Annex C

Air Quality

C1 INTRODUCTION

This document has been prepared by Environmental Resources Management on behalf of *Samsung C&T Corporation, Salini Impregilo and Kayi*, the Special Purpose Vehicle (SPV). It presents the methodology, findings and recommendations of the Air Quality Impact Assessment (AQIA) of the Gaziantep Integrated Healthcare Campus (the Project), located in Şahinbey District of Gaziantep, southeast Turkey.

The assessment considers Project activities during construction and operation with the potential to cause impacts to air quality.

C1.1 ASSESSMENT OBJECTIVES

The primary objective of the AQIA is to consider and assess the potential impacts which the Project may have upon existing air quality, during both construction and operation. Following this, the AQIA ensures that any negative impacts are minimised as far as is practicable, applying mitigation measures where necessary.

C1.2 SCOPE OF THE ASSESSMENT

C1.2.1 Overview

The AQIA has been undertaken in a number of stages. The scope of work and chronology of assessment is broadly as follows:

- the legal framework was examined, focussing on the identification of relevant national and international air quality standards, and applicable emissions limits;
- the receiving environment was characterised, including derivation of the existing baseline and meteorological conditions and the identification of sensitive receptors;
- impacts during the construction and operational stages from both on-site and vehicular emissions have been considered and assessed;
- the significance of impacts has been assessed in relation to air quality standards at sensitive human receptors, with reference to the existing environmental conditions; and
- mitigation measures have been suggested where appropriate.

C1.2.2 *Pollutants of Interest*

The primary pollutants of interest with regards to the Project are:

- emissions of nitrogen dioxide (NO_2) associated with combustion emissions, most notably from the tri-generation plant and boilers to be installed, together with emissions from road vehicles accessing the site during operation; and

- emissions of dust, in particular particulate matter (PM_{10} and $PM_{2.5}$) during the construction phase, arising from both general site activities (including concrete batching) and combustion sources. Emissions from road vehicles accessing the site during operation.

C1.2.3 *Scope of Work*

It is proposed that a gas-fired tri-generation plant (combined heating, cooling and power), will be installed at the site, together with boilers for hot water.

Based on the developing design information at the time of writing, it is understood that the total rated thermal input of all combustion activities within the installation is approximately 57.25 MW_{th}. The combined thermal input of the tri-generation plant during the operational phase is understood to be 17.25 MW_{th} (1) and the boilers are expected to be 40MW_{th}. This therefore means that the activities fall within the governance of the European Union Industrial Emissions Directive (2) (EU IED), with Turkey being an EU accession state. Guidance published by the IFC (3) also states that combustion sources with an equivalent heat input of greater than 50 MW_{th} are considered to be significant sources of emissions. As a result, the potential impacts from the operational plant on-site need to be assessed via detailed air dispersion modelling.

With regards to construction, there are potential impacts associated with emissions of dust arising from construction traffic, non-road mobile machinery, on-site concrete batching and earthworks activities. These have been assessed qualitatively to inform the need for mitigation.

Modelling of dust emissions has not been undertaken due to uncertainties in model source terms. The model itself is also considered to be too uncertain to be meaningful and therefore the focus of the construction assessment is on the level of employed mitigation on and around the Project Site, to minimise the potential impacts as far as is reasonably practicable, rather than fully quantify impacts. Exhaust emissions from on-site construction vehicles and non-mobile plant such as temporary electricity generators, are expected to have negligible

(1) Email Correspondence from M.Bastirmaci@mcninsaat.com.tr to Kemal Karakose on Monday 18 April 2016 Re: Trigeneration Plant

(2) EU, 2010. Industrial Emissions (Integrated Pollution Prevention and Control) Directive of the European Parliament 2010/75/EU, European Union, 2010.

(3) IFC (2007) Environmental, Health and Safety Guidelines: General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality, April 30, 2007.

impact on air quality and have not been assessed. Exhaust emissions from construction vehicles travelling to and from site have however been considered using detailed air dispersion modelling, to quantify the potential impacts on existing sensitive receptor locations alongside the employed haulage route.

Furthermore, given the nature of the Project, there is also the potential for air quality impacts to occur as a result of road traffic emissions during the operational phase from staff, patients, visitors, deliveries etc. As such, predicted pollutant concentrations have been assessed using detailed air dispersion modelling to understand the potential impacts and both existing sensitive receptors and potential future sensitive receptor locations, given that the area surrounding the Project Site is earmarked for extensive further development over the coming years.

The direct emissions of greenhouse gas associated with the Project, including traffic movements have been quantified.

C1.2.4 Issues Scoped Out

Emissions to air will also be associated with mechanical ventilation at the hospital. It is however expected that any air extraction from sources likely to contain hazardous airborne substances (for example isolation rooms, mortuary, medical waste area and research laboratories etc), will pass through a suitably designed air treatment system to remove any pathogens or hazardous substances, such that no significant air quality impacts result. The assessment of ventilation emissions at the hospital has therefore been scoped out. With regards to the treatment of waste, no details on the inclusion of an incinerator at the hospital have been referenced in any design material provided as part of the Project. Assessment of impacts from incineration on-site has therefore also been scoped out. *Annex E Waste* provides some wider detail into the existing Municipal medical waste sterilisation facility in Gaziantep, which is understood to have sufficient capacity to handle associated waste generated as part of the Project and is therefore where the Project hazardous and inert waste is expected to be sent for processing.

Whilst direct emissions of greenhouse gases have been quantified, indirect emissions such as embedded carbon within the building materials has not been quantified or assessed.

C1.3 STUDY AREA

The assessment of operational impacts will focus on the potential effect of the installed plant emissions within the Project Site (given the sensitivity of the hospital as a receptor) and at a small number of sensitive receptors beyond the site boundary, including a nearby school. In terms of road-traffic related emissions, the study area is limited to the road network within the development and immediately surrounding the Project Site, as considered in the *Annex F Traffic*.

C2 METHODOLOGY

C2.1 RELEVANT DOCUMENTS, STANDARDS AND GUIDELINES

The overarching guidance used in the assessment is that set out by the IFC in the General EHS guidelines for air quality (1) and the EU IED (2) guidelines for Large Combustion Plants. The legal framework for air quality is separated into two principle elements: ambient air quality standards and emissions limits for pollutants to air.

For ambient air quality standards, the IFC's General EHS guidelines states that:

> *…Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines, or other internationally recognized sources*

Turkey has established air quality standards based on reliable scientific evidence, and comparable to other national and international standards and guidelines. Therefore, on the basis of this guidance from the IFC, in order to assess the impacts on local air quality, monitored baseline data and predicted impacts have been compared in relation to Turkish Air Quality Limit Values and International Air Quality Standards (collectively referred to as AQS). Reference is also made to the EU ambient air quality standards, as both National and EU standards are expected to be met from the outset by lenders (3).

Annual (long-term) standards are set on the basis of avoiding chronic human health impacts and/or wider long-term impacts on the environment. Short-term standards are set to avoid acute human health effects caused by short exposure to high pollutant concentrations.

International best practice guidance has also been referenced with regards to the assessment of construction and demolition, and operational traffic impacts, in the absence of local guidance documents.

C2.1.1 *Turkish Ambient Air Quality Limit Values*

Ambient air quality in Turkey is regulated under the Air Quality Assessment and Management Regulation 2008 (4) (Amended 2009 (1)) – AQAMR. The air

(1) International Finance Corporation (2007) Environmental, Health and Safety Guidelines: General EHS Guidelines: Environmental Air Emissions and Ambient Air Quality

(2) http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN

(3) EBRD, 2014. Resource Efficiency and Pollution Prevention Control, Performance Requirement 3, EBRD Environmental and Social Policy, May 2014.

(4) MEF, 2008. Air Quality Assessment and Management Regulations, Republic of Turkey Ministry of Environment and Forests. Official Gazette 06.06.2008/26898,

quality Limit Values and alert thresholds, for each of the pollutants of concern in this study are listed in Annex I of the AQAMR.

The limit values for the pollutants of concern in the Project, listed in *Table C2.1* also contain published tolerances and timescales for compliance, however in order to be conservative, no limit value tolerances will be used in the assessment, only the published limit vales themselves.

Table C2.1 Turkish Ambient Air Quality Limit Values

Pollutant	Limit Values		
	Hourly concentration	**24-hour concentration**	**Annual limit**
Nitrogen dioxide (NO_2)	200 µg/m³ (not to be exceeded more than 18 times in one year) (+100 µg/m³ tolerance reducing to zero from 1.1.2014-1.1.2024)	-	40 µg/m³ (+20 µg/m³ tolerance reducing to zero from 1.1.2014-1.1.2024)
Particulate matter (PM_{10})	n/a	50 µg/m³ (not to be exceeded more than 35 times in one year) (+50 µg/m³ tolerance reducing to zero from 1.1.2014-1.1.2019)	40 µg/m³ (+20 µg/m³ tolerance reducing to zero from 1.1.2014-1.1.2019)

C2.1.2 European Union Air Quality Limit Values and Emission Limits

Project lender requirements mandate that as Turkey is an EU accession country, the air quality Limit Values stated within the EU Ambient Air Quality Directive (2) must be achieved. The EU air quality Limit Values for the pollutants of concern for the Project are set out in *Table C2.2*.

Table C2.2 EU Ambient Air Quality Limit Values

Pollutant	Averaging period	Value (µg/m³)
NO_2	1 hour (not to be exceeded more than 18 times in one year)	200
	Annual mean	40
PM_{10}	24 hour	50
	Annual mean	40
$PM_{2.5}$	24 hour	25
	Annual mean	25 (2015) 20 (2020)

(1) MEF, 2009. Air Quality Assessment and Management Regulation Amending Regulation, Republic of Turkey Ministry of Environment and Forests. Official Gazette 05.05.2009/27219,
(2) EC, 2008. Ambient Air Quality Directive of the European Parliament 2008/50/EC, European Commission, 2008.

Furthermore, as the total thermal capacity of the Tri-generation Plant and the Boiler Plant during operation of the hospital exceeds the $50MW_{th}$ threshold covered by IFC guidelines and the EU IED [1], the emissions limits applicable to gas-fired combustion plants are set out in *Table C2.3* and *Table C2.4* as these will form the basis of best practice plant design for the Project. The emissions limits of most interest are those for oxides of nitrogen (NO_x).

Table C2.3 IED Emissions Limit Values for Gas Fired Combustion Plants

	Unit	NO_x
Reciprocating Engines using natural gas as fuel	mg/Nm^3	75
Boiler	mg/Nm^3	100 (gas) 300 (light oil)

Table C2.4 IFC Emission Limit Values for Gas Fired Combustion Plants

	Unit	NO_x
Reciprocating Engines using natural gas as fuel	mg/Nm^3	200 (Spark Ignition) 400 (Dual Fuel)

C2.1.3 *International Best Practice Guidance*

In addition to the criteria set out above, guidance published by the Institute of Air Quality Management (IAQM) has been used in the assessment [2] [3], in the absence of any national or other international guidance. Whilst these documents are UK focussed and therefore not specifically designed for use in Turkey, they do contain methods, criteria and descriptors for assessing potential impacts associated with construction dust and traffic impacts, which are considered to be useful for this study.

The documents also recommend and outline mitigation measures where appropriate, to minimise the effect of any residual impacts.

C2.2 IMPACT ASSESSMENT METHODOLOGY

C2.2.1 *Primary Data Collection*

In order to characterise the existing environment in terms of air quality, ambient air quality monitoring data needed to be obtained. Air quality monitoring data undertaken by local authorities was gathered for 2009 - 2014 for PM_{10}. The monitoring station, which is located in the centre of Gaziantep in a residential area, is considered to be typical of an urban-background site.

(1) http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN ANNEX V, part 2
(2) IAQM, 2014. Guidance on the Assessment of Dust from Demolition and Construction. Institute of Air Quality Management, February 2014.
(3) IAQM, 2015. Land-use Planning & Development Control: Planning For Air Quality. version 1.1. Institute of Air Quality Management, May 2015

Whilst the local monitoring data are useful for context, the data are not considered to be representative of the conditions at the Project Site or in the Study Area. NO_2 is also not monitored, thus not allowing the existing baseline to be identified. A short-term programme of NO_2 monitoring was therefore commissioned in August 2015 for a period of three consecutive months, to establish the existing baseline conditions at the Project Site, since no data were available.

Dust and PM_{10} are also pollutants of concern, however additional site specific monitoring was not considered necessary at this stage.

Further details on the baseline monitoring are set out in *Section C3.3*.

C2.2.2 *Assessment of Construction Impacts*

The assessment of the potential impacts from dust emissions and vehicle exhaust emissions is undertaken with due consideration of weather factors; the proximity of receptors to dust sources; and the duration of activities. On the basis of these factors a qualitative assessment methodology for air quality impacts on receptors during construction is presented in *Table C2.5* below.

Table C2.5 Dust Risk Matrix

Likely Magnitude of Impacts	Conditions
Likely major significant impact	• Receptor within 200m of dust source • Dust generating activities for >12 months • Downwind for >10% of the year where wind and rainfall conditions promote dust generation
Likely moderate significant impact	• Receptor within 200m of dust source • Dust generating activities for <12 months • Downwind for >10% of the year where wind and rainfall conditions promote dust generation
Likely minor significant impact	• Receptor within 200m of dust source • Dust generating activities for <12 months • Downwind for 2-5% of the year where wind and rainfall conditions promote dust generation
	• Receptor within 500m of dust source • Dust generating activities for >12 months • Downwind for 2-5% of the year where wind and rainfall conditions promote dust generation
Negligible	• Receptor 200m - 500m from dust source • Downwind for <12 months of the year where wind and rainfall conditions promote dust generation

In addition to the Risk Matrix above, a more detailed assessment of dust emissions arising from the construction of the proposed development has been carried out in accordance with guidance published by the IAQM, as discussed in *Section C2.1*. The assessment covers the various stages of works, such as demolition, earthworks, construction (including concrete batching) and vehicle track out in greater detail. The assessment will focus on activities within the Project Site, and on the routes used by construction vehicles on the public highway.

C2.2.3 Assessment of Tri-generation Plant and Boiler Emissions

As the total thermal input of the operational hospital is understood to fall within both the EU and IFC guidance which classifies significant combustion sources (>50 MW_{th} input), an assessment of potential impacts from on-site stack emissions from the tri-generation plant and associated boilers using dispersion modelling by AERMOD has been included.

C2.2.4 Aermod Model

AERMOD is considered to be appropriate for this type of assessment and is accepted worldwide by bodies including the IFC, USEPA, the European Environment Agency and many national regulators. The model incorporates a number of parameters to simulate the dispersion of emissions from source, and predict the subsequent pollution concentration at receptors.

The key inputs to the model are emissions data, terrain effects and meteorological data (see *Section C3.2*).

AERMOD calculates the PC at each of the points of the defined receptor grid (see below) for each hour of meteorological data. The results presented in *Section C6* are the highest annual averages, the highest daily and the highest hourly maximum values predicted by the model.

