9.2.7. Waste

9.2.7.1. Construction Phase

No monitoring for residual impacts is considered necessary during the construction phase of the Project.

9.2.7.2. Operational Phase

No monitoring for residual impacts is considered necessary during the operational phase of the Project.

9.2.8. Socio-Economy

The following monitoring and auditing measures should also be implemented throughout the operation phase by the Operator to ensure that any potential impacts relating to waste generated by the Project are minimised and mitigated as far as possible:

- In line with Performance Standard 1 (Section 23), a grievance procedure needs to be established for local residents to ensure that any issues are resolved to the satisfaction of all parties.

9.2.9. Archaeology and Cultural Heritage

9.2.9.1. Construction Phase

No monitoring for residual impacts is considered necessary during the construction phase of the Project due to the lack of any archaeological of cultural heritage items within the Project site. Providing the monitoring measures listed in **Section 9.1.9.1** above, no residual impacts are likely to remain.

9.2.9.2. Operational Phase

No monitoring is proposed as necessary during the operational phase of the Project.

APPENDICES

Appendix 1 – Data on Existing Environment

Appendix 1-1 – Soil and Groundwater Monitoring Report

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اليمنت ماتيريلز تكنولوجي ام اي ليمتد أبو ظبي

قطعة أرض رقم: ٢٥ ام النار (ساس الذخيل)، صندوق
بريد: ٩١٩١ابو ظبي، الإمارات العربية المتحدة

هاتف: ٢٣٤٥ ٥٥٨ ٢ (٠) ٩٧١ +
فاكس: ٤٥١٥ ٥٥٨ ٢ (٠) ٩٧١ +

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SOIL & GROUNDWATER MONITORING REPORT

Al Futtaim Element Materials Technology Dubai LLC, Dubai Investment Park, P.O. Box 34924, Dubai, United Arab Emirates

Tel:+971(0) 4 885 1001
andrew.palliser@Element.com
Your Local Element Contact: Andrew Palliser

Commissioned by
Anthesis Group Middle East

SIte Name & Address
Fujairah 3
Qidfa

Monitoring Location Reference
Fujairah 3 - Qidfa Expansion Project

Dates of the Monitoring Campaign
20th - 21st January 2020

Job Reference Number
DXB ENV 20/003

Report Written by
Luke Prowse Senior Engineer

Report Reviewed by
Andrew Palliser Manager

Report Date
03rd February 2020

Version
Version 1

Signature of Report Reviewer
A Pallis

CONTENTS

Executive Summary

MONITORING OBJECTIVES

Anthesis Group Middle East, Fujairah 3
Fujairah 3 - Qidfa Expansion Project
20th - 21st January 2020

Overall Aim of the Monitoring Campaign

Element were commissioned by Anthesis Group Middle East to carry out an environmental Soil and Groundwater survey at Fujairah 3 - Qidfa Expansion Project in Fujairah 3.

The aim of the monitoring campaign was to perform testing of an investigative nature for the purposes of an Environmental Impact Assessment..

Scope of work

- Groundwater Monitoring with subsequent analysis to be carried out at 3 locations in duplicate.
- Soil sampling and subsequent checmical analysis to be carried out at 3 locations, at 0.5m and 1.0m.

Executive Summary

SITE INFORMATION AND MONITORING LOCATIONS - GROUNDWATER

Site Information

Soil and ground water sampling was carried out at 3 locations, Soils were collected at 0.5m and 1.0m at each location. Water samples were taken in duplicate at each well.
Ground water boreholes were pre-existing on-site, therefore soil samples were obtained adjacent to the wells, within 1m.
Locations are shown below:

Location Map:

Executive Summary

SITE INFORMATION AND MONITORING LOCATIONS - SOIL & GROUNDWATER

Monitoring Location(s) within the site

1.	BH5
2.	BH10
3.	BH13

GPS corodinate(s) within the site

1.	25°18'23.81"N, 56°22'23.46"E
2.	25°18'37.80"N, 56°22'22.78"E
3.	25°18'28.69"N, 56°22'14.28"E

Suitability of sample location

Recommendations	
There are no obvious causes on contamination on the surface layer?	Yes
There are no obstructions present which hamper the sampling procedure.	Yes
The conditions of the groundwater well / borehole / geographical stratification do not impeed sampling.	No
Sampling site is not interfered by a source that is not encompassed by the survey.	Yes

Executive Summary

WELL DEPTHS & PURGING DETAILS - GROUNDWATER

Ground Water		
Location	**Ground Water Depth (Meters Below Surface)**	**Well Depth (Meters below surface)**
BH5	1.8m	4.9m
BH10	0.9m	5.98m
BH13	1.75m	3.93m

MONITORING DATES & TIMES - GROUNDWATER

Ground Water		
Location	**Sampling Date(s)**	**Sampling Times**
BH5 - 1	22/01/2020	08:25:00
BH5 - 2	22/01/2020	08:42:00
BH10 - 1	22/01/2020	10:35:00
BH10 - 2	22/01/2020	10:44:00
BH13 - 1	22/01/2020	09:35:00
BH13 - 2	22/01/2020	09:40:00

MONITORING DATES & TIMES - SOIL

Ground Water		
Location	**Sampling Date(s)**	**Sample Depth Chosen**
BH5 - 0.5m	22/01/2020	0.5m
BH5 - 1.0m	22/01/2020	1.0m
BH10 - 0.5m	22/01/2020	0.5m
BH10 - 1.0m	22/01/2020	1.0m
BH13 - 0.5m	22/01/2020	0.5m
BH13 - 1.0m	22/01/2020	1.0m

Executive Summary

SAMPLING METHODS

GROUNDWATER

Sampling and Analysis

Prior to sampling the groundwater depth was determined and the presence/absence of non aqueous phase liquids (NAPL) using an oil/water interphase probe. The probe was lowered into the well until the sensor at the end of the probe indicates contact with the surface of the NAPL layer, this level was recorded and the probe was then lowered until the sensor indicates contact with groundwater, this second depth was recorded, the process was repeated 3 times and the average difference between depths is used to determine the thickness of the NAPL layer.

Wells were purged of any stagnant groundwater using a bailer or peristaltic pump and LDPE tubing, twenty-four hour prior to sampling. The groundwater was passed through a flow through cell containing a pH and temperature probe and the water continued to be purged until the pH reading stabilised to within ±0.05 pH units and ±0.2oC. If the readings do not stabilise the wells continue to be purged until a minimum of 3 times the well volume of water has been removed.

Groundwater sampling of all groundwater wells was performed using sample bailers and/or peristaltic pump. The groundwater depth presence/absence of NAPL was determined at each well immediately before samples were taken. The bailer shall was lowered into the groundwater column using nylon rope until the bailer was positioned within the groundwater column and the NAPL layer on the surface of the water to ensure the NAPL is collected along with the groundwater sample.

All groundwater samples are filtered prior to collection in the sample bottles. Sample bottles are uniquely labelled and prepared by Element. They are kept in coolboxes for transportation to our Dubai laboratory for analysis as detailed in Appendix A.

Executive Summary

SAMPLING METHODS

SOIL

The soil samples were collected at two depths, 0.5m and 1.0m at each borehole, both depths were submitted for analysis. Upon completion of the sampling the soil samples were sent to our accredited laboratory for analysis.

Cross contamination during soil sample collection was eliminated by the use of disposable equipment and thoroughly cleaning any non disposable equipment, such as hand sampling heads, with de ionized water prior to sample collection. All used and contaminated equipment was disposed of at the Element office in Dubai

Upon collection, soil samples were placed in clean laboratory sample bottles and provided with unique identification labels for each sample bottle. The samples were then stored in a cool box, containing ice packs until the end of the working day.

Upon completion of the sampling each day chain of custody forms were completed to include the analytical suite for each sample collected from each site and/or location and these forms were transported with the samples to the laboratory. The certificate of analysis of the laboratory analysis for the soil samples can be provided upon request.

Executive Summary

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Laboratory	17025 Number
Al Futtaim Element (EXO)	LB-002

SITE PERSONNEL

Name	Title
Luke Prowse	Engineer

Executive Summary

TEST RESULTS SUMMARY - GROUNDWATER

Anthesis Group Middle East, Fujairah 3
Fujairah 3 - Qidfa Expansion Project
20th - 21st January 2020

Ground Water Results
The below table presents a summary of the results obtained from the ground water monitoring campaign.

		Groundwater Results					
		Locations					
Parameter	Unit	BH5 - 1	BH5 - 2	BH10 - 1	BH10 - 2	BH13 - 1	BH13 - 2
Chloride	mg/L	372	337	638	638	128	120
Fluoride	mg/L	0.5	0.5	0.6	0.6	0.2	0.2
Nitrate	mg/L	0.04	<0.04	12	18.1	1.28	0.44
Nitrite	mg/L	0.016	0.02	1.25	1.33	0.516	0.391
Orthophosphate	mg/L	0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Sulphate	mg/L	54	61	296	288	30	33
Benzene	µg/L	<10	<10	<10	<10	<10	<10
Ethyl benzene	µg/L	<10	<10	<10	<10	<10	<10
Toluene	µg/L	<10	<10	<10	<10	<10	<10
m&p-Xylene	µg/L	<20	<20	<20	<20	<20	<20
o-Xylene	µg/L	<10	<10	<10	<10	<10	<10
VPH C5-C10	µg/L	109	218	23	20	66	80
EPH C10-C40	µg/L	10600	6010	14	45	3440	8970
Electrical Conductivity @ 25°C	mS/cm	2.6	2.5	2.8	2.9	1	1
Ammonia	mg/L	0.33	0.1	0.19	0.15	0.44	0.55
Ammonium	mg/L	0.347	0.1	0.206	0.154	0.463	0.579
Nitrogen (Ammonia)	mg/L	0.27	0.08	0.16	0.12	0.36	0.45
Salinity	ppt	1.94	1.86	2.09	2.15	<1.00	<1.00
Total Dissolved Solids	mg/L	1560	1440	1640	1760	548	574
pH Value @ 20°C	pH units	7.4	7.4	8	8.1	7.7	7.8
Chromium (VI)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (III)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury (Hg)	µg/L	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Arsenic (As)	mg/L	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Barium (Ba)	mg/L	0.14	0.11	0.01	0.01	<0.01	<0.01
Beryllium (Be)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron (B)	mg/L	3.75	3.79	2.24	2.35	0.78	0.74
Cadmium (Cd)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium (Ca)	mg/L	31.8	25.3	35.2	40.3	31.6	29.9
Chromium (Cr)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper (Cu)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe)	mg/L	0.21	0.06	0.02	0.1	0.2	0.18
Lead (Pb)	mg/L	<0.01	0.01	0.03	0.01	<0.01	<0.01
Magnesium (Mg)	mg/L	146	138	61.1	69.4	41.6	38.7
Manganese (Mn)	mg/L	0.13	0.09	<0.01	<0.01	<0.01	0.02
Molybdenum (Mo)	mg/L	0.051	0.035	0.015	0.016	0.007	0.006
Nickel (Ni)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Potassium (K)	mg/L	17.1	16.9	17.6	18.2	7.4	6.8
Selenium (Se)	mg/L	0.02	0.03	0.02	0.02	<0.01	0.02
Sodium (Na)	mg/L	318	301	426	436	107	109
Vanadium (V)	mg/L	<0.001	<0.001	0.001	0.001	0.002	0.002
Zinc (Zn)	mg/L	0.02	0.01	0.02	<0.01	<0.01	<0.01
Acenaphthene	µg/L	0.79	1.2	<0.01	<0.01	0.83	0.97
Acenaphthylene	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	µg/L	0.02	0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	µg/L	0.09	0.06	<0.01	<0.01	<0.01	<0.01

Executive Summary

TEST RESULTS SUMMARY - GROUNDWATER CONTINUED

Anthesis Group Middle East, Fujairah 3
Fujairah 3 - Qidfa Expansion Project
20th - 21st January 2020

		Ground Water Results					
		Locations					
Parameter	Unit	BH5 - 1	BH5 - 2	BH10 - 1	BH10 - 2	BH13 - 1	BH13 - 2
Benzo(g,h,i)perylene	µg/L	0.04	0.03	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	µg/L	0.17	0.16	<0.01	<0.01	0.05	0.08
Dibenzo(a,h)anthracene	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	µg/L	0.03	0.07	<0.01	<0.01	0.05	0.06
Fluorene	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-c,d)pyrene	µg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	µg/L	4.679	3.95	<0.02	<0.02	<0.02	<0.02
Phenanthrene	µg/L	1.54	1.88	<0.01	<0.01	0.65	0.73
Pyrene	µg/L	0.04	0.07	<0.01	<0.01	0.33	0.4
2,2',3,3',4,4' - Hexachlorobiphenyl (PCB 128)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,3',4,4',5 - Heptachlorobiphenyl (PCB 170)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,3',4,4',5,5',6,6' - Decachlorobiphenyl	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (PCB 206)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,3',4,4',5,6 - Octachlorobiphenyl (PCB 195)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,4',5,5',6 - Heptachlorobiphenyl (PCB 187)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,4,4',5' - Hexachlorobiphenyl (PCB 138)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,4,4',5,5' - Heptachlorobiphenyl (PCB 180)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,5' - Tetrachlorobiphenyl (PCB 44)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',4,4',5,5' - Hexachlorobiphenyl (PCB 153)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',4,5,5' - Pentachlorobiphenyl (PCB 101)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',5,5' - Tetrachlorobiphenyl (PCB 52)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2`,5 - Trichlorobiphenyl (PCB 18)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3',4,4' - Tetrachlorobiphenyl (PCB 66)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3',4,4',5 - Pentachlorobiphenyl (PCB 118)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3,3',4,4' - Pentachlorobiphenyl (PCB 105)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,4' - Dichlorobiphenyl (PCB 8)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,4,4' - Trichlorobiphenyl (PCB 28)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
3,3',4,4' - Tetrachlorobiphenyl (PCB 77)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
3,3',4,4',5 - Pentachlorobiphenyl (PCB 126)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Executive Summary

TEST RESULTS SUMMARY - SOIL

Anthesis Group Middle East, Fujairah 3
Fujairah 3 - Qidfa Expansion Project
20th - 21st January 2020

Soil Results

The below table presents a summary of the results obtained from the soil monitoring campaign.

		Soil Results					
		Locations					
Parameter	Unit	BH5 - 0.5m	BH5 - 1.0m	BH10 - 0.5m	BH10 - 1.0m	BH13 - 0.5m	BH13 - 1.0m
Chloride (Acid soluble)	%	0.02	0.01	0.02	0.04	0.01	0.01
Fluoride	mg/kg	0.6	0.6	0.9	1	<0.5	<0.5
Nitrate	mg/kg	5.31	<0.22	3.28	3.98	<0.22	<0.22
Nitrite	mg/kg	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Orthophosphate	mg/kg	0.6	1.2	1.1	1.2	4.4	5.5
Benzene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ethyl benzene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
m&p-Xylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o-Xylene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	%	0.68	1.07	0.13	0.15	0.13	0.16
VPH C5-C10	mg/kg	<0.05	0.05	<0.05	<0.05	<0.05	<0.05
EPH C10-C40	mg/kg	300	1310	<50	<50	<50	<50
Carbonate	%	15	15	14	15	14	19
Ammonia	mg/kg	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Ammonium	mg/kg	<0.32	<0.32	<0.32	<0.32	<0.32	<0.32
Nitrogen (Ammonia)	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
pH	pH units	7.7	7.6	8.3	8	8	8.1
Chromium (VI)	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium (III)	mg/kg	70.7	77.8	126	108	127	111
Mercury (Hg)	mg/kg	<0.010	<0.010	0.012	<0.010	<0.010	<0.010
Arsenic (As)	mg/kg	4.4	4.1	18.7	16.6	22.4	19.5
Barium (Ba)	mg/kg	35.6	36.9	14.8	16.9	11.3	12.5
Beryllium (Be)	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron (B)	mg/kg	39.6	45.5	64.4	52.8	37.2	35.7
Cadmium (Cd)	mg/kg	0.6	0.7	<0.5	<0.5	<0.5	<0.5
Calcium (Ca)	mg/kg	107000	109000	101000	98400	169000	183000
Chromium (Cr)	mg/kg	70.7	77.8	126	108	127	111
Copper (Cu)	mg/kg	101	149	31.6	34.4	14.4	17.3
Iron (Fe)	mg/kg	43100	48900	30800	30500	26500	24100
Lead (Pb)	mg/kg	52.8	77.6	2.3	2.2	2.7	2.9
Magnesium (Mg)	mg/kg	25000	26100	72200	64400	87400	76200
Manganese (Mn)	mg/kg	393	420	354	346	296	281
Molybdenum (Mo)	mg/kg	<3.0	3.1	<3.0	<3.0	<3.0	<3.0
Nickel (Ni)	mg/kg	138	148	460	415	697	628
Potassium (K)	mg/kg	1010	1000	581	702	319	349
Selenium (Se)	mg/kg	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Sodium (Na)	mg/kg	2040	1870	2170	2180	1860	2040
Vanadium (V)	mg/kg	296	336	63.7	81.8	34.9	33.5
Zinc (Zn)	mg/kg	695	1040	130	199	23.1	22.7
Acenaphthene	mg/kg	<0.01	0	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	mg/kg	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	mg/kg	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	0.02	0	<0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	mg/kg	0.02	0.02	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

*ND - Non Detected

Executive Summary

TEST RESULTS SUMMARY - SOIL CONTINUED

Anthesis Group Middle East, Fujairah 3
Fujairah 3 - Qidfa Expansion Project
20th - 21st January 2020

		Soil Results					
		Locations					
Parameter	Unit	BH5 - 0.5m	BH5 - 1.0m	BH10 - 0.5m	BH10 - 1.0m	BH13 - 0.5m	BH13 - 1.0m
Chrysene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	mg/kg	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-c,d)pyrene	mg/kg	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	mg/kg	<0.01	0.04	<0.01	<0.01	<0.01	<0.01
Pyrene	mg/kg	<0.01	0.03	<0.01	<0.01	<0.01	<0.01
2,2',3,3',4,4' - Hexachlorobiphenyl (PCB 128)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,3',4,4',5 - Heptachlorobiphenyl (PCB 170)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,3',4,4',5,5',6,6' - Decachlorobiphenyl	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (PCB 206)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,3',4,4',5,6 - Octachlorobiphenyl (PCB 195)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,4',5,5',6 - Heptachlorobiphenyl (PCB 187)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,4,4',5' - Hexachlorobiphenyl (PCB 138)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,4,4',5,5' - Heptachlorobiphenyl (PCB 180)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',3,5' - Tetrachlorobiphenyl (PCB 44)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',4,4',5,5' - Hexachlorobiphenyl (PCB 153)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',4,5,5' - Pentachlorobiphenyl (PCB 101)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2',5,5' - Tetrachlorobiphenyl (PCB 52)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,2`,5 - Trichlorobiphenyl (PCB 18)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3',4,4' - Tetrachlorobiphenyl (PCB 66)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3',4,4',5 - Pentachlorobiphenyl (PCB 118)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3,3',4,4' - Pentachlorobiphenyl (PCB 105)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,4' - Dichlorobiphenyl (PCB 8)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,4,4' - Trichlorobiphenyl (PCB 28)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
3,3',4,4' - Tetrachlorobiphenyl (PCB 77)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
3,3',4,4',5 - Pentachlorobiphenyl (PCB 126)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Asbestos	-	ND	ND	ND	ND	ND	ND

Executive Summary

SITE PHOTOS

No Photography Permitted within F3 facility

APPENDIX CONTENTS

APPENDIX 1

ELEMENT MONITORING PERSONNEL

Position	Name
Engineer	Luke Prowse

LIST OF EQUIPMENT

Well Installation	
Equipment Type	**Equipment I.D.**
Hammer Drill	-
Drill bits	-
Hand Auger	-
Steel Casings	-
HDPE Tubing	-
HDPE End caps	-
Rod Puller	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Oil/water interphase probe	ENV-GW-7.01
Aquaread analyser	ENV-GW-3.02

Sampling Items	
Equipment Type	**Equipment I.D.**
Peristaltic Pump	ENV-GW-4.01
Bailers	-
Silicone Tubing	-
LDPE tubing	-
Bucket	-
Groundwater Filters	-
Sample Bottles	-

Appendix 2 – Methodologies and Data Analysis

Appendix 2-1 – Mott MacDonald Air Dispersion Study

MOTT MACDONALD

Fujairah F3 Independent Power Plant

Air Quality Feasibility Study

6 August 2019

Mott MacDonald
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Fujairah F3 Independent Power Plant

Air Quality Feasibility Study

6 August 2019

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	July 2019	James Brookes	Christopher Mills	Christopher Mills	Draft for comment
A	August 2019	James Brookes	Christopher Mills	Christopher Mills	Final

Document reference: 410042 |

Information class: Standard

Contents

1 Introduction

1.1 Overview

This report provides an assessment of the potential effects of the Fujairah F3 Independent Power Plant (IPP), hereafter referred to as the 'Project', on local air quality. This assessment has been carried out in accordance with national requirements and international guidelines and addresses the operational impacts resulting from emissions to air.

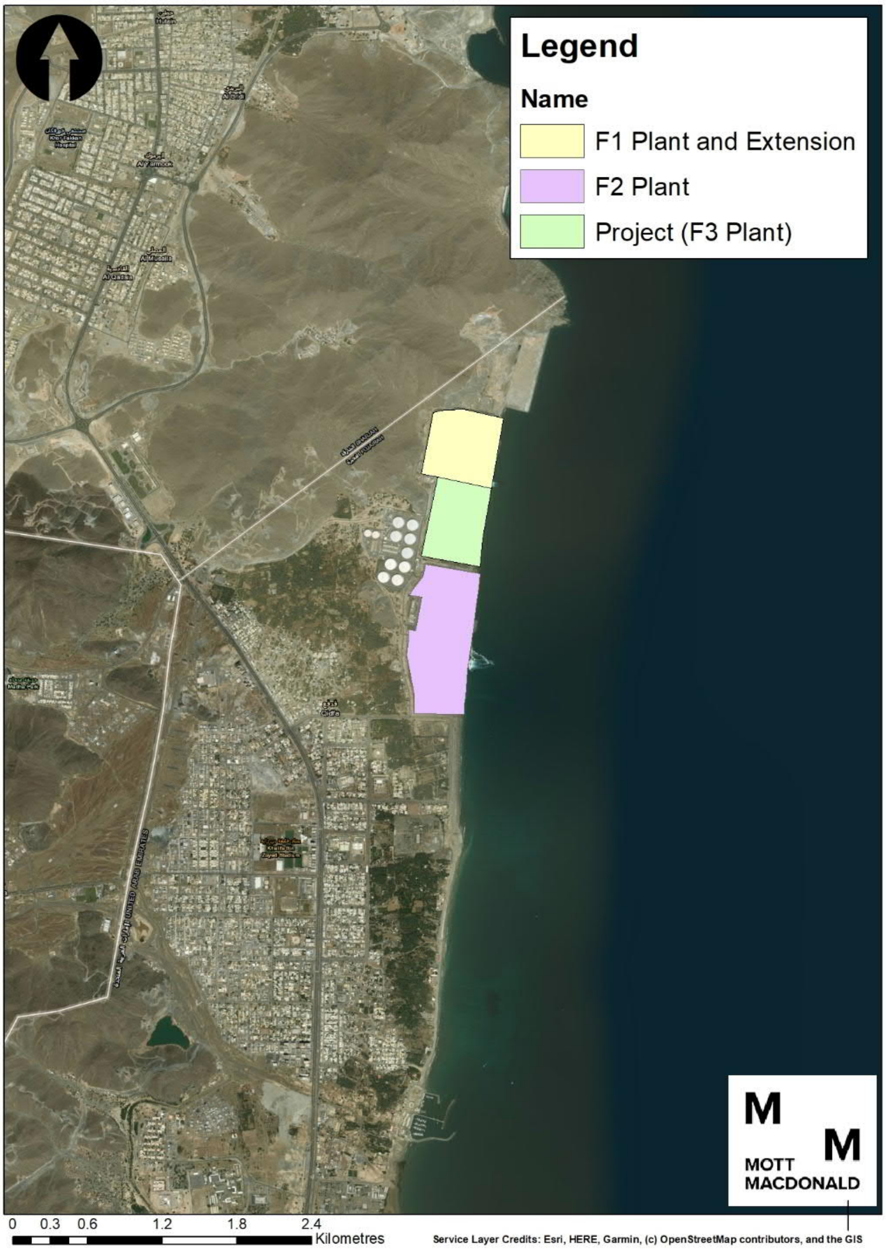
This assessment has been undertaken assuming the Project will consist of four gas turbines with associated heat recovery steam generators. It has been assumed the project will operate on either natural gas or fuel oil and the Project will have an electrical output of 2400MW when operating at full load.

The Project will be located between the existing operational Fujairah F1 and F2 Independent Water and Power Plants, hereafter referred to as F1 and F2. The location of the Project, F1 and F2 is presented in Figure 1.1. The locations of Project's exhaust stacks are subject to change once a final design is selected. The final location of the Project stacks, within the plant boundary, are unlikely to materially affect the modelled concentrations and therefore would not change the overall conclusions.

The effects associated with the construction phase have not been considered within this assessment. However, best practice mitigation measures in accordance with international best practice have been provided in Section 5. The correct implementation of these mitigation measures will reduce the risk of impacts during the construction phase and make them not significant.

This report provides a recommended stack height based on an assessment of potential impacts on air quality only. Amongst others, it does not take account of structural requirements, safety issues or associated regulations which should be considered by those using this information to develop the stack design.

Figure 1.1: Project location



1.2 Key pollutants

1.2.1 Overview

The combustion of fossil fuel gives rise to a number of pollutants with the potential to negatively affect local air quality. With respect to natural gas and fuel oil (the proposed fuels for the Project), the primary pollutants of concern are:

- Oxides of nitrogen (NO_x)
- Carbon monoxide (CO)
- Sulphur dioxide (SO_2)
- Particulate matter (PM)

1.2.2 Oxides of nitrogen

Oxides of nitrogen is a term commonly used to describe a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2), referred to collectively as NO_x. These are primarily formed from atmospheric and fuel nitrogen as a result of high temperature combustion. The major sources in most countries are road traffic and power generation.

During the process of combustion, atmospheric and fuel nitrogen is partially oxidised via a series of complex reactions to NO. The process is dependent on the temperature, pressure, oxygen concentration and residence time of the combustion gases in the combustion zone.

Most NO_x exhausting from a combustion process is in the form of NO, which is a colourless and tasteless gas. It is readily oxidised to NO_2, a more harmful form of NO_x, by chemical reaction with ozone and other chemicals in the atmosphere.

1.2.3 Carbon monoxide

CO is a colourless, odourless gas produced by the incomplete combustion of carbon-based fuels, such as natural gas and fuel oil, and by biological and industrial processes. The major source of carbon monoxide is traffic, particularly in urban areas. CO is produced under conditions of inefficient combustion, is rapidly dispersed away from the source and is relatively inert over the timescales relevant for its dispersion. CO has always been present as a minor constituent of the atmosphere, chiefly as a product of volcanic activity but also from natural and man-made fires and the burning of fossil fuels.

1.2.4 Sulphur dioxide

Sulphur dioxide (SO_2) is a colourless, non-flammable gas with an odour that irritates the eyes and air passages. It reacts on the surface of a variety of airborne solid particles, is soluble in water and can be oxidised within airborne water droplets. The most common sources of SO_2 include fossil fuel combustion, smelting, manufacture of sulphuric acid, conversion of wood pulp to paper, incineration of waste and production of elemental sulphur. Coal burning is the single largest man-made source of SO_2, accounting for about 50% of annual global emissions, with oil burning accounting for a further 25-30%.The most common natural source of SO_2 is volcanoes.

The project will not lead to emissions of sulphur dioxide (SO_2) when firing on natural gas). Comparison of expected SO_2 emission concentration levels calculated from natural gas sulphur content shows that SO_2 emissions from the existing F2 are negligible. In addition, fuel samples undertaken during the commissioning phase of F2 confirmed that there were no monitored concentrations of H_2S or sulphur in the gas supply. Assuming that the gas supply for the Project would be the same or similar to F2, it is anticipated that there would only be trace levels in the natural gas supplied to the Project. Therefore, SO_2 emissions have not been considered further when firing on natural gas.

Analysis of the fuel oil to be supplied to the Project shows that the sulphur content of the fuel is low and at maximum would be 10ppm. Nevertheless, SO_2 emissions when firing on fuel oil have been considered in this assessment.

1.2.5 Particulate matter

When firing on natural gas, particulate emissions are not significant but have the potential to be significant when firing on fuel oil. The desert conditions of the Project location suggest natural levels of PM_{10} and coarse particulate are already elevated. This is likely to increase the particulate loading on the turbine inlets which may, in turn, lead to higher particulate emissions. An increase in particulate loading is undesirable due to the detrimental effects on NO_X control.

This is normally overcome with higher specification air inlet filters. PM_{10} emissions at the exhaust therefore tend to be lower than the particulate loading on the gas turbine inlets. On this basis, emission of particulate matter have not been considered further in this assessment but its inclusion should be reconfirmed at EIA stage when more details of the Project design are available.

2 Legislative Framework

2.1.1 Emission standards

2.1.1.1 National Standards

Emission standards applicable to the United Arab Emirates (UAE) are set out in Federal Law No. (12) of 2006 on Air Quality and Regulation and are presented in Table 2.1.

Table 2.1: Relevant emission standards as per Federal Law No. (12) of 2006 on Air Quality and Regulation

Pollutant	UAE Max. Emission limits - stationary sources (mg/Nm^3)
NO_x (Expressed as NO_2)	Turbine combustion units: • Gas fuel: 70 • Liquid fuel: 150
SO_2	500
CO	500
Total suspended particulate	250

Source: Federal Law No. (12) of 2006
Note: Reference conditions: dry, 0^{o}C, 1 atmosphere, 15% O_2

In addition to the above emission standards in Table 2.1 Federal Law No. (12) of 2006 regarding the Protection of Air Pollution makes provision for regulation of sulphur content in fuel oil. Specifically, Article 4 states that *"all parties are required to take all the precautionary measures to reduce the pollutants resulting from burning as follows".* The relevant text states:

"It is prohibited to use diesel containing more than 0.05 % in weight sulphur provided that the competent authorities in each emirate sets the transitional policies, the work plans, and detailed mechanisms for its gradual replacement with clean fuel in order to arrive at the internationally approved percentage of 10 ppm in weight in coordination with the producing authority in the country." In alignment with this standard, all fuel oils used will have to contain a sulphur content of less than 0.5%.

2.1.1.2 International Standards

The IFC Performance Standard 3: Resource Efficiency and Pollution Prevention aims:

"To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities" To achieve this, the IFC provides both industry-specific and general guidance on Good International Industry Practice with respect to ambient air quality and emissions to air.

The IFC Environmental Health and Safety (EHS) General Guidelines advise that, with respect to emission limits, when host country regulations differ from the levels presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent (It should be noted that the same approach does not apply to ambient concentrations, as described below).

Relevant IFC standards for emissions to air applicable for gas turbines over 50MWth using natural gas, and fuels other than natural gas, are presented in the IFC EHS Guidelines for Thermal Power Plants 2008.

The IFC standards are presented in Table 2.2 below. Emission limits for CO are not prescribed by the EHS Guidelines for Thermal Power Plants.

Table 2.2: Pollutant emissions limit values for all turbine units > 50MWth input

Fuel	Pollutant	IFC Guidelines	
		Non-Degraded airshed	Degraded airshed
Natural gas	NO_x	51 mg/Nm^3	51 mg/Nm^3
Fuels other than natural gas	NO_x	152 mg/Nm^3	152 mg/Nm^3
	PM	50 mg/Nm^3	30 mg/Nm^3
	SO_2	Use 1% sulphur fuels or less	Use 0.5% sulphur fuels or less

Notes: Reference conditions: dry, 0ºC, 1 atmosphere, 15% O_2
Source: Environmental, Health and Safety Guidelines for Thermal Power Plants, IFC 2008.

2.1.2 Ambient standards

2.1.2.1 National standards

Ambient air quality standards applicable to the United Arab Emirates (UAE) are set out in Federal Law No. (12) of 2006 on Air Quality and Regulation and are presented in Table 2.3.

2.1.2.2 International standards

The IFC EHS Guidelines advise that 'relevant standards' with respect to ambient air quality are national legislated standards or, in their absence, the current World Health Organisation (WHO) Air Quality Guidelines or other internationally recognised sources such as those adopted in the European Union. EU standards are presented alongside national requirements in Table 2.3.

Where a host country's legislated standards are less stringent than either the WHO or other internationally recognised sources, the IFC acknowledge that it is acceptable to use the national legislated standards as the principal standards that the project is assessed against.

The IFC EHS Guidelines suggest that, as a general rule, emissions should not contribute more than 25 percent of the relevant air quality standards to allow additional, future sustainable development in the same airshed. It also states that projects located within poor quality airsheds (if the nationally legislated standards are exceeded significantly), should ensure that any increase in pollution is as small as feasible, and amounts to a fraction of the applicable short term and annual average air quality guidelines established in the project-specific environmental assessment.

The impacts of the Project have been discussed in the context of this approach.

2.1.3 Summary

Table 2.3 provides a summary of the ambient air quality standards (AQS) that have been applied to the proposed Project.

The standards related to short term averaging periods (one hour and 24 hour) are maximum values. In many jurisdictions, such as the United States and Europe, short term standards are not set as having maximum values but rather include a threshold of tolerance to account for exceptional, worst case episodes. In practice this means defining a number of allowable occurrences greater than the prescribed value to account for potential abnormal or infrequent pollutions episodes - these are often referred to the guideline values being applied as percentiles. For example, in the EU the standard for the one-hour NO_2 allows for 18 exceedances within a calendar year and therefore the objective level is expressed as the

99.79th percentile. When analysing one-hour NO_2 results, which is the primary pollutant of concern, the maximum result has been presented and compared against national standards as maximum values and using the 99.79th percentile. This provides additional context around the results to account for outliers and results which are influenced by infrequent meteorological conditions.

It should be noted that the AQS only apply in locations of relevant exposure i.e. where members of the public might reasonably be exposed to pollutants for the respective averaging periods.

Table 2.3: Ambient air quality standards relevant to the Project

Pollutant	Averaging Period	UAE Standards [(a)] (μg/m³)	EU Standards (μg/m³)
NO_2	1 hour	400	200 to be achieved 99.79% of the year
	24 hour	150	-
	Annual	-	40
SO_2	1 hour	350	350 to be achieved 99.73%
	24 hour	150	125 to be achieved 99.18% of the year
	Annual	60	-
CO	1 hour	30 000	-
	8 hour	10 000	10 000 (8 hour rolling average)

Source: Federal Law No. (12) of 2006, as amended; EU Directive 2008/50/EC on ambient air quality and cleaner air for Europe.

3 Assessment Methodology

3.1 Overview

This section provides an overview of the assessment approach taken and the inputs used within the dispersion modelling.

3.2 Dispersion model

A number of commercially available dispersion models are able to predict ground level concentrations arising from emissions to atmosphere from elevated point sources such as a power plant. A new generation dispersion model - AERMOD (executable version 18081) was used to inform the basis of the air quality assessment. A model description is included below.

A committee, AERMIC (the American Meteorological Society / Environmental Protection Agency Regulatory Model Improvement Committee), was formed to introduce state-of-the-art modelling concepts into the US Environmental Protection Agency's local-scale air quality models. AERMIC's focus was on a new platform for regulatory steady-state plume modelling. AERMOD was designed to treat both surface and elevated sources in simple and complex terrain.

Special features of AERMOD include its ability to treat the vertical heterogeneity nature of the planetary boundary layer, special treatment of surface releases, irregularly-shaped area sources and limitation of vertical mixing in the stable boundary layer.

AERMOD is a modelling system with three separate components and these are as follows:

- AERMOD (AERMIC Dispersion Model)
- AERMAP (AERMOD Terrain Pre-processor)
- AERMET (AERMOD Meteorological Pre-processor).

AERMET is the meteorological pre-processor for AERMOD. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings. Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

AERMAP is a terrain pre-processor designed to simplify and standardise the input of terrain data for AERMOD. Input data include receptor terrain elevation data. For each receptor, the output includes a location and height scale, which is an elevation used for the computation of air-flow around hills.

3.3 Stack height determination

The purpose of a stack height determination is to calculate the height necessary to ensure that emissions from a stack do not result in excessive ground level concentrations of air pollutants as a result of atmospheric downwash, eddies or wakes which may be created by nearby structures or terrain.

Nearby structures are normally the dominant cause of any atmospheric downwash, eddies or wake effects. For proper dispersion to occur it is necessary for the emissions to be released well above the top of nearby structures. Dispersion of emissions from a stack is also determined by the emission characteristics of the source, particularly their temperature and speed when they exit the stack.

A number of methods are available to determine an appropriate stack height, including simple equations and dispersion modelling. In this case the stack height has been determined by dispersion modelling as detailed below.

The results of the stack height determination are presented in Appendix A and concluded that a stack height of 70 metres is appropriate. Modelling has been undertaken assuming this stack height for the future operating situations.

It is expected that if the Project were to operate in open cycle mode and had its own bypass stack, the impacts would be lower than in when operating in combined cycle. The appropriate height for a bypass stack is usually lower than the main stack. A stack height determination should be undertaken during the EIA stage of the Project, when a more detailed design is available, to assess the optimum height for the bypass stack.

3.4 Baseline conditions

Following the approach specified in the IFC EHS Guidelines for Thermal Power Plants 2008, the existing power plants have been specifically modelled in order to provide baseline concentrations and to assess the incremental impact of the Project. This approach allows identification of areas of cumulative impacts from several sources which may not be accounted for in monitoring results. The results of the baseline modelling assessment are presented in section 4.

3.5 Current and future operating scenarios

To put the future operation of the Project into context, the existing F1 and F2 have been modelled to establish a baseline, F3 in isolation firing on natural gas and fuel oil and all cumulatively on natural gas.

The following situations have been assessed:

- Scenario 1 – The baseline from operation of F1 and F2 firing on natural gas continuously all year.
- Scenario 2 – The Project in isolation firing on natural gas continuously all year.
- Scenario 3 – The cumulative impacts from the operation of the Project, F1 and F2 firing on natural gas continuously all year.
- Scenario 4 – The Project in isolation firing on fuel oil continuously all year.

In all operating situations it has been conservatively assumed that all plant will operate at 100% plant load for the whole year to account for the worst case short term impacts. However, it is likely that, at various intervals, individual units or whole plants will not operate due to periods of shut down (planned or unplanned). Therefore, predicted annual mean impacts presented in this assessment are likely to be higher than will be experienced during the operation phase.

3.6 Emissions data

Emissions data for the Project have been provided by Fichtner for the purpose of this assessment. As the final configuration and size of the Project will only be determined when the tender process is finalised, worst case emissions data have been applied to this assessment. Emissions data for F1 and F2, operating on natural gas, have been based on information specified in the F1 and F2 EIAs.

Table 3.1 presents emission data for the Project and the existing F1 and F2. It should be noted that the stack height determination for the Project, presented in Appendix A, has been carried out for one unit only.

Table 3.1: Emission data

Parameter	F1 GT1-4	F1 Extension	F2 GT1+3	F2 GT2	Project (natural gas)	Project (fuel oil)
Actual Volumetric Flow (Am³/s)	481.0	860.2	684.5	683.8	1145.3	1271.3
Normalised Volumetric Flow (Nm^3/s)[(a)]	390.0[(b)]	536.3	486.1	486.8	1199.4	1232.2
Efflux Temperature (°C)	161.9	164.9	111.4	110.4	60.0	80.0
Efflux Velocity (m/s)	20.3	19.8	22.3	22.3	20.0	22.2
Stack Height (m)	55	55	65	65	70[(c)]	70[(c)]
Stack Diameter (m)	5.50	7.00	6.25	6.25	8.54	8.54
Stack coordinates (m)[(d)(e)]	X:436811 Y:2800068 X:436800 Y:2800011 X:436775 Y:2799875 X:436764 Y:2799818	X:436767 Y:2799540	X:436712 Y:279868 X:436705 Y:2798647 X: 436670 Y: 2798457 X: 436663 Y: 2798418	X:436687 Y:2798550	X:436952 Y:2799374 X:436945 Y:2799335 X:436923 Y:2799222 X:436916 Y:2799183	X:436952 Y:2799374 X:436945 Y:2799335 X:436923 Y:2799222 X:436916 Y:2799183
NO_x (mg/Nm^3)	60.0	60.0	60.0	60.0	20.0	120.0
NO_x (g/s)	23.4	38.3	29.2	29.2	24.0	147.9
CO (mg/Nm^3)	50.00	-	50.0	50.0	50.0	50.0
CO (g/s)	19.00	-	42.4	43.4	60.0	61.6
SO_2 (mg/Nm^3)	-	-	---	---	-	6.0
SO_2 (g/s)	-	-	---	---	-	7.4
Particulates (mg/Nm^3)	-	-	---	---	-	1.0
Particulates (g/s)	-	-	---	---	-	1.2

Notes: '-' means emissions are negligible
'---' Fuel oil only modelled for the Project
(a) Reference conditions: 15 °C, 1atm, Dry, 0°C
(b) Calculated using NOx mass emissions and concentration in F1 EIA
(c) See Appendix A Stack Height Determination
(d) Projection is Universal Transverse Mercator (UTM) Zone 40 North (WGS1984)
(e) The locations of Project's exhaust stacks are subject to change once a final design is selected. The final location of the Project stacks, within the plant boundary, are unlikely to materially affect the modelled concentrations and therefore would not change the overall conclusions.

3.7 Meteorological data

The most important meteorological parameters governing atmospheric dispersion of pollutants are wind direction, wind speed and atmospheric stability, as described below:

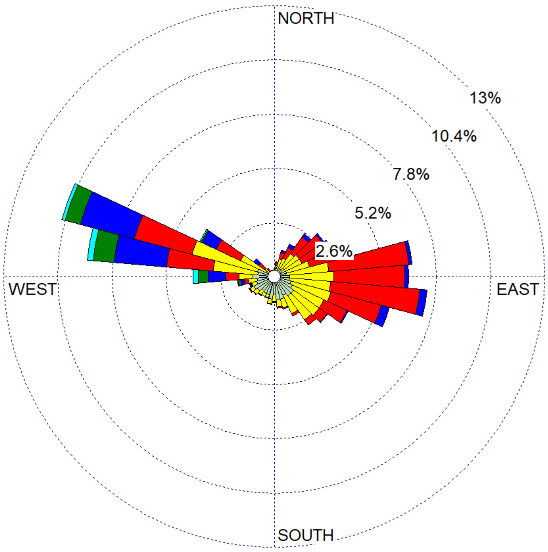
- Wind direction determines the sector of the compass into which the plume is dispersed
- Wind speed affects the distance which the plume travels over time and can affect plume dispersion by increasing initial dilution of pollutants and inhibiting plume rise
- Atmospheric stability is a measure of the turbulence of the air, and particularly of its vertical motion. It therefore affects the spread of the plume as it travels away from the source. New generation dispersion models use a parameter known as the Monin-Obukhov length that, together with wind speed, describes the stability of the atmosphere

For meteorological data to be suitable for dispersion modelling purposes, a number of meteorological parameters are measured on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature.

