The HASHEMITE KINGDOM OF JORDAN

Ministry of Water and Irrigation
Water Authority of Jordan

Feasibility Study, Environmental and Social Impact Assessment and Detailed Designs and Bidding Documents for Zarqa Governorate Wastewater System Reinforcement and Expansion Project

MILLENNIUM CHALLENGE CORPORATION
UNITED STATES OF AMERICA

ENVIRONMENTAL & SOCIAL ASSESSMENT
Overview

MWH
BUILDING A BETTER WORLD

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ABBREVIATIONS

AGTP	Ain Ghazal Preliminary Treatment Plant
ALARP	As Low As Reasonably Practicable
BAT	Best Available Technology
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DAJ	Department of Antiquities of Jordan
DoA	Department of Antiquities
EMMP	Environmental Management and Monitoring Plan
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
EZPA	East Zarqa Pumping Station
GCEP	General Corporation of Environment Protection
GoJ	Government of Jordan
HCPS	Hitteen Camp Pumping Station
HSE	Health and Safety Executive
HSEM	Health, Safety and Environmental Management System
IBA	Important Bird Area
ICAH	International Council of Arts and Heritage
IUCN	The World Conservation Union (often known as International Union for the Conservation of Nature and Natural Resources)
JADIS	Jordan Antiquities Database and Information System
JISM	Jordan Institute for Standards and Meteorology
JS	Jordanian Standard
JSC	Joint Services Councils
JVA	Jordan Valley Authority
km	Kilometers
KTR	King Talal Reservoir

LAL	Land Acquisition Law
ME	Ministry of Energy
MEMR	Ministry of Energy and Mineral Resources
MoE	Ministry of Environment
MoH	Ministry of Health
MOTA	Ministry of Tourism and Antiquities
MoU	Memorandum of Understanding
MWI	Ministry of Water and Irrigation
NRA	Natural Resources Authority
PMU	Program Management Unit
RFP	Request for Proposal
RSCN	Royal Society for the Conservation of Nature
TOR	Terms of Reference
TSP	Total Suspended Solids
UNESCO	United Nations Educational, Scientific and Cultural Organization
VC	Valuation Committee
VOC	Volatile Organic Compounds
WAJ	Water Authority of Jordan
WwTP	Wastewater Treatment Plant
WZPS	West Zarqa Pumping Station

1. INTRODUCTION

MWH was retained by the Ministry of Water & Irrigation / Water Authority of Jordan (MWI/WAJ) on November 19th, 2009 to perform consulting services for the preparation of the feasibility study, environmental and social impact assessment and detailed designs and bidding documents for Zarqa Governorate wastewater system reinforcement and expansion.

This report presents the Draft Overview to be submitted to the Ministry of Environment for the purpose of Environmental and Social Impact Assessment categorization.

The sub-sections below describe the consultant's understanding of the project, the proponent, and the structure of this overview report.

1.1. Project Appreciation and Understanding

Jordan is a semi-desert country and considered to be one of the 10 poorest countries worldwide in water resources. The highly variable seasonal rainfall of 8.3 billion cubic meters is its main source of water.

The per capita annual water share from available renewable water resources dropped from 3,600 m^3 in year 1946 to less than 160 m^3 in year 2007. 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. Special care is advocated for protection against pollution, quality degradation, and depletion of water resources.

Zarqa Governorate is the third largest governorate in population within the Hashemite Kingdom of Jordan. It has present deficiencies in the wastewater system that present a potential hazard to public health. In particular blocked sewers and resulting spills of raw sewage into the streets is not acceptable. The other major problem with Zarqa Governorate existing wastewater system is its extent where only 72% of the governorate's total subscribers were connected to the sewerage system in 2007.

Hence, this project of reinforcing and expanding Zarqa Governorate wastewater system is perceived to be an important step towards protection of both public health and water resources as well as a step towards improving service levels and consequently living standards for the population of that governorate.

Also, since the national water policies consider treated wastewater as a resource for irrigation, this project would enhance the volumes of wastewater collected for treatment and reuse.

1.2. Project Proponent

The project proponent is the Water Authority of Jordan (WAJ) which is the Ministry's of Water and Irrigation entity in charge of water and wastewater systems.

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

The Ministry of Water and Irrigation embraces the two most important entities dealing with water in Jordan. These are the Water Authority of Jordan (WAJ) and the Jordan Valley Authority (JVA).

WAJ is the entity in charge of water and sewage systems.

It should be noted here that part of the project funding will be provided by the Millennium Challenge Corporation (MCC), which is an innovative and independent U.S. foreign aid agency helping lead the fight against global poverty. It provides eligible countries with large-scale grants to fund country-led solutions for reducing poverty through sustainable economic growth. MCC grants complement other U.S. and international development programs. There are two primary types of MCC grants:

- **Compacts** which are large, five-year grants for countries that pass MCC's eligibility criteria.
- **Threshold programs** which are smaller grants awarded to countries that come close to passing these criteria and are firmly committed to improving their policy performance.

The Hashemite Kingdom of Jordan has been declared eligible for a five-year multimillion dollar poverty reduction grant from MCC and an agreement have been signed between MCC and the Government.

1.3. Structure of the Environmental and Social Assessment Overview

The objective of this report is to present an environmental and social assessment overview of the proposed project to the Ministry of Environment so that MoE will provide its recommendations regarding the EIA categorization.

This section describes the Ministry of Environment requirements and the corresponding report structure.

1.3.1. Project Categorization According to MoE Requirements

According to Annex 1 of the Environmental Regulation No. 37/2005, the MoE requires the description of the following items in order to determine the project category for an EIA process.

- Project Description which should cover:
  - Project type
  - Land use during preparation, construction, operation and decommissioning and reclamation.
  - Assessment of quality and quantity of emissions and wastes (pollution of air, water, soil, noise, vibrations, heat and radioactive)

- Estimation of number of people, vehicles and equipment during project stages.

- List of project's most significant alternatives and rationale for choosing preferred alternative.

Determination of potential environmental and social impacts / issues.**Table** 1.1 below lists the section of the report that covers the required aspects.

Table 1.1: Sections relating to information for project categorization according to MoE Regulation No. 37/2005

Requested item for Project Categorization	Section Number & Title	Comments
Project Description	2. Project Description	-
-Project area, type and extent	2.3 Project Area 2.4 Existing Wastewater System	-
-Quality and quantity of emissions and wastes	-	Not possible to asses at this preliminary stage.
-Estimated of number of people, vehicles and equipment during project stages	-	
Most significant alternatives and rationale for choosing preferred alternative	5. Analysis of Proposed Project Alternatives	-
Determination of potential environmental and social impacts / issues	7: Preliminary Identification of Potential Environmental and Social Impacts	-

Based on the findings of this environmental and social assessment overview, the MoE will provide its recommendation on the categorization of the environmental impact assessment for the proposed project.

1.3.2. Report Structure

This environmental and social assessment overview report has been prepared to provide MoE and WAJ/MCC with a description of the proposed project, a brief of the significant environmental and social baseline conditions within project study area, and a feedback of the likely environmental, social and health impacts due to project execution. Hence, this report is structured as follows:

Introduction Overview of the project, its proponent, and report structure.

Project Description A clear and concise description of the project from mobilization, construction, operation through to decommissioning. The description is sufficient to allow the preliminary risks and impacts to be identified, described and evaluated.

Policy, Legal and Institutional Framework Overview of regulatory framework with potential implications to the project.

Overview of Assessment of the baseline conditions against which the preliminary

Environmental and Socio-Cultural Baseline	impacts of the project can be assessed.
Identification of Environmental and Social Receptors	A listing of the potential environmental and socio-cultural receptors within the project area.
Analysis of Project Alternatives	A comparison of the project alternatives considered and their potential impacts.
Preliminary Assessment of Environmental and Social Impacts	A preliminary assessment of the impacts of the project (and methodology used), which includes a listing, description, and assessment (including quantification) of the impact.
Preliminary Recommendations on Mitigation Measures	Preliminary recommendations for measures to eliminate/minimize negative impacts and/or to enhance positive ones.
Conclusions	Presents the overall findings of the environmental and social assessment overview.

2. PROJECT DESCRIPTION

The feasibility study, environmental and social impact assessment and detailed designs and bidding documents for Zarqa Governorate wastewater system reinforcement and expansion are divided into two stages: Stage I, which is the base contract, and Stage II, which is optional and will start only upon authorization after a compact is signed with the Millennium Challenge Corporation (MCC). Stage I of the study includes preparatory studies that are required to define an investment program; preliminary environmental and social assessment; preliminary designs; and the assessment of feasibility of the investment program, including economic analysis. Stage II is the preparation of EIA and detailed design and contract documents, and is dependent upon the successful completion of Stage I.

The sections below present a more detailed description of the project objectives, area, components, phases and other aspects that would lead into an understanding of the project and consequently a more comprehensive appreciation of its environmental and social impacts.

2.1. Project Purpose and Need

Jordan is considered to be one of the 10 poorest countries worldwide in water resources. The available renewable water resources are dropping drastically to an annual per capita share of less than 160 m^3 in recent years, compared to 3600 m^3 per capita in 1946. Thus, the water sector strategy stresses the need for improved resource management, with particular emphasis being placed on the sustainability of the present and future uses. Special care is advocated for protection against pollution, quality degradation and depletion of water resources.

Accordingly, this project aims to plan and prepare urban sanitation improvements in Zarqa Governorate for a project proposal for MCC funding, with the intended purpose to provide collected wastewater, to be later processed and treated, and then used as a substitute for non-domestic purposes (irrigation, industrial, etc), in order to reduce demand on the limited domestic quality water resources.

Fulfilling the objectives of this project will result in a significant general benefit to the entire population of Zarqa due to the decrease or elimination of sewage overflows and the resulting health risks and costs. Also, there will be specific benefit to that part of the population who are presently served only by water and not by sewer when the piped sewerage system is extended.

In addition, the project should be a benefit to people living downstream from Zarqa, near the wadis, due to reduced pollution resulting from the extension of the piped sewerage coverage and the increase in treatment capacity.

Therefore, the objectives of this project are to:

- achieve an overall understanding of the present sanitation conditions and future requirements;

- determine satisfactory service levels and standards commensurate with affordability and environmental concerns;
- project the long-term needs of physical works and how they should be phased in view of investment requirements and availability of funds and criteria to be set on priorities;
- provide justifications for investments in view of expected impacts;
- ensure that the facilities to be provided are least cost solutions, financially and environmentally sustainable and appropriate to the circumstances;
- arrive at the most feasible alternatives for expansion and upgrading of the wastewater collection systems;
- Prepare a feasibility study and detail designs and tender documents for the expansion and upgrading of the sanitation systems in Zarqa Governorate.

2.2. Project Scope of Work

In order to achieve the above mentioned objectives, the following scope of services has been developed:

- **Stage I:** Preliminary Design, PESIA, Feasibility Study and Economic analysis
  - Task 1: Collection of data and preparatory works
  - Task 2: Hydraulic model, analysis of options and Master Plan
  - Task 3: Preliminary environmental and social assessment
  - Task 4: Feasibility study, preliminary design and work plan
- **Stage II:** ESIA and Detailed Design and Preparation of Contract Documents (optional)
  - Option A: Environmental and social impact assessment
  - Option B: Preparation of detailed designs and contract documents

The current study covers Stage I which includes developing and detailing an investment program to reinforce and expand the wastewater system of Zarqa Governorate, conducting a feasibility study and undertaking environmental and social assessments, developing reliable and realistic cost estimates for the proposed investments and developing detailed engineering design and bidding documents for construction.

This study will then form the basis to identify the investment project to be potentially funded by MCC, under a compact that is currently being prepared.

2.3. Project Area

The project covers Zarqa Governorate which extends from Zarqa River in the west to the Saudi border in the east with year 2004 population of 799,000. However, ninety percent of the governorate population is concentrated in the Zarqa, Russeifa and Al-Hashmiyah metropolitan area. This urban area is the second largest metropolitan area in Jordan after Amman with year 2004 population of 687,000 and because of its proximity to Amman is a fast developing area with many urban

development projects planned such as the King Abdullah Bin Abdul Aziz City, with an intended population of 400,300.

The project study area includes all the communities in the Zarqa River basin within the Zarqa Governorate in addition to some of Amman catchment areas that flow downstream of Ain Ghazal pre-treatment facility via the existing West Zarqa wastewater pumping station. After discussions with WAJ, it was understood that a feasibility study and final design and preparation of bidding documents project for the wastewater collection, treatment and reuse for Azraq, in the eastern parts of the governorate, is currently underway. Therefore, the area of Azraq will be excluded from this study. The major communities within the study area include Zarqa, Russeifa, Hashmiyah, Dhuleil and Sukhneh.

The Zarqa Governorate neighborhoods along with 2004 population are presented in **Table 2.1** and the project area is depicted in **Figure 2.1**. Amman neighborhoods were not included as only the wastewater flow downstream of Ain Ghazal Pump Station will be considered.

Table 2.1: Year 2004 Population of Zarqa Governorate

Area	2004 Population
al-Tafeh	**693**
al-Rukban	**177**
Khaw	**369**
al-Farwaniyeh	**110**
Al Wassat AlTejari	**188,291**
Al Thawrah Al Arabiya AlKobraa	**62,226**
Awajan	**76,983**
al-Zawahreh	**30,369**
Al-Zarqa'a Al-Jadida	**37,331**
Birein	**11,899**
Al-Dhuleil	**32,606**
Russeifa	**268,235**
Al-Hashmiyah	45,982
Al-Azraq	**9,021**
Grand Total	**764,292**

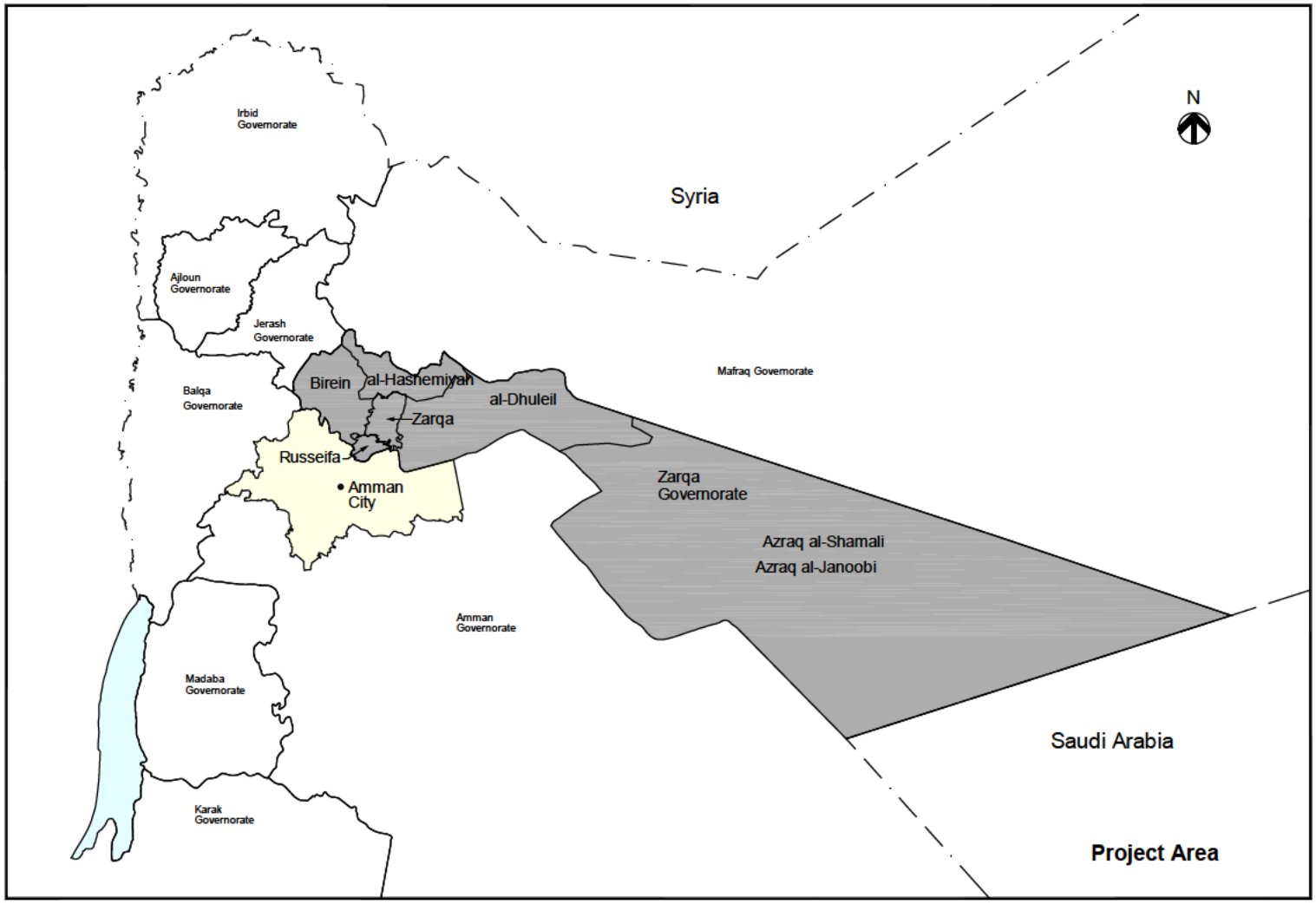

Figure 2.1: Location Map of Project Area

2.4. Existing Wastewater System

The first piped sewerage system was constructed in 1985 serving the central areas of Zarqa and Russeifa cities. Today the total length of the gravity sewer network is about 851 km of diameter 200 – 1000 mm, serving most of Zarqa, Russeifa and al-Hashmiyah areas.

The existing collection systems are supported by three existing pumping stations (West Zarqa, East Zarqa and Hitteen). West Zarqa pumping station serves west Zarqa area that drains towards Zarqa River and Russeifa in addition to flows coming from parts of Amman that drain downstream of Ain Ghazal preliminary treatment plant. East Zarqa pumping station located in Al-Hashmiyah serves the eastern parts of Zarqa and Al-Hashmiyah. Hitteen pumping station is small lifting station serving a small section of Hitteen camp in Russeifa.

All collected wastewater at West Zarqa and East Zarqa pumping stations is delivered to As-Samra WwTP via 1200 mm diameter and two-500 mm diameter pumping mains, respectively.

The existing wastewater collection system is designed as a separate collection system, which is not sized for storm water collection.

2.4.1. Existing Wastewater Collection System

The existing collection system in the Amman-Zarqa Study Area includes the main sewer trunk lines (generally 300 to 1200 mm in diameter) and collector sewers (generally 200 mm in diameter) in three adjacent but distinct areas, as follows:

- Russeifa – West Zarqa Sewer System: The communities of Russeifa and Zarqa form a continuous sewered area with Amman in the Zarqa River Basin. The Northeast Amman areas of Tariq, Marka and part of Shafa Badran, Jubaiha and Naser are also tributary to the Russeifa/West Zarqa sewer system, resulting in a sub-system that accounts for about 70% of the collection system in the Study Area. Flow collected by the Russeifa/West Zarqa system drains by gravity to the West Zarqa Pumping Station. At the West Zarqa Station, wastewater flows are pumped into the 1200 mm siphon under pressure of approximately 110 meters to al-Samra WSP. Trunk sewers in the Russeifa/West Zarqa system are predominantly 300 to 1000 mm diameter pipes.
- East Zarqa – Hashmiyah Sewer System: This system serves developed areas in East Zarqa and al-Hashemiyah, resulting in a sub-system that accounts for about 30% of the collection system in the study area. Flows collected from the area are conveyed by gravity to the al-Hashemiyah Pumping Station and pumped to As Samra WwTP. Trunk sewers in the sub-system are predominantly 300 to 800 mm diameter.

The total length of the main trunk sewers with diameters equal to or above 300 mm is about 117 km. The secondary collection system is a dense network of 200 mm diameter sewers covering most of the populated areas of Zarqa, Russeifa and al-Hashemiyah with a total length of about 789 km. Most of the sewers are made of concrete, and a few are made of ductile iron and vitrified clay.

Investigations have shown that:

- Most of the flat sewers are blocked by sand, silt and grease; and
- Several segments of the collection system are overloaded during rain events, causing backup into streets, wadis, and in some rare cases into residences.