C2.2.5 Receptor Grid

Within the dispersion model, specific receptor locations are defined. For this project, a grid of receptors has been defined to identify impacts across the Study Area. The complete receptor grid is composed of several Cartesian grids as follows (UTM coordinates):

- Centre grid:
  - origin (southwest corner at 355821 m E, 4096958 m N;
  - 50 m resolution;
  - 2 km radius;
- Tier 1 grid:
  - 100 m resolution;
  - 4 km from center grid;
- Tier 2 grid:
  - 500 m resolution;
  - 8 km from center grid.

As mentioned in *Section C1.3* the hospital itself and the nearby school are nearby sensitive receptors. As *Section C3.4* will show these are to be considered of high sensitivity, therefore a set of bespoke elevated receptors has been defined for the nearest hospital buildings and school building (see *Appendix C1*).

C2.2.6 Consideration of Terrain Effects

Changes in terrain elevations (i.e. hills or mountains) can have a significant impact on dispersion of emissions, in terms of funnelling of plumes and changing local wind flows. Terrain effects are typically considered important where there are sustained gradients of 1:10 or greater.

The Study Area is situated in a moderately hilly area. The terrain elevation is significant, with peaks in excess of 50 m above mean sea level (AMSL) within 10 km of the site, therefore terrain was included in the model.

C2.2.7 *Consideration of Building Downwash*

When air flow passes over buildings, a phenomenon known as building downwash occurs where the air is entrained in the lee of the building and drawn down to ground level. This effect can bring the plume from the stack down to ground level quicker than would otherwise be the case, and therefore increase the ground level concentration relative to a case where there are no buildings. Building effects are typically a consideration where the buildings are greater than one third the height of the stacks.

Due to the size of the main hospital buildings and presence of the adjacent school, all of which may affect air flow, the effects of these buildings have been included in the assessment. Further details are provided in *Appendix C1*.

C2.2.8 *Emissions Data*

The operational phase impacts will be determined by following emission sources:

- gas fired tri-generation plant; and
- gas fired boiler plant (in case gas supply is offline the boilers can run on light oil).

The tri-generation units are back-up units, with several operating scenarios:

- **Option 1 - Cold weather conditions** (between December and April): three gas engines in the tri-generation plant and two boilers;
- **Option 2a - Severe weather conditions** (a total of 45 days between December and February): three gas engines in the tri-generation plant and three boilers;
- **Option 2b - Severe weather conditions** (a total of 45 days between December and February): five boilers (when tri-generation plant is off);
- **Option 3 - Hot weather conditions** (between May and November): three gas engines in the tri-generation plant and one boiler.

Based on the above, the reasonable worst case emission scenario consists of three operational gas engines in the tri-generation plant and three operational gas-fired boilers (Option 2a).

A fundamental stage in the air quality assessment has been the liaison with the design engineers in order to optimise the stack parameters and the emissions concentrations from the tri-generation and boiler plants. This was an iterative process which led to modifications of the design. The emission characteristics and stack parameters of the initial design and the subsequent modified/mitigated designs are presented in *Table C2.6* and *Table C2.7* respectively.

The boilers have the capacity to run on light oil, however they will not run on light oil whilst the tri-generation plant is operational therefore the overall NO_x emissions will therefore be lower when light oil is used as the boilers will be the only source. A scenario with boilers running on light oil has not been considered in the assessment. Emissions of particulates and SO_2 will be negligible and are therefore not considered

Table C2.6 Emission Characteristics – Initial Design

Installations		**Tri-generation plant**	**Boiler plant**
Parameter	Units	per unit	per unit
Installed power	MW_{th}	**5.751**	**8**
Number of units		3	5
Number of units per stack		1	1
Stack height	m	13	20
Flue diameter	m	0.6	1.1
Emission velocity	Am/s	22.7	4.09
Volume flow rate gas fired (actual)	Am^3/s	6.43	3.89
Emission temperature gas fired (actual)	Kelvin	393	356
NO_x	mg/Nm^3	500	17.8 (on gas) 26.1 (on light oil)
NO_x	g/s	1.26	0.0345 (on gas) 0.0507 (on light oil)

Table C2.7 Emission Characteristics – Mitigated Designs (Modified Parameters in Bold)

Installations		Tri-generation Plant	Boiler Plant
Parameter	Units	per unit	per unit
Installed power	MW_{th}	5.751	8
Mitigated Design 1			
Number of units		3	5
Number of units per stack		1	1
Stack height	m	13	20
Flue diameter	m	0.6	1.1
Emission velocity	Am/s	22.7	4.09
Volume flow rate gas fired (actual)	Am^3/s	6.43	3.89
Emission temperature gas fired (actual)	Kelvin	393	356
NOx	mg/Nm^3	**100**	17.8 (on gas)
Oxygen (actual)	%	9.8	8.7
Oxygen (normalised)	%	5	3
Moisture (actual)	%	12%	12
Moisture (normalised)	%	0	0
NOx	g/s	**0.252**	0.0345 (on gas)
Mitigated Design 2 (as modelled) [(a)]			
Number of units		3	5
Number of units per stack		**3**	**5**
Number of units modelled		**3***	**3***
Stack height	m	**35**	**35**
Flue diameter	m	**1.039**	**0.995**
Emission velocity	Am/s	22.7	**15**
Volume flow rate gas fired (actual)	Am^3/s	**3 x 6.43**	**3 x 3.89**
Emission temperature gas fired (actual)	Kelvin	393	356
NOx	mg/Nm^3	**100**	**17.8 (on gas)**
NOx	g/s	**0.756**	**0.1035 (on gas)**
Mitigated Design 3 (as modelled)[(b))] – Recommended Option			
Number of units		3	5
Number of units per stack		**3**	**5**
Number of units modelled		**3**	**3**
Stack height	m	**45**	**45**
Flue diameter	m	**1.039**	**0.995**
Emission velocity	Am/s	22.7	**15**
Volume flow rate gas fired (actual)	Am^3/s	**3 x 6.43**	**3 x 3.89**

Installations		Tri-generation Plant	Boiler Plant
Emission temperature gas fired (actual)	Kelvin	393	356
NOx	mg/Nm^3	**100**	**17.8 (on gas)**
NOx	g/s	**0.756**	**0.1035(on gas)**
(a)Tri-generation plant NOx emissions meet IFC Emission Limit Values for Gas Fired Combustion Plants (see Table C2.4), but exceed EU IED emission limits (Table C2.3) of 75mg/Nm^3 (b)Flue design is optimised on the basis of 3 boilers and 3 trigens operating, as this is reasonable worst case operational scenario			

C2.2.9 Conversion of NO_x to NO_2 – Stack Emissions

The combustion process generates oxides of nitrogen (NO_x). In the exhaust gases from the stack, these are in the ratio of approximately 95% nitric oxide (NO) to 5% nitrogen dioxide (NO_2). With regard to the assessment of impact on human health NO_2 is the pollutant of interest as NO is largely inert in the human body. Within the atmosphere various processes oxidise NO to create NO_2 but this process will not occur quickly or completely before the plume reaches ground level. Therefore, it is overly pessimistic to assume 100% conversion from NO to NO_2, and it is necessary to use a factor to estimate ground level concentrations of NO_2 based upon total NO_x emitted.

A number of international agencies have developed guidelines for including in assessments the conversion of NO to NO_2. A summary of the main guidelines are set out below in the table below. The ratios set out in *Table C2.8* indicate that a wide range of ratios to convert NO to NO_2 are recommended by a variety of country agencies as set out in the table. These conversion factors have been applied in the results interpretation.

Table C2.8 Recommended NO to NO2 Conversion Ratio

Country	Averaging period	Recommended NO to NO_2 conversion ratio
United States	24 hour	75%
	Annual	75%
Germany	24 hour	60%
	Annual	60%
United Kingdom	Short term (1 hour)	35%
	Annual	70%
Hong Kong	24 hour	20%
	Annual	20%
Ontario, Canada	24 hour	52%
	Annual	68%

Adopting a conservative approach, a conversion factor of 80% for the short term and 75% for long term was adopted. This however applies for the stack emissions only, since the NO to NO_2 conversion factor from road vehicles is different.

C2.2.10 *Assessment of Road Traffic Emissions*

A Traffic Impact Study (see *Annex F Traffic*) has been undertaken for the Project, which considers the potential maximum level of traffic which will be generated during construction and operation of the Project.

Numerous existing and proposed sensitive receptors surround the Project Site, and therefore there is the potential for detrimental impacts to occur at these locations, as a result of emissions from vehicles generated by the operation of the Project.

The atmospheric dispersion model ADMS-Roads has been used for the assessment.

C2.2.11 *Assessment Scenarios*

The following assessment scenarios regarding traffic generation have been considered in terms of the potential impacts of the Project:

- current baseline traffic;
- current baseline traffic plus construction phase traffic; and,
- current baseline traffic plus operational phase traffic.

C2.2.12 *Traffic Data*

Traffic surveys were undertaken on the road network immediately surrounding the Project Site by a local third party consultant. Full details of these surveys can be found in *Annex F Traffic.*

Existing hourly traffic counts for 400th Street, Özdemir Street, and the O-54 Ring Road connecting link to Özdemir Street were obtained and used in the assessment. The assumption that HGVs comprise 2% of the total fleet in this area has also been included (considered to be buses). Data for the O-54 motorway were also obtained from *Annex F Traffic*.

The assessment of air quality impacts from road traffic is therefore limited to the extent of the roads covered in *Annex F Traffic*, namely those immediately adjacent to the Project Site. Construction traffic data were obtained from *Annex F Traffic*, with the following summary:

- 200 Trucks per day for first 4 months for excavation;
- 90 Trucks per day for first 12 months for concrete;
- 70 Trucks per day for materials after 12 months;
- 150 staff cars from 6 months.

The first year of construction therefore is predicted to result in the worst-case impacts to air quality and as such was considered in this assessment.

For the operational phase of Gaziantep IHC vehicle numbers and trip distribution were also obtained from *Annex F Traffic.* In summary, a total of

40,489 vehicles per day (two-way) are predicted to access the Gaziantep IHC when operational. This total comprises 39,743 cars and 746 heavy goods vehicles (HGVs) (2% of flow).

C2.2.13 *Vehicle Emission Factors*

A survey of the existing vehicle fleet composition around the Project site was not undertaken and therefore representative vehicle emissions data have been calculated as part of this assessment, based on a number of assumptions. These assumptions surround factors such as private car fuel use (petrol / diesel) and the average age of vehicles around the Project site, in terms of engine emissions.

New passenger car registration data per fuel type in Turkey were obtained for a ten-year period between 2004 - 2013[(1)]. The data showed that 52% of the new car sales over this period were petrol engine, with the remaining 48% diesel. The infiltration of diesel-fuelled cars to the Turkish fleet has increased over the past ten years, in-line with much of Europe. It was also assumed that passenger cars had engines predominantly <2.0 litre in capacity and complied with Euro IV emissions. Euro IV emissions were also assumed for heavy good vehicles (HGVs).

Vehicle emissions were therefore calculated separately based on the predicted traffic flows and entered into the ADMS-Roads model manually.

C2.2.14 *Receptors*

As the Project area contains many existing sensitive receptors, and the whole area is due to be developed over the coming years with further residential and sensitive receptors, the use of both discrete receptors and gridded receptors in the modelling was considered to be most appropriate.

A network of discrete ground level grid receptors was included in the modelling covering the primary roads of interest and the existing sensitive receptors, together with areas where future development is considered to be likely. The 'intelligent gridding' module was selected within the ADMS-Roads model, whereby the number of gridded receptor point is increased around the individual sources, to provide a greater resolution of potential impacts close to the sources, rather than the approach of using a standard Cartesian grid with regular receptor intervals.

In addition, a total of eight discrete receptors were included in the modelling, comprising four existing receptors. The remaining four discrete receptors were included as potential future receptor locations, based on the masterplan for the area surrounding the Project Site and the intended future development

(1) Eurostat (2015) http://ec.europa.eu/eurostat/statistics-explained/index.php/Passenger_cars_in_the_EU Accessed 187th May 2016

and land use. The discrete receptor locations used are set out in *Table C2.9* and illustrated in *Figure C2.1.*

Table C2.9 Discrete Sensitive Receptors used in Road Modelling

No	Location	Existing or Future Development	Coordinates	
			X (m)	Y (m)
1	Site Access Road – north side	Existing	355830	4097836
2	400th Street – north side	Existing	355422	4097836
3	400th Street – south side	Existing	355408	4097770
4	O-54 Linking Road – west side	Existing	355513	4097654
5	O-54 Linking Road – east side	Future	355565	4097654
6	Site Access Road – south side	Future	355630	4097777
7	Site Access Road – north side	Future	355626	4097849
8	Özdemir Street – east side	Future	355699	4098006
Note – The additional future receptor locations have been included only to provide an indication as to the potential level of pollutant concentrations at locations identified for development.				

Figure C2.1 Discrete Receptors used in Modelling of Emissions from Road Traffic

Map data from Google earth: © 2016 Basarsoft, © 2016 Google, Image © 2016 DigitalGlobe

C2.2.15 Model Verification and NO_x to NO_2 Conversion – Vehicle Emissions

Model verification for NO_2 was undertaken in ADMS Roads at one single sampling location on the O-54 Ring Road connecting link to Özdemir Street. This was carried out of the baseline scenario, using baseline traffic data obtained on this road and the immediate road network, as part of the Traffic Assessment.

A NO_x to NO_2 conversion rate of 22% has been used to assess the predicted ground level concentrations, based on the performance of the model outlined above. This is considered to be reasonable given the close proximity of the receptors in relation to the road sources, thus allowing insufficient time for a larger proportion of the NO_x to be converted to NO_2, together with the ratio of petrol / diesel vehicle fleet assumed in the assessment. The effect of this assumption however is considered in the discussion where relevant.

C2.3 SIGNIFICANCE CRITERIA

Turkish national regulations do not set out prescriptive definitions for magnitude and significance of impacts; therefore, ERM has adopted and built upon those set out by the IFC. The IFC differentiate the significance of impacts, based upon the existing baseline air quality in the vicinity of the Project, using a risk based approach. This sets out two criteria approaches, based on whether the Project Site is deemed to be a degraded or undegraded airshed.

Classification as to whether a site or location is deemed to be undegraded or degraded (ie where ambient pollutant concentrations meet or exceed local or IFC standards, respectively), is generally ascertained through a review of local air quality monitoring data. It should be noted that an airshed can be classified as degraded for one pollutant and not for another, thus setting out different levels of criteria based on the potential significance of difference pollutant emissions. This is discussed further in *Section C3.3*.

With regards to the potential significance of air quality impacts, consideration of the sensitivity of receptors needs to be given. The following sensitivity definitions have therefore been derived to take into account the potential receptor sensitivity variability:

- High sensitivity: Locations where particularly vulnerable individuals (ie elderly, very young or infirm) are present, which will include the hospital itself and schools.

- Medium sensitivity: Locations where the general population are present for large periods of the year, for example residential areas, towns and villages.

- Low sensitivity: Locations where humans are transient or present for short periods only, such as agricultural areas or fishing areas.

The general principle of the criteria is that project emissions should not exceed a contribution of 25% of a relevant air quality standard within an undegraded airshed, or 10% of a relevant air quality standard within a degraded airshed, to be deemed to have negligible impacts. It should therefore be noted that an airshed can be classified as degraded for one pollutant and not for another, thus setting out different levels of criteria based on the potential significance of difference pollutant emissions.

