquisition	●	●	●	●	●	●	●	●	●	●		●			
	Trenching and Excavation Work	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Solid Waste Generation/Disposal	●		●	●	●	●	●	●	●		●	●	●	●	●
	Material and Chemical/Oil Storage	●		●	●		●	●	●	●			●			
	Vehicle Operation	●	●	●		●	●	●	●	●		●		●	●	●
	Equipment Operation	●	●	●	●	●	●	●	●	●		●	●	●	●	●
	Project Offices/Worker Accommodations (if required)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	

Activity \ Receptor		Physical					Biological			Health and Safety	Socioeconomics					
		Atmosphere	Noise	Soil and Groundwater	Hydrology (Surface Water)	Visual Amenity and Landscape /Topography	Flora / Habitats	Birds	Reptiles and Mammals	Workers/Area's Residents and Land users	Population/ Resettlement	Workforce and employment	Land Use/ Ownership	Utilities / Infrastructure	Transport	Archaeology / Cultural Property
Operation	PS	●	●		●	●		●	●	●		●				
	New Main Pipeline									●				●		
Unplanned Project Activities																
Potential Accidental Events (unplanned) during Construction Phase	Vehicle Collisions	●	●	●	●		●	●	●	●				●	●	●
	Spill of Chemicals or Liquid Fuels	●		●	●	●	●	●	●	●	●		●	●	●	●
	Ignition of Flammable Materials/Accidental Fires	●	●			●	●	●	●	●	●		●	●	●	●
Potential Accidental Events (unplanned) during Operation Phase	PS Power Failure/Malfunction	●		●	●	●				●						
	Pipeline Rupture and Leakage	●	●				●	●	●	●				●	●	

8 ANALYSIS OF PROPOSED PROJECT ALTERNATIVES

The analysis of project alternatives is one of the requirements of environmental impact policy and procedures worldwide. The assessment of alternatives from an environmental and social standpoint is one aspect of the ESIA that contributes to improvement in decision-making. By considering various alternatives prior to the commencement of project activities, the environmental and social project benefits can be maximized, and potential challenges can be identified and addressed.

This part of the ESIA evaluates the potential effects of implementing the proposed project versus the "No Project" alternative to determine which is the more environmentally and socially sound alternative

8.1 "No Action" Alternative versus the Proposed Project

The "No Action" alternative considers 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 proposed project to enhance and reinforce the water system in Bani Kenanah. The environmental and social parameters used in comparing the alternatives included physical parameters (i.e., air, noise, water resources, topography, and soil), ecological resources, socioeconomic impacts, public health and safety, social acceptance, infrastructure impacts, land use, and cultural heritage aspects. Results of this evaluation are presented in **Table 48,** which represents the comparison of the no project alternative versus the operation phase of the proposed project.

Table 48: Comparison of Potential Impacts by Alternative

Environmental and Social Components	Project versus No Project	
	Proposed Project	No Action Alternative
Air Quality	*	*
Noise Generation	*	*
Waste Generation/Disposal	X	*
Topography, Geology, and Soils	*	*
Water Resources	S+	S-
Visual Impacts	*	*
Ecological Resources during Operation Stage	S+	*
Socioeconomic Impacts during operation stage	S+	S-

Environmental and Social Components	Project versus No Project	
	Proposed Project	No Action Alternative
Public Health and Safety	S+	S-
Traffic Disturbance	*	*
Other Utilities/Infrastructure	*	*
Archaeology/Cultural Property	*	*

Symbols indicating the overall evaluation of the specified environmental component and social aspects:

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

Although the construction phase of the proposed project will include disruptions to air quality, noise levels, and traffic within the project areas, these will be temporary impacts limited to the construction phase of the project and would be eliminated once the proposed project is in its operation phase.

The operation of the proposed project would eventually enhance public health and ecological resources. Therefore, although going through with the proposed project could lead to certain impacts on the environment and social aspects within the study area due to project construction activities, those impacts can be mitigated and their significance minimized. In addition, the proposed project is regarded to be of high value to communities within the study area once the operational phase starts.

Furthermore, the proposed project cost benefit is shown in **Table 49**:

Table 49: Proposed Project Cost Benefit

Activities	Cost / percent
Current NRW %	**48%**
Expected NRW % after project execution	**20%**
Current production (m^3/year)	**4,100,000**
Current amount of NRW (m^3/year)	**1,968,000**
Expected NRW amount after project execution (m^3/year)	**820,000**
Total amount of saved water (m^3/year)	**1,148,000**
Total energy cost of saved water (JOD/year) *	**1,469,440**

8.2 Water Supply Options

The current small diameter pipes, high pressures, a lack of reservoirs or reservoirs with insufficient storage, highly unequal water availability, and intermittent supply, have impacted the efficient operation of the existing water system. As a result of these factors, the rate of NRW is high and uncontrollable. The system experiences severe head losses. Pipe breaks are growing increasingly common, wasting energy, incurring greater expenses, and making supply and operation difficult to manage. The distribution and availability of water are very unequally distributed and customers who receive less water from the distribution system must rely on tankers, which increases their water costs.

Three supply options from the Zabda Reservoir were analyzed to determine which option would be both economically realistic and operationally manageable. The options are determined primarily by the pipeline's size; although, the pipeline's path would be the same for all supply options.

- Supply Option 1: 7 Days of Supply from Zabda Reservoir
- Supply Option 2: 4 Days of Supply from Zabda Reservoir
- Supply Option 3: 2 Days of Supply from Zabda Reservoir

The three supply options were analyzed with all options providing the same amount of water to Bani Kenanah. The only difference would be the supply duration. The project feasibility study concluded that Supply Option 1 is the most advantageous and proposed this option because it:

- Requires the least capital investment.
- Provides the best useof the primary and secondary pipelines and provides the optimum value for investment.
- Provides a flexible system and easy response to emergencies. Any failure in any one day can be easily recovered throughout the week.
- Requires the minimum storage for emergency use.

Although Supply Option 1 was the best option financially, it was not practical from the operational aspect. Zabda reservoir is used to supply different areas in Irbid Governorate and it would be difficult to allocate supplies for 7 days per week to Bani Kenanah. Therefore, WAJ selected Supply Option 2 as the most practical option.

8.3 Routing Alternatives

In general, the proposed water pipelines are located inside ROWs to roads, footpaths, and wadis. Routing alternatives were assessed by the design team, considering the following technical considerations:

- Topography (with a preference given to flow by gravity, where possible)
- Ease of construction
- Minimizing conflicts with proposed and existing utilities to the extent possible, although it would be the contractor's responsibility to undertake a detailed survey of these utilities
- Minimizing impacts on potential developments
- Land acquisition and right-of-way considerations

Reservoirs and the Pump Station Site Alternatives

The locations proposed for the reservoirs were chosen to improve the design of the water networks that would be supplied by these reservoirs. The locations were identified to decrease technical losses and electrical energy consumption associated with pumping by supplying the networks by gravity.

Two locations were chosen for the reservoir land. The primary factors for choosing the reservoir land were the availability of undeveloped land with a large enough area for the purpose, the elevation of the site to generate enough pressure to supply the targeted locations, and the position of the land with relation to the supplied places. Using this criterion made it possible to choose the best option.

8.4 Potential Environmental, Social and Health Impacts

This section identifies, and where appropriate quantifies, the primary environmental and social impacts expected to result from construction, rehabilitation, expansion, and operation of the Bani Kenanah water supply system. Impacts on various environmental and social aspects due to project activities were assessed in terms of their potential to cause an impact. Further, the impact significance was assessed considering the consequence and likelihood of the impact. The methodology employed for ranking the impact significance is presented in the final ToR report, which was approved by MoE (**Annex A**).

The primary objectives of the impact assessment are to:

- Identify the potential impacts that may occur because of the project activities being undertaken and establish their significance.
- Differentiate between those impacts that are insignificant (which can be sustained by natural or socioeconomic systems) and those that are significant (which cannot be sustained by natural or socioeconomic systems).

The impacts due to project activities are also discussed for the physical, biological, and socioeconomic environments as well as for unplanned project activities.

8.5 Potential Impacts on the Physical Environment

The main impact of constructing pipelines in the project area would be stress on existing infrastructure, disruption to commercial entities, traffic disruption, temporary visual impacts, and the increased risk of accidents occurring during construction, in addition to air emissions and noise.

The potential impacts on air, noise, land, water, and aesthetic environments are discussed further in this subsection.

Air Quality and Dust

Construction

Equipment and Vehicle Emissions

Construction activities are likely to generate some dust and gaseous emissions near the proposed project (i.e., PM_{10}, NO_2, SO_2, CO, and CO_2, which is one of the greenhouse gas [GHG] emissions). In this study, construction emissions were estimated for the on-site construction equipment engine exhaust.

A summary of the equipment, motor vehicles, and emission factors (EFs) required for on-site construction are shown in **Table 50** and **Table 51**. Construction emissions were based on the methodologies contained in the SCAQMD CEQA handbook (2006) and the USEPA AP-42 guidance.

