Appendix 6-2: ESIA Report

Appendix 6-2 ESIA Report

Annex 1: Baseline Report
Annex 2: Topographic Survey Report
Annex 3: List of Scoping and disclosure Meeting Attendees
Annex 4: Minutes of Meeting for the PC meeting

Environmental and Social Impact Assessment (ESIA)
for
20MW Photovoltaic Power Plant Project in Hurghada

Final Report

November 2012

Japan International Cooperation Agency (JICA)
New&Renewable Energy Authority (NREA)

Table of Contents

List of Tables

List of Figures

List of Acronyms

AC	Alternating Current
CO	Carbon Monoxide
DC	Direct Current
CSP	Concentrated Solar Power
CIS	Copper Indium Selenium
Cd-Te	Cadmium Telluride
ER	Executive Regulations
EEAA	Egyptian Environmental Affairs Agency
EMP	Environmental Management Plan
ESIA	Environmental and Social Impact Assessment
NREA	New & Renewable Energy Authority
GEF	Global Environment Facility
GHG	Green House Gases
HSE	Health Safety and Environment
HW	Hazardous Waste
IFC	International Finance Corporation (a member of the World Bank Group)
JICA	Japan International Cooperation Agency
LL	Load Leveling
Li-ion	Lithium Ion
MLTF	Multi-Layer Thin Film
MWh	Mega Watt Hour
NGOs	Non Governmental Organizations
NOx	Nitrogen Oxides
NAS	Sodium Sulphur
O&M	Operation and Management
PCDP	Public Consultation and Dissemination Plan
PM_{10}	Particulate Matter
PV	Photovoltaic
PPEs	Personal Protective Equipment
PSB	Panasonic Storage Battery
RE	Renewable Energy
SCADA	Supervisory Control and Data Acquisition
SO_2	Sulphur Dioxide

Executive Summary

1. Introduction

The Egyptian New & Renewable Energy Authority (NREA), in cooperation with Japan International Cooperation Agency (JICA), is planning to establish a Photovoltaic (PV) power plant in Hurghada at the Red Sea Governorate. In this context an Environmental and Social Impact Assessment (ESIA) study is being conducted by JICA Study Team. JICA Study Team consists of Tokyo Electric Power Services Co., Ltd. (TEPSCO) and Shikoku Electric Power Company (Yon-den) conducting feasibility study. The ESIA study is supported by Environics as part of the feasibility study.

Project Location

The project is planned to be located at the site of Hurghada wind farm owned by NREA. The PV modules shall be installed in an area inclined from north-west to south west around 30 percent of the wind farm area. The project area is about 500,000 m^2 of which about 354,000 m^2 is designated for the PV modules (for an average number of 100,000 modules) the remaining area is allocated for the transformers and control rooms, buildings and surrounding roads.

The ESIA covers the following phases:

- Construction phase
- Operation phase

Project Description

Project Components

The project is the first of its kind to utilize solar energy to directly generate electricity with a capacity of 20 MW to be connected to the National Grid. The project consists of three main components as follows:

- ***Solar field:*** The main component of PV power plant is the solar field, which is a group of semiconductors made up of silicon or other compounds processed into PV modules that convert photonic energy of the sun into Direct Current (DC) electricity with values proportional to the PV modules absorption factor of sun light.

The basic design for the project suggested 3 types of modules namely, the **Poly Crystalline Silicon** type, the **Multi-Layer Thin Film** (MLTF) type, and **the Copper Indium Selenium** (CIS) type.

- ***Electro and Electromechanical equipment***: such as transformers, inverters and switchgears to be used to control and regulate the power output of the solar field.
- ***Connection to the grid***: method and site of routing generated power to the unified Egyptian electricity grid.

Energy Storage

Energy Storage 2MW－12MWh will be installed. Possible storage type would be Lead Battery or Sodium–Sulfur battery (NAS). At their end of life, the batteries will be returned to the suppliers for recycling for the case of NAS, whereas for lead batteries, these can be recycled in the local market.

Utilities

The PV plant will use water for module cleaning. The overall water requirement for the plant is about 100m^3/month(less than 4m^3/day) for cleaning the modules. The required water quantity will be provided through the city network.

2. Results of Environmental Impact Assessment

2.1 Impact of the project on the Environment

Air emissions

Construction activities may result in minor, localized, short term, air quality impacts in the form of dust/particulate matter, and emissions from soil leveling, and construction equipment and transport vehicles. Air Emissions from mechanical construction equipment may result in potential impacts due to the localized increase in concentration of nitrogen oxides, sulphur oxides and carbon monoxide. Such impacts will occur for relatively short duration and will affect mainly the workplace environment.

Noise levels

The use of construction equipment may result in localized, short term, increase in noise levels. It is not expected that noise from the construction activities would pose impacts on the neighboring areas. Noise during operation can result mainly from the transformers and inverters. These are contained in an enclosure (Kiosk or container box) with restricted access.

Noise levels, expected from the different equipment are less than the allowable limits of law 4/1994.

Impact on the Biological Environment

The most important ecological feature of the area is its location along a major flyway for Palearctic migrant birds. However, the PV project does not have any impact on the flyway of the birds as it does not include any elevated structures nor rotating parts.

2.2 Impact of the project on the Socio-economic Environment

Employment

The project will provide employment opportunities for an average of 250 workers during construction and operation phases. Priority will be given to the community local workforce during labor selection to further enhance positive impact on the local community.

Water

The project will use about 100m^3/month **(**less than 4m^3/day) for module cleaning. The required water quantity will be provided through the city network. The water consumption will not put significant load on the water resources in the area

Aesthetic Impact

The project is to be located within the wind farm area owned by NREA. The PV modules are not installed at significant heights that could be easily seen from the surroundings. Thus, it is not expected that the aesthetic impacts are significant.

2.3 Impact of the Environment on the project

Flash flood

Since the project area might be potentially affected by moderate flood risk to be caused by a series of active wadies, a detailed topographic survey was carried out to identify potential impacts of the flash flood on the project site and whether flood protection is required. The assessment was based on a worst case flash flood scenario including hydrologic analysis for a 100-year return period.

The study results indicated low value of flood intensity therefore the PV site could resist impacts of the potentially expected floods according to 100 year return period. Optimal recommended protection strategy for the PV site is to be addressed in the foundation design of the modules.

Impact of Sand Storms

The study area experiences sand storms during spring and autumn potentially resulting in performance losses due to abrasion and/or deposition of dust on the PV cells. However, the design of the PV module has taken into consideration selection of coating material and periodic module cleaning and maintenance that will minimize the abrasive effect of dust.

Impact of Earthquakes

The project is complying with Egyptian codes and regulations, particularly the Egyptian building code with respect to both earthquakes and type of construction and design requirements. Thus, the potential impacts of the earthquakes will be negligible.

3. Conclusion

The project is considered one of the best and safe energy production projects. The nature of the project does not involve significant negative environmental impacts such as emissions or other pollutants. The main potential impacts are minor and related to the construction including land leveling and support structure which are considered minor and localized for relatively short duration. Impacts of the environment on the project will be minimized through implementation of design integrated measures.

1. Introduction

Background

A consortium of Tokyo Electric Power Services Co., Ltd., Tokyo, Japan (hereinafter referred to as "TEPSCO") and Shikoku Electric Power Company, Takamatsu, Japan (hereinafter referred to as "Yon-den", TEPSCO and Yon-den jointly called as "the JICA Study Team") signed a contract with JICA for performing a "Feasibility Study (F/S) on the Photovoltaic Power Plant (PV Plant) Project in Egypt for the Egyptian New & Renewable Energy Authority (NREA)". The project site is located in Hurghada wind farm area approximately 9 Km north of Hurghada city to the west of Hurghada-Cairo Road. The capacity of the PV Plant is 20 MW, which is intended to be connected to the national electricity grid.

The project has been categorized as "C"- according to the Egyptian EIA categorization system- which will require a full EIA (Environmental Impact Assessment) including public scoping and consultation activities.

Objective of the ESIA

The objective of the ESIA (Environmental and Social Impact Assessment) is to ensure that the project is environmentally and socially sound and sustainable, and that any potential negative environmental impacts are recognized early in the project cycle and taken into account before project implementation. Furthermore, it is also intended to satisfy the environmental legal requirements of the Egyptian Environmental Law 4 of 1994 amended by Law 9/2009 and its executive regulations No. 338 of 1995 modified by Prime Minister Decree no. 1741/ 2005, modified by prime minister decree 1095/2011 and EEAA (Egyptian Environmental Affairs Agency) guidelines for EIAs issued 2009 as well as JICA Guidelines for Environmental and Social Considerations (2010).

Scope of Work

The ESIA of the proposed project would evaluate the project potential environmental impacts in its area of influence; identify ways of improving project environmental performance during its different stages by preventing, minimizing or mitigating potential adverse environmental impacts and enhancing positive impacts. The ESIA will cover the different components of the plant at the different phases of site preparation, construction, startup and operation.

The scope of work covers the specific "terrestrial" impacts of the plant, where no marine components are involved in the study as there will be no

contact with the different activities and the marine environment. Thus, the ESIA report covers the components within the facility premises, which includes the following project components:

- Construction, operation and decommissioning of the PV plant
- The treatment and the discharge of wastewater

This EIA study has been done by the following experts:

Eng. Yasser Sherif,	Supervisor
Chem. Amani Nadim,	Team Leader
Dr. Mohamed El Sobki,	Energy Expert and project advisor
Geol. Ayman Afifi,	Team Leader Environmental Baseline
Dr. Sameh Sakr,	Hydrogeology Expert
Biol. Anwar Sarwat,	Ecology Consultant
Eng. Hamman Sherif,	GIS and remote sensing specialist

2. Policy, Legal and Administrative Framework

This Chapter summarizes the environmental legislation and regulations of relevance to the project. The relevant regulations were identified according to the type of the proposed activity (detailed description is in the next Chapter 3), its geographic location and the expected impacts. The first consideration is given to the national legislations pertaining to the execution of the ESIA, followed by a review of the JICA guidelines for environmental requirements relevant to the project.

2.1 National Legislation Pertaining to EIA

According to Law No.4, the project proponent must prepare an Environmental Impact Assessment (EIA), and environmental requirements are integrated into the existing licensing system.

According to the Egyptian Guidelines for EIA (EEAA, 1996), proposed projects are classified into three categories based on the severity of potential impacts as follows (they reflect the increasing level of environmental impact assessment:

- **Category A:** projects with minor environmental impacts
- **Category B:** projects with substantial impacts
- **Category C:** projects with high potential impacts requiring full EIA

According to the Egyptian Guidelines for EIA (EEAA, 1996) requirements, this project has been classified as "Category C" projects. Thus the proposed PV plant requires a full EIA to include construction and operation phases and public consultation activities. It is worth mentioning that the EEAA has upgraded the Egyptian EIA system to capitalize on higher levels of environmental and social impact assessment and analysis of alternatives, elements of the environmental management plan as well as principles of public consultation and disclosure. These modifications have rendered the, already highly developed, Egyptian EIA system compatible with the EIA systems of the different international entities. The modified guidelines were issued on January 2009 and came into force as of July 2009.

As stated in Law No.4/1994 and its ER (Executive Regulations), the EIA will be submitted to the Competent Administrative Authority (CAA), under which jurisdiction the project falls. For the PV plant project, the CAA is the Ministry of Electricity & Energy. The CAA would send the EIA to EEAA to issue its response within 30 days. If no response is received beyond this period, the assessment shall be deemed approved.

2.2 JICA Guidelines for Environmental and Social Considerations

JICA guidelines confirm that the project proponents are undertaking appropriate environmental and social considerations, through various measures, so as to prevent or minimize the impact on the environment and local communities which may be caused by the projects. It will thus contribute to the sustainable development of the developing regions. In its confirmation of environmental and social considerations, JICA places importance on dialogue with all involved partners regarding environmental and social considerations. Transparent and accountable processes, as well as active participation of key stakeholders (e.g. local residents and local NGOs affected by the project) in all stages of the project are highly considered. It is worth mentioning that JICA guidelines are formulated based on the World Bank Operational Policy (OP 4.01).

In accordance with "JICA GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS (JICA, 2010)", this project was categorized in "C" by JICA.

In the guideline, there are 4 categories according to extent of environmental and social impact as follows:

- Category A: Proposed projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society. Projects with complicated or unprecedented impacts that are difficult to assess, or projects with a wide range of impacts or irreversible impacts, are also classified as Category A. These impacts may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors, projects that have characteristics that are liable to cause adverse environmental impacts, and projects located in or near sensitive areas.
- Category B: Proposed projects are classified as Category B if their potential adverse impacts on the environment and society are less adverse than those of Category A projects. Generally, they are site-specific; few if any are irreversible; and in most cases, normal mitigation measures can be designed more readily.
- Category C: Proposed projects are classified as Category C if they are likely to have minimal or little adverse impact on the environment and society.
- Category FI: Proposed projects are classified as Category FI if they satisfy all of the following requirements: JICA's funding of projects is provided to a financial intermediary or executing agency; the selection and appraisal of the sub-projects is substantially undertaken by such an institution only after JICA's approval of the funding, so that the sub-projects cannot be specified prior to JICA's approval of funding (or project appraisal); and those sub-projects are expected to have a potential impact on the environment.

Then this project has to fulfill the requirement of category "C" stipulated in the guideline. The category "C" project is not required

neither EIA nor IEE. Even if this project is categorized in C by JICA, which does not need EIA/IEE by JICA, this project has to conduct EIA. Because JICA guideline also requires the compliance with the laws or standards related to the environment in the governments of host countries.

Accordingly, this ESIA (Environmental and Social Impact Assessment) report has been prepared.

2.3 National Environmental Regulations Pertaining to the Project

2.3.1 Air Quality

Article 36 of Law No. 4/1994 and article 37 of its modified ERs (710/2012) give the maximum allowable limits for exhaust gases from machines, engines and vehicles.

Article 35 of Law No. 4/1994 and article 34 of its modified ERs give the maximum allowable limits for ambient air pollutants.

Table 2-1 gives the maximum allowable limits for ambient air emissions.

Table 2-1 Maximum Limits of Ambient Air Pollutants According to Annex (5) of the Modified ERs of Law No. 4/1994 as well as the international guidelines (IFC)

Pollutant	Area	Maximum Allowable limits			
		1 hr	8 hrs	24 hrs	1 year
Sulfur Dioxide ($\mu g/m^3$)	Urban Areas	300	-	125	50
	Industrial Areas	350	-	150	60
International guidelines (IFC)				***20***	
Carbon Monoxide (mg/m^3)	Urban Areas	30	10	-	-
	Industrial Areas	30	10	-	-
International guidelines (IFC)		***30***	***10***		
Nitrogen Dioxide ($\mu g/m^3$)	Urban Areas	300	-	150	60
	Industrial Areas	300	-	150	80
International guidelines (IFC)		***400***	***--***	***150***	***--***

Total Suspended Particles (µg/m^3)	Urban Areas	-	-	230	125
	Industrial Areas	-	-	230	125
International guidelines (IFC)				***230***	***90***
PM_{10} (µg/m^3)	Urban Areas	-	-	150	70
	Industrial Areas	-	-	150	70
International guidelines (IFC)				***150***	***70***

2.3.2 Solid Wastes

Articles 37 of the Law No. 9/2009 and articles 38 and 39 of the modified executive regulations are concerned with the collection and transportation of solid wastes.

Article 39 of Law No. 4/1994 and article 41 of its modified ERs set the precautions to be taken during digging, construction, demolition or transport of resulting waste and dust so as to avoid wafting.

Law No. 38/1967 concerning cleanliness and sanitation and its executive regulations (decree 134/1968) regulates the collection, transportation, storage and disposal of solid waste.

2.3.3 Noise

Article 42 of Law No. 4/1994 and article 44 of its modified executive regulations give the maximum allowable limits for sound intensity. Table 2-2 shows the maximum limits for noise levels in the workplace.

Table 2-2 Maximum Limit Permissible for Noise Level in the Different Zones According to Annex (7) of the Modified ERs of Law No. 4/1994

Type of zone	**Permissible limit for noise level, dB (A)**	
	Day time 7 am – 10 pm	**Night 10 pm – 7 am**
Areas on roads whose width is 12 m or more, or industrial areas which comprise light industries and other activities	70	60
International guidelines	***70***	***70***

2.3.4 Protection of Water Resources

Law No. 93/1962 sets the conditions for discharging wastewater to public sewers. Decree 44/2000 of the Ministry of Housing modified the executive regulations of Law No. 93/1962 concerning the conditions for discharge of wastewater to public sewers.

2.3.5 Hazardous Substances and Wastes

Article 33 of Law No. 4/1994 specifies that all precautions must be taken when handling hazardous material either gaseous, liquid, or solid form to avoid any environmental damage. Articles 25, 26 and 27 of the modified executive regulations obligate facilities using hazardous substances to obtain a license from the competent authority. These articles also stated the licensing procedures to be followed by the facility.

2.3.6 Work Environment

The Egyptian Labour Law No. 12/2003 organizes working conditions and management of worker relationship. The national labour law in its different articles; addresses the individual labour contracts, terms of employment, wages and leaves, collective negotiations and collective labour agreements and litigations as well as vocational training are addressed in sections one to four. The occupational health and safety requirements are addressed in Book five. A number of explanatory notes and ministerial decrees have been issued detailing the different stipulations of the law.

Chapter 3 of Book 5 of the labor Law No. 12/2003, articles 208 through 215, address the responsibility of companies to protect workers against risks resulting from handling of gaseous, liquid and solid chemical substances. The Ministerial Decree 134/2003 requires that organizations hiring more than 50 employees establish an occupational health and safety department to be responsible for the workplace and employees' safety and provide the necessary equipment for measuring and monitoring pollution in the work environment. Besides, Ministerial Decree 211/2003 of the Ministry of Manpower also addresses the requirements to prevent adverse physical, chemical, biological and mechanical hazards in the workplace as well as keeping medical surveillance records for the employees

As stated in the articles 43 and 45 of Law No. 4/1994 and articles 44, 45, 46 and 47 of its ERs, the facility owner must provide the protective equipment and all necessary safety measures for the workers against noise, heat stress and gaseous emissions inside the work place. In addition, it is the responsibility of the facility's owner to provide all closed and semi-closed places with efficient ventilation system. Moreover, the facility owner, according to the requirements of the

labour Law No. 12/2003, must ensure that exposure limits and periods for pollutants, inside the work environment, are within the maximum allowable limits.

2.3.7 Environmental and Other Registers

Article 22 of Law 4/1994 and article 17 of its modified executive regulations stipulates that establishments should maintain an environmental register for its activities. Article 17 and Annex (3) of the ER provides the content of the environmental register and state that the owner of the facility must inform EEAA with any non-compliances.

Furthermore, articles 26, 28 and 29 of the modified executive regulations are concerned with the rules and procedures of hazardous substances and waste management. Accordingly, a register for the hazardous waste should be maintained as well as record for the hazardous substances used.

In addition, article 211 of the Labour Law 12/2003 and article 34 of the Decree of the Minister of Labour and Manpower no. 211/2003 regarding requirements to prevent adverse physical, chemical, biological and mechanical hazards in the workplace, stipulates that companies should prepare, records/ reports/register for chemical safety.

2.3.8 International Agreements

Since 1936, Egypt has been party to many regional and international conventions, treaties and agreements addressing environmental protection as well as labor standards. Such regulations have also been incorporated in the different national laws. Relevant legislation to the project in hand includes the following:

- Kyoto Protocol, 2005
- Convention Concerning the Protection of Workers Against Occupational Hazards in the Working Environment due to Air Pollution, Noise and Vibration, 1988
- The Convention on Conservation of Migratory Animals, Bonn, 1979
- The Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer
- The Convention on Biodiversity, 1994

3. Project Description

3.1 Project Location

The project is planned to be located in the northern part of Hurghada city, along Hurghada –Ras Garib road, on the site of Hurghada wind farm owned by NREA. Location of the wind farm where the project is planned is shown in Figure 3-1. The project area is surrounded by an area where a lot of resort hotels and residences constructed/under construction exist.

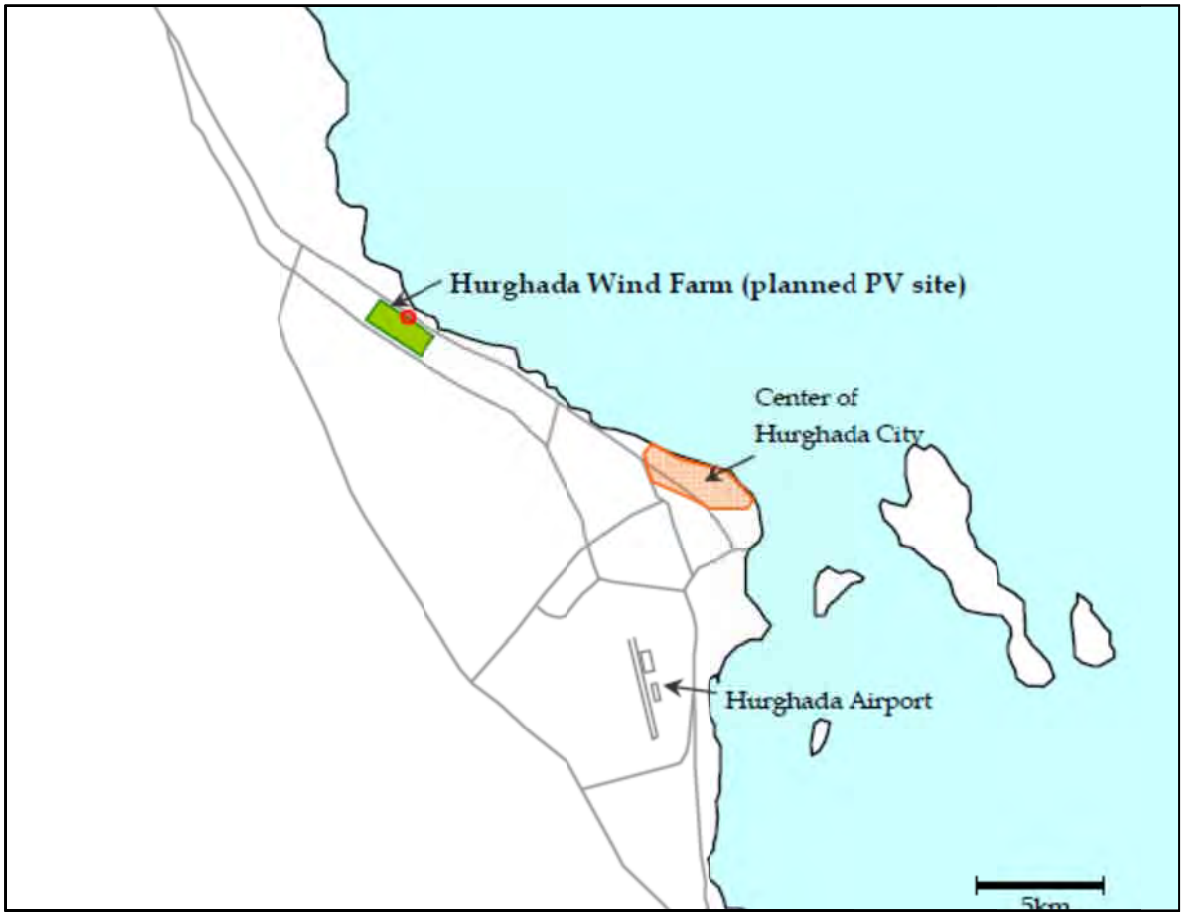


Figure 3-1: planned PV location

The Photovoltaic (PV) modules shall be installed in vacant spaces in the wind farm area. The candidate area is relatively inclined from northwest to south west around 30 degrees at the vacant area of the wind farm. Figure 3-2 illustrates the current situation on the wind farm.

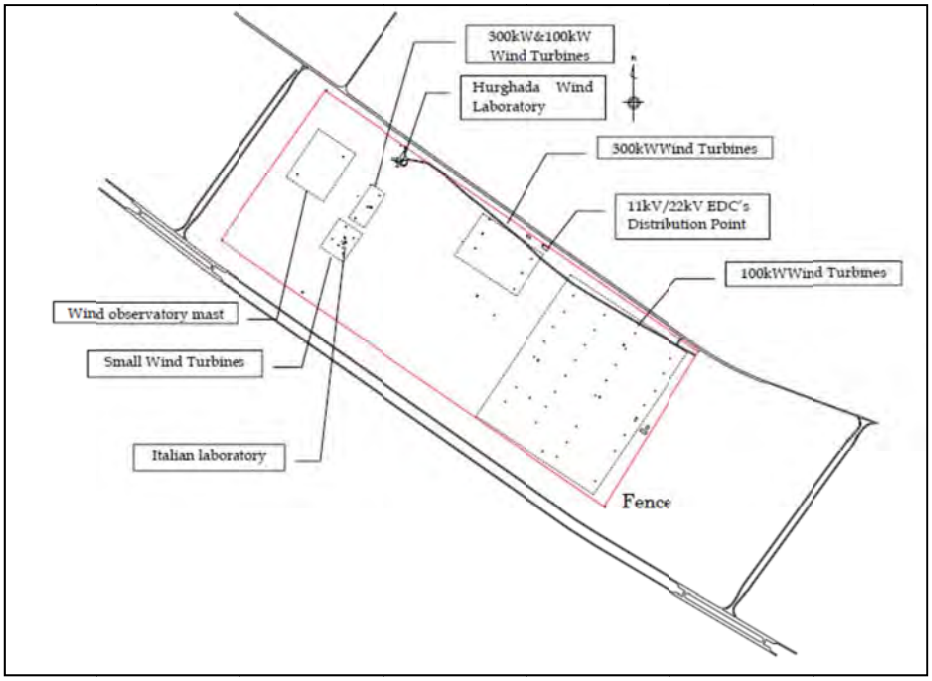


Figure 3-2: Current situation on the wind farm

The layout design for PV arrays takes into consideration the existing wind turbines and wind measuring mast. PV modules would be lined such that they avoid the shade of the existing towers. Example for the shade of towers is shown in Figure 3-3. Length of the shade depends on the height of the towers.

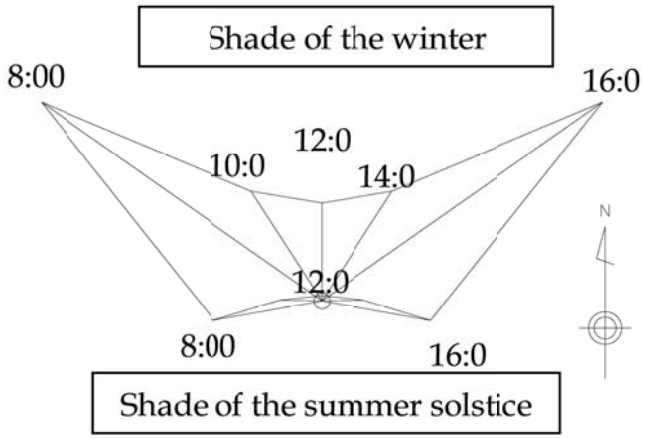


Figure 3-3: Example for shade of existing wind turbine

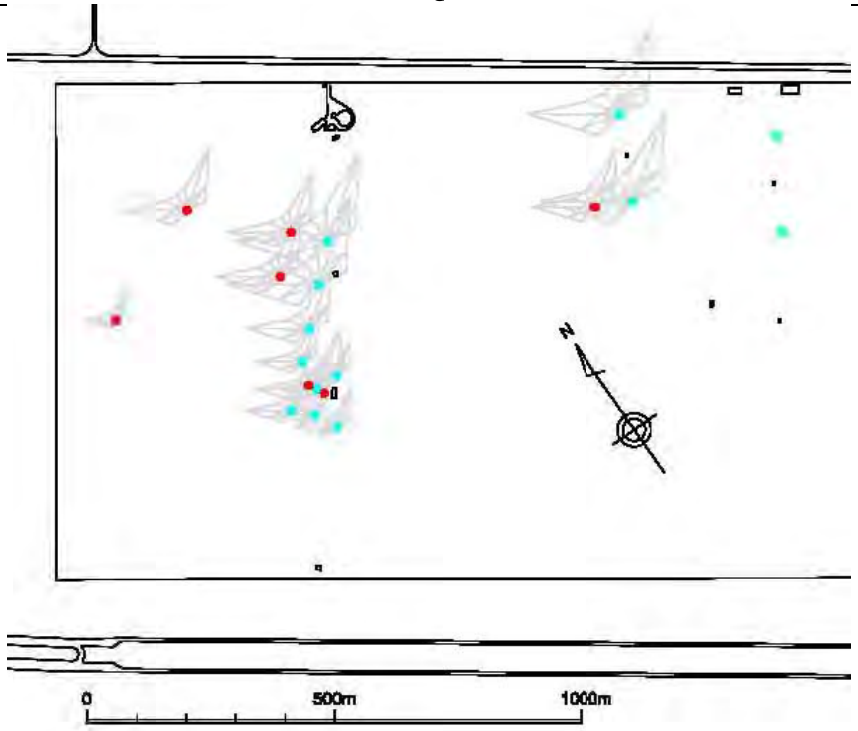


Figure 3-4: Shade effect of the existing wind turbines

The project possesses a relative advantage in terms of electricity grid connection options, as it is situated close to various transmission and distribution infrastructure. As shown in Figure 3-5.

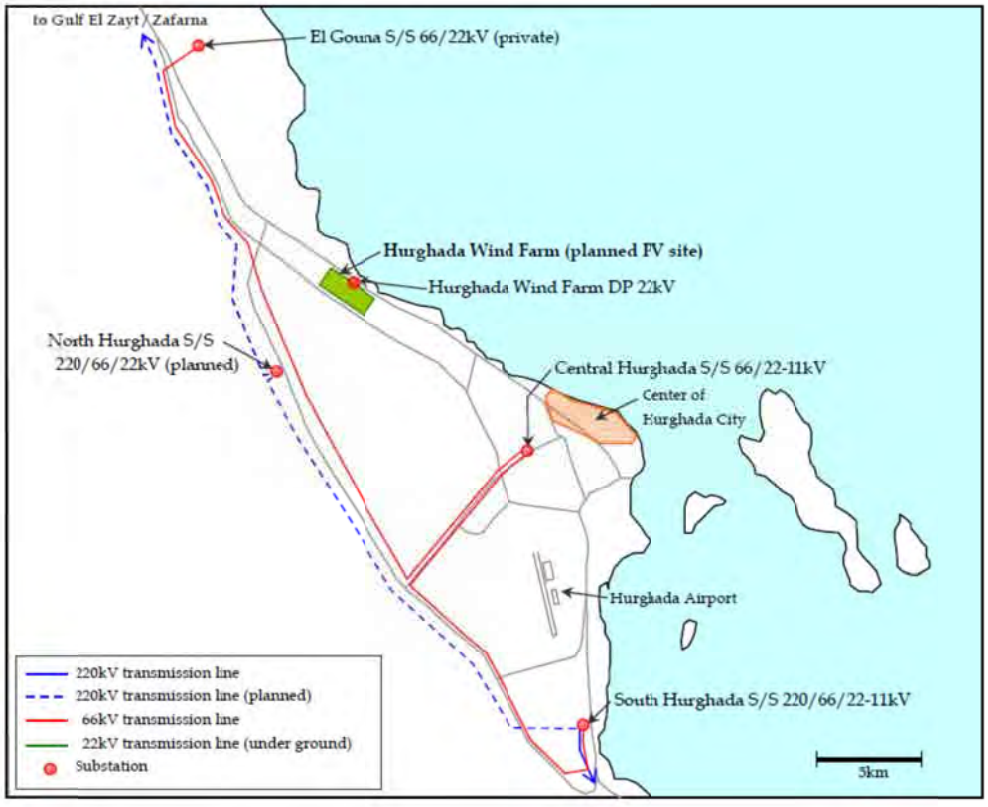


Figure 3-5: Project area and the surrounding power infrastructure.

3.2 Surrounding Land use

- ***To the North:*** Series of Touristic resorts at the coastal line
- ***To the South***: Empty land area
- ***To the East***: NREA wind farm
- ***To the West:*** Empty land area

Figure 3-6 shows the activities surrounding the proposed location of the PV plant.

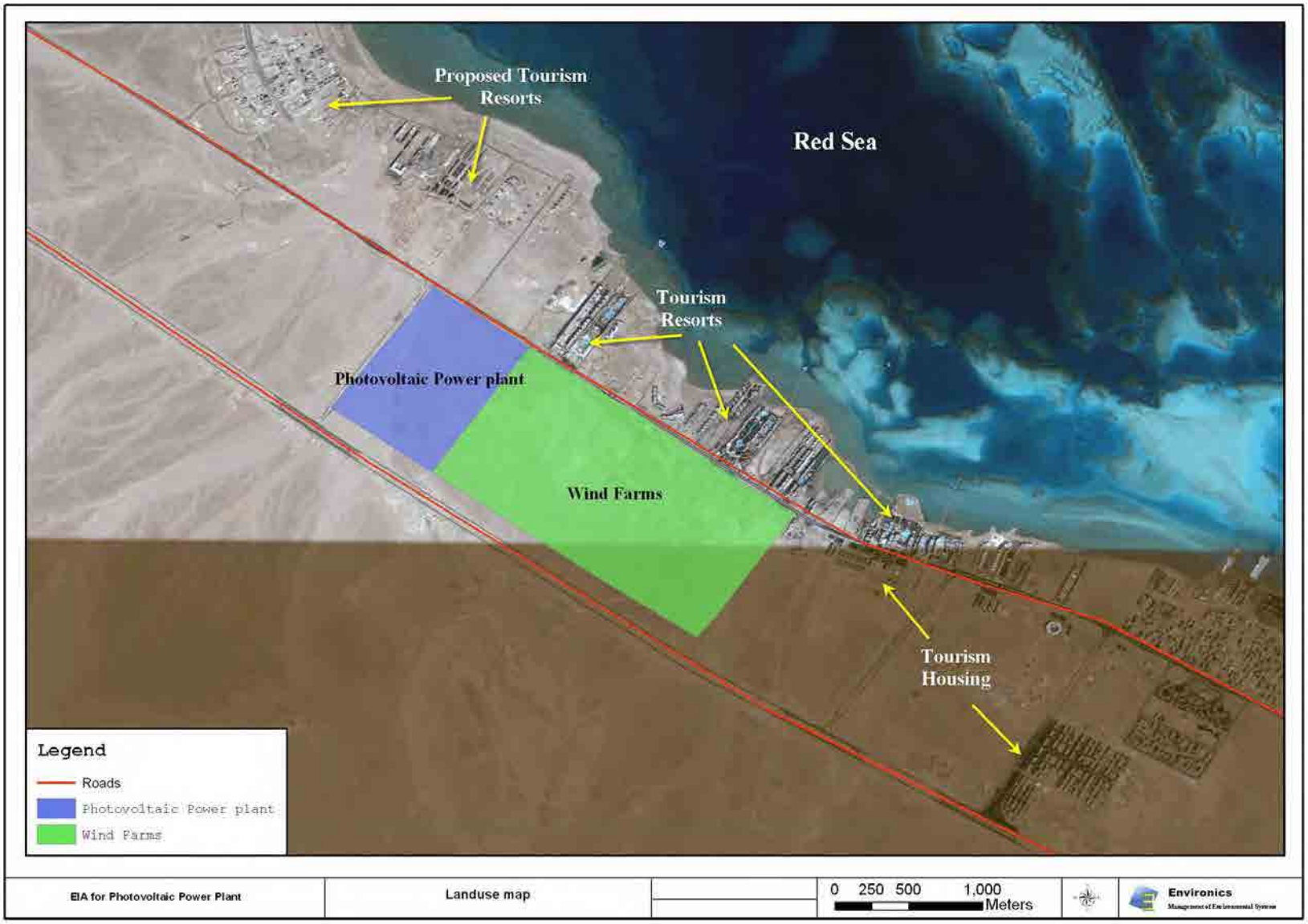


Figure 3-6: The Site and Surrounding Activities

3.3 Project Design and Construction

The project comprises three broad components described as follows:

- ***Solar field:*** the technology and equipment used in converting energy borne by solar radiation into electricity.
- ***Electro and Electromechanical equipment***: equipment, such as transformers, inverters and switchgear used to control and shape the power output of the solar field.
- ***Connection to the grid***: method and site of routing generated power to the local distribution network.

The main component of the photovoltaic power plant is the solar field, which is a group of semiconductors made up of silicon or other compounds processed into PV modules that convert photonic energy of the sun into Direct Current (DC) electricity. The power output of the solar modules is connected to an inverter block to convert the DC power into an alternating one. Inverters are connected to step-up transformers to raise the voltage levels to the required ones. Finally, the power is routed to the unified grid via switchgear and bus bars.

3.3.1 Solar Field

A 20 MW capacity solar field will be installed. The maximum capacity of the solar field is determined in light of the annual energy incident on a surface at different inclination angles at the selected location. The size of the field of a given capacity and technology is determined in terms of solar radiation data.

- **Solar Field Technologies and Positioning**

  PV module technologies can be classified into three categories depending mostly on the module manufacturing technology and/or the main material type and grade employed in producing PV modules. These categories are:

  - Crystalline Silicon
  - Thin-Film Silicon
  - Compound Thin-Film

  Within each category, PV technologies are further classified according to the structure of silicon crystals or the composition of compounds used in non-silicon types.

  Selection of appropriate type of PV module depends on :

  - Cost
  - Efficiency

- Temperature Characteristic
- Life Time
- Environmental consideration
- Effect of Shade

Based on the above-mentioned criteria for selecting appropriate PV modules, the basic design for the project is carried out based on 3 types of modules namely, the **Poly Crystalline Silicon** type, the **Multi-Layer Thin Film** (MLTF) type, and **the Copper Indium Selenium** (CIS) type. Each type of module has specific temperature coefficient,

The final module arrangement has not been decided yet. 20 MW for MLTF was applied as an example for this study.

- **The intensity of the incoming solar radiation:** The performance of a PV cell is directly proportional to the intensity of the solar radiation. Therefore the efficiency is affected by the intensity of the sunlight on an optimally oriented module at the specific location, at the specific time. Clouds cover would cause a decrease in efficiency.

- **The orientation of the modules with respect to the angle of the sun:** For optimal performance, PV systems aim to maximize the time they face the sun. In static mounted systems modules are often set to latitude tilt, an angle equal to the latitude.

Modules Arrangement

The 20 MW solar field will be arranged in ten 2 MW blocks of arrays. Each block is made up of four 500 kW arrays, electrically connected in parallel. Each array is made up of two parallel circuits (lines) with each circuit made up of a number of strings of modules[1] in series. Each array of any one block is connected to a 500kW inverter. Thus for each block of arrays four inverters are connected forming one inverter unit. Ten 2 MW step-up transformers will be connected to each one inverter unit.

Positioning

There are two types of solar field orientations: the modules can be either set at a fixed lifted angle facing a fixed direction, typically south

[1] A module is a string of solar cells. One way to think of a module is a multi-cell battery. An array, on the other hand, would, as it were, be a battery bank.

in the northern hemisphere or it can be equipped with a sun tracking system. The fixed lifted angel type has been selected for this project. For fixed PV systems, the modules are installed with the plane of the modules tilted at an angle to the horizontal, named: Lifted Angle. Whilst Increasing the lifted angle requires increased amounts of material: foundation, frames, etc., it does, on the other hand, have an impact on the calculated total amount of energy output of the modules.

Frames and Civil works

The photovoltaic arrays design conducted by the Team incorporated both Japanese and Egyptian standards as follows:

- Design guide on structures for photovoltaic array (JIS8955)
- Japanese building code for stability analysis
- Wind pressure equation from Egyptian Code #201 for wind load
- Regulations for earthquake-resistant design of buildings in Egypt for seismic loads

The load design of the civil works accounted for: dead load (weight of module, mounting structure and foundation), wind load and seismic load. A stability analysis for the calculated loads was conducted in which safety factors for overturning, sliding, compression and tension loads were calculated and utilized in the calculations of foundations size. Figure 3.7 illustrates a side view for the foundation of one module string.

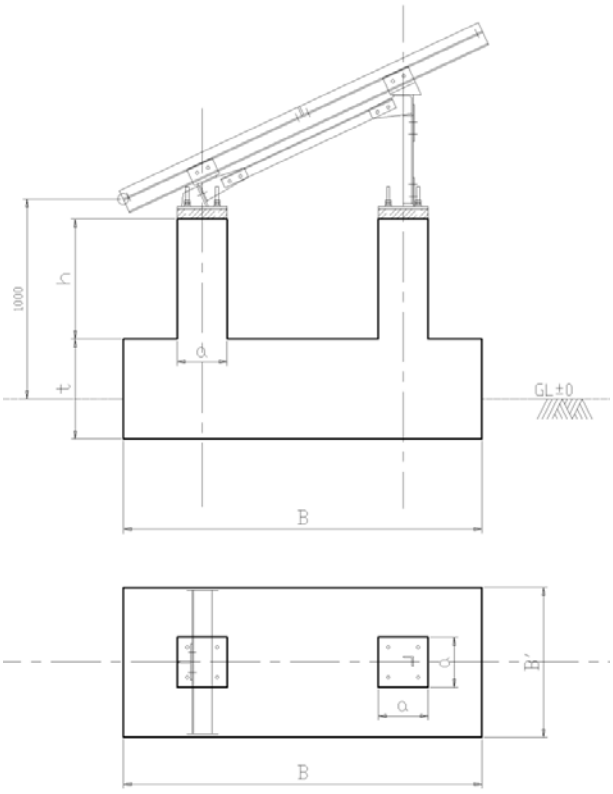


Figure 3-7: Side- view for one foundation of a Multi Layer Thin Film modules string

The design team has denominated a 20^{o} lifted angle for the PV modules.

The distance between the arrays has been decided so as to circumscribe the effect of shade. The following table shows the number of modules and distance of arrays for one of the candidate type of module. The Figure 3-8 shows the tentative arrangement of one of the candidate type of module.

Layout options	Number of modules	Distance of Arrays
MLTF(20)	156,480	1.9m

Calculations of shade effect were taken for the length of shade at 8 a.m. and 4 p.m., which are the times of maximum shade length at the concerned time zone.

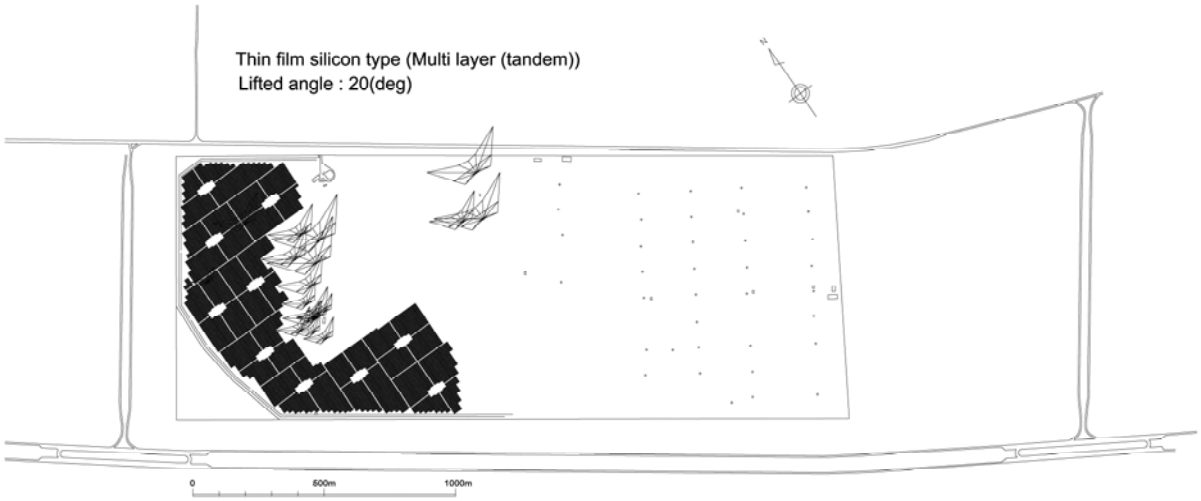


Figure 3-8: Tentative arrangement of the modules

3.3.2 Electric Equipment

The electronic and electrical equipment used are as follows:

- Inverters: devices converting DC to AC
- Switchgear: Circuit breakers that protect the downstream circuits against short circuits, over-loads and other electrical faults
- Transformers: electrical equipment that steps up or down incoming voltage
- Control System: Overall control of the plant.

A two MW inverter unit is made up of four 500KW inverters. Attached to the house is a 'kiosk 'or a container box hosting for 2MW transformer, MV switchgears, LV switchgears and protection relays. Figure 3-9 illustrates the inverter housing. Ten 2MW inverter houses will be required for the plant

In this project four 500kW inverters are connected to a 2MW transformer. LV AC side voltage is 0.4kV

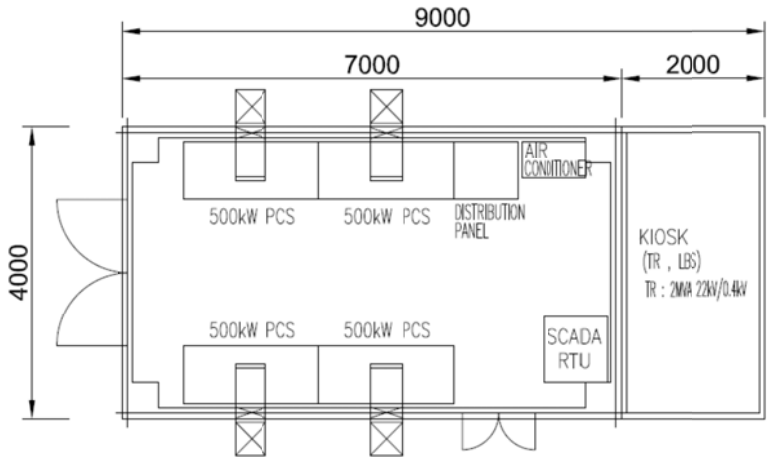


Figure 3-9: Architectural Plan-View of Inverter house and Kiosk

Inverters

The basic function of inverters is to intercept DC voltage and transforms it into an alternating signal AC. In addition, the inverter units set for the project will perform other functions for power quality and control as follows:

- Automatic operation: The inverter automatically shuts off when the sun goes down.
- Prevention of stand-alone operation: When connection to the grid is for some reason disabled, the inverter senses the change and stops the PV power generators.

Step-Up Transformer

Oil cooled transformers and self cooling type transformer are used as these are similar to those used by the Egyptian distribution company.

Switchgear

Mold insulated and clad type switchgear are used as these are similar to those used by the Egyptian distribution company.

Control System

The project has a centralized control system SCADA[2] to perform the aforementioned functions. The system is hosted in a house that contains the 22 kV switchgear connected to the output of the step-up transformer. Figure 3-10 shows plan and location of the control system

[2] Supervisory Control and Data Acquisition.

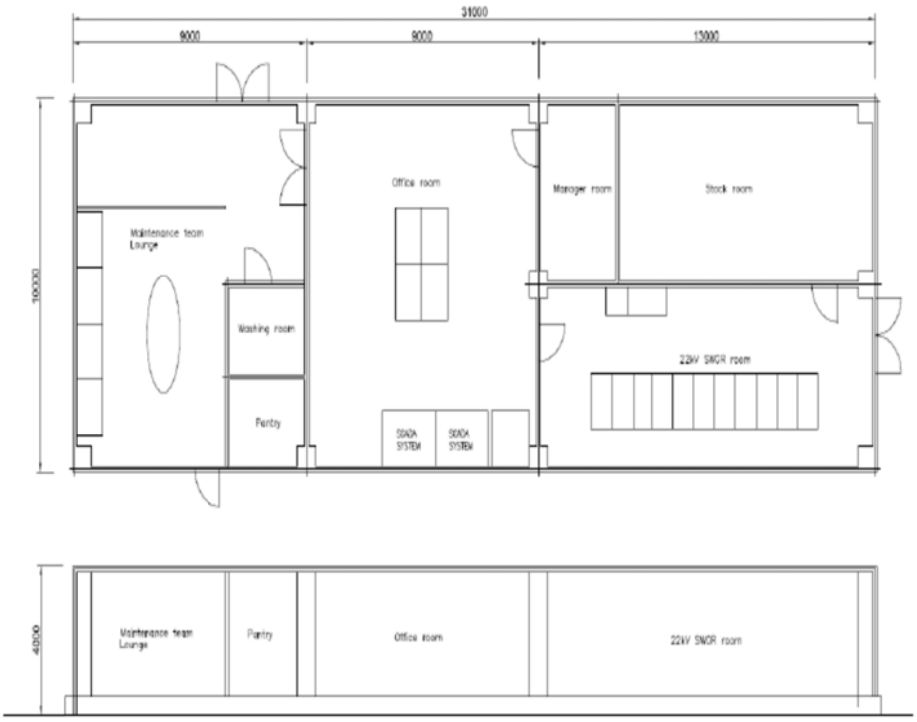


Figure 3-10: Architectural plan and elevation views of the Central Control system housing

3.3.3 Connection to the Grid

Voltage level of the inverter output power will be stepped up to 22kV using the step-up transformers. Two 22kV switchgears will be installed at 22kV/11kV Hurghada Wind Farm Substation, with each of the switchgears connected to 10MW of the power plant with 22kV power cables. Figure 3-11 shows the PV grid connection layout.

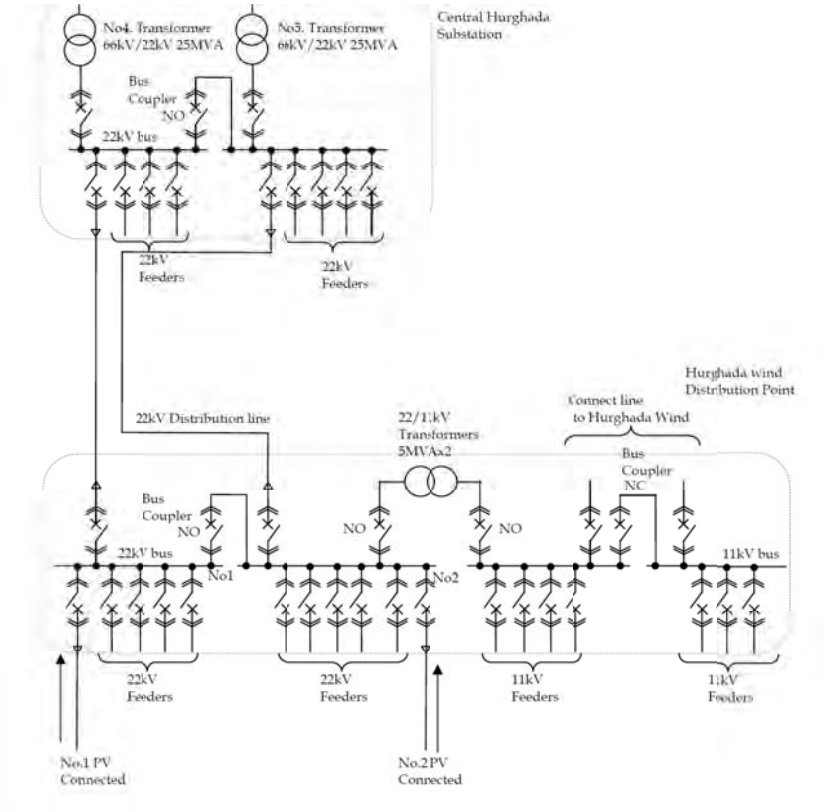


Figure 3-11: PV grid connection layout

Energy Storage

The variable output of the generated electricity from renewable energy resources may cause voltage and frequency fluctuations on the power network. Therefore, off-peak energy storage systems are used and it will discharges at peak periods. It is proposed to use Sodium Sulfur (NAS) batteries or Load Leveling (LL) Lead Batteries as energy storage to connect the PV output to the 22kV bus. Both types of batteries are primarily suitable for large-scale, non-mobile applications and have a high energy density, high efficiency of charge/discharge and a long cycle life (up to 15 years).

Benefits of using energy storage batteries are:

- Smoothing the output from these resources,
- Reducing voltage fluctuations caused by increasing/ decreasing load,
- The battery cells are sealed and there are no emissions in operation,
- Suppress variance of PV power output ,
- Usage as an emergency power on power outage, and
- Easy Maintenance (Periodic inspection every 3 years).

At the end of their life time, the batteries will be returned to the suppliers for recycling for the case of NAS, whereas for lead batteries, these can be recycled in the local market.

