Environmental Impact assessment study for the central water desalination plant in Gaza (GCDP):

NOISE EMISSION STUDY

EMISSIONS, SURVEY, DISPERSION AND MODELLING

Final Report

Prepared by:

Dr. Yousef Meslmani

Gaza Strip - Palestine

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ANNEX III: NOISE DISPERSION STUDY

TABLE OF CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

This report contains the Ambient noise level measurements were carried out at five appropriate positions at or near to the boundaries of the proposed GCDP and near the PV plant on ground structures, on Sunday to Monday 24 - 25 April and Wednesday to Thursday 18 – 19 May 2016. And the assessment of the noise associated with the Gaza Seawater Desalination project "Gaza Central Desalination Plant" (GCDP). Short-term noise impacts associated with the project would result from construction activities associated with on-site facilities at GCDP and nearby-site 2 Wind Turbine Plant and off-site PV power plant. Long-term noise impacts would primarily result from mechanical equipment noise at the site and nearby-site 2 Wind Turbine Plant and the off-site PV power plant.

The modelling program **IMMI-2016** by Woelfel Measurement Systems and Software GmbH was used for a number of different noise propagation according the international standards and offers a variety of graphical representations of the results of calculation.

It is necessary to summarize that in particular the diesel engines of the fossil power plant can cause high noise pollution at the nearest receptor point (NRP).

The following references could provide information and guidance on noise mitigation in building design:

ISO 717-1: 2013-03 Acoustics - Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation. [Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation], (Contain instructions and information regarding the design of plants).

The standard DIN 4109 Supplement 2: 1989-11; Sound insulation in buildings; construction examples and calculation methods, "DIN 4109 Beiblatt 1:1989-11": (Contain information for planning and execution; Proposals for increased sound insulation; Recommendations for sound insulation in personal living and working areas).

The operation of the wind turbines can cause noise pollution by up to 34 dB (A) at the nearest receptor point (NRP).

The building which containing the used machines could reduce the sound propagation.

Construction phase / Earth works in the fields of GCDP/SWRO, the Wind turbines plant, as well as PV-Plant can cause noise emissions ranged between 59-78 dB (A) at the nearest receptor point (NRP).

Furthermore, the proposed short-term construction and long-term operational activities would generate noise levels above the limits set by the Palestinian and IFC/WBG standards for outdoor noise but would not substantially increase the existing ambient noise levels at the adjoining property boundaries. Therefore, the impact is not considered as significant. With all, the noise study recommends mitigation measures such as installing sound absorbing materials on the interior walls and ceiling surfaces, providing acoustical louvers, orienting the louver openings, locating the pump station to minimize noise exposure to the adjacent properties. These and other measures outlined in this report will be implemented and developed during the construction and operation phases in order to reduce the impact generated by the Project.

TERMINOLOGY, ACRONYMS AND DEFINITIONS:

- **Ambient Noise Level** The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
- **AVV-Baulärm**: General administrative regulation for the protection against construction noise; noise immissions.
- **A-weighted sound level:** A frequency weighting filter used to measure of sound pressure level designed to reflect the acuity of the human ear, which does not respond equally to all frequencies.
- **dB(A):** Unit of sound level. The weighted sound pressure level by the use of the A metering characteristic and weighting specified in ANSI Specifications for Sound Level Meter.
- **deciBel (dB)** A measure of sound. It is equal to 10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference sound pressure. The reference sound pressure used is 20 micropascals, which is the lowest audible sound.
- **Equivalent A-weighted sound level (LAeq):** A-weighted sound pressure level in decibels of continuous steady sound that within a specified interval has the same sound pressure as a sound that varies with time. This is an average sound level that would produce the same energy equivalence as the fluctuating sound level actually occurring.
- **FTA:** Federal Transit Administration
- **Impulse time weighting:** A standard time constant weighting applied by the Sound Level Meter. A Sound Level Meter which accumulates the total sound energy over a measurement period and calculates an average.
- **ISO** International Standards Organisation
- **L90** The noise level exceeded 90% of the measurement period with 'A' frequency weighting calculated by statistical analysis. It gives an indication of the underlying noise level, or the level that is almost always there in between intermittent noisy events. It is generally utilized for the determination of background noise, i.e. the noise levels without the influence of the main sources.
- **Leq** Equivalent continuous sound pressure level of a steady state sound that has the same sound energy as that contained in the actual time-varying sound being measured over a specific time, re $2*10^{-5}$ Pa.
- **LA** Sound pressure level in dB(A), re $2*10^{-5} N/m^2$.
- **LA max** Maximum sound pressure level in dB(A) (re $2*10^{-5}$ N/m^2), measured at 1 m distance from outdoor installations and their attenuation devices respectively and at a height of 1,5 m above ground/walkway level.
- **Noise** can be defined as unwanted or offensive sound that unreasonably introduces into our daily activities.
- **NSR** Noise Sensitive Receivers/Receptors.
- **NRP** Nearest Receptor Point
- **Residual noise** Sound in a given situation at a given time that excludes the noise under investigation but encompasses all other sound sources, both near and far.
- **RLS-90:** Guideline for Noise Protection on Streets

- **RMS:** Root Mean Square. The square root of the mean square value of an oscillating waveform, where the mean-square value is obtained by squaring the value of amplitudes at each instant of time and then averaging these values over the sample time.
- **TA Lärm**: Sixth General Administrative Regulation for the Federal Pollution Control Act (Technical Instructions on Noise Abatement).

1. PURPOSE OF THE INVESTIGATION AND TERMS OF REFERENCE

1.1 INTRODUCTION

The proposed Seawater Desalination project "Gaza Central Desalination Plant" (GCDP) main site is located in open rural areas close to the beach with no industrial activities undertaken in the vicinity of the sites. The project would consist of onsite and offsite elements. The onsite elements include a 55 million m3 per year (55 GL/a) desalination facilities contains reciprocating engines power station, electrical transformers, and pump station for seawater supply pipeline, concentrate and waste disposal pipelines, finished water pipeline, as well as related facilities such as nearby-site 2 Wind Turbine farm and off-site PV power plant. Relevant noise sources at the project site are merely due the traffic volume on Al-Rasheed highway and to natural sources such as the sea waves and occasionally wind noise.

The following section provides a detailed discussion of the Noise baseline environment and context in which the proposed project will take place within the GCDP project area.

1.2 PROJECT BACKGROUND INFORMATION

Gaza citizens suffer from essential shortage of fresh water and are mainly dependent on groundwater withdrawn from the Gaza aquifer. However, the aquifer recharge capacity is not sufficient facing significant salt-water intrusions and seeping in of untreated sewage causing high levels of nitrate concentration.

Following conclusions of the FEMIP-ECOFIN (Facility for Euro-Mediterranean Investment and Partnership - Economic and Financial Affairs Council) Ministerial Meeting, held in Brussels on July 12th, 2011, the European Investment Bank (EIB) was requested and accepted to support a landmark project aiming to improve water supply in Gaza. In particular, the EIB accepted to commission and to manage a technical assistance operation aimed at developing the conceptual design and the tendering documents for the Gaza Central Desalination Plant (GCDP).

EIB is providing technical support to the Palestinian Water Authority (PWA) to successfully manage and complete the process of realizing the desalination plant and to procure the EPC/O&M contractor for the plant.

The Project will be funded by several sponsors. A financial mechanism will be in place between respective donors and the Palestinian respective institutions.

The Project Owner is the Palestinian Water Authority (PWA). Whilst the National Water Company (an entity to be created for the Project) is not established yet, the PWA will step in and act as Executing Agency for the Project.

1.3 TECHNICAL PROJECT DESCRIPTION

The Project involves within the Phase I the design, engineering, procurement, construction, commissioning, testing, operation and maintenance of a 55 million m3/a desalination plant (about 161,000 m3/d) based on the reverse osmosis technology. In a later Phase II it is intended to increase the plant capacity to 110 million m3/a.

The Project will be executed in two areas or lots:

- Lot 1: Seawater reverse osmosis (SWRO) plant including on-site power plant with reciprocating engines and PV plant on the roofs of the SWRO building
- Lot 2: Off-site power plant with PV plant on ground structures (separate site) and wind turbines (on coast area in front of SWRO site)

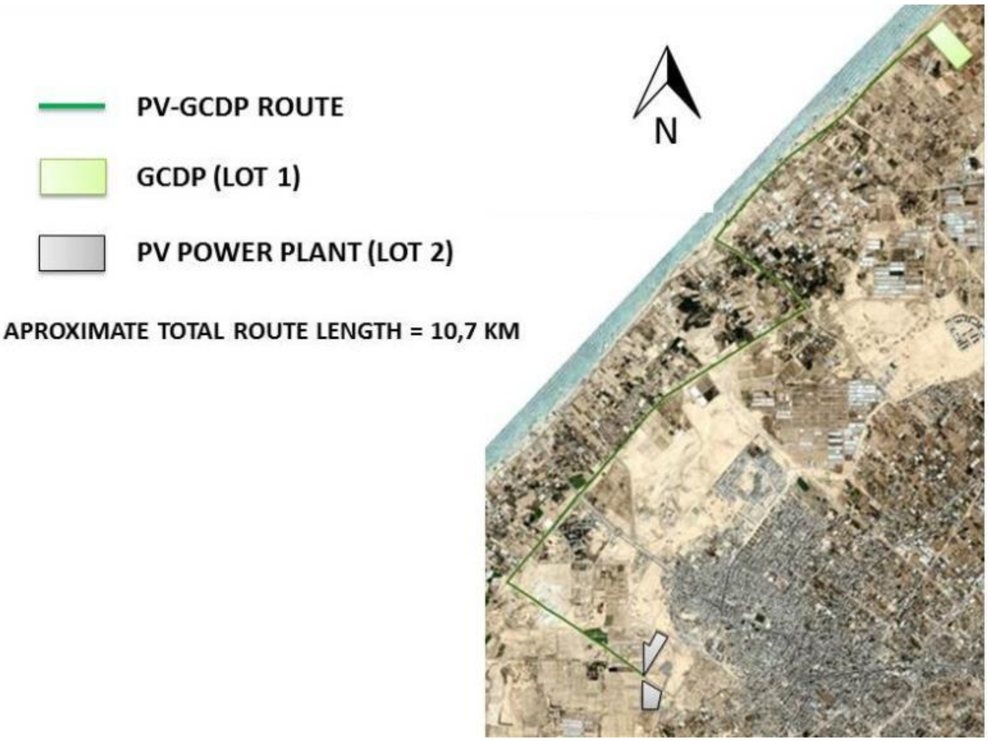


Figure 1 Project: location (Lot 1 & Lot 2). Source: Acciona Ingeniería

The following figure shows the overall plant configuration of the power supply for Lot 1 and 2:

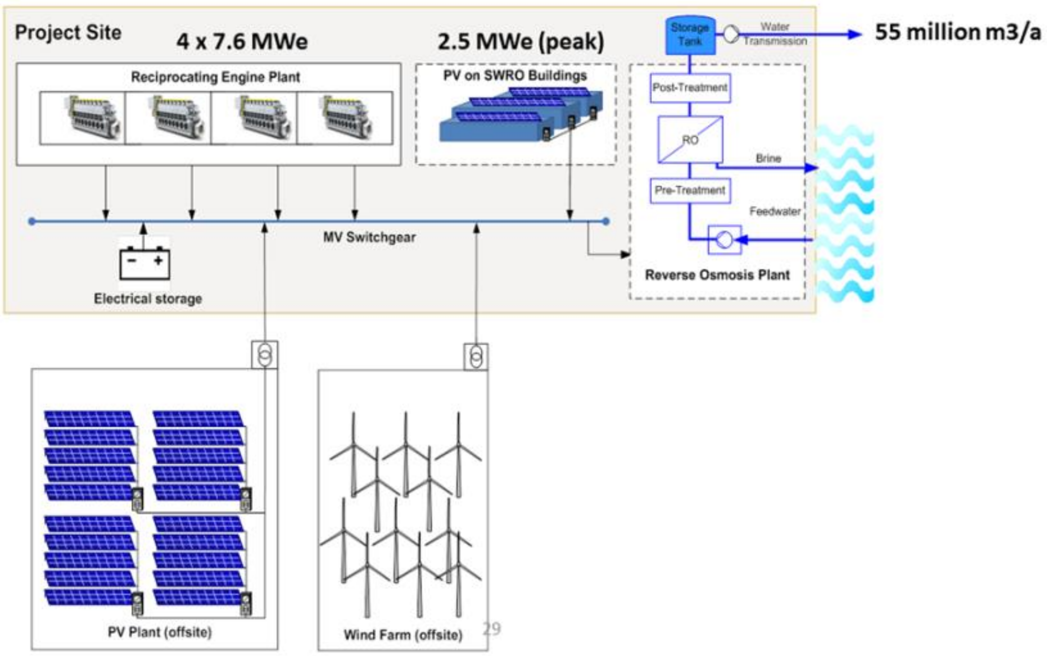


Figure 2 Overall plant configuration for Lot 1 and 2. Source: FITCHNER

It shall be noted that the grid connection from the GCDP to the intended El Matahen substation as well as the water transmission system are not included in the scope of work for this ESIA.

1.3.1 Lot 1

1.3.1.1 Site

The SWRO plant including the on-site power plant shall be realized on a plot with an available area of about 7.3 ha, close to Deir Al-Balah in the center of the Gaza Strip.

The land plot is located on the seaside connected to the Mediterranean Sea.

Figure 3 Location of GCDP site. Source: Acciona Ingeniería

Figure 4 Location of GCDP site (onshore-red square) and area for marine investigations (offshore – blue square). Source: Accion Ingeniería

Figure 5 Lot 1 GCDP Site. Source: Acciona Ingeniería

The land plot is directly located at the quayside Al Rasheed street and is therefore easily accessible. One Bedouin family is still living in the area for residential purposes and for agriculture and will leave it before the construction starts.

In the northern part of the project site of the planned project a Short-Term low Volume (STLV) Sea water desalination Plant with a capacity of 6000 m3/d for the Southern Governorates of the Gaza Strip is presently under construction by PWA with support from UNICEF and the EU. It is planned that the STLV Desalination Plant will be in operation before the GCDP is constructed.

Figure 6 Northern part of the project site: STLV Sea Water Desalination Plant (6000 m3/d) by PWA with support from UNICEF and EU. Source: Acciona Ingeniería

The south-western side of the project site currently holds a military training area. This activity will be stopped and the military infrastructures will be dismantled before construction of the GCDP starts.

The surrounding areas are mainly used for agriculture, residential and tourism activities.

Figure 7: Tourism activities: resort in the mid-foreground. Source: Acciona Ingeniería

1.3.1.2 Technical concept

The seawater reverse osmosis (SWRO) plant will consist of a seawater intake and brine discharge system, a pre-treatment system with dual media filter or ultra-filtration, a two stage reverse osmosis section with isobaric energy recovery and a post treatment system based on acidification by carbon dioxide injection and alkalization in limestone filter.

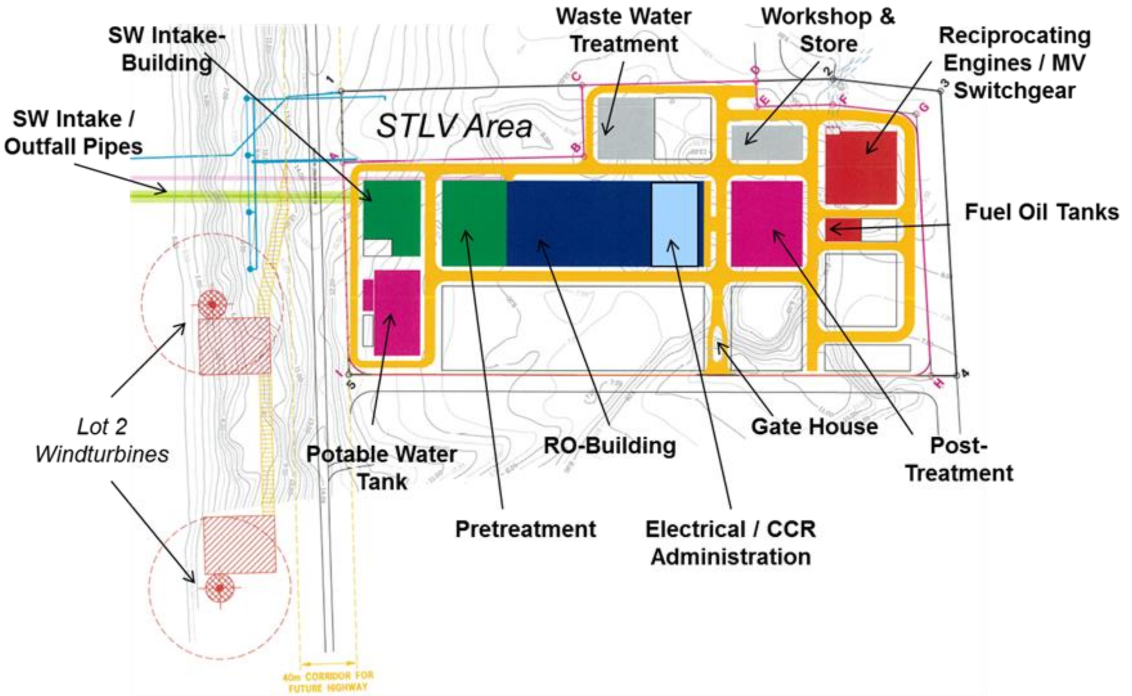


Figure 8: Layout of GCDP. Source: FITCHNER

For illustration purposes the following picture of a similar SWRO plan is shown.

Figure 9: Illustration of SWRO plant. Source: FITCHNER

The produced potable water will be pumped into the on-site product water storage tank. The potable water transfer pumps connected to these storage tanks are the supply limits for Lot 1.

The total power demand of the SWRO plant is in the range of 25 MWe, resulting in a total energy demand of 204 GWh per year.

For the main power supply (Phase I) a grid connection via 66kV cable from the El Matahen substation (within Gaza) to the project site is considered.

Furthermore a full back-up by an on-site fossil plant with reciprocating engines (fired with diesel or natural gas) will be installed (see below picture for illustration purpose only).

Figure 10: Illustration of SWRO plant. Source: FITCHNER

The total capacity of the reciprocating engines is assumed to be between 26-30 MW covering 3-4 units (7-9 MWe each) with 1-2 small back-up diesel engines (container type) to cover the outage of one main engine.

The diesel fuel oil for the reciprocating engines will be supplied by trucks via Israel or Egypt. Fuel oil storage tanks will be arranged adjacent to the fossil power plant to counterbalance potential supply interruptions.

Natural gas supply will be the option for the future following explorations of gas fields in the Mediterranean Sea or gas connections to existing pipelines belonging to Israel or Egypt.

In order to save fuel cost of the reciprocating engines (in case of diesel firing) an on-site PV plant on the rooftops of the SWRO buildings with a peak capacity of about 2.8 MW will be installed in addition (see below picture for illustration purpose only).

Figure 11 Illustration of PV on rooftops. Source: Acciona Ingeniería

To achieve the highest energy output per area a system facing East and West has been selected. Although the specific yield per installed capacity is lower compared to South faced systems more modules can be installed in the same area. The overall yield with a higher installed capacity is greater than a South faced system.

Treated waste water from the desalination plant will be discharged together with the brine discharge via the brine discharge pipeline (about 1850 m from coast line) into the Mediterranean Sea. Sewage water will be treated in an on-site sewage treatment plant and then being utilized as irrigation water or discharged together with the other treated waste water.

