AL-BALQA' APPLIED UNIVERSITY

INTERNATIONAL RESEARCH CENTER FOR WATER, ENVIRONMENT, AND ENERGY (IRCWEE)

Environmental Impact Assessment for Wastewater Treatment Unit at Public Security Directorate Compound Amman - Jordan

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Ministry of Environment

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Contents

List of Figures

List of Tables

List of Appendices

List of Abbreviation

BAU: Al-Balqa' Applied University

EIA: Environmental Impact Assessment

EMP: Environmental Management Plan

GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

IRCWEE: International Research Center for Water, Environment, and Energy

MoEnv: Ministry of Environment

MWI: Ministry of Water and Irrigation

WAJ: Water Authority of Jordan

PSD: Public Security Directorate

PSDC: Public Security Directorate Compound

SBR: Sequencing Batch Reactor

TOR's: Terms of References

VECs: Valued Environmental Components

WWTP: Waste Water Treatment Plant

WWTU: Waste Water Treatment Unit

Executive Summary

This summary presents the findings of the environmental impact assessment (EIA) study conducted for the construction of Wastewater Treatment Unit (WWTU) at Public Security Directorate compound (PSD) in Moqablane area south of Amman. The project aims at installing and operating a wastewater treatment unit (WWTU) to provide a sustainable and effective treatment system for the community of the PSD. It is designed to be simply operated, economically viable with low or no environmental risks. The reclaimed water will be used for landscaping within the boundaries of PSD compound. Therefore, WWTU effluent should meet the relevant Jordanian Standard.

The EIA was focused on the main issues identified during consultation process with the different stakeholders (including the public and the project proponent) that would interact with the important environmental elements at the project site .

The EIA was conducted according to the national and international requirements and standards. A scoping session was organized on March 17th , 2013 in Amman. This EIA report is prepared on the basis of the Scoping Report. The Scoping Report has documented all issues and concerns raised and discussed during the scoping session and is approved by the Ministry of Environment (MoEnv).

The positive and potential adverse impacts of the proposed project have been identified throughout the study. The overall and the net project impacts on the environment within the area are evaluated to be positive. However, the potential adverse impacts are very minimal and are mostly limited to the area immediately surrounding the WWTU. These minimal effects are due to the size of the treatment facility, the amount of wastewater treated and the type of treatment technology used i.e. equalization, aeration (aerobic treatment) and clarification are all occurring in the same tank using a single batch.

The construction stage of the project has a small scale and it includes trenching and excavation work to deploy the WWTU. The potential adverse impacts during this stage are mainly related to air quality deterioration from earthworks and transportation, impacts from the disposal of excavated materials and construction waste as well as health and safety hazards. A number of appropriate mitigation measures are proposed. Example mitigation measures includes the collection and storing of excavated materials and rubbles in a designated area to be used on site for fill. Another example deals with the occupational health and safety standards during all construction activities in accordance with the “Code of Safety for Construction Works” that ensures personal protection measures for face, arms, legs, hearing and vision and installing the appropriate warning signs inside the construction site to warn the workers of potential hazards.

The potential adverse impacts during operation were assessed to be insignificant. However, it shows slight potential impacts on soil and water resource, on public and occupational health and

safety and a slight potential impacts from sludge reuse and disposal. Consequently, a number of proposed mitigation measures have been proposed to minimize such potential impacts.

An Environmental Management Plan (EMP) has been developed as part of the present EIA. The developed EMP outlines the measures that the project proponent (PSD) should implement to mitigate the potential negative impacts and maximize the positive impacts of the project on the environment. Further, the EIA study defines the specific actions required, roles and responsibilities for these actions as well as defining any monitoring requirements, capacity building and training requirements for the implementation of the developed EMP.

1. Introduction

1.1. Background

Wastewater is considered as an important non-conventional water source in Jordan that is normally used in irrigation. According to the Ministry of Water and Irrigation (MWI), about 103 Million Cubic Meter (MCM) of the treated wastewater is annually used for irrigation. The proposed project lies within the framework of SWIM – ***Sustain Water MED: Network of Demonstration Activities for Sustainable Integrated Wastewater Treatment and Reuse in the Mediterranean (SWIM)***. The goal of the project is to demonstrate the potential application of decentralized wastewater management and contribute to achieving the millennium development goals (MDG). Decentralized wastewater management approaches are the optimum solution in many locations in Jordan, where groundwater and surface water can be exposed to pollution as a result of improper sanitation, primarily due to the use of cesspools. This is specifically the case for areas that are not covered with sewer network including parts of the Capital Amman.

According to MoEnv's regulations/instructions, the proposed project is classified as environmental category "A" which requires full EIA. The objective of this full EIA is to help ensure the environmental soundness and sustainability of investment projects. This full EIA assesses the potential impacts of the proposed project on physical, biological, socio-economic, and physical cultural resources and potential impacts on human health and safety. In addition, this EIA aims to address the requirements required to prevent damage to sites of religious, historical or architectural or other cultural significance by project activities, and social issues/impacts. Moreover, the assessment is expected to reflect potential benefits associated with the project. The scope of work for the EIA study involves the following:

1.2. Environmental Impact Assessment (EIA)

Environmental assessment is a process to predict the potential impacts—positive or negative—that a proposed project/action may have on the environment before they are carried out and propose measures to mitigate these impacts. The EIA is usually requested to be "brief but thorough" i.e. not "encylopedic", (World Bank, 1991).

EIA is carried out to achieve two main purposes; minimize or avoid adverse environmental effects before they occur and integrate environmental concerns into decision making process. Therefore, any evaluation of EIA process is in fact an exercise to examine the achievements of these purposes. In addition to analyzing the likely effects of the

decisions, EIA involves public participation and consultation as well as developing and comparing alternatives. Currently, EIA is being implemented through regulation No. 37/2006 and its five annexes, which were enacted in response to Environment Protection Law No.1 of 2003 and subsequently to law No. 52 of 2006, where the process was further strengthened and institutionalized under that regulation.

This regulation has also empowered the MoEnv to develop procedures and measures for EIA. According to the same regulation, MoEnv is responsible for administering the EIA system (to arrange for screening, control and follow up on the EIA process and its implementation), and for coordinating the licensing of development activities. The EIA procedure in Jordan (Table 1) is similar to the standard procedure usually followed in many other countries, where it routinely starts with screening and ending with the approval of the EIA study (MoEnv, 2010).

1.3. Scoping Procedure

The scoping exercise/process is the initial step in assessing environmental impacts. It is undertaken once a project is categorized to:

- Identify key issues and the Valued Environmental Components (VECs) and determine those environmental effects or concerns associated with each VEC.
- Develop the final Terms of Reference (TOR) for the EIA.

It is essential to identify more precisely the likely environmental impacts and to define the project's area of influence at this stage. In this way, scoping ensures that EIA studies are focused on the significant effects and time and money are not wasted on unnecessary investigations. As part of this process, information about the project and its likely environmental effects was shared to all potential stakeholders, followed by consultations with representatives of the same groups. The main purpose of these consultations is to focus the EIA on issues of concern at the local level. The scoping process results in identifying the basis for the Terms of References (TOR's) for the impact assessment phase, the appropriate extent of EIA, the important issues and concerns, the information necessary for decision making and the significant effects and factors to be considered.

Table 1. Summary of the Jordan EIA Procedure

Stage	Activity
Screening	1. Submission of Project Information Form (PIF). 2. Reviewing the PIF by An Inter-ministerial Central Licensing Committee (TRC) and classify the project as: • Category I -EIA is required • Category II -initial EIA is only required • Category III -no EIA is required
Scoping	• Preparing Terms of Reference (ToR), after consultation with all stakeholders (determining the issues and parameters to be addressed in the EIA) • Reviewing and approving the ToR by TRC.
Conducting the EIA/ Assessment	• EIA study is conducted by a qualified team • EIA study is submitted to the Technical Evaluation Committee (TEC) to evaluate it against: ✓ Conformity to the ToR; The methodologies used, the scientific validity and legal value of the evidence presented; ✓ The soundness and compatibility of the impacts with respect to environmental protection, the content of the environment management plan (EMP), standards, and other references. • The TEC submits the findings to the Minister of Environment to make a decision.
Setting the Mitigation Measures/Management	Designing strategies to avoid or mitigate potential negative impacts and enhance potentially positive ones.
Decision and Approval	• Approval/disapproval is notified to the proponent within 45 days. • EIA is deemed to be accepted in case no decision was made within the 45 days after the submission of the EIA report.

Licensing	• Issuing the license- upon the approval of the EIA report.
Monitoring	• Follow up on the implementation of the Environment Management Plan and reporting the results of monitoring.

2. Policy and Legal Framework Regulations Requirements

The present EIA study conforms to a number of Jordanian policies, regulations and standards. The following list summarizes the most relevant policies laws, by-laws, regulations and standards related to the proposed activities in relation to the environment.

Policies:

- Wastewater Policy
- Irrigation Water Policy
- Water strategy 2008-2022

Laws/Bylaws/Regulations:

- Public health law (No. 47/2008)
- Water authority law (No. 18/1988).
- Agricultural law (No. 44/2002).
- Transportation law (No. 89/2003).
- Environment protection law (No. 52/2006)
- EIA Bylaw (37/2005).
- Air protection Bylaw No. 28/2005
- Instruction of avoidance of health nesciences No.1/2011
- Jordanian Guidelines for Prevention of Noise 2003

Standards:

- Air emissions from stationary sources standard (No. 1189/2006)
- Ambient air quality standard (No .1140/2006)
- Uses of treated sludge and sludge disposal (No .1145/2006)
- Reclaimed domestic wastewater (No .893/2006)

Water Strategy 2008-2022 is the most relevance to the proposed project. According to this strategy document, the amount of treated wastewater for reuse should reach 15 % of the total renewable water resources available. Moreover, the strategy stressed the needs to build decentralized treatment plants to serve semi-urban and rural communities in addition to explore the potential for using treated wastewater for aquifer recharge. Decentralized sanitation was adopted recently in the water strategy of Jordan and is considered as the only feasible solution for such cases; examples of decentralized sanitation projects include the wastewater treatment units in universities (Jordan University for Science and Technology and in Mutah University among others) and at

municipal level such as in Tal Al Mantah and Al Shoubak. However, the scope of the proposed project, its objectives and outputs are all in line with the content of this strategy in terms of building treatments plants and the reuse of the treated water in different fields.

Another legal instrument of relevance to the proposed project and its activities is the ***EIA regulation No. 37/2006*** and its five annexes, which were enacted in response to Environment Protection Law No.1 of 2003 and subsequently to law No. 52 of 2006.This regulation empowers the MoEnv to develop procedures and measures for EIA. According to the same regulation, MoEnv is responsible for administering the EIA system (to arrange for screening, control and follow up on the EIA process and its implementation), and for coordinating the licensing of development activities.

3. Project Scope and Description

3.1. Site and Location

The new compound of Public Security Directorate (PSD) is located in Moqablane –Amman (Figure 1). This compound is developed to accommodate up to 2466 person. Around 10 % of the total employees are expected to be on call over 24 hours. The rest are on regular duty hours that extend from 8:00 until 16:00. However, under certain circumstances, all employees could remain on duty 24 hours. At present, the wastewater is collected in a tank with a storage capacity of 70 m^3. The collected wastewater is normally hauled by tankers 2-3 times a week. Internal sewerage network covers all the buildings within the premises of the PSD compound. In order to provide proper sanitation and sustainable water conservation, on-site wastewater treatment and reuse scheme is planned.

The total area of PSD compound is 150,000 m^2. The green area in the compound is around 18,500 m^2. Another 15,500 m^2 is available for use as a green area inside the project borders. In addition, an outside border area of 90,000 m^2 can be used as a green area after coordination with relevant parties including Jordan Telecommunication and Gendarmerie. The total area of buildings is 57,703 m^2. The buildings include headquarter, offices, recreation building, command and control center, internal affairs building, mosque and energy center. The recreation building contains the main kitchen and restaurants with a total number of 3000 meals expected to be served daily. The recreation building also includes the laundry, which is expected to produce around 15000 kg of laundry each day. Overall, the expected average daily amount of generated wastewater is 150 m^3

The study area is characterized by its heterogeneous human activities. It contains two private universities, Amman National Park, Ghamadan Park, Dunes Club, Gendarmerie Directorate and Public Security Directorate and the telecommunication towers and storage facility. In addition, several residential blocks exist in the area including Northern Bnayyat district, Sothern Bnayyat district, Al-Husayneyyeh district, Moqabalane district, Khraibet Al-Souk and Al-Yadoodeh district.

During the last three decades, lands in the vicinity of the compound have been traditionally cultivated by rainfed crops. With the expansion in the urban areas of Amman, the land use is shifted to residential (Figures 1). However, bylaw lands on the eastern border of the PSD compound are vacant due to the presence the telecommunication towers.

3.2. Purpose of the Pilot Project

The aim of the pilot activity is to provide a sustainable and effective wastewater treatment system for the PSD. This system is planned to treat the generated wastewater and the reclaimed water is to be used for landscaping. The effluent should meet the relevant Jordanian Standard (JS893/2006). Overall, the proposed system should be economically viable, environmentally sound, and easily operated. To achieve the main purpose of the pilot project, sequencing Bach Reactor (SBR) technology is preselected. The proposed wastewater treatment unit is planned to start the operation phase by the end of 2013.

3.3. Project Framework

This project is jointly funded by the European Commission and the German Government (coordinated by the German International Cooperation GIZ) in the framework of the Europe Aid - Sustainable Water Integrated Management (SWIM). The project aims to demonstrate the application of decentralized wastewater management in Jordan. The newly constructed compound of the PSD located in Muqabalane was therefore selected to construct an on-site wastewater treatment plant along with an agricultural reuse scheme. In order to initiate this undertaking, the project is required to take into account the effects on the environment in accordance with the Jordanian laws and legislations through the preparation of an Environmental Impact Assessment (EIA). Decentralized wastewater management approaches can be an alternative solution to elevate the level of environmental protection and health safety, especially where groundwater and surface water are vulnerable to point and non-point source pollutions. In fact, treated wastewater can be used to reduce stresses on fresh water through applicable irrigation schemes at smaller community scale.

3.4. Wastewater Treatment Technology and Options Analysis of Alternatives

Several wastewater treatment alternatives are investigated during the baseline study conducted by the project proponent. These alternatives are evaluated based on different factors including the cost of construction, operation, labor, energy, and maintenance. Further, environmental and health factors were addressed.

Considering the above selection criteria, the baseline study has concluded that SBR is the best available alternative technology for this particular location. In addition to the above criteria, the baseline study has considered similar existing experience of using decentralized wastewater including SBR in Jordan. Few treatment systems based on SBR technology have been erected in complexes and professional bodies in Jordan, such as in Mutah University and Security Training Center in Muwaqar. Furthermore, Jordanian

companies have developed experience in commissioning and operating such systems. Other examples of testing decentralized sanitation system using SBR systems are being carried out by SMART project in cooperation with Al-Balqa' Applied University (BAU).

3.5. Sequencing Batch Reactor (SBR)

Sequencing batch reactor (SBR) is a fill-and-draw activated sludge system at which all wastewater treatment processes are accomplished in a single reactor, i.e. equalization, aeration and clarification are all taking place in the same tank. SBR systems are uniquely suited for wastewater treatment applications characterized by low or intermittent flow conditions (the case of PSD). The operation of the SBR technology is based on the fill-and draw principle, which consists of the following five basic steps: Idle, Fill, React, Settle, and Draw. A schematic process flow of a typical SBR technology is shown in Figure 2. Generally, influent wastewater passes through screens and/or grit removal prior to the SBR to remove sand and large objects. Afterward, the wastewater enters a partially filled reactor containing biomass (sludge), which is acclimated to the wastewater constituents during preceding cycles.

The reactor in its full mode behaves like a conventional activated sludge system, however, without continuous influent or effluent flow. The aeration and mixing is discontinued after the biological reactions are complete, allowing settling of the biomass and removal of treated supernatant. Finally, SBR technology is characterized by a closed aerated system that prevents odor formation and eliminate disease vectors (i.e., insects). Advantages and disadvantages of the SBR system are shown in Table 2.

3.5.1. Description of the five basic SBR steps

The Idle step occurs between the Draw and the Fill steps, during which treated effluent is removed and influent wastewater is added. The length of the Idle step varies depending on the influent loading rates. Equalization is achieved during this step if variable idle times are used. Mixing to condition the biomass and sludge wasting can also be performed during the Idle step.

During the **Fill step**, influent wastewater is added to the reactor. Three fill variations are used for this step and any or all of them may be used depending on the operating conditions: static fill, mixed fill, and aerated fill (EPA 832-F-99-073 September 1999). During static fill, influent wastewater is added to the biomass already present in the SBR. Static fill is characterized by no mixing or aeration, meaning that there will be a high substrate concentration when mixing begins. A high food to microorganisms (F:M) ratio creates an environment favorable to floc forming organisms versus filamentous

organisms, which provides good settling characteristics for the sludge. Additionally, static fill conditions favor organisms that produce internal storage products during high substrate conditions, a requirement for biological phosphorus removal. Static fill may be compared to using ‘‘selector” compartments in a conventional activated sludge system to control the F:M ratio.