3.3.4 Construction Activities

The construction phase is expected to take six - nine months in total and will entail a series of activities including:

- The **pre-construction phase** which will include conducting surveys; undertaking site preparation and transporting the required components and equipment to the site.
- The **construction phase** which will include the establishment of internal access roads; erecting the arrays of PV modules, constructing the switching station, visitors centre, canteen facilities, and workshop/administrative/security offices as well as establishing the connections between the PV modules, the switching station, and the existing power line.
- The **site closure phase** will include site remediation

- ***Duration of construction works***

1. land leveling :from 1st to 4th months
2. foundation work for PV module: from 4th to 14thmonth
3. PV module installation work: from 6thto 16thmonths
4. Inverter, electric equipment works and cable wiring works : parallel to PV installation works
5. grid connection equipment works: from 6thto 7thmonths
6. commissioning test: from 13th to 14th month for the first 10MW, from 19th to 20th month for the last 10MW
7. Total construction work will be 20 months
8. Warranty period will continue for the next 2 years.

Figure 3-12 shows the proposed implementation schedule

Draft Implementation Schedule for Hurghada photovoltaic power plant project

Implementation Schedule

	year / month	Duration
1	**Consulting service (Pre-Construction stage)**	**26months**
1.1	Selection of DD Consultant to be done by JICA	**4 months**
	1) incl. Public anouncement, Tendering upto contract sign.	4 months
1.2	Pre-Construction Stage (Phase-1)	**8 months**
	1) incl. Public Announcement, Tendering upto contract sign.	6 months
	2) JICA's concurrence	2 months
1.3	Selection of Consultant to be done by NREA	**12 months**
	incl. Shortlisting, RFP, Public Announcement, Tendering upto contract sign.	12 months
1.4	Pre-Construction stage (Phase-2)	**3 months**
	1) issuing Tender Docs (3 envelopes method: PQ, Technical and Financial)	3 months
	2) Tender Evaluations (PQ, Technical & Financial)	4 months
	3) JICA's concurrence	1 month
	4) Contract Negotiations	2 months
	5) JICA's concurrence to Contract Document	1 month
	6) L/C opening	1 month
2	**Project Implementation Stage (Construction Stage)**	**20 months**
2.1	Commencement date	--
2.2	Detail Design incl. site investigation and approval	**4 months**
2.3	Civil Works incl. land leveling, fence, road, foundation, etc.	**14 months**
2.4	PV module	**14 months**
	1) Manufacturing and shipping to the site	13 months
	2) Installation	12 months
2.5	Cable wiring and connection	**11 months**
	1) LV cable; PV to Invertor	11 months
	2) MV cable; TR to SWG to DP	8 months
2.6	Inverters	**9 months**
	1) Manufacturing and shipping to the site	6 months
	2) Installation	3 months
2.7	MV Transformer	**6 months**
	1) Manufacturing and shipping to the site	5 months
	2) Installation	1 month
2.8	MV Switchgear	**7 months**
	1) Manufacturing and shipping to the site	5 months
	2) Installation	2 months
2.9	Existing Distribution Point and Substation Modifications	**4 months**
2.10	Testing & Commissioning	**2 months**
2.11	Issuing Taking Over Certificate	
2.12	Warranty Period	**24 months**
2.13	Issuing Final Acceptance Certificate	

Remarks: for 2 years

note 1) Issuing of TOAC will be varied depending upon Contractor's responsibilities.
2) TOAC: Taking Over and Acceptance Certificate
3) FAC: Final Acceptance Certificate

Figure 3-12: Implementation Schedule

3.4 Estimated number of the required labor

The estimated number of workers during construction is presented in Figure 3-13 below.

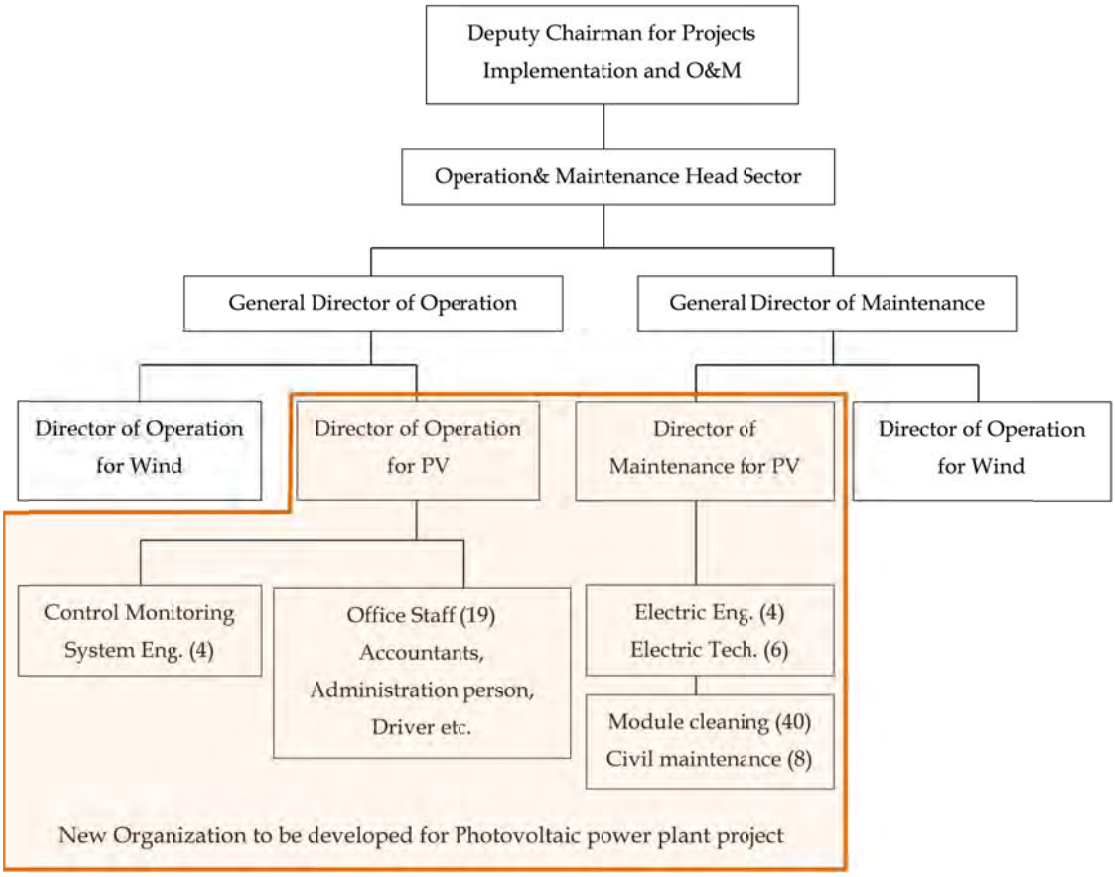


Figure 3-13: Estimated Workforce

3.5 Maintenance

3.5.1 Electronic and Electro-Mechanical

Maintenance include periodic maintenance which includes periodic cleaning of PV modules, switchgear and housings using blowers,; lubricating hinges, bearings and other movable parts; adjusting torques of bolts and studs of electrical connections and transformers.

3.5.2 Solar Field

Maintenance requirements of fixed photovoltaic systems are minimal and are as much as restricted to periodic cleaning. Cleaning will be done once a month for each module in general. It is recommended to clean the modules after the sand storm is occurred as special cleaning.

Module cleaning will be carried out using high pressure water.

3.5.3 Metallic structures

All steel structures will be galvanized or using stainless steel. Thus, maintenance work for corrosive will not be required except for small working such as paint for rusty parts.

3.6 Utilities

The PV plant uses various utility units, which serve either to provide the plants with the required utilities or to handle/treat process effluents.

3.6.1 Water Utilities

The overall water requirement for the plant is about 100m^3/month for cleaning the module. The required water quantity will be provided through the city network.

3.6.2 Roads

Side-tracks as well as the main roads used for trucking equipment and construction gear to the project patch. About 150~280 of 40ft container trucks will be required for transportation of modules.

PV module and Inverters will be imported. Therefore, materials and equipments will be disembarked at the Alexandria port or Ain Sokhnah port and transported to the site on the highway.

The other equipment such as switchgears, transformers and power cables will be manufactured in Egypt, thus those will be transport from Cairo via highway.

The other material such as concrete and steel will be procured at the local dealer.

4. Environmental Baseline

4.1 Physical Environment

This Chapter provides summary of the baseline investigations carried out for the project. The detailed baseline investigations are presented in **Annex (1**) of this ESIA report.

4.1.1 Climate

The climatic and meteorological data presented herein was obtained from the closest station of Hurghada. The study area is located within the Eastern Desert, and accordingly is characterized by hyper-arid conditions. The climate is generally warm and dry except for rare and sporadic rainfalls during the winter, whereas few sprinklers may occur in spring.

- **Wind**

  The prevailing wind is mainly NNW all over the coast of the Red Sea, the winds from this direction are slightly more frequent in summer than in winter. Southerly winds blow during winter months only. The prevailing wind direction creates a mainly NE-SW oriented wave motion, leading to distinct higher waves in the exposed areas rather than in the protected areas (e.g. bays). However, near the coast, the winds alternate daily between a nocturnal land breeze and a daytime sea breeze.

  Generally, moderate NW-NNW winds dominate most of the year, which may change to SE for short periods. Such wind is strong enough to generate moderate water waves. The Khamasin (westerly wind) blows often in spring and autumn and is mostly hot and sandy.

  The average annual percentage occurrence of wind speed-direction groups (0.5 Hour Wind): study area, Gulf of Suez. The wind speed group (5-7.4, m/sec) has a highly percentage of occurrence (about 33%), followed by the wind speed group (2.5-4.9, m/sec) with about 28.9% of occurrence. The wind speed of (15 Plus) is very rare with an occurrence of about 0.3%.

  During winter season at Hurghada, the wind speed varies between 7.0 and 17.9 Knots, affected by the land and sea breezes, while in spring season it varies between 6.9 and 20.2 Knots. Summer season has the maximum value (19.3 Knots) and decreases to about 8.2 Knots. During autumn, the diurnal wind speed fluctuates between 7.6 and 17.5 Knots.

- **Temperature**
  The coast of Red Sea is bordered by a vast area of desert or semi-desert. The temperature along the Red Sea is influenced by the expected high air temperature of the desert.

  January is the coldest month, where it has the minimal air temperature throughout the year (about 14.8^{o}C), while August is the hottest month and the air temperature reaches its maximum value of about 31.7^{o}C.

  The daily air temperature decreases throughout the winter and spring nights, while it increases during summer and autumn nights, affected by sea breeze.

- **Rainfall**
  The closest rainfall station to the study area is Hurghada station. Statistical analysis was carried out for the rainfall data series of this station to get the maximum daily rainfalls for 5, 10, 25, 50, 100 and 500 year return period. Detailed description is provided in annex 1 of this study.

- **Evaporation**
  The evaporation rate is generally high showing a maximum of 19.8cm/M in June and a minimum of 8.9cm/M in December.

- **Relative Humidity**
  The average relative humidity ranges between 37 and 54% over the year. It fluctuates up and down according to the air temperature and wind conditions.

  The relative humidity pattern refers to the presence of two summits through the year in Hurghada during February, and November. The relative humidity varies between 44.4% during May and 67.4% during November.

- **Global Solar Radiation**
  An accurate knowledge of solar radiation distribution at a particular geographical location is of vital importance for the development of many solar energy devices and for estimates of their performances. Global radiation is the total short-wave radiation from the sun falling onto a horizontal surface on the ground. It includes both the direct solar radiation and the diffuse radiation resulting from reflected or scattered sunlight.

- **Atmospheric Pressure**
  The region could be influenced by the west anticyclone of the high pressure existing on the Africa Continent and the westerly strong wind occurring occasionally by the depression moving to the east in the south region of Europe. The air pressure shows some changes over the year. It is low in summer with a minimum of 1004.9mb in July and high in winter with a maximum of 1017 mb in January.

4.1.2 Baseline Air Quality and Noise

- **Air Quality**
  The Central Laboratory of EEAA has been requested to carry out the baseline air quality and noise measurements at the project area. The baseline air quality and noise measurements were carried out on a one day visit to represent a typical working day. The measurements were carried out at the proposed Photovoltaic power plant site and three other locations upwind and downwind of the site as shown in Annex 1 of this ESIA report.

Table 4-1: Measurement Locations

Location No.	Position	Description of the Location
1	27°18'55.24"N 33°42'14.00"E	Inside the site of the Photovoltaic Power Plant
2	27°18'22.52"N 33°43'19.83"E	Residential compounds with low traffic near the tourist resorts
3	27°19'24.16"N 33°41'43.18"E	Downwind measuring point (Roads)
4	27°17'45.23"N 33°42'56.24"E	Upwind measuring point (Roads)

Air quality measurements were taken for SO_2, NO_2, CO and PM10. Ambient air concentrations of NO_2, SO_2 and CO were measured using 205A Series Miran Sapphire portable air analyzer. Dust meter type Personal/DATARAM was used to detect PM10.

Results indicate that all baseline air measurements were complying with the maximum allowable limits of the executive regulations of the Law of Environment (4/1994) issued by the Prime Ministerial Decree No. (710/2012). This is due to the fact that there is no source of air pollution in the project area and/or its vicinity. The area has been developed for tourist and urban purposes.

- **Ambient Noise**
  Noise measurements were carried out during different day and night times. Results indicate that all baseline noise measurements were complying with the maximum allowable limits of the executive regulations of the Law of Environment (4/1994) issued by the Prime Ministerial Decree No. (710/2012).

4.1.3 Geomorphology, Geology and Hydrology

- **Surface Topography and Geomorphology**
  - **The coastal plain**
    The coastal plain forms a narrow strip of low-lying land between the shorelines of the Red Sea to the east and the Precambrian rocks in general to the west. It is occupied by Neogene to Quaternary sediments. Extensive gravel deposits develop gently seaward sloping terraces terminating abruptly on the sea side.

  - **The slopping terrain**
    This zone is located generally in between the highly mountainous zone to the west, and the coastal plain to the east. The zone consists of moderate relief masses of granodiorites, weathered granitic masses e.g. G. Kadbora in the central part, together with some schists, phyllites of moderate to low relief.

  - **The Highly Mountainous Zone**
    This zone is characterized by the Red Sea high mountainous range, and presents deeply incised and rugged terrain, with summit elevations generally ranging up to almost 1000 m. above Sea level, and sometimes exceeding 1500 m. Examples include Gebel Dukhan 1705 m, G. Qattar 1963 m and G. Shayeb El banat 2187 m, which are all in the Northern Red Sea.

- **Hydrology and Hydrogeology**

Hydrology (Surface water)

a. Surface Water Conditions

Historical records indicate prior to the occurrence of floods affecting the coastal areas along the Red Sea (January 2010, May 1997 November 1996 November 1994, August 1991, October 1990, October 1979). Rainfall in the Red Sea area occurs between October-April. Seasonal catastrophic flash floods, characterized by their high velocity and low duration with a sharp discharge, peak are dependant on storm duration, amount of rainfall, and wadi hydrologic features.

b. Topography and Digital Elevation Model

The Digital Elevation Model of the study area where the study area is located in the low land with elevation less than 25 meters above sea level.

c. Flash Flood Hazard

The hydrologic analysis indicated that that the study area is likely to be affected by moderate flood risk to be caused by a series of active wadies. The maximum daily rainfall might reach 70 mm for the 100-year return period. This rainfall causes runoff from the different sub basin. Probability rating of flooding in each wadi (basin) is done by considering certain causative factors such as: maximum daily rainfall, side slopes of watershed, type of soil and land use. Then the flood risk map is reclassified into four classes: very high, high, moderate and low. From the flood risk map, it has been indicated that the flood risk is moderate from all wadies (basins).

A detailed flash flood risk assessment was carried out for the project site and is provided in **Annex (2) of** this ESIA report.

Hydrogeological Units

The drilling of the deep oil boreholes in the Eastern Desert and along the Red Sea revealed that there are ten distinct hydrogeologic units classified as aquifers, aquicludes and aquitards.

Seismicity and Earthquake Hazards

The project area is located within an active seismic belt, namely the Gulf of Suez trend. However, Hurghada City is the main Red Sea urban center and has been developed for tourist and urban purposes where all buildings and infrastructures have been designed according to the national earthquake codes.

The project is located within zone five on the Egyptian seismic zones map. The zone is characterized by frequent earthquakes of moderate magnitude.

The project design will take into account this value of the ground acceleration.

4.2 Biological Environment

Literature review and ground truthing of the project area and its hinterland show that the region is organized ecologically into three principal ecosystems lying on west-east axes parallel to the coast. Thus, a description of these systems and their most representative floral and faunal communities is presented.

4.2.1 Project Hinterland

- **Habitats**

  a. Mountains and Wadies

  Wadies flowing from the mountains to the Red Sea are relatively short, steep and more numerous compared with those draining westwards into the Nile Valley.

  b. Desert Coastal Plain

  The coastal plain is non-saline as it lies above sea level and far from the reach of the tidal water. It is essentially a gravel-covered plain traversed by the main wadies and their tributaries. The project site is located in the coastal plain.

  c. Littoral Belt

  The littoral belt comprises the coastal salt marshes and other associated habitat types as well as human settlements. The marshes comprise areas of land bordering the sea and subject to periodic inundation by tides of high waves.

- **Flora**

  The plant growth is confined to the drainage system (run-off desert). It shows a mosaic pattern and distinct seasonal aspects mainly due to the rich growth of ephemerals in response to occasions of rain. Water supply in the wadi habitat is usually several times the recorded rainfall, but this advantage is counter-balanced by two destructive factors: torrents and grazing. The central part of the wadi bed is usually devoid of perennial plant cover and vegetation is mostly restricted to the sides. As they support a floral community comparatively richer than the rest of the plain and being easily accessible, wadies are subject to grazing and cutting.

- **Fauna**

  According to the 1997 GEF survey, 11 species of reptiles were found in the Hurghada – Ras Abu Soma Bay Sector; as well as three species of turtles which were restricted to the islands.

  There is a great abundance of migratory birds passing through the wadies and mountains, particularly during the autumn migration. Besides, the vegetated wadies of the Eastern Desert seem to play an important role in providing resting areas for small palearctic passage migrants.

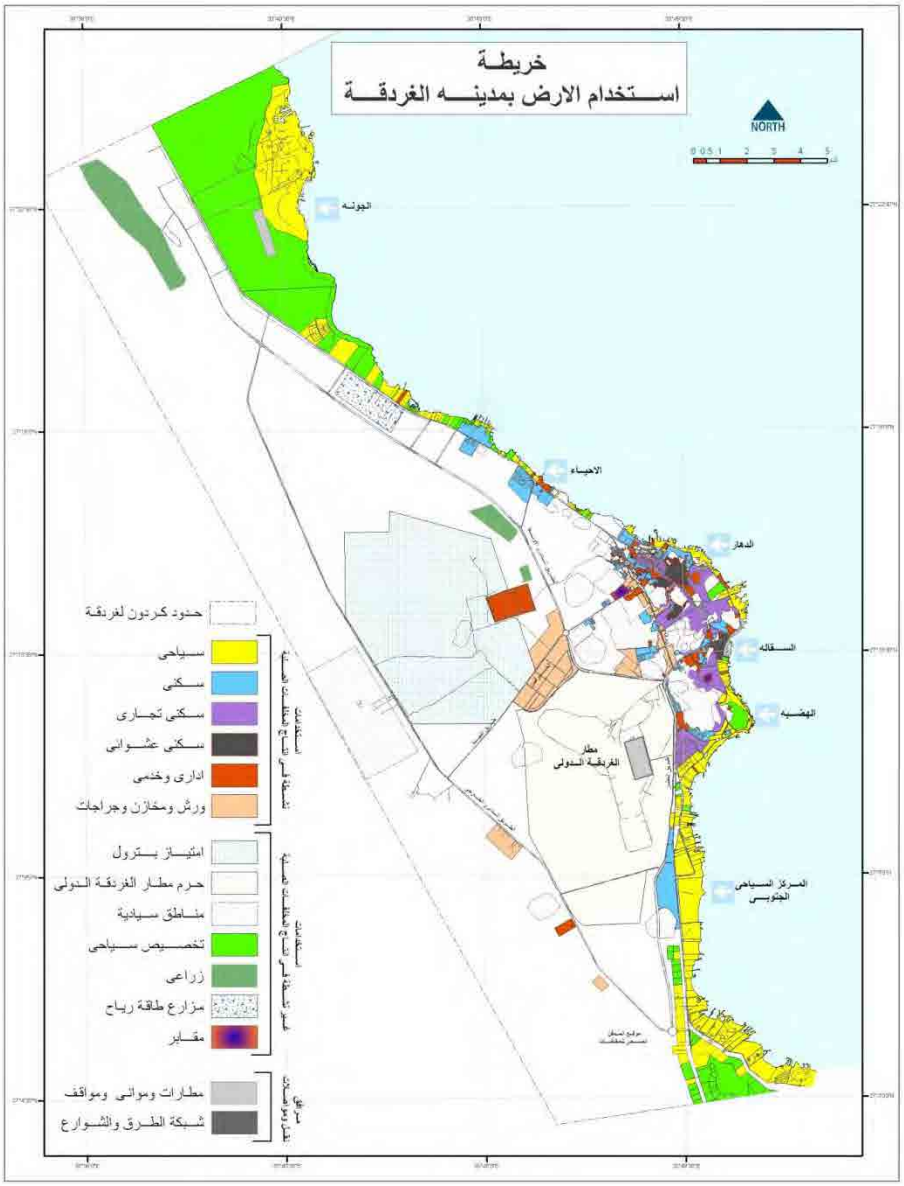
  Also 11 mammals species were recorded in this sector include Rodents and Foxes.

4.3 Socio-economic Environment

This section of the study provides baseline information on the social and economic conditions at the project area and its hinterland. This has relied on literature review of similar studies; in addition, data have been acquired from the Central Agency for Public Mobilization and Statistics (CAPMAS). The project is located approximately 10 km north of Hurghada, a major urban center, 70 north of Safaga and 150 km south of Ras Ghareb.

4.3.1 Regional Population

According to the CAPMAS national 2006 Census, the Hurghada population was 160,746, while Safaga was 35,379 capita. Red Sea local estimates in January 2011 indicated that Hurghada population was 203, 978 while that of Safaga was 44,850 capita (Red Sea Statistical Guide 2011).



The coast and islands are the territory of Rashandeya, and the mountainous area is the territory of Ma'aza tribe. Ma'aza tribe population is relatively very low. In the 1970s, they were only 50 persons. Although they do not have an association and there is not accurate census, their current total population is estimated around 900-1000 persons.

Ma'aza mainly work in tourism. They have more than ten tourist stations, where they are visited by tourists (Saleh, pers. comm., 2011). Their social organization is mainly based on tribal affiliation and extended family systems. The tribe is led by "sheikhs", who are the tribe's representatives in any outside dealings.

Rashandeya territory lies on the Red Sea coast, between Safaga and Ras Ghareb.

Most of Rashandeya have been working in sulfur mines at Ras Gemsha and they also have been known to live on some of the NorthernRed SeaIslands, of these islands are Umm Hiemat and Twal. They still have a cemetery on TwalIsland. Their manpower is divided into: 60 % fishermen, 20% in tourism, 10% governmental employees, 10% project owners (Saleh, pers. comm., 2011).

4.3.2 Regional Education

The literacy rate (10+) in Hurghada was estimated in 2007 at 85.5% and in Safaga was estimated at 87% (CAPMAS, 2007), which is higher than the national average (65.7%) and higher than the urban Governorates average (80.8%).

4.3.3 Regional Employment

Unemployment rates at Hurghada were estimated by CAPMAS at 3.5%, while in Safaga it was 9.1%. This is considered relatively low in comparison to the national rate (9.9%) and the urban Governorate level (7.6%).

4.3.4 Regional Health services

The closest hospitals to the project site are located in Hurghada and Safaga.

4.3.5 Regional Infrastructure

In Hurghada, according to CAPMAS, the total percentage of house holds connected to water networks is 77%, while 87.1% are connected to electricity and 52.1% are connected to sewerage system.

While in Safaga, the total percentage of house holds connected to water networks is 52.9%, 76.6% to electricity and 3.9% have sewerage system.

4.3.6 Transportation

Public transport is available along all the major roads leading to the resort towns. Public and private bus lines link the coastal towns developing centers with other main governorates. In addition, there are several taxis working in the area. Hurghada airport serves as an entry port by air. A ferry service from Sharm El Sheikh to Hurghada is operational. Hurghada and Safaga harbors serve international ports between the Red Sea and Saudi Arabia.

4.3.7 Economic Activities

- **Fishing**

  Fishing was traditionally the most important activity in the area. Fishing pressure used to be low, with only small groups of mostly Bedouin fishermen visiting the area, the number of fishermen has recently increased sharply. The number of registered local fishermen to the Red Sea Fishermen Association is about 500 fishermen who own fishing boats. There are another 400 local fishermen who have fishing permits from the Fisheries Development Authority. The area experiences a strong influx of fishermen from the Nile valley and Mediterranean coast, who import new and destructive fishing methods. Good fish populations primarily still exist on the outer reefs. Most fishing pressure is concentrated in shallow, inshore or shelf localities.

- **Tourism**

  In Hurghada, recent Red Sea Governorates statistics show that there are approximately 146 operating hotels and resorts, with a carrying capacity of 40,413 rooms or 76,786 beds. Information obtained also identified the number of employees in this sector to be 41,209 (Information Department/Red Sea Governorate 2012).

  Tourism currently relies heavily on diving safari tours to the islands and offshore reefs. There are relatively few safari routes; these are, however, heavily used. The main clientele consists of international visitors who stay in the coastal resorts. The high season is from Mid-September until April and then again July and August.

- **Oil Exploration**

  Hurghada has been earlier known as an oilfield since 1911. The Gulf of Suez province produces 75% of oil production. Currently, Oil exploration activities are concentrated around Ras Zeit and the area on the landward side of the Queisum islands (especially South Queisum).

5. Analysis of Alternatives

The analysis of alternatives is based on the evaluation of numerous project alternatives during the conceptual and pre-feasibility design phases.

When evaluating alternatives, particular emphasis was placed on the environmental and social implications of the alternatives to ensure that the option selected is environmentally sound and meets the Egyptian Laws and regulations.

5.1 No Development Alternative

Idea for no development alternative to the proposed plant was used in this ESIA as the scenario with which to compare the environmental and social impacts of project construction, operation and closure.

It is worth mentioning that the project is the first of its kind and size that allows Egypt to benefit from one of its main renewable energy resources, namely the solar energy. The project will also contribute to meeting part of the continuously increasing needs of the energy requirements in Egypt. In addition, the project contributes in minimizing the green house gases emissions, particularly CO_2, that would have been generated if the same amount of energy was generated from fossil fuel fired power plants. GHG emissions of manufacturing Si modules ranges between 24–45 g CO_2- and can reach to over 100g-CO_2 -equiv/ kWh [1] . This is compared to about 0.510(tCO2/MWh) emissions generated from fossil fuel fired power plants to generate the same amount of energy

Should the "no-development" alternative be selected, the land proposed for the development would still be used for other renewable energy projects as the site is owned by NREA and has been designated for renewable energy projects.

Considering the type and nature of the project and that its minimal potential impacts, the "no development" alternative has not been given further consideration.

5.2 Alternative Site Location

All utility-scale solar energy facilities internationally (with a generation capacity of 20 MW or greater) require relatively large areas for solar radiation collection. Solar facilities may interfere with existing land

[1] Emissions from Photovoltaic Life Cycles, 2008, http://pubs.acs.org/doi/pdf/10.1021/es071763q

uses, such as grazing, minerals production or any other developmental activities. Solar facilities could also potentially impact the use of nearby designated/protected areas such as areas of critical environmental concern, or special recreation management areas. Proper siting decisions are a crucial parameter that would avoid land disturbance and land use impacts. In addition, the cost of land area puts financial burden on the overall project cost. In this context, the proposed PV project is located within the site area owned by NREA where the existing Hurghada wind farm is located. Therefore this location is considered the most suitable to establish the project and other locations outside NREA land area has not been considered.

5.3 Alternative Electricity Generating Renewable Energy Technologies

Egypt has made considerable strides in wind energy development in the last decade, with solid plans being underway. However, within NREA's strategy for exploring Egypt's renewable energy potentials, NREA is striving for exploiting Egypt's abundant solar resource by technically matured technology.

Accordingly, the project in hand comes as a timely step in the way of addressing one of the largest potentials of solar energy applications.

- **Concentrated Solar Power Technologies (CSP)**
  Concentrating solar power is the utilization of Parabolic-trough collector fields with oil-based heat transfer fluids used to drive steam-turbine generating plants.

  The solar thermal plants can generate electricity during the evening and night period if they use heat storage system. NREA could have contracted for the development of a CSP plant for this project instead. Solar thermal are considered to be more costly for installation and O&M. In addition, where environmental impacts are concerned, Solar thermal requires huge amount of water for cooling system and produces much waste heat. In the desert situation such as along red sea coast, huge amount of water is difficult to obtain. For PV technologies do not entail utilization of water resources than CSP technologies; and O&M cost of PV are less than those of CSP, hence, PV technologies are more expedient for rationalizing NREA's land resources for further renewable energy development for the proposed.

5.4 Alternative PV Types

Types of PV module can be classified by the following 4 types:

- Silicon Type
- Compound Type
- Organic Type
- Quantum Dot Type

General classification of the types of PV module is shown in Figure 5-1. In Figure 5-1, some materials marked with red dotted lines means that these modules are under research and development stage now. Then detail alternative study was done for the remaining.

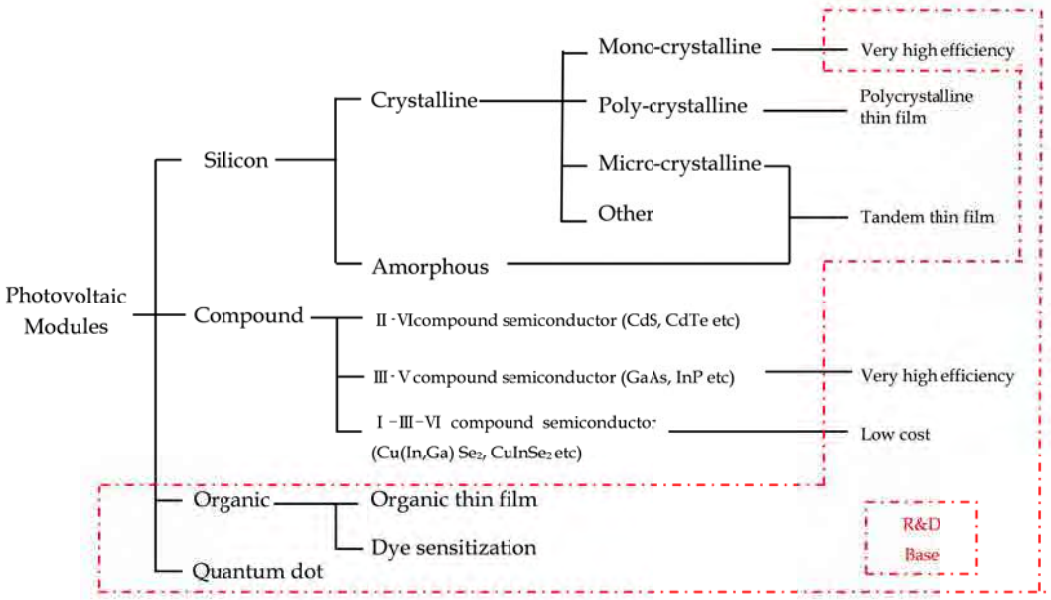


Figure 5-1 Types of PV modules

After the comparison study of six possible types described in Table 5-1 with some points of view, Poly Crystalline type, Multi-Layer Thin Film (MLTF) type and CIS type are selected as possible modules for this project. Table 5-1 shows the evaluation result.

Table 5-1 Evaluation Result for each Photovoltaic Module

	Silicon crystallized		Silicon Thin film		Compound thin film	
	Mono Crystalline	Poly Crystalline	Amorphous Silicon	MLTF	Cd-Te	CIS
Cost	High	Low	Middle	Low	Low	Low
	NG	G	F	G	G	G
Efficiency	Excellent	High	Low	Middle	Middle	Middle
	Ex	G	NG	F	F	F
Temperature Characteristic	Middle	Middle	Excellent	Excellent	Good	Good
	F	F	Ex	Ex	G	G
Life time	Good	Good	Middle	Good	Good	Good
	G	G	F	G	G	G
Environmental consideration	Safe	Safe	Safe Energy efficiency for product	Safe Energy efficiency for product	Caution induce Cd	Caution some products include small amount of Cd
	G	G	Ex	Ex	NG	F
Effect of shade	Middle	Middle	Middle	Middle	Middle	Good
	F	F	F	F	F	G
Total	High cost Weakness to high temperature	Good Efficiency Weakness to high temperature	Low efficiency and require huge space	Adequate	Require environmental consideration - Recycling	Adequate
	NG	G	NG	G	NG	G

<Note> Ex: Excellent, G: Good, F: Fair, NG: Not Good

Source : JICA Study Team

5.5 Alternative module cleaning

Three methods have been investigated for module cleaning, namely:

- **Dry cleaning** : Wiping modules with dry cloths
- **Wet cleaning**: Wiping modules with wet cloth
- **Washing**: Washing with high pressure water

Table 5-2 presents a comparison between the three types of cleaning methods.

Table 5-2: Evaluation of the ways of module cleaning

Items	Wipe with dry cloth	Wipe with wet cloth	Wash with high pressure water
Work time	3 minutes for one module (including cleaning and moving)	1.5 minutes for one module (including cleaning and moving)	1 minute for one module (20 seconds for cleaning + 40 seconds for moving)
Tools and resources	Cloth	Water, Cloth	High pressure cleaning machine, water, fuel
Number of workers	124 men/month (Total hours: 5,000 hours = 100,000 modules x 3 minutes, Workers: 124 men/month = 5,000 hours / (4 hours/day/team x 62 teams x 2 men/team x 20 days/month))	62 men/month (Total hours: 25,000 hours = 100,000 modules x 1.5 minutes, Workers: 62 men/month = 25,000 / (4 hours/day/team x 31 teams x 2 men/team x 20 days/month))	40 men/month (Total hours: 1,667 hours = 100,000 modules x 1 minutes, Workers: 40 men/month = 1,667 / (4 hours/day/team x 20 teams x 2 men/team x 20 days/month))
Water volume	No	Little for washing clothes	100,000 liter/month = 1 liter / module x 100,000 modules)
Working effort	Need force	Easy	Easy
Effectiveness	Well recovered (generation down 7% to 0%)	Well recovered (generation down 7% to 0%)	Well recovered (generation down 7% to 0%)
Damage on glass surface	Scuff by dust on the surface might cause breaking glass	Stuck dust on the glass might remain and cannot be removed	No damage on the glass
Waste	Waste clothes	Waste clothes, waste water for washing clothes	No waste water (the small amount of water will evaporate)
Conclusion	Not selected: It does not need any water, but longer maintenance time, possible damage on the surface and produce huge waste.	Not selected: It does not need much water, but longer maintenance time, possible stuck dust hard.	Selected: It needs some amount of water, but shorter maintenance time, no possible damage.

5.6 Energy Storage batteries[2]

In many types of stand alone photovoltaic (PV) systems, batteries are required to even out irregularities in the solar irradiation and concentrate the solar energy to higher power. There are various types of batteries used in PV systems including Li-ion, and Ni – cadmium batteries. Other battery technologies suitable for storage of renewable energy are different types of redox flow batteries and high temperature sodium–sulphur batteries. This section presents alternative types of energy storage batteries and their characteristics:

- ***Li-ion batteries***: are used mostly in small scale applications. The charge–discharge efficiency is the highest for the Li-ion battery. However, their relatively high production cost has precluded them from employment in applications for storage of several hundreds of kilowatt hour.

  These have not been considered for this project

- ***PSB batteries***: are redox flow batteries based on liquid electrolytes. The charge–discharge efficiency is the lowest for the PSB battery. The PSB battery technology has not yet been demonstrated in commercial operation.

  These have not been considered for this project

- ***NAS batteries:*** The NAS battery is commercially produced and is used in applications for power quality and uninterrupted power supply. The effects of ambient temperature on the performance and service battery are limited since their operating temperatures are regulated by thermal management systems. Feasibility studies of various demonstration projects showed that the NAS battery technology is attractive for use in relatively large scale battery energy storage system applications due to its outstanding energy density, efficiency and long life cycle of up to 15 years. NAS batteries are characterized by high efficiency of charge/discharge (89–92%) and long cycle life [3], and is manufactured from inexpensive materials. Such cells are primarily suitable for large-scale, non-mobile applications such as grid energy storage.

  These can be considered for this project

[2] Energy analysis of batteries in photovoltaic systems. Part I: Performance and energy requirements, Carl Johan Rydh a,b, , B jo¨rn A. Sande´n (2004), Modeling of Sodium Sulfur Battery for Power System Applications, Zahrul F. Hussien (2007)

[3] **Battery Cycle Life** is defined as the number of complete charge - discharge cycles a battery can perform before its nominal capacity falls below 80% of its initial rated capacity

- ***Load Leveling (LL) Lead Batteries:*** LL battery is used for large scale energy storage. It requires relatively large space for installation. This type of batteries can be considered for this project mainly due to the following:
  - It has relatively large scale and long life
  - Cost for project is relatively low
  - O&M and treatment/recycling method are feasible

  These can be considered for this project

6. Impacts Assessment and Mitigation

6.1 Methodology

Environmental assessment was carried out to cover potential impacts of the project on the environment as well as impacts of the environment on the project. The assessment was carried out in three main steps, as follows:

1. Identification of potential impacts
2. Evaluation and assessment of the impacts in terms of their significance
3. Identification/ proposing mitigation measures for minimizing the affects of the significant impacts.

6.1.1 Identification of Potential Environmental Impacts

Potential impacts of the proposed project are identified based on a modification of the potential/residual impact matrix (see Table 6-1 in page 45). The matrix has been designed so that the key potential impacts associated with the project become immediately apparent. The layout of the matrix is arranged as follows:

- The "rows" of the matrix consists of a list of activities presented according to construction and operation activities. It also consists of the list of aspects associated with each activity or group of activities.
- The "columns" axis consists of the resources and receptors susceptible to impacts categorized as physical, biological and socio-economic environment. Identified resources and/or receptors were:
    - Air quality
    - Noise level
    - Soil
    - Groundwater resource
    - Marine water quality
    - Terrestrial life
    - Aquatic life
    - Employment
    - Transportation
    - Aesthetic Impact

6.1.2 Evaluation and Assessment of Impacts

Interaction between the different activities and the environmental receptors, identified through the baseline information, was carried out. Such interactions may result in negative or positive impacts. The different types of impacts were identified.

Based on the analysis of the baseline environmental conditions and the nature of the receiving environment, some aspects were found to be irrelevant to specific activities of this particular project. These are identified as "scoped out impacts"

Potential impacts were subject to a process of impact evaluation, based on the analysis of the proposed project components and activities, in order to determine the significance of the different impacts. The evaluation process takes into account the information collected in the field, available in the literature and/or based on the professional judgment of the consulting team, public consultation as well as environmental modeling activities.

Impact evaluation is based on pre-set criteria including, impact magnitude, duration, built in mitigation measures, regulatory standards and sensitivity of environmental receptors.

6.1.3 Mitigation Measures

Mitigation measures are either incorporated as integral part of the plant design or through environmental management and monitoring measures. By implementing both types of mitigation measures, the residual impacts, which are those potentially remaining after implementing the mitigation measures, will be minimal/insignificant/ acceptable. Based on the impact identification and evaluation process, Irrelevant impacts are scoped out of the assessment process, mitigation measures are proposed for significant impacts, while minor impacts are integrated within the management plans of the facility.

6.2 Impact Identification

6.2.1 Scoped out Impacts

Potential impacts in the Leopold matrix were identified in relation to their effects on potential receptors. This step would facilitate eliminating and scoping out irrelevant impacts taking into consideration the following:

- Type of project
- Location
- Characteristics of the surrounding environment.
- Receptor sensitivity or importance: depends on its nature, value, scarcity etc. There are three types of receptors:
    - On site receptors encompassing soil and workplace.
    - Receptors surrounding the site such as ambient air, humans, plants and animals.
    - Final sinks/receptors such as surface and groundwater.

Examination of the environmental setting of the area and the production processes has shown that the following impacts are irrelevant:

Impacts on "marine water quality" and "aquatic life"
The project activities will have no contact with marine water or marine life.

6.2.2 Positive Impacts

It is estimated that the construction phase of the project would provide direct labour force. More important, the positive impact of the project will reach farther than the employment at the site. This project is the first of its kind in Egypt to directly provide electricity from solar energy at utility scale. This project will open the doors to other mega project in Egypt to extensively explore the solar energy in Egypt. This would contribute to minimizing the dependence on the depletable fossil fuels and minimize their environmental adverse impacts.

6.2.3 Potential Negative Impacts

After exclusion of the irrelevant impacts and identifying the positive impacts, the remaining "potential negative impacts" were assessed based on the following criteria:

- ***Magnitude*** of the impact.
- ***Duration:*** period of time that impact lasts.
- ***Mitigation measures;*** its availability whether integrated in the project design or implemented as management measures**.**
- ***Adherence to regulatory standards according to Egyptian legal and regulatory framework*** (described in Chapter 2).
- ***Public concern and perception***

Using the impact identification matrix (Table 6.1), the different types of impacts were identified. The table presents the different types of potentially negative impacts during the construction and operation phases. Fore each potential negative impact the significance before and after implementing the design integrated measures and/or applying management and monitoring practices were determined.

Table 6-1: Potentiel/ Residual Impacts Matrix

Activities (Sources of impacts)	Aspects	Environmental Attributes[1]								
		Physical Environment				Biological Env.	Socio-economic			
		Air Quality	Noise level	Soil	Groundwater Resource	Terrestrial life	Transportation	Employment	Aesthetic Impact	Waste
Construction Phase										
Site leveling Civil Works Steel erection Equipment erection Electrical and instrumentation Mechanical completion Pre-commissioning	• Labor	NA	NA	NA	NA	NA	NA	+	NA	NA
	• Dust Emissions	-/I_m	NA	NA	NA	-/I_m	NA	NA	NA	NA
	• Emissions (vehicles, equipment & material)	-/I_m	NA	NA	NA	-/I_m	NA	NA	NA	NA
	• Noise (vehicles & equipment)	NA	-/I_m	NA	NA	NA	NA	NA	NA	NA
	• Construction Waste (including generation of solid and liquid municipal waste)	NA	NA	NA	NA	NA	NA	+	NA	-/I_m
	• Transportation	NA	NA	NA	NA	NA	-/I_m	NA	NA	NA
	• Spills (vehicles & equipment)	NA	NA	-/I_m	NA	NA	NA	NA	NA	NA
	• Sewage	NA	NA	-/I_m	NA	NA	NA	NA	NA	NA
Operation Phase										
Activities related to Workforce	• Labor employment	NA	NA	NA	NA	NA	NA	+	NA	NA
	• Municipal Solid Waste	NA	NA	-/I_m	NA	NA	NA	NA	NA	-/I_m
	• Sewage	NA	NA	-/I_m	NA	NA	NA	NA	NA	NA
Maintenance work	• Cleaning Modules	-/I_m	NA	NA	-/I_d	NA	NA	NA	NA	NA
	• Maintenance equipment	NA	NA	NA	NA	NA	NA	NA	NA	NA
	• Waste of panels and buttery	NA	NA	-/I_m	NA	NA	NA	NA	NA	-/I_m
Structures	• Existence of the structure	NA	NA	NA	NA	-/I_m	NA	NA	-/I_m	NA
Transformers and inverters	• Noise from transformers and inverters	NA	-/$I_{d,m}$	NA	NA	NA	NA	NA	NA	NA

[1)](-): Negative impact(+): positive impact
I_m: minor residual impacts acceptable after mitigation through management
I_d:minor residual impacts acceptable after design integrated mitigation
NA: Not applicable

6.3 Assessment of Potential Negative Impacts

6.3.1 Impact on Physical Environment

(1) Air Quality

Construction Phase

Construction activities may result in minor, localized, short term, air quality deterioration in the form of dust/particulate material, and emissions from soil leveling, construction equipment and transport vehicles. Air Emissions from mechanical construction equipment may result in potential impacts due to the localized increase in concentration of nitrogen oxides, sulphur oxides and carbon monoxide.

Such impacts will occur for relatively short duration and will affect mainly the workplace environment. Impact on public health is unlikely due to the fact that there are no nearby residential areas to the site.

Mitigation Measures

The PV project will ensure that the contractors will carry out the necessary measures to minimize impacts. This is to be included in the contractor's scope of work (contract). Possible measures include:

- Dust suppression measures: Although no significant emissions will result mainly due to relatively hard nature of the soil. In this regard, dust management would be achieved through slowing the driving speed of construction vehicles.
- Maintaining machinery and vehicles in good working conditions to minimize fugitive emissions
- Frequent inspection of all construction equipment will be carried out to minimize fugitive emissions

Therefore the residual impacts after implementation the management measure are negligible

Operation phase

No air emissions are generated during operation

(2) Noise levels

Construction phase

The use of construction equipment may result in localized, short term, increase in noise levels. Table 6-2 shows typical noise levels, in decibels, expected at various distances from construction machinery. It is not expected that noise from the construction activities would pose impacts on the neighboring areas.

Table 6-2 Average Noise Levels from Construction Equipment

Equipment Type	Distance from Noise Source (dBA)		
	10m	50m	100m
Crane	72	58	52
Bulldozer	74	60	54
Generator	76	62	56
Backhoe	79	65	59

Mitigation Measures

- When construction equipment are used, such as during site excavation, earth moving, and land grading, workers will be provided with the necessary PPEs (Personal Protective Equipment) to minimize possible impacts from noise.
- Maintain machinery and vehicles in good working conditions to minimize noise generation.

Residual Impacts

Acceptable if mitigation measures are applied

Thus, noise resulting during construction activities is unlikely to have an impact on the general public. However, the impact of construction activities on workplace can be potentially significant. But with implementing the necessary mitigations measures and health and safety procedures, residual impacts are considered negligible.

Operation phase

Noise during operation can result mainly from the transformers and inverters (four 500 kV Invertors and one 2,000 kW Transformer). The transformers, switchgears, LV switchgears and protection relays are contained in an enclosure (Kiosk or container box) with restricted access.

Noise levels, expected from the different equipment as shown in Table 6-3 below, are less than the allowable limits of Law No. 4/1994 as described in Chapter 2.

Table 6-3 Expected noise levels from different Instrumentation

Noise source	No/Size	noise level (dB(A)	Location
500 kV Invertors	4 inverters 0.5m(w) x 0.5m(h)	75dB	Inside of the inverter room
2,000 kW Transformer	One transformer 3m(w) x 2m(d) x 2m(h)	64dB	Outside transformer room

Mitigation measures

- Potential noise generating machines and equipment are designed to meet statutory regulations concerning noise.
- Acoustic enclosures are installed for casings of all noise generating equipment, wherever possible
- Workers at noise generating machinery and equipment will be provided with the necessary personal protective equipment (PPEs).

Residual Impacts

The contribution of the facility to the increase in noise level to the surrounding environment is minimal taking into account the design mitigation measures in the project place and due to the fact that there is a big distance to the nearest sensitive receptors, all noise levels produced from the proposed facility would completely vanish by the time they reach the closest sensitive receptors.

Regarding the noise levels within the workplace, implementing the mentioned mitigation measures and implementation of effective occupational health and safety measures including restricted access to the transformers area and providing the workers with the necessary PPEs and limiting the exposure period, the residual impacts in the workplace are considered negligible.

Thus, noise resulting during operation activities is unlikely to have an impact on the general public. However, the impact of noise on workplace will be negligible with implementing the mitigations measures and health and safety procedures.

(3) Soil

Construction phase

The activities carried out during construction phase are unlikely to result in soil contamination that will need future decontamination and clean-up activities. Moreover, during construction contracts with different contractors will include requirements for periodic inspection of equipment and machinery which will contribute to minimizing spills and leaks. Wastes generated during construction including municipal and construction waste will be collected by an approved contractor to be disposed of designated in landfill sites.

Mitigation measures

Mitigation measures mainly involve site management procedures and good housekeeping activities and proper waste management measures. The contractor will implement measures for spill prevention that will contribute to controlling and minimizing any potential impacts.

Residual impacts

With implementation of the mitigation measures, the residual impacts are negligible.

Thus, impact on soil during construction activities will be negligible with implementing proper housekeeping and management measures.

Operation phase

No soil contamination is expected during operation.

(4) Groundwater resource

The project will use about 100m^3/month **(**less than 4m^3/day) for panel cleaning. The required water quantity will be provided through the city network. The water consumption will not put significant load on the water resources in the area.

6.3.2 Impact on the Biological Environment

Important species of conservation value do not occur within the project site and its close hinterland as the area has experienced intensive anthropogenic changes due to the establishment of the wind farm and the large number of trouristic villages and resorts along the coast. The most important ecological feature of the area is its location along a major flyway for Palearctic migrant birds. However, the PV project does not have any impact on the flyway of the birds as it does not include any elevated structures.

Construction Phase

The project area represents a small part of the vast coastal desert plain and is not considered a critical habitat. Gaseous emissions, noise from construction machinery are short term and their impacts are considered insignificant.

Mitigation Measures

- Implement mitigation measures to reduce emissions and noise, as detailed in previous sections;
- Avoid working at night and using high energy lights;
- Use, as much as possible, native floral species for landscaping;
- Develop, implement and update a waste management plan to include waste collection, storage, transport and disposal in an environmentally sustainable manner.

Residual impacts are minor with proper mitigation and management measures are implemented.

Operation Phase

As mentioned before the project does not include activities that would affect the wildlife in the area. Moreover, the PV modules are non-reflecting surfaces, to enable maximum solar radiation absorbtion, thus will not have any disturbing reflective adverse impacts

Thus the impacts on the wild life is not significant

6.3.3 Social Impacts

(1) Employment

Construction phase

The construction phase of the project will provide employment opportunities for an average of 250 workers. Priority will be given to the community local workforce during labor selection to further enhance positive impact on the local community.

Operation phase

The project has the potential to decrease unemployment levels in the area by creating employment opportunities. Moreover, it would provide an opportunity for education, training and technology transfer to the Egyptian context related to Solar Energy. This is expected to contribute significantly to disseminating the project in other area in Egypt.

(2) Transportation

Side-tracks as well as the main roads used for trucking equipment and construction gear to the project patch. About 100,000 PV modules are required for this project; these PV modules and Inverters will be imported from abroad through Alexandria port or Ain Sokhnah port. In addition, the transformers, switch gears may be acquired from the Egyptian Markets, mainly from Cairo, as well as steel and concrete which will be acquired from local agents.

Imported components will be transported from the ports via the highways. Locally purchased components will be transported through the road network extended from Cairo to Hurghada.

An average of 2,500 trucks of various sizes will be required for transportation of all project components distributed throughout its construction period, about 20 months. Thus it is not expected to have significant impacts on the roads network in the area during the project's construction period (expected average number of trucks = 10 trucks/day)

(3) Aesthetic Impact

The project is to be located within the wind farm area owned by NREA. The PV panels are not installed at significant heights that could be easily seen from the surroundings. Thus, it is not expected that the aesthetic impacts are significant.

(4) Waste

The project produces some waste such as construction waste during construction, domestic waste, waste modules, and waste batteries during operation. Most of the construction waste and domestic waste do not include hazardous substance. If they are treated properly, no environmental impact will be assessed. Waste modules do not include hazardous substance such as cadmium. Then it can be treated as normal industrial waste. Waste battery might include hazardous substances but treatment measures have been already established and if it is treated properly, no environmental impact is predicted.

6.3.4 Impact of the Environment on the project

- **Flash flood**

Based on the baseline investigations presented in Chapter 4, the hydrologic analysis indicated that the study area is likely to be affected by moderate flood risk to be caused by a series of active wadies. To evaluate the flood intensity, and hence the potential risks at the PV site, as well as to identify the optimal locations that suit the construction of the flood protection structures, if any, a comprehensive topographic field survey was carried out. The topographic survey covered not only the PV site but also the surrounding areas to identify the flow direction when the water reaches the borders of the PV site. The topographic study entailed field activities including

- Accurate determination of the ground surface elevation to determine the flow direction at the PV site,
- Identify the main wadies that intersect with the PV site and the geometry of these wadies and their slopes

The assessment was based on a worst case flash flood scenario including hydrologic analysis for a 100-year return period.

