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Environmental
Resources
Management

ANNEX K

Air Quality

CONTENTS

K1 CLIMATIC FACTORS

1.1 GENERAL CLIMATIC CONDITIONS

In terms of climatic characterisation, Istanbul is located at the transition zone of the Oceanic and Mediterranean climates. Istanbul has many topographic diversities and experiences a variety of sub-climates. While the Bosphorus Strait and surroundings are dominated by the Mediterranean climate (dry summers, mild and rainy winters), the Black Sea climate prevails to the north (mostly rainy), the Balkan climate to the west (cold winters and snow) and the Anatolian Continental climate to the east (hot summers and cold winters). Summers are generally hot and humid; winters are cold, wet and often snowy. Spring and autumn are usually mild and wet but erratic, and the weather can range from chilly to warm, though the nights are normally chilly.

There are several meteorological stations located in the vicinity of the project site:

- Atatürk Airport Meteorological Station is located at 40°58'N and 28°49'°E, 33 m above sea level (asl); about 22 km southwest of the centre of the European part of the scheme;
- Florya Station is located at 40°59'N and 28°47'E, 37 m asl; about 28 km west of the centre of the European part of the scheme;
- Göztepe Station is located at 40°58'N and 29°05'E, 33 m asl; about 10 km southeast of the centre of the Asian part of the scheme;
- Kartal Station (now closed) was located at 40°58'N and 29°03'E, 18 m asl; about 7 km south from the centre of the Asian part of the scheme.

Meteorological data on rainfall, temperature, relative humidity, and wind flow are described in following sections. Data from the Istanbul meteorological stations has been averaged over periods between 3 and 10 years depending on the available time frame. Due to a system change only limited past data from the relevant meteorological stations were suitable.

1.2 TEMPERATURE AND SUNSHINE

The average annual temperature is +15.7°C at Göztepe Station. At Florya Station it was +14.7°C, with, on average, a monthly minimum of +6.5°C / +5.7°C in January and a maximum of +25.9°C /+25.2°C in July (cf. Figure 1-1).

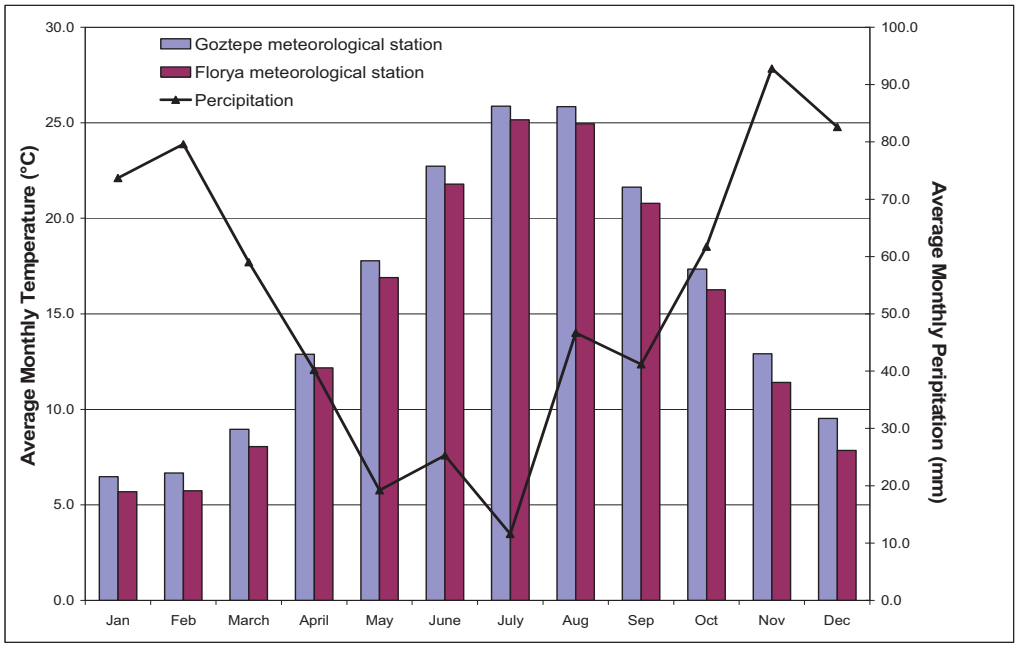
At Kartal Station a monthly minimum of +5.9°C in February, and a maximum of +23.8°C in July was recorded (cf. Table 1-1).