Table 2. Advantages and disadvantages of the SBR system (EPA 1999)

Key advantages	+ Closed aerated system prevents odor formation and disease vectors (i.e., insects). + Minimal foot print. + Equalization, primary clarification, biological treatment and secondary clarification can be achieved in a single reactor. + Operational flexibility and control. + Potential capital cost savings due to elimination of clarifiers and other equipment. + Expandable system
Key concerns	– High level of sophistication is needed (compared with activated sludge system) due to timing units and control. – Higher level of maintenance needed for the controls, automated switches and automated valves. – Potential plugging of aeration devices depending on aeration system provided by manufacturer.

Mixed fill is classified by mixing influent organics with the biomass, which initiates biological reactions. During mixed fill, bacteria biologically degrade the organics and use residual oxygen or alternative electron acceptors, such as nitrate-nitrogen. In this environment, denitrification may occur under these anoxic conditions. Denitrification is the biological conversion of nitrate-nitrogen to nitrogen gas. An anoxic condition is defined as an environment in which oxygen is not present and nitrate-nitrogen is used by the microorganisms as the electron acceptor. In a conventional biological nutrient removal (BNR) activated sludge system, mixed fill is comparable to the anoxic zone which is used for denitrification. Anaerobic conditions can also be achieved during the mixed fill phase. After the microorganisms use the nitrate-nitrogen, sulfate becomes the electron

acceptor. Anaerobic conditions are characterized by the lack of oxygen and sulfate as the electron acceptor.

Aerated Fill is classified by aerating the contents of the reactor to begin the aerobic reactions completed in the React step. Aerated Fill can reduce the aeration time required in the React step.

The biological reactions are completed in the **React step**, in which mixed react and aerated react modes are available. During aerated react, the aerobic reactions initialized during aerated fill are completed and nitrification can be achieved. Nitrification is the conversion of ammonia-nitrogen to nitrite-nitrogen and ultimately to nitrate-nitrogen. If the mixed react mode is selected, anoxic conditions can be attained to achieve denitrification. Anaerobic conditions can also be achieved in the mixed react mode for phosphorus removal.

The **Settle step** is typically carried out under quiescent conditions in the SBR. In some cases, gentle mixing during the initial stages of settling may result in a clearer effluent and a more concentrated settled sludge. In an SBR, there are no influent or effluent currents to interfere with the settling process as in a conventional activated sludge system.

The **Draw step** uses a decanter to remove the treated effluent, which is the primary distinguishing factor between different SBR manufacturers. In general, there are floating decanters and fixed decanters.

Significant operating flexibility is associated with SBR systems. An SBR can be set up to simulate any conventional activated sludge process, including biological nutrient removal systems. For example, holding times in the aerated react mode of an SBR can be varied to achieve simulation of a contact stabilization system with a typical hydraulic retention time (HRT) of 3.5 to 8 hours or, on the other end of the spectrum, an extended aeration treatment system with a typical HRT of 18 to 36 hours. In addition, the aerated react mode (oxic conditions) and the mixed react modes (anoxic conditions) can be alternated to achieve nitrification and denitrification. The mixed fill mode and mixed react mode can be used to achieve denitrification using anoxic conditions. In addition, these modes can ultimately be used to achieve an anaerobic condition where phosphorus removal can occur. Conventional activated sludge systems typically require additional tank volume to achieve such flexibility. SBRs operate in time rather than in space and the number of cycles per day can be varied to control desired effluent limits, offering additional flexibility with an SBR.

3.5.2. Operation and Maintenance

The SBR typically eliminates the need for primary and secondary clarifiers in most municipal systems, which reduces operations and maintenance requirements. Therefore, pumps for return activated sludge are not required. In addition, anoxic basins, anoxic equipment, oxic basins and aeration equipment are accomplished in one reactor using aeration/mixing equipment. This will minimize operation and maintenance requirements. However, due to the fact that SBR system is operated with controls, automatic valves, and automatic switches, extensive maintenance is required compared to the conventional activated sludge system.

3.6. SBR system at PSD

The planned unit operations and processes are designed to treat the generated wastewater of approximately 150 m^3 for the PSD. Description of the treatment components is presented in the following three subsections

3.6.1. Pretreatment

The pretreatment process involves preliminary and primary treatments. According to the conceptual design of the SBR unit, pretreatment takes place in an enclosed system to allow gravity flow of the influent wastewater to. For this purpose, a reinforced concrete underground structure is designed in two levels. The upper level (preliminary treatment) includes a Bar Screen and Grit channel. The bottom level (primary treatment) consists of two tanks (primary compartment and a balancing tank). Figure 3 shows a structural design of the pretreatment unit.

3.6.2. Secondary Treatment

SBR is the main component of the treatment system. The system has two identical SBR units working simultaneously so that each unit receives half of the average daily flow (about 75 m^3). A structural design of the secondary treatment is shown in Figure 4. During this stage, each SBR unit is designed so that the duration of each cycle is 8 hours (Section 3.5). During each cycle, wastewater is treated to remove carbonaceous and nitrogenous compounds to achieve the Jordanian standards for reclaimed water. Further, the SBR tanks are closed structure that are made of reinforced concrete to be installed underground. As a final unit process, chlorination for disinfection is designed so that reclaimed water meets JS 893/2006 effluent hygienic standards for landscaping reuse in urban areas. However, irrigation tank and pumps are provided by the PSD, and are already available on site. The collected treated wastewater will be directly reused for landscaping within the premises of the PSD using drip irrigation techniques.

3.6.3. Sludge disposal

As a result of pretreatment and secondary treatment, excess sludge is produced. In order to eliminate the microorganisms and bacterial growth, excess sludge is stored and stabilized in a sludge holding tank. Sludge holding tank is made of reinforced concrete constructed underground with a working volume of about 75 m^3. Supernatant will be pumped back to the balancing tank in the pretreatment stage. The settled sludge will be hauled by tankers to the nearest centralized treatment facility. Frequent hauling of the generated sludge ensures clean ambient with minimum odor and disease vectors.

3.7. Wastewater Characteristics

Raw wastewater

According to the generated data, the estimated wastewater flow rate is 150 m^3/day. The daily peak flow takes place in the middle of the day (1-3 pm, after lunch). The detailed influent characteristics of the wastewater flowing into the current collection tank have been defined on the basis of the analytical results determined on 3 composite samples collected from the main sewer line serving the PSD compound. Average values are shown in Table 3 and 4.

Based on the analysis, wastewater exhibit domestic characteristics as indicated by the ratio of COD to BOD_5. Nevertheless, the nitrogen level seems to be higher than the average values in the domestic wastewater. These relatively higher values are due to the high urine content, which may require frequent monitoring of the effluent wastewater. Table 4, however shows that trace metals concentrations in the raw wastewater are within the allowable limits in the Jordanian standards.

Expected Quality

The effluent of the wastewater treatment unit are expected to be internally reused for landscaping within the premises of the PSD compound. However, the wastewater quality should meet the limits set in the Jordanian Standard JS893/2006 category (A) for the reuse of reclaimed water. Allowable limits for selected parameters are presented in Table 5.

Table 3. Wastewater characteristics

Parameter	Average value	Average value (without WW from the restaurant)
pH	8.33*	__
COD (mg/l)	1725	1262
BOD_5 (mg/l)	745	320
TSS (mg/l)	788	225
TVSS (mg/l)	590*	200
T.K.N (mg/l)	175	210
NH_4^+-N (mg/l)	133	190
Ptot (mg/l)	52*	49
PO_4-P (mg/l)	12*	__
FOG (mg/l)	43	9
MBAS (mg/l)	0.75	0.57
SO_4^- (mg/l)	34	33
Cl^- (mg/l)	203	217
E.coli (MPN/100ml)	5.7×10^7	2.4×10^7
HCO_3^- (mg/l)	759	835
Mg^{++} (mg/l)	18	9
Ca^{++} (mg/l)	76	28
Nematode eggs (egg/5 liter)	Not seen	Not seen
* Based on one measurement		

Table 4.: Trace metals in PSD wastewater

Trace metal	Concentration (mg/l)	Trace metal	Concentration (mg/l)
Cu	0.049	Cr	0.02
Fe	3.74	Co	0.03
Li	0.01	Mo	0.01
Mn	0.081	V	0.1
Ni	0.04	As	0.01
Pb	0.09	Be	0.02
Cd	0.005	Se	0.01
Zn	0.605	Hg	0.001

Table 5. Allowable limits for selected parameters in the Jordanian standards

Parameter	Unit	Cooked Vegetables, Parks, Playgrounds and Sides of Roads within city limits	Fruit Trees, Sides of Roads outside city limits, and landscape	Field Crops, Industrial Crops and Forest Trees	Water discharge to wadies, streams and water bodies	Artificial recharge of groundwater aquifers
		A	B	C		
Biological Oxygen Demand	mg/l	30	200	300	60	15
Chemical Oxygen Demand	mg/l	100	500	500	150	50
Dissolved Oxygen	mg/l	>2	-	-	>1	>2
Total suspended solids	mg/l	50	150	150	60	50
pH	unit	6-9	6-9	6-9	6-9	6-9
Turbidity	NTU	10	-	-	-	<2
Nitrate	mg/l	30	45	45	45	30
Total Nitrogen	mg/l	45	70	70	70	45
Eschericia Coli	MPN or CFU*/100 ml	100	1000	-	1000	<2.2
Intestinal Helminthes Eggs	Egg/l	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1