The sludge from the desalination plant (mainly from backwash water) will be dewatered and then transported to the nearby Sofa landfill via trucks. The thickened sludge from the sewage treatment plant will be pumped into a tanker and then also transported to nearby Sofa landfill.

The off-shore sea water intake pipelines (3 pipes in total) are shorter than the outfall pipeline (about 870 m from the coast line) and run parallel to it.

Figure 12 Layout with Seawater Intake and Brine Discharge Pipelines. Source: FITCHNER

Auxiliary systems like compressed air system, fire protection and fighting system, cranes and lifting equipment are required to enable a reliable and functional Plant.

The Plant will be designed for continuous, intermediate and peak load duty. Start-up and shutdown operation will be done fully automated. The Plant will be monitored, controlled and safeguarded by a DCS. Full control will be possible from the central control room.

It is expected that the logistic and the supply of equipments and consumables will be done through Israel to the Gaza strip.

1.3.2 Lot 2

1.3.1.3 Site

The off-site PV plant will be installed on a 10 ha site located about 7.3 km (linear distance) from the main project site, where the SWRO plant and the on-site power plant is located.

Figure 13 Lot 2 PV site. Source: Acciona Ingeniería

Figure 14 Picture of off-site for PV plant (area 2). Source: Acciona Ingeniería

The below picture shows the coast strip where the two wind turbines will be placed in front of the main site area.

Figure 15 Off-site locations for wind turbines. Source: Acciona Ingeniería

1.3.1.4 Technical concept

In order to save further fuel costs an off-site power plant with PV modules and two wind turbines will be installed.

The off-site PV plant with a peak capacity of about 13 MW will be arranged on two areas each with about 5 ha with fixed mounting ground structures resulting in the highest specific yield per available area (see figure 14).

Figure 16 Off-site photovoltaic plant. Source: Acciona Ingeniería

A cable connection with a transformer will enable the power supply to the MV switchgear on the main project site (Figure 1).

Furthermore two wind turbines will be placed in front of the main site area (see above picture for illustration purposes only). Since the wind potential in the Gaza strip can be considered as low, wind turbines designed for sites with low wind speeds were selected.

The wind turbines selected are characterized by a large rotor of about 100 m and a hub height of about 95 m. The peak capacity of each wind turbine is about 2 MW.

2. BASELINE NOISE ENVIRONMENTS

2.1 OVERVIEW

Noise can be defined as unwanted or offensive sound that unreasonably introduces into our daily activities. Environmental noise consists of all the unwanted sounds in our communities except that which originates in the workplace *(Botte and chocholl, 1991).* Environmental noise pollution, a form of air pollution, is a threat to health and well-being. It is more severe and widespread than ever before, and it will continue to increase in magnitude and severity because of population growth, urbanization, and the associated growth in the use of increasingly powerful, varied, and highly mobile sources of noise. It will also continue to grow because of sustained growth in highway, rail, and air traffic, which remain major sources of environmental noise.

There is growing evidence that noise pollution is not merely an annoyance; like other forms of pollution, it has wide-ranging adverse health, social, and economic effects. (*Babisch W. 2006; Suter AH. 1992; Lee CSY 2002; Ising H 2004; Shapiro SA. 1991; Stansfeld S 2000; Passchier-Vermeer W 2000; Stansfeld SA 2003*)

The potential health effects of noise pollution are numerous, pervasive, persistent, and medically and socially significant. People experiencing high noise levels differ from those with less exposure in term of: increased number of headaches, greater susceptibility to minor accidents, increased mental hospital admission rates (*Evans GW 1993*).

Noise produces direct and cumulative adverse effects that impair health and that degrade residential, social, working, and learning environments with corresponding real (economic) and intangible (well-being) losses. It interferes with sleep, concentration, communication, and recreation. The aim of enlightened governmental controls should be to protect citizens from the adverse effects of airborne pollution, including those produced by noise.

Sound is created when an object vibrates and radiates part of that energy as acoustic pressure or waves through a medium, such as air, water or a solid. Sound and noise are measured in units of decibels (dB). The dB scale is not linear but logarithmic. This means, for example, that if two identical noise sources, each producing 60 dB, operate simultaneously they will generate 63 dB. Similarly, a 10-decibel increase in sound levels represents ten times as much sound energy.

The human ear can accommodate a wide range of sound energy levels, including pressure fluctuations that increase by more than a million times. The human ear is not equally receptive to all frequencies of sound. The A-weighting of sound levels is a method used to approximate how the human ear would perceive a sound, mostly by reducing the contribution from lower frequencies by a specified amount. The unit for the A-weighted sound levels is dB(A).

Small changes in ambient sound levels will not be able to be detected by the human ear. Most people will not notice a difference in loudness of sound levels of less than 3 dB(A), which is a two-fold change in the sound energy. A 10-dB(A) change in sound levels would be perceived as doubling of sound loudness.

The level of ambient sound usually varies continuously with time. A human's subjective response to varying sounds is primarily governed by the total sound energy received. The total sound energy is the average level of the fluctuating sound, occurring over a period of time, multiplied by the total time period.

In order to compare the effects of different fluctuating sounds, one compares the average sound level over the time period with the constant level of a steady, non-varying sound that will produce the same energy during the same time period. The average of the fluctuating noise levels over the time period is termed Leq, and it represents the constant noise level that would produce the same sound energy over the time period as the fluctuating noise level.

Another noise descriptor used in community noise assessments is termed the **Community Noise Equivalent Level (CNEL).** The CNEL scale represents a time-weighted 24-hour average noise level. CNEL accounts for the increased noise sensitivity during the evening (7:00 p.m. to 10:00 p.m.) and night time hours (10:00 p.m. to 7:00 a.m.) **by adding five and ten dBA,** respectively, to the hourly average sound levels occurring during these hours.

Percentile parameters (Ln) are also useful descriptors of noise. The Ln value is the noise level exceeded for "n" per cent of the measurement period. The Ln value can be anywhere between 0 and 100. The two most common ones are L10 and the L90, which are the levels exceeded for 10 and 90 per cent of the time respectively. **The L90 has been adopted as a good indicator of the "background" noise level.** The L10 has been shown to give a good indication of people's subjective response to noise.

Sound levels diminish with distance from the source because of dispersion, and for point noise sources the calculated sound pressure is:

$$Lp2 = Lp1 - 20 \log (r2/r1)$$

Lp2 = sound pressure level in dB at distance **r2** in meters,

Lp1 = sound pressure level in dB at distance **r1** in meters

In the case of a line source the sound pressure is:

$$Lp2 = Lp1 - 10 \log (r2/r1)$$

In simple terms, for point sources, the distance attenuation would be approximately 6 dB (A) per doubling of distance from the source. For line sources the same attenuation is approximately 3 dB (A). The atmospheric conditions, interference from other objects and ground effects also play an important role in the resulting noise levels. For example, "hard" ground, such as asphalt or cement transmits sound differently than "soft" ground, such as grass. The first ground type promotes transmission of sound, thus producing louder sound levels farther from the source. In general terms, the above effects increase with distance, and the magnitude of the effect depends upon the frequency of the sound. The effects tend to be greater at high frequencies and less at low frequencies (*David A. Bies 2003,* ISO 9613-2 1996).).

Typical noise levels for various environments are shown in the following figure:

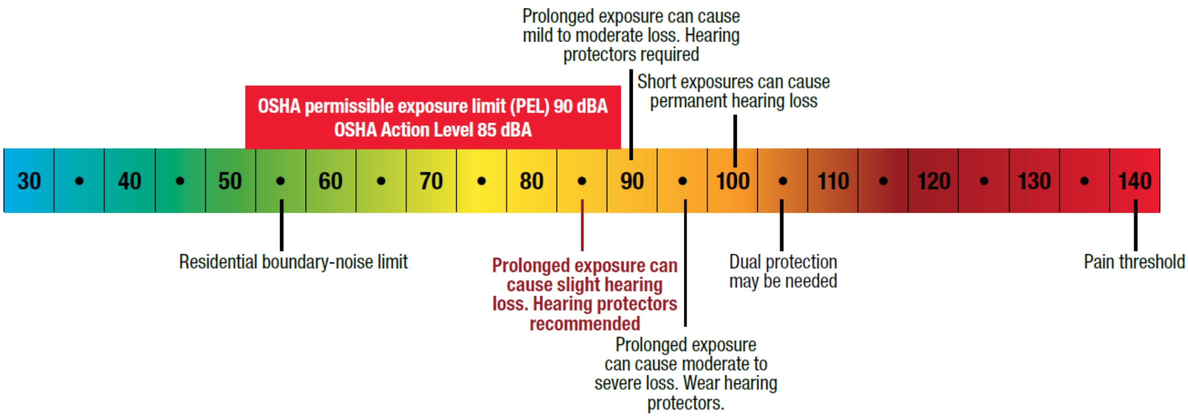


Figure 17 Typical Sound pressure levels dB (A). Source: OSHA Requirements

2.1.1 Noise Propagation

In order to predict the sound pressure level at a distance from a known power level, one must determine how the sound waves propagate. In general, as noise propagates without obstruction from a point source, the sound pressure level decreases. The initial energy in the noise is distributed over a larger and larger area as the distance from the source increases. Thus, assuming spherical propagation, the same energy that is distributed over a square meter at a distance of one meter from a source is distributed over 10,000 m^2 at a distance of 100 meters away from the source. With spherical propagation, the sound pressure level is reduced by 6 dB per doubling of distance. This simple model of spherical propagation must be modified in the presence of reflective surfaces and other effects. For example, if the source is on a perfectly flat and reflecting surface, then hemispherical spreading has to be assumed, which also leads to a 6 dB reduction per doubling of distance, but the sound level would be 3 dB higher at a given distance than with spherical spreading. Details of sound propagation in general are discussed in Beranek and Vers (1992). The development of an accurate noise propagation model generally must include the following factors:

- Source characteristics (e.g., directivity, height, etc.)
- Distance of the source from the observer
- Air absorption, which depends on frequency
- Ground effects (i.e., reflection and absorption of sound on the ground, dependent on source height, terrain cover, ground properties, frequency, etc.)
- Blocking of sound by obstructions and uneven terrain
- Weather effects (i.e., wind speed, change of wind speed or temperature with height). The prevailing wind direction can cause considerable differences in sound pressure levels between upwind and downwind positions.

A discussion of complex propagation models that include all these factors is beyond the scope of this paper. More information can be found in Wagner, et al. (1996). For estimation purposes, a simple model based on the more conservative assumption of hemispherical noise propagation over a reflective surface, including air absorption is often used (International Energy Agency, 1994):

$$\mathbf{L_p = L_w - 10 \log_{10} (2\pi R^2) - \alpha R}$$

Here **Lp** is the sound pressure level (dB) a distance **R** from a noise source radiating at a power level, **Lw** (dB) and **α** is the frequency-dependent sound absorption coefficient. This equation can be used with either broadband sound power levels and a broadband estimate of the sound absorption coefficient (α = 0.005 dB(A) per meter) or more preferably in octave bands using octave band power and sound absorption data. The total noise produced by multiple wind turbines would be calculated by summing up the noise levels due to each turbine at a specific location using the dB math mentioned above.

2.1.2 Sound power and sound pressure

(Ref. Compare Sound power, Sound pressure, and Sound intensity in a distance from the sound source, http://www.sengpielaudio.com/calculator-soundpower.htm)

"Sound Power Level SWL", "Sound Pressure level SPL", and "Sound Intensity Level SIL" are different quantities which should not be confused. Sound emission is defined as the sound power, which is continuously emitted from a sound source. The total sound energy emitted by a source per unit time is the sound power.

All share as level the same unit of measure: the decibel (dB). The term "sound level" is commonly substituted for each. As characteristic impedance of air we use the round value Z = 400 N·s/m³ (Pa·s/m). Then the "sound level", that is the sound pressure level L_p and the sound intensity level L_I is exactly the same as a decibel value.

The sound power or acoustic power is the sound energy constantly transfered per second from the sound source. A sound source has a given constant sound power that does not change if it is placed in a different room environment. Sound power is a theoretical value that is not measurable. It is calculated and expressed in watts and as sound power level L_W in decibels.

A sound source produces sound power and this generates a sound pressure fluctuation in the air. Sound power is the distance independent cause of this, whereas sound pressure is the distance-dependent effect.

1.1.2.1 Conversion of Sound Power Level to Sound Level

$$L_p = L_W - \left|10 \cdot \log\left(\frac{Q}{4\pi \cdot r^2}\right)\right|$$

At r = 1 meter distance, the sound pressure level (SPL) of a point source is 11 dB less than its sound power level (SWL), when Q = 1, the full sphere propagation is given.

For Q = 1 (full sphere propagation) the sound power level is equal to sound pressure level or intensity level at the distance of r = 0.2821 m from the source.

1.1.2.2 Conversion of Sound Level to Sound Power Level

$$L_W = L_p + \left|10 \cdot \log\left(\frac{Q}{4\pi \cdot r^2}\right)\right|$$

2.2 INTERNATIONAL STANDARDS AND GUIDELINES

In general, the standards applied by the international community are similar for different countries. Internationally, the current trends are to apply more stringent criteria due to the deteriorating noise climate.

The noise impacts due to a proposed project are generally based on the difference between the expected noise level increase and the existing noise levels in the area, as well as on comparisons against area-specific noise guidelines. The available international and national guidelines are presented in the sections below and have taken into consideration the following adverse effects of noise:

- Annoyance.
- Speech intelligibility and communication interference.
- Disturbance of information extraction.
- Sleep disturbance.
- Hearing impairment.

The World Health Organisation (WHO) together with the Organisation for Economic Co-ordination and Development (OECD) has developed their own guidelines based on the effects of the exposure to environmental noise. These provide recommended noise levels for different area types and time periods.

The World Health Organisation has recommended that a standard guideline value for average outdoor noise levels of 55 dB(A) be applied during normal daytime, in order to prevent significant interference with the normal activities of local communities. The relevant night-time noise level is 45 dB(A).

These standards will be used for further environmental and noise assessment.

The WHO specifies that an environmental noise impact analysis is required before implementing any project that would significantly increase the level of environmental noise in a community (WHO, 1999). Significant increase is considered a noise level increase of greater than 5 dB.

The World Bank Group has developed a program in pollution management so as to ensure that the projects they finance in developing countries are environmentally sound (WBG, 1998). Noise is one of the pollutants covered by their policy. It specifies that noise levels measured at noise receptors, located outside the project's property boundary, should not be 3 dB (A) greater than the background noise levels, or exceed the noise levels depicted in the Table 1.

The International Finance Corporation (IFC) has recently revised and published Performance Standards on Social & Environmental Sustainability *(IFC 2012, IFC 2007)*. Performance Standard 3 regarding "Pollution Prevention and Abatement" deals with forms of pollution such as noise, and adopts the WBG guidelines presented in the table below. The Standard also refers to the WHO Guidelines for Community Noise *(WHO, 1999)* for the provision of guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in **non-industrial environments**.

Receptor	Maximum Allowable Ambient Noise Levels 1-hour LAeq (dB(A))	
	Daytime (07:00 – 22:00)	Night-time (22:00 – 07:00)
Residential, institutional, educational	**55**	**45**

Note: No LAeq values are stipulated for rural areas.

Table 1: IFC/WBG Recommended noise limits (IFC 2007)

2.3 LEGAL REQUIREMENTS

In Palestine, some regulations relating to standards for environmental quality and emissions were published in 2005. These regulations establish the general concerns for standards for environmental quality, and aim at the control and maintenance of the admissible levels of concentration of pollutants in the environment. Among these regulations, the Ministry of Environmental Affairs has established the National Standard for Outdoor Noise (Table 2).

These limits are applicable for transportation noise sources, identify compatible exterior noise levels for various land use types. Residential land uses are considered normally acceptable up to 55 dB (day time) and 45 dB (night time). Commercial land uses are considered normally acceptable up to 65 dB (day time) and 50 dB (night time). The industrial uses are considered normally acceptable up to 75 dB (day time) and 65 dB (night time). The Palestinian standards will be used for further environmental and noise assessment according to the following (Tables 2.and 3.

Region type / Receptor	Maximum noise intensity [dB(A)]	
	Daytime (7:00 am – 8:00 pm)	Night-time (8:00 pm – 7:00 am)
Rural residential areas, recreation areas, schools, Hospitals	40	30
Residential areas in centers of cities	50	40
Residential areas with some of the workshops and business or on a public road	**55**	**45**
Highway	55	45
Commercial areas	65	50
Industrial areas	75	65
Concerts, festivals	85	75

* Palestine Outdoor Noise Standard (No.840-2005)

Table 2: Palestinian Outdoor Noise Standard (No.840-2005)

Admissible time subject to noise levels							
Noise Level (dB)	85	90	95	100	105	110	115
Time per day (hr)	8	4	2	1	0.5	0.25	0.125

Ministry of Labor (MoL) Occupational Health, Instructions No. 4, Year 2005

Table 3: Recommended Permissible Exposure Limits for Occupational Noise in Palestinian

The Palestinian Outdoor Noise Standard and World Health Organisation (WHO) guideline will be applied in the assessment of the baseline noise levels and subsequent impact assessment.

It is probable that the noise is annoying or otherwise intrusive to the community or to a group of persons if the rating level of the ambient noise under investigation exceeds the applicable rating level of the residual noise (determined in the absence of the specific noise under investigation), or the typical rating level for the ambient noise for the applicable environment.

The noise monitoring of the baseline conditions within and around the proposed GCDP provides the rating level of the residual noise. The noise impact and the noise emission requirements will be determined by comparing:

- Predicted noise under investigation with the measured rating level of the existing background noise levels and
- Predicted noise under investigation with the typical rating level for the ambient noise for the applicable environment given in the table.

For environmental noise rating purposes this impact is usually defined as the difference in dB between the predicted noise and the measured baseline noise (or recommended zone noise level) as in the table below:

Amount in dB(A) by which the rating level exceeds the noise criterion	Estimated community response	
	Category	Description
0	None	No observed reaction
5	Little	Sporadic complaints
10	Medium	Widespread complaints
15	Strong	Threats of community action
20	Very strong	Vigorous community action

Table 4: Estimated community response. Source: Brüel & Kjær 2000

2.4 EXISTING CONDITIONS

The existing noise environment varies widely throughout the alignment area, generally ranging from quiet uninhabited areas to urban residential with no industrial activities undertaken in the vicinity of the sites.

Major noise sources in the project site are merely due the traffic volume on Al Rasheed highway and as well as noise associated with nearby canteens and restaurants on the beach, and to natural sources such as the sea waves and occasionally wind noise.

It is assumed that operations in the GCDP will take place during a 24-hour day, 365 days a year, according with the Concept design Report. Wind turbines operation will take place during the moments when the wind is able to move the turbines blades and generates energy, and this could happen at any moment along the day or night and the year. In order to be able to assess both the quantitative and geographical extent of the potential impact, it is necessary to predict the noise levels generated by the operation of the GCDP and the Wind Turbines and compare these with the zone noise level for the type of district backed up by confirmatory noise measurements on site. The extent of community response can then be assessed according to national and international standards which take into account sociological factors as well as the estimated change in noise levels.