Table 1-1 Average temperature and sunshine data for a period of 33 years at Kartal Station between 1975 and 2008

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Average Temp (°C)	6.1	5.9	7.7	12.1	16.7	21.5	23.8	23.5	20.0	15.6	11.2	8.0
Average Maximum Temp (°C)	9.0	9.2	11.6	16.6	21.3	26.2	28.5	28.3	24.9	19.9	14.8	10.7
Average Minimum Temp (°C)	3.6	3.2	4.6	8.3	12.4	16.8	19.4	19.5	16.0	12.3	8.3	5.4
Average sunshine (hour)	2.3	3.1	4.6	6.0	8.0	9.8	10.5	9.4	7.9	5.2	3.3	2.2

Between 1999 and 2007, the average minimum and maximum temperatures recorded at Göztepe Station are -2.2°C in January and +35.3°C in August, respectively, with a minimum temperature of -6.4°C in January and a maximum temperature of 40.2°C in June. At Kartal Station, the average minimum and maximum temperatures between 1975 and 2008 were 3.6°C in January and 3.2°C in February and +28.5°C in July.

January is the coldest month at Göztepe and Florya and February in Kartal. Although the highest temperatures at Göztepe were measured in June, the hottest month of the 10 years average is August. The maximum temperature in the region can go up to 40°C.



Source: *DEVLET METEOROLOJİ İŞLERİ GENEL MÜDÜRLÜĞÜ, Göztepe and Florya Meteorological Stations; 1999 – 2007*

Figure 1-1 Monthly Average Temperature and Precipitation

With respect to the temperature data, the climate is classified as a hot climate, given an average annual temperature above 15°C. Temperatures below 0°C were reported for November and March.

The average monthly hours of sunshine range between 2.2 (Kartal) or 2.3 (Göztepe) hours in December and 10.5 (Kartal) and 11.7 (Göztepe) hours in July (cf. Table 1-1). The average annual sunshine duration is 6.8 hours. The monthly mean daily total global sun radiation can reach 430 kW/m².

1.3 PRECIPITATION AND SNOWFALL

The average annual precipitation in the region is 692 mm with average monthly precipitations ranging from 12 mm in July to 93 mm in November (cf. Table 1-2). As can be seen from Figure 1-1, there is a dry season between May and July, and a rainy season between October and February. During a 10 years observation, a maximum monthly precipitation of 250 mm was recorded in December at Göztepe Station and a monthly minimum of 0.1 mm in August. Istanbul on average experiences 152 days with precipitation per year. Summer is the driest season with July as the driest month (10 years average is 12 mm). Precipitation during summer is irregular and often torrential.

Table 1-2 summarizes the number of rainy days and precipitation at Kartal Station. Within this period, 38% of rainfall occurred in winter, 25% in spring, 12% in summer, and 25% in autumn.

Table 1-2 ***Number of rainy days and amount of precipitation over a period of 33 years at Kartal Station (1975 – 2008)***

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Average number of rainy days	17.3	14.9	13.0	11.3	7.6	6.4	3.9	5.6	7.0	11.3	13.7	16.9
Average precipitation amount (mm)	83.9	64.9	58.8	45.3	30.2	25.7	24.7	31.8	35.9	72.4	89.6	101.3

Snowfall is observed in the region between November and March. A snow cover irregularly occurs and snow cover of more than 10 cm was registered for December, January and February. Maximum snow depth was measured as 40 cm in December 2001.

1.4 PRESSURE, HUMIDITY AND EVAPORATION

Maximum average pressure is observed in autumn and winter months in Istanbul. Table 1-3shows the data of average vapour pressure and average relative humidity recorded at Göztepe Station over the period 1999 - 2006. The long-term average humidity is ranging between 69% in summer (June) and 80% in October.

Evaporation in the region of Istanbul is affected by the geographical situation comprising the Bosphorus Strait, the Marmara Sea, the Aegean Sea and the Black Sea. Average monthly evaporation observed in 2006 at Göztepe Station was 80 mm (April), 115 mm (May), 156 mm (June), 202 mm (July), 199 mm (August), 102 mm (September), 66 mm (October), and 3.4 mm (November).