*Most probable number or colony forming unit

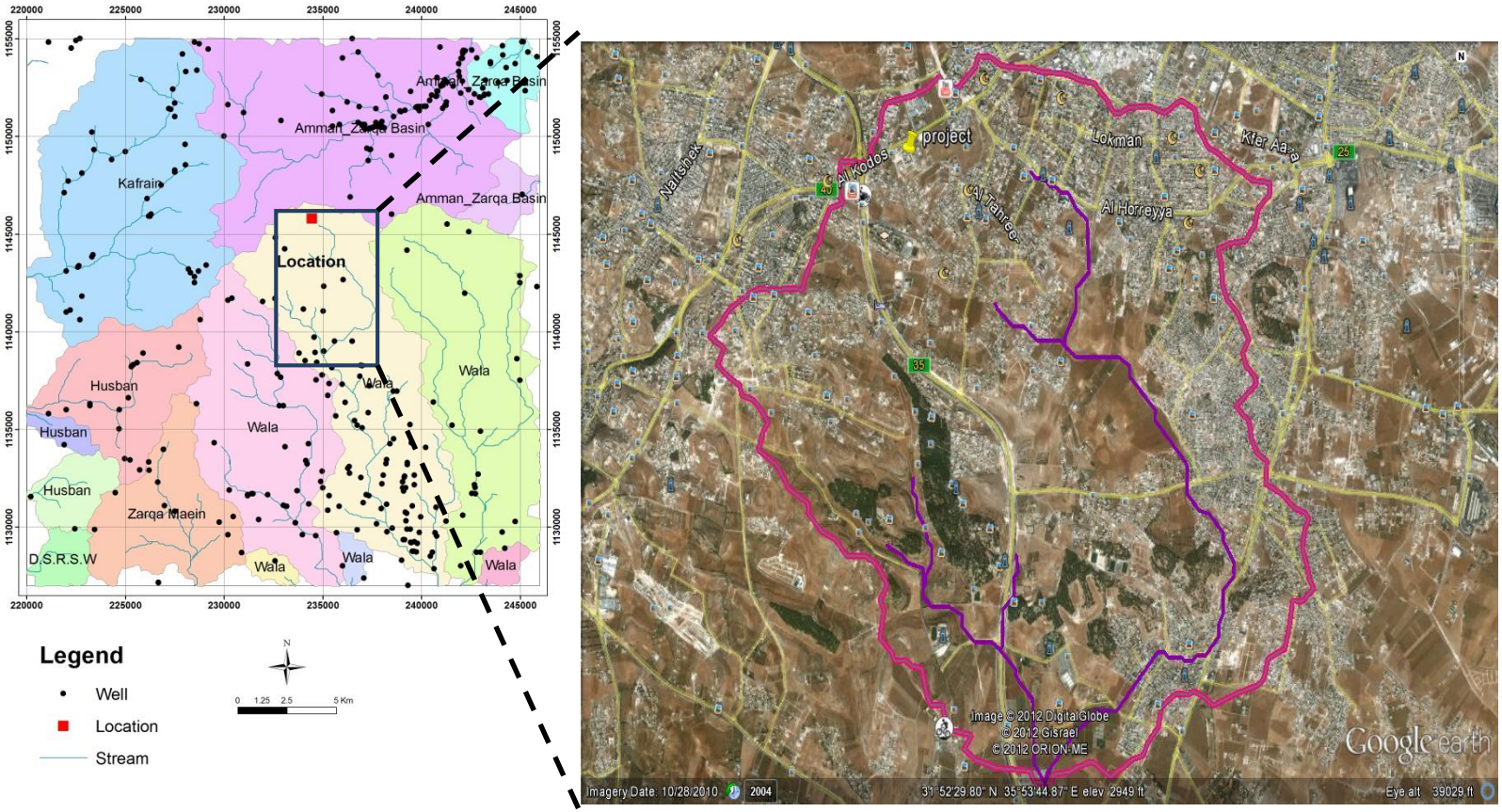

Figure 1. Overview of the study area

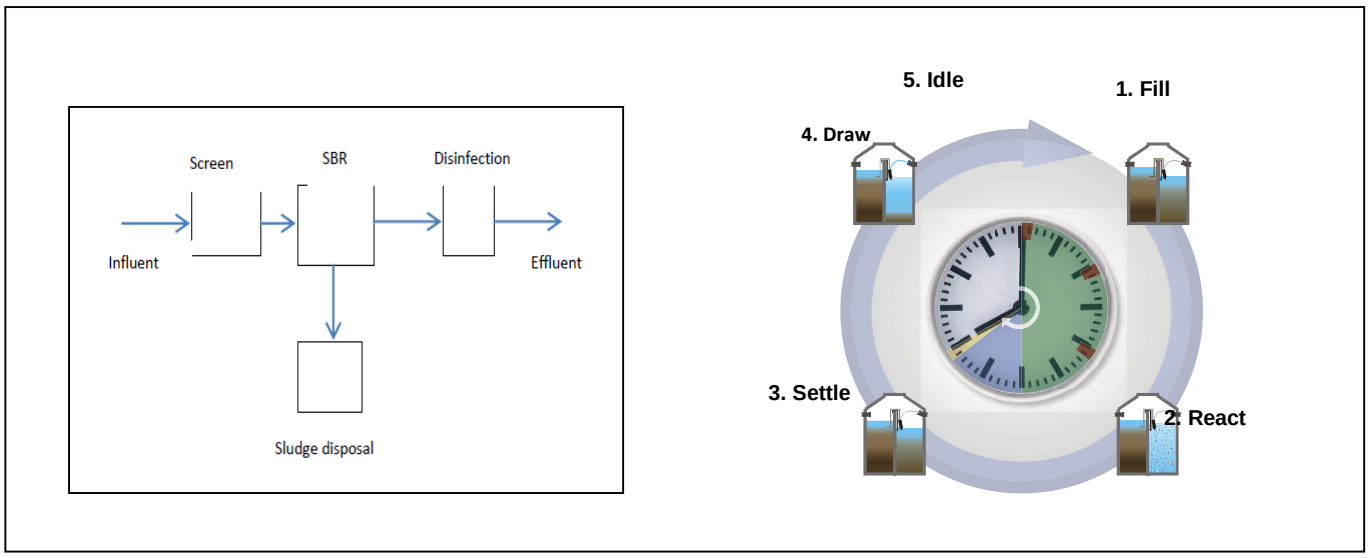

Figure 2.: Flow Process Schematic for SBR Treatment Plant

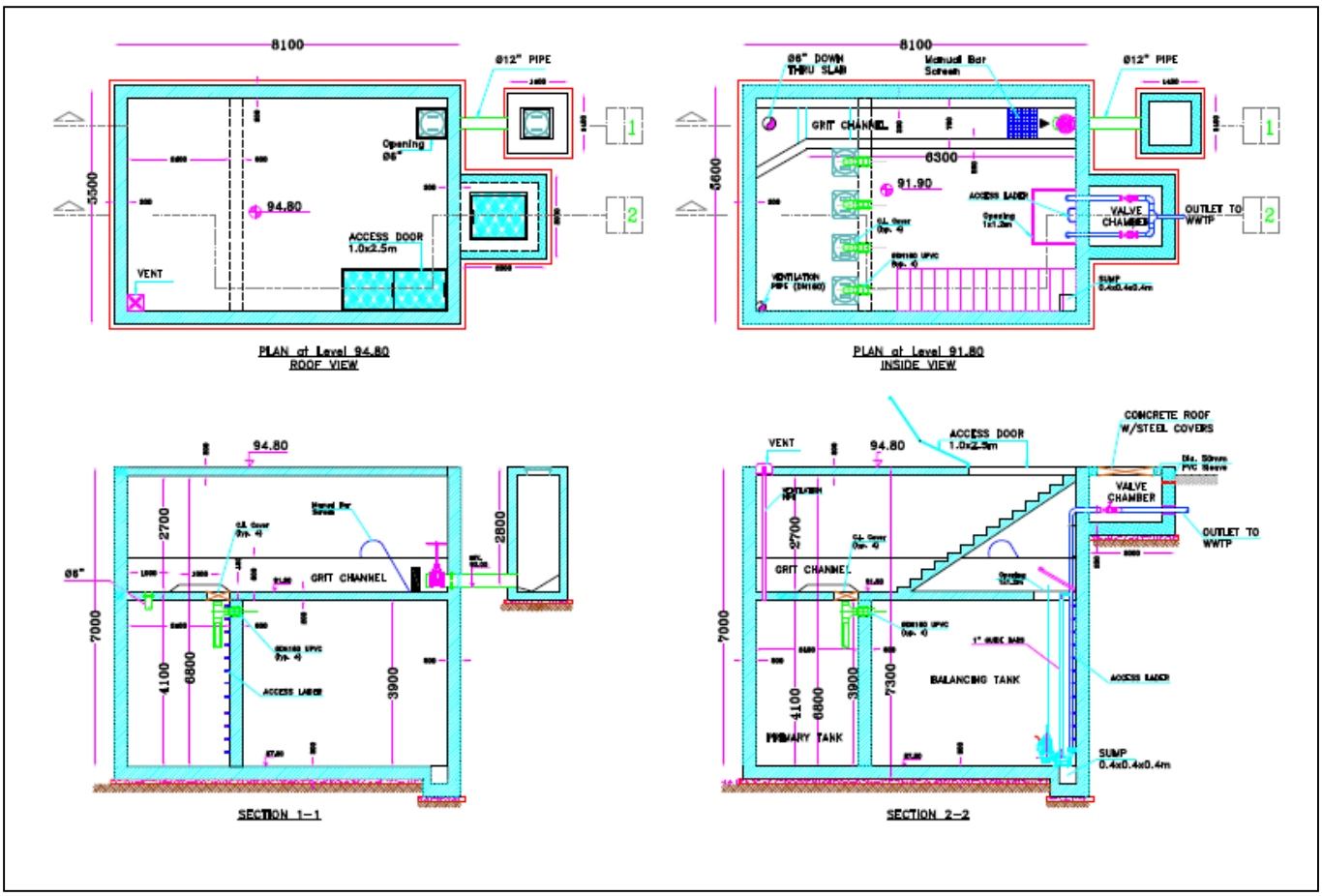

Figure 3. Structural design of the pretreatment units.

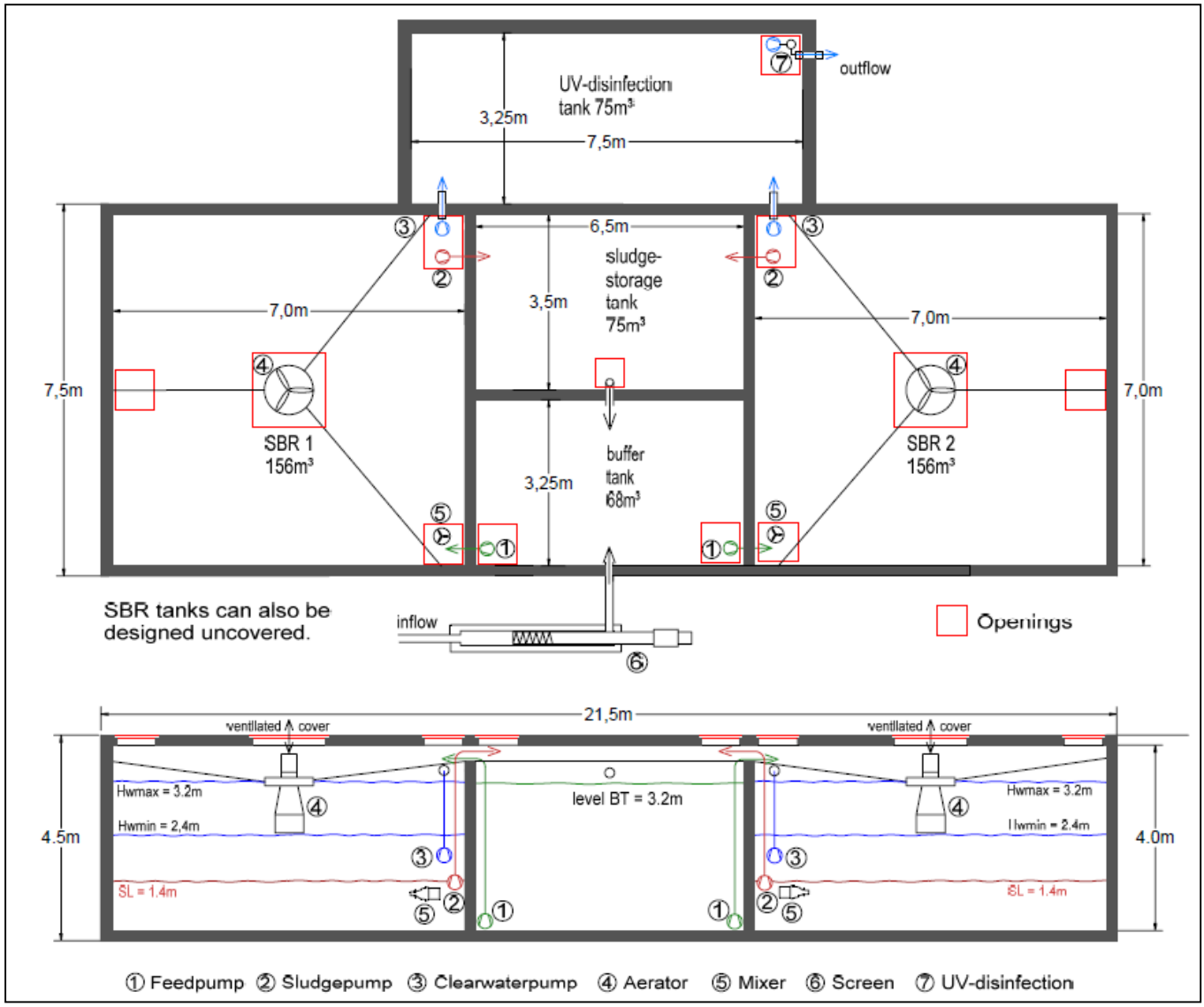

Figure 4. Structural design of the SBR units.

4. Environmental Setting at the Project Area

4.1. Climatic Conditions

Generally, the study area is located within Wadi Albniyat catchment and is classified as semi-arid to arid, with cold rainy winter and dry hot summer. Climate data including temperature, humidity, rainfall, evaporation, and wind speed and direction are available from the closest station to the site;" Yadouda Abu Jaber" station, that is located within the catchment. Data for past 20 years is analyzed to estimate trends of the major attributes. The mean maximum and minimum temperature of 35 ^{o}C in July and 4.4 ^{o}C in January are recorded. The area has an average total yearly precipitation of 400 mm (Figure 5). This average is calculated based on rainfall data observed at three nearby stations namely Naur, abu Alanda, and Yaduda during the period 1986-2008. This variability in rainfall is highly affected by the topography. Figure 6 shows a digital elevation model obtained and processed based on a 10 meters interval topographic map.

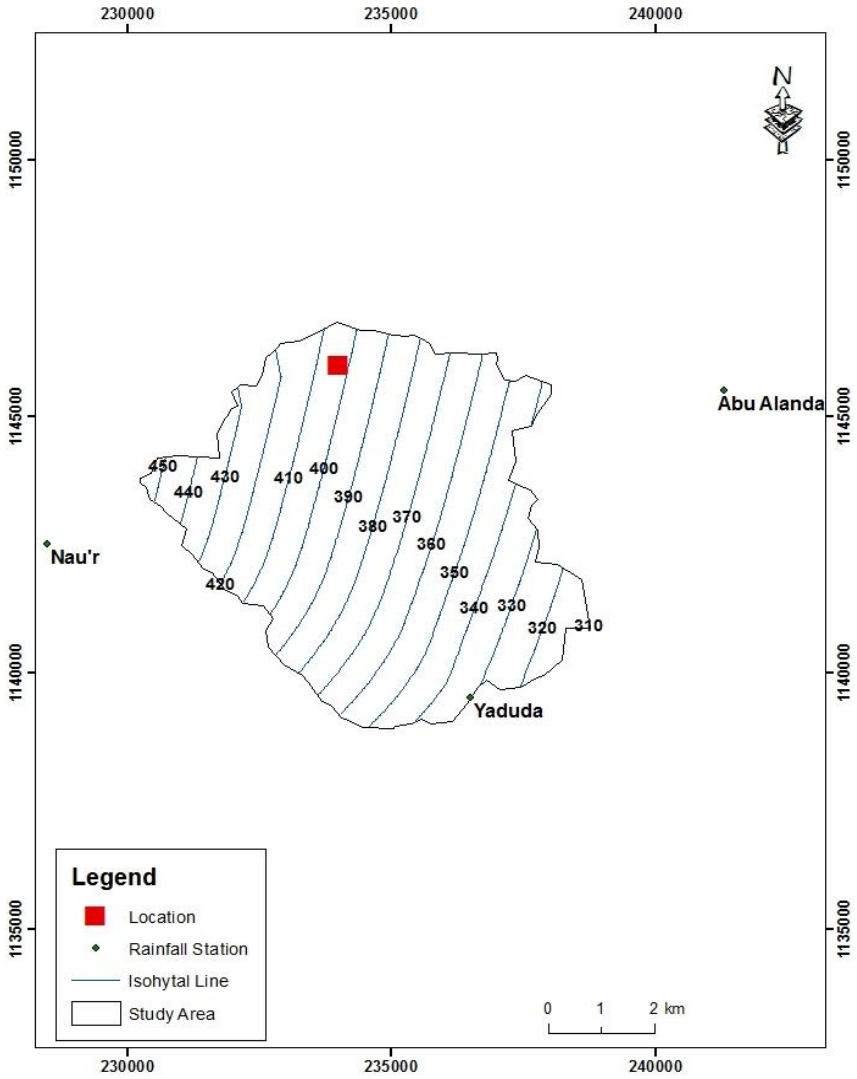

Figure 5. Isohyethal Map of Wadi Al Bniyat Catchment Area

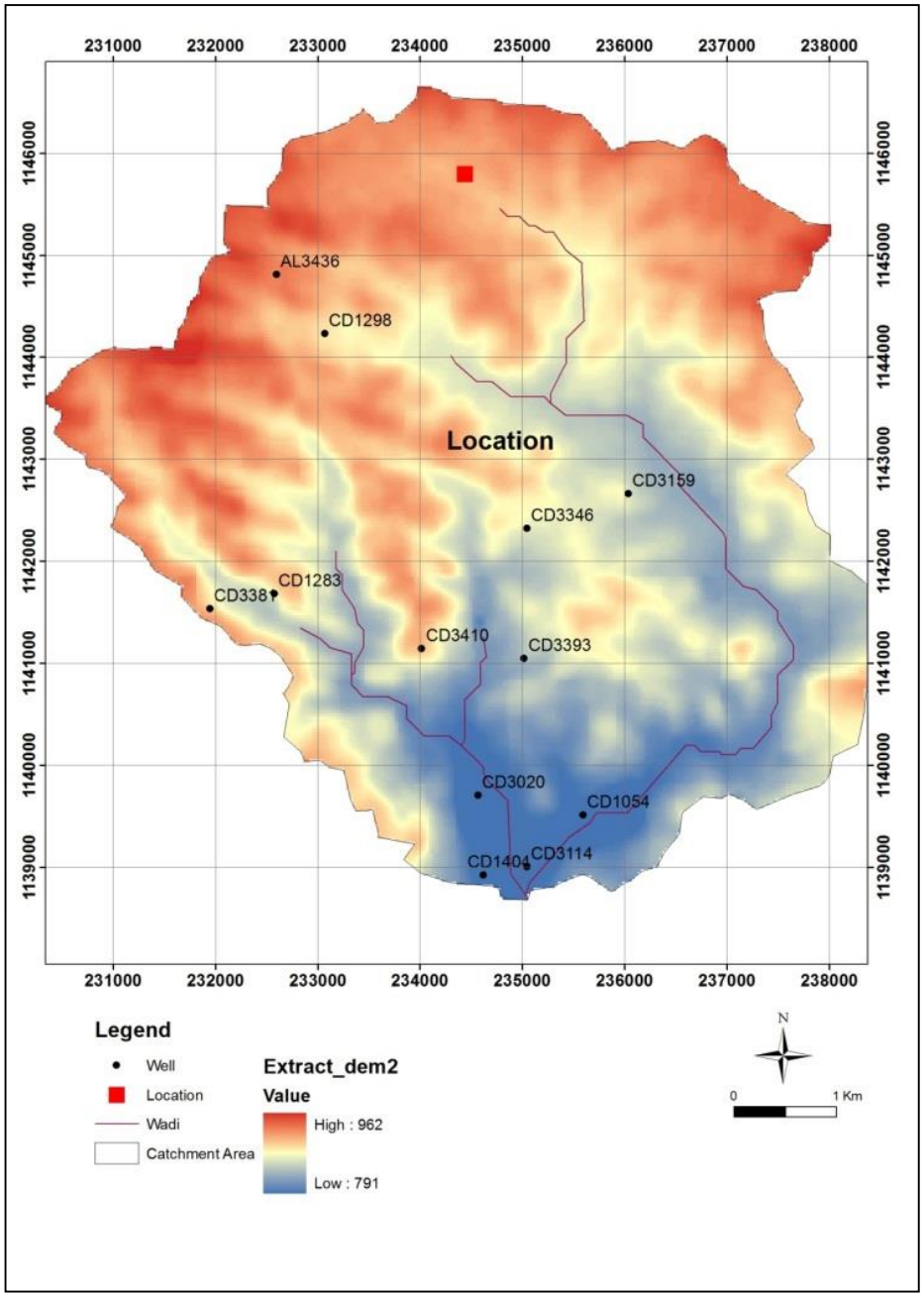

Figure 6. Digital Elevation Model (Topographic Map)

4.2. Geological Setting

Geological formation in the study area is shown in Figure 7. The study area consists of three main geological formations; namely Wadi Sir Formation, Amman Hasa formation and Wadi Um Ghudran formation. Wadi Sir Formation that covers the western parts of the study area is of late Turonia-Coniacian age and consists of limestone and dolomitic limestone with thin intercalations of marl and calcareous siltstone. The sequence comprises a massive limestone unit towards the top. Dolomite is more common in the lower and middle part of the section. Thickness ranges from 80 to 150 m. At the base of this formation, finely laminated gypsierrous beds are encountered.

Amman silicified limestone formation consists of pale to dark grey and brown bedded chert which is intercalated with grey limestone, chalk and marl. The formation is of Campanian Age. The thickness of the formation is between 50-50 m. its lower and upper parts were deposited in a lagoonal environment. The middle sequence indicates shallow marine conditions. Wadi Um Ghurdan formation varies in thickness between 15 and 50 m. The lower parts of the formation composed of massive, buff-grey chalk. The chalk in the upper parts is laminated and pink-buff in color. This formation was deposited during the Santonian in a shallow marine environment.

With respect to hydrogeological formation, the uppermost unit of the Ajlun Group and the lower part of the Balqa Group are considered one hydrogeological unit. Massive limestone, dolomitic limestone and dolomite with intercalated beds of sandy limestone, chalk, marl. Gypsum, chert and phosphorite are predominant in the A7/B2 unit. However, It should be noted that A7/B2 aquifer represents the most important water source in the northern and central Jordan. The aquifer contributes to more than half of the ground water abstraction. Consequently, ground water in the aquifer should be protected from any pollution source including pollution that might result from inadequate sanitation.

The natural vegetation in the Hisban soil (BAN) is degraded Mediterranean dominated by Poterium sp. There are limited pine plantations. Cereal cropping is carried out on the wadi alluvium and on the less steep colluvial slopes. Tree crops are an important component with groundwater irrigated horticulture in the valleys. The natural vegetation is an important source of grazing. The hill slopes in the area can be suitable for tree crops. The gently sloping colluvial footslopes can be suitable for cereals with appropriate conservation measures".

The less steep slopes of the IRI soil unit are "cultivated by barley and wheat. Valleys are intensively cultivated with vegetables and flowers under irrigation. Tree crops are grown on foot slopes. This unit is moderately suitable for cereal cropping. The area is more suitable for tree crops. The valley fill alluvium is suitable for irrigated horticulture.

The Madaba soil (MAD)" is intensively cultivated with the only semi-natural vegetation being degraded Mediterranean species on the isolated limestone hills. Cereals are widely grown and a range of summer crops including tobacco. Significant areas produce horticultural crops and flowers usually under plastics. Tree crops are grown on the more sloping areas. The Madaba soil consists mostly of 90% deep fine soils. The soil is suitable for cereal crops production although the high clay content provides some problems in tillage".