2.5 AMBIENT NOISE MONITORING

Ambient noise level measurements were carried out by the Environmental and rural research centre – Islamic university of Gaza (EERC), using Handheld DS-102 Sound Level Meter with a range between 26 and 130 dB (A), according to the method of ISO 1996, at five appropriate positions at or near to the boundaries of the proposed GCDP and near the PV plant on ground structures, on Sunday to Monday 24 - 25 April and Wednesday to Thursday 18 – 19 May 2016 (Figure 19), the monitored sites were considered as uninhabited areas to urban residential with no industrial activities.

Monitoring Sites nearby GCDP

Monitoring Site (5) nearby PV-Plant

Figure 18 Monitoring Sites of the Noise levels Survey

The background noise results (daytime and night-time) showed that the noise levels were higher than Palestine National Standard and WHO Standards (for residential area, acceptable up to 55 dB day-time and 45 dB night-time) in all monitoring sites, and in particular at the (Site 4), which located on the north western part of the desalination plant

As described under each noise measurement position reported below, these positions were chosen for one or more of the following reasons:

1) Easily definable and with easy future access in case of need for comparison measurements during or after completion of the project.

2) Most likely to continue to exist after completion of the project.

3) Representative of the important background noise regimes.

4) Near identified sensitive receptors likely to be affected by construction or operation noise.

- ***Note 1:*** *It is important to know that another project (STLV plant from UNICEF) currently under construction in the same area.*
- ***Note 2:*** *All noise levels in this report are A-weighted noise levels expressed in dB (A).*
- ***Note 3:*** *LA_{eq} is the A-weighted equivalent sound level as recommended in ISO 1996.*
- ***Note 4:*** *The maximum noise level (LA_{Max}) is taken as an expression of the highest background noise at specific intrusive noisy events, primarily road traffic and random noise events such as pedestrians, animals, birds, local road or air traffic.*

The result of the noise measurement in all five proposed sites (1, 2, 3, 4 and 5) shows that the noise level average ranged between 55.4 to 64.7 dB (day-time) and between 51.1 to 61.9 dB (night-time). The greatest noise levels resulted at noise measurement sites that were exposed to traffic noise from Al Rashed Street at the sites 1, 2 and at site 5 where there is frequent traffic to the slaughterhouse. The lower noise levels were at sites where there was no traffic nearby or within the areas such as Site 3, or Site 4 nearby the seasonal residential building as the nearest receptor point of GCDP.

The next tables from section 2.5.1 to 2.5.5 show a summary of the results:

2.5.1 Measurement Site 1

Directly located at the quayside Al Rasheed Street in the front site of GCDP, monitoring is shown in the following photographs.

GPS Coordinates and elevation	N 31 24 207	E 34 18 571	5.5 m

Figure 19 Site 1

Furthermore the adjacent STLV plant from UNICEF (under construction during the background noise monitoring) has to be taken into account.

Day time	T °C	RH %	Wind m/s	LA_{eq} (dbA)	$LA90_{,t}$ (dbA)	$LA10_{,t}$ (dbA)	LA_{max} (dbA)	Comment
24.4.2016	24	67	Moderate	62.0	70.2	76.0	77.4	*sandstorms*
25.4.2016	25	66	Moderate	64.5	71.4	79.1	80.9	
18.5.2016	33	67	Moderate	63.8	71.7	82.1	84.4	

Night time	T °C	RH %	Wind m/s	LA_{eq} (dbA)	$LA90_{,t}$ (dbA)	$LA10_{,t}$ (dbA)	LA_{max} (dbA)	Comment
24.4.2016	24	67	high*	61.1	68.8	72.6	73.4	*sandstorms*
25.4.2016	25	66	Moderate	61.2	69.1	74.1	75.2	
18.5.2016	33	67	Moderate	58.6	69.4	76.2	77.4	

**(In night time: Endowed sandstorms and wind speed increases dramatically).*

Table 5 Average of Day and Night Noise Levels at Site 1

Observations:

The Location located directly at the quayside Al Rasheed Street in the front site of GCDP and current STLV desalination plant (UNICEF), during the measurements were taken, there were some construction activities of STLV plant.

Al-Rasheed Street is one of the main roads in Gaza Strip linking the provinces of Rafah and Khan Younis with Gaza City and the north. The average number of small vehicles (passenger cars) cars passing through every 24 hours is equal 1500 vehicles. The average number of large vehicles (buses, trucks) passing through every 24 hours is equal 200 vehicles (Counted during the survey period).

2.5.2 Measurement Site 2

This location consider as reference site at the same quayside Al Rasheed Street is located to the south of the desalination plant is about 800 meters from the Site 1. between Site 1 and Site 2 along shoreline the wind turbines will be installed.

GPS Coordinates and elevation	N 31 23 593	E 34 18 309	6.7 m

Figure 20 Site 1

Day time	T °C	RH %	Wind m/s	LA_{eq} (dbA)	$LA90_{,t}$ (dbA)	$LA10_{,t}$ (dbA)	LA_{max} (dbA)	Comment
24.4.2016	24	67	**Moderate**	63.3	70.5	76.8	77.9	
25.4.2016	25	66	**Moderate**	64.7	70.7	78.9	78.5	
18.5.2016	33	67	**Moderate**	63.3	70.3	81.1	82.6	

Night time	T °C	RH %	Wind m/s	LA_{eq} (dbA)	$LA90_{,t}$ (dbA)	$LA10_{,t}$ (dbA)	LA_{max} (dbA)	Comment
24.4.2016	24	67	**Moderate**	61.9	69.2	75.0	76.2	
25.4.2016	25	66	**Moderate**	60.9	68.4	74.0	74.0	
18.5.2016	33	67	**Moderate**	57.9	68.8	75.9	77.0	

Table 6 Average of Day and Night Noise Levels at Site 2

Observations:

The main sources of noise were the sound of the waves and the noise caused by the movement of vehicles in the Al-Rasheed Street.

The average number of small vehicles (passenger cars) cars were passing through every 24 hours is equal 1500 vehicles, and the average number of large vehicles (buses, trucks) were passing through every 24 hours is equal 200 vehicles (Counted during the survey period).

2.5.3 Measurement Site 3

This site is located east of the GCDP, currently occupied in its south half by a military training, and surrounded by irregular farmhouse activities.

GPS Coordinates and elevation	N 31 24 116	E 34 19 055	11 m

Figure 21 Site 3

Day time	T °C	RH %	Wind m/s	LA_{eq} (dbA)	$LA90_{,t}$ (dbA)	$LA10_{,t}$ (dbA)	LA_{max} (dbA)	Comment
24.4.2016	24	67	**Moderate**	60.2	68.2	72.2	72.9	
25.4.2016	25	66	**Moderate**	59.7	68.7	71.5	72.0	
18.5.2016	33	67	**Moderate**	55.4	67.8	72.6	73.4	

Night time	T °C	RH %	Wind m/s	LA_{eq} (dbA)	$LA90_{,t}$ (dbA)	$LA10_{,t}$ (dbA)	LA_{max} (dbA)	Comment
24.4.2016	24	67	**Moderate**	59.0	67.0	70.9	71.6	
25.4.2016	25	66	**Moderate**	58.5	66.7	70.3	70.8	
18.5.2016	33	67	**Moderate**	51.1	64.5	67.5	67.7	

Table 7 Average of Day and Night Noise Levels at Site 3

Observations: Occasional intrusion of noise from the military training base.

2.5.4 Measurement Site 4

This Site (Figure 23) is located near a seasonal residential building (about 400 m) on the East side of the GCDP and considered as the nearest receptor point (NRP).

GPS Coordinates and elevation	N 31 24 708	E 34 19 168	9 m

Figure 22 Site 4

Day time	T °C	RH %	Wind m/s	LA_{eq} (dbA)	$LA90,_{t}$ (dbA)	$LA10,_{t}$ (dbA)	LA_{max} (dbA)	Comment
24.4.2016	24	67	**Moderate**	60.5	68.0	73.3	74.4	
25.4.2016	25	66	**Moderate**	59.6	67.5	72.5	73.3	
18.5.2016	33	67	**Moderate**	55.4	67.8	72.4	73.2	

Night time	T °C	RH %	Wind m/s	LA_{eq} (dbA)	$LA90,_{t}$ (dbA)	$LA10,_{t}$ (dbA)	LA_{max} (dbA)	Comment
24.4.2016	24	67	**Moderate**	55.3	63.6	67.0	67.5	
25.4.2016	25	66	**Moderate**	55.9	63.2	68.3	68.9	
18.5.2016	33	67	**Moderate**	51.5	64.4	68.3	69.0	

Table 8 Average of Day and Night Noise Levels at Site 4

Observations:

This site is located in a rural area with agriculture activity and some rural buildings near from an agriculture road, - Traffic movement through 24 hour:

- Motorcycle, tractor and Truck = 200
- Small vehicle =150
- Big vehicle= 40

2.5.5 Measurement Site 5

This site (Figure 24) is located within Khan Younis area at the off-site PV plant next to the municipal slaughterhouse near the mean road passing large and small vehicles, especially in the night hours where there are frequent traffic to the slaughterhouse and there is a clear noise transfers and the slaughter of calves and cows.

GPS Coordinates and elevation	N 31 20 771	E 34 17 506	8.9 m

Figure 23 Site 5

Day time	T °C	RH %	Wind m/s	LA_{eq} (dbA)	$LA90_{,t}$ (dbA)	$LA10_{,t}$ (dbA)	LA_{max} (dbA)	Comment
24.4.2016	24	67	**Moderate**	63.0	70.1	76.7	78.0	
25.4.2016	25	66	**Moderate**	63.0	70.1	76.7	78.0	
18.5.2016	33	67	**Moderate**	63.0	70.1	76.7	78.0	

Night time	T °C	RH %	Wind m/s	LA_{eq} (dbA)	$LA90_{,t}$ (dbA)	$LA10_{,t}$ (dbA)	LA_{max} (dbA)	Comment
24.4.2016	24	67	**Moderate**	60.9	66.8	75.6	77.0	
25.4.2016	25	66	**Moderate**	60.9	66.8	75.6	77.0	
18.5.2016	33	67	**Moderate**	60.9	66.8	75.6	77.0	

Table 9 Average of Day and Night Noise Levels at Site 5

Observations:

Site location near the Khan Younis's municipal slaughterhouse, in the night hours observed the frequent traffic to the slaughterhouse.

- Noise pollution caused by different transport vehicles (trucks and motorcycle). The average number of small vehicles passing through every 24 hours is equal 150 vehicles, and the average number of large vehicles (buses, trucks) passing through every 24 hours is equal 40 vehicles (Counted during the survey period).
- Nearby also a compilation of the remnants of demolished buildings of stone and concrete crushed assembled by the Karoo carts pulled by an animal and then be packaged by bulldozers Lorries point.

2.6 QUANTIFYING THE NOISE IMPACT

The investigation's purpose is to estimate the potential noise impact of the proposed GCDP on the existing ambient noise levels in the surrounding areas and on any potential sensitive receptors. In order to be able to assess both the quantitative and geographical extent of the potential impact, it is necessary to predict the noise levels generated by the operation of the site and compare these with the zone noise level for the type of district backed up by confirmatory noise measurements on site. The extent of community response can then be assessed according to national and international standards which take into account sociological factors as well as the estimated change in noise levels.

Mitigation methods can then be applied to unacceptable environments, both in terms of machinery choice, equipment layout, operational procedures, and administrative procedures.

3. IMPACT ANALYSIS

The project (GCDP) would include three general components. Component 1 involves the construction of a desalination plant (SWRO: Intake pump station, RO-Building and Fossil power plant); Component 2 consists of a Wind Turbine farm; Component 3 consists of the off-site PV power plant. The project would include both short-term construction noise impacts as well as long-term operational noise.

Fundamentals of immission protection law:

The basis for calculating the sound propagation is the standard ISO 9613-2: 1996-12 Acoustics - Abatement of sound propagation outdoors - Part 2: General method of calculation (ISO 9613-2, 1996), which are compatible with the German and European standards (TA Lärm 1998, and General administrative regulation 1970).

According to this standard the point sources and area sound sources were modeled taking into consideration the traffic during construction of the SWRO plant, as well as the wind turbines. The noise imissions of the Al-Rasheed highways according to the guidelines for noise protection on roads (RLS-90, 1990) were considered.

According to these principles surcharges were awarded for the calculation. It is assumed that the noises emissions (both sound as well as pulse) in the construction phase are sustainable. In the operating phase it is assumed that noise of the wind turbines is pulse sustainable, for the sounds emissions of the water desalination plant, a ton sustainable is recognized. These considerations are listed in table below.

Type of surcharge	Level of the surcharge in dB (A)	application
Surcharge for pulse sustainability	5	During the construction phase according AVV - construction noise (AVV Baulärm)
	6	Operational phase of the wind turbines according with (TA Lärm)
Surcharge for Ton sustainability	5	During the construction phase according to (AVV Baulärm)
	6	Operational phase of the water desalination plant in accordance with (TA Lärm)

Table 10 Overview of surcharges

Forecast:

The program (IMMI, 2016) by Woelfel Measurement Systems and Software GmbH (Hoechstadt b. Würzburg) was used for a number of different noise propagation according the international standards and offers a variety of graphical representations of the results of calculation.

The IMMI program system is a detailed noise mapping software system, which also simulates noise events. This program provides algorithms to calculate noise propagation from various sound sources, and emission and reception point calculations are based on relevant guidelines. All rules, algorithms, tables and nomograms belonging to a particular specification are listed in an element library, and results and interim results are documented in lists with selectable levels of details (IMMI Reference Manual, 2003).

According to the assumptions grid calculations were performed, their results can be found in grid noise maps in the following section. The forecasts for the operating phase were carried out with the adopted building and without this, to show the influence of the building. It is also noted that during the construction phase, only the noise emissions were considered in the assessment Day-period, as limiting the construction work on this period. Below some results are summarized.

Section	Distance from the sound source in (m)	Evaluated rating level in dB (A)
Water desalinization plant (SWRO) – construction - earthworks	261	45
Wind plant – construction - earthworks	407	45
PV plant - construction - earthworks	580	45
Water desalinization plant (SWRO) – in operation with buildings	89	45
Water desalinization plant (SWRO) – in operation with buildings at Night	98	45
Wind plant in operation with building	489	45
Wind plant in operation with building at Night	528	45

Table 11 Summary of results

It is summarized that the wind turbines have a greater sound propagation, compared to the desalinization plant. In the grid noise maps is also recognizable that a building to the water treatment plant reduces the sound propagation.

3.1 CONSTRUCTION PHASE

Noise generated by construction equipment will occur with varying intensities and durations during the various phases of construction. The maximum noise level ranges for various pieces of construction equipment at a distance of 15 meters are depicted in (Table 12) Note that these are maximum noise levels. The equipment operates in alternating cycles of full power and low power, thus, producing noise levels less than the maximum level. The average sound level of the construction activity also depends upon the amount of time that the equipment operates and the intensity of the construction during the time period.

Type of equipment	Number	Weighted sound pressure level in dB (A) at 15 m from the Source	Sound power level in dB (A)
Excavators / Backhoe	6	80	112
Loader/Concrete mixer	3	85	117
Grader	2	85	117
Compactor	2	82	114

Table 12 Construction Equipment Noise Emission Levels. Source: FTA-Guidance Manual 1995

3.1.1 SWRO Plant and Fossil Power Plant

The construction activities at the on-site facility would include the fuel storage tank, the Construction of the Diesel Fuel Tanks and pumps (Period of construction is 4 months) this includes:

- Construction of two diesel fuel tanks of 12 M Diameter each.
- Connecting the fuel piping and fitting.
- Connecting the fuel pumps.

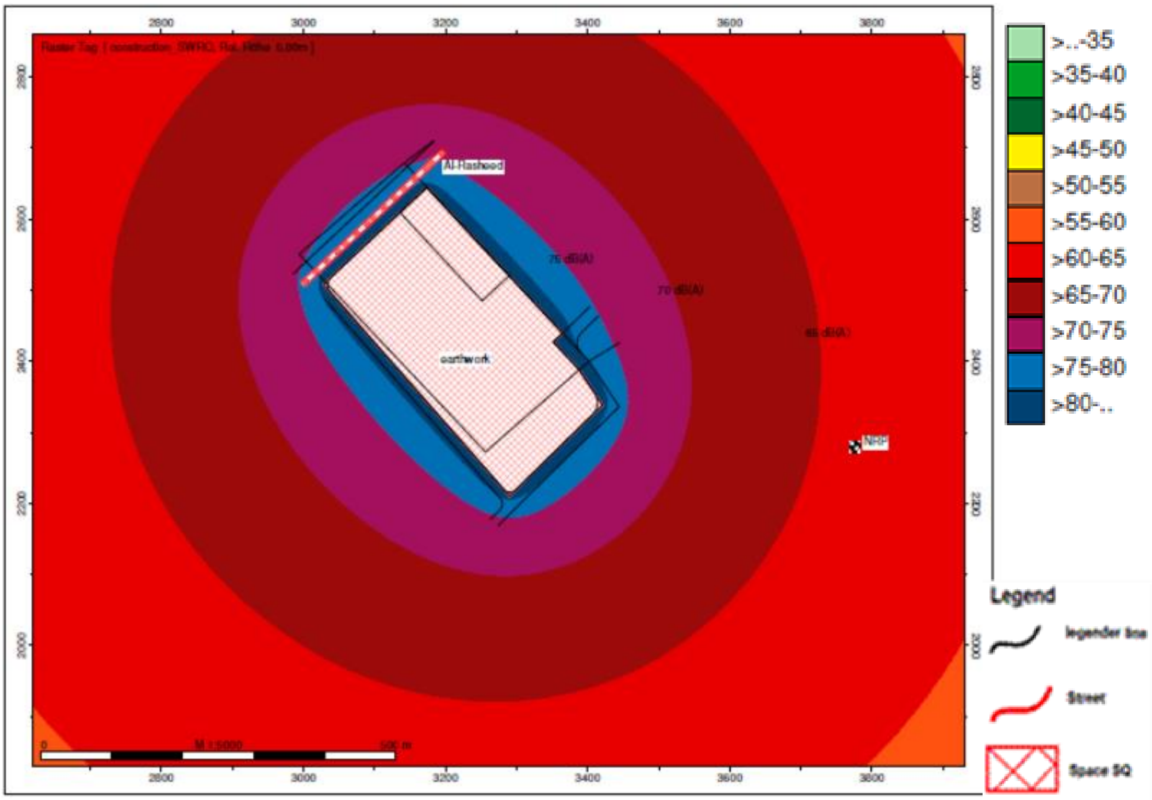
Construction of Fossil Power Plant 4x7.6 KW, (Period of construction 3 months) this includes:

- Fixing of the duel reciprocating engines (diesel / gas) on the concrete basses in the power house.
- Connecting the reciprocating engines with the diesel fuel supply (power plant).
- Connecting the power / control cables to the MV switch gear.
- Allow for the gas connection (future use).

In addition to earthwork, building structures, trenching and pipe lying, paving and landscaping. The construction equipment would depend on the phase on construction. The greatest amount of equipment operating at the site would be during the earthwork and the building structure phases. Equipment would include approximately 3 excavators, 3 backhoes, 3 loaders, 2 graders and 2 compactors during the earthwork phase, and 3 cranes, 2 cement mixers, 1 generator set and 4 welders when building the structures. Other types of equipment that would be used during different phases would include pumps, pavers, rollers, pile drivers, trenchers and a drill rig.