The last records obtained from WAJ show that the total number of subscribers for water services in 2009 is 130,948, while the number of subscribers for wastewater services is 94,265, which indicates that approximately 72% of households with water connections are sewered.

Although stormwater inflow is recognized as a significant source of excess flow into the collection system during rainfall events, the relative infrequency of significant rainfall events does not justify major upsizing of the system to accommodate storm flows. Rather, it is assumed that WAJ will continue efforts to promote compliance with current stormwater regulations that require that roof and area drains not be connected to the wastewater system.

In 2008, WAJ started a program for cleaning the sewers using specialized bucket cleaning machines. About 23.1 km of sewers were cleaned by WAJ operators during the last two years and the cleaning of another 13.3 km was contracted to a local contractor. Results of the sewer cleaning operations are very promising as sewers blocked to more than half full have been fully cleared of the sediments. It is thought that such cleaning operations should be continued, as they will increase the expected life of the sewers considerably, and will eliminate the need for upgrading or replacement of many of the sewers.

The extent of the existing wastewater collection networks is shown in **Figure 2.2** and the lengths of the sewers are summarized in **Table 2.2**.

Table 2.2: Summary of Lengths of Existing Gravity Sewers

Sewer Diameter (mm)	West Zarqa System	East Zarqa System	Total
200	570,101	219,310	789,411
300	43,944	11,210	55,154
400	8,381	7,287	15,668
500	7,351	12,443	19,794
700	1,422	6,975	8,397
800	20,167	6,996	27,163
1000	2,366		2,366
Total	653,732	264,221	917,953

The sewer networks are operated and maintained by WAJ Zarqa Directorate through two wastewater operation offices: one for the Zarqa and al-Hashemiyah networks and one for the Russeifa networks.

The operation and maintenance activities are largely confined to clearing blocked manholes and sewers.

The operation and maintenance activities of the Zarqa and al-Hashemiyah collection networks are carried by a total workforce of 38 staff. This labor force are supported by 6 jet trucks, 1 rodding machine, 1 backhoe excavator, 1 compressor, 1 two-ton dump trucks, 2 portable pumps (which are not operational), 4 pickups in addition to a bucket machine sewer cleaning.

The operation and maintenance activities of the Russeifa collection networks are carried by a total workforce of 27 staff. This labor force are supported by 6 jet trucks, of which only two are operational and the other four are in bad condition and 3 pickups in addition to various hand tools.

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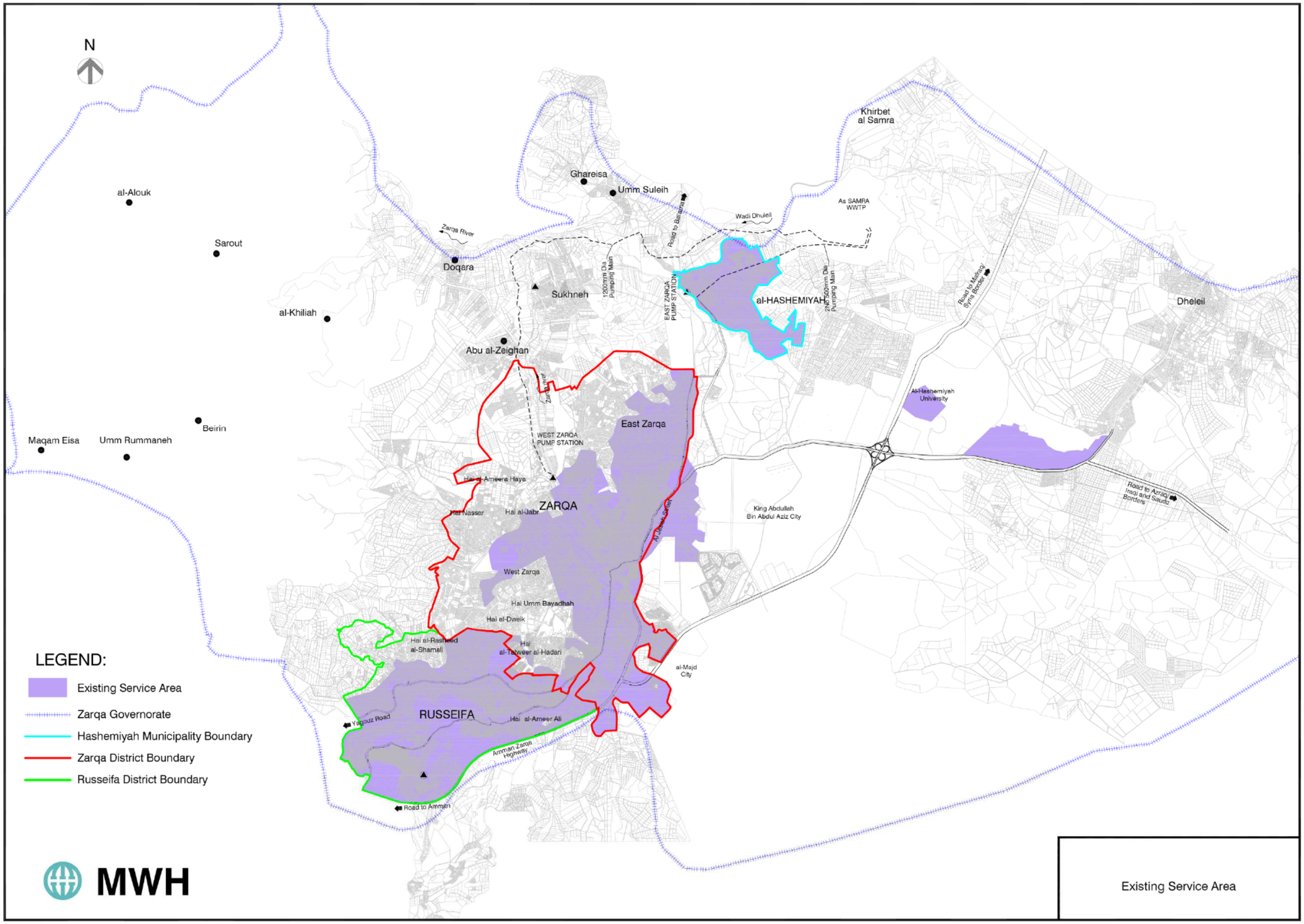

Figure 2.2: Extent of the Existing Service Area

2.4.2. Existing Pump Stations

Zarqa sewerage system includes two main pump stations: West Zarqa Pumping Station (WZPS), and East Zarqa Pumping Station (EZPS) that deliver to As-Samra WwTP. A lifting station, Hitteen Camp Pumping Station (HCPS), serves a small section of the camp and delivers to the Russeifa collection network. West Zarqa and East Zarqa Pumping Stations are currently operated and maintained by the As-Samra Plant Operation & Maintenance Co. Ltd., and Hitteen Camp Pumping Station is operated by WAJ / Russeifa operations. **Table 2.3** presents the observations and findings concerning these pumping stations.

The odor problem at West Zarqa Pump Station could be contributed to one or a combination of the following problems:

- Odor at the inlet work indicates prolong storage of screening and grit at the facility.
- Because of the relatively small size wet wells, the emergency pond (10,000 m^3) is used frequently to store excessive flows. The overflow during the day passes from the wet wells to the emergency pond and is returned back during the night. Odor is believed to be generated at the emergency pond because it is not being regularly cleaned.
- The aeration system in the emergency pond is not operational due to the fact that the pond is located at a low level which causes the accumulation of rocks, solids...etc to at the bottom of the pond. This causes clogging the aeration system by the accumulated solids.
- At summer time, the pond will be a good environment and food source for flies and insects which cause a severe health and environmental problems.

Table 2.3: Overview of the Operating Pump Stations

Pump Station	Catchment Area	Discharge Location	Approximate Daily Average Discharge	Facilities at Pump Station	Observations & Comments
West Zarqa Wastewater Pumping Station - WZPA	Russeifa, west Zarqa and the northern parts of Amman	Downstream of Ain Ghazal Treatment Plant (AGTP)	57,000 m^3/day at a pressure of 65 m	• Inlet Structure • Grit Removal System • Wet Wells • Pumps • One discharge flow meter • Emergency pond • Emergency power generator	• The pump station is working close to its full capacity; any additional inflow will require pump station upgrade or replacement. • The manual coarse screen at the inlet work needs periodic and continuous cleaning due to high continuous flow load; being manual consumes a lot of time and effort in cleaning. • A fairly noticeable amount of oil and grease are collected at the top level in the Grit Removal and is removed by flushing (which is technically unacceptable and inefficient). • Rotten egg odor is an indication of hydrogen sulfide formation. This can be read as well from the H_2S indicator in the control room.
East Zarqa Wastewater Pumping Station - EZPS	East Zarqa and Al-Hashmiyah	As-Samra WwTP	12,000 m^3/day	• Inlet Structure • Wet Wells • Pumps • Outlet force main • Power generator	• The screenings produced from the fine screens are removed manually (the conveyor does not work). At high load, this will be an operational problem and manual removal will not be applicable, furthermore, odor problems will be clearly noticed. • This station can receive more flow in the future, however the need for expansion will depend on the future flows estimated and the final alternative considered.
Hitteen Camp Pumping Station	The lower elevations in Hitteen Camp and nearby areas	-	-	• Inlet chamber with a screening basket including lifting crane • Wet Well • 3 submersible pumps including lifting crane	• The station is in a bad operational condition and up to now details of flows and capacities are not available.

2.5. Evaluation of Existing Wastewater Network

Presently, the deficiencies in the sewerage system in Zarqa Governorate are such that they represent a danger to public health. The deficiencies can be outlined as follows:

1. Blocked sewers by sand, silt and grease, causing spills of raw sewage into the street. Some of the sewers have been found to be more than half full with sediments. This can be explained in various ways: undersized pipes; poor condition of some pipes and manholes; and poor maintenance of the sewerage system.
2. Several segments of the collection system are overloaded during rain events, causing backup into streets, wadis, and, in some rare cases, into residences. These wet weather problems are largely attributed to unauthorized storm drain connections from many buildings, as well as open manhole covers in flooded streets and wadis.
3. Inadequate pumping (storage) capacity at the pumping stations to cater for rain events. Storm water collected through the sewer system is allowed to overflow into Zarqa River.

The other major problem with the existing sewer system in Zarqa Governorate is its extent, where the system coverage is around 72%.

Future wastewater generation rates for the Zarqa Governorate, based on population forecasts, water consumption rates and the wastewater return value, are estimated at 143,408 m^3/day by the year 2035. It is urgent to improve, renew and extend the wastewater collection, treatment and disposal systems. To address these issues, the following aspects will be studied:

- The extension of the coverage of piped sewerage within Zarqa Governorate to areas that are not presently connected.
- The expansion of the trunk sewer system to better cope with present and future demand.
- The reduction of the number of blockages and sewage overflows through the upgrading of trunk sewers.
- Increasing wastewater volumes being collected and treated.

Collection system improvements will require immediate implementation primarily of maintenance and management actions intended to reduce the impacts of storm water inflow, silt and debris, and industrial discharges on system performance. Specific recommended actions include:

1. Sewer Cleaning and Maintenance: Proceed with immediate implementation of a systematic program of sewer inspection, cleaning and repair to reduce the impacts of silt and debris accumulations, protruding taps and structural damage on system performance. Initial efforts should be prioritized based on the results of the field investigations performed for the master plan.
2. Control of Storm water Inflow: Initiate immediate action for preventing future connection of storm water drains to sanitary sewers and encourage the re-direction of exiting storm water connections. Actions required may include improved enforcement of building codes,

development of typical details for elimination of private storm water connections and implementation of public education programs aimed at encouraging the redirection of storm water connections. Progress in this area should be monitored through annual monitoring of wet weather sewer flows at select locations.

3. Control of Discharges to Sewer System: Develop and implement programs to more aggressively control potentially toxic industrial discharges of oils, heavy metals and/or toxics to the sewer system. Actions required may include the identification and registration of industrial dischargers and the enforcement of industrial pre-treatment regulations. Public education efforts should also promote the use of low “suds” detergents to reduce foaming in the treated wastewater effluent.

2.6. Determination of New Service Areas

The new service areas within the catchments of the existing networks consist mainly of the newly developed neighborhoods of Zarqa and Russeifa west of the Zarqa River and some parts of Hai Batrawi in north Zarqa.

The towns and villages in Birein, Dhuleil and Al-Hashmiyah districts that do not drain to the existing pumping stations will be included in the study. Topographic maps for the whole study area were used to define the main and sub-main flow catchment areas for both served and proposed to be served areas.

Most areas of Birein district drain to Zarqa River downstream of Sukhneh. The town of Dhuleil and nearby villages drain to Wadi Dhuleil which passes near As-Samra WwTP. Flows from eastern parts of al-Hashmiyah district could be collected at the town of Sukhneh which lies at the confluence of Zarqa River and Wadi Dhuleil and flows from the western parts of this district could be collected at point downstream of Zarqa River along with flows from al-Birein district.

2.7. Description of Proposed Wastewater System Reinforcement and Expansion

To meet the needs of the Zarqa wastewater systems over the proposed service area through the year 2035, improvements to the existing systems will be required. The objective is to develop a long-range plan for the improvement to the wastewater systems over the planning horizon.

2.7.1. Main Catchment Zones

Based on the topography of the study area, and based on the main system elements of the Zarqa wastewater system, the study area is divided into four main wastewater collection zones as illustrated in **Figure 2.3**. The boundary of each zone includes all existing sewer networks as well as any future sewer networks that will be implemented within the zone. This gives a clear idea about future service areas that will affect any existing or new sewers. The four zones are:

1. West Zarqa Pumping Station Zone: This zone includes the areas that drain by gravity towards the existing West Zarqa Pumping Station. This zone includes mainly the old developed parts

of west Zarqa, Russeifa and the northeast parts of Amman (Marka, Tareq, part of Shafa Badran, parts of Jubaiha and parts of Nasser).

2. East Zarqa Pumping Station Zone: This zone includes the areas that drain towards the existing East Zarqa Pumping Station. This zone includes mainly east Zarqa, al-Hashmiyah and the new development area of King Abdullah Bin Abdul Aziz City.
3. Sukhneh Pumping Station Zone: This zone includes the areas that drain towards the proposed Sukhneh Pumping Station. This zone includes mainly the Sukhneh town, new developed neighborhoods west of Zarqa (such as Hai al-Ameera Haya, Hai al-Hashemi, Hay al-Bustan, Hai Shomar, Hai al-Jabr, Hai Nassar, Hai al-Ahmad, Hai Makka al-Mukarrama and parts of Hai al-Madinah al-Munawwara). It also includes communities along Wadi Zarqa and upstream of Sukhneh such as Abu Zeighan and Salheyah.
4. Wadi Zarqa Zone: This zone includes the areas that are located downstream of the proposed Sukhneh Pumping Station and drain their sewers directly toward the proposed Wadi Zarqa Treatment Plant. This zone includes mainly the staggered communities located in the northwestern part of Zarqa Governorate, such as Birein, Um Rummanah, Maqam Eisa, Dogara, al-Khilah, Sarout, al-Alouk, Ghareisa and Um Sulaih.

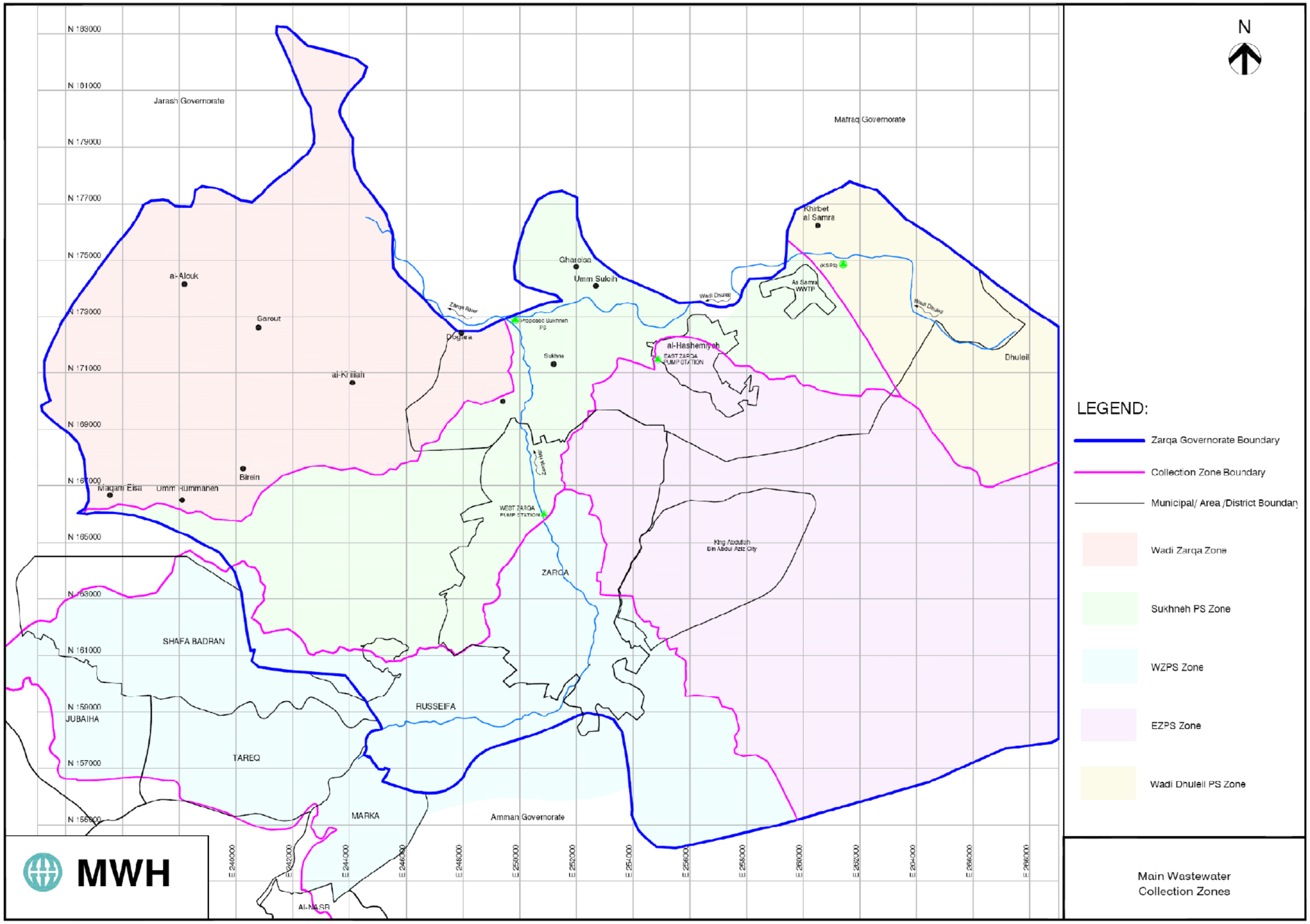

Figure 2.3: Five main W0astewater Collection Zones

2.7.2. New Service Areas

The ToR has asked for the following areas to be served by new wastewater networks:

- Russeifa North (120 ha).
- Otl al-Zarqa and al-Russeifa (170 ha).
- Batrawi (220 ha).
- Sukhneh (290 ha).
- Hashmiyah (200 ha).
- Other unserved parts within served areas (filling gaps).

Accordingly, and based on the findings regarding the extent of the existing wastewater network, a layout of the proposed wastewater networks was prepared that covers the unserved areas within the main Zarqa zones described above, as shown on **Figure 2.4**.