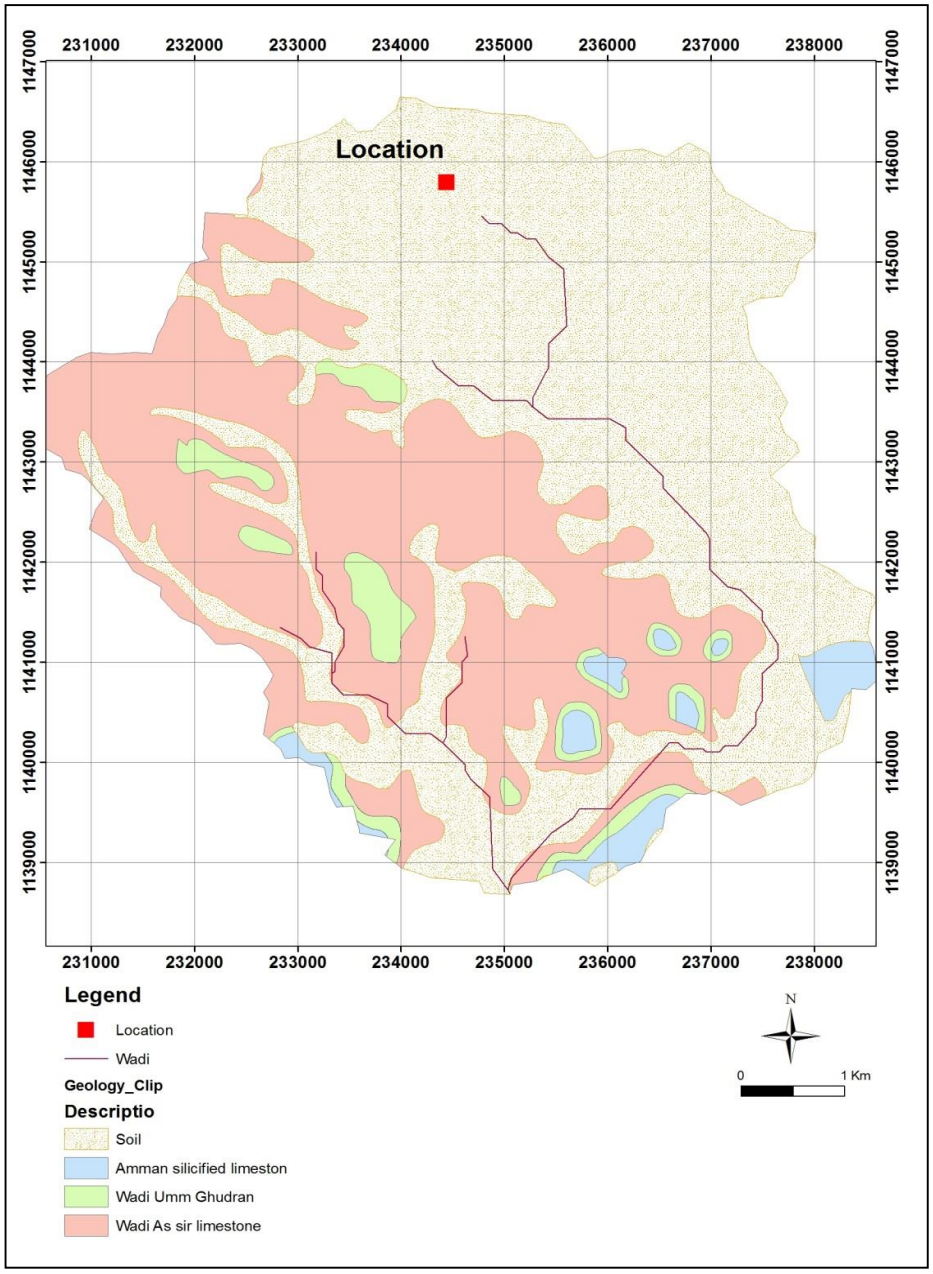

Figure 7: Geological Formation in the Study Area

As for the exact location of the project, the top soil structure layer extend to about 2 m composed of dark brown, highly plastic Silty Clay with pebbles and gravels of limestone (Soil Test report of PSD). The permeability of such soil type is classified as slow to very slow (less than 0.2 inches of water /hr) (Soil Interpretation Help Sheet). This provides a safety layer to ground water (100 m deep). Further, it is concluded that geological faults do not exist in PSD location (site). A few faults, however, exist in the study area. The closest to the site is about 450 m to the north –east and the other is 1 km to the south. The non-existence of faults directly at the site is considered a favorable geological property for the safe management of wastewater at the site.

4.3. Water Resources

The project area (site) is located in the northern parts of Wadi Wala watershed. The total drainage area of of Wadi Wala watershed is around 1800 km^2. The present study area lies in Wadi Al Bniyat sub-catchment area, which forms the uppermost part of Wadi Wala catchment area. Wadi Wala catchment is largely comprising semi-arid to arid plateau land. Wadi Al Bniyat sub-catchment covers an area of about 43 km^2 and lies between and covers an area of about 43 km^2. The study area lies between 230.5 -280.2 E and 139 -146.9 N according to Palestine Grid system (Figure 8). The general shape of the catchment area is nearly oval shape with the longer axis oriented NW-SE direction; accordingly, the general slope of the area is from northeast to southwest. The elevation difference between the highest point of the main channel and the lowest point at the outlet about is more than 150 meters. Elevations range from more than 950 m above the mean sea level to less than 800 m above the mean sea level at the confluence of Wadi Al Mashour with Wadi Al- Hinu, (Figure 9).

The main groundwater aquifer in the study area is A7/B2 of the Balqa group and the deeper Ajloun group as described in the following section. The discharge of the groundwater is through springs and seepage zones. The study area of this project does not include springs. On the other hand, 12 wells exist in the study area of which two are governmental (belonging to WAJ). Remaining wells are private. Yield of the two governmental wells are 26 and 6 m^3/hr, respectively. Yield of the private wells range 6 to 63 m^3/hr depending on the well. Salinity of water ranges from 304 mg TDS/l to 768 mg TDS/l. These values are within Jordanian drinking water quality standards that requests water TDS not exceeding 1000 mg/l.

Over abstraction of ground water in the study area can easily be observed according to data obtained for the monitoring well CD3116 existing 3 km away from the study area. Water level declines at excessively high rate of around 4 m/yr (no data is available after 2000). In general, A7/B2 aquifer suffers from enormous groundwater abstraction and water levels decline rapidly. Data on the effect of over abstraction on water quality and specifically on water salinity is not available. On the other hand and with respect to surface water system, the area is characterized by dry wadis that only flow during limited periods of the year. As mentioned before, the area has an average yearly precipitation of 240 mm. In wet seasons, the precipitation becomes significant; in 1992 it exceeded 450 mm, while in 2003 it exceeded 300 mm.

Figure 10 and Table 6 show map and list of the existing groundwater wells in the area. The data indicates relatively deep unconfined groundwater level (water table). Hence, groundwater is not vulnerable to contamination.

Water pollution in the area may be caused by improper sanitation, where most of the populated lands are not connected to the sewer system. The residential areas surrounding the PSD discharge and collect the generated wastewater in cesspools and/or septic tanks. The collected wastewater is normally hauled by tankers to the nearest transfer station (Ain Ghazal). The possible infiltration

of raw wastewater threatens groundwater resources depending on the soil and geological structure. The industrial activities around PSD site are classified as small scale industries (not water intensive). On the other hand, agricultural practices exist in the downstream of PSD to the south and south east. This might cause water pollution due to uncontrolled use of fertilizers, herbicides and pesticides.

Table 6. Wells Penetrated Amman Wadi Es Sir Aquifer (B2/A7) in Wadi Bniyat catchment area

Well IDN	Well Name	Aquifer Type	Coordinates		Elevation (m)	Water Table	SWL (m)
			North	East			
AL3436	Jordan University for Women	B2/A7	144.810	232.600	936	750	186
CD1054	Fahed Abu Jaber /Yadouda	B2/A7	139.510	235.600	816	743	73
CD1283	Jamal Bshara Al Bsharat	B2/A7	141.680	232.580	881	765	116
CD1298	Basheer Abdelkareem	B2/A7	144.230	233.070	904	779	125
CD3020	Fahed S. F. Abu Jaber	B2/A7	139.700	234.570	819	728	91
CD3346	Ghaleb Saleh Abu Jaber	B2/A7	142.320	235.050	871	691	180