Based on the outcome of the topographic study it was indicated that flood intensity that describes the power of flash flood varies between 0.01 and 0.21 m^2/sec. This low value of the flood intensity is a good indication that the PV site could resist the damage impact of the expected 100-year flood provided that the flood protection measures will be considered in the construction design (foundation)

and that the optimal recommended protection strategy for the PV site is the In-situ Flood protection for the solar panels. **Annex (2)** of this ESIA study presents the detailed flood assessment survey. In this respect, a ''let water go'' strategy has been recommended.

- **Impact of Sand Storms**
  One of the impacts of strong wind is sand and dust deposition. The study area experiences sand storms during spring and autumn. Higher wind speeds potentially increases the performance losses due to abrasion and/or deposition of aeolian dust on PV cells (Goossens and Van Kerschaever 1999). However, the design of the PV panel has taken into consideration selection of coating material that will minimize the abrasive effect of dust. In addition, periodic panel cleaning and maintenance will minimize the impact of deposited dust. (Thornton 1992).

  Thus, with appropriate design materials and with implementing proper maintenance and cleaning procedures the impact of dust will be minimized.

- **Impact of Earthquakes**
  As discussed in Chapter 4, Egypt is divided into 5 seismic zones, of which Hurghada as well as the project is located within zone 5 which experience the maximum peak ground acceleration. The project is complying with Egyptian codes, regulations, particularly the Egyptian building code with respect to the type of construction and design requirements.

  Thus, taking into consideration the building code requirements in the project design, the residual impacts will be negligible.

7. Environmental Management Plan

The project's Environmental Management Plan (EMP) consists of a set of mitigation, monitoring and institutional measures to be taken into consideration during the construction and operation phase to ensure the sound environmental performance of the project. The plan also includes the actions needed to be taken to implement these measures.

The project's EMP consists of the following:

- ***Summary of the impacts***

- ***Mitigation measures*** to identify feasible and cost effective measures that will reduce potentially significant adverse environmental impacts to acceptable levels as discussed in Chapter 6.

- ***Monitoring Plan*** during project implementation to provide information about key environmental aspects of the project, particularly to monitor environmental impacts of the project and the effectiveness of mitigation measures.

7.1 Summary of Impacts

As discussed in Chapter 6, impacts were categorized into the followings:

Table 7-1 Impact Categories

Potentially Significant impacts	Insignificant impacts	Irrelevant impacts
Noise levels in workplace	*Construction phase* - Air quality - Soil quality - Noise level - Workplace health and safety *Operation phase* - Noise impact on surrounding environment	Impact on marine water quality and aquatic life

7.2 Mitigation Measures

Following is a brief summary of the mitigation measures for the construction and operation phases previously discussed in Chapter 6. The mitigation measures either address the environmental aspect (for example contributes to preventing/ avoiding/ minimizing the occurrence of the aspect) or address the potential exposure to the impact. The project's EMP will be developed in accordance with the relevant national regulatory requirements.

7.2.1 Construction Phase

Contractors commissioned for the construction will be required to undertake the necessary measures to protect the environment and the workers. NREA will ensure that Contractors will carry out necessary measures to minimize impacts. This is to be included in the Contractor's scope of work (contract). This is in accordance with Chapter 2 (construction and work sites) of the Ministerial Decree 211/2003, implementing Labour law 12/2003.

Table 7-2 presents a summary of impacts during construction, the possible mitigation measures and the elements addressed.

Table 7-2 Summary of Impacts of the Construction Phase and Related Mitigation Measures

Parameter	Measures
Air quality	- Dust suppression - Maintaining machinery and equipment - Frequent inspection of all construction equipment
Noise level	- Using PPEs - Machinery maintenance - Restrict noise generating activities to morning hours, as possible
Soil and groundwater	- Implement measures for site management, good housekeeping and spill prevention
Workplace Health and Safety	- Provision of PPEs to workers - Adopting spill prevention plans - Proper material storage, labeling and handling - Installing fire detection and fighting system - Proper waste management

7.2.2 Operation Phase

Table 7-3 Summary of Impacts of the Operation Phase and Related Mitigation Measures

Parameter	Measures
Noise levels in workplace	- Machinery and equipment designed according to standard specifications - Implement all applicable occupational health and safety measures stipulated in the Egyptian labour law 12/2003 - Acoustic enclosures are installed for casings of all noise generating equipment - Provide workers with PPEs

7.3 Institutional Arrangements

Stemming from its concern for ensuring high standard of environmental performance, the project is committed to meet the stipulations of national environmental and labour laws, no 4/1994 and 12/2003 respectively. Furthermore, the facility will have an HSE policy. The outline of the HSE policy requirements for the PV project is summarized as follows:

- Carry out Environmental Impact Assessment
- HSE training for all staff in safety and emergency plans and procedures,
- HSE Requirements for Contractors

7.3.1 Health and Safety Policy

According to the requirements of the Ministerial Decree 134/2003of the Ministry of Labour and Manpower implementing law 12/2003, an occupational, environment health and safety committee will be formed comprising of various disciplines of the employees and top management. A Safety committee will also be formed. Besides, the facility is also to have an environmental department. Within this framework, following are the key responsibilities for the different departments:

<u>Responsibilities of the HSE committee</u>

These include, but are not limited to the following:

- Maintain and update the environmental register
- Develop and review of company HSE policies and maintain periodic communication meetings.
- Monitor the different pollutants in the workplace and identify measures for pollution minimization and control

- Determine -in cooperation with different departments- occupational, health, safety and environmental criteria and identify the necessary personal protective equipment.
- Contribute in organizing awareness and training programmes and workshops for all employees in cooperation with the different concerned bodies and institutions.
- Carry out daily inspections to ensure compliance of workers HSE requirements. Safety and environmental audits will be conducted by internal and external audit agencies.
- Maintain register for occupational health and safety management procedures.
- Last but not least, the head of the HSE committee will also be the focal point for the environmental and socioeconomic issue in cooperation with the external communities.

7.4 Management Plans

Within its commitment to ensure environmental protection and maintain efficient environmental performance, the project will develop various environmental management plans addressing the different environmental aspects. The different environmental dimensions will be incorporated throughout the operation of the plant. In this regard, the environmental plans to be developed will address:

- Hazardous and solid waste management
- Preventative maintenance
- Housekeeping
- Fire Fighting and emergency response
- Training and awareness

The following sections provide details of the different environmental management plans.

7.4.1 Hazardous Waste (HW) Management

HW includes mainly the used machinery oils and used lead batteries. In this project machinery oils will not be used. In case lead acid batteries are used for this project, the batteries will be recycled in the local market after end of the lead batteries' life time.

7.4.2 Solid Waste Management

Main source is domestic activities from workers. Solid waste will be stored on-site till submission to authorized solid waste contractor for final disposal. Solid waste would include damaged PV modules which could be disposed of as solid waste or sold for recycling as they contain substances such as glass, aluminum and semiconductor materials that can be successfully recovered and reused in other relevant products.

7.4.3 Housekeeping

Regarding housekeeping of the plant, periodic inspection will be carried out to ensure proper housekeeping. Good housekeeping practices will be followed such as:

- Optimizing the use of water for cleaning purposes.
- Performing noise measurement in the related places within the project area.

7.4.4 Fire Fighting Plan

Fire hazards may only arise from electric equipment, wires and cables. A well designed Electrical Safety Program will protect employees as well as the project. Basic components of the safety program will include:

- Justify why work- must be performed on energized equipment.
- Perform an electrical hazard assessment.
- Inform and train employees of the potential hazards and the application of Lockout/tagout Devices and warning labels
- Test and verify that employees are "qualified" to work- on specific equipment.
- Select and provide proper personal protective equipment for employees.
- Provide their employees with a job briefing and written Energized Work-Permit signed by management.
- Provide Fire Alarms
- Fixed and semi-fixed dry chemical fire extinguishing equipment

7.4.5 Training and Awareness

Employees training and awareness

In order to ensure the competence of the project personnel in undertaking the environmental management procedures and plans, training will be conducted for the personnel according to the particular responsibility.

Training programmes will involve training staff on safe handling of equipment and wastes and on the use of equipment. They will be informed of any potentially harmful health effects related to the PV plant operations. They will also be trained on the use of fire hose reels and fire extinguishers. Besides, NREA will develop a training plan for the project in advance of construction.

Contractor Training and Awareness

Contractors and vendors that perform work on site will be required to show evidence of appropriate health, safety and emergency response training.

7.4.6 Project Decommissioning Plans

Decommissioning is defined as the close down of operations, the removal of process equipment, buildings and structures and carryout site cleanup and remediation if required. The expected lifetime of the project is 25 years that will be renewable as long as the proper predictive maintenance measures are taken and all the necessary revamps and upgrades are done. Following are the main issues addressed by the facility's decommissioning plan

- Development of the decommissioning plan accordingly in light of the national and international requirements.
- Removal procedures for all above ground structures
- Disassemble the PV Modules: The components of the plant will be disassembled and removed. Thereafter they will be reused and recycled (where possible) or disposed of in accordance with regulatory requirements.

7.5 Monitoring Plan

The monitoring plan is an essential element for the environmental management scheme of the project. It provides information for periodic review and adjustment of the environmental management plan as necessary, ensuring that environmental protection is achieved through early detection of negative environmental impacts.

Monitoring results will be fed into the decision making process as a trigger for the implementation of corrective actions, in order to maintain compliance with environmental laws and regulations, ensure environmental protection and workplace safety, as well as to ensure appropriate operation of the mitigation measures and management plans.

It is important to note here that environmental monitoring is a dynamic process. Generally, a first round of monitoring is carried out based on the potential pollution parameters which are included in the monitoring plan. The results of this round and the deviation from the permissible limits of applicable laws are considered as the base for the consequent monitoring rounds. In other words, the results of the first monitoring round draws the critical points and helps to identify the necessary measurements in the following rounds. It is worth mentioning, that in the first phase of operation (project trial operation), monitoring will include many additional parameters more than those monitored during normal operation. Therefore, the periodic monitoring plan will exclude those parameters which are temporarily released and are only relevant to the trial phase.

7.5.1 Monitoring Air Quality

During Construction

Workplace air monitoring of equipment exhaust will be performed quarterly. Emissions are generated from exhaust from construction equipment and motor vehicles and particulates during site works. Monitoring results will be compared with the allowable limits of Law 4/1994 provided in Chapter 2 of this study.

The following parameters shall be measured:

- Carbon monoxide, CO
- Sulfur dioxide, SO2
- Nitrogen oxides, NOx
- PM10

7.5.2 Workplace Monitoring

Workplace Noise

During Construction

During construction, the facility will ensure that the noise level from all operating equipments would not exceed the allowable limit set by Law 4/ 1994 for 8 hours duration shift (90 dB). In case the noise levels exceeded this limit, the exposure periods will be carried out according to those indicated in Annex (7) of Law 4/1994. Moreover, ear plugs will be provided for the workers at the locations generating increased noise levels. Noise level measurement will be carried out biannually.

During Operation

Sources of noise inside the plant include compressors, pumps, and boilers. The measured noise levels will be compared to the levels set in Annex (7) of Law 4/1994. In case the noise exceeded the maximum limit of 90 dB, exposure periods will be proceeded as stipulated in Law 4/1994. Table (7.4) shows the noise monitoring locations and frequencies and the estimated monitoring cost. Regular checks will be carried out twice a year for areas of direct exposure to equipment. Moreover, ear plugs will be provided for the workers at the given locations.

7.5.3 Solid and Hazardous Wastes

Non-hazardous solid wastes will be recorded in the Environmental register of the plant. On the other hand according to Law 4/1994, a register will be prepared for hazardous wastes. Information of the HW register should include types and quantities of hazardous wastes, storage means and disposal.

7.5.4 Approximate Monitoring Costs

An independent consultant would be hired for carrying out the monitoring activities. The following Table 7-4 provides approximate monitoring costs for guidance purposes only. The costs only cover

analysis and field measurements. However, they do not include specific sample collection costs.

Table 7-4 Approximate costs for Environmental Monitoring

(**Parameter**	**Description**	**Approximate annual cost (L.E)**
Construction Phase		
Noise level	Measurement at four locations twice a year	2000
Air quality (SO_2, NO_2, CO, PM_{10})	Measurement at 2 locations 4 times per year	6000
Operation phase		
Workplace noise	Measurement at 2 locations twice a year	1000

8. Public Consultation

8.1 Background

As part of the comprehensive ESIA, a process of public scoping was carried out for the identification of the environmental concerns of different stakeholders regarding the proposed project. Accordingly, individual scoping meetings were conducted with key stakeholders in Cairo and Hurghada. Following the individual meetings a public scoping meeting was organized to present the stages of the ESIA and allow for additional interaction between the different stakeholders as well as with the project team.

The following sections present process of the public scoping meeting and its results

8.2 Stakeholder Identification

The identification of the project stakeholders was based on an analysis of the institutional, legal and administrative framework of the project as well as the project location and activities.

In this context, stakeholders were identified taking into consideration:

- Nature of project
- Location
- Potential impact of the project

The target groups that were invited for the scoping meeting included those who are directly or indirectly involved in the project and those who have expertise and are interested in the topic (e.g. NGOs, scientists). Accordingly, stakeholders included:

- Public (affected community)
- Regulatory agencies and competent authorities
- NGOs and scientific community

Table 8-1 below presents description of the different stakeholders and their roles and/or potential interests in the project.

Table 8-1 Project Stakeholder

Stakeholders	Role/Potential interest
- EEAA - EIA Department - Red Sea Governorate	Overall coordinating body of monitoring, enforcement and regulating developments through setting the ESIA system, managing the protection and preservation of natural environment and managing the use of hazardous substances in coordination with concerned and responsible authorities.
- Environmental Management Unit, Red Sea Governorate	The entity concerned with the environment on the governorate level.
- NGOs and/or Representatives of the public	Safeguard the environment and influence decision making.

8.3 Stakeholder meetings and scoping

Within the scope of the PV project ESIA, the first public consultation meeting (scoping meeting) took place on February 28th, 2012 at Palm Beach Hotel – Hurghada. Personal invitations were sent to relevant stakeholders. A list of the meeting attendees is included in **Annex (3).**

This meeting is part of the scoping activities and it complements the individual scoping activities carried out within the scope of the project.

The objective of the meeting is to present the project to the stakeholders as well as verifying the preliminary findings of the environmental and social impact assessment study and to discuss any further views and comments related to the project activities.

The scoping meeting witnessed high level of interaction between the different attendees and the project team. The overall feedback from the attendees emphasized the importance of organizing such meeting that gives opportunity to all concerned entities to contribute in the consultation process for the well-being of the community.

8.3.1 Topics discussed

The topics raised by the attendees during discussions can be categorized into the four **main categories as follows:**

- Project location and technology including:
  - selection of Hurghada for establishing the project and alternative locations
  - Impact on the electricity grid
  - Module cleaning method
  - PV modules manufacturing

- Impacts of the project on the environment
  - Water sources and wastewater management
  - Noise
  - Waste management
  - Transportation of project components
  - Impact on work place
  - Public health

- Impacts of the environment on the project
  - Flash flood impact
  - Impact of dust
  - Impacts of high temperature

- Socio-economic aspects
  - Employment and training
  - Aesthetic impacts

During the discussions an issue related to impact on migratory birds was raised. It was clarified that this project does not have any impacts on the birds and thus such impact is considered irrelevant to the project activities.

Another issue related to consultation with the tourists and the investment authorities is required for this project. It was clarified that such entities, who are not directly concerned with the project, would be invited through the newspaper advertisement at the disclosure stage of the ESIA. Details of the issues discussed during the scoping meeting are presented in **Annex (4**) of the ESIA

8.3.2 Conclusion of the Scoping meeting

The overall feedback from the attendees emphasized the importance of organizing this meeting that gives opportunity to all concerned entities and the general public to contribute in the consultation process for the well-being of the community. The meeting gave the opportunity to the different entities to interactively comment on the different aspects of the project with the project team and the environmental consultant.

All attendees expressed their support to the different types of renewable energy projects in Egypt

8.4 Public Disclosure meeting

After preparation of the draft ESIA report, a public disclosure meeting has been carried out to present the results of the ESIA to the stakeholders and discuss the proposed mitigation measures. Stakeholders where invited to the meeting through personal invitations as well as a newspaper advertisement in Al Ahram newspaper on 29th September 2012. In this respect, a brief summary of the findings of the environmental and social impact assessment was prepared and sent to the stakeholders with the invitation letters. For public access, the findings have been published on NREA website as well as at the Hurghada Wind Farm office.

The meeting took place on Tuesday 9th of October, 2012 at Palm Beach Hotel in Hurghada. The following sections present process of the public scoping meeting and its results.

The meeting witnessed high level of interaction between the different attendees and the project team. The overall feedback from the attendees emphasized the importance of organizing such meeting that gives opportunity to all concerned entities to contribute in the consultation process for the well-being of the community.

Presentations

A welcome speech was given by General/ Saad El Din Amin Secretariat General of Red Sea Governorate. In his speech he emphasized on the importance of encouraging Egypt's expansion of the renewable energy projects to meet the continuous drastic increase in the Egyptian market demand on energy sources.

Following the welcome speech, Eng. Khaled Fekry, Head of the Research and Studies Department at NREA, introduced NREA as a leading entity in the area of renewable energy applications in Egypt and its cooperation with the JICA study team in the project as well as NREA's expansion plans in exploration of renewable energy projects.

Following the speech of Eng. Fekry, Mr. Masaki Kudo, Representative, JICA Egypt Office Japan International Cooperation Agency (JICA) presented the unique and distinctive characteristics of Egypt that qualifies it as a major renewable energy generator as well as a touristic place. In his word, Mr. Masaki emphasized the long cooperation between Egypt and JICA in the different development projects particularly the renewable energy sector. He also highlighted the importance of public consultation activities in enhancing the interaction and cooperation between the public and the project.

Finally, Eng. Amany Salah, of the central Department for ESIA and EEAA gave a short word on the role of EEAA in the project and emphasized the importance of renewable energy projects as environmental friendly projects to minimize the dependence on the depletable fossil fuels for energy generation.

Following the welcome speeches, the technical presentations included an introductory presentation by Eng. Yasser Sherif – Environics General Manager. Environics presented the objective of the public disclosure meeting and its importance in the ESIA process. The presentation also summarized the results of the public scoping meeting that took place in February 2012 and how the raised issues were incorporated in the ESIA report.

Following the introductory ESIA presentation, the results of the ESIA were presented by Chem. Amani Nadim from Environics including description of the project components and its surrounding environment

as well as identification of the potential impacts and their recommended mitigation measures.

Finally, the flash flood assessment studies were presented by Geo. Ayman Afifi from Environics which included description of the flood assessment process and its results.

After the presentations, Eng. Yasser Sherif facilitated the discussions with the participants. Comments were made either verbally during the discussions or in writing through submission of a comments form, which was distributed to the attendees at the beginning of the meeting.

The topics raised by the attendees during discussions can be categorized into three main categories as follows:

Project location and technology including:
- Project locations
- Module types
- Use of storage batteries
- Supply of project components
- Project implementation schedule

Impacts of the project on the environment
- Water sources and wastewater management
- Waste management
- Impacts on migratory birds
- Impact on marine environment

Impacts of the environment on the project
- Impact of Flash flood
- Impact of dust
- Impact of wind

Socio-economic aspects
- Employment and training
- Landuse management
- Aesthetic impacts
- Egyptian components in the project
- Public contribution to the project discussions.

Other issues

Other issues were raised regarding the type of JICA contribution to the project implementation and whether this contribution is in form of loans or grants. It was clarified that JICA contributed through a grant for preparation of the project feasibility study. The project implementation will be carried out through a loan. However, the

precise details of the project execution are currently under discussion between NREA and JICA. In addition, the issue of reflection of the ESIA results on the project design was raised. It was clarified that the ESIA is one of the main tools that supports the project design. This has manifested in investigating the modules' foundation design to resist the flash flood, and the selection of the module cleaning process.

Annex (4) presents details of the issues raised during the disclosure meeting and the discussions that have taken place.

8.5 Ongoing Consultation during project development and operation

The objective of the consultation is to support the Stakeholder Engagement on issues of concern and enable all stakeholders to have their interests considered during the project entire lifetime.

The consultation is essential to:

- Keep those affected by the project informed of work progress and related changes
- Managing issues and grievances as they arise
- Monitoring the effectiveness of environmental and social mitigation measures

This is undertaken through the development of a Public Consultation and Dissemination Plan (PCDP). The plan includes the following components:

- Public consultation means and related schedule
- Reporting

8.5.1 Public Consultation Meetings during the Project Lifetime

A schedule of stakeholder meetings will be developed based on a variety of objectives, such as:

- Providing information to stakeholders on project development,
- Obtaining public feedback, and
- Coordinating community development objectives.

For each of the consultations, a follow-up on feedback, management tasks, agreements or commitments should be made. If commitments are made, responsibilities must be defined and a timeline should be estimated for carrying out these commitments. Actions will be initiated and follow-up will be undertaken and reported to the concerned stakeholder.

8.5.2 Grievance System

An effective grievance mechanism will be functioning throughout the project lifetime and available to the affected communities at no cost and without retribution. The grievance system will allow direct communication between the community and project management at any time, independently of the meeting schedules. This will likely involve a combination of avenues, such as telephone, mail, emails, oral communication through meetings, etc.

Grievance related to any aspect of a project will be resolved through consultations conducted in a transparent manner with the ultimate goal of reaching consensus.

A computerized data-base will be established to record all grievances/complaints and the completion date that the complaint was closed/corrected. This will include the suggested actions, date to be completed by, date it actually was completed by and the effectiveness of the response. Once the data base is established, staff will be trained and will be required to use the data-base. A grievance log will include a documentation of grievance and documentation of the results of consultation to the project-affected communities, and either demonstrating how the comments and recommendations made by the project-affected communities have been accommodated; or providing a rationale why these comments and recommendations have not been accommodated. As much as possible, the meetings will strive for a win-win situation through facilitation and discussion between the facility personnel and affected groups. The project will publicize the grievance system and how it works among project affected people. The response time between activating the procedures and reaching a resolution should be as short as possible.

Annex 1

Baseline Report

Table of Contents

Annexes

List of Figures

List of Tables

1. Physical Environment

This section provides a description of the main physical environmental components at the project area including climate and meteorology, air quality and noise, as well as electricity infrastructure. The aim of presenting these data is providing benchmark analysis of the status of these components before commencing the project activities to provide information for decision makers as well as secure reference conditions for future environmental monitoring/audit, if any.

1.1 Climate

The climatic and meteorological data presented herein was obtained from the closest station of Hurghada. The study area is located within the Eastern Desert, and accordingly is characterized by hyper-arid conditions. The climate is generally warm and dry except for rare and sporadic rainfalls during the winter, whereas few sprinklers may occur in spring.

1.1.1 Wind

The prevailing wind is mainly NNW all over the coast of the Red Sea, the winds from this direction are slightly more frequent in summer than in winter. Southerly winds blow during winter months only (Morcos, 1970). The prevailing wind direction creates a mainly NE-SW oriented wave motion, leading to distinct higher waves in the exposed areas rather than in the protected areas (e.g. bays). However, near the coast, the winds alternate daily between a nocturnal land breeze and a daytime sea breeze. This well developed daily pattern, based on energy transfer between land and sea, is caused by large diurnal differences in local heating (Flohn, 1969).

Generally, moderate NW-NNW winds dominate most of the year, which may change to SE for short periods (Figure 1). Such wind is strong enough to generate moderate water waves. The Khamasin (westerly wind) blows often in spring and autumn and is mostly hot and sandy.

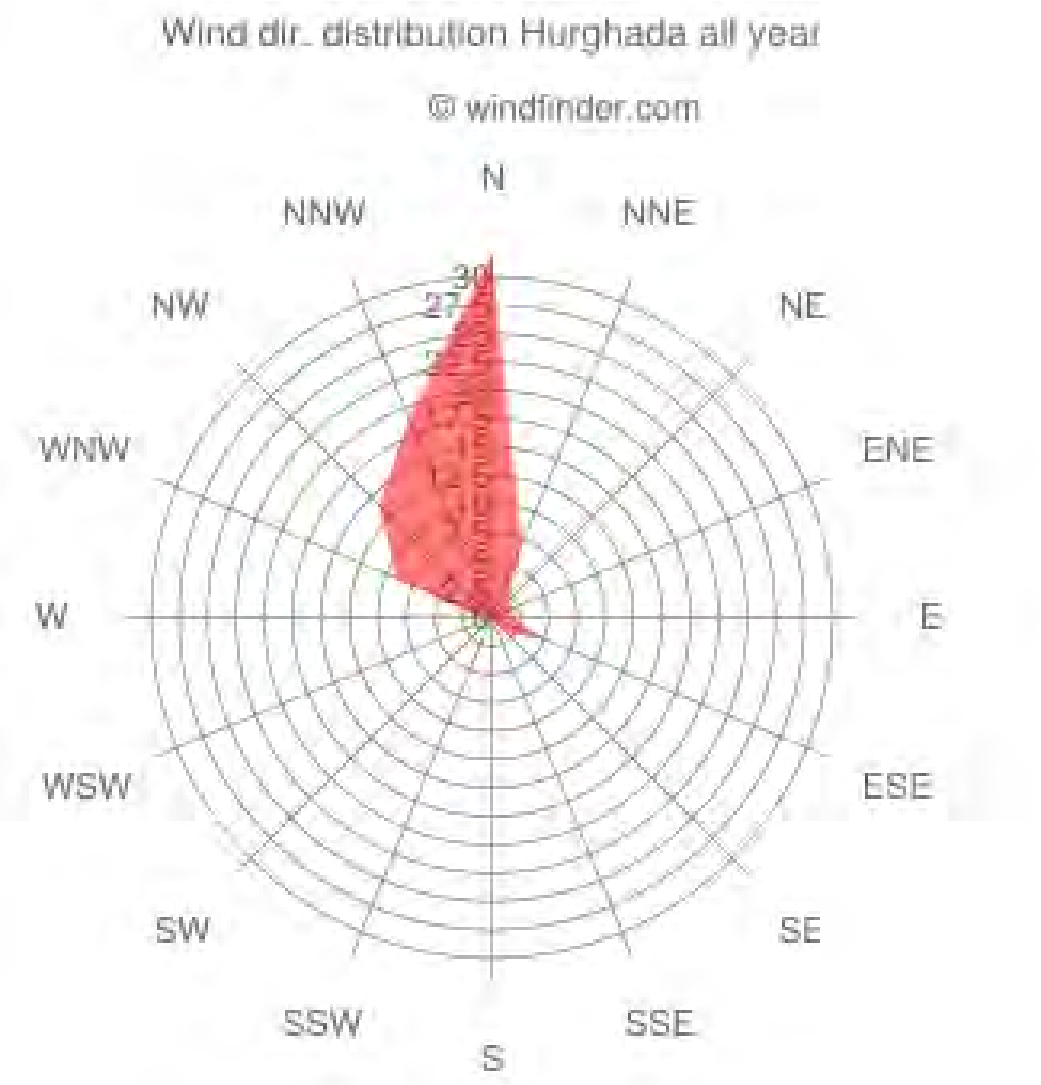


Figure 1: Wind direction Distribution (%), Hurghada, Egypt

Source: Windfinder.com (http://www.windfinder.com/) Statistics based on observations taken between 11/2000 - 10/2012 daily from 7am to 7pm local time.

During winter season at Hurghada, the wind speed varies between 7.0 and 17.9 Knots, affected by the land and sea breezes, while in spring season it varies between 6.9 and 20.2 Knots. Summer season has the maximum value (19.3 Knots) and decreases to about 8.2 Knots. During autumn, the diurnal wind speed fluctuates between 7.6 and 17.5 Knots (Figure 2).

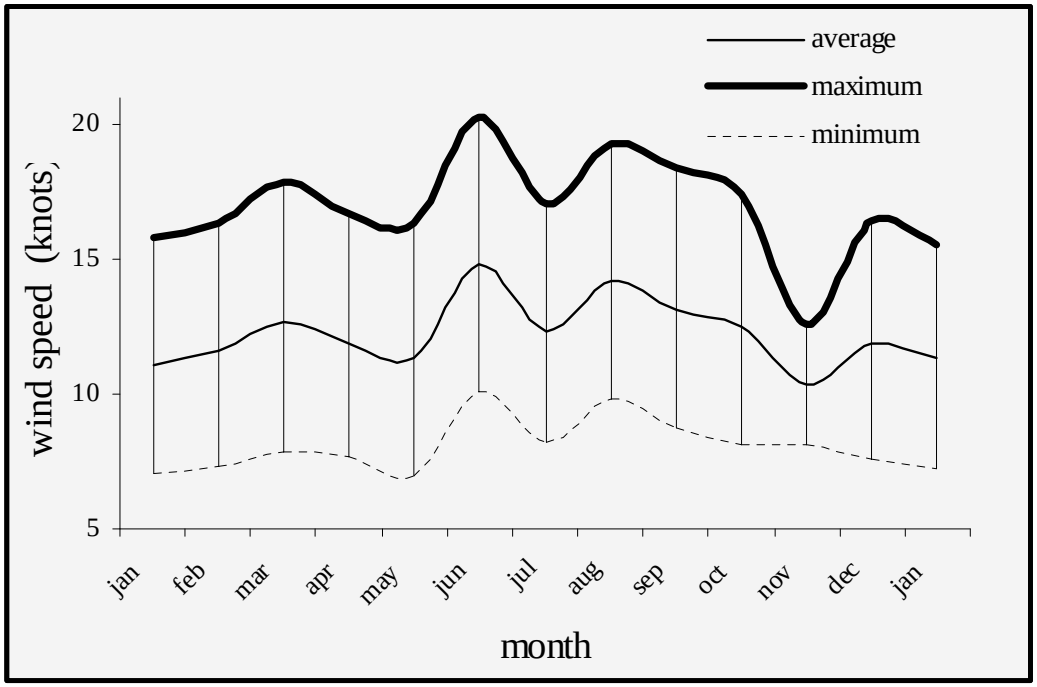


Figure 2: The maximum, minimum, and monthly average values of wind speed for the Red Sea Region (Environics 2008)

The Wind Rose (Figure 3) shows that the coast of Hurghada is influenced by winds with directions between the northerly and northwesterly directions (Saman, 2000).

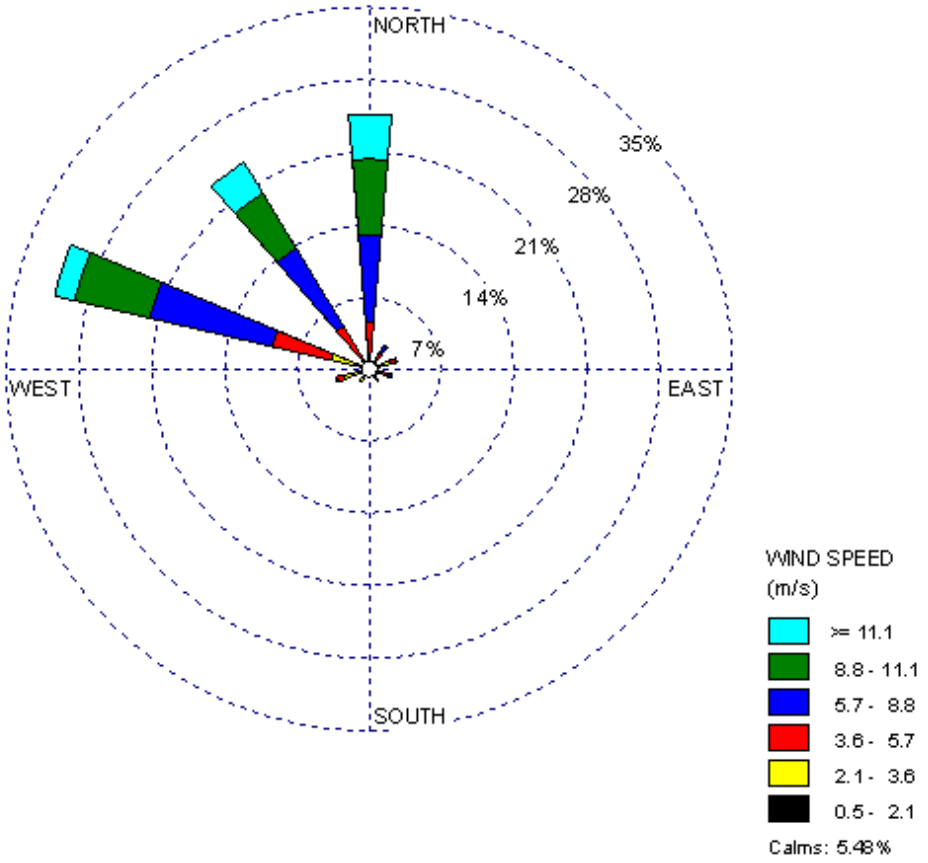


Figure 3: Wind rose (El Saman 2000)

1.1.2 Temperature

The coast of Red Sea is bordered by a vast area of desert or semi-desert. The temperature along the Red Sea is influenced by the expected high air temperature of the desert.

January is the coldest month, where it has the minimal air temperature throughout the year (about 14.8ºC), while August is the hottest month and the air temperature reaches its maximum value of about 31.7ºC.

The daily air temperature decreases throughout the winter and spring nights, while it increases during summer and autumn nights, affected by sea breeze.
Figure (4) shows the monthly distribution of maximum, minimum and monthly average air temperature in Hurghada from the Egyptian Meteorological Authority

Arab Repuplic of Egypt
Egyptian Meteorological Authority
Climate Depart

Date : 31/3 /2011
Req. NO. : 59
File NO. : 38

MONTHLY MEAN FOR SOME METEOROLOGICAL ELEMENTS
PERIOD FROM 1/1/2007 TO 31/12/2009

STATION : (EL HURGHADA)

▼METEOROLOGICAL ELEMENT/ MONTH►	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
MAXIMUM AIR TEMPERATURE (°C)	23.3	26.1	27.2	29.0	34.2	36.6	37.6	37.3	33.9	31.8	27.4	23.0	
MINIMUM AIR TEMPERATURE (°C)	10.8	12.0	14.9	18.0	23.8	26.5	28.1	27.5	25.0	22.7	16.8	13.5	
AMOUNT OF RAINFALL (MM / MONTH)	0.0	0.0	Trace	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2007
RELATIVE HUMIDITY (%)	52	46	42	41	35	31	35	39	46	50	47	49	
Wind Speed (knot)	13	10	13	13	11	15	11	14	16	12	11	13	
MAXIMUM AIR TEMPERATURE (°C)	20.2	22.1	28.7	31.1	33.1	37.1	36.8	37.9	35.7	30.5	27.4	24.2	
MINIMUM AIR TEMPERATURE (°C)	10.9	11.1	16.5	19.6	22.8	26.9	28.0	28.4	26.3	21.5	17.7	13.6	
AMOUNT OF RAINFALL (MM / MONTH)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2008
RELATIVE HUMIDITY (%)	50	46	39	36	32	28	37	35	40	51	51	55	
Wind Speed (knot	13	12	11	12	13	14	12	13	14	13	10	11	
MAXIMUM AIR TEMPERATURE (°C)	22.9	23.9	25.0	29.9	32.3	35.7	37.8	36.8	34.7	32.6	27.1	24.5	
MINIMUM AIR TEMPERATURE (°C)	11.3	12.4	14.0	18.9	22.2	26.5	28.3	27.7	25.2	22.1	17.2	13.1	
AMOUNT OF RAINFALL (MM / MONTH)	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2009
RELATIVE HUMIDITY (%)	48	42	44	36	35	31	35	38	44	54	53	51	
Wind Speed (knot	12	12	14	14	15	13	12	14	12	10	12	10	

REMARKS :-

Trace = AMOUNT OF RAINFALL < 0.1 mm .
Knot = 1.85 km / Hour .
This Data Actually from Registers (EL HURGHADA) Station and covering 50 Km. Area .
This Data Provided to (T E P S C O) as Requested on 24/3 / 2011.

PREPARED BY

HEAD OF DATA
31-3-2011

DIRECTOR OF CLIMATE DATA
31-3-2011

GENERAL DIRECTOR OF CLIMATE
31/3/2011

1.1.3 Rainfall

The closest rainfall station to the study area is Hurghada station. Statistical analysis was carried out for the rainfall data series of this station to get the maximum daily rainfalls for 5, 10, 25, 50, 100 and 500 year return period. Figure (12) shows the frequency analysis of Hurghada station using the different statistical distribution.

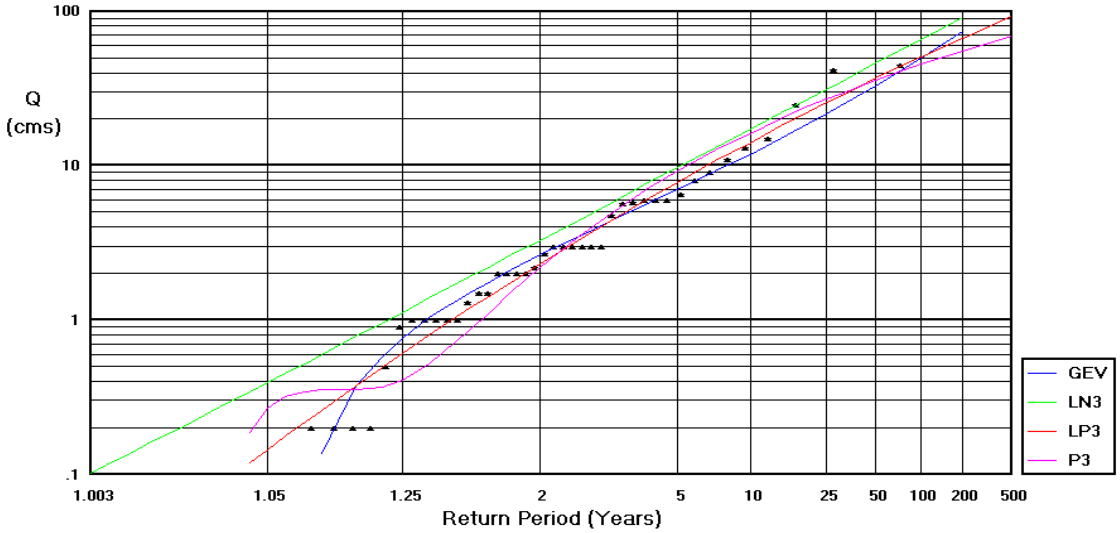


Figure 4: Rainfall Frequency Analysis of Hurghada Station

1.1.4 Global Solar Radiation

An accurate knowledge of solar radiation distribution at a particular geographical location is of vital importance for the development of many solar energy devices and for estimates of their performances. Global radiation is the total short-wave radiation from the sun falling onto a horizontal surface on the ground. It includes both the direct solar radiation and the diffuse radiation resulting from reflected or scattered sunlight.

JICA Study team has obtained the Monthly Data of Global and diffuse Solar Radiation at Hurghada from the Regional Radiation Centre in Hurhgada. Although the global radiation is being measured at the site.

1.1.5 Evaporation

The evaporation rate is generally high showing a maximum of 19.8cm/M in June and a minimum of 8.9cm/M in December (Table 2).

1.1.6 Relative Humidity

The average relative humidity ranges between 37 and 54% over the year (Table 2). It fluctuates up and down according to the air temperature and wind conditions.

The relative humidity pattern refers to the presence of two summits through the year in Hurghada during February, and November. The relative humidity varies between 44.4% during May and 67.4% during November (Figure 5).

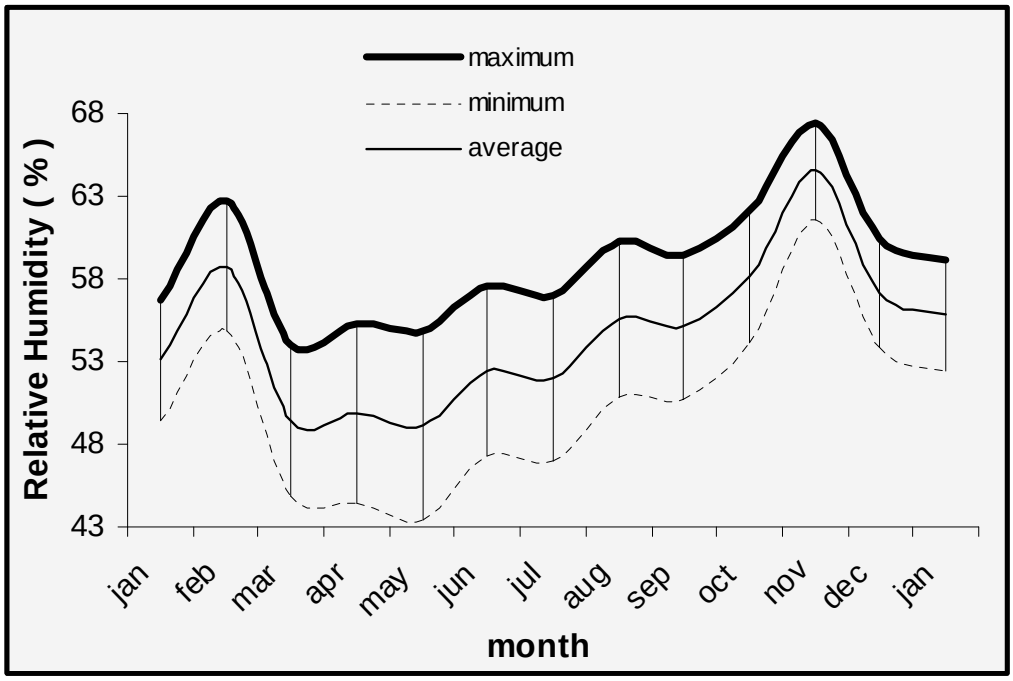


Figure 5: Maximum, minimum, and monthly averages of relative humidity over the Red Sea (Environics 2008)

1.1.7 Atmospheric Pressure

The region could be influenced by the west anticyclone of the high pressure existing on the Africa Continent and the westerly strong wind occurring occasionally by the depression moving to the east in the south region of Europe. The air pressure shows some changes over the year. It is low in summer with a minimum of 1004.9mb in July and high in winter with a maximum of 1017 mb in January (Table 2)

Table 2: Atmospheric Pressure, Relative Humidity and Evaporation rate during the year 2003

Month	Atmospheric Pressure (mb)	Relative humidity (%)	Evaporation Rate (cm)
January	1017.1	50	10.1
February	1014.9	49	8.4
March	1012.5	52	8.6
April	1010.2	53	9.9
May	1009.1	43	11.3
June	1006.2	43	13.0
July	1004.7	49	12.0
August	1005.1	46	12.1
September	1008.3	51	11.9
October	1011.7	58	8.6
November	1015.5	53	8.5
December	1017.4	48	7.3

1.2 Baseline Air Quality and Noise

The Central Laboratory of EEAA has been requested to carry out the baseline air quality and noise measurements at the project area. The baseline air quality and noise measurements were carried out on Tuesday October 4, 2011, on a one day visit to represent a typical working day. The measurements were carried out at the proposed Photovoltaic power plant site and three other locations upwind and downwind of the site as shown in figure (6).

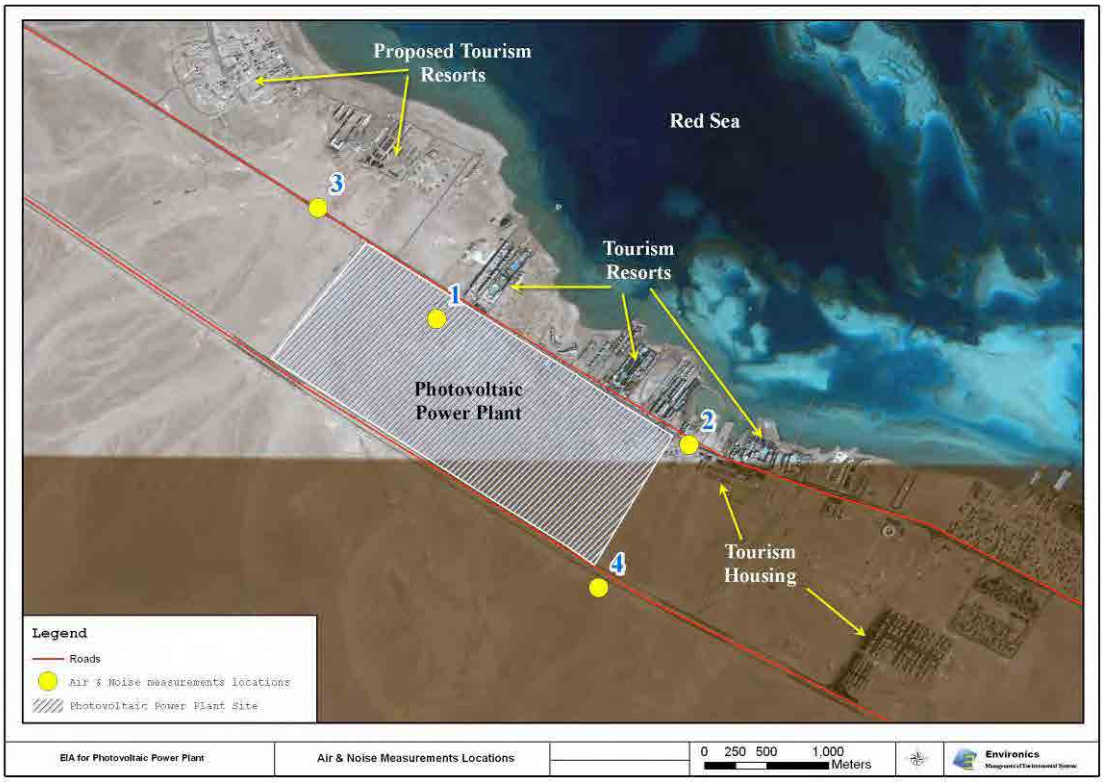


Figure 6: Air & Noise Ambient measurements locations

The selection of these measurement locations relied on many factors including the direction of prevailing winds as well as potential sources and receptors within the surrounding area. Moreover, the selected locations represent areas of different impacts and activities surrounding the proposed power plant location. Table (3) shows the geographical locations of the selected sites and their description,

Table 3: Measurement Locations

Location No.	Position	Description of the Location
1	27°18'55.24"N 33°42'14.00"E	Inside the site of the Photovoltaic Power Plant
2	27°18'22.52"N 33°43'19.83"E	Residential compounds with low traffic near the tourist resorts
3	27°19'24.16"N 33°41'43.18"E	Downwind measuring point (Roads)
4	27°17'45.23"N 33°42'56.24"E	Upwind measuring point (Roads)

1.2.1 Air Quality

- ***Methodology***

  Air quality measurements were taken for SO_2, NO_2, CO and PM10. Ambient air concentrations of NO_2, SO_2 and CO were measured using 205A Series Miran Sapphire portable air analyzer. Dust meter type Personal/DATARAM was used to detect PM10.

- ***Results***

  Results, shown in table 4, indicate that all baseline air measurements were complying with the maximum allowable limits of the executive regulations of the Law of Environment (4/1994) issued by the Prime Ministerial Decree No. (1095/2011). This is due to the fact that there is no source of air pollution in the project area and/or its vicinity. The area has been developed for tourist and urban purposes.

Table 4: Results of Air Quality Monitoring Survey

Location No.	Position	Description of the Location	PM_{10}		CO		NO_2		SO_2	
			Result	Limits of law 4/94	Result	Limits of law 4/94	Result	Limits of law 4/94	Result	Limits of law 4/94
1[1]	27°18'55.24"N 33°42'14.00"E	Inside the site of the Photovoltaic Power Plant	0.25 mg\m^3	3 mg\m^3	1.6 mg\m^3	30 mg\m^3	0.4 mg\m^3	5.6 mg\m^3	ND*	5.2 mg\m^3
2	27°18'22.52"N 33°43'19.83"E	Residential compounds with poor traffic near the tourist resorts	14.5 µg\m^3	150 µg\m^3	2.65 mg\m^3	30 mg\m^3	38.4 µg\m^3	400 µg\m^3	25.7 µg\m^3	350 µg\m^3

(1) Measurement site 1 is located inside the proposed site, therefore measurements for this specific location are compared with the working environment according to the law 4/1994.

Location No.	Position	Description of the Location	PM_{10}		CO		NO_2		SO_2	
			Result	Limits of law 4/94	Result	Limits of law 4/94	Result	Limits of law 4/94	Result	Limits of law 4/94
3	27°19'24.16"N 33°41'43.18"E	Downwind measuring point (Traffic area)	28.9 µg\m^3	150 µg\m^3	5.23 mg\m^3	30 mg\m^3	43.7 µg\m^3	400 µg\m^3	34.3 µg\m^3	350 µg\m^3
4	27°17'45.23"N 33°42'56.24"E	Upwind measuring point (Traffic area)	21.5 µg\m^3	150 µg\m^3	3.83 mg\m^3	30 mg\m^3	40.2 µg\m^3	400 µg\m^3	32.7 µg\m^3	350 µg\m^3

ND*: Not detected

1.2.2 Ambient Noise

- ***Methodology***

  Noise measurements presented in table (5) were carried out during different day and night times. Measurements of the ambient noise level were conducted using "Ono Sokki Noise meter type II".

Table 5: Results of Noise Monitoring Survey

Location No.	Position	Description of the Location	Measured Noise Level, dB(A)		
			Day Time 7 a.m.- 10p.m.	Night time 10 p.m. – 7 a.m.	Law 4/1994 limits
1	27°18'55.24"N 33°42'14.00"E	Inside the site of the Photovoltaic Power Plant	48.7	47.4	Industrial area 70
2	27°18'22.52"N 33°43'19.83"E	Residential compounds near the tourist resorts	43.8	43.2	Residential area 60
3	27°19'24.16"N 33°41'43.18"E	Downwind measuring point	47.3	46.3	Industrial area 70
4	27°17'45.23"N 33°42'56.24"E	Upwind measuring point	52.6	49.6	Industrial area 70

- ***Results***

  Results indicate that all baseline noise measurements were complying with the maximum allowable limits of the executive regulations of the Law of Environment (4/1994) issued by the Prime Ministerial Decree No. (1095/2011).

1.3 Geomorphology, Geology and Hydrology

1.3.1 Surface Topography and Geomorphology

The project area is located in Hurghada City, Red Sea. Geomorphologically, the Red sea is characterized by many features including terrestrial features such as hills and hummocks, dry wadis, wind abrasion, and costal features such as shelves, sharms, cliffs, bays, coral reefs, tidal flats, beaches, etc. The Relief analysis of the Red Sea indicates that the area could be divided into three main physiographic zones (Fig. 8), which generally are parallel to the direction of the Red Sea and each zone forming a unique geomorphologic unit.

These zones are: the coastal plain, the slopping terrain, and the high mountains. The following is a summary of the characterizations of each zone.

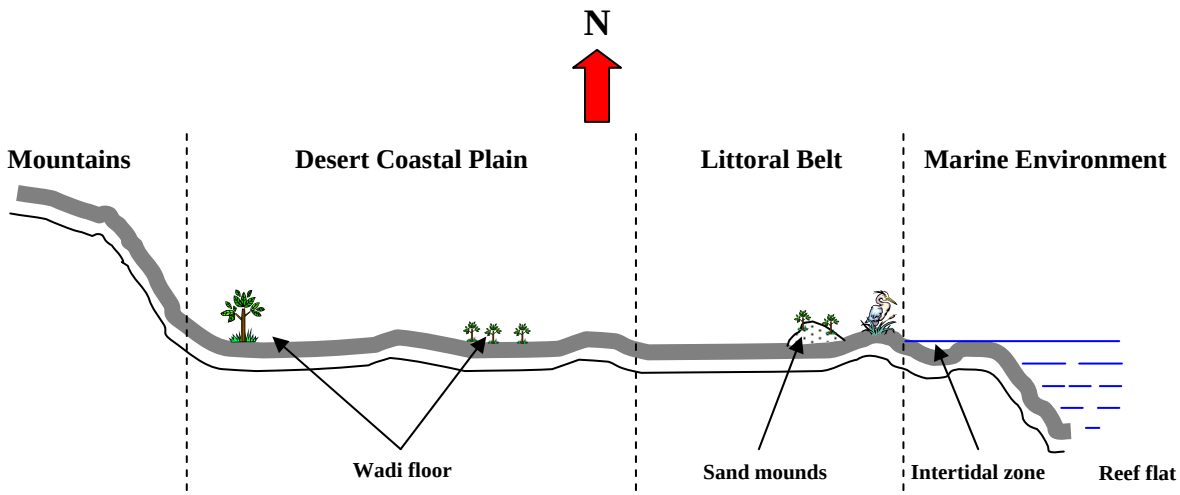


Figure 7: Cross Section Showing Eastern Desert Physiographic Zones

- **The coastal plain**
  The coastal plain is located to the east, directly adjacent to the Red Sea shores where most of the urban developments take place. The coastal plain forms a narrow strip of low-lying land between the shorelines of the Red Sea to the east and the Precambrian rocks in general to the west. It is occupied by Neogene[2] to Quaternary sediments. Extensive gravel deposits develop gently seaward sloping terraces terminating abruptly on the sea side. Miocene and recent sediments rise dominantly through the terraces in the form of hills and hummocks, sometimes coated with fossil reefs. Although, in Qusier and Safaga areas, strike slipping caused remarkable topographic complexity in which the pre-Miocene strata are preserved forming Gebel Duwi (Said, Rushdi 1990).