The new service areas can be classified into two main categories:

- New Service Areas within Zarqa, Russeifa and Hashmiyah Municipalities: The main new served areas within this category are:
  1. Hai Batrawi (partially)
  2. Sukhneh town
  3. Salheyah
  4. Abu al-Zeigan
  5. Hai al-Bustan
  6. Hai Shomar
  7. Hai al-Hashemi
  8. Hai al-Jneneh
  9. Hai al-Ameera Haya
  10. Hai Nassar
  11. Hai al-Jabr
  12. Hai al-Ahmad
  13. Hai al-Madinah al-Munawwarah (partially)
  14. Hai Makka al-Mukarramah
  15. Hai Umm Bayadhah
  16. Hai al-Duwaik
  17. Hai al-Falah (partially)
  18. Hai al-Rasheed al-Shamali (partially)
  19. Hai al-Tatweer al-Hadari
  20. Hai al-Jraiba (partially)
  21. Networks to fill gaps (scattered in various areas)
- Remote and Isolated Communities: The proposed systems can be classified as follows:
  - West communities that could be served either by gravity to the proposed Wadi Zarqa Treatment Plant, or by sewer force main back to the proposed Sukhneh Pumping Station. These communities include:
    - Maqam Eisa;
    - Umm Rummanh;
    - Birein;
    - al-Khillah;
    - al-Alouk;
    - Sarout;
    - Ghareisa;
    - Umm Suleih; and

    - Dogara.
- East communities that could be served by sewer trunk line along Wadi Dhuleil and force main up to the existing As-Samra Wastewater Treatment Plant. A pre-treatment facility will be provided at the proposed pumping station at Wadi Dhuleil. The communities are:
    - Dhuleil; and
    - Khirbet As-Samra.
- Abu Sayyah community south of Russeifa that could be served by a sewer trunk line and connected to the main existing sewer line along Amman-Zarqa Highway.

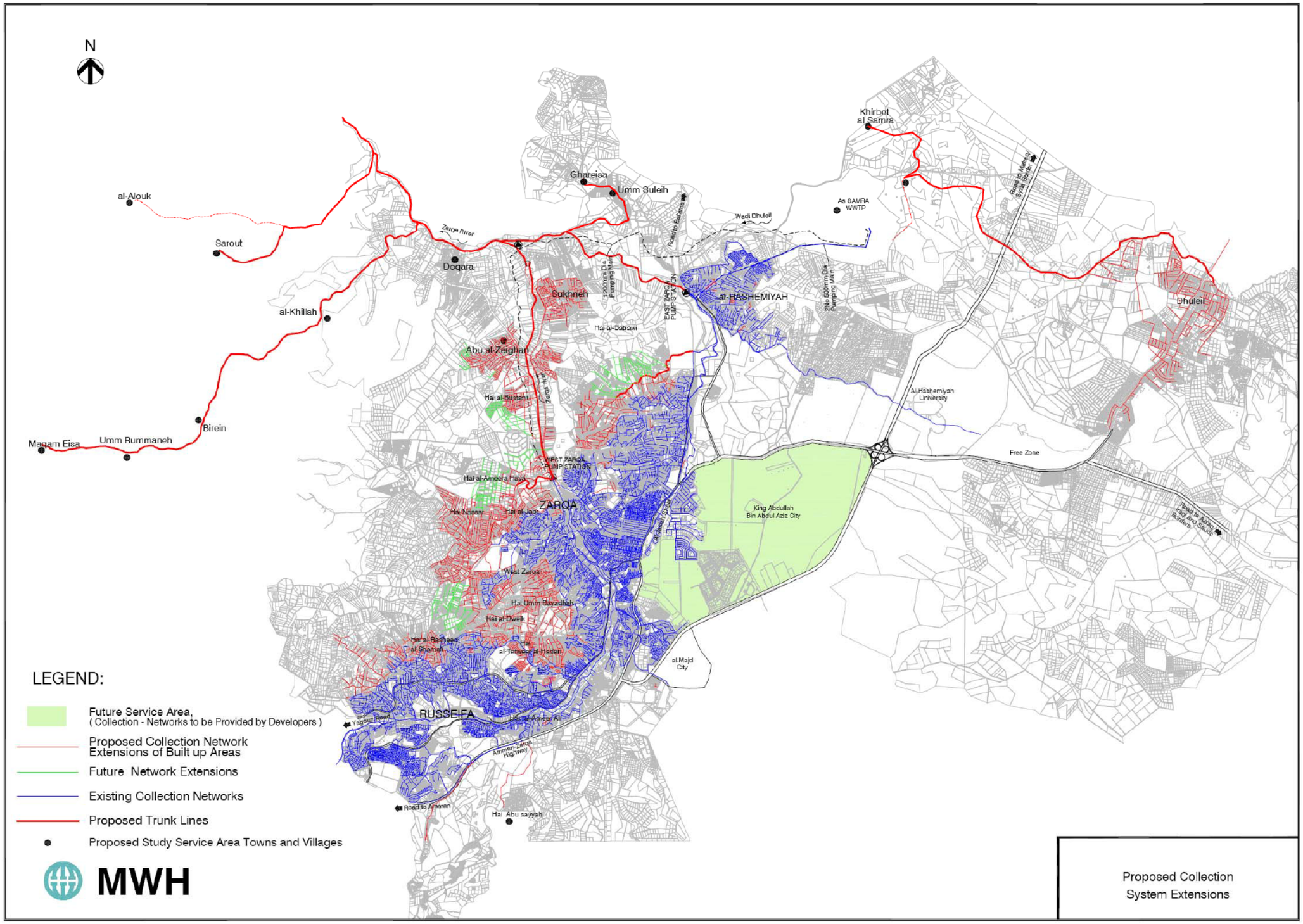

Figure 2.4: Proposed Collection System Extensions

2.7.3. Proposed Waste Water Management System

The proposed waste water management system for the governorate of Zarqa involves keeping the conveyance of all flows generated within the project area to As Samra WwTP. This system involves the upgrading of the main elements of the existing Zarqa wastewater conveyance system, basically to serve the projected population of Zarqa until the year 2035.

Both West Zarqa Pump Station (WZPS) and East Zarqa Pump Station (EZPS) will be upgraded at their current locations.

The existing pumping mains will be retained for use until year 2025. Therefore, it is assumed that the existing pumping main from WZPS will be exclusively used to convey the flows of WZPS until year 2025 before a second line is introduced. Also, a second force main will be introduced for EZPS.

A new main pumping station will be required at al-Sukhneh, to pump contributing flows from al-Sukhneh to EZPS. Flows from Hai al-Ameera Haya and its surrounding neighborhoods will be drained towards this pumping station through a new 800 / 900 mm trunk sewer along Wadi Zarqa.

Another pumping station will be installed in Wadi Dhuleil near As Samra WwTP to pump the flows from Dhuleil to the plant.

Flows of communities within the Wadi Zarqa Zone (downstream of al-Sukhneh) in Birein District are treated locally by two small packaged wastewater treatment plants.

The conveyance and trunk sewerage system of the recommended system are presented in **Figure 2.5**.

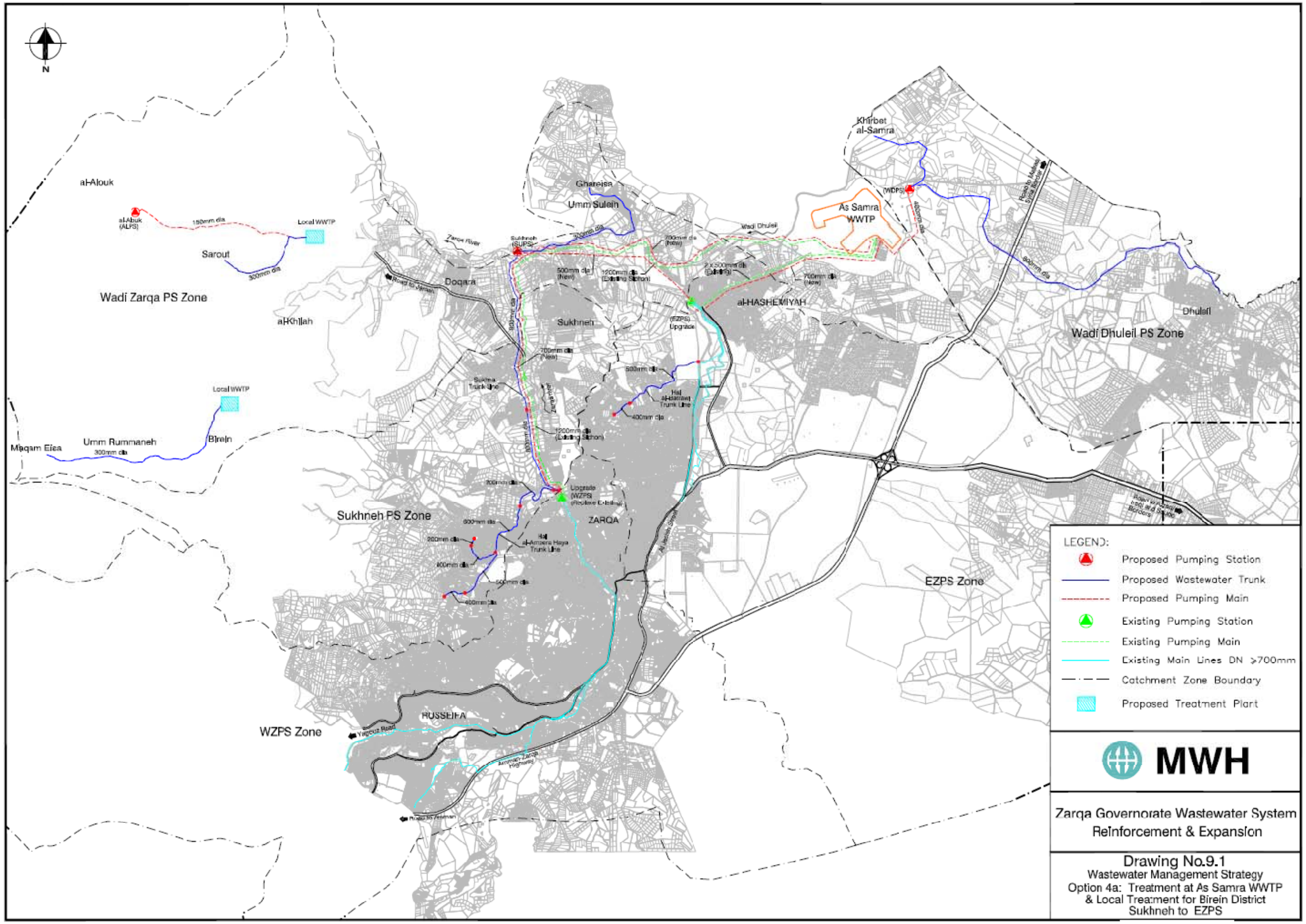
N
al-Abuk (ALPS)
150mm dia
Local WWTP
Sarout
320mm dia
Wadi Zarqa PS Zone
aKhllah
Local WWTP
Maqam Eisa
Umm Rummaneh
300mm dia
Birein
Ghareisa
Umm Sulein
Zarqa River
Sukhneh (SUPS)
300mm dia
Wadi Dhuleil
700mm dia (New)
Road to Amman
Doqara
500mm dia (New)
1200mm dia (Existing Siphon)
2 x 500mm dia (Existing)
700mm dia (New)
Sukhneh
(EZPS) Upgrade
700mm dia (New)
Sukhna Trunk Line
500mm dia
Hal al-Samrae Trunk Line
400mm dia
1200mm dia (Existing Siphon)
Upgrade (WZPS) (Replace Existing)
Sukhneh PS Zone
600mm dia
200mm dia
Hal al-Amaera Haya Trunk Line
400mm dia
500mm dia
400mm dia
ZARQA
Khirbet al-Samra
(WDPS)
400mm dia
As Samra WWTP
Road to Mafraq Dyke Bridge
900mm dia
al-HASHEMIYAH
Dhuleil
Wadi Dhuleil PS Zone
EZPS Zone
WZPS Zone
RUSSEIFA
Yajouz Road
Amman-Zarqa Highway
Road to Amman
LEGEND:
Proposed Pumping Station
Proposed Wastewater Trunk
Proposed Pumping Main
Existing Pumping Station
Existing Pumping Main
Existing Main Lines DN >700mm
Catchment Zone Boundary
Proposed Treatment Plant
MWH
Zarqa Governorate Wastewater System Reinforcement & Expansion
Drawing No.9.1
Wastewater Management Strategy
Option 4a: Treatment at As Samra WWTP & Local Treatment for Birein District
Sukhneh to EZPS

Figure 2.5: Treatment at As Samra WWTP & Local Treatment for Birein District Sukhneh to EZPS

2.7.4. Planning Criteria

The establishment of basic planning criteria and the subsequent projection of wastewater services requirements using these criteria are crucial to the formation of a proper Wastewater Development Plan for Zarqa. The following criteria and projections have been established and used by the Project Team in its formation of the Master Plan. For the most part, the criteria and projections summarized herein are based on the experiences of WAJ and on the past studies conducted within the planning area supplemented with additional data and information collected by the Team under this current study. These planning and design criteria are discussed below.

Planning Period

The planning period for this project was established to be the period through year 2035. Therefore, key planning parameters, such as population, water consumption and wastewater production projections, have been defined in five-year increments, with the first being 2010.

Service Area

In accordance with the Terms of Reference all villages and towns in the Governorate of Zarqa shall be included in the study. After discussions with WAJ it was understood that a feasibility study and final design and preparation of bidding documents project for the wastewater collection, treatment and reuse for Azraq, in the eastern parts of the governorate, is currently underway. Therefore this area will be excluded from this Study.

The proposed area consists of the existing wastewater service area plus approximately 10,300 hectares within the current municipality boundaries encircling the existing service from west and north directions in addition to the proposed development areas in the King Abdullah Bin Abdul Aziz City and al-Majd City and the towns and villages in Birein, al-Hashmiyah and al-Dhuleil districts. This area has been developed in conjunction with WAJ and is also consistent with the planning boundaries of the municipalities of Zarqa, Russeifa and al-Hashmiyah.

Level of Service

The initial focus of the reinforcement and expansion program will be on bringing sewers to areas that are currently only served by water and to areas that have inadequate wastewater collection systems. These areas will be given high priority under the evaluation of areas to be included in the MCC funded Investment Program. As future areas develop, the plan will be formulated on the basis that both water and sewerage services will be provided to each new development at the same time.

Relative to the specific targeted levels of service to be provided, the following principals have been used for this Master Plan:

- 100 percent coverage by reticulated sewer system for all developed urban areas within the Zarqa, Russeifa and al-Hashmiyah municipality boundaries;

- 100 percent coverage by reticulated sewer system for all towns and villages that could be connected to the existing systems by gravity or are within close proximity to the existing systems;
- If found feasible, reticulated sewer system will be provided to towns and villages in Birein, al-Hashmiyah and Dhuleil districts; and
- Outlying small villages such as Tafeh, Mazare'e Halabat and Ruheil will remain on on-site wastewater disposal systems.

Population

The results of the 2004 Census revealed that the resident population of Zarqa Governorate for that year was approximately 799,000, about 15% of the national population. This indicated a growth rate for the governorate of 2.2% per annum between the 1994 and 2004 inter-censal period. The national and Amman Governorate growth rates were 2.6% and 2.8% respectively for the same period. It is considered that migration to Amman skews the population growth rates below the average for Amman Governorate.

The population projections are based on the Department of Statistics (DOS) projections and the planning considerations of the major urban development areas. The DOS projected population of the Zarqa Governorate is presented in **Table 2.4**.

Table 2.4: Department of Statistics Zarqa Governorate Projected Population

Year	Population	Growth rate
2004	799,000	
2010	921,451	2.40%
2015	1,033,404	2.32%
2020	1,133,368	1.86%
2025	1,231,580	1.68%
2030	1,329,048	1.53%
2035	1,426,229	1.42%

Source: Department of Statistics

In discussions with DOS officials it was understood that the above projections do not consider the effects of the two major urban development projects of King Abdullah Bin Abdul Aziz City and al-Majd City in east Zarqa. The planned population of these two areas at year 2035, shown in **Table 2.5**, as collected from the developers is about 33% of the DOS projected population.

Table 2.5: Populations Projections of Major Development Areas

Year	King Abdullah Bin Abdul Aziz City	Al-Majd City	Total
2010		-	
2015	67,945	31,800	99,745
2020	121,824	42,400	164,224
2025	260,429	42,400	302,829
2030	339,071	42,400	381,471
2035	430,400	42,400	472,800

Therefore, to arrive at a reasonable population projection for the project area it is considered that half of the population of the new major development areas would come from outside the Zarqa Governorate. The adopted growth rates and population projection at five year intervals up to year 2035 based on the above criterion is shown in **Table 2.6**.

Table 2.6: Proposed Zarqa Governorate Population Projection

Year	Migration from other governorates	DOS Zarqa population projection	Proposed projected population	Overall growth rate
2010		921,451	921,451	
2015	49,873	1,033,404	1,083,277	3.29%
2020	82,112	1,133,368	1,215,480	2.33%
2025	151,415	1,231,580	1,382,995	2.62%
2030	190,736	1,329,048	1,519,784	1.90%
2035	236,400	1,426,229	1,662,629	1.81%

The projected population distribution in the districts and municipalities of Zarqa is based on the projected growth of the existing population of the existing built up areas and on the projected population densities in the planned new residential expansion areas in each of the districts.

The population distribution projection in the towns and villages outside the municipality planning boundaries of Zarqa, Russeifa and al-Hashmiyah is primarily based on the forecasts made by DOS.

The population distribution projection in the existing built up areas within the above mentioned municipality boundaries is primarily based on the forecasts made by judgment of the present saturation levels determined from examination of the satellite images and observations made by the Team during reconnaissance trips. For areas judged to be currently built up more than 60% of saturation levels an annual growth rate of 1% was adopted for the period from 2004 to 2010 and a constant growth rate of 0.5% thereafter until 2035 or until the area reached saturation levels.

For areas judged to be to currently saturated (40% to 60% saturation level) an annual growth rate of 1.5% was adopted for the period from 2004 to 2010 and a constant growth rate of 1% thereafter until 2035 or until the area reaches its saturation levels.

The population distribution projections in the new expansion within the planned municipality boundaries of Zarqa and Russeifa have been made by distributing the total projected population in the new expansion areas for each phase by assuming a constant population density for all districts and for each phase.

Detailed population projection calculations in the districts are summarized in **Table 2.7** and **Table 2.8**.

Table 2.7: Population Growth Rates in Project Areas

Period	Towns and villages outside Zarqa, Russeifa and al-Hashmiyah	Zarqa, Russeifa and al-Hashmiyah areas		
		Current saturation level less than 40%	Current saturation level between 40-60%	Current saturation level more than 60%
2004-2010	2.40%	22.90%	1.50%	1.00%
2010-2015	2.32%	6.76%	1.00%	0.50%
2015-2020	1.86%	5.45%	1.00%	0.50%
2020-2025	1.68%	2.39%	1.00%	0.50%
2025-2030	1.53%	1.03%	1.00%	0.50%
2030-2035	1.42%	2.19%	1.00%	0.50%

Table 2.8: Projected Zarqa Governorate Population

District / Community	Year						
	2004	2010	2015	2020	2025	2030	2035
Zarqa District [1]	1,410	1,626	1,823	1,999	2,173	2,345	2,516
Zarqa Municipality	412,982	497,032	539,433	585,503	614,876	634,111	665,392
Birein District	12,434	14,339	16,081	17,637	19,165	20,682	22,194
Dhuleil District	34,071	39,292	44,066	48,329	52,517	56,673	60,817
Russeifa District	280,287	304,925	312,807	323,832	333,108	341,387	351,211
al-Hashmiyah Municipality	26,619	28,257	28,971	29,702	30,452	31,221	32,009
al-Hashmiyah District *	21,772	25,109	28,159	30,883	33,559	36,215	38,863
Azraq District	9,426	10,871	12,192	13,371	14,530	15,680	16,826
King Abdullah Bin Abdul Aziz City			67,945	121,824	220,000	339,071	430,400
al-Majd City			31,800	42,400	42,400	42,400	42,400
Total	**799,000**	**921,451**	**1,083,277**	**1,215,480**	**1,362,780**	**1,519,784**	**1,662,629**

Wastewater Flow

Based on a review of the water billing data for the period between 2006 and 2009, the average per capita billed amount was 64.6 L/d. The reported average unaccounted-for water during the same period was 46%, with the administrative losses being 80% of the physical losses (25.5% for physical

1 Population of towns and villages outside planned municipality boundaries.

losses and 20.5% for administrative losses). Consequently, the average water consumption during this period was about 90 lpcd, assuming all of the administrative losses were consumed by the population.

The recommendations of the year 2004 National Water Master Plan (NWMP) for municipal water use are adopted to estimate the water consumption for the project area. The NWMP municipal water consumptions are presented in **Table 2.9**. These consumption figures include all municipal uses such as residential, commercial, institutional and light industrial.