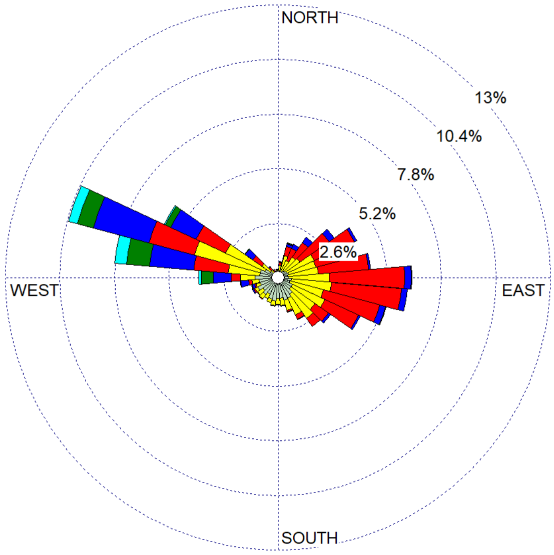
The closest meteorological station to the Project with suitable available data is at Fujairah International Airport approximately 22 kilometres to the south of the Project site. The data is considered representative of conditions expected at the proposed project site due to the short distance between them.

Figure 3.1 presents wind roses of the meteorological data used within the assessment. The windroses illustrate that the dominant wind direction is from the west although there is a strong easterly component.

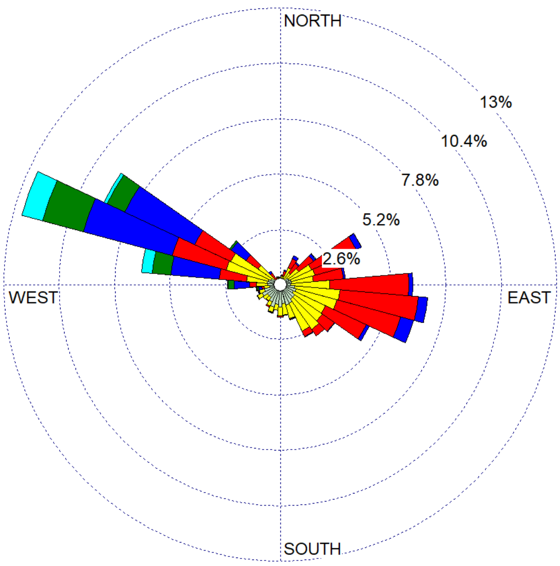
Figure 3.1: Windroses



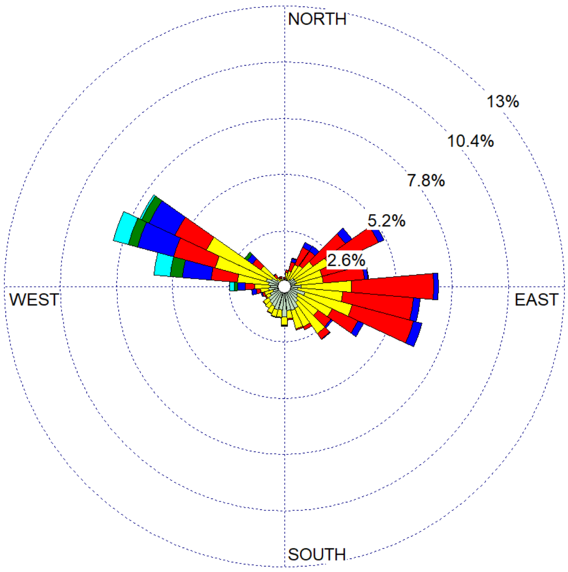
2014



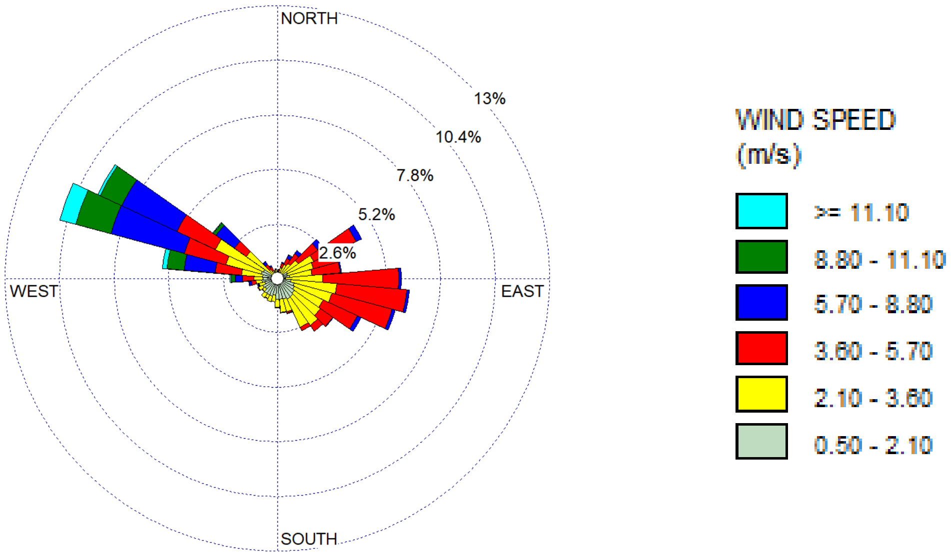
2015



2016



2017



2018 **Scale**

Note: Derived from Fujairah International Airport

3.8 Modelled receptors

3.8.1 Gridded receptors

This assessment has included modelling of pollutant concentrations across two Cartesian grids. The first grid has a receptor spacing of 100 metres and has been used for the first 2.5 kilometres from the Project site. The second grid has a spacing of 1000 metres and covers the area that is between five and 15 kilometres from the Project. These grids have been assumed to represent sensitive receptors which are likely to receive the largest change in concentrations of NO_2 associated with the Project.

The maximum impacts presented in section 5 are within approximately 1.5km of the Project site and are therefore fall within the higher resolution (100m spacing) grid.

3.8.2 Discrete receptors

A number of discrete receptors representing the closest sensitive receptors have been included within the model so that a comparison against the AQS can be made. Table 3.2 shows the locations of the discrete receptors considered within this assessment.

The presence of discrete Receptor 2 should be confirmed at EIA stage. For the purpose of this assessment it has been assumed that there is public exposure at the location known as Receptor 2 for durations respective to all averaging periods.

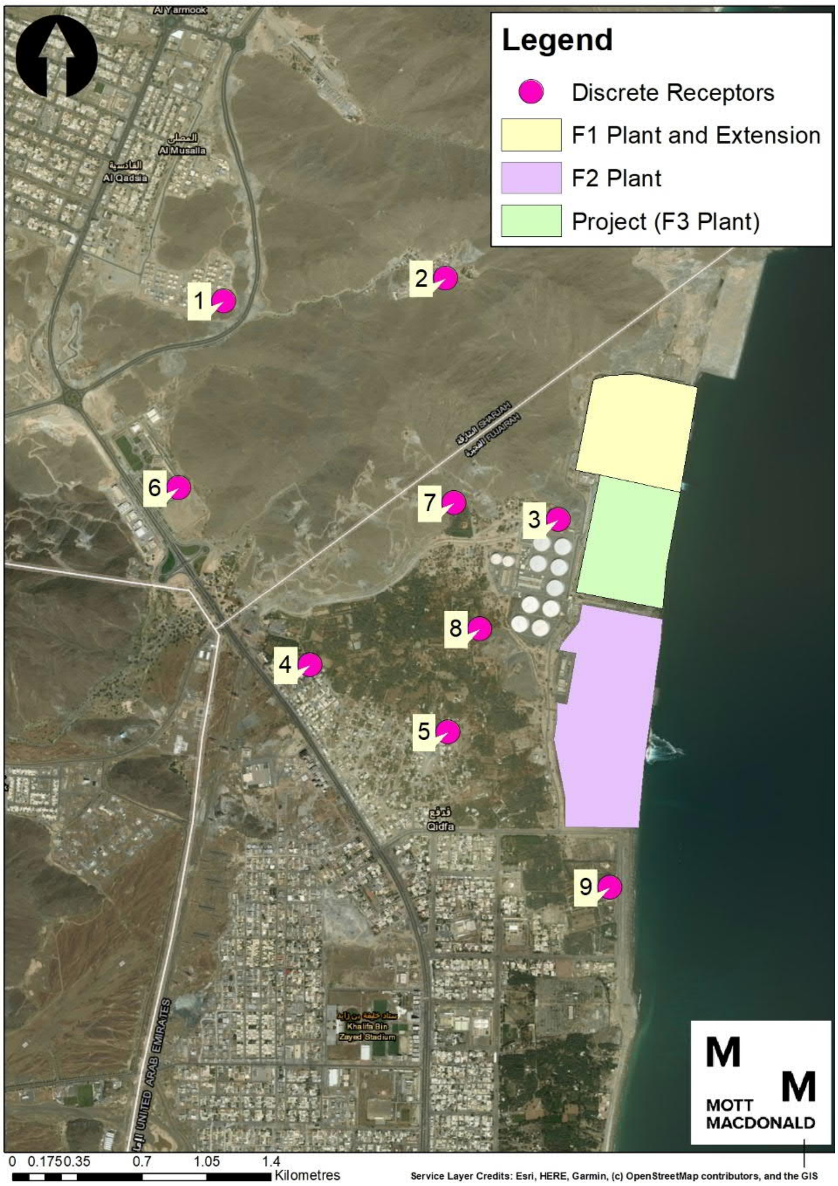
Table 3.2: Modelled human health receptors

Receptor number	X	Y	Height above sea level (m)
1	434653	2800609	33
2	435853	2800732	109
3	436464	2799428	10
4	435120	2798641	8
5	435867	2798278	7

Receptor number	X	Y	Height above sea level (m)
6	434412	2799600	14
7	435899	2799519	25
8	436040	2798836	4
9	436742	2797438	6

Note: Projection is Universal Transverse Mercator (UTM) Zone 40 North (WGS1984)

Figure 3.2: Modelled discrete receptors



3.9 Surface roughness and terrain

Roughness of the terrain over which a plume passes can have a significant effect on dispersion by altering the velocity profile with height, and the degree of atmospheric turbulence. This is accounted for in the meteorological data processing by a parameter called the 'surface roughness length'.

The surface roughness length within the study area has been calculated based on the land uses around the meteorological station and calculated within the AERMET meteorological processor.

The presence of elevated terrain can significantly affect (usually increase) ground level concentrations of pollutants emitted from elevated sources such as stacks, by reducing the distance between the plume centre line and ground level and increasing turbulence and, hence, plume mixing. Terrain has been incorporated into the model with a horizontal spatial resolution of 1 arc second (approximately 25m by 25m).

3.10 NO_x to NO_2 relationship

NO_x emissions associated with combustion sources such as gas turbines will typically comprise of approximately 90-95% NO and 5-10% NO_2 at source. The NO oxidises in the atmosphere in the presence of sunlight, ozone and volatile organic compounds to form NO_2, which is the principal pollutant of concern with respect to environmental health effects.

There are various techniques available for estimating the proportion of the NO_x that is converted to NO_2. A 50% conversion of NO_x to NO_2 has been assumed for short term averaging periods (1 hour and 24 hour), and 70% conversion for long term averages (annual). This approach is considered appropriate based on a range of international best practice guidance from countries such as the United Kingdom's Environment Agency (EA) and United States Environmental Protection Agency (USEPA).

3.11 Buildings and plant layout

The movement of air over and around buildings generates areas of flow circulation, which can lead to increased ground level concentrations in the building wakes. Building dimensions included within the dispersion model are presented in Table 3.3 and illustrated in Figure 3.3.

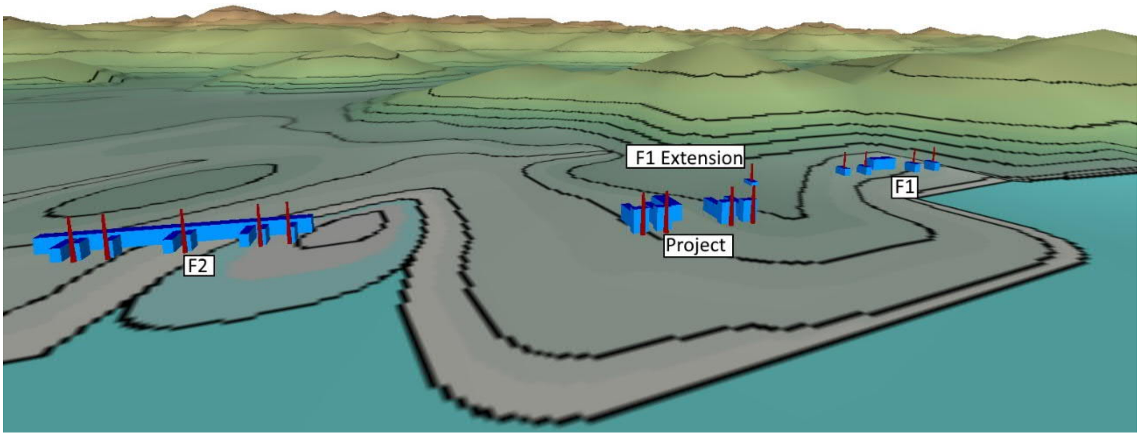
Table 3.3: Buildings included within dispersion model

Power Plant	Building	X	Y	Height (m)	Length (m)	Width (m)
F1	Steam Hall / Admin block	436733	2799931	25	64	27
F1	HRSG SCR1	436792	2800063	30	15	20
F1	HRSG SCR2	436782	2800006	30	15	20
F1	HRSG SCR3	436757	2799870	30	15	20
F1	HRSG SCR4	436746	2799813	30	15	20
F1	HRSG SCR5 (NEW)	436751	2799535	30	15	20
F2	Turbine Hall	436585	2798363	21	363	24
F2	HRSG1	436683	2798686	25	11	25
F2	HRSG2	436676	2798647	25	11	25
F2	HRSG3	436658	2798551	25	11	25
F2	HRSG4	436641	2798457	25	11	25
F2	HRSG5	436634	2798419	25	11	25
F2	ST1	436655	2798626	43	13	20
F2	ST2	436637	2798530	43	13	20
F2	ST3	436612	2798398	43	13	20
F3	Steam Turbine Hall	436820	2799261	65	28	33

Power Plant	Building	X	Y	Height (m)	Length (m)	Width (m)
F3	GT1 Hall	436869	2799383	60	15	30
F3	HRSG 1	436927	2799366	15	26	42
F3	GT2 Hall	436861	2799343	60	15	30
F3	HRSG 2	436919	2799327	15	26	42
F3	GT3 Hall	436840	2799230	60	15	30
F3	HRSG 3	436898	2799214	15	26	42
F3	GT4 Hall	436832	2799191	60	15	30
F3	HRSG 4	436890	2799175	15	26	42

Note: Projection is Universal Transverse Mercator (UTM) Zone 40 North (WGS1984)

Figure 3.3: Buildings included within dispersion model



4 Impact Identification

4.1 Overview

This section provides an overview of the likely impacts from the Project. It also presents the future baseline accounting for emissions from the combustion of natural gas from F1 and F2 and the likely cumulative impacts of all three plants operating simultaneously and the combustion of fuel oil from the Project in isolation.

As presented above, the assessed scenarios are:

- Scenario 1 – The baseline of the airshed based on the operation of F1 and F2 firing on natural gas continuously all year.
- Scenario 2 – The Project in isolation firing on natural gas continuously all year.
- Scenario 3 – The cumulative impacts from the operation of the Project, F1 and F2 firing on natural gas continuously all year.
- Scenario 4 – The Project in isolation firing on fuel oil continuously all year.

Contour plots for all scenarios have been presented in Appendix B.

The presence of discrete Receptor 2 should be confirmed at EIA stage. For the purpose of this assessment it has been assumed that there is residential exposure at the location known as Receptor 2.

4.2 Scenario 1 – Baseline

This scenario presents the existing baseline based on the operation of F1 and F2 firing on natural gas continuously all year.

Table 4.1 presents the maximum results from the modelled grids and indicates that the maximum baseline concentrations are above both the national and international AQS for NO_2.

Figure B.1 presents the one-hour maximum contour plot for scenario 1 which demonstrates that elevated concentrations coincide with uninhabited areas of complex terrain. Although elevated concentrations in breach of relevant standards are predicted over areas of complex terrain, NO_2 concentrations at inhabited areas at lower elevation which are representative of the majority of sensitive populations remain well below relevant AQS. The pattern of dispersion shown in the contour plot is similar to all other scenarios suggesting that the complex terrain is heavily influencing the dispersion of pollutants.

Table 4.2 presents the maximum baseline concentrations from the nine discrete receptors discussed in section 3.8.2. The receptor with the highest predicted concentrations is receptor two. Receptor two is located approximately 1.7km north west of the Project site at an elevation of 109m. At this location predicted concentrations do not exceed the relevant AQS, although they are much higher than those at lower elevations.

Table 4.1: Scenario 1 – Maximum predicted concentrations for comparison with relevant standards (μg/m^3)

Pollutant	Averaging period	PC	PC as a % of AQS	National standard
NO_2	Maximum 1 hour	3234.3	808.6	400
	1 hour 99.79th %ile[(a)]	3063.9	766.0	400

Pollutant	Averaging period	PC	PC as a % of AQS	National standard
	Maximum 24 hour	501.8	334.5	150
	Annual mean[b]	101.1	252.9	40
CO	Maximum 1 hour	6253.3	20.8	30000
	Maximum 8 hour	1988.6	19.9	10000

Note: [a] Percentile in accordance with allowances under EU standards – discussed in Section 2.1.3
[b] EU AQS
PC – process contribution

Table 4.2: Scenario 1 – Predicted NO_2 Concentrations at modelled discrete receptors for comparison with relevant standards (µg/m^3)

Receptor	Baseline concentrations (PC) (µg/m^3)					
	Maximum 1-hour NO_2	1 hour 99.79th %ile[a] NO_2	Maximum 24-hour NO_2	Annual mean NO_2 [b]	Maximum 1-hour CO	Maximum 8-hour CO
AQS	**400**	**400**	**150**	**40**	**30000**	**10000**
1	42.4	33.2	6.1	2.6	100.4	26.8
2	237.4	216.5	48.8	11.8	665.4	201.6
3	41.0	18.1	4.5	1.6	95.7	25.9
4	37.9	27.5	6.7	4.4	95.5	45.4
5	38.4	24.9	8.4	3.8	88.0	53.0
6	40.3	31.8	6.2	3.4	103.4	33.8
7	41.2	23.5	7.7	3.7	88.7	41.9
8	42.8	22.5	8.0	3.9	94.3	52.4
9	44.3	25.7	3.4	0.5	94.4	24.7

Note: [a] Percentile in accordance with allowances under EU standards – discussed in Section 2.1.3
[b] EU AQS
PC – process contribution

4.3 Scenario 2 – The Project operating on natural gas

This scenario presents the impacts from the Project in isolation and assumes continuous full load operation and natural gas firing.

Table 4.3 presents the Projects impacts at the maximum modelled gridded receptor outside the site boundary.

The Project's maximum predicted process contributions are above 25% of the national and international standards for all NO_2 and CO averaging periods. The application of the IFC's 25% rule is a suggested approach to allow future sustainable development in an airshed. Figure B.4 presents the one-hour maximum contour plot for scenario 2 which demonstrates that elevated concentrations coincide with uninhabited areas of complex terrain. The pattern of dispersion shown in the contour plot is similar to all other scenarios suggesting that the complex terrain is heavily influencing the dispersion of pollutants.

Table 4.4 presents the maximum process contributions from the Project at the nine discrete receptors discussed in section 3.8.2. The receptor with the highest predicted concentrations is receptor two. Receptor two is located approximately 1.7km north west of the Project site at an elevation of 109m. At this location predicted concentrations do not exceed the relevant standards, although they are much higher than those at lower elevations.

With the exception of concentrations predicted at Receptor 2, process contributions at sensitive receptors are below the IFC 25% rule for all averaging periods for both NO_2 and CO. Therefore, the Project's process contributions are considered to meet the requirements of the IFC EHS guidelines given that the concentrations above 25% of the standard are isolated to areas of complex terrain which includes the location of Receptor 2 which is representative of a small population relative to the rest of the airshed and process contributions are not greater than the AQS at this location.

Table 4.3: Scenario 2 – Maximum predicted concentrations for comparison with relevant standards (µg/m³)

Pollutant	Averaging period	PC	PC as a % of AQS	AQS
NO_2	Maximum 1 hour	2083.3	520.8	400
	1 hour 99.79th %ile[(a)]	1529.5	382.4	400
	Maximum 24 hour	282.6	188.4	150
	Annual mean[(b)]	38.1	95.2	40
CO	Maximum 1 hour	10421.4	34.7	30000
	Maximum 8 hour	2877.8	28.8	10000

Note: [(a)] Percentile in accordance with allowances under EU standards – discussed in Section 2.1.3
[(b)] EU AQS
PC – process contribution

Table 4.4: Scenario 2 – Predicted NO_2 Concentrations at modelled discrete receptors for comparison with relevant standards (µg/m³)

Receptor	Process contributions with percentage of AQS in parenthesis ()					
	Maximum 1-hour NO_2	1 hour 99.79th %ile[(a)] NO_2	Maximum 24-hour NO_2	Annual mean NO_2 [(b)]	Maximum 1-hour CO	Maximum 8-hour CO
AQS	**400**	**400**	**150**	**40**	**30000**	**10000**
1	29.8 (7.5)	18.9 (4.7)	3.5 (2.3)	1.1 (2.8)	149.3 (0.5)	42 (0.4)
2	**320 (80)**	**281.3 (70.3)**	51.8 (34.5)	7.4 (18.5)	1601 (5.3)	629.9 (6.3)
3	22.4 (5.6)	16.9 (4.2)	5.4 (3.6)	2.2 (5.5)	112.2 (0.4)	70.6 (0.7)
4	29.9 (7.5)	17 (4.3)	4.2 (2.8)	1.6 (4)	149.5 (0.5)	50.3 (0.5)
5	28.9 (7.2)	16.8 (4.2)	5 (3.3)	1.3 (3.3)	144.4 (0.5)	64.1 (0.6)
6	29.1 (7.3)	16.6 (4.2)	3.6 (2.4)	1.7 (4.3)	145.5 (0.5)	43.7 (0.4)
7	27.2 (6.8)	19.4 (4.9)	6.4 (4.3)	3.1 (7.8)	135.9 (0.5)	76.8 (0.8)
8	24.6 (6.2)	18.5 (4.6)	6.9 (4.6)	2.1 (5.3)	123.1 (0.4)	81.4 (0.8)
9	24.8 (6.2)	10.1 (2.5)	1.3 (0.9)	0.2 (0.5)	124.2 (0.4)	15.5 (0.2)

Note: [(a)] Percentile in accordance with allowances under EU standards – discussed in Section 2.1.3
[(b)] EU AQS
Bold text indicates that process contribution is greater than the IFC 25% rule

4.4 Scenario 3 – Cumulative impacts

This scenario presents the cumulative impacts associated with the operation of the Project in conjunction with F1 and F2 firing on natural gas continuously all year.

Table 4.5 presents the maximum results from the modelled grids for the modelled baseline, the Project in isolation and the cumulative operation of all three plants. The results indicate that the maximum cumulative concentrations will be above both the national and international AQS for NO_2. Cumulative concentrations of CO do not exceed the relevant AQS.

Figure B.7 presents the one-hour maximum contour plot for scenario 3 which demonstrates that elevated concentrations coincide with uninhabited areas of complex terrain. Although elevated concentrations in breach of relevant standards are predicted over areas of complex terrain, NO_2 concentrations at inhabited areas at lower elevation representative of the majority of sensitive populations remain well below relevant standards. The pattern of dispersion shown in the contour plot is similar to all other scenarios suggesting that the complex terrain is heavily influencing the dispersion of pollutants.

Table 4.6 presents the maximum baseline concentrations from the nine discrete receptors discussed in section 3.8.2. The receptor with the highest predicted concentrations is receptor two. Receptor two is located approximately 1.7km north west of the Project site at an elevation of 109m. At this location the predicted 1-hour maximum concentration does not exceed the AQS of 400µg/m^3.

Table 4.5: Scenario 3 – Comparison with legislated UAE standard and relevant international standards (µg/m^3)

Pollutant	Averaging period	Baseline (scenario 1)	Project (scenario 2)	Cumulative	AQS
NO_2	Maximum 1 hour	3234.3	2083.3	4254.5	400
	1 hour 99.79th %ile[(a)]	3063.9	1529.5	3892.7	400
	Maximum 24 hour	501.8	282.6	784.4	150
	Annual mean[(b)]	101.1	38.1	137.5	40
CO	Maximum 1 hour	6253.3	10421.4	12570.8	30000
	Maximum 8 hour	1988.6	2877.8	4012.3	10000

Note: [(a)] Percentile in accordance with allowances under EU standards – discussed in Section 2.1.3
[(b)] EU AQS

Table 4.6: Scenario 3 – Predicted NO_2 concentrations at modelled discrete receptors for comparison with relevant standards (µg/m^3)

Receptor	Predicted cumulative concentrations (µg/m^3)					
	Maximum 1-hour NO_2	1 hour 99.79th %ile[(a)] NO_2	Maximum 24-hour NO_2	Annual mean NO_2 [(b)]	Maximum 1-hour CO	Maximum 8-hour CO
AQS	**400**	**400**	**150**	**40**	**30000**	**10000**
1	69.6	52.8	9.6	3.7	227.8	60.3
2	385.5	346.0	84.9	19.2	1610.6	663.1
3	61.7	22.1	9.5	3.7	197.1	85.1

Receptor	Predicted cumulative concentrations (μg/m^3)					
	Maximum 1-hour NO_2	1 hour 99.79th %ile[(a)] NO_2	Maximum 24-hour NO_2	Annual mean NO_2 [(b)]	Maximum 1-hour CO	Maximum 8-hour CO
4	62.6	40.8	9.8	6.0	211.2	76.8
5	57.2	41.5	11.7	5.1	187.0	89.1
6	65.4	45.6	9.4	5.0	216.4	67.3
7	58.7	35.8	11.8	6.7	174.1	89.6
8	61.0	31.0	11.0	6.0	185.1	85.2
9	66.2	36.3	4.2	0.8	204.2	36.8

Note: [(a)] Percentile in accordance with allowances under EU standards – discussed in Section 2.1.3
[(b)] EU AQS

4.5 Scenario 4 – The Project operating on fuel oil

This scenario presents the impacts from the Project in isolation and assumes continuous full load operation and fuel oil firing.

Table 4.7 presents the Projects impacts at the maximum modelled gridded receptor outside the site boundary.

The Project's maximum predicted process contributions are above 25% of the national and international standards for all NO_2 averaging periods and the 1 hour and 24 hour SO_2 averaging periods. Figure B.7Figure B.10 presents the 1-hour maximum contour plot for scenario 4 which demonstrates that elevated concentrations coincide with uninhabited areas of complex terrain. The pattern of dispersion shown in the contour plot is similar to all other scenarios suggesting that the complex terrain is heavily influencing the dispersion of pollutants.

Table 4.8 presents the maximum process contributions from the Project at the nine discrete receptors discussed in section 3.8.2. The receptor with the highest predicted concentrations is receptor two. Receptor two is located approximately 1.7km north west of the Project site at an elevation of 109m. At this location predicted concentrations do not exceed the relevant standards, although they are much higher than those at lower elevations.

Process contributions of the 1 hour and annual mean NO_2 and the 1hour SO_2 AQS at sensitive receptors are above IFC 25% rule. For SO_2 and for 24 hour and annual mean NO_2, this only occurs at Receptor 2, which as discussed above, is located in an area of complex terrain. However, predicted concentrations of SO_2 and NO_2, with the exception of 1 hour NO_2, are below all relevant AQS Receptor 2.

With the exception of 1-hour NO_2, predicted concentrations of all pollutants do not exceed the relevant AQS at sensitive receptor locations.

For NO_2, the Project's process contributions are above the 25% rule at the point of maximum impact and at a number of sensitive receptors.

Table 4.7: Scenario 4 – Maximum predicted concentrations for comparison with relevant standards (μg/m^3)

Pollutant	Averaging period	PC	PC as a % of AQS	AQS
NO_2	Maximum 1 hour	8006.6	2001.7	400
	1 hour 99.79th %ile[(a)]	6349.5	1587.4	400

Pollutant	Averaging period	PC	PC as a % of AQS	AQS
	Maximum 24 hour	1154.5	769.6	150
	Annual mean[b]	199.1	497.7	40
CO	Maximum 1 hour	6669.5	22.2	30000
	Maximum 8 hour	2444.0	24.4	10000
SO_2	Maximum 1 hour	801.2	228.9	350
	Maximum 24 hour	115.5	77.0	150
	Annual mean	14.2	23.7	60

Note: [a] Percentile in accordance with allowances under EU standards – discussed in Section 2.1.3
[b] EU AQS
PC – process contribution

Table 4.8: Scenario 4 – Predicted NO_2 Concentrations at modelled discrete receptors for comparison with relevant standards (µg/m^3)

Receptor	Process contributions with percentage of AQS in parenthesis ()								
	Max 1-hour NO_2	1 hour 99.79th %ile[(a)] NO_2	Max 24-hour NO_2	Annual mean NO_2 [(b)]	Max 1-hour CO	Max 8-hour CO	Max 1-hour SO_2	Max 24- hour SO_2	Annual mean SO_2
AQS	**400**	**400**	**150**	**40**	**30000**	**10000**	**350**	**150**	**60**
1	**120.5 (30.1)**	85.6 (21.4)	16.2 (10.8)	5.2 (13)	100.4 (0.3)	32.8 (0.3)	12.1 (3.5)	1.6 (1.1)	0.4 (0.7)
2	**1296.6 (324.2)**	**858.1 (214.5)**	**140.4 (93.6)**	**14.7 (36.8)**	1080.1 (3.6)	349.2 (3.5)	**129.8 (37.1)**	14.1 (9.4)	1 (1.7)
3	88 (22)	64.2 (16.1)	20.3 (13.5)	8.8 (22)	73.3 (0.2)	44.4 (0.4)	8.8 (2.5)	2 (1.3)	0.6 (1)
4	**118.1 (29.5)**	73.4 (18.4)	19 (12.7)	7 (17.5)	98.3 (0.3)	37.4 (0.4)	11.8 (3.4)	1.9 (1.3)	0.5 (0.8)
5	**109 (27.3)**	70.7 (17.7)	20.8 (13.9)	5.6 (14)	90.8 (0.3)	46.2 (0.5)	10.9 (3.1)	2.1 (1.4)	0.4 (0.7)
6	**120 (30)**	81.5 (20.4)	16.3 (10.9)	7.7 (19.3)	100 (0.3)	35 (0.4)	12 (3.4)	1.6 (1.1)	0.6 (1)
7	93.5 (23.4)	80.5 (20.1)	25.3 (16.9)	**12.2 (30.5)**	77.9 (0.3)	53.8 (0.5)	9.4 (2.7)	2.5 (1.7)	0.9 (1.5)
8	90.1 (22.5)	77 (19.3)	27.7 (18.5)	8.5 (21.3)	75.1 (0.3)	54.6 (0.5)	9 (2.6)	2.8 (1.9)	0.6 (1)
9	94.7 (23.7)	49 (12.3)	5 (3.3)	1.1 (2.8)	78.8 (0.3)	12.1 (0.1)	9.5 (2.7)	0.5 (0.3)	0.1 (0.2)

Note: [(a)] Percentile in accordance with allowances under EU standards – discussed in Section 2.1.3
[(b)] EU AQS
Bold text indicates that process contribution is greater than the IFC 25% rule

5 Mitigation and Enhancement Measures

5.1 Construction phase

The following mitigation measures (which are in accordance with the WBG General EHS Guidelines) for controlling air quality impacts will be incorporated into the construction phase to reduce construction impacts, particularly those associated with dust generation:

- Minimizing dust from material handling sources, such as conveyors and bins, by using covers and/or control equipment (water suppression)
- Minimizing dust from open sources, including storage piles, by using control measures such as installing enclosures and covers, and increasing the moisture content
- Dust suppression techniques should be implemented, such as applying water or non-toxic chemicals to minimise dust from vehicle movements
- Manage emissions from mobile sources as per the WBG General EHS Guidelines for Air Emissions and Ambient Air Quality
- No open burning of solid waste
- Development of a dust management plan for the construction and operational phases

Emissions from on-road and off-road vehicles should comply with national or regional programs. In the absence of these, the following should be considered:

- Regardless of the size or type of vehicle, owners / operators should implement the manufacturer recommended engine maintenance programmes
- Drivers should be instructed on the benefits of driving practices that reduced both the risk of accidents and fuel consumption, including measured acceleration and driving within safe speed limits
- Implement a regular vehicle maintenance and repair program.

5.2 Operation phase

The following key design features which have been accounted for in the modelling include:

- An exhaust stack height of 70 metres to ensure effective dispersion of emissions
- NOx emission limits[1] to meet
  - 20mg/Nm^3 when firing on natural gas
  - 120mg/Nm^3 when firing on fuel oil.

These emission limits meet those set by the UAE and by the IFC for degraded airsheds.

In accordance with the IFC EHS Guidelines, emissions of NO_x will be monitored continuously via a continuous emissions monitoring system.

In accordance with the IFC EHS Guidelines, ambient air quality monitoring will be required at two ambient monitoring stations and will be required to take account of the following:

- Continuously monitor ambient concentrations of NO_x and NO_2 in accordance with internationally recognised approach.

[1] Reference conditions: 15 °C, 1atm, Dry, 0°C

- Include a dispersion model ready meteorological station in accordance with US EPA guidance which can monitor wind speed, direction and temperature.
- Be subject to regular calibration procedures and audits to ensure proper function
- One to be located offsite at the point of maximum impacts as predicted by the dispersion modelling where human exposure is present.
- One to be located offsite in the populated area close to the site.

An air quality monitoring survey should be undertaken prior to the EIA to establish baseline ambient pollutant concentrations in the areas surrounding the Project site. The monitoring survey would be used in the EIA to further establish baseline conditions. The choice of pollutants to be monitored should include, but would not be limited to, NO_2 and SO_2.

6 Summary

This air quality assessment has demonstrated that:

- The Projects emissions meet the standards included within the IFC EHS Guidelines for Thermal Power Plants 2008 for use in degraded and non-degraded airsheds which are applicable for this Project.
- The assessment has considered the potential future baseline conditions in the airshed based on the operation of F2 and F2. Modelling suggests that concentrations of NO_2 and CO from F1 and F2 are below the relevant ambient standards in inhabited areas and the airshed will be non-degraded.
- Modelling has demonstrated that the proposed stack height of 70 metres is sufficient to overcome wake effects associated with building downwash.
- Modelled impacts of NO_2 from the Project in isolation firing on natural gas show that the Projects maximum process contribution will be well above the relevant AQS. Contour plots demonstrate that the highest concentrations are predicted in areas of complex terrain. Process contributions at most discrete receptors are below 25% of the relevant AQS.
- Modelled impacts of NO_2 from the Project in isolation firing on fuel oil show that the Projects maximum process contribution will be well above the relevant AQS. Contour plots demonstrate that the highest concentrations are predicted in areas of complex terrain. Process contributions at discrete receptors are above 25% of the relevant AQS.
- Modelled impacts of SO_2 from the Project in isolation firing on fuel oil show that the Projects maximum process contribution will be well above the relevant AQS for the 1 hour and 24 hour averaging periods and below 25% for the annual mean. Contour plots demonstrate that the highest concentrations are predicted in areas of complex terrain. Process contributions at discrete receptors, with the exception of Receptor 2, are below 25% of the relevant AQS.
- The assessment has demonstrated that the relevant standards at locations of human exposure are predicted to be achieved with F1, F2 and the Project all operating on natural gas continuously at full load all year.
- An air quality monitoring survey should be undertaken prior to the EIA to establish baseline ambient pollutant concentrations in the areas surrounding the Project site including at receptor 2.

Based on the findings of this assessment, during operation the Project would be required to

- Monitor emissions via a continuous emissions monitoring system.
- Monitor ambient concentrations of NOx and NO_2 continuously at two locations.

Appendices

A. Stack Height Determination

The stack height determination has assessed a range of stack heights to determine potential air quality impacts. Amongst others, it does not take account of structural requirements, safety issues or associated regulations which should be considered by those using this information to develop the stack design.

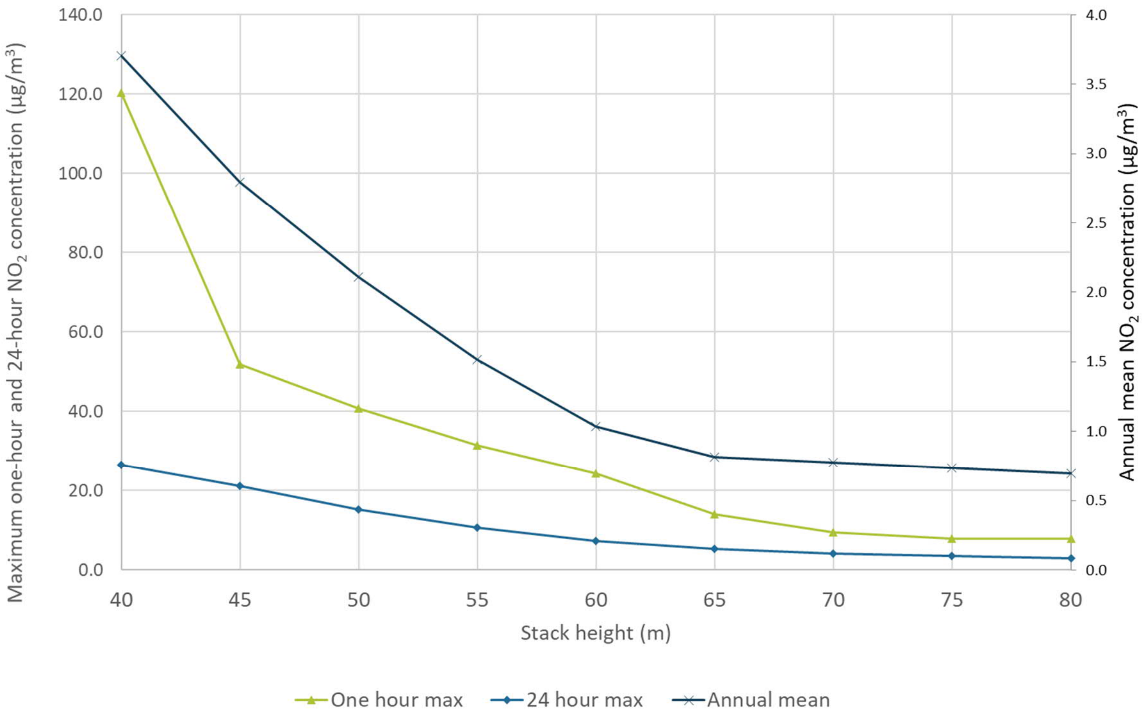
Table A.1 and Figure A.1 present the results of the stack height determination assuming full load operation of one unit firing on gas. As the purpose of the stack height determination is to calculate the point at which the exhaust gases overcome building downwash effects, complex terrain is not included. Therefore, the results presented here have not been compared to the AQS.

Modelled results indicate that a stack height of 70m is adequate to overcome building downwash as at heights beyond 70m there is no significant reduction in predicted ground level concentrations.

Table A.1 Maximum modelled ground level NO_2 concentrations based on one stack in operation ($\mu g/m^3$)

Averaging period	40	45	50	55	60	65	70	75	80
1 hour max	120.4	51.9	40.8	31.5	24.4	14.0	9.5	8.0	7.9
24 hour max	26.5	21.2	15.3	10.6	7.2	5.3	4.1	3.5	3.0
Annual	3.7	2.8	2.1	1.5	1.0	0.8	0.8	0.7	0.7

Figure A.1 Maximum modelled ground level NO_2 concentrations (µg/m³)



B. Contour Plots

This appendix presents the contour plots for NO_2 for all scenarios and SO_2 for scenario 4.