Figure 24 SWRO - Construction Phase

Figure 25 : Distance of the Nearest Receptor Point (NRP) to the noise sources, and the positions of the monitoring Sites



Day level (7h-20h) dB (A)

Height of calculation: 5,00 m

Figure 26 Noise Map - SWRO Construction Phase

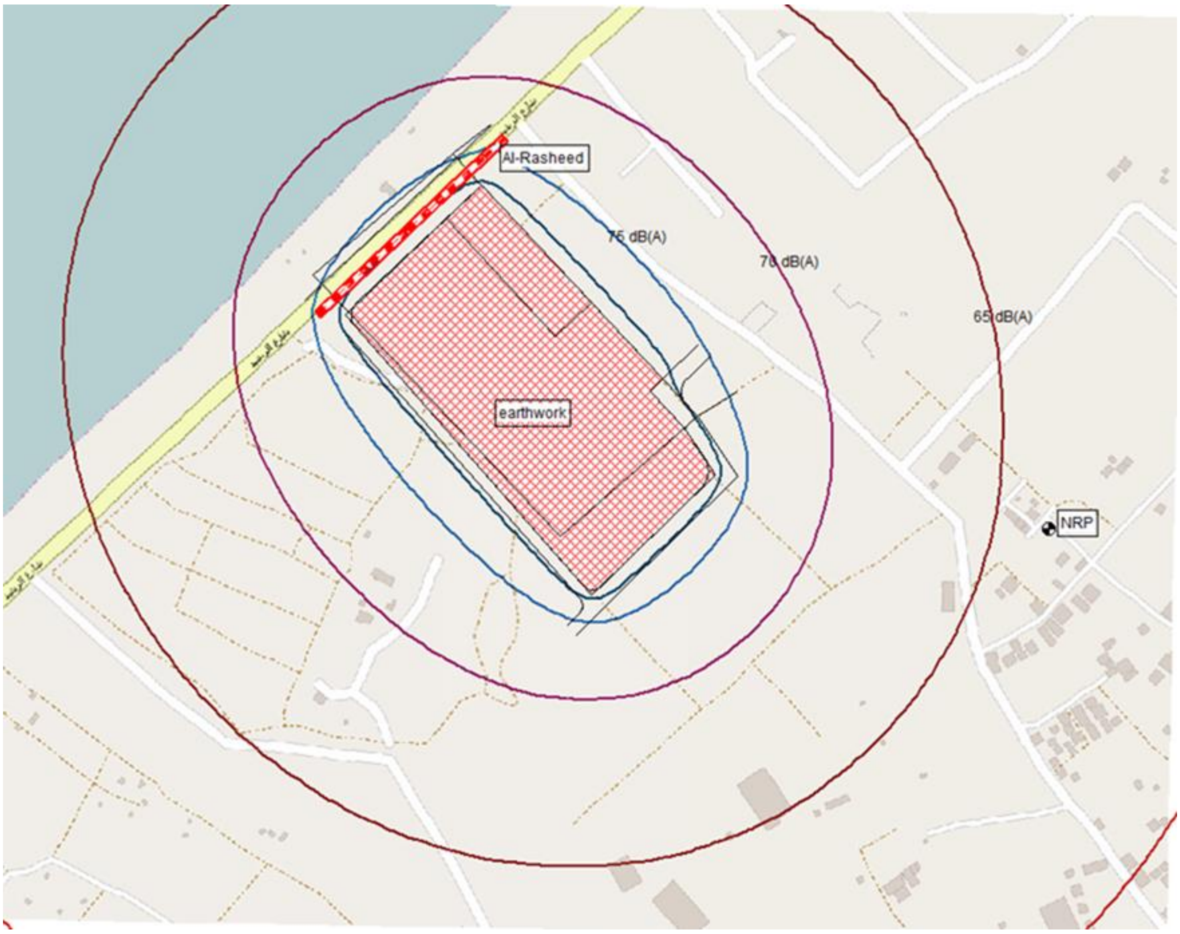


Figure 27 SWRO Sound Propagation - Construction Phase

The modeling forecast of noise propagation during the construction of the GCDP showed that the nearest receptor point (NRP) located about 640 meters from the middle of GCDP (Figure 28), at this distance the noise level would be approximately 64 dB (A).

During the construction work heavy trucks will be used to deliver materials to the site and remove soil and demolition materials. The number of heavy truck trips will vary considerably depending on the construction activity. The greatest number of trucks would occur during the desalination plant earthwork construction phase. The heavy trucks would generate noise during the construction periodusing Al Rasheed Highway. The current baseline average numbers of small vehicles (passenger cars) were passing through every 24 hours is equal 1500 vehicles. And the average number of large vehicles (buses, trucks) were passing through every 24 hours is equal 200 vehicles. The traffic assignments of the highway near the site are presented in the following table.

Average daily traffic occupancy in vehicles / 24h	Proportion of heavy traffic in %	Speed passenger cars / trucks in km / h
1737	13,7	100 / 80

Table 13 Average of daily traffic during the construction of SWRO, earthworks *(Counted during the survey period)*

Construction traffic noise levels were calculated using noise prediction Model (IMMI, 2016). Assuming worst-case that all the heavy trucks are distributed along one road, the construction noise would generate a noise level of approximately 60 dB CNEL at a distance of 15 meters from the road. This noise level would be above the limits set by the Palestinian and IFC/WBG Standards. However, the impact is not considered as significant since as the baseline average ranged between (62.0 and 63.8) dB (A) at the same site (Table 13). In any case, the mitigation measures outlined in Section 4 will be implemented to reduce the impact during construction.

3.1.2 Wind Turbine Plant

The project will construct two wind turbines 2 x 2 MW (Height of 100 m), at the beach in front of the main area of the site (Figure 16).

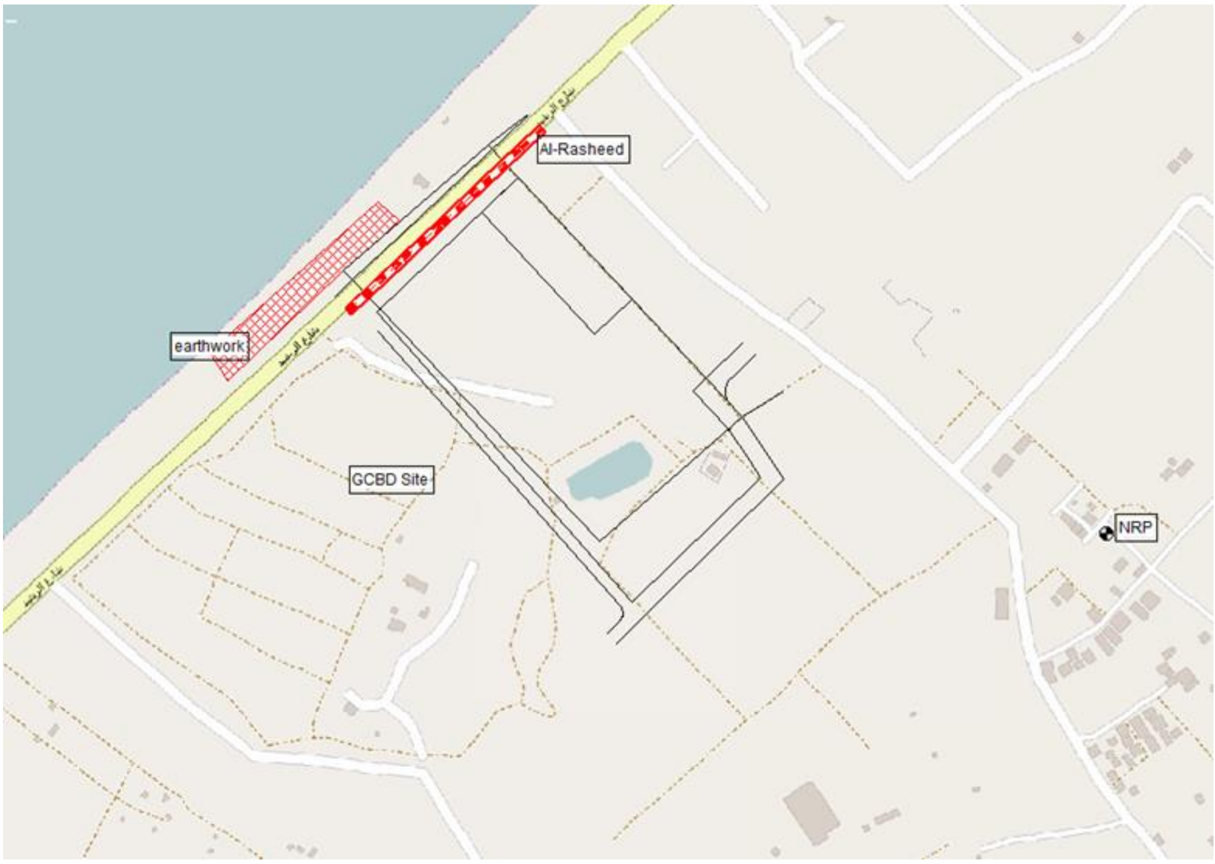
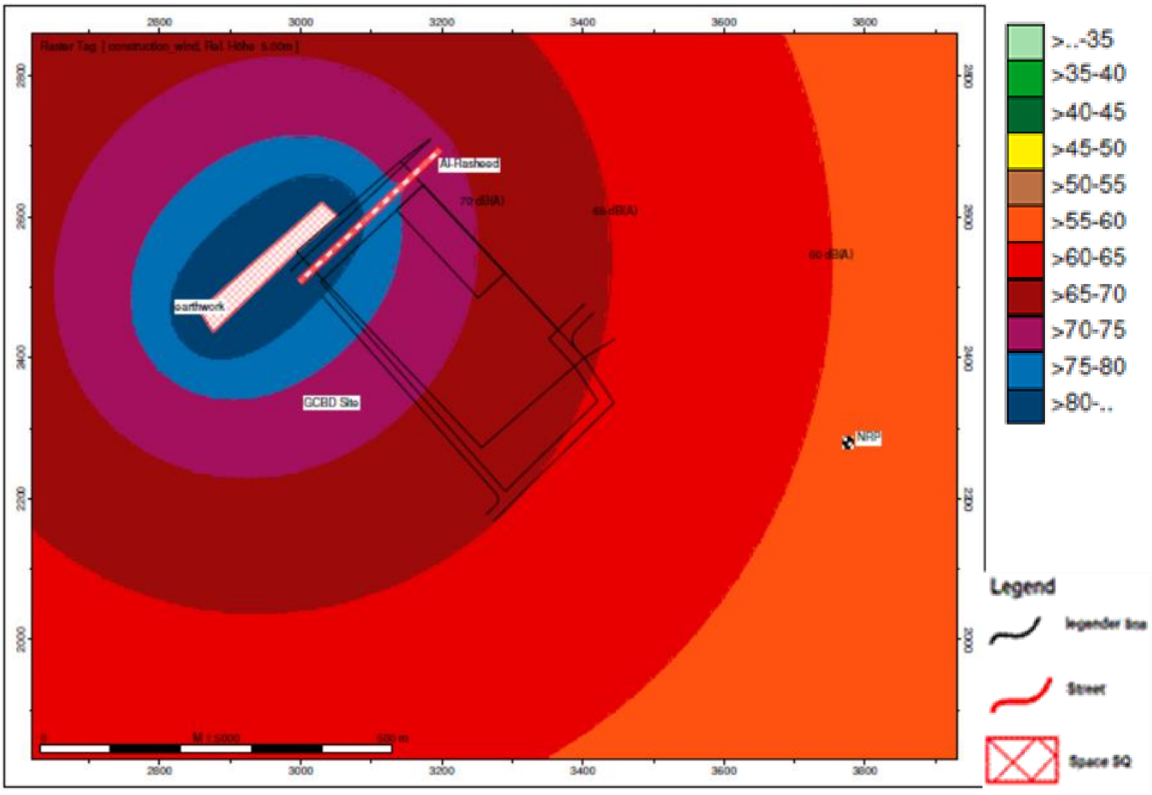


Figure 28 Wind Plant - Construction Phase

Noise impacts could occur at properties near to the construction works associated with digging the trench and laying the cable, and also from the works required at the beach site includes:

- Construction of concrete base slabs for fixing the 2 wind turbines near the shore.
- Assembly of wind mills.
- Connecting the power / control cables to the MV switch gear.



Day level (7h-20h) dB (A)

Height of calculation: 5,00 m

Figure 29 Noise map - Wind Plant Construction phase

The modeling forecast of noise propagation during the construction of the Wind Plant showed that the nearest receptor point (NRP) located about 808 meters from the middle of Wind Plant area (Figure 3.1.4), at this distance the noise level would be approximately 59 dB (A). It is assumed that all construction activity will be limited to the hours of 7 a.m. to 5 p.m. Saturday through Thursday.

During the construction work heavy trucks will be used to deliver materials to the wind turbine site and remove soil and demolition materials. The number of heavy truck trips will vary considerably depending on the construction activity. The great number of trucks would occur during the desalination plant earthwork construction phase. The heavy trucks would generate noise during the construction period using Al Rasheed Highway.

Figure 30 Wind Plant Sound propagation - Construction phase

The calculated baseline average numbers of daily traffic during construction of Wind Plant on Al Rasheed Highway is presented in the following table:

Average numbers of vehicles in (vehicles/24h)	Proportion of heavy traffic in (%)	Driving speed passenger cars / trucks in (km/h)
1719	12,7	100 / 80

Table 14 Average of daily traffic during construction of Wind Plant, earthworks

Construction traffic noise levels were calculated using noise prediction Model (IMMI, 2016).

Assuming worst-case that all the heavy trucks are distributed along one road, the construction noise would generate a noise level of approximately 60 dB CNEL at a distance of 15 meters from the road. Again this noise level would be above the limits set by the Palestinian and IFC/WBG Standards but the impact is not considered as significant as the baseline average ranged between (63.3 and 64.7) dB (A) at the same site (Table 2.5.2). In any case, the mitigation measures included in **Section 4: Mitigation Measures**, will be implemented for a reduction of the impact.

3.1.3 Off-Site PV Power Plant

An Off-site PV plant would be installed on a 10 ha site located in Khan Yunis governorate about 7.3 km (linear distance) south west from the main project site, where the SWRO plant and the on-site power plant are located. (Figure 32).

The Construction of the Off-site photovoltaic (PVs) 11.7 KW (Period of construction is 8-10 months), includes:

- Earth works (levelling and preparation of the site).
- Fixing of the PVs installations in the 10 ha site.
- Fixing of individual PV cables.
- Connecting cables to the main panel in the PVs site.

In addition to the Construction of the Cables between the Off-site PVs and the MV Switch Gear includes: Excavation, laying cables and backfilling in the road shoulder between the PVs and MV switch gear.

Construction equipment is expected to consist of a forklift, excavator, compactor, backhoe, crane, water truck and two concrete trucks.

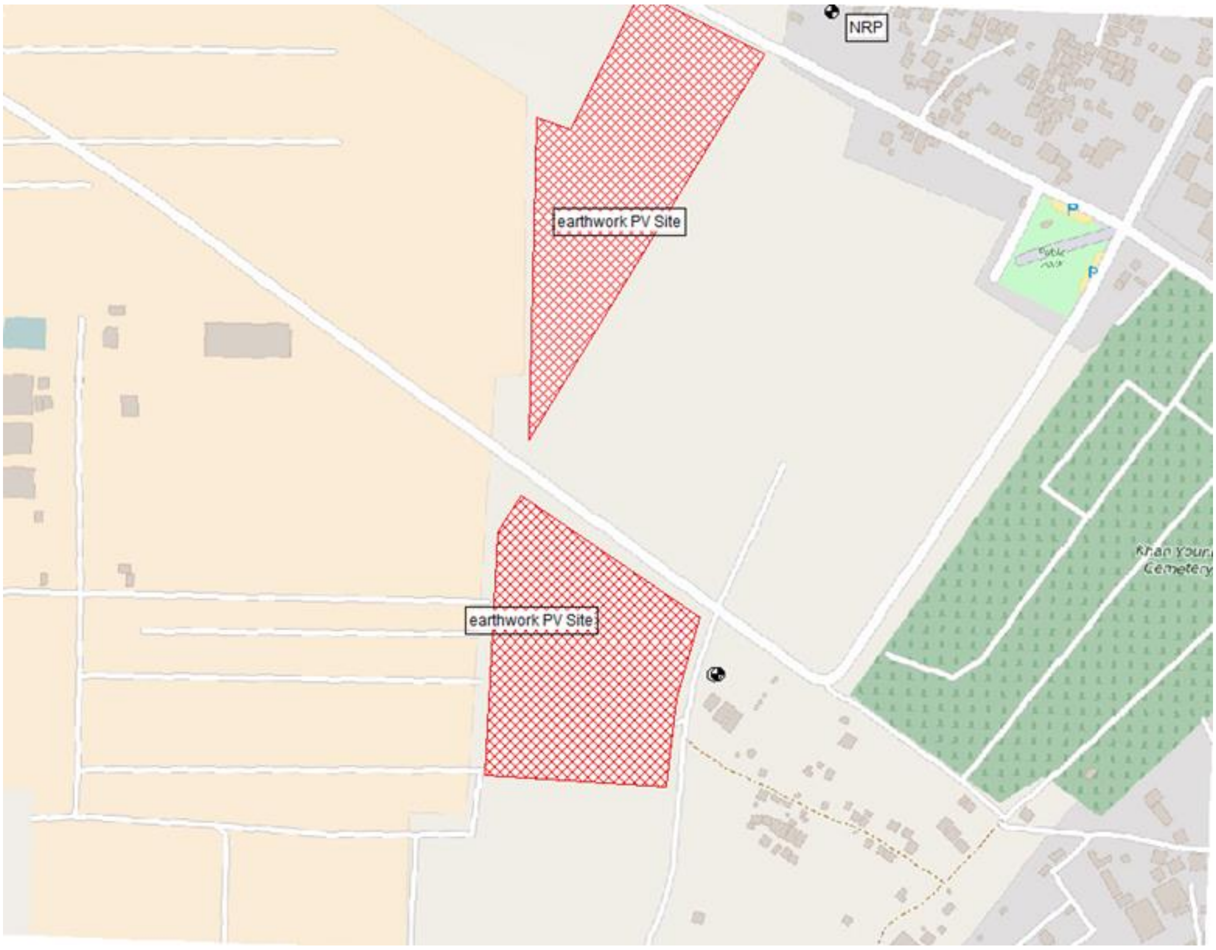
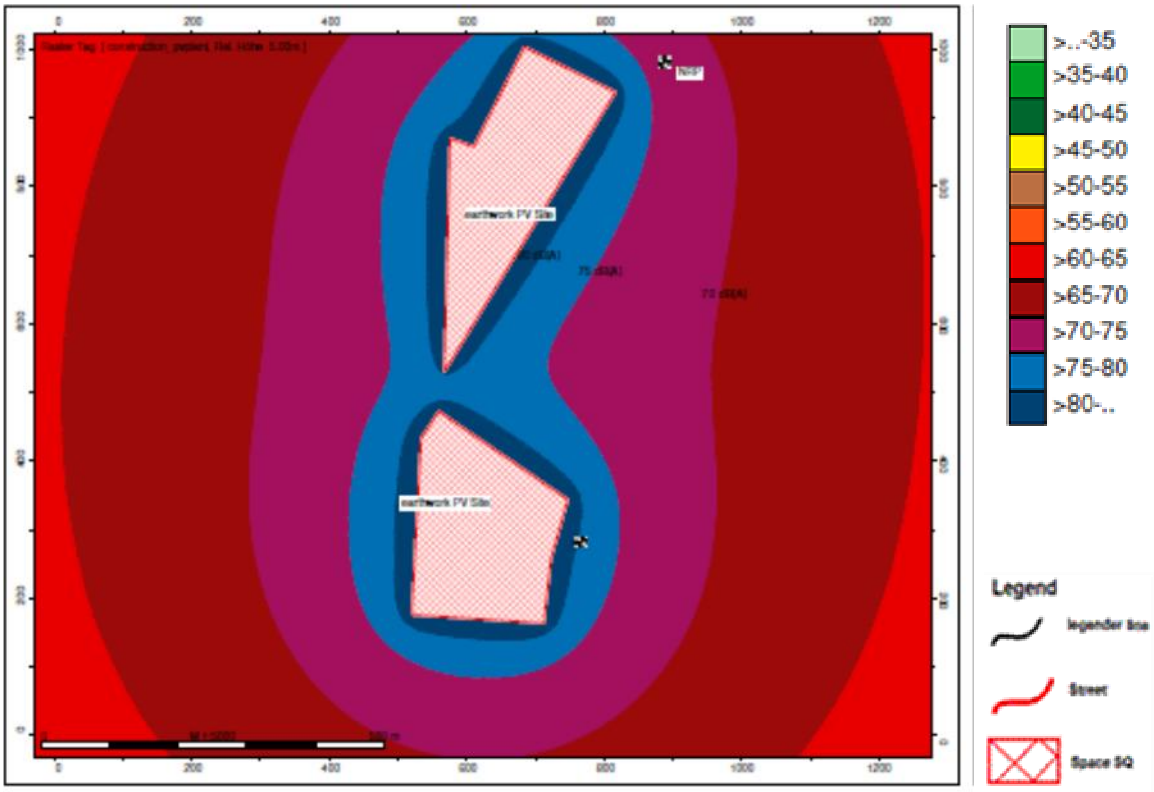