Table 2.9: NWMP per Capita Water Consumption Projections (L/c.d)

Socio-economic unit	2015	2020	2025	2030	2035
Governorates	128	132	132	132	132
Urban areas (Amman and Irbid)	145	150	150	150	150

The jump in the 2015 water consumption rate NWMP projection is very steep from the current consumption rates. As this rise cannot be foreseen to happen prior to the implementation of the major water supply projects such as the Disi project the water consumption rate for years 2010 and 2015 are assumed to be 101 and 106 L/c.d as recommend by the year 1997 Harza Master Plan report.

In 1997 Master Plan, wastewater flows were calculated to be about 87% of water consumption based on wastewater flows measured at AGTP and the WZPS and EZPS. This same proportion was used as the basis of projecting wastewater flow in the master plan. The 2006 update of the master plan also recommended the use of this percentage, so for the purpose of this study it is also assumed that 87% of the water consumed results in wastewater generation.

The recommendations of the MWI Policy Note, issued on 21 April 2010, on water allocation for municipal water use is adopted to estimate the water consumption for the project area. The MWI Policy Note municipal water consumptions are presented in **Table 2.10**. These consumption figures will be used for the design and sizing of wastewater system facilities and they include all municipal uses such as residential, commercial, institutional and light industrial.

Table 2.10: NWMP per Capita Water Consumption Projections (L/c.d)

Location	Water consumption (lpcd)
Amman	120
Other cities	100
Villages	80
Suburbs	80

Future wastewater generation rates estimated based on population forecasts, water consumption rates and the wastewater return value are presented in **Table 2.11**.

Table 2.11: Wastewater Generation Projections of Zarqa Governorate (m^3/d)

	2010	2015	2020	2025	2030	2035
Zarqa District*	113	127	139	151	163	175
Zarqa Municipality	43,996	47,899	50,853	53,680	55,919	57,970
Birein District	998	1,119	1,228	1,334	1,439	1,545
Dhuleil District	2,735	3,067	3,364	3,655	3,944	4,233
Russeifa District	25,732	26,916	27,570	28,237	28,890	29,470
al-Hashmiyah Municipality	2,458	2,584	2,649	2,716	2,784	2,855
al-Hashmiyah District *	2,014	2,258	2,477	2,691	2,904	3,117
Azraq District	757	849	931	1,011	1,091	1,171
King Abdullah Bin Abdul Aziz City		4,350	11,745	20,010	29,580	39,185
al-Majd City		2,767	3,689	3,689	3,689	3,689
Total	**78,803**	**91,935**	**104,643**	**117,175**	**130,406**	**143,408**

Note: * Population of towns and villages outside planned municipality boundaries

Applying the water consumption rates recommended by the MWI Policy Note and the same return factor of 87% as used for Zarqa areas, the projected wastewater flow quantities from the Amman Tributaries are as summarised in **Table 2.12**.

Table 2.12: Wastewater Flow Projections from Tributaries of Amman (m^3/d)

Area	2010	2015	2020	2025	2030	2035
Shafa Badran	1,459	1,636	1,794	1,950	2,104	2,258
Jbaiha	1,874	2,102	2,305	2,505	2,703	2,901
Tareq	5,734	6,431	7,053	7,664	8,271	8,876
Marka	10,742	12,047	13,212	14,357	15,493	16,626
Al Nasr	7,649	8,578	9,408	10,224	11,033	11,839
Basman	445	499	547	595	642	689
Total	27,903	31,293	34,321	37,295	40,246	43,189

Sewer Design and Installation Considerations

The minimum size of sewer pipe, to prevent clogging shall be:

- Minimum service connection diameter: 150 mm
- Minimum sewer diameter: 200 mm

The minimum depth of sewers shall be 1.50 m to allow house connections to be made and to reduce the crossing probabilities with other utilities such as water, electricity and telephone.

The minimum cover of the sewer pipe shall be 1.0 m to protect the pipe from traffic loads. If this protection is not achieved then the sewers shall be encased in concrete.

The maximum depth depends on the slope, topography, ground conditions and other factors, but typically should be limited to 6 m.

The horizontal separation distance between sewers and water mains shall not be less than 3.0 m. The vertical separation distance at crossings between inverts of water lines and crown of sewers shall not be less than 0.5 m. Where this vertical separation distance in not secured, both lines shall be concrete encased for at least 3.0 m from both sides of the crossings.

Width of trenches shall be limited to outside pipe diameter plus 600 mm. Minimum working space around the sides of the pipe shall be 200 mm.

House Connections

House connections, usually 150 mm in diameter, shall be connected to the main sewers at manholes. These shall be installed at a minimum gradient of 2 percent and at 90 degrees to the centerline of the sewer. House connections shall end at an inspection manhole one meter outside the property wall to permit cleaning out the connection and to locate blockages.

All house connections inside the properties shall be provided with ventilation pipes.

Wherever possible a single connection to a manhole shall be used to serve two or three houses. This will be accomplished by running a 150 mm parallel sewer along the sidewalk.

Manholes

Manholes are provided on sewers as a means of access for inspection, testing and clearance of obstructions. Except for very shallow sewers of less than one meter depth to invert; all manholes should be of adequate dimensions to facilitate entry and for the operation of cleaning apparatus while wearing full safety equipment.

Manholes shall be provided at the head of a sewer, at every junction of two or more sewers and wherever there is a change in its alignment, gradient, diameter or material. Otherwise maximum spacing should be as listed in **Table 2.13**.

Table 2.13: Maximum Spacing between Manholes

Sewer diameter	Maximum spacing
200 mm	50 m
300 & 400 mm	70 m

Sewer diameter	Maximum spacing
500 mm and larger	100 m

Recommended Pipe Materials

It is recommended that the technical specifications for the construction of gravity sewers in Zarqa permit only the pipe materials shown in **Table 2.14**.

Table 2.14: Recommended Pipe Material

Pipe diameter	Pipe material
Up to 200 mm	Concrete, uPVC
300 mm to 1000 mm	Reinforced concrete, GRP
Over 1000 mm	GRP

2.7.5. Pumping Station Design Criteria

Pumping stations are provided in a sewerage system generally to either avoid the construction of uneconomically deep gravity sewers or to transfer sewage flows from isolated communities which cannot be connected to the treatment works or point of disposal by a gravity pipeline.

The pumping station must be located so that neither noise nor odors are potential causes of nuisance. The location of all pumping stations should be such as to permit reasonable vehicular access for the purposes of repair and maintenance.

Planning Period

The design flow for the sewage pumping stations shall consider the current and projected peak flow rates. Sewage pumping station discharge flow rates shall, at minimum, accommodate the 25-year planning horizon taking into consideration the lifecycle of the pump station components as the follows:

- Site works, civil and structural components: 50 years
- Electrical works: 25 years
- Instrumentation: 10 years
- Mechanical equipment: 15 years

In circumstances where the pumping station is planned for interim use the planning period for establishing flow rate can be shorter. For all pumping stations, consideration shall be given to future upgrading flexibility necessary to accommodate flows beyond the planning horizon. This is especially important for the larger sewage pumping stations.

Pumping Station

Submersible wastewater non-clog pumps shall be used for wastewater pump stations. Pumping stations shall be designed to pump the flow utilizing a minimum of three pumps (2 operational + 1 standby) with consideration for future expansion.

Ductile Iron pipe work will be used in the pump station and for inter-connecting pipe work.

All main pumping station sumps should be constructed in reinforced concrete of rectangular design. The wet wells will be lined with GRP or PE, which perform satisfactorily provided that they are installed with care, allowing no possibility for attack of the concrete beneath it.

A single manhole outside the station sump shall be provided at all pumping stations into which all incoming sewers are collected so that there is only one inlet to the sump itself. This simplifies the problem of over pumping of sewage in the event of a major failure of the pumping station.

Sluice valves and non-return valves are fitted to each pump outlet, and further valves are often not necessary unless it is intended to be able to isolate the rising main for washing out purposes or for the addition of further pumping units in the station at some future date.

If twin rising mains are installed, an emergency by-pass should be provided between the two pipelines, and sufficient sluice valves must then be fitted immediately outside the station, so that either main can operate as the duty main or both pipelines can operate either separately or together.

Although the sumps are entirely closed there is the possibility of odor problem at most main pumping stations. De-odorisation equipment may therefore need to be provided.

Flow metering is to be provided as standard in all pumping stations.

Sewage composition can vary widely, adequate consideration and necessary provisions shall be taken to ensure that sewage pumping station equipment and materials are suitable for the anticipated composition of sewage. Mechanical screens and in some cases grit removal systems should be provided to protect pumps and prevent the pumps being clogged by large objects.

Also, consideration should be given to providing main pumping stations with emergency storage facilities, should space permit.

Sewerage systems normally incorporate two types of pumping stations:

- Submersible stations: These could be used to serve average wastewater flows up to 100 L/s, the submersible station basically comprises a wet well with two or more submersible pump sets.

- Wet well / dry well stations: These are designed essentially to be able to isolate the pumping equipment from the sewage without moving the equipment, for ease of maintenance. These main pumping stations normally operate on trunk sewers.

3. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

This section presents the national and international guidelines that apply to this project including MCC requirements since this project will be partially funded by the MCC and need to abide by its guidelines. It 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 the national law.

Specifically, the legislative framework presented in this section is relevant to the wastewater system reinforcement and expansion works and the assessment associated with this type of project.

3.1. National and International Environmental Policies and Agreements

3.1.1. Policies

In this section reference is made to MWI water policies on irrigation, water, groundwater, and wastewater management.

The Wastewater management policy key considerations are:

- Provision of adequate wastewater collection and treatment facilities for all the major cities and towns in Jordan.
- Protection of the environment and public health in the areas affected by the proposed systems, especially, surface and ground waters.
- Consideration of treated effluents as a source for irrigation reuse.
- Improvement of the socioeconomic conditions in the areas to be served by the proposed systems.

The aspects of the wastewater management policy related to this project are as follows:

- On Resource Development:
  - Wastewater is a perennial water source and shall form an integral part of renewable water resources and the national water budget.
  - Collection and treatment of wastewater is a necessity to circumvent hazards to the public health and the environment. It becomes imperative when contamination of freshwater resources with wastewater is eminent.
  - Collection and treatment of wastewater becomes mandatory to protect public health against water borne diseases, and where epidemics become a threat otherwise.
  - Existing levels of wastewater services shall be maintained and upgraded where necessary to enhance public health and the environment.
- On Wastewater Collection and Treatment:

- The existing level of services shall be sustained and promoted. Where it is necessary to meet public health and environmental objectives, treatment shall be improved. Wastewater shall be collected and treated in accordance with WHO and FAO Guidelines as the basis for effluent quality requirements for reuse in irrigation. However, final reuse options, type of crops to be irrigated, location of the reuse and the treatment plant location shall govern the level of treatment (effluent parameters), and the treatment technology to be adopted.
- Priority shall be given to protecting public health and water resources from chemical and microbiological pollutants.
- Where possible, gravity flow shall command the collection and conveyance lines.

- On Pricing:
  - In view of increasing marginal cost of wastewater collection and treatment, wastewater charges, connection fees, sewerage taxes and treatment fees shall be set to cover the operation and maintenance costs at a minimum. It is also highly desirable that part of the capital cost of the services is recovered. The ultimate aim is for a full cost recovery.
  - Appropriate criteria in order to apply the "polluter pays" principle shall be established.
  - Different charges for different areas may be applied. This shall be assessed for each geographical area as a function of end use and effluent quality and will be subject to economic and social considerations.
- On Selected Priority Issues:
  - Priority shall be accorded to situations and locations where waste-water disposal practices threaten the environmental integrity of freshwater resources, and where performance of cesspools and percolation pits pollute underground water aquifers.
- On Standards, Regulations and Quality Assurance:
  - Jordanian Standards JS893/95, JS202/91, JS 1145/96, WAJ's regulations for the quality of industrial wastewater to be connected to the collection system and WAJ's specifications for sewerage works, have been, thus far, the benchmarks against which plans and specifications of treatment plants and wastewater reuse were evaluated. They were established to bring about relative uniformity throughout the country. Periodically, these standards and regulations should be reviewed and modified to reflect special ambient conditions or end uses. Other aspects shall also be considered, e.g. economic socio-cultural, environmental and regional aspects.
  - Roof and storm water connections to public sewers shall be prohibited. Collection of storm water shall be done separately and will be the subject of water harvesting.
- On Financing and Investment:
  - Because of the limited financial resources available to Jordan, setting investment priorities in wastewater will be compatible with government investment plans.
  - Criteria for prioritizing investments in the wastewater sector shall take into account the current and future needs of the country, needs to expand wastewater systems in urban

areas and to provide wastewater systems to smaller towns and villages that are not yet served.

- Priorities of wastewater projects shall not be disconnected from water supply projects and urbanization in general. Decisions will be made concerning them to attain optimum solutions to the need for services, availability of finance and availability of trained manpower.

- On Public Awareness:
  - The public shall be educated through various means about the risks associated with the exposure to untreated wastewater and the value of treated effluents for the different end uses.
  - Public awareness campaigns shall also be waged to educate the public on the importance of domestic hygiene, wastewater collection, treatment and disposal.

3.1.2. Regional and International Agreements and Protocols

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

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

3.2. Relevant Environmental-Related Institutions

MWH have identified the main ministries, institutions and authorities that are directly involved with the environmental control, protection and regulation within the Project's study areas. These different entities are described in the following sections.

3.2.1. Ministry of Environment

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

The 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. The MoE develops environmental policies that are implemented and enforced throughout the Kingdom. Moreover, it is dedicated to ensuring that legislation is enforced through raising public awareness, implementation of inspection and monitoring programs, and encouraging cooperation with national, regional and international bodies.

The MoE is legally reinforced by the environmental law which provides the Ministry with the tools necessary to perform their duties. The Environmental Protection Law was one of the temporary laws issued in 2003, and was officially endorsed by the Jordanian Parliament in 2006 and issued as the Law No. 52 for the Year 2006.

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

Law No. 52 provides the Ministry with the legal power to inspect any facility, and according to the findings of the audit, gives the Ministry the right to order a facility shutdown until the proper mitigation and control measures are implemented and the environmental violation eliminated. This inspection system was further strengthened with the establishment of the Environmental Police in 2007. The police now act as an implementation tool and a fully fledged partner in the implementation of the environmental law.

The Environmental Protection Law has also introduced a system of an environmental "pre-emptive" assessment of all economic and developmental projects to be established in Jordan. This process is known as the Environmental Impact Assessment (EIA) where any developmental or economic project should carry out a detailed assessment of the expected environmental impacts potentially arising from the implementation of the project, and how these impacts can be mitigated through remedial action at the technical, legislative and public levels.

According to the Environmental Protection Law, the EIA study should be done before the project is initiated and sent to the Ministry of Environment where it will be reviewed. A reference to the EIA Regulation No. (37) / year 2005 should be made as it sets out the process for conducting an EIA study and the required documentation for obtaining an environmental clearance. In addition, it lists the projects that require a full EIA or a Preliminary Environmental Impact Assessment.

This wastewater system project is classified as infrastructure. According to the Jordanian EIA Regulation No. (37) for year 2005, infrastructure projects are listed under Category 2 projects i.e. it requires a preliminary EIA.

However, the results of the preliminary EIA will indicate whether the project will remain as a Category 2 project or would be classified as a Category 1 requiring a full EIA. If the project is to be categorized as a Category 1, and in accordance with Article (9) of Jordanian EIA Regulation, the Project Owner (i.e. WAJ) need to submit a preliminary draft of the Terms of Reference (ToR) for the EIA Study followed by the subsequent Draft Scoping Statement, Final Scoping Statement and TOR, Draft EIA Report with Environmental Management Plan and then a Final EIA report incorporating all received comments and feedback.

If the Impact assessment is approved, the project will get the 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.

3.2.2. Ministry of Energy and Mineral Resources

Ministry of Energy and Mineral Resources (MEMR) shares the responsibility with the Ministry of Environment and Ministry of Health for the protection of the environment within Jordan.

3.2.3. Ministry of Water and Irrigation (MWI) / Water Authority of Jordan (WAJ)

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

Units for public relations, internal monitoring and water security and protection are directly subordinate to the Minister of Water and Irrigation with responsibilities overarching MWI, WAJ and JVA (Ministry By-Law No.52 of 1992).

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

- The Water Authority of Jordan (WAJ): in charge of water & sewage systems.

- The Jordan Valley Authority (JVA): responsible for the socio-economic development of the Jordan Rift Valley, including water development and distribution of irrigation.

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

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

3.2.4. Other Relevant Institutions

Ministry of Health

The Ministry of Health (MoH) undertakes all health affairs in the Kingdom and its tasks and duties include:

- Maintaining public health by offering preventive, treatment and health control services.
- Organizing and supervising health services offered by the public and private sectors.
- Providing health insurance for the public within available means.
- Establishing and controlling the management of health, educational and training institutes and centers according to relevant provisions of the legislations enacted.

- The Ministry also works in coordination with concerned parties, to raise public health standards by fighting diseases resulting from malnutrition.

Ministry of Municipalities and Municipal Affairs

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

- Providing the various facilities to the municipalities to enable them to perform their functions and support them in improving the services efficiency.
- Oversee, coach and monitor the financial, administrative and organizational performance of the municipalities.
- Enhance the institutional capabilities of the sector.
- Manage the financial transactions and arrange with the relevant parties to provide the necessary funding for the programs and projects.
- Set, develop and implement the legislative, administrative, financial and institutional frameworks that are effective for the municipal operations.
- Prepare the regional, organizational and detailed construction plans for the municipalities.
- Monitor and control the implementation of the regulations, policies and instructions of the municipalities and joint services councils. Draw up the regulatory bills of the municipal affairs sector. Review and supervise the infrastructure projects of the municipal councils and develop the designs, technical specifications and tender documents in addition to sustaining and developing the inhabited clusters that have no municipal councils.

Ministry of Public Works and Housing

The Ministry of Public Works and Housing aims to develop a network of public roads in the kingdom, linking towns, villages and communities, sites of industrial production, agricultural and tourist areas and archaeological sites. The Ministry of Public Works and Housing also aims to link the Kingdom and neighboring countries and sustain this network. The Ministry is also working on upgrading the quality of roads and the promotion of safety requirements in addition to keeping abreast of the latest updates and techniques of modern roads and lighting.

Department of Land and Survey

The Department of Land and Survey is responsible for maintaining, documenting, preserving and facilitating the use of the land property rights, and providing the data base 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 in order to carry out its mission:
- Devising the general policy for transport and overseeing its implementation in coordination and cooperation with all related parties.
- Regulating and monitoring the road freight transport sector and its services, as well as issuance of necessary permits for individuals and companies operating in the sector.
- Regulating and monitoring the freight transport by rail sector and its services, as well as issuance of necessary permits for operating in the sector and many other responsibilities.

Public Security Directorate / Traffic Department

The Traffic Department of the Public Security Directorate is needed to coordinate any changes in road traffic due to construction works. The department's duties include:

- Participate in the general policy of traffic control and transport in the Kingdom in cooperation with other involved entities.
- Enforce the 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 in order to reach suitable solutions.
- Put plans and procedures to monitor and control roads used by official envoys.
- Issue tickets and collecting fines for issued tickets.
- Participate in implementation of public transport policy in coordination with Public Transport Regulatory Commissions.
- Monitor the work of traffic safety volunteers and activate the role of social police.
- 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 traffic problems, their reasons and suitable solutions.

Ministry of Awqaf and Islamic Affairs and Holy Sites

This Ministry is responsible for the development of religious tourism and economic investment, identifying investment priorities and laying the foundations for investment projects to cover all the governorates of the Kingdom. The Ministry also looks after and manages all Awqaf, Islamic affairs and Holy sites in the Kingdom of Jordan.

Ministry of Agriculture

The Ministry of Agriculture (MoA) is responsible for managing public rangelands and forests; protecting soil; pasture-land and flora; provision of agricultural loans; supporting farmers, and granting permits for the import and export of agricultural products of plant, animal and 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, provide training for farmers, protecting and managing wildlife, and issuing fishing and hunting licenses and regulations.

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

Ministry of Tourism and Antiquities / Department of Antiquities

The Ministry will work towards developing tourism in a comprehensive and integrated approach to express the nation's legacy, culture, history, heritage, inheritance, successive civilizations and economic prosperity. It aims to develop an advanced tourism industry capable of utilizing its comparative and competitive advantages through highly developed infrastructure facilities and superstructure services.

