AFRICAN DEVELOPMENT BANK GROUP

**PROJECT: Damanhour Combined Cycle Power Plant Project**

**COUNTRY: Egypt**

**SUMMARY OF THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)**

| | | | | | |
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## 1. INTRODUCTION

The main objective of the Damanhour power plant project, subject of this Environmental and Social Impact Assessment (ESIA), is to support socio-economic development in Egypt over the medium-term with expected GDP growth of about 5 – 6% by expanding the power infrastructure thus improving the security and reliability of power supply to all economic sectors. A gap between the supply and demand has been increasing during the last few years leading to power shortages of 4,000 – 5,000 MW during the summer peak period resulting in load shedding.

This ESIA summary is prepared in accordance with the African Development Bank's (AfDB) Integrated Safeguard System (ISS) and Environmental Assessment Procedures (ESAP). It fulfils the ISS requirements for category 1 projects. It provides information on project activities; anticipated impacts of the project activities; measures to be put in place to mitigate identified adverse impacts; and institutional arrangements to facilitate implementation and monitoring of the Environmental and Social Management Plan (ESMP).

## 2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The ESIA has been prepared in line with the Egyptian Environmental Law, Environmental and social policies and procedures of the AfDB, the European Bank for Development and Reconstruction (EBRD) and the European Investment Bank (EIB). Below are the key requirements applicable to the project.

### 2.1 National requirements

The Egyptian environmental law No. 4 of 1994 amended with law No. 9 of 2009, and its executive amendment no. 338 of 1995 modified by ministerial decrees no. 1741 of 2005, no. 1095 of 2011 and no. 964 of 2015 which divides the types of projects into three lists: A, B, and C. This project is a C-list project, which is comparable to an AfDB "*Category 1*" project. The project will comply with the main national standards summarized in table 1 below.

A comprehensive list of standard limits considered for this project is provided in annex. This relates to: (i) limits for gaseous emissions from fuel combustion sources (energy generation) according to law 4/94, (ii) Permissible limits for noise inside work places according to law 4/94, (iii) Maximum (permissible) limits for air pollutants inside work places according to law 4/94, (iv) Wastewater discharged on aquatic environments standards and specifications.

*Table 1: summary of applicable national laws*

| Environmental Issues | Applicable Laws |
|---|---|
| **Noise** | Appendix 7 of the Egyptian environmental law 4/94 indicates the noise permissible limits inside work places. |
| **Air Quality** | Appendix 6 of law 4/94 indicates Gaseous emissions from fuel combustion sources and permissible stack heights and other specifications- permissible limits for gaseous emissions from various sources. Appendix 8 indicates maximum (permissible) limits for air pollutants inside work places according to the type of each industry. |
| **Waste Water** | Law No. 48 of year 1982 on the Nile River, waterways and its executive amendment. The Ministerial Decree 964 of 2015 state the limits for the wastewater discharge on aquatic environments. |
| **Hazardous Material Waste Management** | Article 29 which forbids to displace hazardous substances and waste without a license from the competent administrative authority. |
| **Labor** | The Egyptian Labor Law no. 12 of year 2003. 55/83 decree for safety and occupational health in the workplace; it includes tables of safety criteria due to risks. Occupational health and safety is regulated by a number of articles under this law. |

***Source: Adapted from the ESIA report (2015)***

**2.2 African Development Bank**

AfDB's ISS with its five operational safeguards as indicated in table 2 below, as well as other applicable policies.

*Table 2:* ***Operational Safeguards applicable to the project***

| **Operational Safeguards (OSs)** | **Triggered (Y/N)** | **Reasons** |
|---|---|---|
| OS1. Environemntal and Social Assessment | (Y) | This OS is triggered through the mandatory Environmental and Social Screening Process through which the project was assigned a Category 1 |
| OS2. Involuntary resettlement land acquisition, population displacement and compensation | (N) | This OS is not triggered because the project does not involve resettlement or land acquisition |
| OS3. Biodiversity and Ecosystem Services | (N) | This OS is not triggered because the project is not located in a habitat where there may be potential biodiversity impacts or in areas providing ecosystem services |
| OS4. Pollution prevention and control, hazardous materials and resource efficiency | (Y) | This OS is triggered because the project may cause adverse environmental owing to the emission of pollutants and waste. |
| OS5. Labour conditions, health and safety | (Y) | This OS is triggered because the project involves the establishment of workforce (temporary and permanent) |

*Source: Adapted from the ESAP (2015)*

Other donors' environmental and social policies and procedures applicable to the project are: (i) The EIB environmental and social safeguards which are based on the European Principles for the Environment (EPE) developed in version 9.0 of 02/12/2013; (ii) the EBRD Environmental and Social Policy (EBRD Performance Requirements).

The entities below are the key institutions that will be involved in preparing and approving the ESIA for this project as well as implementing, monitoring and auditing the ESMP as required:

- **The Ministry of State for Environmental Affairs (MSEA)** is the ministry responsible for environmental affairs in the Arab Republic of Egypt.
- **The Egyptian Environmental Affairs Agency (EEAA), which is the executive arm of the MSEA,** was established, as a result of the Environmental Affairs Law Law No. 4 /1994, to be the competent national authority in environment management. EEAA will be responsible of approving the ESIA and issuing the environmental licence for this project;
- **West Delta for Electricity Production Company (WDEPC)**: WDEPC, is one of the **Egyptian Electricity Holding Company (EEHC)** subsidiaries. As the project proponent, the EEHC/WDEPC has the role of preparing the ESIA including the ESMP and submitting them to EEAA for review and approval. Once EEAA has approved the ESIA to proceed with the project, WDEPC will ensure that necessary measures are taken to implement the ESMP.
- **Ministry of Water Resources and Irrigation (MWRI):** Under law No. 12 of 1984, MWRI retains the overall responsibility for the management of all water resources, including available surface water resources of the Nile system, irrigation water, drainage water and groundwater. The MWRI is the central institution for water quality management. It has been given authority to issue licenses for domestic and industrial discharges.
- **Ministry of Health and Population (MOHP)**: The MOHP is the main organization charged with safeguarding drinking water quality and is responsible for public health in general. Within the framework of Law 48/1982, this Ministry is involved in standard setting and compliance monitoring of wastewater discharges.

- **Ministry of Defense**: Permitting the location of plant and the routes of overhead transmission line;
- **The General Authority for Roads, Bridges & Land Transport**: Permissions for the road cut during the implementation of the associated projects;
- **GASCO**: Responsible for providing the new plant with natural gas. As well as, preparation of the ESIA related to the pipeline

## 3. PROJECT DESCRIPTION AND JUSTIFICATION

### *3.1 Project's components*

The Damanhour project involves the construction of a combined cycle power plant (CCPP) with a total installed capacity of 1800 MW. The design of the proposed new plant anticipates 2x900 MW combined cycle modules, each of a configuration of 2x300 MW highest-efficiency gas turbines, two multi-pressure heat recovery steam generators without supplementary firing, and 1 x 300 MW reheat steam turbine generator. Details of the project components and cost are provided in the table 3 below.

*Table 3: project's components*

| Component | Est. cost (milllion USD) | Component description |
|---|---|---|
| Construction of 2x900 MW combined-cycle power generation facility | 1,154.3 | • Site Preparations & Services<br>• Civil Works and Yard Tanks<br>• Combustion Turbine Generators & spare parts<br>• Heat Recovery Steam Generators<br>• Steam Turbine Generators<br>• Condensers (air cooled)<br>• 500 kV Switchyard<br>• Pumps and Drives (Service, Raw & Circulating Water Pumps)<br>• Pumps and Drives (Feed Water and Condensate Pumps and Drives)<br>• Water and Wastewater Treatment Systems<br>• Critical Piping and Valves<br>• Power Transformers<br>• Distributed Control Systems<br>• Mechanical Equipment & Pipe Installation<br>• Electrical Equipment & Instrument Installation<br>• Medium & Low Voltage Switchgear |
| Environmental Monitoring | 1.08 | Design, supply, installation, testing and commissioning of environmental equipment for the Damanhour power plant project including ambient air quality and meteorological monitoring, portable flue gas analysers, portable sound level meters, instrument calibration equipment and data acquisition & electronic storage equipment. This component also includes training to selected site staff on the full operation of the complete system, in addition to preparation of a Quality Assurance Project Plan detailing an environmental monitoring plan and the related organizational structure of the project with tasks and responsibility. |
| Insurance during project construction | 15.03 | Purchase of insurance for equipment and personnel during the construction, testing, commissioning and start-up phases till project completion and handing-over. |
| Project management and engineering services | 37.6 | Engineering consultancy services to support the project's execution agency in project design, procurement and management. Activities include: (i) design of 2x900 MW combined cycle power generation modules with auxiliary systems; (ii) preparation of bidding documents and support in bidding process until successful award of contracts; (iii) management and coordinate of the interfacing between the contractors; (iv) supervision of construction, testing, commissioning and start-up till project hand-over; and (v) preparation of final project report. |
| TOTAL | 1,208 | |

*Source: project appraisal report as at 6 June 2015*

The plant will be connected to the 500 kV national grid via two new transmission lines: a 14 km single-circuit connection to the existing Abu Qir / Kafr El-Zayat 500 kV line, and a 60 km double-circuit 500 kV line to connect Damanhour with Abo El-Matamir 500/220 kV substation. This substation will be expanded with 2x500 MVA 500/220 kV transformers and the necessary switchgear. The existing substation has sufficient land for the required expansion. These works are not included in the scope of the proposed project (but are considered as associated facilities with regards to environmental and social aspects) and will be financed by the EIB/other development partners under a separate ongoing transmission project implemented by EETC. Once completed, the necessary ESIA, ESMP and RAP reports will be submitted to development partners including AfDB.