The treatment of significance of potential impacts is outlined in the methodology chapter (*Volume I, Chapter 5*).

C3 BASELINE

C3.1 OVERVIEW

Baseline air quality typically varies across a particular study area. In essence, the baseline can be considered in the following components.

- Natural baseline – this represents the pollution concentrations that are ubiquitous in the region due to sources other than human activity, primarily regarding PM_{10} / $PM_{2.5}$ concentrations. For pollutants such as NO_x and NO_2 this will contribute a very small percentage of the relevant air quality standards. This is because the sources of these pollutants in the area arise almost entirely due to human activity.

- Regional sources – this represents the pollution concentrations that arise from large sources that will affect substantial areas.

- Local sources – this represents pollutant concentrations that vary on a small spatial scale, but may be substantially elevated. An example of such sources includes road traffic and in the middle of towns where there are vehicles and other small scale sources. These sources can lead to elevated pollutant concentrations on a very small scale, for the pollutants of interest.

The Project Site is situated on the outskirts of Gaziantep adjacent to the Gaziantep Çevreyolu / Otoyol-54 (O-54) motorway. The predominant background air quality for dust, PM_{10} and $PM_{2.5}$ will be made up from natural sources, exacerbated by the arid nature of the area. Local sources of combustion emissions from Gaziantep include traffic, cooking, domestic heating and other industry. These will contribute to ambient NO_2 and to a lesser extent PM_{10}. Emissions from traffic on the O-54 will also contribute to NO_2 concentrations. Regional sources of emissions may affect the area, however their effects are not considered to be as strong as the natural and local component sources.

C3.2 CLIMATE CONDITIONS

Gaziantep is located at the junction of South-eastern Anatolian Region and Mediterranean Region; therefore, the city experiences both continental and Mediterranean climates, with hot, dry summers and mild to cold, wet winters. Most of the rainfall in the city occurs in the winter and spring. The climate of the city is classified as arid and semi-arid by different classification methods. Meteorological data on temperature, precipitation, relative humidity, pressure and wind flow obtained from General Directorate of Meteorology are described in the following sections.

C3.2.1 Temperature and Sunshine

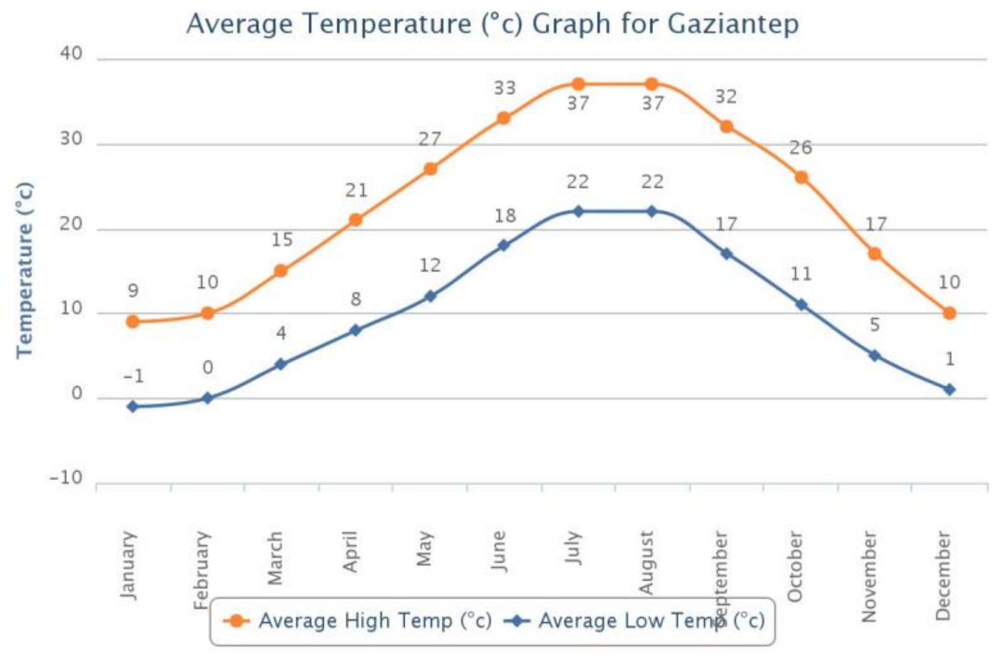
Monthly average values of temperature parameters based on the data of Turkish State Meteorological Service for the last 64 years (1950–2014) are set out in *Table C3.1*. The data reveals that the annual mean temperature, annual mean maximum temperature and annual mean minimum temperature observed in the city are 14.9 ^{0}C, 21.6 ^{0}C and 9.3 ^{0}C, respectively. For the same period, the maximum temperature was recorded in July as 44 ^{0}C whereas the minimum temperature was recorded in January as -17.5 ^{0}C. A temperature chart for Gaziantep between 2000 and2012, is also illustrated in *Figure C3.1.*

Table C3.1 Average Temperature and Sunshine Data for a Period of 64 Years (1950-2014)

Temperature parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean temp.(°C)	3.0	4.2	8.1	13.2	18.5	24.0	27.7	27.4	22.8	16.1	9.3	4.8
Mean high temp.(°C)	7.6	9.4	14.0	19.7	25.4	31.2	35.2	35.3	31.1	24.2	16.1	9.7
Mean low temp. (°C)	-0.8	0.0	3.0	7.3	11.8	17.0	21.0	20.9	16.1	10.0	4.4	1.0
Max. recorded temp.(°C)	19.0	22.7	28.1	34.0	37.8	39.6	44.0	42.8	40.8	36.4	27.3	25.2
Min. recorded temp. (°C)	-17.5	-15.6	-11.0	-4.3	2.5	4.5	10.6	12.1	3.4	-2.8	-9.7	-15.0
Mean daily sunshine (hrs)	3.4	4.3	5.4	7.1	9.0	11.6	11.2	10.3	9.2	7.2	5.3	3.4

Source: Official website of Turkish State Meteorological Service - http://www.mgm.gov.tr/

Figure C3.1 Average Temperature Chart 2000-2012



Source: World Weather Online (accessed 14th October 2014)

C3.2.2 *Precipitation*

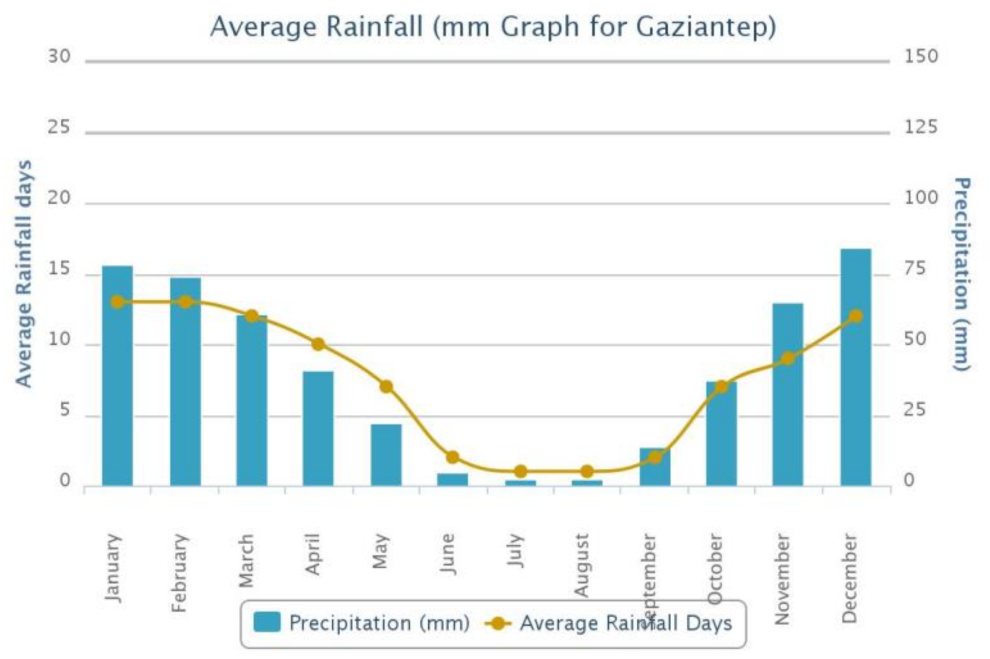
Within the same 64 years period, the maximum monthly average precipitation was recorded in December months as 96.8 mm, while the lowest was experienced in August months with an average value of 2.1 mm. The annual mean total precipitation for the same 64 years period is 46.3 mm and the average number of rainy days per year is 86.5. A rainfall chart for Gaziantep between 2000 and 2012 is also illustrated in *Figure C3.2*.

Table C3.2 Precipitation Data for Gaziantep

Precipitation parameters	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Mean number of days with precipitation	12.9	12.3	12.0	10.3	7.3	2.2	0.6	0.4	1.6	6.2	8.6	12.1
Mean total monthly precipitation (kg/m²)	96.4	83.1	73.1	53.7	32.6	6.8	2.4	2.1	5.9	35.9	63.6	96.8

Source: Official website of Turkish State Meteorological Service - http://www.mgm.gov.tr/
Note – 1 kg/m² of precipitation = 1 mm of precipitation

Figure C3.2 Average Rainfall Chart 2000-2012



Source: World Weather Online (accessed 14th October 2014)

C3.2.3 *Humidity and Pressure*

Based on the meteorological data obtained from the Gaziantep regional meteorological station the maximum humidity level was observed in February with 97%; on the other hand the minimum humidity was recorded as 18% in July. Seasonally, October – May has been the part of the year with highest humidity observations and June – August can be regarded as the driest season of the year.

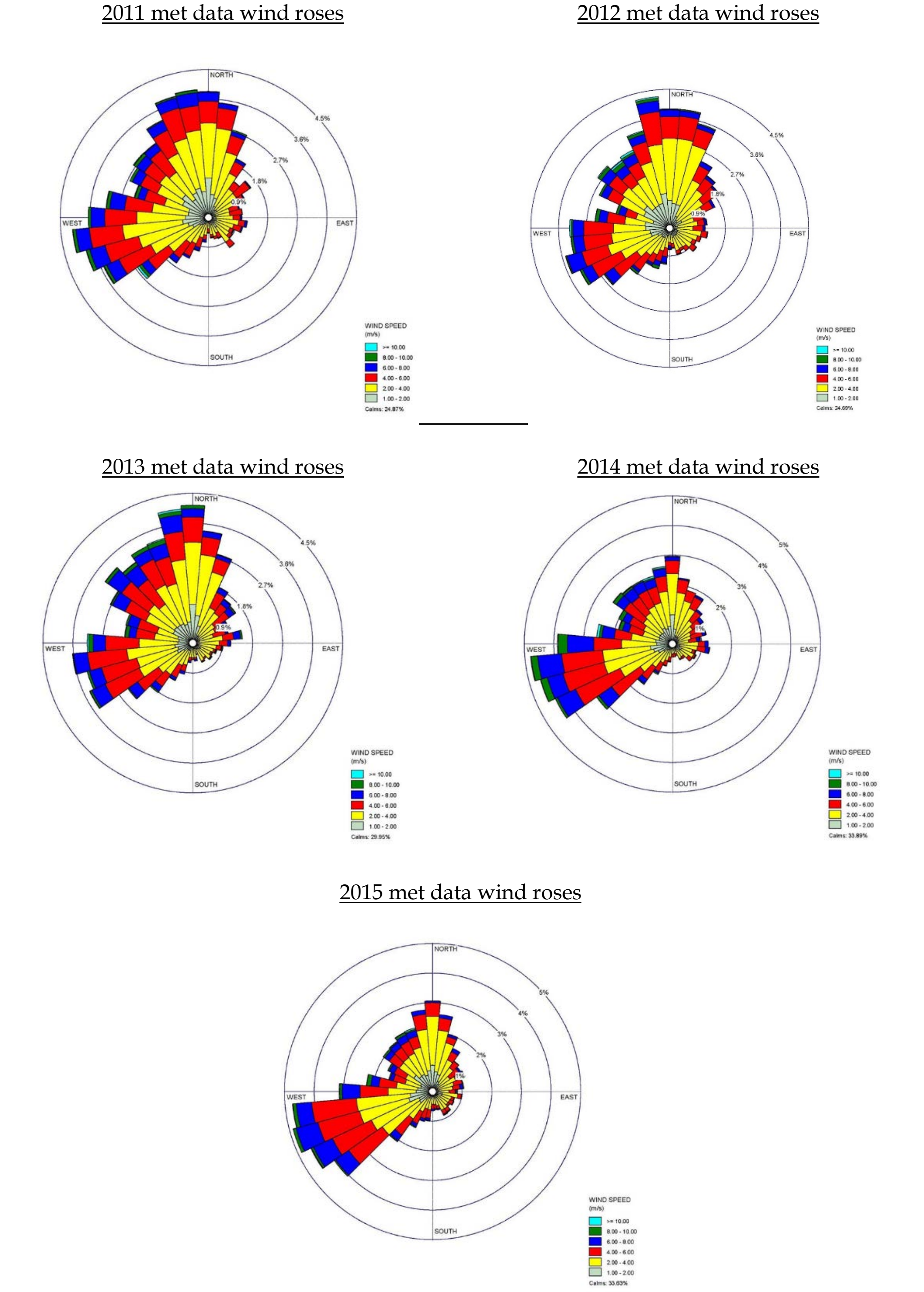
The highest recorded pressure was measured as 931 mb in January; whereas the lowest value was observed in July as 908.1 mb.

C3.2.4 Meteorological Data used for Dispersion Model

The meteorological data used in the model must be reflective of the local conditions. There are only a limited number of meteorological stations in Turkey which measure all of the parameters required by the model. A review of available meteorological sites was undertaken, which focussed on the surrounding land use, the surrounding terrain and relative proximity to the coast. On the basis of these criteria, the nearest meteorological station considered representative of conditions is at Oguzeli Airport. This is located approximately 10 km southeast of the Project.

Five years of meteorological data (2011 – 2015, inclusive) were used for this assessment. The wind roses for 2011 – 2015 are presented in *Figure C3.3* and show that the prevailing wind direction at Oguzeli Airport is mainly from the north and the west.

Figure C3.3 Wind Roses for Gaziantep Oguzeli Airport (2011 – 2015)



C3.3 AIR QUALITY

Ambient PM_{10} monitoring is undertaken by local Turkish authorities in the centre of Gaziantep. Whilst the monitoring site location and recorded pollutants are not considered to be representative of conditions at the Project Site, the data are useful to understand the wider air quality environment. A summary of the recorded pollutant concentrations from 2009 - 2014 are set out in *Table C3.3*. The data show that within Gaziantep, the monitored annual and daily maximum PM_{10} concentrations have exceeded the Turkish and EU air quality Limit Values for the past six years. This is not unexpected in Gazientep given the arid environment, and therefore the generation of dust from open ground, unpaved surfaces and resuspended dust and dirt. For ambient PM_{10} therefore, the Project site is classified as a degraded airshed. These data therefore reinforce the necessity for effective dust mitigation practices to be embedded within the Project design during the construction phase, as public awareness and overall sensitivity to dust nuisance is likely to be high.