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

The first unit that took the role of a Department of Antiquities of 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 works. The official Department of Antiquities of Jordan was established in 1928.

The main institutional policy of the DoA:

- The principal policy of the Department of Antiquities 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 presentation of antiquities, including research, survey, excavation and site management.

One of the important issues the DoA would be involved in such a wastewater project is the possibility of coming across some artifacts during construction work due to excavation activities. The Law of Antiquities (No. 21, 1988) calls for immediate reporting of any found remains where Article (21) of this law indicates that all antiquities discovered during excavations carried out by any party shall be considered the property of the State. The Department then has the right to assess the significance of any discovered remains/antiquities and puts its recommendations accordingly.

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 the Kingdom. To keep pace with social and economic development, the Labor Law No. (8) for the year 1996 was issued and the administrative regulation No. (38) of the year 1994 was established, along with its amendments.

The tasks of the Ministry include:

- Organizing the labor sector, as well as updating labor legislations so as to meet the needs of the labor market in light of the social and economic developments within a framework that maintains the production parties rights, and contributes in encouraging the foreign investments.
- Contribution in the development of workforces through the Vocational and Technical Training and Educational Council.
- Collaboration in human resources and workforces development projects.
- Applying the Law of Vocational Work Organization.
- Organizing the foreign labor in the Jordanian Labor Market.
- Maintain available job opportunities to employ Jordanian Labor.
- Restructuring and re-organizing the Ministry of Labor so as to enable it to achieve its objectives with full efficiency.
- Building up labor market databases.
- Consolidating cooperation and partnership with the private sector.
- Consolidating regional and international cooperation and partnership.
- Consolidating partnership and cooperation with corporations concerned with preparing and developing Human Resources.

Jordan Institute for Standards and Meteorology (JISM)

Jordan Institution for Standards and Metrology (JISM) plays a proactive role in protecting the interests, health and safety of citizens and environment and enhancing the competitiveness of Jordanian products in the national, regional and international markets in keeping with the national goals and contributing to achieving them within the defined priorities.

JISM prepares, approves, revises, amends and monitors the implementation of standards and technical regulations with regard to all services and products (with the exception of pharmaceutical products, medicines, veterinary medicines, serums and vaccines).

JISM fulfils 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 supporting working environment and developing all needed human, knowledge, material, technological and financial resources.

3.3. Principal National Legislation

3.3.1. Laws

- The Environment Protection Law No. 52 for the year 2006.
- Water Authority Law No. 18 of the year 1988 and its amendments.
- Underground Water Control By-Law No. 85 of 2002.

- General Health Law (No.47, 2008).
- Public Health Law No. 54 of 2002.
- Decree (12) of 1987 or Land Acquisition Law (LAL) and its amendments.
- The Development Zones Law No. (2) for the year 2008.
- Traffic Law (No. 49, 2008).
- Transportation Law (No. 89, 2003).
- Agricultural Law of 2002.
- Temporary Law (No.64, 2002) – General Electricity Law.
- Labor Law No. 8 for the year 1996 and its amendments.
- Law of Awqaf and Islamic Affairs and Holy Sites (No. 32, 2001).
- The Antiquities Law and its amendments year 2004, simultaneously read with The Antiquities Law No. 21 / year 1988.
- Civil Defense Law (No. 18, 1999).
- Forestry and Soil Protection Law No. 23, year 1972, issued in accordance with Article 31 of the Jordanian Constitution.
- The Organization of the Natural Resources Affairs Law no. (12) / year 1968.
- Law of Handicrafts and Industries (No.16, 1953)
- Municipality Law (No. 55, 1954).
- Administration of Public Property Law (No. 17, 1974).

3.3.2. Regulations

- The Environmental Impact Assessment Regulation No. (37) For the year 2005.
- Land use planning Regulation No. 6 for the year 2007.
- Regulation for the licensing and permitting of excavation and infrastructure network projects (No. 112/2007).
- Natural Reserves and National Parks Regulation No. (29) / Year 2005.
- The Protection of the Environment from Pollution in Emergency Situations Regulation No. 26 for the year 2005.
- Regulation of Harmful and Hazardous Waste Management, Transfer & Handling No. 24, 2005.
- Soil Protection Regulation No. 25 for the year 2005.
- Regulation of Solid Waste Management No. 27 for the year 2005.
- Air Protection Regulation No. 28 for the year 2005.
- Regulation of Controlling the Use of Substances that Deplete the Ozone Layer for the year 2003, issued in accordance with Law No. (1) 2003 Articles 9-15; 'Law for the Protection of the Environment'.
- Regulation (No.43, 1998) of Protection and Safety from Industrial Tools and Machines and Worksites – Issued by the virtue of the provisions of Paragraph (c) of Article (85) of the Labor Law No. (8) of 1996.

- Regulation for the establishment of Occupational Health and Safety Committees no.(7) / year 1998, issued in accordance to Article (85) of the Jordanian Labor Law no.(8) / year 1996 and its amendments.
- Groundwater Control Regulation No. 85 of 2002, Issued pursuant to Articles 6 and 32 of Water Authority Law No. 18 or 1988.
- Regulations for Protection of Birds and Wildlife and rules covering their hunting (No. 113, 1973).
- Regulation of Awqaf and Islamic Affairs and Holy Sites (No.142, 1966) and its amendments till 16th of December, 1991.

3.3.3. Instructions

- Instructions for the Limitation and Control of Noise for the year 2003.
- Instructions for Disposal of Industrial and Commercial wastewater into the sewage network, issued in accordance with Water Authority Law No. 18 for year 1998 and Article No. 23 of the Sewage System Law No. 66 for the 1994.
- Instructions No. (1) for year 2006 or the prevention of occupational hazards related to health hazards resulting from labor housing units onsite, issued in accordance to article (51) of the temporary general health law No. (54) for the year 2002.
- Instructions for disposal of industrial wastewater to public sewer of the year 1998 / Water Authority of Jordan.

3.3.4. Standards

- Standards for industrial reclaimed domestic wastewater (No. 202/2007) (JS893).
- Standards for reclaimed domestic wastewater (No. 893/2006).
- Ambient Air Quality (Standard No. 1140/2006).
- Standards for the prevention and elimination of noise (2003).
- Standard 1189/1998 Maximum Allowable Limits of Air Pollutants Emitted from Stationary Sources.
- Standard JS 525: 1987 Heat – Heat Levels allowed to be exposed to in work environment.
- Standard JS 524: 1987 Lighting Levels in work environment.
- Jordanian Standard JS 286 / 2001 Requirements for Drinking Water and its amendments.
- Jordanian Standard JS 893/ 2007 Requirements for Reclaimed Domestic Wastewater.
- Jordanian Standard JS 202 / 2006 Requirements for Discharges of Industrial Effluents.

3.4. National Water Strategy

Jordan Water Strategy 2008-2022 states that the vision for a water strategy is one whereby 2022, Jordan has:

- Adequate, safe and secure drinking water supply.
- Greater understanding and more effective management of groundwater and surface water.
- Healthy aquatic ecosystems.

- A sustainable use of water resources, and implemented fair, affordable and cost -reflective water charges.
- Adaptation to increased population growth and economic development across the water sector and water users.

Despite the huge improvements in infrastructure to supply water, Jordan is still facing a critical and serious supply-demand imbalance. A sustainable water supply and demand balance must be secured which means that there is a need to limit and even reduce water consumption, while not ruling out new supply infrastructure.

More pressure will be put on our water resources from changes in population, household formation and development, and lifestyles. The increase in demand is witnessed in areas where there is already a lot of pressure on the country's water resources.

The economic development of the past two decades has created enormous pressures on the quality of ground and surface water resources. The process of deteriorating water quality must be halted. This requires that water sources are actively protected from pollution through actions of the Ministry of Water and Irrigation and other involved Ministries/Agencies (i.e. Ministry of Environment), such as setting up and implementing groundwater and surface water protection zones as well as through appropriate land use planning which takes the need for water resources protection into account.

This water strategy outlines a strategic and integrated approach to the sustainable management of the country's water resources, for the public water supply as well as for the provision of healthy ecosystems and the services they provide. Achieving the vision will have social, environmental and economic implications, which need to be addressed.

This water strategy sets out Jordan's vision and key priorities for water.

In order to achieve the visions of this Water Strategy, the implementation are set under the following main themes:

- An efficient and effective institutional reform.
- A drastic reduction in the exploitation of the groundwater.
- Efficient use of water resources.
- Implementation of the Disi water conveyance and the Red Dead conveyance projects.
- Irrigated agriculture in the highlands will need to be capped and regulated and the by-laws will need to be reinforced.
- Appropriate water tariffs and incentives will be introduced in order to promote water efficiency in irrigation and higher economic returns for irrigated agricultural products

The National Water Strategy consists of the following chapters:

1. A Summary of Jordan's Water Vision

2. Water Demand
3. Water Supply
4. Institutional Reform
5. Water for Irrigation
6. Wastewater
7. Alternative Water Resources
8. Summary of Goals, and Actions

These chapters contain statements that are articulated as goals and approaches for strategic management of the Kingdom's water resources. Each of these approaches needs to be elaborated in one or more action plans that will specify how the approach will be achieved. This includes more details on the specific approach, identification of the responsible party for implementation, a timeline, and, as appropriate, geographic focus area.

3.5. Specific Relevant Government of Jordan Standards and Guidelines

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

- Ambient air quality.
- Air emission limits from stationary sources.
- Ambient noise.
- Waste Management (aqueous, solid and radio-active).

3.5.1. Ambient Air Quality

Ambient air quality limits recommended by the Ambient Air Quality Standards (No. 1140/2206) are enforced in Jordan. A summary of these recommended standards is presented in **Table 3.1**.

Table 3.1: Relevant Ambient Air Quality Standards

Air Pollutant	Average Time	Maximum Allowable Concentration in the Ambient Air	Number of Allowed Exceedences
Sulfur Dioxide (SO_2)	1 Hour	0.30 mg/kg	3 times within a given month in one year
	24 Hour	0.14 mg/kg	Once a year
	1 Year	0.04 mg/kg	--
Carbon Monoxide (CO)	1 Hour	26 mg/kg	3 times within a given month in one year
	8 Hour	9 mg/kg	3 times within a given month in one year
Nitrogen Dioxide (NO_2)	1 Hour	0.21 mg/kg	3 times within a given month in one year
	24 Hour	0.08 mg/kg	3 times within a given month in one year
	1 Year	0.05 mg/kg	--
Hydrogen Sulfide (H_2S)	1 Hour	0.03 mg/kg	3 times within a given month in

Air Pollutant	Average Time	Maximum Allowable Concentration in the Ambient Air	Number of Allowed Exceedences
			one year
	24 Hour	0.01 mg/kg	3 times within a given month in one year
Ozone (O_3)	1 Hour	0.08 mg/kg	--
	8 Hour	0.12 mg/kg	--
Ammonia (NH_3)	24 Hour	270 µg/m^3	3 times within a given month in one year
	1 Year	8 µg/m^3	--
Total Suspended Particles (TSP)	24 Hour	260 µg/m^3	3 times within a given month in one year
	1 Year	75 µg/m^3	--
PM_{10}	24 Hour	120 µg/m^3	3 times within a given month in one year
PM_{10}	1 Year	70 µg/m^3	--
$PM_{2.5}$	24 Hour	65 µg/m^3	3 times within a given month in one year
	1 Year	15 µg/m^3	--
Lead (Pb)	Seasonal	1 µg/m^3	--
	1 Year	0.5 µg/m^3	--
Phosphate (P_2O_5)	24 Hour	100 µg/m^3	3 times within a given month in one year
	1 Year	40 µg/m^3	--
Cadmium (Cd)	1 Year	0.005 µg/m^3	--

3.5.2. Air Emissions from Stationary Sources

Regulation for the Maximum Allowable Limits of Air Pollutants Emitted from Stationary Sources (No. 1189/2006) sets standards and limits for air emissions from various stationary sources and applicable to this Project (**Table 4.2**)).

Table 3.2: Air Emission Standards for Stationary Sources Relative to the Project

Air Pollutant	Maximum Allowable Concentration (mg/m^3)
Sulfur Dioxide (**SO_2**) from combustion of petroleum products	6500[2]
Nitrogen Dioxide (**NO_2**) from: Combustion sources with temperature less than 1200 ^oC Combustion sources with temperature more than 1200 ^oC	 200 1500
Volatile Organic Compounds (**VOC**)	20
Lead (Pb)	0.5
Lead compounds	20

3.5.3. Ambient Noise Limits

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

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

- All construction activities utilizing noise producing plants and equipments (e.g. mixers and vibrators) must cease between 8:00 pm and 6:00 am, unless a permit is granted by the Minister of Environment.
- Work activities within light industrial areas with residential dwellings are prohibited to continue between 9:00 pm and 7:00 am (summer) and between 8:00 pm and 6:00 am (winter).
- The Project area encompasses residential, commercial and industrial uses.
- 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 4.3**.

Table 3.3: 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

2 Until another petroleum source with lower sulfur content is made available or after five years, whichever comes first.

3.5.4. Soil and Groundwater Quality

Soil

The Soil Protection Regulation No. 25 for the year 2005 outlines the requirements of protecting the soil and preventing its contamination through proper management and monitoring. However, due to the absence of soil quality standards in Jordan, international standards such as the Dutch Ministry of Housing Soil Quality Standards presented in **Table 3.4** below are adopted for this project.

Table 3.4: Dutch Soil Quality Standards

Parameter	Soil (mg/kg dry matter)	
	Reference Value	Intervention Value
I. Metals		
Cadmium (Cd)	0.8	12
Chromium (Cr)	100.0	380
Copper (Cu)	36.0	190
Nickel (Ni)	35.0	210
Lead (Pb)	85.0	530
Zinc (Zn)	140	720
Mercury (Hg)	0.3	10.0
Arsenic (As)	29.0	55.0
Barium (Ba)	160	625
Cobalt (Co)	9.0	240
Beryllium (Be)	1.1	30
Silver (Ag)	-	15
Selenium (Se)	0.7	100
Tin (Sn)	-	900
Antimony (Sb)	3.0	15
II. Inorganic Compounds		
Bromide	20	-
Chloride	-	-
Fluoride	500	-
III. (Volatile) Aromatic Compounds		
Benzene	0.01	1
Toluene	0.01	130
Ethyl benzene	0.03	50
Xylene	0.1	25
Phenol	0.05	40
Styrene (vinylbenzene)	0.3	100
IV. Polycyclic Aromatic Hydrocarbons		
PAH (sum of 10)	1	40
V. Chlorinated Hydrocarbons		
Polychlorobiphenyl (sum)	0.02	1

Groundwater

The general rules of the Groundwater Control Regulation No. (85) of 2002, issued pursuant to Articles 6 and 32 of Water Authority Law No. 18 of 1988, is that:

"The groundwater is state-owned and subject to its control. It is not permissible to pump out or utilize underground water without obtaining a license issued according to the provisions of the law. The purpose usage and the quantities of pumped-out water and any other conditions should be identified in the license".

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

"Anyone who is granted a license to extract groundwater shall be committed not to cause water pollution or depletion and to strictly comply with the conditions of the license".

The regulation also covers licensing rules and fees as well as water prices, pollution control, and requirements from private well owners.

3.5.5. Waste Management

Solid Waste Management

Solid waste management must comply with the Regulation of Solid Waste Management No. 27 for the 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 observing and collecting operations, transportation of wastes, permitting, supervising, scheduling and archiving and outlining the responsibilities and tasks for the Ministry of Municipalities, Rural Affairs and Environment. In addition, it sets the duties to be fulfilled by the Ministry in cooperation with the related bodies. These duties include picking up the waste, defining stipulations of storage, collection, sorting, recycling, and treatment and awareness and training programs, in addition to dealing with compliance, offences, punishments and fines.

Handling of Hazardous Waste

Regulation of Harmful and Hazardous Waste Management, Transfer & Handling No. 24, 2005 focuses mainly on setting the general procedures for hazardous waste producers in terms of storing, handling and collection and disposal procedures for hazardous waste 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 for owners or managers of the specified site for storing, treating and disposing of hazardous waste in terms of receiving and registering the waste, ensuring the implementation of safe procedures in order to prevent fire and other accidents, since there are special restrictions for safety and health of the employees in the site.

Handling of Spent Oils

The handling of spent oils must follow the Instructions for Recycling and Handling of Consumed Oils of the year 2003. These instructions provide definitions of consumed oils as oils refined from raw petrol or industrial oils that have been used, and which, as a result, are transferred into polluted waste together with chemicals or physical pollutants that should be disposed of, treated or recycled. Examples are machine oils, engines oils, hydraulic oils, energy transfer and movement oils, heat exchange or any other oils that are used for lubrication. Other definitions are given for underground tanks used as storage tanks to store and treat oil, oil containers and oil collecting licensed stations. 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:

- Prohibition of discharge of oil into sewage networks or septic tanks or surface and ground water resources or the environment.
- All parties mentioned in Article 3 must obtain a license from the 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 an approval is given.
- Mixing of oils with hazardous waste and chemicals is prohibited.

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

3.5.6. 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, Decree (12) of 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 World Bank guidelines for land acquisition and resettlement respectively, noting where appropriate provisions that would not apply in the present Zarqa Governorate Wastewater System Reinforcement and Expansion 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 (i.e. in de facto possession of) the land on the day of issuance of the Council of Ministers' Resolution to acquire shall, 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 and 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 Water Rights

Compensation for farmlands may include separately itemized compensations for features such as walls, greenhouses, wells, water rights, etc.

The LAL in Article 10 stated clearly that compensation should be fair to all PAPs 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*".

The loss of water rights also attracts compensation: "*That the appropriation of the land which includes water spring by the Water Authority does not include the waters of that spring. The owners if the land was irrigated from the spring shall have the right to claim for compensation due to harm accrued to their land as a result of depriving it from the right of irrigation*."

Crops and Trees

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

Under past practice Tree Crops have been compensated in the basis of 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 dated, 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. However, Zarqa Governorate Wastewater System Reinforcement and Expansion Project for this purpose will use the table guide of Department of Land and Survey (DLS), which originally prepared and adopted by the Ministry of Agriculture.

Amount of Compensation Payable to Renters

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

- 15% if the compensation is for occupation for industrial or commercial purposes.
- 5% 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 extremely unlikely.

Source of funds

More accurate estimation of compensation will be provided in the next stage. Therefore, the necessary fund for compensation should be secured and allocated in a separate budget line item in the DLS, a Department of the Ministry of Finance.

Procedures and Mechanism for Expropriation

The LAL lays down the following procedure for the acquisition of land.

Table 3.5: Land Expropriation under Decree 12, 1987

Ministry of Water & Irrigation/WAJ	Other concerned authorities	Project Affected Persons
Step 1: WAJ provide detailed information on the land and properties to be expropriated.	PMU assist WAJ to identify and finalize information on the land and properties to be expropriated	
Step 2: Concerned WAJ announces in 2 daily newspapers the WAJ intent to expropriate specified land, providing full details.	PMU will help WAJ to estimates the budget for the proposed expropriation and support WAJ to ensure budget allocations.	
Step 3: Establish valuation committee VC to estimate compensation[3], (valuations are based on current land values and prices).	PMU will monitor the valuation process and make sure total cost within the allocated budget.	
Step 4: Announce the details of land acquisition profile including compensation cost and publish them in the official magazine.		**Step 5**: Affected persons then have 30 days to discuss compensation with Concerned municipalities and VC. Owners have the right to object, and appeal against the Compensation estimate.

3 The committee include representatives from WAJ, DLS and Ministry of Finance.

Ministry of Water & Irrigation/WAJ	Other concerned authorities	Project Affected Persons
Step 6: Negotiation and establish final offer in full coordination with VC.		**Step 7**: If no agreement is reached, owners have recourse to the Courts.[4]
Step 8: Minister of Water & Irrigation approval.	**Step 9**: The cost of compensation is finalized on ratification by the Minister of Water & Irrigation.	
Step 10: Disburse fund to PAPs.	PMU will follow-up and ensure that PAPs receive their compensation without any delay.	
	Step 11: Judicial involvement when no agreement is reached.	

3.6. MCC Environmental and Social Guidelines

MCC recognizes the following:

- The pursuit of sustainable economic growth and a healthy environment are necessarily related.
- Gender inequality can be a significant constraint to economic growth and poverty reduction.
- Development projects can have unintended negative impacts on people when not well designed.