The ADB & AGTF loans (USD 60 million and USD 20 million respectively) will co-finance the full cost of the following sub-components: (A): i) Pumps and Drives (Service, Raw & Circulating Water Pumps); ii) Pumps and Drives (Feed Water and Condensate Pumps and Drives); iii) Critical Piping & Valves, iv) Power Transformers; and v) Electrical Equipment & Instrument Installation; inclusive of their contingency allocations but excluding custom duties.

### *3.2 Resource Requirements*

***Quantity of Natural Gas***: About 2 billion cubic meters of natural gas will be required per annum. Natural gas (primary fuel) is supplied to the project site by the means of GASCO at about 24-27 bar through a pipeline of 24-inch diameter.

***Quantity of light fuel*** : About 90,000 tons of light fuel oil (secondary fuel) is required. It will be supplied and transported via trucks.

***Water***: The quantity of water withdrawn to start the operation is 4400 m3 per day of the steam turbines is taken only for once. Subsequently, only about 5% of this amount will be needed for operation as make-up water.

### 3.3 Process design

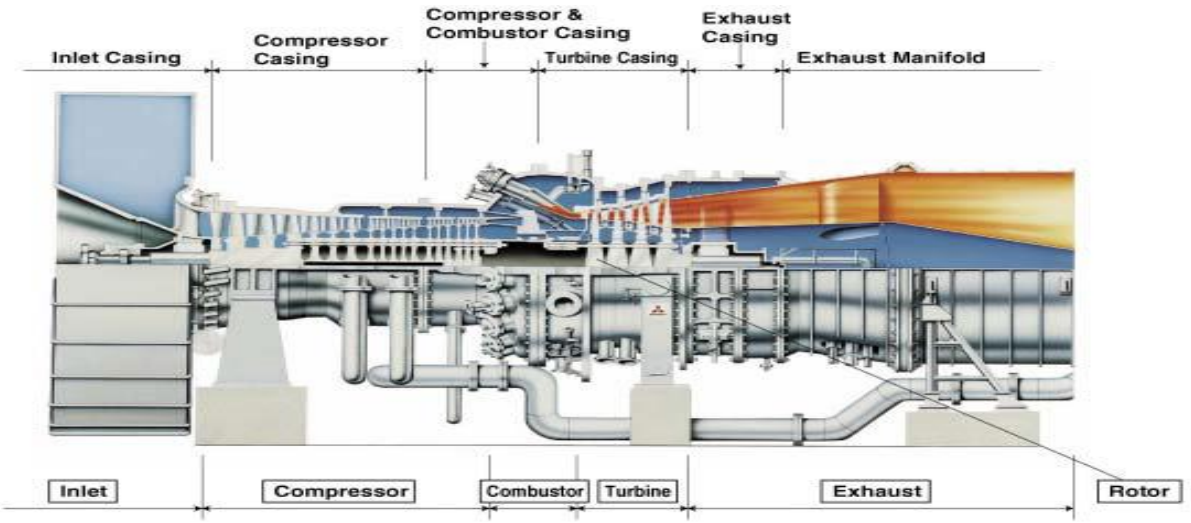
By combining both gas and steam cycles, high input temperatures and low output temperatures can be achieved. A combined cycle plant has a thermodynamic cycle that operates between the gas-turbine's high firing temperature and the waste heat temperature from the condensers of the steam cycle. This large range means that the Carnot efficiency is high. The actual efficiency, while lower than this is still higher than that of either plant on its own If the plant produces only electricity, efficiencies of up to 59% can be achieved.

**Each of the two 900-Meh modules consists of the following key components:**

- **Two indoor combustion turbine generator (CTG) units**

Each CTG consists of six main parts, which are inlet, compressor, combustor, turbine, exhaust and rotor in addition to essential casing parts (figure 1).

***Figure 1: Combustion Gas Turbine (CTG) fundamental structure***




*Source: ESIA report (2015)*

The auxiliary equipment provided to support each gas turbine (GT) operation consists of; an intake air system, exhaust system, lubricating oil system, control oil system, generator cooling system, fire protection system, fuel gas control system, fuel oil control system and gas turbine control system. Each gas turbine (GT) drives a 50-Hz electric generator. The Generators coupled to each gas turbine is of Hydrogen (H2) cooled type and therefore storage cylinders for both Hydrogen and Carbon dioxide are provided. Carbon dioxide is used as the purge gas when filling or emptying the generator with Hydrogen. The H2 and CO2 cylinders are stored at a central location and piped to each of the generators.

The gas turbine is equipped with a dry low-NOx burner (combustor) which lowers the NOx emissions to be released. The key to decrease the exhaust NOx is to decrease flame temperature. This is achieved by Dry Pre-Mix Combustion where gas and air are premixed resulting in a uniform flame temperature. Each gas turbine is housed in an enclosure and is provided with its own Carbon dioxide ($CO_2$) fire protection system. Heat detectors are strategically arranged within the package enclosures to detect a fire. The detection system consists of two strings of heat detectors, if either string is activated an alarm sounds. If both strings activate, the gas turbine is tripped and the $CO_2$ is discharged and the enclosure ventilation fan stops.

- **Two outdoor heat recovery steam generators (HRSGs) without supplementary firing**

Each HRSG operates independently with its own gas turbine and produces steam to drive the common steam turbine. The HRSG operates with natural circulation at three pressure levels and includes a reheater. Each of these levels includes economizer(s), evaporator(s) and superheater (s).

- **One indoor condensing steam turbine generator (STG) unit.**

The steam turbine (ST) drives a 50-Hz electric generator. A horizontal air cooling condenser is used. The power plant will be cooled by an Air Cooling Condenser (ACC) system. An ACC is a direct dry cooling system where the steam is condensed inside air-cooled finned tubes.

## 4. DESCRIPTION OF THE ENVIRONMENT OF THE PROJECT

### 4.1 Location

The Damanhour CCPP project lies on a vacant land attached to an existing power generation plant (already in service) in Zaweyat Ghazal suburb in Damanhour town. This site is 4.5 km to the northwest of the city of Damanhour. El-Mahmoudya canal in line with Elbahr road lie

to the north of the site, and to the south lies the company employees' housing complex. Elkhandak canal lies to the east of the project site, while farmlands lie to the west of the site and Garboua' village. Map 1 shows the project site and its surrounding area.

*Map 1: project location.*


*Source: ESIA report (2015)*

### 4.2 Physical environment

***Climate*** in the study area (Zawyet Ghazal, Damanhour, Elbeheria Governorate) is semi-arid. It is characterized by short winter and long summer (from May to September). The total annual rainfall is 99.6 mm per year. The maximum rainfall values are recorded in December and January ranging between 22.3 mm and 35.1 mm.

***Atmospheric temperature***: The minimum temperature values are recorded during January and February (7.6 C°). Maximum temperatures occur during the period of July/August, the highest temperature value of 32.1 C° is recorded in July. The annuals mean temperature is 19.4 C°

***Wind*** is most frequently from North and North West directions during most of the year.

***Air Quality***

*Technical and analytical tools used*

Within the project's site boundaries, measurements were undertaken on December 23, 2014, at five locations (map 2), which represent the on-site baseline. The following technical and analytical tools were used for air quality analysis:

- The EVM 7 (Quest) Simultaneous Particulate and Gas Measurement device was used to measure carbon dioxide, aldehydes and flying ash levels;
- The Thermo 450C H2S/SO2 Monitor was used to measure sulfur dioxide and hydrogen sulfide concentrations;
- The Thermo 42C NO-NO2-NOx Monitor was used to measure nitrogen dioxide;'
- The Thermo CO Analyzer, 48i to measure Carbon monoxide;

- A medium volume sampler is used for the gravimetric determination of Total Suspended Particles in ambient air.

For the air modelling, Hybrid Single-Particle Lagrangian Integrated Trajectory-(HYSPLIT) Model was used. Through this study, dispersion models are derived for carbon monoxide, nitrogen dioxide and sulfur dioxide concentrations, which result from the fuel combustion process.

Map 2: Air Quality measurement sites


*Source: ESIA report (2015)*

*Results of the measurements*

All measurement parameters showed low concentrations. $SO_2$, $H_2S$, NOx, CO and, $CO_2$ concentrations did not exceed the permissible limits (2, 10, 3, 25 and 5000 ppm respectively) according to the Egyptian Environmental Law 4/1994 and its amendment modified by the ministerial decrees 1095/2011 and 710/2012. Aldehydes showed no detectable concentrations. Flying ash and smoke have not stated permissible limit in the Egyptian Environmental Law 4/1994 and its amendment modified by the ministerial decrees 1095/2011 and 710/2012.

*Results of the dispersion model*

From the dispersion models of the emitted pollutants, carbon monoxide concentrations range from $1*10^{-5}$ to > 0.01 mg/m$^3$ which are far below the maximum permissible limit (30 mg/m$^3$ per hour in urban and industrial areas) according to the Egyptian Environmental Law 4/1994 and its amendment modified by the ministerial decrees 1095/2011 and 710/2012. Nitrogen dioxide concentrations range from $1*10^{-5}$ to > 0.01 mg/m$^3$ which are equivalent to (0.01 and 10 µg/m$^3$ respectively) and are far below the maximum permissible limit (300 µg/m$^3$ per hour in urban and industrial areas) according to law 4/1994. Sulfur dioxide concentrations range from $1*10^{-3}$ to > 0.1 mg/m$^3$ which are equivalent to (1 and 100 µg/m$^3$ respectively) and are below the maximum permissible limit (300 µg/m$^3$ per hour in urban areas) according to law 4/1994. Details on the permissible limits are provided in annex. Total Suspended Particulates (TSP) concentrations at the five locations ranged from 42 to 68 µg/m$^3$ which indicate low levels.