Scenario	Pollutant	Averaging period	Year	Minimum concentration (µg/m³)	Maximum concentration (µg/m³)	Interval (µg/m³)	Figure number
1	NO_2	Maximum 1 hour	2015	50	400	50	Figure B.1
		Maximum 24 hour	2018	25	150	25	Figure B.2
		Annual mean	2014	10	40	10	Figure B.3
2	NO_2	Maximum 1 hour	2015	50	400	50	Figure B.4
		Maximum 24 hour	2018	25	150	25	Figure B.5
		Annual mean	2014	10	40	10	Figure B.6
3	NO_2	Maximum 1 hour	2017	50	400	50	Figure B.7
		Maximum 24 hour	2018	25	150	25	Figure B.8
		Annual mean	2014	10	40	10	Figure B.9
4	NO_2	Maximum 1 hour	2014	50	400	50	Figure B.10
		Maximum 24 hour	2018	25	150	25	Figure B.11
		Annual mean	2014	10	40	10	Figure B.12
4	SO_2	Maximum 1 hour	2014	50	350	100	Figure B.13
		Maximum 24 hour	2018	25	150	25	Figure B.14
		Annual mean	2014	2	6	2	Figure B.15

Figure B.1: Scenario 1 - Maximum 1 hour NO_2 ($\mu g/m^3$)

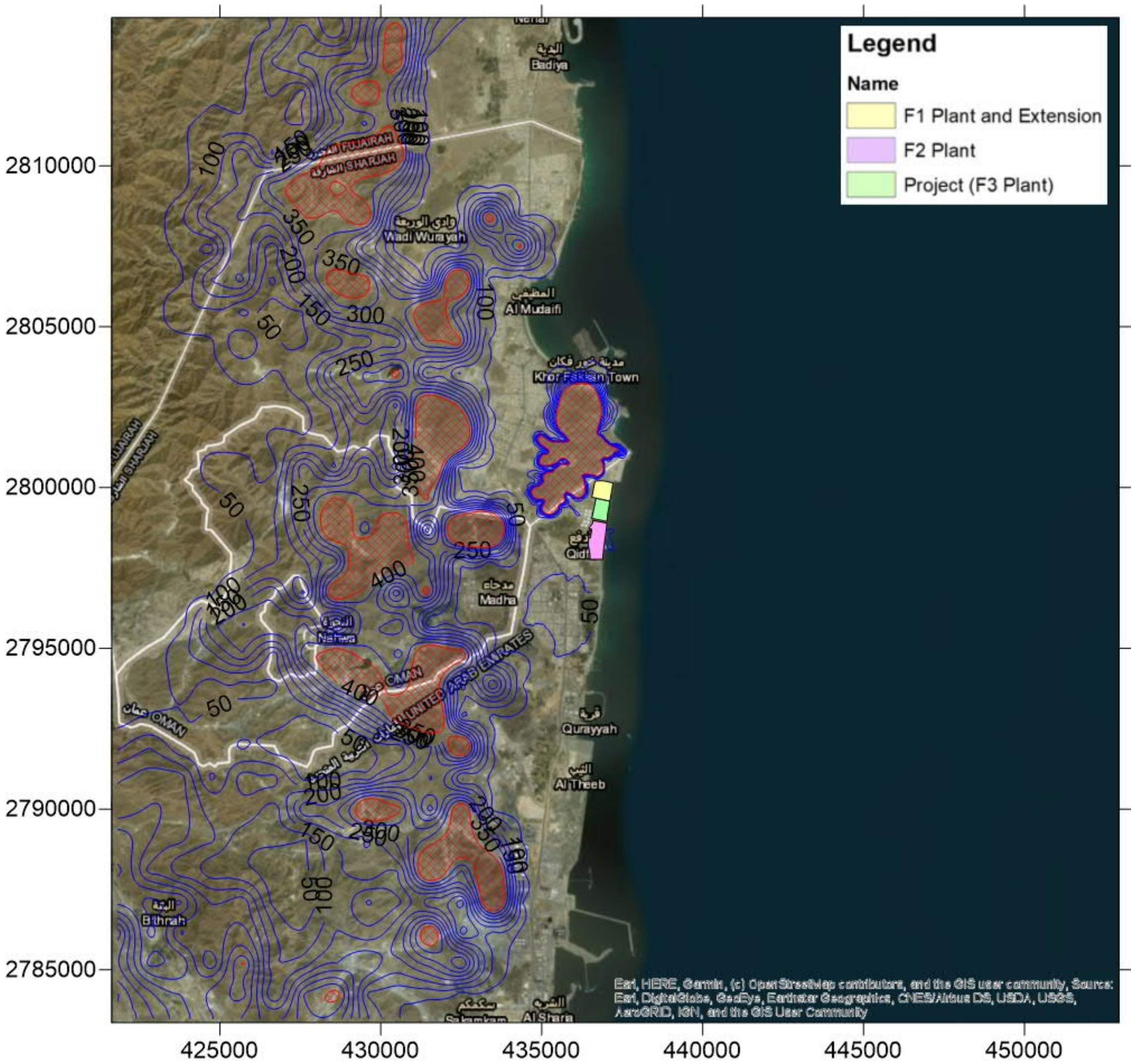


Figure B.2: Scenario 1 - Maximum 24 hour NO_2 (µg/m³)

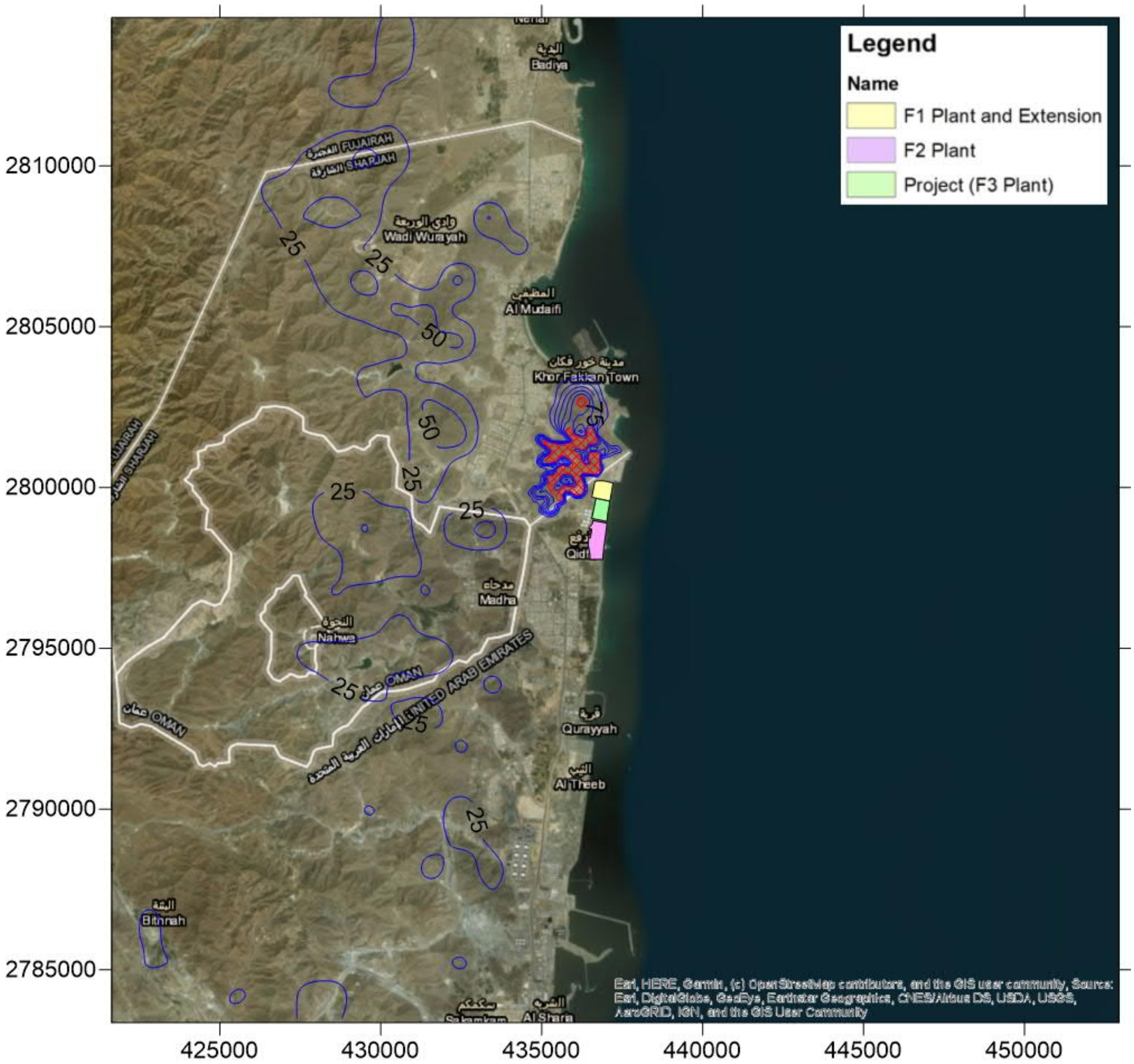


Figure B.3: Scenario 1 - Annual mean NO_2 (µg/m³)

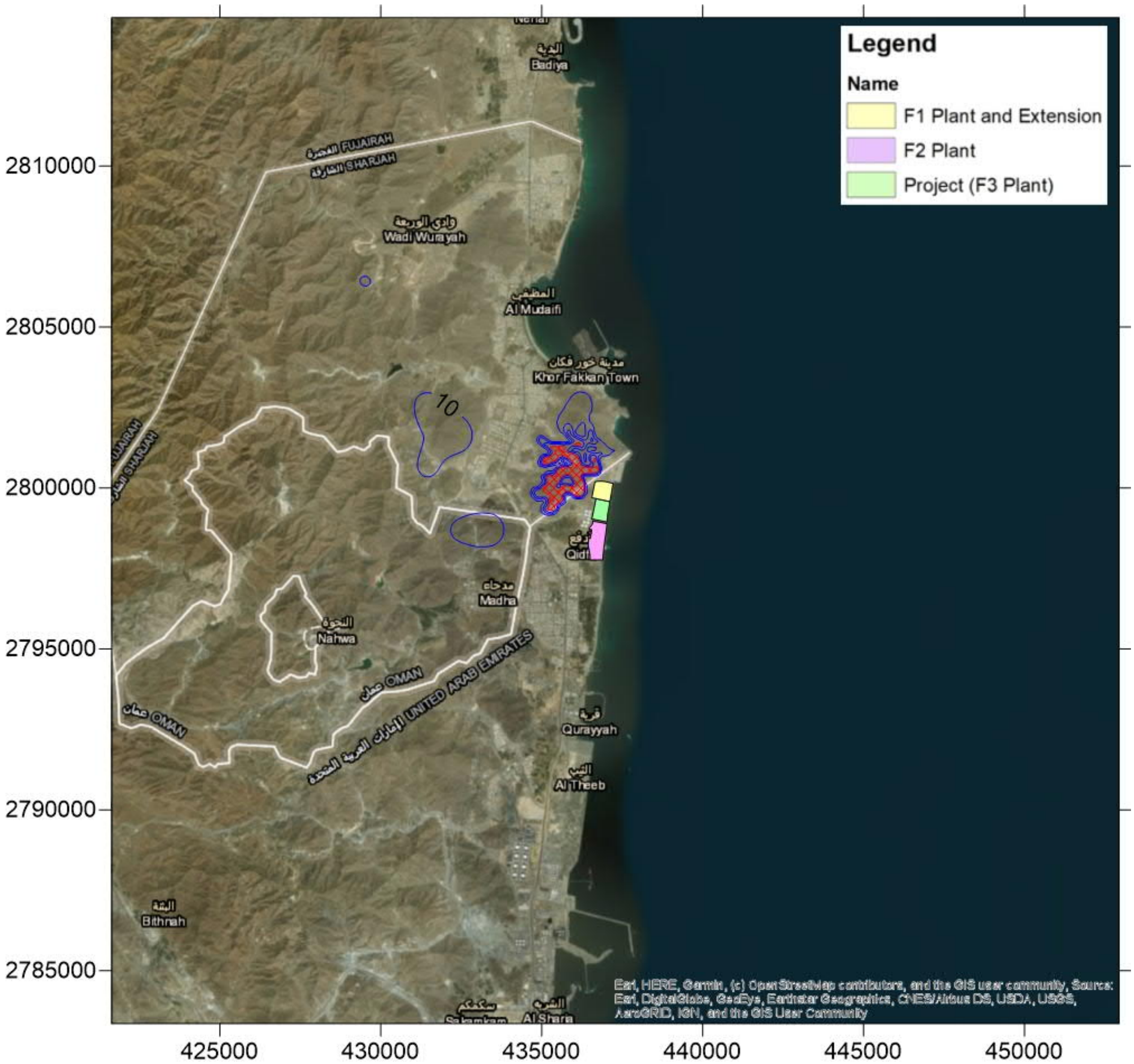


Figure B.4: Scenario 2 - Maximum 1 hour NO_2 (µg/m^3)

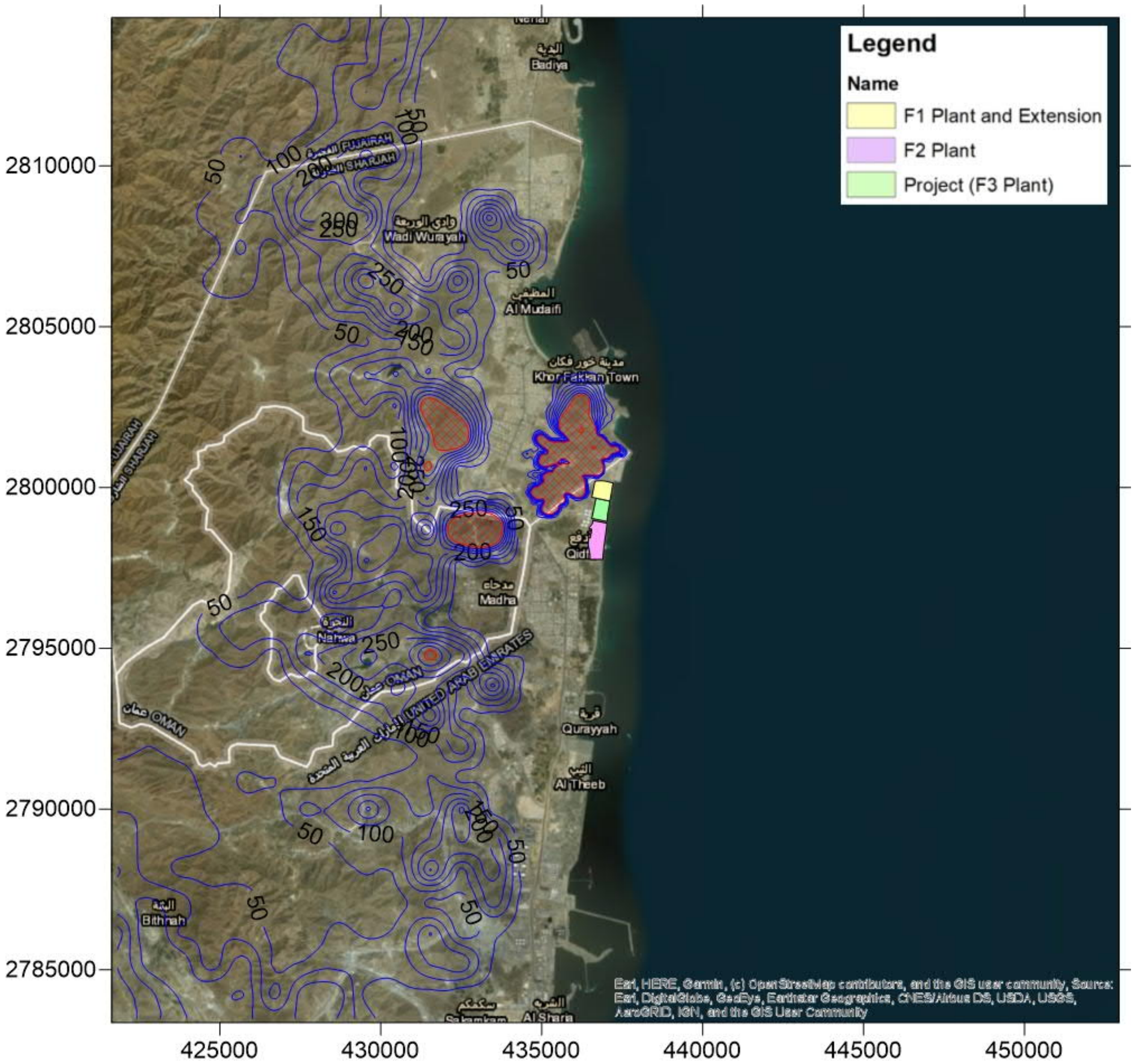


Figure B.5: Scenario 2 - Maximum 24 hour NO_2 (µg/m^3)

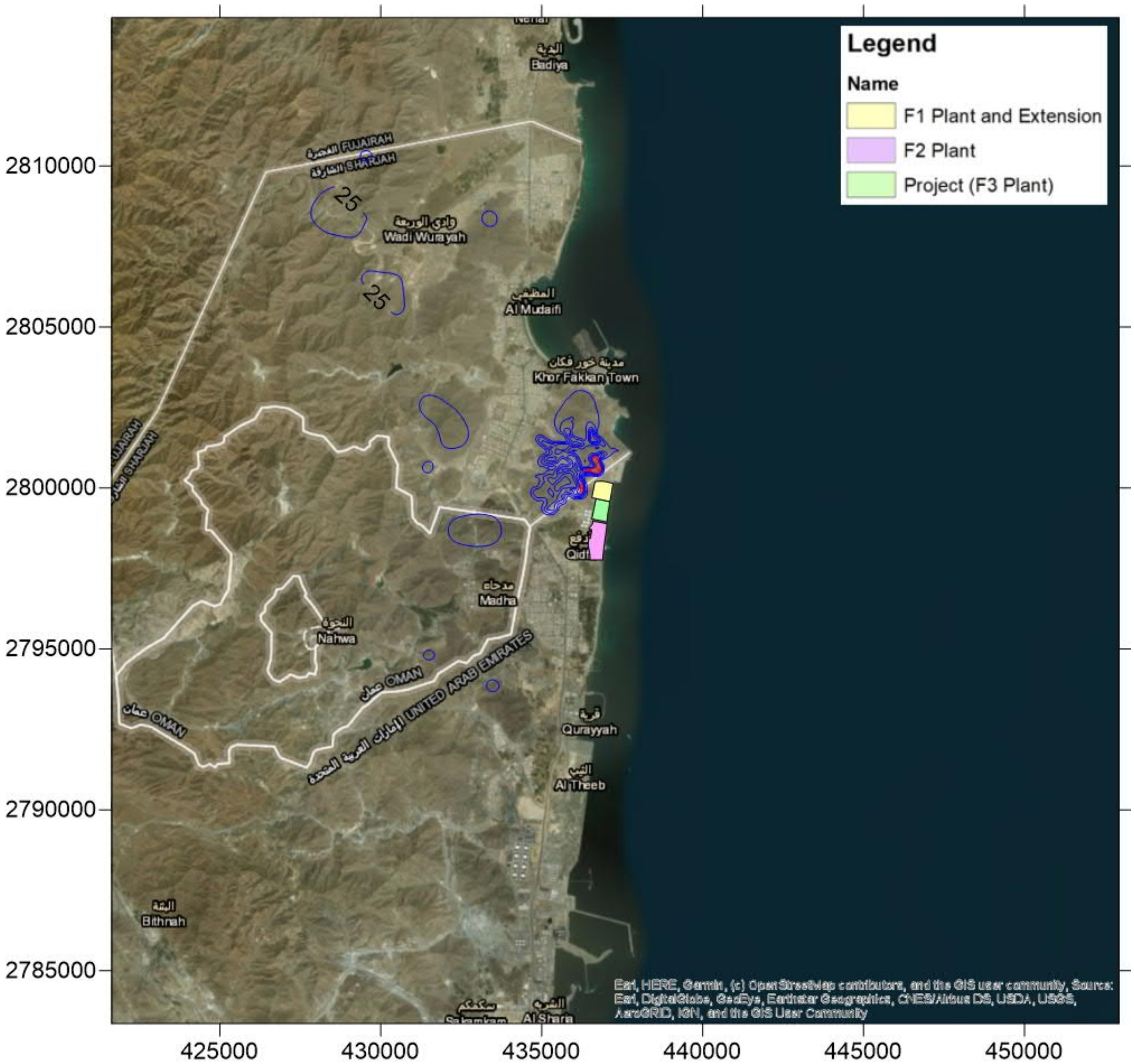


Figure B.6: Scenario 2 – Annual mean NO_2 (µg/m^3)

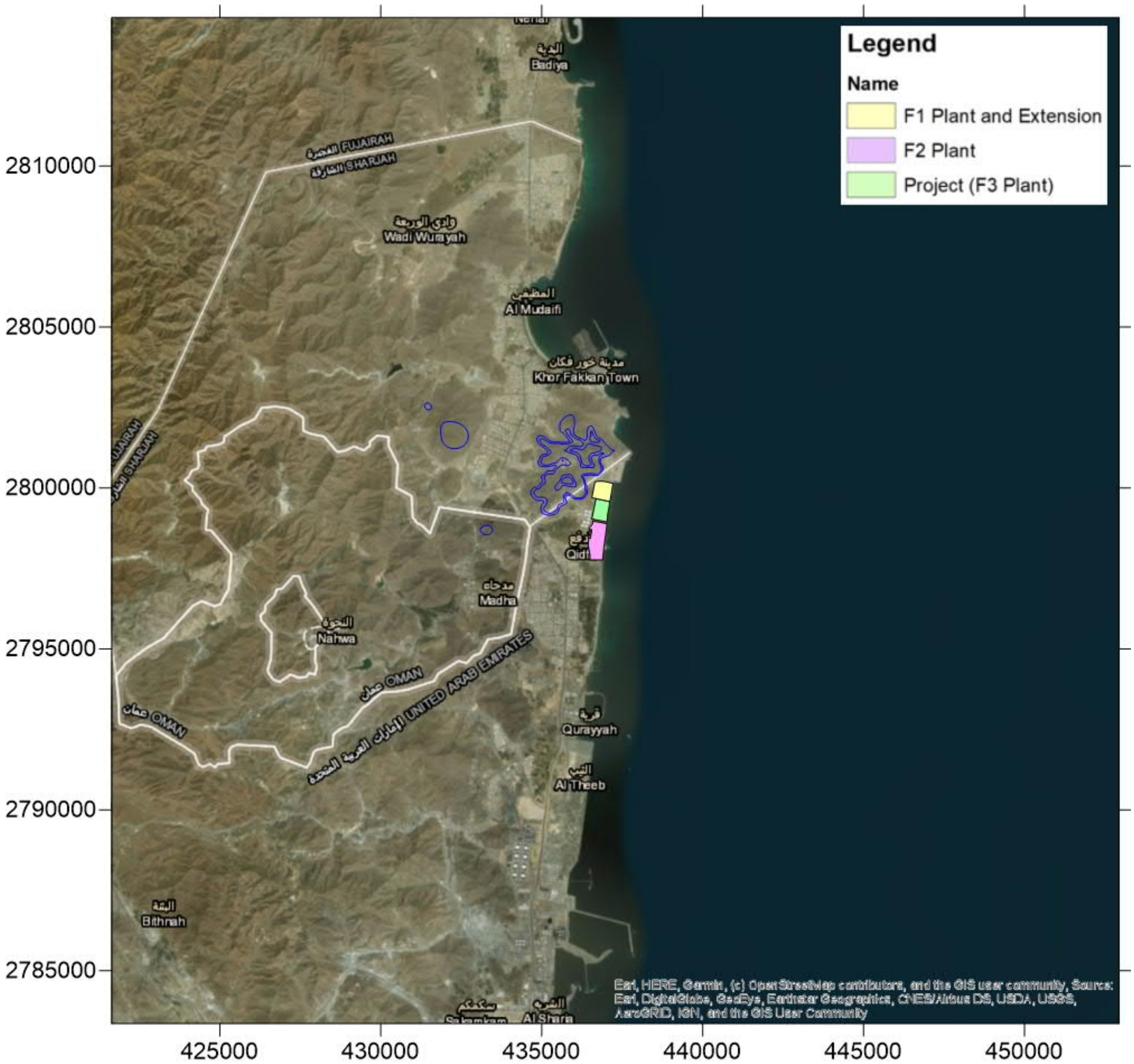


Figure B.7: Scenario 3 - Maximum 1 hour NO_2 (µg/m³)

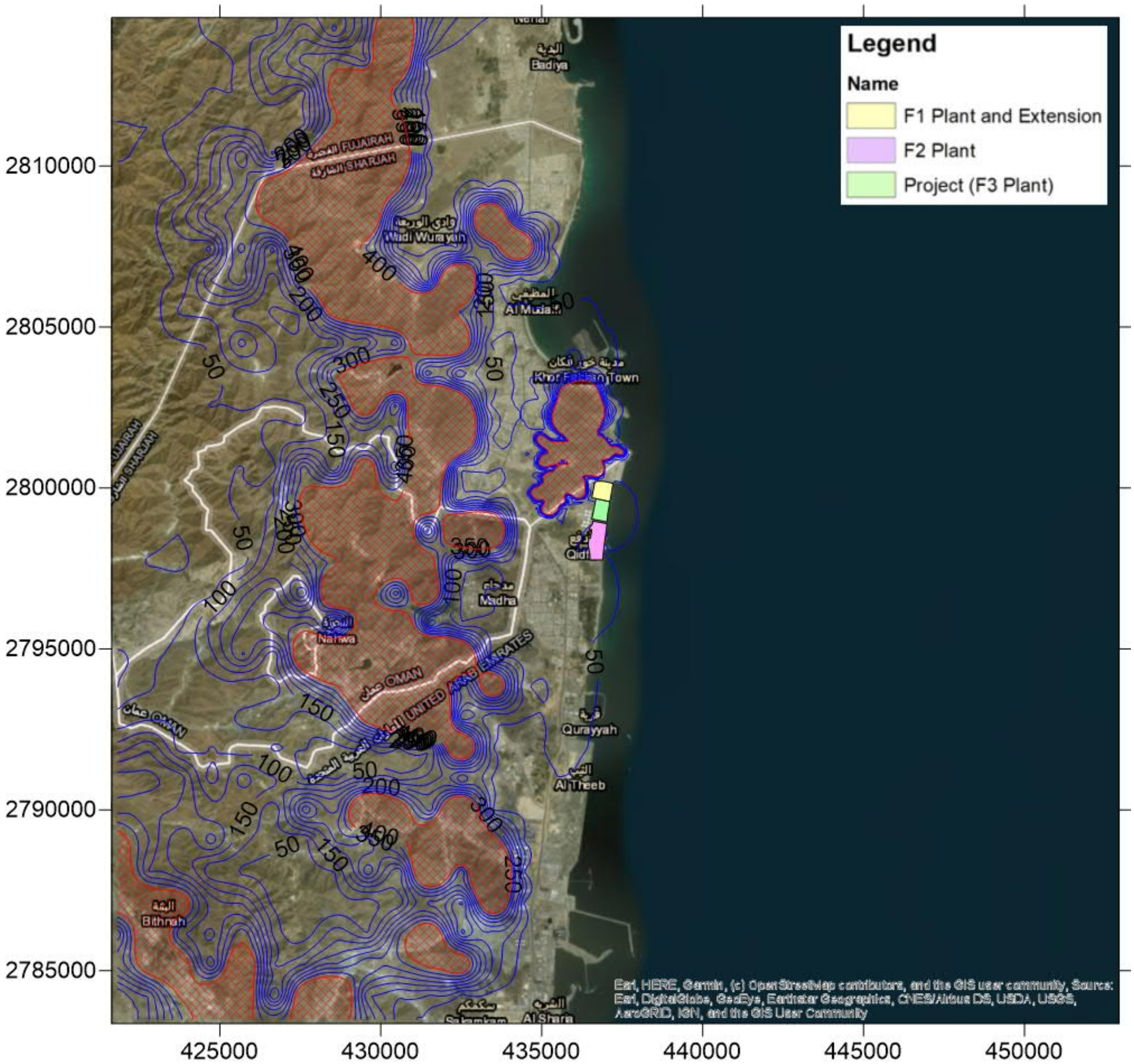


Figure B.8: Scenario 3 - Maximum 24 hour NO_2 (µg/m^3)

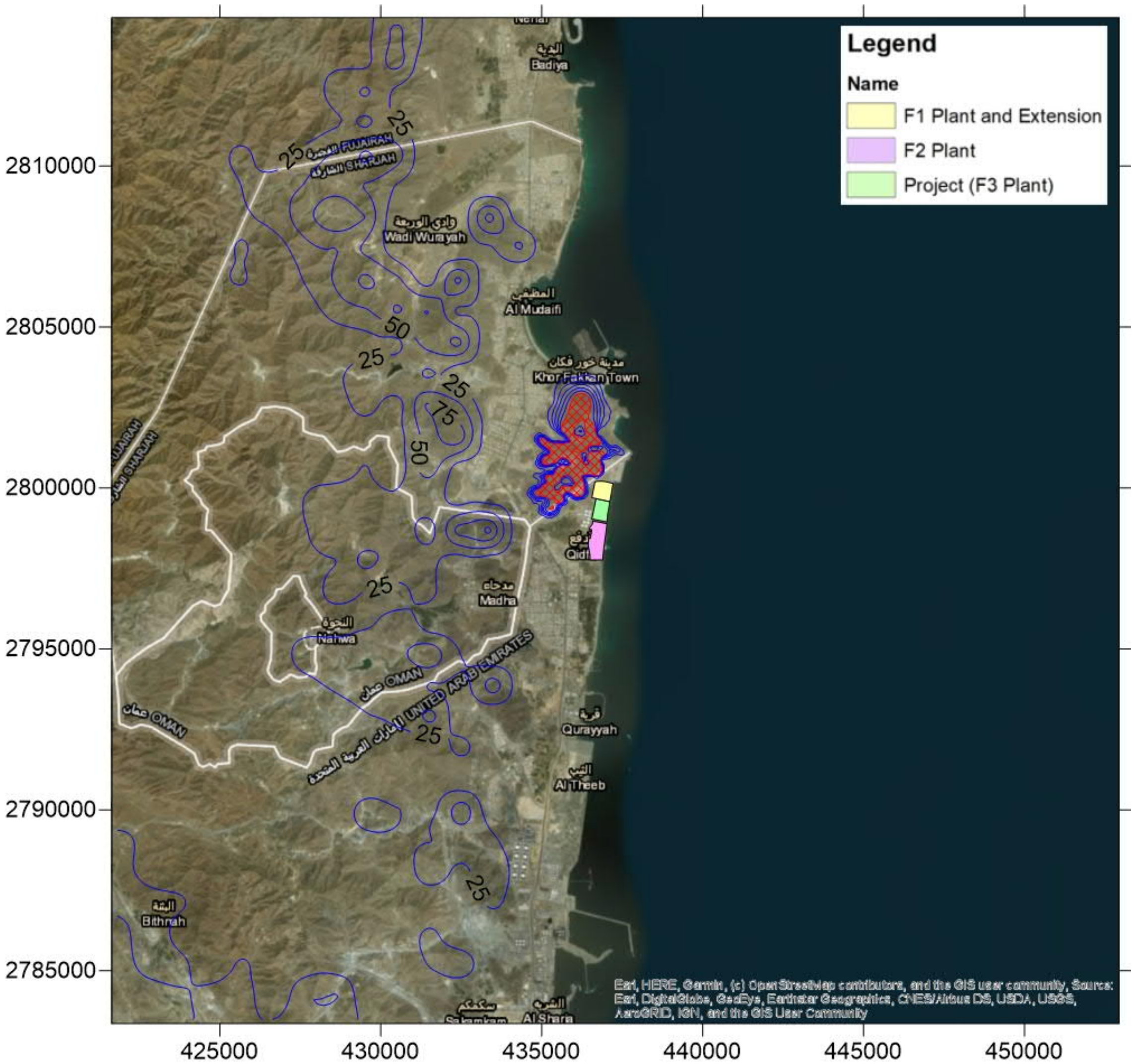


Figure B.9: Scenario 3 – Annual mean NO_2 (µg/m[3])

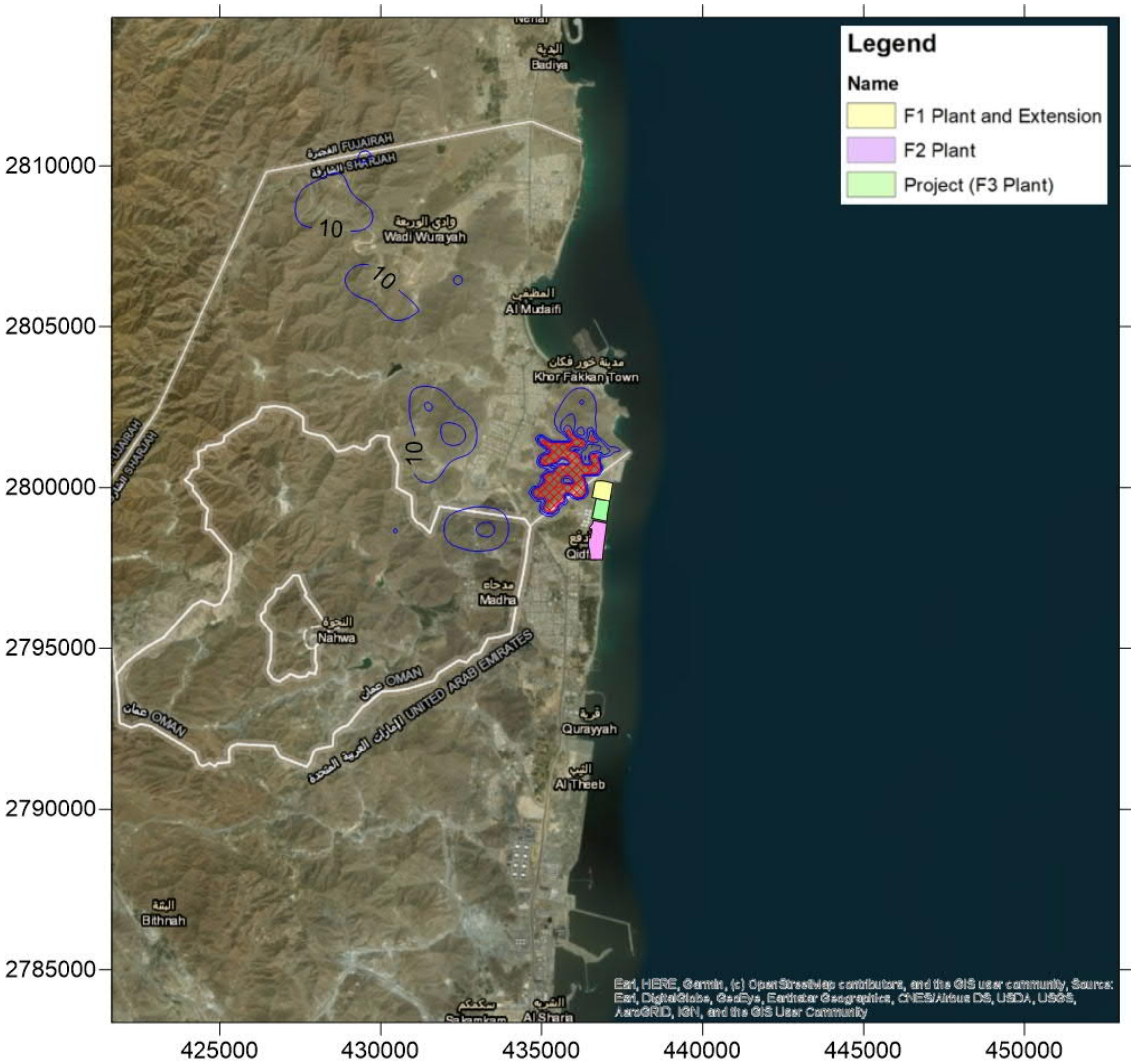


Figure B.10: Scenario 4 - Maximum 1 hour NO_2 (µg/m^3)

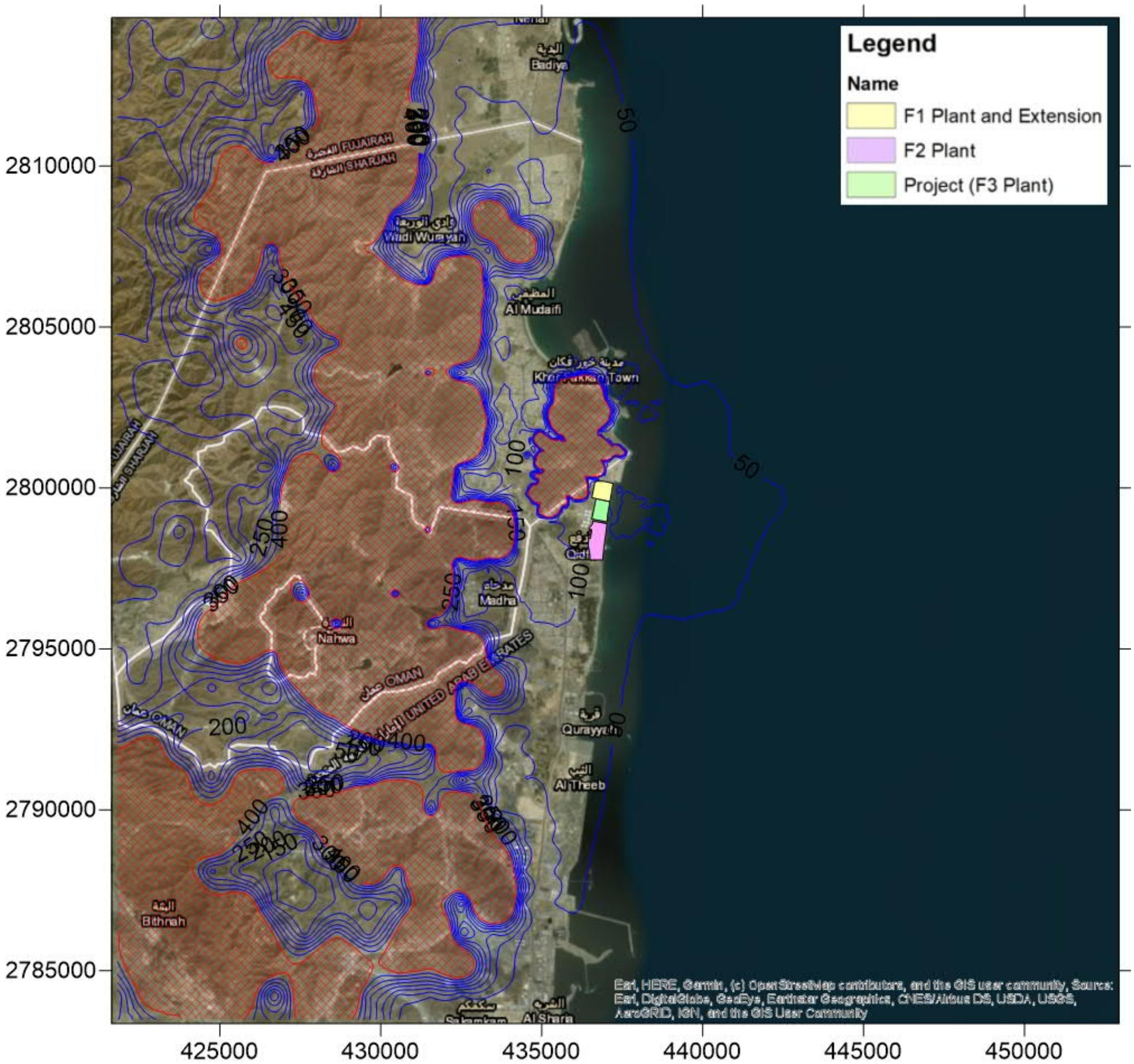


Figure B.11: Scenario 4 - Maximum 24 hour NO_2 (µg/m^3)

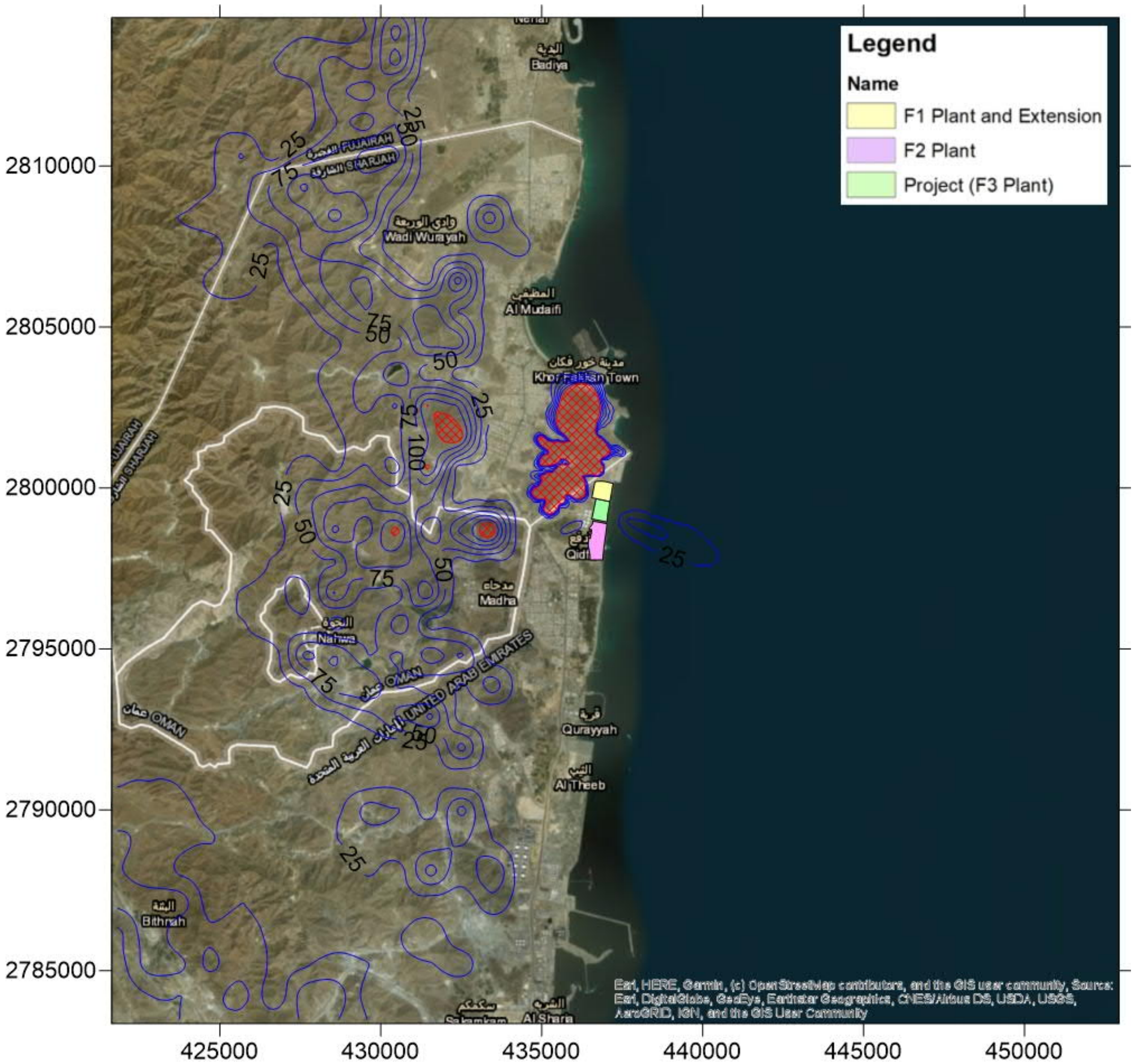


Figure B.12: Scenario 4 – Annual mean NO_2 (μg/m^3)

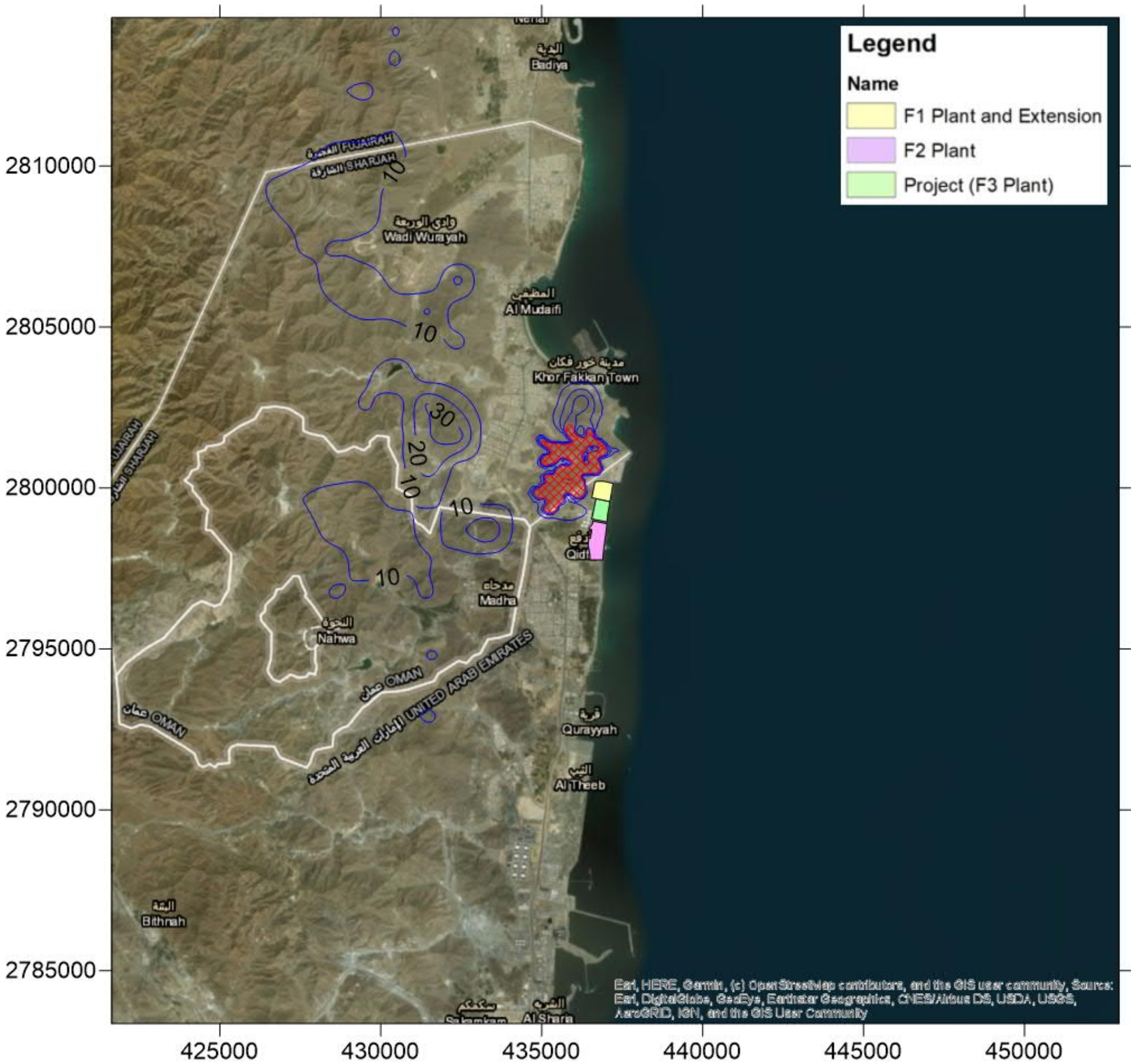


Figure B.13: Scenario 4 - Maximum 1 hour SO_2 (µg/m[3])