- **The slopping terrain**
  This zone is located generally in between the highly mountainous zone to the west, and the coastal plain to the east. This zone generally forms a moderately sloping terrain starting at the foothills of the high mountains, and sloping moderately towards the coast. The zone consists of moderate relief masses of granodiorites, weathered granitic masses e.g. G. Kadbora in the central part, together with some schists, phyllites of moderate to low relief.

(2) The Neogene is a geologic period and system in the International Commission on Stratigraphy (ICS) Geologic Timescale starting 23.03 ± 0.05 million years ago and ending 2.588 million years ago.

- **The Highly Mountainous Zone**
  This zone is characterized by the Red Sea high mountainous range, and presents deeply incised and rugged terrain, with summit elevations generally ranging up to almost 1000 m. above Sea level, and sometimes exceeding 1500 m. Examples include Gebel Dukhan 1705 m, G. Qattar 1963 m and G. Shayeb El banat 2187 m, which are all in the Northern Red Sea.

  Another distinct feature of this zone is that all wadis draining to the Red Sea originate in this zone and forming the main watershed of the region at its western limit. Metavolcanics and related rocks, together with gneisses, metagabbros and serpentinites constitute the main rock types, which belong to the Precambrian.

1.3.2 Regional Lithology

The Red Sea is part of the Eastern Desert, which is mainly characterized by basement rocks represented by the Red Sea Mountains. However, the coastal plain, low-lying lands and wadis, as being parts of the different depositional basins, include sediments and sedimentary units which belong in general to Tertiary and Quaternary.

The sedimentary rocks of the area could be divided into to main groups: pre-rifting Cretaceous-Eocene group, and post-rifting Oligocene and later sediment groups (Said, Rushdi 1990). The review of available literature points out to the following:

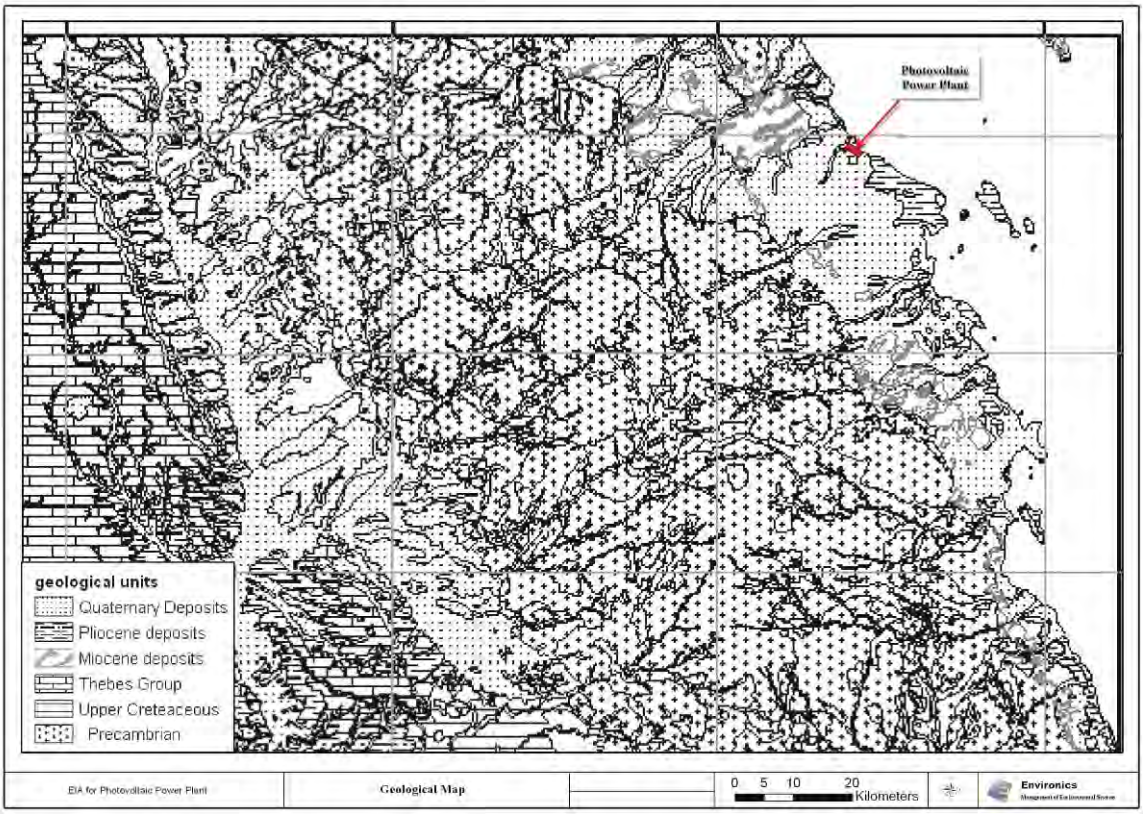


Figure 8: Regional Geologic Map of the Area Showing the Project Location (Modified from Youssef, A. M., and Hegab, M. A. 2007)

Miocene and later sediments form a strip along the coast of the Red Sea. They are essentially littoral in character exhibiting marked lithological changes laterally and vertically. In addition, they rest unconformably with a depositional dip on older rocks forming angular unconformity. Beds of Miocene and later sediments fall into the units shown below, of which evaporates are the most important and conspicuous, both topographically and geologically:

- Reefs and raised beaches — Pleistocene
- Shagra Formation — Pliocene
- Gabir Formation
- Samh Formation
- Um Gheig Formation
- Abu Dabbab Formation — Miocene
- Um Mahara Formation
- Ranga Formation

1. **Ranga Formation**. The Ranga overlies unconformably the older sediments. The lowermost bed is a polymictic conglomerate derived mainly from the basement with rounded to angular clastics that range in size from granules to boulders (up to one m in diameter). The basal conglomerate bed ranges in thickness from 8 to 16 m. It is followed upward by a long series of fine to medium-grained sandstones of varying colors and minor shale beds.

2. **Um Mahara Formation**. The Um Mahara rests unconformably over the Range from which it is separated by a thin conglomerate bed. It is made up of a lower sandy limestone member and an upper gypsiferous fossiliferous limestone member. The beds are massive, partly dolomitic, and many form reefs.

3. **Abu Dabbab Formation**. (Evaporite series). Evaporite deposits extend for hundreds of kilometres along the costal plain of the Red Sea. Their distribution is patchy and their thickness varies from one place to another being in the range of 90 to 400 m in the onshore areas. An excess of about 300 meters of rock salt, equivalent to the onshore gypsum and anhydrites, was penetrated in the offshore wells.

4. **Um Gheig Formation**. Overlying the Abu Dabbab is a characteristic 8 to 10 m thick, hard, ledgeforming dolomite bed. The bed is a grainstone (mud-free carbonate rock). This unit is frequently referred to in the literature as the oil-tainted limestone; the rock when fractured emits an odor of petroleum.

5. **Samh Formation**. The Samh overlies unconformably the Abu Dabbab Formation or the Um Gheig bed. It is made up of a lower 5 m thick green to grey shale and fine-grained variegated sandstones, middle 2 m-thick escarpment maker bed of hard stone and an upper 15 to 20 m-thick limestone bed with occasional conglomerates. The limestones are recrystallined and form the bulk of the formation.

6. **Gabir Formation**. (Oyster and cast beds). The Gabir overlies the Samh with seeming conformity. Unit made up mainly of sandstone which is overlain conformably by the lower member of the overlying Shagra Formation. It is made up of a lower 44 m-thick succession of sand stones (80%) and an upper 80 m-thick unit of sandstone (40%), marls (29%), reefal limestones (10%), calcareous grits and gravel beds. Many beds are rich in casts of molluscas.

7. **Shagra Formation**. The Gabir is followed unconformably by a succession of littoral deposits containing mainly arkosic sandstones and minor marls, and is assigned to the Pliocene. The thickness of this formation is 22 m.

8. **Pleistocene reefs and raised beaches**, a 34 m section made up of a succession of four organic reefs separated by conglomerate and gravel beds. Several raised beaches skirt the coast. Three levels are recorded which may belong to the reef complexes; 1m, 7m, and 11 meters beaches.

1.3.3 Local Lithology

The project area is located within the geological province of the Northern Red Sea, where Tertiary representing by Oligocene and later sediment groups dominates in higher lands. On the other hand, Quaternary sediments cover low-laying lands and wadis. The sequence of sedimentary rocks is composed of a thick succession of sandstone, shale, limestone and evaporites unconformably overlying the igneous and metamorphic rocks. These sediments are represented by Miocene sediments, Pleistocene sediments and Quaternary deposits (Q).

Because of the nature of the project area as low-laying lands, sands and gravels dominate on the surface constituting the soil layer with considerable thickness occur in the form of alluvial fans. These are derived directly from the disintegration of the surrounding rocks. When land topography is evayed in some points, tertiary could outcrop. Figure (10) shows a geologic map of the project location demonstrating that the area is covered by quaternary deposit of recent sediments.

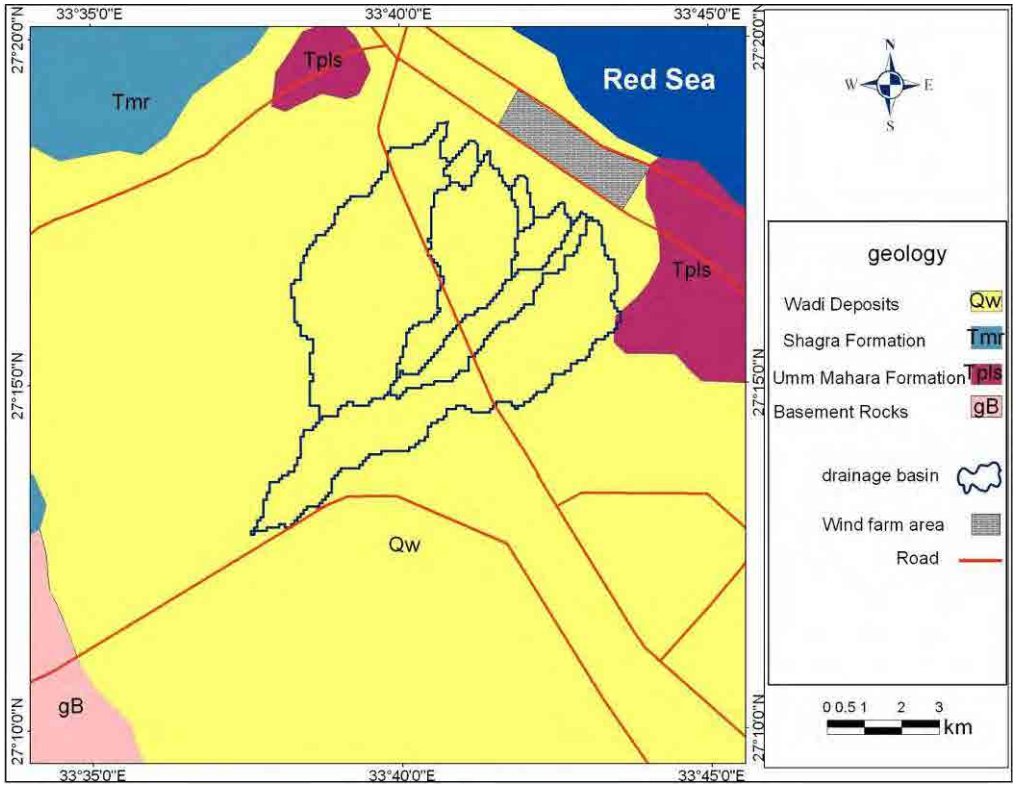


Figure 9: Local Geologic Map of the Project Area (Computer-generated using data from literature)

1.3.4 Regional structure

The distribution and disposition of the sediments along the Red Sea coastal strip points out that the rifting of the Red sea began directly after the deposition of the early Eocene strata, and has continued with episodic intensity since that time. From the time of the first faulting until the beginning of the middle Miocene, only non-marine sediments were deposited. This indicates that the earliest trough must have been perched and must have had no access to the sea.

The oldest of these sediments is the Nakheil, a lacustrine deposit with many interbedded gravity breccias, the clasts of which are of local derivation and include no Precambrian pebbles. This deposit seems to have filled the valleys and troughs of this emerging landscape. Subsequent erosion truncated the majority of the sedimentary cover, which is now known only in a few of the infolded and faulted hills of the Qusier-Safaga area. In fact, similar sediments to those which make up these hills must have covered the entire Red Sea range. Since none of these early sediments is recorded in any of the wells hitherto drilled in the offshore areas of the north Red Sea, it is believed that immediately after the accumulation of the Nakhiel formation intensive erosion must have occurred, transporting these sediments away from the Red Sea basin.

Oceanographically, the Red Sea is considered as a typical example of an embryo ocean that is being developed. The revolution of the Red Sea, an on-going process, is mainly due to structural movements of the earth's tectonic plates by which the Arabian plate is spreading apart from the African one. This has given rise to the formation of the Great Rift Valley. Numerous studies discuss the Red Sea evolution as a key for understanding continental rifting and the initiation of sea floor spreading.

The Red Sea rift system was formed in the late Oligocene- Early Miocene in response to the NE separation of Arabia away from Africa. In the late Miocene, continued opening of the Red Sea was linked to sinistral offset along the Gulf of Aqaba Levant Transform.

Because of these mass tectonic movements, in addition to uplifting forces, the coastal plain has been formed and shaped forming huge horst system of mostly normal faulting dipping in a direction parallel to the Red Sea basin.

1.3.5 Hydrology and Hydrogeology

Collected data were analyzed and used to provide a characterization of the groundwater and surface water resources in the area. Maps were developed to better illustrate the different hydrological issues.

1.3.5.1 Hydrology (Surface water)

a. Surface Water Conditions

The Red Sea area is subject to seasonal catastrophic flash floods which were characterized by their high velocity and low duration with a sharp discharge peak. The recorded history indicated the occurrence of significant flash floods that affect the coastal areas along the Red Sea as shown in Table (6). These floods threaten activities that have been established in the main streams and the outlet of the catchments.

Table 6: Flash Floods Historical Records along the Coastal Areas of the Red Sea

Date	Area	Reference	Notes
17-18 January 2010	Along the Red Sea	Water Resources Research Institute (WRRI)	The flood in Hurghada city recorded by WRRI team. Water depth reached about 30 cm in the streets.
May 1997	Safaga and El Qusier	- Information and Decision Support Center in Red Sea	
November 1996	Hurghada and Marsa Alam		

Date	Area	Reference	Notes
November 1994	Safaga and El Qusier	Governorate, 2009. - The National Authority for Remote Sensing and Space Sciences (NARSS)- Red Sea Governorate, 1997.	
August 1991	Marsa Alam	- Reports of Red Sea Governorate, 1994. - Red Sea Environmental Profile 2008	
20 October 1990	Wadi El Gemal between Marsa Alam and Shalateen		
23 October 1979	Marsa Alam and El Qusier		

b. Topography and Digital Elevation Model

Topographic maps that cover the study area have been collected and analyzed. A topographic map of scale 1:50,000 was used to create the Digital Elevation Model (DEM) for study area. Geographic Information System (GIS) has been used to convert the topographic maps, with a suitable scale, to digital maps using the information of the Spot Heights (SH) and the Digital Elevation Model (DEM).

According to the data availability for the study area, DEM 30-meter is used to produce hydrographic features required for hydrologic model. However, for the hydrologic modeling purposes, different hydrographic features preformed using DEMs are examined using topographic maps and satellite images to check their accuracy in representing the reality. Figure (11) shows the DEM of the study area where the study area is located in the low land with elevation less than 25 meters above sea level.

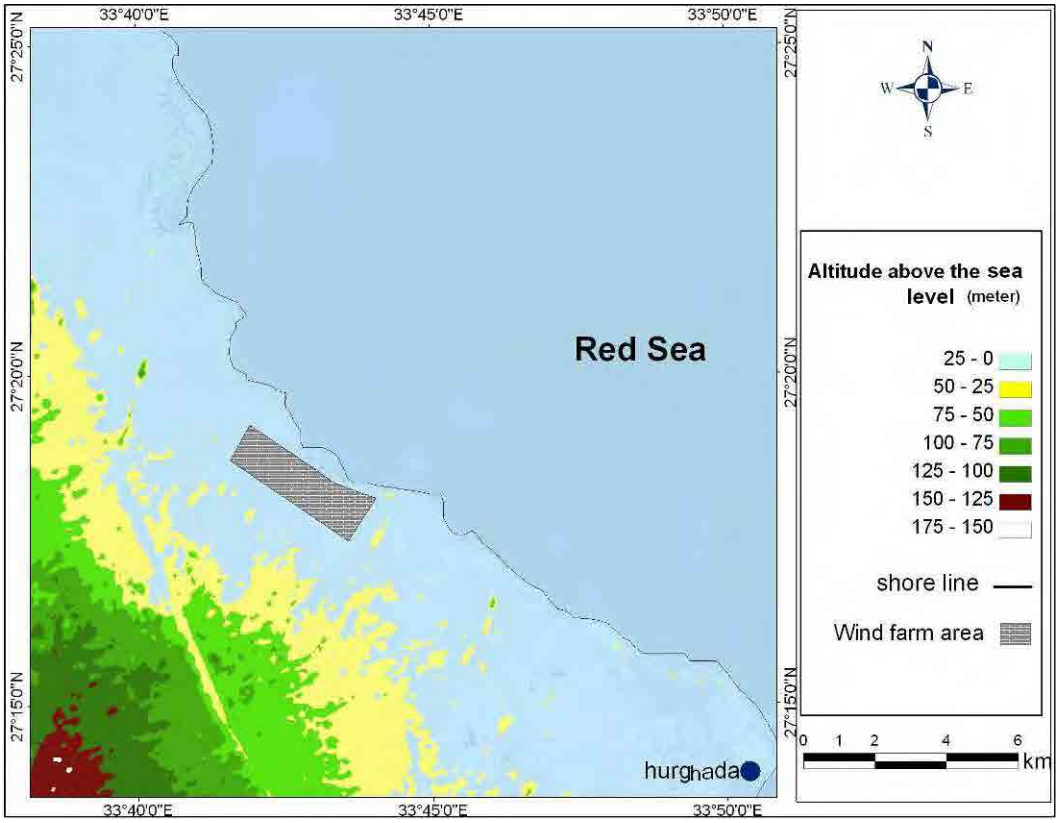


Figure 10: Digital Elevation Model (DEM) of the Study Area

c. Modeling of flash floods

The application of the Watershed Molding Simulation (WMS) model, developed by Brigham Young University - USA (2005), is used to identify the watersheds affecting the photovoltaic power plant and surroundings area. Starting from the Digital Elevation Model (DEM) of the area, the WMS model is used to delineate the boundary of the drainage basins. Figure (12) shows the basins affecting the photovoltaic power plant area. Once boundaries have been created, geometric attributes such as area, slope and runoff distances are computed automatically. The following subsections illustrate the hydrological analysis such as morphology, meteorology and rainfall losses. These data are required to assess the impact of the flash floods on the study area.

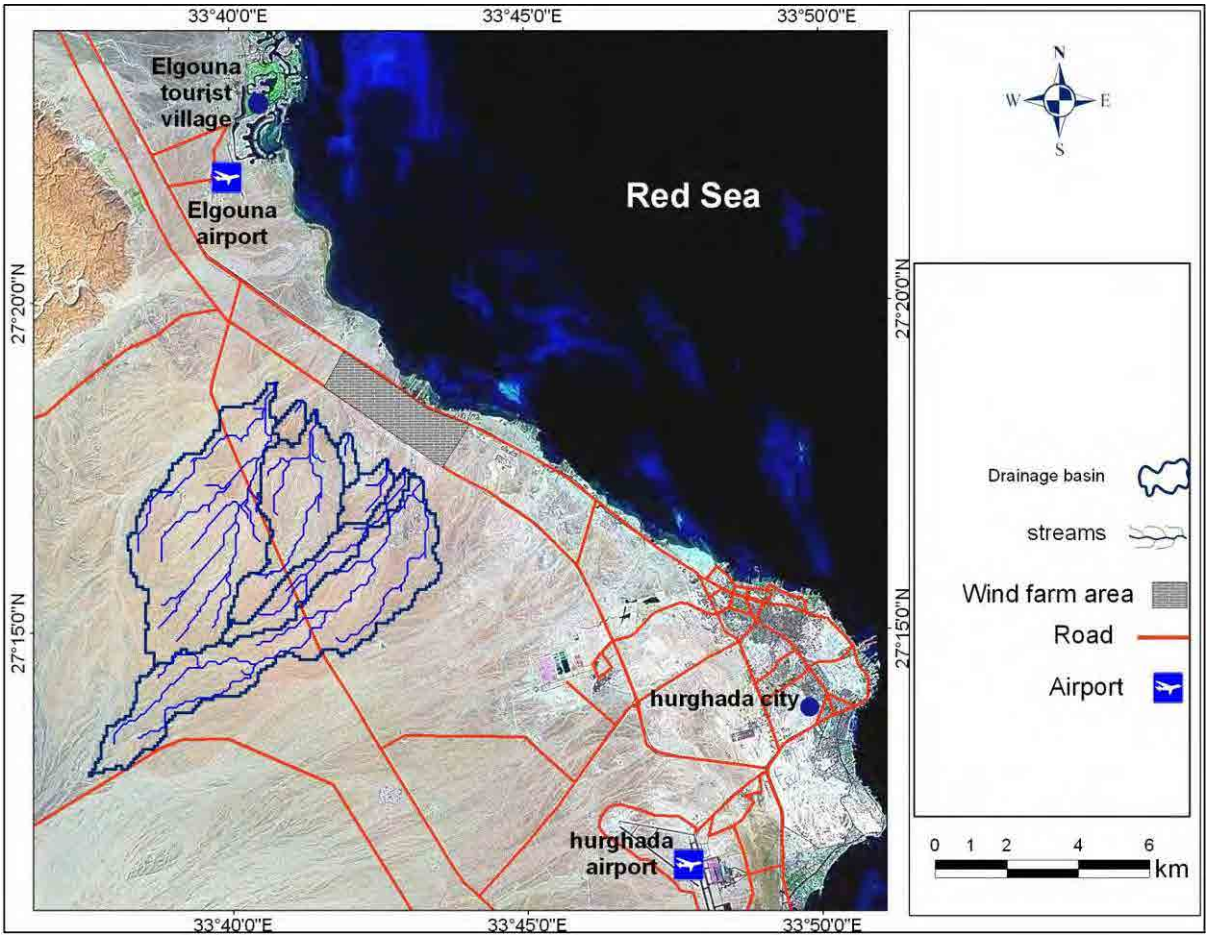


Figure 11: Drainage Basins Affecting the Photovoltaic Power Plant and Surroundings

- ***Morphological Analysis***
  The morphological analysis is concerned with the determination of the physical characteristics of the selected basin. The basin characteristics include lengths, areas, and slopes, etc... This analysis is done using the information of the Digital Elevation Model (DEM) through the (WMS) model. Furthermore, the morphological analysis is concerned with the determination of the unit hydrograph parameters such as the Lag time (Lag), Concentration Time (TC), and Storage Coefficient (R) as shown in Table (7).

Table 7: General morphologic characteristics of the basins

Wadi ID	Area (km^2)	Length (km)	Lag Time[3] (hr)	Concentration Time [4] (hr)	Storage Coefficient [5] (R)
W1	18.9	8.6	1.80	2.88	0.88
W2	0.72	1.3	0.39	0.62	0.22
W3	8.7	6.5	1.38	2.2	0.83
W4	0.6	1.4	0.48	0.77	0.34
W5	1.7	2.4	0.71	1.14	0.47
W6	4.2	7.0	1.54	2.47	1.48
W7	18.1	12.4	2.21	3.53	1.58

- ***Hydrologic Analysis***

With the absence of the runoff hydrographs measurements in the study area, synthetic unit hydrograph methods are used, instead, to calculate the characteristics of the surface runoff. The synthetic unit hydrograph is based on a dimensionless unit hydrograph developed from an analysis of a large number of unit hydrographs. In this method, the discharge is expressed by the ratio of discharge "Q" to peak discharge "Qp" while the time is expressed by the ratio of time "T" to the time of rise of the unit hydrograph "Tp". The peak flow and the time to peak are computed using the following equations:

Peak Discharge

$$Q_{peak} = 484 \times \frac{A}{T_b} \qquad (5)$$

Where:

Q_p = Peak flow of Unit hydrograph (cfs);

A = Basin area (mi^2);

T_b = Time of base of the unit hydrograph.

The time to peak is given by:

[3] Lag time is defined as the time from the centroid of rainfall excess to the time of peak runoff for a watershed

[4] The time required for runoff to become established and flow from the hydraulically most remote part of the drainage area to the point under design

[5] The storage coefficient, is defined as the time difference between centers of mass of rainfall excess and direct runoff.

$$T_p = 0.5 \times \Delta t + Lag \quad (6)$$

Where:

T_p = Time to peak of U.H (hr);

Δt = Duration of rainfall excess or computation interval (hr);

Lag = Basin lag (hr).

In order to obtain the hydrograph for each catchment for the different return periods, the HEC-1 model is used. This model is developed by the U.S. Army Corps of Engineers. Figures (13) and (14) show the basin hydrograph for 100 and 200 year return periods while Table (8) shows a summary of these results.

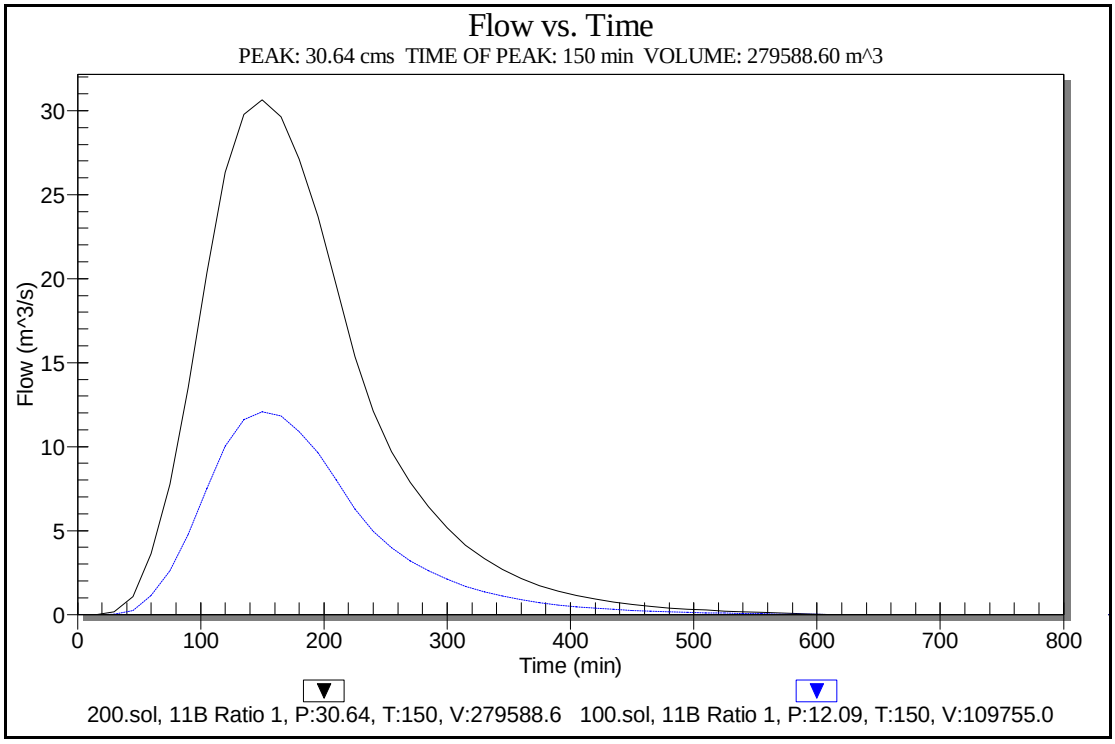


Figure 12: Flood Hydrographs of W1

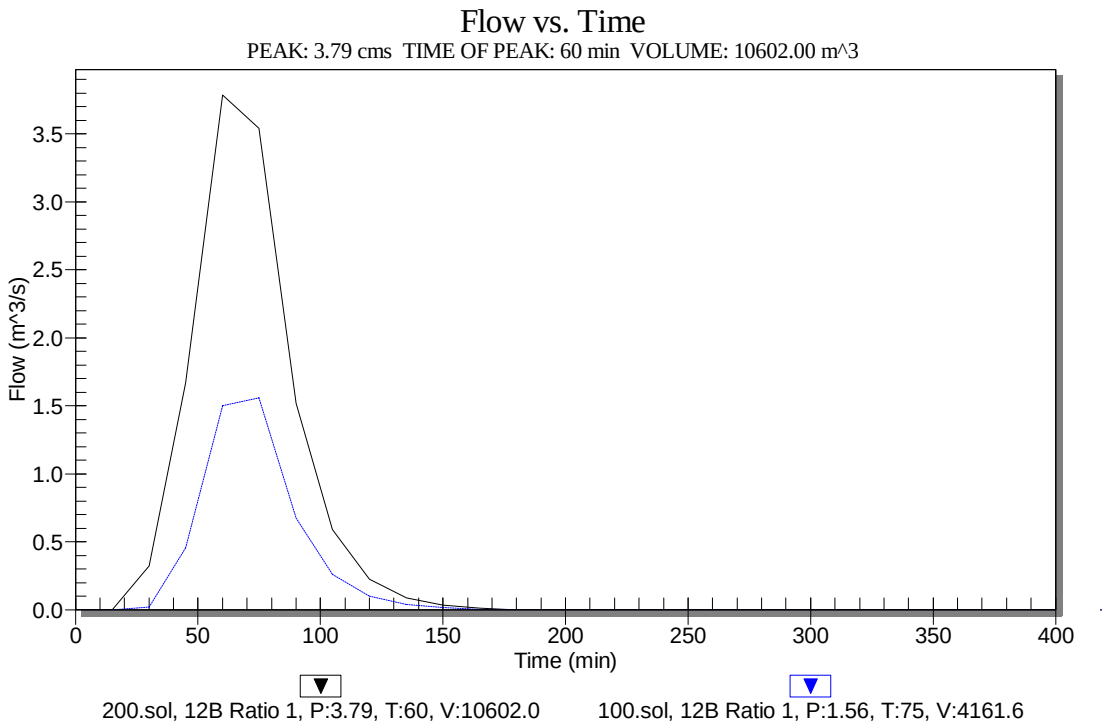


Figure 13: Flood Hydrographs of W2

Table 8: Summary of the hydrologic analysis

Wadi ID	Peak Discharge (m^3/s)		Volume (1000 m^3)		Time to peak (min)
	100-Year	200-Year	100-Year	200-Year	
W1	12.1	30.6	109.8	279.6	150
W2	1.6	3.8	4.2	10.6	60
W3	7.3	18.5	50.5	128.7	120
W4	1.2	2.9	3.3	8.4	75
W5	2.5	6.1	9.7	24.6	90
W6	3.1	7.9	24.2	61.6	135
W7	9.3	23.7	105.3	268.3	180

The results of the hydrologic analysis for the 100 year return period showed that the maximum runoff occurs from W1 with a total discharge of 12.1 m3/s and runoff volume of 109,755 m3. On the other hand, the minimum runoff occurs from W4 with a total discharge of 1.2 m3/s and runoff volume of 3313 m3.

In this respect, is important to point out that from the hydrologic point of view, it is considered that all the wadis affect the project area. In order, to identify the specific flow direction and its intersection with

the project area, comprehensive topographic surveys are to be carried out.

d. Flood Hazard

To determine the possible impact of the flash floods on the study area, the flood risk and the flood intensity mapping were developed.

- ***Mapping of flood risk***

  Probability rating of flooding in each basin is done by considering certain causative factors. The causative factors taken into account for this study include: maximum daily rainfall, side slopes of watershed, type of soil and land use. Then the flood risk map is reclassified into four classes: very high, high, moderate and low as shown in Figure (15). According to Figure (15), the flood risk is moderate from all basins.

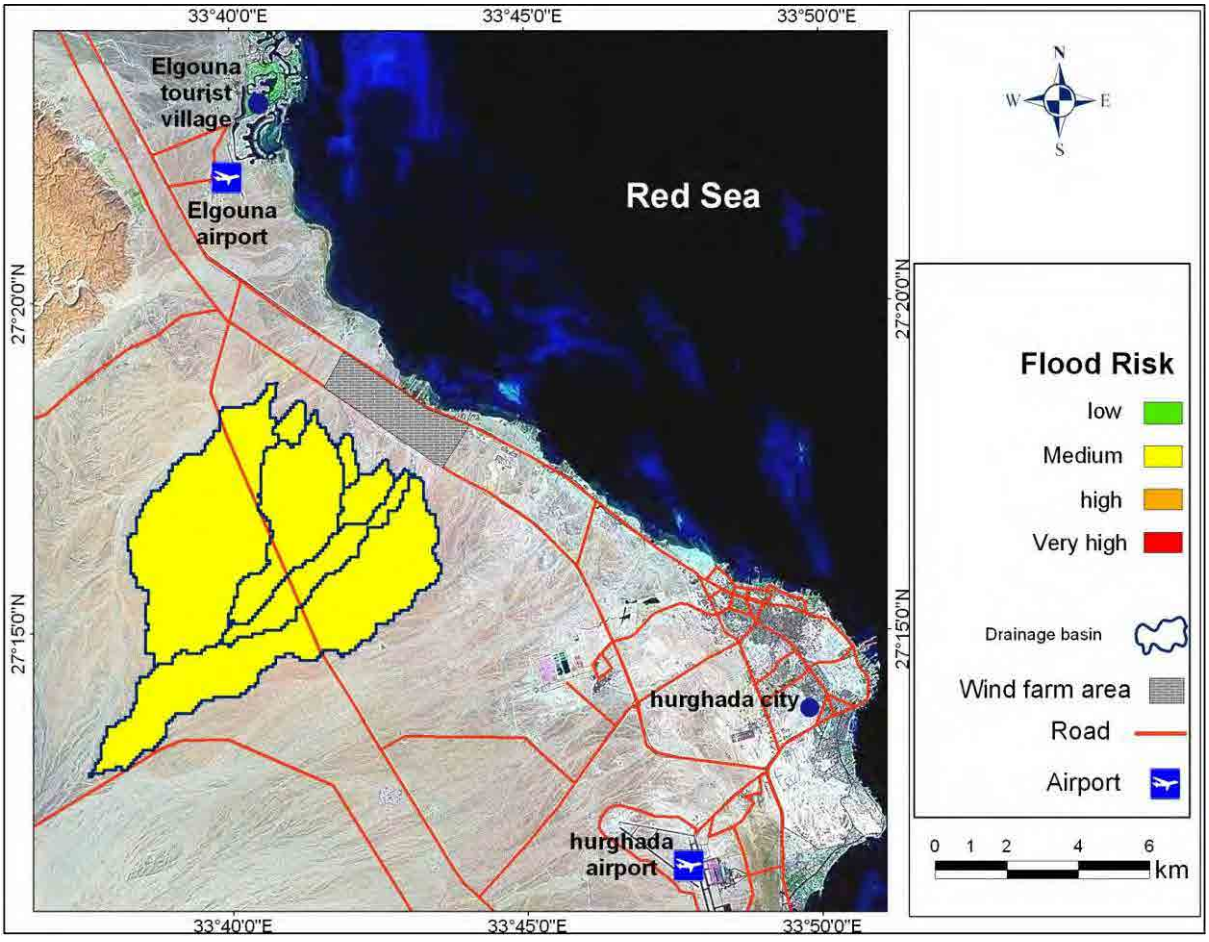


Figure 14: Flood Risk Map for the Study Area

- ***Mapping of flood intensity***

  The hazard level is estimated as a function of two readily available parameters from the hydraulic model; flood depth and flow velocity.

  Flood Intensity = flood depth * flow velocity

  Flood intensity map is reclassified into four classes: very high, high, moderate and low as shown in Figure (16). According to Figure (16), the flood intensity is low for all streams. It is worth to mention that the low flood intensity doesn't mean that the study area is safe against flash floods. Therefore, flood protection structures should be implemented with further detailed investigation. These include the following:

  - Details of the Current land use;
  - Detailed topographic survey to identify the ground surface elevation and hence to determine the flow direction in relation to the project area;
  - Construct topographic cross sections in the vicinity of the project area to calculate the water depth and water velocity (flood intensity) at the project site;
  - Based on the land use and the flood intensity, the appropriate flood protection structures will be identified to minimize the impact on the project site as well as the surrounding environment.

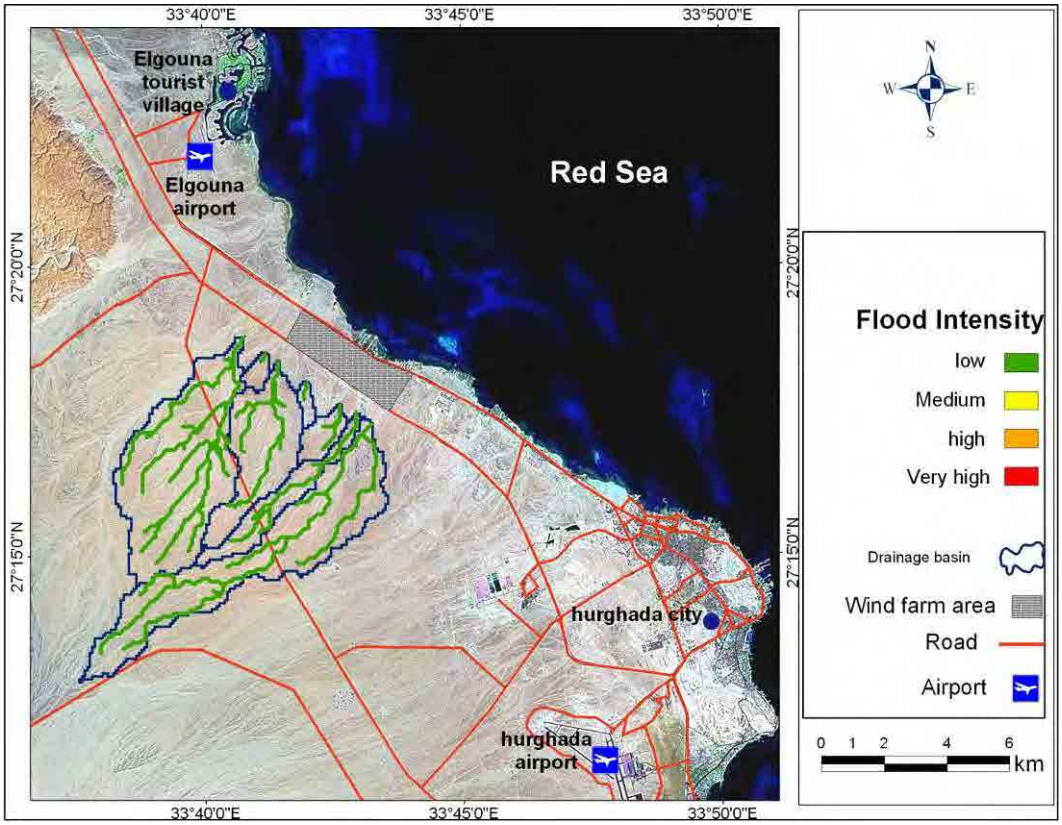


Figure 15: Flood Intensity Map for the Study Area

- ***Conclusion***

  The hydrologic analysis indicated that the study area is probably affected by flash floods from a series of active wadis. The maximum daily rainfall might reach 70 mm for the 100-year return period. This rainfall causes runoff from the different sub basin. The maximum runoff occurs from basin W1 with a discharge rate of 12.1 m3/s and a total runoff volume of 109755 m3. The flood risk from the basins is moderate while the flood intensity is low.

1.3.5.2 Hydrogeological Units

The drilling of the deep oil boreholes in the Eastern Desert and along the Red Sea revealed that there are ten distinct hydrogeologic units classified as aquifers, aquicludes and aquitards. The idealized hydrogeological columnar section is shown in Figure (17).

- ***The Basement Rocks***

  The igneous and metamorphic basement rocks crop out at the western part of the study area where they represent the main catchment areas and watersheds. They are highly weathered and strongly fractured, jointed and faulted. Such structural features permit the accumulation and movement of the ground water. Most of the hand dug wells in the Eastern Desert are drilled on the fault planes and fractures lineament. The replenishment of those wells depends on the fracture depth at the well location, fracture width and its extension. Due to the limited rainfall in the study area, the annual water storage in these wells is limited for drinking purposes for both human and livestock. Water salinity increases and attains its maximum level before the beginning of the next rainfall events. Hydrogeologists proved that most of the natural springs in the Eastern Desert are structurally controlled. Some other springs are formed along the regional fault planes where water from the deep Nubia faciese aquifer is moving upward along the fault plane. Such springs are not affected directly by the recharge from the surface runoff or the direct precipitation.

Thickness (m)	Log	Description	Age assignment of Hydrogeologic units	Water Quality	Water Geneses and Type
		Detritus, sands, pebble	Quaternary aquifer	fresh	meteoric
224-234		Conglomerate sands and coral limestone.	Upper Miocene-Pliocene aquifer		
50-100		Gypsum, marls and shale.	The aquifuge of Middle Miocene Sediments		
193		Sandstone, Conglomerate and Shale	Middle Miocene aquifer	Slightly Brackish	Meteoric Na_2 So_4
20-80		Conglomerate, sandstone and shale.	Oligocene aquifer	Brackish	Marine Mg Cl_2
133		Limestone and chert bands	The aquitard of Lower Eocene limestone.		
300		Shale, Chalk and Marls	The aquiclude of Upper Cretaceous-Paleocene Sediments.		
136-400		Shale, siltstone, limestone and Phosphate beds.	The aquitard of Upper Cretaceous sediments.	Highly Saline	Marine Mg Cl_2 or Ca Cl_2
70-229		Sandstone	Sandstone aquifer with Nubia facies.	Saline	Marine Ca Cl_2
		Igneous and Metamorphic rocks	Fissure Collectors	Saline	Marine Ca Cl_2

Figure 16: Idealized hydrogeological columnar section in the study area (Environics 2006)

- ***Sandstone Aquifer of Nubia Facies***
  The sandstone aquifer of the Nubia Facies is composed of medium to coarse grains. The sandstone is well sorted and the grain shape ranges from sub-rounded to sub-angular, reflecting a good porosity and permeability of this aquifer. The aquifer thickness varies from 70 meters to 229 at the low hills. The water quality of the aquifer is saline and not suitable for direct use. The aquifer is recharged from the high mountains in the West, which act as the main catchment area for the first order hydrogeological basin. Moreover, the sedimentary hills, which constitute the second order hydrogeological basins, serve as

local recharge area. The discharge area for this aquifer is mainly restricted to fault planes located at the east or through the upward leakage to the upper hydrogeological units under high water pressure.

- ***The Aquitard of Upper Cretaceous Sediments***
  This aquitard includes the Quseir and Duwi Formations. Those two formations are composed of limestone, phosphates, and shale and sandstone beds. The thickness of this layer varies from 136 m to 400 m. Local recharges from the sedimentary hills, as well as, upward leakage from the deeper sandstone aquifer prevail. This aquifer is of low transmissivity and the water salinity is very high.

- ***The Aquiclude of Upper Cretaceous—Paleocene Sediments***
  This aquiclude includes the Dakhla shale, Tarawarn Chalk and Esna shale formations. The thickness of this layer is 300 m and crops out along the extension of the second order hydrogeological basins. The hydrogeologic characteristics of this formation reveal a high porosity and very low hydraulic conductivity values. This formation therefore acts as a confining layer between the deeper sandstone aquifer and the overlying aquifer units. In addition, there is no groundwater potential in this formation.

- ***The Aquitard of the Lower Eocene Limestone***
  This aquitard is composed of dolomitic limestone and chert bands of the Thebes Formation and attains about 133 meters in thickness. The Thebes Formation represents itself as an unconformity surface, denoting for an interval of none marine deposition and prevalence of weathering under continental environment. Hence, the permeability of limestone increased. The aquitard of the Lower Eocene limestone crops out at the top of the second order hydrogeological basins. It is recharged by direct rainfall, as well as from the deeper aquifers along Fault planes.

- ***Oligocene Aquifer***
  This aquifer is composed of conglomerate, limestone, clays and sandstones. The conglomerates are in the pebble size and the sandstones are very coarse. The conglomerate porosity ranges from 20% to 30% and that of the sandstone from 25% to 35%. Consequently, the aquifer permeability has the ability to store and transmit water with economic quantities. The thickness of this aquifer varies from 20 to 80 meters of the second order hydrogeological basins. The aquifer is recharged through direct rainfall, the fissured aquitard limestone and from deeper aquifers through fault planes. Water quality is of marine origin and salinity is high.

- ***Middle Miocene Aquifer***
  The Middle Miocene aquifer is composed of conglomerate at the base, overlain by sandstones and shale with good porosity and permeability.

The outcrops of this aquifer extend along the Red Sea coast with an average thickness of 193 m at wadi Esel. It is recharged from the catchement area of the first order hydrogeological basin, while the discharge area is located along the Red Sea coast in the East. The low water salinity of this aquifer proves that this aquifer is mainly recharged during the torrent floods.

- ***The Aquifuge of the Middle Miocene Sediments***
  This layer is composed of gypsum, marl and shale. Its thickness varies from 50 to 100 meters and acquires a wide distribution along the Red Sea coast. This aquifuge neither transmits nor stores water and is considered to act as a confining layer for the lower previously discussed Middle-Miocene aquifer.

- ***Upper Miocene - Pliocene Aquifer***
  It is composed of the conglomerate, sandstone and coral limestone where the conglomerate is in the pebble size and the sandstone is of coarse grains. The thickness of this aquifer varies from 220 to 230 meters. It acquires a limited extension along the Red Sea. It is recharged from the sudden limited precipitation that falls on the sedimentary hills and discharges towards the Red Sea in the East.

- ***Quaternary Aquifer***
  The Quaternary aquifer is formed of detritus, sands, pebbles and rare boulders. This aquifer has variability in its thickness and is widely distributed in the area in the form of terraces or wadi deposits. The main source of recharge is the precipitation and the occasional torrents, which reach down along the mountain slopes, where infiltration takes place.

a. Hydrogeology (Groundwater Hydrology)
Well Inventory

Since 1998 groundwater wells were drilled in the Quaternary aquifer to provide water for the industrial use and the tourism activities within the study area. All these wells produce water from the Quaternary aquifer which is hydraulically connected to the seawater boundary. In coastal aquifers, three factors influence the groundwater quantity and quality which are distance from the coast, well depth and the pumping rate.

The recent well inventory and the literature review revealed that groundwater potential in the study area is low and water is not used directly due its high salinity. There are 23 existing wells in the study area (drilled in 1998 by a resort located to the north of the study with an estimated depth of 70 meters). The well productivity varies between 25 and 35 m3/hr and the water salinity varies approximately between 8000 and 10,000 ppm. Table (9) shows the available information about these wells while Figure (18) shows the location of the existing wells along with the project area.

Table 9: Existing Groundwater Wells Located Within the Study Area

Serial no.	Well Name	Coordinate		Discharge m3/hr	Salinity (ppm)
		E	N		
1	Gona 1	33 28 20.6	27 21 01.4	-	-
2	Gona 2	33 38 19.8	27 21 17.5	30	-
3	Gona 3	33 38 22.4	27 21 20.4	30	7830
4	Gona 4	33 28 22.6	27 21 21.9	35	-
5	Gona 5	33 38 14.2	27 21 34.3	-	-
6	Gona 6	33 28 26.7	27 21 39.8	-	-
7	Gona 7	33 38 11.9	27 21 49.5	-	-
8	Gona 8	33 38 05.6	27 21 45.1	-	-
9	Gona 9	33 38 23.0	27 21 48.8	-	-
10	Gona 10	33 37 46.4	27 22 00.6	-	-
11	Gona 11	33 37 46.6	27 22 01.5	-	9010
12	Gona 12	33 37 52.8	27 22 21.2	-	8560
13	Gona 13	33 37 44.9	27 22 20.7	30	8370
14	Gona 14	33 37 42.3	27 22 21.1	-	-
15	Gona 15	33 37 28.4	27 22 22.8	-	-
16	Gona 16	33 37 31.9	27 22 27.0	25	8260
17	Gona 17	33 37 29.3	27 22 27.9	-	-
18	Gona 18	33 37 27.3	27 22 32.9	-	-
19	Gona 19	33 37 21.9	27 22 33.9	-	-
20	Gona 20	33 37 19.1	27 22 37.8	-	8980
21	Gona 21	33 37 13.3	27 22 38.4	-	-
22	Gona 22	33 37 35.0	27 22 16.4	-	-
23	Gona 23	33 37 57.4	27 22 02.7	-	10190

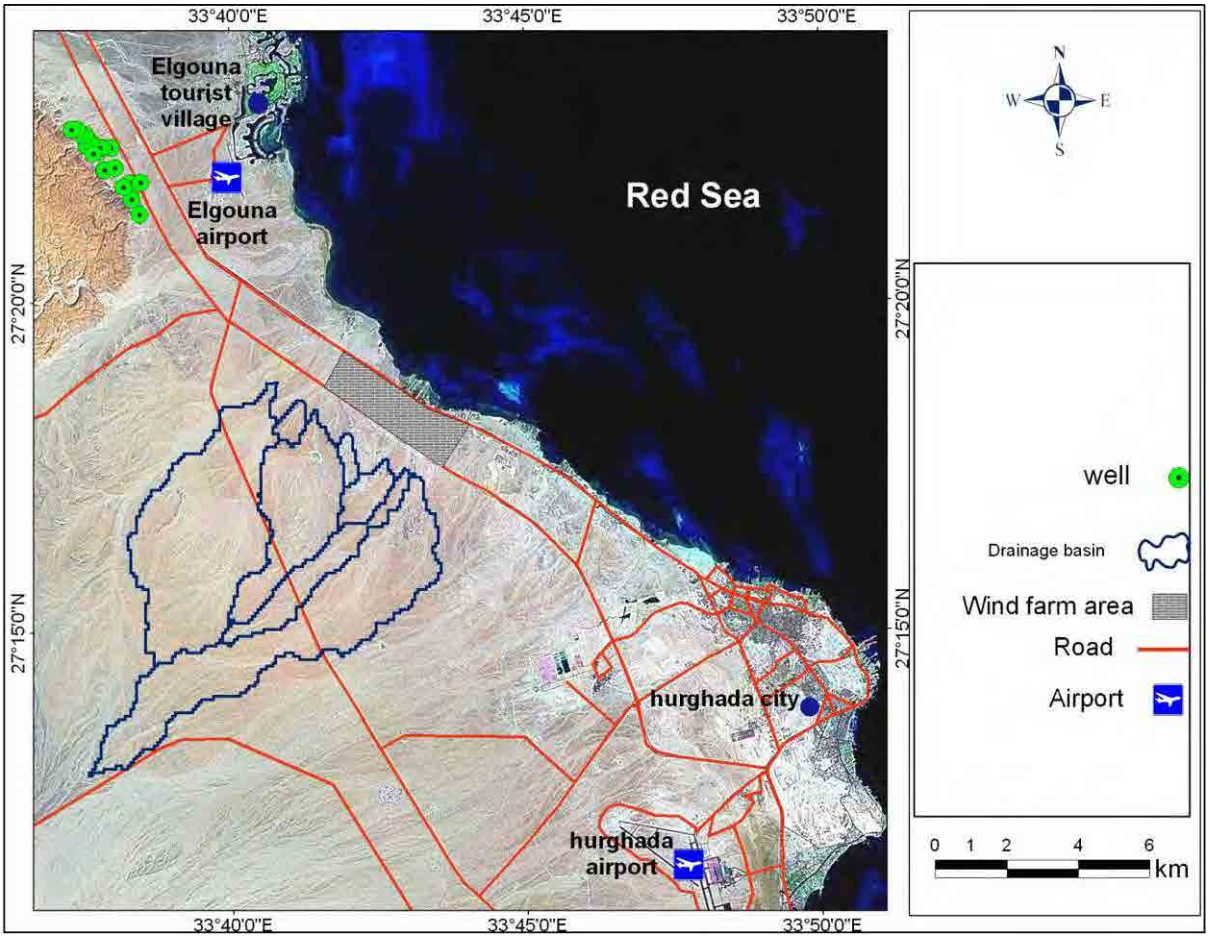


Figure 17: Well Location Map for the Study Area (Legened)

The well inventory showed that these wells have suffered from lowering the static water level and increasing the salinity level. These two evidences indicate clearly that pumping from the Quaternary aquifer is not sustainable and should be avoided. Due to the high salinity of the groundwater, desalination plants are used to remove the salts to the potable level. The use of the desalinated groundwater is limited to the drinking purposes and the wastewater is recycled and used to irrigate the landscape. On the other hand, the reject of the desalination plants is diverted to evaporation ponds which are used as part of the landscape of the resorts

b. Groundwater Monitoring System in the Project Area

Groundwater monitoring in Egypt is limited to existing fresh groundwater in the Nile Valley, the Nile Delta aquifer and the Nubian Sand Stone aquifer in the western desert. As described earlier, the hydrogeologic units indicated clearly that fresh groundwater in the study area is rare. Therefore, there is no regular groundwater monitoring for these aquifer units. It is worth mentioning that in Year 2003, the Ministry of Water Resources and Irrigation conducted a complete well inventory for the existing wells that are used to utilize

the brackish groundwater in the touristic and the domestic activities after being desalinated.

c. Groundwater Levels and Flow Direction in the Study Area

Due to the absence of the groundwater monitoring network, it was not possible to construct a groundwater level map and hence to determine the groundwater flow in the study area. Furthermore, the well inventory was limited to the measurement of the depth to the static water level and did not refer to the mean sea level.