Table C3.3 Gaziantep Ambient Air Quality Monitoring

Year	Recorded Pollutant Concentrations (µg/m³)	
	PM_{10} annual average	**PM_{10} 24hr max 99.2%ile**
2009	87.0	321
2010	71.2	352
2011	101	261
2012	109	278
2013	77.1	279
2014	57.8	183
Six-Year Average	83.9	279
EU Limit values	40	50
Turkish Limit values (excluding threshold tolerance)	40	50
Note - IFC guidance states that WHO/IFC limits are only to be considered where there are no national standards; as Turkey has applicable standards these are considered alongside the EU standards.		

As outlined in *Section C1.2*, a programme of air quality monitoring for nitrogen dioxide (NO_2) was commissioned by ERM (undertaken by local partner, ELC) in August 2015 for a period of three consecutive months, to establish the existing baseline conditions.

Monitoring of NO_2 was undertaken at twelve sensitive locations across the study area through the use of passive diffusion tubes (1), as NO_2 is considered to be the primary pollutant of concern for the Project. Whilst NO_2 concentrations are likely to be below the relevant Turkish air quality limit values at the Project Site, it is recognised that ambient NO_2 concentrations can vary considerably near to major roads / junctions. Given the number of existing and proposed high density residential receptors surrounding the Project Site, an NO_2 sampling programme was considered essential to understand the level of variation in concentrations.

The sampling locations were therefore chosen to reflect where potential impacts from both operational road traffic and on-site plant during operation, were considered most likely to occur, in order to establish a robust baseline.

(1) Passive diffusion tubes supplied and analysed by UK accredited laboratory, Gradko International.

Sampling was undertaken at the site over the following three periods:

- August 7th 2015 – September 6th 2015;
- September 6th 2015 – October 5th 2015; and
- October 5th 2015 – November 4th 2015.

Locations of the sampling sites are detailed in *Table C3.4* and illustrated in *Figure C3.4*. Recorded annual average NO_2 sampling data for the 12 sites are also detailed in *Table C3.4* below, where data are available (1).

Figure C3.4 Baseline Air Quality Monitoring Survey Locations

(1) The data gaps at a number of the sampling sites over the period are attributed to a combination of multiple potential reasons, such as missing samples through theft or displacement and sample contamination / damage whilst in-situ or in transit.

Table C3.4 Ambient Sampled NO2 Concentrations

ID	Coordinates				Monitored Concentrations (µg/m³)			Site type
	Latitude	Longitude	X UTM	Y UTM	Aug 2015	Sep 2015	Oct 2015	
1	37.014267	37.3760274	355527	4097688	22.3	13.5	30.1	R
2	37.015999	37.383099	356159	4097869	21.7	15.0	31.1	R
3	37.013373	37.385074	356330	4097575	11.0	-	28.1	B
4	37.015207	37.381954	356056	4097783	12.1	15.8	0.84*	R
5	37.018756	37.387687	356573	4098168	0.80*	1.30*	25.6	R / S
6	37.015841	37.393369	357073	4097836	19.0	13.3	31.5	R
7	37.016252	37.395294	357245	4097879	28.6	21.0	24.8	R
8	37.014467	37.398772	357551	4097676	-	-	30.3	R
9	37.016019	37.389870	356762	4097861	-	1.31	-	Site
10	37.016267	37.396416	357345	4097879	-	0.00	27.5	R
11	37.013416	37.389500	356724	4097573	14.4	6.28	29.1	B
12	37.005718	37.379807	355847	4096734	18.3	6.31	30.0	B
*Note – WGS UTM Zone 37 *Values considered to be anomalies and therefore excluded from summary*								
Turkish and EU ambient annual mean NO_2 limit value = 40 µg/m³								
Site type: R = Roadside; S = School, B = Background								

Given the location of sampling sites differ in terms of classification and their contribution from existing sources, the NO_2 concentrations considered to be representative of the ambient concentrations in the vicinity of the Project Site, and not attributed to any specific emission sources, are set out in *Table C3.5*.

Table C3.5 Background NO2 Concentrations Used in Assessment

Pollutant	Units	Value
Annual mean NO_2	µg/m³	18.1
24 hour NO_2	µg/m³	36.2
1 hour NO_2	µg/m³	36.2
Note: The average of the background sites over the monitoring period has been assumed to represent the annual mean concentration in the vicinity of the Project Site. In order to derive shorter-term baseline concentrations for the purpose of comparing modelled results plus baseline against shorter-term air quality criteria from the annual mean, the annual mean is multiplied by a factor of 2 to derive the baseline for the 1 hour mean. This approach was adopted by the Environment Agency for England (1), as cited by the IFC. This approach has also been adopted for the 24 hour mean baseline to be conservative.		

Based on the ambient air quality monitoring data collected for the Project, it is considered that the site location is an undegraded airshed for NO_2, as the ambient concentrations are below the relevant standards at each site for each period (*Table C3.4*). For PM_{10} however, ambient concentrations recorded in the centre of Gaziantep are consistently above the Turkish and EU air quality Limit Values (*Table C3.3)*.

Whilst the Gaziantep urban background monitoring site location is not considered to be representative of conditions at the Project Site, the data are useful to understand the wider air quality environment. As the predominant

(1) Environment Agency (2011) Horizontal Guidance Note H1: Annex F Air Quality, version 2.2 December 2011.

source of the elevated concentrations at the monitoring station is likely to be attributed to natural windblown dust from open surfaces (set out further in *Section C3.3*), it is considered likely that PM_{10} concentrations at the Project Site will be of a similar order of magnitude ie above the Turkish and EU Limit values, and the WHO/IFC guidelines, therefore the airshed for PM_{10} (and $PM_{2.5}$) is classified as degraded.

C3.4 SENSITIVE RECEPTORS

Surrounding the Project Site, there are a number of developed residential areas, together with educational and recreational facilities. These will therefore be considered as the primary sensitive receptors for the Project during construction and operation.

The following are considered to be sensitive receptors:

- The hospital itself, including above ground level receptors representing hospital wards and ventilation air intakes in the high rise elements of the hospital;
- large numbers of high-density existing residential properties are located to the west of the site;
- existing recreational and educational facilities are also located to the west and on the site boundary;
- the O-54 bounds the site to the south, with further high-density residential properties to the south of the O-54;
- the areas to the east and north comprise largely undeveloped land; and
- proposed residential units will surround the hospital site as part of the wider master plan for the area.

On the basis of the receptor sensitivity ratings set out in *Section C2.3*, the identified off-site receptors are classified as medium to high sensitivity. The hospital itself is classified as a high sensitivity receptor due to the constant presence of vulnerable individuals, together with the proximity of schools and high-density residential units surrounding the site. The closest off-site receptor is the adjacent Türkiye Odalar ve Borsalar Birliği Fen Lisesi (high school), which is approximately 10 m from the site boundary.

There are no statutory or non-statutory ecological designations surrounding the Project Site.

C4 IMPACT ASSESSMENT

C4.1 CONSTRUCTION IMPACTS

Construction impacts on air quality typically result from the following activities:

- earth moving activities and ground preparation;
- movement of vehicles over open ground, on unpaved roads and on the surrounding road network; and
- on-site concrete batching, handling of friable materials and stockpiling.

The potential degradation in local ambient air quality due to dust emissions from general construction activities has been considered on the basis of the potential for fugitive emissions to result in nuisance issues, and due to the potential for elevated PM_{10} and $PM_{2.5}$ concentrations.

Modelling of dust emissions has not been undertaken due to uncertainties in model source terms. The model itself is also considered to be too uncertain to be meaningful. The focus of the construction assessment is therefore on the level of employed mitigation on and around the Project Site, to minimise the potential impacts as far as is reasonably practicable, rather than fully quantify impacts. PM_{10} and $PM_{2.5}$ monitoring will be undertaken during construction to understand the existing baseline, assess the effectiveness of employed mitigation and also inform the subsequent level of mitigation needed, to ensure that project does not consume more than 25 percent of the assimilative capacity between the pre-project case and the relevant ambient quality guideline standards. Further details are set out in *Section C5.1.*

C4.1.1 Construction Dust

The unpaved road network used across the Project Site prior to works completion, is likely to be constructed from a mixture of rocks, stone, gravel, sand and silt, and can be particularly dusty when disturbed by vehicle movements. Whilst less of an issue during winter months, any moisture in the material or applied by water sprays, rapidly evaporates during periods of high temperatures and low moisture content in the air. When the surface is disturbed little or no moisture is therefore available to fix fine particulates and reduce the generation of dust. The elevated wind speeds occurring in the region together with the absence of natural barriers at the Project Site further increase the high potential for dust generation.

Any dust generated will remain airborne and travel considerable distances. Research undertaken by the Desert Research Institute (2010) states:

> *"Based on gravitational setting velocities that apply to particles with aerodynamic diameters >~2 µm (Slinn, 1982), … half of the 10 µm particles*

mixed within the first meter are removed after ~3.5 minutes, and that half of the 2.5 µm particles in this layer are gone after an hour. Less than 10% of the 10 µm particles remain after 12 minutes, with 90% of the 2.5 µm particles depleted after 3.5 hours. A 1 m/s wind speed results in a transport distance of 3.6 km/hr. In an average 5 m/s wind, only 10% of the 10 µm particles uniformly mixed through a 10 m depth would travel more than 36 km from the source within two hours after suspension, while 10% of the 2.5 µm particles could achieve distances of nearly 600 km".

On the basis of the above, it is clear that during dry periods, emissions of particulates from fugitive sources are able to travel very considerable distances from source.

Ameliorating weather conditions such as rainfall and wind speed should also be considered, as dust emissions are negligible during wet and calm periods. The USEPA state that precipitation of greater than 0.2 mm/hr will affectively attenuate dust; and wind speeds of >5.3 m/s are typically required to lift dust from open surfaces. This will be lower for dust generated by mechanical means (ie during excavation and due to the movement of vehicles over unpaved surfaces), at around 3 m/s.

On this basis:

- at all but the most extreme wind speeds, dust will typically travel a maximum of 200 m from source before falling from the air column;
- at the highest wind speeds, dust is unlikely to travel more than 500 m from source; and
- precipitation will effectively attenuate dust, with rainfall of >0.2 mm/hour likely to effectively attenuate dust emissions.

The duration of the impact will continue for the duration of the construction phase, lasting approximately three years and thus the dust-generating activities, referencing the Dust Risk Matrix in *Table C2.5*, will occur for >12 months. The climatic conditions within the Project area are also considered to promote dust-generation for a large proportion of the year. Therefore, exposure to dust generating activities and associated dust emissions are likely to occur intermittently over the duration of the Project construction.

On this basis, dust emissions have the potential to result in impacts of a **major** significance for the sensitive receptors found within 200 m of the source, without the application of mitigation. All other receptors are considered to be at distances between 200 m and 500 m and greater away from the source and therefore have the potential to experience impacts of **minor** significance, again without the application of mitigation.

Given the existing high concentrations of PM_{10} recorded in Gaziantep, which consistently exceeds both Turkish and EU Limit Values, it is expected that mitigation measures will be embedded into the Project Design and employed at the site during construction reducing the impact during construction to **minor** significance at worst.

C4.1.2 Construction Dust Impact Evaluation and Risk Rating

A detailed assessment of dust emissions arising from construction of the proposed development has been carried out in accordance with IAQM guidance. Each dust generating activity has been assigned a dust emission magnitude as shown in *Table C4.1*, covering the various stages of works.

Table C4.1 Dust Emission Magnitude for Construction Activities

Activity	Dust Emission Magnitude	Reasoning
Demolition/Blasting	Large	No demolition required, however blasting 200,000m^3 of existing site material will occur.
Earthworks	Large	Total site area >10,000 m^2, potentially dusty soil type (e.g. material which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, total material moved >100,000 tonnes;
Construction	Large	Total building volume >100,000m^3, on-site concrete batching and use of dusty construction materials.
Trackout	Large	>50 HDV (>3.5t) outward movements in one day.

In total it is expected that there will be 645,000 m^3 of excavated material in total, at a rate of approximately 3,000 m^3 per day. There will be up to 200 heavy truck movements per day estimated during excavation, travelling on unpaved roads and then on the local road network to transport for disposal approximately 4.2km south of the Project Site. Concrete batching will also take place on-site.

The sensitivity of the area to dust soiling, human health and ecological impacts has been assessed for each dust-generating activity. High and medium sensitivity receptors surround the site boundary however there are no sensitive ecological receptors in the vicinity of the proposed development.

Following the IAQM methodology to assess the risk of dust impacts, the sensitivity of the area takes into account a number of factors, including; the specific sensitivities of the receptors in the area, the proximity and number of those receptors to potential emission sources, existing local PM_{10} background concentrations and any additional site-specific factors which may affect the risk of wind-blown dust e.g. surrounding vegetation.

The sensitivity of the surrounding area to dust soiling impacts for all activities is considered to be medium, given the small number of receptors located within <20m from the site boundary and existing levels of dust. However, the sensitivity of the area to human health impacts for all activities is considered to be high sensitivity, given background PM_{10} concentrations are likely to be exceeding Turkish and international air quality standards at the site. Using this approach, the overall sensitivity of the area is summarised in *Table C4.2*.

Table C4.2 *Sensitivity of the Area to Dust Soiling, Human Health and Ecological Impacts*

Activity	Dust Soiling	Human Health	Ecological
Demolition/Blasting	Medium sensitivity	High sensitivity	n/a
Earthworks	Medium sensitivity	High sensitivity	n/a
Construction	Medium sensitivity	High sensitivity	n/a
Trackout	Medium sensitivity	High sensitivity	n/a

Taking into consideration the dust emission magnitude and the sensitivity of the area, the site has been classified as Medium and High Risk (*Table C4.3*). This has been determined based on the likely activities at the site, in combination with the proximity to the nearest sensitive receptors. It should be noted that this is the risk prior to the implementation of mitigation measures which are expected to be embedded within the Project as part of an approved Air Quality Management Plan (AQMP), to be developed by the contractor.

It is anticipated that with the implementation of the measures outlined below (to be included within an AQMP), the risk of impacts will be reduced further.

This assessment is also consistent with the Dust Risk matrix approach outlined earlier in *Table C2.5* and set out in *Section C4.1*.

Table C4.3 Risk of Significant Impacts Prior to Mitigation

Activity	Dust Soiling	Human Health	Ecological
Demolition	High Risk	High Risk	n/a
Earthworks	Medium Risk	High Risk	n/a
Construction	Medium Risk	High Risk	n/a
Trackout	Medium Risk	High Risk	n/a

C4.1.3 Impacts from Construction Traffic Emissions

The potential effect of the movement of construction vehicles to and from the Project Site upon local air quality have been assessed and summarised using the methodology detailed in *Section C2.2*.

Results are expressed as the greatest ground level concentrations for each pollutant averaging period at existing receptors along each of the modelled roads and have been assessed against the corresponding existing baseline scenario.

The results presented for NO_2 incorporate the relevant background concentrations (Process Environmental Contribution / PEC) to allow the magnitude and significance of potential impacts, in relation to the relevant air quality standards and guidelines, to be discussed. Given the degraded airshed for PM_{10} (and $PM_{2.5}$ for EU) however, the PM_{10} and $PM_{2.5}$ results account for the construction traffic emissions contribution only, and the significance of potential impact is discussed accordingly.