Table 50. Construction Equipment Emission Factors

Equipment	No. of Equipment	EF (lb/hr)				
		PM_{10}	NO_x	SO_2	CO	CO_2
Excavator	8	0.48	9.104	0.0584	4.168	960
Loader	7	0.581	5.712	0.0245	3.192	763
Crane	3	0.156	3.069	0.0177	1.278	387
Compactors	7	1.127	22.54	2.254	7.889	NA
Concrete Mixer	As needed	0.0018	0.046073	0.0001	0.038591	6.3
Asphalt Finisher	As needed	0.005402	0.142351	0.000237	0.076832	18.7

Table 51. Motor Vehicle Emission Factors during Construction

Vehicle Type	No. of Vehicles	EF (lb/hr)				
		PM_{10} (Exhaust)	NOx (Exhaust)	SO_2 (Exhaust)	CO (Exhaust)	CO_2 (Exhaust)
Trucks	8	0.3672	10.6576	0.0216	4.6648	2,080
Pickups	20	0.918	26.644	0.054	11.662	5,200
Passenger Vehicles	30	3	6	0	64.8	120

These exhaust emissions are likely to disperse rapidly into the atmosphere, and as presented in section 6, there is no current exceedance to the local standards; therefore, the local degradation of air quality during construction is considered to be **Medium** significance **(6)** with a **Marginal** consequence **(2)** and the likelihood of **Likely (3).**

Dust Emissions

Construction activities would potentially generate dust from activities such as ground clearing and earthwork including trenching, levelling, site construction, and surface restoration work. The major dust sources would be from movement of vehicles over unpaved areas within the proposed pumping station site and along the pipeline network easements and from vehicles transporting material and equipment to the work areas. Under normal meteorological conditions, dust impacts would be limited to within close proximity of the project site. However, under strong wind conditions, these effects could extend further and may impact nearby sensitive receptors that are near the construction area.

Typically, only wind-blown dust is considered a nuisance to those residents exposed and to the agricultural areas. Hence, it can be considered that the receptors are the passers by and those living and working near the areas undergoing excavation and trenching. These include mainly residents, businesses, mosques, and schools, in addition to construction workers and employees working within a construction area. In addition, dust generation can affect the ability of nearby vegetation to survive and maintain effective evapotranspiration, especially at agricultural areas.

Dust generation may potentially impact cow and sheep in the barns near the project area, especially along the primary pipeline, particularly where construction would be undertaken near the barns' entrances. Dust could potentially affect the animals; therefore, the contractor should coordinate with the barns' owners prior to starting construction to avoid any nuisance and consider moving the animals to a different location.

Considering the short duration of construction activities at a given location, it is not anticipated that dust levels will greatly impact the existing sensitive receptors within the adjoining areas provided mitigation measures are implemented properly.

Because the impact consequence is **Critical (3)** and the likelihood is **Likely (3)**, the impact significance is assessed as **Medium (9).**

Operation

During normal operation conditions, emissions from the water pipeline network are not anticipated. Although some nuisance would occur through the maintenance work for the pipelines and/or the PS at the Sama Reservoir.

Noise

Construction

Site preparation activities such as site excavation, transportation of equipment and materials to and from the site through the surrounding road network, and installation of project facilities, would contribute to noise generation that would impact adjacent facilities and local communities. Some examples of adjacent facilities and local communities are any occupied premises outside a residence (including gardens), places of worship, educational establishments, hospitals or similar institutions, or any other property likely to be adversely affected by an increase in noise level. However, noise exceedances from the construction vehicles, machinery, and equipment would be limited to the construction period and would be of short-term duration at any one location.

The maximum average noise daytime and night-time levels recorded within the site were 61.5 dBA and 52.4 dBA, respectively. The recorded averages were found to be lower than the maximum allowable noise limits of 65 dBA for daytime and 55 dBA for night-time provided by the Jordanian Instruction for the Prevention and Elimination of Noise, year 2003.

The noise levels of construction equipment and machinery are likely to exceed the allowable noise limits mainly at trenching locations. However, this may cause noise disturbances to local users and identified sensitive receptors, such as residences adjacent to the reservoir locations, schools, mosques, medical clinics, and animal farms. Because there would be no nighttime work, noise impacts would only occur during daytime construction hours. Noise levels decrease with distance from the noise sources, so the extent of the impact would be limited.

The contractor will consider all nearby sensitive receptors identified and any other additional receptors identified by the contractor on-site such as schools, mosques, medical clinics, churches, etc. and will try to schedule the more noise-intense activities for less intrusive times such as midmorning or afternoon to avoid complaints and potential annoyance to people living or working adjacent to the construction sites.

Construction activities would occur under normal operating conditions and are expected to have a localized effect with intermittent breaches of statutory or prescribed limits mainly resulting in noise impacts within the neighborhood’s immediately adjacent to the work area.

Because the impact consequence is **Critical (3)** and the likelihood is **Very Likely (4)**, the impact significance is assessed as **High (12).**

Operation

In the operation phase, the water pipeline network itself is inherently quiet under normal operational conditions. Because the impact consequence is **Negligible (1)** and the likelihood is **Very Unlikely (1)**, the impact significance is assessed as **Negligible (1).**

For the new PS at Sama Reservoir, slightly elevated noise levels might be perceived at the generator room or pumping room, or when emergency back-up generators are used during a power mains failure. As the PS buildings would be fully enclosed and generators would be located within separate generator rooms, potential noise impacts due to operations are expected to be limited to within the PS compound. Therefore, there would be a low impact on neighboring areas, residents, and businesses. Because the impact consequence is **Marginal (2)** and the likelihood is **likely (3)**, the impact significance is assessed as **Medium (6)**.

Land and Soil

Construction

Removal of soil in the alignment for the proposed pipeline network during construction and construction activities in some erosion-prone areas would be unavoidable. There would be a potential for erosion to result from surface water runoff, which would largely be confined to episodic intense rainfall events. This would be considered a temporary impact.

Because the impact consequence is **Marginal (2)** and the likelihood is **Likely (3)**, the impact significance is assessed as **Medium (6)**.

Soil pollution in the construction area is considered a local impact and may occur from accidental leakage of chemicals or fuel or oil products, particularly if such materials are not properly stored. Therefore, disposal of hazardous products including disposal of oils must be according to legal requirements. The proper implementation of the proposed mitigation measures would reduce the magnitude of the potential impact.

Because the impact and the likelihood are **Likely (3),** with a **Marginal (2)** consequence, the overall impact significance is considered **medium (6).**

Operation

During normal pipeline operation, potential consequences to soil would be negligible. However, in the case of pipeline emergencies such as leaks or rupture of the pipeline, maintenance and repair operations may lead to disturbances in the area. Such incidents would be localized and are considered **Unlikely (2),** but if the impact occurs, it will cause a **Marginal (2)** consequence. As a result, the impact significance is considered **low (4).**

Water Resources

Construction

Wastewater from construction sites can be divided into construction site surface runoff, wastewater from vehicle washing, wastewater from site toilets and facilities, and wastewater from civil work. Discharge of untreated or contaminated wastewater from construction sites could cause damage to the ecosystems in downstream waterbodies. The contractor should protect the construction site from the identified risks of spills, contamination, or misuse of materials during pollution-risky activities and use temporary sanitary facilities provided at site so sanitary wastewater or sewage is collected and disposed of properly.

Water supply network construction activities could lead to existing sewer line damage, resulting in the release of untreated wastewater, which would then be a major source of soil and groundwater pollution. This impact would be indicated by the presence of bacteriological contamination. Prior to excavation, interference with existing water and sewer infrastructure would be identified by the contractor and the existing water and sewer infrastructure would be protected, supported, and maintained in place throughout the duration of work. All construction activities would be undertaken without affecting other infrastructure or utilities.

Spills of chemicals or oils on-site is possible if such materials are improperly stored or handled. The primary reason for spills is a lack of education to workers on proper storage and handling methods. Spills of chemicals and oils at construction sites, in addition to contaminating the land, can also lead to contamination of groundwater (in construction areas) during rainfall events. Groundwater can be contaminated by infiltration of rainwater that washes contaminants through the soil.

To prevent such accidents, necessary measures would be implemented (i.e., complying with a spill prevention and response plan to avoid spillage of such material to the ground because it might eventually reach groundwater). In addition, management of excavated and construction material is essential during rainfall events because construction wastes can contaminate water quality by carrying such wastes to surface waters along with the generated runoff.

Because the impact consequence is **Critical (3)** and the likelihood is **Likely (3),** the impact significance is assessed as **Medium (9)**.

Operation

The pipeline network's normal operation would pose no threat to Bani Kenanah groundwater resources. Furthermore, the infrastructure rehabilitation and replacement of the water supply system for the Bani Kenanah District would minimize NRW. The current water system has a high NRW percentage (estimated at 48 percent), which does not (legally) benefit the public. With the proposed project, NRW would be reduced to approximately 20 percent and energy consumption associated with water pumping would also be reduced.

As a result, the proposed project is anticipated to have a **Positive (+)** impact.

Waste Generation and Disposal

Construction

Construction activities would generate non-hazardous and hazardous types of waste at construction sites, which if not appropriately managed, would lead to impacts on soil, water, the visual environment, and affect the health and safety of construction workers and the public.

Non-hazardous construction waste includes excavated excess spoils, plastic, paper, domestic waste, and domestic wastewater. Hazardous construction waste includes empty chemical containers and waste oil.

All waste generated at construction sites would be managed in accordance with the Contractor's Waste Management Plan. Domestic wastewater generated at site would be collected in storage tanks. These must be transported to the nearest approved municipal wastewater treatment facility, after the completion of construction activities in each specific area.

Because the impact consequence is **Marginal (2)** and the likelihood is **Likely (3),** the impact significance is assessed as **Medium (6).**

Operation

Waste generation is considered as an insignificant impact during operation phase of the project because there would be a very small number of workers involved in operations.

Aesthetics

Construction

For most of the pipeline route, the pipeline would be located within or adjacent to existing road ROWs. In these areas, the visual effects of the construction would not be significant or long term. Road ROWs are already visually complex environments with a lot of vehicles, equipment, and materials visible. In addition, the construction activities would be of relatively short duration at each location.