As a result and since all the existing pumping wells are exploited from the Quaternary aquifer, the well inventory indicated that the depth to groundwater is about 38 meters measured from the ground surface with an approximate groundwater level that varies between 0 and 2 meters above the mean sea level. The groundwater flow direction is mainly from West to East towards the Red Sea. The hydraulic gradient can be assumed similar to the slope of the ground surface. For the other aquifer systems, there is no data which could describe the groundwater flow regime.

d. Hydraulic Properties of the Quaternary Aquifer

The hydraulic properties of the Quaternary aquifer are determined from the long duration pumping test analysis. No data is available in the area. However, data from other wells located along the Red Sea coast revealed that the aquifer hydraulic conductivity varies between 5 and 31 m/day. The value of the specific yield is unavailable.

e. Groundwater Quality

As mentioned earlier, the Quaternary aquifer system is hydraulically connected to the seawater boundary. If freshwater is withdrawn from the aquifer, saltwater will move inland causing what is called seawater intrusion phenomenon. If such aquifer is not managed properly, the groundwater quality will deteriorate. As mentioned above, fresh potable ground water in the study area is very rare. Most of the available groundwater is characterized by being brackish with high TDS levels.

f. Groundwater-Surface Water Interaction

When rainfall occurs in any system, part of the rainfall infiltrates downward to recharge the top soil and hence reaches the shallow groundwater aquifer. Within the study area and as described earlier, the shallow groundwater exists in the main wadis and in the flood plain of the watershed catchment. Therefore, the hydraulic interaction between rainfall -surface runoff and the groundwater Quaternary aquifer depends on the following: (1) hydraulic characteristics of the wadi system; (2) hydrogeologic properties of the aquifer system and (3) the head difference between the aquifer and the water level in the wadis.

In the study area, the occurrence of the rainfall and runoff is rare and happens at very low frequency. Furthermore, the surface water runoff never stays in the wadis for long time after the flood event. On the other hand, the static groundwater level is deep. Therefore, the potential groundwater recharge from the surface runoff is not significant due to the aforementioned facts.

g. Groundwater Vulnerability of the different groundwater aquifer systems to the possible pollution

As shown in the land use map, there are two major economic activities within the broad context of the study area, which are the touristic villages and the wind farm. The pollution sources from these activities might threaten the groundwater quality if not properly managed. In case of dumping intentionally or accidentally any pollution on the ground surface, there is a potential for the pollution load to migrate downwards to the top soil and the shallow groundwater aquifer. The aquifer vulnerability to the pollution load depends on the following characteristics (1) Depth to groundwater; (2) Recharge rate to the water table; (3) aquifer properties; and (4) soil characteristics.

On the other hand, some resorts use desalination plant to provide potable water. The reject of the desalination plants is managed through evaporation ponds or shallow injection wells. These two practices have negative long term impact on the shallow groundwater aquifer and would affect the sustainability of the existing brackish groundwater in the area.

h. Groundwater importance in the project area

The available fresh water resource in the area is limited to the rare rainfall which can hardly be harvested for the purpose of sustainable development. The main available water resource in the study area is the shallow and the deep groundwater. Despite its high salinity, it is still more economic to use in-situ rather than transporting the sea water from the Red Sea. Therefore, groundwater in the area should be managed properly to protect it against depletion and deterioration from the quality point of view.

1.4 Seismicity and Earthquake Hazards

The seismicity of Egypt has been investigated through numerous studies, and is well documented (El-Hadidy, S. et al 2003). During the last century, the 1995 Gulf of Aqaba was the strongest event in Egypt since the 1969 Shedwan Island earthquake. In addition, the 1992 Cairo earthquake was the worst in terms of associated severe damage compared to the other events (Abou El Enein K. M. et al 2007). Table (10) provides information on the highest magnitude earthquakes that took place during the last century.

Table 10: Destructive Earthquakes in Egypt in the Last Century

Date			Region	I_o [6]	M
Year	Month	Day			
1955	9	12	Alexandria	VII	6
1969	3	31	Shedwan	IX	6.1
1981	11	14	Kalabsha	VII	5.6
1992	10	12	Cairo	VIII	5.4
1995	11	22	Gulf of Aqaba	VII	5.9
1998	5	28	Alexadria	VII	5.9

1.4.1 Seismic Belts

The seismic activities in the Egyptian territory occur along the following belts (El-Hadidy, S. et al 2003):

- Gulf of Aqaba-Dead Sea trend,
- Gulf of Suez trend,
- Cairo-Suez road trend,
- East Mediterranean-Cairo-Fayum trend,
- Mediterranean coastal dislocation trend, and
- Southwest Cairo seismogenic zone.

1.4.2 The project location

The Hurghada City is located along the Gulf of Suez seismic belt, which is known as one of the active seismic zones in Egypt. The area experienced one of the strongest ever recorded earthquakes in Egypt in 1969, epicentered in Shedwan Island. Moreover, the area is classified according to the Egyptian seismic codes (Fig. 21) as zone 5, which has the highest ground acceleration generated by earthquakes in the Egyptian territory.

A recent study (Hamouda 2011) attempts to estimate Probabilistic Seismic Hazard Analysis (PSHA) for Hurghada area using specific parameters for the site, such as the mean seismic activity, the Gutenberg-Richter parameter, and the maximum regional magnitude.

[6] I_o is the maximum observed intensity in MSK scale. Intensity is a subjective scale which is not measurable relying only on action and reaction, and human and structures responses to quakes. Magnitude (M) is an objective scale which calculated as the base 10 logarithm of the maximum amplitude, measured in micrometers (10-6m) of the earthquake record obtained by a horizontal Wood-Anderson seismograph with magnification 2800, the natural period T = 0.8 s, damping coefficient 0.8, and corrected to a distance of 100 km.

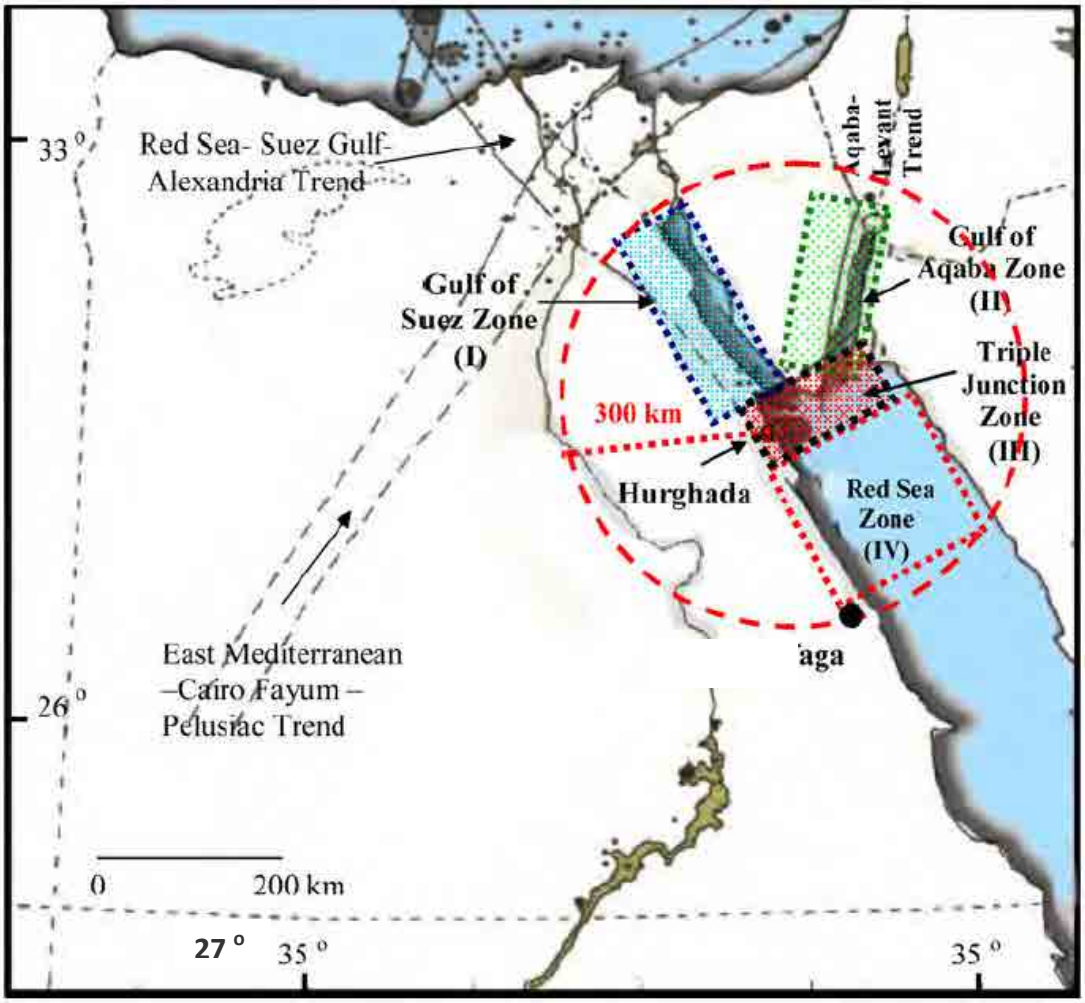


Figure 18: Major seismic trends of Egypt (after Kebeasy 1990) and the seismic zones within an area of about 300 km from the Hurghada site, (Modified by Hamouda 2011)

Hamouda (2011) modeled the seismic hazard of the city; the study concluded that Hurghada could be subject to a maximum probable earthquake of a magnitude of 7.1 ± 0.31 at a hypothetical distance of 31.6 ± 10 Km. This potential event could generate peak ground acceleration of 0.29 g [(7)].

1.4.3 Egyptian Seismic Codes

Before the October 1992 Earthquake, there was no enforcement for seismic design code in Egypt, although Regulations for Earthquakes-Resistant Design of Buildings in Egypt was found since 1988 (Sobaih, M. et al. 1988)). But, it seems that these regulations were not in effect. The October 1992 Earthquake was the first incident to attract the attention of the Egyptian government to potential earthquakes damage.

The provisions of calculations of the seismic effects on buildings and bridges in the Egyptian Code for the Calculation of Loads and Forces on Structural and Masonry Works was completely revised and issued in the 2001 version of

[(7)] g is the intensity of gravity = 9.8 ms^{-2}.

the Egyptian Building Codes. The Egyptian Code follows "the Eurocode 8 – General rules and seismic actions" (Salama 2006).

Earthquakes occur within the Egyptian territory could generate ground acceleration up to 0.l5g, 0.25g and 0.35g (VIII-IX, IX-X and X-XI, on MSK intensity scale) in the Nile Delta, in the Gulf of Suez and in the Gulf of Aqaba respectively (El Sayed, A. et al 1999). On the other hand, Hamouda (2011) as mentioned previously points out that the peak ground acceleration associated with the maximum possible earthquake in Hurghada in particular would be 0.29g.

Ground acceleration is estimated based on the following factors: magnitude of earthquakes, epicentral distances, focal depths and fault rupture dimensions, in addition to wave propagation determined by soil or rock types (García, Silvia R. 2007).

Ground acceleration is the most important design factor for earthquake-resistant structures, given by earthquakes intensity.

Egypt is divides into five seismic zones as follows (Salama 2006):

- The first zone : ground acceleration = 0.1g (g=gal=9.81 ms-2)
- The second zone: ground acceleration = 0.125g
- The third zone : ground acceleration = 0.15g
- The fourth zone : ground acceleration = 0.2g
- The Fifth zone : divided into two zones:
- zone 5 - a ground acceleration = 0.20g - 0.25g
- zone 5 - b ground acceleration = 0.25g - 0.30g

The Egyptian seismic code contains many recommendations, especially for seismic design of masonry buildings based on the increased awareness and understanding of factors influencing the seismic behaviour of masonry structures. For instance in seismic zones 4 and 5, the code does not permit un-reinforced masonry buildings.

The project, according to the seismic zones map, is located in zone five. Thus, it would experience earthquakes that generate ground acceleration of 0.20-30g or. Accordingly, the project design is taking into account this value of the ground acceleration.

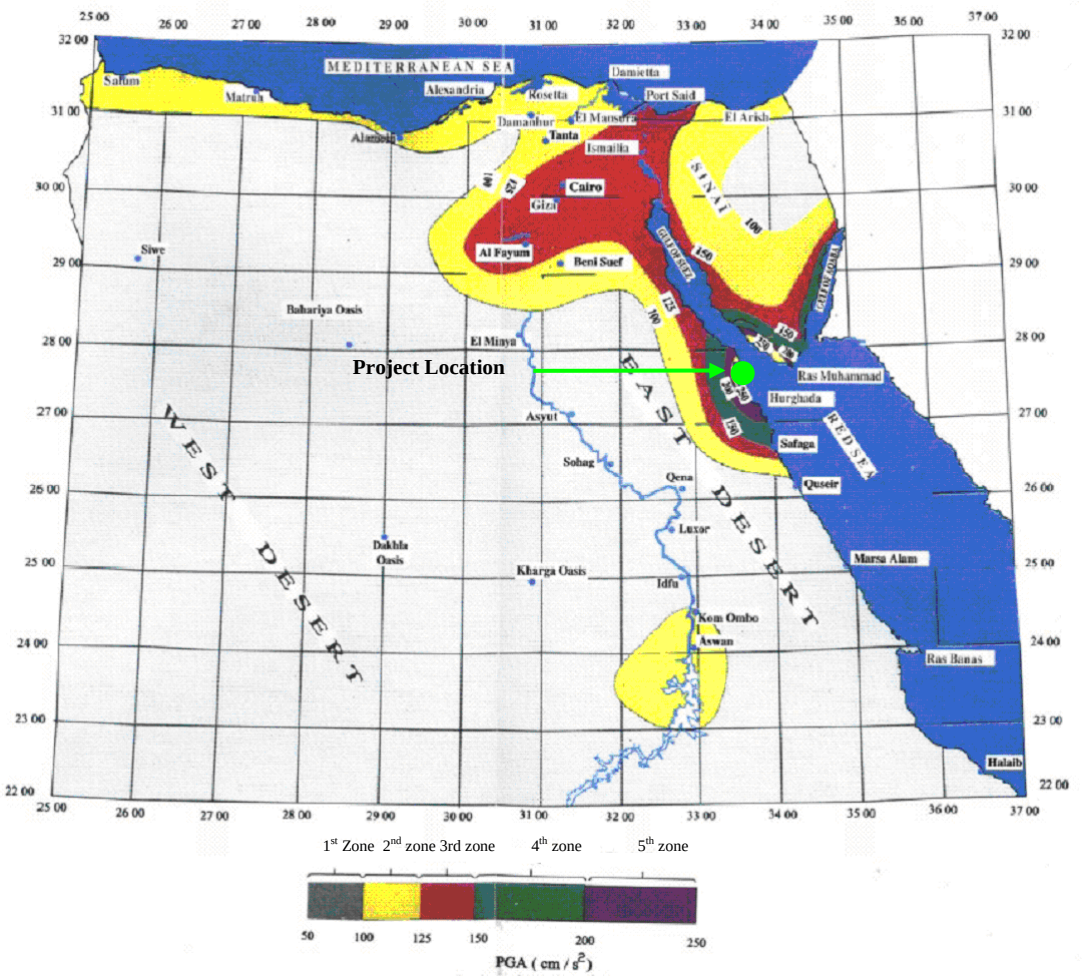


Figure 19: Seismic zones of Egypt

1.4.4 Conclusion

- The project area is located within an active seismic belt, namely the Gulf of Suez trend. However, Hurghada City is the main Red Sea urban center and has been developed for tourist and urban purposes where all buildings and infrastructures have been designed according to the national earthquake codes.
- The project is located within zone five on the Egyptian seismic zones map. The zone is characterized by frequent earthquakes of moderate magnitude.
- Hamouda (2011) concluded that the mean return period with the selected ground acceleration for Hurghada is expected to occur every 74-106 years, with an average of 90 years. This means that peak acceleration is expected once a century.

2. Biological Environment

The study area is located in the Red Sea Coastal Land, which is part of the wide Eastern Desert ecosystem. The land adjacent to the Red Sea is bounded on the western side by the range of coastal mountains. Between the shoreline and the highlands, extends a gently sloping plain, which varies in width. This coastal plain is covered with sand and rock detritus over which the drainage systems (wadis) meander with their shallow courses. Seawards, the coastal area is characterized by a fringing reef frequently interrupted by a series of sharms, marsas and bays.

Literature review and ground truthing of the project area and its hinterland show that the region is organized ecologically into three principal ecosystems lying on west-east axes parallel to the coast (Figure 21). Thus, a description of these systems and their most representative floral and faunal communities is here presented.

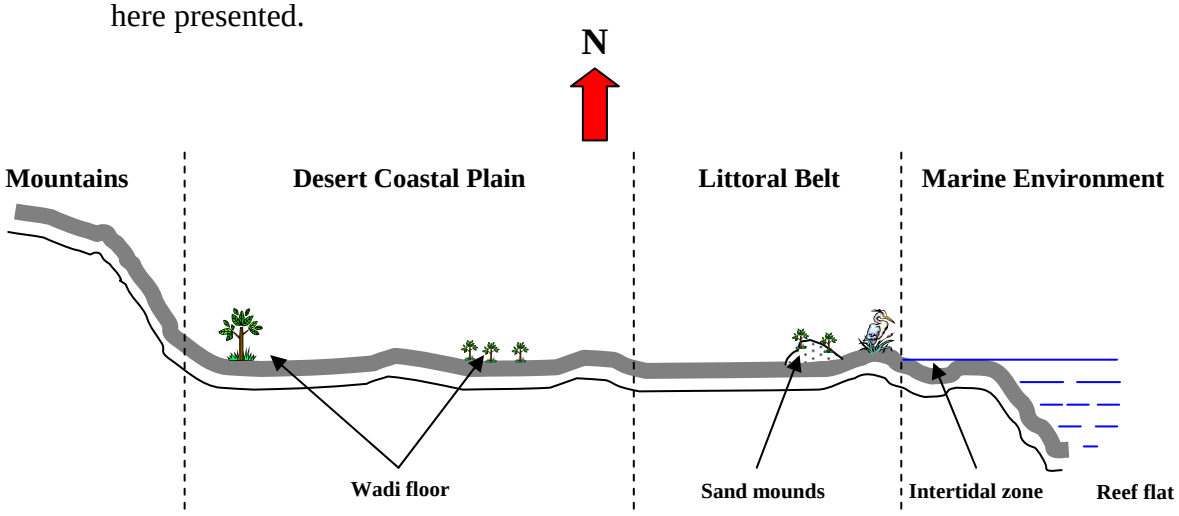


Figure 20: Schematic Representation of the Ecological Zones of the Study Area

2.1 Project Hinterland

2.1.1 Habitats

a. Mountains and Wadis

In the Eastern Desert, mountains of igneous or metamorphic rocks rise gradually from west to east. An extensive system of wadis dissects these mountains. Wadis flowing from the mountains to the Red Sea are relatively short, steep and more numerous compared with those draining westwards into the Nile Valley. Wadis may extend from the foothills to the coastal front or may not reach the coast. There are several large wadis in the Hurghada – Ras Abu Soma Sector, the primary one being Wadi Bali Watershed which flows into Hurghada.

b. Desert Coastal Plain

The coastal plain is non-saline as it lies above sea level and far from the reach of the tidal water. It is essentially a gravel-covered plain

traversed by the main wadis and their tributaries. The project site is located in the coastal plain.

c. Littoral Belt

The littoral belt comprises the coastal salt marshes and other associated habitat types as well as human settlements. The marshes comprise areas of land bordering the sea and subject to periodic inundation by tides of high waves. They have certain qualities related to the proximity of the sea that distinguish them from inland salt marshes (Chapman, 1974 and Zahran, 1977 *in* EEAA/UNEP, 1993).

2.1.2 Flora

The plant growth of is confined to the drainage system (run-off desert). It shows a mosaic pattern and distinct seasonal aspects mainly due to the rich growth of ephemerals in response to occasions of rain. Water supply in the wadi habitat is usually several times the recorded rainfall, but this advantage is counter-balanced by two destructive factors: torrents and grazing. The central part of the wadi bed is usually devoid of perennial plant cover and vegetation is mostly restricted to the sides. As they support a floral community comparatively richer than the rest of the plain and being easily accessible, wadis are subject to grazing and cutting.

In general, the salt marsh vegetation of the area comprises a number of community types: *Halocnemum strobilaceum, Arthrocnemum machrostachium* (*glaucum*), *Halopeplis perfoliata, Limonium pruinosum, L. axillare, Aleuropus* spp., *Zygophyllum* spp., *Nitraria retusa, Suaeda monoica* and *Tamarix* sp.

2.1.3 Fauna

According to the 1997 GEF survey, 11 species of reptiles were found in the Hurghada – Ras Abu Soma Bay Sector; namely Gray's (Spiny) Agama (*Agama spinosa*), Spiny-tailed Lizard (*Uromastyx acanthinurus*), Rough-tailed Gecko (*Cyrtopodion scaber*), Turkish Gecko (*Hemidactylus turcicus*), Sand Gecko (*Tropiocolotes steudneri*), Horned Viper (*Cerastes cerastes*), Painted Saw-scaled Viper (*Echis coloratus*) and Field's Horned Viper (*Pseudocerastes persicus fieldi*); as well as three species of turtles: Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*) and Leatherback Turtle (*Dermochelys coriacea*), which were restricted to the islands.

There is a great abundance of migratory birds passing through the wadis and mountains, particularly during the autumn migration. Besides, the vegetated wadis of the Eastern Desert seem to play an important role in providing resting areas for small palearctic passage migrants. Recorded species of birds include the Brown Booby (*Sula leucogaster*), Night Heron (*Nycticorax nycticorax*), Reef Heron (*Egretta gularis*), Honey Buzzard (*Pernis apivorous*), Black Kite (*Milvus migrans*), Common Buzzard (*Buteo buteo*), Osprey (*Pandion haliaetus*), Common Kestrel (*Falco tinnunculus*), Lanner Falcon (*Falco biarmicus*), Ringed Plover (*Charadrius hiaticula*), Little Stint (*Calidris minuta*), White-eyed Gull (*Larus leucophtalmus*), Caspian Tern (*Sterna caspia*), Rock Dove (*Columba livia*) and Gray Wagtail (*Motacilla cineracea*).

Mammals recorded in this sector include the Cape Hare (*Lepus capensis*), Lesser Gerbil (*Gerbillus gerbillus*), Pigmy Dipodil (*Dipodillus henley*), Sundevall's jird (*Meriones crassus*), House Mouse (*Mus musculus*), Cairo Spiny Mouse (*Acomys cahirinus*), Lesser Egyptian Jerboa (*Jaculus jaculus*) and Rüppell's Fox (*Vulpes rueppelli*).

2.2 Project Site

The project site has been leveled and all potential vegetation has been removed. In addition, the site has been fenced to protect the current wind farm. Accordingly, the site is almost void of faunal diversity.

Figure 21: Part of the site showing poor vegetation cover

2.2.1 Ecological Value of the Site

Due to the absence of vegetation cover and related faunal diversity, the ecological value of the site is insignificant.

The area is situated along a major flyway for Palearctic migrant birds. But the nature of the proposed project will not interrupt the migration route. Then the related activities are not expected to cause any impact on migrating birds.

Figure (23), extracted from (EEAA/DANIDA/Governorate of Suez, 2004), shows the route of migratory birds.

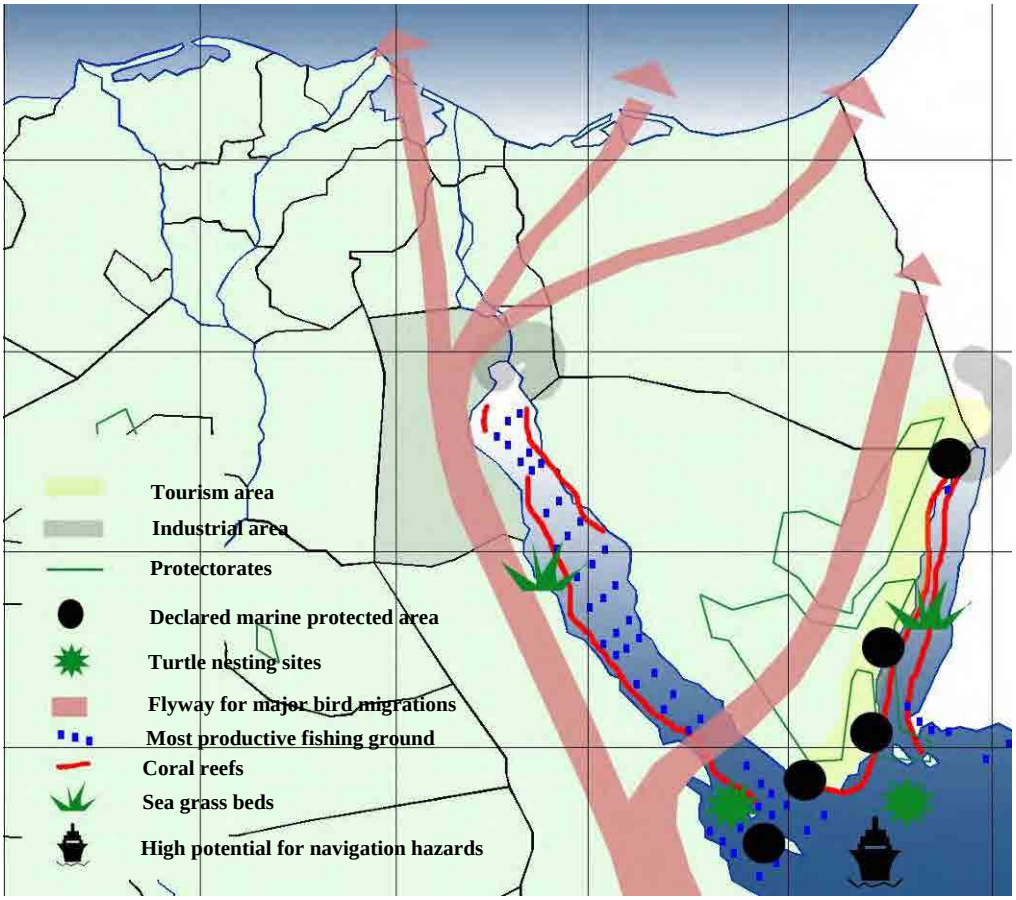


Figure 22: Major Birds' Migratory Routes
(Modified after DANIDA/EEAA/Suez Governorate 2004)

3. Socio-economic Environment

The project is located approximately 10 km north of Hurghada, a major urban center, 70 north of Safaga and 150 km south of Ras Ghareb. In the following section Hurghada and Safaga data from previous census will be shown, because they are the closest urban centers to the project location.

3.1 Regional Population

According to the CAPMAS national 2006 Census, the Hurghada population was 160,746, while Safaga was 35,379 capita. Red Sea local estimates in January 2011 indicated that Hurghada population was 203, 978 while that of Safaga was 44,850 capita (Red Sea Statistical Guide 2011). Other population centers exist at the oil installations at Ras El Zeit and Ras Shukeir. The population near the project location has been experiencing fast growth and this trend is likely to continue.

The coast and islands are the territory of Rashandeya, and the mountainous area is the territory of Ma'aza tribe. Ma'aza tribe ancestors originated from Menia and Beni Suef Governorates. Ma'aza tribe population is relatively very low. In the 1970s, they were only 50 persons. Although they do not have an association and there is not accurate census, their current total population is estimated around 900-1000 persons.

Ma'aza mainly work in tourism. They have more than ten tourist stations, where they are visited by tourists (Saleh, pers. comm., 2011). Their social organization is mainly based on tribal affiliation and extended family systems. The tribe is led by "sheikhs", who are the tribe's representatives in any outside dealings.

Rashandeya territory lies on the Red Sea coast, between Safaga and Ras Ghareb. During British occupation, Rashandeya were supported and catered with food by the British; and they possess documents which they think can enable them to claim their territory.

Most of Rashandeya have been working in sulfur mines at Ras Gemsha and they also have been known to live on some of the Northern Red Sea Islands, of these islands are Umm Hiemat and Twal. They still have a cemetery on Twal Island. Their manpower is divided into: 60 % fishermen, 20% in tourism, 10% governmental employees, 10% project owners (Saleh, pers. comm., 2011).

3.2 Regional Education

The literacy rate (10+) in Hurghada was estimated in 2007 at 85.5% and in Safaga was estimated at 87% (CAPMAS, 2007), which is higher than the national average (65.7%) and higher than the urban Governorates average (80.8%). With the exception of the Faculty of Education in Hurghada, and a tourism and hostelry higher institution, there is no higher education institution in the Red Sea.

3.3 Regional Employment

Unemployment rates at Hurghada were estimated by CAPMAS at 3.5%, while in Safaga it was 9.1%. This is considered relatively low in comparison to the national rate (9.9%) and the urban Governorate level (7.6%).

3.4 Regional Health services

The closest hospitals to the project site are located in Hurghada and Safaga. There following table (11) shows the health facilities in both cities.

Table 11: Health Facilities in Hurghada and Safaga

	General Hospital	Private Hospital	Private Clinic	Specialized Clinic
Hurghada	2	5	85	22
Safaga	1	-	9	2

Source: CAPMAS, 2007

3.5 Regional Infrastructure

In Hurghada, according to CAPMAS, the total percentage of house holds connected to water networks is 77%, while 87.1% are connected to electricity and 52.1% are connected to sewerage system.

While in Safaga, the total percentage of house holds connected to water networks is 52.9%, 76.6% to electricity and 3.9% have sewerage system.

3.6 Transportation

Public transport is available along all the major roads leading to the resort towns. Public and private bus lines link the coastal towns developing centers with other main governorates (such as Cairo, upper Egypt, Suez Canal, and Nile Delta) with stops in all major settlements. In addition, there are several taxis working the area. Hurghada airport serves as an entry port by air. A ferry service from Sharm El Sheikh to Hurghada is operational. Hurghada and Safaga harbors serve international ports between the Red Sea and Saudi Arabia.

3.7 Economic Activities

3.7.1 Fishing

Fishing was traditionally the most important activity in the area. Fishing pressure used to be low, with only small groups of mostly Bedouin fishermen visiting the area, the number of fishermen has recently increased sharply. The number of registered local fishermen to the Red Sea Fishermen Association is

about 500 fishermen who own fishing boats. There are another 400 local fishermen who have fishing permits from the Fisheries Development Authority. The area experiences a strong influx of fishermen from the Nile valley and Mediterranean coast, who import new and destructive fishing methods. Good fish populations primarily still exist on the outer reefs. Most fishing pressure is concentrated in shallow, inshore or shelf localities.

Figure 23: Traditional fishing boats in the area

3.7.2 Tourism

In the entire Red Sea area, tourism is the fastest growing and most important economic activity. In Hurghada, recent Red Sea Governorates statistics show that there are approximately 146 operating hotels and resorts, with a carrying capacity of 40,413 rooms or 76,786 beds. Information obtained also identified the number of employees in this sector to be 41,209 (Information Department/Red Sea Governorate 2012). During 2010, the Red Sea was visited by 2.12 million tourists, where in 2011 the figure has been decreased to 1.21 million tourists (43%), which is attributed to the political instability in the country (Information Department/Red Sea Governorate 2012).

Tourism currently relies heavily on diving safari tours to the islands and offshore reefs. There are relatively few safari routes; these are, however, heavily used. The main clientele consists of international visitors who stay in the coastal resorts. They are transported by charter boats through the area. These trips last one day only or several days. The high season is from Mid-September until April and then again July and August.

Figure 25 : A safari boat working in the area

3.7.3 Oil Exploration

Hurghada has been earlier known as an oilfield since 1911, when the first important exploration was made by the Anglo Egyptian Oilfields Ltd. The Gulf of Suez province produces 75% of oil production. Currently, Oil exploration activities are concentrated around Ras Zeit and the area on the landward side of the Queisum islands (especially South Queisum).

References

Abou El Enein, K.M., H.M. Hussein, A.S. Abu El Ata and E.M. Ibrahim (2000): *Seismological aspects of the Cairo earthquake, 12 October 1992*, Ann. Geofis., 43 (3), 485-504.

CAPMAS (2007), *Central Agency for Public Mobilization and Statistics, Selected reports*, www.capmas.gov.eg

DANIDA/EEAA/Suez Governorate (2004), *Environmental Profile*.

EEAA/UNEP (1993) *Habitat Diversity: Egypt*, Publications of the National Biodiversity Unit, EEAA, Cairo: 302 pp.

El-Hadidy, S., Tealeb A. A, Abuo El-Ela A. Mohamed, and S. S. R. Mustafa (2003), *Destructive Earthquakes Affected Egypt for the Last Decade and the Development of the Egyptian National Seismic Network*, IISEE Bull., Japan, pp. 47-67.

El Saman, M.I. (2000) *Hydrographic studies of some lagoons near Hurghada*. M.Sc. thesis, Aswan, South Valley University.

El Sayed, A. et al (1999), *Deterministic seismic Hazard in Egypt*, UNSECO/IAEA, THE ABDUS SALAM INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS. IC/99/34.

Environics (2006), *Environmental and Social Impact Assessment*, Abu Dabbab Tantalum Mine, Tantalum Egypt.

Environics (2008), *Integrated Environmental Impact Assessment*, Gemsha Bay, DAMAC.

Hamouda, Amr (2011), A*ssessment of seismic hazards for Hurghada, Red Sea, Egypt, Nat. Hazards*, Volume 59, Number 1, October 2011 , pp. 465-479(15)

Morcos, S. A. (1970), *Physical and Chemical Oceanography of the Red Sea,* Oceanography and Marine Biology Annual review, 8: 73-202.

Red Sea Statistical Guide 2011, acquired from Red Sea Governorate Website: www.redsea.gov.eg

Salama, Amr Ezzat (2006), *Egyptian Codes for Design and Construction of Buildings*, a presentation at "Eudocodes Workshop", Varese, Italy.

Saleh, pers. comm., 2011

Sobaih, M. et al. (Editor) (1988), *Regulations for Earthquake-Resistant Design of Buildings in Egypt, Cairo, Egypt.*

Youssef, A. M., and Hegab, M. A. 2007, *Investigation of new proposed Sohag-Hurghada highway across the Egyptian Eastern Desert using Geographic Information Systems and Remote Sensing techniques*. Egypt J. Remote Sensing & Space Sci., v.10, pp, 3-20 (2007).

Annex 2

Topographic Survey Report

Table of Contents

List of Figures

List of Tables

1. INTRODUCTION

Flash flood has become a serious event resulting in great disaster and extensive loss of life and property. The Red Sea area is subjected to seasonal catastrophic flash floods which are characterized by their high velocity and low duration with a sharp discharge peak. The recorded history indicated the occurrence of significant flash floods that affect the coastal areas along the Red Sea. These floods often cause infrastructure damages and loss of lives.

The designated site for the PV power plant nearby Hurghada City is located at the outlet of some major wadies. Based on the maximum daily rainfall, slopes of the watersheds, type of soil and land use, the hydrologic analysis that was carried out in the baseline report, indicated that the PV site is subject to a moderate flood risk. To evaluate the flood intensity at the PV site, a comprehensive topographic field survey was carried out. The topographic survey covered not only the PV site but also the surrounding areas to identify the flow direction when the water reaches the borders of the PV site.

The flood intensity entails the determination of the water depth and water velocity. These two parameters are mainly function of the channel geometry, channel slope and soil characteristics. Based on the flow direction at the PV site and the estimated flood intensity, the appropriate flood protection structures would be identified to minimize the flood hazards on the PV site as well as the surrounding environment.

It should be pointed out that a conservative approach has been adopted in developing this topographic survey.

2. OBJECTIVE OF THE TOPOGRAPHIC SURVEY

The main objective of the topographic survey is as follows:

i. Accurate determination of the ground surface elevation to determine the flow direction at the PV site,
ii. Identify the main wadies that intersect with the PV site,
iii. Identify the geometry of these wadies and their slopes,
iv. Identify the optimal locations that suit the construction of the flood protection structures.

3. SURVEY EQUIPMENT

The following equipment was used in the field survey:
G.P.S. 1200 Leica, Figure (1)
G.P.S. (Navigator)
Total Station 1200 Leica

Figure (1) Field Survey Equipment, G.P.S 1200 Leica

4. COORDINATE SYSTEM

"WGS 84" is used for horizontal coordinates system and "UTM, zone 36N" is used for projection system. On the other hand, "Mean Sea Level" is used for vertical coordinate system. Then, the coordinate system is converted from "UTMz36N" to "Geodetic – WGS 84" using Leica Geo-Office software.

5. SURVEY METHOD

Topographical features (infrastructures, road edges, services …etc) and Land Survey (Ground survey) were implemented in the field using combination of total station and GPS.

6. MESH DISTANCE AND GRASPING MINIMUM LEVEL GAP

Horizontal distance spacing for survey points is 10 m in field measurement. When there is change in the ground level of 0.25 meter, this point is surveyed and recorded in the field. In such case, the horizontal distance is less than 10 meters.

7. SURVEY AREA

The study area is located within the wadi system of the Eastern Desert. These wadies start from the Red Sea Mountains in the west and end at the Red Sea coast passing through the project area. Accordingly, the project area is potentially affected by the flood water of these wadies.

Geographically and according to the available topographic maps and the satellite images, the PV power plant is bordered to the north by some touristic villages and the upstream of wadi Om Dahes. From South, it is bordered by the Egyptian-Saudi Company for water desalination, touristic villages, Fairouz building and the upstream of wadi Abo Malaka. On the other hand, it is bordered by the coastal road (Suez / Hurghada) and touristic villages from the east. It is bordered by the middle ring road and the road (Hurghada / Safaga) from the west side in addition to the downstream of some wadies (seven wadies indicated as W_1 to W_7) as shown in Figure (2).

The surveyed area covers the following features:

a. All the infrastructures (hotels, roads…etc) located in the vicinity of the PV project site;
b. Outlets of the main wadies that intersects with the boundaries of the PV site;
c. A buffer zone around the boundaries of the PV project site. The zone extends to a distance that reaches the nearest existing infrastructure. In case

of not having an infrastructure, the zone extended to a distance of 500 meters at maximum or according to the changes in the ground surface topography.

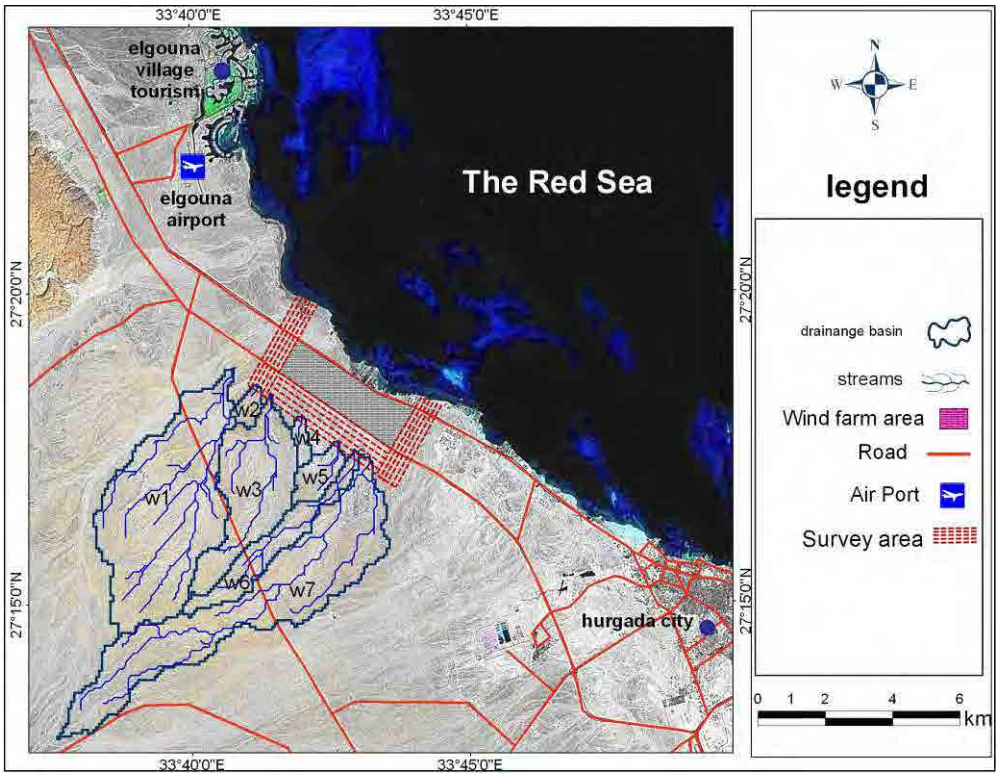


Figure (2) Location map of the surveyed area

7.1 Site Investigation

A field visit was conducted to collect all the relevant hydrologic and topographic information. The collected data included the following:

- Determination of all wadis that affect the project site;
- Identifying the existing infrastructures in the vicinity of the project site;
- Determine the wash lines (water markers) of the historical flash floods;
- Allocate the existing hydraulic structures such as culverts, dams, lakes...etc.
- Allocate the suitable locations for flood protection works.

The field investigation has revealed the following:

- **Wadies that affect the project area**

The field investigation revealed the existence of some major wadies sloping towards the PV project site. It has been indicated in the baseline report that seven wadies intersect with the borders of the PV project site as shown previously in Figure (2). However, the field investigation proofed that W_7, which is located to the East of the PV site, is running away from the project site. On the other hand, another major wadi ($W_{1'}$) exists to the Northwest of the project site. The flood water from this wadi would flow towards the PV site. Hence, the flow of this wadi should be considered in the estimation of the water depth and water velocity at the PV site. Figure (3) shows all the wadies (from W_1 to W_7) that intersect with the PV site, as well as, the other wadi ($W_{1'}$) which is sloping towards the project site as will be described later.

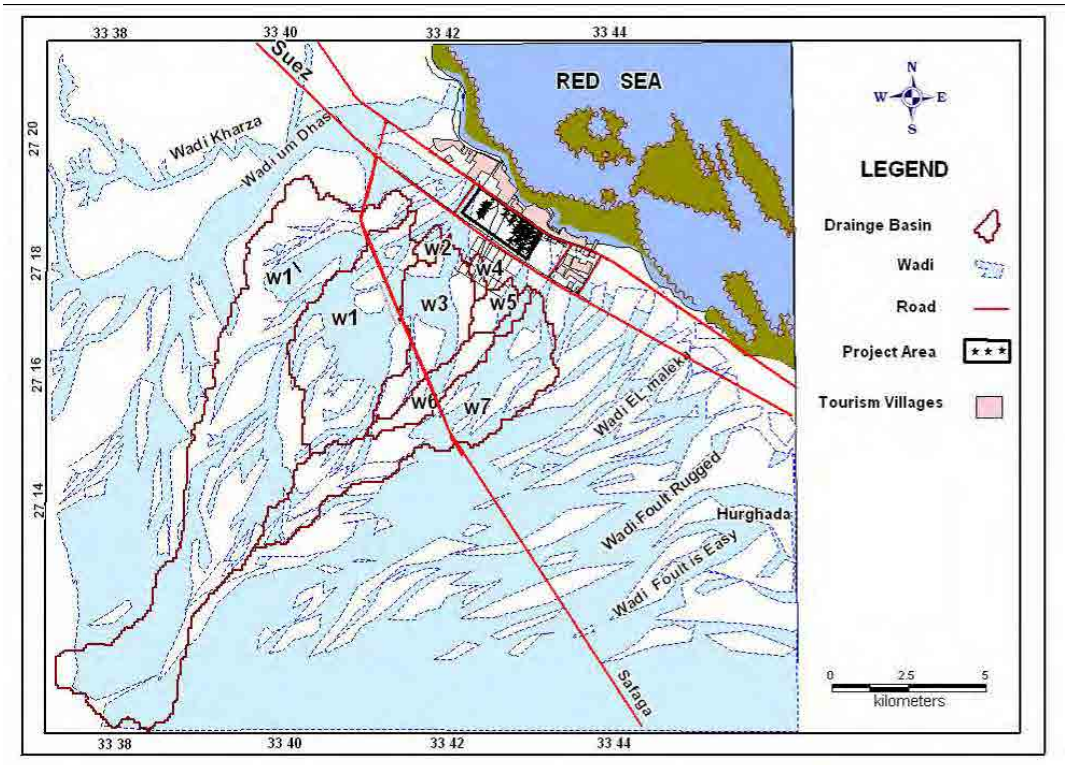


Figure (3) Wadies that affect the project site

- **Existing infrastructures in the vicinity of the project site**

Using the available satellite images, topographic maps and the field survey data, a land use map for the project area was developed as shown in Figure (4). The major concern regarding the existing infrastructures is their vulnerability to the flood hazards as well. Therefore, any protection measures for the PV site should

consider the impact on the surrounding infrastructures especially the existing resorts located at the coastal line. As Shown in figure (5), the following infrastructures were observed in the field:

- Wire fence surrounding the project area and the internal services buildings such as administrative building, Italian plant, warehouses, solar panels and wind towers as shown in Figure (6).

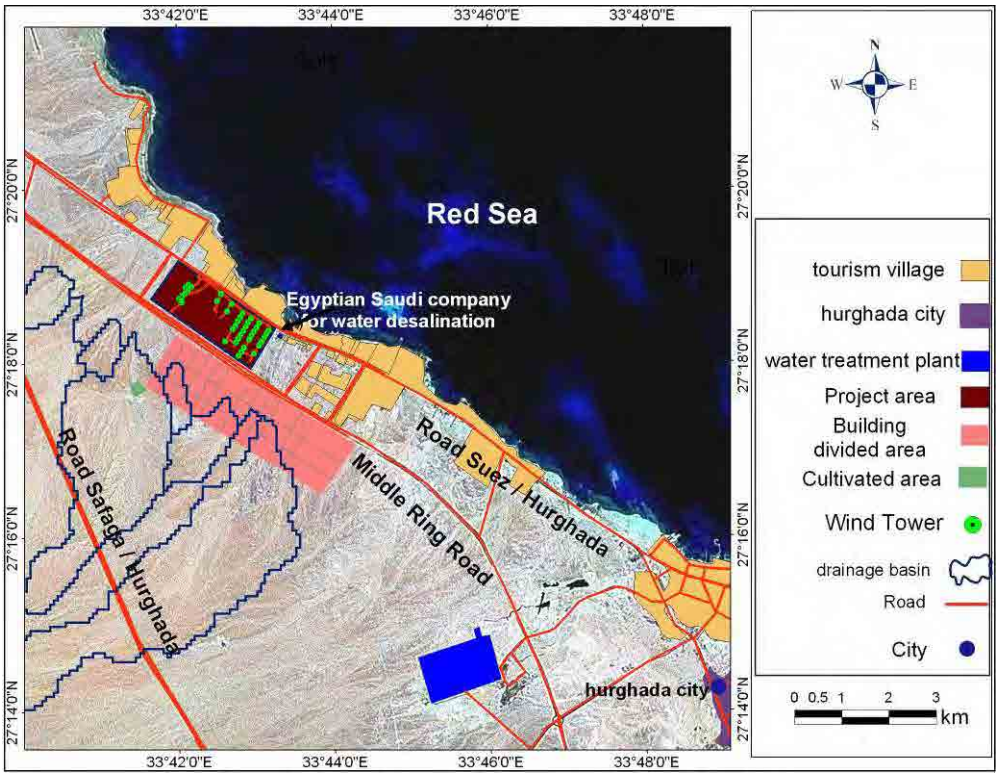


Figure (4) Land use map of the study area

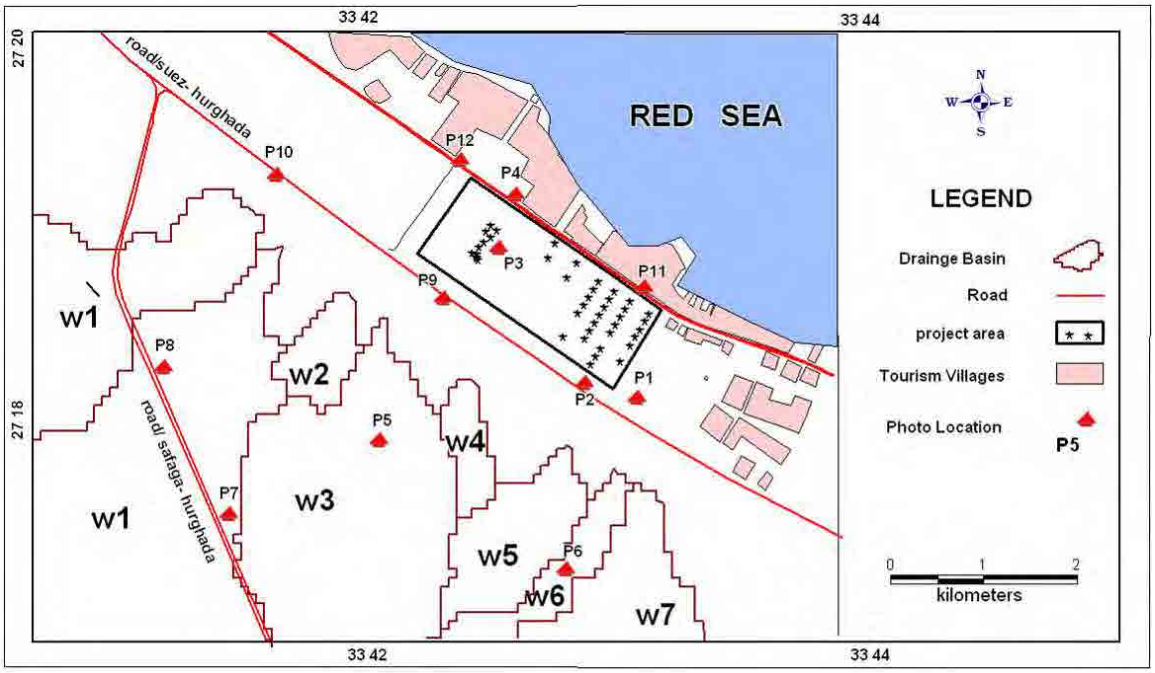


Figure (5) Key map of the photo locations

- To the west of the project site, there is a planned residential area (under development) and wood forest (approximately 20 Feddan) which is irrigated from the treated sewage water as shown in Figure (7).
- Two major roads which are the Middle ring road and Hurghada- safaga road. These roads intersect with the wadies and there are not any protection works for these roads as shown in Figure (8).