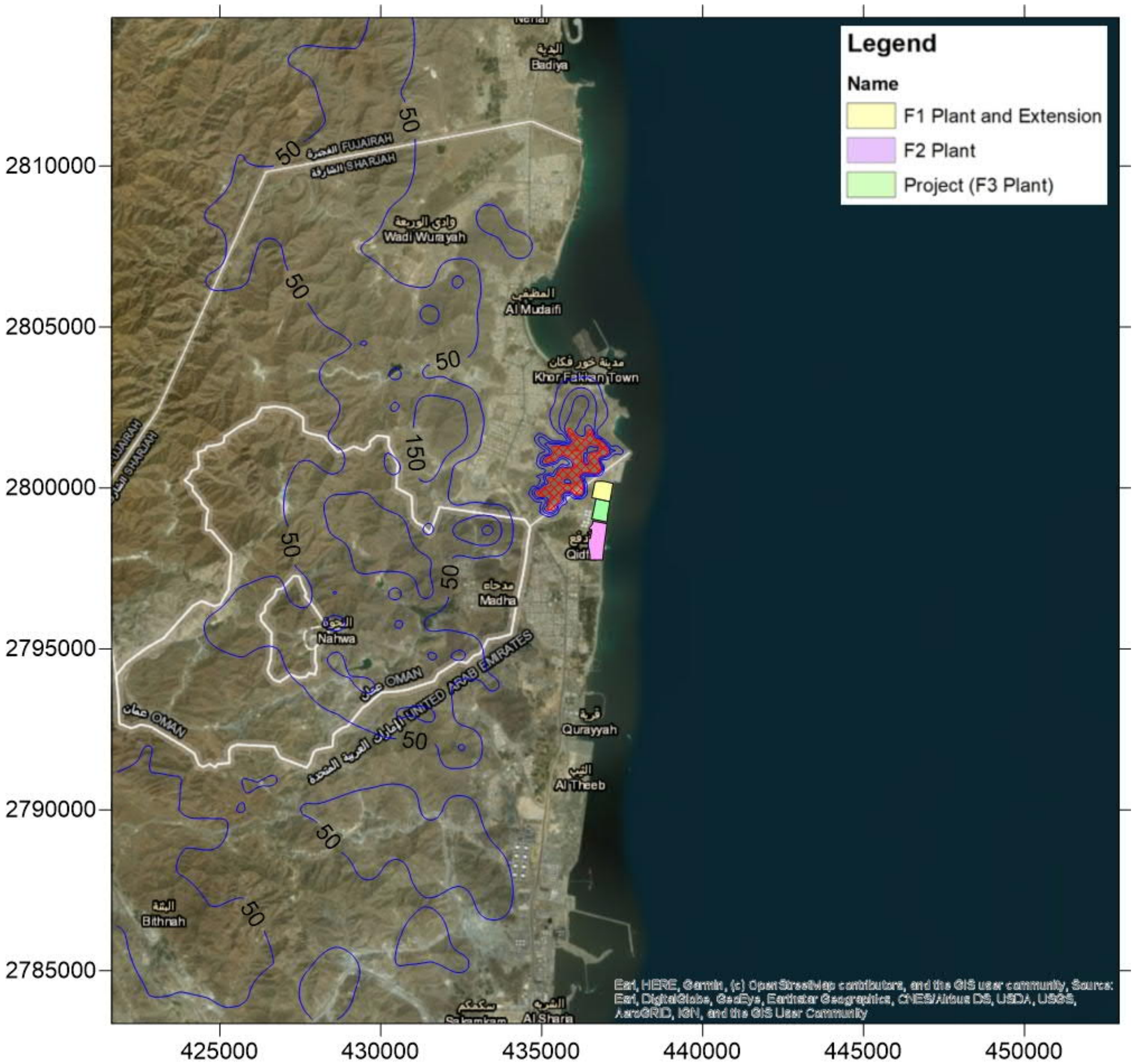


Figure B.14: Scenario 4 - Maximum 24 hour SO_2 (µg/m^3)

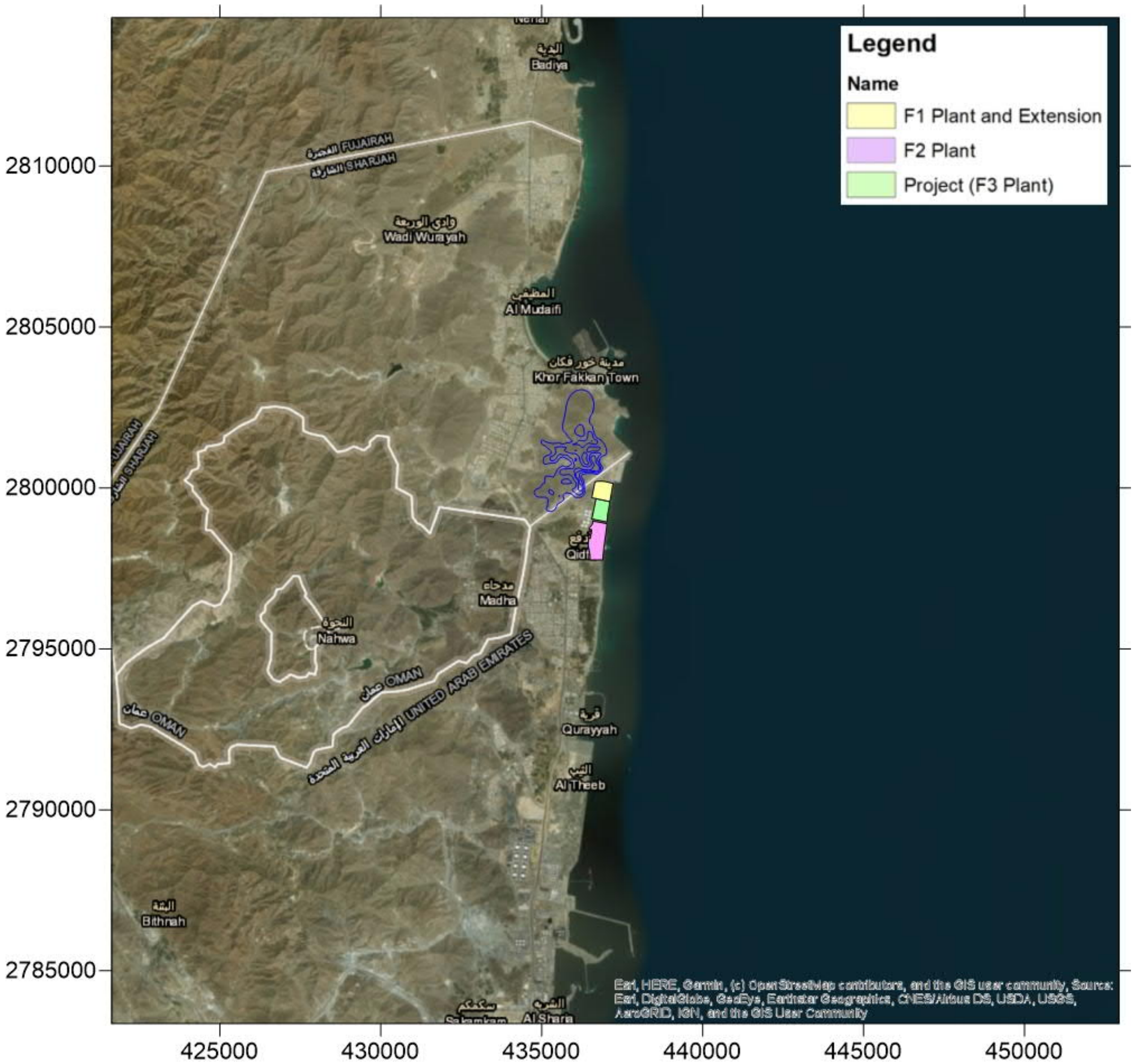
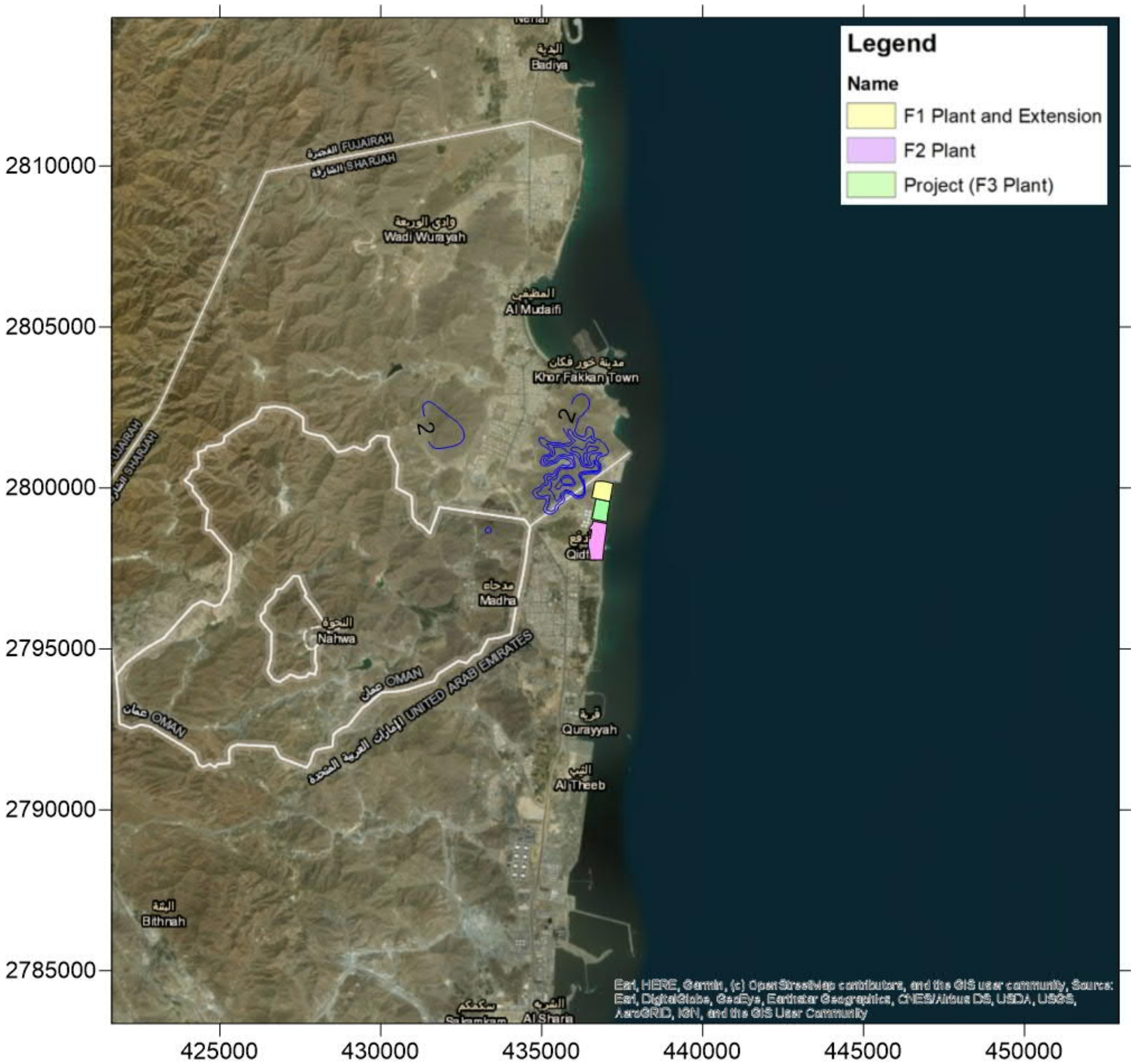


Figure B.15: Scenario 4 – Annual mean SO_2 ($\mu g/m^3$)



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Appendix 2-2 – Air Dispersion Modelling Report

Anthesis

Fujairah 3 Independent Power Project (IPP)

Air Dispersion Modelling Report

Prepared for: Anthesis

Ref.: J20042

Date: 24 February 2020

Report Approval & Revision Record

Project:	Fujairah 3 Independent Power Project (IPP)			
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03	24 February 2020	Shazelle Govender Environmental Engineer	Marc Blanche Partner	Marc Blanche Partner

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Acronyms

%	Percentage
$\mu g/m^3$	Microgram per cubic metre
AAQS	Ambient Air Quality Standards
CALPUFF	California Puff Model
CO	Carbon Monoxide
DEFRA	Department for Environment, Food and Rural Affairs
DMP	Detailed Masterplan
EAD	Environment Agency Abu Dhabi
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EU	European Union
g/s	gram per second
GLC	Ground Level Concentration
HRSG	Heat Recovery Steam Generator
IFC	International Finance Corporation
km	kilometre
MW	Megawatt
m E	Metres Easting
m N	Metres Northing
m	Metre
m^2	metre squared
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 micrometres
SO_2	Sulphur Dioxide
SRTM	Shuttle Radar Topography Mission
UAE	United Arab Emirates
US EPA	United States Environmental Protection Agency
UTC	Universal Time Co-ordinated
UTM	Universal Transverse Mercator
WHO	World Health Organisation
WKC	WKC Environment Consultancy
WRF	Weather, Research and Forecasting

1 Introduction

1.1 Project Background

WKC Environment Consultancy (WKC) has been contracted by Anthesis to undertake an air dispersion modelling (ADM) study for the proposed Fujairah 3 (F3) Independent Power Project, hereafter referred to as the “Project”. The Project is planned as a gas powered combined cycle facility with a net power capacity of 2,400 MW located in Fujairah Emirate, adjacent to the existing Fujairah 1 (F1), with a capacity of 760 MW net, and the existing Fujairah 2 (F2), with a capacity of 2,000 MW net. This assessment has been undertaken for the three gas turbines and associated heat recovery steam generators (HRSG), in addition to the existing emission sources associated with F1 and F2.

1.2 Study Objectives

The key objectives of this study are as follows:

- To evaluate the potential impacts of Project activities on the local environment and sensitive receptors using the US EPA approved CALPUFF regulatory dispersion model.
- To undertake a review of the relevant national ambient air quality legislation and Project Standards and provide a summary of the minimum standards that will need to be achieved; and,
- To undertake a quantitative assessment of the operational phase activities, including the cumulative impacts of the neighbouring F1 and F2 facilities and measured background pollutant concentrations.

1.3 Scope of the Modelling Study

This report presents the findings associated with the operation of the F3 facility. In the absence of recent and quality assured background data, and in accordance with international best practice, the facility was modelled both in isolation and in a cumulative context with the neighbouring F2 and F3 facilities. These facilities are expected to cause a significant concentration gradient in the vicinity of the F3 facility and therefore were explicitly modelled. In addition, the measured background data from the nearby Fujairah Municipality ambient monitoring stations have also been added to the model results. The maximum modelled ground level concentrations (GLCs) at the nearest sensitive receptors (SRs) have been compared directly with the assessment criteria detailed in Section 3.

2 Project Description

2.1 Project Location

The Project site is located in the emirate of Fujairah. The F3 Power plant will be situated within the Fujairah power and water complex, between the existing F1 and F2 power plants. This site is 280 km northeast of the United Arab Emirates (UAE) capital of Abu Dhabi. The location of the Project is depicted in regional and local contexts in Figure 2-1 and Figure 2-2 respectively. The Project boundary together with the locations of F1 and F2 are shown in Figure 2-3.

Figure 2-1 – Project Location (Regional Context)

Figure 2-2 – Project Location (Local Context)

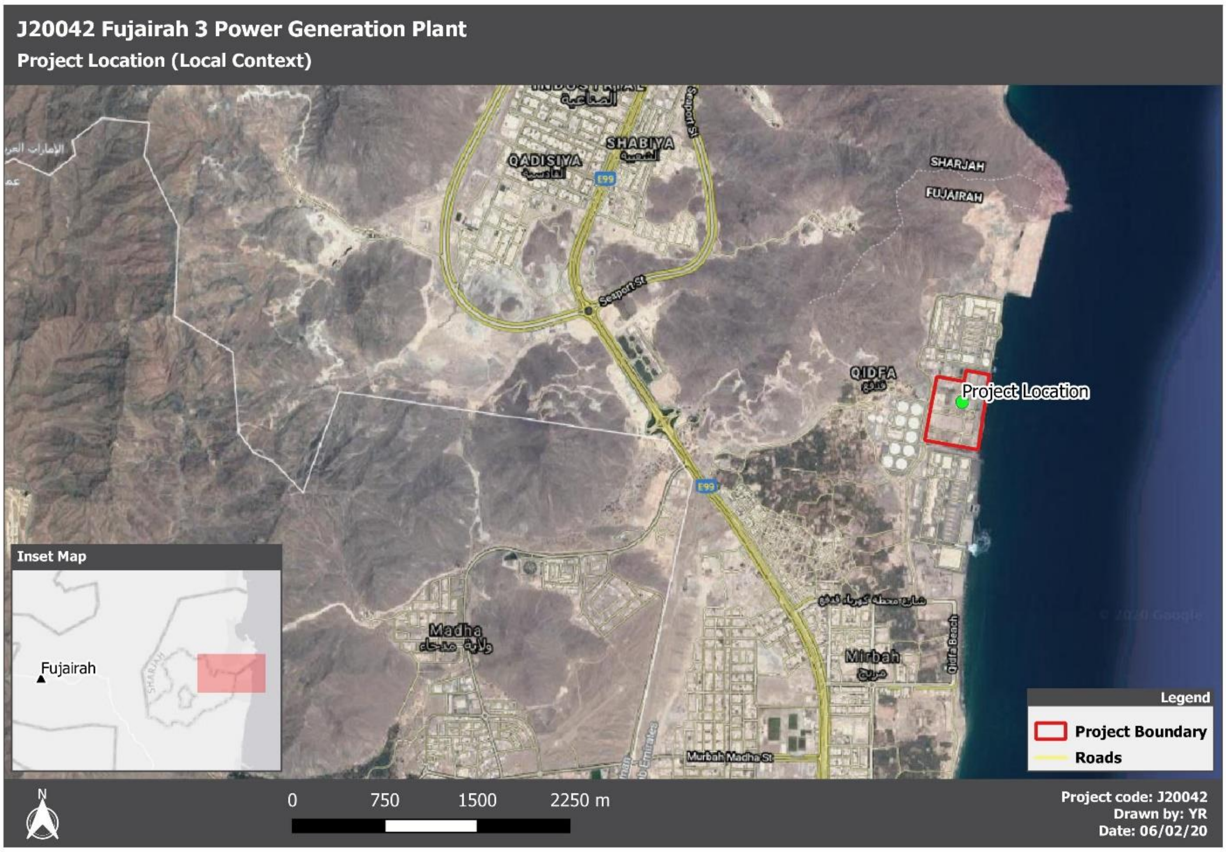
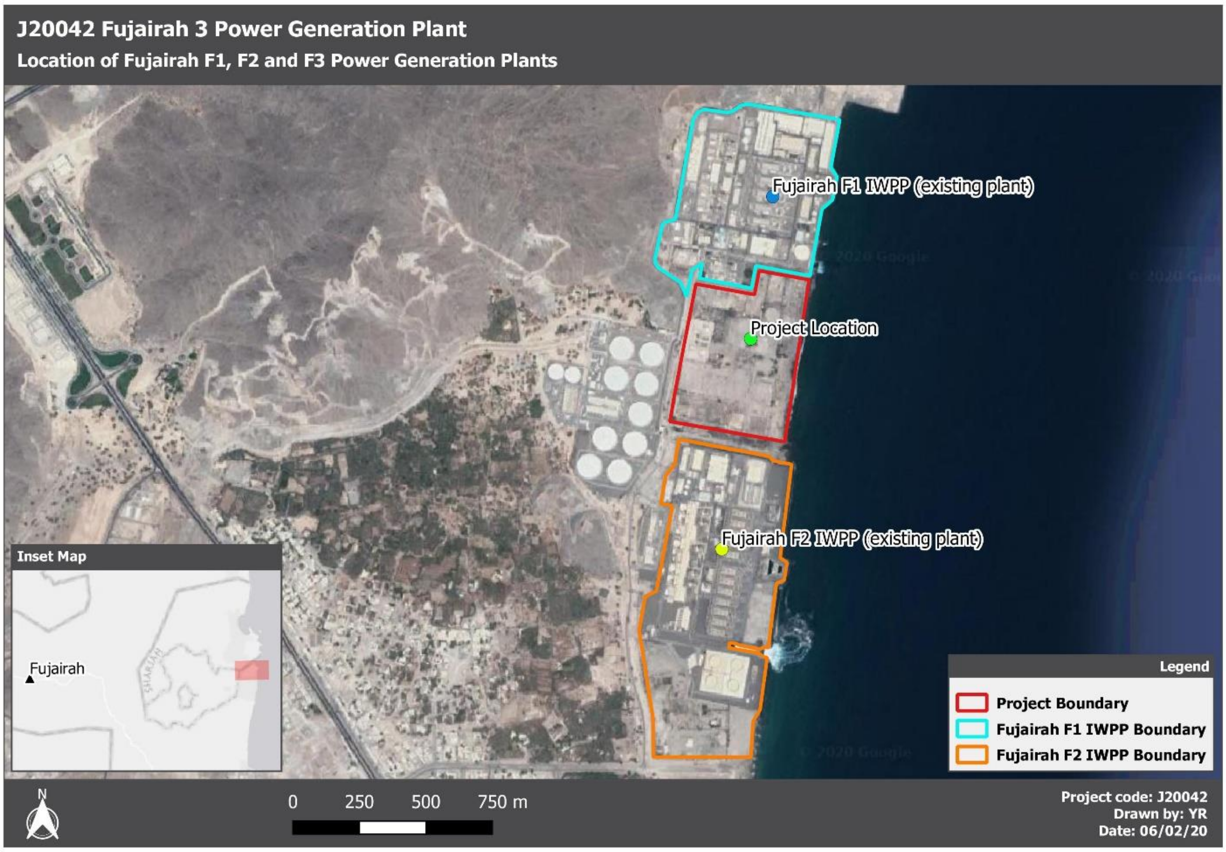


Figure 2-3 – Map of Project Boundary with F1 and F2



2.2 Pollutants of Concern

The project will use natural gas, an existing regionally abundant fuel stream to generate electricity. The use of natural gas offers a number of environmental benefits over other sources of energy, particularly other fossil fuels. For example, coal and oil have a much higher carbon ratio and higher nitrogen and sulphur contents. This means that when combusted, coal and oil release higher levels of harmful emissions, including a higher ratio of carbon emissions, NOx and sulphur dioxide (SO_2), in addition to particulate matter. The combustion of natural gas, on the other hand, releases negligible quantities of sulphur dioxides, virtually no ash or particulate matter, and lower levels of CO. Notwithstanding the above, the following pollutants have been considered in this assessment due to their known impacts on human health and association with turbines. The potential health impacts of each pollutant are summarised as follows [1]:

- Nitrogen Oxides (represented by NO_2): Collective term for the group of pollutants, predominantly comprising Nitrogen Dioxide (NO_2) and Nitric Oxide (NO). NO_2 is toxic even at relatively low concentrations and can be readily formed through the oxidation of NO in the presence of atmospheric oxidants. Epidemiological studies have shown that symptoms of bronchitis in asthmatic children increase in association with long-term exposure to NO_2.

- Sulphur Dioxide (SO_2): Anthropogenic emissions of SO_2 originate from the combustion of sulphur containing fuels. SO_2 can affect the respiratory system and the function of the lungs and causes irritation to the eyes. Inflammation of the respiratory tract causes coughing, mucous secretion, aggravation of asthma and chronic bronchitis and makes people more prone to infection of the respiratory tract.

- Carbon Monoxide (CO): Anthropogenic emissions of CO originate mainly from incomplete combustion of carbonaceous materials. In the human body, it reacts readily with haemoglobin to form carboxyhaemoglobin, which reduces the oxygen-carrying capacity of the blood and impairs the release of oxygen from haemoglobin to extra vascular tissues.
- Particulate Matter (PM_{10}): Small particles which are less than 10 micrometres in diameter (PM_{10}) pose a risk to human health as these particles can penetrate deep into the lungs, and may even enter into the bloodstream. Exposure to such particles can affect both the lungs and heart.

3 Regulations

For projects which seek the access of capital from Equator Principal Financial Institutions, it is expected that the requirements of the International Finance Corporation (IFC) General Environmental Health and Safety (EHS) Guidelines are met [2]. In accordance with these requirements, emissions from these projects should not result in pollutant concentrations that reach or exceed relevant national Ambient Air Quality Standards (AAQS), or in their absence, the World Health Organisation (WHO) Air Quality Guidelines or other internationally recognised standards such as European Union (EU) Directive 2008/50/EC [3].

Air pollution in Fujairah is legislated through national AAQS and regulations as prescribed within the Regulations for the Protection of Air from Pollution at a Federal level [4]. In accordance with the IFC General EHS Guidelines (which only advocates the use of an international standard in the absence of a national standard), the Federal AAQS have been adopted. In addition, specific Project Standards for the pollutants NO_2 and SO_2 are also applicable to the Project. For comparative purposes, the EU AAQS have also been adopted for the assessment, as in many jurisdictions, including the United States and Europe, short-term standards include a threshold of tolerance to account for exceptional, worst case meteorological episodes.

In practice this means defining a number of allowable occurrences greater than the prescribed value to account for potential abnormal or infrequent pollutions episodes. In a dispersion modelling setting, these are referred to as percentiles. As an example, the EU 1-hour NO_2 standard allows for 18 exceedances within a calendar year and therefore the objective level is expressed as the 99.79th percentile. This provides additional context around the results to account for outliers and results which are influenced by infrequent meteorological conditions [5].

The Federal AAQS and Project-specific AAQS are presented in Table 3-1. The EU AAQS which have been included for comparative purposes are detailed in Table 3-2.

Table 3-1 – Federal AAQS and Applicable Project AAQS

Pollutant	Averaging Period	Federal AAQS (µg/m^3) [4]	Project Standards (µg/m^3)
NO_2	1 Hour	400	200
	24 Hour	150	-
SO_2	1 Hour	350	200
	24 Hour	150	-
	Annual	60	-
CO	1 Hour	30,000	-
	8 Hour	10,000	-
PM_{10}	24 Hour	150	-

Table 3-2 – EU AAQS

Pollutant	Averaging Period	EU AAQS ($\mu g/m^3$) [3]	No. of Allowable Exceedances
NO_2	1 Hour	200	18
	Annual	40	-
SO_2	1 Hour	350	24
	24 Hour	125	3
CO	8 Hour	10,000	-
PM_{10}	24 Hour	50	35
	Annual	40	-
$PM_{2.5}$	Annual	25	-

4 Baseline Air Quality

Ambient air quality data from the Qidfa and Al Qurayyah continuous ambient air quality monitoring stations were obtained from the Fujairah Municipality. The location of both stations in relation to the Project site is depicted in Figure 4-1.

Figure 4-1 – Location of the Ambient Air Quality Monitoring Stations

Continuous hourly data was collected over a 5 month period at the Qidfa station (August – December 2019) and over a year (January – December 2019) at the Al Qurayyah station. The specific methods of monitoring, data capture, quality assurance and quality control were not provided with the data. The data was processed into averaging periods relevant to the AAQS. A summary of the monitored data, compared with the relevant standards, is presented in Table 4-1 and Table 4-2.

Table 4-1 – Summary of the Qidfa Station Ambient Air Quality Baseline Data

Parameter	NO_2	NO_2	PM_{10}	CO	CO
Unit	µg/m^3	µg/m^3	µg/m^3	mg/m^3	mg/m^3
Averaging Period	1 hour	24 hour	24 hour	1 hour	8 hour
Percent Data capture over the five month period (Hourly Values)	86.87	86.87	86.79	83.09	83.09
Maximum	110	46.75	203.92	8.16	1.75
Minimum	0	4.74	44.58	0.03	0.07
Average		21.22	72.88		0.662
Ambient Standards	400	150	150	30	10
Number of Exceedances	0	0	0	0	0

Table 4-2 – Summary of the Al Qurayyah Station Ambient Air Quality Baseline Data

Parameter	NO_2	NO_2	PM_{10}	CO	CO
Unit	µg/m^3	µg/m^3	µg/m^3	mg/m^3	mg/m^3
Averaging Period	1 hour	24 hour	24 hour	1 hour	8 hour
Percent Data capture over the 1 year period (Hourly Values)	96.38	96.38	87.92	99.47	99.47
Maximum	214	108	371	2.76	2.33
Minimum	73.30	14.99	5.56	0.39	0.43
Average		19.47	101.28		0.9052
Ambient Standards	400	150	150	30	10
Number of Exceedances	0	0	46	0	0

Based on the measured data for each of the sites, it can be concluded that the airshed would be considered "Non-Degraded" in terms of the IFC General EHS definition [2] with regards to gaseous pollutants, where an airshed is considered as having poor air quality if nationally legislated air quality standards or WHO Air Quality Guidelines are exceeded significantly. The measured data does show elevated particulate matter concentrations which is a well-documented regional phenomenon.

One important aspect of cumulative impact assessment entails combining modelled concentrations with monitored background concentrations to determine the potential cumulative ambient air quality impacts. The use of a single uniform monitored background contribution is the simplest approach to implement since it can be applied outside of the modelling system. However, in determining a suitable background value for short-term periods it is acknowledged that use of the overall highest hourly background concentration will be overly conservative in many cases, as the maximum process contribution and maximum background concentration may be separated both temporally and spatially, so that the addition of the two “worst-case” concentrations together may not represent a likely event.

In order to be able to provide a comparison of the short-term average AAQS in conjunction with short-term average model outputs, the approach advocated by the UK Environmental Agency has been adopted. When assessing short-term effects, it is reasonable to consider the maximum short-term modelled output in an additive context with a background concentration equal to two times (double) the long-term background value [6]. An average of the data from both monitoring stations was used to obtain the background concentrations used for the cumulative assessment. The background concentrations considered for the cumulative assessment are presented in Table 4-3 below. Given the naturally high levels of dust and particulate matter that occur in the region, PM_{10} and $PM_{2.5}$ background concentrations have not been included in the cumulative assessment.

Table 4-3 – Background Ambien Air Quality (BAAQ) for cumulative assessment

Pollutant	Background Concentration (µg/m³)	
	Long-Term Concentration (µg/m³)	Short-Term Concentration (µg/m³)
NO_2	27.29	54.57
CO	784.24	1,568.48

5 Overview of Modelling Analysis

5.1 Model Selection

The ADM assessment was carried out using the United States Environmental Protection Agency (US EPA) California Puff Model (CALPUFF) Version 8.6.1. CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion modelling system that simulates the effects of time-and space-varying meteorological conditions on pollutant transport, transformation, and removal. The main components of the CALPUFF modelling system are CALMET (a diagnostic 3-dimensional meteorological model), CALPUFF (an air quality dispersion model), and CALPOST (a post processing package). The CALPUFF model was selected for this air quality impact assessment based on the model's ability to account for the complex terrain/ topography surrounding the facility, in addition to the model's ability to simulate complex coastal effects such as fumigation and recirculation.

CALPUFF can fully treat stagnant conditions, wind reversals such as those experienced in land-sea breezes, mountain-valley breezes and in very rugged terrain. Water bodies and coastal lines present spatial changes to meteorological and dispersion conditions due to the abrupt change in surface properties between land and water bodies. CALMET contains overwater and overland boundary layer algorithms that allows for the effects on plume transportation, dispersion and deposition to be simulated in CALPUFF. The model includes a subgrid scale complex terrain algorithm for terrain impingement. Plume impingement on subgrid scale hills is evaluated using a dividing streamline to determine which material of the plume is deflected around the hills or adverted over the hills.

CALPUFF could have a distinct advantage over the use of a steady-state plume models such as AERMOD for near field impact analyses. One type of application where CALPUFF may be better than AERMOD is when there are strong localised influences on the wind field, such as valley channelling, upslope / downslope flows, and coastal areas [7].

5.2 Meteorology Data Development

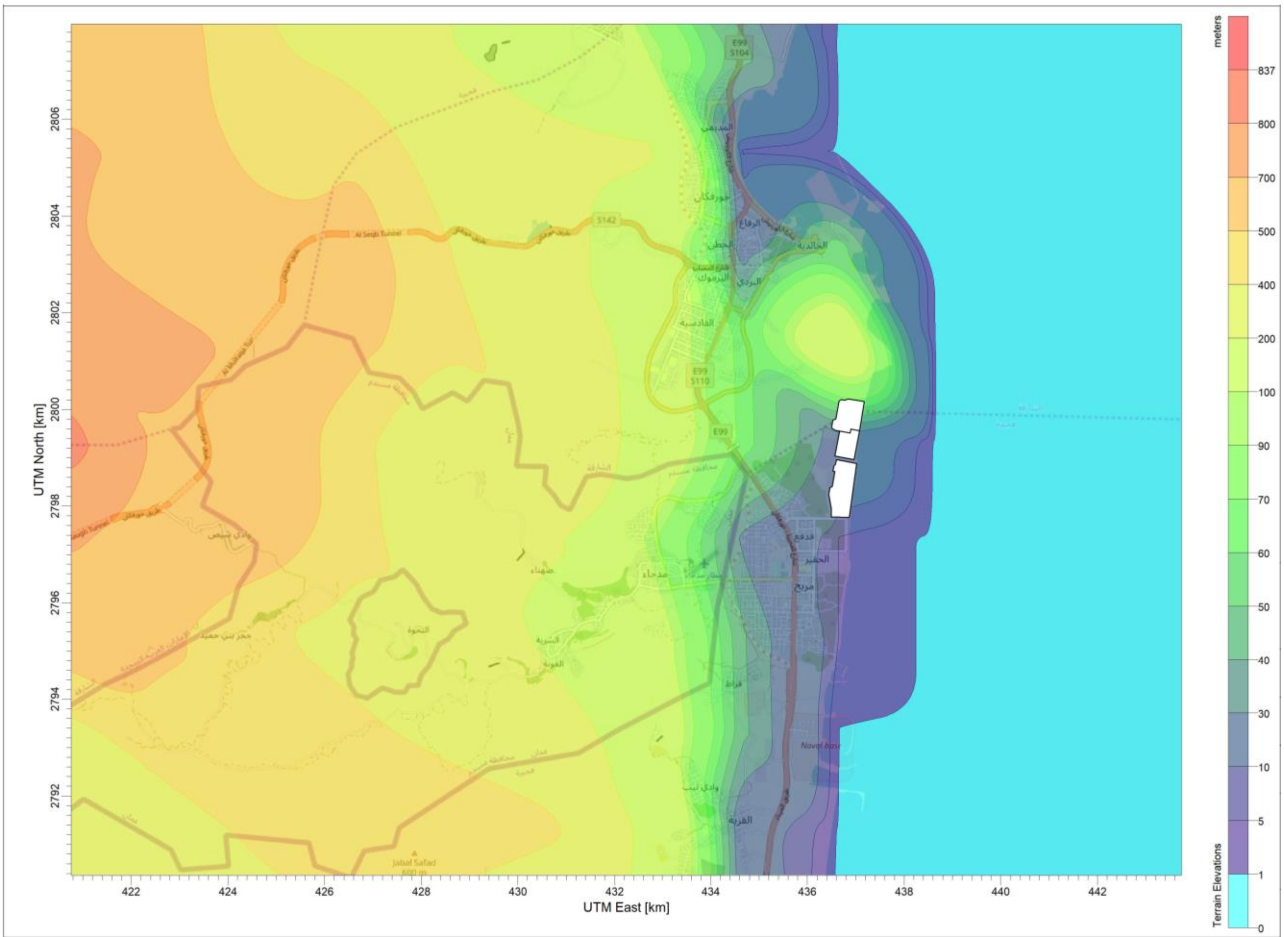
The Weather, Research and Forecasting (WRF) model was used to generate a 3D dataset for the region for a period of three years (2016 – 2018), over a 50 km x 50 km domain. The meteorological data was provided by Lakes Environmental, a specialist meteorological service provider. A total of ten vertical levels were defined based on the WRF model outputs, with the CALMET layers set to 10; 30; 60; 120; 240; 480; 920; 1,600; 2500; and 3,500 m above ground level. A summary of the properties of the meteorological data is provided in Table 5-1.

Table 5-1 – Met Data Summary

Met Data Type:	CALMET-Ready WRF Data (3D.DAT Format)
Start-End Date:	01 January 2016 to 31 December 2018
Centre Point:	Latitude: 25.30927 N - Longitude: 56.37082 E
Datum:	WGS 84
UTM Zone:	40
WRF Resolution:	4 km
WRF Domain Size:	50 x 50 km
WRF Vertical Levels:	35 (lowest level at ~20 m above ground level)
Site Time Zone:	Universal Time Co-ordinated (UTC)+0400
Location:	Fujairah, United Arab Emirates

The terrain elevations within the model domain are shown in Figure 5-1.

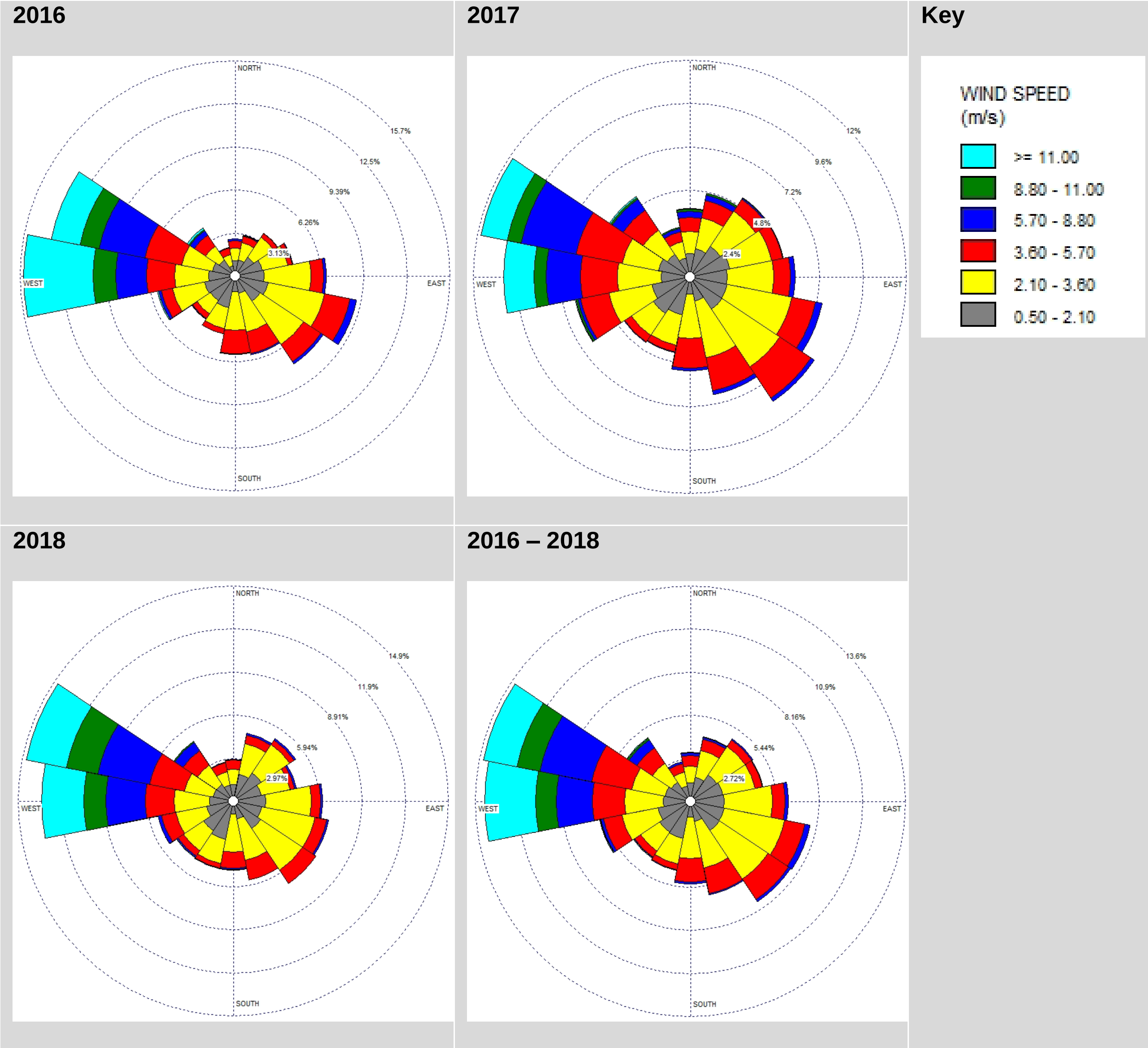
Figure 5-1 – Terrain Elevations within Modelling Domain



5.2.1 Annual Wind Roses

Wind roses for each year of the meteorological data period as well as an overall wind rose for the period (2016 – 2018) is detailed in Figure 5-2. When considering the average wind direction and speeds over the period 2016 to 2018, the most dominant winds emanate from the west while other major winds blow from the south east. A smaller percentage of minor winds blow from the other directions.