Table 1-3 ***Average vapour pressure and relative humidity observed 1999 - 2006 at Göztepe Station***

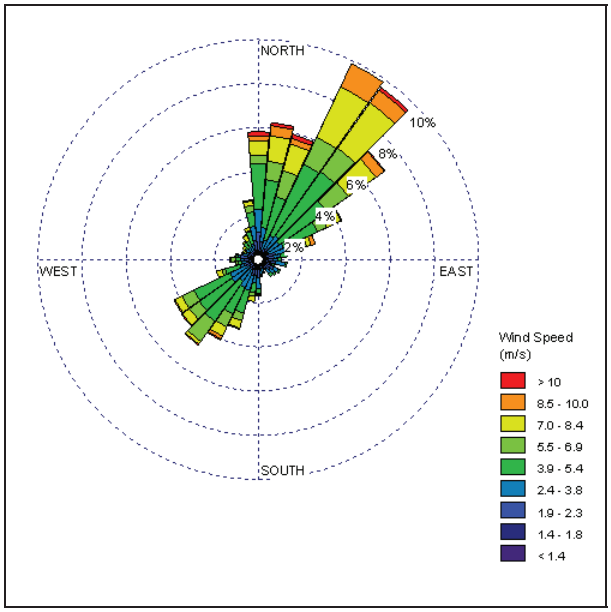
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average Pressure (hPa)	1015	1013	10138	1010	1011	1010	1007	1008	1011	1015	1016	1016
Average Relative Humidity (%)	77.7	75.4	72.0	70.5	70.2	69.0	70.0	73.0	76.4	79.6	78.4	76.5

1.5 WIND CHARACTERISTICS

Wind flow in the Istanbul region is strongly affected by the location between the Aegean Sea to the southwest and the Black Sea to the northeast. In summertime, strong, dry north winds of the Aegean Sea, the so-called meltemi (Greek) or meltem (Turkish) are present at the region. The meltem is generally caused by deep continental depression centred over southwest Asia and blow from a direction between north-east and north-west depending on local topography. In addition, a Mediterranean wind from the Sahara, the so-called sirocco, blows as a strong southern wind over the Istanbul region. Furthermore, the wind directions recorded at the meteorological stations is influenced by the local topography.

For the Asian side, the prevailing wind direction at Göztepe Station is southwest (SW) with a north-easterly direction during four months of the year. Over a 10 years recording period, the average wind speed is in the range of 2.7 m/s (9.6 km/h) with a maximum wind speed of 25 m/s with north-north-eastern (NNE) direction recorded in December 2003.

On the European side, at Florya Station the prevailing wind direction is north-northwest or north-northeast throughout the year. The dominant wind direction at the Ataturk Airport station is northeast and north-northeast with abundance above 30% and wind speeds can be above 10 m/s (cf. Figure 1-2). A secondary maximum is the opposite wind coming from the southwest having an abundance of about 16%. Wind speed of the south-western winds occasionally reaches 8.5 m/s to 10 m/s. In 2009 the average wind speed was 4.5 m/s.



Data Source: *DEVLET METEOROLOJİ İŞLERİ GENEL MÜDÜRLÜĞÜ, Ataturk Airport Meteorological Station 2009*

Figure 1-2 ***Annual Average of Wind Direction and Wind Speed - Wind rose of Istanbul-Atatürk meteorological station (2001 – 2009 long-term average)***

K2 AMBIENT AIR QUALITY MEASUREMENTS AND AIR POLLUTANT DISPERSION MODELLING

2.1 INTRODUCTION

This Annex provides results of the ambient air quality measurements and the dispersion modelling performed for the Eurasia Tunnel ESIA.

The Annexes structure is as follows:

1. Overview of national and international ambient air quality standards
2. Description and documentation of ambient air quality measurements
3. Air dispersion modelling – methodology and used data
4. Results of the air dispersion modelling

2.2 NATIONAL AND INTERNATIONAL AMBIENT AIR QUALITY STANDARDS

This section provides an overview of Turkish and international ambient air quality standards (cf. Table 2-1 and Table 2-2). Different standards and reference values are established for annual average and short-term ambient air concentrations. Annual (long-term) standards are specified to avoid cumulative effects on human health and/or the environment during long-term exposure. Short-term standards based on 1-hour, 8-hour, or 24-hour average concentrations are designed to avoid acute effects on human health caused by short exposures to high levels of a pollutant.

2.2.1 *Turkish Ambient Air Quality Standards*

Ambient air quality is regulated under the Air Quality Assessment and Management Regulation - AQEMR (Official Gazette Date/Number: 06.06.2008/26898). Annexes I and IA of the regulation specify air quality targets which are summarized in Table 2-1 below.