C4.1.4 Nitrogen Dioxide

The impact assessment predicts that there will be no exceedances of either the 1-hour mean (99.79th percentile) or annual mean NO_2 Turkish and EU ambient air quality limit values (200 $\mu g/m^3$ and 40 $\mu g/m^3$ respectively) during the construction phase scenario from traffic-related emissions at existing sensitive receptors. Results are summarised in *Table C4.4*.

The maximum impact at an existing sensitive receptor is predicted to occur on the western side of the O-54 Link Road. With regards to assessment against IFC criteria, the Process Contribution (PC)/Air Quality Standards (AQS) is predicted to be less than 1% (25% criterion) and therefore the significance of the annual mean and 1 hour NO_2 impacts during construction of the Project are considered to be negligible.

In addition, no exceedances of the EU ambient air quality limit values for NO_2 are predicted.

Table C4.4 Traffic Impact on NO_2 Concentrations during Construction

			Construction Phase Scenario					
Standard	*Averaging period*	*AQS (µg/m³)*	*PC (µg/m³)*	*PC/ AQS*	*PEC* (µg/m³)*	*PEC/ AQS*	*Magnitude*	*Significance*
Site Access Road – north side								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	0.975	0.49%	40.0	20%	Negligible	Negligible
	annual mean	40	0.189	0.47%	18.7	47%	Negligible	Negligible
400th Street – north side								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	0.401	0.20%	47.9	24%	Negligible	Negligible
	annual mean	40	0.0194	0.05%	19.4	49%	Negligible	Negligible
400th Street – south side								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	0.346	0.17%	43.6	22%	Negligible	Negligible
	annual mean	40	0.0223	0.06%	19.2	48%	Negligible	Negligible
O-54 Link Road – west side								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	1.85	0.93%	54.3	27%	Negligible	Negligible
	annual mean	40	0.195	0.49%	20.1	50%	Negligible	Negligible
Note: PEC = Process Environmental Contribution, which is the sum of the Process Contribution (PC) added to the relevant baseline concentration								

C4.1.5 *Particulate Matter*

The potential increases in the annual mean and 24-hour mean PM_{10} (and $PM_{2.5}$ for EU) concentrations, resulting from vehicle emissions during construction of the Project, are summarised below. Given the assumed de-graded airshed for PM_{10} (and $PM_{2.5}$ for EU) however, the results account for the construction traffic emissions contribution only, and the significance of potential impact is discussed accordingly.

The impact assessment predicts that there will be no exceedances of either the 24-hour mean (90.41th percentile) or annual mean PM_{10} Turkish ambient air quality limit values (50 µg/m^3 and 40 µg/m^3 respectively) during the construction phase scenario at existing sensitive receptors. Results are summarised in *Table C4.5* and *Table C4.6.*

Whilst monitored annual and daily maximum PM_{10} concentrations in Gaziantep have exceeded the Turkish and EU air quality Limit Values for the past six years, as the PC/AQS at all identified receptors is predicted to be less than 1% (IFC criterion 10%), the significance of the annual mean and 24 hour PM_{10} impacts during construction of the Project are considered to be negligible.

In addition, no exceedances of the EU ambient air quality limit values for $PM_{2.5}$ are predicted and the impacts are considered to be negligible.

Table C4.5 Traffic Impact on PM_{10} Concentrations during Construction

Standard	Averaging period	AQS (µg/m³)	PC (µg/m³)	PC/ AQS	Magnitude	Significance
Site Access Road – north side						
Turkey / EU	24 hour (not to be exceeded > 35 times in one year)	50	0.0104	0.02%	Negligible	Negligible
	annual mean	40	0.00736	0.02%	Negligible	Negligible
400th Street – north side						
Turkey / EU	24 hour (not to be exceeded > 35 times in one year)	50	0.00140	0.00%	Negligible	Negligible
	annual mean	40	0.000816	0.00%	Negligible	Negligible
400th Street – south side						
Turkey / EU	24 hour (not to be exceeded > 35 times in one year)	50	0.00122	0.00%	Negligible	Negligible
	annual mean	40	0.00101	0.00%	Negligible	Negligible
O-54 Link Road – west side						
Turkey / EU	24 hour (not to be exceeded > 35 times in one year)	50	0.0218	0.04%	Negligible	Negligible
	annual mean	40	0.00920	0.02%	Negligible	Negligible

Table C4.6 Traffic Impact on $PM_{2.5}$ Concentrations during Construction

Standard	Averaging period	AQS (µg/m³)	PC (µg/m³)	PC/ AQS	Magnitude	Significance
Receptor 1 –Site Access Road – north side						
EU	24 hour maximum	25	0.0232	0.09%	Negligible	Negligible
	annual mean	20	0.00736	0.04%	Negligible	Negligible
Receptor 2 –400th Street – north side						
EU	24 hour maximum	25	0.0163	0.07%	Negligible	Negligible
	annual mean	20	0.000816	0.00%	Negligible	Negligible
Receptor 3 –400th Street – south side						
EU	24 hour maximum	25	0.00820	0.03%	Negligible	Negligible
	annual mean	20	0.00101	0.01%	Negligible	Negligible
Receptor 4 –O-54 Link Road – west side						
EU	24 hour maximum	25	0.0480	0.19%	Negligible	Negligible
	annual mean	20	0.00920	0.05%	Negligible	Negligible

C4.1.6 *Greenhouse Gas Emissions from Construction Traffic*

An assessment of the potential greenhouse gas emissions associated with the movement of construction vehicles during construction of the Project has been undertaken.

As set out in *Section C2.2,* construction traffic data were obtained from *Annex F Traffic,* which provided the following:

- 200 Trucks per day for first four months for excavation;
- 90 Trucks per day for first 12 months for concrete;
- 70 Trucks per day for materials after 12 months; and
- 150 staff cars from 6 months.

The first year of construction therefore is predicted to result in the worst-case emission and as such is used as the basis for this assessment.

In order to assess the potential impact of greenhouse gas emissions from construction vehicles, assumptions have been made as to the typical distance travelled by each vehicle. The disposal site that is anticipated to be used for the Project is located 4.2 km to the south. It is therefore assumed that all non-excavation HGVs will travel on average 20 km per day (two way total) and that site personnel will travel on average 10 km per day (two way total).

Calculations for the emissions of carbon dioxide (CO_2) have therefore been undertaken based on these assumptions and applying general emission factors [(1)]. For HGVs, an emission factor of 0.869382 kg CO_2 per km is used which assumes a 50% laden HGV (two way), and for cars and emission factor of 0.17545 kg CO_2 per km, which assume a low-medium sized cars with a mixed petrol and diesel fuel fleet.

Based on the assumptions set out above, this therefore equates to indicative emission totals of: -

- Year 1 of construction– 512 t of CO_2 associated with the vehicle movements; and

- Year 2 of construction onwards – 414 t of CO_2 associated with the vehicle movements.

Once further detailed information is available on the estimated vehicle kilometres travelled by construction related traffic and personnel on-site during the construction phase, this indicative assessment of CO_2 emissions can be updated to reflect the exact scenario.

(1) DECC 2015, Greenhouse gas reporting - Conversion factors 2015, Department of Energy and Climate Change, January 2015.

C4.2 OPERATIONAL IMPACTS

C4.2.1 *Impacts from Tri-generation Plant and Boiler Emissions*

The initial modelling of operational impacts of the base case design (reasonable worst case emissions scenario) were assessed using the detailed dispersion model, AERMOD. The modelling indicated that impacts associated with the base case design of the Tri-generation plan and the boilers had the potential to cause exceedances of the Turkish and EU air quality Limit Values for NO_2 (major adverse impacts). Further details are set out *Appendix C2 Detailed Dispersion Modelling for Plant Emissions*. As a result, the design of the tri-generation plant and boilers, in particular the stack parameters and emissions characteristics have been modified in order to reduce the predicted impacts.

Three modified designs were assessed, taking into account the following design changes (separately and in-combination):

- amended design with increased stack height;
- use of combined stacks for the Tri-generation Plant and Boiler Plant; and
- reduction of the NO_x emission concentration of the Tri-generation Plant from 500 mg Nm^3 to 100 mg /Nm^3.

A summary of the stack parameters and the emissions inventory for these design variations can be found in *Table C2.7*. In summary, with the application of all three of the above design changes it has been possible to reduce predicted impacts to as low as reasonably practicable. The recommended mitigated design therefore incorporates a reduction in emission concentrations, an increase in stack height to 45m and the combination the emission point flues into two single stacks (one for the boilers and one for the tri-generation plant).

The results of the preferred and final design model run, referred to as 'Mitigated Design Three', are set out in *Table C4.7* below. Full details of the additional two modelling scenarios can be found in *Appendix C2 Detailed Dispersion Modelling for Plant Emissions*.

Table C4.7 Impacts to Ambient Air Quality for Preferred Design (Mitigated Design 3)

Standard	*Averaging period*	*AQS ($\mu g/m^3$)*	*PC ($\mu g/m^3$)*	*PC/ AQS*	*Baseline ($\mu g/m^3$)*	*PEC ($\mu g/m^3$)*	*PEC/ AQS*	*Magnitude*	*Significance*
	Mitigated Design 3 - Ground and Elevated Level Receptors								
Turkey	1 hour (not to be exceeded > 18 times in one year)	200 (+100 $\mu g/m^3$ reducing to zero 1.1.2014-1.1.2024)	25.3	13%	36.2	61	31%	Negligible	Negligible
	annual mean	40 (+20 $\mu g/m^3$ reducing to zero 1.1.2014-1.1.2024)	1.16	2.9%	18.1	19.3	48%	Negligible	Negligible
EU	1 hour maximum	200	25.3	13%	36.2	61	31%	Negligible	Negligible
	annual mean	40	1.16	2.9%	18.1	19.3	48%	Negligible	Negligible

Figure C4.1 NO_2 1-Hour Maximum PC ($\mu g/m^3$) - Ground Level Concentrations, Design 3

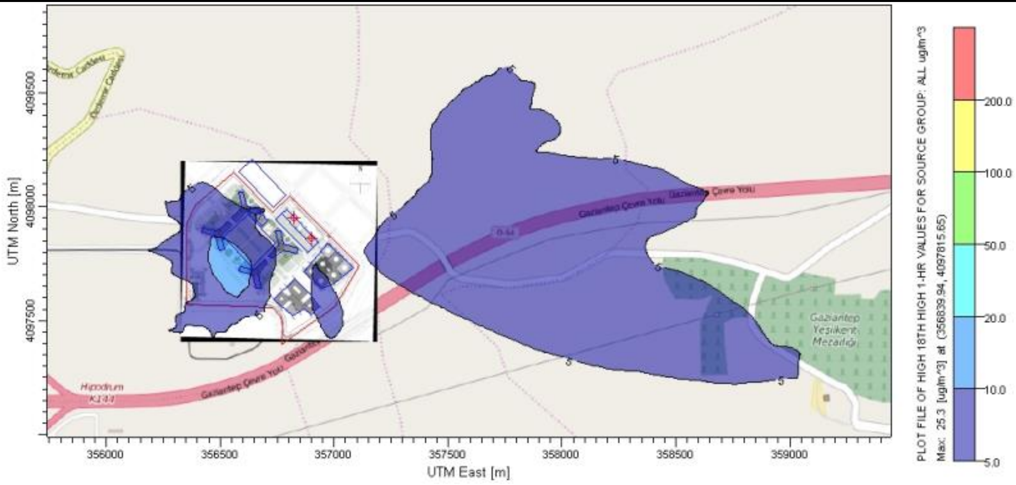
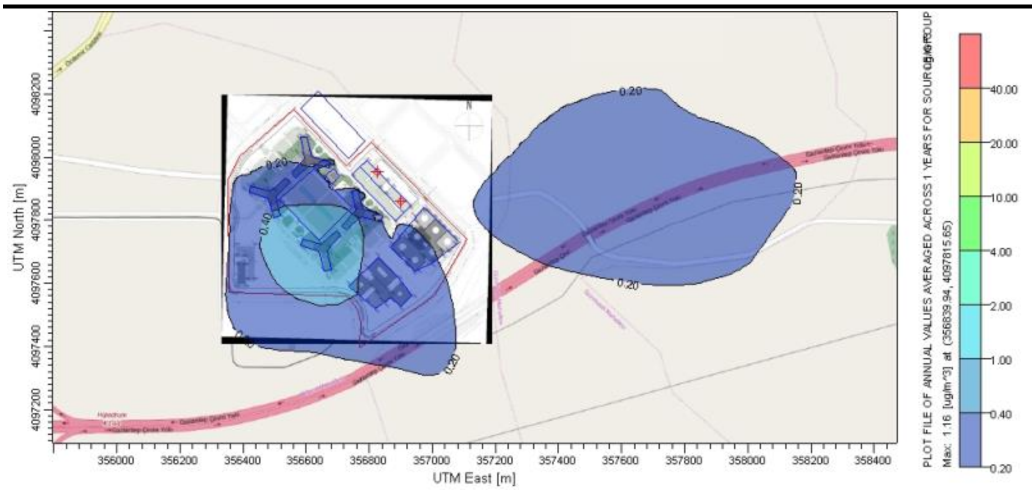


Figure C4.2 NO_2 Annual Mean PEC ($\mu g/m^3$) - Ground Level Concentrations, Design 3



C4.2.2 *Impacts from Road Traffic Emissions – Operational Phase*

The potential effect of the movement of road traffic to and from the Project Site during the operational phase of the Project upon local air quality have been assessed and summarised using the methodology detailed in *Section C2.2*. Results are expressed as the greatest ground level concentrations for each pollutant averaging period at existing receptors and have been assessed against the corresponding existing baseline scenario.

The results presented for NO_2 incorporate the relevant background concentrations to allow the magnitude and significance of potential impacts, in relation to the relevant air quality standards and guidelines, to be discussed. Given the degraded airshed for PM_{10} and $PM_{2.5}$ however, the results for PM_{10} and $PM_{2.5}$ account for the operational traffic emissions contribution only, and the significance of potential impact is discussed accordingly.

C4.2.3 *Nitrogen Dioxide*

The impact assessment predicts that there will be no exceedences of either the 1-hour mean (99.79th percentile) or annual mean NO_2 Turkish and EU ambient air quality limit values (200 $\mu g/m^3$ and 40 $\mu g/m^3$ respectively) during the operational phase scenario at existing sensitive receptors. Results are summarised in *Table C4.8*.

The greatest impact in annual mean NO_2 concentrations at an existing sensitive receptor is predicted to occur on the Site Access Road. The greatest impact in 1 hour NO_2 concentrations at an existing sensitive receptor will occur on the western side of the O-54 Link Road. With regards to assessment against IFC criteria, the worst-case PC/AQS at both existing receptors is predicted to be less than 25% criterion and therefore the significance of the annual mean and 1 hour NO_2 impacts during operation of the Project are considered to be negligible.