***Table 4 : Measurement results of air pollutants at Damanhour Power Plant project site***

| Location | $SO_2$ (ppm) | $H_2S$ (ppm) | NOx (ppm) | CO (ppm) | $CO_2$ (ppm) | Aldehydes (ppm) | | Flying Ash ($\mu g/m^3$) | Smoke ($\mu g/m^3$) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.005 | 0.007 | 0.015 | 0.73 | 419 | ND * | | 68 | 32 |
| 2 | 0.007 | 0.012 | 0.001 | 0.75 | 431 | ND * | | 63 | 22 |
| 3 | 0.007 | 0.011 | 0.006 | 1.02 | 441 | ND * | | 64 | 23 |
| 4 | 0.007 | 0.007 | 0.001 | 0.67 | 431 | ND * | | 59 | 23 |
| 5 | 0.009 | 0.002 | 0.005 | 0.93 | 416 | ND * | | 42 | 17 |
| AQL inside the working environment | **2** | **10** | **3** | **25** | **5000** | Acetaldehyde | 25 | - | - |
| | | | | | | Formaldehyde | 0.3 | | |
| AQL in the ambient air (1-hour) | **300 $\mu g/m^3$** | - | **300 $\mu g/m^3$** | **30 $mg/m^3$** | - | - | | - | **150 (24-hour)** |

* *The lower detection limit for aldehydes (LDL) is 0.01 ppm.*

***Table 5: Measurement results of air pollutants outside Damanhour Power Plant***

| Site | SO2 (µg/m3) | NOx (µg/m3) | CO (mg/m3) | TSP (µg/m3) | PM10(µg/m3) |
|---|---|---|---|---|---|
| SE1 | 12 | 20 | 0.88 | 168 | 68 |
| SE2 | 11 | 18 | 0.79 | 166 | 59 |
| S1 | 9 | 18 | 0.67 | 153 | 73 |
| S2 | 8 | 18 | 0.55 | 148 | 68 |
| SW1 | 10 | 19 | 0.75 | 138 | 65 |
| SW1 | 8 | 18 | 0.71 | 127 | 63 |
| AQL (Egyptian Standards) | 300 | 300 | 30 | 230 | 150 |
| Air Quality Standard European Commission (EC) | **350** µg/m3-1hr<br><br>125 µg/m3-24hr | **200** µg/m3-1hr | **10** mg/m3 maximum daily 8-hr mean | - | **50** µg/m3-24hr |

Source: ESIA report (2015)

***Noise Level inside Damanhour Power Plant***

*Tool*

A Digital Sound Level Meter was used to measure noise levels. Noise levels were monitored during day and night from 21 December 2014 to 7 January 2015 at the selected sites inside and outside the project site.

Map 3: Noise levels measurement locations


Source: ESIA (2015)

***Table 6 : Noise Levels (dB) inside the West Delta for Electricity Production Co., Damanhour Station, El Behaira Governorate., January, 2015***

| Site Description | N | E | Noise Levels dB | | | Allowable levels | Avg./Allowable % |
|---|---|---|---|---|---|---|---|
| | | | Range | | Average | | |
| | | | Max. | Min. | | | |
| site1 (northeastern corner) | 31° 5'12.77 | 30°25'42.05 | 68.5 | 64.4 | 66.3 | 90 | 73.7 |
| site2 (northwestern corner) | 31° 5'11.48 | 30°25'38.27 | 71.2 | 66.2 | 68.2 | | 75.8 |
| site3 (southwestern corner) | 31° 5'3.53 | 30°25'39.30 | 75.5 | 69.3 | 72.0 | | 80.0 |
| site4 (southeastern corner) | 31° 5'2.97 | 30°25'45.53 | 67 | 64.3 | 66.0 | | 73.3 |
| site5 (central point) | 31° 5'7.71 | 30°25'41.77 | 69.3 | 64.5 | 66.8 | | 74.2 |

The levels of noise inside the new Damanhour station are lower than the maximum allowable level (90 Db for 8 hours exposure). Details on the permissible limits are provided in annex.

***Table 7: Noise Levels (dB) outside Damanhour Power Plant***

| Site Description | N | E | Noise Levels dB | | | Allowable levels for day from 7 am to 10 pm | Avg./Allowable % |
|---|---|---|---|---|---|---|---|
| | | | Range | | Average | | |
| | | | Max. | Min. | | | |
| Site 1 North | 31° 5'8.90"N | 30°26'0.05"E | 89.3 | 65.3 | 75.9 | 65 | 116.8 |
| Site 2 North | 31° 5'15.32"N | 30°25'54.54"E | 91.4 | 69.8 | 80.6 | | 124.0 |
| Site 1 South | 31° 5'15.10"N | 30°25'24.76"E | 68.4 | 54.4 | 61.0 | | 93.8 |
| Site 2 South | 31° 5'12.54"N | 30°25'24.63"E | 64 | 50.8 | 55.1 | | 84.8 |
| Site 3 South | 31° 5'2.16"N | 30°25'39.39"E | 57 | 46.6 | 51.3 | | 78.9 |
| Site 4 South | 31° 5'2.16"N | 30°25'39.39"E | 64.7 | 47.1 | 51.4 | | 79.1 |
| Site 1 East | 31° 5'4.44"N | 30°26'3.97"E | 78.6 | 63.5 | 73.3 | | 112.8 |
| Site 2 East | 31° 5'1.06"N | 30°25'58.22"E | 62.9 | 58.4 | 60.6 | | 93.2 |
| Site 3 East | 31° 5'1.52"N | 30°25'48.00"E | 74.4 | 58.6 | 62.7 | | 96.5 |
| Site 1 West | 31° 5'16.77"N | 30°25'51.11"E | 77 | 66 | 70.9 | | 109.1 |
| Site 2 West (Parking) | 31° 5'16.43"N | 30°25'46.29"E | 70.3 | 64.1 | 66.7 | | 102.6 |
| Site 3 West | 31° 5'15.72"N | 30°25'35.97"E | 69.4 | 63.7 | 66.4 | | 102.2 |
| Site 4 West | 31° 5'15.76"N | 30°25'28.13"E | 66.4 | 57.3 | 61.8 | | 95.1 |

*Source: ESIA report (2015)*

During daytime (from 10 am to 7 pm) some measurements sites outside the project site show higher levels of noise (65 dB during daytime) than the maximum allowable level.

***Geomorphology and soils***, the project area can be distinguished as the properly deltaic morphology created by river discharge behind the barrier. This geomorphic unit has been identified and named as the Nile flood plain. The main soil is the Torrifluvents type which has an aridic (or torric) soil moisture regime

***Water quality***

*Technical and analytical tools*

The sampling was done according to the method described by "*Standard Methods for the Examination of Water and Wastewater*, 22ed edition 2012". Van Veen sampler was used for sediment samples. Water samples were collected (map 4) in special glass containers for organic matter measurements, sterile containers for biological parameters and plastic containers for physical and in-organic parameters. Sediment samples were collected in aluminum foil for organic parameters and in plastic bags for inorganic parameters. Some of the physical parameters were performed in the field including temperature, pH, TDS, conductivity DO.

***Map 4: Sampling locations for water quality analysis***

*Source: ESIA (2015)*

*Results*

The water analysis of El-Mahmoudeya and El-Khandak canal were in general in good condition (table 8). The physical and inorganic content of water were within the permissible where the BOD and COD didn't exceed the limits except high levels of total nitrogen and low values of DO were recorded. Most of the tested heavy metals were not detected in canal water only lead and chromium were detected in high levels. Fecal coliform was present in excessive amount, an indicator for sewage disposal in water.

***Table 8: Summary of water quality results***

| Parameter | Reading/ Concentration | | | | Maximum allowable limits |
|---|---|---|---|---|---|
| | **D1** | **D2** | **D4** | **D5** | |
| **Temperature °C** | 19.1 | 19.1 | 19.3 | 22.5 | 38* |
| **pH** | 7.66 | 6.94 | 7.24 | 7.25 | 6-9 |
| **Ammonia mg/L** | 0.16 | 0.71 | 1.56 | 0.87 | **3** |
| **BOD mg/L** | < 2 | < 2 | < 2 | < 2 | 60 |
| **COD mg/L** | < 5 | < 5 | < 5 | < 5 | 100 |
| **Phenol mg/L** | < 0.01 | < 0.01 | < 0.01 | < 0.01 | 0.015 |
| **Oil and grease mg/L** | < 0.5 | < 0.5 | < 0.5 | < 0.5 | 15 |

* shall not exceed the prevailing temperature by 5 °C, with maximum of 38 °C.
*Source: ESIA (2015)*

**4.2 Biological environment**

Field surveys of the flora and fauna of the power station site and surrounding areas were carried out in December 2014. The study showed that the ecosystem of the proposed power plant site is poor in diversity and structure. No significant habitats or species were encountered in the surveyed area. No protected areas for their conservation value are located

on, or in the vicinity of the project area. No rare or threatened species are found in this area or recorded around it. There are four species of amphibians known in the study area. A total of 27 species of reptiles in the study site were recorded 19 species of lizards and 8 species of snakes. Common birds in the study area Include 71 species.

### 4.3 Socioeconomic environment

The project area which is predominated by the village of Zouyat Ghazal has a population of approximately 8868 people. The gender sex ration is in favor of men at 105.4%. On the other hand literacy levels are in disfavor of women who display a 55% rate of illiteracy compared to 34% among men. The area has a labor force of 42.9% of which only 9% are women compared to 69% men. Population incomes for the majority hover between 500 and 1000 EGP per month with a few (23%) of the population earning over 3000 EGP per month. The project area is connected to reticulated water supply system and access to electricity is almost universal. The most common diseases among the interviewed households were hypertension (36%) and diabetes (32%). Other diseases included hepatic diseases (mainly hepatitis C) and hepatic fibrosis; heart related diseases, cancer, systemic lupus erythematosus, and recurring kidney stones. Most of the households depend on private healthcare facilities as their primary healthcare provider (clinics, polyclinics or hospitals) and turn to the public hospitals especially during emergencies. Only 8% visit public health insurance facilities (hospitals or polyclinics). The two major problems associated with electricity are related to the costly electricity bills, indicated by 27% of surveyed households, and repeated power cuts which is stated by approximately 34% of the surveyed households.