Table 2-1 Turkish Ambient Air Quality Standards (from 2014 on)

Substance	Concentration in µg/m³		
	Hourly Average	**Daily Average**	**Annual Average**
Carbon monoxide (CO)	-	10 000 (daily and also for 8 hours periods)	10 000
Nitrogen dioxide (NO_2) (1)	300 (200 from 2024 on)	-	60 (40 from 2024 on)
Sulphur dioxide (SO_2) (2)	500 (350 from 2019 on)	250 (125 from 2019 on)	150 (no long-term standard from 2019 on)
PM10 (airborne particles with aerodynamic diameter of 10 µm or less)	-	100 (50 from 2019 on)	60 (40 from 2019 on)

Source: Turkish Requirements as per AQEMR (Annexes I and IA)

2.2.2 *International Ambient Air Quality Standards*

References for international standards are the standards on ambient air quality published in the IFC General EHS Guidelines and in European Union Directives.(3). The applicable standards are provided in Table 2-2.

Comparison of the Turkish air quality standards with those of the European Union shows that for CO, NO_2, and SO_2 the standards will be the same from 2014 on. The standard for PM10 will be the same from 2019 on.

[1] There is also a standard of 30 µg/m³ for nitrogen oxides (NOx) which applies to the protection of sensitive vegetation. This does not apply for city areas.

[2] For SO_2 a standard for the protection of ecosystems is specified. As for NOx this standard is not applicable for the city area.

[3] For the application of ambient air quality standards, it is important to note that assessing compliance with some ambient air quality standards requires use of a specific modelling approach. The European standards, for example, require modelling which predicts the number of exceedances of standards in a given time period as a statistical parameter.

Table 2-2 IFC and EU Ambient Air Quality Standards

Substance	Concentration in µg/m³		
	Hourly Average	**Daily Average**	**Annual Average**
Carbon monoxide (CO)	-	10,000 ** (8 hour period)	-
Nitrogen dioxide (NO_2) (4)	200 (G)* 200** (5)	-	40 (G)* 40 **
Sulphur dioxide (SO_2) (6)	500 (10 min)* 350** (7)	125 / 50 / 20 (T1/T2/G)* 125**	-
PM10 (airborne particles with aerodynamic diameter of 10 µm or less)	-	150 / 100 / 75 / 50 (T1/T2/T3/G) * 50** (8)	70 / 50 / 30 / 20 (T1/T2/T3/G) * 40**
Hydrocarbons (HC) Benzene	-	-	5 **

** *IFC General EHS Guidelines, (IFC 2007):* T1= IFC interim target-1; T2 = interim target-2; T3= interim target-3; G= Guideline value: The guideline values provided in the IFC General EHS Guidelines are adapted from the WHO Ambient Air Quality Guideline 2005. The guideline values cascade down from higher to lower levels indicated as 'interim-target 1' through 'interim-target 3', to end up at the 'guideline value' with the lowest concentration and highest ambient air quality. Interim-targets take into consideration that achievement of the guideline value in less developed countries requires long-term development and improvement effort.
** EU Council Directive 2008/50/EC on ambient air quality

[4] There is also a standard of 30 µg/m³ for nitrogen oxides (NOx) which is applicable only for remote areas and ecosystems with no industries within about 30 km distance. Thus it is not applicable to the Project.

[5] The NO_2 standard for 1-hour average may be exceeded up to 18 times per year.

[6] For SO_2 a standard for the protection of ecosystems is specified. As for NOx this standard is not applicable for the city area.

[7] The SO_2 standard for 1-hour average may be exceeded up to 24 times per year.

[8] The PM10 standard for daily average may be exceeded up to 35 times per year.

2.3 DESCRIPTION AND DOCUMENTATION OF AMBIENT AIR QUALITY MEASUREMENTS

2.3.1 Data from Existing Air Quality Monitoring Stations

For characterization of the current ambient air quality in the project area, monitoring data obtained at municipal ambient air quality measuring stations in 2009 are summarized in Table 2-3. The considered stations are:

- Istanbul-Aksaray: Situated at the European side on the historic peninsula at Ataturk Bulvari; substances monitored: CO, NO_x, PM10, SO_2
- Istanbul-Kadikoy: Situated on the Asian side south of D100 in residential area with major roads; substances monitored: CO, NO_x, PM10, SO_2, O_3
- Istanbul-Uskudar: Situated on the Asian side in a mixed city area north of the project area; substances monitored: CO, PM10, SO_2

Their locations are shown in Figure 2-1 and Figure 2-2. These stations are all in locations where evidence of air pollution is expected; there is no monitoring station operated in the Istanbul region for the determination of underlying background concentrations.