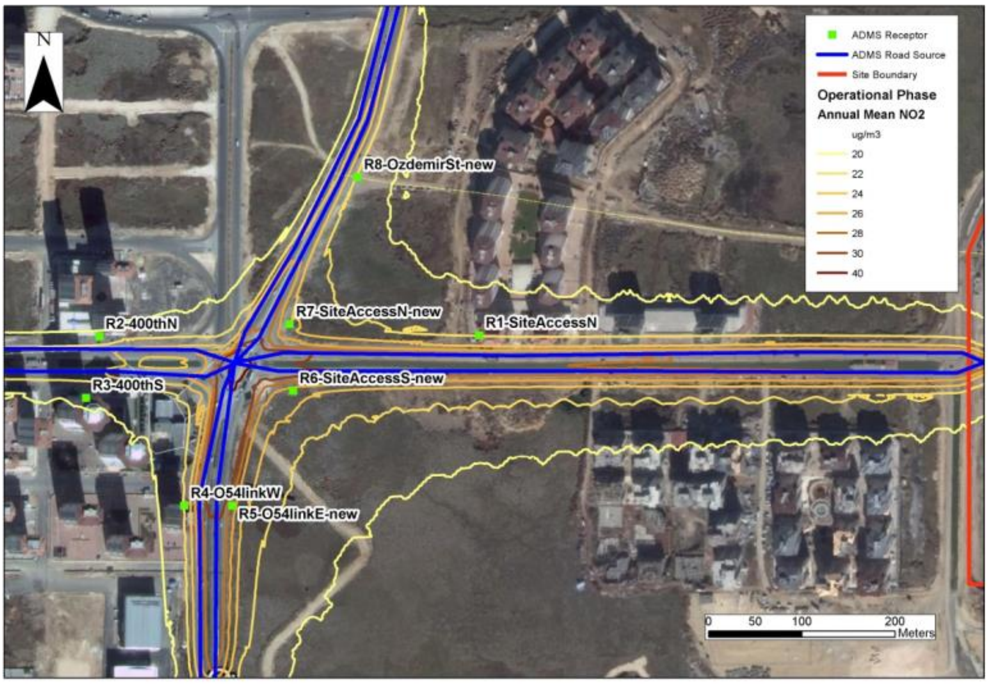
Furthermore, as the area surrounding the Project Site is subject to future development, the greatest impact in annual mean NO_2 concentrations at future potential sensitive receptors are predicted to occur to the south side of the junction of the Site Access Road/ O-54 Link Road and Özdemir Street/400th Street. The greatest impact for 1 hour NO_2 concentrations at future potential sensitive receptors occur to the northern side of the same junction. In-line with IFC criteria, as the worst-case PC/AQS is predicted to be less than the 25% criterion, the significance of the annual mean and 1 hour NO_2 impacts during operation of the Project are also considered to be negligible and allow room for future development in the same airshed.

Figure C4.3 and *Figure C4.4* have been prepared to illustrate the predicted pollutant concentration contours for NO_2 in currently developed and undeveloped land areas surrounding the Project Site, during the operation of Gaziantep IHC.

Table C4.8 Traffic Impact on NO_2 Concentrations during Operation

Operational Phase Scenario								
Standard	*Averaging period*	*AQS (µg/m³)*	*PC (µg/m³)*	*PC/ AQS*	*PEC (µg/m³)*	*PEC/ AQS*	*Magnitude*	*Significance*
Site Access Road – north side (existing)								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	17.6	8.79%	56.6	28%	Negligible	Negligible
	annual mean	40	3.52	8.79%	22.0	55%	Negligible	Negligible
400th Street – north side (existing)								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	9.45	4.73%	57.0	28%	Negligible	Negligible
	annual mean	40	1.01	2.53%	20.4	51%	Negligible	Negligible
400th Street – south side (existing)								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	9.51	4.75%	52.8	26%	Negligible	Negligible
	annual mean	40	0.937	2.34%	20.2	50%	Negligible	Negligible
O-54 Link Road – west side (existing)								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	18.6	9.29%	71.1	36%	Negligible	Negligible
	annual mean	40	2.10	5.25%	22.0	55%	Negligible	Negligible
O-54 Link Road – east side (proposed)								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	15.4	7.72%	68.5	34%	Negligible	Negligible
	annual mean	40	4.68	11.7%	26.9	67%	Negligible	Negligible
Site Access Road – south side (proposed)								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	15.7	7.84%	61.5	31%	Negligible	Negligible
	annual mean	40	5.26	13.1%	25.3	63%	Negligible	Negligible
Site Access Road– north side (proposed)								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	16.5	8.26%	63.8	32%	Negligible	Negligible
	annual mean	40	3.70	9.26%	24.4	61%	Negligible	Negligible
Ozdemir Street – west side (proposed)								
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	7.64	3.82%	51.7	26%	Negligible	Negligible
	annual mean	40	1.90	4.74%	21.9	55%	Negligible	Negligible

Figure C4.3 Predicted PEC for Annual Mean NO_2 Concentration (µg/m³) Contours during Operation



Map data from Google earth: © 2016 Basarsoft, © 2016 Google, Image © 2016 DigitalGlobe

Figure C4.4 Predicted PEC for 1 hour NO_2 Concentration (99.79th percentile) (µg/m³) Contours during Operation

Map data from Google earth: © 2016 Basarsoft, © 2016 Google, Image © 2016 DigitalGlobe

C4.2.4 *Particulate Matter*

The potential increases in the annual mean and 24-hour mean PM_{10} (and $PM_{2.5}$ for EU) concentrations, resulting from vehicle emissions during construction of the Project, are summarised in *Table C4.9*. Given the degraded airshed for PM_{10} and $PM_{2.5}$ however, the results account for the construction traffic emissions contribution only, and the significance of potential impact is discussed accordingly.

The impact assessment predicts that there will be no exceedances of either the 24-hour mean (90.41th percentile) or annual mean PM_{10} Turkish ambient air quality limit values (50 µg/m^3 and 40 µg/m^3 respectively) during the operational phase scenario at either existing or potential future sensitive receptor locations. Results are summarised in *Table C4.9* and *Table C4.10*

Monitored annual and daily maximum PM_{10} concentrations in Gaziantep have exceeded the Turkish and EU air quality Limit Values for the past six years. However, as the PC/AQS at all identified receptors is predicted to be less than the 10% IFC criterion for a degraded airshed, the significance of the annual mean and 24 hour PM_{10} impacts during operation of the Project are considered to be negligible.

In addition, no exceedances of the EU ambient air quality limit values for either PM_{10} or $PM_{2.5}$ are predicted during operation at any identified receptor location and the significance of the impacts are considered to be negligible.

Table C4.9 Traffic Impact on PM_{10} Concentrations during Operation

Standard	Averaging period	AQS (µg/m³)	PC (µg/m³)	PC/ AQS	Magnitude	Significance
Site Access Road – north side						
Turkey	24 hour (not to be exceeded > 35 times in one year)	50	1.15	2%	Negligible	Negligible
	annual mean	40	0.588	1%	Negligible	Negligible
EU	24 hour maximum	50	1.90	4%	Negligible	Negligible
	annual mean	40	0.558	1%	Negligible	Negligible
400th Street – north side						
Turkey	24 hour (not to be exceeded > 35 times in one year)	50	0.317	1%	Negligible	Negligible
	annual mean	40	0.166	0%	Negligible	Negligible
EU	24 hour maximum	50	1.44	3%	Negligible	Negligible
	annual mean	40	0.166	0%	Negligible	Negligible
400th Street – south side						
Turkey	24 hour (not to be exceeded > 35 times in one year)	50	0.354	1%	Negligible	Negligible
	annual mean	40	0.154	0%	Negligible	Negligible
EU	24 hour maximum	50	0.966	2%	Negligible	Negligible
	annual mean	40	0.154	0%	Negligible	Negligible
O-54 Link Road – west side						
Turkey	24 hour (not to be exceeded > 35 times in one year)	50	0.960	2%	Negligible	Negligible
	annual mean	40	0.359	1%	Negligible	Negligible
EU	24 hour maximum	50	2.47	5%	Negligible	Negligible
	annual mean	40	0.359	1%	Negligible	Negligible
O-54 Link Road – east side (proposed)						
Turkey	24 hour (not to be exceeded > 35 times in one year)	50	1.32	3%	Negligible	Negligible
	annual mean	40	0.793	2%	Negligible	Negligible
EU	24 hour maximum	50	2.02	4%	Negligible	Negligible
	annual mean	40	0.793	2%	Negligible	Negligible

Standard	Averaging period	AQS (µg/m³)	PC (µg/m³)	PC/ AQS	Magnitude	Significance
Site Access Road – south side (proposed)						
Turkey	24 hour (not to be exceeded > 35 times in one year)	50	1.39	3%	Negligible	Negligible
	annual mean	40	0.867	2%	Negligible	Negligible
EU	24 hour maximum	50	1.83	4%	Negligible	Negligible
	annual mean	40	0.867	2%	Negligible	Negligible
Site Access Road– north side (proposed)						
Turkey	24 hour (not to be exceeded > 35 times in one year)	50	1.11	2%	Negligible	Negligible
	annual mean	40	0.634	2%	Negligible	Negligible
EU	24 hour maximum	50	1.93	4%	Negligible	Negligible
	annual mean	40	0.634	2%	Negligible	Negligible
Ozdemir Street – west side (proposed)						
Turkey	24 hour (not to be exceeded > 35 times in one year)	50	0.491	1%	Negligible	Negligible
	annual mean	40	0.303	1%	Negligible	Negligible
EU	24 hour maximum	50	0.905	2%	Negligible	Negligible
	annual mean	40	0.303	1%	Negligible	Negligible

Table C4.10 Traffic Impact on $PM_{2.5}$ Concentrations during Operation

Standard	Averaging period	AQS (µg/m³)	PC (µg/m³)	PC/ AQS	Magnitude	Significance
Site Access Road – north side						
EU	24 hour maximum	25	1.90	8%	Negligible	Negligible
	annual mean	20	0.558	3%	Negligible	Negligible
400th Street – north side						
EU	24 hour maximum	25	1.44	6%	Negligible	Negligible
	annual mean	20	0.166	1%	Negligible	Negligible
400th Street – south side						
EU	24 hour maximum	25	1.00	4%	Negligible	Negligible
	annual mean	20	0.154	1%	Negligible	Negligible
O-54 Link Road – west side						
EU	24 hour maximum	25	2.47	10%	Negligible	Negligible
	annual mean	20	0.359	2%	Negligible	Negligible
O-54 Link Road – east side (proposed)						
EU	24 hour maximum	25	2.02	8%	Negligible	Negligible
	annual mean	20	0.793	4%	Negligible	Negligible
Site Access Road – south side (proposed)						
EU	24 hour maximum	25	1.83	7%	Negligible	Negligible
	annual mean	20	0.867	4%	Negligible	Negligible
Site Access Road– north side (proposed)						
EU	24 hour maximum	25	1.93	8%	Negligible	Negligible
	annual mean	20	0.634	3%	Negligible	Negligible
Özdemir Street – west side (proposed)						
EU	24 hour maximum	25	0.905	4%	Negligible	Negligible
	annual mean	20	0.303	2%	Negligible	Negligible

C4.2.5 *Combined Project Impacts during the Operational Phase*

The impacts associated with road traffic and the operation of the tri-generation and boiler plant will overlap to some extent and must therefore be considered in combination with each other. The emissions from the tri-generation plant and the boiler plant have the greatest overlap with road traffic at receptors alongside the Site Access Road.

The predicted impacts at receptors alongside this road are below 25% of the Turkish and EU air quality Limit Values for NO_2 annual mean and 1 hour mean (<10µg/m³ and <50µg/m³, respectively), and when considered with the existing baseline remain below the air quality Limit Values.

Taking the western access roundabout to the Project Site as the most likely location of the greatest in-combination impact during operation, the contribution from the tri-generation plant and boilers, together with road traffic emissions and the existing background concentrations are set out in *Table C 4.11*.

Table C 4.11 Combined Operational NO_2 Impacts at Western Site Entry Roundabout

Standard	Averaging period	AQS (µg/m³)	Baseline	Road Traffic PC (µg/m³)	On-site Plant PC (ug/m³)	Combined PC (µg/m³)	PC/ AQS	Significance
Turkey / EU	1 hour (not to be exceeded > 18 times in one year)	200	36.1	17.6	5.87	23.5	12%	Negligible
	annual mean	40	18.1	3.52	0.2	3.72	9.3%	Negligible

On this basis, impacts are considered to not be significant when considered in combination.

Whist the predicted impacts are not in excess of the air quality Limit Values, it is foreseeable that given the likely future development around the Project Site, the cumulative impacts with other schemes in the area could increase to the point that the annual mean standard is exceeded. This is discussed further in *Section C7*.

C4.2.6 *Greenhouse Gas Emissions during the Operational Phase*

Imported Electricity, Tri-generation Plant and Boilers

The Greenhouse Gas calculations for the operational phase of the Gaziantep IHC are based on a combination of the indirect emissions associated with the generation of the electricity supplied to the Project from the Turkish national grid, and direct emissions from the onsite tri-generation plant and boilers, and traffic associated with the Project. Calculations for the annual emissions of carbon dioxide (CO_2) have therefore been undertaken using emission factors based on the provided energy demand. Natural gas is used on-site to fuel the tri-generation plant providing heating, cooling and power, together with the on-site boiler providing hot water.

Assuming a conservative approach of a 30MW supply from the grid for 24 hours a day, 365 days per year, the estimated annual electricity usage will be 262,800 MWh. Using a specific emission factor for electricity generation in Turkey of 0.605 tCO_2 / MWh[(1)], this equates to a total of 158,994 tonnes of CO_2 per year.

The total volume of natural gas to be consumed by the Project is estimated to be 7,800 m^3/h [(2)]. Using an emission factor for natural gas combustion of 2.0291 kg CO_2/m^3 [(3)], the emissions associated with natural gas usage at the Project equates to a total of 138,644 tonnes of CO_2 per year.

Road Traffic

As set out in *Section C2.2,* a total of 40,489 vehicles per day (two-way) are predicted to access the Gaziantep IHC when operational. This total comprises 39,743 cars (98%) and 746 heavy goods vehicles (HGVs) (2%) per day.

Using a similar approach to above, calculations for the emissions of CO_2 have been undertaken for the operational traffic accessing the site, using general emission factors assuming 4.73 tonnes CO_2 equivalent /vehicle/year [(4)].

Whilst this factor is largely based on the weighted average combined fuel economy of cars and light trucks, rather than HGVs, given the small percentage of HGVs predicted to be in use during the operational phase, the calculation is considered to be appropriate to provide an estimation as to the likely CO_2 emissions.

This therefore equates to a total of 191,513 tonnes of CO_2 per year [(5)] associated with the vehicle movements during the operation phase.

Identifying Impact Magnitude

During the operational phase of Gaziantep IHC, the annual emissions of CO_2 based on electricity supply, gas supply and the predicted vehicle movements accessing the site over the course of one year, results in 489,151 tonnes of CO_2 per year.

(1) EBRD 2009. Electricity Emission Factors Review, November 2009.
(2) Information supplied by the SPV on 30th June 2016
(3) DECC 2015, Greenhouse gas reporting - Conversion factors 2015, Department of Energy and Climate Change, January 2015.
(4) https://www.epa.gov/energy/ghg-equivalencies-calculator-calculations-and-references <<accessed 21st June 2016>>
(5) 40489 vehicles x 4.73 tonnes CO_2 equivalent per vehicle per year

In 2013, Turkey's reported CO_2 emissions from fuel combustion [1] were 283.8 Megatonnes CO_2 ie 283,800,000 tonnes of CO_2. The calculated emissions from the operation of Gaziantep IHC therefore equate to <1% of this national total.