Figure 31 PV Power Plant - Construction Phase



Day level (7h-20h) dB (A)

Height of calculation: 5,00 m

Figure 32 Noise map - PV Plant Construction phase

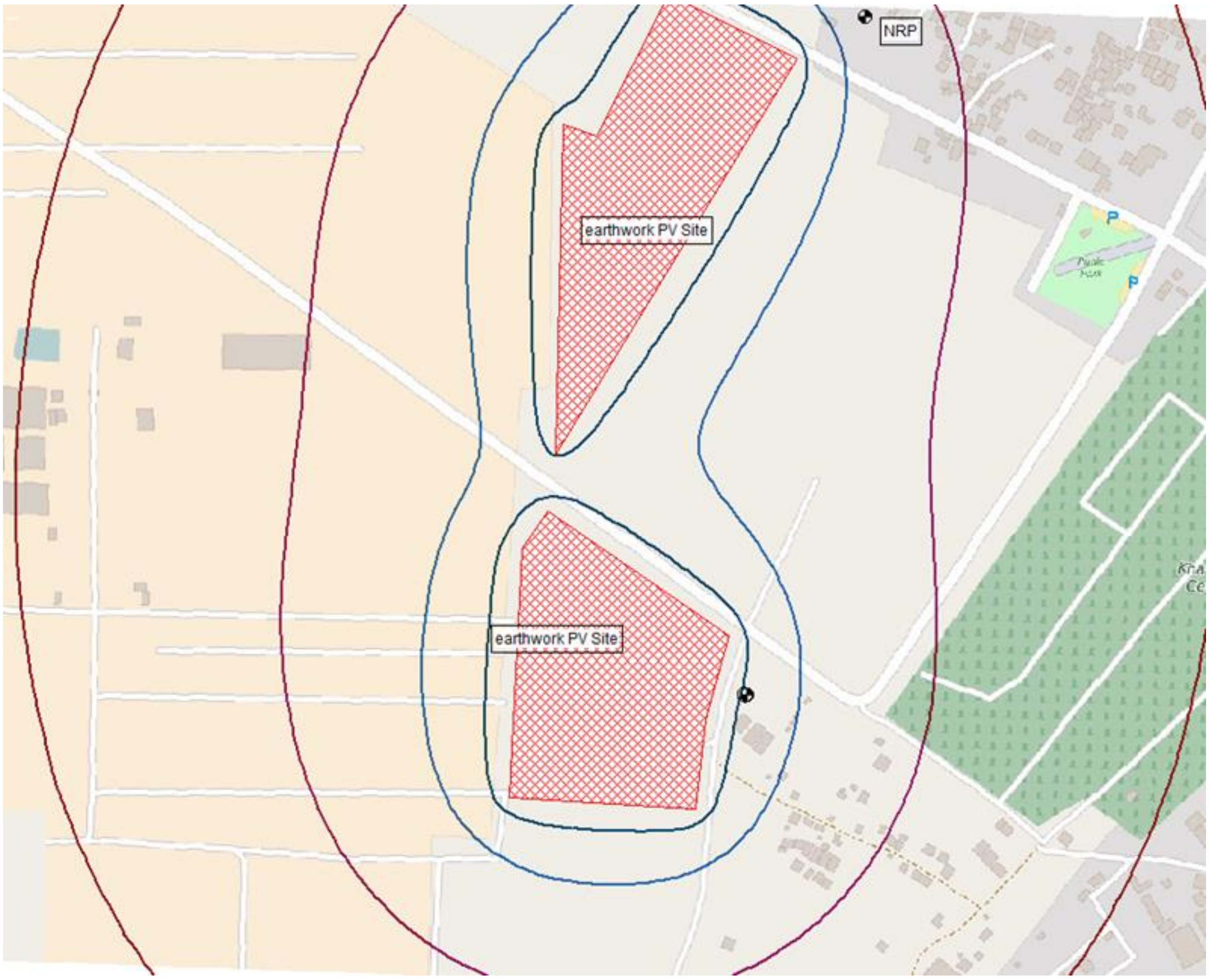


Figure 33 Sound propagation - PV Plant Construction phase

The modeling forecast of noise propagation during the construction of the PV-Plant showed that the nearest receptor point (NRP) located about 87 meters from the north east site of PV-Plant area, at this distance the noise level would be approximately 72 dB (A). This noise level is 8.7 dB (A) higher than the baseline average of 63.3 dB (A) at the same site and higher than the noise limits set by the national and international applicable regulations. Therefore, a significant noise impact is expected during the construction period. However, this impact will be reduced by the application of the mitigation measures depicted in **Section 4: Mitigation Measures**.

3.2 OPERATIONAL PHASE

The project would construct several facilities at the site including a seawater pump station, a building for the pre-treatment and reverse osmosis process area, an on-site power plant (4x7.6 KW reciprocating engines), and a product water pump station. The facilities would contain mechanical equipment that would generate noise. According to information available to the project and compared with similar projects, a preliminary facility design and mechanical equipment list has been prepared. The noise levels are estimated using the maximum sound levels anticipated for the equipment based on the type and size of the equipment.

3.2.1 Seawater Intake Pump Station

A seawater intake pump station would be located at the beach in front the main area (north-western) of GCDP. The pump station structure would consist of bandscreens and pump wet well. The intake station would include three duty and one standby vertical turbine pumps. All the pumps would be rated at approximately 750 HP and would be installed along with auxiliary equipment outdoors on a concrete slab. The pumps/motors would have a maximum sound level rating of 90 dBA at one meter.

3.2.2 Reverse Osmosis Building

3.2.2.1 Pretreatment Filter Structure

The pre-treatment facility would include filter service equipment (backwash blowers and pumps) and filtered effluent transfer pumps. The mechanical equipment would include two 150-HP centrifugal blowers and two 180-HP vertical turbine pumps. All the equipment would be located inside the reverse osmosis building discussed in *Section 3.2.8.* The maximum noise level of all the pumps and blowers would be 88 dB at one meter.

3.2.2.2 Product Water Pump Station

The water pump station would include five vertical turbine pumps (four duty and one standby) equipped with 550-HP motors. The water pumps and their auxiliary equipment would be located in the reverse osmosis building discussed in *Section 3.2.8.* The maximum noise level of all the pumps would be 88 dB at a distance of one meter.

3.2.2.3 Membrane Cleaning System

The membrane cleaning system would include membrane cleaning pumps (three 80-HP duty and one standby), storage tank mixing blowers (one 50-HP duty and one standby), flush pumps (two 150-HP duty and one standby), mechanical mixers (1-HP motor), and sewer system transfer pumps (one 25-HP duty and one standby). All the equipment would be located inside the membrane cleaning room of the reverse osmosis building discussed in *Section 3.2.8*. The maximum noise level of all the pumps, blowers and equipment would be 88 dB at one meter.

3.2.2.4 Chemical Feed Equipment

The chemical feed facility would include mixers and chemical feed pumps. The mechanical equipment would include 15 duty and 7 standby pumps/motors ranging from 30 to 150-HP. The chemical day tanks and the pumps for all chemical feed systems would be located in the chemical feed room of the reverse osmosis building discussed in *Section 3.2.8.* The maximum noise level of all the pumps and other equipment would be 88 dB at one meter.

3.2.2.5 Service Facilities

Service facilities for the desalination plant would include miscellaneous small service equipment such as sump pumps, storm drain pumps as well as a Heating, Ventilation and Air Conditioning (HVAC) system for the reverse osmosis building. The equipment, other than some of the HVAC equipment, would be located inside the reverse osmosis building. The maximum noise level of all the pumps and other equipment would be 88 dB at one meter.

3.2.2.6 Solids Handling Equipment

Under a worst-case scenario, the solids removed from the source seawater during the pre-treatment process will be settled and dewatered on site in a solids handling system. The equipment would consist of four sludge removal 50-HP pumps (two duties and two standbys) located outdoors, adjacent to the settling tanks. Two 150-HP belt presses, two 2-HP clarifier sludge collection mechanisms, two 10-HP sludge chemical conditioning system and two 60-HP sludge conveyors will be located inside the solids handling area. The maximum noise level of all pumps and other equipment would be 88 dB at one meter. The equipment would be located at the reverse osmosis process area.

3.2.2.7 Reverse Osmosis Process Area

The reverse osmosis process area would be located inside a cast-in-place concrete and steel construction building. A preliminary design plan indicates that building would include roll up doors, entry doors, louvers, and windows.

The building would house noise generating equipment including 13 high pressure reverse osmosis vertical turbine pumps (up to 3,500 HP with one standby), 13 filter effluent transfer pumps (350-HP with one standby), 13 energy recovery turbines (with one standby), five product transfer pumps (see *Section 3.2.3*), two centrifugal backwash blowers and two filter backwash pumps (See *Section 3.2.2*). The high pressure reverse osmosis pumps and energy recovery turbines would have a maximum sound rating of 90 dB at one meter. The remaining pump/motors would have a maximum sound level rating of 88 dB at one meter. Additional equipment that would be located in the Reverse Osmosis area has been previously identified

3.2.3 Fossil Power Station: Reciprocating Diesel / Gas Engines

An on-site power plant, 4x7.6 KW reciprocating engines and electrical transformers, would be located in the back area (South-East) of GCDP. The total capacity of the reciprocating engines is assumed to be between 26-30 MW covering 3-4 units (7-9 MWe each) with 1-2 small back-up diesel engines (container type) to cover the outage of one main engine. The reciprocating engines would have a maximum sound level rating of 117 dBA at one meter and the maximum noise level of the Engines Exhaust would be 122 dB (A) at one meter.

3.3 SWRO PLANT

The noise sources described in the preceding sections, which can cause noise emissions within this building (SWRO) summarized in following sketch and tables.

Mathematical modelling of the noise in the operation phase has in the consideration that the construction section of the station at an altitude of 10 meters and in this plan all point sources are located at 0.5 m height.

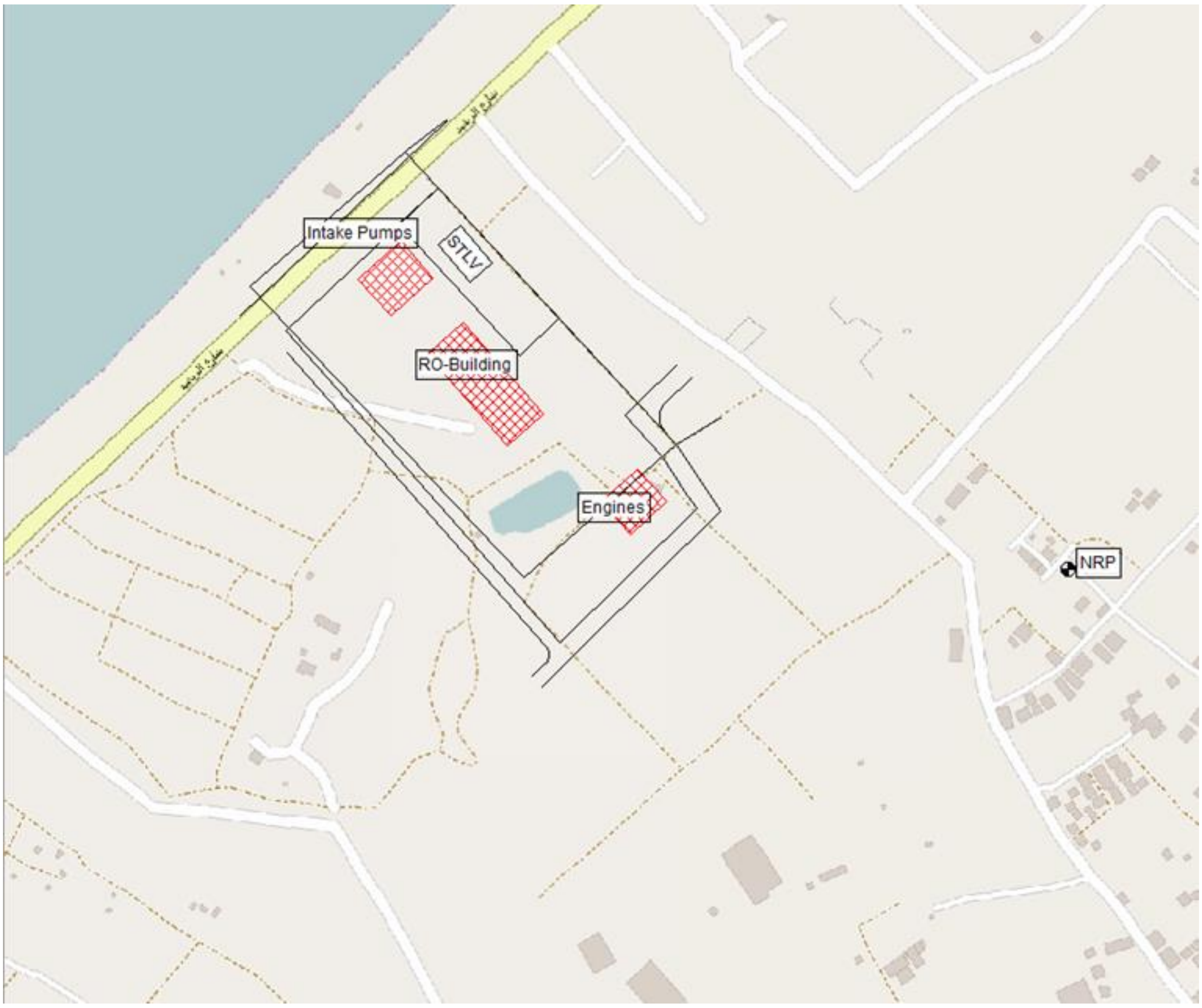


Figure 34 SWRO - Operating phase

The figure above shows the positions of the noise sources placed inside the GCDP, which includes the three main surface sources:

- Seawater Intake Pump station.
- RO-Building / SWRO: Pre-treatment Filter Structure, Product Water Pump Station, Membrane Cleaning System, Chemical Feed Equipment, Service Facilities, Solids Handling Equipment.
- Fossil Power Station: Reciprocating Diesel / Gas Engines.
- An on-site power plant, 4x7.6 KW reciprocating engines and electrical transformers, would be located in the back area (South-East) of GCDP. The total capacity of the reciprocating engines is assumed to be between 26-30 MW covering 3-4 units (7-9 MWe each) with 1-2 small back-up diesel engines (container type) to cover the outage of one main engine. The reciprocating engines would have a maximum sound level rating of 117 dBA at one meter and the maximum noise level of the Engines Exhaust would be 122 dB (A) at one meter.

Sound source		Weighted sound pressure level in dB (A)	Sound power level in dB (A)
Intake Pump station		90	98
Pre-treatment Filter Structure		88	96
Product Water Pump Station		88	96
Membrane Cleaning System		88	96
Chemical Feed Equipment		88	96
Service Facilities		88	96
Solids Handling Equipment		88	96
Reverse Osmosis Process Area		90	98
		88	96
Reciprocating Engines	Engine noise	117	125
	Exhaust noise	122	130

Table 15 Overview of equipment used in the operations of the GCDP / (SWRO)

Based on this information the sound power level data in dB (A) were converted and summarized as total level in dB (A) in the following table (the set up were prepared as surface sound sources).

Acoustic source	Sound power level in dB (A)
Intake Pump station	98
Reverse Osmosis Process Area (SWRO)	105,3
Reciprocating engines (Fossil Power Station)	137,2

Table 16 Overview of all surface acoustic sources (sound power level) inside of GCDP

Furthermore, it was considered how a building, which comprises the sound sources, could influence the sound propagation. In the forecast a building of 10 m height was applied.

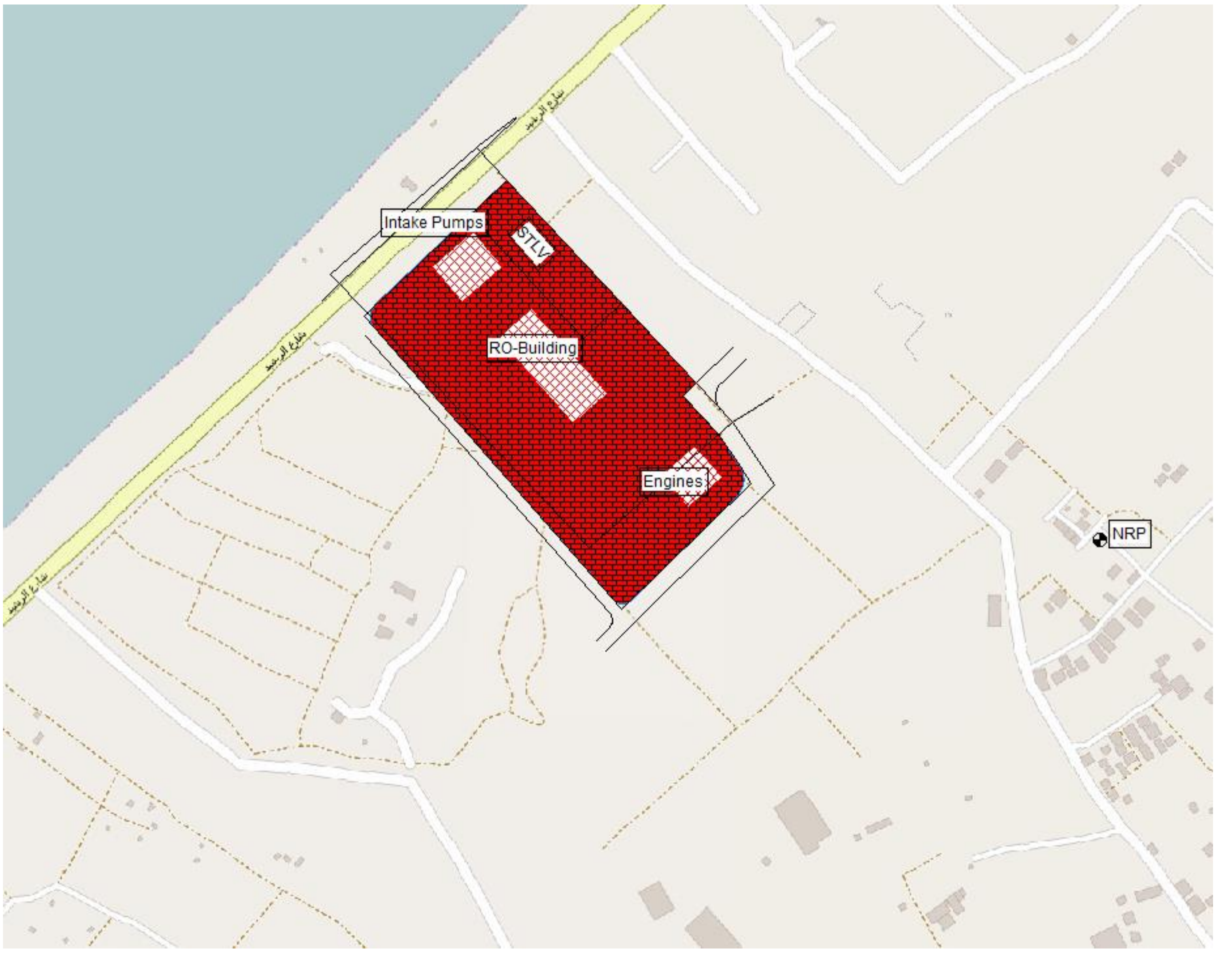


Figure 35 SWRO with building – Operational Phase

The following graphics are to illustrate the propagation of sound of the operation phase surrounding the GCDP.