The air quality at the sampling locations is affected from all kind of emission sources: traffic, households, commercial enterprises, parking areas, and also background pollution from distant regional sources in and outside of Istanbul.

Table 2-3 ***Ambient Air Quality Monitoring Data recorded in 2009 by Istanbul Municipality Operated Stations***

Substance	Station	Concentration		
		Hourly Average, maximum	Daily Average, maximum	Annual Average
Carbon monoxide (CO) in mg/m³	Aksaray	16.8	2.9	0.83
	Kadikoy	40.5	3.4	0.62
	Uskudar	10.2	2.5	0.63
Nitrogen dioxide (NO_2) in µg/m³	Aksaray	1060	590	106
	Kadikoy	446	129	54
Nitrogen oxides (NO_x as NO_2 equivalent) in µg/m³	Aksaray	2170	1070	181
	Kadikoy	1490	523	104
Sulphur dioxide (SO_2) in µg/m³	Aksaray	210	116	11
	Kadikoy	150	22	5
	Uskudar	228	25	7
PM10 in µg/m³ (airborne particles with aerodynamic diameter of 10 µm or less)	Aksaray	802	204	45
	Kadikoy	887	299	42
	Uskudar	521	150	37

Source: http://www.havaizleme.gov.tr

The monitoring data show some elevated levels and exceedances of the standards for 2014 (9). In summary:

- Standards for carbon monoxide are met at all locations.
- The measured hourly maximum for nitrogen dioxide (NO_2) exceeds the 2014 Turkish and the IFC/EU standards at Aksaray and Kadikoy;
  The current Turkish standard for NO_2 was also exceeded at Aksaray as were the 2014 Turkish standards for the maximum of the daily average and the annual average.
  At both stations the IFC and EU standards for annual average NO_2 were exceeded.
- Nitrogen oxides: NO_x standards refer to ecosystems and therefore are not applicable at the inner city locations of the above stations.

[9] Reference is made to the standards for 2014 as the Project will start operation after this date.

- Sulphur dioxide: All Turkish and EU standards are met for SO_2. With reference to the IFC standards, the interim target T1 is met at Aksaray and T2 at the other two stations.

- Particulate matter: The monitored maximum daily average exceeded the 2014 Turkish standard as well as the IFC and EU standards at all stations. The 2014 Turkish standard for the annual average was slightly exceeded at Aksaray and Kadikoy. The IFC interim target T2 was met at all stations.

It has to be stressed that the maximum hourly and the maximum daily levels provided in the table are the single highest values of the year. However, such high levels may indicate local and short-term pollution episodes.

Comparison of the data with the IFC interim target values shows that achievement of the IFC guideline values in Turkey will require long-term development and improvement effort.

In general, an improvement in air quality can be expected to occur with steadily improving of vehicle engine technology and operation of exhaust emission control equipment. Emissions from domestic heating and cooking and industry should be reduced with replacement of old inefficient equipment and use of new emission control technology. Alongside these improvements, however, the predicted growth of Istanbul's population, households, traffic, and enterprises may work in the opposite direction.

2.3.2 *Passive Sampling of Nitrogen Dioxide (NO_2) and Sulphur Dioxide (SO_2)*

In order to obtain local data on ambient air quality a baseline monitoring survey was undertaken as part of the ESIA. The purpose of this sampling was to obtain indicative data regarding pollution levels at various locations along the scheme

Passive sampling was employed for the measurement of nitrogen dioxide (NO_2) and sulphur dioxide (SO_2). Sampling locations were selected along the project scheme and at offset locations in the build-up areas of Istanbul. The locations are shown in Figure 2-1 and Figure 2-2.

Passive air sampling of NO_2 and SO_2 was performed by means of diffusion samplers to receive information on long-term concentration along the alignment and in its vicinity.

The sampling tubes, which are specific to the compound being sampled, are designed to allow air to circulate by passive diffusion during long-term sampling (produced and analysed by Passam AG, Switzerland). Each tube contains a small quantity of a chemical that reacts with the subject substance in the air. The tubes are exposed to the ambient air for a certain period of time,

resealed and returned to the laboratory for determination of the average concentration during the sampling period.