International standards however have also been used to place the Project GHG emissions into perspective

An annual GHG emissions threshold of 25,000 tonnes of CO2e has been adopted by the EBRD within its Environmental and Social Policy (November 2014) [2]. This updated policy reduces the GHG reporting threshold within projects that the EBRD supports from 100,000 to 25,000 tonnes of CO2e per year. EBRD guidance on assessment of GHG emissions also defines a series of categories and thresholds for different project types (shown in *Table C4.12*). This suggests the operation of the Project is classified as having a Medium-High magnitude description, which is in-line with the listed example sector categories, including district heating and small generation plants.

Table C4.12 EBRD GHG Emissions Reporting Categories

GHG Emissions / annum	*Magnitude Description*
> 1,000,000 tCO_2e	High
100,000 – 1,000,000 tCO_2e	Medium-High
20,000 – 100,000 tCO_2e	Medium-Low
< 20,000 tCO_2e	Low
Not defined	Negligible

As the Project falls within the GHG reporting threshold for EBRD, the Performance Requirements 3 state that "*Quantification of GHG emissions will be conducted by the client annually and reported to the EBRD*". The consideration of alternatives is also a key requirement of EBRD – further details on this can be found in *Vol I, Chapter 2 Project Description*.

(1) IEA, 2015. CO2 Emissions From Fuel Combustion – Highlights. Table 1World CO_2 emissions from Fuel Combustion and Kyoto Protocol first commitment period targets, International Energy Agency. Available at https://www.iea.org/publications/freepublications/pub

(2) EBRD 2014. Performance Requirement 3, Resource Efficiency and Pollution Prevention and Control, Environmental and Social Policy, November 2014.

C5 MITIGATION MEASURES AND ALTERNATIVE DESIGNS

C5.1 CONSTRUCTION PHASE

The key impacts during the construction phase are considered to be associated with emissions of dust due to construction activities (including concrete batching) and vehicle movements.

The control and mitigation of dust is therefore identified to be of primary consideration within the assessment and will be achieved by implementing following measures:

- Impacts associated with road traffic can be adequately mitigated by the use of salt encrusting or chemical treatment of unpaved roads as this will effectively attenuate dust emission. Salt treatment forms a crust on top of the sprayed area. Chemical treatments can also be employed such as the use of oil based binding agents, which attenuate dust by binding particulates onto the road surface.

- At the early phases of construction works, wetting the unpaved road surfaces may be adequate for short term mitigation of dust emissions; however, due to the arid conditions and elevated wind speeds in the Study Area during a large proportion of the year, it is anticipated that evaporation rates will be very high and therefore render this technique ineffective on larger areas for large periods of time.

- A speed limit of 32 km/h on unpaved surfaces should be used.

- Vehicles should be kept clean to avoid tracking dirt around and off the site.

- Vehicles transporting friable materials should be covered.

- Where feasible, surface binding agents should be used on exposed open earthworks.

- Exposed ground and earthworks areas should be covered as much as possible, for example with sheeting or boarding, or the use of chemical binders should be investigated.

- Where ground and earthworks are covered or surface binders are used, the smallest possible area for working should be exposed.

- Blasting should be carried out as infrequently as possible.

- Use of localised dampening and activity specific dampening should be used to reduce localised emissions of dust.

- Stockpiling of material, for example, rocks, sand and soils should be minimised.

- Stockpiles should be enclosed or sheeted as much as possible.

- Stockpiles should be located as far away from receptors as possible.

- The design of stockpiles should be optimised to retain a low profile with no sharp changes in shape.

- Wind breaks should be erected around the key construction activities and, if possible, in the vicinity of potentially dusty works and blasting activities, to minimise impacts at nearby residential receptors, particularly next to the Türkiye Odalar ve Borsalar Birliği Fen Lisesi school.

It is good practice to use vehicles that are compliant with recent emission standards (for example, EURO 3 or USEPA Tier 2) and maintained in reasonable working order. When not in use, vehicles should be switched off, unless impractical for health and safety reasons (for example maintenance of air conditioning during warm weather).

In addition to mitigation measures being implemented, given the large magnitude of predicted dust impacts together with the medium and high risk sensitivity classifications identified above, on-going monitoring of meteorological conditions, NO_2, PM_{10} and ambient dust should be carried out. PM_{10} monitoring should be undertaken at the site boundary and where there are sensitive receptors close to access roads, and should include establishment of 'action levels'. The 'action levels' are thresholds that should trigger investigation of on-site dust lifting activities and baseline conditions. When activities result in unacceptable emissions of dust, additional mitigation and control should be implemented (i.e. localised water spraying), or activities should cease until the specific activity is complete, more effective dust suppression is identified or weather conditions improve. These will be set out in an approved AQMP.

C5.2 OPERATIONAL PHASE

C5.2.1 *Tri-generation Plant and Boiler Emissions*

Impacts associated with the operation of the Tri-generation Plant and Boiler Plant under the base design have the potential to be major and are predicted to result in AQS being exceeded within an area of 0.6 km from the stacks, and at the school and the hospital buildings which are considered highly sensitive receptors.

Working with the design engineers an iterative process was undertaken to identify measures to reduce these impacts. Consideration was made of options to reduce the concentration of emission arising from the boilers and tri-generation plant; increase stack height from the boilers and tri-generation plant; and combine flues to increase the buoyancy of the plume. The assessment considered impacts both at ground level receptors, and elevated receptors (ie windows and air intakes) on the nearby hospital buildings.

The impact assessment considered each of these measures in isolation, with stack heights of 35m and 45m, and also considered these options in various combinations. The results of this assessment process were reviewed to work towards a final design where impacts would be acceptable. This identified that a combination of these design features would be considered. Therefore, in order to result in negligible impacts, the following mitigation/variations to the design of the base case were recommended and subsequently incorporated into the design (see *Table C2.7*):

- increased stack height (45m);
- use of combined stacks for the Tri-generation Plant and Boiler Plant; and
- reduction of the NO_x emission concentration of the Tri-generation Plant from 500 mg /Nm^3 to 100 mg /Nm^3.

C5.2.2 *Road Traffic*

Negligible impacts are predicted at all identified existing and potential future receptor locations for all assessed pollutants. On this basis, no mitigation measures or alternatives designs are proposed regarding potential road traffic emissions.

C6 RESIDUAL IMPACTS

C6.1 CONSTRUCTION IMPACTS

The impact of construction will be reduced to **minor** significance at worst, with the full application of embedded mitigation and the additional mitigation set out in *Section 4.3*.

C6.2 OPERATIONAL IMPACTS

C6.2.1 Traffic

The impact of traffic related emissions will be negligible.

C6.2.2 Impacts from Tri-generation Plant and Boiler Emissions

The original design of the tri-generation plant and boiler plant resulted in major impacts, however with the implementation of the suggested mitigated and variation to the design, the residual impacts from during operation of the Project will be negligible.

Cumulative air quality impacts have the potential to occur during operation of the Project. This is due to impacts of the proposed hospital development potentially occurring simultaneously with impacts of other development in the area surrounding the Project Site. There are a substantial number of residential developments proposed in the area, which will in themselves, add traffic to the local road network.

When considering impacts of the proposed development in the context of the existing baseline, these are, at worst, approximately 70% of the annual mean air quality standard for NO_2. Whist this is not in excess of the air quality standard, it is foreseeable however that given the other likely developments in the vicinity of the hospital, this could increase to the point that the annual mean standard is exceeded.

Future developments will therefore need to consider air quality, in terms of the impacts relating to increasing road traffic, and also the positioning of sensitive receptors, such as residential properties, with regards to distance from the roadside.

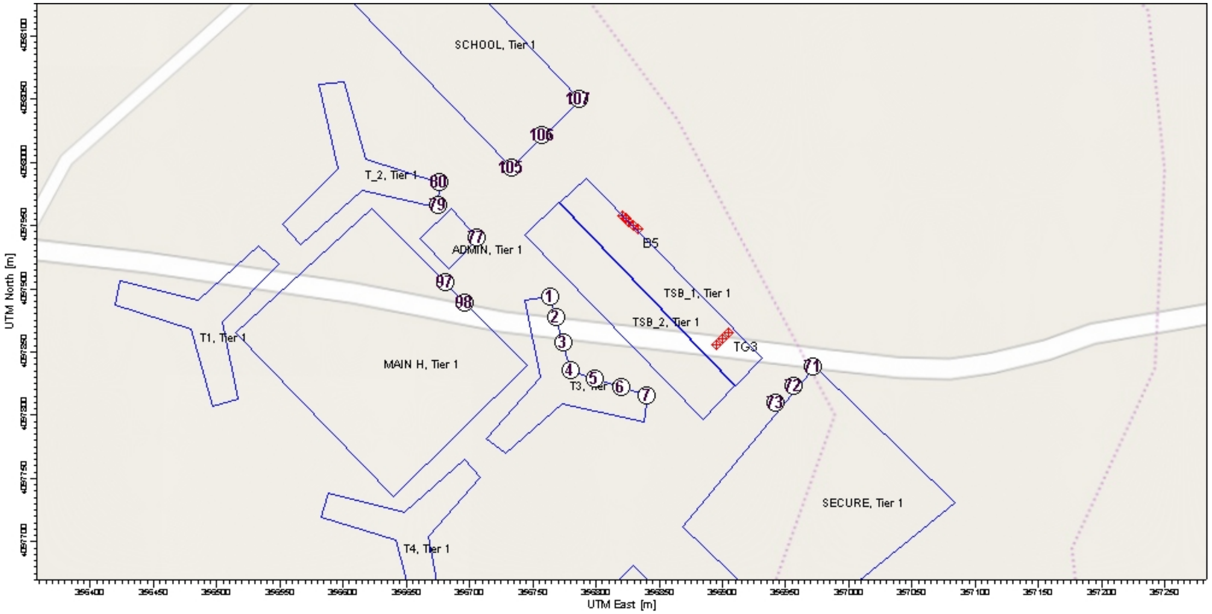
Appendix C1

Buildings

C1-1 BUILDINGS

Table C1-1.1 Elevated Receptors

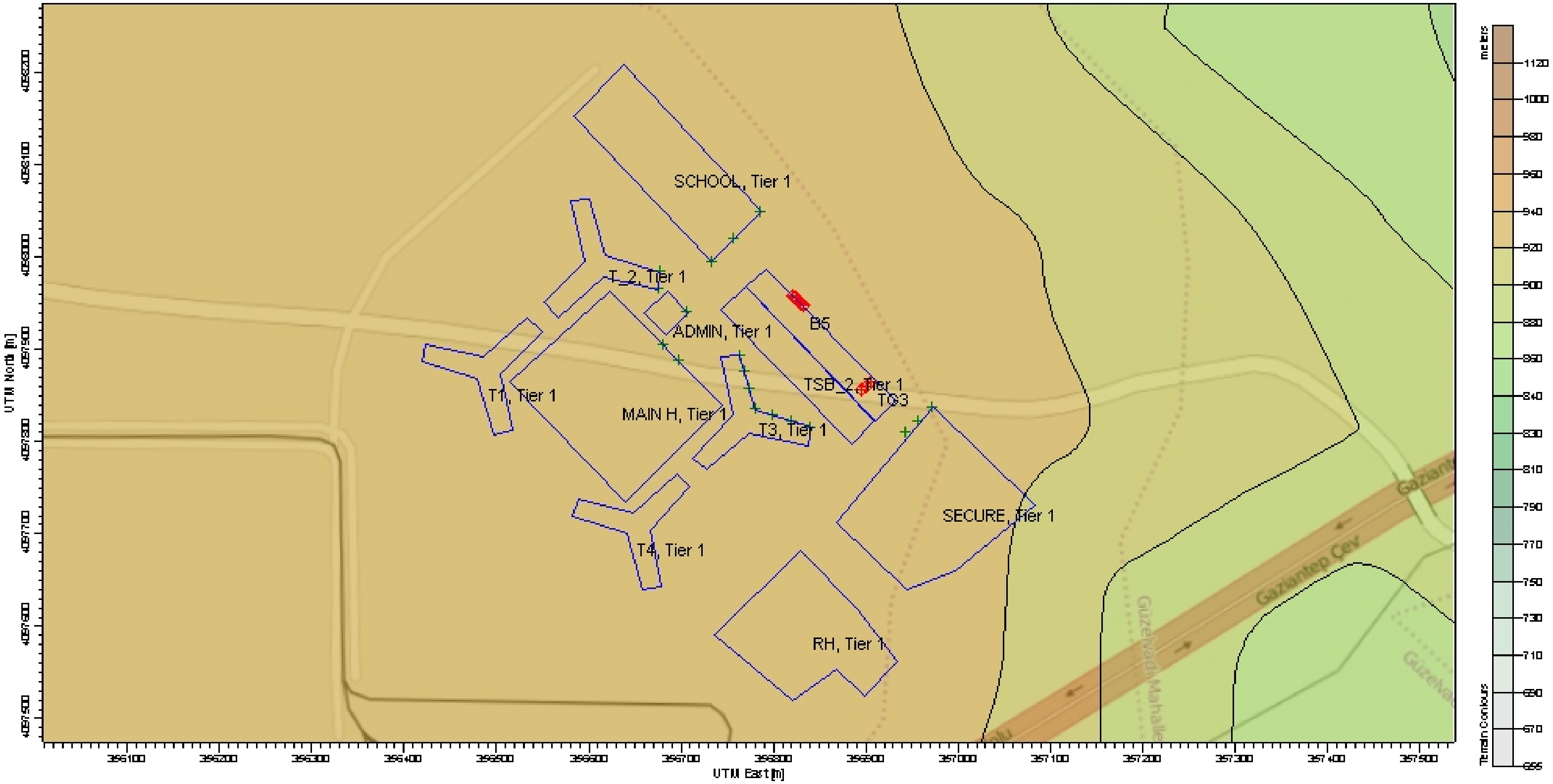
nr	*building*	*Location (UTM)*		*Height (m)*									
		X (m)	Y (m)	receptor 1	receptor 2	receptor 3	receptor 4	receptor 5	receptor 6	receptor 7	receptor 8	receptor 9	receptor 10
1	T3	356764	4097894	6.4	10.8	16.2	21.6	26.8	30	34.2	38.4	42.6	44.1
2	T3	356768	4097877	6.4	10.8	16.2	21.6	26.8	30	34.2	38.4	42.6	44.1
3	T3	356774	4097857	6.4	10.8	16.2	21.6	26.8	30	34.2	38.4	42.6	44.1
4	T3	356780	4097836	6.4	10.8	16.2	21.6	26.8	30	34.2	38.4	42.6	44.1
5	T3	356799	4097829	6.4	10.8	16.2	21.6	26.8	30	34.2	38.4	42.6	44.1
6	T3	356820	4097823	6.4	10.8	16.2	21.6	26.8	30	34.2	38.4	42.6	44.1
7	T3	356840	4097816	6.4	10.8	16.2	21.6	26.8	30	34.2	38.4	42.6	44.1
71	Secure	356972	4097838	4.65	9.3								
72	Secure	356956	4097823	4.65	9.3								
73	Secure	356942	4097810	4.65	9.3								
77	Admin	356706	4097941	4.65	9.3								
79	T2	356675	4097966	6.4	10.8	16.2	21.6	26.8	30	34.2	38.4	39.9	
80	T2	356676	4097985	6.4	10.8	16.2	21.6	26.8	30	34.2	38.4	39.9	
97	Main H	356681	4097905	4.65	9.3	14	17.5						
98	Main H	356697	4097889	4.65	9.3	14	17.5						
105	School	356733	4097996	4.5	9	14							
106	School	356757	4098021	4.5	9	14							
107	School	356786	4098050	4.5	9	14							