To address these issues more fully, MCC has two specific guidance documents:

- The Environmental Guidelines: These establish a process for the review of environmental and social impacts to ensure that the projects undertaken in a Compact are environmentally sound, are designed to operate in compliance with applicable regulatory requirements, and, as required by the legislation establishing MCC, are not likely to cause a significant environmental, health, or safety hazard.
- Gender Policy: Gender is defined as the social roles, behaviors, and responsibilities assigned to women and men in any society. Unlike biology, gender is mutable, and women's and men's roles, behaviors, and responsibilities change over time and are different in different societies. MCC's Gender Policy provides overall guidance to country partners with their responsibilities for the integration of gender in all stages of Compact development and implementation. Countries should review the Gender Policy as they plan their consultative process and review the Environmental Guidelines as they start to identify potential priorities and should integrate relevant organizations and government ministries or agencies in the Compact development process.

The environmental guidelines cover environmental review, environmental screening, public consultation and disclosure, monitoring and reporting.

4 If PAPs are continue to object the acquisition plan then WAJ could proceed with compulsory expropriation.

The completion of the requisite environmental and social impact analysis is the responsibility of the eligible country. However, the MCC's ESA experts will advise and consult on these requirements and work closely with the country Core Team.

The MCC will work to ensure that the preparation of Environmental Impact Assessments will include consultation with affected parties and public disclosure of the associated documents. Finally, MCC is committed to the principle of host-country ownership of a Compact, and consequently a Compact project is expected to comply with host-country laws, regulations and standards, as well as requirements by which the host country is bound under international agreements.

3.7. World Bank Operational Policy 4.12 on Involuntary Resettlement

The World Bank experience indicates that involuntary resettlement under development projects, if unmitigated, often gives rise to severe economic, social, and environmental risks: production systems are dismantled; people face impoverishment when their productive assets or income sources are lost; people are relocated to environments where their productive skills may be less applicable and the competition for resources greater; community institutions and social networks are weakened; kin groups are dispersed; and cultural identity, traditional authority, and the potential for mutual help are diminished or lost. This policy includes safeguards to address and mitigate these impoverishment risks.

Involuntary resettlement may cause severe long-term hardship, impoverishment, and environmental damage unless appropriate measures are carefully planned and carried out. For these reasons, the overall objectives of the Bank's policy on involuntary resettlement are the following:

- Involuntary resettlement should be avoided where feasible, or minimized, exploring all viable alternative project designs.
- Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share in 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 pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher Impacts Covered

This policy covers direct economic and social impacts that both result from Bank-assisted investment projects, and are caused by:

- The involuntary taking of land resulting in relocation or loss of shelter; lost of assets or access to assets; or loss of income sources or means of livelihood, whether or not the affected persons must move to another location; or
- The involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.

The policy indicates that requests for guidance on the application and scope of this policy could be addressed to the Resettlement Committee. It also provides details on the following aspects for policy application:

- Required Measures
- Eligibility for Benefits
- Resettlement Planning, Implementation, and Monitoring
- Resettlement Instruments
- Assistance to the Borrower

4. DESCRIPTION OF ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

4.1. Data Sources, Field Investigations, and Literature Reviews

To have an overview of environmental and social baseline conditions in the study area, the following were carried out:

- Demographic, meteorological and water resources data were collected.
- Field visits conducted to study area by various study groups for this preliminary ESIA.
- Various studies and reports were reviewed and these are listed in **Section 1** of this report.

4.2. Physical Environment

4.2.1. Meteorology and Climate

Jordan's climate varies from Mediterranean in the west to desert in the east and south, but the land is generally arid. The proximity of the Mediterranean Sea is the major influence on Jordan's climate, although continental air masses and elevation also modify it. The prevailing winds throughout the country are westerly to north-westerly, but spells of hot, dry, dusty winds blowing from the southeast off the Arabian Peninsula frequently occur and bring the country its most uncomfortable weather.

The project area belongs to the Arid Mediterranean and Saharan Mediterranean climatic zones and its meteorological characteristics can be obtained from Al Zarqa Al Jadeida and Wadi Dhuleil stations.

The mean maximum and minimum temperatures recorded at Al Zarqa Al Jadeida and Wadi Dhuleil stations indicate hot summers and cold winters. The relative humidity in Al Zarqa Al Jadeida and Wadi Dhuleil are around 59% and 58%, respectively. Precipitation rates at Al Zarqa Al Jadeida station (105.5 mm) are slightly higher than at Wadi Dhuleil area (93.76 mm).

4.2.2. Air Quality

High air pollution is one of the main environmental risks at Zarqa Governorate due to the surrounding industrial areas including the thermal power plants, oil refinery, and industrial plants stack emissions. Hence, these industrial enterprises can be considered the major source of air pollution within the project area.

4.2.3. Topography and Geology

The project area elevation ranges from 498 m in the northern part to about 807 m in southern part of the project area.

The geology of the project area is part of the geology of Amman-Zarqa Basin. The outcropping of Amman-Zarqa Basin extends from Lower Cretaceous (except for the wadi fill deposits which are of Quaternary) to recent age, which is belonging to the Ajloun and Belqa Groups according to Jordanian classification. However, the Kurnub Group (Lower Cretaceous) is usually found at certain depths except

outcrops at the western parts of the study area (Baq'a Valley) along the axis of Sweileh anticline. In addition, the older Zarqa Group (Jurassic-Triassic age) occurs at considerable depth.

The outcropping rocks in the study area mainly consist of Ajloun group (A4, A5/6 and A7) and Balqa Group (B1 and B2). Soil cover is generally thin, although local topography has led to accumulation of wind-blow soils in numerous places. Valleys are generally filled with alluvial deposits of gravel, boulders, and pebbles. The Amman Formation B2 (Santonian – Campanian) consists of cyclic deposits of chalk, phosphate, silicified phosphate, limestone and chert. The limestone is occasionally silicified. In the Amman-Russeifa and Zarqa areas, two members of the formation are recognized:

- Upper chalk-marl and phosphate member (26-27m thick in Russeifa); and
- Lower chert-limestone member (about 90m east of Amman).

Tectonic Setting

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

4.2.4. Water Resources

The water resources of the study area include the Zarqa surface water basin and the Amman-Zarqa groundwater basin.

Zarqa Surface Water Basin

This basin is one of the most significant surface water basins in Jordan and the Zarqa River is the third largest river in Jordan. It has approximately 65% of the country's population and more than 85% of its industries located within its catchment area. The main populated centers are the cities of Amman, Zarqa, Jerash and Russeifa. The industrial activities in the basin have witnessed a sudden expansion in urban development. Agricultural areas (irrigated) are concentrated around groundwater wells and along the side beds of the river while rain fed agriculture can be found in high rainfall areas. The rest of the basin is scattered vegetative areas used for grazing, bare and rocky areas and forests.

The Zarqa River flows northeasterly as it leaves Amman toward Zarqa, and turns west at its confluence with Wadi Dhuleil, near Sukhneh. The river flows through the King Talal Reservoir (KTR) and into the Jordan Valley where it joins the Jordan River 20 km north of the Dead Sea.

Amman-Zarqa Groundwater Basin

Amman-Zarqa groundwater basin is on the country's basins suffering from overexploitation. It has a safe yield of 88 MCM per annum and is considered to be the critical renewable groundwater basin in Jordan. The intensive urbanization and agricultural expansion in the area of Dhuleil and Hallabat included within this basin have resulted in over-pumping reaching to 157% of the safe yield. Sewage infiltration from septic tanks and broken sewer networks in addition to over-pumping resulted in a fast depletion of water quality and quantity in the aquifer which contributed to desertification.

According to the potentiality of water bearing, three aquifer systems are available in Amman-Zarqa Basin:

- Upper aquifer system, which includes Basalt and underlying Amman-Wadi As Sir (B2/A7) formation;
- Middle aquifer system, consisting of Hummer (A4) and Naur (A1/2) formations; and
- Lower aquifer system (Kurnub Group).

The two main aquifers in the Amman-Zarqa basin are the Amman/Wadi Sir formation (B2/A7) and the Hummer (A4) formation. Both of them are exposed to the high rainfall region which reaches 400 mm/year to the west of Amman, while in the area, the rainfall does not exceed 150 mm/year.

Main Sources of Water Pollution Discharges

The main sources of degradation of the Zarqa River Basin water quality and quantity are as follows:

- Domestic and industrial effluents.
- Domestic and industrial solid waste.
- Over abstraction of groundwater and the competition in water usage between municipal, agricultural, and industrial sectors.
- Overgrazing and deforestation.
- Agricultural activities as well as construction activities that have increased the sediment load of surface water.
- Wide fluctuations in annual rainfall due to climate change and associated desertification.

4.3. Biological Environment

The study area is located in Zarqa and it extends from Zarqa Free Zone in the east to Alouk in the west and from Greesa in the north to Mukhiam Hitteen in the south. It falls under two biogeographical regions, namely the Mediterranean and the Irano-Turanian. In the Eastern side of the study area, Saharo-Arabian (Desert) affinities intersect with the Irano-Turanian zone.

The Mediterranean region covers the western part of the study area. The area can be further subdivided into the Batha Steppe and the forested Mediterranean sub-groups based on the dominant representative vegetation in this area. The majority of the western part is a series of barren slopes with Batha steppe vegetation that changes to grass land steppe as we move to the east. Farm lands are predominantly confined around both sides of the wadi system and mostly near Khirbet As-Samra area. Very limited planted pine forests occur only on the extreme mid-western borders of the study area. Forested areas are limited to the stretch between Birein and north of Sarrout, and it extends after to the west-north up to Al Alouk.

The Irano-Turanian covers the central and eastern parts of the study area, and it represents Zarqa city Russeifa and its outskirts, reaching Al-Hashmiyah and Al-Sukhneh. The dominant representative vegetation is Grassland Steppe. It is interrupted by Zarqa River tributaries flowing from the south and

south-east to north and north-west, and then turns to the west. This riverine joins wadi system arising from Khirbet As-Samra and Wadi Al Dhuleil to the east. Elevation ranges from 750 to 450 m asl. It should be noted that the man-made lagoons of Samra WWTP have been designated as an IBA.

The central section of this area is heavily populated, most significantly in Mukhiam Hitteen. It is considered the most densely populated area in Jordan. However, the side banks of Zarqa River in the area between El Nuzha and El Jabal El Abied, between Hai Eth Thawra El Arbiya El Kubra and Awajan, and the stretch in Russeifa are being cultivated. The same applies for the side banks of Wadi Ed Dhuleil and other wadis and tributaries in Khirbet As-Samra, Al Hashmiyah, Um EsSulieh and Al Sukhneh.

The eastern side is an arid land of the Irano-Turanian with Eastern Badia affinities. The vegetation cover is grassland but with much less density compared to the north-western grassland basically due to rainfall volumes. This area, in particular along the Zarqa to Mafraq highway, is under growing urbanization and development in the form of residential and commercial uses.

Within this section, and on the area between the Zarqa Free Zone and the Refinery, land uses include industrial, residential and agricultural. Two universities exist within this zone: Zarqa Private University and Al-Hashmiyah University.

In general, the populated urban centre is of no ecological significance since population density in these areas is very high and different environmental challenges contributed to deteriorating the ecological character of the area.

4.4. Socio-cultural Conditions

The approaches utilized to prepare a description of the socio-economic baseline included:

- A comprehensive literature review of secondary data available through reports and other publications; and
- A quantitative socio-economic profiling of the target study area through collected secondary data from official records, mainly the Population Census 2004 of the Department of Statistics.

4.4.1. Social Baseline Conditions within Study Area

The resident population of Zarqa Governorate the year 2004 was approximately 799,000, which is about 15% of the national population. This indicated a growth rate for the governorate of 2.2% per annum between the 1994 and 2004 inter-censal period.

It is important to note that the projections, as well as the Governorate's general projected growth rate, do not take into consideration the effects of the two major urban development projects of King Abdullah Bin Abdul Aziz City and al-Majd City in East Zarqa.

Areas selected for the preliminary assessment fell in three municipalities in Al-Zarqa Governorate which are Al-Zarqa Municipality, Russeifa Municipality, and Al-Hashmiyah Municipality. The main results of the demographic characteristics of the target neighborhoods are as follows:

- The average family size in the target neighborhoods is higher than the national average of 5.4, being the highest in the target neighborhoods within Zarqa Municipality at 5.68.
- The marital status of the target neighborhoods shows that more than 55% of the people are married.
- The majority of the residents in the target neighborhoods live in apartments, while others own their houses.
- The educational levels at those areas are more or less consistent with the national numbers.
- Zarqa Governorate has an unemployment rate of 12.3% which is very close to the national unemployment rate for the same period (12.2%).
- The female economic activity rate in Zarqa Governorate at 11.4% is lower than the corresponding national number of 14.3%.
- The overwhelming majority of males in the workforce in Zarqa and Russeifa municipalities' target neighborhoods work in the private sector, and the majority of working females in Zarqa and Hashmiyah municipality work in the public sector.

4.4.2. Existing Public Health within Study Area of Zarqa Governorate

Health indicators reflect that Zarqa Governorate is deprived of equal share of health care. Epidemic hepatitis, typhoid and paratyphoid diseases are higher than expected.

Communicable diseases profile in Zarqa Governorate is changing but infectious diseases remain on the list of major causes of morbidity.

With respect to non-communicable diseases, Zarqa is witnessing an epidemiological transition characterized by an increase of non-communicable diseases. Among the factors contributing to the high prevalence of illness are the increasing elderly in the population as well as the lifestyle changes.

Health Issues Associated with the Existing Wastewater System within Study Area

The main potential health and safety impacts associated with the existing wastewater system within study area include:

- Potential health and safety impacts of existing wastewater networks due to possible transmission of typhoid, salmonellosis, shigellosis, and infectious hepatitis to residents, wastewater workers and agriculture workers
- Potential health and safety impacts of continued use of cesspools and septic tanks. These are dangerous because the wastewater would seep into the soil and gradually extend the zone of pollution and endanger the safety of wells at a considerable distance way. Besides the disposal of wastewater by cesspool may contaminate the ground with parasites that would in turn contaminate community drinking water and food especially vegetables eaten raw.

- The main potential health and safety impacts of existing pumping stations include:
  - Odor problem associated with the existing pump stations.
  - Insect Problem associated with open wastewater reservoirs.

4.5. Cultural Heritage Resources

The following major archaeological sites have been identified in Zarqa Governorate:

- Qasr Shabib
- Khirbat Masarah
- Qasr al- Hallabat
- Hammam as-Sarah
- Khirbet Russeifa
- Qasr Azraq
- Quseir Amra
- Tall Al-Sukhneh
- Tall al-Birah
- Hashmiyah Mill stones
- Gharesa
- Khirbet As-Samra
- Batrawi

5. ANALYSIS OF PROPOSED PROJECT ALTERNATIVES

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

This part of the preliminary ESIA deals with the analysis of alternatives considered to meet the ultimate project objectives. The analysis covers five major alternatives proposed for the project including the 'no project' alternative.

5.1. Proposed Alternatives

The following alternatives are assessed in this section to determine whether a more environmentally and socially sound alternative to the proposed project can be adopted. These alternatives are listed in **Table 5.1** below.

Table 5.1: Proposed Alternatives

Alternative 1	No-Project Option: Is there a need for the proposed project?
Alternative 2	Proposed system: Continue to convey flows from the study area to as-Samra WwTP, but provide towns of Birein with package wastewater treatment units.

This preliminary ESIA completed for the project has examined the several major environmental components and social aspects as a basis for comparison between the proposed project and the No Project Option as listed above. **Table 5.2** below presents the symbols that denote the various levels of environmental impact to aid in comparison of the alternatives. Each symbol indicates an overall evaluation of the specified environmental component and social aspect.

Table 5.2: Evaluation symbols for levels of environmental impact

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

5.2. "No Action" Alternative versus the Proposed Project

The 'No-Action' option considers the alternative of not conducting the project at all. It is normally evaluated to assess the impacts if the project does not go ahead. This alternative is evaluated against

the new project proposed to enhance and reinforce the wastewater system in Zarqa Governorate. Results of this evaluation are presented in **Table 5.3** below.

Table 5.3: Comparison of Overall Environmental and Social Impacts as a Result of the Proposed Project against the 'No-Action' Alternative

Environmental & Social Components	Project vs. No Project	
	Proposed Project	No-Action Alternative
Air Quality	X	S-
Noise Generation	X	*
Wastewater Generation	S+	S-
Waste Generation / Disposal	X	S-
Topography, Geology and Soils	S-	S-
Water Resources	X	S-
Visual Impacts	X	S-
Ecological Resources	X	S-
Socio-economic Impacts	S-	S-
Land Use / Land Value	S-	S-
Public Health & Safety	S+	S-
Traffic Disturbance	X	*
Other Utilities/Infrastructure	X	*
Archaeology / Cultural Property	X	*

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

The main adverse impacts introduced as a result of the project activities are mostly related to the land value as perceived by the local communities. This is based on previous experience with As-Samra WwTP.

Other temporary impacts include disruptions to air quality, noise levels, and traffic within the study area caused by the construction activities. However, these are limited to the construction phase of the project and would be eliminated or minimized once the proposed project is in its operation phase.

However, the 'No-Action' alternative will deprive the people within the study area from a project that has the potential to improve public health conditions and protect Zarqa Basin from the impacts caused by the discharge of domestic wastewater. As shown in Table 5.3, the negative significant impacts on water resources, ecological resources and public health will persist.

Therefore, although going through with the proposed project could lead to certain impacts on the environment and the social aspects within the study area due to project construction activities, those impacts can be mitigated and their significance eliminated or minimized. In addition, the proposed project is regarded to be of high value to communities within the study area when operational.

6. IDENTIFICATION OF ENVIRONMENTAL AND SOCIO-ECONOMIC RECEPTORS

6.1. Identification of Environmental and Socio-Economic Receptors

Table 6.1 below provides a summary of the identified environmental and socio-economic receptors within and in the vicinity of the project area.

Table 6.1: Identified Environmental and Socio-economic Receptors

RECEPTOR	COMMENT
Physical Environment	
Atmosphere	The atmosphere at and around the project area.
Soil	The soils of areas in which project activities are to 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 land forms and terrain at the Project sites.
Biological Environment	
Flora	Plant species that could potentially occur in the areas in which the construction and operational activities will occur.
Fauna	
Birds	*Birds that rely on the area as a habitat and/or food source.*
Reptiles	*Reptiles that could potentially be present within or in the vicinity of project area which might be affected by to construction and operation activities of the project.*
Mammals	*Mammals that occur in the environments in which construction activities are proposed to occur.*
Health & Safety	
Workers	Staff on the project site who will be subjected to occupational hazards / 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 operational hazards such as noise, dust, etc.
Socio-economic Environment	
Population in the Vicinity of Activity	The population (people) that utilize the areas during construction activities.
Land Use & Land Ownership/Acquisition	Existing uses of the land areas in which the construction activities are to occur. Traditional boundaries, access issues, permit requirements and distr bution of any private and/or government-owned lands. Possibility for need of Land Acquisition for network expansion or building of new pump stations.
Utilities and infrastructure	The utilities (e.g. power supply, water services) and infrastructure (e.g. commercial and industrial and leisure facilities) of areas in which the construction activities are proposed to occur.
Workforce	Impacts of new workforce on the Project area.

RECEPTOR	COMMENT
Transport	Road transport systems of the area in which the construction activities are to occur.
Archaeology / Cultural Property	Archaeological sites and artifacts that have cultural significance (if found in within or in the vicinity of the Project area).

6.2. Preliminary Identification of Project Stakeholders

A preliminary identification of stakeholders with a specific interest in the project activities has identified the following stakeholder groups:

- Municipalities of the study area (Zarqa, Al-Russeifa, and Hashmiyah)
- Ministry of Agriculture – Al-Zarqa Agriculture Directorate
- NGOs within study area
- Ministry of Environment – Al-Zarqa Directorate
- Al-Hashmiyah University
- Water Authority of Jordan - Wastewater Directorate
- Local Community members of target neighborhoods
- Households and business owners around the pumping stations

6.3. Environmental and Socio-Economic Aspect Matrix

Identified project activities and legal, environmental and socio-economic 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 socio-economic impacts are presented in **Table 6.2** below.