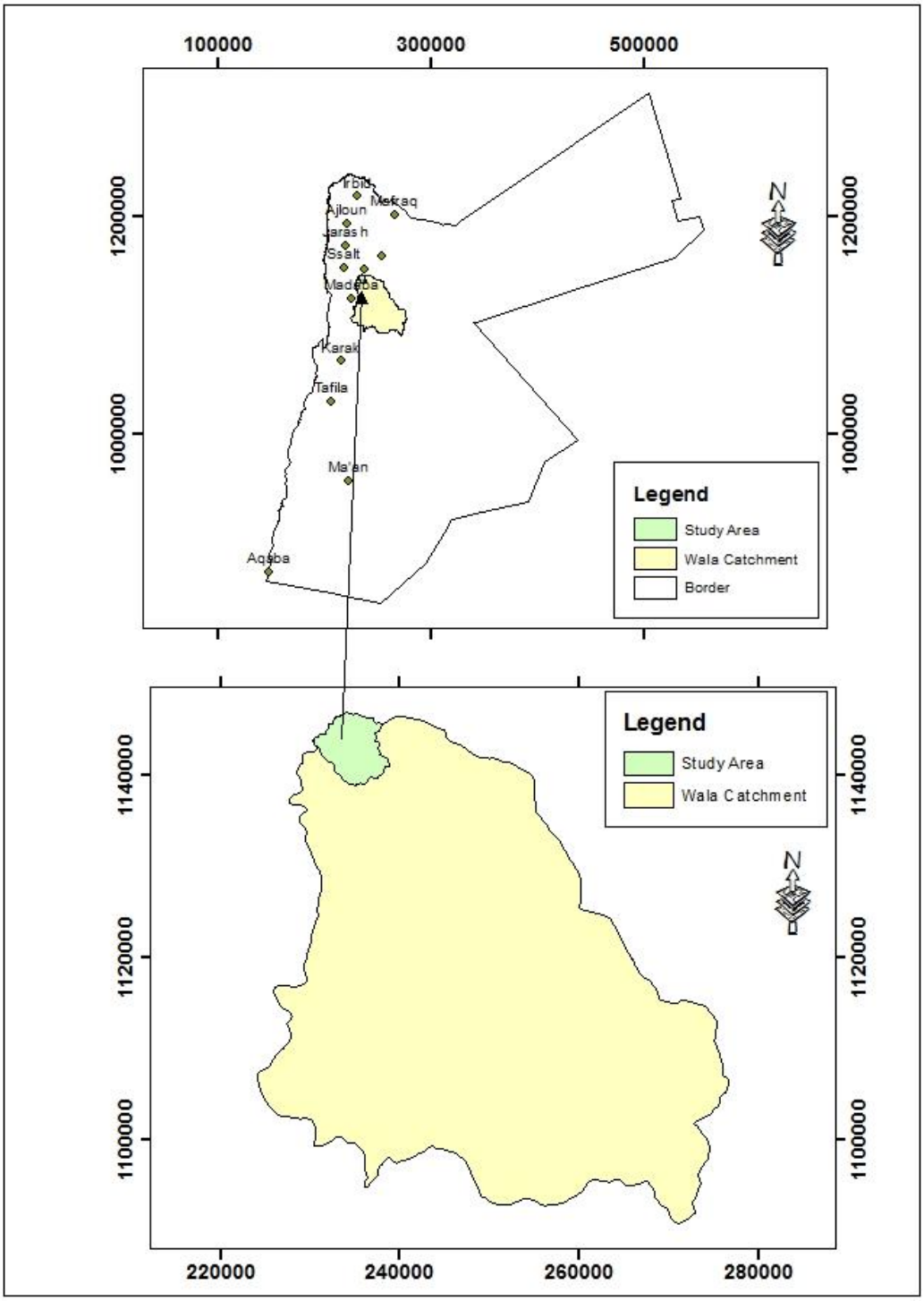

Figure 8. Location map of Wadi Al Bniyat Catchment Area

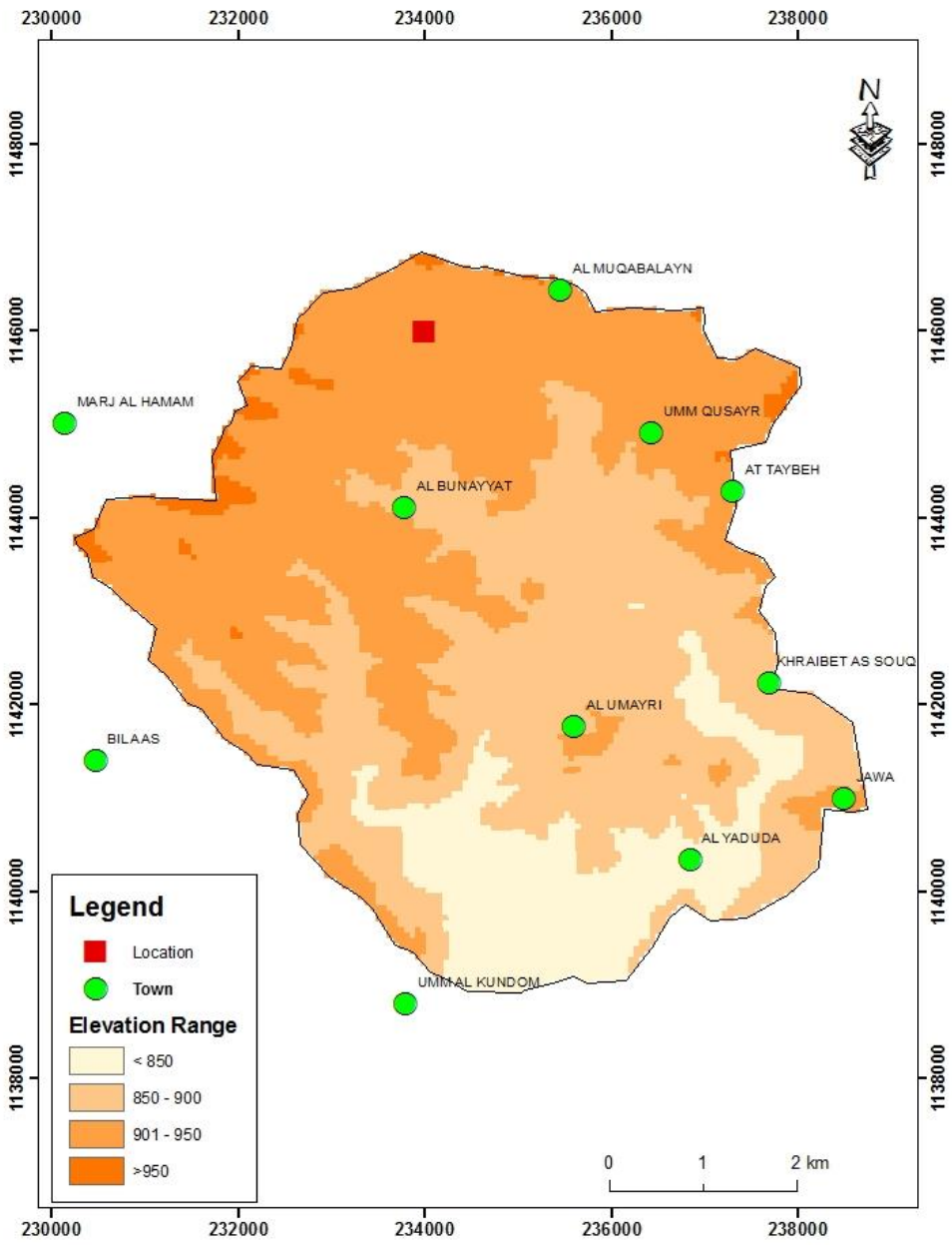

Figure 9. Topographic map of Wadi Al Bniyat Catchment Area

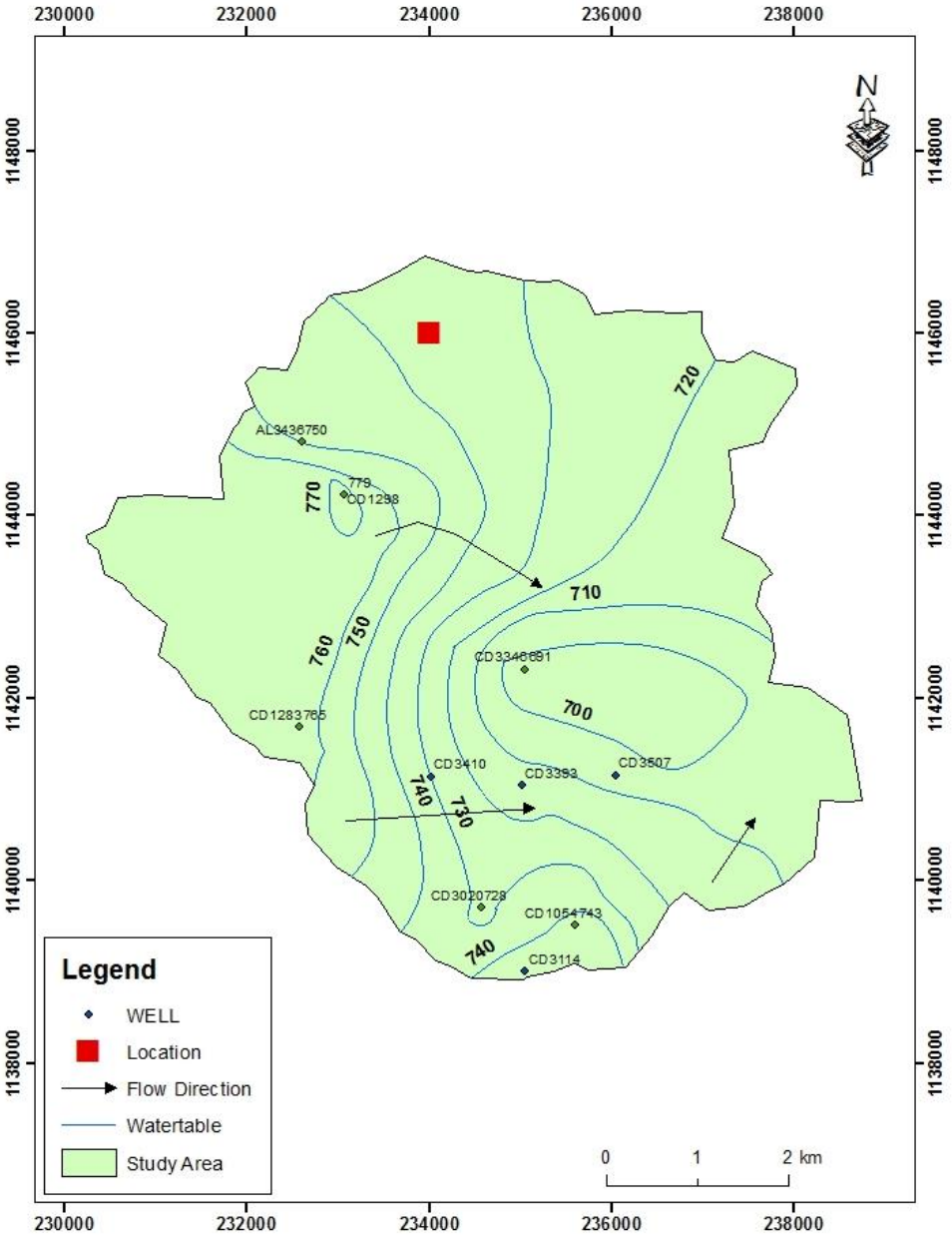

Figure 10. Groundwater Movement Map in the Upper Aquifer

4.4. Water Supply

The main source of municipal water in the area of Moqabalane is the Zara Water supplied by WAJ /Miyahuna Water Company. The TDS value of the water supply is 350 mg/l and the total hardness does not exceed 200 mg/l. PSD compound is connected to the water supply network and receives municipal water twice a week. However, for landscaping purposes, PSD relies on rainwater harvesting and on private tanks.

Current water consumption rate together with expected amounts of consumption in the future are shown in Table 7. The expected water demand after full occupation of the compound have been estimated to be 87.9 l/cap/d. This is calculated based on both the average per capita share

computed for the existing operational building (command and control center) and the total number of occupants after the compound is fully occupied.

The water consumption of the PSD compound is divided into two major types; domestic and irrigation. The per capita per day for domestic use is estimated at 48 to 87 liters. Considering the full capacity scenario of the PSD population (about 2466 person), the water demand for domestic use is calculated as 118 to 217 m^3/day. For irrigation, the current cultivated area is 18500 m^2. According to PSD, this area consumes about 900 m^3 per month. PSD plans to develop another 15500 m^2. Assuming the same water consumption rate, the 15500 m^2 are expected to consume 754 m^3. However, the irrigation efficiency seems to be low due to lack of water resources and to evapotranspiration as well. The amount of the generated reclaimed water mainly depends on the domestic consumption and system losses. Assuming the generated wastewater is 70 % of the total water consumption for domestic use, the treatment unit is expected to produce 82 m^3 to 151 m^3 per day. The 30 % loss is primary sludge, outdoor surface cleaning, and evaporation from paved surfaces.

Considering potential evapotranspiration rate of 6 mm/d, and assuming 50 % biomass computed as area, the potential evapotranspiration is calculated as 55.5 m^3/day and 45 m^3/day for the 18500 $m^2$and 15500 m^2 respectively. The total is 100.5 m^3/day. On the other hand, it is estimated that the trees average consumption is 40 liters per tree per day. Since the trees count up to 40 trees in one donom (1000 m^2), the 18500 m^2 and 15500 m^2 areas will require 29.6 m^3/day and 24.8 m^3/day repectively. The total is 54.4 m^3/day. To sum up, the total reclaimed water ranges from 82 m^3 to 151 m^3 per day, the total evapotranspiration is 100.5 m^3 per day, and the total irrigation demand is 54.4 m^3 per day. Therefore, the proposed treatment unit will provide adequate reclaimed water to meet the irrigation demand.

4.5. Social Setting and Main Stakeholders

Stakeholders analysis made as part of the baseline study indicated that the PSD internal community is the main key stakeholder. Other than this, the residential areas around PSD are not expected to be affected by the unit nor the reclaimed water and they do not have direct access to the site. Furthermore, the pilot project is not expected to have direct interaction with the neighboring community around PSD in terms of water reuse. Therefore, for this pilot project, the community in consideration is limited to PSD. However, the planned demonstration and awareness raising activities by the pilot project will in the future advance the knowledge and understanding of target groups on reclaimed water reuse.

Table 7. Water demand of the public security directorate in formal and Moqablaine compounds

Building	Number of occupants	Water demand m^3/month	Per capita share liter/person - d	Compound	Sources and use

Command and control center	350	923	87.9	Moqablaine	Municipal
Command and control center *(irrigation of 18500 m^2)*	350	900	85.7	Moqablaine	Tankers for irrigation
Sub-Total			174		
Public Security directorate	2116	1850	29	Abdali	Municipal
Public Security directorate	2116	1200	19	Abdali	Tankers
Sub-Total			48		

**estimated based on current irrigation water demand at PSD*

5. Assessment of Impacts and Proposed Mitigation Measures

The positive and potential adverse impacts of the proposed project have been identified throughout the study and are discussed under this section. All of these potential impacts were assessed in a comprehensive manner. Adequate mitigation measures for these impacts were proposed.

5.1. Positive Impacts

The study has identified a number of significant positive impacts on the different environment components and human health. These impacts were evaluated both directly and indirectly in short and long terms. These positive impacts include:

- The project will provide a controlled approach for the collection and treatment of wastewater that avoids any unsafe disposal options and associated environmental and health impacts
- The project will provide marginal water for irrigation and alleviate stress on fresh water
- The project sets practical example for adopting decentralized wastewater treatment as part of the national strategies toward the utilization of nonconventional water resources
- This project acts as knowledge transfer and public awareness opportunities toward reclaimed water
- The installment of the treatment unit will contribute to the improvement of public health and sanitation
- The project will maintain good living conditions for flora and fauna in the surrounding areas
- The quality of the reclaimed water will reduce the usage of inorganic fertilizers leading to soil conservation
- The project will contribute to reduce pollution of water resources (surface and groundwater) and soil
- The use of the treated wastewater in irrigation will improve the aesthetics of the area and landscaping along the site's perimeter

5.2. Potential Adverse Impacts during Construction Stage

The following is a description of the potential adverse impact and proposed mitigation measures during construction and operation. A summary of the assessment of the potential impacts during each stage of the treatment within the treatment unit itself is also discussed. All discussed environmental aspects have been conceived from the scooping session discussion of different working groups.

5.2.1. Construction Wastes and Materials

The overall size of the proposed treatment unit is small. Also, the unit is composed of different components. Hence, it is anticipated that waste and materials expected to be generated from the small-scale construction and installment activities will be minimal and there will be no hazardous waste. This includes small quantities of cement and/or ready-mix concrete, steel, sand and gravel, etc that will be used for construction, assembly and connection of the different parts of the unit. Accordingly, no hazardous material will be needed or used on the site and thus no impact of their packaging waste. Low quantities of excavated materials and rubbles are expected to be generated form the construction of the treatment facility, as they will be mostly used for backfillfill

Mitigation Measures

Excavated materials and rubbles have to be collected and stored in a designated area. These materials can be used for leveling and landscaping within PSD site, or transported outside. Other wastes should be disposed off in the nearest domestic solid waste landfill.

5.2.2. Public Health and Safety

Although no large scale construction operations will take place, usual occupational risks (e.g. risk of injury from falling debris) might be associated with excavation operations. Collapse or parts falling from loose scaffolding could harm construction workers. Such impacts on health and safety may be significant but can be easily averted and mitigated by appropriate construction practices.

Mitigation measures

The following are the main measures that could be adopted to mitigate and avert any potential impact and risk on human health and safety.

- Following the occupational health and safety standards during all construction activities in accordance with the "Code of Safety for Construction Works."
- Providing personal protection measures for face, arms, legs, hearing and vision.
- Installing the appropriate warning signs inside the construction site to warn the workers of potential hazards (e.g. excavated areas)
- Providing protective railings, if necessary , in order to prevent workers from falling into excavated areas.

5.2.3. Air Quality and Noise

During the construction stage, noise pollution is expected from machinery. However, the time required for excavation is minimal and this noise will not last for extended weeks. On the other hand, the excavation will produce significant amounts of dust. This dust will negatively impact the air quality within the vicinity of the site for a short period of time. This impact on air quality is due to smaller dust particulates rather than chemical or biological matters.

Mitigation measures

- Consider wind direction so that minimal dust would affect residential areas. Most populated areas located south and west of the site. Hence, it is advisable to do the bulk of the excavation work during days with western and/or south-western wind direction(s)
- Avoid excavation during holidays, Fridays and night times to reduce the effect of noise on people
- Ensure proper truck covers while transporting excavated materials and generated wastes
- Avoid peak hours while transporting excavated materials to reduce effects on traffic

5.2.4. Landscaping

The project is located in eastern corner of PSD compound, where only natural flora exists. The site has been allocated for the purpose of sanitation in the very first planning stage of the compound development. Hence, the site of the project is not included in landscaping scheme of PSD. Further, and considering the engineering design, most of the structural work of the treatment unit, including reservoirs and tanks, will be constructed underground

5.2.5. Water Resource

Construction effect on groundwater might be an issue in case of extensive excavation and high water table. In this project, these two effective components are not significant. However, abandoned excavated areas should be avoided in order to eliminate confinement of possible wastewater overflow in the later stage during plant operation.

5.3. Potential Adverse Impacts during Operation and their Mitigation

SBR system has been identified as one of the promising treatment options in Jordan and worldwide. It is an efficient and robust system with reliable operational capacity and minimal malfunctioning events. Two SBR units are designed to be installed in this project. This design of two SBR units ensures the flexibility of wastewater diversion between the two units during maintenance periods. In addition, the entire system components (pretreatment, secondary treatment and sludge holding tank) are all designed to be closed and isolated. Hence, not directly exposed to the surrounding environment. This section presents the adverse impacts during operation on the following environmental aspects

5.3.1. Soil and Water Resources

Soil and water resources may be affected by direct flowing of wastewater. Wastewater can reach soil and ultimately water resource for two reasons; Seepage due to cracks or overflow due to storm water and malfunctioning. Further, the quality of the reclaimed water may alter the soil quality depending on the chemical and biological constituents of the reclaimed water and irrigation schedule.

Water resources assessment indicates deep groundwater and absence of surface water. Hence, no significant adverse impacts are anticipated. The study of soil and geology of the project area and the surroundings indicated no geological faults. In addition, the soil structure of the site is thick plastic silty clay of about 2 m. These characteristics provide an excellent protection layer against infiltration to groundwater. Further, groundwater table is more than 100 m deep which eliminate the possibility of groundwater percolation. On the other hand, no surface water bodies are directly

located near the project site. Moreover, the treatment system is designed to ensure low levels of nutrients, mainly nitrogen and phosphorus. Hence, eutrophication is not a possibility

Mitigation Measures

- Proper design of concrete structure and skillful supervision should be provided to ensure sustainable and reliable tanks with no chance for wastewater exfiltration
- Proper runoff diversion channels and structure should be designed to eliminate flood risk. Hence, to protect the treatment unit and to avoid overflow
- Wastewater sewer network should be protected from storm water to avoid overloading during heavy rain events
- Adopt adequate irrigation scheme and schedule that considers the crop pattern and type as well as the potential evapotranspiration rates. Hence, protect crop and soil from residuals

5.3.2. Air Quality and Noise

During the operation stage, noise pollution is not expected to occur. In fact, the SBR mechanical and electrical components have no noise. Overall, the project does not have major noise contributors during the operation stage. The use of machinery during construction will not impact the residential places since the noise level of the machines assumed (100 dB(A) at 1 m from source) will be damped with distance to reach less than 60 dB(A) at the nearest residential place. It should be taken into account that a major 4 lanes road separates the site from the nearest residential place (the nearest residential place is more than 150 m away).

Similarly, there is no to minimal air quality problems during the operation stage. For example, there is no dust, volatiles, vapor, or gas emission to the surrounding atmosphere. Further, the technology of treatment of the selected SBR closed system and its operation is designed to avoid the generation of smell. Overall, the SBR unit it is not expected to generate significant odors. In other words, the engineering design and the chemical and biological reactions within the SBR units produce no gases. Hence, there is no odor generation. Furthermore, the treatment cycle of 8 hours takes place in a closed system and allows aerobic biological degradation. Hence, no smelly gases such as H_2S are expected. However, there is a slight chance of generation of malodorous compound and noticeable smell to develop for a short period of time during sludge hauling process. The hauling process is planned and scheduled to occur once a month, and therefore it is not a regular process. For more details on the mechanism of the SBR processes please refer to Section 3. To sum up, the project is considered an environmental feature as it is designed to solve current environmental problems including smells and flies, that are associated with the wastewater collection and transportation by a tanker every other day (at full occupancy. Currently, around 10 wastewater tanks hauling wastewater from the site on daily basis are needed. Finally, The property of PSD is relatively large and no significant noise or odor will cross the boundaries of PSD property.

Mitigation Measures

- No mitigation measures for noise and air quality are required during the operation stage
- Mitigation measures may be necessary during the sludge hauling process to avoid odor spread during the very short periods of time required to pump the sludge. For example,

well-equipped tankers with sufficient pumping/extracting equipment are recommended to ensure quick and clean sludge hauling process

- Sludge hauling should be scheduled to avoid peak hours, and windy days. It is recommended that this process occur during the weekends
- Planting of different types of tress around the site perimeter

5.3.3. Visual impacts

During the operation stage, the EIA study founds no significant adverse visual impacts. The site of the treatment unit has been selected to be within the premises of PSD and not on the border, most of its components will be installed underground, and the structure has been designed properly to avoid negative visual impacts. Figure 11 provides example of how the decentralized wastewater treatment unit looks like during operation stage. Figure 11 shows the SBR technology at the demonstration site of SMART project at Fuhais and indicates that there is no significant visual adverse impacts.

Mitigation Measures

- Planting trees around the site and introducing walking baths and shaded areas may improve the image of the area of the treatment unit
- Installing informative signs and posters will make it looks environmentally friendly location

Figure 11. Wastewater Treatment Technologies at SMART demonstration site – JORDAN

5.3.4. Sludge

Considering the potential amount of wastewater that will be treated, sludge generated from the unit is minimal and consequently will have no significant effect on the surroundings. In fact, the treatment unit is equipped with a well-sealed storage facility (container), so that all sludge generated from the treatment processes will be stored in a closed underground tank and eventually hauled to a nearby central treatment plant.

Mitigation measures

- Although no significant impacts are expected from the collection and storage of sludge which will be stabilized, samples will be collected to ensure in strict adherence to JS 1145/1996 (Uses of treated sludge and sludge disposal)
- PSD is responsible of sampling and monitoring sludge

5.3.5. Biodiversity

No significant adverse impact is anticipated during operation on the flora and fauna in the area. At the contrary, the project will contribute to the development of vegetation cover at the compound and reduce soil erosion, which may consequently congregate important birds and other fauna around the site. It is worth mentioning that a major concern by the public during the Scoping Session was to avoid planting edible species. After analysis, this is not relevant to the project because PSD is planning to cultivate ornamentals plants and not vegetables nor fruit trees. However, the selection of ornamental trees is very important, since many trees or shrubs can bear edible fruits such as the carob tree *Ceratonia siliqua*. The purpose is maintaining plant growth rate. Plant growth may be reduced due to drier summers. Method of irrigating the plants is very important in this project. The method of application is important, especially if the cost of water is high. Some factors that determine the method and type of system used are: climate, type of plants, cost of water, slope of land, physical properties of soil, water quality, water availability, drainage capability, and salinity or other problems.