Potential waste generated from construction activities would consist mainly of non-hazardous combustible wastes such as paper, wood, and cardboard, which biodegrade at a relatively slow rate. In addition, construction activities would also generate scrap metals, debris generated during excavation of trenches, and garbage because of littering in project area. These wastes may pose aesthetic impacts if not managed and disposed of in a regular manner as per the proposed procedures in the contractor's Construction Environmental Management Plan (CEMP).

Because the impact consequence is **Marginal (2)** and the likelihood is **Likely (3)**, the impact significance is assessed as **Medium (6)**.

Although some roads/areas would be disturbed during excavation for trenches during construction, this would be a temporary issue, and the contractor would be obliged to restore the pavement/surface to be compatible with adjacent undisturbed pavement/surface.

Because the impact consequence is **Marginal (2)** and the likelihood is **Likely (3)**, the impact significance is assessed as **Medium (6)**.

Operation

Once the water network is operational, no aesthetic impacts are anticipated. Therefore, this is considered an insignificant impact during operation.

Potential Impacts to Flora and Fauna

Construction

Project activities that may potentially cause an impact on ecological resources (flora, fauna, and other habitats within the project area) during the construction phase would include:

- Trenching and excavation work
- Waste generation and disposal
- Littering in the construction areas
- Materials, chemicals, and oil storage and disposal including accidental spills of chemicals and liquid fuels, ignition of flammable materials, and/or accidental fires
- Vehicle and equipment operation
- Potential removal or trimming of trees or shrubs within the construction areas

Priority biodiversity features are a subset of biodiversity that are particularly irreplaceable or vulnerable, but at a lower priority level than critical habitats. Some fauna and flora species reported from the site have conservation status according to the International Union for the Conservation of Nature Red List. If proper mitigation measures are followed, then potential for negative impacts on these species would be minimal and negligible.

The project area includes part of the Yarmouk PA and is close to IBAs. Part of the project would be inside deciduous oak forest vegetation community, which supports several species with conservation status. In addition, this type of vegetation is highly degraded due human activities, and it is recommended that work inside this vegetation type be limited to minimal extents and that mitigation measures be implemented. The proposed project would not further fragment, convert, or degrade habitats to the extent that their ecological integrity or biodiversity importance would be compromised. Therefore, the proposed project would have a low negative impact on biodiversity aspects and it is not anticipated that the project would have an adverse impact on these areas.

Most of the project activities would be mainly in urban areas and along road ROWs, while a very small part of the proposed activities would be outside urban areas and limited to small areas along the project. the project would not be expected to have a negative impact on vegetation cover because the area is already highly disturbed.

The potential for a negative impact on biodiversity if proper mitigation measures are considered would be minor. For the work that would take place in Malka, Mansoura, and Um Qais (the part inside Yarmouk PA), close coordination with the Yarmouk PA management would be required.

Flora

The recorded flora species in and adjacent to the proposed project area is considered to be common species frequently found in similar habitats in other parts of the country. Some species have conservation status, those species should be closely observed and protected during construction. Work inside urban areas would not be expected to have high negative impact on flora, because the area is already highly disturbed. Construction of the pipeline network would involve clearance and removal of some vegetation resulting in a permanent loss of vegetation. The project should avoid cutting trees as much as feasible, especially oak trees.

Work around or within Yarmouk PA should be coordinated with the protected area management and the project should avoid any vegetation clearance as much as is feasible. If vegetation removal is required, the contractor staff would need to coordinate with the PA management and follow their instructions.

Terrestrial Fauna

No significant impact would be expected on fauna species except for disturbance from construction noise and excavation activities. Some fauna species would tend to leave the area due to construction-related disturbances; however, such activities would be in very limited areas, generally inside urban areas, and would not affect a large diversity of fauna species. Movement of machinery may result in an accidental killing of fauna species.

The proposed project activities would be limited to small areas inside urban areas that would not be expected to have negative impact on IBAs.

Sensitive Habitats

As mentioned above, some activities would take place near and inside Yarmouk PA, these activities are not expected to have high negative impact on fauna, flora, and habitats, if mitigation measures are followed with full coordination with the protected area management.

Because the impact consequence is **Marginal (2)** and the likelihood is **likely (3)**, the impact significance is assessed as **Medium (6).**

Operation Phase

Flora

No significant impact is anticipated during the operation phase.

Terrestrial Fauna

Terrestrial fauna in Jordan has a very wide distribution; however, the project activities of the supply water network during the operation phase would not be expected to have an impact on fauna species.

Sensitive Habitats

No significant negative impact on sensitive habitats would be expected during the operation phase.

8.6 Social and Health Impact Assessment

Construction Phase

As with any other construction project, most of the people interviewed understood that there would be noise and pollution issues. However, because of the temporary nature of the construction work and expected project benefits, residents reported actually looking forward to the construction work to start. As with all other negative impacts related to construction work, participants asserted throughout their interviews that any effects resulting from construction work are temporary, expected, and well known to the community.

The interviewed local communities knew that construction works pose a nuisance in general, but they could be tolerated because a more reliable water supply network is a worthy outcome. The necessary minimization measures, as prescribed in the ESMP or dictated by MoE and MWI, would alleviate possible disturbances and hazards.

Residential Environment

The proposed project construction could impede access to services such as infrastructure services (e.g., garbage truck and water tanks) and emergency services (e.g., ambulance, emergency response). In addition, the construction schedule could coincide with critical times for households, which would cause stress for the entire households primarily because of noise impacts. One example would be noise and construction affecting students during exam periods, where increased noise levels would cause stress for students and impede their ability to concentrate.

Mobility of Individuals

Mobility is considered one of the areas in residents' lives that could get impacted significantly during the construction phase. Community members may have to change their routine routes to avoid construction sites and trenches and avoid laborers, noise, or unsafe routes.

The mobility of vulnerable people, such as children, women, elders, and people with disabilities, would be expected to be restricted to some extent during construction. Although impacts on mobility affect all people, the impact significance would be greater for vulnerable populations. Because of trenches, rubble, detours, noise, and dust, it is expected that there would be a high probability for people to need to change their routes because the street could become less accessible for pedestrians and cars.

Community Safety

Community safety is one of the most significant impacts when it comes to construction works for a water supply system. Open trenches and earth fill create hazards in streetscapes that could pose a direct threat to the physical safety of individuals. Children and students could be the most vulnerable to such threats.

Gender Based Impacts

Some of the potential impacts could have more adverse effects on women than they do to men:

- Females' ability to access neighborhood markets around the construction trenches
- Housewives' ability to access neighborhood markets around the construction site workers

- Females' ability to socialize during the day in the neighborhood around construction sites
- Females' ability to maintain free mobility for their daily routines (study, work, socialize, shop, and other activities)
- Females' ability to complete domestic chores among construction dust
- Females' ability to conduct domestic chores in case of sudden electricity and\or water outages
- Females' ability to conduct domestic chores among construction noise and ground vibrations
- Female community members' need to change routine routes to avoid construction trenches
- Female children's safety in walking to and from school around construction trenches
- Female children's safety walking to and from school around construction workers

Economic Impacts

During construction of the proposed project, some utility lines may be accidentally damaged, cutting off service that would result in some economic impacts on households including the following:

- **Damage of household electrical appliances due to sudden outages and restarts in electricity**, which could damage some valuable household appliances (e.g., refrigerator or water heater).
- **An increase in the household's water budget** — if water utility lines were to accidentally break because of construction work, households would be obliged to purchase water from private tanks.

Community Businesses

Weak construction site cleanup and management would have an impact on commercial facilities and community businesses because if construction areas are not cleaned correctly, they can generate dust and other pollutants that can have a detrimental impact on the items in stores and on safe passage and access to the stores, especially for children and women. Electricity blackouts or accidental outages due to construction activities are also a major concern because most shops rely heavily on freezers and electrical equipment, and blackouts can cause catastrophic electrical damage to these machines and/or to the goods.

Noise and vibration from clearing, grading, trenching, and other site works are anticipated to impact commercial facilities and activities significantly and directly in the project area.

Business owners who rely heavily on car traffic for their transactions would be impacted by road closures and reduced traffic to their operations. Therefore, road closures could greatly affect these commercial facilities and cause financial loss.

Agricultural Impacts

Cutting trees or destroying some bushes, crops, or vegetables along the pipeline routes may occur during construction. The contractor would need to compensate farmers and residents for the value of trees, and it is recommended that plants, particularly olive trees, be transplanted as much as possible in neighboring locations.

Potential Impacts Due to Land Acquisition

Although the project would result in a significant benefit to the entire population of Bani Kenanah District, its implementation would entail some negative impacts on some of the landowners. This is due to the need to expropriate the land for the proposed reservoirs and the new PS.

Socioeconomic Impacts During Operation Phase

Benefits to Local Communities

Improvements to the water supply network would reduce the level of supply interruption that local communities currently experience, where the insufficient public supply forces residents to buy water from tankers on a frequent basis. By improving the service quality and reliability, the project would benefit people at all levels of society. It would also improve the lives of women, who are generally in charge of water supply issues at home. In addition, commercial and industrial activities would benefit as result of the project.
The proposed project is expected to have **a positive (+)** impact on the local community members in general.

Benefits to the Economy

The main expected economic benefits of the project include the following:

- Water savings by reducing NRW from 48 percent to 20 percent, with a resulting annual energy cost savings of 1,469,440 JOD.
- The water supply system would use gravity rather than the four existing pumps (i.e., Harima, Malka, Syfeen, and Kufur Asad), which would result in an annual energy cost savings of 1,200,380 JOD.
- Savings in maintenance costs due to the improvements and rehabilitation of the existing infrastructure.

It is expected that the proposed project would have a **positive (+)** impact on the economy.