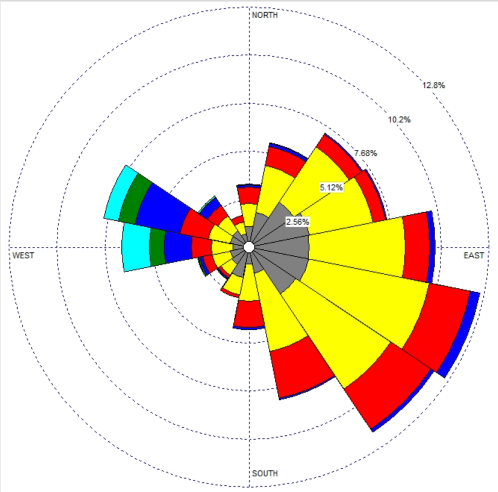
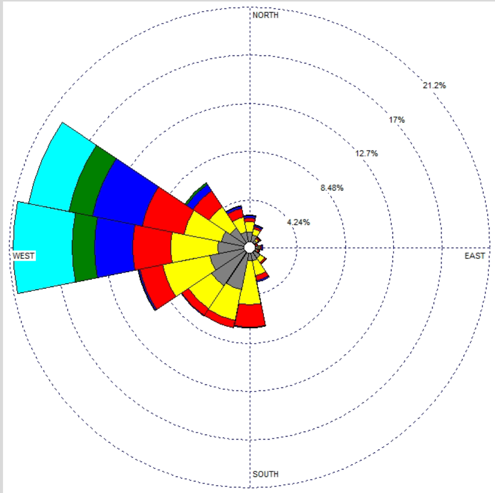
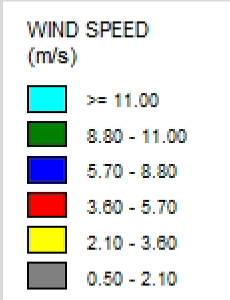
Figure 5-2 – Annual Wind Roses for the Years 2016 - 2018



5.2.2 Diurnal Wind Roses

Wind roses were also generated to illustrate differences between daytime and night-time conditions. The day-time wind rose plot describes wind predominantly emanating from the southwest, while also showing a greater overall frequency of winds from other directions than observed with the night-time wind rose. The night-time wind rose indicates dominant, high speed winds originating from the westerly direction, with winds from minor occurrences of amount of wind from in the other directions. The diurnal wind roses are illustrative of a classic land / sea breeze occurring at the project site and are shown in Figure 5-3.

Figure 5-3 – Diurnal Wind Roses (2016-2018)

Day Time	Night-time	Key
		

5.3 Receptor Grid and Sensitive Receptors

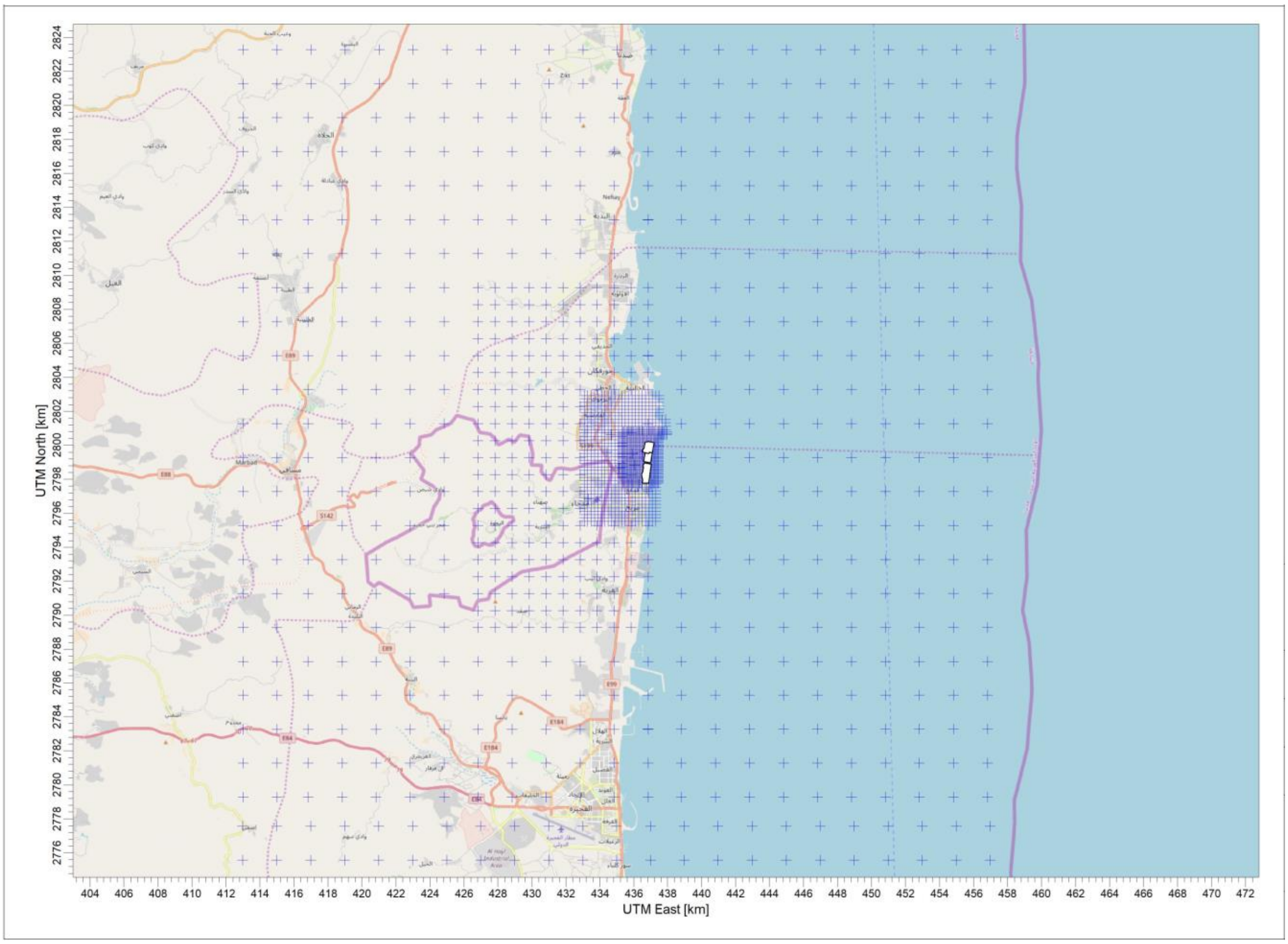
5.3.1 Receptor Grid

The receptor modelling domain and receptor grid (Figure 5-4) used in the modelling assessment covers a domain of 50 km x 50 km and included 2,454 discrete Cartesian receptors, with high-density receptor grids placed over areas of high community amenity. The receptor spacing and resolution within the Project domain is presented in Table 5-2 and illustrated in Figure 5-4.

Table 5-2 – Receptor Grid Spacing and Resolution

Receptor Grid Size	Receptor Grid Resolution
Boundary	50 m
3 km x 3 km	75 m
7.5 km x 7.5 km	200 m
20 km x 20 km	1,000 m
40 km x 40 km	2,000m

Figure 5-4 – Model Receptor Grid



5.3.2 Sensitive Receptors

Several sensitive receptors were included in order to provide an indication of the air quality impacts from the Project on community health. These sensitive receptors are presented in Figure 5-5 and Table 5-3.

Figure 5-5 – Sensitive Receptor Locations

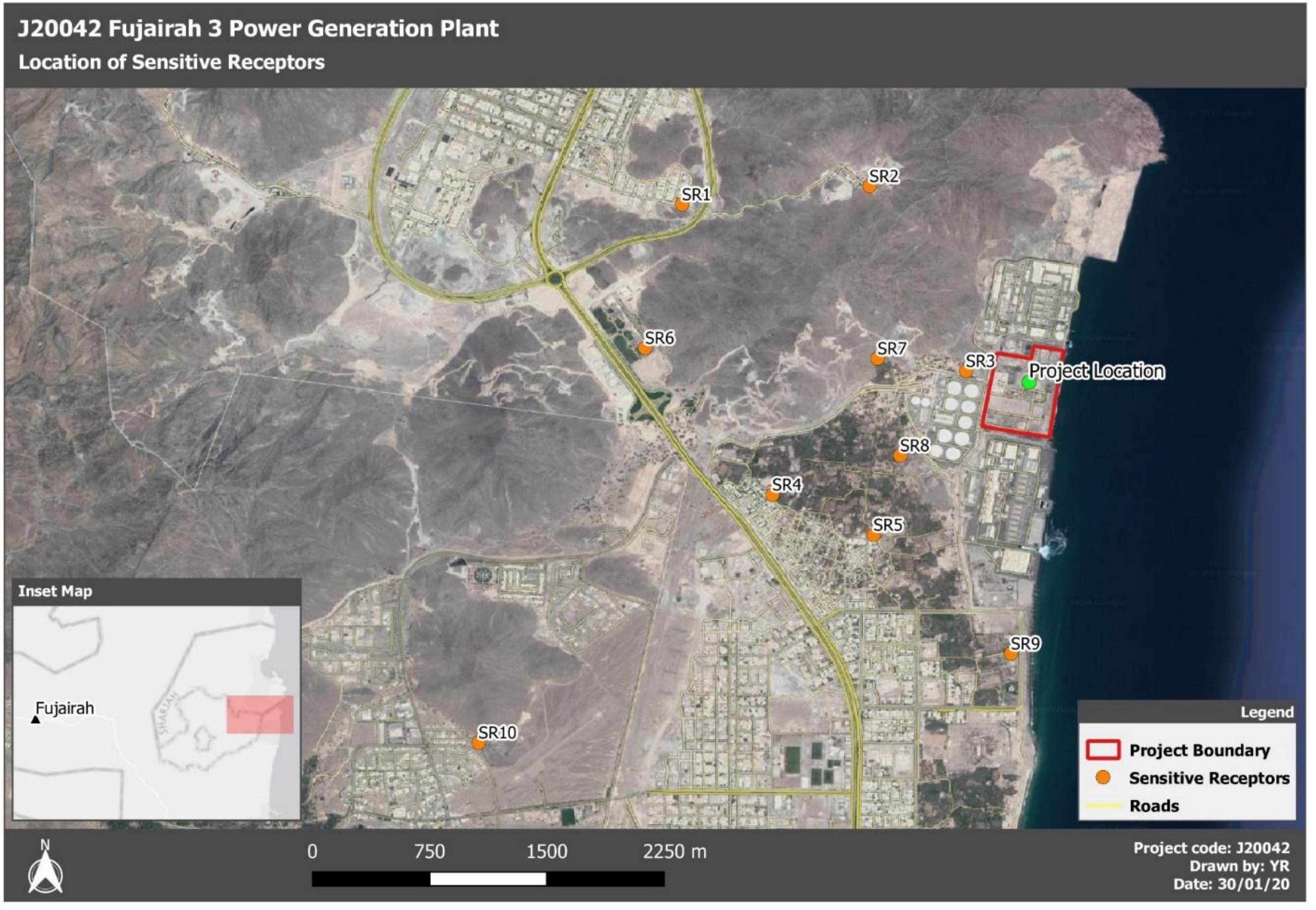


Table 5-3 – Sensitive Receptors

ID	Description	Universal Transverse Mercator (UTM) co-ordinates	
		m E	m N
SR1	Residential	227,142.1	3,559,108.0
SR2	Residential	227,166.3	3,559,090.9
SR3	Residential	227,419.7	3,558,885.1
SR4	Residential	227,028.9	3,559,380.9
SR5	Residential	227,529.1	3,558,770.6
SR6	Residential	227,618.6	3,558,677.5
SR7	Residential	227,752.4	3,558,520.6
SR8	Residential	227,858.5	3,558,415.5
SR9	Residential	228,052.9	3,558,252.8
SR10	Residential	228,175.0	3,558,043.5

5.4 Model Scenarios

A total of eight modelling scenarios were considered for this assessment. A summary of each of the scenarios is provided below. Note the pollutant SO_2 is only considered for the diesel fuel case.

Table 5-4 – Modelling Scenarios

Scenario	Description	Fuel Type	Pollutants of Concern
1	Baseline Case - normal operation of existing power stations F1 and F2	Natural Gas	NO_2, CO*
2A	F3 in isolation -normal operations with the Selective Catalytic Reduction (SCR) Unit. The NO_x emission limit for this scenario is 20 mg/Nm^3.	Natural Gas	NO_2, CO and PM
2B	Cumulative assessment -normal operations of all three power plants (F1, F2 and F3) with the F3 turbines operating with a SCR Unit. The F3 NO_x emission limit for this scenario is 20 mg/Nm^3.	Natural Gas	NO_2, CO and PM
3A	F3 in isolation- normal operations of F3 with the F3 turbines operating without SCR Unit. The NO_x emission limit for this scenario is 50 mg/Nm^3.	Natural Gas	NO_2, CO and PM
3B	Cumulative assessment -normal operations of all three power plants (F1, F2 and F3) with the F3 turbines operating without a SCR Unit. The F3 NO_x emission limit for this scenario is 50 mg/Nm^3.	Natural Gas	NO_2,.CO and PM
4	Alternate fuel operations Short TermF3 turbines operating on diesel, with a 10ppm sulphur content (20 hours per year).	Diesel	NO_2, SO_2, CO and PM
5A	F3 in isolation- bypass operations of F3 with the F3 turbines operating in simple cycle without SCR Unit. The NO_x emission limit for this scenario is 50 mg/Nm^3.	Natural Gas	NO_2,.CO and PM
5B	Cumulative assessment- bypass operations of F3 with normal operations of the other two power plants (F1 and F2). The F3 turbines operate	Natural Gas	NO_2,.CO and PM

Scenario	Description	Fuel Type	Pollutants of Concern
	without a SCR Unit. The F3 NO_x emission limit for this scenario is 50 mg/Nm^3.		

*The baseline case data obtained from previous studies did not include SO_2 or PM as these pollutants were screened out based on the fuel gas specification [5].

5.5 Emission Parameters

The emission parameters associated with each of the scenarios are detailed below (Table 5-5).

Table 5-5 – Emission Source Modelling Parameters

Equipment	Scenario	UTM Co-ordinates		Fuel	Exit Temperature (K)	Stack height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Emission Rate (g/s)			
		m E	m N						NO_x	SO_2	CO	PM_{10}
F1 GT1	1,2B,3B,5B	436,811	2,800,068	Natural Gas	434.9	55	5.50	20.30	23.40	-	19.00	-
F1 GT2	1,2B,3B,5B	436,800	2,800,011	Natural Gas	434.9	55	5.50	20.30	23.40	-	19.00	-
F1 GT3	1,2B,3B,5B	436,775	2,799,875	Natural Gas	434.9	55	5.50	20.30	23.40	-	19.00	-
F1 GT4	1,2B,3B,5B	436,764	2,799,818	Natural Gas	434.9	55	5.50	20.30	23.40	-	19.00	-
F1 Extension	1,2B,3B,5B	436,767	2,799,540	Natural Gas	437.9	55	7.00	19.80	38.30	-	-	-
F2 GT1	1,2B,3B,5B	436,712	2,798,680	Natural Gas	384.4	65	6.25	22.30	29.20	-	42.40	-
F2 GT2	1,2B,3B,5B	436,705	2,798,647	Natural Gas	384.4	65	6.25	22.30	29.20	-	42.40	-
F2 GT3	1,2B,3B,5B	436,670	2,798,457	Natural Gas	384.4	65	6.25	22.30	29.20	-	42.40	-
F2 GT4	1,2B,3B,5B	436,663	2,798,418	Natural Gas	384.4	65	6.25	22.30	29.20	-	42.40	-
F2 GTS2	1,2B,3B,5B	436,687	2,798,550	Natural Gas	383.4	65	6.25	22.30	29.20	-	43.40	-
F3 GT1	2A,2B	436,919	2,799,183	Natural Gas	361.0	60	8.00	20.07	51.78	-	51.78	1.04
F3 GT2	2A,2B	436,931	2,799,245	Natural Gas	361.0	60	8.00	20.07	51.78	-	51.78	1.04
F3 GT3	2A,2B	436,968	2,799,429	Natural Gas	361.0	60	8.00	20.07	51.78	-	51.78	1.04
F3 GT1 with SCR	3A,3B	436,919	2,799,183	Natural Gas	361.0	60	8.00	20.07	20.71	-	51.78	1.04
F3 GT2 with SCR	3A,3B	436,931	2,799,245	Natural Gas	361.0	60	8.00	20.07	20.71	-	51.78	1.04
F3 GT3 with SCR	3A,3B	436,968	2,799,429	Natural Gas	361.0	60	8.00	20.07	20.71	-	51.78	1.04
F3 GT1	4	436,919	2,799,183	Diesel	373.0	60	8.00	21.01	116.78	-	48.66	0.97

Equipment	Scenario	UTM Co-ordinates		Fuel	Exit Temperature (K)	Stack height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Emission Rate (g/s)			
		m E	m N						NO_x	SO_2	CO	PM_{10}
F3 GT2	4	436,931	2,799,245	Diesel	373.0	60	8.00	21.01	116.78	-	48.66	0.97
F3 GT3	4	436,968	2,799,429	Diesel	373.0	60	8.00	21.01	116.78	-	48.66	0.97
F3 GT1 Bypass	5A,5B	436,919	2,799,183	Natural Gas	933.0	30	8.30	48.21	51.78	-	51.78	1.04
F3 GT2 Bypass	5A,5B	436,931	2,799,245	Natural Gas	933.0	30	8.30	48.21	51.78	-	51.78	1.04
F3 GT3 Bypass	5A,5B	436,968	2,799,429	Natural Gas	933.0	30	8.30	48.21	51.78	-	51.78	1.04

5.6 Modelling Assumptions

The following assumptions have been considered in the dispersion modelling assessment, and wherever possible, a conservative approach has been taken:

- The assessment results are considered conservative, as the nearby sources (F1 and F2) have been explicitly modelled, with the model results added to the measured background data. This will result in double counting of pollutants.
- UTM co-ordinates have been based on best approximation of the source locations from the Plot Plans. Where an exact stack location was not provided the location has been assumed based on utility Plot Plans.
- The emissions inventory has been compiled based upon data received from the project team and historical reports [5]. Where data was not made available, assumptions were made based on engineering or international practice, and the profession judgement of the team developing the study.
- Model results have been presented at the relevant percentile values to account for exceptional, worst case meteorological episodes in accordance with best international modelling practice.
- Complex terrain and buildings have been included in the model.
- SO_2 was screened out based on the fuel specification provided for the neighbouring F2 facility (which the F3 will tie into for its fuel supply); and
- All turbines are operating in combined cycle on gas unless otherwise stated.

5.6.1 NO_x: NO_2 Assumptions

Conversion of NO to NO_2 is significant with respect to locations within 5 – 10 km downwind of the Project areas. However, the chemistry of this conversion is complex and subject to many influences, and therefore it is not possible to accurately predict the rate of conversion of NO to NO_2.

For the purposes of this investigation, the NO_2 to NO_x ratio has been assumed to be 50% for short term averaging periods (1 hour and 24 hour) and 70% for long term averaging periods (annual) in the ambient air in accordance with the United Kingdom (UK) Guidance [8]. This is regarded as being conservative, it is likely to lead to a higher estimation of ground level NO_2 concentration than would occur in reality.

5.6.2 Uncertainty

Air quality models attempt to predict concentrations at a specific point and time based on “known” or measured values of various parameters input into the model, such as wind speed, temperature profiles, solar radiation. There are, however, variations in the “unknown” parameters that are not measured, as well as unresolved details of atmospheric turbulent flow. Variations in these “unknown” parameters can result in deviations of the predicted concentrations of the same event, even though the “known” parameters are fixed. As a result of the deviations of the “unknown” parameters, a “perfect” model may be able to predict an average of identical events well, while each repetition of that event will provide somewhat different results. The statistics of these concentration residuals are termed ‘‘inherent’’ uncertainty of a model. In addition, there are “reducible” uncertainties due to inaccuracies in the model, errors in input values and errors in the measured concentrations. “Reducible” uncertainties include inaccuracies in the input values of the known conditions (for example, poor quality or unrepresentative meteorological, geophysical and source emission data); errors in the measured concentrations that are used to compare with model predictions and inadequate model physics and formulation used to predict the concentrations. As the term indicates, “reducible” uncertainties can be controlled or minimised by collecting accurate input data, preparing the input files correctly, checking and re-checking for errors, correcting for unexpected model behaviour, ensuring that the errors in the measured data are minimised and applying better model physics. It is acknowledged that there will always be some error in any geophysical model, however notwithstanding the limitations and assumptions detailed, the structure of the modelling approach has been prepared in such a way as to minimise the total error.

6 Modelling Results and Discussion

The modelled results and discussion for the modelled scenarios are presented in the section below. The results have been compared against both the Federal ambient air quality standards, the specific Project Standards, in addition to the EU ambient air quality standards.

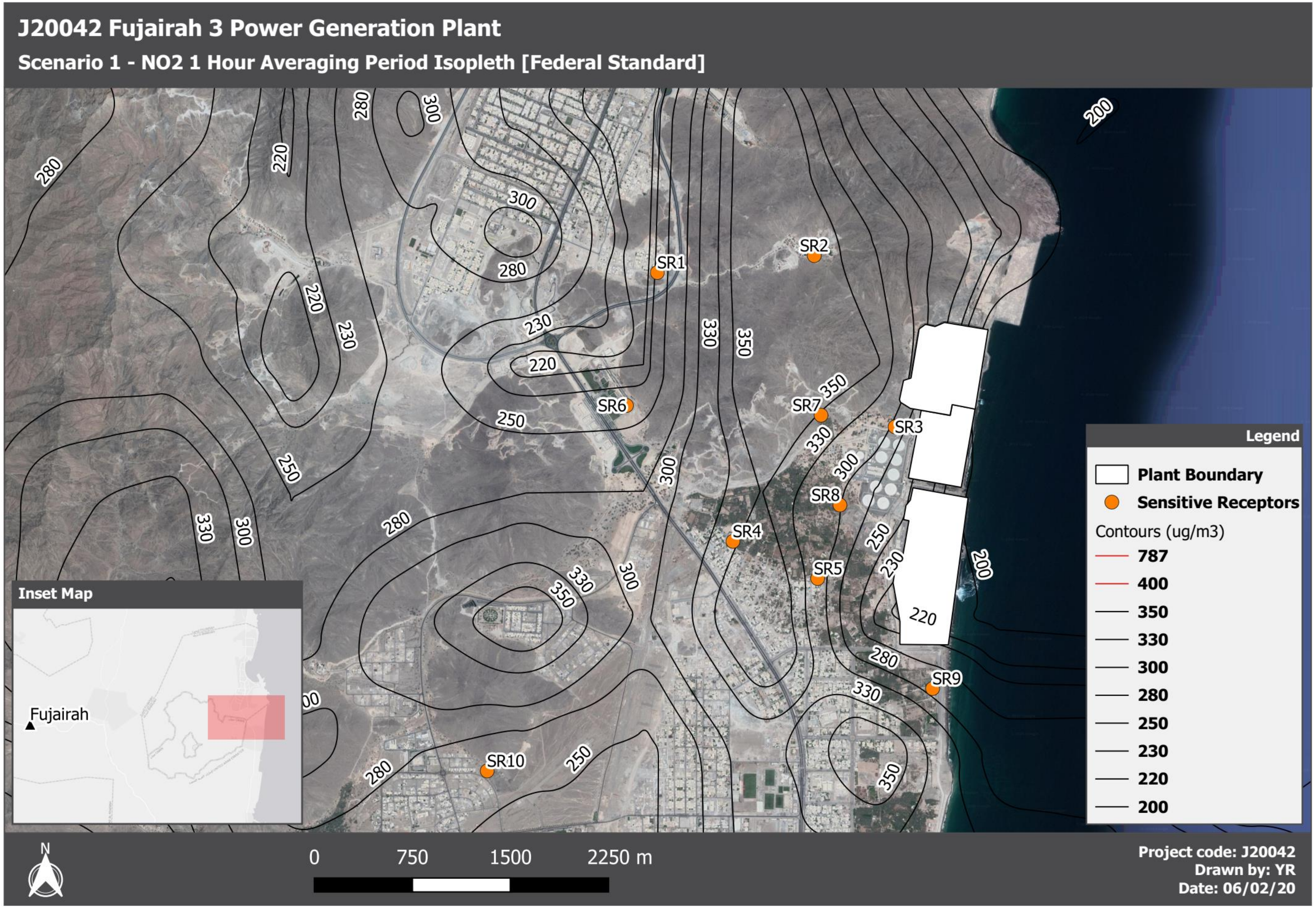
6.1 Scenario 1 – Baseline

This scenario presents the existing F1 and F2 powerplants operating on natural gas under normal operating conditions. The modelled results were assessed against the Federal standards in Table 6-1. These results indicate an exceedance of the standard for NO_2 for the 1 hour averaging period (refer to Figure 6-1 for the isopleth), whilst compliance is expected for the 24-hour averaging period. Assessment of the NO_2 results at the SRs (Table A- 1) show exceedances of the 1-hour AAQS at 2 SRs (SR8 and SR9). The CO model values indicated compliance for all averaging periods at all locations. Note that the exceedance contours for Figure 6-1 are not visible, as the high values only occur at a few isolated receptors (interpolation of contours not visible at this scale).

Table 6-1 – Scenario 1 Results for Federal Standards

Pollutant	Averaging Period	Federal AAQS (µg/m^3)	Model Results (µg/m^3)	Measured Background Concentration (µg/m^3)	Cumulative Results (µg/m^3)	Model Results % of Federal Standard	Below Federal Standard?
NO_2	1 Hour	400	787.17	54.57	841.74	196.79	No
	24 Hour	150	63.50	54.57	118.07	42.33	Yes
CO	1 Hour	30,000	1,984.60	1,568.48	3,553.08	6.62	Yes
	8 Hour	10,000	406.46	1,568.48	1,974.94	4.06	Yes

Figure 6-1 – Scenario 1 NO_2 1 Hour Isopleths (Federal Standard)

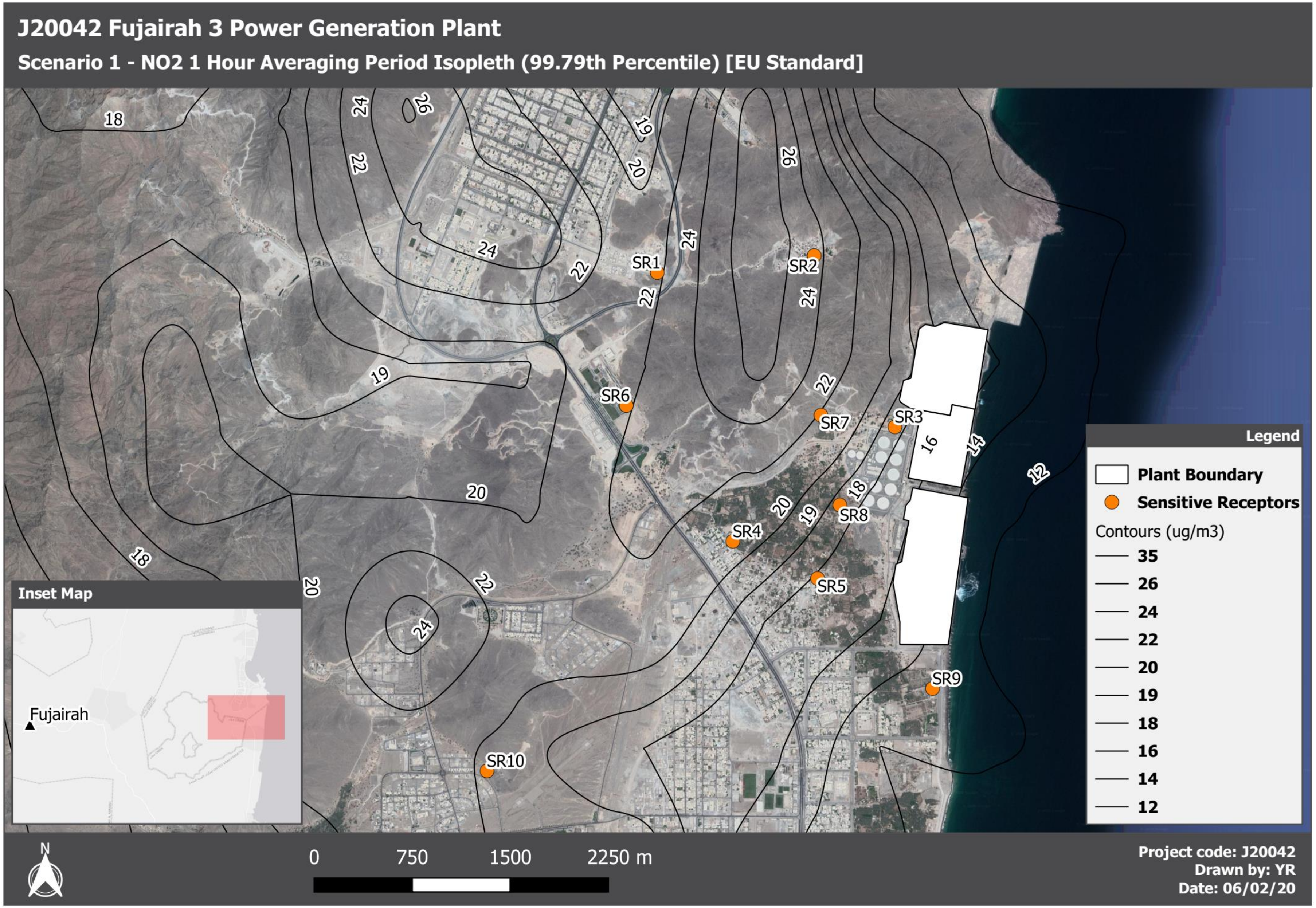


It should be noted that predicted concentrations, in the short-term, are subject to high variability during the year, being dependent on specific local meteorological conditions. Consequently, exceedances of short term air quality guideline values are often linked to adverse meteorological conditions that may not occur often over the course of a year (e.g. calm winds, stable atmospheric conditions). To account for rare conditions that may result in short-term exceedances, many regulatory regimes (for example the EU) allow for a certain number of exceedances per year for short-term standards. The results taking into account the number of exceedances permitted by the EU AAQA are presented in Table 6-2 for the model maximum, and in Table A- 2 for the SRs. These results show predicted compliance for all averaging periods for all pollutants. Figure 6-2 below shows the NO_2 1 hour averaging period isopleth for the EU standards.

Table 6-2 – Scenario 1 Results for EU Standards

Pollutant	Averaging Period	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of EU Standard	Below EU Standard?
NO_2	1 Hour	200	18	107.83	54.57	162.40	53.92	Yes
	Annual	40	-	5.49	27.29	32.78	13.73	Yes
CO	8 Hour	10,000	-	406.46	1,568.48	1,974.94	4.06	Yes

Figure 6-2 – Scenario 1 NO_2 1 Hour Isopleths (EU Standard)



6.2 Scenario 2A – Normal Operations of F3 in Isolation with SCR

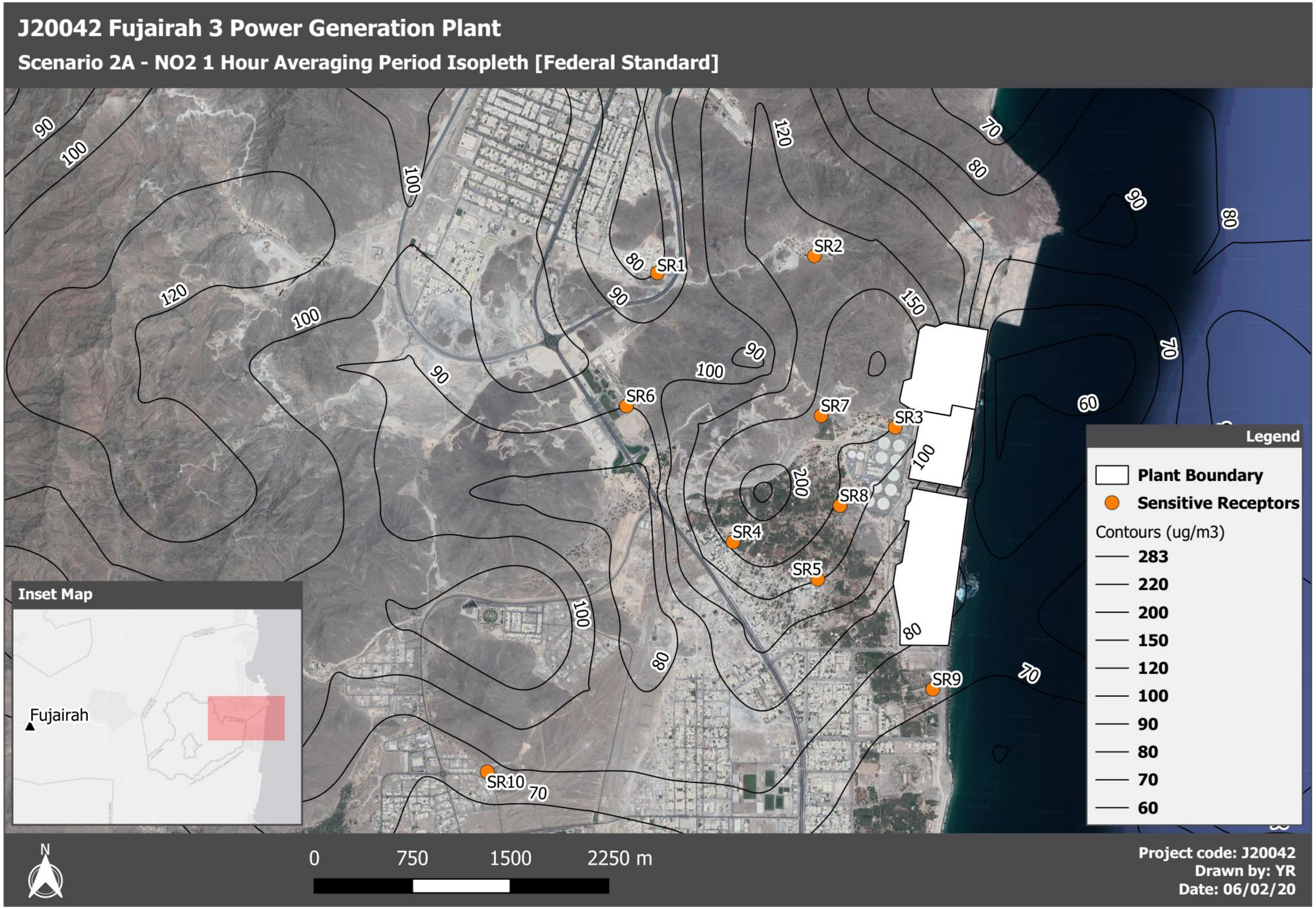
This scenario presents normal continuous operations of the Project (F3) with natural gas as the fuel and the inclusion of a Selective Catalytic Reduction (SCR) unit. SCR is a means of converting nitrogen oxides, also referred to as NOx with the aid of a catalyst into diatomic nitrogen, and water. A gaseous reductant, typically anhydrous ammonia or aqueous ammonia is added to the flue gas and is adsorbed onto a catalyst. The NO_x emission limit for this scenario is 20 mg/Nm^3.

This case also considers the Project NO_2 1 hour ambient standard of 200 mg/Nm^3, which has been set by the Project Owners. The results presented in Table 6-3 show that both the NO_2 and CO modelled results for all relevant averaging periods are below the Federal and Project specific standards, with the exception of the comparison against the NO_2 1 hour Project standard. All maximum GLCs, with the exception of the NO_2 1-hour averaging period were found to be less than 25 % of the federal standard. The SR results in Table A- 3 and Figure 6-3 show that concentrations at all SRs are expected to be complaint with both the Federal and Project standards. The modelled result was predicted to be in excess of 25 % of the AAQS at 6 SRs (SR2, SR4, SR5, SR6, SR7 and SR8) for NO_2 for the 1-Hour averaging period.

Table 6-3 – Scenario 2A Results for Federal and Project Standards

Pollutant	Averaging Period	Federal AAQS (µg/m^3)	Project Standards (µg/m^3)	Model Results (µg/m^3)	Model Results % of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
NO2	1 Hour	400	200	283.00	70.73	No	Yes	No
	24 Hour	150	-	18.80	12.53	Yes	Yes	NA
CO	1 Hour	30,000	-	1,422.1	4.74	Yes	Yes	NA
	8 Hour	10,000	-	2,73.15	2.73	Yes	Yes	NA
PM10	24 Hour	150	-	1.89	1.26	Yes	Yes	NA

Figure 6-3 – Scenario 2A NO_2 1 Hour Isopleths (Federal Standard)

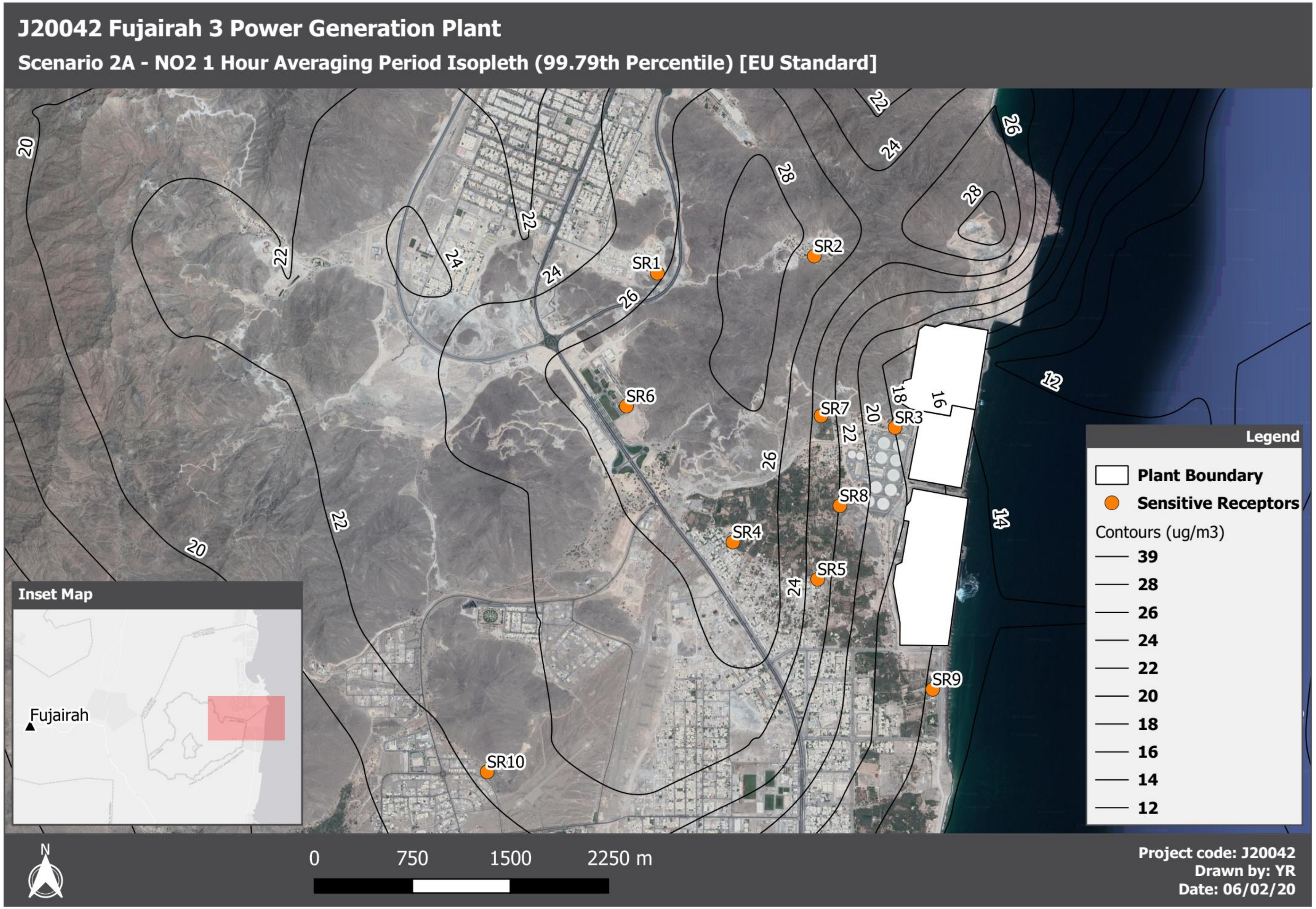


The assessment against the EU standards was undertaken to account for rare meteorological conditions that may result in short-term exceedances of the standards. The model predicted values (Table 6-4), indicate that all pollutant concentrations are expected to be below the AAQS and less than 25 % of the standard. As depicted in Table A- 4 this was also the case at all SR's for all averaging period. Figure 6-4 below shows the NO_2 1 hour averaging period isopleths for the EU standards.

Table 6-4 – Scenario 2A Results for EU Standards

Pollutant	Averaging Period	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Model Results % of EU Standard	< 25% of the EU Standard	Below EU Standard?
NO_2	1 Hour	200	18	39.11	19.56	Yes	Yes
	Annual	40	-	1.53	3.82	Yes	Yes
CO	8 Hour	10,000	-	273.15	2.73	Yes	Yes
PM_{10}	24 Hour	50	35	0.33	0.66	Yes	Yes
	Annual	40	-	0.11	0.28	Yes	Yes
$PM_{2.5}$	Annual	25	-	0.11	0.44	Yes	Yes

Figure 6-4 – Scenario 2A NO_2 1 Hour Isopleths (EU Standard)



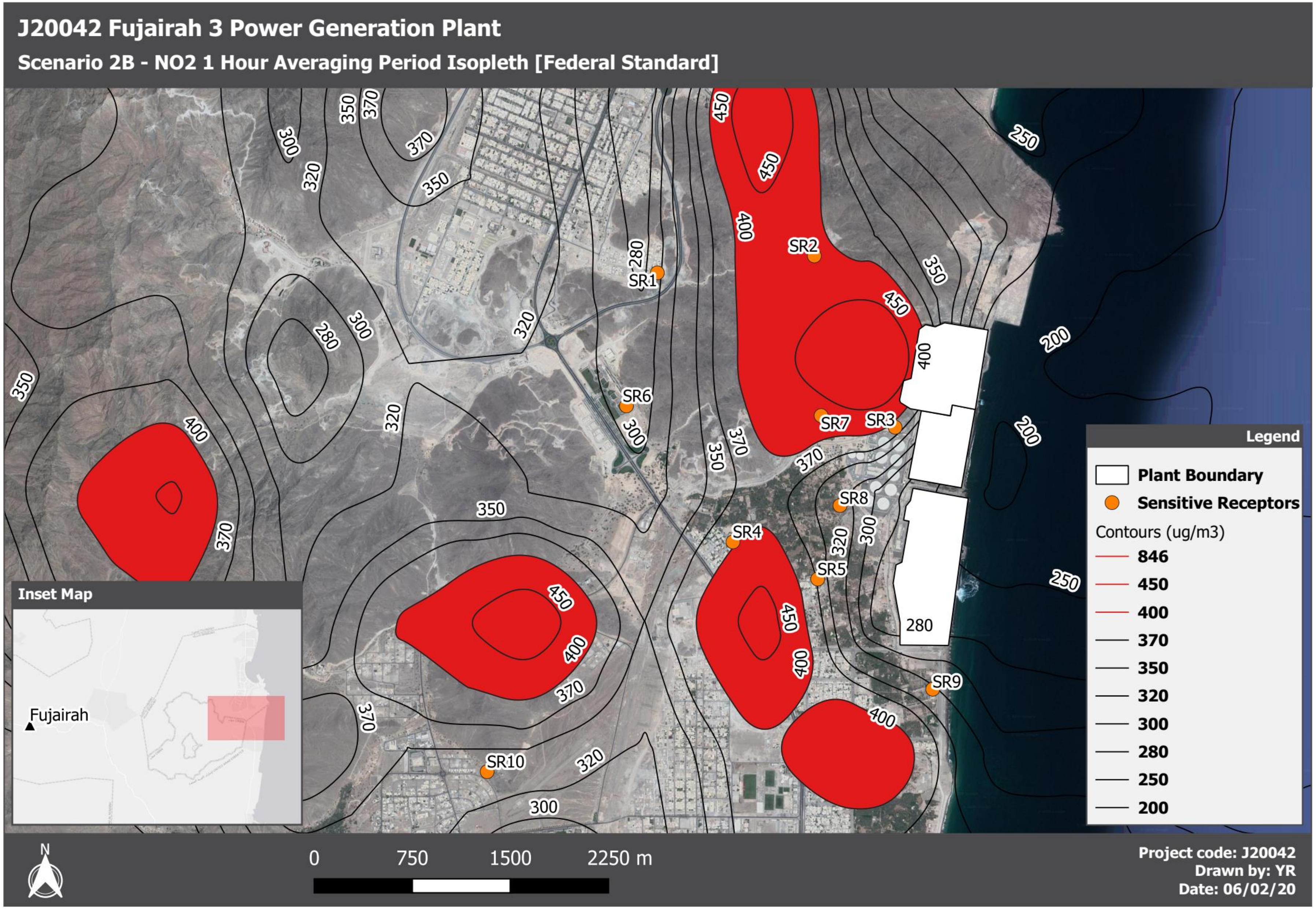
6.3 Scenario 2B – Normal Operations of F3 with SCR including Baseline (F1 and F2)

This scenario considers the cumulative impacts from F1, F2 and F3, with the inclusion of an SCR unit at F3 with a NOx emission limit of 20 mg/Nm^3. The results presented in Figure 6-5 and Table 6-5 indicate that the modelled concentrations for the NO_2 1-hour averaging periods are expected to be above the Federal standards, whilst CO and PM_{10} are expected to be compliant with the Federal standards. In terms of SR results (Table A- 5), the model values are expected to exceed the NO_2 1 hour Federal standards at 3 locations (SR7, SR8 and SR9). The cumulative results, which included the addition of the measured air quality baseline data, showed the same trend as the modelled results for all pollutants and averaging periods. With the addition of background data to the model results, the NO_2 1 hour standard may be exceeded at SR2, SR6-SR10, while sensitive receptor results for all other pollutants are expected to be below the standards.