Mitigation Measures:

- Adopt proper irrigation techniques and schemes
- Planting fast-growing trees to provide shade should be considered. The addition of trees may be beneficial to biodiversity by providing insect and bird habitats with suitable environment
- Genetically diverse tree stands will offer positive effects for soil microorganisms, insects etc.
- If trees are planted in species-rich unimproved grassland they may reduce biodiversity by shading out the ground flora.

5.3.6. Socio-economic Settings

No socio-economic aspects have been identified during the scoping process, nevertheless, the socio-economic settings have been studied in the project area. The findings indicate that the project will have no direct interaction with the neighboring community around PSD. Therefore, expected socioeconomic impacts, if any, will not affect local community. For example, the project will not

adversely affect job opportunities or land value. However, the project will indirectly generate income to the PSD by providing immediate cuts on their water consumption bill. At social level, small scale wastewater systems should be socially accepted, and the project will provide good opportunity to promote for decentralized wastewater treatment, mainly among the PSD staff. PSD staff are expected to transfer their knowledge to friends and family outside PSD compound.

Mitigation Measures:

- Public awareness activities, mainly among PSD staff to eliminate any negative image about the concept of wastewater treatment and reuse

5.3.7. Public and Occupational Health and Safety

No exposure to sludge or to open water during operation stage. The design ensures closed tanks, and proper electric connections. However, exposure is anticipated during emptying the sludge storage tanks, which may pose a minimal health risk to workers. This risk would be mitigated and reduced through adopting and complying with relevant reuse standards and reuse practices. Hazards from operating machinery is not likely to occur because the SBR unit is designed and assembled to comply with safety standards and codes.

Mitigation Measures

The following are the main measures that could be adopted to mitigate and avert any potential impact and risk on human health and safety during operations:

- Practices and standard operating procedures should be followed
- The concerned staff/operators should receive training on the safe and efficient operation of such wastewater treatment facilities.
- Warning signs should be placed around the unit and warning notices should be distributed/circulated particularly in the events of maintenance and sludge disposal.
- Protective clothing and tools should be wear at all time
- The site of the treatment facility should be well demarked and if necessary fenced off will be fenced to control access by non-authorized people

The preceded discussion was dedicated to analyze the different environmental aspects associated with the construction of the wastewater treatment unit. However, analysis of the impact of the major components (unit processes and operations) within the SBR treatment system is indispensable. Table 8 provides a summary of impact assessment and mitigation measures for the different phases of the treatment within the unit.

Table 8. Summary of impact assessment and mitigation measures for the different phases of the treatment within the unit.

Unit process/operation	Description	Possible interface with environmental components			Possible occurrence	Indicators and monitoring parameters	Mitigation measures	Remarks
		Soil	Water	Air				
Primary treatment PT	This unit is designed to reduce both organic and inorganic loadings by removing large objects, debris, grits as well as portions of carbonaceous suspended solids. PT takes place within a closed reinforced concrete underground structure built into two levels.							
a. Grit chamber	The upper level includes a Grit channel, which shall be equipped with a manual bar screen made of galvanized steel.			√	Odor problems develop where the sewers are long or where it is necessary to collect sewage in pump sumps. Emission of odorous compounds resulting from septic water and becomes objectionable only after anaerobic decomposition has	Basically, inorganic compounds such as hydrogen sulfide and ammonia are developed. In some rare cases, organic compounds such as amines, mercaptans, indole, skatole, organic acids, and organic sulfides might exceed the threshold.	Grit chamber should be compounded in an enclosed system, which is achieved in this project. In case of a development of nuisance and objectionable odors, chlorination of the wastewater influent might be an	Due to the fact the sewer network is very short (onsite system) and pump sumps are not existed, malodorous compound are unlikely to be developed.

					taken over with a high degree of putrefaction.		economically feasible solution.	
b. Collection tank	The bottom level consists of two tanks (compartments), primary compartment and a balancing tank	√	√	√	Seepage of raw wastewater from the underground tanks due to cracks or breaks of the concrete structure as a result of some extraordinary conditions, i.e earthquake.	If seepage takes place due to cracks and breaks of the concrete structure, wastewater would percolate into the underground, especially as underground soil at PSD compound is limestone. Soil contamination (biological, organic and inorganic) might occur. Nitrogenous compound might increase the nitrogen level of groundwater.	Continuous inspection of the surrounding soil should be carried out in order to ensure a complete seal of the concrete structure. In addition, periodical monitoring of the groundwater nitrogen level in a nearby check wells must be undertaken. In case of cracks and breaks, the concrete tank should be repaired and maintained.	- Carbonaceous material might not endanger the groundwater as soil is capable to breakdown the organics. Similarly for microorganisms and helminth eggs (ex. Ascaris). - Groundwater level in the study area is about 200 m deep. Thus, potential of groundwater contamination is unexpected.
					Overflow of the tanks due mechanical malfunction and storm water runoff.	Wastewater is flooding the surrounding area around the tank. Soil contamination occurs and therefore causing water pollution (in case of surface run off) and air pollution as described in the grit chamber.	Hauling the tank content via vehicle tankers is the direct required response. Contaminated soil should be replaced by new soil.	This is an unlikely risk due to the fact that the collection tank is equipped with two pumps (in duty and standby)
					Development of malodorous	Inorganic compounds such as hydrogen	Proper ventilation of the tank to provide the	The low hydraulic retention time in the

					compounds due to the prolonged detention time.	sulfide and ammonia are developed especially in the hot weather, where dissolved oxygen level in wastewater is reduced. In some cases, organic compounds such as amines, mercaptans, indole, skatole, organic acids, and organic sulfides might exceed the threshold.	water air interface with oxygen. In some unexpected cases, chlorination of the influent wastewater can alleviate the objectionable odor.	tank can barely produce malodorous compounds unless large amount of putrefied compounds are available.
Secondary Treatment **Sequencing batch reactor system (SBR)**	The system has two identical SBR units working in parallel, so that each unit receives half of the daily flow of 150 m^3. Carbonaceous and nitrogenous compounds are to be removed within the SBR tanks. Treated wastewater quality should comply with the Jordanian standards JS893/2006 over the entire year.	√	√	√	Seepage of raw wastewater from the SBR tanks due to cracks or breaks of the concrete structure as a result of some extraordinary conditions, i.e earthquake.	Similar indicator as in the collection tank	Similar indicator as in the collection tank	
					Overflow of the tanks due mechanical malfunction	Wastewater is flooding the surrounding area around the tank. Soil contamination occurs and therefore causing water pollution	- Maintenance of SBR mechanical aggregates is required. Meanwhile diversion of the wastewater to the other SBR unit should take place. Accordingly SBR control panel should be programmed	Risk associated with SBR malfunction is minimal due to the existence of the second unit. In emergency cases, the entire wastewater stream could be diverted to

							to receive this emergent excess flow. - Contaminated soil should be replaced by new soil.	one SBR unit (temporal solution)
					Development of odor due to mechanical malfunction and development of NO_3 due to incomplete denitrification	Hydrogen sulfide and mercaptans can develop due to prevailing anaerobic condition. In case of incomplete denitrification, the level of NO3 in the surrounding area is much less than the threshold of nuisance concentration. This is due to low amount of wastewater and thus low nitrate concentration flux.	Maintenance of the SBR aggregates is promptly required. In addition, means and measures to enhance denitrification should be investigated. This can be accomplished through testing of alternatives within a single SBR cycle. For example induce intermittent aeration, static fill, mixed fill, or aerated fill.	
Sludge holding tank SHT	Excess sludge will be stored and stabilized in a sludge holding tank where sludge stabilization might be provided. SHT is made of reinforced concrete constructed underground with a	√	√	√	Seepage of raw wastewater from the SHT tanks due to cracks or breaks of the concrete structure as a result of some extraordinary conditions, i.e earthquake.	Similar indicator as in the collection tank	Similar indicator as in the collection tank	

	working volume of about 75 m^3.				Overflow of the tanks due mechanical malfunction and storm water runoff.	Similar indicator as in the collection tank	Similar indicator as in the collection tank	
					Development of malodorous compounds due to the prolonged detention time.	Similar indicator as in the collection tank	Proper ventilation of the tank to provide the water air interface with oxygen. In some cases, chlorination of the tank content can alleviate the objectionable odor. Frequent emptying of the tank (possibly every other day).	Malodourous compound will rarely developed due to the decreased level of biodegradable organics in the excess sludge.
Irrigation system	Treated wastewater is diverted to the irrigation tank equipped with irrigation pumps (in duty and standby pumps). The collected treated wastewater will be directly reused for landscaping within the premises of the PSD using drip irrigation techniques	√			Contamination of soil with biological vectors basically microorganisms causing diseases such as Ascaris.	Increased level of pathogenic indicator in soil. This might be due to inefficient disinfection method including insufficient disinfection dose and/or contact time.	Optimization of the disinfection unit is required. This includes doses, disinfectant, and contact time.	This type of contamination is the most hazardous risk due to the high potential of exposure between workers, gardeners, or employees and the soil. However, due to the drip irrigation method employed, this risk is highly reduced due to inexistent aerosols particulates.

Noise pollution resulting for the SBR unit is insignificant. This is due to the fact that mechanical parts (pumps, blowers etc) are either submerged or bounded in a closed container (tanks).								

6. Environmental Management Plan

The Environmental Management Plan (EMP) outlines the measures that the project proponent i.e. PSD should implement to mitigate the potential negative impacts and maximize the positive impacts of the project on the environment. Furthermore, the EMP defines the specific actions required, roles and responsibilities for these actions as well as defining any monitoring requirements, capacity building and training requirements for the implementation of this EMP. Following are the environmental aspects that must be observed and monitored

6.1. Monitoring requirements

Monitoring is crucial component of any EIA study as it aims to ensure better operation and maintenance of any proposed project. It contributes significantly to preventing accidents. Generally, in waste treatment plants/units, there are a number of parameters that are routinely monitored. This includes quality of treated wastewater (output) and quantity, sludge quantity and quality, occupational health and safety and quality of any surrounding key environmental component e.g. groundwater and surface water. Further, noise and gases (H_2S and CH_4) are among the most important parameters that need to be monitored. Hence, these parameters are observed and analyzed to establish a baseline before the construction and operation of the unit.

Noise level at the location of the treatment unit as DeciBel A-weighted (dBA) was monitored over the entire week (from 10 to 16 November 2013). Highway traffic noise is a dominant noise source in the location of plant. The average results for the entire week are represented in Figure 12. The figure shows the average measured value of sound level in dBA distributed over the whole day. According to international standards as well as the Jordanian standard, the maximum registered level of sound/noise (71 dBA) was found to be between moderately loud and quiet. It is clearly seen from the Figure xxx that the level of noise is much lower in the time between 1 am and 6 am (below 55 dBA) and can be therefore considered as quiet ambient.

Concentrations of some nuisance gases were monitored over a week from 10 to 16 November using a M40.M multi-sensor detector. The gases in question were methane gas (CH_4) and Hydrogen sulphide (H_2S). The measurements were taken place in the downstream of the wind direction around the location of the treatment unit. For most of the measurements, the level of the two gases was below the detection limit of the device (0.05 ppm for H_2S and 0.1% for CH_4). However the device registered maximum level of H_2S of 2.8 ppm during the time of emptying (desludging) of the septic tank. This value is considered to be moderate odor that can be detected by the smiling sense of human being, however, is not offensive or causing any side effects on human being. The following table shows the level of effects of H_2S gas on humans.

The level of methane over the entire monitoring period was found to be below the detection limit of the detector except for the desludging time. During desludging time, the level of CH_4 gas was found to be 0.1 % by all monitoring events. However, due to the fact that the detector measures the gas in 0.1 % increment, this value can be between 0.05 and 0.15 %. Finally, Table 10 lists the most important parameters and their monitoring frequency.

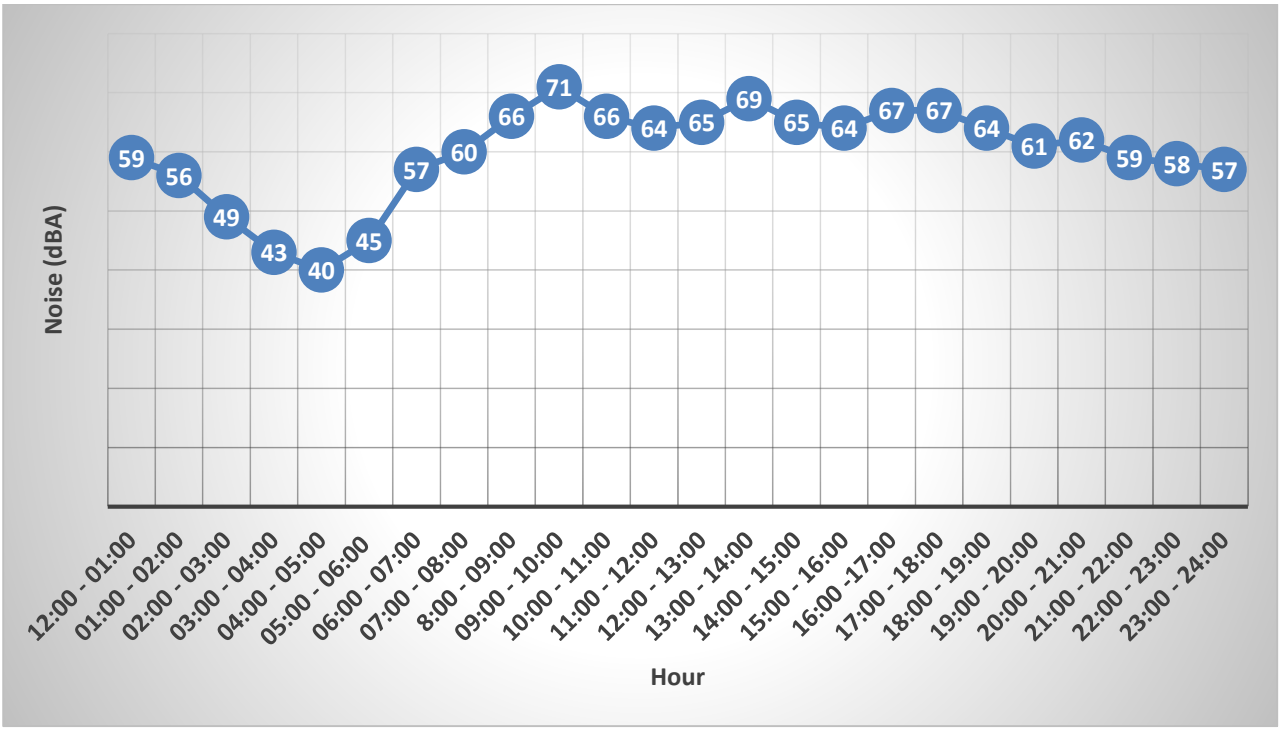

Figure 12. Average hourly noise at the proposed site of the WWTU calculated over a period of one complete week

Table 9. Hydrogen Sulfide level in PPM and the corresponding effect on humans

Concentration ppm	Resulting Conditions on Humans
0.13	Minimal perceptible odor
4.60	Easily detected, moderate odor
10	Beginning eye irritation
27	Strong, unpleasant odor, but not intolerable
100	Coughing, eye irritation, loss of sense of smell after 2 to 5 minutes
200-300	Marked conjunctivitis (eye inflammation) and respiratory tract irritation after one hour of exposure
500-700	Loss of consciousness, cessation (stopping or pausing) of respiration, and death
1000-2000.	Unconsciousness at once, with early cessation of respiration and death in a few minutes. Death may occur even if individual is removed to fresh air at once

Table 10: Environmental management Plan; parameters and their monitoring frequency

Parameters	Monitoring frequency
Treatment plant influent	
BOD, COD, TS, EC, pH	weekly
Treatment plant effluent	
BOD_5, COD, TS, EC, pH	Weekly and if possible twice a week
Coliform, E.Coli	Weekly
Helminth eggs	Quarterly (once every three months)
FOG	Quarterly (once every three months)
Soil, at irrigation fields	
Soil salinity and acidity, i.e. EC, SAR, etc	biannually
Coliform at different depth (surface, 15 and 30 cm)	biannually
Air, next to the treatment pant	
CH_4	Monthly
H_2S	Monthly
Noise, next to the treatment plant	
dBA	
Others	
Groundwater well, the next one to PSD location	
NH_3-NH_4, NO_3, EC, coliform	Annually

6.2. Reclaimed water quantity quality

Quantitative and qualitative monitoring plan should cover the reclaimed water. It is necessary that PSD monitor the variability in the generated treated wastewater and to observe its chemical and biological constituents. This data is important to predict future reclaimed water supplies and therefore to better manage it. Also, the quality of the reclaimed water should be monitored to ensure it is reliability for reuse. A meter is to be installed at the outlet of each SBR unit to measure the generated treated wastewater, and the readings are to be collected on daily basis at the same time. Samples of reclaimed water are to be analyzed every two weeks at the beginning of the operation stage and can be reduced to be monthly afterwards

6.3. Sludge quantity and quality

Sludge quantity and quality should be monitored regularly by the unit operators. The disposal of the collected sludge, sampling and testing should all meet the Jordanian sludge treatment and reuse standards (JS1145/1996).