Benefits to Bani Kenanah Water Resources Sustainability

According to a BGR/GIZ study for the Bani Kenanah Wellfields, all the wells will be nearly depleted by 2025, and water will be sourced mostly from the Wehda Wellfield and the Zabda Reservoir. Throughout the 2035 design horizon, the estimated annual production capacity of the wellfields will not be sufficient to supply the expected demand of the Bani Kenanah areas. As a result, the Zabda Reservoir would cover the predicted gap between demand and available quantities from local resources.

It is expected that by implementing this proposed water supply system to Bani Kenanah, the region’s water supplies would be sustained through to the 2050 design horizon.

The proposed project is expected to have **a positive (+)** impact on the sustainability of water resources.

Sama and Hibras Reservoirs and the Pump Station

During normal reservoir and PS operation, potential consequences to air quality and noise are regarded negligible. However, in the event of maintenance work, there may be some air emissions, spills or leaks, noise, and other typical construction-related impacts in the adjacent area. However, such incidents would be localized and considered **likely (3),** but if they occur, they will cause a **Negligible (1)** consequence. As a result, the impact significance is considered **low (3).**

Health and Safety Impact Assessment

Potential Impacts on Local Community Health and Safety during Construction

The proposed water network would have positive safety and health effects on the local community such as:

- Covering unserved households and areas in Bani Kenanah
- Protection of public health and the environment and improvement in the quality of life

During the construction phase some negative impacts would occur. Examples of the potential negative impacts are:

- Air pollution caused mainly by releasing suspended particulates that can exacerbate respiratory ailments
- Noise pollution due to operation of heavy equipment that interferes with communication and sleep, especially for sick people and children
- Road closures and detours may create traffic problems that may result road and traffic accidents
- Soil disturbance
- Infrastructure disruption

The local residents, business owners, employees, and children, or any other users in the area may be subject to potential injuries if there are no proper safety measures on trenches, or signage/safety barriers around excavation works. Therefore, it is the responsibility of the contractor to put warning signs, barricades and lighting to prevent accidents. The contractor would also be required to train and supervise workers, provide first aid kits, provide a separate storage area for hazardous materials, prepare a health and safety plan and CEMP specific to the project's construction activities.

These impacts would be limited in place (construction areas) and in time (just for the duration of construction in each location).

Implementing the proper mitigation measures, the provision of safe and healthy working conditions on-site, and ensuring that workers are complying with the CEMP and other relevant Jordanian laws and regulations would reduce the impact significance.

Because the impact consequence is **Critical (3)** and the likelihood is **Likely (3)**, the impact significance is assessed as **Medium (9).**

Potential Impacts on Occupation Health and Safety during Construction

There is a potential health and safety risk to workers and possibly the public within or surrounding the construction area.

Workers' risk of exposure to injuries may occur because of potential accidents such as falls, lack of proper handling of materials on-site, trenching, and improper shoring, maneuvering of construction equipment and machinery, operation of transportation vehicles, and generation of airborne dust. It is worth noting that the Jordanian Labor Law No. 8 for the year 1996 and its amendments mentions that when an employee is stricken 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 compensation 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.

Because the impact consequence is **Critical (3)** and the likelihood is **Likely (3)**, the impact significance is assessed as **Medium (9).**

Implementing the proper mitigation measures, the provision of safe and healthy working conditions on-site, and ensuring that workers are complying with the CEMP and other relevant Jordanian laws and regulations would reduce the impact significance.

Potential Impacts on Occupational Health and Safety During Operation

In terms of occupational health and safety, it is important to ensure that the O&M personnel are carrying out regular technical checks and are made aware of potential health effects that could occur on-site. This can be done through proper training and capacity programs.

Because the impact consequence is **Critical (3)** and the likelihood is **Likely (3)**, the impact significance is assessed as **Medium (9)**.

Potential Impacts to Cultural Heritage and Archaeological Sites

The field survey, investigation, and assessment resulted in a finding of no archaeological sites within or under direct threat by the proposed Bani Kenanah water project and its associated construction or activities. However, precautionary and management measures should still be implemented regarding the need to conserve any chance-found sites during construction activities. Minor and indirect impacts are also not expected. Indirect impacts may be avoided by implementing the recommendations mentioned in the ESMP.

The proposed mitigation plan will present means to reduce potential negative impacts on the archaeological sites if any are discovered or found during the construction phase by defining site-specific protective measures and a management framework necessary to minimize project-related damage to cultural resources located within project area for each specific site, if found.

Because the impact consequence is **Marginal (2)** and the likelihood is **likely (3)**, the impact significance is assessed as **Medium (6).**

Greenhouse Gas Impacts

Considering Jordan's power emission factor of 0.67 tCO2eq/MWh (Jordan second national communication, MoE, 2009.), eliminating the four PSs in the proposed project would lower energy consumption and lower the total GHG emissions and the pumping cost for the Bani Kenanah water supply system over the project lifetime. **Table 52** shows the annual saved GHG emissions from the proposed project.

Table 52: The Annual Saved GHG Emissions and the Pumping Cost for the Bani Kenanah Water Supply System

PS	Annual Production m^3	Q (m^3/hr)	H (m)	Annual Power Consumption (kW)	Annual Power Cost (JOD)	Annual tCO^2 Reduction
Harima	1,270,000	180	200	1,546,358	170,099	1,036.1
Malka	2,331,000	260	220	3,122,061	343,427	2,091.8
Syfeen	2,331,000	260	220	3,122,061	343,427	2,091.8
Kufur Asad	2,331,000	260	220	3,122,061	343,427	2,091.8
Total				10,912,541	1,200,380	7,311.5

A Climate Change Management (CCM) table for the proposed Bani Kenanah water supply is provided in **Annex B.**

9 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The project developer is committed to achieving and maintaining environmental standards, such that Jordanian environmental regulations and EIB guidelines are met and potential adverse environmental impacts resulting from the project activities are minimized as practicably as possible. This will be achieved through appropriate project planning and methods of project operation. Implementation of ongoing environmental monitoring programs will enable the assessment and modification, if required, of the Environmental Management program.

9.1 Objectives

This ESMP establishes the mitigation and monitoring measures presented in **Table 53** and **Table 54** that are needed to reduce the various environmental and social impacts due to the proposed project. The key objectives of the ESMP are to:

- Minimize any adverse environmental, social, and health impacts resulting from the project activities.
- Conduct all project activities in accordance with relevant Jordanian Legislation and applicable EIB guidelines.
- Implement ongoing environmental and social monitoring program.
- Include an environmental and social safeguards framework embedded in the ESMP to monitor the implementation of mitigation measures and propose relevant performance indicators.
- Periodically review the environmental and social management programs to allow for iterative improvement.
- Ensure that all stakeholder concerns are addressed.

9.2 Mitigation and Monitoring

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 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. This section provides measures that further reduce the medium and low potential impacts.

Table 53: 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	Dust generation due to construction activities	Setting an appropriate site speed limit to reduce dust generation from vehicles traveling over unpaved surfaces.	Visual monitoring of vehicle speeds .	Daily, at construction site and at boundaries of the nearest public receptor	Corrective actions for all significant dust generation issues The contractor must prepare and submit monthly report to the Supervising Engineer	No visible dust plumes originating from construction sites. Complete records of monitoring activities. Regular vehicle maintenance records. No irregular exhaust (heavy black or white smoke) from equipment and vehicles originating from construction sites. Compliance with Jordanian Ambient Air Quality Standards JS 1140/2006	Construction Contractor
		Unnecessary handling of dusty materials will be avoided such as minimizing drop heights when loaders dump soils into trucks.	Visual monitoring of dust generated from construction activities, construction vehicle movement, stockpiles, storage of construction materials, etc.	Daily, at construction site and at boundaries of the nearest public receptor			
		Train workers to handle construction materials and debris during construction to reduce fugitive emissions.	Training sessions	For the new construction site staff.			
		Cover trucks when transferring fine and dusty materials outside the project location.	Visual monitoring of emissions from vehicles and equipment if not covered properly	Daily, at construction site and at boundaries of the nearest public receptor			
		Vehicle and machinery movements during construction must be restricted to designated routes at all times where practicable.	Visual monitoring of emissions from vehicles and equipment	Daily, at construction site and at boundaries of the nearest public receptor			
		No stockpiling of fine material is allowed within the construction sites.	Visual monitoring of dust generated from construction activities, construction vehicle movement, stockpiles, storage of construction materials, etc.	Daily, at construction site and at boundaries of the nearest public receptor			
		The contractor must 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 dust generated from construction activities, construction vehicle movement, stockpiles, storage of construction materials, etc.	Daily, at construction site and at boundaries of the nearest public receptor			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		The contractor must make sure that any vehicle or equipment leaving the project area is cleaned of loose debris.	Visual monitoring of emissions from vehicles and equipment	Daily, at construction site and at boundaries of the nearest public receptor			
		The contractor must store cement, sand, or other such fine-grained material in manner to prevent wind erosion and dust.	Visual monitoring of dust generated from construction activities, construction vehicle movement, stockpiles, storage of construction materials, etc.	Daily, at construction site and at boundaries of the nearest public receptor			
		Spills of materials on roads or pathways must be cleaned up promptly in accordance with the spill prevention and response plan that must be developed by the contractor as part of the CEMP.	Visual monitoring of dust generated from construction activities, construction vehicle movement, stockpiles, storage of construction materials, etc.	Daily, at construction site and at boundaries of the nearest public receptor			
	Exhaust emissions due to operation of construction plant and machinery	Ensure adequate maintenance and inspection of vehicles to minimize exhaust emissions.	Visual monitoring of emissions from vehicles and equipment	Daily, at construction site and at boundaries of the nearest public receptor			
		The contractor must limit idling of engines when not in use.	Visual monitoring of emissions from vehicles and equipment	Daily, at construction site and at boundaries of the nearest public receptor			
Noise and Vibration	Increased noise levels due to construction and machinery	Contractor must take reasonable measures, such as installing acoustic screens or close barricades, to maintain noise levels within the national requirements at all construction sites. If such measures are not reasonable, the contractor must try to minimize disruption through other means such as scheduling noisy activities during less sensitive times in consultation with the sensitive receptors (e.g., consult with schools to avoid exam periods) or using alternative techniques that create less noise.	Noise measurements to be undertaken during construction activities, at the site to demonstrate compliance with the national environmental noise guidelines using a portable noise meter at boundaries of the nearest public or sensitive receptor	Daily and after receiving any complaints from workers or third parties.	Monthly report to supervisory engineer	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