Figure (6) Wire fence and some structures near the project area

Figure (7) Wood forest area and the planned residential area

P7


P8

Hurghada / Safaga highway at the west side of the project area


P9


P10

Middle Ring road at the west side of the project area


P11


P12

Coastal road Hurghada / Suez at the east of the project area

Figure (8) Main roads intersecting the wadies that affect the project area

- **Flood Wash Line**

Evidence of flood wash lines have been observed at the north western and south western corners of the project area as shown in Figure (9). In addition, vegetation is scattered around the PV site as well as inside some wadies. This vegetation is another evidence of the flash flood occurrence.

Effects of the flood water at the north-western corner of the project area

Effects of the flood water at the south-western corner of the project area

Figure (9) Effects of the flood water at the corners of the project area

- **Existing hydraulic structures**

The field investigation revealed that all the existing infrastructures in the area are not protected against the flood hazards, i.e no hydraulic structures are in place.

8. SURVEYING WORK

Surveying works were carried out in the project area and its surroundings. Using the survey equipment, a comprehensive land leveling was performed where a ground surface contour map was created as shown in Figure (10). Using the ground surface elevation data, a vector map was created to show the flow direction as shown in Figure (11). From the two maps, it is quite clear that the ground surface is sloping towards the PV site. Hence, the site is subject to the possible flood hazards that might occur.

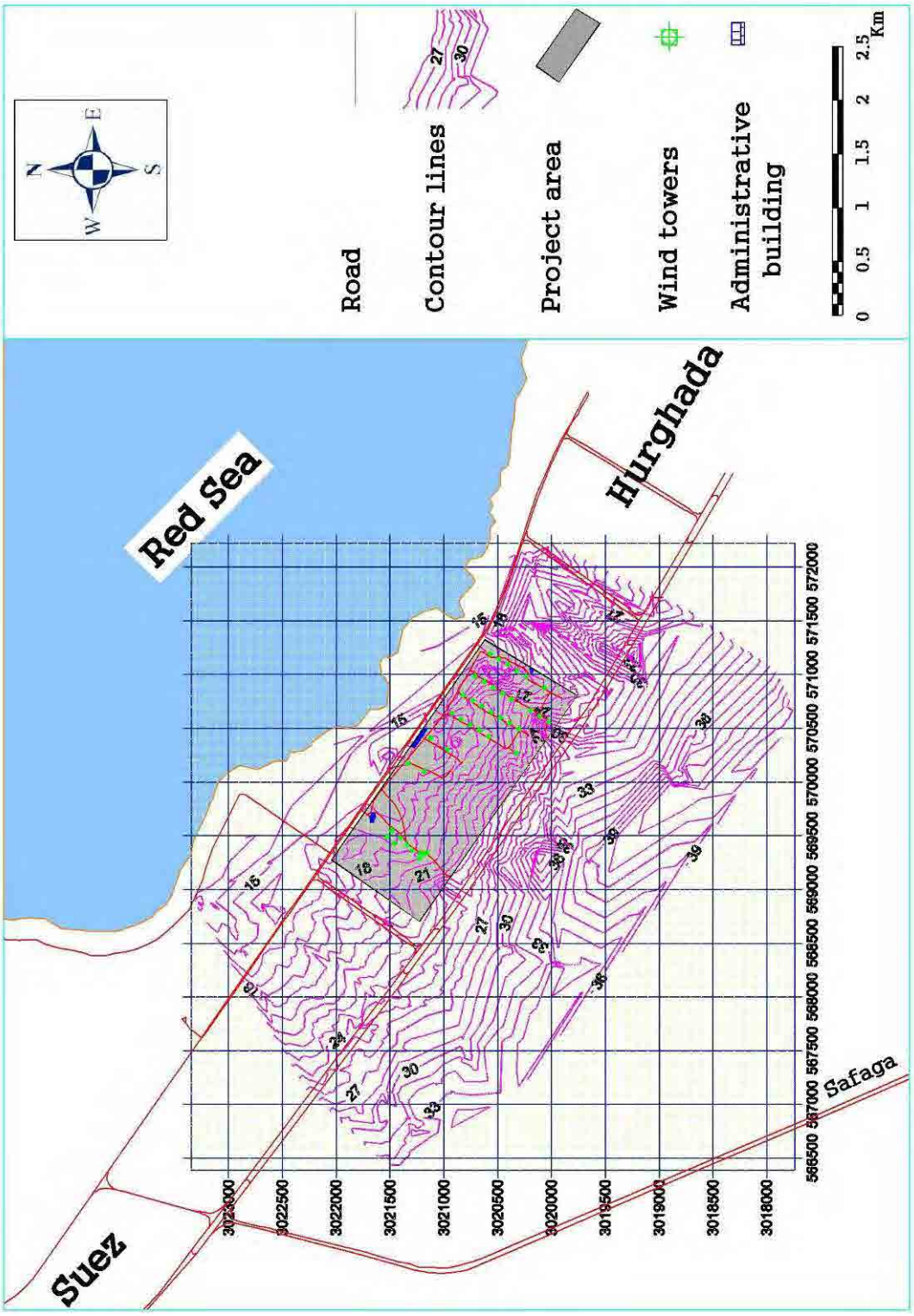


Figure (10) Ground surface contour map of the project area

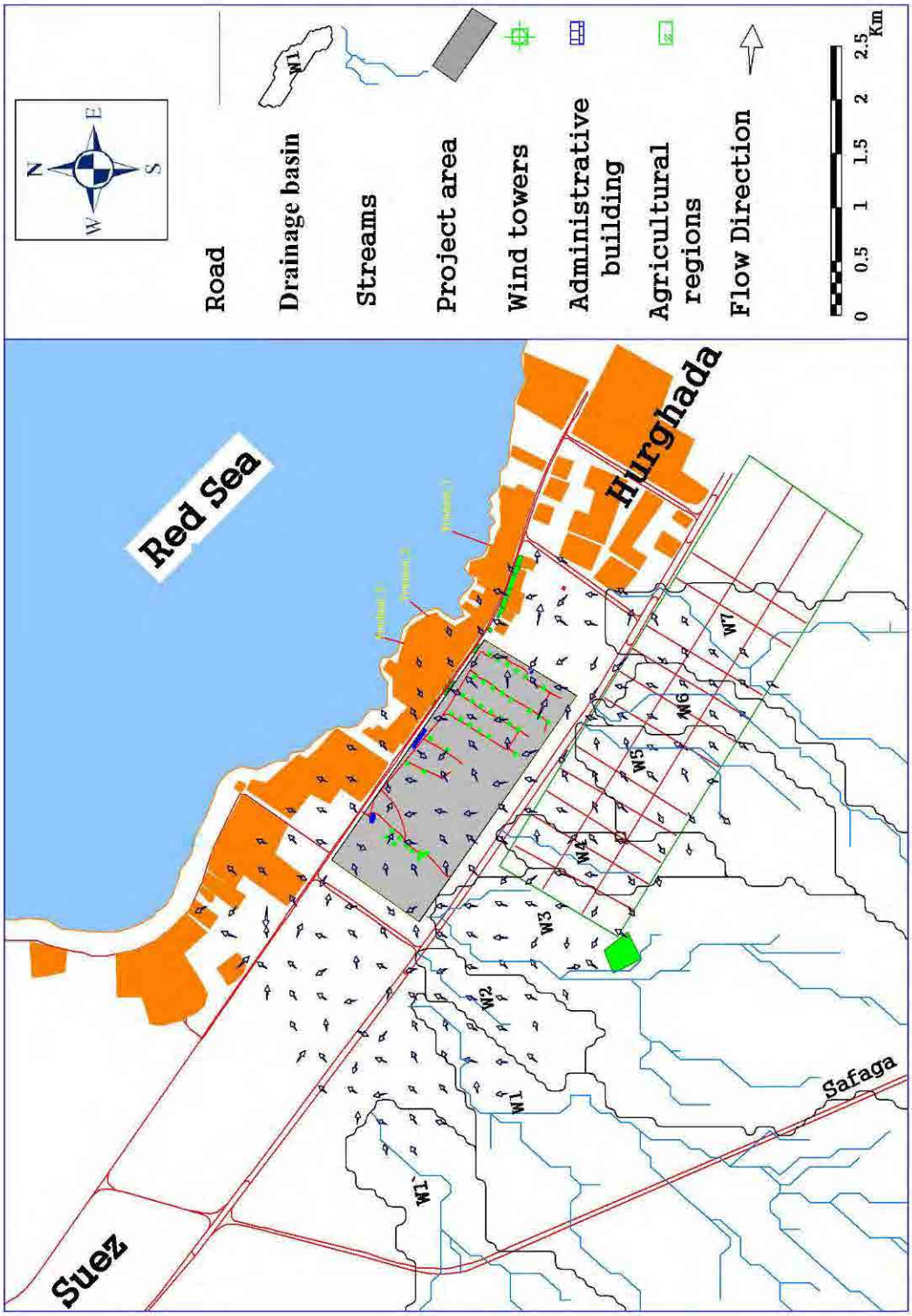


Figure (11) Expected flow direction towards the PV site

In addition to the regular ground surface leveling, a detailed topographic survey was carried out for all wadies intersecting with the PV site. Figure (12) shows the locations of the cross sections that have been surveyed. The survey includes the determination of the geometry of the cross sections and the longitudinal section of the wadies. Table (1) summarizes the coordinate of all surveyed sections using the coordinate system (Geodetic – WGS 84), (UTMz36N-WGS 84).

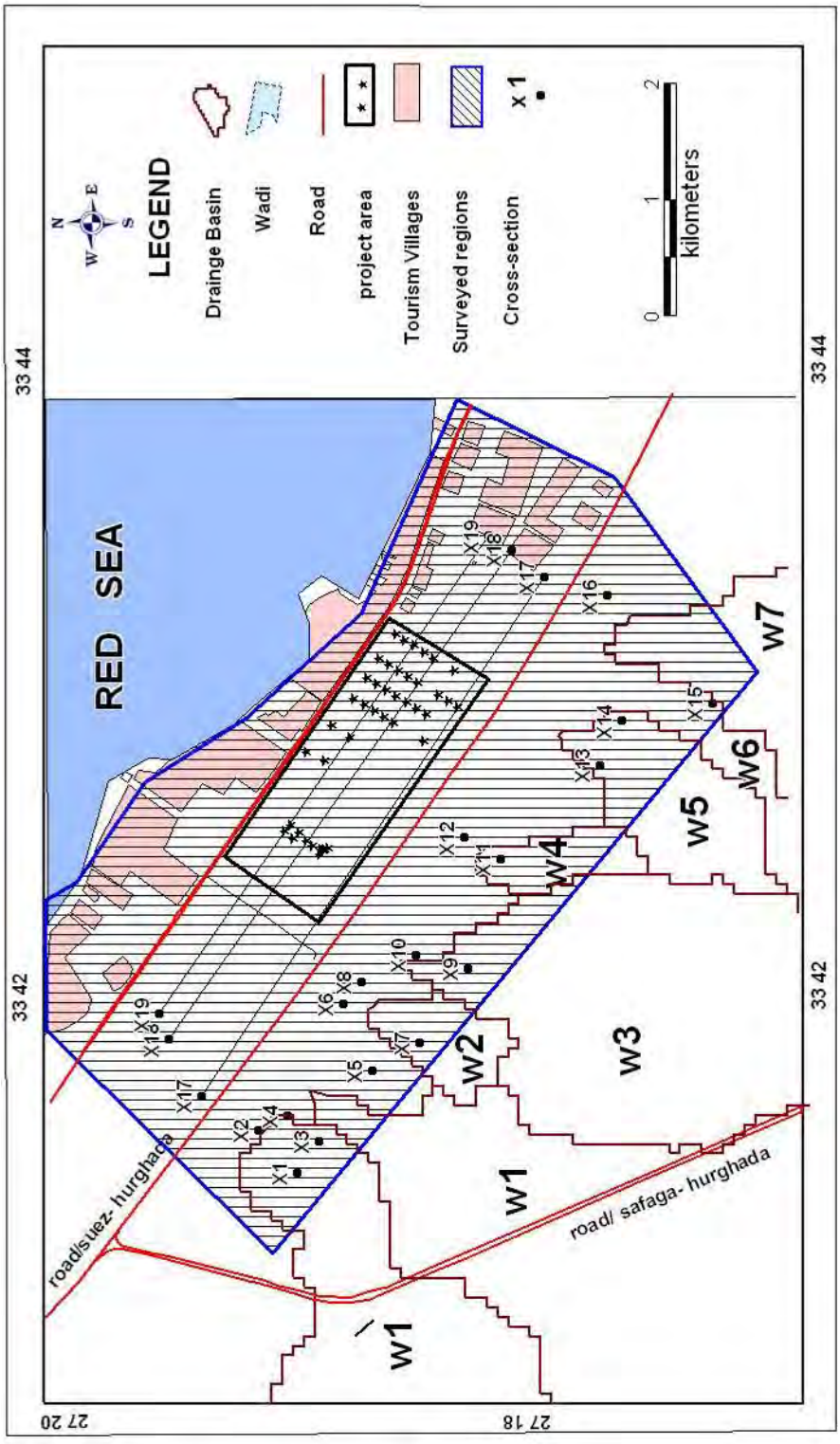


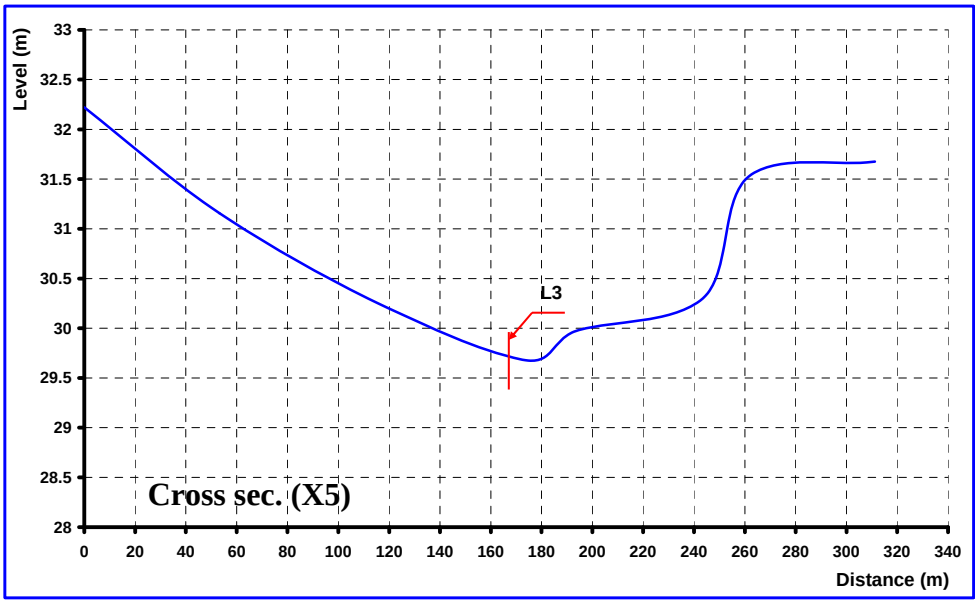
Figure (12) Locations of the surveyed cross sections

Table (1) Coordinates of all surveyed sections

Basin	Sec Cross	Coordinates (Geodetic – WGS 84)		Coordinates (UTMz36N-WGS 84)	
		Latitude	Longitude	Easting	Northing
W1'	X1	27° 18' 51.15" N	33° 40' 21.14" E	566540.48	3021416.74
	X2	27° 19' 01.80" N	33° 40' 34.54" E	566907.12	3021746.29
	X3	27° 18' 44.90" N	33° 40' 31.05" E	566813.90	3021225.77
	X4	27° 18' 53.70" N	33° 40' 39.36" E	567040.81	3021497.80
W1	X5	27° 18' 29.84" N	33° 40' 53.38" E	567430.05	3020765.80
	X6	27° 18' 37.80" N	33° 41' 14.12" E	567998.73	3021013.98
W2	X7	27° 18' 16.62" N	33° 41' 01.71" E	567661.33	3020360.27
	X8	27° 18' 32.82" N	33° 41' 21.11" E	568191.84	3020861.52
W3	X9	27° 18' 02.63" N	33° 41' 25.05" E	568305.35	3019933.34
	X10	27° 18' 17.43" N	33° 41' 29.42" E	568422.81	3020389.45
W4	X11	27° 17' 53.41" N	33° 41' 59.43" E	569251.97	3019654.84
	X12	27° 18' 03.37" N	33° 42' 06.13" E	569434.17	3019962.50
W5	X13	27° 17' 25.37" N	33° 42' 28.68" E	570060.77	3018796.75
W6	X14	27° 17' 19.07" N	33° 42' 42.52" E	570442.22	3018605.05
W7	X15	27° 16' 53.34" N	33° 42' 47.81" E	570592.34	3017814.19
	X16	27° 17' 22.95" N	33° 43' 21.90" E	571523.90	3018730.71
PV Site	X17	27° 19' 17.91" N	33° 40' 45.52" E	567206.11	3022243.82
	X18	27° 19' 26.87" N	33° 41' 03.32" E	567693.68	3022521.91
	X19	27° 19' 29.67" N	33° 41' 11.36" E	567914.32	3022609.50

8.1 Analysis of the Surveying works

Surveying works is analyzed using the Leica Geo-office software. 19 cross sections and 9 longitudinal sections were developed. Figure (13) illustrates an example of one cross section (X5) and the corresponding longitudinal section (L3) for wadi W1. The remaining cross sections and longitudinal sections are shown in ANNEX (A).



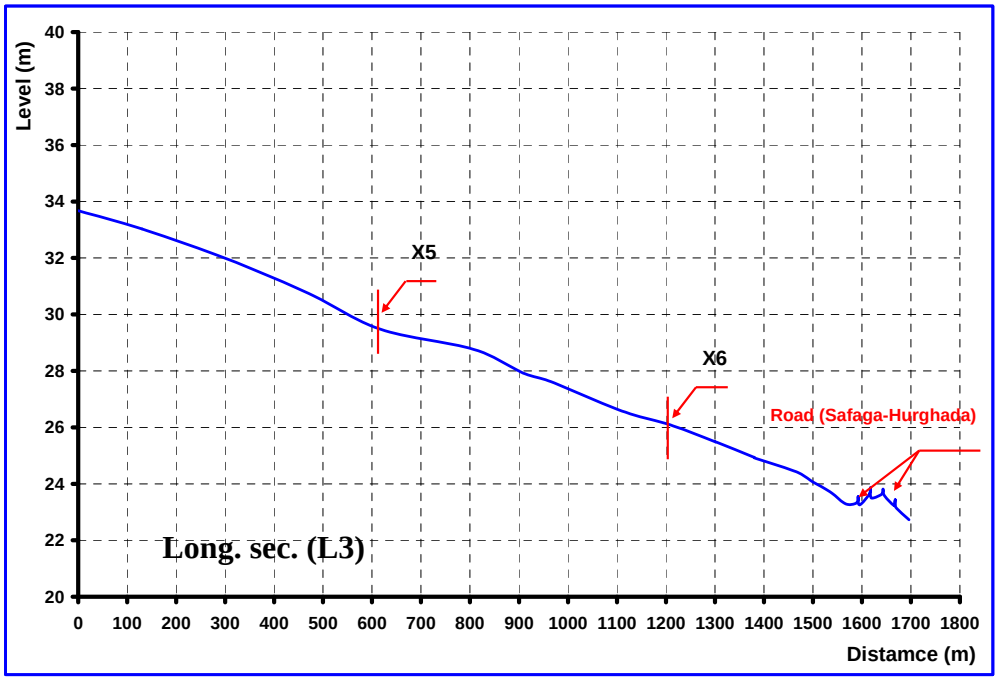


Figure (13) Longitudinal and Cross sections in wadi (W_1)

9. HYDRAULIC ANALYSIS

The hydraulic Analysis is carried out to estimate the water depth and the flood velocity. This analysis is performed at the points of intersections of the active wadies with the photovoltaic power plant site as shown in Figure (14). The geometry of the cross sections at these points are obtained from the field survey as presented previously.

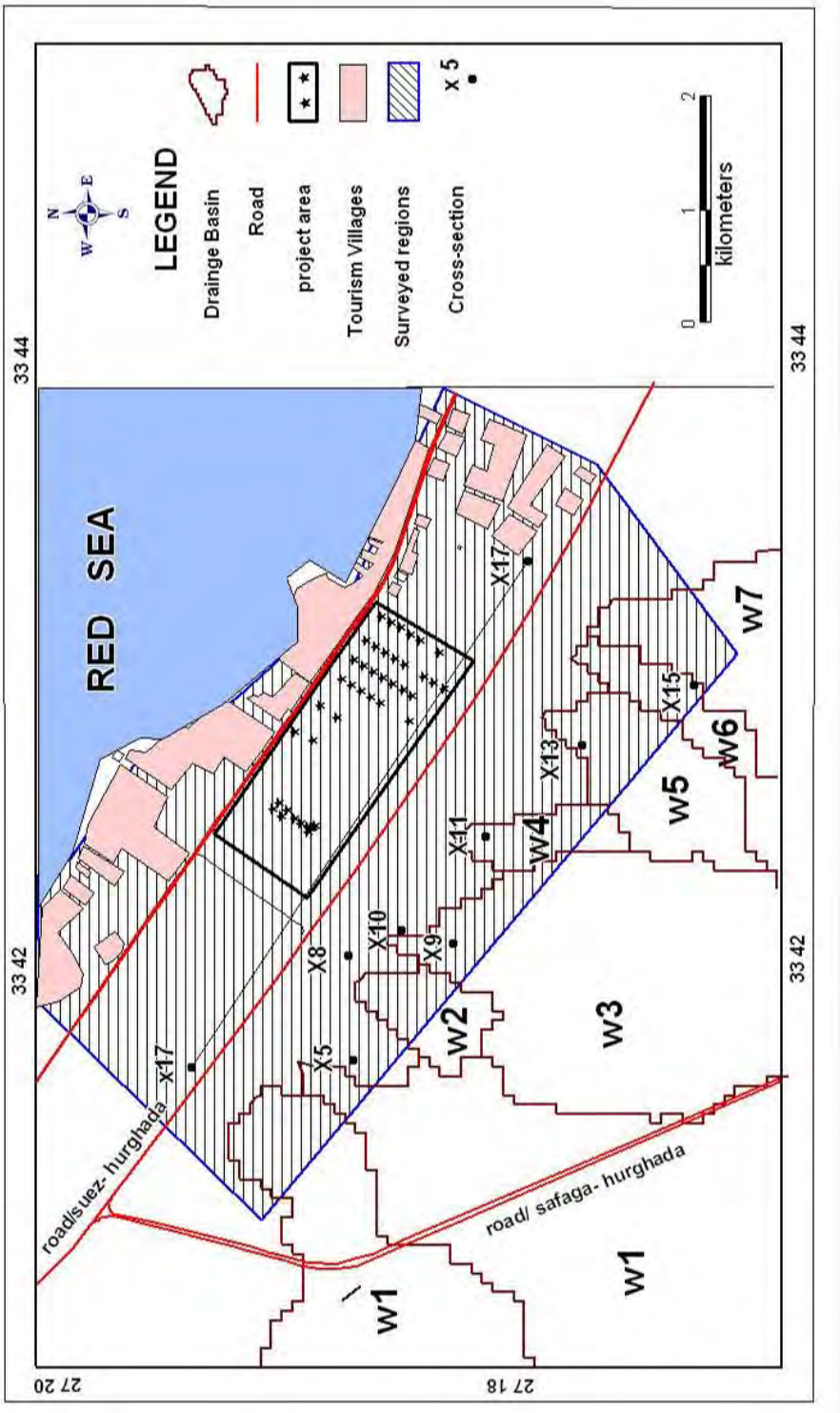


Figure (14) location map of the points intersecting the border of the PV site

The hydrologic analysis of the baseline report has shown that the study area is subject to flash floods due to the rainfall. The following sections explain the methodology and the assumptions that were used to carry out the hydrologic analysis

Approach and Methodology:

1- Rainfall statistical analysis

Long rainfall data series are available for Hurghada meteorological station from 1968 till 2011. Table (2) shows the maximum daily rainfall data used in the statistical analysis.

Table (2) Maximum daily rainfall data for Hurghada meteorological station

Year	Max. Daily Rainfall (mm)	Year	Max. Daily Rainfall (mm)	Year	Max. Daily Rainfall (mm)
1927	0	1949	7.3	1977	0.1
1928	0	1954	24.7	1978	0.2
1929	0	1957	3	1979	6
1930	0	1958	1	1980	6
1931	0	1960	1	1982	1.5
1932	0	1961	2	1983	0.2
1933	3	1962	0	1984	0.2
1934	3	1963	0	1985	4.8
1935	0	1964	0	1987	13
1936	0	1965	2	1988	6.5
1937	0	1966	1	1989	0
1938	1	1967	2	1990	15
1939	41	1968	3	1991	5.7
1940	0	1969	2.7	1992	3
1941	9	1970	0.1	1994	3
1942	0	1971	2.2	1995	1.5
1943	1	1972	1.3	1996	45
1944	8	1973	0.5	1997	0.9
1945	4	1974	2	1998	0.2
1946	0	1975	11	2010	10
1947	0	1976	5.8	2011	0

HYFRAN software is used to perform the frequency analysis. The frequency distribution of the available rainfall data at Hurghada meteorological station indicated that the maximum daily rainfall data reaches up to 50 mm for the 100-year return period as shown in Figure (15) and table (3).

The return period is the average time interval, usually in years, between the occurrence of a flood or other hydrologic event of a given magnitude or larger. The reciprocal, or inverse, of the recurrence interval is the probability (chance) of occurrence, in any year, of a flood equaling or exceeding a specified magnitude. For example, a flood that would be equaled or exceeded on the average of once in 100 years would have a recurrence interval of 100 years and a 0.01 probability, or 1 percent chance of occurring or being exceeded in any year.

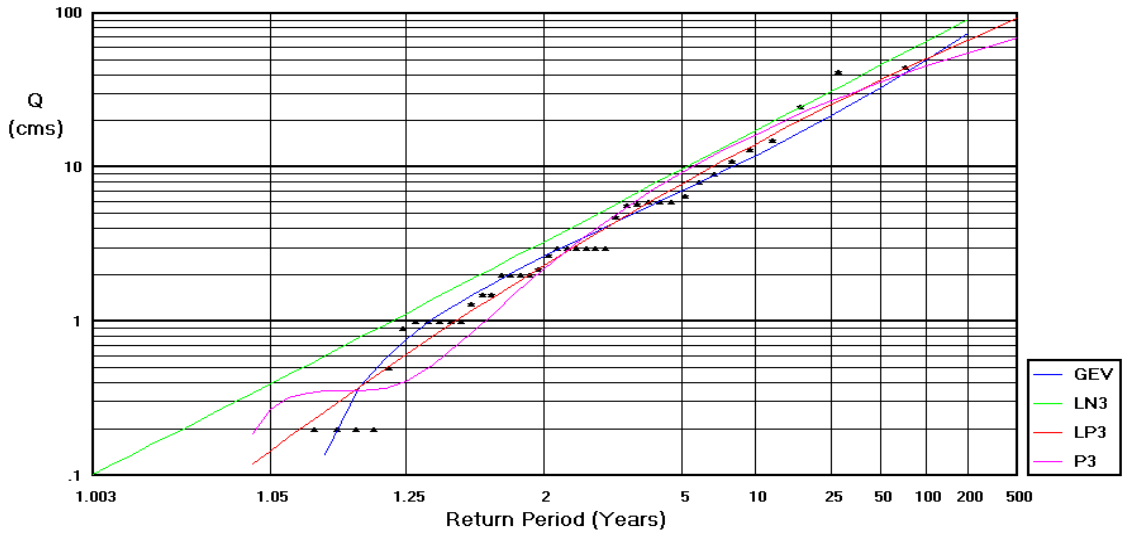


Figure (15) Rainfall Frequency Analysis of Hurghada Station

Table (3) Results of Rainfall Frequency Analysis of Hurghada Station

	Rainfall (mm)			
Return Period (yr)	GEV	LN3	LP3	P3
2	3.6	3.3	3.2	3.2
5	8.4	9.0	8.5	11.0
10	13.6	15.6	15.2	18.1
20	20.9	24.6	25.6	25.9
25	23.9	28.1	30.1	28.5
50	35.6	41.2	48.4	37.0
100	52.5	58.2	76.2	46.0
200	76.8	80.0	117.8	55.4
500	126.1	117.6	205.1	68.3

2- Runoff estimation

The occurrence of the rainfall will cause surface water runoff especially at the high rates of the rainfall intensity. The calculation of the estimated flow discharge and volume at the outlet of each wadi was also presented in the baseline report. This calculation can be done using one of the following methods:

A- Rational Method

The rational method is the oldest, and still the most useful and readily applicable method for a wide range of catchments. Peak discharges are estimated with the following formula:

Q=CIA
Where:
Q is the peak discharge (m^3/s)
C is a dimensionless runoff coefficient
I is the rainfall intensity (m/s)
A is the catchment area (m^2)

The designer must use judgement to select the appropriate "C" value within the range. Generally, larger areas with permeable soils, flat slopes and dense vegetation should have the lowest "C" values. Smaller areas with dense soils, moderate to steep slopes, and sparse vegetation should assigned the highest "C" values.Table (4) summarized the base values of runoff coefficient.

Table (4) Base Values of Runoff Coefficient (C) for Rational Formula

Land Use	C	Land Use	C
Business:		***Lawns:***	
Downtown areas	0.70 - 0.95	Sandy soil, flat, 2%	0.05 - 0.10
Neighborhood areas	0.50 - 0.70	Sandy soil, avg., 2-7%	0.10 - 0.15
		Sandy soil, steep, 7%	0.15 - 0.20
		Heavy soil, flat, 2%	0.13 - 0.17
		Heavy soil, avg., 2-7%	0.18 - 0.22
		Heavy soil, steep, 7%	0.25 - 0.35
Residential:		***Agricultural land:***	
		Bare packed soil	
Single-family areas	0.30 - 0.50	*Smooth	0.30 - 0.60
Multi units, detached	0.40 - 0.60	*Rough	0.20 - 0.50
Munti units, attached	0.60 - 0.75	*Cultivated rows*	
Suburban	0.25 - 0.40	*Heavy soil, no crop	0.30 - 0.60
		*Heavy soil, with crop	0.20 - 0.50
		*Sandy soil, no crop	0.20 - 0.40

		*Sandy soil, with crop *Pasture* *Heavy soil *Sandy soil Woodlands	0.10 - 0.25 0.15 - 0.45 0.05 - 0.25 0.05 - 0.25
Industrial: Light areas Heavy areas	 0.50 - 0.80 0.60 - 0.90	*Streets:* Asphaltic Concrete Brick	 0.70 - 0.95 0.80 - 0.95 0.70 - 0.85
Parks, cemeteries	0.10 - 0.25	Unimproved areas	0.10 - 0.30
Playgrounds	0.20 - 0.35	Drives and walks	0.75 - 0.85
Railroad yard areas	0.20 - 0.40	Roofs	0.75 - 0.95

Since there is no recorded floods in the region, it is inappropriate to use this method due to the high uncertainty ion the C value. Therefore, we used the hydrologic modeling approach as shown in the following section.

B- Hydrologic model

Watershed Modeling System (WMS) software was selected as an integrated solution to the catchment's modeling. Several hydrologic modeling tools are provided within WMS, from which HEC-1 was selected as the model to be applied in this study.

WMS is a comprehensive modeling package for hydrologic analysis. It was developed by the Environmental Modeling Research Laboratory of Brigham Young University in cooperation with the U.S. Army Corps of Engineers Waterways Experiment Station. WMS incorporates a variety of hydrologic models including: HEC-1, TR-20, HSPF, TR-55, Rational Method, the National Flood Frequency (NFF), and MODRAT (LA County Modified Rational Method) which are lumped parameter models. In addition, WMS provides a physically based, distributed parameter model; GSSHA (Gridded Surface Subsuraface Hydrologic Analysis) which is a significant reformulation and enhancement of the former CASC2D model.

The distinguishing difference between WMS and other applications designed for setting up hydrologic models like HEC-1 and TR-20 is its unique ability to take advantage of digital terrain data for hydrologic model development. WMS uses three primary data sources for model development:

- Geographic Information Systems (GIS) Vector Data
- Digital Elevation Models (DEMs) or Gridded Elevation Sets

- Triangulated Irregular Networks (TINs)

The interface for WMS is divided into eight modules. One module is provided for each of the basic data types or modeling environments supported by WMS. The following modules are supported in WMS:

- Terrain Data Module
- Drainage Module
- Map Module
- Hydrologic Modeling Module
- Hydraulic Modeling Module
- GIS Module
- 2D Grid Module
- Scatter Point Module

The HEC-1 model is designed to simulate the surface runoff response of a river basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components. Each component models an aspect of the precipitation-runoff process within a portion of the basin, commonly referred to as a subbasin. A component may represent a surface runoff entity, a stream channel, or a reservoir. Representation of a component requires a set of parameters which specify the particular characteristics of the component and mathematical relations which describe the physical processes. The result of the modeling process is the computation of stream flow hydrographs at the desired locations in the river basin.

Several different unit hydrograph methods are available to generate synthetic hydrographs including SCS, Clark, and Snyder. The SCS unit hydrograph was adopted. Generating a unit hydrograph using the SCS dimensionless method involves a single parameter; TLAG - SCS lag time in hours. Rainfall distributions are assumed uniform over the entire area of each catchment. Rainfall excess is computed by subtracting infiltration and detention losses based on a soil water infiltration rate function (Curve Number CN). Note that the rainfall and infiltration are assumed to be uniform over the sub-catchment. The resulting rainfall excesses are then routed by the unit hydrograph to the outlet of the sub-catchment producing a runoff hydrograph. The unit hydrograph technique produces a runoff hydrograph at the most downstream point in the sub-catchment.

Table (5) summarizes the peak flow and the water volume for three different return periods such as 25, 50 and 100 year. From this table, it is found that the

peak discharge for the return periods 25 and 50 years equal to almost 1% and 28% of the 100- year return period respectively.

Table (5) Discharge and water volume at the outlets of the different wadies

Wadi ID	Peak Discharge (m^3/s)			Volume (1000 m^3)			Time to peak (min)
	25Year	50Year	100-Year	25Year	50Year	100-Year	
W1	0.1	3.3	12.1	0.9	31.6	109.8	150
W2	0.01	0.4	1.6	0.044	1.6	4.2	60
W3	0.06	2.1	7.3	0.4	14.8	50.5	120
W4	0.01	0.4	1.2	0.038	1.4	3.3	75
W5	0.02	0.7	2.5	0.1	4	9.7	90
W6	0.02	0.7	3.1	0.2	7.5	24.2	135
W7	0.07	2.6	9.3	0.8	31.4	105.3	180

The estimated peak flow discharge will pass through the wadi cross section with certain depth and velocity. In order to estimate these two hydraulic parameters, Manning Equation is applied such as:

$Q = A * V$

$$V = \frac{1}{n} R^{\frac{2}{3}} \sqrt{S}$$

Where:

Q: discharge (m^3/s)
A: Area of the wadi cross section (m^2)
V: velocity (m/s)
1/n: Manning Roughness coefficient (20-50)
R: hydraulic radius (area of cross section (A) / wetted perimeter of the cross section (P))
S: longitudinal slope of the wadi

For the Manning Roughness coefficient (1/n), the critical values of 20 and 50 were used to calculate the water depth and the water velocity respectively.Table (6) shows the base values of roughness coefficient (Manning's "n").

Table (6) Base Values of Roughness Coefficients (Manning's "n")

Bed Material	Median Size of bed material (in millimeters)	Base *n* Value	
		Straight Uniform Channel[1]	Smooth Channel[2]
Sand Channels			
Sand[3]	0.2	0.012	--
	.3	.017	--
	.4	.020	--
	.5	.022	--
	.6	.023	--
	.8	.025	--
	1.0	.026	--
Stable Channels and Flood Plains			
Concrete	--	0.012-0.018	0.011
Rock Cut	--	--	.025
Firm Soil	--	0.025-0.032	.020
Coarse Sand	1-2	0.026-0.035	--
Fine Gravel	--	--	.024
Gravel	2-64	0.028-0.035	--
Coarse Gravel	--	--	.026
Cobble	64-256	0.030-0.050	--
Boulder	>256	0.040-0.070	--

[Modified from Aldridge & Garret, 1973, Table 1 --No data
1Benson & Dalrymple --No data
2 For indicated material; Chow(1959)
3 Only For Upper regime flow where grain roughness is predominant

- **Calculated water level and velocity at the outlet of wadies**

The Manning Equation is used to calculate the water depth and velocity. The surface water elevation is calculated as the summation of the ground surface elevation and the calculated water depth. The results of the hydraulic analysis are illustrated in Figures (16) through (22) as shown below. It is important to point out that the used range for Manning coefficient is 20-50. Since the study has adopted a conservative approach we are adopting, the values used for 1/n have been selected to present the critical values for the depths and the critical value for the velocity. Therefore, for calculating the water depth we used 1/n = 20 while we used 1/n = 50 when calculating the water velocity to ensure that we considered the worst case scenarios

Cross section in (W_1)

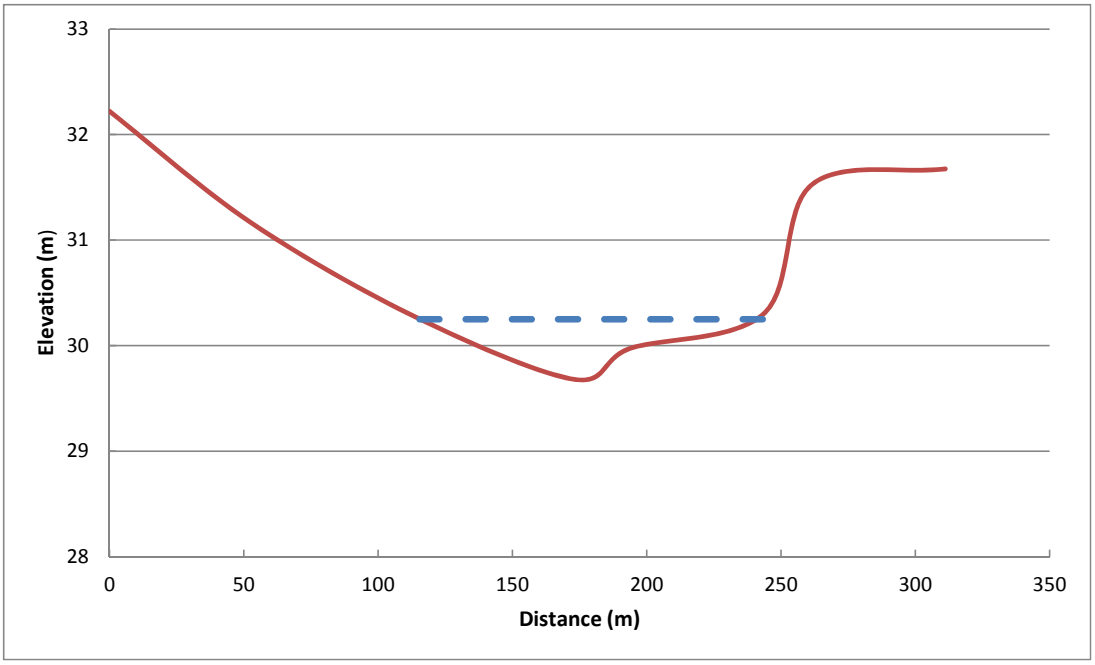


Figure (16) Surface water elevation at sec (X5) - W_1

Cross section in (W_2)

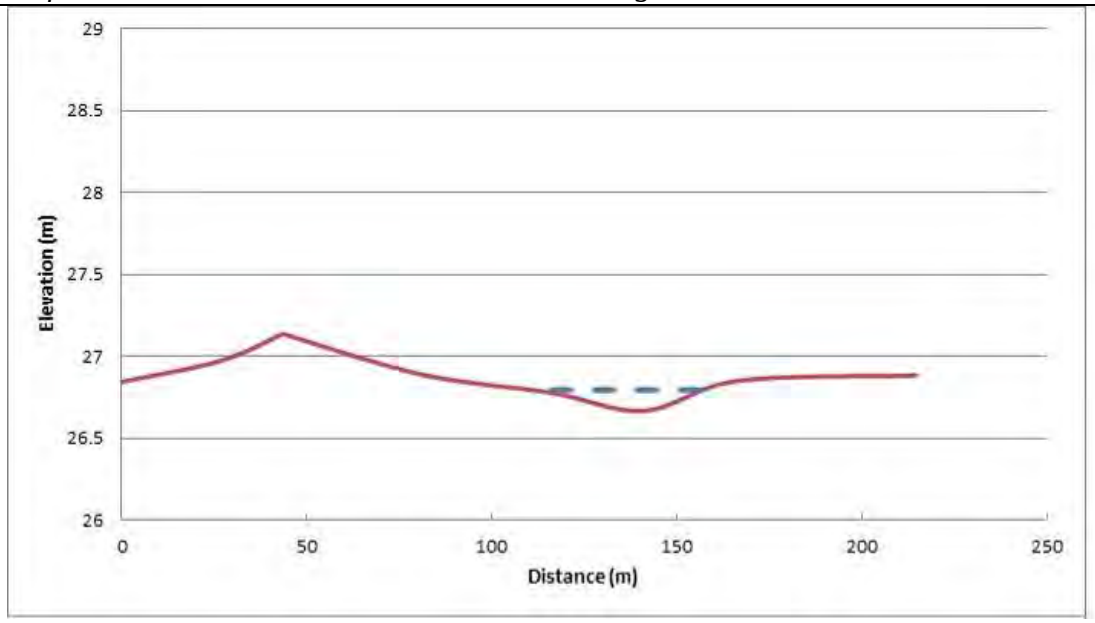


Figure (17) Surface water elevation at sec (X8) - W_2

Cross sections in (W_3)

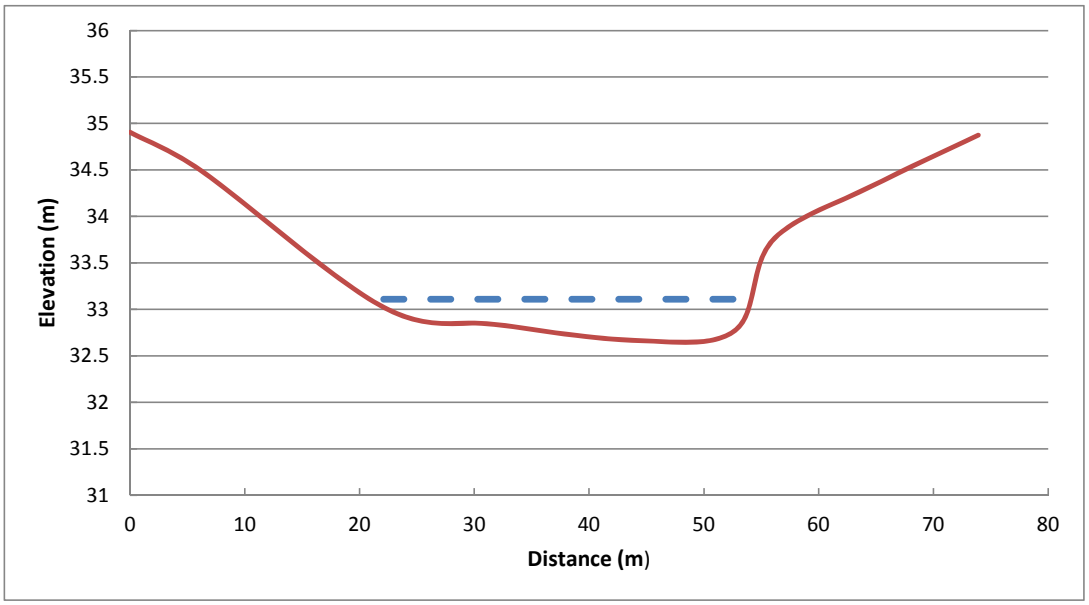


Figure (18) Surface water elevation at sec (X9) - W_3

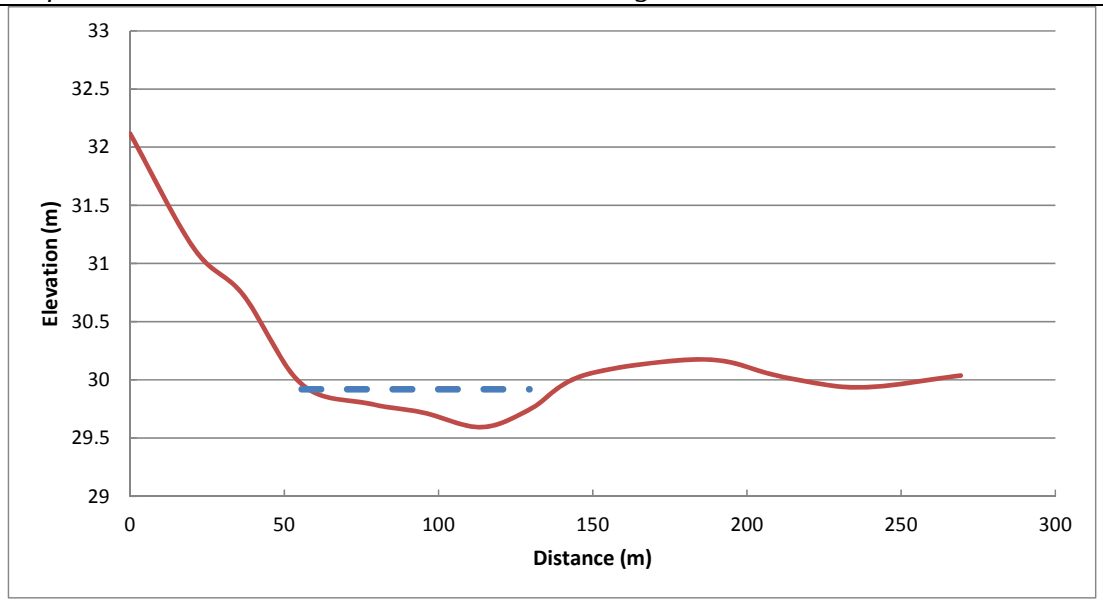


Figure (19) Surface water elevation at sec (X10) - W_3

Cross section in (W_4)

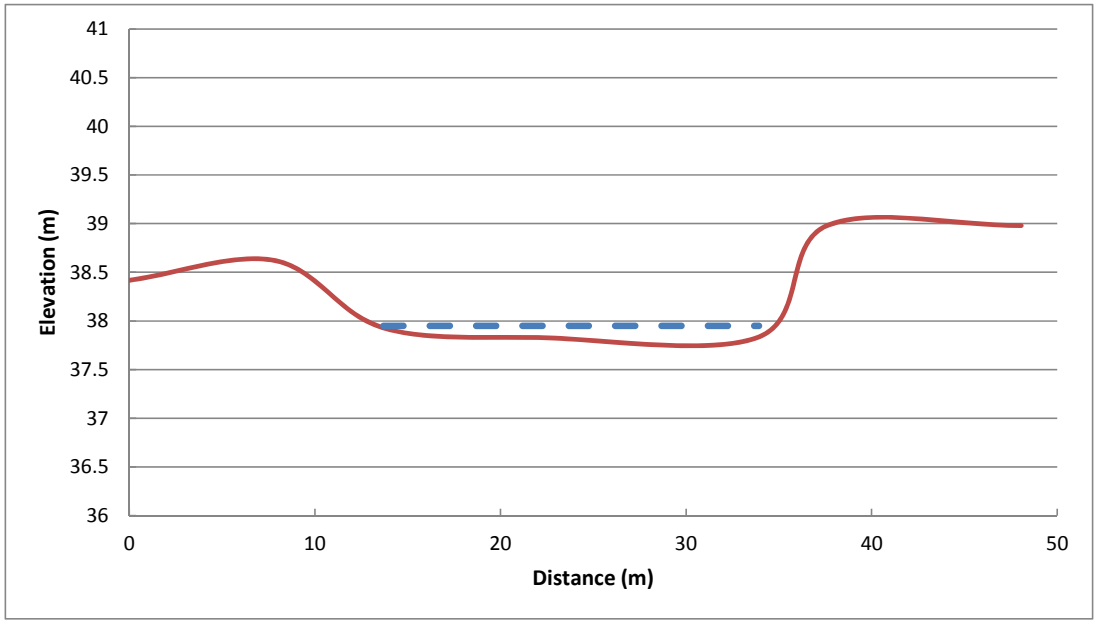


Figure (20) Surface water elevation at sec (X11) - W_4

Cross section in (W_5)

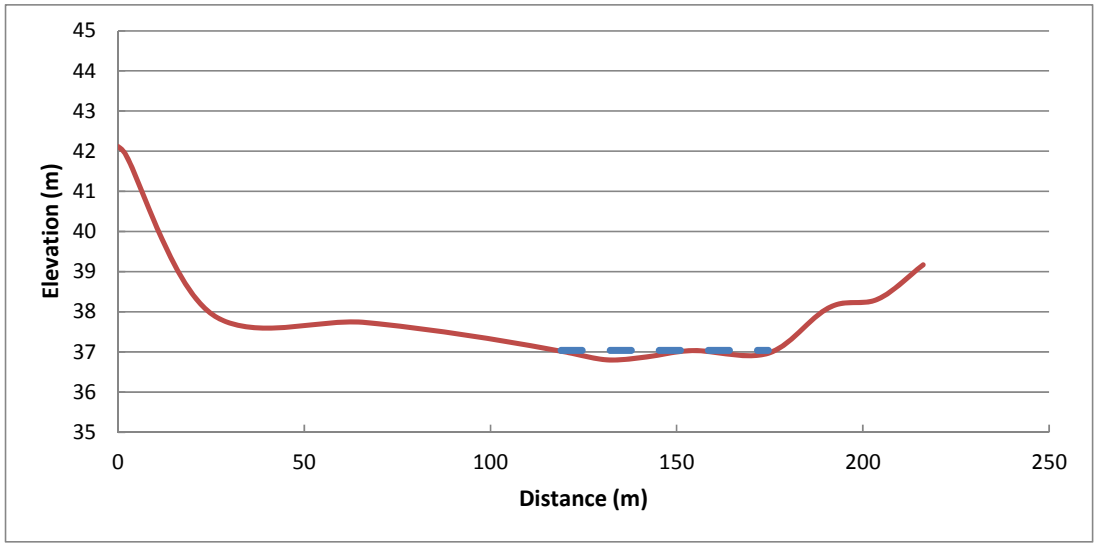


Figure (21) Surface water elevation at sec (X13) - W_5

Cross section in (W_6)

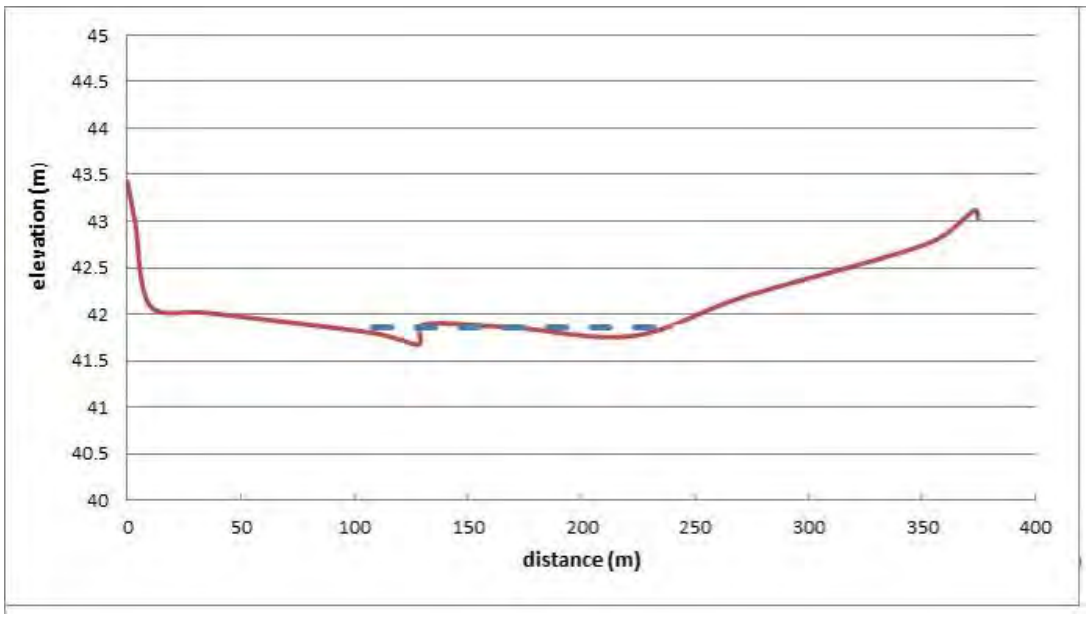


Figure (22) Surface water elevation at sec (X15) - W_6

For comparative analysis, Table (7) summarizes the results of the hydraulic analysis. From this table, the estimated water depth varies between 9 cm at cross

section X8 (W2) and 55 cm at cross section X5 (W1). Similarly, the flow velocity varies between 0.29 m/sec at cross section X8 (W2) and 0.69 m/sec at cross section X9 (W3).