For identification, each sampler was labelled with an individual sampler ID. The samplers were mounted outdoors on trees to provide a free exposure to the air stream. After exposure, the samples were sent to the laboratory and analysed for the content. From the content and knowledge of exposure duration, the concentration was determined by the laboratory. The results are provided below which shows the laboratory's documentation (cf. Figure 2-3). Table 2-4 summarizes the results with reference to the sampling location IDs.

Figure 2-1 Map of the sampling locations – European side

Figure 2-2 Map of the sampling locations – Asian side

Following - Data sheets of passive air sampling analyses:

passam ltd, CH-8708 Männedorf
www.passam.ch

STS Nr. 149

Nitrogen dioxide (NO2) - Measurement by Diffusive Samplers

sampling method: diffusive sampler analytical method: Saltzmann SP01

ERM GmbH period 25.11.2009 til 24.12.2009
D- Neu-Isenburg Date of analysis: 7.01.2010 blanc 0.008 color reagent: 16.12.2009 SR 9°C ml/min 0.8536

Site	start		end		exposure	absorption brutto						concentration ug/m3			mean	rel. SD
Code DERM	date	time	date	time	time	code	value 1	code	value 2	code	value 3	value 1	value 2	value 3	ug/m3	%
	25.11.2009	15:30	24.12.2009	16:30	697.00	1	0.455		2 x color reagent			55.4			55.4	
	25.11.2009	13:30	24.12.2009	15:00	697.50	2	0.437			2 x cr		53.2			53.2	
	25.11.2009	10:00	24.12.2009	11:40	697.67	3	0.553			2 x cr		67.6			67.6	
	25.11.2009	12:30	23.12.2009	13:30	673.00	4	0.375			2 x cr		47.1			47.1	
	25.11.2009	16:45	23.12.2009	12:45	668.00	5		sampler dirty, unmeasurable								
	24.11.2009	16:00	24.12.2009	11:00	715.00	6	0.533			2 x cr		63.5			63.5	
	25.11.2009	09:00	24.12.2009	17:30	704.50	7	0.012			2 x cr		0.3			0.3	
	25.11.2009	15:30	23.12.2009	11:15	667.75	8	0.790			2 x cr		101.4			101.4	
	25.11.2009	13:45	23.12.2009	10:00	668.25	10	0.406			2 x cr		51.5			51.5	
	25.11.2009	18:00	23.12.2009	10:30	664.50	11	0.800		cobweb	2 x cr		103.2			103.2	
	25.11.2009	13:00	24.12.2009	14:00	697.00	12	0.378			2 x cr		45.9			45.9	
	25.11.2009	16:00	23.12.2009	11:30	667.50	13	0.828			2 x cr		106.4			106.4	
	25.11.2009	14:30	23.12.2009	09:45	667.25	14	0.620			2 x cr		79.4			79.4	
	24.11.2009	16:30	24.12.2009	11:20	714.83	15	0.534			2 x cr		63.6			63.6	
	25.11.2009	12:00	24.12.2009	13:00	697.00	16	0.353			2 x cr		42.7			42.7	
	24.11.2009	16:35	24.12.2009	11:25	714.83	17	0.487			2 x cr		57.9			57.9	
	25.11.2009	15:00	24.12.2009	16:00	697.00	18	0.541			2 x cr		66.1			66.1	
	25.11.2009	13:30	23.12.2009	14:30	673.00	19	0.654			2 x cr		83.1			83.1	
	25.11.2009	15:00	23.12.2009	11:00	668.00	20	0.676			2 x cr		86.6			86.6	
	25.11.2009	10:25	24.12.2009	12:05	697.67	21	0.475			2 x cr		57.9			57.9	
	25.11.2009	14:45	23.12.2009	09:30	666.75	22	0.017	sampler wet inside		2 x cr		1.0			1.0	
	25.11.2009	12:45	23.12.2009	12:15	671.50	23	0.486			2 x cr		61.6			61.6	
	25.11.2009	10:20	24.12.2009	12:00	697.67	24	0.522			2 x cr		63.7			63.7	
	25.11.2009	17:15	23.12.2009	13:00	667.75	25	0.493			2 x cr		62.8			62.8	
	24.11.2009	15:30	24.12.2009	10:30	715.00	26	0.550			2 x cr		65.6			65.6	
	25.11.2009	12:00	23.12.2009	12:00	672.00	27	0.429			2 x cr		54.1			54.1	
	25.11.2009	11:00	24.12.2009	12:20	697.33	28	0.473			2 x cr		57.7			57.7	
	25.11.2009	12:30	23.12.2009	13:45	673.25	30	0.476			2 x cr		60.1			60.1	
	25.11.2009	14:00	24.12.2009	15:30	697.50	60	0.455			2 x cr		55.4			55.4	