About 36% of the interviewed household had a family member with hypertension, while 32% have family member with diabetes. These are the two major health issues in the project area.

There is no area of cultural and historical importance near the project that can be affected by its activities. The nearest area is Wadi Elnatroon which is distinguished by its cultural heritage of the Coptic monastery and its natural reserves. Wadi Elnatron is about 80-85 km away from the plant site to the south direction which is out of the project area of impact.

### *4.5 Natural Hazards*

*Seismic Activity*
Egypt is a country of low to moderate seismic hazard and earthquakes are active in the north parts of the country. Damanhour and its surrounding are located in zone 2 according to the Egyptian classification. The Egyptian code recommend that structures located in zone 2 should be capable to resist a ground acceleration of 0.125 from the gravitational acceleration. The site and its surrounding area have had minor seismic activity, during recent historic time. As mentioned in 8.2 this factor has been taken into account in the Quantitative Risk Analysis and more importantly will inform the plant design.

*Flash Floods:* The project site does not contain any of the narrow Wadies, which collect the rainwater in concentrated streams and may cause flash floods. Accordingly, the project site is not affected by these drains and is considered protected from possible hazards of flash floods.

## 5. PROJECT ALTERNATIVES AND RESULTS OF THE COMPARISON

### 5.1 No project option

The alternative studies the conditions that would exist if the project is not established. In this case, there would still be shortage in the electrical power supply and the gap between demand and supply would get wider. National production would be thus affected as well as the overall economic status of the country. This option is not acceptable neither economically nor

socially since Egypt is currently suffering from power shortage due to insufficient infrastructure, and the demand is expected to further increase.

Import electricity through one of the existing interconnections and/or construct new ones. Egypt is currently interconnected with Jordan to the East, Libya to the west, and a new interconnection with Saudi Arabia is under implementation. The interconnections with Jordan and Libya are already fully exploited, mainly for exporting electricity from Egypt to these regions. The interconnection with Saudi Arabia will have a potential for exchanging the maximum potential of 3,000 MW between the two countries. This will still not be sufficient to cover all the expected increase in the demand in Egypt. There is also potential for interconnection with Sudan and Ethiopia, but the studies are still being completed.

**5.2 Project option**

***Technology Alternatives***

**Renewable Energy (RE) sources (solar, wind and tidal)** are possible option and were explored. The government has a target to increase the power generation capacity from RE to 25% by 2022, including 4,300 MW to be developed by 2017. To this end, several new projects are either under implementation, or under preparation. However, RE especially solar, is not the least cost solution for covering the peak load in Egypt, which typically occurs after sunset. ***Thermal generation is therefore still needed.***

Based on the above, the thermal generation is the preferred option from a commercial and financial viability point of view. Below are the alternatives considered for the Damanhour CCPP project.

- ***Site Alternatives*** : The proposed site is distinguished by the following criteria and advantages: (i) The site is a property WDEPC, thus it puts the project away from land acquisition; (ii) the infrastructure required for a power station already exists; (iii) Well-trained workers with long experiences are nearby the new project; (iv) Natural gas pipelines are already in reach to the power plant site; (v) the presence of the New Power Plant in Elbeheira governorate near the rest of Delta governorates will reduce the loss of electrical power which is probable for long-distance transfer. *Thus, the proposed project site is the best available location for the New Damanhour from an environmental and social point of view.*
- ***Fuel Alternatives explored for the gas turbines***:
  - **Light fuel oil**: Light fuel oil is compatible with the design of the gas turbines. High grade of light oil is used in power plants to avoid damage to the equipment. It is proportionally expensive and coasty compared to the natural gas. Air emissions resulting from its combustion are relatively high, yet within the permissible limits of the Egyptian Environmental Law;
  - **Heavy fuel oil (mazott)** The design of the gas turbines is not compatible with the use of heavy oil. It is designed only for the use of natural gas and light fuel oil. In addition, the heavy fuel oil is known for its excessive pollutant emissions to the air and consequently pollution of surface water and soil through dry and wet depositions.
  - ***Natural gas:*** Natural gas is the prefered option from an environmental and social point of view because it is a clean energy source, distinguished by its low sulfur content and thus emissions. It has better effects on the physical environment and hence on the public health in the surrounding areas. It is compatible with the turbines design.

- ***Fuel Alternatives for steam turbine units***

Steam turbines run without firing on the heat recovered through the HRSG in the combined cycle system. If the combined cycle system is not used steam turbines would run either on

natural gas or on dual system of natural gas and heavy oil. Both scenarios would exploit more natural gas resources and in both cases heat energy is wasted in addition to the increase of air pollutants in the second case. *As per the previous justifications, natural gas as the primary fuel for the New Damanhour Power Plant and the use of the combined cycle system with no firing in the steam units are the best available alternatives.*

The selected design meets all EU Best Available Technology (BAT) requirements for Large Combustion Plants. The following assessment (table 9) was conducted for the New Damanhour Combined Cycle Power Plant.

***Table 9: BAT Assessment for the combustion of gaseous fuels***

<table>
<tr><th colspan="6">Best Available Techniques (BAT) for the combustion of gaseous fuels</th></tr>
<tr><td colspan="6">1. Supply and handling of gaseous fuels and additives</td></tr>
<tr><td>Material</td><td>Environmental Effect</td><td colspan="2">BAT</td><td>BAT met (Y/N)</td><td>Project Compliance</td></tr>
<tr><td rowspan="2">Natural Gas</td><td>Fugitive emissions</td><td colspan="2">- using fuel gas leak detection systems and alarms.</td><td>(Y)</td><td>Natural gas is the primary fuel used in the project.</td></tr>
<tr><td>Efficient use of natural resources</td><td colspan="2">- using expansion turbines to recover the energy content of the pressurized fuel gases<br>- preheating the fuel gas by using waste heat from the boiler or<br>gas turbine</td><td>(Y)</td><td>- Leak detection systems and alarms will be used.<br>- Air cooling condenser saves water resources.<br>- The combined cycle system conserves wasted heat and converts it into energy.</td></tr>
<tr><td colspan="6">2. Thermal efficiency of gas-fired combustion plants</td></tr>
<tr><td colspan="4">BAT</td><td>BAT met (Y/N)</td><td>Project Compliance</td></tr>
<tr><td colspan="4">- Combined cycle operation and co-generation of heat and power. (Electrical efficiency 54-58 %)</td><td>(Y)</td><td>Combined cycle system is applied.</td></tr>
<tr><td colspan="4">- The use of an advanced computerized control system to achieve a high boiler performance with increased combustion conditions that support the reduction of emissions.</td><td>(Y)</td><td>Advanced control system will be used.</td></tr>
<tr><td colspan="4">- Preheating of the natural gas, before its supply to the combustion chambers or burners.</td><td>(Y)</td><td>Preheating is applied.</td></tr>
<tr><td colspan="6">3. Dust and $SO_2$ emissions from gas-fired combustion plants</td></tr>
<tr><td colspan="4">BAT</td><td>BAT met (Y/N)</td><td>Project Compliance</td></tr>
<tr><td colspan="4">- For gas-fired combustion plants using natural gas as a fuel, emissions of dust and $SO_2$ are very low. The emission levels of dust by using natural gas as a fuel are normally well below 5 $mg/Nm^3$ and $SO_2$ emissions are well below 10 $mg/Nm^3$ (15 % $O_2$), without any additional technical measures being applied.</td><td>(Y)</td><td>- See table (3-1) in this chapter.<br>- Stacks will be equipped by online continuous emission monitoring system (CEMS).</td></tr>
<tr><td colspan="6">4. $NO_x$ and CO emissions from gas-fired combustion plants</td></tr>
<tr><td rowspan="2">BAT</td><td colspan="2">Emission levels associated with BAT ($mg/Nm^3$)</td><td rowspan="2">BAT met (Y/N)</td><td rowspan="2" colspan="2">Project Compliance</td></tr>
<tr><td>$NO_x$</td><td>CO</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| - Dry low $NO_X$ premix burners (DLN) to reduce $NO_x$ emissions with continuous monitoring. | 20 - 50 | 5 - 100 | (Y) | - Dry low-$NO_x$ burner is applied.<br>- See table (3-1). |
| - Complete combustion with good furnace design, the use of high performance monitoring and process control techniques and maintenance of the combustion system to reduce CO emissions. | | | (Y) | The project will apply to these. |
| **5. Water pollution** | | | | |
| Source | BAT (to reduce waste water discharge) | | BAT met (Y/N) | Project Compliance |
| Regeneration of demineralizers and condensate polishers | - Neutralization and sedimentation. | | (Y) | See section (3.6.3) of this chapter. |
| Elutriation | - Neutralization. | | (Y) | |
| Washing of boilers, gas turbines, air preheater and precipitator | - Neutralization and closed loop operation, or replacement by dry cleaning methods where technically possible. | | (Y) | |
| Surface run-off | - Sedimentations or chemical treatment and internal re-use. | | (Y) | |
| Small amounts of oil-contaminated water | - Oil separation wells. | | (Y) | |
| General treatment techniques | - filtration<br>- pH correction/neutralisation<br>- coagulation/flocculation/precipitation<br>- sedimentation/filtration/flotation<br>- dissolved hydrocarbon treatment<br>- oil-water separation systems<br>- biological treatment. | | (Y) | |
| **6. Combustion residues** | | | | |
| BAT | | | BAT met (Y/N) | Project Compliance |
| - Utilization and re-use of combustion residues and by-products instead of depositing them in landfills. | | | (Y) | Combustion residues will be reused. |
| **7. Cooling System** | | | | |
| BAT | | | BAT met (Y/N) | Project Compliance |
| Air-cooling system will be used instead of water cooling system | | | Y | |

***Source: ESIA (2015)***

## 6. POTENTIAL IMPACTS

A combination of quantitative and qualitative assessment techniques, ranging from computer and/or physical modeling for air, water, noise and traffic impacts to ecological and aquatic surveys and visual evaluation, have been undertaken. The results of the assessment work have been compared with applicable national standards as well as those of AfDB and other donors, whichever is the more stringent. This section examines the main environmental and social impacts on: (i) Air Quality; (ii) Noise; (iii) Terrestrial and Aquatic Ecology; (iv) Resources Efficiency and Energy Conservation; (v) Traffic; (vi) Socio-economics and Public Health; (vi) Industrial and Hazardous wastes.