Table (7) Summary of the results of the hydraulic analysis at the wadies outlet

Basin	Cross sec	Peak flow (m^3/s)	Ground surface elevation (m)	Water depth (m)	Surface water elevation (m)	Velocity (m/s)
W_1	X5	12.1	29.7	0.55	30.25	0.66
W_2	X8	1.6	26.7	0.09	26.79	0.29
W_3	X9	7.3	32.7	0.41	33.11	0.69
	X10		29.6	0.32	29.92	0.53
W_4	X11	1.2	37.8	0.15	37.95	0.46
W_5	X13	2.5	36.8	0.24	37.04	0.53
W_6	X15	3.1	41.7	0.16	41.86	0.34

- **Calculated water level and velocity at the border of the PV site**

The previous analysis focused on calculating the water level and water velocity at the outlet of each wadi and before reaching the border of the PV site. Therefore, it is still required to determine the flood characteristics (depth and velocity) at the PV site to evaluate the impact of the flash floods on the project site. Hence, an integrate cross section, X17 as shown in Figure (23), was considered to estimate the surface water profile along the PV border.

The peak flow which is used in the calculation is equal to the summation of all the peak flow from all the wadies (W_1-W_6) in addition to the component of the peak flow from W_1'. The component from W1' is calculated using the ratio between the slope towards the PV site and the slope in the perpendicular direction. The estimated value of this component is about 5.6 m^3/s.

The assumption of having the peak flow from all the wadies at the same time is a sever assumption. However, it represents the worst scenario which assumes that the rainfall storm will occur at different times over the watersheds but due to the lag time effect, the peak discharge of the runoff from each wadi will reach the PV site at the same time. Although this is a sever assumption but it might occur as a

result of the unpredictable behavior of the rainfall storms and the uncertainty in the watershed characteristics.

To illustrate the water surface profile at the PV border, the cross section X17 was divided into three reaches such as X17', X17'' and X17''' as shown in Figures (24), (25) and (26) respectively.

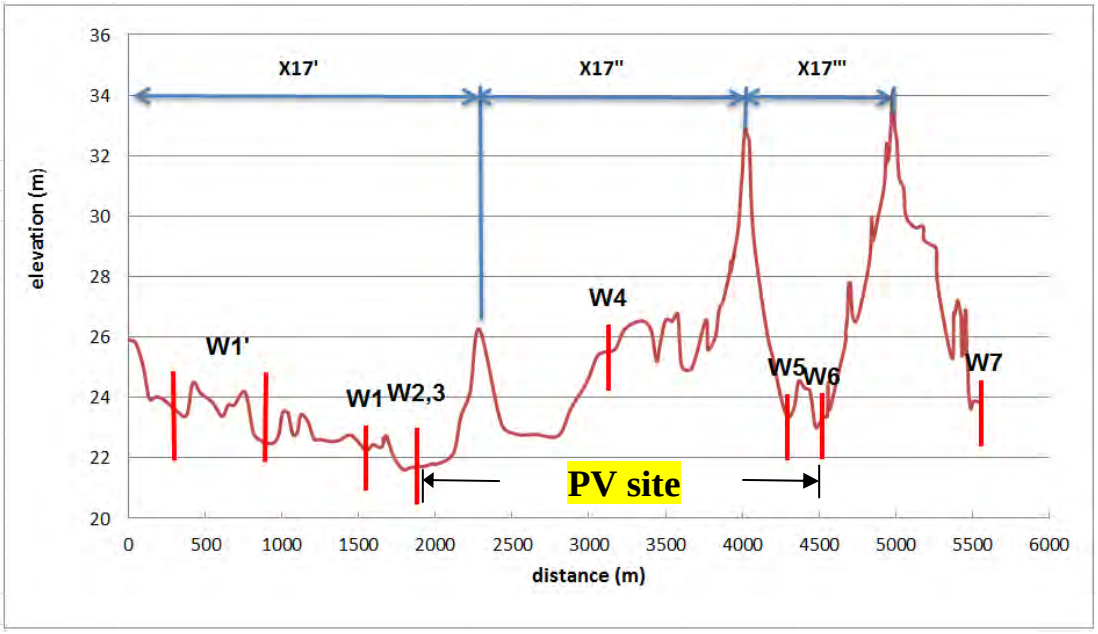


Figure (23) Integrated cross section (X17) at the border of the PV site

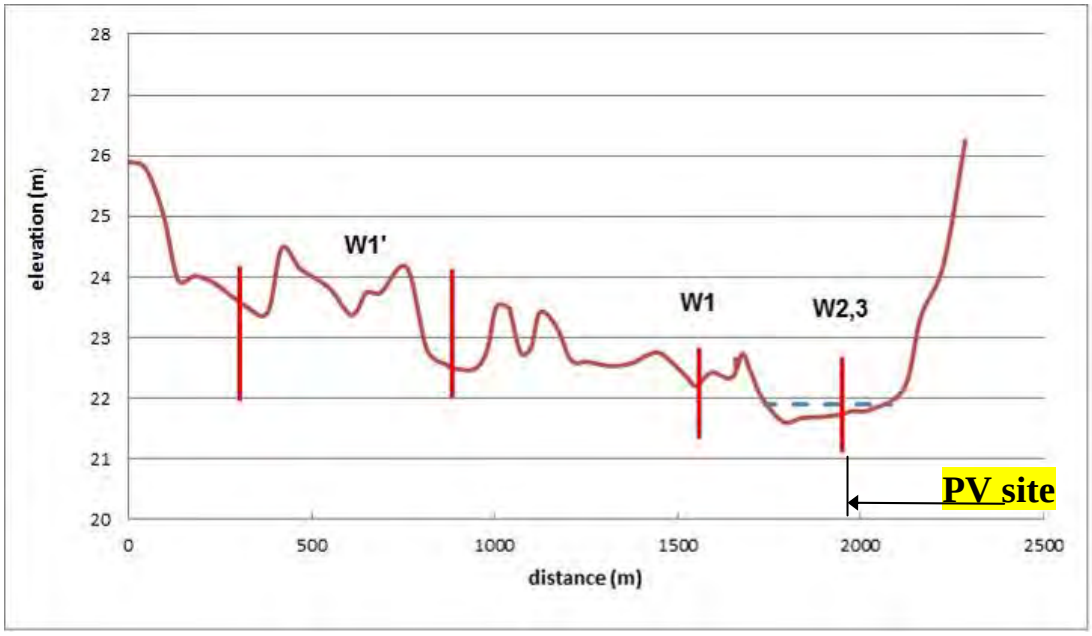


Figure (24) Surface water elevation at cross section X17'

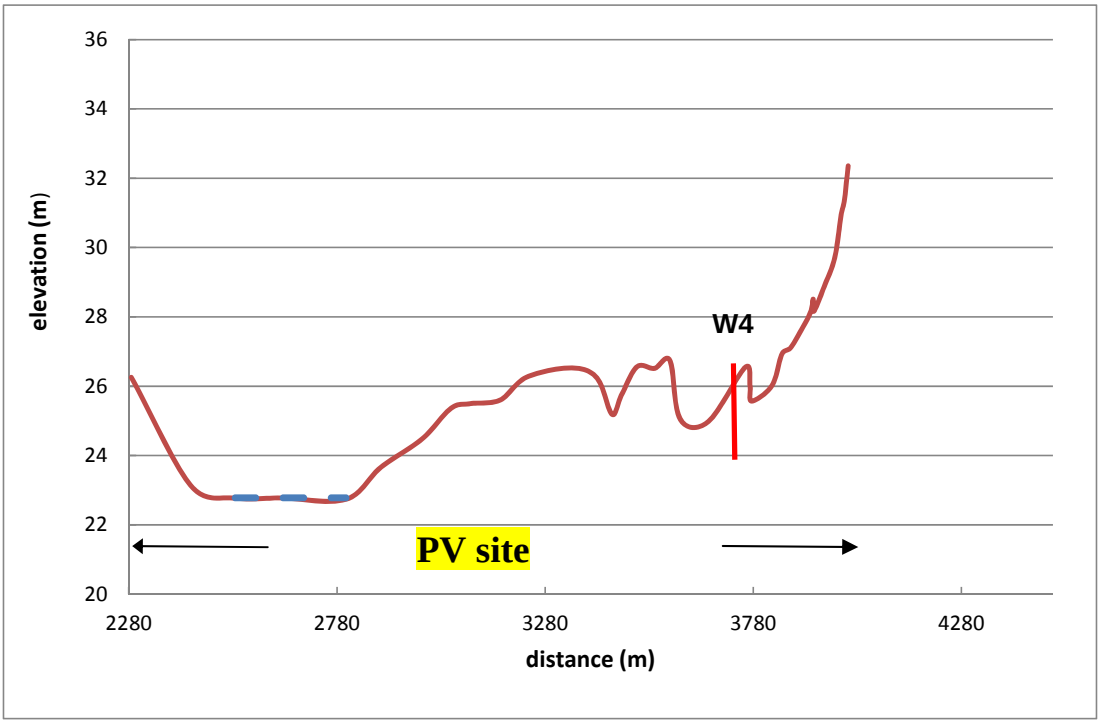


Figure (25) Surface water elevation at cross section X17"

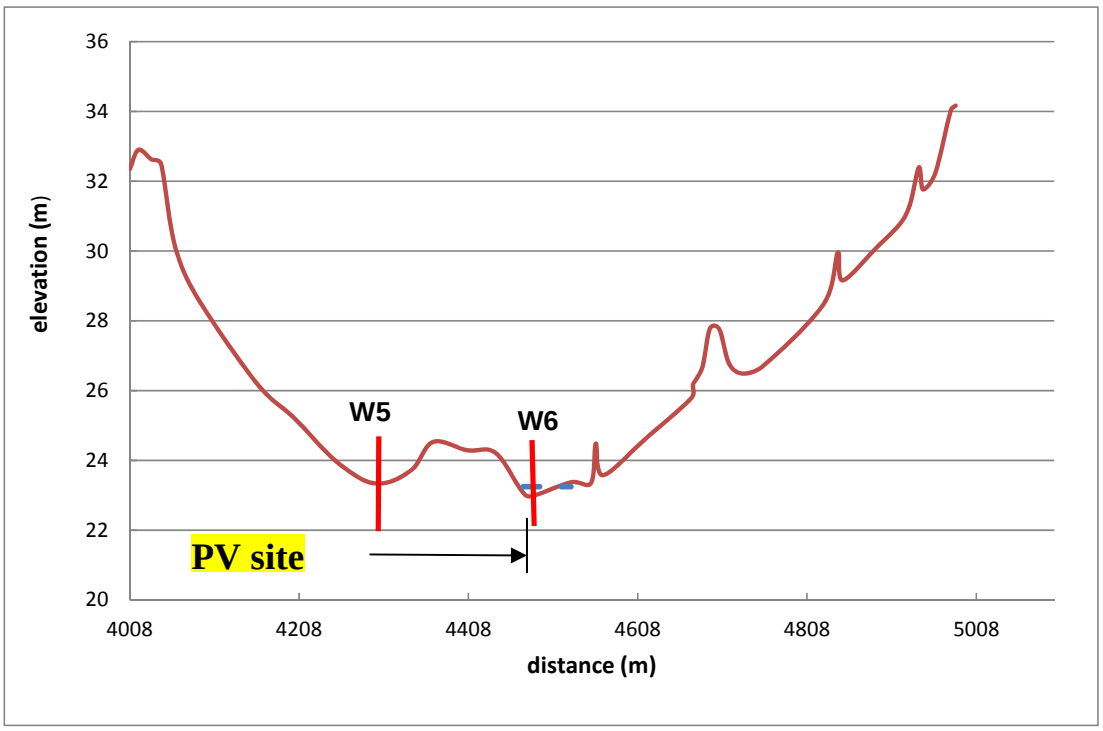


Figure (26) Surface water elevation at cross section X17'"

Table (8) summarizes the results of the hydraulic analysis for the integrated cross section at the PV border. From this table, the estimated water depth varies between 8 cm at cross section X17" and 35 cm at cross section X17"'. Similarly, the flow velocity varies between 0.17 m/sec at cross section X17" and 0.60 cm/sec at cross section X17"'.

Table (8) Summary of the results of the hydraulic analysis at the PV border

Basin	Cross sec	Peak flow (m^3/s)	Ground surface elevation (m)	Water depth (m)	Surface water elevation (m)	Velocity (m/s)	Flood Intensity (m^2/sec)
$W_1'+W_1+W_2+W_3$	X17'	26.6	21.6	0.30	21.9	0.53	0.16
W_4	X17"	1.2	22.7	0.08	22.78	0.17	0.01
W_5+W_6	X17"'	5.6	22.9	0.35	23.25	0.60	0.21

- **Flood Intensity at the border of the PV site**

The flood intensity is represented by the multiplication of the water depth and the flow velocity. By applying this definition, the possible flood intensity varies between 0.01 and 0.21 m^2/sec. According to the Ministry of Water Resources and Irrigation Flood Atlas of Sinai and Aswan, the flood intensity is classified into four categories as follows:

Low: flood intensity < 1 m^2/sec
Medium: flood intensity > 1 m^2/sec and < 3 m^2/sec
High: flood intensity > 3 m^2/sec and 5 m^2/sec
Very High: flood intensity > 5 m^2/sec

Therefore, the calculated value of 0.21 m^2/sec indicates that the flood intensity is low and development in the wadies is permissible after taking the preventive measures.

In this respect, it is worth to mention that the flow velocity at the PV border is moderate and therefore the soil erosion could be managed easily.

10. PROPOSED PROTECTION WORK

A main objective of the field survey is to identify the optimal locations and types of protection works that are suitable for flood protection structures such as dams, lakes, culvert...etc..

The site investigation and the hydrologic analysis revealed that the PV site is subject to the occurrence of flash floods. The historical records indicated that the site experienced several floods in the past years. The last recorded flood was in January 2010. The local people nearby the PV site reported that the water depth at the outlet of the wadies reached more than 0.3 meters. The flood caused a moderate damage to the main roads due to the scouring affects and the random settlement inside the main channel of the wadi. The latest led to reducing the cross section of the wadi and hence increasing the water height and water velocity. Therefore, preventive measures are required to protect the PV site against the possible flash flood.

In this respect, three protection alternatives are proposed as follows:

1. Upstream protection: at the wadi upstream the PV Plant
2. Downstream Flood protection at the borders of the PV plant
3. In-situ Flood protection inside the PV site location

10.1 Upstream Flood protection

The flood control structures may be suggested in the upstream of the catchment by storing the flood water through dams and lakes. These two types of hydraulic structures reduce the peak flow and slow down the flow velocity at the wadi outlet. However, this reduction depends mainly on the storage capacity of such structures and their operation scheme. In order for these structures to be effective in reducing the peak discharge of the flood, a set of dams should be constructed across the main tributaries of the wadi. The dam's solution would be the provision of a large water storage potential, as well as the possible contribution to groundwater recharge and achieve the safety against flash flood and get use of its yield.

Due to the severe topographic conditions namely the steep slopes of the wadies and the lower storage capacity for any proposed dam or lake, the implementation of this alternative is not applicable for our study area.

10.2 Downstream Flood protection (at the boundary of the PV site)

Downstream flood control structures may be suggested in the catchments by implementing diversion channels that collects the surface runoff away from the site. This channel normally ends to the coastal line or the sea.

However, this approach is obstructed due to the complexity of the land use around the study area. The diversion of the water will force the flood to create new paths that might be occupied with the already existing infrastructures such as resorts, roads, industrial facilities…etc. This alternative requires availability of land to construct the channel outside the PV site which is not possible especially near the coastal area. Therefore, this alternative is not applicable to protect the PV site against flash floods.

10.3 In-situ Flood protection (single protection of the solar panels)

This option involves allowing flood water to pass through the PV borders, i.e. not constructing solid fence around the site. In such case, flood protection measures would entail protection of the infrastructures through plant design interventions such as follows:

(a) Allow the flood water to pass through the PV borders; i.e. no solid fence to be constructed at the borders; In case of building a solid fence with a foundation of 30 cm above the ground surface, the flood water might over flow and run inside the PV site. Therefore, it is recommended to have openings in the fence to allow the flood water to pass through main channels to the sea as shown in Figure (27).
(b) Land leveling of the PV site towards the coast;
(c) Avoid structures at the wadies that would lead water running inside the PV site.
(d) Consider the effect of the lateral force from the flood water when designing the foundations of the solar panels/towers.
(e) Consider the effect of the soil erosion around the foundations;
(f) Strengthen the sides of the existing roads inside the PV site;

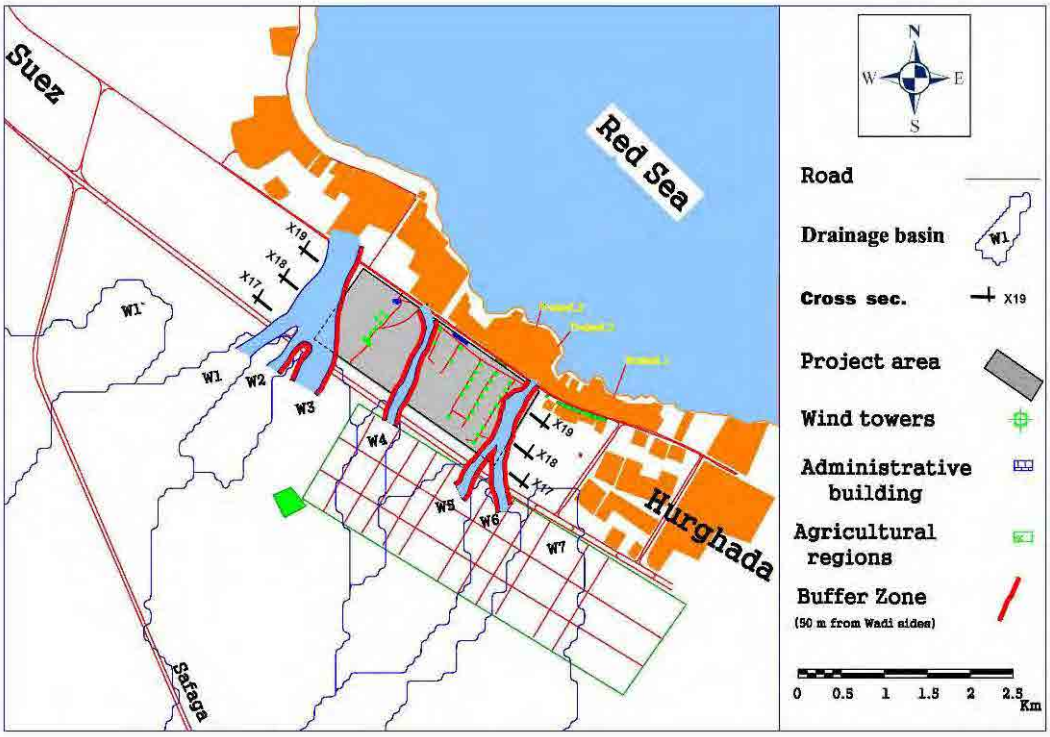


Figure (27) Flood water paths through the PV site

11. CONCLUSION

A comprehensive field topographic survey was carried out to investigate the flood intensity at the PV site. The field data revealed that the PV site is threatened directly by six wadies (W1-W6) with another wadi (W1') located to the north of the PV site that indirectly affect the project site. The historical records proved that the flood water reached the PV site in several occasions. The analysis showed that the water depth varies between 8 and 35 cm and the flow velocity varies between 0.17 and 0.60 m/sec. The flood intensity that describes the power of flash flood varies between 0.01 and 0.21 m^2/sec. This low value of the flood intensity is a good indication that the PV site could resist the damage impact of the expected 100-year flood provided that the flood protection measures will be considered in the construction design (foundation).

The existence of the infrastructures located downstream the PV site along the coastal line constrains the development of flood protection measures outside the PV site. Therefore, it is not recommended to stop or divert the flood water by any diversion structures.

The optimal recommended protection strategy for the PV site is the In-situ Flood protection for the solar panels

In this context, it is important to mention that the assessment was based on a worst case flash flood scenario including hydrologic analysis for a 100-year return period. However, given the expected average life time of the project, 25 – 30 years, the estimated water level and the flow velocity for the 25 or 50 year return period is expected to be less than those calculated for the 100 years, and thus the flood intensity would also be reduced.

Annex 3
List of Scoping and disclosure Meeting Attendees

Photovoltaic Power Plant in Hurghada- Red Sea Governorate - Scoping

No.	Name	Affiliation
1.	Bassem Nagy	Environmental Research and Consultation Center (ERCC)
2.	Hassan Mahmoud Hamady	Red Sea Governorate
3.	Safwat Farag Awad	Red Sea Governorate - Public Relations
4.	Hassan Hamed Ahmed	Canal Electricity Distribution Company
5.	Mostafa Helmy Mohamed	Hurghada City Council
6.	Khamees Gomaa Abdel Salheen	Hurghada City Council
7.	Medhat Mohamed Ibrahiem	General Administration of groundwater in Hurghada
8.	El Sayed Mohamed Mohamed Khaleel	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
9.	Saad Mashhon Emam El Helbawy	Egyptian New & Renewable Energy Authority (NREA)
10.	Tarek Modeer Ibrahiem	Canal Electricity Distribution Company
11.	El Sayed Mahmoud Mansour	Wind Farm Site Manager- NREA
12.	Bassam Fawzy Abbas Sayed	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
13.	Ragab Ahmed Mohamed Kahy	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
14.	Sharqawy Mostafa Baghdady Ali	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
15.	Rashad Aboel Ftooh Badr	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
16.	Mostafa Mohamed Abdel Raoof Zanoon	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
17.	Farag Othman Hamed	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
18.	Tarek Mohamed Saleem	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
19.	Mohamed Abdallah Fareed	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
20.	Mansour Mohamed Abdel Baset	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
21.	Mohamed Faheem Abdel Rasoul Shaltoot	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
22.	Wael Saleh Taher Mohamed	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
23.	Shazly Aboel Hassan Mohamed	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
24.	Helmy Mohamed Hassan Ahmed	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
25.	Ahmed Mareey Ahmed	Egyptian New & Renewable Energy Authority (NREA) - Hurghada
26.	Yasser Mohamed Abdel Salam	EEAA- Red Sea RBO

	Mohamed	
27.	Sayed Mohamed Sayed Madeen	EEAA
28.	Mohamed Abdel Gawaad Ali	General Directorate of Environmental Affairs- Red Sea Governorate
29.	El Nabawy Abdel Megeed Attia	Egyptian Company for Electricity Transmission
30.	Salah Hassan Sayed Abo Aoof	Egyptian New & Renewable Energy Authority (NREA)
31.	Khaled Mohamed Fekry Ismaiel	Egyptian New & Renewable Energy Authority (NREA)
32.	Helmy Aboel Fetooh Ibrahiem	Egyptian New & Renewable Energy Authority (NREA)
33.	Hassan Hasab Allah	Egyptian New & Renewable Energy Authority (NREA)
34.	Abeer Abd Allah Ibrahiem Ghanm	Red Sea Protectorates - EEAA
35.	Waled Ramadan Mostafa	Red Sea Protectorates - EEAA
36.	Mohamed Abdel Wahab Mohamed Ahmed	Institute of Oceanography and Fisheries in Hurghada (Abu Salama Association)
37.	Mohamed Abdel Ghany Abdel Naeem	Red Sea Protectorates - EEAA
38.	Rafeek Youssaf Gorgy	Egyptian New & Renewable Energy Authority (NREA)
39.	Akikov Urago	IC NET Ltd
40.	Afaf Mekhaeel Tawfeek	Egyptian New & Renewable Energy Authority (NREA)
41.	Amani Salah El Saeed	EEAA
42.	Dina Karam	JICA
43.	Abdallah Ali Mohamed Kamed	Egyptian New & Renewable Energy Authority (NREA)
44.	Mostafa Mostafa Mohamed El Shala	Egyptian New & Renewable Energy Authority (NREA)
45.	Ahmed Ali Sadek	Egyptian New & Renewable Energy Authority (NREA)- Hurghada
46.	Saeed Abbas Ahmed El Kholy	Egyptian New & Renewable Energy Authority (NREA)- Hurghada
47.	Yasser Abdel Moneem Abdel Salam Gafar	Wind Farm- Hurghada

Photovoltaic Power Plant in Hurghada - Red Sea Governorate _Disclosure

No.	Name	Affiliation
1.	Khamees Gomaa Abdel Salheen	Hurghada City Council
2.	Mohammed Bekheet Mahmoud	Hurghada City Council
3.	Ahmed Attaya Hassan Mohammed	National Institute of Oceanography and Fisheries in Hurghada
4.	Tamer Kamal El Dein	Read Sea Northern Islands Protected areas
5.	Waheed Salama Hameed	Ministry of Environment
6.	Yasser Saeed	Red Sea Protectorates
7.	Hassan Hassan Ali Hemdan	Reporter in El Masreen and Al Wafed newspapers
8.	Ramadan Shawky Mohammed	Canal Electricity Distribution Company - Red Sea
9.	Ahmed Lasheen	Masr 25 Channel
10.	Tarek Ali Ali Ibrahim	Canal Electricity Distribution Company
11.	Ahsraf Abdel Monem Abdel Aziz	Canal Electricity Distribution Company
12.	Salah Al Awady IFsmail	Electricity Transmission company Red Sea – Canal
13.	Mohammed Ramadan Al Sharkawy	Safaga Transformer Station
14.	Maha Sobhy Hashem	Red Sea News Newspaper
15.	Mahmoud Abdel Radee Dar	National Institute of Oceanography and Fisheries
16.	Lotfy Al Damrany	Al Wafed
17.	Youssef Abu Al Hagag Abdullah	South of Hurghada Transformer Station
18.	Maher Sayed Ali	General Authority of the Red Sea networks
19.	Saeed Makraby Mohammed	South of Hurghada Transformer Station
20.	Mohammed El Sayed Soliman	Al Masry Al Youm
21.	Yasser Mohammed Abdel Salam	Red Sea Regional branch of the EEAA
22.	Shazly Ahmed Awady	EEAA – Hurghada
23.	Gamal Sadek Hassan Abdullah	General Authority of Environmental Affairs - General Bureau
24.	Mohammed Abdel Gawad Ali	General Authority of Environmental Affairs in the Red Sea
25.	Waleed Ramadan Mustapha	Rea Sea Protectorates
26.	Al Sayed Mohammed Al Saeed Saleh	General Authority of Groundwater
27.	Mohammed Abdullah Awady	EEAA
28.	Mohammed Abdel Wahab Mohammed	Institute of Oceanography and Fisheries in Hurghada
29.	Al Nabawy Abdel Megeed Attya	Egyptian Company for Electricity Transmission
30.	Rafik Youssef Geogi	New & Renewable Energy Authority (NREA)
31.	Yasser Mahfouz Saleh	Red Sea Governorate
32.	Salah Helmy Abdullah	Red Sea Networks
33.	Mahmoud Ahmed Mohammed Badawy	Makawy Beach
34.	Maohmmed Abdul Hameed Riad	Governorate Public Relations
35.	Ismail Mohammed Ismail	New & Renewable Energy Authority (NREA)
36.	Salah Hassan Sayed Abu Ouf	New & Renewable Energy Authority (NREA)
37.	Afaf Mikhail Tawfiq	New & Renewable Energy Authority (NREA)
38.	Al Sayed Mahmoud Mansour	Wind Farm Site Manager in Hurghada
39.	Adel Ibrahim Abdel Fatah	Helwan Engineering. Department of Environmental

		Engineering
40.	Khaled Mohammed Fekry Ismail	New & Renewable Energy Authority (NREA)
41.	Helmy Abu El Fotouh Ibrahim	New & Renewable Energy Authority (NREA)
42.	Hassan Hasaballah Ran	Renewable Energy Expert
43.	Ashraf Shazly Hassan	Gas Power Station – Hurghada
44.	Sharkawy Mustapha Baghdady	New Energy Authority (NEA)
45.	Abdul Fatah Mohammed Kamel	New & Renewable Energy Authority (NREA)
46.	Bassem Fawzy Abbas	Energy Authority (EA)
47.	Fawzy Abbas Sayed	New Energy (NE)
48.	Mustapha Mustapha Mahmoud	Energy Authority (EA)
49.	Abbas Dandarawy Ali	New Energy Authority (NEA)
50.	Abdel Basit Abbas Mustapha	Energy Authority – Hurghada (NE)
51.	Helmy Mohammed Hassan Ahmed	Hurghada
52.	Ahmed Boraie Ahmed	New & Renewable Energy Authority (NREA)
53.	Yahia Ali Ragheb	Energy Authority (EA)
54.	Mohammed Hassan Mahmoud Mohammed	New & Renewable Energy Authority (NREA)
55.	Khalefa Mourad	New & Renewable Energy Authority (NREA)
56.	Youssef Hamza Youssef	New & Renewable Energy Authority (NREA)
57.	Ragab Ahmed Mohammed Kelmy	Hurghada
58.	Rashad Abu El Ftouh Badr	Energy Authority (EA)
59.	Shazly Abu El Hassan Mohammed	New & Renewable Energy Authority (NREA)
60.	Mohammed Abdullah Farid	Energy Authority (EA)
61.	Mansour Mohammed Abdel Basit	New Energy Authority (NEA)
62.	Maohmmed Sayed Hassan Ali	Energy Authority – Hurghada (EA)
63.	Shehab Mohammed Saleem	New & Renewable Energy Authority (NREA)
64.	Mahmoud Abu El Hassan Mohammed	New & Renewable Energy Authority (NREA)
65.	Ali Atyatallah Rashid Mohammed	New Energy Authority (NEA)
66.	Al Sayed Mohammed Mohammed Ali	New Energy Authority (NEA)
67.	Mustapha Mohammed Abd El Raouf Farghony	New & Renewable Energy Authority (NREA)
68.	Mohammed Hussien Mohammed	Energy Authority – Hurghada (EA)
69.	Tarek Mohammed Saleem Mustapha	New & Renewable Energy Authority (NREA)

Annex 4
Minutes of Meeting for the PC meeting

Public Scoping meeting for The PV project in Hurghada

Palm Beach Hotel – Hurghada

February 28th, 2012

1. Background

As part of the comprehensive ESIA, a process of public scoping was carried out for identification of environmental concerns of different stakeholders regarding the proposed project. Accordingly, individual scoping meetings were conducted with key stakeholders in Cairo and Hurghada. Following the individual meetings a public scoping meeting was organized to present the stages of the EIA and allow for additional interaction between the different stakeholders as well as with the project team.

The following sections present process of the public scoping meeting and its results

2. Stakeholder Identification

The identification of project stakeholders was based on an analysis of the institutional, legal and administrative framework of the project as well as the project location and activities.

In this context, stakeholders were identified taking into consideration:

- Nature of project
- Location
- Potential impact of the project

The target groups that were invited for the scoping meeting included those who are directly or indirectly involved in the project and those who have expertise and are interested in the topic (e.g. NGOs, scientists). Accordingly, stakeholders included:

- Public (affected community)
- Regulatory agencies and competent authorities
- NGOs and scientific community

Dr. Hassan

3. The Public Scoping Meeting

This meeting is part of the scoping activities and it complements the individual scoping activities carried out within the scope of the project.

The objective of the meeting is to present the project to the stakeholders as well as verifying the preliminary findings of the environmental and social impact assessment study and to discuss any further views and comments related to the project activities.

The scoping meeting witnessed high level of interaction between the different attendees and the project team. The overall feedback from the attendees emphasized the importance of organizing such meeting that gives opportunity to all concerned entities to contribute in the consultation process for the well-being of the community.

The following section summarizes the issues raised during the scoping meeting and the discussions that have taken place.

Presentations

A welcome speech was given by Mrs Samia Mehrez, Deputy of Red Sea Governorate Secretariat General. In her speech she emphasized on the importance of encouraging Egypt's expansion of the renewable energy projects.
Following the welcome speech, Dr. Hassan Rakha, Head of the PV Department at NREA, introduced NREA as a leading entity in the area of renewable energy applications in Egypt and its cooperation with the JICA study team in the project. Dr. Rakha also described briefly the aim of the project and its components as well as its benefits in the national and local context as well as the significance of selecting Hurghada for establishing the project.
Finally, Eng. Amany Salah, of the central Department for EIA and EEAA gave a short word on the role of EEAA in the project and emphasized the importance of renewable energy projects as environmental friendly projects to minimize the dependence on the depletable fossil fuels for energy generation.

Following the welcome speeches, the technical presentations included introduction to the environmental impact assessment process and the objective of the scoping meeting by Eng. Yasser Sherif - General Manager, Environics followed by a description of the EIA process and description of the environmental considerations of the project, by Chem. Amani Nadim, Environics

After the presentations, Eng. Yasser Sherif facilitated the discussions with the participants to obtain their feedback, inquiries and comments on the project.

The topics raised by the attendees during discussions can be categorized into four **main categories as follows:**

Salah Dr. Hassan

- Project location and technology including:
  - selection of Hurghada for establishing the project and alternative locations
  - Impact on the electricity grid
  - Panel cleaning method
  - PV panels manufacturing

- Impacts of the project on the environment
  - Water sources and wastewater management
  - Noise
  - Waste management
  - Transportation of project components
  - Impact on work place
  - Public health

- Impacts of the environment on the project
  - Flash flood impact
  - Impact of dust
  - Impacts of high temperature

- Socio-economic aspects
  - Employment and training
  - Aesthetic impacts

During the discussions, the issue related to potential impact on migratory birds was raised. It was clarified that this project does not have any impact on the birds and thus such impact is considered irrelevant to the project activities.

Another issue related to consultation with the tourists and the investment authorities is required for this project. It was clarified that such entities, who are not directly concerned with the project, would be invited through the newspaper advertisement at the disclosure stage of the EIA.

Salah Dr. Hassan

Salah

Summary of discussions and inquiries

Topic	Inquiries/comments	Response	Action to be taken	Responsible party
I) Project location and technology				
Selection of Hurghada for establishing the project	The reason for selecting Hurgdada for establishing the project and could it be replicated in other areas.	It was clarified that the reasons for selecting Hurghada include: - Availability of land area, as the project will be installed on the existing wind farm site that is owned by NREA - The proximity of existing electricity grid and connection lines - PV project locations preferred to be in the southern hemisphere close to the equator. - The suitable weather conditions particularly clear sky and high solar radiations which favor this site It was also clarified that the project is the first of its kind in Egypt at utility level. Upon the successful operation of this pilot project, it could be replicated in other areas.		
Impact on the unified electricity grid	The impact of converting the DC current to the AC current on the harmonics of the unified electricity grid	The inverters that will be used by the project are compatible with the national grid and their frequency meets the connection requirements to the unified electricity grid.		
PV panels cleaning	- The question was raised about the cleaning method of the PV panels. It was commented that given the expected huge number of arrays, a mechanical cleaning method is to be used instead of	The project team clarified that the PV panel cleaning options are still under investigation and these include water cleaning and/or dry cleaning depending on the dust impact experiments currently undergoing at the site. This should take water consumption as an issue of concern	Take decision on whether wet cleaning will be considered and quantity of fresh water consumption required for cleaning	JICA study team

Dr. Hassan

Salah

Topic	Inquiries/comments	Response	Action to be taken	Responsible party
	the manual method using labour. - Another recommendation was made to use anti repulsion coating material to prevent dust from accumulation on the panels' surface. In addition, fine brushing could be used to remove the dust and to avoid scratching of panel.			
PV panels manufacturing	- A question was raised related to the Life Cycle Assessment (LCA) of the PV panels, namely the energy consumption for manufacturing the PV panels and the period required for the project to compensate such energy - A question whether the PV panels will be manufactured in Egypt.	It was clarified that the panels will not be manufactured in Egypt and will be acquired from the international market. Regarding the LCA of the panels, it was clarified that the energy consumed during manufacturing is a particularly important issue at the manufacturing country and need to be considered as tool to minimize the impact on resources at the various stages of the products life cycle. However, for the case of Egypt, the main issue is related to minimize the fossil fuel consumption for energy generation by using PV technology..		
II) Impact of the Project on the Environment				
Water resources for panel cleaning	If water is to be used for cleaning purposes, then the amount if water and its source need to be specified taking into account that fresh water is a scarce resource in the area of Hurghada.	The project team clarified that the decision for cleaning method has not yet decided. The options include dry and wet cleaning. If wet cleaning is selected, the cleaning technology will take into consideration the resources conservation approaches when determining the water quantities required. However, the expected water requirements would be minimal	Decision on wet / or dry cleaning process	JICA study team
Wastewater management	Management of the potential wastewater from panel cleaning should be addressed by the project.	It was clarified that management of potential wastewater, if applicable, will be addressed in detail in the EIA report.		

Salah

Topic	Inquiries/comments	Response	Action to be taken	Responsible party
Waste management	- A question was raised regarding the disposal of the PV panels including hazardous materials at the end of the project life time. - The issue of storage batteries disposal was also raised. It was mentioned that without battery storage, the PV plant will not contribute to meeting the peak demand.	- It was clarified that most types of PV panels do not include hazardous constituents as the main raw material for manufacturing is silicon oxides. However, some PV panel types can include small amount of Cd (cadmium) which is considered a hazardous substance. It is expected that the project will not use PV cells that include Cd as a constituents. Moreover, most Solar PV manufacturers around the world implement programs for take back of decommissioned solar panels and recycle the panels responsibly. In this context, the possible options for PV panels' disposal will be investigated and presented in the EIA and the most suitable option will be determined. - Regarding storage batteries, it was clarified that the issue of storage has not yet been decided by the project team. However, in case batteries are used, the proper management and disposal will be addressed in the EIA report.	Decision regarding the use of storage batteries	JICA study team
Noise	The question of impact of noise on the surrounding community was raised	It was clarified that the potential impacts of noise will be assessed during construction and operation in the EIA report. - ***Noise during construction***: It was clarified that potential noise during construction is localized and short term. However, proper mitigation measures will be taken to consideration such as avoid carrying out noise generating activities during the night and ensure proper maintenance for the construction machinery. - ***Noise during operation***: noise generation		

Salah

Topic	Inquiries/comments	Response	Action to be taken	Responsible party
		sources will be assessed in the EIA report. However, based on the preliminary assessment according to the project location and surrounding activities, it is expected that the noise impact is insignificant as the nearest receptor is at about 500m northern the site. Moreover, potentially noise generating equipment, namely the transformers and inverters will be placed in proper enclosure which would minimize the noise reaching the sensitive receptors. This will be more detailed in the EIA report	Provision of data regarding the expected noise levels of the noise generating sources (transformers/inverters)	JICA study team
Transportation	The impact of transportation of project components on the surrounding roads	It was clarified that the potential impacts of transportation will be assessed in the EIA report. It was clarified that the impact is only during construction activities for short term compared to the project lifetime. Besides, the project location is surrounded by two major highways.		
Electromagnetic waves	- ***workplace***: impact of electromagnetic waves on the workers during panel maintenance activities - ***public health:*** Impacts of electromagnetic waves on the public health	- ***workplace***: it was clarified that the maintenance activities are usually carried out during night time when panels are not in operation so no electricity generation at that time. Moreover, maintenance will be carried out by authorized personnel and according to the proper instructions and guidelines. - ***public health***: it was clarified that the project does not entail construction of new high voltage networks, but it will connect to the existing transmission lines.	Provide information about potential electromagnetic waves	JICA study team

Dr. Hassan

Topic	Inquiries/comments	Response	Action to be taken	Responsible party
III) Impacts of the environment on the project				
Flash Floods	Questions were raised regarding potential impacts of flash flood on the project and the protection measures to be taken	Based on investigating of the flash flood potential in the project area as well as the results of the individual scoping meetings, it was indicated that the flash flood impacts are generally moderate thus no destructive impacts are to be expected. It was also indicated by the representative of the ministry of water resource irrigation in Hurghada that the government is trying to develop a regional flood protection plan for all activities in the area in cooperation with the different concerned authorities. However, further precautions may be required to investigate ensure safety of equipment and personnel.	Investigate possible flood protection	JICA study team
Dust	The potential impact of dust on the PV efficiency was raised	The issue is being investigated at the site through installation of two model panels. In addition, techniques for periodic dust cleaning are also investigated.	Investigate dust cleaning options	JICA study team
Temperature	The issue of reduction of PV efficiency at elevated temperature was raised.	It was clarified that different PV types are affected differently by rise in temperatures; therefore the project will select the optimum PV cells that are suitable for the climatic conditions in Egypt.		
IV) Socio-economic impacts				
Employment and training	It was mentioned that the EIA is to address the impacts of the project in terms of providing job opportunities	It was clarified that the socio-economic aspects of the project are a major component of the EIA report and these issues will be addressed in the report.	Provide expected number of employees	NREA/ JICA study team

Topic	Inquiries/comments	Response	Action to be taken	Responsible party
	to the surrounding communities as well as training to workers.	NREA also clarified that this is the first project of its kind in Egypt and therefore and will have a very important role in the capacity building, similar to the first wind projects NREA has implemented several years ago.		
Aesthetic impacts	It was commented that the PV panels may have adverse aesthetic impact on the surrounding communities. Recommendations for minimizing such impacts is to introduce short plantations around the site	It will not have any significant aesthetic impacts.		
Future Land use plans in the area	The need for identifying the future urbanization plan of the area was raised during discussion to enable identifying the potential socio-economic impacts of the project.	The development plans for the area will be investigated and referred to in the EIA report.	Investigate and review the future development plans for the area	Environics

4. Conclusion of the Scoping meeting

The meeting gave the opportunity to the different entities to interactively comment on the different aspects of the project with the project team and the environmental consultant.

All attendees expressed their support to the different types of renewable energy projects in Egypt

Salah Abaoud. Dr. Hassan H. Rakha
4/4/2012

Minutes of the Public Disclosure Meeting for 20MW Photovoltaic Power Plant Project in Hurghada

Palm Beach Hotel – Hurghada

October 9th, 2012

1. Background

As part of the comprehensive ESIA, a process of public scoping was carried out for identification of environmental concerns of different stakeholders regarding the proposed project. Accordingly, individual scoping meetings were conducted with key stakeholders in Cairo and Hurghada. Following the individual meetings a public scoping meeting was organized to present the stages of the ESIA and allow for additional interaction between the different stakeholders as well as with the project team. After preparation of the draft ESIA report, a public disclosure meeting has been carried out to present the results of the ESIA to the stakeholders and discuss the proposed mitigation measures. Stakeholders where invited to the meeting through personal invitations as well as a newspaper advertisement in Al Ahram newspaper on 29th September 2012. In this respect, a brief summary of the findings of the environmental and social impact assessment was prepared and sent to stakeholders with the invitation letters. For public access, the findings have been published on NREA website as well as at the Hurghada Wind Farm office.

The meeting took place on Tuesday 9th of October, 2012 at Palm Beach Hotel in Hurghada. The following sections present process of the public scoping meeting and its results.

2. The Public Disclosure Meeting

The meeting witnessed high level of interaction between the different attendees and the project team. The overall feedback from the attendees emphasized the importance of organizing such meeting that gives opportunity to all concerned entities to contribute in the consultation process for the well-being of the community.

The following section summarizes the issues raised during the disclosure meeting and the discussions that have taken place.

Presentations

A welcome speech was given by General/ Saad El Din Amin Secretariat General of Red Sea Governorate. In his speech he emphasized on the importance of encouraging Egypt's expansion of the renewable energy projects to meet the continuous drastic increase in the Egyptian market demand on energy sources.

Following the welcome speech, Eng. Khaled Fekry, Head of the Research and Studies Department at NREA, introduced NREA as a leading entity in the area of renewable energy applications in Egypt and its cooperation with the JICA study team in the project as well as NREA's expansion plans in exploration of renewable energy projects.

Following the speech of Eng. Fekry, Mr. Masaki Kudo, Representative, JICA Egypt Office Japan International Cooperation Agency (JICA) presented the unique and distinctive characteristics of Egypt that qualifies it as a major renewable energy generator as well as a touristic place. In his word, Mr. Masaki emphasized the long cooperation between Egypt and JICA in the different development projects particularly the renewable energy sector. He also highlighted the importance of public consultation activities in enhancing the interaction and cooperation between the public and the project.

Finally, Eng. Amany Salah, of the central Department for EIA and EEAA gave a short word on the role of EEAA in the project and emphasized the importance of renewable energy projects as environmental friendly projects to minimize the dependence on the depletable fossil fuels for energy generation.

Following the welcome speeches, the technical presentations included introductory presentation by Eng. Yasser Sherif - General Manager, Environics presenting the objective of the public disclosure meeting and its importance in the ESIA process. The presentation also summarized the results of the public scoping meeting that took place in February 2012 and how the issues raised where incorporated in the ESIA report.

Following the introductory ESIA presentation, the results of the ESIA were presented by Chem. Amani Nadim, Environics including description of the project components and it surrounding environment as well as identification of the potential impacts and their recommended mitigation measures.

Finally, the flash flood assessment studies were presented by Geo. Ayman Afifi – Environics which included description of the flood assessment process and its results.

After the presentations, Eng. Yasser Sherif facilitated the discussions with the participants. Comments were made either verbally during the discussions or in writing through submission of a comments form, which was distributed to the attendees at the beginning of the meeting.

The topics raised by the attendees during discussions can be categorized into the three **main categories as follows:**

- <u>Project location and technology including:</u>
  - Project locations
  - Panel types
  - Use of storage batteries

- Supply of project components
- Project implementation schedule

- Impacts of the project on the environment
  - Water sources and wastewater management
  - Waste management
  - Impacts on migratory birds
  - Impact on marine environment

- Impacts of the environment on the project
  - Impact of Flash flood
  - Impact of dust
  - Impact of wind

- Socio-economic aspects
  - Employment and training
  - Landuse management
  - Aesthetic impacts
  - Egyptian components in the project
  - Public contribution to the project discussions.

- Other issues

Other issues were raised regarding the type of JICA contribution to the project implementation and whether this contribution is in form of loans or grants. It was clarified that JICA contributed through a grant for preparation of the project feasibility study. The project implementation will be carried out through a loan. However, the precise details of the project execution are currently under discussion between NREA and JICA. In addition, the issue of reflection of the ESIA results on the project design. It was clarified that the ESIA is one of the main tools that supports the project design. This is manifested in investigating the panels' foundation design to resist the flash flood, and the selection of the panel cleaning process.

Summary of Discussions

Topic	Inquiries/comments	Response
I) Project location and technology		
Alternative project location	Mr. Wahid Salama, Head of Red Sea Protectorate indicated that alternative locations for establishing the project should be investigated because land area need to be preserved for touristic development in the area.	It was clarified that the land has been allocated for NREA since 1980's and that the plans of the General Organization for Physical Planning till 2020 for Hurghada has allocated the area for renewable energy projects. Moreover, a renewable energy project already exists in the area and preserving the area for touristic development would mean relocation of the existing project which is not a viable option. In addition, the site has been developed for wind farm; therefore, using the same area for another project is an added value to the land. Legally, the land administrative agency is Red Sea Governorate. If the governorate has another plan for the landuse, they would have asked NREA to close down or move the wind farm project. Logistically, moving the wind farm to another site would require a lot of cost for moving the existing structures, which is not a practical option.
Types of PV panels	- Mr. Ahmd Fathy – Owner of Middle East Company - private company indicated that there exist studies concluding the most suitable types of panels to be used, these need to be used by NREA in deciding the type of panels. - Eng. El Nabawi Atteia – Projects consultant at EETC recommended that the criteria for panel selection need to take into consideration the potential for manufacturing such panels in Egypt using the available natural resources. - A question whether the PV panels and other components will be supplied from Japan was also raised.	It was clarified that panel type selection depends on various parameters include but not limited to site natural characteristics such as solar radiation, temperature and dust, etc..In this respect, 16 Japanese experts have been investigating the site specific characteristics over one year to enable selection the most suitable panel types for this specific location. Moreover, it was clarified that the project is the first of its kind in Egypt on the commercial scale which is expected to open the door to other similar project. The project presents also an opportunity for technology transfer in Egypt. In this respect, the potential for manufacturing such panels in Egypt would need to be investigated for future projects. It was clarified that the supply source of the panels and other project components are not yet decided, They can be provided from Japan or any other international market. However, some components/feeding components will be provided from the local market.

Topic	Inquiries/comments	Response
Use of Storage batteries	- Eng. El Nabawi Atteia commented on the issue regarding return of the NAS batteries to supplier at the end of its life time. He commented that it might be the case that the battery supplier is out of business at the time of battery return. In such case other management options need to be investigated which would pose burden on the project. In this regard, it is recommended to use lead batteries which are common in the local market and have an established recycling system on the national level. - It was questioned whether the capacity of the batteries (2MW) is enough for electricity storage.	- JICA study team clarified that at the end of life of NAS batteries (at full discharge) the batteries can be safely disposed of. Although recycling of NAS batteries is not yet established in Egypt, JICA study team would provide guidelines/support on the recycling technologies. However, it should be pointed out that the decision regarding the battery type has not been taken yet. - It was clarified that most electricity generated will be provided immediately to the national electricity grid. Only excess generated energy will be charged in batteries. The excess energy is not expected to be large quantities, therefore the 2MW batteries would be sufficient to store the excess energy.
Project implementation schedule	What is the time for project implementation?	NREA advised that it is expected that the project will start its construction activities by April 2013.
II) Impact of the project on the environment		
Water resources for panel cleaning	Mr. Ahmd Fathy – Owner of Middle East Company - private company indicated that the water quantities required for cleaning might need to be more than $100m^3$/month.	It was clarified that required water quantity has been identified based on continuous monitoring over a whole year.
Waste management	A question was raised regarding the disposal of the PV panels at the end of the project life time.	- It was clarified that the main raw material for manufacturing the PV is silicon oxides and metal frames these will be managed as non-hazardous waste or sold for recycling as they contain substances such as glass, aluminium and semiconductor materials that can be successfully recovered and reused in other relevant products. - Regarding storage batteries, it was clarified that for the case of using NAS batteries these will be returned to the supplier, whereas lead batteries will be managed as hazardous waste according to the requirements of Environmental Law 4/1994. The lead batteries can be recycled within the battery recycling system in Egypt.

Topic	Inquiries/comments	Response
Impact on Migratory birds	Mr. Wahid Salama – Head of Red Sea Protectorate commented that the reflective characteristics of the panels would adversely affect the migratory birds.	Up-to-date literature on solar PV panels demonstrates that there are no impacts on birds. It was clarified that the panels are treated with antireflective coating such that the surface do not reflect the sun radiations to achieve maximum absorption and hence maximum electricity generation efficiency. In this respect the panels' surfaces will not pose adverse impacts on the migratory birds.
Impact on the marine environment	Mr. Yasser Said – Red Sea Protectorate inquired about the impact of the project on the marine environment.	It was clarified that the project activities do not have any interactions with the marine environment and hence no impact is expected.
III) Impact of the environment on the project		
Impact of Dust	The potential impact of dust on the PV efficiency was raised.	It was clarified that the panels manufacturing has been designed in a such a way that would resist the dust impact, moreover, the periodic cleaning will minimize the potential impacts of dust. The issue has been investigated over a whole year at the site through installation of two model panels. In addition, techniques for periodic dust cleaning are also investigated. Accordingly the cleaning process and frequency has been identified, namely panel washing with water once per month using about $100m^3$/month of water.
Impact of flash flood	The potential erosion impact on the foundations has been raised.	It was clarified that the flash flood study has been prepared in cooperation with the National Water Resources Research Institute (WRRI) - Ministry of Water Resources and Irrigation. The study has adopted a conservative approach in assign the potential flood impacts. In this respect, the study has indicated that the flood intensity is low and the recommended protection measures included mainly strengthening the panels' foundation to withstand the lateral forces of the flood. In addition, floodways have been protected; no structures are allowed on these water pathways. The new Egyptian flood code will be enforced adding more buffer protection to these ways to about 50 m width for each stream.
Impact of wind	The impact of wind on the panels was raised and whether the strong winds during the months of February and March can affect the stability of the panels.	It was clarified that investigating the site characteristics included monitoring of the wind in the area and accordingly the foundation design took the wind speed and direction into consideration.