Table 6-5 – Scenario 2B Results for Federal Standards

Pollutant	Averaging Period	Federal AAQS (μg/m^3)	Model Results (μg/m^3)	Background Concentration (μg/m^3)	Cumulative Results (μg/m^3)	Model Results % of Federal Standard	Below Federal Standard?
NO_2	1 Hour	400	846.12	54.57	900.69	211.53	No
	24 Hour	150	69.68	54.57	124.25	46.45	Yes
CO	1 Hour	30,000	2,226.00	1,568.48	3,794.48	7.42	Yes
	8 Hour	10,000	504.64	1,568.48	2,073.12	5.05	Yes
PM_{10}	24 Hour	150	1.89	-	1.89	1.26	Yes

Figure 6-5 – Scenario 2B NO_2 1 Hour Isopleths (Federal Standard)

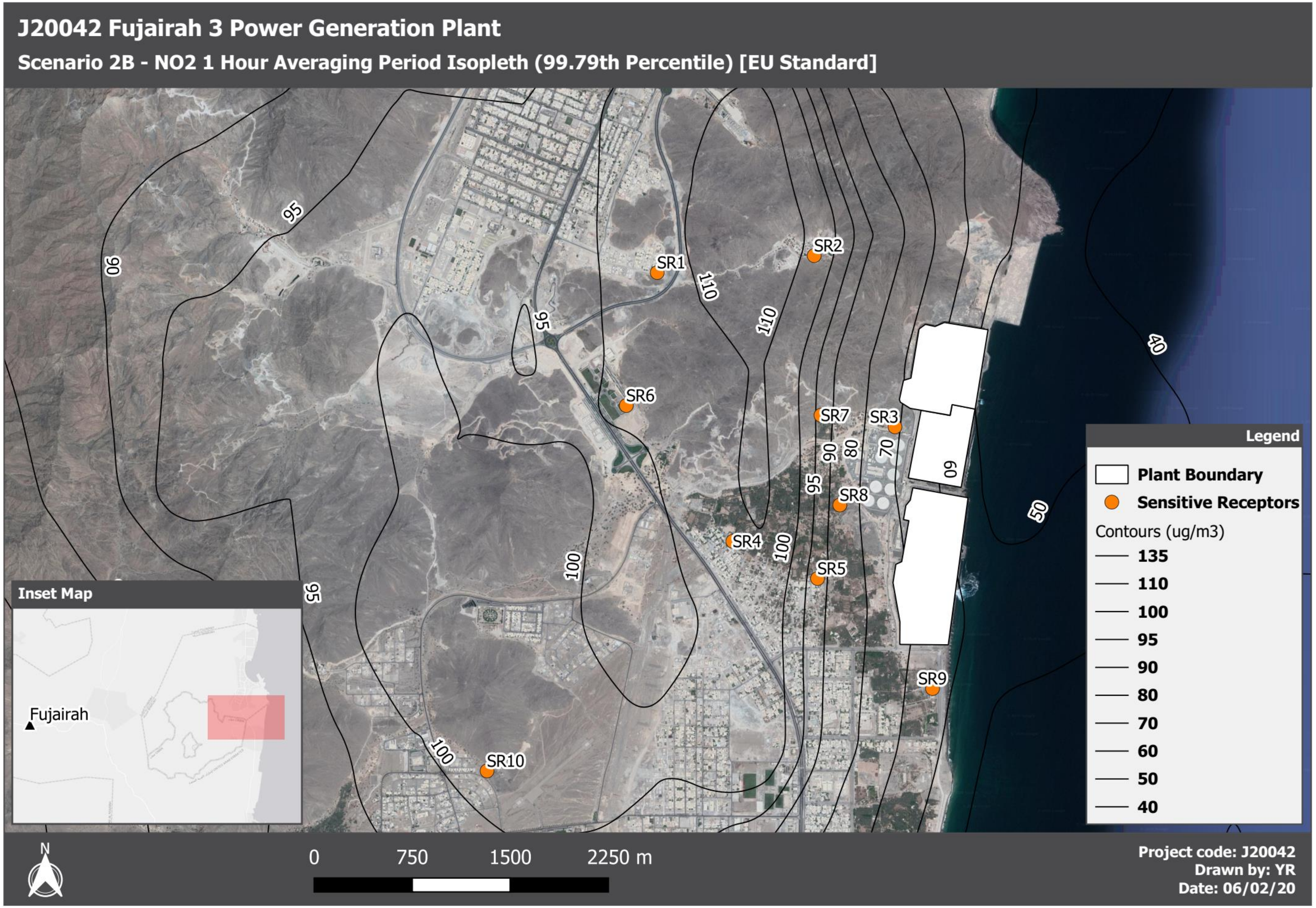


The results in Table 6-6 and Table A- 6 show the comparison against the EU standards, taking into account the permitted number of exceedances to account for rare conditions that may result in short-term exceedances. No exceedances of the standards for any of the pollutants for any of the averaging periods were observed with the modelled results. Figure 6-6 below shows compliance of the NO_2 1 hour averaging period for the EU standards. The cumulative assessment yielded the same conclusions in that there are no predicted exceedances of the standards for any of the pollutants for all averaging periods. All sensitive receptor results were also below the relevant standards for all pollutants.

Table 6-6 – Scenario 2B Results for EU Standards

Pollutant	Averaging Period	EU AAQS(μg/m³)	Permitted Exceedances as per EU AAQS	Model Results (μg/m³)	Background Concentration (μg/m³)	Cumulative Results (μg/m³)	Below EU Standard?
NO_2	1 Hour	200	18	135.09	54.57	189.66	Yes
	Annual	40	-	6.75	27.29	34.04	Yes
CO	8 Hour	10,000	-	504.64	1,568.48	2,073.12	Yes
PM_{10}	24 Hour	50	35	0.33	-	0.33	Yes
	Annual	40	-	0.11	-	0.11	Yes
$PM_{2.5}$	Annual	25	-	0.11	-	0.11	Yes

Figure 6-6 – Scenario 2B NO_2 1 Hour Isopleths (EU Standard)



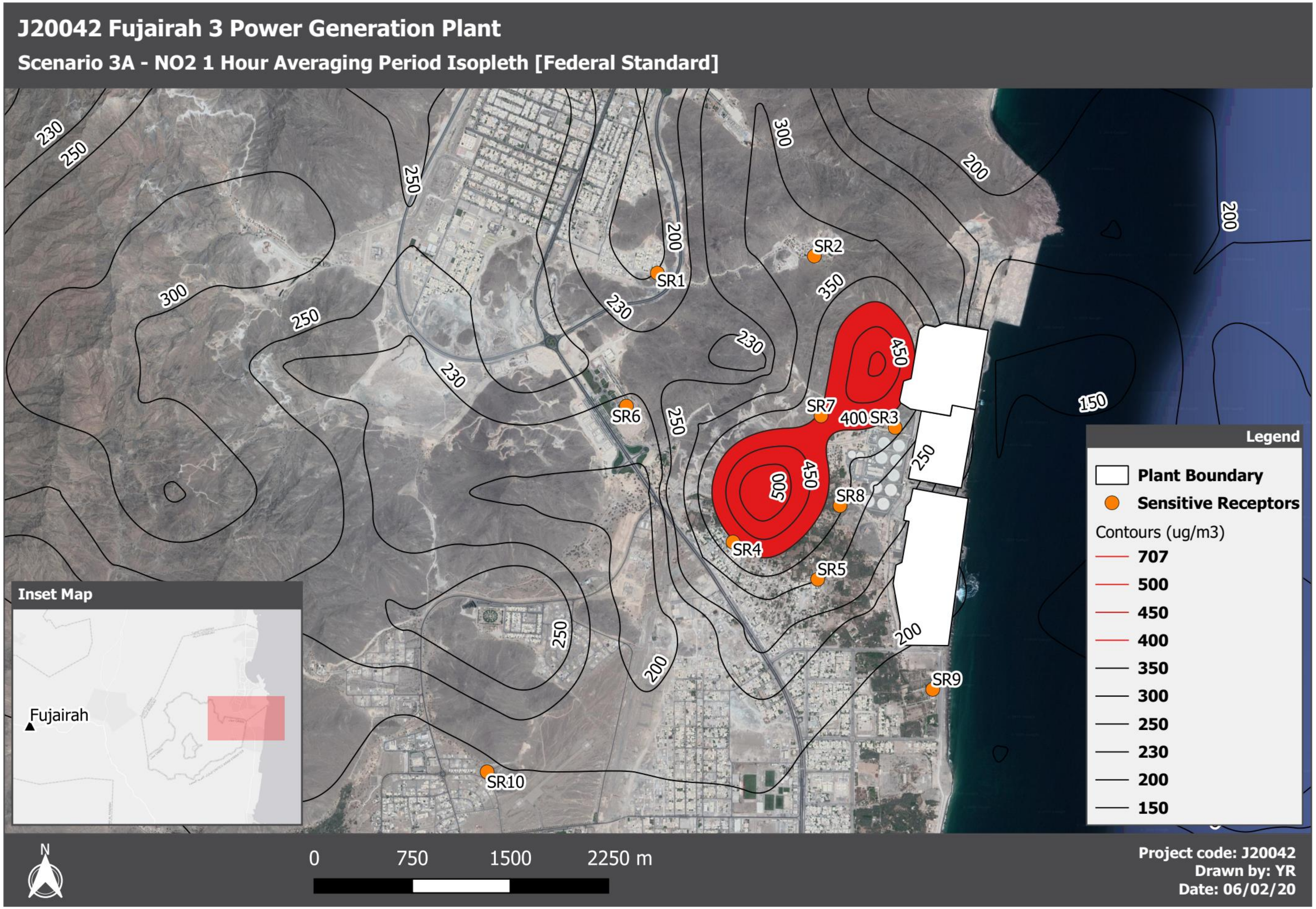
6.4 Scenario 3A – Normal Operations of F3 in Isolation without SCR

Scenario 3A considers the Project in isolation with the SCR unit offline. The vendor NO_x guarantee for the turbines in the absence of the SCR unit emission limit is 50 mg/Nm^3. The results for this scenario compared against the Federal and Project Standards are presented in Table 6-7. The modelled concentrations show that the NO_2 1-hour model values are likely to exceed both the Federal AAQS and the Project Standards at the point of maximum impact (as shown in Figure 6-7), and therefore do not achieve the IFC guidelines requirement (below 25 % of the relevant standard). The CO and PM results were found to be both below and less than 25 % of the Federal standard. Table A- 7 shows the modelled results at all SRs assessed against the Federal and Project standards. The results at the SRs were found to exceed the Federal standards for NO_2 (1 hour) at 3 receptors (SR4, SR5 and SR7) while the Project standard was exceeded at 7 SRs (SR2, SR4, SR5, SR6, SR7, SR8, SR10). The values at all SRs were above 25% of the Federal Standard. The NO_2 24-hour results as well as the CO results for both averaging periods (1-hour and 8-Hour) at the SRs were below the Federal standard and all less than 25 % of the standards.

Table 6-7 – Scenario 3A Results for Federal and Project Standards

Pollutant	Averaging Period	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Model Results % of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
NO_2	1 Hour	400	200	707.41	176.85	No	No	No
	24 Hour	150	-	47.02	31.35	No	Yes	NA
CO	1 Hour	30,000	-	1,422.10	4.74	Yes	Yes	NA
	8 Hour	10,000	-	273.15	2.73	Yes	Yes	NA
PM_{10}	24 Hour	150	-	1.89	1.26	Yes	Yes	NA

Figure 6-7 – Scenario 3A NO_2 1 Hour Isopleths (Federal Standard)



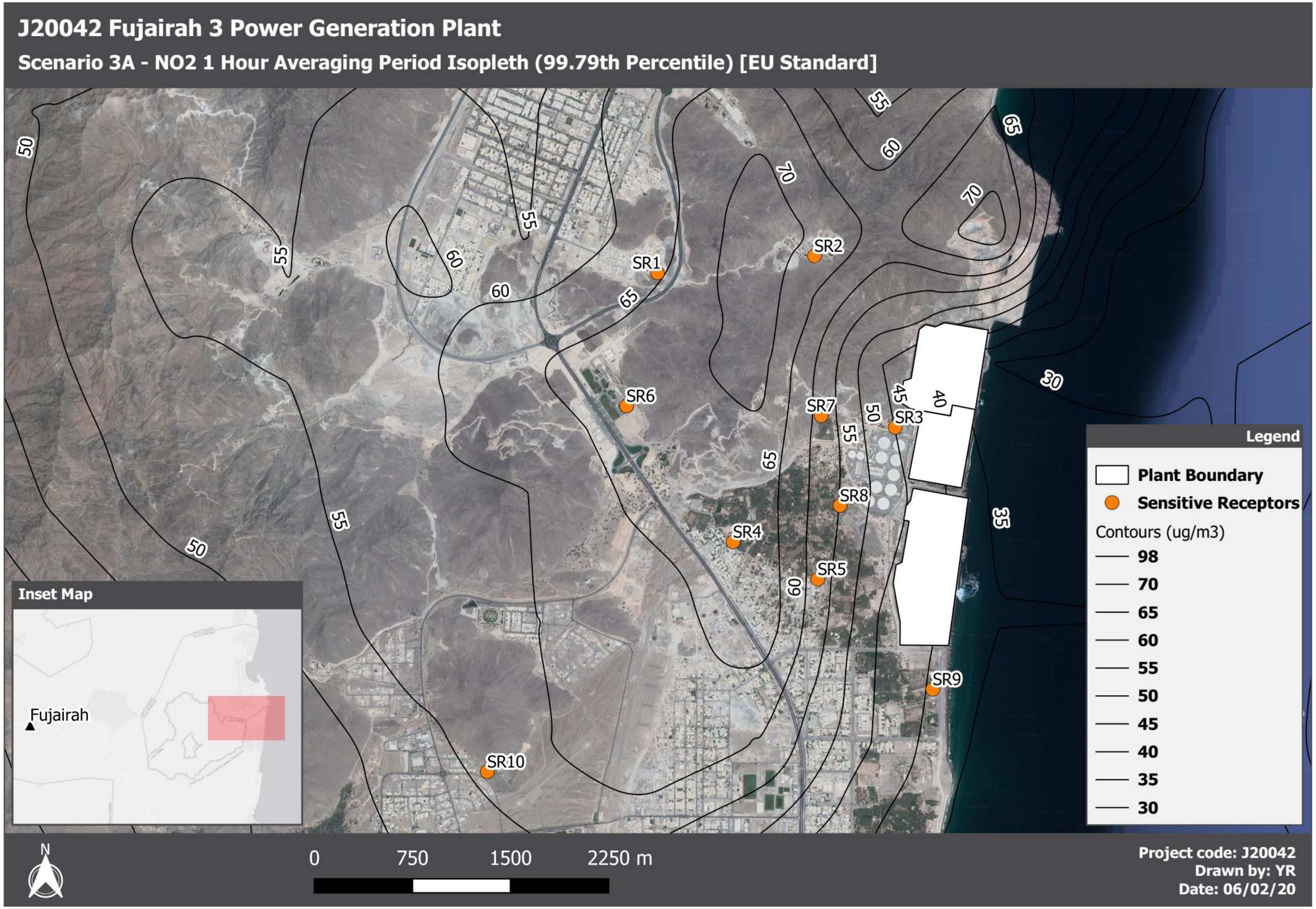
Assessing the modelled results against the EU standards, i.e. taking into account a permitted number of exceedances, it was found that the NO_2 , CO and PM results are expected to be compliant with the EU standards (amounting to less than 50% of the standard) (Table 6-8), however the NO_2 1 hour maximum may exceed the IFC 25% guideline.

The results at the SRs (Table A- 8) are predicted to be below the EU standards for all pollutants and relevant averaging periods. In terms of the IFC guideline, the model values at the SR's were predicted to be less than 25 % of the standard for PM, CO and for NO_2 for the annual averaging period however regarding the NO_2 1-hour averaging period the results were only below the 25 % threshold at 2 of the SRs (SR3 and SR9). Figure 6-8 below shows compliance with the NO_2 1 hour averaging period for the EU standards.

Table 6-8 – Scenario 3A Results for EU Standards

Pollutant	Averaging Period	EU AAQS(µg/m^3)	Permitted Exceedances as per EU AAQS	Model Results (µg/m^3)	Model Results % of EU Standard	< 25% of the EU Standard	Below EU Standard?
NO_2	1 Hour	200	18	97.78	48.89	No	Yes
	Annual	40	-	3.82	9.56	Yes	Yes
CO	8 Hour	10,000	-	273.15	2.73	Yes	Yes
PM_{10}	24 Hour	50	35	0.33	0.66	Yes	Yes
	Annual	40	-	0.11	0.28	Yes	Yes
$PM_{2.5}$	Annual	25	-	0.11	0.44	Yes	Yes

Figure 6-8 – Scenario 3A NO_2 1 Hour Isopleths (EU Standard)



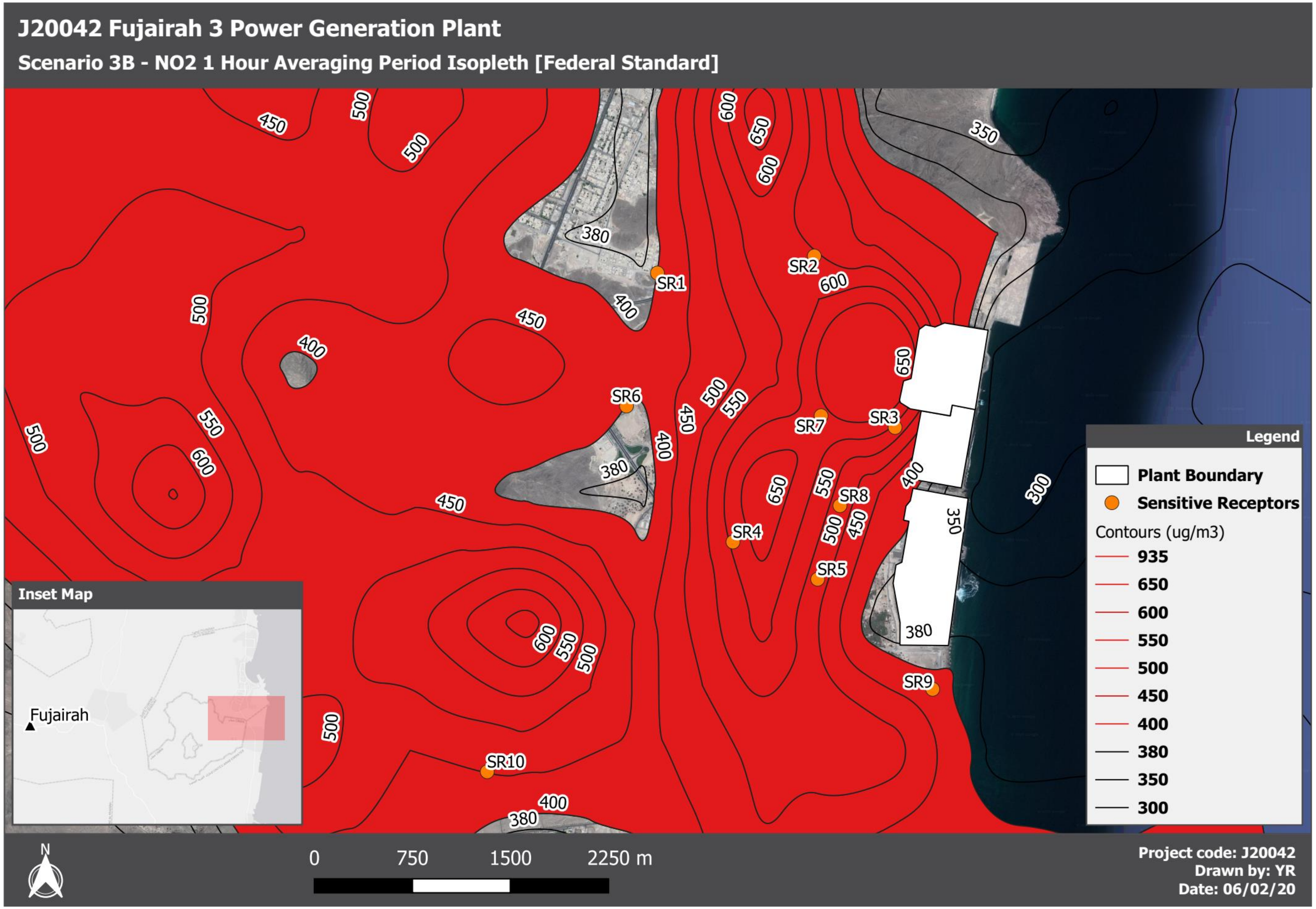
6.5 Scenario 3B – Normal Operations of F3 without SCR including Baseline (F1 and F2)

Scenario 3B considers the cumulative assessment of F1, F2 and F3, with the Project (F3) SCR unit (SCR offline (50 mg/Nm^3 NO_x emission limit). The results presented in Table 6-9 shows the modelled results against the Federal standards. All values except the NO_2 1-hour results were below the Federal standards, as shown in Figure 6-9. When considering the SR locations, the NO_2 1-hour results (Table A- 9) were also found to exceed the Federal at all SR locations with the exception of SR1 and SR3. All other pollutant averaging periods and concentrations are expected to be compliant with the Federal Standards. The cumulative assessment (addition of measured background) also indicates compliance for all pollutants at all averaging periods with the exception of the NO_2 1 hour period. The sensitive receptor cumulative assessment showed potential exceedances for the NO_2 1 hour averaging at all receptors, while sensitive receptor results for all other pollutants were predicted to be below the relevant standards at all receptors.

Table 6-9 – Scenario 3B Results for Federal Standards

Pollutant	Averaging Period	Federal AAQS (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Below Federal Standard?
NO_2	1 Hour	400	934.56	54.57	989.13	No
	24 Hour	150	79.04	54.57	133.61	Yes
CO	1 Hour	30,000	2,226.00	1,568.48	3,794.48	Yes
	8 Hour	10,000	504.64	1,568.48	2,073.12	Yes
PM_{10}	24 Hour	150	1.89	-	1.89	Yes

Figure 6-9 – Scenario 3B NO_2 1 Hour Isopleths (Federal Standard)

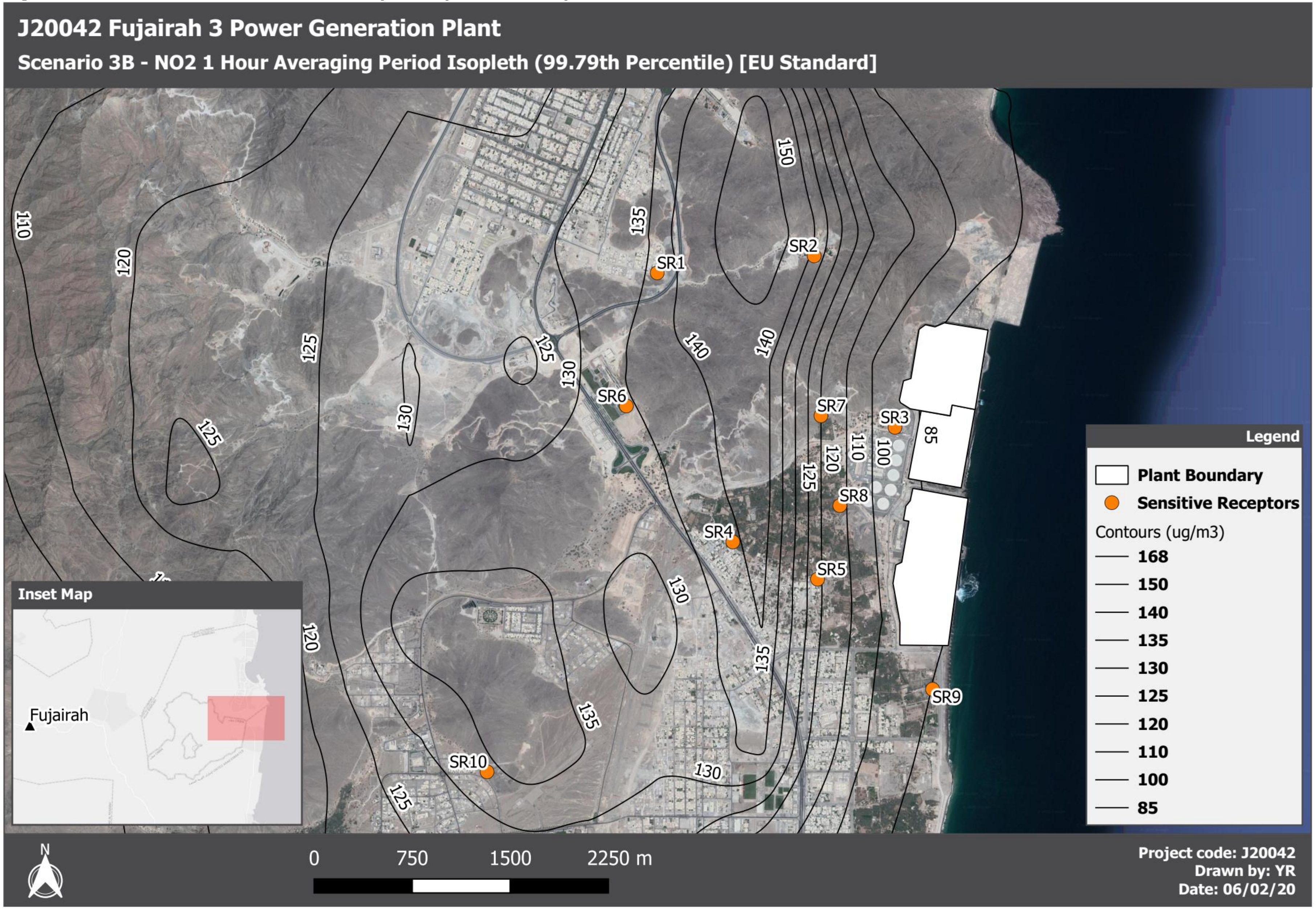


When considering a number of permitted exceedances (EU standards Table 6-10 and Table A- 10) the results show that modelled concentrations for all pollutants and all averaging periods are expected to be below the EU AAQS. Figure 6-10 below shows compliance of the NO_2 1 hour averaging period for the EU standards. The cumulative assessment indicates an exceedance for NO_2 1 hour value, with all other pollutant concentrations expected to be below the relevant standards. It should be noted that there is an element of double counting as the measured background data also includes the existing F1 and F2, which have also been modelled. The cumulative sensitive receptor results were found to be below the relevant standards for all pollutants at all sensitive receptors.

Table 6-10 – Scenario 3B Results for EU Standards

Pollutant	Averaging Period	EU AAQS(μg/m^3)	Permitted Exceedances as per EU AAQS	Model Results (μg/m^3)	Background Concentration (μg/m^3)	Cumulative Results (μg/m^3)	Below EU Standard?
NO_2	1 Hour	200	18	167.52	54.57	222.09	No
	Annual	40	-	8.65	27.29	35.94	Yes
CO	8 Hour	10,000	-	504.64	1,568.48	2,073.12	Yes
PM_{10}	24 Hour	50	35	0.33	-	0.33	Yes
	Annual	40	-	0.11	-	0.11	Yes
$PM_{2.5}$	Annual	25	-	0.11	-	0.11	Yes

Figure 6-10 – Scenario 3B NO_2 1 Hour Isopleths (EU Standard)



6.6 Scenario 4 – Alternate Fuel Case: Short Term Operation of F3 on Diesel

This scenario considers the F3 facility operating on diesel fuel with a sulphur content of 10 ppm and vendor guaranteed emission limits for NO_2 (120 mg/Nm^3) and CO (50 mg/Nm^3) respectively. The gas turbines will operate with natural gas as the primary fuel and only in the event of natural gas interruption, off specification supply gas, or requirement for testing purposes, will the plant operate on a back-up liquid fuel, which is diesel.

Based on discussions with the Project team this is a very unlikely scenario and is only expected to occur for very short periods (1 to 2 hours per year, with a conservative maximum of 20 hours). The approach that may be considered when modelling impacts from intermittent emissions follows a US EPA method and is based on an average hourly rate, rather than the maximum hourly emission. In this instance the modelling analysis assumes continuous operation at the average hourly rate, i.e., the maximum hourly emission rate for each turbine multiplied by a factor of 20/8760. This approach accounts for potential worst-case meteorological conditions associated with turbine emissions by assuming continuous operation, while use of the average hourly emission represents a simple approach to account for the probability of the turbines operating on diesel for a given hour in the year [9].

The results in Table 6-11 were assessed against the Federal and Project standards. The modelled concentrations showed compliance with all standards for all pollutants. The SR results presented in Table A-11 show no exceedances for any of the pollutants at any of the SRs. The temporary operation of the turbines on diesel is also not likely to lead to a breach of the EU standards (Table 6-12). Figure 6-11 and Figure 6-12 below shows compliance of the NO_2 1 hour averaging period for the Federal and EU standards respectively. A cumulative assessment of the results for this scenario displayed the same trend as the modelled results. Once the relevant background concentrations were added to the model results it was found that the results for all pollutants were below the relevant standards for all pollutants. This was also the case at all sensitive receptors.

Table 6-11 – Scenario 4 Results for Federal and Project Standards

Pollutant	Averaging Period	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	Below Federal Standard?	Below Project Standard?
NO_2	1 Hour	400	200	3.88	54.57	58.45	0.97	Yes	Yes
	24 Hour	150	-	0.24	54.57	54.81	0.16	Yes	-
SO_2	1 Hour	350	200	0.05	-	0.05	0.01	Yes	Yes
	24 Hour	150	-	Negligible	-	Negligible	Negligible	Yes	-
	Annual	60	-	Negligible	-	Negligible	Negligible	Yes	-
CO	1 Hour	30,000	-	3.17	1,568.48	1,571.65	0.01	Yes	-
	8 Hour	10,000	-	0.56	1,568.48	1,569.04	0.006	Yes	-
PM_{10}	24 Hour	150	-	Negligible	-	Negligible	Negligible	Yes	-

Figure 6-11 – Scenario 4 NO_2 1 Hour Isopleths (Federal Standard)

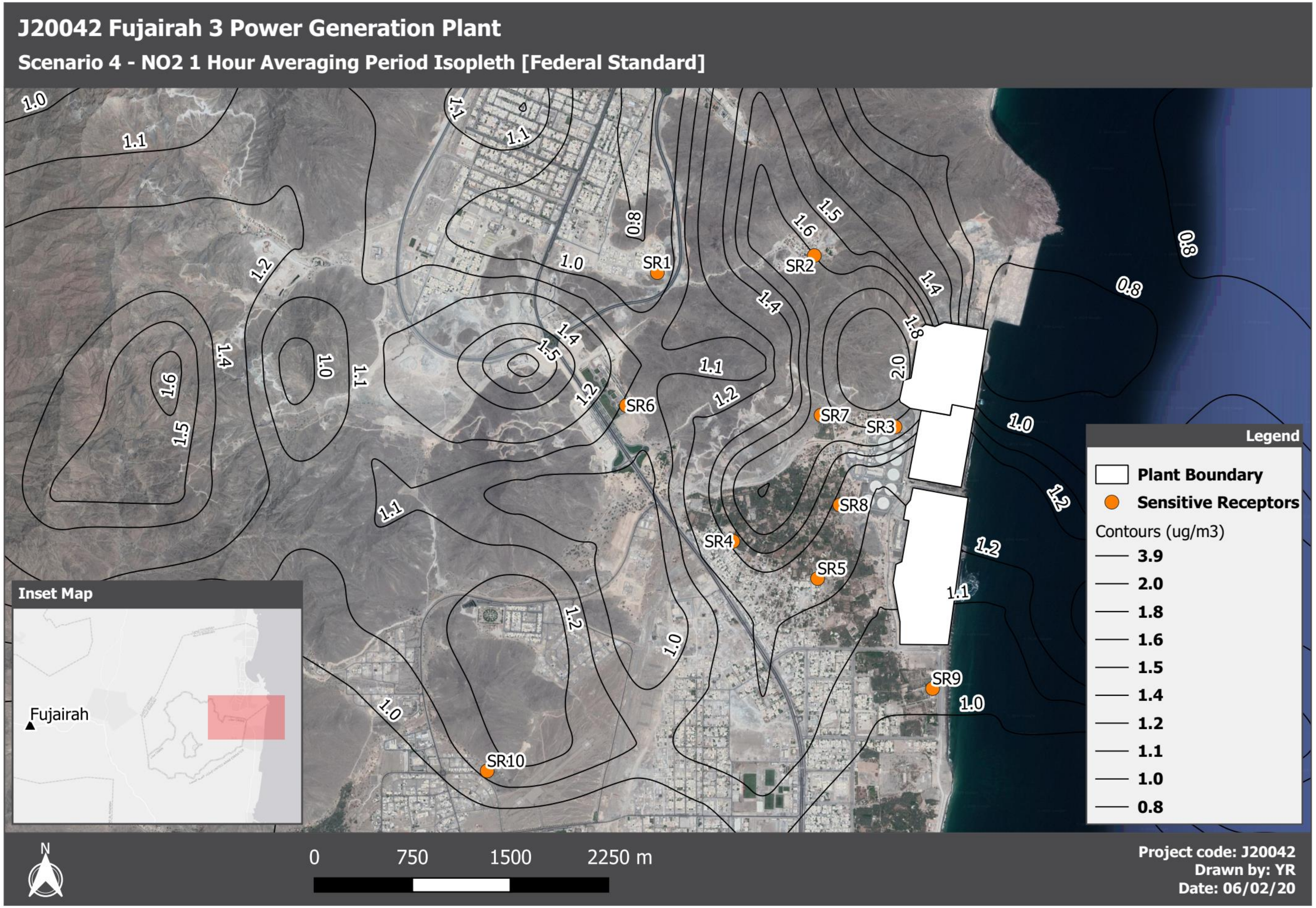


Table 6-12 – Scenario 4 Results for EU Standards

Pollutant	Averaging Period	EU AAQS($\mu g/m^3$)	Permitted Exceedances as per EU AAQS	Model Results ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Cumulative Results ($\mu g/m^3$)	Model Results % of EU Standard	Below EU Standard?
NO_2	1 Hour	200	18	0.42	54.57	54.99	0.21	Yes
	Annual	40	-	0.01	27.29	27.30	0.04	Yes
CO	8 Hour	10,000	-	0.56	1,568.48	1,569.04		Yes
SO_2	1 Hour	350	24	0.010	-	0.010	0.003	Yes
	24 Hour	125	3	Negligible	-	Negligible	Negligible	Yes
PM_{10}	24 Hour	50	35	Negligible	-	Negligible	Negligible	Yes
	Annual	40	-	Negligible	-	Negligible	Negligible	Yes
$PM_{2.5}$	Annual	25	-	Negligible	-	Negligible	Negligible	Yes

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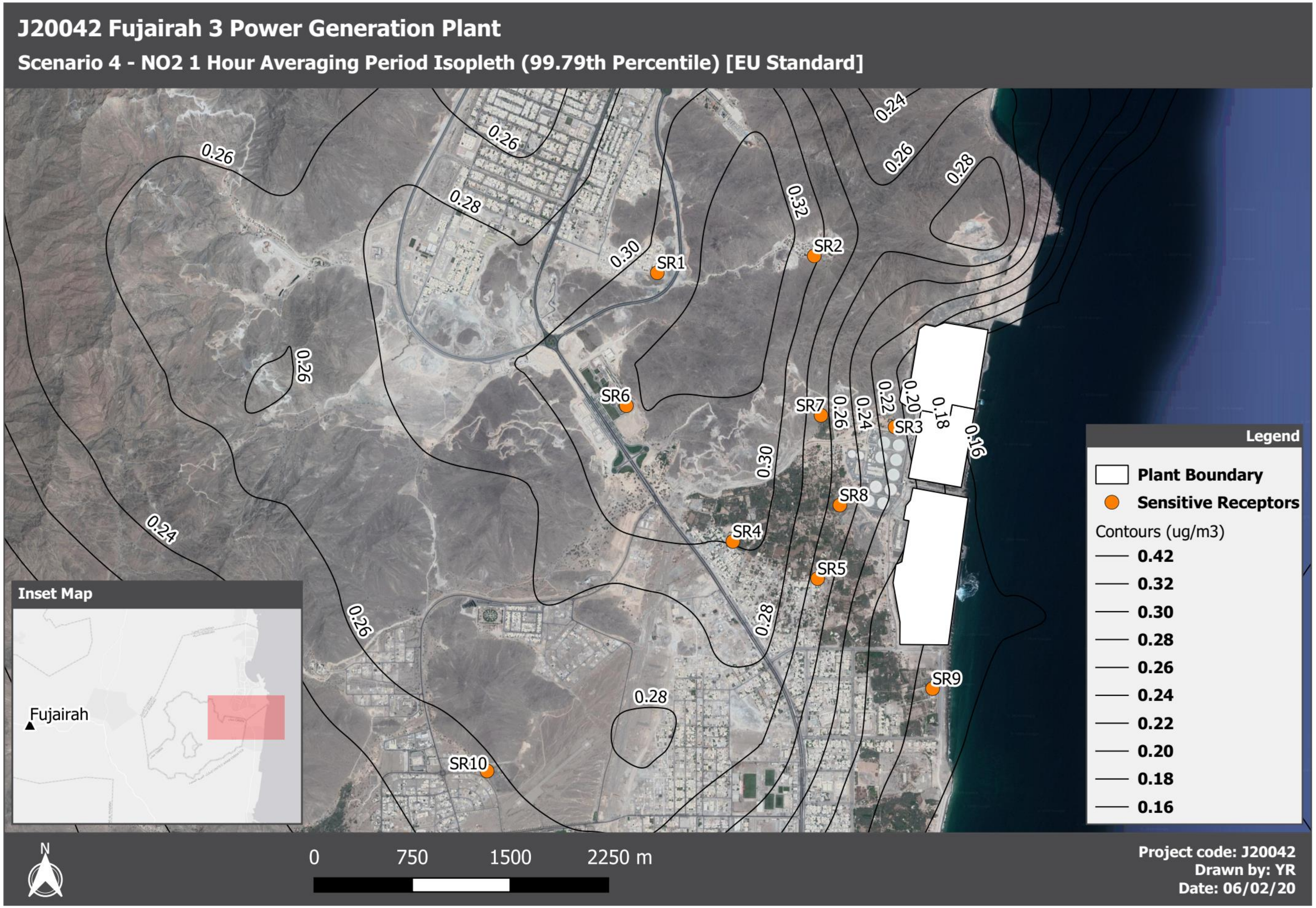
Figure 6-12 – Scenario 4 NO_2 1 Hour Isopleths (EU Standard)



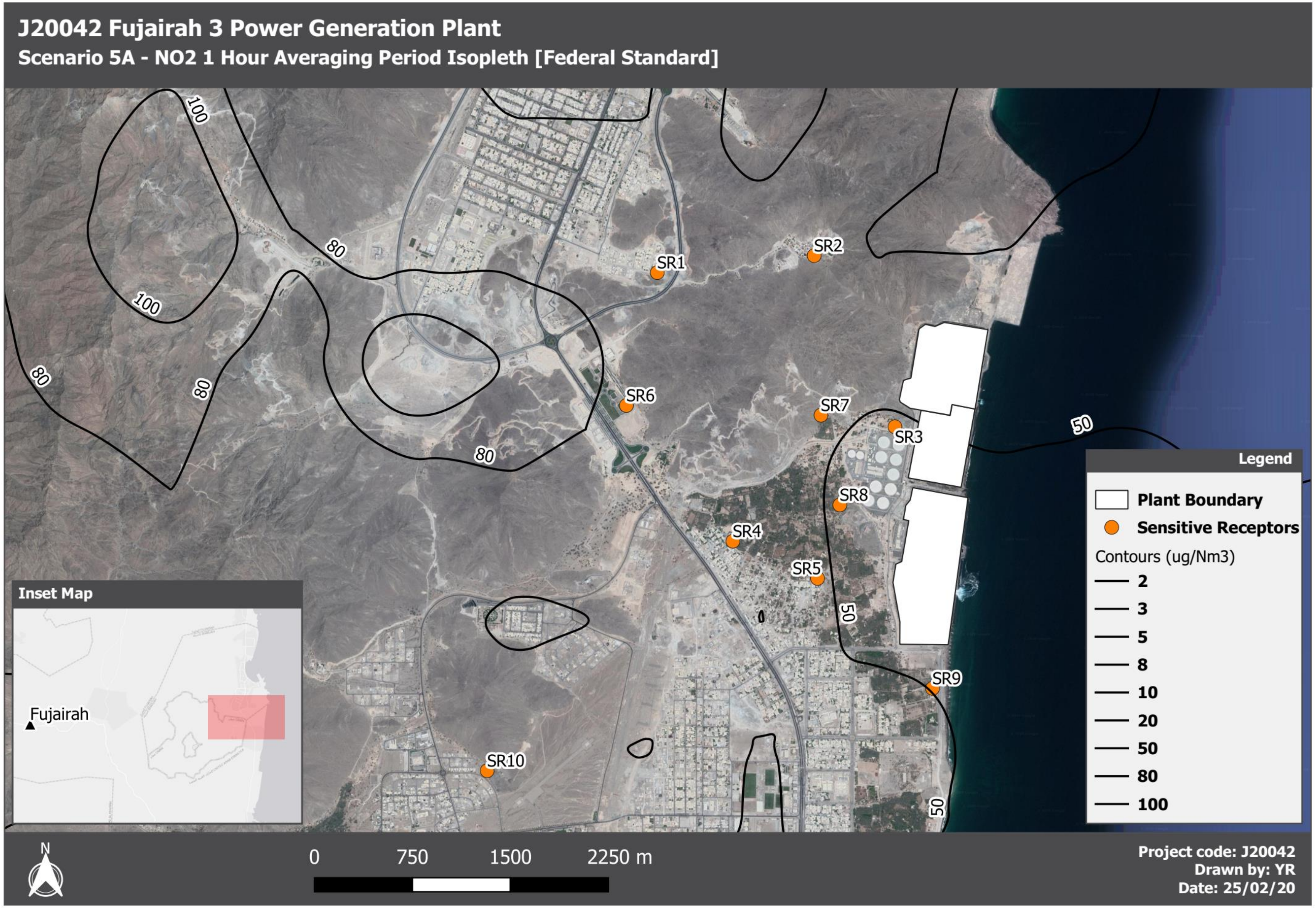
6.7 Scenario 5A – Bypass Operations of F3 in Isolation without SCR

This scenario presents the F3 power plant operating all 3 turbines running on bypass (i.e. simple cycle) fuelled by natural gas without the inclusion of an SCR unit. This scenario was included as the Project is anticipated to operate with all three turbines in open cycle between April 2022 and March 2023 as part of the Phased introduction to plant capacity. In the absence of the SCR the NO_x emission limit was set at 50 mg/Nm^3. The results for the scenario, presented in Table 6-13, were compared against the Federal and Project standards. The modelled concentrations for all pollutants were below the relevant Federal and Project standards. All maximum GLCs, except the NO_2 1 Hour concentration was less than 25% of the Federal standard. The SR results presented in Table A-13 and Figure 6-13 show that concentration at all SRs are expected to be below both the Federal and Project standards.