Table 6.2: Environmental and Socio-economic Aspects and Receptor Matrix

Receptor / Activity		Physical					Biological			Health & Safety	Socio-Economics						Other
		Atmosphere	Noise	Soil & Groundwater	Hydrology (Surface Water)	Visual Amenity and Landscape / Topography	Flora / Habitats	Birds	Reptiles & Mammals	Workers/Area's Residents and Land users	Population / Resettlement	Workforce & employment	Land Use / Ownership	Utilities / Infrastructure	Transport	Archaeology / Cultural Property	Liability / Reputation
Planned Project Activities																	
Construction	Land Use & Land Acquisition									●	●		●				●
	Trenching and Excavation Works	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Solid Waste (Spoil) Generation/Disposal			●	●	●	●	●	●	●		●	●		●	●	●
	Material & Chemical / oil storage	●		●	●		●	●	●	●			●				●
	Vehicle operation	●	●	●		●	●	●	●	●		●		●	●	●	●
	Equipment operation	●	●	●		●	●	●	●	●		●	●	●	●	●	●
	Access roads (if needed)	●	●	●		●	●	●	●	●		●			●	●	●
	Project Offices/Workers Accommodations (if required)	●	●	●	●		●	●	●	●		●	●	●	●		●
Operation	Pump Station	●	●		●	●		●				●					●

Receptor / Activity		Physical					Biological			Health & Safety	Socio-Economics						Other
		Atmosphere	Noise	Soil & Groundwater	Hydrology (Surface Water)	Visual Amenity and Landscape / Topography	Flora / Habitats	Birds	Reptiles & Mammals	Workers/Area's Residents and Land users	Population / Resettlement	Workforce & employment	Land Use / Ownership	Utilities / Infrastructure	Transport	Archaeology / Cultural Property	Liability / Reputation
	New Trunk & Sewer Lines			●		●				●			●	●			●
Unplanned Project Activities																	
Potential Accidental Events (unplanned) during Construction Phase	Vehicle collisions	●	●	●	●		●	●	●	●				●	●	●	●
	Spill of chemicals or liquid fuels	●		●	●	●	●	●	●	●			●	●	●	●	●
	Ignitions of flammable materials / accidental fires	●	●			●	●	●	●	●	●		●	●	●	●	●
Potential Accidental Events (unplanned) during Operation Phase	Pump Station Power Failure / Malfunction	●		●	●	●				●							●
	Trunk / Sewer Pipeline Rupture and Leakage			●	●					●				●	●		●

7. PRELIMINARY IDENTIFICATION OF POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

In order to enable the determination of the overall significance of the impact, each identified aspect - receptor interaction was ranked in terms of consequence and likelihood. Impact significance is expressed as the product of the consequence and likelihood of occurrence of the activity.

- **Likelihood**: the likelihood that an activity will occur.
- **Consequence**: the resultant effect (positive or negative) of an activity's interaction with the legal, natural and/or socio-economic environments.
- **Significance = Consequence x Likelihood**.

Based on its consequence-likelihood score, each environmental aspect was ranked into five categories or orders of significance. These are: critical, high, medium, low and negligible. Any impact that remains after mitigation measures have been applied is labeled as a residual impact.

The potential environmental and socio-economic impacts due to the project planned and unplanned activities are presented in **Table 7.1** below.

It should be noted here that although the overall evaluation of the project will result in a significant general benefit to the entire population of Zarqa Governorate, its implementation will entail some negative impacts on some of the landowners. This is due to the need to expropriate areas to serve the pumping stations downstream and the new trunk sewers in many other locations in Zarqa Governorate.

Table 7.1: Summary of Preliminary Impact Assessment of Planned and Unplanned Activities

No.	Project Activity	Planned or Unplanned	Potential Environmental and Social Impacts	Likelihood	Consequence	Impact Significance	Impact Management[5]
Construction Phase							
1	Trenching and Excavation Works	Planned	Degraded air quality due to dust and emissions	Very Likely (4)	Marginal (2)	Medium (8)	ALARP/BAT
			Noise pollution	Very Likely (4)	Marginal (2)	Medium (8)	ALARP/BAT
			Degraded topography, geomorphology and soils	Certain (5)	Critical (3)	High (15)	ALARP/BAT
			Visual intrusion and aesthetic interference	Certain (5)	Negligible (1)	Low (5)	HSEMS
			Pollution of surface water resources	Unlikely (2)	Critical (3)	Medium (6)	ALARP/BAT
			Pollution of groundwater	Unlikely (2)	Critical (3)	Medium (6)	ALARP/BAT
			Damage to floral and faunal habitats	Likely (3)	Marginal (2)	Medium (6)	ALARP/BAT
			Risk to public health and safety	Likely (3)	Sever (4)	High (12)	ALARP/BAT
			Disruption to existing businesses	Very Likely (4)	Critical (3)	High (12)	ALARP/BAT
			Damage to Infrastructure – Transport system and potential traffic impacts	Very Likely (4)	Severe (4)	High (16)	ALARP/BAT
			Damage to water and wastewater lines	Unlikely (2)	Severe (4)	Medium (8)	ALARP/BAT
			Damage to power and communication lines	Unlikely (2)	Severe (4)	Medium (8)	ALARP/BAT
			Employment opportunities	Certain (5)	Positive (+)	Positive (+)	None
			Damage to archaeological/cultural heritage sites	Very Unlikely (1)	Catastrophic (5)	Low (5)	MSEMS
2	Solid Waste (Spoil) Generation/Disposal	Planned	Impact to soil	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Visual intrusion and aesthetic interference	Likely (3)	Marginal (2)	Medium (6)	ALARP/BAT
			Impact to surface water	Unlikely (2)	Critical (3)	Medium (6)	ALARP/BAT
			Damage to floral and faunal habitats	Unlikely (2)	Marginal (2)	Low (4)	HSEMS

5 Unacceptable or Managed to ALARP, BAT, or with HSEMS
ALARP: As Low As Reasonably Practicable
BAT: Best Available Technology
HSEMS: Health, Safety and Environment Management System

No.	Project Activity	Planned or Unplanned	Potential Environmental and Social Impacts	Likelihood	Consequence	Impact Significance	Impact Management[5]
			Risk to transport system and potential traffic impacts	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Risk to public health and safety	Vey Likely (4)	Severe (4)	High (16)	ALARP/BAT
			Damage to archaeological/cultural heritage sites	Unlikely (2)	Catastrophic (5)	High (10)	ALARP/BAT
3	Material and Chemical / oil storage	Planned	Degraded air quality due to emissions	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Impact to soil	Likely (3)	Severe (4)	High (12)	ALARP/BAT
			Visual intrusion and aesthetic interference	Unlikely (2)	Marginal (2)	Low (4)	HSEMS
			Impact to surface water	Unlikely (2)	Severe (4)	Medium (8)	ALARP/BAT
			Impact to shallow groundwater	Unlikely (3)	Severe (4)	Medium (8)	ALARP/BAT
			Damage to flora and fauna	Unlikely (2)	Marginal (2)	Low (4)	HSEMS
			Risk to public health and safety	Unlikely (2)	Severe (4)	Medium (8)	ALARP/BAT
4	Vehicle operation	Planned	Degraded air quality due to emissions	Very Likely (4)	Marginal (2)	Medium (8)	ALARP/BAT
			Noise pollution	Very Likely (4)	Critical (3)	High (12)	ALARP/BAT
			Impact to soil	Likely (3)	Marginal (2)	Medium (6`)	ALARP/BAT
			Impact to surface water	Unlikely (2)	Marginal (2)	Low (4)	HSEMS
			Damage to flora and fauna	Unlikely (2)	Marginal (2)	Low (4)	HSEMS
			Risk to transport system and potential traffic impacts	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Workforce employment	Certain (5)	Positive (+)	Positive (+)	
			Risk to utilities due to accidents	Unlikely (2)	Severe (4)	Medium (8)	ALARP/BAT
			Risk to public health and safety	Unlikely (2)	Severe (4)	Medium (8)	ALARP/BAT
			Damage to archaeological/cultural heritage sites	Very unlikely (1)	Severe (4)	Low (4)	HSEMS
5	Equipment operation	Planned	Degraded air quality due to emissions	Likely (3)	Marginal (2)	Medium (6)	ALARP/BAT
			Noise pollution	Very Likely (4)	Marginal (2)	Medium (8)	ALARP/BAT
			Impact to soil	Likely (3)	Severe (4)	High (12)	ALARP/BAT

No.	Project Activity	Planned or Unplanned	Potential Environmental and Social Impacts	Likelihood	Consequence	Impact Significance	Impact Management[5]
			Visual intrusion and aesthetic interference	Unlikely (2)	Marginal (2)	Low (4)	HSEMS
			Impact to surface water	Unlikely (2)	Critical (3)	Medium (6)	ALARP/BAT
			Damage to floral and faunal habitats	Unlikely (2)	Marginal (2)	Low (4)	HSEMS
			Impact to land use	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Risk to transport system and potential traffic impacts	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Workforce employment	Certain (5)	Positive (+)	Positive (+)	
			Risk to public health and safety	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Risk to utilities due to accidents	Unlikely (2)	Critical (3)	Medium (6)	ALARP/BAT
			Damage to archaeological/cultural heritage sites	Very unlikely (1)	Severe (4)	Low (4)	HSEMS
6	Access Roads (if needed)	Planned	Degraded air quality due to dust emissions	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Disturbance to top soil	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Damage to floral and faunal habitats	Unlikely (2)	Marginal (2)	Low (4)	HSEMS
			Risk to public health and safety	Unlikely (2)	Severe (4)	Medium (8)	ALARP/BAT
			Workforce employment	Certain (5)	Positive (+)	Positive (+)	
			Damage to archaeological/cultural heritage sites	Very unlikely (1)	Severe (4)	Low (4)	HSEMS
7	Vehicle Collisions	Unplanned	Degraded air quality due to exhaust emissions	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Noise pollution	Very Likely (4)	Marginal (2)	Medium (8)	ALARP/BAT
			Impact to soil	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Impact to surface water	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Disturbance to flora and fauna	Unlikely (2)	Marginal (2)	Low (4)	HSEMS
			Risk to public health and safety	Likely (3)	Severe (4)	High (12)	ALARP/BAT
			Risk to transport system and potential traffic impacts	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Damage to archaeological/cultural heritage sites	Unlikely (2)	Catastrophic (5)	High (10)	ALARP/BAT

No.	Project Activity	Planned or Unplanned	Potential Environmental and Social Impacts	Likelihood	Consequence	Impact Significance	Impact Management[5]
8	Spill of chemical and liquid fuels	Unplanned	Degraded air quality due to emissions	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Impact to soil	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Impact to surface water	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Impact to shallow groundwater	Unlikely (2)	Marginal (2)	Low (4)	HSEMS
			Damage to floral and faunal habitats	Likely (3)	Marginal (2)	Medium (6)	ALARP/BAT
			Risk to public health and safety	Very Likely (4)	Severe (4)	High (16)	ALARP/BAT
			Impact on land use	Likely (3)	Severe (4)	High (12)	ALARP/BAT
			Impact to existing infrastructure / utilities	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
9	Ignitions of flammable materials / accidental fires	Unplanned	Degraded air quality due to emissions	Very likely (4)	Critical (3)	High (12)	ALARP/BAT
			Noise pollution	Likely (3)	Marginal (2)	Medium (6)	ALARP/BAT
			Damage to floral and faunal habitats	Likely (3)	Marginal (2)	Medium (6)	ALARP/BAT
			Risk to public health and safety	Very likely (4)	Severe (4)	High (16)	ALARP/BAT
			Impact on land use	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Impact to transport and other infrastructure/utilities	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Damage to archaeological/cultural heritage sites	Very unlikely (1)	Severe (4)	Low (4)	HSEMS
Operation Phase							
1	Pump Stations Operation	Planned	Odor generation	Unlikely (2)	Critical (3)	Medium (6)	ALARP/BAT
			Noise pollution	Very unlikely (1)	Marginal (2)	Low (2)	HSEMS
			Visual intrusion	Likely (3)	Marginal (2)	Medium (6)	ALARP/BAT
			Impact to surface and ground water resources	Likely (3)	Marginal (2)	Medium (6)	ALARP/BAT
			Employment opportunities	Certain (5)	Positive (+)	Positive (+)	
			Energy need	Certain (5)	Critical (3)	High (15)	ALARP/BAT
2	Flow of wastewater in sewer networks	Planned	Impact to soil	Unlikely (2)	Critical (3)	Medium (6)	ALARP/BAT
			Visual intrusion (Only above ground trunk lines)	unlikely (2)	Marginal (2)	Low (4)	HSEMS

No.	Project Activity	Planned or Unplanned	Potential Environmental and Social Impacts	Likelihood	Consequence	Impact Significance	Impact Management[5]
			Impact to groundwater	Certain (5)	Positive (+)	Positive (+)	
			Land value	Certain (5)	Positive (+)	Positive (+)	
			Public health and living standards	Certain (5)	Positive (+)	Positive (+)	
3	Pump station power failure / malfunction problems	Unplanned	Odor generation	Very Likely (4)	Critical (3)	High (12)	ALARP/BAT
			Impact to soil	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Impact to surface water	Likely (3)	Marginal (3)	Medium (9)	ALARP/BAT
			Risk to public health	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
4	Rupture/breakage of utility lines	Unplanned	Impact to shallow groundwater	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Impact to soil	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT
			Impact to infrastructure (road subsidence)	Very Likely (4)	Critical (3)	High (12)	ALARP/BAT
			Risk to public health	Likely (3)	Critical (3)	Medium (9)	ALARP/BAT

8. PRELIMINARY IDENTIFIED MITIGATION MEASURES AND EMMP

8.1. Preliminary Mitigation Measures

Mitigation measures recommended by this study are summarized in **Table 8.1** below.

Table 8.1: Proposed Preliminary Mitigation Measures

Impact	Mitigation Measure
Impacts to flora / habitats	• Minimize width of access tracks. • Limit driving to marked tracks and lines except in an emergency. • Prevent the removal of plants by workers on site.
Impacts to Fauna	• Deviate work away from faunal communities' concentration areas. • Avoid human and vehicular contact with fauna, including their burrows / nests and feeding grounds. • Prevent illegal hunting by workers on site. • Avoid working in times of bird migration.
Impact to water resources	• All fuel storage (if applicable) must be appropriately bonded and refueling must be undertaken in designated areas following set procedures. • Develop a spill response plan, to control any inadvertent leakage or spillage of hydrocarbons. Spill response measures should be instigated (as necessary) to contain and clean up any contaminated soil present. • Adopt appropriate soil conservation measures, reducing the disturbed area and scheduling work, where practical, to avoid periods of high rainfall. • The slopes and slope lengths of steeper sections of the pipeline route and any areas of cut and fill will be minimized and drains installed to intercept and divert run-off water. • Road crossings and other traffic areas will be located and constructed to minimize the concentration or diversion of water into the wadi bed and drainage lines. Where practical, surface cover will be maintained in these areas. • Third party environmental specialists will be appointed to periodically review implementation of the management plan. • Proper design of the pumping stations to accommodate potential overflows • Develop and redesign the storm water collection system to minimize the flow of storm water through the sewer system.
Impacts to Population	• Use noise attenuation devices on plant. Ensure that noise levels at receptors do not exceed standards. • avoiding work on weekend (Friday) and ceasing work activities during the weekdays between 8:00 pm and 6:00 am • Give advance warning to the area's residents as to the project activities and possible disturbances (noise, dust etc). • Compensate any loss to livelihood. • Provision for the additional traffic may need to be made, potentially with additional turn-off lanes and traffic signaling installed to prevent congestion and minimize the risk of vehicular accidents at road crossing points. • A formal traffic management plan to be developed in consultation with the main project contractor. • If pumping stations are a must, ensure that those will be properly designed to handle the wastewater flow, where the need for exposed overflow emergency ponds is illuminated or significantly minimized. • Where it would not increase dust and erosion levels, break up compacted soil, especially in cultivated areas.

8.2. Preliminary Environmental Management and Monitoring Plan

This section presents a summary of the EMMP activities in **Table 8.2** followed by a summary of the Resettlement Policy Framework.

Table 8.2: Summary of Proposed Preliminary Mitigation and Monitoring Measures

Potential Impact	Mitigation	Monitoring
Dust & Noise		
• Construction of the pipeline network and pumping stations will result in increased levels of dust and noise generation.	• Dust – During construction dust generated on unpaved roadways and work areas should be controlled by the application of water on an "as needs" basis. • Noise – Activities that are likely to generate elevated noise levels (for example, blasting) must be avoided during weekends (Friday) and ceased during weekdays between 8:00 pm and 6:00 am in compliance with Standards for the Prevention and Elimination of Noise (2003). • Give advance warning to area residents within 100m from the construction site, at the beginning of the campaign, alerting them of the project activities and potential disturbances (noise, dust, light, etc). • Maintain a safe distance of 100m between the construction equipment and nearest human receptor (whenever possible). • Establish a simple complaints procedure to enable community feedback on issues of concern. • Maintain open dialogue with the residents of the area within or surrounding the construction site, if and when complaints are received. • Minimize transportation of project personnel to and from the project area to the extent possible. • Maintain open dialogue with stakeholders through the development of a Stakeholder Engagement Program. • Appropriate occupational health and safety measures to be employed for on-site personnel.	• Dust and noise monitoring should be undertaken on site and, where required, in surrounding areas. Noise shall be monitored by use of portable noise dose meters/sound level meters and dust monitoring will largely be completed by visual assessment of nuisance.
Solid & Liquid Waste		
• Wastes will be generated as a result of construction activities on site.	• All inert and domestic waste generated during construction must be removed from site and disposed of in accordance with the regulatory requirements and within landfills approved by the local municipality.	• Quarterly monitoring during construction.

Potential Impact	Mitigation	Monitoring
• Minimum solid waste will be generated once the pipeline network and pumping stations are operational	• Hazardous wastes and liquid wastes generated should either be recycled or disposed off-site to an approved waste facility. • Elimination or minimization of sewage overflow from pumping stations during operation through proper engineering design to enable the station (i.e. West Zarqa Pumping Station) to handle wastewater flows, especially upstream discharges (Amman).	
• Possible significant risk to groundwater quality being affected due to construction activities • Potential significant risk to groundwater during operation of pumping stations due to overflow discharges during normal and emergency operations.	• All fuel storage areas (if applicable) must be appropriately bonded and refueling activities undertaken in designated areas following specified procedures. • Specific procedures shall be developed for the removal of waste or spilled fuel, oil and contaminated soil at approved recycling / disposal facilities. • Provide spill cleanup kits on site. • Provide proper training for construction personnel on the containment and clean up of spills of they occur. • Ensure proper operation of the pumping stations, where overflows can be avoided whenever possible.	• Daily monitoring of construction activities to ensure that available means for the control and clean up of spills are adequately placed and properly utilized when needed. • Daily monitoring of pumping station performance including quality and volumes of overflow into the River.
Terrestrial Flora and Fauna		
• Potential impact to flora.	• Clearing of vegetation should be avoided • Access tracks should be aligned such that a minimal loss of vegetation will occur. • Vegetation should be cut to ground level to keep rootstock in place (if clearing of vegetation cannot be avoided. • Disturbance/destruction of sensitive environmental units, identified in Section 5 of this report must be avoided. • Management strategies will be implemented to restrict the spread of weeds and to minimize	• Pre construction survey, Initial monitoring after installation of pipeline networks and construction of the newly proposed pumping stations, then annually.