### 6.1 Air quality

During the pre-construction activities, particularly the site clearing including 3 fuel tanks, particulate matter, volatile hydrocarbons, gas emissions (carbon monoxide, nitrogen oxides and sulphur dioxide) are likely to impact air negatively. During operation, particulate matter in addition to gas emissions of carbon monoxide, nitrogen oxides and especially sulphur dioxide are reduced to minimum as the new project is run on the natural gas known for its clean combustion with low emission concentrations. It is also worth to mention that the current plant (3*65 MW) which is run on heavy fuel oil will be decommissioned once the new project is operated. The emissions from the old plant shall be terminated. Air quality around the study area is thus enhanced.

According to the dispersion model results, the highest projected concentrations of carbon monoxide, nitrogen dioxide and sulphur dioxide are slithly above 0.01, 0.01, and 0.001 $mg/m^3$ respectively. These add to the baseline air quality 0.03 - 0.3% of carbon monoxide AQL (30 mg/m3 per hour in urban and industrial areas), 3.3 - 33% of nitrogen dioxide AQL (300 $\mu g/m^3$ per hour in urban and industrial areas), and 0.33-3.3% of sulphur dioxide AQL (300 $\mu g/m^3$ per hour in urban areas).

### 6.2 Noise

During construction and pre-construction activities, noise is considered a negative impact on the surrounding environment due to the continuous work on the project site, involving equipment installation, digging and other civil works prior to and during the construction of the plant. During operation, noise is considered a slight temporary negative impact especially at the start-up of the operation in case no mitigation measures taken into account.

### 6.3 Terrestrial and Aquatic Ecology

Both current conditions of existing operations and the new project construction and operation have insignificant impact on the flora, fauna and aquatic ecosystem. The quality and quantity of Elmahmoudya canal surface water, would have been negatively affected if air cooling was not used and water-cooling was used instead.

### 6.4 Resources Efficiency and Energy Conservation

Resources efficiency is not optimally met by current operation technologies. Unlike the combined cycle technology of the new project where up to 59% efficiency is achieved, current operations are less energy efficient. In the combined cycle, the lost energy from the combustion in gas turbines in the form of heat is recovered and reused to produce more energy through the steam turbines.

## 6.5 Traffic

During construction and operation traffic on the access and nearby roads (Elbahr, Damanhour-Desouk, the International Highway, Cairo-Alexandria Agricultural road, Cairo-Suez highway and Portsaid-Suez highway), is expected to experience higher load of about 5% (Traffic Impact Study attached). Thus the impact on traffic is negative.

### 6.6 Socio-economic and public health

The overall impact of project construction on the social component is neutral to positive. Project construction will add about 1500-2000 temporary job opportunities for technical and non-technical workers. WDEPC states as a condition with the contractor that 90% of the labour must be of the Egyptian nationality. The overall impact on the economical component is positive through alleviating the power shortages to the consumers especially the industrial

and commercial sectors, and also the social services. In addition, the project will result in creating 175 000 indirect jobs which will have a positive impact on poverty reduction.

The community standard of life and welfare are enhanced due to the availability and improvement of electricity-based services. These services vary from lightening, and electronic affairs in homes and work offices, to the services in public agencies and institutions. Public health in the surroundings areas will slightly improved due to the reduction in air emissions especially for risks of asthma attacks. Power supply from the new Damanhour power plant will positively affect the overall modernization and urbanization of the Egyptian communities.

In addition, the on-site workers are in healthier conditions as an environmental and social commitment of the company that the workers comply with the appropriate Personal Protection Equipment (PPE) and they are well trained on safety attitudes inside the work place and during emergencies to keep themselves and their fellows away from harm. Their awareness of different hazards and health and safety issues are raised up and thus less work injuries are probable to occur. Furthermore, as part of the ESMP are the regular medical checks on the workers' health.

The project area is connected to reticulated water supply system and access to electricity is almost universal. Most of the households depend on private healthcare facilities as their primary healthcare provider (clinics, polyclinics or hospitals) and turn to the public hospitals especially during emergencies. The project Power Plant shall continue to provide full access to the communities in terms of education where the power utility has 2 basic schools and a health center. The project will monitor the impact over these parameters on the population during implementation and during operation."

### 6.7 Industrial and Hazardous Waste

It is worth to mention that the construction activities of the project will not produce any hazardous waste. However, the clearing activities prior to the construction might pose a hazardous waste risk due to the clearance of 3 fuel tanks existing on-site. During the operation phase, hazardous wastes are produced in very low quantities from maintenance works and wastewater residue. These hazardous materials pose a risk inside the working environment and on the nearby areas if they are not safely handled and disposed.

### 6.8 Cumulative Impacts

The main air pollution sources in the area are primarily the power plant and secondarily the traffic on the nearby roads. Baseline measurements on-site and off-site the plant shows that the air pollutants are far below applicable limits. The dispersion models for the projected emissions show that the add-on concentrations are very low. Thus, the overall cumulative impact on air quality is within the acceptable limits and no significant negative impact is expected.

During construction and pre-construction activities, civil and installation works will be a major source of noise added to the existing operations and the noise from traffic. Nevertheless, compliance with the permissible limits shall be met.

Traffic impact will be cumulative with the normal traffic growth, which is expected to be about 5% increase.

## 7. MITIGATION/ENHANCEMENT MEASURES AND COMPLEMENTARY INITIATIVES

### 7.1 Environmental and Social Management System (ESMS)

The ESMP will be implemented through the New Damanhour Power Plant's Environmental and Social Management System (ESMS). The objectives of the ESMS are: (i) to provide a means of ensuring that environmental compliance with relevant laws and regulations is achieved; (ii) to ensure that environmentally-sound performance is achieved; (iii) to provide for the ability to comply with external standards and expectations that may arise in the future; (iv) and to provide a guide for the systems to be implemented at the plant and how they combine to achieve an effective ESMS.

The key elements of the ESMS are: (i) Compliance with applicable laws, regulations and standards; (ii) Assessing environmental impacts and setting targets; (iii) Procedures and procedural reviews; (iv)Training / employee education; (v) Emergency preparedness; (vi) Reporting; (vii) Audit and management review; and Community partnerships.

### 7.2 Air quality

Natural gas is distinguished by its low sulfur emissions. Thus the air quality regarding sulfur dioxide concentrations is enhanced. Nevertheless, gas turbines will be designed with low-NOx burner which decreases nitrogen oxides (NOx) emissions. The key idea to decrease the exhaust NOx is to decrease flame temperature. This is achieved by Dry Pre-Mix Combustion where gas and air are premixed resulting in a uniform flame temperature. This technique is proved to be efficient in NOx exhaust reduction.

### 7.3 Noise

All units and equipment are designed to produce equivalent noise levels not exceeding 85 dB at one-meter distance far from the equipment. The overall design also takes into account that the equivalent noise levels at the site boundaries will not exceed 55 dB.

### 7.4 Terrestrial and Aquatic Ecology

The use of air-cooling system eliminates the negative impact on the surface water quality of Elmahmoudya canal unlike the water cooling where the output of the cooling process was heated and used to influence the physical properties of the water. The air cooling technology also preserves Elmahmoudya canal waters as a natural resource and gives a push towards sustainable strategies.

### 7.5 Resources Efficiency and Energy Conservation

Regarding sustainable use of resources, the project also adopts a closed-circle system for demineralized water used for steam generation. The condensate out of the ACC is recirculated in a closed system to regenerate further super-heated steam essential for the run of the steam turbine. This closed system guarantees efficient use of Elmahmoudya canal waters as the quantity of water withdrawn to start the operation of the steam turbines is taken only once and then very small amount of water is used for makeup.

### 7.6 Socio-economic and public health

All workers must be aware of their environmental responsibilities under the Egyptian Environmental Law, and all contractors and operational staff members must undergo an induction session, which includes a section on environmental awareness and responsibilities. The new Damanhour CCPP will run an employee education program. This program will cover the following aspects: (i) Environmental and Social Management System; (ii) Security; (iii)

Incident Reporting; (iv) Emergency Response and Notification; (v) Environmental and Social Protection; (vi) Site Hazards; (vii) Operation Hazards; (viii) Personal Protective Equipment (PPE); and (ix) General Safety Rules & Safety Program.

The project shall also include among the complementary initiatives facilitating communities in the effort to clean up the surrounding by removing garbage which was observed during preparation as being a menace in the project area. Literature on gender and urban waste attests to the fact that irrespective of the status of women outside of the household, within the home women are widely accepted as maintainers of the domestic environment including disposing off household garbage. Often the burden of caring for children who fall ill due to being exposed to uncollected garbage disproportionately falls on women. The assistance from WDEPC in this regard will free up time for women to be engaged in economic activities and reduce morbidity among children. The communities in the project area are already organized and contribute a small fee towards meeting the cost of removing garbage, but WDEPC could facilitate by providing tools and transport the garbage.