Table 6-13 – Scenario 5A Results for Federal and Project Standards

Pollutant	Averaging Period	Federal AAQS (μg/m^3)	Project Standards (μg/m^3)	Model Results (μg/m^3)	Model Results % of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
NO_2	1 Hour	400	200	190.94	47.74	No	Yes	Yes
	24 Hour	150	-	14.63	9.75	Yes	Yes	NA
CO	1 Hour	30,000	-	382.68	1.28	Yes	Yes	NA
	8 Hour	10,000	-	70.86	0.71	Yes	Yes	NA
PM_{10}	24 Hour	150	-	0.59	0.39	Yes	Yes	NA

Figure 6-13 – Scenario 5A NO_2 1 Hour Isopleths (Federal Standards)

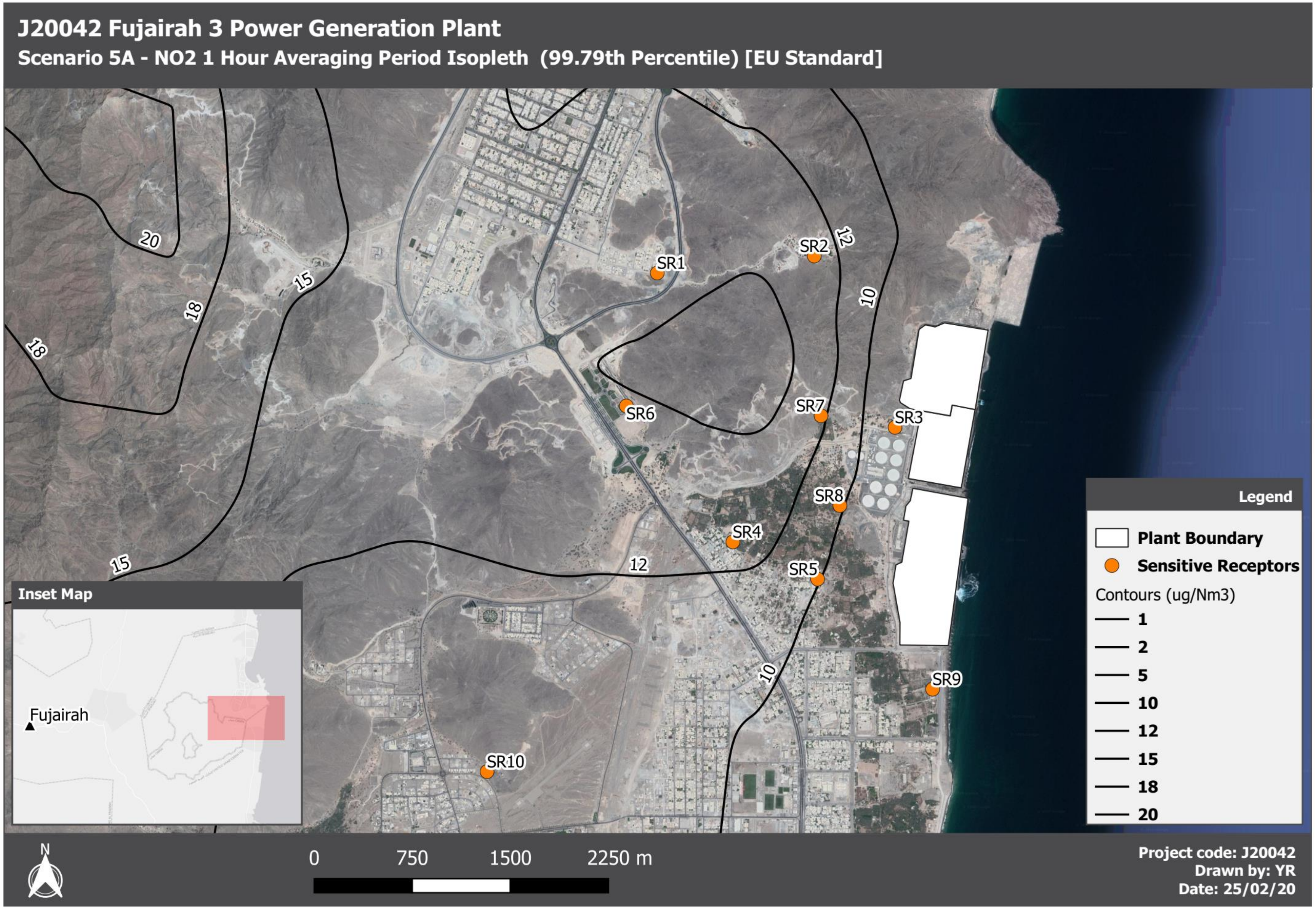


Assessing the modelled results against the EU standards it was found that all concentrations are expected to be complaint with the EU standards. Modelled results for all pollutants were also predicted to be less than 25% of the relevant standard. The SR results, presented in Table A-14, were found to be compliant with the EU standards at all SRs for all pollutants. Modelled concentrations for NO_2, CO and PM_{10} were predicted to be well below 25 % of the relevant EU standard. The isopleths displayed in Figure 6-14 depict that the predicted modelled concentrations at the SRs are well below the EU standards.

Table 6-14 – Scenario 5A Results for EU Standards

Pollutant	Averaging Period	EU AAQS(μg/m³)	Permitted Exceedances as per EU AAQS	Model Results (μg/m³)	Model Results % of EU Standard	< 25% of the EU Standard	Below EU Standard?
NO_2	1 Hour	200	18	22.93	11.47	Yes	Yes
	Annual	40	-	0.51	1.28	Yes	Yes
CO	8 Hour	10,000	-	70.86	0.71	Yes	Yes
PM_{10}	24 Hour	50	35	0.59	1.18	Yes	Yes
	Annual	40	-	0.02	0.05	Yes	Yes
$PM_{2.5}$	Annual	25	-	0.02	0.08	Yes	Yes

Figure 6-14 – Scenario 5A NO_2 1 Hour Isopleths (EU Standards)



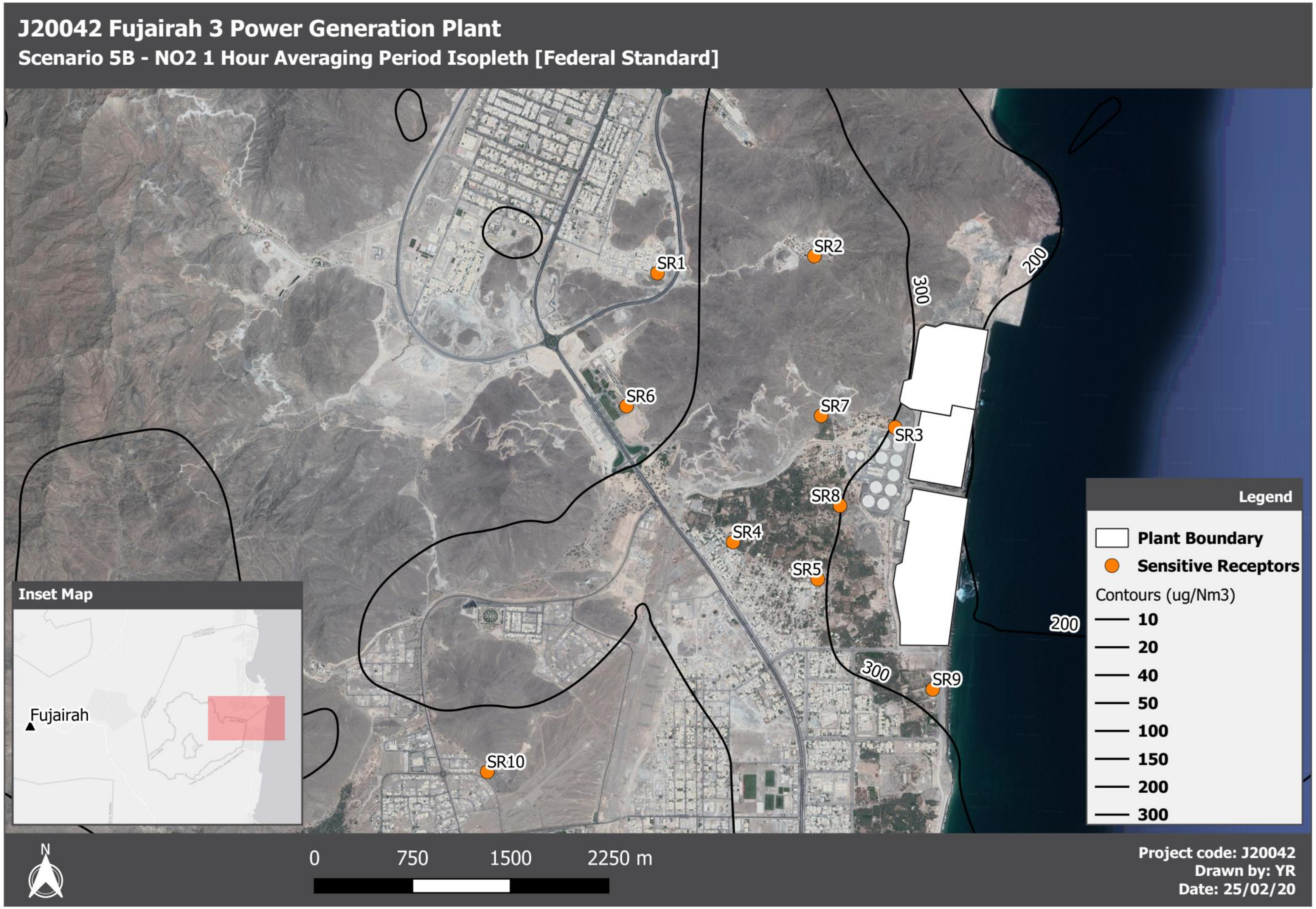
6.8 Scenario 5B – Bypass Operations of F3 without SCR including Baseline (F1 and F2)

This scenario considers the cumulative impacts from F1, F2 and F3, without the inclusion of an SCR unit and all 3 turbines running on simple cycle with a NO_x emission limit of 50 mg/Nm^3. The modelled results presented in Figure 6-15 and Table 6-15 indicate that the modelled concentrations for the NO_2 1-hour averaging period are expected to be above the Federal standards, whilst CO and PM_{10} are expected to be compliant with the Federal standards. In terms of the SR results, the model values do not exceed the Federal standards at any of the SRs (Table A-15). The cumulative results (with addition of measured baseline) presented in Table 6-15 showed the same trend as the modelled results for all pollutants and averaging periods.

Table 6-15 – Scenario 5B Results for Federal and Project Standards

Pollutant	Averaging Period	Federal AAQS (µg/m^3)	Model Results (µg/m^3)	Background Concentration (µg/m^3)	Cumulative Results (µg/m^3)	Below Federal Standard?
NO_2	1 Hour	400	787.17	54.57	841.74	No
	24 Hour	150	63.48	54.57	118.05	Yes
CO	1 Hour	30,000	1,985.00	1,568.48	3,553.48	Yes
	8 Hour	10,000	406.46	1,568.48	1974.94	Yes
PM_{10}	24 Hour	150	0.59	-	0.59	Yes

Figure 6-15 – Scenario 5B NO_2 1 Hour Isopleths (Federal Standards)

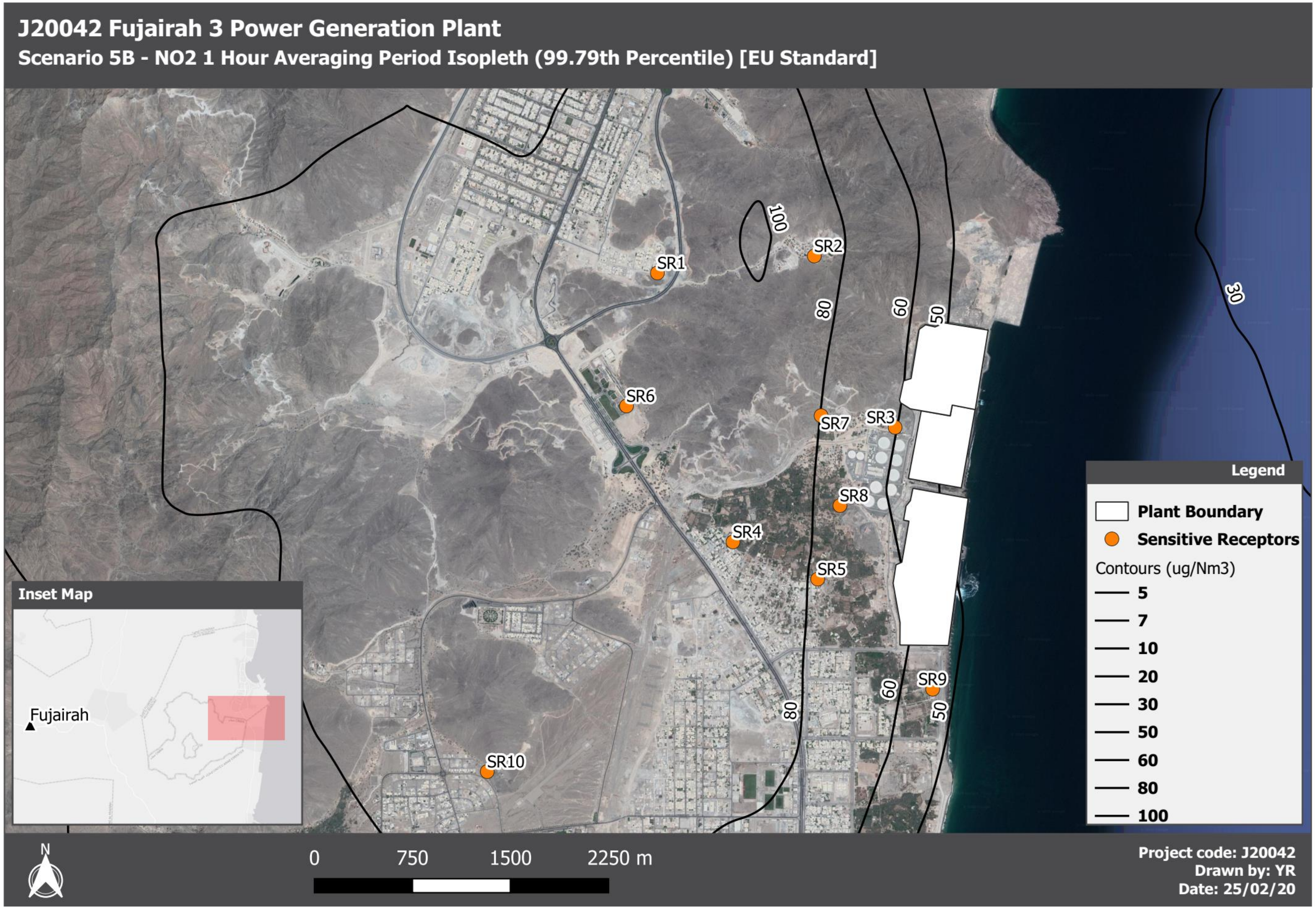


When accounting for the permitted number exceedances, as per the EU standards, the results show that the modelled concentrations for all pollutants were below the relevant standards (Table 6-16). Figure 6-16 displays the NO_2 concentration across the SRs, showing that the NO_2 are expected to be complaint with the EU AAQS at all SRs (Table A-16). The cumulative results presented in Table 6-16 and Table A-16 indicate that the pollutant maximum GLCs as well as the SR results are below the relevant EU standards.

Table 6-16 – Scenario 5B Results for EU Standards

Pollutant	Averaging Period	EU AAQS(µg/m^3)	Permitted Exceedances as per EU AAQS	Model Results (µg/m^3)	Background Concentration (µg/m^3)	Cumulative Results (µg/m^3)	Below EU Standard?
NO_2	1 Hour	200	18	109.06	54.57	163.63	Yes
	Annual	40	-	4.40	27.29	31.69	Yes
CO	8 Hour	10000	-	406.46	1,568.48	1,974.94	Yes
PM_{10}	24 Hour	50	35	0.59	-	0.59	Yes
	Annual	40	-	0.02	-	0.02	Yes
$PM_{2.5}$	Annual	25	-	0.02	-	0.02	Yes

Figure 6-16 – Scenario 5B NO_2 1 Hour Isopleths (EU Standards)



7 Conclusion

This assessment has considered the potential impacts to ambient air quality from the operation of the F3 Project using the internationally recognised CALPUFF dispersion modelling system. Emissions from the various sources have been considered in terms of the potential impact to air quality for NO_2, SO_2, CO, and PM associated with normal and abnormal operations of the facility.

The following scenarios were considered in the assessment, namely:

- Scenario 1: Baseline Case - normal operation of existing power stations F1 and F2
- Scenario 2A: F3 in isolation -normal operations with the Selective Catalytic Reduction (SCR) Unit. The NO_x emission limit for this scenario is 20 mg/Nm^3.
- Scenario 2B: Cumulative assessment -normal operations of all three power plants (F1, F2 and F3) with the F3 turbines operating with a SCR Unit. The F3 NO_x emission limit for this scenario is 20 mg/Nm^3.
- Scenario 3A: F3 in isolation- normal operations of F3 with the F3 turbines operating without SCR Unit. The NO_x emission limit for this scenario is 50 mg/Nm^3.
- Scenario 3B: Cumulative assessment -normal operations of all three power plants (F1, F2 and F3) with the F3 turbines operating without a SCR Unit. The F3 NO_x emission limit for this scenario is 50 mg/Nm^3.
- Scenario 4: Alternate fuel operations (short term- 20 hours per year), F3 turbines operating on 10ppm diesel.
- Scenario 5A: F3 in isolation- bypass operations of F3 with the F3 turbines operating in simple cycle without SCR Unit. The NO_x emission limit for this scenario is 50 mg/Nm^3.
- Scenario 5B: Cumulative assessment- bypass operations of F3 with normal operations of the other two power plants (F1 and F2). The F3 turbines operate without a SCR Unit. The F3 NO_x emission limit for this scenario is 50 mg/Nm^3.

The modelled results have been compared against both the Federal ambient air quality standards, the specific Project Standards, in addition to the EU ambient air quality standards. It should be noted that predicted concentrations, in the short-term, are subject to high variability during the year, being dependent on specific local meteorological conditions. Consequently, exceedances of short-term air quality guideline values are often linked to adverse meteorological conditions that may not occur often over the course of a year (e.g. calm winds, stable atmospheric conditions). To account for rare conditions that may result in short-term exceedances, many regulatory regimes (for example the EU) allow for a certain number of exceedances per year for short-term standards. It should be noted that as the Federal Standards do not allow for any exceedances, the EU standards were adopted for comparative purposes.

In summary the assessment concluded that the pollutants SO_2, CO and PM are not considered to be a constraint for the project, given that the fuel is natural gas (normal operations), and that the pollutant concentrations for these pollutants are expected to contribute a fraction of the ambient air quality standards.

In terms of the pollutant NO_2, only the short-term model results were of concern as all long term model results were well below the relevant standards or guidelines. A summary of the short term NO_2 findings for the various scenarios is outlined in Table 7-1.

Table 7-1 – Summary of Short Term NO_2 Model Result Findings

Scenario	Description	Compliant with Federal Standard?	Less than 25% of Federal Standard?	Compliant with Project Standards?	Compliant with EU Standards?	Less than 25% of EU Standards?
1	Baseline (F1 and F2)	No	N/A	N/A	Yes	N/A
2A	F3 Normal Ops with SCR	Yes	No	Yes	Yes	Yes
2B	F3 Normal Ops with SCR + Baseline	No	N/A	N/A	Yes	N/A
3A	F3 Normal Ops without SCR	No	No	No	Yes	No
3B	F3 Normal Ops without SCR + Baseline	No	N/A	N/A	No	N/A
4	Alternate Fuel Case-Short Term Diesel Operation	Yes	N/A	N/A	Yes	N/A
5A	F3 Bypass without SCR	Yes	No	Yes	Yes	Yes
5B	F3 Bypass without SCR + Baseline	No	N/A	N/A	Yes	N/A

In summary the findings were as follows:

- Normal Operations with SCR (Project in isolation), is expected to be compliant with the Federal standards, and compliant with EU standards, but not the Project Standard. In addition, the Project in isolation is expected to contribute less than 25% of the EU AAQS. In a cumulative context with baseline (F1 and F2) the EU standards are likely to be met. This scenario also results in the lowest predicted concentrations at the SR locations.

- Normal Operations without SRC (Project in isolation). The Federal standards may be exceeded on a short-term basis, however when compared against the EU standards compliance is expected. This case does not meet the IFC 25% requirement for the Federal or EU standards in isolation, however with the addition of baseline (F1 and F2), and in a cumulative context with background data, compliance with the EU standards is expected (with the exception of the 1 hour NO_2 averaging period, which is predicted to exceed the standards with the addition of background measured data).

- Based on the above it is recommended that the SCR is adopted over the “without” SCR option for normal operations.

- In terms of the short term (approximately 20 hours in a year), alternate fuel case (diesel) it is expected that the operation of the facility on diesel is not likely to lead to exceedances of the relevant AAQS.

- Operating the F3 turbines on bypass without an SCR unit for the Project in isolation is likely to be complaint with the Federal and EU standards. In a cumulative context however, the scenario is predicted to exceed the NO_2 1-hour Federal standard.

8 References

[1] World Health Organisation Regional Office for Europe, *Air Quality Guidelines for Europe,* 2nd Edition ed., Copenhagen, 2000.

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[4] *UAE Federal Regulation for the Protection of Air from Pollution.*

[5] Mott MacDonald, “Fujairah F3 Independent Power Plant Air Quality Feasibility Study,” 2019.

[6] Department for Environment, Food & Rural Affairs and Environment Agency, “Air emissions risk assessment for your environmental permit,” 2016. [Online]. Available: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#screen-out-insignificant-pcs. [Accessed 2016].

[7] Department of Environmental Affairs (South Africa), “ACT NO. 39 OF 2004: NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT: REGULATIONS REGARDING AIR DISPERSION MODELLING,” 2014.

[8] UK Environmental Agency, “Gov.uk,” 24 05 2019. [Online]. Available: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports. [Accessed 10 09 2019].

[9] US EPA, “Additional Clarification Regarding Application of Apendix W Modeling Guidance for the 1-hour National Ambient Air Quality Standard,” 2011.

Appendix A – Sensitive Receptor Results

Table A- 1 – Scenario 1 Sensitive Results for Federal Standards

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	Below Federal Standard?
NO_2	1 Hour	SR1	400	216.67	54.57	271.24	54.17	Yes
		SR2		331.44	54.57	386.01	82.86	Yes
		SR3		249.98	54.57	304.55	62.50	Yes
		SR4		262.51	54.57	317.08	65.63	Yes
		SR5		248.23	54.57	302.80	62.06	Yes
		SR6		290.36	54.57	344.93	72.59	Yes
		SR7		351.14	54.57	405.71	87.79	Yes
		SR8		476.37	54.57	530.94	119.09	No
		SR9		462.67	54.57	517.24	115.67	No
		SR10		300.54	54.57	355.11	75.14	Yes
	24 Hour	SR1	150	24.24	54.57	78.81	16.16	Yes
		SR2		37.10	54.57	91.67	24.73	Yes
		SR3		26.02	54.57	80.59	17.34	Yes
		SR4		19.22	54.57	73.79	12.81	Yes
		SR5		23.82	54.57	78.39	15.88	Yes

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	Below Federal Standard?
		SR6		26.60	54.57	81.17	17.73	Yes
		SR7		41.97	54.57	96.54	27.98	Yes
		SR8		32.14	54.57	86.71	21.43	Yes
		SR9		28.04	54.57	82.61	18.69	Yes
		SR10		39.20	54.57	93.77	26.13	Yes
CO	1 Hour	SR1	30,000	551.88	1,568.48	2,120.36	1.84	Yes
		SR2		700.56	1,568.48	2,269.04	2.34	Yes
		SR3		572.02	1,568.48	2,140.50	1.91	Yes
		SR4		765.24	1,568.48	2,333.72	2.55	Yes
		SR5		677.13	1,568.48	2,245.61	2.26	Yes
		SR6		677.66	1,568.48	2,246.14	2.26	Yes
		SR7		899.52	1,568.48	2,468.00	3.00	Yes
		SR8		1394.20	1,568.48	2,962.68	4.65	Yes
		SR9		1127.40	1,568.48	2,695.88	3.76	Yes
		SR10		725.96	1,568.48	2,294.44	2.42	Yes
	8 Hour	SR1	10,000	105.85	1,568.48	1,674.33	1.06	Yes
		SR2		195.56	1,568.48	1,764.04	1.96	Yes
		SR3		149.21	1,568.48	1,717.69	1.49	Yes
		SR4		101.52	1,568.48	1,670.00	1.02	Yes
		SR5		165.17	1,568.48	1,733.65	1.65	Yes
		SR6		156.02	1,568.48	1,724.50	1.56	Yes
		SR7		260.42	1,568.48	1,828.90	2.60	Yes

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	Below Federal Standard?
		SR8		252.38	1,568.48	1,820.86	2.52	Yes
		SR9		168.46	1,568.48	1,736.94	1.68	Yes
		SR10		160.63	1,568.48	1,729.11	1.61	Yes

Table A- 2 – Scenario 1 Sensitive Results for EU Standards

Pollutant	Averaging Period	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Sensitive Receptor	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	Below EU Standard?
NO_2	1 Hour	200	18	SR1	86.31	54.57	140.88	43.16	Yes
				SR2	92.29	54.57	146.86	46.15	Yes
				SR3	57.01	54.57	111.58	28.51	Yes
				SR4	87.22	54.57	141.79	43.61	Yes
				SR5	80.88	54.57	135.45	40.44	Yes
				SR6	85.25	54.57	139.82	42.63	Yes
				SR7	88.02	54.57	142.59	44.01	Yes
				SR8	69.08	54.57	123.65	34.54	Yes
				SR9	51.99	54.57	106.56	25.99	Yes
				SR10	89.41	54.57	143.98	44.70	Yes
	Annual	40	-	SR1	5.02	27.29	32.31	12.54	Yes
				SR2	3.19	27.29	30.48	7.98	Yes
				SR3	1.49	27.29	28.78	3.72	Yes
				SR4	3.97	27.29	31.26	9.93	Yes
				SR5	2.34	27.29	29.63	5.85	Yes

Pollutant	Averaging Period	EU AAQS(μg/m³)	Permitted Exceedances as per EU AAQS	Sensitive Receptor	Model Results (μg/m³)	Background Concentration (μg/m³)	Cumulative Results (μg/m³)	Model Results % of Federal Standard	Below EU Standard?
				SR6	4.97	27.29	32.26	12.41	Yes
				SR7	2.80	27.29	30.09	6.99	Yes
				SR8	2.25	27.29	29.54	5.61	Yes
				SR9	1.40	27.29	28.69	3.49	Yes
				SR10	3.10	27.29	30.39	7.74	Yes
CO	8 Hour	10,000	-	SR1	105.85	1,568.48	1,674.33	1.06	Yes
				SR2	195.56	1,568.48	1,764.04	1.96	Yes
				SR3	149.21	1,568.48	1,717.69	1.49	Yes
				SR4	101.52	1,568.48	1,670.00	1.02	Yes
				SR5	165.17	1,568.48	1,733.65	1.65	Yes
				SR6	156.02	1,568.48	1,724.50	1.56	Yes
				SR7	260.42	1,568.48	1,828.90	2.60	Yes
				SR8	252.38	1,568.48	1,820.86	2.52	Yes
				SR9	168.46	1,568.48	1,736.94	1.68	Yes
				SR10	160.63	1,568.48	1,729.11	1.61	Yes

Table A- 3 – Scenario 2A Sensitive Receptor Results for Federal Standards

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Results (µg/m³)	% of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
NO_2	1 Hour	SR1	400	200	65.66	16.42	Yes	Yes	Yes
		SR2			117.53	29.38	No	Yes	Yes
		SR3			65.68	16.42	Yes	Yes	Yes
		SR4			163.95	40.99	No	Yes	Yes
		SR5			125.44	31.36	No	Yes	Yes
		SR6			102.45	25.61	No	Yes	Yes
		SR7			177.33	44.33	No	Yes	Yes
		SR8			106.94	26.74	No	Yes	Yes
		SR9			77.21	19.30	Yes	Yes	Yes
		SR10			85.60	21.40	Yes	Yes	Yes
	24 Hour	SR1	150	-	7.12	4.75	Yes	Yes	-
		SR2			8.61	5.74	Yes	Yes	-
		SR3			4.41	2.94	Yes	Yes	-
		SR4			9.41	6.27	Yes	Yes	-
		SR5			12.27	8.18	Yes	Yes	-
		SR6			7.18	4.79	Yes	Yes	-
		SR7			11.64	7.76	Yes	Yes	-
		SR8			7.11	4.74	Yes	Yes	-
		SR9			4.23	2.82	Yes	Yes	-
		SR10			9.80	6.53	Yes	Yes	-
CO	1 Hour	SR1	30,000	-	328.56	1.10	Yes	Yes	-
		SR2			588.16	1.96	Yes	Yes	-

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Results (µg/m³)	% of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
		SR3			328.45	1.09	Yes	Yes	-
		SR4			825.18	2.75	Yes	Yes	-
		SR5			627.49	2.09	Yes	Yes	-
		SR6			514.44	1.71	Yes	Yes	-
		SR7			893.57	2.98	Yes	Yes	-
		SR8			534.78	1.78	Yes	Yes	-
		SR9			386.30	1.29	Yes	Yes	-
		SR10			428.67	1.43	Yes	Yes	-
	8 Hour	SR1	10,000	-	84.68	0.85	Yes	Yes	-
		SR2			87.89	0.88	Yes	Yes	-
		SR3			65.64	0.66	Yes	Yes	-
		SR4			132.33	1.32	Yes	Yes	-
		SR5			168.48	1.68	Yes	Yes	-
		SR6			90.07	0.90	Yes	Yes	-
		SR7			174.16	1.74	Yes	Yes	-
		SR8			101.58	1.02	Yes	Yes	-
		SR9			63.46	0.63	Yes	Yes	-
		SR10			87.27	0.87	Yes	Yes	-
PM_{10}	24 Hour	SR1	150	-	0.72	0.48	Yes	Yes	-
		SR2			0.87	0.58	Yes	Yes	-
		SR3			0.44	0.30	Yes	Yes	-
		SR4			0.94	0.63	Yes	Yes	-
		SR5			1.22	0.81	Yes	Yes	-

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (μg/m³)	Project Standards (μg/m³)	Results (μg/m³)	% of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
		SR6			0.72	0.48	Yes	Yes	-
		SR7			1.12	0.74	Yes	Yes	-
		SR8			0.71	0.48	Yes	Yes	-
		SR9			0.43	0.28	Yes	Yes	-
		SR10			0.99	0.66	Yes	Yes	-

Table A- 4 – Scenario 2A Sensitive Receptor Results for EU Standards

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(μg/m³)	Permitted Exceedances as per EU AAQS	Results (μg/m³)	% of EU Standard	< 25% of the EU Standard	Below EU Standard?
NO_2	1 Hour	SR1	200	18	26.43	13.21	Yes	Yes
		SR2			28.67	14.34	Yes	Yes
		SR3			12.72	6.36	Yes	Yes
		SR4			27.55	13.77	Yes	Yes
		SR5			24.31	12.16	Yes	Yes
		SR6			25.22	12.61	Yes	Yes
		SR7			22.93	11.47	Yes	Yes
		SR8			23.64	11.82	Yes	Yes
		SR9			15.16	7.58	Yes	Yes
		SR10			22.87	11.43	Yes	Yes
	Annual	SR1	40	-	1.24	3.09	Yes	Yes
		SR2			0.95	2.36	Yes	Yes
		SR3			0.39	0.97	Yes	Yes
		SR4			0.87	2.17	Yes	Yes
		SR5			0.60	1.51	Yes	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Results (µg/m³)	% of EU Standard	< 25% of the EU Standard	Below EU Standard?
		SR6			1.15	2.88	Yes	Yes
		SR7			0.85	2.13	Yes	Yes
		SR8			0.60	1.50	Yes	Yes
		SR9			0.40	0.99	Yes	Yes
		SR10			0.71	1.77	Yes	Yes
CO	8 Hour	SR1	10,000	-	84.68	0.85	Yes	Yes
		SR2			87.89	0.88	Yes	Yes
		SR3			65.64	0.66	Yes	Yes
		SR4			132.33	1.32	Yes	Yes
		SR5			168.48	1.68	Yes	Yes
		SR6			90.07	0.90	Yes	Yes
		SR7			174.16	1.74	Yes	Yes
		SR8			101.58	1.02	Yes	Yes
		SR9			63.46	0.63	Yes	Yes
		SR10			87.27	0.87	Yes	Yes
PM_{10}	24 Hour	SR1	50	35	0.22	0.44	Yes	Yes
		SR2			0.17	0.35	Yes	Yes
		SR3			0.06	0.13	Yes	Yes
		SR4			0.16	0.33	Yes	Yes
		SR5			0.11	0.22	Yes	Yes
		SR6			0.21	0.43	Yes	Yes
		SR7			0.14	0.28	Yes	Yes
		SR8			0.1	0.2	Yes	Yes
		SR9			0.08	0.15	Yes	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(μg/m³)	Permitted Exceedances as per EU AAQS	Results (μg/m³)	% of EU Standard	< 25% of the EU Standard	Below EU Standard?
		SR10			0.14	0.27	Yes	Yes
	Annual	SR1	40	-	0.09	0.22	Yes	Yes
		SR2			0.07	0.17	Yes	Yes
		SR3			0.03	0.07	Yes	Yes
		SR4			0.06	0.16	Yes	Yes
		SR5			0.04	0.11	Yes	Yes
		SR6			0.08	0.21	Yes	Yes
		SR7			0.06	0.15	Yes	Yes
		SR8			0.04	0.11	Yes	Yes
		SR9			0.03	0.07	Yes	Yes
		SR10			0.05	0.13	Yes	Yes
$PM_{2.5}$	Annual	SR1	25	-	0.09	0.36	Yes	Yes
		SR2			0.07	0.28	Yes	Yes
		SR3			0.03	0.12	Yes	Yes
		SR4			0.06	0.24	Yes	Yes
		SR5			0.04	0.16	Yes	Yes
		SR6			0.08	0.32	Yes	Yes
		SR7			0.06	0.24	Yes	Yes
		SR8			0.04	0.16	Yes	Yes
		SR9			0.03	0.12	Yes	Yes
		SR10			0.05	0.20	Yes	Yes

Table A- 5 – Scenario 2B Sensitive Receptor Results for Federal Standards

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Below Federal Standard?	Below Project Standard?
NO_2	1 Hour	SR1	400	200	274.72	54.57	329.29	Yes	No
		SR2			392.43	54.57	447.00	No	No
		SR3			275.09	54.57	329.66	Yes	No
		SR4			289.71	54.57	344.28	Yes	No
		SR5			295.16	54.57	349.73	Yes	No
		SR6			378.46	54.57	433.03	No	No
		SR7			408.28	54.57	462.85	No	No
		SR8			484.82	54.57	539.39	No	No
		SR9			520.14	54.57	574.71	No	No
		SR10			370.16	54.57	424.73	No	No
	24 Hour	SR1	150	-	29.52	54.57	84.09	Yes	-
		SR2			43.01	54.57	97.58	Yes	-
		SR3			30.01	54.57	84.58	Yes	-
		SR4			24.24	54.57	78.81	Yes	-
		SR5			36.09	54.57	90.66	Yes	-
		SR6			32.56	54.57	87.13	Yes	-
		SR7			48.69	54.57	103.26	Yes	-
		SR8			33.58	54.57	88.15	Yes	-
		SR9			31.78	54.57	86.35	Yes	-
		SR10			49.00	54.57	103.57	Yes	-
CO	1 Hour	SR1	30,000	-	844.14	1,568.48	2,412.62	Yes	-
		SR2			995.85	1,568.48	2,564.33	Yes	-

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (μg/m³)	Project Standards (μg/m³)	Model Results (μg/m³)	Background Concentration (μg/m³)	Cumulative Results (μg/m³)	Below Federal Standard?	Below Project Standard?
		SR3			642.76	1,568.48	2,211.24	Yes	-
		SR4			916.50	1,568.48	2,484.98	Yes	-
		SR5			922.95	1,568.48	2,491.43	Yes	-
		SR6			1015.40	1,568.48	2,583.88	Yes	-
		SR7			1471.80	1,568.48	3,040.28	Yes	-
		SR8			1436.80	1,568.48	3,005.28	Yes	-
		SR9			1415.30	1,568.48	2,983.78	Yes	-
		SR10			1076.20	1,568.48	2,644.68	Yes	-
	8 Hour	SR1	10,000	-	157.77	1,568.48	1,726.25	Yes	-
		SR2			276.14	1,568.48	1,844.62	Yes	-
		SR3			186.99	1,568.48	1,755.47	Yes	-
		SR4			165.80	1,568.48	1,734.28	Yes	-
		SR5			295.70	1,568.48	1,864.18	Yes	-
		SR6			245.00	1,568.48	1,813.48	Yes	-
		SR7			328.51	1,568.48	1,896.99	Yes	-
		SR8			265.56	1,568.48	1,834.04	Yes	-
		SR9			209.10	1,568.48	1,777.58	Yes	-
		SR10			247.90	1,568.48	1,816.38	Yes	-
PM_{10}	24 Hour	SR1	150	-	0.72	-	0.72	Yes	-
		SR2			0.87	-	0.87	Yes	-
		SR3			0.44	-	0.44	Yes	-
		SR4			0.94	-	0.94	Yes	-
		SR5			1.22	-	1.22	Yes	-

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Below Federal Standard?	Below Project Standard?
		SR6			0.72	-	0.72	Yes	-
		SR7			1.12	-	1.12	Yes	-
		SR8			0.71	-	0.71	Yes	-
		SR9			0.43	-	0.43	Yes	-
		SR10			0.99	-	0.99	Yes	-

Table A- 6 – Scenario 2B Sensitive Receptor Results for EU Standards

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Below EU Standard?
NO_2	1 Hour	SR1	200	18	107.03	54.57	161.60	Yes
		SR2			117.79	54.57	172.36	Yes
		SR3			68.5	54.57	123.07	Yes
		SR4			103.79	54.57	158.36	Yes
		SR5			100.46	54.57	155.03	Yes
		SR6			103.57	54.57	158.14	Yes
		SR7			99.98	54.57	154.55	Yes
		SR8			84.88	54.57	139.45	Yes
		SR9			64.63	54.57	119.20	Yes
		SR10			108.58	54.57	163.15	Yes
	Annual	SR1	40	-	6.25	27.29	33.54	Yes
		SR2			4.00	27.29	31.29	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(μg/m³)	Permitted Exceedances as per EU AAQS	Model Results (μg/m³)	Background Concentration (μg/m³)	Cumulative Results (μg/m³)	Below EU Standard?
		SR3			1.87	27.29	29.16	Yes
		SR4			4.82	27.29	32.11	Yes
		SR5			2.94	27.29	30.23	Yes
		SR6			6.12	27.29	33.41	Yes
		SR7			3.65	27.29	30.94	Yes
		SR8			2.84	27.29	30.13	Yes
		SR9			1.79	27.29	29.08	Yes
		SR10			3.79	27.29	31.08	Yes
CO	8 Hour	SR1	10,000	-	157.77	1,568.48	1726.25	Yes
		SR2			276.14	1,568.48	1844.62	Yes
		SR3			186.99	1,568.48	1755.47	Yes
		SR4			165.80	1,568.48	1734.28	Yes
		SR5			295.70	1,568.48	1864.18	Yes
		SR6			245.00	1,568.48	1813.48	Yes
		SR7			328.51	1,568.48	1896.99	Yes
		SR8			265.56	1,568.48	1834.04	Yes
		SR9			209.10	1,568.48	1777.58	Yes
		SR10			247.90	1,568.48	1816.38	Yes
PM_{10}	24 Hour	SR1	50	35	0.22	-	0.22	Yes
		SR2			0.17	-	0.17	Yes
		SR3			0.06	-	0.06	Yes
		SR4			0.16	-	0.16	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Below EU Standard?
		SR5			0.11	-	0.11	Yes
		SR6			0.21	-	0.21	Yes
		SR7			0.14	-	0.14	Yes
		SR8			0.1	-	0.1	Yes
		SR9			0.08	-	0.08	Yes
		SR10			0.14	-	0.14	Yes
	Annual	SR1	40	-	0.09	-	0.09	Yes
		SR2			0.07	-	0.07	Yes
		SR3			0.03	-	0.03	Yes
		SR4			0.06	-	0.06	Yes
		SR5			0.04	-	0.04	Yes
		SR6			0.08	-	0.08	Yes
		SR7			0.06	-	0.06	Yes
		SR8			0.04	-	0.04	Yes
		SR9			0.03	-	0.03	Yes
		SR10			0.05	-	0.05	Yes
$PM_{2.5}$	Annual	SR1	25	-	0.09	-	0.09	Yes
		SR2			0.07	-	0.07	Yes
		SR3			0.03	-	0.03	Yes
		SR4			0.06	-	0.06	Yes
		SR5			0.04	-	0.04	Yes
		SR6			0.08	-	0.08	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Below EU Standard?
		SR7			0.06	-	0.06	Yes
		SR8			0.04	-	0.04	Yes
		SR9			0.03	-	0.03	Yes
		SR10			0.05	-	0.05	Yes