Potential Impact	Mitigation	Monitoring
	the impact of erosion/sedimentation. These measures to minimize the potential for adverse impact on vegetation communities in the area. • Re-vegetation of disturbed areas to be undertaken on an "as required" basis. Where practical, regeneration of native flora will be assisted by exclusion of grazing animals.	
• Potential loss of some habitat for terrestrial fauna through the clearing of vegetation whenever applicable. • Restricted impact to reptile, mammal and bird species during construction period.	• During the construction and operational phases of the project, the habitats supporting the highest species diversity in the study area will be protected where practical from on-going disturbance. Impact on the habitat value and condition will be minimized by preventing indirect impacts associated with erosion, drainage, waste contamination and the spread of weeds. • Damage to important environmental features to fauna such as water sources, Zarqa River Basin and Wadi and mature nesting trees should avoided. • Where poss ble, animals that fall into the trench during construction will be removed and ladders or branches placed in open excavations to assist fauna to escape.	• Pre construction survey. Initial monitoring after completion of construction activities. Annual survey of fauna during operation.
Archaeology		
• Potential impact to archaeological sites.	• Required site specific protective measures are identified during design phase and a general plan of works necessary to minimize project related damage to the Cultural Resources. • Definition of tender requirements as they relate to the implementation of the specified design measures.	• A construction and post-project monitoring program.
Health and Safety		
Potential health and safety risks and measures to minimize or eliminate them are detailed in Table 10.1 of the preliminary ESIA report.		

9. PRELIMINARY CONCLUSIONS OF THE OVERVIEW

This section presents the main findings and recommendations of this overview of the preliminary ESIA. The main findings relate to the main environmental and social aspects of concern during the construction and operation phases of this project, the preliminary analysis of alternatives, and the potential impacts associated with identified environmental and social receptors.

The major findings on existing environmental and social conditions are as follows:

- Air pollution is one of the main environmental risks at Zarqa Governorate due to the surrounding industrial areas.
- The water resources of the study area include the Amman-Zarqa surface and groundwater basin whose water quality and quantity are being degraded by:
  - Domestic and industrial effluents and solid waste.
  - Over abstraction of groundwater and the competition in water usage between municipal, agricultural, and industrial sectors.
  - Overgrazing and deforestation.
  - Agricultural activities as well as construction activities that have increased the sediment load of surface water.
  - Wide fluctuations in annual rainfall.
- The man-made lagoons surrounding area of Samra WWTP have been designated as an IBA.
- The populated urban centre of the study area is of no ecological significance since population density in these areas is very high and different environmental challenges contributed to deteriorating the ecological characteristics of the area.
- The existing wastewater system within the study area is associated with several health issues:
  - Possible transmission of typhoid, salmonella, shigellosis, and infectious hepatitis to residents, wastewater workers and agriculture workers.
  - Cesspools and septic tanks are causing the wastewater to infiltrate the soil and gradually extend the zone of pollution and endanger the safety of wells. Besides the disposal of wastewater by existing cesspools may contaminate the ground with parasites that would in turn degrade the quality of community drinking water and food sources especially vegetables eaten raw.
  - The existing pumping stations are causing odor and insects problems.
- The “No Action” alternative of not going ahead with the proposed project would deprive the local communities within the study area of a high value project once in its operational phase.

On environmental and social impacts, it is concluded that majority of the impacts are of medium to low significance during the project construction phase and operation phase. Identified potential impacts of medium to high significance during the construction phase were:

- Degraded topography, geomorphology and soils, risk to public health and safety, and disruption to existing businesses due to trenching and excavation works.
- Risk to public health and safety and damage to archaeological/cultural heritage sites due to solid waste (spoil) generation/disposal.
- Impact to soil due to material and chemical / oil storage and equipment operation.
- Noise pollution due to vehicle operation.
- Risk to public health and safety as well as damage to archaeological/cultural heritage sites due to accidental vehicle collisions.
- Risk to public health and safety and impact on land use due to possible risks of spill of chemical and liquid fuels.
- Degraded air quality due to emissions.
- Risk to public health and safety due to possible accidental ignitions of flammable materials / accidental fires.
- Need for acquiring land areas for the new pumping stations from private land owners.

Identified potential impacts of medium to high significance during the operation phase included:

- Energy need due to pump stations operation.
- Impact to water resources within the project area (Zarqa river and groundwater wells) due to emergency situations such as pump station power failure and/or malfunction problems.
- Impact to infrastructure (such as road subsidence) due to rupture/breakage of utility lines.
- Impacts to air, soil and groundwater quality during the operation of the proposed packaged waste water treatment plants.

Positive impacts of the project were the employment opportunities to be generated by the construction activities. The operation of new pumping stations is expected to generate few employment opportunities. However, the major positive impacts during that phase would be the improved conditions to groundwater, land value, as well as to public health and living standards.

10. REFERENCES

1. *Ministry of water and Irrigation*, Jordan. Website: http://www.mwi.gov.jo/English
2. Ministry of Water and Irrigation, (2009).Water for Life: Jordan's Water Strategy - 2008-2022.
3. Ministry of Environment (MoE), (2006). *Environmental Profile of Jordan*, as part of the National Capacity Self Assessment for Global Environmental Management (NCSA) – Jordan.
4. *Water Resources in Jordan, June 2004* as part of the National Water Master Plan (NWMP), Report Managed by: the German Technical Cooperation (GTZ) & Ministry of Water and Irrigation (MWI).
5. F. J. Aukour & M. I. Al-Qinna, (Mar. 2008). *Marble Production and Environmental Constrains: Case Study from Zarqa Governorate, Jordan*. Jordan Journal of Earth and Environmental Sciences. Volume 1, Number 1, Pages 11 -21.
6. B&E ENGINEERS in association with Arabic International Centre for Environmental Health (AICEH). Zarqa River Basin Wastewater and Solid Waste Treatment Project: Final Report. Submitted to the Ministry of Environment, Jordan.
7. *Geology, Geography and History in Jordan in Brief,* Eng. Kamal Jerisat, website: http://www.nra.gov.jo/index.php?option=com_content&task=view&id=11&Itemid=16
8. IDRC (Interdisciplinary Research Consultants), Ministry of Environment, IUCN, & Italian Cooperation (November 2006). *The Integrated Environmental Management of the Zarqa River, A Proposal for Restoration of the Zarqa River*. Final Report.
9. *Biological Baseline Assessment for the JOSCO Oil Shale Concession area.* This report was prepared in 2009 for a number of governorates within the Kingdom including the Zarqa Governorate.
10. *Archaeological & Cultural Heritage Study of Exploration and Drilling in Jordan*. This report was issued in 2009 covering number of governorates within the Kingdom including the Zarqa Governorate.
11. *Environmental, Social and Health Impact Assessment (ESHIA), Social Impact Assessment (SIA).* This report was issued in 2009 covering number of governorates within the Kingdom including the Zarqa Governorate.
12. Abu Baker, M. and Amr, Z., (2003a). A morphometric and taxonomic revision of the genus Gerbillus in Jordan with notes on its current distribution, *Zoologische Abhandlungen* (Dresden), 53:177-204.
13. Abu Baker, M. and Amr, Z., (2003b). Rodent diversity in the Northeastern Desert of Jordan, with special reference on the ecology of *Gerbillus cheesmani (Mammalia: Rodentia), Casopis Národního Muzea, Rada prirodovedná*, 172:141-152.
14. Abu Baker, M., Qarqaz, M. and Amr, Z., (2005). Small mammal remains recovered from pellets of the Barn Owl (Tyto alba) at Shawmari Wildlife Reserve, eastern Jordan, *Casopis Národního Muzea, Rada prirodovedná*, 174:127-129.

15. Abu Baker, M., Rifai, L., Joger, U., Nagy, Z., Wink, M. and Amr, Z., (2002). Occurrence of Coluber (Hierophis) schmidti Nikolsky, 1909 in Jordan (Squamata: Colubridae), Herpetozoa, 15(1/2):29-36.
16. Albert, R, Petutsching, B. and Watzka, M. 2003. Zur Vegetatataton und Flora Jardaniens. In: Waitzbauer, W., Albert R., Petutsching, B. and Aubrecht, G. (eds). Reise Durch Die Natur Jordaniens. Germany.
17. Al-Disi, A. M., (1997). Reptiles survey, October to December 1996, Amman: CORD/BRDP, RSCN, p. 70 plus annexes.
18. Disi A., Damhoureyeh S., Al-Khader I., and Al-Jbour S., (2006). The Badia of Jordan: Biodiversity, Threats and Conservation.
19. Al-Eisawi, D. (1998): Field Guide to Wild Flowers of Jordan and Neighbouring Countries. UNDP, Al-Rai Print shop, Amman. Pp. 290.
20. Al-Eisawi, D. M. (1985): Vegetation of Jordan. In: studies in The History and Archaeology of Jordan II, A. Hadidi (ed.). Ministry of Archaeology, Amman: 45-57.
21. Al-Eisawi, D. M. (1997): Vegetation of Jordan. UNESCO, Regional Office for Science and Technology for Arab States, Cairo.
22. Allison, R. J., Higgitt, D. L., Kirk, A. J., Warburton, J., Al-Homoud, A., Sunna, B. F. and White, K., (1998). Geology, geomorphology, hydrology, groundwater and physical resources, In: Dutton, R. W., Clarke, J. I. and Battikhi, A. (eds), Arid land resources and their management: Jordan's desert margin, London: Kegan Paul International, pp. 21-46.
23. Al-Melhim, W. N., Amr, Z. S., Disi, A. M. and Katbeh-Bader, A., (1997). On the diet of the Little Owl, *Athene noctua*, from Safawi area, eastern Jordan, Zoology in the Middle East, 15:19-28.
24. Amr, Z., Abu Baker, M. and Qumsiyeh, M., (2006). Bat diversity and conservation in Jordan, Turkish Journal of Zoology, 30:235-244.
25. Amr, Z. and Quatrameez, M., (2002). Wildlife conservation in Jordan: a cultural and Islamic perspective, In: Menon, V. & Sakamoto, M (Eds.). Heaven and earth and I: Ethics of nature conservation in Asia: Penguin Enterprise, pp. 172-184.
26. Amr, Z. S., (2000a). Conservation of the carnivores of the northeastern Badia, World Conservation, 2:24.
27. Amr, Z. S., (2000b). Mammals of Jordan, Amman: United Nations Environment ProgRume.
28. Amr, Z. S., Hamidan, N. and Quatrameez, M., (2004). Nature conservation in Jordan, Denisia, 14:467-477.
29. Andrews, J. 1995. The Birds of the Hashemite Kingdom of Jordan. Musselburgh, UK.
30. Borzatti, A., Al-Eisawi, M., Garbari, F. 2000. Studies on the Flora of Jordan 14. The Speceis of the Hisma Basin (Wadi Rum Desert). Webbia (55) 195-277.
31. Budieri, A. 1995. Wetlands of Jordan. In: D. Scott (ed.): Directory of Wetlands in the Middle East. IUCN, Wetland International.
32. Bunaian, F., Hatough, A., Ababaneh, D., Mashaqbeh, S., Yuosef, M. and Amr, Z. S., (2001). The carnivores of the northeastern Badia, Jordan, Turkish Journal of Zoology, 25:19-25.

33. Bunaian, F., Mashaqbeh, S., Yousef, M., Budairi, A. and Amr, Z. S., (1998). A new record of the Sand cat, *Felis margarita* Loche, 1858 from Jordan, Zoology in the Middle East, 16:5-7.
34. Disi, A. M., (1993). A contribution to the knowledge of the herpetofauna of Jordan. V. New records of three colubrid snakes from Jordan, The Snake, 25:109-113.
35. Disi, A. M., Modry, D., Bunian, F., Al-Oran, R. and Amr, Z. S., (1999). Amphibians and reptiles of the Badia region of Jordan, Herpetozoa, 12 (3-4):135-146.
36. Dutton, R. W. and Brown, K., (1996). Darwin initiative for the protection of species project: Management of biodiversity in the Badia region, north-east Jordan, annual report year one: CORD, University of Durham, BRDP report, p. 12.
37. Eig, (1946): Synopsis of the phytosociological units of Palestine. Pal. J. Bot. Jerusalem Ser. 1: 4-12.
38. Evans, M.I. (ed.) (1994). Important Bird Areas in the Middle East. BirdLife Conservation Series No.2. BirdLife International, Cambridge, U.K. 410 pp.
39. Feinbrun, N. (1978-1986): Flora Palaestina. Vol. III, IV. The Israel Academy of science and Humanities. Jerusalem.
40. General Corporation for Environmental Protection (GCEP) 1998. Jordan Country Study on Biodiversity. UNEP/GEF. Amman
41. General Corporation For Environmental Protection (GCEP) 2000. Plant Taxonomy and Diversity in Jordan. UNEP/GEF. Amman.
42. Higgitt, D. L. and Allison, R. J., (1998). Characteristics of basalt boulder surfaces, In: Dutton, R. W., Clarke, J. I. and Battikhi, A. (eds), Arid land resources and their management: Jordan's desert margin, London: Kegan Paul International, pp. 171-182.
43. Kirk, A. J., (1998a). The effect of intensive irrigated agriculture upon soil degradation: a case study from Ashrafiyya, In: Dutton, R. W., Clarke, J. I. and Battikhi, A. (eds), Arid land resources and their management: Jordan's desert margin, London: Kegan Paul International, pp. 127-156.
44. Kirk, A. J., (1998b). A synthesis of climatic data with specific interest in the precipitation record, In: Dutton, R. W., Clarke, J. I. and Battikhi, A. (eds), Arid land resources and their management: Jordan's desert margin, London: Kegan Paul International, pp. 47-66.
45. Moravec, J. and Böhme, W., (1997). A new subspecies of the Mediterranean gecko, *Hemidactylus turcicus* from the Syrian lava desert (Squamata: Sauria: Gekkonidae), Herpetozoa, Wien, 10 (3/4):121-128.
46. Parker, H. W., (1935). A new melanic lizard from Transjordania, and some speculations concerning melanism, Proceedings of the Zoological Society of London, 1935:137-142.
47. Poore M.E and Robertson, V. 1964. An Approach to the Rapid Description and Mapping of Biological Habitats. Hunting Technical Services Ltd, British Jordan Expedition. The Sub Commission on Conservation of Terrestrial Biological Communities of International Biological Programme.
48. Qarqaz, M., Abu Baker, M. and Amr, Z. S., (2004). Status and ecology of the Striped Hyaena, *Hyaena hyaena*, in Jordan, Zoology in the Middle East, 33:87-92.

49. Qumsiyeh, M. B., Amr, Z. S. and Al-Oran, R. M., (1998). Further records of bats from Jordan and a synopsis, Turkish Journal of Zoology, 22:277-284.
50. Qumsiyeh, M. B., Amr, Z. S. and Shafei, D., (1993). The status and conservation of carnivores in Jordan, Mammalia, 57(1):55-62.
51. Rifai, L., Al-Shafee, D., Al-Melhim, W. and Amr, Z. S., (1999). Status of the Marbled Polecat, *Vormela peregusna* (Güldenstaedt, 1770), in Jordan, Zoology in the Middle East, 17:5-8.
52. Rifai, L. B., Al-Melhim, W. N., Gharaibeh, B. M. and Amr, Z. S., (2000). The diet of the Desert Eagle Owl, *Bubo bubo ascalaphus*, in the eastern desert of Jordan, Journal of Arid environments, 44(3):369-372.
53. RSCN. 2000. Important Bird Areas of Jordan. RSCN, BirdLife International. Amman, Jordan.
54. Schmidt, K. P., (1939). Reptiles and amphibians from Southwestern Asia, Field Mus. Nat. Hist., Zool. Ser, 24:49-92.
55. Schmidt, K. P., (1930). Reptiles of Marshall Field north Arabian Desert expeditions 1927-1928, Field Mus. Nat. Hist., Zool. Ser, 17:223-230.
56. Scott, D. M. and Dunstone, N., (2000). Environmental determinants of the composition of desert-living rodent communities in the north-east Badia region of Jordan, Journal of Zoology, 251:481-494.
57. Searight, A., (1987). Some records of mammals from north eastern Jordan, Proceedings of the symposium on the fauna and zoogeography of the Middle East pp. 311-317.
58. Wallace, D.I.M. (1982). Observations of Migrant Birds at Azraq and North-east Jordan, up to April 1967. Sandgrouse 4: 77-99.
59. Wallace, D.I.M. (1983). The Breeding Birds of the Azraq Oasis and its Desert Surround, Jordan, in the mid-1960s. Sandgrouse 5: 1-18.
60. Warburton, J., (1998). A reconnaissance survey of surface water infiltration characteristics, In: Dutton, R. W., Clarke, J. I. and Battikhi, A. (eds), Arid land resources and their management: Jordan's desert margin, London: Kegan Paul International, pp. 157-170.
61. Werner, Y. L., (1992). Identity and distribution of Agama stellio picea Parker (Sauria: Agamidae), endemic to the volcanic desert of Jordan, Zoology in the Middle East, 6:41-44.
62. Werner, Y. L., (1971). Lizards and snakes from Transjordan, recently acquired by the British Museum (Natural History), Bulletin of the British Museum (Natural History), Zoology, London, 21(6):213-256.
63. Werner, Y. L., (1991). Notable herpetofaunal records from Transjordan, Zoology in the Middle East, 5:37-42.
64. Wettstein, O., (1951). Ergebnisac dat Oster reichischen Iran Expedition 1994/1950, Sitz-ber. Oster reichischen Akad. Wiss., Abt. I Wien, 160 (5):427- 448.
65. Zohary, M. (1962): Plant Life of Palestine. New York, Roland Press Co. Pp. 262.
66. Zohary, M. (1968-1972): Flora Palaestina. Vol. I, II, III. The Israel Academy of science and Humanities. Jerusalem.
67. Al-Hashemiyah Municipality Development Unit (2007). Al-Hashemiyah Municipality Development Plan Report.

68. Zarqa Governorate Development Unit (2005). Socioeconomic Reality of Zarqa Governorate.
69. Jabarin, A. (2009). Social Assessment Report by Dr. Amer S. Jabarin.
70. (2009). Zarqa River Habilitation Launch Report.
71. Zarqa Tourism & Antiquities Department (2009). Antiquities in Zarqa Governorate.
72. Alt, A. (1936a). Der sudliche Endabschnitt der romischen Strasse von Bostra nach Aila, ZDPV 59:92-111.W.
73. Alt, A. (1936b). Aila und Adroa im spatromischen Grenzschutzsystem ZDPV 59: 181-193.
74. Bisheh, G., Farajat, S., Palumbo, G. and Waheeb, M. (1993). Archaeological Rescue Survey of the Ras en-Naqab-Aqaba Highway Alignment, ADAJ 37:119-133.
75. Bowersock, G.W. (1971). A Report on Arabia Province, JRS 61 :219-292.
76. Fiema, Z. (1992). The Islamic Conquest of Southern Jordan, ADAJ 36:325-333.
77. Gebel, H.G. (1992). Ayn Jammam, near Ras an-Naqab, Field Operations, September 1992. Report deposited at the Department. of Antiquities, Registration Center, Amman.
78. Glueck, N. (1935). Explorations in Eastern Palestine II, AASOR 15, New Haven.
79. Glueck, N. (1939). Explorations in Eastern Palestine III, AASOR 18-19, New Haven.
80. Graf, D.F. (1979). A Preliminary Report on a Survey of Nabataean-Roman Military Sites in Southern Jordan, ADAJ 23: 121-127.
81. Graf, D.F. (1983). The Nabateans and the Hisma: In the Steps of Glueck and Beyond, Pp.647-664 in C.Meyers and M. O'Connor (eds) The Word of the Lord Shall Go Forth: Essays in Honor of David Noel Freedom, Philadelphia.
82. Hart, S. and Falkner, R. (1985). Preliminary Report on a Survey in Edom, 1984, ADAJ 29:255-277.
83. Henry, D. O. (1982). The Prehistory of Southern Jordan and Relationship with the Levant, JFA 9/4:418-444.
84. Jobling, W.J. (1983). Preliminary Report on the Fourth Season of the' Aqaba- Ma 'an Archaeological and Epigraphic Survey, 1982/1983. ADAJ27: 197-208.
85. Kirkbride, D. (1966). Five Seasons of the Pre-Pottery Neolithic Village of Beidha In Jordan, PEQ 98: 8-72.
86. Nissen, H. J., Muheisen, M., Gebel, H.G., Becker, C., Neef, R., Pachur, H., Qadi, N., and Schultz, M. (1987). Report on the First Two Seasons of Excavations at Basta 1986-1987, ADAJ 31 :79-119.
87. Oleson, J.P. (1986). The Humayma Hydraulic Survey: Preliminary Report 1986 Season, ADAJ 30:253-260.
88. Parker, S.T. (1967). Archaeological Survey of the Limes Arabicus: A Preliminary Report, ADAJ 21: 19-31.
89. Savignac, M.R. (1932). Chronique: Notes de Voyage. RB 41: 235-262.