### 7. 7 Traffic

North entrance of Damanhour Power Plant shall be renewed, prepared and readied for use as the plant main entrance. This action, as per the traffic impact study, will help reduce the effect on traffic and any crowdedness resulting from vehicles queues outside the entrance gate.

### 7.8 Industrial and Hazardous wastes

Industrial wastewater will be treated to meet the specifications set by the Law no. 93/1962 which to be disposed of, along with treated sewage wastewater, on the domestic wastewater network of the city. Industrial wastewater treatment unit in addition to water/oil separator unit and sewage treatment unit are constructed as basic components of the project. Solid wastes will be disposed of by the means of an authorized party so they cause no harmful effects on the surrounding area such as anxiety, odor and infections. Oils collected from the water/oil separator unit will be safely handled and stored then sold to a licensed entity.

Hazardous wastes, which are generated in small amounts, will be handled by well trained workers and safely managed and stored. Contracts are made with authorized transportation company and with the Hazardous Waste Management in Alexandria Governorate to finally dispose of the hazardous waste at Elnasserya Hazrdous Waste Landfill.

A full Waste Management Plan shall be submitted by the construction contractors and the operation management prior to the start of both phases; construction and operation.

### 7.9 Security measures

The Emergency Procedures state the site contingency plans that cover all potential accidental events during both construction and operation. Specific Emergency Procedures must be developed by the Construction Contractor and Operation Management prior to the commencement of these phases. These procedures govern any emergency incidents on the project site such as spills, fires, gas leaks or personnel injury or rescues. Emergency Response procedures cover most chemical emergency incidents.

#### *Accident Response*

As part of the preparation of emergency procedures and the plans for accident response arrangements, the project company will carry out the following:

- review industry-specific and Egyptian and applicable International standards and regulations;

- establish general guidelines on potential safety and accident risks;
- prepare job-specific operating instructions where appropriate;
- establish safety and security notices for hazardous materials;
- prepare specific emergency operating instructions;
- provide protective equipment (including clothing, air and ear protection etc.) as required;
- evaluate information and feedback from employees; and record and investigate all accidents, injuries and incidents.

***Contingency and emergency plans***

Contingency plans and emergency procedures are being developed to cover events due to operational failures, natural causes and acts of third parties. The plans and procedures will cover, as a minimum, the following:

- fire;
- explosion;
- bomb alerts;
- leaks and spills of hazardous materials;
- structure or equipment failures;
- injuries and illnesses;
- risk from natural disasters (wind, sandstorm, earthquake).

An emergency Response Team (ERT) will be setup. Please see section 9.1 for additional information. The contingency and emergency plans during construction will be required from the contractors prior to the beginning of the works. During operation, the existing contingency and emergency plans for the old Damanhour Power Plant's will be improved as part of the plant's ESMS. The plans will be operational prior to operation of the plant.

# 8 EXPECTED RESIDUAL EFFECTS AND ENVIRONMENTAL HAZARD MANAGEMENT

## 8.1 Expected residual effects

From the above, there are no significant environmental impacts resulting from the construction and operation of the plant. Therefore, good site management and engineering practices during construction and implementation of appropriate measures during operation will ensure that any residual impacts are reduced to minimum/insignificant levels.

## 8.2 Environmental Hazard Management

A Quantitative Risk Assessment (QRA) of the Damanhour CCPP has been conducted which includes: (i) Quantitative site risk assessment; (ii) Quantitative operational risk assessment; (iii) Quantitative normal emissions and accidental risk assessment; (iv) and Quantitative health risk assessment.

Results (summarized in table 10 below) indicate that the overall risks are very low and do not constitute any significant risks to adjacent population or workers. In particular, the following points are to be considered: (i) Design and construction have taken into consideration international regulations and site codes for earthquake risks and for construction standards; (ii) the risk associated with near range dispersions in both cases of normal operations or accidental releases are very low and do not constitute any significant risks; (iii) the risk associated with field dispersion is also extremely low and does not constitute any significant risk; (iv) Operational risks associated with operations have been identified and have indicated safety measures for operation. Recommendations for a contingency plan has been proposed in

this regard; (v) Potential health risks of all emissions have also been estimated and found not to exceed normal conditions and do not constitute any risk to the community.

***Table 10: Estimated values of risks***

| Risk | Estimated value | Mitigation measures |
|---|---|---|
| Site Risk | Less than $10^{-7}$ (if earthquake codes are considered) | Design and construction should take into consideration international regulations for quality assurance and quality control of construction and site codes for earthquake risks are observed |
| Normal emissions risk | Highly insignificant | Operational team will be well trained on various aspects of operations, preventive maintenance and precautionary measures are observed and checked periodically. |
| Accidental emissions risk | Highly insignificant outside the factory<br>Less than $10^{-6}$ for plant workers if appropriate measures are taken | An Environmental Management System (EMS) will be established with responsibilities for identifying and follow up of various safety measures of operation of the site<br><br>A detailed contingency plan including monitoring programs is recommended and training and testing are emphasized |

*Source: Adapted from QRA report 2015*

An Emergency Response Plan covering all potential accidental events during both construction and operation will be implemented by the Construction Contractor and Operation Management prior to the commencement of these phases.

# 9 MONITORING PROGRAM

## 9.1 Monitoring roles and responsibilities

A Project Implementation Team (PIT) will be appointed from the existing staff of WDEPC to oversee the implementation of the project. The PIT will be headed by a resident engineer as Project Manager, assisted by General Managers in areas relevant to the project such as mechanical engineering, electrical engineering, civil engineering, instrumentation and controls engineering, commissioning and operations, environment, health and safety, procurement and finance/accounting.

One of the duties of the environmental officer (EO) is : (i) to be the interface with authorities for environmental authorizations and permits; (ii) that all contracts with Contractors and sub-contractors stipulate all construction management measures (as given in the ESMP), operational design criteria and environment, health and safety standards which must be implemented at the project site; (iii) ensure that mitigation measures to reduce impacts during the construction phases are implemented; (iv) the monitoring program/requirements are fulfilled and properly implemented.

The role of the emergency response team (ERT) is to handle any emergency incident during construction and operations of the project site. The ERT is responsible for all incidents including Hazardous material handling, rescue and fire control. Members of this team, or other nominated employees may be requested by the construction contractor and/ or Operation management to give advice or assistance in any incident in which is related to the plant. The ERT may be requested by construction contractor and/ or operation management to assist any other company in the event of mutual aid. The ERT may consist of shift operators and relevantly trained day staff volunteers. This team will be lead by the Incident Controller, based in the construction offices (Construction) or control room (Operation). A site chief will

be assigned and control the incident from the field. A coordinator will be assigned to control all services requested from the site chief, these will include all outside services, such as fire, ambulance and other public services.

Each contractor shall be expected to prepare a construction ESMP (CESMP) and shall be responsible for the implementation of the CESMP falling under the scope of its contract. The Supervising Engineer's environmental, health and safety experts shall be responsible of the surveillance of the implementation of the CESMPs during pre-construction and construction phases. WDEPC's relevant experts shall undertake the monitoring of the CESMPs for all the phases of the project. This shall be done by one Environmental Specialist (from the Chemical Department) and one Health and Safety Expert (from the Health and Safety Department).

An independent accredited laboratory third party will be responsible of an annual review and audit of sample analyses, to ensure that impartial objective data are collected and produced.

Where applicable, the EEAA will carry out the external monitoring of the ESMP.

### 9.2 Components of the Monitoring Program

Environmental and social management and monitoring activities will be implemented (according to the ESMP), following the same project schedule, as all activities are mainstreamed in the project design. The proposed monitoring program is composed of three main categories:

- **Environmental Monitoring** which will target air emissions, water bodies, solid and hazardous waste, incoming and outgoing chemicals, trucking and machinery activities and tracks, Health risk/workplace safety;
- **Socio-Economic Monitoring** which covers relevant socio-economic impacts of the project and surrounding community/activities. A community survey should be undertaken annually beginning during the first year of construction and continuing annually for first 2 years of operation and every 3 years thereafter, in coordination with the community advisory panel (comprising members who represent the local community) and,; **Documentation Monitoring** which involves checking that all data are documented and interpreted, and that corrective actions are followed up and implemented. The documentation system (including logbooks, internal/external communication documentation, etc.) and environmental register should be regularly checked (bi-monthly) and updated (daily), in compliance with the requirements of Egyptian Law 4/1994.

### 9.3 Main monitoring parameters and frequency

Tables 11 to 14 below indicate for each measurement parameter the monitoring regime including the monitoring locations and frequency as well as the performance standards.