In particular, the diesel engines of the power plant can cause high noise pollution at the nearest receptor point (NRP) as illustrated.

The noise levels expected at the NRP during operation are 71-72 dB, which is above the limits set by the Palestinian and IFC/WBG standards for outdoor noise for residential areas. For this reason, the mitigation measures outlined in Section 4 of this report will be developed and implemented, reducing significantly the noise levels to be generated and thus the impact at the receptors.

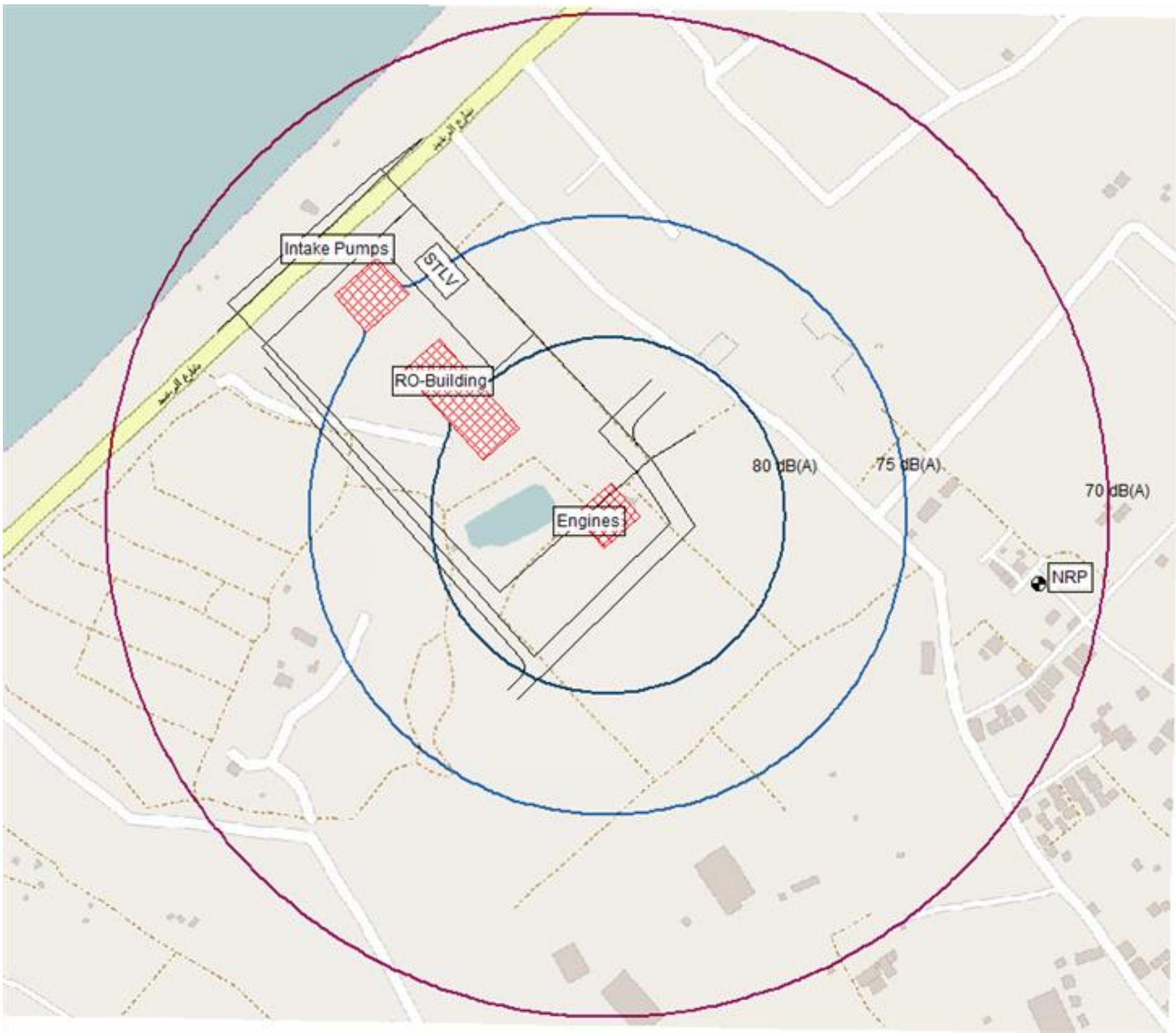


Figure 36 Sound propagation – SWRO - Operational Phase

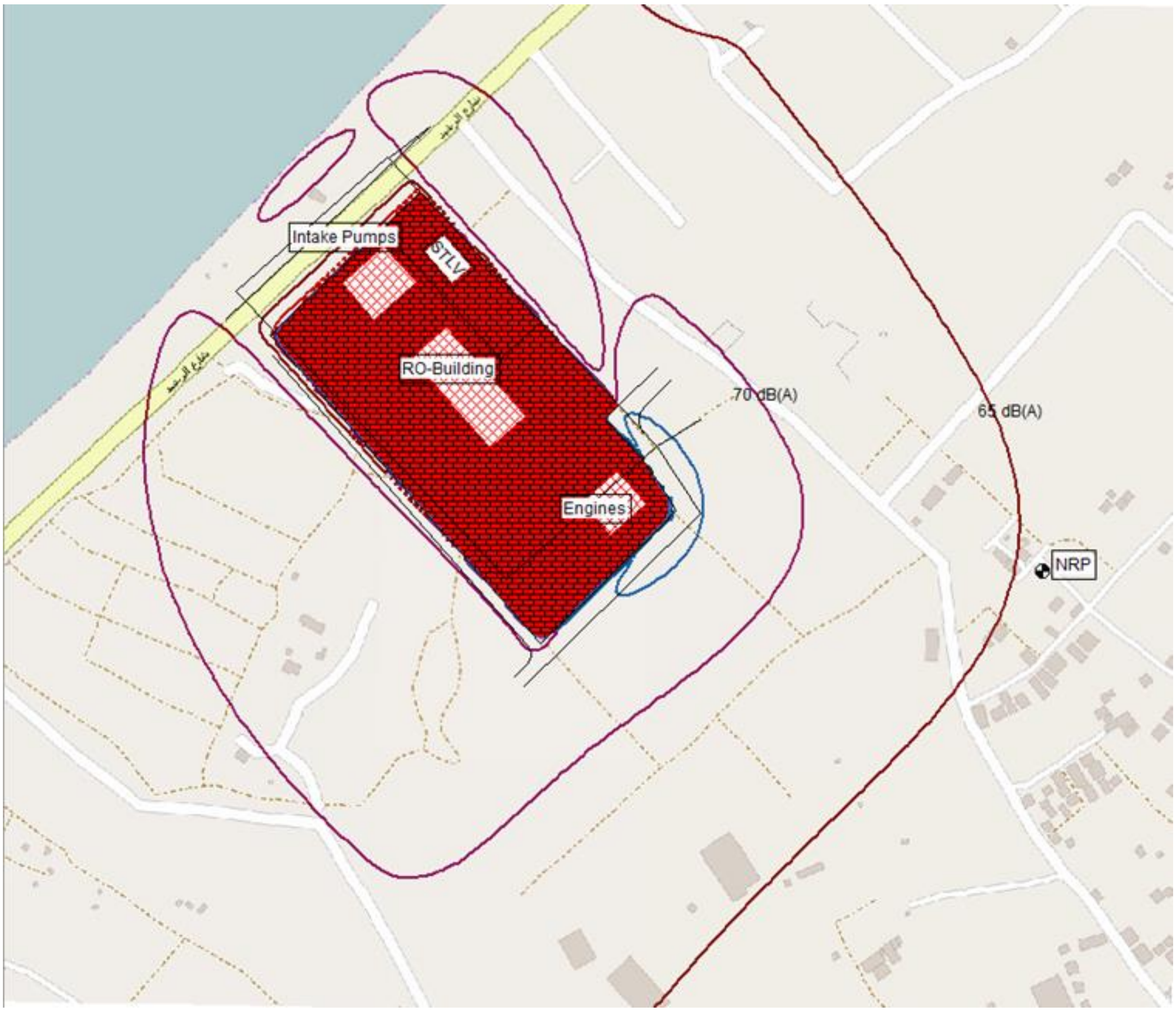
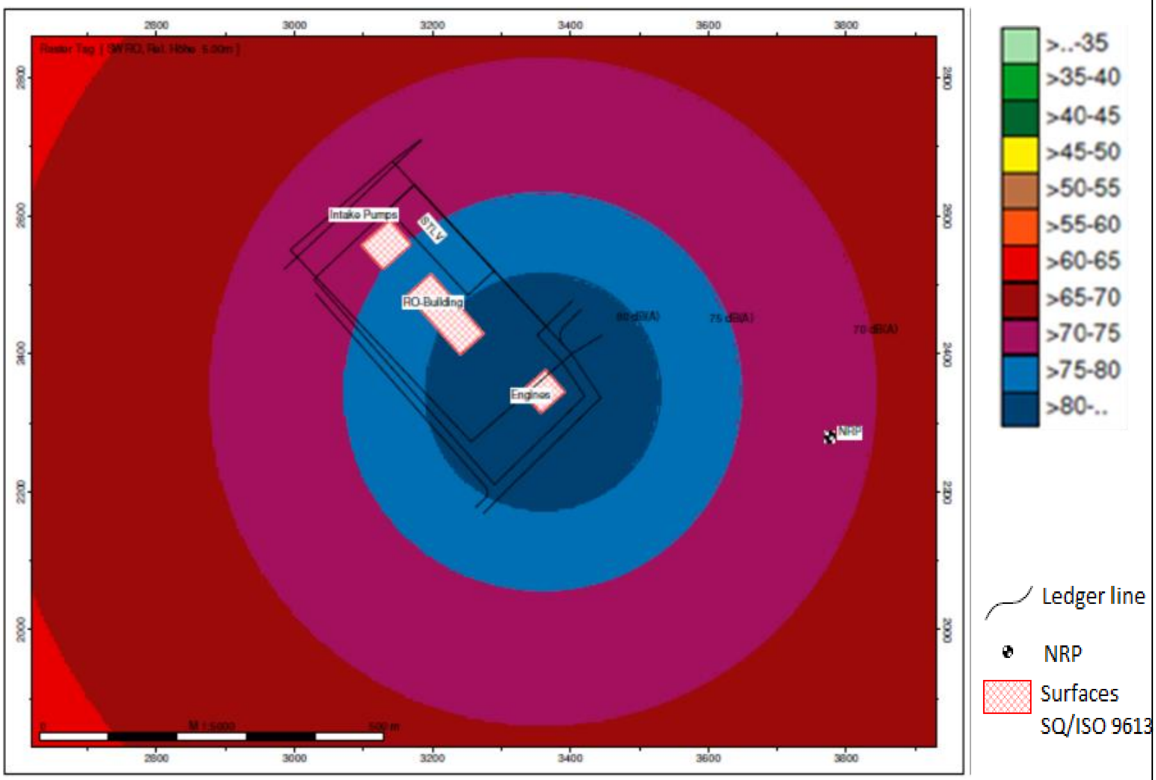


Figure 37 Sound propagation – SWRO with building - Operational Phase

This graphic is meant to illustrate that the building containing the used machines, can reduce the sound propagation.

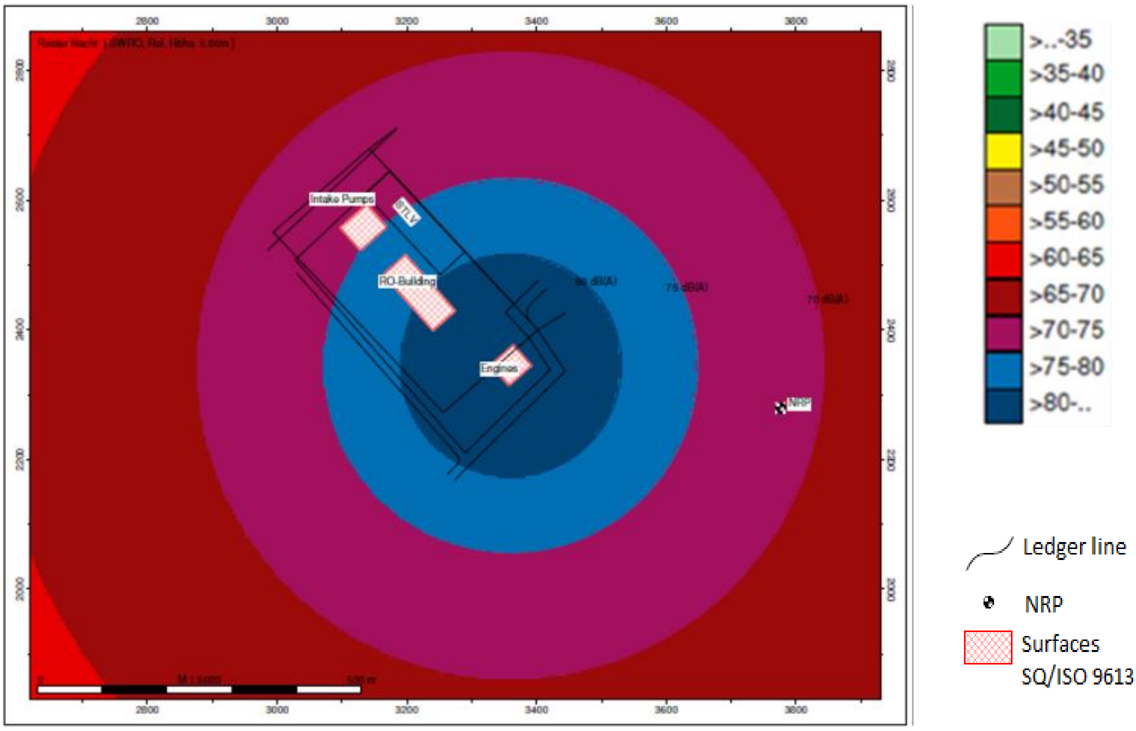
The following references could provide information and guidance on noise mitigation in building design:

- ISO 717-1: 2013-03 Acoustics - Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation. [Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation], *(Contain instructions and information regarding the design of plants).*
- The standard DIN 4109 Supplement 2: 1989-11; Sound insulation in buildings; construction examples and calculation methods, "DIN 4109 Beiblatt 1:1989-11": *(Contain information for planning and execution; Proposals for increased sound insulation*; *Recommendations for sound insulation in personal living and working areas)*.



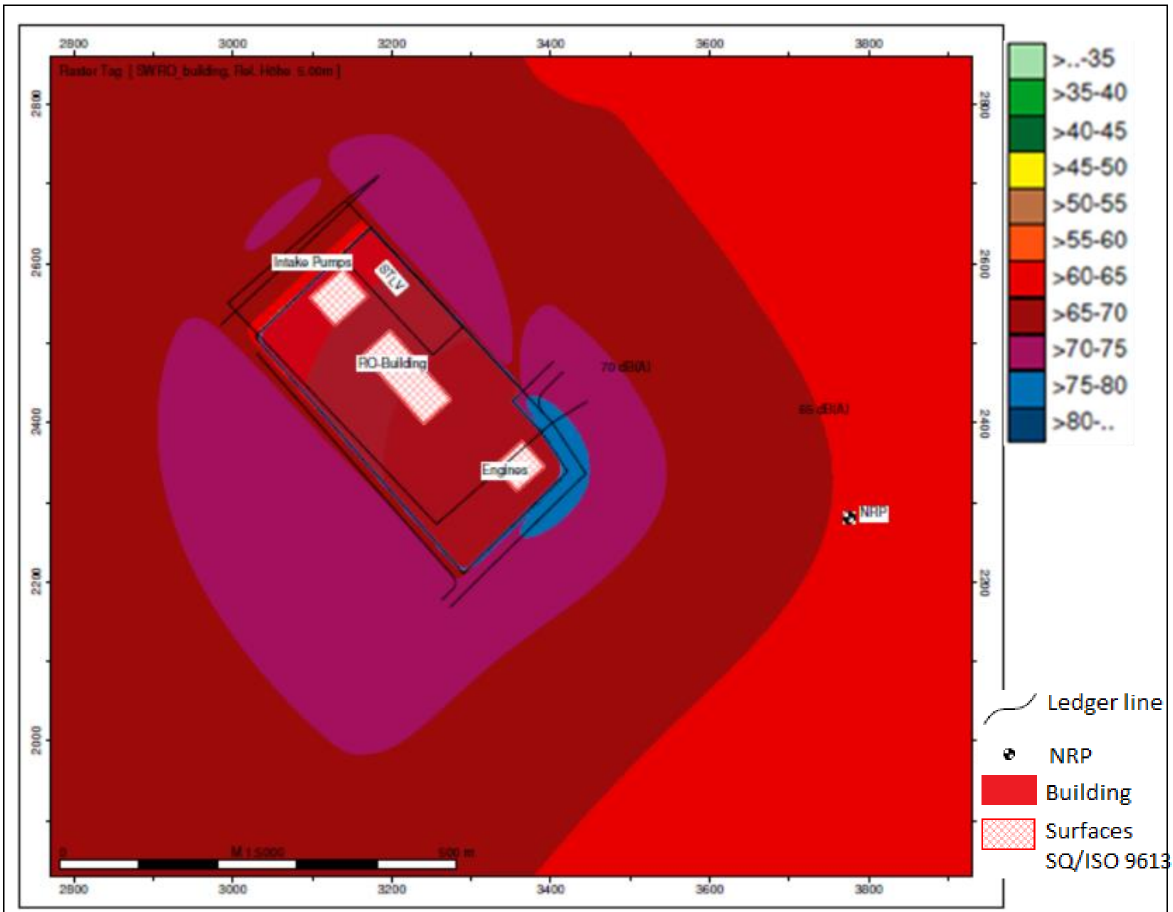
Day level (6h-22h) dB (A) Height of calculation: 5,00 m