Topic	Inquiries/comments	Response
IV) Socio-economic aspects		
Employment and training	– Ms. Ghada El Sherbiny – Association of Strong Egypt inquired about the number of Egyptian employees at the project. She also inquired about the direct benefit of the project to the average Egyptian citizen.	It was clarified that the project will provide around 250 work opportunities during construction phase and around 70 job opportunities during operation. This is in addition to enhancing other feeding industries and services to the project. Mr. Khaled Fekry of NREA also clarified that priority in hiring will be for the surrounding communities and Hurghada residents. Regarding the direct benefits to the individual Egyptian people, it was clarified that the project being the first of its kind in Egypt is a good opportunity for the country to explore one of its major natural resources not yet used to match the high potential, and is to be regarded as a tool for technology transfer and education so that it opens the door to many other projects. Eng. Afaf Tawfic of NREA also added that the project open to receive visitors from different entities and institution to promote the renewable technology.
Aesthetic impacts	Eng. Salah Ouf – NREA inquired about the potential of trees plantation around the site	It is not expected that the aesthetic impacts are significant. However, the plantation option is faced by a main constraint which is the scarcity of water in the area. Moreover, plantation would attract birds which droppings would adversely affect the panels. Moreover, trees shadows can reduce the efficiency of the panels. Plantation also would create an artificial habitat attracting insects which would impact the panels efficiency; literature reveal that insect eggs on panels is a main issue.
Public Contribution to the PC meeting	Mr. Mohamed Awad – MP commented on the public contribution to the meeting and that more people needed to be invited to the meeting.	It was clarified that this meeting is the second public meeting for this project. Invitations have been sent to various of stakeholders, in addition to a public invitations were published in Al Ahram newspaper so that all interested individuals and entities are invited. In this respect, it is important to point out that the responsibility of the project owners is mainly to invite the public to the meeting by following the procedures determined by the regulatory entity, namely EEAA.

Other comments received through the comment forms included mainly encouragement to expand in implementing such project that would meet the continuous increase in electricity demand in Egypt. Other recommendations included encouraging the touristic villages in the area to use solar energy to provide their energy needs.

3. Conclusion of the Disclosure meeting

The meeting gave the opportunity to the different entities to interactively comment on the draft ESIA components of the project with the project team and the environmental consultant.

All attendees expressed their support to the different types of renewable energy projects in Egypt.

Afa|M RY

RY

Salam. 1/11 (24) HT (5)

Appendix 7-1: Template Form for "Contribution of a Project in Sustainable Development"

Appendix 7-1 Template Form for "Contribution of a Project in Sustainable Development"

Att: Dr. Eng. Ezzat Lewis Hanalla
Head of Climate Change Central Department
Coordinator of Egyptian Designated
National Authority- DNA for CDM

Fax: 2524 61 62

From: [Name of the Head of national authority/company]
[Title]

Date: / /2010

Subject: Request for DNA's Letter of No Objection for [project title] for Application as a CDM Project

Dear Dr. Mansour,

Reference is made to the a/m subject, kindly be informed that [name of national authority/company] hereby confirms that the said project contributes [positively/fairly/in an acceptable range/negatively] to sustainable development of Egypt through supporting the main three pillars of sustainable development, Economic Sustainability, Social Sustainability and Environmental Sustainability.

For Economic Sustainability:

[Explain in brief how the project contributes in sustainable development of Egypt from the point of view of Economic Sustainability]

For Social Sustainability:

[Explain in brief how the project contributes in sustainable development of Egypt from the point of view of Social Sustainability]

For Environmental Sustainability:

[Explain in brief how the project contributes in sustainable development of Egypt from the point of view of Environmental Sustainability]

Kindly accept my best regards, I remain

Sincerely yours,

[Name of the Head of national authority/company]

[Title]

Appendix 7-2: Template Form for "Confirmation of Voluntarily Participation in a Project"

Appendix 7-2 Template Form for "Confirmation of Voluntarily Participation in a Project"

Att: Dr. Eng. Ezzat Lewis Hanalla
Head of Climate Change Central Department
Coordinator of Egyptian Designated
National Authority- DNA for CDM

Fax: 2524 61 62

From: [Name of the Head of national authority/company]
[Title]

Date: / /2010

Subject: Request for DNA's Letter of No Objection for [project title] for Application as a CDM Project

Dear Dr. Mansour,

Reference is made to the a/m subject, kindly be informed that [name of national authority/company] is participating in the project willingly and voluntarily, in view of its positive impact and benefit to sustainable development of Egypt.

Kindly accept my best regards, I remain

Sincerely yours,

[Name of the Head of national authority/company]
[Title]

Appendix 7-3: Template Form for "Confirmation of no Official Development Assistance (ODA) will be diverted to the Project"

Appendix 7-3 Template Form for "Confirmation of no Official Development Assistance (ODA) will be diverted to the Project"

Att: Dr. Eng. Ezzat Lewis Hanalla
Head of Climate Change Central Department
Coordinator of Egyptian Designated
National Authority- DNA for CDM

Fax: 2524 61 62

From: [Name of the Head of national authority/company]
[Title]

Date: / /2010

Subject: Request for DNA's Letter of No Objection for [project title] for Application as a CDM Project

Dear Dr. Mansour,

Reference is made to the a/m subject, kindly be informed that [name of national authority/company] hereby declares that the a/m project will be financed through [……] and that no ODA will be diverted for such purpose.

Kindly accept my best regards, I remain

Sincerely yours,

[Name of the Head of national authority/company]
[Title]

Appendix 7-4: Draft Project Idea Note (PIN)

Appendix 7-5 Draft Project Idea Note (PIN)

Arab Republic of Egypt		جمهورية مصر العربية
Ministry of State for Environmental Affairs		وزارة الدولة لشئون البيئة
Egyptian Environmental Affairs Agency		جهاز شئون البيئة
Egyptian Bureau for Clean Development Mechanism		المكتب المصري لآلية التنمية النظيفة
———	(EB-CDM)	———

Draft Project Idea Note (PIN)

Description of size and quality expected of a PIN

Basically a PIN will consist of approximately 5-10 pages providing indicative information on:

- **A.** Project participants
- **B.** Project description, type, size, location and schedule
- **C.** Avoided / reduced GHG emissions
- **D.** Financial aspects
- **E.** Expected environmental and socio-economic benefits
- **F.** Risks
- ***G.*** Other relevant information

The completed PIN and attachments should be sent to:

Ministry of State for Environmental Affairs (*MSEA*)

Egyptian Environmental Affairs Agency (*EEAA*)

Egyptian Designated National Authority (*DNA*)

Egyptian Bureau for Clean Development Mechanism (*EB-CDM*)

Tel/Fax: (202) 2524 61 62

30 Misr Helwan El-Zyrea Rd., Maadi, Cairo

P.O. Box : 11728 Maadi, Cairo, Egypt

E.Mail : ccu@eeaa.gov.eg

Arab Republic of Egypt
Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency
Egyptian Bureau for Clean Development Mechanism

(EB-CDM)

جمهورية مصر العربية
وزارة الدولة لشئون البيئة
جهاز شئون البيئة
المكتب المصري لآلية التنمية النظيفة

Project Idea Note
Photovoltaic Power Plant Project

A- Project Participants

Project title	Photovoltaic power plant project
Project developer (proponent)	New & Renewable Energy Authority (NREA)
Name of the project developer	
Organizational category	Government agency
Other function(s) of the project developer in the project	Operational entity
Summary of the relevant experience of the project developer	NREA acts as the national focal point to develop and introduce renewable energy technologies to Egypt on a commercial scale together with implementation of related energy conservation programs.
Address	Ext. Abbass El-Akkad St. El-Hay El-Sades. Nasr City, Cairo, Egypt
Contact person	Name of the Project Development Manager
Telephone / fax	
E-mail and web address, if any	
Project sponsors	
(List and provide the following information for all project sponsors)	
Name of the project sponsor	New & Renewable Energy Authority (NREA)
Organizational category	Government agency
Address (include web address, if any)	Ext. Abbass El-Akkad St. El-Hay El-Sades. Nasr City, Cairo, Egypt
Main activities	NREA act as the national focal point to develop and introduce renewable energy technologies to Egypt on a commercial scale together with implementation of related energy conservation programs.
Summary of the financials	*Summarize the financials (total assets, revenues, profit, etc.) in less than 5 lines.*
Cooperation with Annex 1 countries (*mention types of cooperation such as equity participation, foreign direct investment, buyer of CERs and/or services provided (documentation, technical, design and supplier of equipment*)	

30 طريق مصر حلوان الزراعي – خلف فندق سوفيتل المعادي – القاهرة الرقم البريدي 11728ت:25246162 فاكس: 252461622
30 Misr Helwan El-Zyrae Rd., Maadi Cairo Egypt P.O. 11728 Tel: 25246162 Fax: 25246162
e-mail: ccu@eeaa.gov.eg URL: http://www.cdm-egypt.org

Arab Republic of Egypt
Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency
Egyptian Bureau for Clean Development Mechanism

(EB-CDM)

جمهورية مصر العربية
وزارة الدولة لشئون البيئة
جهاز شئون البيئة
المكتب المصري لآلية التنمية النظيفة

B. Project Description, Type, Size, Location and Schedule

Technical Summary of the Project	
Objective of the Project	The proposed photovoltaic power plant project will generate electricity free of green house gases to supply to the Unified Electric Grid in Egypt (national grid) replacing electricity that would otherwise have been generated from conventional power plant using fossil fuel.
Project description and proposed activities (including a technical description of the project)	The project is the first commercial scale photovoltaic power plant in Egypt to deliver electricity to the national grid. The rated capacity of the power plant is 20 MW.
Technology to be employed	The project uses (multilayer (tandem) (128Wp)) modules. 40 units of 500 KW inverters are used to convert DC power to AC power. (High performance energy storage batteries are installed to avoid any adverse effect to the national grid by fluctuations of output of photovoltaic power plant.)
Type of Project	
Greenhouse gases targeted	CO_2
Type of activities	Abatement
Field of activities	
a. Energy supply	Renewable Energy /Photovoltaic electricity/ generation of capacity factor is 17 – 19%, depend on the type of PV modules
b. Energy demand	Not applicable
c. Transport	Not applicable
d. industrial processes	Not applicable
e. waste management	Not applicable
Location of the Project	
Governorate	Red Sea
City	Hurghada
Brief description of the location of the plant	Site location is situated in northern part of Hurghada city near by El-Gouna town. Photovoltaic modules are installed into available spaces in the wind farm area avoiding the existing wind facilities.
Expected schedule	
Earliest project start date	Year in which the plant will be operational
Estimate of time required before becoming operational after approval of the PIN	Time required for financial commitments: xx months Time required for legal matters: xx months Time required for negotiations: xx months Time required for construction: xx months
Expected first year of CER delivery	Year
Project lifetime	21 years
Current status or phase of the project	Feasibility study phase
Current status of the acceptance of the Host Country	Preparing the request of letter of No Objection
The position of the Host Country with regard to the Kyoto Protocol	Egypt signed and ratified the Kyoto Protocol.
Project Size	
Is the project a small-scale project?	No, the project is large scale (20 MW)

30 طريق مصر حلوان الزراعي – خلف فندق سوفيتل المعادي – القاهرة الرقم البريدي 11728ت:25246162 فاكس: 252461622
30 Misr Helwan El-Zyrae Rd., Maadi Cairo Egypt P.O. 11728 Tel: 25246162 Fax: 25246162
e-mail: ccu@eeaa.gov.eg URL: http://www.cdm-egypt.org

Arab Republic of Egypt
Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency
Egyptian Bureau for Clean Development Mechanism

(EB-CDM)

جمهورية مصر العربية
وزارة الدولة لشئون البيئة
جهاز شئون البيئة
المكتب المصري لآلية التنمية النظيفة

C- Avoided/ Reduced GHG Emissions

Selected Crediting Period	
❑ 10 years ❑ 7 years ❑ 3 x 7 years	
Estimated Avoidance/Reduction of emissions in accordance with the Kyoto Protocol	
× Carbon Dioxide(CO_2)	15,442 – 17,916 Tons/year
□ Methane (CH_4)	…… 0 Tons
□ Nitrous Oxide (N_2O)	…… 0 Tons
□ Hydrofluorocarbons (HFCs)	…… 0 Tons
□ Perfluorocarbons (PFCs)	…… 0 Tons
□ Sulphur Hexafluoride SF_6	…… 0 Tons

Reference Scenario or Baseline :

Description of the reference level:

❑ Baseline Methodology to be used:

Existing Baseline Methodology (The approved consolidated baseline and monitoring methodology ACM0002: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" version12.1.0 is applied to the project activity)

It refers to:

- Tool to calculate the emission factor for an electricity system (version02.2.0)
- Tool for the demonstration and assessment of additionality (version 05.2)

❑ What modifications the project would induce?

The project will replace the same amount of electricity that would be generated from conventional thermal power plants using natural gas and fuel oil.

❑ What would be the situation in the absence of the project activity?

Conventional power plants will produce the same amount of electricity through burning of fossil fuel.

Expected Emission Reductions During the Crediting Period

Total Certified Emission Reductions (CERs) per year:

…… 15,442 – 17,916 Tons/year

Total emission reduction for the Crediting period:

- Period of 10 years …… … T-CO_2 equivalent
- 1st Period of 7 years ……..T Eq CO_2
- 2nd Period of 7 years …… ……T Eq CO_2
- 3rd Period of 7 years …….. ..T Eq CO_2

30 طريق مصر حلوان الزراعي – خلف فندق سوفيتل المعادي – القاهرة الرقم البريدي 11728ت:25246162 فاكس: 252461622
30 Misr Helwan El-Zyrae Rd., Maadi Cairo Egypt P.O. 11728 Tel: 25246162 Fax: 25246162
e-mail: ccu@eeaa.gov.eg URL: http://www.cdm-egypt.org

Arab Republic of Egypt
Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency
Egyptian Bureau for Clean Development Mechanism

(EB-CDM)

جمهورية مصر العربية
وزارة الدولة لشئون البيئة
جهاز شئون البيئة
المكتب المصري لآلية التنمية النظيفة

D- Financial Aspects

Total Estimated Costs(*)	
Development Costs	…… millions of US$
Installation Costs	…… millions of US$
Other Costs	…… millions of US$
Total Cost of Project	……65 – 75 millions of US$
(*) Please add any additional relevant information in this table if needed.	
Sources of Identified Financing	
Cash	Organisations participating in financing and amount in US$
Long Term Loan	Organisations participating in financing and amount in US$
Short Term Loan	Organisations participating in financing and amount in US$
Expected Revenues from CERs transfer:	
Projected Price of the CERs	……14$/TCO2 equivalent
Estimated total CDM Revenues	4.5 – 5.0 million In $ US over expected lifetime of 21 years
Details of the expected Revenues during the accountability period	❑ Period of 10 years …… … $ ❑ 1st Period of 7 years.1.50–1.67 million$ ❑ 2nd Period of 7 years to be determined ❑ 3rd Period of 7 years to be determined
Amount and Modalities for the transfer of the CDM Contribution Advanced allocation…… Yearly transfers……	 …….In $ US …….In $ US
Additional Financing	
Will the project receive co-financing under ODA (Overseas Development Aids) or from any other sources like GEF ? Please mention the amount(s)	No

30 طريق مصر حلوان الزراعي – خلف فندق سوفيتل المعادي – القاهرة الرقم البريدي 11728ت:25246162 فاكس: 252461622
30 Misr Helwan El-Zyrae Rd., Maadi Cairo Egypt P.O. 11728 Tel: 25246162 Fax: 25246162
e-mail: ccu@eeaa.gov.eg URL: http://www.cdm-egypt.org

Arab Republic of Egypt
Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency
Egyptian Bureau for Clean Development Mechanism

(EB-CDM)

جمهورية مصر العربية
وزارة الدولة لشئون البيئة
جهاز شئون البيئة
المكتب المصري لآلية التنمية النظيفة

E. Expected Environmental and socio-economic Benefits

Specific global & local environmental benefits	Photovoltaic power plant is one of the cleaned sources of renewable energy, with no associated emissions and waste products. The proposed photovoltaic power plant will generate electricity free of green house gases to supply to the national grid replacing electricity that would otherwise have been generated from conventional power plants using fossil fuel.
Which guidelines will be applied?	Name and, if possible, the website location
Local benefits	● Increasing job opportunities ● Encouraging and increasing the foreign investment in Egypt ● Transferring latest technologies and experience
Global benefits	● Economical benefits that comes out from selling CERs ● The project contributes to mitigating the danger of climate change ● Saving the fossil fuel with potential for export ● Reducing CO_2 emission
Socio-economic aspects What social and economic effects can be attributed to the project and which would not have occurred in a comparable situation without that project? Explain the relationship between the project and the benefiting community/ies.	The project will assist Egypt in its sustainable development in several ways. The project will: ● Save fossil fuel mainly natural gas, which then will provide for a possibility of exporting such saved natural gas. ● Diversify the present electricity generation portfolio, thus insuring energy security. ● Create new jobs. ● Makes economic use of desert areas with no other or minimum potential use.
Which guidelines will be applied?	Name and, if possible, the website location
What are the possible direct effects (e.g., employment creation, capital required, foreign exchange effects)?	The project will assist Egypt in its sustainable development in several ways such as create new jobs, save fossil fuel mainly natural gas, which then will provide for a possibility of exporting such saved natural gas and securing hard currency as well as improve balance of payment.
What are the possible other effects? For example: • training/education associated with the introduction of new processes, technologies and products and/or • the effects of a project on other industries	The project will assist in diversifying the present electricity generation portfolio, thus ensuring energy security and create technology transfer, and capacity development. Also, provide courses for training on monitoring plants, maintenance and operation as well as development remote areas. The project will be a step towards larger percentage of local manufacturing of photovoltaic power generation system components.
Environmental strategy/ priorities of the Host Country	The project will contribute to efforts towards decreasing pollution and desirable emissions associated with bearing fossil fuel such as particulate matter Sox and NOx, etc.

30 طريق مصر حلوان الزراعي – خلف فندق سوفيتل المعادي – القاهرة الرقم البريدي 11728ت:25246162 فاكس: 252461622
30 Misr Helwan El-Zyrae Rd., Maadi Cairo Egypt P.O. 11728 Tel: 25246162 Fax: 25246162
e-mail: ccu@eeaa.gov.eg URL: http://www.cdm-egypt.org

Arab Republic of Egypt
Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency
Egyptian Bureau for Clean Development Mechanism

(EB-CDM)

جمهورية مصر العربية
وزارة الدولة لشئون البيئة
جهاز شئون البيئة
المكتب المصري لآلية التنمية النظيفة

F. Risks

Risks in the Project	
Estimate the Degree of Risk	
Technical risk	Low
Timing risk	Low
Budget risk	Low

G - Other Relevant Information

Please mention any additional information or precisions to justify the project under CDM

FOR OFFICIAL USE ONLY	
Date received by TIMS/E2RC	
Date received by E2RC CDM unit	
Date of pre-screening	
Date submitted to technical committee	
Date of technical committee meeting	
Date of informing the expert by the decision	

30 طريق مصر حلوان الزراعي – خلف فندق سوفيتل المعادي – القاهرة الرقم البريدي 11728ت:25246162 فاكس: 252461622
30 Misr Helwan El-Zyrae Rd., Maadi Cairo Egypt P.O. 11728 Tel: 25246162 Fax: 25246162
e-mail: ccu@eeaa.gov.eg URL: http://www.cdm-egypt.org

Appendix 7-5: Calculation of the Emission Factor for the Egyptian Unified Electric Grid

Appendix 7-5 Calculation of the Emission Factor for the Egyptian Unified Electric Grid

(1) Application of the "Tool to calculate the emission factor for an electricity system"

Step 1: Identify the relevant electricity systems

In Egypt, all power plants are connected to the Egyptian Unified Electric grid (the national grid). The project will be physically connected to the national grid. NREA has confirmed that all its information sources indicated that none of the major Egyptian transmission lines are operated at 90 % or more of its rated capacity during 90 % or more of the hours of a year. Further, electricity spot markets do not yet exist in Egypt. Therefore the relevant electricity system for the project is the Egyptian Unified Electric grid.

Egypt is not a net electricity importer. Therefore no electricity imports are considered.

Step 2: Choose whether to include off-grid power plants in the project (optional)

Option Ⅰ（Only grid power plants are included in the calculation）is selected for the project.

Step 3: Select a method to determine the operating margin (OM)

The low-cost/must-run resources constitutes less than 50 % of the total gird generation in average of five most recent years in the Egyptian Unified Electric grid.

Table: Ratio of the low-cost/must-run resources in the Egyptian United Electric grid

	Electricity generated (GWh)				
	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010
Hydro power plants	12,644	12,925	15,510	14,682	12,863
Wind parks	552	616	831	931	1,133
Total low cost/must run	13,166	13,541	16,341	15,613	13,996
Total net electricity generated	108,368	115,060	124,779	130,769	138,782
Rate of low cost/must run (%)	12.1%	11.8%	13.1%	11.9%	10.1%
Five year average of the rate (%)	11.8%				

Therefore the simple OM method is selected for the project. Ex ante option will be used for the project. The data vintage chosen is 07/08, 08/09 and 09/10 as the most recent data available at the time of submission of the CDM-PDD to the DOE for validation.

Step 4: Calculate the operating margin emission factor according to the selected method

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.

The simple OM may be calculated:

Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit; or

Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

Option B can only be used if:

(a) The necessary data for Option A is not available; and

(b) Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known; and

(c) Off-grid power plants are not included in the calculation (i.e., if Option I has been chosen in Step 2).

Fuel consumption data by type of fuel which is necessary to calculate CO_2 emission factor of each power unit is not available in Egypt. Only renewable power generation is considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by the renewable sources is known and off-grid power plants are not included in the calculation. Therefore option B is chosen to calculate the simple OM for the project. Following option B, the simple OM emission factor is calculated as follows.

$$EF_{grid,\,OMsimple,\,y} = \frac{\sum_i (FC_{i,\,y} \times NCV_{i,\,y} \times EF_{CO2,\,i,\,y})}{EG_y}$$

Where:

$EF_{grid,OMsimple,y}$ = Simple operating margin CO_2 emission factor in year y(tCO2/MWh)

$FC_{i,y}$ = Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)

$NCV_{i,y}$	= Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	= CO2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
EG_y	= Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year *y* (MWh)
i	= All fossil fuel types combusted in power sources in the project electricity system in year *y*
y	= The relevant year as per the data vintage chosen in Step 3

Step 5: Calculate the build margin (BM) emission factor

In terms of vintage of data, Option 1 (ex ante calculation) shown bellow is chosen for the The project.

Option 1: For the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

The sample group of power units *m* used to calculate the build margin should be determined as per the following procedure, consistent with the data vintage selected above:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-}units}$, in MWh);

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET\text{-}\geq 20\%}$, in MWh);

(c) From $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

Table: Sample group of power units used to calculate the BM emission factor

Power plant name	Type of power generation	Commissioning year	Rated capacity (MW)	Net generated power (GWh)	Percentage (%)
El-Atf	CC	2009	500	2,991	
Sidi Kir	CC	2009	500	3,080	
Nubaria 1-3	CC	2005-2009	2000	11,515	
Kuriemat 3	CC	2009	500	2,784	
Kuriemat 2	CC	2007-2009	750	5,035	19.0%
Talkha 750	CC	2006-2008	750	4,347	22.3%
Cairo North	CC	2005-2008	1500	9,346	29.3%
Total net generated power (GWh), excluding CDM projects				133,461	

Commissioning year of the latest unit of both Talkha and Cairo North power plants is 2008. Therefore both power plants are included in the sample group.

Zafarana wind farm is excluded from the sample group, since the recent additions of wind power plants of Zafarana wind farm after 2005 are registered as CDM projects or are requesting CDM project registration.

Table CDM registration status of the Zafarana wind farm

Name of plant	Capacity (MW)	Net generated power 2009/2010 (MWh)	Commissioning date	CDM status
Zafarana 1	30	68,728	12/2000	-
Zafarana 2	33	73,482	03/2001	-
Zafarana 3	30	90,059	12/2003	-
Zafarana 4	47	119,852	06/2004	-
Zafarana 5	85	195,423	10/2006	Requesting CDM project registration
Zafarana 6	80	220,808	04/2008	Registered 22/06/2007
Zafarana 7	120	311,620	06/2009	Registered 02/03/2010
Zafarana 8	120	54,177	9/2010	Registered 23/09/2010

Source: NREA

The build margin emission factor is the generation-weighted average emission factor (tCO2/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,\,BM,y} = \frac{\sum_{m} EG_{m,\,y} \times EF_{EL,\,m,\,y}}{\sum_{m} EG_{m,\,y}}$$

Where:

$EF_{grid,BM,y}$ = Build margin CO2 emission factor in year y (tCO_2/MWh)

$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)

$EF_{EL,m,y}$ = CO2 emission factor of power unit m in year y (tCO_2/MWh)

m = Power units included in the build margin

y = Most recent historical year for which power generation data is available

Step 6: Calculate the combined margin emission factor

The combined margin (CM) emission factor ($EF_{grid, CM,y}$) is calculated based on the weighted average CM, as follows:

$$EF_{grid, CM ,y} = EF_{grid, OM, y} \times w_{OM} + EF_{grid, BM, y} \times w_{BM}$$

Where:

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh)

$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year y (tCO_2/MWh)

w_{OM} = Weighting of operating margin emissions factor (%)

w_{BM} = Weighting of build margin emissions factor (%)

The following default values of solar power generation are used for w_{OM} and w_{BM}.

w_{OM} = 0.75

w_{BM} = 0.25

(2) Data and parameters those are available at validation

Data/Parameter:	EG_y
Data unit:	MWh
Description:	Total net electricity generation of all power plants serving to the Egyptian Unified Electric grid, excluding low-cost/must-run resources in year y
Source of data:	Annual reports of the Egyptian Electricity Holding Company (EEHC) for the business year 2007/2008 (Page 18), 2008/2009 (Page 19) and 2009/2010 (page 19)
Value to be applied:	2007/2008: 10,4351,000 2008/2009: 11,0797,000 2009/2010: 120,366,000
Justification of the choice of data or description of measurement methods and procedures actually applied:	Annual report for the year 2009/2010 is the latest available report. All hydro power plants and wind power plants are considered as low-cost/must-run resources.
Any comment:	

Data/Parameter:	$FC_{i,y}$
Data unit:	Mass or unit
Description:	Amount of fossil fuel type i consumed in the Egyptian Unified Electric grid in year y (mass or volume unit)
Source of data:	Annual reports of the Egyptian Electricity Holding Company (EEHC) for the business year 2007/2008 (page 26), 2008/2009 (page 25) and 2009/2010 (page 25)
Value to be applied:	See the below table
Justification of the choice of data or description of measurement methods and procedures actually applied:	Annual report for the year 2009/2010 is the latest available report.
Any comment:	

Table Amount of fossil fuel consumed in the Egyptian Unified Electric grid

	Parameter	Unit	Year		
			2007/2008	2008/2009	2009/2010
Fuel consumption of relevant power sources (mass units)	$FC_{i,y}$				
Natural gas	$FC_{NatGas,y}$	million $m3_{NaGas}$	21,907	23,013	24,314
Natural gas	$FC_{NatGas,y}$	kt_{NatGas}	16,349	17,174	18,145
Light fuel oil	$FC_{LFO,y}$	kt_{LFO}	105	121	175
Heavy fuel oil	$FC_{HFL,y}$	kt_{HFO}	4,774	5,321	5,929

Natural gas: 1 ton = 1,340 m^3 (Energy in Egypt 2002/2003, Organization for Energy Planning)

Data/Parameter:	NCV_i
Data unit:	GJ/tonne
Description:	Net caloric value (energy content) of fossil fuel type i.
Source of data:	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value to be applied:	Heavy fuel oil (HFO): 39.8 Natural gas (NG): 46.5 Light fuel oil (LFO): 41.4
Justification of the choice of data or description of measurement methods and procedures actually applied:	With the reference to the version02.2.0 of " Tool to calculate the emission factor for an electricity system"
Any comment:	Country specific NCV for fossil fuels used in Egypt are not available.

Data/Parameter:	$EF_{co2, i, y}$
Data unit:	tCO_2/GJ
Description:	CO2 emission factor of fossil fuel type i in year y
Source of data:	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value to be applied:	Heavy fuel oil (HFO): 0.0755 Natural gas (NG): 0.0543 Light fuel oil (LFO): 0.0726
Justification of the choice of data or description of measurement methods and procedures actually applied:	With the reference to the version02.2.0 of " Tool to calculate the emission factor for an electricity system"
Any comment:	

Data/Parameter:	$EG_{m,y}$
Data unit:	MWh
Description:	Net electricity generated by power plant m in the cohort for the build margin in year y
Source of data:	Annual reports of the Egyptian Electricity Holding Company (EEHC) for the business year 2009/2010
Value to be applied:	See the table below
Justification of the choice of data or description of measurement methods and procedures actually applied:	Annual report for the year 2009/2010 is the latest available report.
Any comment:	

Data/Parameter:	$EF_{EL,m,y}$
Data unit:	tCO_2/MWh
Description:	CO2 emission factor of power plant m in the cohort for the build margin in year y. CO2 emission factor is calculated using option A1 of Step 4 of the Tool to calculate the emission factor for an electricity system.
Source of data:	Calculations based on fuel consumption data and electricity generation data obtained from Annual reports of the Egyptian Electricity Holding Company (EEHC) for the business year 2009/2010
Value to be applied:	See the table below
Justification of the choice of data or description of measurement methods and procedures actually applied:	Annual report for the year 2009/2010 is the latest available report.
Any comment:	

Table Net electricity generated and CO_2 emission factors by power plants of sample group to calculate BM emission factor

Power plant name	Net generated power (GWh) $EG_{m,y}$	Fuel consumption (ktoe)	CO2 emissions (tCO2)	Emission factor (tCO2/MWh) $FE_{EL,m,y}$
El-Atf	2,991	646	1,468,637	0.491
Sidi Kir	3,080	750	1,705,074	0.554
Nubaria 1-3	11,515	2,117	4,812,856	0.418
Kuriemat 3	2,784	755	1,716,441	0.617
Kuriemat 2	5,035	760	1,727,809	0.343
Talkha 750	4,347	784	1,782,371	0.410
Cairo North	9,346	1,577	3,585,203	0.384

(3) Calculation of the emission factor of the Egyptian Unified Electric grid

OM emission factor

Table Calculation of OM emission factor

	Parameter	Unit	Year		
			2007/2008	2008/2009	2009/2010
Fuel consumption of relevant power sources (mass units)	$FC_{i,y}$				
Natural gas	$FC_{NatGas,y}$	million $m3_{NaGas}$	21,907	23,013	24,314
Natural gas	$FC_{NatGas,y}$	kt_{NatGas}	16,349	17,174	18,145
Light fuel oil	$FC_{LFO,y}$	kt_{LFO}	105	121	175
Heavy fuel oil	$FC_{HFL,y}$	kt_{HFO}	4,774	5,321	5,929
Net caloric value	NCV_i				
Natural gas	NCV_{NatGas}	GJ/t_{NatGas}	46.5		
Light fuel oil	NCV_{LFO}	GJ/t_{LFO}	41.4		
Heavy fuel oil	NCV_{HFO}	GJ/t_{HFO}	39.8		
CO_2 emission factor of fossil fuel	$EF_{CO2,i,y}$				
Natural gas	$EF_{CO2,NG,y}$	tCO2/GJ	0.0543		
Light fuel oil	$EF_{CO2,LFO,y}$	tCO2/GJ	0.0726		
Heavy fuel oil	$EF_{CO2,HFO,y}$	tCO2/GJ	0.0755		
Net quantity of electricity delivered to the grid	$EG_{grid,y}$	1000MWh	104,351	110,797	120,366
CO_2 emissions					
Natural gas		tCO_2	41,279,164	43,363,190	45,814,652
Light fuel oil		tCO_2	314,691	364,795	526,618
Heavy fuel oil		tCO_2	14,345,393	15,989,073	17,816,052
Total			55,939,247	59,717,057	64,157,323
OM emission factor					
Simple OM emission factor	$EF_{gridOMsimple,y}$	t_{CO2}/MWh	0.536	0.539	0.533
OM emission factor (3 years)	$EF_{gridOMsimple,y}$	t_{CO2}/MWh	0.536		

BM emission factor

Table Calculation of BM emission factor

Power plant name	Net generated power (GWh) $EG_{m,y}$	Emission factor (tCO_2/MWh) $EE_{EL,\ m,\ y}$	CO_2 emissions (tCO_2)	BM emission factor (tCO2/MWh)
El-Atf	2,991	0.491	1,468,581	
Sidi Kir	3,080	0.554	1,706,486	
Nubaria 1-3	11,515	0.418	4,813,228	
Kuriemat 3	2,784	0.617	1,717,728	
Kuriemat 2	5,035	0.343	1,726,936	
Talkha 750	4,347	0.410	1,782,270	
Cairo North	9,346	0.384	3,588,941	
Total	39,098		16,804,171	0.430

CM emission factor

Table Calculation of CM emission factor

	OM	BM	CM
Weighting of OM and BM	0.75	0.25	
Emission factor (tCO_2/MWh)	0.536	0.430	0.510

Appendix 8-1: Assumptions and Calculation of Unit Cost

Appendix 8-1 Assumptions and Calculation of Un-served Energy Cost

As for the assumptions and calculation of the un-served energy cost, the Team referred to the Appendix of "FR on SAPROF Study for the Rehabilitation of UERCC Project".
That material is attached as follows.

Appendix-10

Economic Benefit for Un-Served Energy

Calculation of
The Cost of Unserved Energy

The cost of unserved energy in an electric power system is not an easy task to do. The cost of unserved energy to the different sectors of customers or even to the sub-sectors differs from one sector to the other. Some sectors like the residential sector are marginally affected by the interruption of the supply while other sectors, like the industrial sectors are is highly affected by the loss of supply. Some industries are more affected by the interruption of the supply like the electrical smelters for which the ingots are totally ruined.

Accordingly the cost of unserved energy and hence the contribution to the gross domestic production of the country varies between the different types of industries as well as the residential and commercial customers which contribute very little to the gross domestic production.

The estimation of the cost of unserved energy by just dividing the national gross domestic production by the total electric energy production is a crude methodology and may be applied only in systems where the customers are of the same type. However, when the customers are diversified with nearly balanced ratios, this methodology fails.

Detailed investigations, including measurements and calculations should be carried out to evaluate how each sector and each industry is affected by the loss of supply and also how this loss of supply affects its production and how it will consequently affect the gross domestic production.

In the absence of these investigations, a methodology is suggested and applied for the system of Egypt. It gives more correct evaluation for the cost of unserved energy than that which just divides the total GDP by the total energy production. The suggested mehtodology is based on the estimation of the incremental loss (or gain) in the GDP with an incemental loss (or increase) in the electric energy production. As these values cannot be obtained except by experimentation, a good approximation can be obained from the relationship between the comparison of these incrementals for a series of successive years, and a correlation is obtained.

The values of the GDP (P) and the Energy Sales (E) for the series of years 2004/2005 to 2006/2007 are analyzed by regression analysis and the best fit for a straight line relationship was found to be

$P = a + bE$ where a , b are constant

The cost of unserved energy is equal to $\frac{dP}{dE} = b$

This was proved as follows :

Let P = a + bE (Straight line equation)

Differentiate both sides with respect to P

$$\frac{dP}{dE} = b$$

From the attached results of the regression analysis the cost of unserved energy is equal to the coefficient of the variable E i.e. 2.144 $/KWh.

Appendix 8-2: Calculation of Nominal Feed in Tariff

Appendix 8-2 Calculation of Nominal Feed in Tariff

The PV power selling price excluding cost of exhibition system, training cost to NREA, battery, etc. from the unit power selling cost is calculated as follows.

Nominal Costs/kWh of the Project

Nominal Costs/kWh of the Project 0.183 USD FIRR= 4.20%

Order	Year	Cost			Benefit		Net Cash Balance (B-C)	Accumulation
					Power Sales increase			
		Investment (1,000 $)	O&M (1,000$)	Total (C)	Electricity Production (MWh)	Total 1,000USD. (B)		
	2014	41	0	41			-41	-41
	2015	41	0	41			-41	-82
	2016	24,964	0	24,964			-24,964	-25,046
	2017	31,412	0	31,412			-31,412	-56,458
1	2018	3,199	0	3,199	35,130	6,437	3,238	-53,220
2	2019	3,225	0	3,225	34,591	6,338	3,113	-50,107
3	2020		529	529	34,052	6,240	5,710	-44,397
4	2021		529	529	33,513	6,141	5,611	-38,785
5	2022		682	682	32,974	6,042	5,360	-33,426
6	2023		529	529	32,435	5,943	5,414	-28,012
7	2024		529	529	31,896	5,844	5,315	-22,697
8	2025		529	529	31,357	5,746	5,216	-17,481
9	2026		529	529	30,818	5,647	5,117	-12,363
10	2027		10,919	10,919	30,279	5,548	-5,370	-17,734
11	2028		529	529	30,279	5,548	5,019	-12,715
12	2029		529	529	30,279	5,548	5,019	-7,696
13	2030		529	529	30,279	5,548	5,019	-2,678
14	2031		529	529	30,279	5,548	5,019	2,341
15	2032		786	786	30,279	5,548	4,762	7,103
16	2033		529	529	30,279	5,548	5,019	12,122
17	2034		529	529	30,279	5,548	5,019	17,140
18	2035		529	529	30,279	5,548	5,019	22,159
19	2036		529	529	30,279	5,548	5,019	27,178
20	2037		3,132	3,132	30,279	5,548	2,416	29,593
Total		62,882	22,932	85,814		115,408	29,593	

Annual Fund Requirement

(Million US$)

No.	Item	Total			2013			2014			2015			2016			2017			2018		
		F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
A. ELIGIBLE PORTION																						
1	Construction of 20MW PV Power Plant including necessary equipment incl. 2MW battery	35.087	17.865	52.952							14.035	7.146	21.181	17.544	8.933	26.477	1.754	0.893	2.647	1.754	0.893	2.647
2																						
3																						
4																						
5	Total (1-4)	35.087	17.865	52.952							14.035	7.146	21.181	17.544	8.933	26.477	1.754	0.893	2.647	1.754	0.893	2.647
6	Price Escalation	2.849	6.697	9.546							0.903	2.057	2.960	1.521	3.584	5.105	0.192	0.468	0.660	0.233	0.588	0.821
7	Physical Contingency	1.896	1.228	3.124							0.747	0.460	1.207	0.953	0.626	1.579	0.097	0.068	0.165	0.099	0.074	0.173
8	Total (5+6+7)	39.832	25.790	65.622							15.685	9.663	25.348	20.018	13.143	33.161	2.043	1.429	3.472	2.086	1.555	3.641
9	Consulting Service																					
10	Price Escalation																					
11	Physical Contingency																					
12	Total (9+10+11)																					
13	**A. Total (8+12)**	39.832	25.790	65.622							15.685	9.663	25.348	20.018	13.143	33.161	2.043	1.429	3.472	2.086	1.555	3.641
B. NON ELIGIBLE PORTION																						
14	Land acquisition & Compensation																					
15	Price Escalation																					
16	Physical Contingency																					
17	Total (14+15+16)																					
18	Administration cost																					
19	Price Escalation																					
20	Physical Contingency																					
21	Total (18+19+20)																					
22	VAT		2.579	2.579								0.966	0.966		1.314	1.314		0.143	0.143		0.156	0.156
23	CD		3.984	3.984								1.569	1.569		2.002	2.002		0.204	0.204		0.209	0.209
24	**B. Total (21+22+23)**		6.563	6.563								2.535	2.535		3.316	3.316		0.347	0.347		0.365	0.365
25	**Total (A+B)**	39.832	32.353	72.185							15.685	12.198	27.883	20.018	16.459	36.477	2.043	1.776	3.819	2.086	1.920	4.006
26	**IDC**	0.846		0.846							0.102		0.102	0.233		0.233	0.248		0.248	0.263		0.263
27	Commitment Charge	0.244		0.244	0.041		0.041	0.041		0.041	0.041		0.041	0.040		0.040	0.040		0.040	0.040		0.040
28	**Grand TOTAL (25+26+27)**	40.922	32.353	73.275	0.041		0.041	0.041		0.041	15.828	12.198	28.026	20.291	16.459	36.750	2.331	1.776	4.107	2.389	1.920	4.309
29	**Financial Costs**	37.227	25.656	62.883	0.041		0.041	0.041		0.041	14.823	10.141	24.964	18.537	12.875	31.412	1.891	1.308	3.199	1.893	1.332	3.225

Cost for PV project (Reference only)

No.	Items to be requested	Nos. of Required	Cost (Thousand dollar)					Notes
			CIF to Port Saied		Inland Transportation	Site Works (Installation replacement etc.)	Total	
			unit	amount				
			(Foreign Currency)		(Local Currency)			
1 Construction of 20MW PV Power Plant including necessary equipment				**34,124.7**	**449.5**	**17,415.7**	**51,989.9**	51,989.9
1) PV module								
1-1	PV Module (MLTF)	LS		22,689.6	84.5	3,487.1	26,261.2	
1-2	Terminal Box	LS		728.0	2.0	105.3	835.3	
1-3	DC cable	LS		1,564.8	35.8	397.7	1,998.3	
1-4	Frame for PV	LS		896.0	37.0	8,840.4	9,773.4	
Sub-Total				25,878.4	159.3	12,830.5	38,868.2	
2) Inverter								
2-1	Inverter	LS		3,600.0	3.4	363.6	3,967.0	
2-2	Step-up Transformer	LS		260.0	1.7	3.7	265.4	
2-3	LV, MV switchgear	LS		300.0	6.7	17.9	324.6	
2-4	LV,MV cable for inverter	LS		87.0	0.0	37.6	124.6	
2-5	Monitoring System terminal unit	0		5.0	0.0	17.1	22.1	
Sub-Total				4,252.0	11.8	439.9	4,703.7	
3) MV switchgear								
3-1	Switchgear Box	LS		320.0	0.8	36.3	357.1	
3-2	Monitoring System terminal unit	LS		4.5	0.0	8.9	13.4	
Sub-Total				324.5	0.8	45.2	370.5	
4) Distribution line connection								
4-1	Feeder Box	LS		80.0	0.8	1.2	82.0	
4-2	Monitoring System terminal unit	LS		1.0	0.0	0.9	1.9	
Sub-Total				81.0	0.8	2.1	83.9	
5) Monitoring System								
5-1	Monitoring System	LS		281.5	0.0	10.1	291.6	
Sub-Total				281.5	0.0	10.1	291.6	
6) Internal cable connection								
6-1	MV Cable Connection	LS		1,320.0	5.5	278.1	1,603.6	
6-2	LV Cable Connection	LS		600.0	0.5	105.3	705.8	
6-3	Optic fiber cable connection	LS		176.0	0.5	48.7	225.2	
Sub-Total				2,096.0	6.6	432.1	2,534.7	
7) Grounding system								
7-1	Grounding conductor	LS		200.0	0.5	37.3	237.8	
Sub-Total				200.0	0.5	37.3	237.8	
8) Civil works								
8-1	PV and transformer foundation	LS		0.0	262.1	2,600.9	2,863.0	
8-2	land leveling	LS		0.0	0.0	111.8	111.8	
8-3	road and drain work	LS		0.0	0.0	152.2	152.2	
Sub-Total				0.0	262.1	2,865.0	3,127.0	
9) House construction								
9-1	Inverter house construction	LS		0.0	2.5	252.0	254.5	
9-2	MV Switchgear house construction	LS		0.0	2.5	248.0	250.5	
Sub-Total				0.0	5.0	500.0	505.0	
10) Guard Fence								
10-1	Guard Fence	LS		0.0	2.5	250.6	253.1	
Sub-Total				0.0	2.5	250.6	253.1	
11) Information Center								
11-1	Exhibition System	LS		0.0	0.0	0.0	0.0	
11-2	Construction of house	LS		0.0	0.0	0.0	0.0	
Sub-Total				0.0	0.0	0.0	0.0	
12) Central Hurghada Substation Modifications								
12-1	Central Hurghada S/S modifications	LS		20.0	0.2	3.0	23.2	
Sub-Total				20.0	0.2	3.0	23.2	
13) Training to Owner's engineers								
13-1	Training	LS		0.0			0.0	
Sub-Total				0.0			0.0	
14) Maintenance contract for PV power plant								
14-1	Maintenance Contract Cost for 2 years	LS		662.2			662.2	1% of the above 1) -7)per year * 2 years
Sub-Total				662.2			662.2	
15) Spare parts								
15-1	Spare parts for PV, Inverter, etc.	LS		329.1			329.1	1% of above 1)-6)
Sub-Total				329.1			329.1	
2 Installation of 2MW High Performance Battery including necessary equipment				**0.0**	**0.0**	**0.0**	**0.0**	0.0
1) High Performance Battery								
1-1	High Performance Battery	LS		0.0	0.0	0.0	0.0	
1-2	Power conditioning system for battery	LS		0.0	0.0	0.0	0.0	
1-3	MV Switchgear for Battery	LS		0.0	0.0	0.0	0.0	
1-4	MV Cable Connection	LS		0.0	0.0	0.0	0.0	
1-5	Room for Battery and PCS	LS		0.0	0.0	0.0	0.0	
Sub-Total				0.0	0.0	0.0	0.0	
2) Training to Owner's engineers								
2-1	Training	LS		0.0			0.0	
Sub-Total				0.0			0.0	
3) Maintenance contract for Battery System								
3-1	Maintenance Contract Cost for 2 years	LS		0.0			0.0	1% of the above 1) per year * 2 years
Sub-Total				0.0			0.0	
4) Spare parts								
13-1	Spare parts for Battery,PCS, etc.	LS		0.0			0.0	1% of above 1)
Sub-Total				0.0			0.0	
3 Dispute Board for 3 persons				**963.0**	**0.0**	**0.0**	**963.0**	
Total				**35,087.7**	**449.5**	**17,415.7**	**52,952.9**	52,952.9

Cost breakdown for materials and equipment

1 US$= 82.43 JP Yen 1EGP= 13.67

1 EGP= 0.166 US $

		No.	Item	Specification	Unit Price (US$)	Unit Price (EGP)	Total Quantity	units	Total Price (US$)	Total Price (EGP)	Remarks
1.PV	PV module	1	PV module (MLTF)	128W							
			1MW	(1.1$/W)	145	880	156,480		22,689,600	137,702,400	
		2	Terminal Box								
					1,300	7,840	560		728,000	4,390,400	
		3	DC cable connection								
			From PV module to Terminal box		2	20	782,400	m	1,564,800	15,648,000	
		4	DC cable connection								
			From Terminal box to Inverter		8	50	112,000	m	896,000	5,600,000	
		5	Frame for PV								
					2,000.0	12,060	4,420	t	8,840,000	53,305,200	
		6	Sub Total (1+2+3+4+5)						**34,718,400**	**216,646,000**	
	Inverter	7	Inverter	500kVA							
					90,000	542,700	40		3,600,000	21,708,000	
		8	Step-up Transformer	400V/22kV							
				2000kVA	26,000	156,780	10		260,000	1,567,800	
		9	LV Switchboard	400V							
					10,000	60,300	10		100,000	603,000	
		10	MV Switchgear	22kV							
					20,000	120,600	10		200,000	1,206,000	
		11	LV cable Connection								
			From Inverter to LV Switchboard		50	310	1,200	m	60,000	372,000	
		12	LV cable Connection								
			From LV Switchboard to Step-up transformer		50	310	180	m	9,000	55,800	
		13	MV Cable Connection								
			From Step-up transformer to MV Switchgear		100	610	180	m	18,000	109,800	
		14	Monitoring system terminal unit								
					500	3,020	10		5,000	30,200	
		15	Sub Total (7+8+9+10+11+12+13+14)						**4,252,000**	**25,652,600**	
	MV Switchgear	16	Feeder box								
					40,000	241,200	6		240,000	1,447,200	
		17	VT Box								
					20,000	120,600	2		40,000	241,200	
		18	Bus coupler Box								
					40,000	241,200	1		40,000	241,200	
		19	Monitoring system terminal unit								
					500	3,020	9		4,500	27,180	
		20	Sub Total (16+17+18+19)						**324,500**	**1,956,780**	
	Distribution line connection	21	Feeder Box (Extension)								
					40,000	241,200	2		80,000	482,400	
		22	Monitoring system terminal unit								
					500	3,020	2		1,000	6,040	
		23	Sub Total (21+22)						**81,000**	**488,440**	
	Monitoring System	24	M/M computer system								
					80,000	482,400	1		80,000	482,400	
		25	server system								
					200,000	1,206,000	1		200,000	1,206,000	
		26	Communication interface								
					1,000	6,030	1		1,000	6,030	
		27	UPS								
					500	3,020	1		500	3,020	
		28	Sub Total (24+25+26+27)						**281,500**	**1,697,450**	
	Internal cable connection	28	MV Cable Connection								
			from unit substation to 22kV bus unit		100	610	13,200	m	1,320,000	8,052,000	
		29	MV cable Connection from 22kV bus unit								
			to Hurghada Wind Distribution Point		100	610	6,000	m	600,000	3,660,000	
		30	Optical fiber cable Connection								
					20	130	8,800	m	176,000	1,144,000	
		31	Sub Total (28+29+30)						**2,096,000**	**12,856,000**	
	Grounding system	32	Grounding conductor								
					20	130	10,000	m	200,000	1,300,000	
		33	Sub Total (32)						**200,000**	**1,300,000**	
	Civil works	34	PV foundation								
					335	2,030	7,764		2,600,940	15,760,920	27730 x 0.28m3
		35	Ground leveling								
					3	20	33,880	m3	111,804	677,600	
		36	road construction								
					2	20	63,420	m	152,208	1,268,400	
		37	Sub Total (34+35+36)						**2,864,952**	**17,706,920**	
	Inverter house construction	38	Inverter house								
					350	2,120	360	m2	126,000	763,200	36m2 / 1room x 10 rooms
		39	Interior work								
					350	2,120	360	m2	126,000	763,200	
		40	Sub Total (38+39)						**252,000**	**1,526,400**	
	MV switch gear house	41	MV switch gear house								
					400	2,420	310		124,000	750,200	
		42	Interior work								
					400	2,420	310		124,000	750,200	
		43	Sub Total (41+42)						**248,000**	**1,500,400**	
	Guard Fence work	44	Guard Fence								
					58	350	4,320	m	250,560	1,512,000	
		45	Sub Total (44)						**250,560**	**1,512,000**	
	Information Center	46	Exhibition System								
					300,000	1,809,000		LS	0	0	
		47	Construction of house								
					350	2,120		m2	0	0	
		48	Interior work								
					350	2,120		m2	0	0	
		49	Sub Total (46+47+48)						**0**	**0**	
	Central Hurghada S/S modifications	50	S/S modifications								
					20,000	120,600	1	LS	20,000	120,600	
		51	Sub Total						**20,000**	**120,600**	
2.Battery	High Performance Battery	1	High Performance Battery	1,000kW							
					4,543,000	27,394,290		**unit**	0	0	
		2	Power conditioning system(PCS) for Battery	500kW							
					400,000	2,412,000		unit	0	0	
		3	MV Switchgear								
					40,000	241,200		unit	0	0	
		4	MV Cable connection								
					100	610		m	0	0	
		5	Room for battery and PCS								
					350	2,120		m2	0	0	
		6	Room Interior work including air conditioner								
					350	2,120		m2	0	0	
		7	Sub Total (1+2+3+4+5+6)						**0**	**0**	
3. DB	Dispute Board	1	Dispute Board								
					963,000	5,806,890	1	LS	963,000	5,806,890	
		2	Sub Total						**963,000**	**5,806,890**	