**Table 11: Water Monitoring Plan**

| **Construction** | | | |
|---|---|---|---|
| Item | Performance Standard | Measurement Parameters | Monitoring Location(s) and Frequency |
| Quantity and type of direct or indirect waste reaching Elmahmoudya canal | No reportable incidents | | |
| Freshwater and sediment Analyses | Comparison to baseline values / relevant legislation | Temperature, pH, DO, BOD, COD, heavy metals, THCs, oil and grease and microbiological | **Every Three Months** down stream and upstream the construction location. |

| | | | |
|---|---|---|---|
| | | analysis. | |
| **Operation** | | | |
| Treated industrial wastewater | Permissible limits and standards set by<br>Law no. 48/1982<br>Law no. 93/1962<br>Code no. 105/2005 | Temperature, pH, DO, BOD, COD, heavy metals, THCs, oil and grease and microbiological analysis. | Every six months |
| Treated Municipal wastewater | Law no. 48/1982<br>Law no. 93/1962<br>Code no. 105/2005 | Temperature, pH, DO, BOD, COD, heavy metals, THCs, oil and grease and microbiological analysis. | Every six months |
| Freshwater analyses | Comparison to baseline values / relevant legislation | Temperature, pH, DO, BOD, COD, heavy metals, THCs, oil and grease and microbiological analysis. | Annual sampling and analysis upstream and downstream |

**Table 12: Air quality Monitoring plan**

| **During construction** | | |
|---|---|---|
| Item | Performance Standard | Monitoring Location(s) and Frequency |
| Ambient air quality | | |
| PM10 | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012:<br>150 µg/m3 | ***Quarterly monitoring***:<br>Active sampling for:<br>- PM10;<br>- SO2;<br>- CO; and<br>- NOx.<br><br>***Monitoring locations:***<br>- Two locations within the plant boundaries; and,<br>- One location outside the plant boundary. |
| SO2 | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012:<br>300 µg/m3 (1-hour) | |
| CO | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012:<br>30 mg/m3 (1-hour) | |
| NOx (measured as NO2) | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012:<br>300 µg/m3 (1-hour) | |
| ***Fuel burning equipment*** (Stacks) | | |
| Equipment failures | No reportable failure | Leakages should be checked by:<br>(i) Visual inspection every eight hours; and,<br>(ii) Using leak detection equipment at least once a week |

| During operation | | |
|---|---|---|
| Ambient air quality | | |
| PM10<br>SO2<br>CO<br>NOx (measured as NO2) | Same as for the construction phase Monitoring | ***Quarterly monitoring*** (activesampling).<br>***Monitoring locations:***<br>- Two locations within the facility boundaries; and,<br>- One location outside the facility boundary.<br><br>Quarterly sampling to take place for the first 2 years of operation after which if no adverse impacts are noted, the frequency and parameters for monitoring can be reduced. |
| Air quality inside the working environment | | |
| PM10<br>SO2<br>CO<br>NO2 | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012:<br>PM10: 3000 μg/m3<br>SO2: 2 ppm<br>CO: 25 ppm<br>NO2: 3 ppm | Quarterly monitoring inside the units and control rooms. |
| Stacks/vents | | |
| Equipment failure | No reportable failure | Air emissions should be visually monitored for opacity at least once every eight hours. |
| Stacks/vents Emissions | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012:<br>For natural gas:<br>SO2: 150 mg/m3<br>NOx: 500 mg/m3<br>CO: 100 mg/m3<br>For fuel oil:<br>SO2: 1300 mg/m3<br>NOx: 500 mg/m3<br>CO: 250 mg/m3 | ***Quarterly monitoring***<br>Active sampling for:<br>- Particulate Emissions;<br>- SOx;<br>- NOx;<br>- CO; and,<br>- CO2.<br>***Sampling Port*** (1 inch diameter)<br><br>Quarterly sampling to take place for the first 2 years of operation after which if no adverse impacts are noted, the frequency and parameters for monitoring can be reduced. |

**Table 13: Noise Levels Monitoring**

| Item | Performance standard | Monitoring Location(s) and Frequency |
|---|---|---|
| **During construction** | | |
| Noise from pile driving activities | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012: 85 dB (From 2014 and on). | Monitoring should take place each day while pile-driving activities are occurring |
| Areas with direct contact to equipment usage | | Weekly noise recording |
| Ambient noise | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012: 65 dB (Day time 7 am – 10 pm). 55 dB (Night time 7 pm – 10 am). | Biannual monitoring at the plant boundaries.<br>• 24-hour noise measurement using Type 1 sound level meter (Precision Grade).<br>• Biannual sampling to take place for the first 2 years of operation after which if no adverse impacts are noted, the frequency and parameters for monitoring can be reduced. |
| **During operation** | | |
| Noise inside the working environment | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012: 85 dB (From 2014 and on). | Quarterly monitoring during the first two years at possible noise sources inside the work places.<br><br>Annual monitoring further on at possible noise sources inside the work places. |
| Ambient noise | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012: 65 dB (Day time 7 am – 10 pm).<br>55 dB (Night time 7 pm – 10 am). | Quarterly monitoring during the first two years at the facility boundaries and annually further on.<br><br>24-hour noise measurement using Type 1 sound level meter (Precision Grade). |

**Monitoring of Incoming and Outgoing Chemicals**

A logbook shall be kept and maintained for all incoming and outgoing chemicals. This book shall be reviewed regularly to check the chemicals consumption. An inventory of material data sheets for all chemicals on the site should also be kept.

**Monitoring of Trucking and Machinery Activities**

During both construction and operational phases, trucking and machinery shall be continuously monitored and documented to avoid unnecessary use. Road and truck related accidents should be recorded.

**Table 14: Health Risk / Workplace Monitoring**

In addition to the requirements listed above for monitoring inside the workplace, other important items should be taken included in the monitoring plan.

| Item | Performance Standard | Monitoring regime |
|---|---|---|
| Heat stress | The Egyptian Environmental Law no. 4/1994 and its amendment no. 9/2009 modified with ministerial decrees 1059/2011 and 720/2012: According to the work system (°C):<br>Continuous: **25.0**<br>25% rest: **25.9**<br>50% rest: **27.9**<br>75% rest: **30.0** | ***Quarterly monitoring*** at work areas near heat sources |
| Light intensity | The Egyptian Labor Law no. 12/2003 | Quarterly monitoring at work areas and offices. |
| Cleanliness, and tidiness | No reportable violation | On-going monitoring – personal judgment |
| Accidents/month | No reportable accidents | Daily records<br>Monthly review of records |
| Employees health conditions | No reportable work-related health problems | A baseline check-up on all employees (before they start work) should be carried out.<br><br>Employee medical check-up results, carried out semiannually shall also be documented and stored. |

**Socio-Economic Monitoring**

This monitoring covers relevant socio-economic impacts of the project and surrounding community/activities. A community survey should be undertaken annually beginning during the first year of construction and continuing annually for first 2 years of operation and every 3 years thereafter, in coordination with the community advisory panel (comprising members who represent the local community). There will be a mechanism to allow for community feedback to be evaluated and standards of performance monitored. This would include addressing complaints from the local community and public in a transparent manner. Annual socio-economic monitoring reports shall be kept with the EO.

## 9.4 Reporting and Auditing

During construction and operation, environmental performance against targets is reviewed and reported to the project management on a monthly frequency. On an annual basis, the yearly results from this system will provide annual performance figure for scrutiny by interested parties, both internally and externally. The audit program will follow plant's internal audit program set up by management as well as EEAA.

### 9.3 ESMP cost

The ESMP cost is estimated to 1.08 million USD (table 15). This cost covers design, supply, installation, testing and commissioning of environmental equipment for the Damanhour power plant project. It also includes training to selected site staff on the full operation of the complete system, in addition to preparation of a Quality Assurance Project Plan detailing an environmental monitoring plan and the related organizational structure of the project with tasks and responsibility. All construction contacts will be based on a lump sum price, and hence the cost of the ESMP implementation will be embedded in those contracts. As indicated in table 3, the cost estimate is included in the overall project cost.

Table 15: tableau des coûts du PGES

| Item | USD |
|---|---|
| Air quality monitoring | 545,000 |
| Hazardous gases & noise monitoring | 225,000 |
| Water monitoring & waste management | 230,000 |
| Social monitoring, training & awareness | 80,000 |
| TOTAL | 1,080,000 |

*Source: WDEPC (2015)*

## 10 PUBLIC CONSULTATIONS AND DISCLOSURE

### 10.1 Requirements

Public consultation shall be held prior to the approval of the ESIA for a proposed project in line with the Egyptian environmental law no. 4/ 1994 and its executive amendment no. 9/2009 modified with ministerial decrees no. 1095/2011 and no. 710/2012. According to AfDB's ISS, the borrower or client is responsible for conducting and providing evidence of meaningful consultation (i.e., consultation that is free, prior and informed) with communities likely to be affected by environmental and social impacts, and with local stakeholders, and also for ensuring broad community support especially for Category 1 projects. Consultation shall be undertaken with reference to the updated IESIA Guidance Notes on consultation, participation and broad community support. The same is also requires for the other financiers such as EBRD and EIB.

### 10.2 Stakeholders consultation during project identification and design

The Damanhour project was identified and prioritised as part of EEHC generation investment plan for 2012 – 2017. The process of identifying the project started long ago when EEHC carried out the exercise of developing this investment plan. Although the process initially starts at EEHC due to the technical nature of the work involved, once a draft plan is developed, EEHC takes the leading role of ensuring due consultation and coordination with the various government institutions and other key stakeholders. The key government institutions consulted with include the Ministry of Petroleum which is responsible for securing fuel supply to the project; the Ministry of Water Resources in order to ensure water availability in the project area, especially if fresh water resources are going to be used; the Egyptian Electricity Transmission Company for studying the feasibility of connecting the project to the grid; the Ministry of Civil Aviation for possible conflict with aviation routes; and the Ministry of Environment for compliance with Egyptian environmental regulations. Once all these consultations have been concluded successfully, EEHC finally submits the investment plan to the Cabinet for endorsement before it can start actual project implementation.

### 10.3 Stakeholders consultation as part of the ESIA preparation and approval

According to the EEAA requirements, a scoping meeting was conducted on December 2014 with EEAA, Ministry of Irrigation, Roads authority, Governorate environmental office representatives, GASCO (gas supplier contractor), Operation authority of the Egyptian Armed Forces. From December 2014 to January 2015, discussions were held with 120 households through group discussions as well as household surveys. The main objective was to collect baseline data for the study.