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		The contractor must execute construction activities during night times along the main commercial streets only with prior approval from the supervisory engineer, police, and local authorities.					
		The contractor must use heavy equipment, machinery in compliance with national regulations. The contractor must perform regular maintenance on all equipment, vehicle and machinery to prevent noise emissions.					
		The contractor must limit idling of engines when not in use to reduce its contribution to noise emissions.					
		Contractor must restrict work activities to be between 8 a.m. to 5 p.m. on weekdays with coordination and approval of WAJ and/or supervising engineer, and must avoid work on Fridays (weekend) in residential areas. If work is initiated at nighttime, approvals must be obtained by WAJ.					
		The contractor must provide 24 hours advance notification of construction schedule and activities with the potential to produce noise disturbance to nearest residences and sensitive receptors that are abutting the proposed water supply network alignment or near the reservoir and the PS construction sites.					
		The contractor must take responsibility for rectifying damage caused by vibration generated from or by the use of any equipment, machinery, and haulage vehicles.					

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Soil	Soil contamination at the water supply network alignment and at the reservoirs and the PS site.	A spill prevention and response plan must be prepared by the contractor to control any inadvertent leaks or spills.	Visual inspection of storage area and machinery through conduct of regular audits of on-site activities and incident reporting forms. Visual inspection of vehicles, machinery and equipment for leaks of oils, grease, etc.	Daily	Immediate reporting to supervising engineer in case of accidental spills. All unplanned incidents/accidents must be recorded by the contractor. Deployment of all site workers trained on spill response procedures.	Number of spills or incidents to be recorded Up-to-date and complete records as required by spill prevention and response procedures. Training records of personnel on spill prevention and response procedures.	Construction Contractor
		Machinery and equipment must 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, machinery and equipment must not be operated until repaired.	Visual Inspection of storage area and machinery through conduct of regular audits of on-site activities and preparation of incident reporting forms.	Daily			
		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 spills and minimize the potential for migration to the underlying soil.	Conducting regular audits of on-site activities and incident reporting forms.	Weekly			
			Visual inspection of waste storage area, chemical storage area and fuel storage area for spills and leaks.	Daily			
		Any spilled chemical must be immediately collected and disposed of in accordance with Spill Prevention and Response Plan and Safety Data Sheets (SDS).	Visual Inspection	Spill incidents			
		Contractor must ensure that a spill kit and adequate personal protective equipment (PPE) is available at each site for emergency cleanup activities in case of chemical/oil spills.	Visual Inspection	Weekly			
	Soil disrtubance	The contractor must adopt soil conservation methods all sides of the entire water network alignment to reduce the area of disturbance during excavation works.	Visual inspection of disturbed area in and around construction site for erosion.	Daily	Corrective actions reported to the supervisory engineer	Up-to-date and complete records as required for soil disturbance incidents.	Construction Contractor
		Removed topsoil must be stored separately so that it can bespread	Visual inspection of disturbed area in and	Daily			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		over restored areas when applicable.	around construction site for erosion.				
		Upon completion of excavation works, the contractor must restore disturbed areas to their original condition.	Visual inspection of disturbed area in and around construction site for erosion.	Daily			
		Roadway restoration works after completion of water supply lines network construction.	Visual inspection of disturbed area in and around construction site for restoration.	Daily			
		To control soil erosion, surface runoff should be collected from all paved working areas into retention ditches to restrict concentration of flows in rainy seasons.	Visual inspection of any temporary soil storage and runoff controls	Daily in rainy seasons.			
Visual Amenity	Visual impacts from construction activities such as materials lay down, excavation, backfilling	The contractor must ensure general cleanliness and good housekeeping practices at the water pipeline network alignment and at the reservoir sites at all times.	Visual inspection	Daily	Inspection reports	Good housekeeping practices and tidiness of work areas within the project site.	Construction Contractor
		Prohibit the disposal of solid waste into the surrounding land during construction activities.	Visual inspection of waste management on-site.	Daily			
		The contractor must restore disturbed areas back to their original conditions after excavation works have been completed.	Visual inspection	Daily			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Waste Generation	Hazards presented by improper management and handling of hazardous and nonhazardous waste during construction.	The contractor must segregate storage for different types of wastes, such as nonhazardous, recyclable, construction material, plastic, paper, etc. to facilitate proper disposal.	Inspect that segregated waste disposal or storage areas are clearly marked.	Daily	Contractor must prepare and submit monthly waste report to supervisory engineer.	Compliance with waste management plan. Current and complete records of regular waste pickup and disposal. Records of workers attending follow-up health, safety, and environment (HSE) training on monthly basis. Compliance with applicable regulations including: • Instruction of solid waste management year 2019 • Instructions of Harmful and Hazardous Waste Management, Transfer and Handling year 2019 • Regulation of hazardous materials and waste management No. 68 year 2020. • Instructions for Recycling and Handling of Consumed Oils year 2014	Construction Contractor
		The contractor must provide a separate storage area for hazardous materials (if any). The hazardous materials/products must be labeled with proper identification of the hazardous properties.	Inspect that segregated waste disposal or storage areas are clearly marked.	Daily			
		Littering in the project area and surrounding areas must be prohibited.	Visual monitoring of site cleanliness and proper storage and handling of waste.	Daily			
		Contractor must provide trash bins within each construction site to prevent littering in the project area and surrounding areas.	Visual monitoring of site cleanliness and proper storage and handling of hazardous waste.	Daily			
		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.	Visual monitoring of site cleanliness and proper storage and handling of hazardous waste.	Daily			
		Hazardous wastes generated must be disposed off-site at an approved waste facility.	Visual monitoring of site cleanliness and proper storage and handling of hazardous waste.	Daily			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Water Resources	Potential surface water runoff/potential flood risks.	All chemicals must be stored in dedicated areas in tightly closed containers and must be protected from adverse weather conditions.	Visual inspection of any spills.	Daily during rainy seasons at construction site and along wadis	Inspection reports and Incident reports to WAJ in case of floods from high precipitation events.	Runoff from construction sites should be clear of heavy particulates, oils/chemicals, or trash. Complete records as required by spill prevention and response procedures.	Construction Contractor
		A spill prevention and response plan must be prepared by the contractor to control any inadvertent leaks or spills. Spill response measures must be implemented (as necessary) to contain and clean up any contaminated soil.	Visual inspection of any spills.	Daily during rainy seasons at construction site and along wadis			
		Any spilled chemical must be immediately collected and disposed of in accordance with the spill prevention and response plan and SDS.	Visual inspection of any spills.	Daily during rainy seasons at construction site and along wadis			
		Contractor must ensure sediment and any contaminants present do not come into contact with, or are transported off-site in, surface water runoff.	Visual inspection of any erosion from construction area.	Daily during rainy seasons at construction site and along wadis			
		If the water pipes cross a hydraulic structure such as a pipe or a box culvert, then the designer should check if the proposed carrier pipe passes either above or under the culvert. In both cases, the fill between the crown of the one located below and the bottom of the other will be at least 0.3 m.	Designer check	Once at design stage			
		If the water pipes are above the culvert, then the fill between the crown of the pipe and the asphalt should be 0.6 m or more, otherwise encasement with reinforced concrete should be applied to water pipeline.	Designer check	Once at design stage			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		If the water pipes pass along or across an open channel or a wadi then, the pipe should be protected with reinforced concrete for these parts of the crossing.	Designer check	Once at design stage			
		If the water pipes pass along a culvert, depending on the sizes of both, the pipe can be constructed either in or beside the culvert.	Designer check	Once at design stage			
Biological Environment							
Biological Environment	Removing or damaging vegetation cover.	Excavation and earthwork work must take place in areas with low vegetation cover.	Observation and recording	Daily during earthwork that may involve vegetation removal.	Reporting to: WAJ, RSCN (Yarmouk PA Management) MoE and MoA	Number of trees and areas of vegetation removed. No trees should be removed from Yarmouk PA.	Construction Contractor
		Avoid cutting trees as much as possible, if trees must be cut, RSCN, MoE, and MoA should be informed, or a biodiversity expert should be hired to follow up and propose the best actions to avoid removing flora species that have conservation status.	Observation and recording				
		In places close to or within Yarmouk PA, a full and continuous coordination should be kept with PA management. No vegetation must be removed nor tree cut without their permit.	Observation and recording				
		If trees must be cut, the trees should be transported to closest area and replanted.	Observation and recording				
		If a tree must be removed, it should be carefully dug up and transported to the closest area and replanted.	Observation and recording				
	Workers collect firewood and edible or medicinal plants to use them and hunt fauna species.	Prohibit workers from collecting wood or any plant species and prohibit hunting. The contractor should put in place a monitoring procedure to avoid any violation by workers.	Visual inspection for any case involving any disturbance to fauna.	Daily	Number of violations and reports to relevant authorities	No hunting or plant collection	Construction Contractor
			Coordination with RSCN	As needed.			
	Accidental wildlife death from	Watch and decrease machinery movement and speeds as much as possible, and limit machinery	Visual inspection for any case involving any disturbance to fauna.	Daily	Number of violations and reports to relevant authorities	Number of animals killed and reports to relevant authorities	Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	machinery movement.	movement to the project site. Report any killed animals to the MoE and RSCN.	Coordination with RSCN	As needed			
	Accidental wildlife death from moving piles or pipes.	Animals may choose to hide in pipe piles, but when the pipes are moved, the animals may be hurt or killed.	Visual inspection for any case involving any disturbance to fauna.	Daily			
			Coordination with RSCN	As needed.			
	Solid waste disposal and accidental oil spill	Proper disposal of solid waste and prevention of oil spills by changing machinery oil in mechanic workshops.	Visual inspection for any case involving any disturbance to fauna.	Daily	Contrctors must prepare and submit monthly report to supervisory engineer	No solid waste disposal on the site No oil spill on the site	contractor
			Coordination with RSCN	As needed.			
	Excavation and earthworks	Limit the excavation and earthworks to the minimum needed and only in necessary areas. Recover the area with soil after finishing the work.	Visual inspection for any case involving any disturbance to fauna.	Daily and once work finished	Contractors must prepare and submit monthly report to supervisory engineer	Pipeline covered with soil after work finished	contractor
			Coordination with RSCN	As needed.			
Health and Safety							
Health and Safety risks	Potential of exposure to safety events such as tripping, falls from heights, 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 must be completed by the contractor prior to construction.	Vehicle and residents' safety ensured through visual spot checks and inspections.	Prior to construction	Contractors must prepare and submit monthly health and safety report to supervisory engineer	Total Recordable Incident Rate (TRIR) Lost Time Incidents Frequency Fatal accident rate Number of safety trainings performed Number of non- conformance events. Reports of events. Training records of workers on HSE policies and procedures	Construction Contractor
		Presence and compliance with HSE-related policies and procedures on-site.	Routine facilities and site inspections.	Daily			
		Allocate specific personnel responsible for health and safety management on-site.	Vehicle and residents' safety ensured through visual spot checks and inspections.	Daily			
		Adequate and appropriate training of all workers of the contractor's HSE policies and procedures before they are permitted to undertake a task.	Training sessions	Continuously; for all new workers before they start			
		All construction equipment used for the execution of the project works must be fit for the purpose and carry valid inspection certificates and insurance requirements.	Preventive maintenance and patrol inspections for all vehicles and mobile plant.	Monthly			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		Risk assessment must be prepared and communicated prior to commencement of work for all types of work activities on-site.	Monitor work areas and activities to identify fire and explosions hazards.	Monthly			
		Provide walkways that are clearly designated as a walkway; all walkways must be provided with good conditions underfoot; signposted, and with adequate lighting.	Vehicle and residents' safety ensured through visual spot checks and inspections.	Daily			
		Signpost any slippery areas, ensure proper footwear with a good grip is worn for personnel working within slippery areas.	Vehicle and residents' safety ensured through visual spot checks and inspections.	Daily			
		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 must be run through designated corridors.	Visual inspection of compliance with health and safety procedures.	Daily			
		Avoid work at heights where it reasonably practicable to do so, e.g., by assembly at ground level.	Inspection of equipment and tools used during working at height activities.	Monthly			
		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.	Inspection of equipment and tools used during working at height activities.	Monthly			
		Arrest a fall with equipment to minimize the distance and consequences of a fall, e.g., safety nets, where work at height cannot be avoided or the fall prevented.	Inspection of equipment and tools used during working at height activities.	Monthly			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		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.	Fire Emergency Response Drills	As specified by the risk assessment			
		Set up a system to alert workers on-site. This may be temporary or permanent mains-operated fire alarms.	Fire Emergency Response Drills	As specified by the risk assessment			
		Fire extinguishers should be located at identified fire points around the site. The extinguishers must be appropriate to the nature of the potential fire.	Inspection for fire extinguishers, testing for fire detection system, and other firefighting equipment.	Monthly			
		Establish and communicate emergency preparedness response plan (EPRP) with all parties; the EPRP is to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedures, in addition to training for personnel and drills to test the plan.	Monitor work areas and activities to identify fire and explosions hazards.	Monthly			
		Ensure all machinery and vehicles are regularly inspected, serviced and maintained; ensure all staff assigned is trained and competent to operate machines and vehicles.	Preventive maintenance and patrol inspections for all vehicles and mobile plants.	Monthly			