6.4. Groundwater level and quality

This EIA study and previous baseline study concluded that there is no permanent surface watercourses within the area of the proposed project. On the other hand, groundwater levels are significantly deep and the top soil is clay to silt with very low permeability. Hence, groundwater is not vulnerable to pollution from accidental seepage or leak. Further, groundwater is not subject to deep percolation due to return flows caused by irrigation. As a result, this EIA study concluded that there is no need to monitor the quality or quantity of surface water and groundwater in the area during the construction and the operation stages of the proposed wastewater treatment unit

6.5. Health and Safety

The assessment of occupational health and safety during construction and operation indicated that there would be minimal adverse impacts. The size of the treatment unit, the construction associated with its development, and the treatment technology are among the important factors that prevent smell generation during operation and collecting the generated sludge into “built-in” containers/tanks that will be according to the standards (JS1145/1996). However, the project proponent and the assigned personnel should make sure that standard safety precautions and practices are met during the construction and the placement of the unit as well as during the operation by the workers

6.6. Biodiversity

Monitoring cumulative effects, if any, on both the flora and fauna should be taken into consideration. The impact on flora and fauna species, monitoring should be seasonal throughout the year. In this regard, the main biodiversity concerns regarding water characteristics are both the quantity and quality. It is well known that water makes up approximately 90% of a plant’s mass and performance many functions in plants. Without sufficient water, plant growth and development is

inhibited. Therefore, the relationship between soil and water in the soil as it relates to plant growth is an important concept that must evaluated. In evaluating the suitability of land for irrigated agriculture, both the availability and quality of water must be considered. Water used for irrigation almost always contains measurable quantities of dissolved substances that, in general, are soluble salts. If irrigation water contains soluble salts in sufficient quantities to accumulate within the root zone and interfere with crop yields, a salinity problem arises. The concentration of salts in the water can increase soil salinity to the point where the osmotic pressure leaves plants unable to extract sufficient water for growth. The plants show much the same symptoms they would in a drought – wilting, reduced growth, and in some plants a color change from bright green to bluish green. Thus, drip or trickle irrigation, which uses small amounts of water that are allowed to trickle slowly into the soil through mechanical devices called emitters, will be utilized. Some of the advantages include; controlling the emission rate of water, which ranges from about 2 to 8 liters per hour, and water regulation for pressure and time application.

Table 11 summarizes the environmental management plan including potential impacts, mitigation measures, and the responsibility

Table 11: Environmental Management Plan summary

Potential impact	Mitigation measures	Responsibility	Frequency
Positive Impacts			
Providing a controlled approach for the collection and treatment of the wastewater generated from the compound and avoid any unsafe disposal. Contributing to the improvement of public health and sanitation. Maintaining good living conditions for flora and fauna in the surrounding areas. Contributing to reduce pollution of water (surface and ground) and soil resources. The use of the treated wastewater in irrigation will also improve the visual aesthetics of the area and landscaping along the site's perimeter.			
Potential adverse impacts during Construction			
Disposal of Construction Waste and Materials	Excavated materials and rubbles will be collected and stored separately to use them on site for backfill. All other wastes may be disposed off in local dump sites as they are not hazardous material.	Contractor & project team	During construction
Potential impacts on Public and Occupational Health and Safety	Following the occupational health and safety standards in accordance with the "Code of Safety for Construction Works." Providing personal protection measures for face, arms, legs, hearing and vision. Installing the appropriate warning signs inside the construction site. Providing protective railings to prevent workers from falling into excavated areas.	Contractor & project proponent	|During Construction
Potential Adverse Impacts During Operation and their Mitigation			

Potential Adverse Impacts on Soil and Water Resource	Continuous inspection of the surrounding soil should be carried out in order to ensure a complete seal of the concrete structure. Periodical monitoring of the groundwater level and quality is not necessary. In case of cracks and breaks, the concrete tank should be repaired and maintained.	The project proponent The unit operators	During Operation
Potential Adverse Impacts on Air Quality and Noise	Planting of different types of tress around the site perimeter to further minimize odors. Providing plant operators with protective masks in the event that sudden odor flows.	The project proponent	During construction During Operation
Potential Impacts from Sludge Reuse and Disposal	Samples should be collected on a regular basis so as to ensure in strict adherence to JS 1145/1996.	The unit operators	During Operation
Potential Impacts on Biodiversity (Flora and Fauna)	Optimization of the disinfection unit is required. This includes doses, disinfectant, and contact time.	The unit operators	During Operation
Potential Impacts on Public and Occupational Health and Safety	Training on the safe and efficient operation of the existing wastewater treatment facilities. Placing warning signs around the unit. Protective clothing and tools should be worn at all time. Demarcation/fencing of the site of the treatment facility.	The project proponent	During construction During Operation

7. Conclusion

The proposed treatment unit undoubtedly will contribute to solve an environmental problem related to the collection, disposal and treatment of wastewater, therefore, the project is solely an environmental project.

However, the EIA for the proposed project was conducted according to the standard procedure and practices, and in accordance with the guidelines and regulations of the Ministry of Environment. The main conclusion of the assessment is that the overall net impact of the proposed treatment unit on the different environment elements will be positive.

A few potential adverse impacts have been identified during the assessment and raised in the scoping session, but however, they all can be considered insignificant and will be minimized through the implementation of a set of “mitigation measures” proposed as part of this EIA

Annexes

Annex 1. Summary of Stakeholder Consultations (Scoping Outputs)

Environmental Issues and Concerns: Scoping Session Findings

Minutes of the Scoping Sessions

The scoping workshop was held at Geneva hotel in Amman on March 17, 2013. Forty participants have joined the workshop. They represent the Governmental institutions, NGOs and academia. Names and contacts of participants are listed in Annex 2. The workshop program (Annex 1) included –in addition to the opening session- two main sessions; the first was assigned to brief the attendees on the scope of the project while the other session assigned for working groups to review, discuss and comment on the draft ToR. The following is brief summary of the event.

Opening Session

At the opening session, speeches were delivered by: Dr. Rakad Ta'ani, Director of IRCWEE and representative of BAU President, Dr. Ismail Al Baz, Manager, SWIM project, representative of GIZ, Lieutenant colonel Murad al Masri, representative of PSD and Eng. Izzat abu Hamra, Director of EIA and representative of Minister of environment. Speakers welcomed the participants and stressed the importance of scoping exercise to ensure that a wider consultation with all relevant stakeholders on the issues that should be covered in the EIA and to what level of details. They requested the participants to make a contribution and give their feedback on issues that should be taken into consideration in the next step of the study. The objectives, methodology and the expected outputs of the scoping session were all explained before switching to the working sessions I and II.

Session I

In session I, a presentation was made first on the umbrella project; Sustainable Water Integrated Management (SWIM) followed by details on the scope of the proposed project (i.e. Wastewater Treatment Unit at Public Security Directorate Compound). The focus was made on the description of "Sequencing Batch Reactor Technology" which will be used at the proposed site. The study team presented a comparison between this technology and other different decentralized systems in terms of the economic efficiency, cost, impact on the environment/environmental concerns, etc.

The second part of Session I was assigned to describe the EIA framework and to include a presentation on the project site and its environmental elements. The draft TOR was presented and covered the main list of potential impacts identified at this early stage by the study team. The study team has also presented and described briefly the following:

- Project Justification
- Baseline Study (conducted at an early stage of the project so as to provide the basic and necessary data required by the EIA)
- Environmental Settings
- EIA – Scoping
    - EIA: Objectives and Expected Outcomes

  - Key Environmental Impacts
  - Terms of References (Pre-Scoping)
- Legal Framework
- Scoping Report; Structure and Format
- IRCWEE Study Team (a list of all specialists and their background/relevant experience was presented to the workshop)

By the end of Session, floor was open for general discussion and feedback on the presentations. It was also agreed on the methodology to be followed in the next session where five working groups were established –according to the scope of the project and the main environmental concerns- and participants were requested afterward to choose one working group to join according to his/her concern.

Session II

Session II assigned to the working groups that discussed the draft TOR and made some input and modifications. According to the discussions made in the earlier session, the five groups selected covered the following themes:

Group I: Water and Air Quality
Group II: Soil and Water Resources
Group III: Public Health
Group IV: Biodiversity
Group V: Socioeconomics

The findings of all of these five groups as well as the VECs identified based on these findings are listed and summarized in the following matrices.

Scoping outputs

Table 12: Findings of the working group no. I (Water and Air Quality)

Potential impacts	Project phases			Significance *				
	Const.	Oper.	Decom	1	2	3	4	5
Noise level	X	X	X				X	
Dust	X		X				X	
Odors		X	X				X	
Malfunctioning /H_2S, CH_4		X				X		
Groundwater	X	X					X	
Green Areas (positive impact)		X						X

Table 13**:** Findings of the working group no. III (Public and Occupational Health)

Potential impacts	Project phases			Significance *				
	Const.	Oper.	Decom	1	2	3	4	5
Impacts of gases emissions								X
Noise level	X		X					X
Accidents	X		X				X	
Dust	X					X		
Solid wastes/ construction wastes (Occupational impact)	X		X					X
Odors		X	X					X
Safety kits	X	X	X					X
Insects		X						X
Insecticides		X						X
Sludge		X						X

Table 14: Findings of the working group no. II (Soil and Water Resources)

Potential impacts	Project phases	Significance *

	Const.	Oper.	Decom.	1	2	3	4	5
Alternative source (positive impact)		X						X
Ground pollution		X		X				
Soil degradation		X		X				
Landscaping (positive impact)		X						X
Soil fixation (positive impact)		X						X
Fauna & Flora (positive impact)		X					X	
Rainfall (moist)		X			X			
Leakage		X			X			
Dust (positive impact: minimize impact)							X	

Table 15: Valued Ecosystem Components (VECs)

Potential impacts	**Project Phases**		
	Const.	**Oper.**	**Decom.**
Potential impacts on soil and water resources			
Soil degradation (positive impact)		X	
Landscaping (positive impact)		X	
Soil fixation (positive impact)		X	
Bridge the gap between water supply and demand		X	
Alleviate stress on domestic water from network		X	
Groundwater pollution			
Water and Air Quality			
Noise level	X	X	X
Dust	X		X
Odors		X	X
Malfunctioning /H_2S, CH_4		X	
Groundwater	X	X	

Green Areas (positive impact)		X	
Public and Occupational Health			
Impacts of gases emissions		X	
Noise level	X	X	
Accidents	X		
Dust	X		X
Solid wastes/ construction wastes (Occupational impact)	X		
Odors		X	
Socioeconomics			
Job opportunities	X	X	
Generate income / avoid payments		X	

Annex 2: IRCWEE Profile

Introduction

Modern approaches for natural resource management require the integration of social, environmental and economic research within an interdisciplinary framework. It also requires a capacity to handle complexity and uncertainty and the application of different methods of analysis and different techniques. In response to that, the International Research Center for Water, Environment, and Energy (IRCWEE) was established in late 2009 Under the umbrella of Balqa' Applied University (BAU) to complement the university's vision in offering and maintaining balance between the high academic standards and applied requirements that it has committed itself to achieve in addition to draw upon the expertise of faculties in a wide range of their international disciplines. The center was founded with a generous contribution from The MDG Achievement Fund (MDGIF) and UNESCO. IRCWEE conducts research on a considerable variety of topics e.g., water resources management, soil, environment assessment, nature protection, pollution prevention and control, wastewater treatment, energy efficiency and renewable energy.IRCWEE also offers short courses and periodical training programs on water, environment, and energy. The research, educational, and training programs will be carried out in close cooperation and coordination with the concerned governmental agencies as well as non-governmental organizations representing the public interest. Based on core thematic issues, the center would aim in generating and documenting new acquired knowledge to provide references that can serve both the academic community and the beneficiaries.

Mission

To contribute to the efforts aiming at conserving our natural resources through **education, research and training,** and to guide the research efforts in the field of its focus into productive innovations by creating better conditions and environment for the performance of applied research.

Objectives:

- To make use of and benefit from the wide and multidisciplinary expertise available in-house;
- Enhance and implement research programs in core thematic issues in a multidisciplinary approach;

- Develop training programs for academics, service professionals, field technicians, and local communities;
- To sensitize people to make the right decisions with regard to environmental management choices and practices;
- To collaborate and conduct joint research with national, regional and international research institutions in fields relevant to our focus.
- Fostering synergies and cooperation between academia, research and development institutions and industry.

Scope of work

The scope of work and activities of IRCWEE will cover the main fields of relevance to natural resources management, *inter alia,:*

Water and Environment

- Development of environmental policies, strategies and action plans
- Environmental Impact Assessment (EIA)
- Strategic Environmental Impact Assessment (SEA)
- Site Environmental Assessment
- Environmental Auditing
- Environmental Monitoring
- Solid, Toxic and Hazardous Waste
- Contaminant transport in unsaturated and saturated soils
- Bioremediation of contaminated soils
- Ground Water Hydrology
- Surface water Hydrology
- Wastewater Treatment and Reuse
- Water Resources Management
- Water Harvesting Management
- The use of space technology for water resources and environment management
- Effect of climate changes on water resources
- Development of new technology for protection of water basins

Energy

- Analysis of energy demand with respect to economic and social growth.
- Conduct energy policy research and analysis.
- The use of clean, domestic energy resources and technologies, such as solar, biomass, alternative fuels, and wind power.
- Institutional framework for energy environment protection and implementation of ethics.

Services and Consultation

- Support the national economic development and international competitiveness through facilitating the use of environmentally-sound practices and technology;
- Perform environmental studies and auditing for local industry and corporation;
- Implementation of Cleaner production concepts and environmental management systems
- Conduct environmental impact assessments for new development and projects;
- Offer technical and financial??? assistance for energy efficiency and renewable energy projects to the different stakeholders;
- Collect and report energy data, and conduct energy policy research and analysis;
- Maintain national plan for energy emergencies;
- Researching socioeconomic aspects/consequences of water/energy/environmental projects and programs;
- Public awareness regarding renewable energy use and energy efficiency techniques;
- Capacity building of government officials, NGOs, private sector and public regarding water, environment and energy issues;
- Conduct International, Regional and local training in core thematic issues;
- Provide policy and strategic advice to the public/private sector on a need-basis.
- Participation in public private partnership (PPP) projects.

Annex 3: Study Team CV'S

Rakad Ayed Abder-rahim Ta'any,

1. Family name: Ta'any
2. First names : Rakad Ayed
3. Date of Birth: 15 -9 -1949
4. Nationality : JORDANIAN
5. Civil Status : MARRIED

6. Key Qualifications

Institution [Date from – Date to]	Degree(s) or Diploma(s) obtained:
Baghdad University (1993-1996)	Ph.D IN WATER RESOURCES MANAGEMENT
University of Yarmouk (1989- 1993)	M.Sc SURFACE WATER HYDROLOGY
ISTANBUL UNIVERSITY/TURKEY (1969-1976)	M.Sc GROUNDWATER HYDROLOGY
Hussein College (1966-1968)	GENERAL SECONDARY SCHOOL

7. Present Position:

Director of the International Research Center for Water, Environment and Energy and Division Head of the Water Resources and Environmental Management

8. Professional Experience:

Date	2006- Up to date
Place(s)	Al Salt/Jordan
Employer	Al Balqa' Applied University
Position	Division Head (Department of Water Resources and Environemental Management).
Description	Senior lecturer at Department of Water Resources and Environment, Involvement of different projects and researches regarding water resources and Environmental management (more than 25 research papers published in International Journals).Trainer in the field of Hydrology, Environment and Water resources Management in Jordan and Gulf Areas Particularly (UAE and Sultanate of Oman)

Date	2004-2006
Place(s)	United Arab Emirates (Abu Dhabi)
Employer	Ministry of Presidential Affairs

Position	Expert in the Field of Water Resources Management
Description	Involvement in Different Projects regarding Water Resources Assessment of the Emirates, Consultant in the field of Surface and Groundwater , Building capacity of the Ministry staff in Water Resources Management and Evaluating Projects of consultants or other Ministries.

Date	2002- 2004
Place(s)	Al Salt/Jordan
Employer	Al Balqa' Applied University
Position	Senior lecturer at the Department of Water Resources and Environment
Description	Senior lecturer in the field of (Hydrology, Hydrogeology, Design of small Dams, Water Harvesting and Environment), implementing of different researches regarding water resources and Environmental management published in International Journals).Trainer in the field of Hydrology, Environment and Water Resources Management in Jordan and Gulf Areas Particularly (UAE and Sultanate of Oman)

Date	1999 -2002
Place(s)	Jordan
Employer	MINISTRY OF WATER AND IRRIGATION
Position	DIRECTOR OF WATER RESOURCES MONITORING
Description	The supervision and administrating on about 70 persons (Engineers, Geologists, different Diploma graduates, Technicians and Labours) for: Designing and installation of hydro-meteorological stations and Rehabilitation of Stream Flow Gauging Stations Modernization of the groundwater network.