SCHOOL, Tier 1
T_2, Tier 1
ADMIN, Tier 1
B5
TSB_1, Tier 1
TSB_2, Tier 1
TG3
T1, Tier 1
MAIN H, Tier 1
SECURE, Tier 1
T4, Tier 1
107
106
105
80
79
77
97
98
1
2
3
4
5
6
7
71
72
73
UTM North [m]
UTM East [m]

Table C1-1.2 Building Locations and Dimensions

Building	Base Elevation	Building Height	X1	Y1	X2	Y2	X3	Y3	X4	Y4	X5	Y5	X6	Y6	X7	Y7	X8	Y8	X9	Y9
	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
T3	937.04	39.9	356764	4097894	356780	4097835	356840	4097815	356838	4097795	356773	4097809	356729	4097770	356713	4097781	356756	4097830	356744	4097891
TSB_1	934.65	9.5	356792	4097987	356932	4097845	356911	4097823	356771	4097969										
TSB_2	936.9	11.5	356910	4097823	356884	4097797	356744	4097942	356770	4097968										
T_2	936.56	44.1	356600	4098063	356618	4098003	356677	4097984	356675	4097965	356615	4097978	356567	4097935	356552	4097951	356596	4097995	356581	4098062
SECURE	933.2	13.3	356973	4097838	357084	4097731	356997	4097660	356944	4097640	356869	4097712								
ADMIN	936.42	12.3	356685	4097964	356707	4097939	356683	4097915	356661	4097939										
MAINH	937.92	17.5	356623	4097964	356745	4097839	356640	4097735	356515	4097865										
RH	936.94	19.4	356829	4097682	356736	4097591	356820	4097519	356869	4097553	356899	4097524	356935	4097561	356890	4097619				
T4	939.04	57.9	356696	4097765	356649	4097723	356589	4097738	356582	4097720	356642	4097701	356658	4097640	356679	4097643	356667	4097704	356709	4097751
T1	938.47	48.3	356533	4097934	356549	4097920	356504	4097874	356517	4097813	356497	4097807	356480	4097868	356420	4097887	356424	4097906	356485	4097891
SCHOOL	936.08	20	356734	4097996	356787	4098050	356638	4098208	356584	4098152										


SCHOOL, Tier 1
T_2, Tier 1
ADMIN, Tier 1
B5
TSB_2, Tier 1
TG3
T1, Tier 1
MAIN H, Tier 1
T3, Tier 1
SECURE, Tier 1
T4, Tier 1
RH, Tier 1
UTM East [m]
UTM North [m]
meters
Terrain Contours
356100
356200
356300
356400
356500
356600
356700
356800
356900
357000
357100
357200
357300
357400
357500

Appendix C2

Detailed Modelling

C2-1 *IMPACTS FROM TRI-GENERATION PLANT AND BOILER EMISSIONS – BASE DESIGN*

The operational impacts of the Project (reasonable worst case emission scenario) are summarised in *Table C2-1.1*. Impacts shown are the highest predicted impacts anywhere in the Study Area (see *Figure C2-1.1)*. These show that impacts associated with the Project have the potential to cause exceedances of the AQS for NO_2.

As shown in *Figure C2-1.1* the PC is predicted to exceed the one hour AQS in an area reaching approximately 0.6 km from the stacks. This includes highly sensitive receptors in the adjacent Türkiye Odalar ve Borsalar Birliği Fen Lisesi school and the hospital buildings. The table shows impacts at elevated receptors (patient and class rooms) are substantially higher than at ground level. The significance of the impact therefore is to be considered major when compared to the one hour AQS.

When compared to the annual AQS, the PC exceeds the AQS, within an area reaching approximately 0.13 km from the stacks, but not outside the site boundary (see *Figure C2-1.2*). This includes high sensitive receptors in the hospital buildings at ground level. The table shows impacts at elevated receptors (patient and class rooms) are lower than at ground level but still exceed the AQS. The significance of the impact when compared to the annual AQS therefore is to be considered major at ground level and moderate at elevated level. The PC at ground level are set out in *Figure C2-1.1* and *Figure C2-1.2*.

On this basis, redesign of the tri-generation plant was required to mitigate these impacts.

Table C2- 1.1 Impacts to Ambient Air Quality NO_2 – Anywhere within Study Area, Original Design, reasonable worst case

Standard	*Averaging period*	*AQS (μg/m³)*	*PC (μg/m³)*	*PC/ AQS*	*Baseline (μg/m³)*	*PEC (μg/m³)*	*PEC/ AQS*	*Magnitude*	*Significance*
	Ground Level Receptors								
Turkey	1 hour (not to be exceeded > 18 times in one year)	200 (+100 μg/m³ reducing to zero 1.1.2014-1.1.2024)	626	313%	36.2	662	331%	Large	Major
	annual mean	40 (+20 μg/m³ reducing to zero 1.1.2014-1.1.2024)	64.3	161%	18.1	82.4	206%	Large	Major
EU	1 hour maximum	200	626	313%	36.2	662	331%	Large	Major
	annual mean	40	64.3	161%	18.1	82.4	206%	Large	Major
	Elevated receptors – Hospital and School Buildings								
Turkey	1 hour (not to be exceeded > 18 times in one year)	200 (+100 μg/m³ reducing to zero 1.1.2014-1.1.2024)	1438	719%	36.2	1474	737%	Large	Major
	annual mean	40 (+20 μg/m³ reducing to zero 1.1.2014-1.1.2024)	43.2	108%	18.1	61.3	153%	Large	Major
EU	1 hour maximum	200	1438	719%	36.2	1474	737%	Large	Major
	annual mean	40	43.2	108%	18.1	61.3	153%	Large	Major

Figure C2- 1.1 NO_2 One Hour Maximum PC (μg/m³)

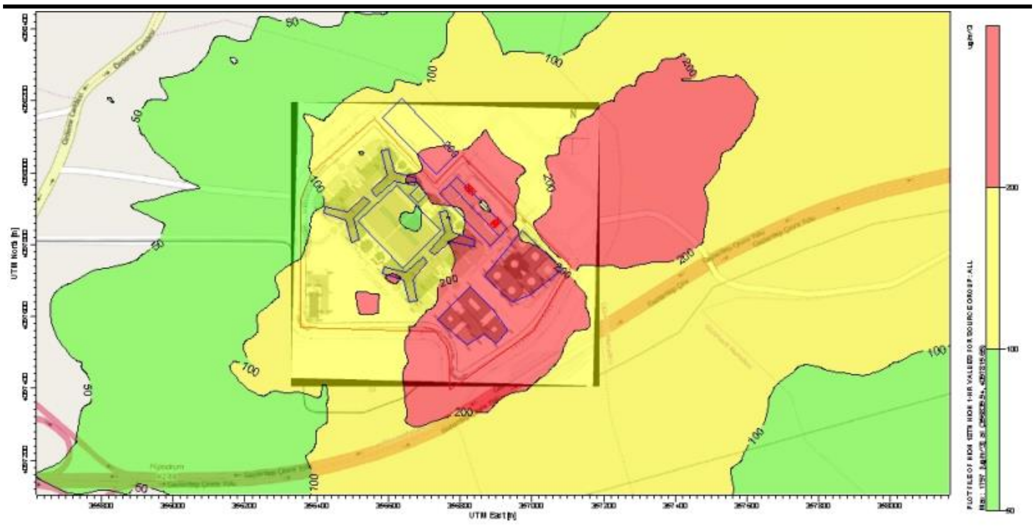


Figure C2- 1.2 NO_2 Annual Mean PC (μg/m³)

C2-1.1 IMPACTS FROM TRI-GENERATION PLANT AND BOILER EMISSIONS – ALTERNATIVE DESIGN

Three mitigated designs were considered as set out in in the main report.

Results of these mitigated designs are presented in *Table C2-1.2*, and show that impacts:

- for design 1:
  - exceed the 1 hour AQS and are therefore Major; and
  - are moderate when compared to the annual AQS;
- for design 2 are:
  - moderate when compared to the 1 hour AQS; and
  - negligible when compared to the annual AQS;
- for design 3 are:
  - negligible when compared to the 1 hour; and
  - negligible when compared to the annual AQS.

The predicted contour plots for the three alternatives are also illustrated in *Figure C2-1.3* to *Figure C2-1.8*.

Table C2- 1.2 Impacts to Ambient Air Quality for Mitigated Designs

Standard	Averaging period	AQS (μg/m³)	PC (μg/m³)	PC/ AQS	Baseline (μg/m³)	PEC (μg/m³)	PEC/ AQS	Magnitude	Significance
	Mitigated Design 1 - Ground and Elevated Level Receptors								
Turkey	1 hour (not to be exceeded > 18 times in one year)	200 (+100 μg/m³ reducing to zero 1.1.2014-1.1.2024)	288	144%	36.2	324	162%	Large	Major
	annual mean	40 (+20 μg/m³ reducing to zero 1.1.2014-1.1.2024)	13.2	33%	18.1	31.3	78%	Small	Moderate
EU	1 hour	200	288	144%	36.2	324	162%	Large	Major

Standard	*Averaging period*	*AQS (µg/m³)*	*PC (µg/m³)*	*PC/ AQS*	*Baseline (µg/m³)*	*PEC (µg/m³)*	*PEC/ AQS*	*Magnitude*	*Significance*
	maximum								
	annual mean	40	13.2	33%	18.1	31.3	78%	Small	Moderate
	Mitigated Design 2 - Ground and Elevated Level Receptors								
Turkey	1 hour (not to be exceeded > 18 times in one year)	200 (+100 µg/m³ reducing to zero 1.1.2014-1.1.2024)	71.1	36%	36.2	107	54%	Small	Moderate
	annual mean	40 (+20 µg/m³ reducing to zero 1.1.2014-1.1.2024)	3.16	7.9%	18.1	21.3	53%	Negligible	Negligible
EU	1 hour maximum	200	71.1	36%	36.2	107	54%	Small	Moderate
	annual mean	40	3.16	7.9%	18.1	21.3	53%	Negligible	Negligible
Mitigated Design 3 - Ground and Elevated Level Receptors									
Turkey	1 hour (not to be exceeded > 18 times in one year)	200 (+100 µg/m³ reducing to zero 1.1.2014-1.1.2024)	25.3	13%	36.2	61	31%	Negligible	Negligible
	annual mean	40 (+20 µg/m³ reducing to zero 1.1.2014-1.1.2024)	1.16	2.9%	18.1	19.3	48%	Negligible	Negligible
EU	1 hour maximum	200	25.3	13%	36.2	61	31%	Negligible	Negligible
	annual mean	40	1.16	2.9%	18.1	19.3	48%	Negligible	Negligible

Figure C2- 1.3 NO_2 One Hour Maximum PC (µg/m³) - Ground Level Concentrations, Original Design, Alternative 1

Figure C2- 1.4 NO_2 Annual Mean PEC (µg/m³) - Ground Level Concentrations, Original Design, Alternative 1

Figure C2- 1.5 NO_2 One Hour Maximum PC (μg/m³) - Ground Level Concentrations, Original Design, Alternative 2

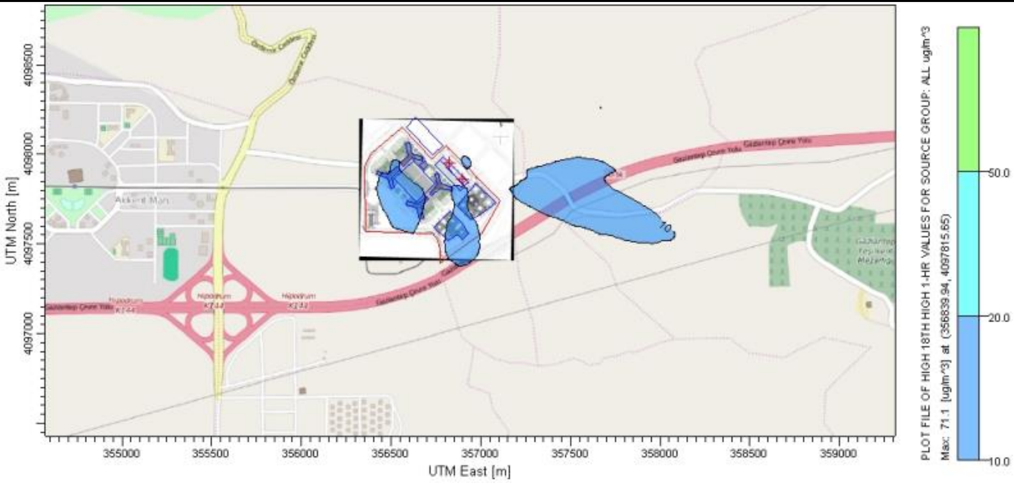


Figure C2- 1.6 NO_2 Annual Mean PEC (μg/m³) - Ground Level Concentrations, Original Design, Alternative 2

Figure C2- 1.7 NO_2 One Hour Maximum PC (µg/m³) - Ground Level Concentrations, Original Design, Alternative 3

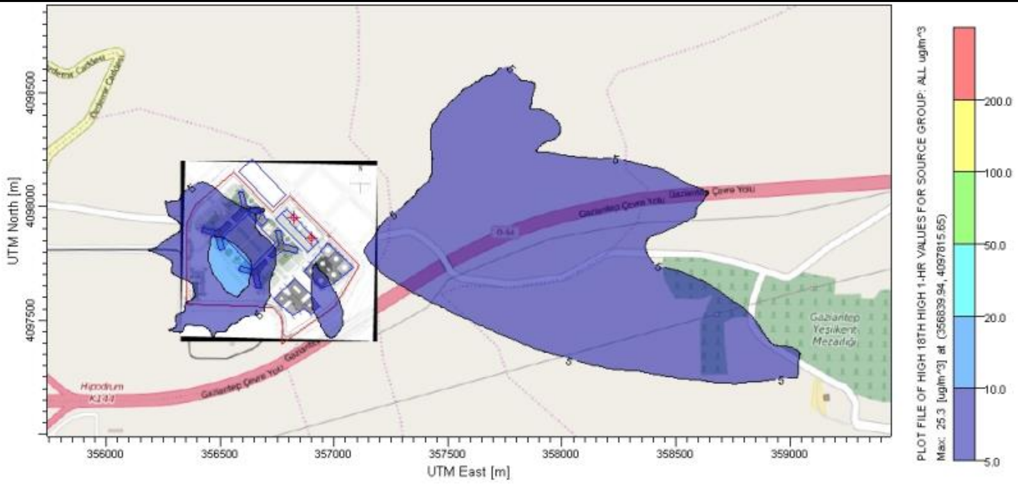


Figure C2- 1.8 NO_2 Annual Mean PEC (µg/m³) - Ground Level Concentrations, Original Design, Alternative 3