		Ensure all routes are suitable and wide enough for the vehicles; routes should be planned by minimizing bends/junctions, steep gradients, and the need for reversing; clearly designate areas for pedestrian walkways and crossing points.	Visual inspection of compliance with health and safety procedures.	Daily			
		Ensure clear signs are in place, such as warning of speed limits, obstructions, allowable widths/heights, etc.	Visual inspection of compliance with health and safety procedures.	Daily			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		Electrical equipment must be safe and properly maintained; works must not be carried out on live systems.	Preventive maintenance and inspections for all electrical equipment	Monthly			
		Only competent authorized persons must carry out maintenance on electrical equipment; adequate PPE for electrical works must be provided to all personnel involved in the tasks.		Monthly			
		Lock-Out/Tag-Out system must be implemented during any electrical works.	Visual inspection of compliance with health and safety procedures.	Daily			
		Adequate number of staff and first aiders must be on-site in accordance with Jordanian Labor Law requirements.	Staffing according to Risk Assessment Plan.	Prior to work			
		First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, nonlatex gloves, scissors, thermometer, etc. must be made available by the contractor on-site.	Visual inspection of compliance with health and safety procedures.	Daily			
		Emergency evacuation response must be prepared by the contractor and relevant staff must be trained through mock-up drills.	Monitor work areas and activities to identify fire and explosions hazards.	Monthly			
	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 HSE policies and procedures before they are permitted to undertake a task.	Monitor the health of workers	Monthly	Contractors must prepare and submit monthly health and safety report to supervisory engineer.	TRIR Lost Time Incidents Frequency Fatal Accident Rate Medical Treatment Case Number of Restricted Work Day Cases HSE training hours Number of nonconformance events.	Construction Contractor
		Ensure that operations, which involve manual handling, are eliminated so far as reasonably practicable, provide mechanical aids such as forklifts, trolleys, cranes, or hoists.	Visual spot checks and inspections.	Continuously			
		Ensure all equipment are suitable for jobs (safety, size, power, efficiency, ergonomics, cost, user acceptability etc.) and provide the lowest-vibration tools that are suitable and can do the work.	Visual spot checks and inspections.	Continuously			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		Ensure all tools and other work equipment are serviced and maintained in accordance with maintenance schedules and manufacturer's instructions.	Monitor the health of workers.	Monthly			
		Regular noise exposure assessments and noise level surveys of noisy areas, processes, and equipment must be carried out to form the basis for remedial actions when necessary.	Monitor work areas and operations to identify noise hazards.	Monthly			
		As far as reasonably practical, all steps to reduce noise exposure levels of employees by means other than that of PPE must be taken, such as reducing exposure times, enclosures, silencers, and machine covers.	Monitor work areas and operations to identify noise hazards.	Monthly			
		Provide suitable and effective hearing protection to employees working in high noise level areas.	Inspection for use of hearing protection equipment.	Continuously			
		Designate and clearly mark hearing protection zones, which may include particular areas, operations, or pieces of equipment. All personnel entering these zones must be required to wear hearing protection inside these areas.	Monitor work areas and operations to identify noise hazards. Inspection for use of hear protection equipment.	Monthly			
		Awareness training sessions should be established and provided to all personnel involved during the construction phase to highlight the heat related illnesses of working in hot conditions such as heat cramps, heat exhaustion, heat stroke, and dehydration.	Monitor the health of workers.	Monthly			
		Ensure adequate quantities of drinking water are available at different locations within the site.	Visual spot checks and inspections.	Continuously			
		Ensure proper planning of works to consider the time of peak temperatures during the day; provide rest breaks during the peak times.	Visual spot checks and inspections.	Continuously			
		Provide sun shades at different locations within the site.	Visual spot checks and inspections.	Continuously			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		Eliminate the risk of exposure whenever possible, provide proper PPE wherever necessary, and ensure that there are satisfactory washing and changing facilities.	Visual spot checks and inspections.	Continuously			
		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.	Monitor the health of workers.	Monthly			
	Public Health and Safety:	The maximum length of open trench permitted in any location must be 150 cm, or the length necessary to accommodate the amount if pipe installed in a single day, whichever is lesser.	Visual spot checks and inspections.	Continuously			
		The contractor must make available a maintenance crew to repair immediately any water or wastewater pipelines that are broken due to excavation works. The contractor must coordinate repair works in close cooperation with WAJ/Irbid.	Visual spot checks and inspections.	Continuously			
		Safe and adequate public transportation stops and pedestrian crossings at intervals not exceeding 30 m must be provided.	Visual spot checks and inspections.	Continuously			
		Works on footpaths must leave at least 1.5 m unobstructed width where possible and a minimum of 1 m must be provided. Where 1 m minimum unobstructed width is not obtainable, an alternative safe route for pedestrians must be provided. Temporary pedestrian ways should never be less than 1 m wide and, where possible, they should be 1.5 m or more in width.	Visual spot checks and inspections.	Continuously			
		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	Visual spot checks and inspections.	Continuously			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		at the ends of the barriers at night. For pedestrian crossings, handrails should be between 1.0 and 1.2 m above ground level and tapping rails should be fixed with the lower edge approximately 150 mm above the ground.					
		Continuous unobstructed, safe, and adequate pedestrian and vehicular access must be provided to fire hydrants and commercial and industrial establishments such as mosques, schools, parking lots, service location, police stations, and hospitals.	Visual spot checks and inspections.	Continuously			
		The priority ranking of safety measures that could be employed would be: 1) backfilling to the extent possible, 2) bridges/stable plates (to support pedestrians in residential areas and vehicular traffic in main streets) placed over any open segments with side barriers along the segment, and 3) barriers with supervision and oversight, in cases where neither of the previous measures are possible.	Visual spot checks and inspections.	Continuously			
		All trenches located close to schools, and houses regardless of width must be guarded during the entire school day. Direct supervision on trenches is essential to prevent any accidental falls and injuries.	Visual spot checks and inspections.	Continuously			
		Construction works must cease for half an hour in the morning during (school days) weekdays (Sunday through Thursday) during the school start time and school leaving time, where schools are located within 100 m of the construction site. During that time, the contractor's HSE engineer can	Visual spot checks and inspections.	Continuously			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		carry out the daily toolbox talk to workers.					
		The contractor must maintain and facilitate mobility and access for the public within the construction sites.	Visual spot checks and inspections.	Continuously			
		The contractor will ensure workers are properly trained on public health and safety concerns.	Training sessions	Monthly			
		The contractor will provide training and awareness materials to the affected communities on public health and safety issues of the construction project prior to construction.					
		A Traffic Control Plan must be developed and implemented by the contractor that must address health and safety issues associated with safe and efficient movement of traffic around the construction area, reversing vehicles, movement of materials, and interface with site pedestrians/members of the public.	Regular coordination with the Traffic Directorate.	Continuously			
		Vehicular movement to and from the project area must be minimized to the extent possible.	Regular coordination with the Traffic Directorate.	Continuously			
		The contractor must establish an adequate coordination system with other contractors working in the project area to minimize traffic disruption to localities in Bani Kenanah including residents and visitors and ensure that all traffic hazards are kept to a minimum.	Regular coordination with the Traffic Directorate.	Continuously			
		Where excavation is performed in primary streets or highways, one lane in each direction must be always kept open to traffic unless otherwise indicated.	Regular coordination with the Traffic Directorate.	Continuously			
		Contractor must provide, place, and maintain all necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the Jordanian	Visual spot checks and inspections.	Continuously			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		Traffic Directorate to protect traffic in public and private streets.					
		Barricades and obstructions must be illuminated at night, and all lights must be kept on from sunset until sunrise. The contractor must station guards or flaggers and must conform to any special safety regulations relating to traffic control that may be required by the public authorities within their respective jurisdictions.	Visual spot checks and inspections.	Continuously			
		A representative from the Jordanian Traffic Directorate must be allowed to access and observe the Traffic Control Plan prepared by the contractor to make any changes as field conditions warrant. Any changes must supersede the contractor's plan and be done solely on the contractor's expense.	Regular coordination with the Traffic Directorate.	Continuously			
		Contractor must remove traffic control devices when no longer needed and must repair all damage caused by their installation and removal (i.e., backfilling holes, etc.)	Regular coordination with the Traffic Directorate.	Continuously			
		If closure of any street is required during construction, the contractor must submit a formal application to the concerned municipality or other relevant competent authorities as directed by the supervisory engineer at least 30 days in advance of the required closure. A proposed detour scheme and Traffic Control Plan must be	Regular coordination with the Traffic Directorate.	Continuously			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		submitted along with the application.					
		The contractor must notify the owner or occupant of any driveway to be closed for more than one eight-hour workday at least 3 working days prior to closure. The contractor must minimize the duration for which a driveway will be closed. The contractor must provide information to the owner/occupant about timing of the closure.	Visual spot checks and inspections.	Continuously			
		Provision for additional traffic lanes and traffic regulating devices (traffic lights, road sign) must be made available by the contractor to prevent congestion and minimize the risk of vehicular accidents at road crossing points.	Regular coordination with the Traffic Directorate.	Continuously			
		Vehicle traffic on roads leading to the areas surrounding the project, especially residential and service premises, must remain smooth and unblocked.	Regular coordination with the Traffic Directorate.	Continuously			
Socioeconomics							
Noise and traffic disturbance	Nuisance and mobility impacts.	The contractor must coordinate with local authorities, utility providers, etc. conducting or planning construction work in the same project area to reduce public disruption.	Inspection of mobility and access facilitation procedures.	Continuously	Contractor must prepare and submit monthly report of nuisance and mobility impacts to Supervising Engineer.	Up-to-date records of complaints and how they were addressed. Records of public consultations/stakeholder engagement where needed.	Construction Contractor
		The public located near the project working area must be notified prior to noisy activities taking place on-site.	Inspection of mobility and access facilitation procedures.	Continuously			
		Dust suppression measures must be implemented as necessary to avoid nuisance to the public.	Inspection of mobility and access facilitation procedures.	Continuously			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		The contractor to establish a grievance mechanism for the local community.	Inspection of mobility and access facilitation procedures.	Continuously			
Traffic	Additional traffic load due to transport of equipment and materials to and from the sites through the surrounding road network, through the construction of the pipelines network in the different localities.	The contractor to ensure that all trucks and vehicles used for the project are operated by licensed operators.	Monitor vehicle movement to and from the pipelines network working area.	Continuously	Contractor must prepare and submit monthly report to supervising engineer	Traffic Control Plan and mobility and access facilitation procedures are revised and updated to prevent future incidents.	Construction Contractor
		Pedestrian Safety: All project vehicles and trucks must comply with the proposed speed limits.	Monitor vehicle movement to and from the pipelines network working area.	Continuously			
		Ensure adequate maintenance and inspection of vehicles.		Continuously			
		Presence of flagman at the project site (construction sections) to control vehicles and truck movements.	Monitor road condition and signage and traffic calming needs.	Continuously			
		All workers on the project site must make sure that all needed signs and preventive measures are implemented when starting any activity.	Monitor road condition and signage and traffic calming needs.	Continuously			
		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.	Monitor road condition and signage and traffic calming needs.	Continuously			
		Signs must always be in good conditions and be visible to every road user.	Monitor road condition and signage and traffic calming needs.	Continuously			
		Vehicle transit across any restricted area and/or limited to working activities is prohibited.	Monitor vehicle movement to and from the pipelines network working area.	Continuously			
		Vehicle repairmen and/or maintenance activities are not allowed within the project area.	Monitor vehicle movement to and from the pipelines network working area.	Continuously			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		The contractor must 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.	Monitor vehicle movement to and from the pipelines network working area.	Continuously			
		The contractor must prepare a traffic management plan to address safe and efficient movement of traffic around the construction area, reversing vehicles, movement of construction materials, and interface with site pedestrians/members of the public.	Monitor vehicle movement to and from the pipelines network working area.	Continuously			
		Contractor must 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 pipelines network working area.	Continuously			
Local communities	Potential impacts on local community groups.	Preparation of a community grievance mechanism in compliance with the EIB guidelines.	Ensure to establish specific monitoring procedures for stakeholder consultation and records of grievances where needed.	Throughout the project phases	Contractor to report to supervisory engineer	Compliance with EIB guidelines and implementation of community grievance mechanism. Number of grievances and time taken to resolve them.	Construction Contractor
		Land acquisition to be settled before the construction work commences at the reservoirs and the PS site.					
		Contractor to repair any infrastructure damage that might occur during the construction phase.					
	Community Health, Safety, and Security	Appoint a Community Liaison Officer whose responsibility must include the management of all community related matters for the project.	Ensure project area is secure and access is well monitored throughout the construction phase.	Throughout the construction phase.	Contractor to report to supervisory engineer	Compliance with EIB guidelines and implementation of community grievance mechanism. Number of grievances and time taken to resolve them.	Construction Contractor
		Implementation of approproate security management on-site.					