Date	1989 -1999
Place(s)	Jordan
Employer	Water Authority of Jordan (WAJ)
Position	DIVISION HEAD (SURFACE WATER)
Description	Supervision, administrating, lecturing, doing practical and theoritical traini governmental employees in the Water Authority and Jordan Valley Authority. In

	implement different projects regarding the studies of the characteristics of t water resources quality and quantity in the Kingdom.

Date	1984-1988
Place(s)	Jordan
Employer	Water Authority of Jordan (WAJ)
Position	SENIOR HYDROLOGIST
Description	Worked as Senior Hydrological Research Engineer for the Surface Water Potenti the concerned project. Also participation in the groundwater modelling includin and calibration of a two dimensional finite difference groundwater model of the Basin for both steady and transient condition.

Date	1977 -1984
Place(s)	Jordan
Employer	NATURAL RESOURCES AUTHORITY
Position	SITE ENGINEER – SECTION HEAD 9SURFACE WATER SECTION)
Description	Surface Water Division office and field engineer involving for hydrometeorological network design, operation and maintenance. Including stream flow gauges, both manual and automatic precipitation and meteorological stations. Surface water data collection, analysis, checking, filing and preparation of different technical papers for (springs, rainfall, evaporation and runoff).

Date	1976 -1977
Place(s)	Jordan
Employer	MINISTRY OF PUBLIC WORKS
Position	MATERIAL ENGINEER
Description	The main duties were testing concrete, cement, gravels, iron and so on to specify these materials suitability for constructions. In addition to supervision of roads constructions.

9. Specific experience Relevant to EIA

- Conducting Comprehensive Environmental Impact Assessment for Using Different Energy Alternatives in the Cement Factory at Al Rashadiyyeh.
- Conducting EIA for extraction of oil shale at Ellajun area.
- Conducting EIA for Swaqa landfill for hazardous materials.
- Publishing more than ten Researches in International Journals in the field of Environment regarding the (Impact of Industrial, agricultural and Waste water on the Water Resources.
- Studies regarding water resources of different basins and the influence of wastewater on the environment.
- Supervising more than 50 students in the level of higher education and graduate projects in the field of water resources and environment.
- Achieving of Training courses for local and Arab countries trainees.
- Teaching (Principles of Environment, Environmental Monitoring, EIA and Environment and Society).

10. Languages

Language	Reading	Speaking	Writing
English	excellent	good	excellent
Arabic	Mother tongue		
Turkish	excellent	good	excellent

11. Certification:

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe my qualifications, my experience, and me.

Nedal Musa Al Ouran

1. **Name:** Nedal Musa Al Ouran
1. **Profession:** Environmentalist (Engineer)
2. **Date of Birth:** 15th Feb.,1972
3. **Nationality:** Jordanian

4. **Education:**

Name of institution	Degree(s) or Diploma(s) obtained:	Date of obtainment
Würzburg University-Germany	PhD / Natural Sciences/Environnent Assessment and Management	2004
International Training Center/ Turino	Diploma / Technical Management	2002
Jordan University(Jordan)	MSc. / Geology / Sedimentology & Geochemistry	1996
Yarmouk University (Jordan)	BSc. / Geology & Environment	1993

5. **Employment Record:**

From: 2007	TO: Now
Employer:	Al-Balaq'a Applied University
Positions held:	Assistant professor in Environmental Sciences: Dept. of Water and Environment Resources Management Faculty of Agricultural Technology

From: 2005	TO: 2006
Employer:	Al-Balaq'a Applied University
Positions held:	Principal Researcher: International Research Centre for Water, Environment and Energy (recently established at Balqa Applied University).

From: 2008	TO: Now
Employer:	United Nations Environment Program (UNEP)
Positions held:	Environmental impact Assessment (EIA) Specialist

From: 2004	TO: 2007
Employer:	Royal Scientific Society-Jordan, Friends of the Earth Organization /Middle East
Positions held:	Research Team Leader, the Red Sea-Dead Sea Conduit Project

From: 2002	TO: 2003

Employer:	United Nations Development Program (UNDP),
Positions held:	Project Coordinator;: Establishment of a National Strategy and an Action Plan to Combat Desertification Project/ Jordan

From: 2000	TO: 2003
Employer:	United Nations Development Program (UNDP) and the Ministry of Environment
Positions held:	Project Coordinator: Biodiversity Strategy and Action Plan (Jordan)

From: 2001	TO: 2002
Employer:	the Regional Organization for the Conservation of the Red Sea and Gulf of Aden (PERSGA P.O.Box 53662, Jeddah 21583, Saudi Arabia Tel: 96626573224 Fax:966-2-6521901
Positions held:	Environmental Consultant

From: 2000	TO: NOW
Employer:	Free lancer
Positions held:	Environmental consultant; specialist in conducting EIA's and SEA's

From: 1997	TO: 2000
Employer:	Jordan Royal Ecological Diving Society (JREDS)
Positions held:	Executive Director

From: 1997	TO: 2000
Employer:	Heinrich Böll Foundation
Positions held:	Project Coordinator

From: 1996	TO: 1997
Employer:	Mu'tah University & The Middle East Regional Corporation
Positions held:	Research Assistant

From: 1996	TO: 1996
Employer:	University of Jordan & The Higher Council For Science and Technology
Positions held:	Researcher

From: 1993	TO: 1995
Employer:	Faculty of Science /Jordan University
Positions held:	Teaching & Research Assistant

Date	2005-2007
Place(s)	Jordan, Sudan and Iraq
Employer	United Nations Environment Program (UNEP)/Post conflict assessment branch
Position	EIA/SEA Specialist-un Iraq program
Description	• Conducting environmental assessment and Review for all projects being implemented under the UN Reconstruction Program for Iraq • Mainstreaming environmental consideration into the UN program in Iraq • Conduct environmental review of the projects approved under the Iraq Trust fund (ITF) 2004 funding cycle. • Conduct a rapid review of the projects proposed under the ITF 2005 funding cycle. • Create database of ITF projects, map and categorize ITF projects on environmental indicators. • Identify mitigation measures, cost estimates and action plans, on priority projects jointly with project proponents and environmental focal points. • Train the environmental focal points in the UN agencies (in Amman and Baghdad) in environmental screening and impact assessment, and the rapid review and formulation of mitigation measures for new projects proposed for funding under the ITF. • Conducting training on SEA • Provide inputs to the UNEP project on capacity building for environmental management as required

Date	1/7/2004-11/5/2007
Place(s)	Red Sea-Dead Sea Conduit Project (Gulf of Aqaba-Jordan)
Employer	Royal Scientific Society-Jordan, Friends of the Earth Organization /Middle East
Position	Research Team Leader
Description	Researching the Environmental impact of constructing a canal connecting the Red Sea and the dead Sea.

Date	1/2/2002-1/7/2003
Place(s)	Jordan
Employer	United Nations Development Program (UNDP)
Position	National Project Coordinator
Description	• Establishing The National Strategy and an Action Plan to Combat Desertification for Jordan

Date	1/7/2000 -Present
Place(s)	Jordan
Employer	Free lancer

Position	Consultant
Description	• Specialist in conducting EIA's and SEA's, *Conducting the following main studies:-* ➢ EIA study/ marine component for the KIMERA Fertilizer project; a joi venture between Jordan and Finland, February 2000. ➢ EIA study for the Jordan Bromine Company/ marine component; a join project between Jordan and U.S.A, November, 2000 ➢ EIA study/ marine component for the Jordan Magnesia Company, December 2000 ➢ Strategic Environmental Assessment study (marine component); a stu conducted as part of the overall SEA assessment for Aqaba upon the establishment of the ASEZ, EcoConsult, 2001. ➢ EIA study/ marine component for the new marina project, June 20 ➢ EIA / marine component "Aqaba Coastal Highway" , August ,2002. ➢ EIA / marine component "MEREN silica sand Project in Aqaba", Oct., 2 ➢ Monitoring of Marine Environment (Once per year), KEMIRA Arab Potash company, 2003

6. **Countries of Work Experience***:* Jordan, Iraq and Sudan

7. **Specific experience Relevant to EIA:**

Detailed Tasks Assigned	Work Undertaken that Best Illustrates Capacity to Handle the Tasks Assigned
Name of assignment or project:	EIA for Usage Different Energy Alternatives in the Cement Factory at Alrashadyeh
Year:	2012
Location:	Jordan
Client:	Al-Balaq'a Applied University
Main project features:	Comprehensive EIA of usage different energy alternatives in the cement factory at alrashadyeh
Positions held:	Coordinator and consultant
Activities performed:	Prepared the legal framework study

8. **Languages:**

Language	Reading	Speaking	Writing
Arabic	Native	Native	Native
English	Excellent	Excellent	Excellent
German	Poor	Poor	Poor

9. **Certification:**

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe my qualifications, my experience, and me.

Issam Mustafa Qrunfleh

1. Family name: Qrunfleh
2. First names: ISSAM
3. Date of Birth: Aug. 24, 1973
4. Nationality: Jordanian
5. Civil Status: Married

6. Key Qualifications

Institution [Date from – Date to]	Degree(s) or Diploma(s) obtained:
2007 to 2010	Ph.D in Horticulture, Dept. of Agronomy and Horticulture, University of Nebraska, United States of America
1995 to 1997	M.Sc in Horticulture, University of Jordan, Amman, Jordan
1991 to 1995	B.Sc in Plant Production, University of Jordan, Amman, Jordan

7. Present Position:

Jan. 2011: Assistant Professor at the Dept. of Plant Production and Protection, Faculty of Agricultural Technology, Al-Balqa' Applied University, Al-Salt, Jordan. Duties included: teaching courses for B.Sc students majoring in plant production such as: plant physiology, plant propagation, and principals of plant production in addition conducting scientific research.

8. Professional Experience:

Date	Sept. 2005 to Dec. 31, 2007
Place(s)	Faculty of Agricultural Technology
Employer	Al-Balqa' Applied University, Al-Salt, Jordan.
Position	Assistant Dean for Developmental & Planning Affairs
Description	Duties included: planning and developing to achieve educational accreditation.

Date	April, 1998 to Sept. 2005.
Place(s)	Faculty of Agricultural Technology
Employer	Al-Balqa' Applied University, Al-Salt, Jordan.

Position	Assistant Lecturer
Description	Duties included: teaching courses for B.Sc students majoring in plant production such as: principles of plant production, home gardening, and fruit tree production, in addition conducting scientific research

Date	Nov. 1997 to April, 1998.
Place(s)	Faculty of Agricultural Technology
Employer	Al-Balqa' Applied University, Al-Salt, Jordan.
Position	Agricultural Supervisor
Description	Duties included: assisting in establishing an agricultural research station for the university.

9. Specific experience Relevant to EIA

My experience relevant to EIA includes helping in plant (flora) assessment both phenotypically and physiologically. In addition, plant identification, landscaping, plant water and soil requirements, and determining plant species to be planted in the proposed area.

1. Certification:

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe my qualifications, my experience, and me.

Abd Al-Nasser Al-zyoud

1. Name: Abd Al-Nasser Al-zyoud
2. Profession:
3. Date of Birth: April 1st, 1969
4. Nationality:

5. Education:

Name of institution	Degree(s) or Diploma(s) obtained:	Date of obtainment
University of Cairo, Egypt	PhD. Economics and Public Finance	2002
University of Cairo, Egypt	MSc. Economics	1996
University of Cairo, Egypt	Higher diploma in economic policies	1995
University of Zaqaziq, Egypt	BSc. in Economics	1991

6. Employment Record:

From: 2009	TO: now
Employer:	World Islamic Science University
Positions held:	Dean of Faculty of Finance and Business

From: 2006	TO: 2008
Employer:	World Islamic Science University
Positions held:	Dean of Student Affairs Faculty

From: 2008	TO: now
Employer:	World Islamic Science University
Positions held:	Associate professor at Faculty of Finance and Business

From: 2005	TO: 2007
Employer:	Al Balqa' Applied University
Positions held:	Dean of Student Affairs Faculty

From: 2003	TO: 2004
Employer:	Al Balqa' Applied University
Positions held:	Head of Economics and Finance Department

From: 2005	TO: 2008
Employer:	Al Balqa' Applied University
Positions held:	Assistant Professor in Economics

From: 1998	TO: 2005
Employer:	Al Balqa' Applied University

Positions held:	Full Time Lecturer at the Faculty of Business and Planning

7. **Countries of Work Experience*:*** Jordan

8. **Languages:**

Language	Reading	Speaking	Writing
Arabic	Native	Native	Native
English	Excellent	Excellent	Excellent

9. **Professional Experience:**
   Expert in socioeconomics
10. **Specific experience Relevant to EIA**
    Several EIA studies / socioeconomics components
11. **Certification**:

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe my qualifications, my experience, and me.

Bassim Dababneh

1. Family name: Dababneh
2. First names: Basem
3. Date of Birth: 30.7.1955
4. Nationality: Jordanian
5. Civil Status: Married

6. Key Qualifications

Institution [Date from – Date to]	Degree(s) or Diploma(s) obtained:
Microbiology Department, King's College, University of London, United Kingdom.(1981-1987)	Ph.D.
Food Science and Technology Department, University of Baghdad, College of Agriculture, Iraq. (1977-1980)	M.Sc.
Food Science and Technology Department, University of Baghdad, College of Agriculture, Iraq.(1973-1977)	B.Sc.

7. **Present Position:** Associate Professor / Microbiology & Hygiene
Department of Nutrition and Food Processing, Al – Balq'a Applied University

8. **Professional Experience:**

Date	1998- Present
Place(s)	Amman-Jordan
Employer	World Health Organization (WHO) Center for Environmental Health Activities (CEHA).
Position	Temporary consultant
Description	WHO-CEHA Technical Cooperation Mission and National Seminar on Establishing Program for Healthy Marketplaces in Sana'a. Yemen, 1998; and in Khartoum, Sudan;1999. 1998 - Submitted Confidential Assignment at country level Report to CEHA Technical Cooperation Mission and National Marketplaces in Sana'a – Yemen. 1999-Submitted Confidential Assignment at country level Report to CEHA Technical Cooperation Mission and National Seminar on Establishing Program for Healthy Marketplaces in Khartoum – Sudan.

Date	2008 - present
Place(s)	Bonn-Germany
Employer	Bonn University- DFG
Position	Expert with the team of Food and Resources Economics Department, Bonn University
Description	Contribution to the international research project: Monitoring and Quality Assurance in the Food Supply Chain(MoniQA). Harmonization of analytical methods for controlling quality and safety in the food supply chain (Cost and benefit). 2008 - Participation in setting up the cost and benefit questionnaire on food new analytical rapid methods in EU (Validation Accuracy, Precision, etc.). 2010- Participation in a Study of Dynamic expert system for safety and policy

Date	2001- present
Place(s)	Al- Salt /Jordan
Employer	Al-Balqa' Applied University.
Position	Associate professor
Description	Faculty of Agriculture Technology, Head Department of Nutrition and Food Processing.(2005-2007;2009-2010;2010-2011) -Member of faculty Board.(2006-2011), -Teaching: Food Quality Control, Microbiology, Food Microbiology, Food Biotechnology, Food Additives, Nutrition and food processing, Nutrition, Diet Therapy and Meat Processing. - Head Department of Applied Science.(2003-2004) -Participation in establishment of new Applied Microbiology, Nutrition and Food Processing Programs for B.Sc. Degree. -Teaching: Microbiology, Mycology. Quality Assurance, General Biology I, II, Food Microbiology and Microbial physiology.
Date	1988-1998
Place(s)	AMMAN-JORDAN

Employer	Ministry of Health
Position	General Supervisor of Food Affairs
Description	General Directorate of Health- General Supervisor of Food Affairs This entailed the following activities: -To develop work plans for food inspection and quality assurance. -To evaluate, monitor, control the quality of food and to ensure its compliance with Jordanian regulations. -To organize and conduct training courses for public health employees in the field of food quality control. -To participate in research studies concerning food safety and hygiene. 1989 - 1996 Head of Food Section, Central Laboratory, Ministry of Health, Jordan.This encompassed the following activities: -Microbiological and chemical analysis of food for human consumption. -Training food technology and nutrition students of Jordan University, Ministry of Health food inspectors and other technicians of some food companies on food quality assurance. -Participation in the preparation of Jordan's food standards. -Participation in research studies concerning food safety and hygien Participation in delegation (Participated in the Jordanian national delegation to India to observe slaughterhouses, warehouses, packing, transporting of frozen meat). Providing official consultation to local food firms on how to trouble-shoot their food processing problems and defects. -Defend the Ministry's official rejection of firms' food during trials in Jordanian courts. -Entrusted to supervise the establishment of the new Aqaba, Irbid and Zarqa Food Quality Control Laboratories.