Figure 38 Noise map: day time - SWRO Plant Operational Phase



Night level (22h-6) dB (A) Height of calculation: 5,00 m

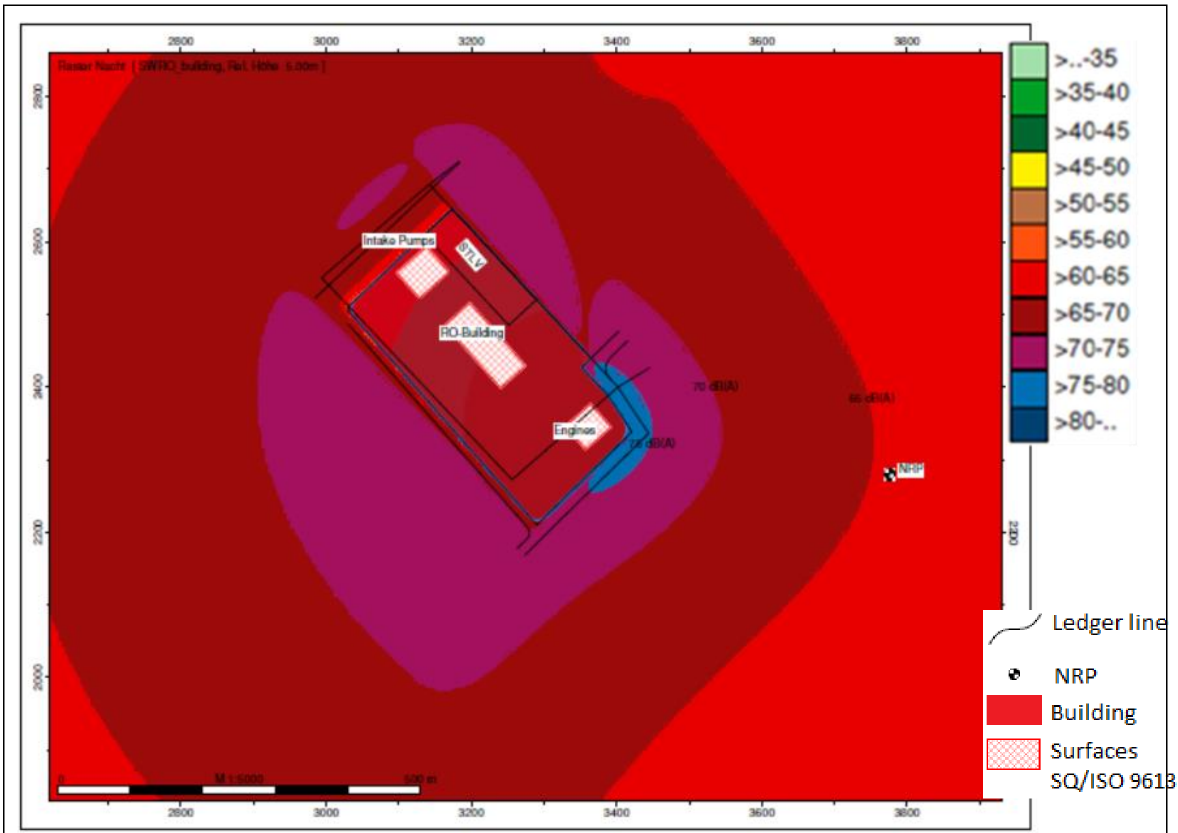
Figure 39 Noise map: night time - SWRO Plant Operational Phase



Day level (6h-22h) dB (A)

Height of calculation: 5,00 m

Figure 40 Noise map: day-time - SWRO with Building Plant Operational Phase



Night level (22h-6 h) dB (A)

Height of calculation: 5,00 m

Figure 41 Noise map: night-time - SWRO with Building Plant Operational Phase

3.4 WIND PLANT

The wind turbines plant (2 x 2 MW) were recognized as point sources at a height of 100 m, would be located at the shore in front of the main GCDP area, the following illustration is intended to represent the locations of the wind turbines.

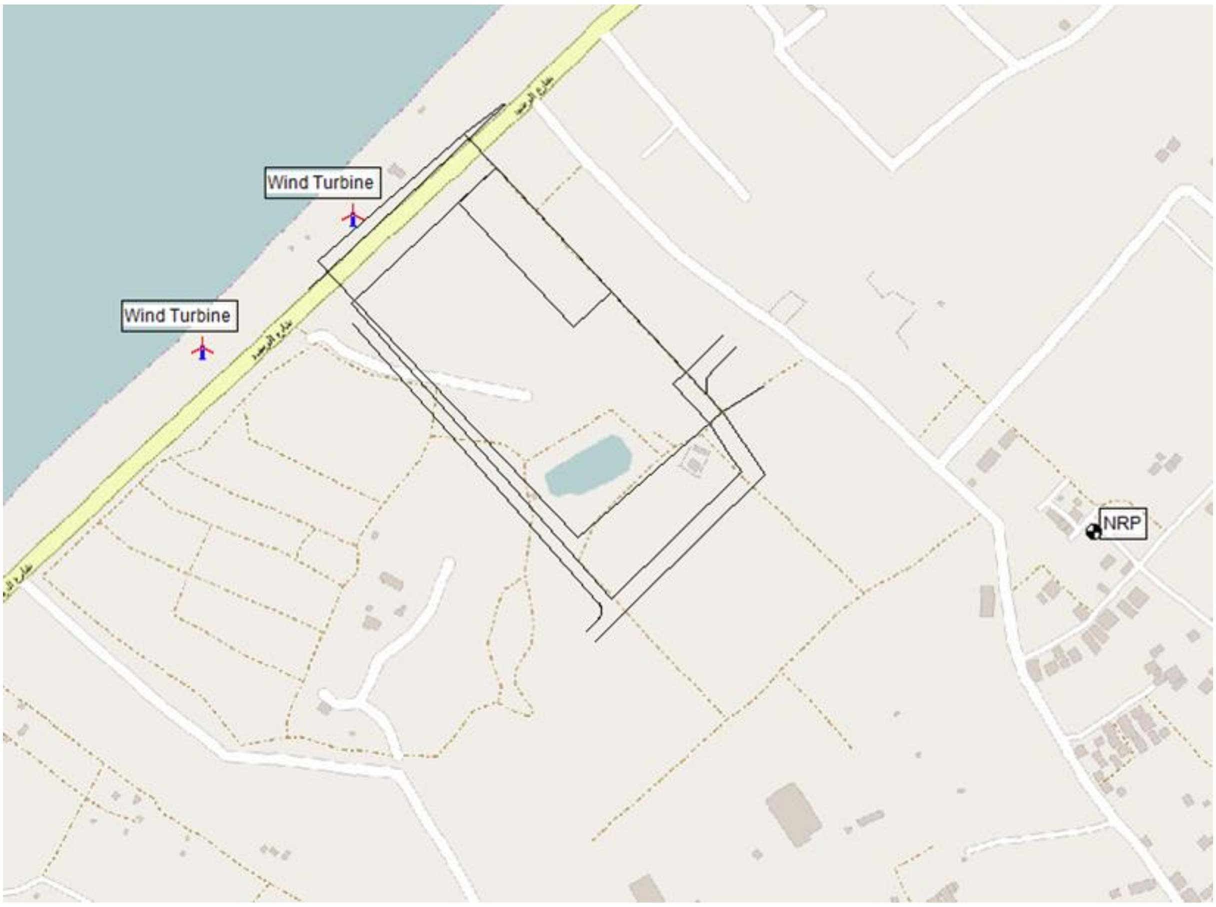


Figure 42 Wind Turbines plant - Operating phase

Sound source	Weighted sound pressure level in dB (A)
Wind turbine	102

Table 17 Overview of the Wind turbine

Similarly, the impact of a building of 10 m height was inspected in the sound propagation of the wind turbines. The building will also be located on the surface of the GCDP.

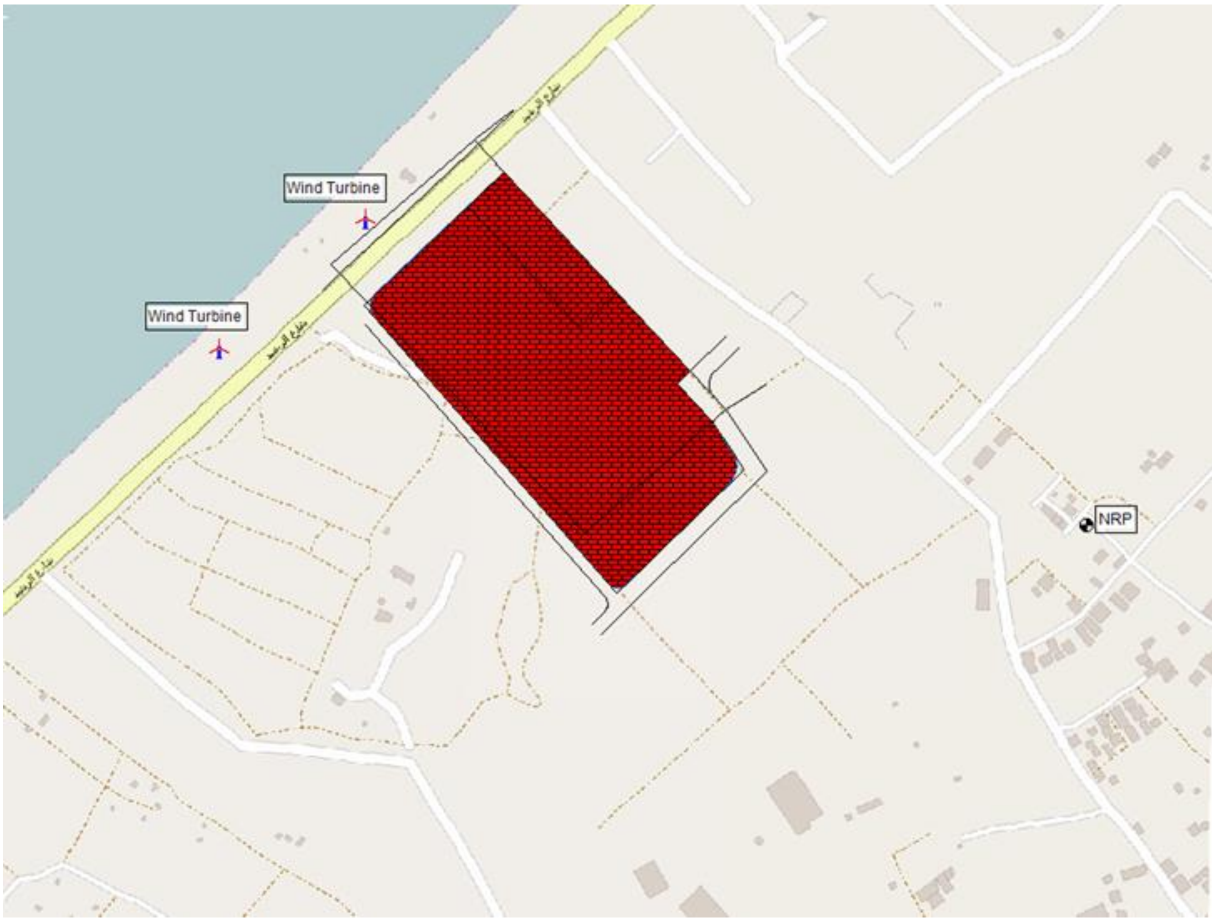


Figure 43 Wind Turbines plant with building - Operating

The modeling forecast of noise propagation during the Wind Plant operation showed that the nearest receptor point (NRP) located about 808 meters from the middle of Wind Plant area, at this distance the noise level would be approximately 34 dB (A), which is in compliance with the limits set by the national and international applicable regulations. However, since they will operate at the same time as the plants, the cumulative noise levels are expected to be above the standards. In order to reduce the overall impact generated the mitigation measures included in **Section 4: Mitigation Measures**, will be developed and implemented.

The following figure is intended to illustrate, that the wind turbines can cause noise pollution by about 34 dB (A) at the NRP.

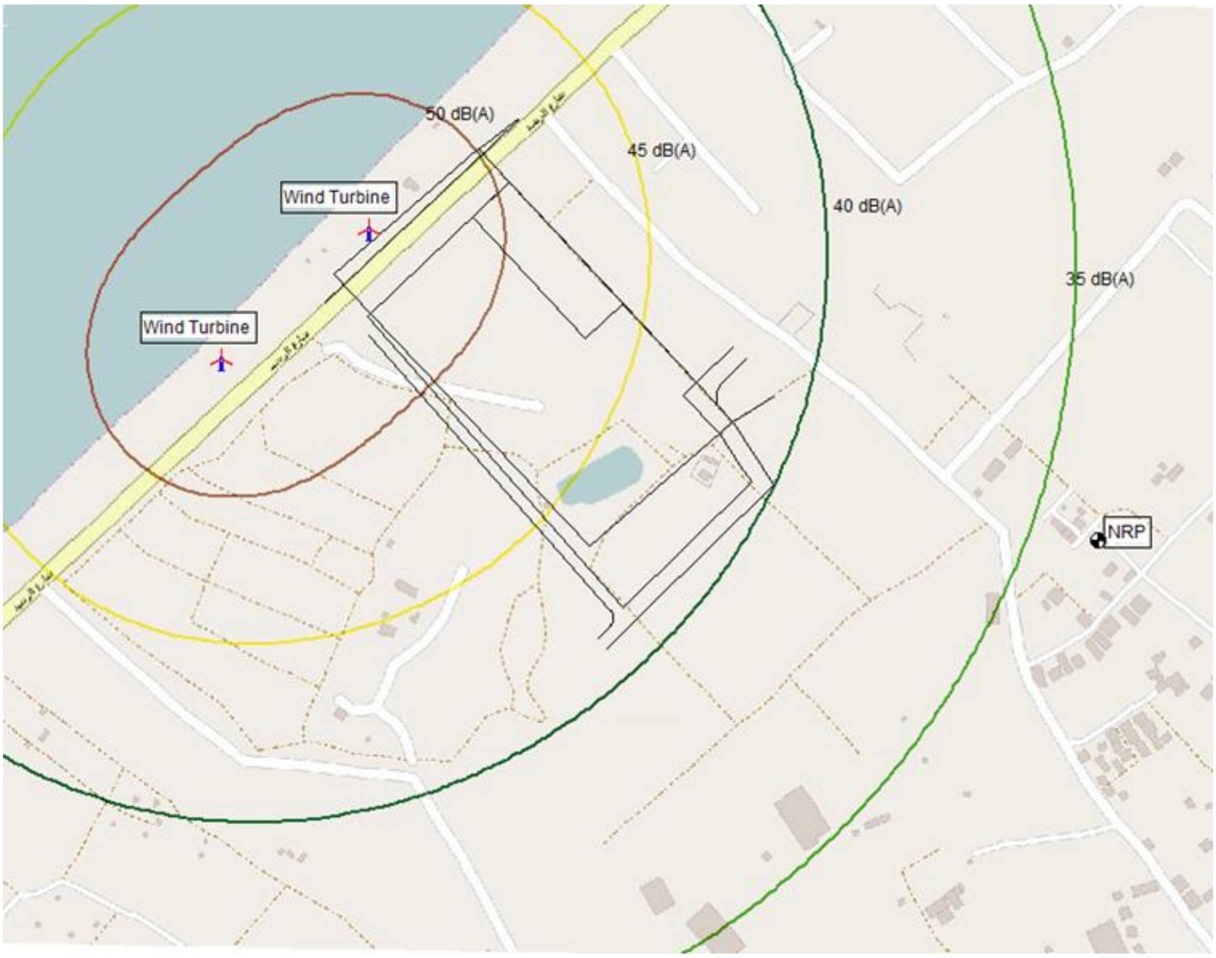


Figure 44 Sound propagation, operation of Wind Turbines plant - Operating

According to the calculation using noise prediction Model (IMMI, 2016) with operating both wind turbines the influence of the building on the sound propagation of the wind turbines is insignificant, as the sound propagation of the SWRO plant (Figure 45) This could be due to the hub height of the wind turbines of 100 m.

The heights of the noise emissions in consideration of acoustic propagation of wind turbines with and without building are according to the forecast 34 dB (A).