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Worker Community	Labor and Working Conditions	The contractor must take all reasonable steps to ensure that work is in compliance with all national legislation on labor and health and safety, the requirements of (Labor and Working Conditions), relevant standards and procedures as developed and implemented by WAJ, and any other relevant standards identified by EIB. The contractor must 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 sites. The contractor must 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 must 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 must ensure that there must be no use of forced or compulsory labor. The contractor must ensure that hiring, recruitment, and training plans satisfy the all legal requirements and that the human resources procedures are tailored to comply with local Jordanian Laws, EIB, and WAJ's human resources policies and procedures.	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. Monitor suppliers and subcontractors' performance. This must be conducted through internal audits and/or inspections to monitor compliance.	Regularly through project phases	Contractor to report to WAJ management	Compliance with WAJ guidelines and implementation of worker grievance mechanism. Number of grievances reported by workers/employees and time taken to resolve them.	Construction Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Archaeological Resources and Cultural Heritage							
Archaeology and Cultural Resources	Only potential concern would be impacts on possible unseen archaeological sites/remains (chance finds).	Based on the Archaeological Survey report documented for the project, the following recommendations are proposed: 1- Adhere to the project area allocated for the project and work must not exceed it. 2- Implementation of chance find procedures in accordance with the Jordanian Antiquities Law. This is described as follows: Construction works must cease if any historical/culturally sensitive or archaeological sites/remains are found by chance during construction activities. If any known sites are found during construction and may potentially be threatened by construction, the area with the newly discovered remains/sites must be fenced and the DoA must be notified immediately and invited for consultations and assessment of the finding. Agreement must be reached with the DoA to minimize damage to the any sites. It must also be the Contractor's responsibility to notify the supervisor of the Cultural Resources Management Office of the DoA if any sites are encountered in any area during construction and also comply with the specifications set in Article 15 of the Antiquities Law No. 21 (1988).	Minimum of one site inspection immediately after chance find. Informing personnel present on-site of chance find procedures in case any archaeological or cultural resources are encountered.	One site inspection after chance find	To DoA in case of chance finds.	Number of chance findings at the project location	Construction Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		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 accidentally 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 must 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 Water Company must employ specialized personnel to oversee and supervise the implementation of mitigation measures.					