Table A- 7 – Scenario 3A Sensitive Receptor Results for Federal Standards

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Results (µg/m³)	% of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
NO_2	1 Hour	SR1	200	200	164.17	41.04	No	Yes	Yes
		SR2			293.85	73.46	No	Yes	No
		SR3			164.22	41.06	No	Yes	Yes
		SR4			409.93	102.48	No	No	No
		SR5			313.63	78.41	No	No	No
		SR6			256.16	64.04	No	Yes	No
		SR7			443.37	110.84	No	No	No
		SR8			267.38	66.85	No	Yes	No
		SR9			193.04	48.26	No	Yes	Yes
		SR10			214.02	53.51	No	Yes	No
	24 Hour	SR1	150	-	17.80	11.87	Yes	Yes	-
		SR2			21.53	14.35	Yes	Yes	-
		SR3			11.04	7.36	Yes	Yes	-
		SR4			23.53	15.69	Yes	Yes	-

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (μg/m³)	Project Standards (μg/m³)	Results (μg/m³)	% of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
		SR5			30.67	20.45	Yes	Yes	-
		SR6			17.95	11.96	Yes	Yes	-
		SR7			29.10	19.40	Yes	Yes	-
		SR8			17.77	11.85	Yes	Yes	-
		SR9			10.58	7.06	Yes	Yes	-
		SR10			24.50	16.34	Yes	Yes	-
CO	1 Hour	SR1	30,000	-	328.56	1.10	Yes	Yes	-
		SR2			588.16	1.96	Yes	Yes	-
		SR3			328.45	1.09	Yes	Yes	-
		SR4			825.19	2.75	Yes	Yes	-
		SR5			627.49	2.09	Yes	Yes	-
		SR6			514.45	1.71	Yes	Yes	-
		SR7			893.57	2.98	Yes	Yes	-
		SR8			534.78	1.78	Yes	Yes	-
		SR9			386.30	1.29	Yes	Yes	-
		SR10			428.67	1.43	Yes	Yes	-
	8 Hour	SR1	10,000	-	84.68	0.85	Yes	Yes	-
		SR2			87.89	0.88	Yes	Yes	-
		SR3			65.64	0.66	Yes	Yes	-
		SR4			132.33	1.32	Yes	Yes	-
		SR5			168.48	1.68	Yes	Yes	-
		SR6			90.07	0.90	Yes	Yes	-
		SR7			174.16	1.74	Yes	Yes	-

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Results (µg/m³)	% of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
		SR8			101.58	1.02	Yes	Yes	-
		SR9			63.46	0.63	Yes	Yes	-
		SR10			87.27	0.87	Yes	Yes	-
PM_{10}	24 Hour	SR1	150	-	0.72	0.48	Yes	-	PM_{10}
		SR2			0.87	0.58	Yes	-	
		SR3			0.44	0.30	Yes	-	
		SR4			0.94	0.63	Yes	-	
		SR5			1.22	0.82	Yes	-	
		SR6			0.72	0.48	Yes	-	
		SR7			1.12	0.74	Yes	-	
		SR8			0.71	0.48	Yes	-	
		SR9			0.43	0.28	Yes	-	
		SR10			0.99	0.66	Yes	-	

Table A- 8 – Scenario 3A Sensitive Receptor Results for EU Standards

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Results (µg/m³)	% of EU Standard	< 25% of the EU Standard	Below EU Standard?
NO_2	1 Hour	SR1	200	18	66.08	33.04	No	Yes
		SR2			71.69	35.85	No	Yes
		SR3			31.81	15.90	Yes	Yes
		SR4			69.13	34.56	No	Yes
		SR5			60.78	30.39	No	Yes
		SR6			63.06	31.53	No	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(μg/m^3)	Permitted Exceedances as per EU AAQS	Results (μg/m^3)	% of EU Standard	< 25% of the EU Standard	Below EU Standard?
		SR7			57.33	28.67	No	Yes
		SR8			59.09	29.55	No	Yes
		SR9			37.91	18.96	Yes	Yes
		SR10			57.18	28.59	No	Yes
	Annual	SR1	40	-	3.09	7.72	Yes	Yes
		SR2			2.36	5.91	Yes	Yes
		SR3			0.97	2.44	Yes	Yes
		SR4			2.17	5.43	Yes	Yes
		SR5			1.51	3.76	Yes	Yes
		SR6			2.88	7.21	Yes	Yes
		SR7			2.13	5.32	Yes	Yes
		SR8			1.50	3.75	Yes	Yes
		SR9			0.99	2.47	Yes	Yes
		SR10			1.77	4.43	Yes	Yes
CO	8 Hour	SR1	10,000	-	84.68	0.85	Yes	Yes
		SR2			87.89	0.88	Yes	Yes
		SR3			65.64	0.66	Yes	Yes
		SR4			132.33	1.32	Yes	Yes
		SR5			168.48	1.68	Yes	Yes
		SR6			90.07	0.90	Yes	Yes
		SR7			174.16	1.74	Yes	Yes
		SR8			101.58	1.02	Yes	Yes
		SR9			63.46	0.63	Yes	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Results (µg/m³)	% of EU Standard	< 25% of the EU Standard	Below EU Standard?
		SR10			87.27	0.87	Yes	Yes
PM_{10}	24 Hour	SR1	50	35	0.22	0.44	Yes	Yes
		SR2			0.17	0.35	Yes	Yes
		SR3			0.06	0.13	Yes	Yes
		SR4			0.16	0.33	Yes	Yes
		SR5			0.11	0.22	Yes	Yes
		SR6			0.21	0.43	Yes	Yes
		SR7			0.14	0.28	Yes	Yes
		SR8			0.1	0.2	Yes	Yes
		SR9			0.08	0.15	Yes	Yes
		SR10			0.14	0.27	Yes	Yes
	Annual	SR1	40	-	0.09	0.22	Yes	Yes
		SR2			0.07	0.17	Yes	Yes
		SR3			0.03	0.07	Yes	Yes
		SR4			0.06	0.16	Yes	Yes
		SR5			0.04	0.11	Yes	Yes
		SR6			0.08	0.21	Yes	Yes
		SR7			0.06	0.15	Yes	Yes
		SR8			0.04	0.11	Yes	Yes
		SR9			0.03	0.07	Yes	Yes
		SR10			0.05	0.13	Yes	Yes
$PM_{2.5}$	Annual	SR1	25	-	0.11	0.36	Yes	Yes
		SR2			0.21	0.28	Yes	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Results (µg/m³)	% of EU Standard	< 25% of the EU Standard	Below EU Standard?
		SR3			0.14	0.12	Yes	Yes
		SR4			0.1	0.24	Yes	Yes
		SR5			0.08	0.16	Yes	Yes
		SR6			0.14	0.32	Yes	Yes
		SR7			0.09	0.24	Yes	Yes
		SR8			0.07	0.16	Yes	Yes
		SR9			0.03	0.12	Yes	Yes
		SR10			0.06	0.20	Yes	Yes

Table A- 9 – Scenario 3B Sensitive Receptor Results for Federal Standards

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	Below Federal Standard?	Below Project Standard?
NO_2	1 Hour	SR1	400	200	361.80	54.57	416.37	90.45	No	No
		SR2			539.82	54.57	594.39	134.96	No	No
		SR3			362.02	54.57	416.59	90.51	No	No
		SR4			535.69	54.57	590.26	133.92	No	No
		SR5			482.04	54.57	536.61	120.51	No	No
		SR6			529.53	54.57	584.10	132.38	No	No
		SR7			673.90	54.57	728.47	168.48	No	No
		SR8			527.24	54.57	581.81	131.81	No	No
		SR9			606.36	54.57	660.93	151.59	No	No
		SR10			474.59	54.57	529.16	118.65	No	No

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	Below Federal Standard?	Below Project Standard?
	24 Hour	SR1	150	-	37.43	54.57	92.00	24.95	Yes	-
		SR2			51.89	54.57	106.46	34.59	Yes	-
		SR3			36.01	54.57	90.58	24.01	Yes	-
		SR4			38.36	54.57	92.93	25.58	Yes	-
		SR5			54.49	54.57	109.06	36.33	Yes	-
		SR6			41.50	54.57	96.07	27.67	Yes	-
		SR7			58.77	54.57	113.34	39.18	Yes	-
		SR8			39.00	54.57	93.57	26.00	Yes	-
		SR9			37.40	54.57	91.97	24.93	Yes	-
		SR10			63.70	54.57	118.27	42.47	Yes	-
CO	1 Hour	SR1	30,000	-	844.14	1,568.48	2,412.62	2.81	Yes	-
		SR2			995.85	1,568.48	2,564.33	3.32	Yes	-
		SR3			642.75	1,568.48	2,211.23	2.14	Yes	-
		SR4			916.52	1,568.48	2,485.00	3.06	Yes	-
		SR5			922.97	1,568.48	2,491.45	3.08	Yes	-
		SR6			1015.40	1,568.48	2,583.88	3.38	Yes	-
		SR7			1471.80	1,568.48	3,040.28	4.91	Yes	-
		SR8			1436.80	1,568.48	3,005.28	4.79	Yes	-
		SR9			1415.30	1,568.48	2,983.78	4.72	Yes	-
		SR10			1076.20	1,568.48	2,644.68	3.59	Yes	-
	8 Hour	SR1	10,000	-	157.77	1,568.48	1,726.25	1.58	Yes	-
		SR2			276.14	1,568.48	1,844.62	2.76	Yes	-

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	Below Federal Standard?	Below Project Standard?
		SR3			186.98	1,568.48	1,755.46	1.87	Yes	-
		SR4			165.80	1,568.48	1,734.28	1.66	Yes	-
		SR5			295.70	1,568.48	1,864.18	2.96	Yes	-
		SR6			245.00	1,568.48	1,813.48	2.45	Yes	-
		SR7			328.50	1,568.48	1,896.98	3.29	Yes	-
		SR8			265.56	1,568.48	1,834.04	2.66	Yes	-
		SR9			209.10	1,568.48	1,777.58	2.09	Yes	-
		SR10			247.90	1,568.48	1,816.38	2.48	Yes	-
PM_{10}	24 Hour	SR1	150	-	0.72	-	0.72	0.48	Yes	-
		SR2			0.87	-	0.87	0.58	Yes	-
		SR3			0.44	-	0.44	0.30	Yes	-
		SR4			0.94	-	0.94	0.63	Yes	-
		SR5			1.22	-	1.22	0.82	Yes	-
		SR6			0.72	-	0.72	0.48	Yes	-
		SR7			1.12	-	1.12	0.74	Yes	-
		SR8			0.71	-	0.71	0.48	Yes	-
		SR9			0.43	-	0.43	0.28	Yes	-
		SR10			0.99	-	0.99	0.66	Yes	-

Table A- 10 - Scenario 3B Sensitive Receptor Results for EU Standards

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of EU Standard	Below EU Standard?
NO_2	1 Hour	SR1	200	18	136.73	54.57	191.30	68.37	Yes
		SR2			154.00	54.57	208.57	77	No
		SR3			77.20	54.57	131.77	38.6	Yes
		SR4			134.96	54.57	189.53	67.48	Yes
		SR5			133.85	54.57	188.42	66.93	Yes
		SR6			128.61	54.57	183.18	64.31	Yes
		SR7			127.11	54.57	181.68	63.56	Yes
		SR8			123.05	54.57	177.62	61.53	Yes
		SR9			80.55	54.57	135.12	40.27	Yes
		SR10			138.12	54.57	192.69	69.06	Yes
	Annual	SR1	40	-	8.11	27.29	35.40	20.26	Yes
		SR2			5.37	27.29	32.66	13.43	Yes
		SR3			2.44	27.29	29.73	6.11	Yes
		SR4			6.1	27.29	33.39	15.24	Yes
		SR5			3.84	27.29	31.13	9.61	Yes
		SR6			7.85	27.29	35.14	19.62	Yes
		SR7			4.92	27.29	32.21	12.31	Yes
		SR8			3.73	27.29	31.02	9.32	Yes
		SR9			2.39	27.29	29.68	5.96	Yes
		SR10			4.83	27.29	32.12	12.08	Yes
CO	8 Hour	SR1	10,000	-	157.77	1,568.48	1,726.25	1.58	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(μg/m³)	Permitted Exceedances as per EU AAQS	Model Results (μg/m³)	Background Concentration (μg/m³)	Cumulative Results (μg/m³)	Model Results % of EU Standard	Below EU Standard?
		SR2			276.14	1,568.48	1,844.62	2.76	Yes
		SR3			186.98	1,568.48	1,755.46	1.87	Yes
		SR4			165.8	1,568.48	1,734.28	1.66	Yes
		SR5			295.7	1,568.48	1,864.18	2.96	Yes
		SR6			245	1,568.48	1,813.48	2.45	Yes
		SR7			328.5	1,568.48	1,896.98	3.29	Yes
		SR8			265.56	1,568.48	1,834.04	2.66	Yes
		SR9			209.1	1,568.48	1,777.58	2.09	Yes
		SR10			247.9	1,568.48	1,816.38	2.48	Yes
PM_{10}	24 Hour	SR1	50	35	0.22	-	0.22	0.44	Yes
		SR2			0.17	-	0.17	0.35	Yes
		SR3			0.06	-	0.06	0.13	Yes
		SR4			0.16	-	0.16	0.33	Yes
		SR5			0.11	-	0.11	0.22	Yes
		SR6			0.21	-	0.21	0.43	Yes
		SR7			0.14	-	0.14	0.28	Yes
		SR8			0.1	-	0.1	0.2	Yes
		SR9			0.08	-	0.08	0.15	Yes
		SR10			0.14	-	0.14	0.27	Yes
	Annual	SR1	40	-	0.09	-	0.09	0.22	Yes
		SR2			0.07	-	0.07	0.17	Yes
		SR3			0.03	-	0.03	0.07	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(μg/m³)	Permitted Exceedances as per EU AAQS	Model Results (μg/m³)	Background Concentration (μg/m³)	Cumulative Results (μg/m³)	Model Results % of EU Standard	Below EU Standard?
		SR4			0.06	-	0.06	0.16	Yes
		SR5			0.04	-	0.04	0.11	Yes
		SR6			0.08	-	0.08	0.21	Yes
		SR7			0.06	-	0.06	0.15	Yes
		SR8			0.04	-	0.04	0.11	Yes
		SR9			0.03	-	0.03	0.07	Yes
		SR10			0.05	-	0.05	0.13	Yes
$PM_{2.5}$	Annual	SR1	25	-	0.11	-	0.11	0.36	Yes
		SR2			0.21	-	0.21	0.28	Yes
		SR3			0.14	-	0.14	0.12	Yes
		SR4			0.10	-	0.10	0.24	Yes
		SR5			0.08	-	0.08	0.16	Yes
		SR6			0.14	-	0.14	0.32	Yes
		SR7			0.09	-	0.09	0.24	Yes
		SR8			0.07	-	0.07	0.16	Yes
		SR9			0.03	-	0.03	0.12	Yes
		SR10			0.06	-	0.06	0.20	Yes

Table A- 11 – Scenario 4 Sensitive Receptor Results for Federal Standards

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
NO_2	1 Hour	SR1	400	200	0.77	54.57	55.34	0.19	Yes	Yes	Yes
		SR2			1.45	54.57	56.02	0.36	Yes	Yes	Yes
		SR3			1.23	54.57	55.80	0.31	Yes	Yes	Yes
		SR4			1.89	54.57	56.46	0.47	Yes	Yes	Yes
		SR5			1.37	54.57	55.94	0.34	Yes	Yes	Yes
		SR6			1.48	54.57	56.05	0.37	Yes	Yes	Yes
		SR7			2.29	54.57	56.86	0.57	Yes	Yes	Yes
		SR8			1.14	54.57	55.71	0.28	Yes	Yes	Yes
		SR9			0.84	54.57	55.41	0.21	Yes	Yes	Yes
		SR10			1.09	54.57	55.66	0.27	Yes	Yes	Yes
	24 Hour	SR1	150	-	0.08	54.57	54.65	0.06	Yes	Yes	-
		SR2			0.10	54.57	54.67	0.06	Yes	Yes	-
		SR3			0.06	54.57	54.63	0.04	Yes	Yes	-
		SR4			0.10	54.57	54.67	0.07	Yes	Yes	-
		SR5			0.15	54.57	54.72	0.10	Yes	Yes	-
		SR6			0.10	54.57	54.67	0.07	Yes	Yes	-
		SR7			0.14	54.57	54.71	0.09	Yes	Yes	-
		SR8			0.07	54.57	54.64	0.05	Yes	Yes	-
		SR9			0.05	54.57	54.62	0.03	Yes	Yes	-
		SR10			0.12	54.57	54.69	0.08	Yes	Yes	-
SO_2	1 Hour	SR1	350	200	0.01	-	0.01	0.003	Yes	Yes	Yes

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
		SR2			0.02	-	0.02	0.005	Yes	Yes	Yes
		SR3			0.02	-	0.02	0.005	Yes	Yes	Yes
		SR4			0.02	-	0.02	0.007	Yes	Yes	Yes
		SR5			0.02	-	0.02	0.005	Yes	Yes	Yes
		SR6			0.02	-	0.02	0.006	Yes	Yes	Yes
		SR7			0.03	-	0.03	0.008	Yes	Yes	Yes
		SR8			0.02	-	0.02	0.005	Yes	Yes	Yes
		SR9			0.01	-	0.01	0.003	Yes	Yes	Yes
		SR10			0.02	-	0.02	0.004	Yes	Yes	Yes
	24 Hour	SR1	150	-	Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR2			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR3			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR4			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR5			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR6			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR7			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR8			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR9			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR10			Negligible	-	Negligible	Negligible	Yes	Yes	-
	Annual	SR1	60	-	Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR2			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR3			Negligible	-	Negligible	Negligible	Yes	Yes	-

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
		SR4			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR5			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR6			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR7			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR8			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR9			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR10			Negligible	-	Negligible	Negligible	Yes	Yes	-
CO	1 Hour	SR1	30,000	-	0.63	1,568.48	1,569.11	0.002	Yes	Yes	-
		SR2			1.19	1,568.48	1,569.67	0.004	Yes	Yes	-
		SR3			1.00	1,568.48	1,569.48	0.003	Yes	Yes	-
		SR4			1.55	1,568.48	1,570.03	0.005	Yes	Yes	-
		SR5			1.11	1,568.48	1,569.59	0.004	Yes	Yes	-
		SR6			1.21	1,568.48	1,569.69	0.004	Yes	Yes	-
		SR7			1.87	1,568.48	1,570.35	0.006	Yes	Yes	-
		SR8			0.93	1,568.48	1,569.41	0.003	Yes	Yes	-
		SR9			0.68	1,568.48	1,569.16	0.002	Yes	Yes	-
		SR10			0.89	1,568.48	1,569.37	0.003	Yes	Yes	-
	8 Hour	SR1	10,000	-	0.15	1,568.48	1,568.63	0.001	Yes	Yes	-
		SR2			0.18	1,568.48	1,568.66	0.002	Yes	Yes	-
		SR3			0.15	1,568.48	1,568.63	0.002	Yes	Yes	-
		SR4			0.23	1,568.48	1,568.71	0.002	Yes	Yes	-
		SR5			0.32	1,568.48	1,568.80	0.003	Yes	Yes	-

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
		SR6			0.23	1,568.48	1,568.71	0.002	Yes	Yes	-
		SR7			0.35	1,568.48	1,568.83	0.003	Yes	Yes	-
		SR8			0.16	1,568.48	1,568.64	0.002	Yes	Yes	-
		SR9			0.12	1,568.48	1,568.60	0.001	Yes	Yes	-
		SR10			0.19	1,568.48	1,568.67	0.002	Yes	Yes	-
PM_{10}	24 Hour	SR1	150	-	Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR2			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR3			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR4			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR5			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR6			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR7			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR8			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR9			Negligible	-	Negligible	Negligible	Yes	Yes	-
		SR10			Negligible	-	Negligible	Negligible	Yes	Yes	-

Table A- 12 – Scenario 4 Sensitive Receptor Results for EU Standards

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of EU Standard	Model Results (µg/m³)	Below EU Standard?
NO_2	1 Hour	SR1	200	18	Negligible	54.57	54.57	Negligible	Yes	Yes
		SR2			Negligible	54.57	54.57	Negligible	Yes	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of EU Standard	Model Results (µg/m³)	Below EU Standard?
		SR3			Negligible	54.57	54.57	Negligible	Yes	Yes
		SR4			Negligible	54.57	54.57	Negligible	Yes	Yes
		SR5			Negligible	54.57	54.57	Negligible	Yes	Yes
		SR6			Negligible	54.57	54.57	Negligible	Yes	Yes
		SR7			Negligible	54.57	54.57	Negligible	Yes	Yes
		SR8			Negligible	54.57	54.57	Negligible	Yes	Yes
		SR9			Negligible	54.57	54.57	Negligible	Yes	Yes
		SR10			Negligible	54.57	54.57	Negligible	Yes	Yes
	Annual	SR1	40	-	Negligible	27.29	27.29	Negligible	Yes	Yes
		SR2			Negligible	27.29	27.29	Negligible	Yes	Yes
		SR3			Negligible	27.29	27.29	Negligible	Yes	Yes
		SR4			Negligible	27.29	27.29	Negligible	Yes	Yes
		SR5			Negligible	27.29	27.29	Negligible	Yes	Yes
		SR6			Negligible	27.29	27.29	Negligible	Yes	Yes
		SR7			Negligible	27.29	27.29	Negligible	Yes	Yes
		SR8			Negligible	27.29	27.29	Negligible	Yes	Yes
		SR9			Negligible	27.29	27.29	Negligible	Yes	Yes
		SR10			Negligible	27.29	27.29	Negligible	Yes	Yes
CO	8 Hour	SR1	10,000	-	0.15	1,568.48	1,568.63	0.001	Yes	Yes
		SR2			0.18	1,568.48	1,568.66	0.002	Yes	Yes
		SR3			0.15	1,568.48	1,568.63	0.002	Yes	Yes
		SR4			0.23	1,568.48	1,568.71	0.002	Yes	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of EU Standard	Model Results (µg/m³)	Below EU Standard?
		SR5			0.32	1,568.48	1,568.80	0.003	Yes	Yes
		SR6			0.23	1,568.48	1,568.71	0.002	Yes	Yes
		SR7			0.35	1,568.48	1,568.83	0.003	Yes	Yes
		SR8			0.16	1,568.48	1,568.64	0.002	Yes	Yes
		SR9			0.12	1,568.48	1,568.60	0.001	Yes	Yes
		SR10			0.19	1,568.48	1,568.67	0.002	Yes	Yes
SO_2	1 Hour	SR1	350	24	Negligible	-	Negligible	Negligible	Yes	Yes
		SR2			Negligible	-	Negligible	Negligible	Yes	Yes
		SR3			Negligible	-	Negligible	Negligible	Yes	Yes
		SR4			Negligible	-	Negligible	Negligible	Yes	Yes
		SR5			Negligible	-	Negligible	Negligible	Yes	Yes
		SR6			Negligible	-	Negligible	Negligible	Yes	Yes
		SR7			Negligible	-	Negligible	Negligible	Yes	Yes
		SR8			Negligible	-	Negligible	Negligible	Yes	Yes
		SR9			Negligible	-	Negligible	Negligible	Yes	Yes
		SR10			Negligible	-	Negligible	Negligible	Yes	Yes
	24 Hour	SR1	125	3	Negligible	-	Negligible	Negligible	Yes	Yes
		SR2			Negligible	-	Negligible	Negligible	Yes	Yes
		SR3			Negligible	-	Negligible	Negligible	Yes	Yes
		SR4			Negligible	-	Negligible	Negligible	Yes	Yes
		SR5			Negligible	-	Negligible	Negligible	Yes	Yes
		SR6			Negligible	-	Negligible	Negligible	Yes	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of EU Standard	Model Results (µg/m³)	Below EU Standard?
		SR7			Negligible	-	Negligible	Negligible	Yes	Yes
		SR8			Negligible	-	Negligible	Negligible	Yes	Yes
		SR9			Negligible	-	Negligible	Negligible	Yes	Yes
		SR10			Negligible	-	Negligible	Negligible	Yes	Yes
PM_{10}	24 Hour	SR1	50	35	Negligible	-	Negligible	Negligible	Yes	Yes
		SR2			Negligible	-	Negligible	Negligible	Yes	Yes
		SR3			Negligible	-	Negligible	Negligible	Yes	Yes
		SR4			Negligible	-	Negligible	Negligible	Yes	Yes
		SR5			Negligible	-	Negligible	Negligible	Yes	Yes
		SR6			Negligible	-	Negligible	Negligible	Yes	Yes
		SR7			Negligible	-	Negligible	Negligible	Yes	Yes
		SR8			Negligible	-	Negligible	Negligible	Yes	Yes
		SR9			Negligible	-	Negligible	Negligible	Yes	Yes
		SR10			Negligible	-	Negligible	Negligible	Yes	Yes
	Annual	SR1	40	-	Negligible	-	Negligible	Negligible	Yes	Yes
		SR2			Negligible	-	Negligible	Negligible	Yes	Yes
		SR3			Negligible	-	Negligible	Negligible	Yes	Yes
		SR4			Negligible	-	Negligible	Negligible	Yes	Yes
		SR5			Negligible	-	Negligible	Negligible	Yes	Yes
		SR6			Negligible	-	Negligible	Negligible	Yes	Yes
		SR7			Negligible	-	Negligible	Negligible	Yes	Yes
		SR8			Negligible	-	Negligible	Negligible	Yes	Yes

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Model Results % of EU Standard	Model Results (µg/m³)	Below EU Standard?
		SR9			Negligible	-	Negligible	Negligible	Yes	Yes
		SR10			Negligible	-	Negligible	Negligible	Yes	Yes
$PM_{2.5}$	Annual	SR1	25	-	Negligible	-	Negligible	Negligible	Yes	Yes
		SR2			Negligible	-	Negligible	Negligible	Yes	Yes
		SR3			Negligible	-	Negligible	Negligible	Yes	Yes
		SR4			Negligible	-	Negligible	Negligible	Yes	Yes
		SR5			Negligible	-	Negligible	Negligible	Yes	Yes
		SR6			Negligible	-	Negligible	Negligible	Yes	Yes
		SR7			Negligible	-	Negligible	Negligible	Yes	Yes
		SR8			Negligible	-	Negligible	Negligible	Yes	Yes
		SR9			Negligible	-	Negligible	Negligible	Yes	Yes
		SR10			Negligible	-	Negligible	Negligible	Yes	Yes

Table A- 13 – Scenario 5A Sensitive Receptor Results for Federal Standards

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Results (µg/m³)	% of Federal Standard	< 25% of the Federal Standard	Below Federal Standard?	Below Project Standard?
NO_2	1 Hour	SR1	400	200	86.80	21.70	Yes	Yes	Yes
		SR2			59.89	14.97	Yes	Yes	Yes
		SR3			40.13	10.03	Yes	Yes	Yes
		SR4			94.68	23.67	Yes	Yes	Yes
		SR5			46.19	11.55	Yes	Yes	Yes

		SR6			77.07	19.27	Yes	Yes	Yes
		SR7			52.79	13.20	Yes	Yes	Yes
		SR8			34.64	8.66	Yes	Yes	Yes
		SR9			36.03	9.01	Yes	Yes	Yes
		SR10			67.80	16.95	Yes	Yes	Yes
	24 Hour	SR1	150	-	9.87	6.58	Yes	Yes	-
		SR2			4.49	2.99	Yes	Yes	-
		SR3			2.8	1.87	Yes	Yes	-
		SR4			6.68	4.45	Yes	Yes	-
		SR5			3.56	2.37	Yes	Yes	-
		SR6			10.56	7.04	Yes	Yes	-
		SR7			4.61	3.07	Yes	Yes	-
		SR8			2.62	1.75	Yes	Yes	-
		SR9			3.47	2.31	Yes	Yes	-
		SR10			6.33	4.22	Yes	Yes	-
CO	1 Hour	SR1	30000	-	173.96	0.58	Yes	Yes	-
		SR2			119.79	0.40	Yes	Yes	-
		SR3			80.41	0.27	Yes	Yes	-
		SR4			189.63	0.63	Yes	Yes	-
		SR5			92.42	0.31	Yes	Yes	-
		SR6			154.61	0.52	Yes	Yes	-
		SR7			105.59	0.35	Yes	Yes	-
		SR8			69.29	0.23	Yes	Yes	-
		SR9			72.56	0.24	Yes	Yes	-
		SR10			135.77	0.45	Yes	Yes	-
	8 Hour	SR1	10000	-	38.49	0.38	Yes	Yes	-
		SR2			24.03	0.24	Yes	Yes	-
		SR3			16.58	0.17	Yes	Yes	-

		SR4			31.13	0.31	Yes	Yes	-
		SR5			17.71	0.18	Yes	Yes	-
		SR6			57.02	0.57	Yes	Yes	-
		SR7			21.33	0.21	Yes	Yes	-
		SR8			14.5	0.15	Yes	Yes	-
		SR9			16.73	0.17	Yes	Yes	-
		SR10			37.92	0.38	Yes	Yes	-
PM_{10}	24 Hour	SR1	150	-	0.4	0.27	Yes	Yes	-
		SR2			0.18	0.12	Yes	Yes	-
		SR3			0.11	0.07	Yes	Yes	-
		SR4			0.27	0.18	Yes	Yes	-
		SR5			0.14	0.09	Yes	Yes	-
		SR6			0.42	0.28	Yes	Yes	-
		SR7			0.19	0.13	Yes	Yes	-
		SR8			0.11	0.07	Yes	Yes	-
		SR9			0.14	0.09	Yes	Yes	-
		SR10			0.25	0.17	Yes	Yes	-

Table A- 14 – Scenario 5A Sensitive Receptor Results for EU Standards

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(μg/m^3)	Permitted Exceedances as per EU AAQS	Results (μg/m^3)	% of EU Standard	< 25% of the EU Standard	Below EU Standard?
NO_2	1 Hour	SR1	200	18	13.34	6.67	Yes	Yes
		SR2			12.65	6.33	Yes	Yes
		SR3			7.75	3.88	Yes	Yes
		SR4			12.38	6.19	Yes	Yes
		SR5			10.41	5.21	Yes	Yes

		SR6			14.5	7.25	Yes	Yes
		SR7			13.24	6.62	Yes	Yes
		SR8			10.24	5.12	Yes	Yes
		SR9			6.96	3.48	Yes	Yes
		SR10			10.61	5.31	Yes	Yes
	Annual	SR1	40	-	0.30	0.75	Yes	Yes
		SR2			0.26	0.65	Yes	Yes
		SR3			0.18	0.45	Yes	Yes
		SR4			0.28	0.70	Yes	Yes
		SR5			0.20	0.50	Yes	Yes
		SR6			0.31	0.78	Yes	Yes
		SR7			0.27	0.68	Yes	Yes
		SR8			0.20	0.50	Yes	Yes
		SR9			0.14	0.35	Yes	Yes
		SR10			0.22	0.55	Yes	Yes
CO	8 Hour	SR1	10000	-	38.49	0.38	Yes	Yes
		SR2			24.03	0.24	Yes	Yes
		SR3			16.58	0.17	Yes	Yes
		SR4			31.13	0.31	Yes	Yes
		SR5			17.71	0.18	Yes	Yes
		SR6			57.02	0.57	Yes	Yes
		SR7			21.33	0.21	Yes	Yes
		SR8			14.5	0.15	Yes	Yes
		SR9			16.73	0.17	Yes	Yes
		SR10			37.92	0.38	Yes	Yes
PM_{10}	24 Hour	SR1	50	35	0.03	0.06	Yes	Yes
		SR2			0.03	0.06	Yes	Yes
		SR3			0.02	0.04	Yes	Yes

		SR4			0.02	0.04	Yes	Yes
		SR5			0.02	0.04	Yes	Yes
		SR6			0.03	0.06	Yes	Yes
		SR7			0.02	0.04	Yes	Yes
		SR8			0.02	0.04	Yes	Yes
		SR9			0.01	0.02	Yes	Yes
		SR10			0.02	0.04	Yes	Yes
	Annual	SR1	40	-	0.012	0.03	Yes	Yes
		SR2			0.01	0.03	Yes	Yes
		SR3			0.007	0.02	Yes	Yes
		SR4			0.011	0.03	Yes	Yes
		SR5			0.008	0.02	Yes	Yes
		SR6			0.012	0.03	Yes	Yes
		SR7			0.011	0.03	Yes	Yes
		SR8			0.008	0.02	Yes	Yes
		SR9			0.005	0.01	Yes	Yes
		SR10			0.009	0.02	Yes	Yes
$PM_{2.5}$	Annual	SR1	25	-	0.012	0.05	Yes	Yes
		SR2			0.01	0.04	Yes	Yes
		SR3			0.007	0.03	Yes	Yes
		SR4			0.011	0.04	Yes	Yes
		SR5			0.008	0.03	Yes	Yes
		SR6			0.012	0.05	Yes	Yes
		SR7			0.011	0.04	Yes	Yes
		SR8			0.008	0.03	Yes	Yes
		SR9			0.005	0.02	Yes	Yes
		SR10			0.009	0.04	Yes	Yes

Table A- 15 – Scenario 5B Sensitive Receptor Results for Federal Standards

Pollutant	Averaging Period	Sensitive Receptor	Federal AAQS (µg/m³)	Project Standards (µg/m³)	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Below Federal Standard?	Below Project Standard?
NO_2	1 Hour	SR1	400	200	217.64	54.57	272.21	Yes	No
		SR2			331.44	54.57	386.01	Yes	No
		SR3			249.98	54.57	304.55	Yes	No
		SR4			262.59	54.57	317.16	Yes	No
		SR5			248.23	54.57	302.80	Yes	No
		SR6			290.46	54.57	345.03	Yes	No
		SR7			351.14	54.57	405.71	No	No
		SR8			476.97	54.57	531.54	No	No
		SR9			462.67	54.57	517.24	No	No
		SR10			300.54	54.57	355.11	Yes	No
	24 Hour	SR1	150	-	24.42	54.57	78.99	Yes	-
		SR2			37.1	54.57	91.67	Yes	-
		SR3			26.02	54.57	80.59	Yes	-
		SR4			19.26	54.57	73.83	Yes	-
		SR5			23.82	54.57	78.39	Yes	-
		SR6			26.63	54.57	81.20	Yes	-
		SR7			41.97	54.57	96.54	Yes	-
		SR8			32.32	54.57	86.89	Yes	-
		SR9			28.2	54.57	82.77	Yes	-
		SR10			39.21	54.57	93.78	Yes	-
CO	1 Hour	SR1	30,000	-	553.84	1,568.48	2,122.32	Yes	-
		SR2			700.56	1,568.48	2,269.04	Yes	-
		SR3			572.02	1,568.48	2,140.50	Yes	-
		SR4			765.41	1,568.48	2,333.89	Yes	-

		SR5			677.13	1,568.48	2,245.61	Yes	-
		SR6			677.87	1,568.48	2,246.35	Yes	-
		SR7			899.52	1,568.48	2,468.00	Yes	-
		SR8			1395.4	1,568.48	2,963.88	Yes	-
		SR9			1127.4	1,568.48	2,695.88	Yes	-
		SR10			725.96	1,568.48	2,294.44	Yes	-
	8 Hour	SR1	10,000	-	105.85	1,568.48	1,674.33	Yes	-
		SR2			195.56	1,568.48	1,764.04	Yes	-
		SR3			149.21	1,568.48	1,717.69	Yes	-
		SR4			101.73	1,568.48	1,670.21	Yes	-
		SR5			165.17	1,568.48	1,733.65	Yes	-
		SR6			156.07	1,568.48	1,724.55	Yes	-
		SR7			260.42	1,568.48	1,828.90	Yes	-
		SR8			252.8	1,568.48	1,821.28	Yes	-
		SR9			168.46	1,568.48	1,736.94	Yes	-
		SR10			160.63	1,568.48	1,729.11	Yes	-
PM_{10}	24 Hour	SR1	150	-	0.4	-	0.40	Yes	-
		SR2			0.18	-	0.18	Yes	-
		SR3			0.11	-	0.11	Yes	-
		SR4			0.27	-	0.27	Yes	-
		SR5			0.14	-	0.14	Yes	-
		SR6			0.42	-	0.42	Yes	-
		SR7			0.19	-	0.19	Yes	-
		SR8			0.11	-	0.11	Yes	-
		SR9			0.14	-	0.14	Yes	-
		SR10			0.25	-	0.25	Yes	-

Table A- 16 – Scenario 5B Sensitive Receptor Results for EU Standards

Pollutant	Averaging Period	Sensitive Receptor	EU AAQS(µg/m³)	Permitted Exceedances as per EU AAQS	Model Results (µg/m³)	Background Concentration (µg/m³)	Cumulative Results (µg/m³)	Below EU Standard?
NO_2	1 Hour	SR1	200	18	88.34	54.57	142.91	Yes
		SR2			92.29	54.57	146.86	Yes
		SR3			59.62	54.57	114.19	Yes
		SR4			89.09	54.57	143.66	Yes
		SR5			81.04	54.57	135.61	Yes
		SR6			87.05	54.57	141.62	Yes
		SR7			89.17	54.57	143.74	Yes
		SR8			71.13	54.57	125.7	Yes
		SR9			52.35	54.57	106.92	Yes
		SR10			89.56	54.57	144.13	Yes
	Annual	SR1	40	-	3.88	27.29	31.17	Yes
		SR2			2.54	27.29	29.83	Yes
		SR3			1.24	27.29	28.53	Yes
		SR4			3.11	27.29	30.4	Yes
		SR5			1.87	27.29	29.16	Yes
		SR6			3.85	27.29	31.14	Yes
		SR7			2.27	27.29	29.56	Yes
		SR8			1.80	27.29	29.09	Yes
		SR9			1.10	27.29	28.39	Yes
		SR10			2.39	27.29	29.68	Yes
CO	8 Hour	SR1	10,000	-	105.85	1,568.48	1,674.33	Yes
		SR2			195.56	1,568.48	1,764.04	Yes
		SR3			149.21	1,568.48	1,717.69	Yes
		SR4			101.73	1,568.48	1,670.21	Yes

		SR5			165.17	1,568.48	1,733.65	Yes
		SR6			156.07	1,568.48	1,724.55	Yes
		SR7			260.42	1,568.48	1,828.90	Yes
		SR8			252.8	1,568.48	1,821.28	Yes
		SR9			168.46	1,568.48	1,736.94	Yes
		SR10			160.63	1,568.48	1,729.11	Yes
PM_{10}	24 Hour	SR1	50	35	0.03	-	0.03	Yes
		SR2			0.03	-	0.03	Yes
		SR3			0.02	-	0.02	Yes
		SR4			0.02	-	0.02	Yes
		SR5			0.02	-	0.02	Yes
		SR6			0.03	-	0.03	Yes
		SR7			0.02	-	0.02	Yes
		SR8			0.02	-	0.02	Yes
		SR9			0.01	-	0.01	Yes
		SR10			0.02	-	0.02	Yes
	Annual	SR1	40	-	0.012	-	0.012	Yes
		SR2			0.01	-	0.01	Yes
		SR3			0.007	-	0.007	Yes
		SR4			0.011	-	0.011	Yes
		SR5			0.008	-	0.008	Yes
		SR6			0.012	-	0.012	Yes
		SR7			0.011	-	0.011	Yes
		SR8			0.008	-	0.008	Yes
		SR9			0.005	-	0.005	Yes
		SR10			0.009	-	0.009	Yes
$PM_{2.5}$	Annual	SR1	25	-	0.012	-	0.012	Yes
		SR2			0.01	-	0.01	Yes

		SR3			0.007	-	0.007	Yes
		SR4			0.011	-	0.011	Yes
		SR5			0.008	-	0.008	Yes
		SR6			0.012	-	0.012	Yes
		SR7			0.011	-	0.011	Yes
		SR8			0.008	-	0.008	Yes
		SR9			0.005	-	0.005	Yes
		SR10			0.009	-	0.009	Yes

Appendix 2-3 – Noise Modelling Report

Fujairah 3 Power Generation Plant

Environmental Noise Modelling Report

Prepared for: Anthesis

Ref.: J20042

Date: 13 February 2020

Report Approval & Revision Record

Project:	Fujairah 3 Power Generation Plant			
Document Title:	Environmental Noise Modelling Report			
Client:	Anthesis			
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01	06 February 2020	Yuvika Ramsaran Environmental Engineer	Ian Goble Environmental Consultant	Richard Palmer Partner
02	07 February 2020	Yuvika Ramsaran Environmental Engineer	Ian Goble Environmental Consultant	Ian Goble Environmental Consultant
03	13 February 2020	Yuvika Ramsaran Environmental Engineer	Marc Blanché Partner	Marc Blanché Partner

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Acronyms

Symbols

%	percent
°C	degree celsius
<	less than

General

B	Boundary Receptor
BS	British Standard
CCW	Closed Cooling Water
CEMP	Construction Environmental Management Plan
CPH	Cycles per Hour
CW	Circulating Water
DAF	Dissolved Air Flotation
E	East
EHS	Environmental, Health and Safety
EP	Equator Principle
EPC	Engineering, Procurement and Construction
ESWPC	Emirate Sembcorp Water and Power Company
F1	Fujairah 1
F2	Fujairah 2
F3	Fujairah 3
FAPCO	Fujairah Asia Power Company
FEWA	Federal Electricity and Water Authority
GIIP	Good International Industry Practice
GT	Gas Turbine
GTG	Gas Turbine Generator

HP	High-Pressure
HRSG	Heat Recovery Steam Generator
HSE	Health, Safety and Environment
IEMA	Institute of Environmental Management and Assessment
IFC	International Finance Corporation
IoA	Institute of Acoustics
IP	Intermediate-Pressure
IPP	Independent Power Plant
ISO	International Organisation for Standardisation
IWPP	Independent Water and Power Plant
LP	Low-Pressure
N	North
NSW	New South Wales
PPA	Power Purchase Agreement
RSC	Reference Site Condition
SR	Sensitive Receptor
ST	Steam Turbine
STG	Steam Turbine Generator
UAE	United Arab Emirates
UAT	Unit Auxiliary Transformer
UTM	Universal Transverse Mercator
WHO	World Health Organisation
WKC	WKC Environment Consultancy

Units of Measurement

Hz	hertz
Kg/m^2	kilogram per square metre
kHz	kilohertz
km	kilometre