A preliminary meeting with relevant stakeholders was held during the scoping phase at a conference hall attached to Damanhour power plant on Sunday, March 15th 2015. These stakeholders include Elbeheira governorate general court, EEAA Elbeheira branch, Zawyet Ghazal village mayors and residents and some attendants from industry. The main objectives were to: (i) provide a description of the proposed project and he environmental and social impacts predicted from both construction and operation phases; (ii) open discussions with the environmental consultant and the project technical responsible personnel.

On March 29th 2015, a Public consultation session (public disclosure meeting) chaired by the EEAA was organized. Over 75 participants attended the session. The main outcomes of the public consultation carried out are summarized as follows: (i) Emphasis on mitigation measures regarding the project emissions and wastewater effluents as well as the noise levels; (ii) Recommendation of selecting the project labour from the plant neighbours (Zawyet Ghazal residents); (iii) Effective involvement of interested public with the project aspects; (iv) WSEPC and contractors obligation to occupational health and safety requirements; and (v) New Damanhour Power Plant and contractors' obligation to relevant environmental legislation and standards. These concerns were taken into account in the project design. The concerned raised were addressed and taken into account as follow: (i) residents of Zawyet Ghazal have the priority in non-technical jobs, whereas the technical jobs candidates will be selected by competition according to the technical criteria.; (ii) As part of further planned consultations, a stakeholder engament plan as been prepared which will guide relavant stakeholders' involvement into the project and for; (iii) and (iv) the construction activities will be undertaken by about 20 contractors responsible for the workers they employ. Good training of workers is a matter of concern of the projects. Each contractor shall be expected to prepare a construction ESMP (CESMP) and shall be responsible for the implementation of the CESMP falling under the scope of its contract. The Supervising Engineer's environmental, health and safety experts shall be responsible of the surveillance of the implementation of the CESMPs during pre-construction and construction phases.

The consultation session was recorded and broadcasted on the local TV channel (Channel 5) as well as published in some newspapers and online.

In line with AfDB's requirements, the ESIA summary and relevant document will be disclosed on its website at least 120 days before the project proposal is submitted to its Board of Directors.

### 10.4 Further Planned Consultation Activities

***Community Advisory Panel***

In order to ensure clear and consistent communication with population in the project's surroundings, a Community advisory panel comprising of 6 residents of Zawyet Ghazal and 2 representatives of the New Damanhour Power Plant will be established. The Company will continue to consult with the community advisory panel during both the construction and operation of the project. The committee will be responsible for the following: (i) Facilitating access to information on the project; (ii) Informing stakeholders of on-going communications

and meetings; (iii) Informing stakeholders about project progress, issues to expect, construction time table etc. (iv) Providing feedback from stakeholders on issues that have been raised; and (v) Alongside WDEPC, facilitate implementing community projects as appropriate.

***Company Representatives***
Until a permanent Stakeholder Consultation Officer for the New Damanhour Power Plant is appointed, Engineer Essmat Hassan Ibrahim will have the overall responsibility for handling the consultation and information disclosure process, including organisation of the consultation process, communication with identified stakeholder groups, collecting and processing comments/complaints, and responding to any such comments and complaints.

***Public Grievance Mechanism***
The objective of a grievance procedure is to ensure that all comments and complaints from any project stakeholder are considered and addressed in an appropriate and timely manner. The Company will accept all comments and complaints associated with the project from any stakeholder. Comments can be made via email, post, fax, on the telephone or in person. The comments and complaints will be summarized and listed in a Complaints/Comments Log Book, containing the name/group of commenter/complainant, date the comment was received, brief description of issues, information on proposed corrective actions to be implemented (if appropriate) and the date of response sent to the commenter/complainant.

All grievances will be registered and acknowledged within 6 days and responded to within one month. The project management will keep a grievance log and report on grievance management, as part of annual project progress reports, which will be available on the company (WDEPC) website. Comments and concerns regarding the project can be submitted in writing in the following ways:

- ***Email: essmat_771@yahoo.com***
- ***By telephone/ fax: Tel: 7576555-30 Fax:7561057-30***
- ***By post or hand delivered to: WDEPC 7 Reyad Basha St. Gleem- Alexandria***

Individuals who submit their comments or grievances have the right to request that their name be kept confidential. During construction of the NDPP plant, grievances in relation to construction activities will be managed by the Company and the construction contractor(s). The Company will provide contact information for the contractor to residents of Zawyet Ghazal before construction begins.

## 11 CLIMATE CHANGE

***Vulnerability analysis*:** The key climate change risks in the project area are inter alia:

(i) reduction in water availability. Indeed, results of vulnerability Assessment of Water Resources in Egypt in the Nile Basin indicates that a 20% decrease of average rainfall, with a 2°C rise in temperature above its range, could lead to a 12% reduction in surface flow below the average.;
(ii) increases in ambient air temperatures. By considering the plant's lifetime of 40 years, the current ambient air temperature is likely to increase by 1.36°C (at a rate of 0.34°C per decade).

***Adaptation***: The first risk has been addressed by considering the air cooling system instead of a water cooling option. In addition, the project will use a closed-circle system for

demineralized water used for steam generation. This closed system guarantees efficient use of water resources as the quantity of water withdrawn to start the operation of the steam turbines is taken only once and then very small amount of water is used for makeup. The second risk will be mitigated through the optimal design of the air cooling system, which will be done at detailed design stage.

***Attenuation***: Electricity generation is the largest contributor, accounting for 32 % of the total Green House Gas (GHG) emissions. The technology used for the Damanhour CCPP has a relatively low $CO_2$ equivalent emission, which will ultimately contribute to improving the overall emission performance of the grid in Egypt. The project will contribute to reducing emissions of $CO_2$ by 1.4 million tons per year.

## 12 INSTITUTIONAL CAPACITIES AND STRENGTHENING PLAN

As part of the ESMP cost, provisions are made to training selected site staff on the full operation of the complete system, in addition to preparation of a Quality Assurance Project Plan detailing an environmental monitoring plan and the related organizational structure of the project with tasks and responsibility.

In addition, an engineering consultant will be recruited to support WDEPC/EEHC in project design, construction supervision and management. The cost of these services is included in the project and will be fully financed by WDEPC. Procurement of the consultant is currently ongoing by EEHC/WDEPC, based on international competitive bidding.

## 13 CONCLUSION

The ESIA has evaluated the potential environmental impacts during construction and operation of the proposed power plant. In particular, the potential impacts of gas emissions to the air and the emissions of noise have been assessed. The assessment indicates that no significant environmental impacts will occur as a result of the construction or operation of the power plant and, when taken together, the overall environmental and social impact will not be significant.

## 14 REFERENCES AND CONTACTS

**List of documents consulted**


- WDEPC. 2015. Environmental and Social Impact Assessment (ESIA) report for the Damanhour Combined Cycle Power Plant (CCPP) Project.
- WDEPC. 2015. Quantitative Risk Assessment Study for the Damanhour CCPP. 96 pages;
- Egypt's Cabinet Information and Decision Support Centre (IDSC) and UNDP. 2011. Egypt's National Strategy for Adaptation to Climate Change and Disaster Risk Reduction. 167 pages.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## ANNEX 1: STANDARDS LIMITS CONSIDERED

***Maximum (permissible) limits for gaseous emissions from fuel combustion sources (energy generation) according to law 4/94***

| Fuel Type | Maximum limit for emissions ($mg/m^3$) | | | |
|---|---|---|---|---|
| | TSP | CO | $SO_2$ | NOx |
| Natural gas | 50 | 100 | 150 | 500 |
| Diesel | 100 | 250 | 1300 | 500 |

***Permissible limits for noise inside work places according to law 4/94***

| | | | | | | |
|---|---|---|---|---|---|---|
| Noise level (dB) | 90 | 95 | 100 | 105 | 110 | 115 |
| Time of exposure (hr) | 8 | 4 | 2 | 1 | 0.5 | 0.25 |

***Maximum (permissible) limits for air pollutants inside work places according to law 4/94***

| Measurement Parameter (unit) | $SO_2$ (ppm) | $H_2S$ (ppm) | NOx (ppm) | CO (ppm) | $CO_2$ (ppm) | Smoke ($\mu g/m^3$) |
|---|---|---|---|---|---|---|
| Max. Permissible Limit inside the working environment | 2 | 10 | 3 | 25 | 5000 | - * |
| Max. Permissible Limit in the ambient air (1 hour) | 300 $\mu g/m^3$ | - | 300 $\mu g/m^3$ | 30 $mg/m^3$ | - | 150 (24-hour) |

***Wastewater discharged on aquatic environments standards and specifications***

| Parameter | Maximum Value |
|---|---|
| Temperature | Does not exceed 5 degrees above the dominant temperature with maximum of 38 °C. |
| pH | 6-9 |
| Color | Lack of coloring materials |
| BOD | 60 mg/L |
| COD | 100 mg/L |
| TSS | 60 mg/L |
| $H_2S$ | 1 mg/L |
| Oil and grease | 15 mg/L |
| Total P | 2 mg/L |
| Total N | 10 mg/L |
| Phenols | 0.015 mg/L |
| Ammonia (N) | 3 mg/L |
| V | 0.002 mg/L |
| Se | 0.001 mg/L |
| Hg | 0.001 mg/L |
| Pb | 0.01 mg/L |
| Cd | 0.01 mg/L |
| As | 0.01 mg/L |
| Cr | 0.01 mg/L |
| Cu | 1 mg/L |
| Ni | 0.1 mg/L |
| Fe | 1.5 mg/L |
| Mn | 0.1 mg/L |
| Zn | 1 mg/L |
| Ag | 0.05 mg/L |
| Pesticides | 0.2 mg/L |
| CN | 0.01 mg/L |
| Coliform count (in 100 $cm^3$) | 1000 |
| B | 0.4 mg/L |