Table 54: Environmental and Social Management Plan during Operation Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Performance Indicator	Responsibility
Air Quality	PS emissions at the Sama Reservoir location.	Continuous PS maintenance to enhance pump efficiency.	Compliance with MoE and national guideline limits for ambient air quality JS 1140/2006.	Monitoring every 3 months	Number of community complaints in relation to project	
Noise	Nearby residents disturbed by PS noise.	Continuous PS maintenance to enhance pump efficiency.	Compliance with MoE instructions on Noise limitation and prevention year 2003.	Monitoring every 3 months	Number of community complaints in relation to project	Operator (Yarmouk Co.)
Waste Generation	Hazards presented by improper management and handling of hazardous and nonhazardous waste during operation of the reservoirs and the PS. And/or in case	The operator must segregate storage for different types of wastes, such as hazardous, nonhazardous, recyclable, plastic, paper, etc. to facilitate proper disposal.	Inspect that segregated waste disposal or storage areas are clearly marked.	Daily	Compliance with waste management plan. Current and complete records of regular waste pickup and disposal.	Yarmouk Co. Operator

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Performance Indicator	Responsibility
	of pipeline maintenance.	The operator must provide a separate storage area for hazardous materials (if any). The hazardous materials/products must be labeled with proper identification of its hazardous properties.	Inspect that segregated waste disposal or storage areas are clearly marked.	Daily	Records of workers attending follow-up HSE training on monthly basis. Compliance with applicable regulations including: • Instruction of solid waste management, year 2019 • Instructions of Harmful and Hazardous Waste Management, Transfer and Handling year 2019 • Regulation of hazardous materials and waste management No. 68, year 2020. • Instructions for Recycling and Handling of Consumed Oils, year 2014	
		Littering in the reservoir area and surrounding areas must be prohibited.	Visual monitoring of site cleanliness and proper storage and handling of waste.	Daily		
		Operator must provide trash bins within each site to prevent littering in the project area and surrounding areas.	Visual monitoring of site cleanliness and proper storage and handling of waste.	Daily		
		Hazardous wastes generated must be disposed of off-site at an approved waste facility.	Visual monitoring of site cleanliness and proper storage and handling of hazardous waste.			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Performance Indicator	Responsibility
Safety risks	Potential of exposure to safety events during operation activities such as slipping and tripping, falls due to working at height activities, and fire at the reservoirs locations.	Adopt specific Occupational Health and Safety policies to be complied with during operation.	HSE Policy available at site.	Prior construction commencement	Operator to prepare regular report to Yarmouk Co. top management TRIR Lost Time Incidents Frequency Number of safety trainings performed Number of non conformance events	Operator Yarmouk Co.
		Provide walkways that are clearly designated as a walkway; all walkways must be provided with good conditions underfoot; signposted and with adequate lighting.	Facilities and site inspections.	Daily		
		Ensure all works and storage areas are tidy, all material deliveries must be planned to minimize accumulated materials at project site.	Maintain proper housekeeping for the Sama and Hibras Reservoirs site.	Daily		
		Signpost any slippery areas and provide proper footwear during working within slippery areas.	Facilities and site inspections.	Daily		
		Avoid work at height where it is reasonably practicable to do so, e.g., by assembly at ground level.	Inspection of equipment and tools used during working at height activities.	Monthly		

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Performance Indicator	Responsibility
		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.	Inspection of equipment and tools used during working at height activities.	Monthly		
		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.	Monitor work areas and activities to identify fire hazards.	Semiannually		
		Set up a system to alert workers on-site. This should be a permanent mains-operated fire alarm.	Fire emergency response drills.	Semiannually		
		Fire extinguishers should be located at identified fire points around the site. The extinguishers must be appropriate to the nature of the potential fire.	Maintenance check for fire extinguishers, testing for fire detection system, and other fire fighting equipment.	Semiannually		

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Performance Indicator	Responsibility
		Establish and communicate emergency preparedess 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.	Fire emergency response drills.	Semiannually		
		Adequate first aid providers must be on-site in accordance with Jordanian labor law requirement.	Facilities and site inspections.	Daily		
		First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, nonlatex gloves, scissors, thermometer, etc. must be made	Facilities and site inspections.	Daily		

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Performance Indicator	Responsibility
		available by the contractor on-site.				
		Emergency evacuation response must be prepared by the contractor and relevant staff must be trained through mock-up drills.	Emergency response drills.	Semiannually		

Table 55: Periodic Monitoring

Aspect	Potential Impact	Monitoring Requirements	Frequency	Responsibility
Air Quality	Air emissions at the reservoir locations	Compliance with JS 1140/2006 for ambient air monitoring to the following parameters: NO_2, PM10, SO_2.	Every 3 months for 3 consecutive days through the operation and decommissioning phases.	Yarmouk Water Company

Aspect	Potential Impact	Monitoring Requirements	Frequency	Responsibility
Noise	Nuisance to the workers and local community	Compliance with noise instructions year 2003.	Monthly spot checks at construction phase. Quarterly spot checks at the reservoirs locations at the operation and decommissioning phases.	Contractor at construction phase Yarmouk Water Company at the operation phase

9.3 Decommissioning

The project aims to provide water supply and consider all relevant national codes and legislation.

The design life of the water supply system would be approximately 30 years and would be renewed or rehabilitated upon mutual consent between project stakeholders.

The postdesign life might involve rehabilitation and upgrading of the water supply system. As a result, impacts from decommissioning are not expected to arise soon.

The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be like those identified for the construction phase. However, it is recommended that before any decommissioning activities take place, a Disposal Plan for the reservoirs, PSs, and pipes must be prepared by the responsible entity undertaking decommissioning activities. The Disposal Plan must consider the following options, at a minimum, and compare the feasibility and applicability of each:

- Recycling any existing components, where suitable
- Reuse in other circumstances
- Disposal of the other materials that cannot be reused at existing waste facilities in Jordan through coordination with the MoE and/or the Ministry of Local Administration

Disposal methods will be established at the appropriate time, depending on new available technologies, reuse/recycling options, and other appropriate disposal facilities.

Table 48 provides detailed mitigation measures that overlap with decommissioning.

10 OVERVIEW OF ESMS AND AUDITING PROTOCOL

10.1 Environmental and Social Management System Framework

After the identification and assessment of environmental and social risks/impacts potentially generated by the project (throughout the ESIA stage), the project developer will be obliged to manage such risks during the project life cycle, 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 is commensurate to the level of risks/impacts identified and as per the requirements of EIB Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.

The ESMS developed by the project developer should apply to the contractor and the operator. The ESMS documentation must 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 by the lenders (if any)

10.2 Monitoring and Reporting

After the preparation of the relevant ESMS plans and procedures, the project developer 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 monthly reporting from the contractor and operator (at a later stage) must be submitted to the project developer. The issued reports must include information and indicators with EIB environmental and social reporting requirements.

10.3 Auditing

Environmental and social audits will assess a project's 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 operators' existing operations. For this project, the audit must be conducted during the construction phase, usually by an independent third-party consulting company/environmental and social management expert.

Key issues that are recommended to be covered under the environmental and social management audit may include, but not be limited to:

- A review of the Yarmouk Water Company's existing and approved ESMS policies and practices.
- Organizational capacity and resources.
- Human resources and employment policies (e.g., child labor, forced labor, nondiscrimination and equal opportunity, workers' organizations, contractor management, retrenchment, and employment).
- Occupational health and safety practices (e.g., 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 and regulatory compliance with national requirements including applicable best available techniques.
- Community health, safety, and security as it relates to the existing operations.
- Management of potentially hazardous work.
- 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, subcontractors of main materials and resources) and identification of relevant environmental, social, labor, and/or reputation issues.
- 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 EIB guidelines. A check of the grievance mechanism and the records and frequency of response must be conducted.
- Updating the ESMP accordingly.

The successful implementation of the ESMS will require detailed training of employees and some training of other stakeholders to ensure that they are aware of the main objectives and purpose of the ESMS and its benefit to the project.

10.4 ESIA Conclusions

Most of the potential impacts are of medium to low significance during the project construction and operation phases; however, some impacts are of high significance.

- Noise pollution due to construction activities and the use of heavy machinery, vehicles, and equipment.
- Needed land acquisition.
- Risks to public and occupational health and safety from different construction activities, including maneuvering of equipment and machinery.
- Limitations on customers' access to businesses due to road closures.
- Degraded air quality, degraded topography, geomorphology and soils, and impacts on water resources.
- Visual intrusions due to solid waste generation and disposal.
- Potential traffic impacts due to vehicles and equipment operation and the associated accidental vehicles collisions, as well as due to solid waste (spoiling) generation/disposal.
- Potential disturbance of some roads/areas during excavation of trenches during construction activities. This will be a temporary issue, given that the contractor is obliged to restore the pavement to be compatible with adjacent undisturbed pavement.
- Disruption to utilities due to trenching and excavation works, vehicles and equipment operation, and accidental fires.
- Impact to land use due to equipment operation and accidental fires and spills of chemicals and liquid fuels.
- The local community expressed tolerance toward the general nuisance posed by the construction works because these are short term and the end product of a water supply system is a worthy cause. However, the contractor should take precautionary measures, such as cleanups after construction, prevention of electricity blackouts or water supply interruption, road closures, and noise and dust emissions associated with the construction phase, and commitment to project schedules.

Overall, although people perceive several negative impacts that may affect their daily lives during the construction phase, it is expected that as long as proper reinstatement and mitigation measures are taken by the contractor, they are willing to bear those temporary, expected, and well-known impacts for the sake of the larger benefits to be achieved once project is in operation.

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Annex A: Final Approved ToR

Annex B: Climate Change Management Table

Annex C: Local Community Questionnaire

Annex D: Air Quality Report