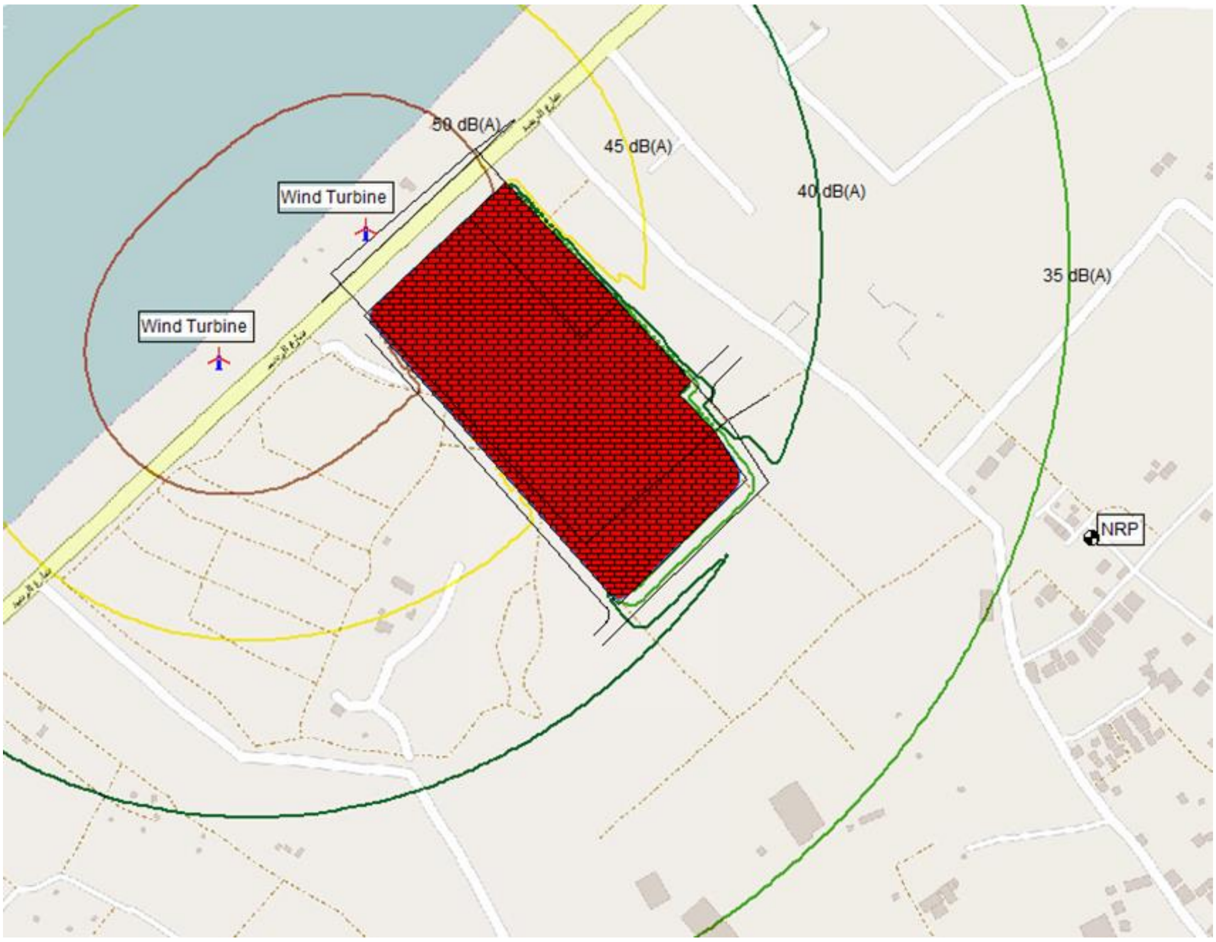
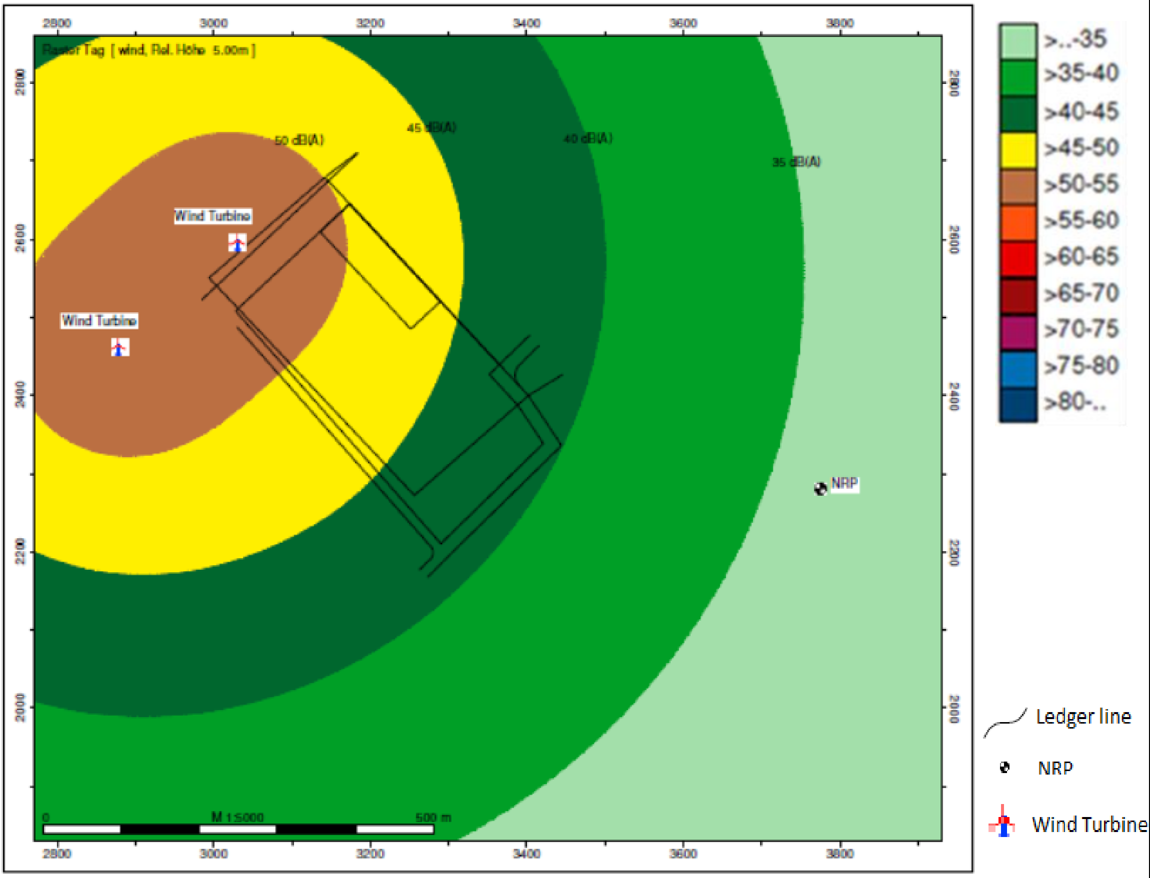


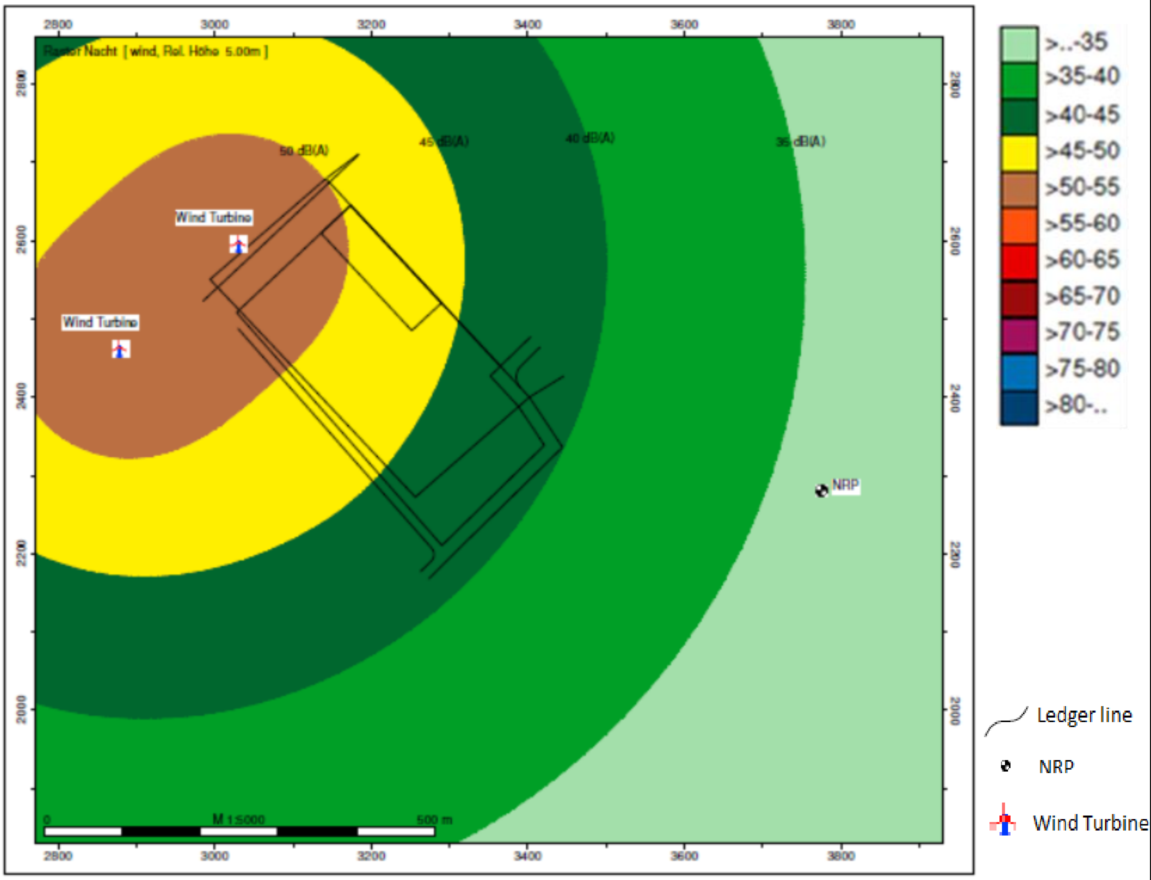
Figure 45 Sound propagation, operation of Wind Turbines plant with building



Day level (6h-22h) dB (A)

Height of calculation: 5,00 m

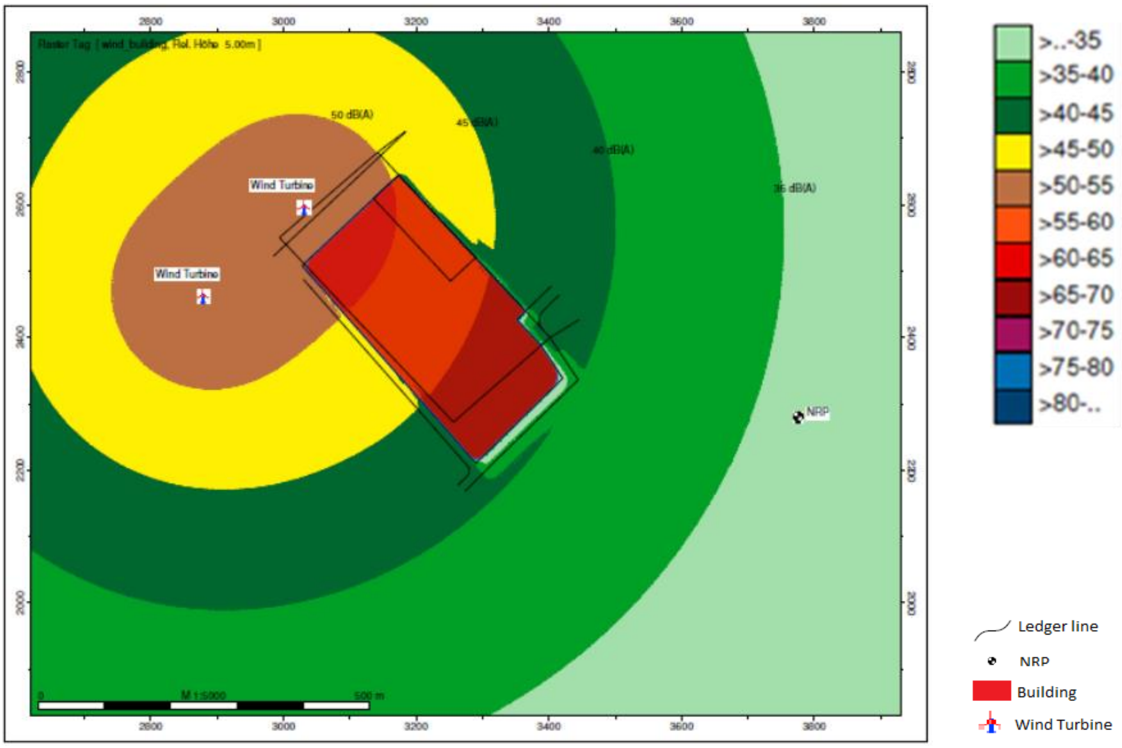
Figure 46 Noise map: day-time – Wind Plant Operational Phase



Night level (22h-6 h) dB (A)

Height of calculation: 5,00 m

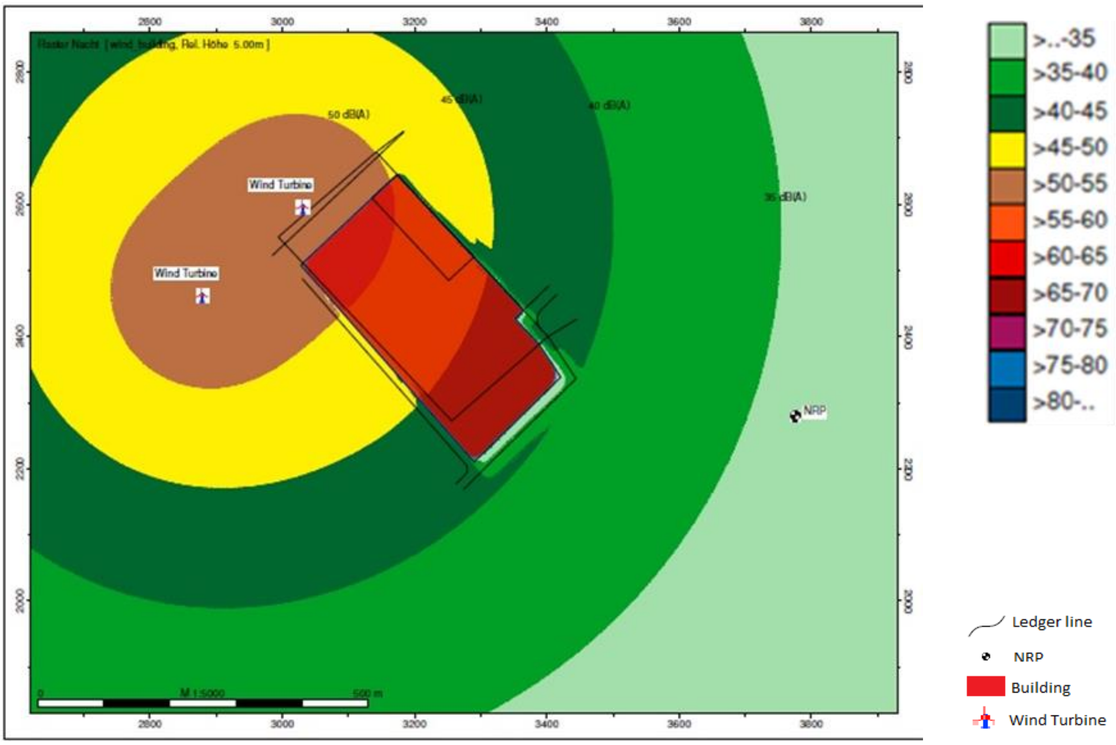
Figure 47 Noise map: night-time - Wind Plant Operational Phase



Day level (6h-22h) dB (A)

Height of calculation: 5,00 m

Figure 48 Noise map: day-time – Wind Plant with Building Plant Operational Phase



Night level (22h-6 h) dB (A)

Height of calculation: 5,00 m

Figure 49 Noise map: night-time – Wind Plant with Building Plant Operational Phase

3.5 TRAFFIC DURING PLANT OPERATIONS

The plant will require heavy truck deliveries of chemicals, disposal of waste solids, solid residuals, and supply of equipment and spare parts. It is anticipated that a maximum of 10 truckloads of chemicals, one truck load of waste solids and up to three truck trips for solid residuals disposal (i.e., a total of approximately 28 truck trips) would be required each week.

4. MITIGATION MEASURES

The issue of potential noise exceedances is practically best addressed by the implementation of a range of noise control measures and monitoring adapted to the construction activities occurring at any one time. Methods of mitigation to reduce the noise impact generated during the construction and operation phases of the project are outlined in the following subsections.

4.1 CONSTRUCTION PHASE

The measures below are generally consistent with the EPA Environmental Guidelines for Major Construction Sites and are expected to protect the amenity of local noise and vibration sensitive receivers throughout the construction period.

- Where practicable, all typically noisy construction activities should be kept within the daytime working hours. This includes haul trucks not accessing and leaving site before 7:00 am and after 10:00 pm. This is important to minimize noise impacts at the receptors located close to the traffic roads.
- All site workers (including subcontractors and temporary workforce) should be sensitized to the potential for noise and vibration impacts upon local residents and encouraged to take all practical and reasonable measures to minimize noise during the course of their activities.
- Work methods should be reviewed with a preference for quieter and non-vibration generating methods wherever possible. This is particularly important for any night-time activities.
- Fixed and mobile equipment fleet should be reviewed with a preference for more recent and silenced equipment wherever possible. Equipment used on site would typically be in good condition and good working order.
- Only equipment should be used that is fit for the required tasks in terms of power requirements. Maintenance should be conducted regularly.
- Fixed equipment (i.e. pumps, generators and compressors), material dumps, and loading and unloading areas should be located as far as practicable from the nearest sensitive receptors.
- Equipment that is used intermittently should be shut down when not in use.
- All engine covers should be kept close while equipment is operating.
- As far as possible, materials dropped from heights into or out of the trucks should be minimised.
- Materials should be stockpiled (whenever possible) so as to provide acoustic screening between noise sources and receptors.
- Road surfaces should be regularly maintained to avoid corrugations, potholes, etc.
- Individual vehicle engine, transmission and body noise/vibration should be minimized through the implementation of an equipment maintenance program.
- The need for trucks/equipment to reverse should be minimized. This will reduce the frequency at which disturbing but necessary reverse warnings will occur. Alternatives to the traditional reverse “beeper” alarm, such as a “self-adjusting” or “smart” alarm could be considered.
- If necessary, temporary acoustic barriers should be provided (where effective) specifically for noise control.

- A Construction Environmental Management Framework should be developed and implemented for all potential construction methods, detailing Noise and Vibration Management.
- Noise and vibration monitoring should be undertaken by a qualified professional and with consideration to the relevant standards and guidelines at the beginning of the construction works to provide an understanding of acceptable work activities to site management.

4.2 OPERATION PHASE

The mitigation measures below are expected to reduce the impact of the noise generated during Project operation on receptors:

- Maintenance operations should be conducted for all equipment used to ensure proper operation.
- All equipment should be used according to manufacturer's instructions.
- Pumps on the outside of the plant should be enclosed in casings, whenever possible.
- An Environmental Management Framework should be developed and implemented for operation, detailing Noise and Vibration Management.
- Operation procedures should be reviewed and engineering noise and vibration attenuation controls incorporated (including buffer design) if needed (e.g., PVC soundproof doors for the plants, mufflers for the reciprocating engines).
- Acoustic lovers specifically designed for noise abatement should be included in the initial buildings design.
- Strategies for reducing aerodynamic noise from wind turbines include adaptive approaches and wind turbine blade modification methods. They should be considered, as far as possible, in the wind turbine design.
- A strict procedure should be developed to ensure that workers in the Plants maintain all building doors perfectly closed, opening them only during the minimum needed time.
- A barrier could be created between the plants and the nearest sensitive receptors, so that the noise level perceived by the receiver is reduced. Acoustic barriers should be without gaps and have a continuous minimum surface density of 10 kg/m2 in toder to minimize the transmission of sound through the barrier. Barriers should also be located as close to the source or to the receptor to be effective. Barriers of living materials (green buffer) are preferred due to the fact that they will not create a negative visual impact. Studies have shown that green belts can lead to noise reduction levels (Kragh, J., 1979): 25 m wide consisting of oaks, hornbeams, poplars, silver firs and various sorts of bushes can lead to noise reduction levels of 6 -7 dB; 50 m wide consisting of beeches and various conifers planted between older birches and elms can lead to noise reduction levels of 8 to 9 dB. However, it must be considered here that for trees to have significant attenuation benefits they will need to be planted very close together and to cover a substantial propagation distance. Also for the Project site other species would have be used, such as a combination of date palms and tamarix species, which are well adapted to the area and easy to manage.
- Noise and vibration monitoring should be undertaken by a qualified professional and with consideration to the relevant standards and guidelines at the beginning of the operational stage to provide an understanding of acceptable work activities to site management.

- Once operation starts and noise monitoring has been conducted for the first six months, the situation should be assessed again. If noise thresholds have been consistently reached, additional mitigation measures, such as the ones outlined below, should be put in place:
    - Additional equipment enclosure;
    - Additional noise barriers in the vicinity of doors;
    - Building louvers redesign;
    - Installation of double windows in residential premises affected by noise, especially if the noise thresholds breaching occurs during night time.
    - Creation of an acoustic berm/wall made up with sand and vegetation surrounding the GCDP site. This would require the purchase of additional land due to the limited space on site. Should this not be possible, external acoustic walls should be installed.
- The RO pumps (especially the high pressure pumps) will create a considerable amount of noise that will mainly affect the staff of the plant. This impact can be mitigated by providing all the employees by hearing protector whose exposure is likely to exceed the maximum permitted levels. Moreover, noise warning signs should be installed at the instance to the RO main building indicating the level of noise inside the building. The signs should be visible and readily interpreted.

Additionally, the following references could provide information and guidance on noise mitigation in building design:

- ISO 717-1: 2013-03 Acoustics - Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation. [Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation], *(Contain instructions and information regarding the design of plants).*
- The standard DIN 4109 Supplement 2: 1989-11; Sound insulation in buildings; construction examples and calculation methods, "DIN 4109 Beiblatt 1:1989-11": *(Contain information for planning and execution; Proposals for increased sound insulation*; *Recommendations for sound insulation in personal living and working areas)*.

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