Date of arrival: 29.12.2009 Detection limit 0.4 ug/m³ 14 days

The values are representativ for the immediate measuring site only. Conclusions to remote points with reservation. Estimate of uncertainty www.passam.ch/products.htm

These data are part of a long-term measuring serie and it is not allowed to publish partly without permission of passam ltd.

Exit 18.03.2010

QC-coordinator
Dr. M. Hangartner

DERM010901.xls
approved 31.01.2006

page 1 of 1

passam ltd, CH-8708 Männedorf
www.passam.ch

STS Nr. 149

Nitrogen dioxide (NO2) - Measurement by Diffusive Samplers

sampling method: diffusive sampler analytical method: Saltzmann SP01

ERM GmbH period 23.12.2009 til 20.01.2010
D- Neu-Isenburg Date of analysis: 26.01.2010 blanc 0.008 color reagent: 15.01.2010 SR 9°C ml/min 0.8536

Site	start		end		exposure	absorption brutto						concentration ug/m3			mean	rel. SD
Code DERM	date	time	date	time	time	code	value 1	code	value 2	code	value 3	value 1	value 2	value 3	ug/m3	%
	23.12.2009	11:30	20.01.2010	13:35	674.08	31	0.745		2 x color reagent			94.7			94.7	
	24.12.2009	13:00	21.01.2010	13:10	672.17	32	0.468			2 x cr		59.2			59.2	
	24.12.2009	15:30	21.01.2010	12:50	669.33	33	0.564			2 x cr		71.9			71.9	
	24.12.2009	16:30	21.01.2010	09:07	664.62	34	0.542			2 x cr		69.5			69.5	
	24.12.2009	10:00	21.01.2010	10:50	672.83	35	0.530			2 x cr		67.1			67.1	
	23.12.2009	12:00	20.01.2010	13:55	673.92	36	0.511			2 x cr		64.6			64.6	
	23.12.2009	11:00	20.01.2010	13:10	674.17	37	0.698			2 x cr		88.6			88.6	
	24.12.2009	14:00	21.01.2010	13:40	671.67	38	0.490			2 x cr		62.1			62.1	
	23.12.2009	14:30	20.01.2010	11:20	668.83	39	0.590			2 x cr		75.3			75.3	
	24.12.2009	16:00	21.01.2010	09:20	665.33	40	0.710			2 x cr		91.3			91.3	
	23.12.2009	09:45	20.01.2010	11:55	674.17	41	0.398	sampler damaged		2 x cr		50.0			50.0	
	24.12.2009	12:00	21.01.2010	12:20	672.33	42	0.467			2 x cr		59.0			59.0	
	23.12.2009	13:00	20.01.2010	10:20	669.33	43	0.511			2 x cr		65.0			65.0	
	23.12.2009	10:30	20.01.2010	12:30	674.00	45	0.734	cobweb		2 x cr		93.3			93.3	
	24.12.2009	13:30	21.01.2010	13:00	671.50	46	0.481			2 x cr		60.9			60.9	
	23.12.2009	13:45	20.01.2010	10:45	669.00	47	0.410			2 x cr		51.9			51.9	
	23.12.2009	12:15	20.01.2010	14:15	674.00	48	0.575			2 x cr		72.8			72.8	
	24.12.2009	11:00	21.01.2010	11:05	672.08	49	0.496			2 x cr		62.8			62.8	
	23.12.2009	09:30	20.01.2010	11:45	674.25	50	0.546			2 x cr		69.0			69.0	
	24.12.2009	17:30	22.01.2010	10:45	689.25	51	0.009			2 x cr						
	24.12.2009	10:30	21.01.2010	09:45	671.25	54	0.481	cobweb		2 x cr		60.9			60.9	
	23.12.2009	10:00	20.01.2010	12:05	674.08	55	0.444			2 x cr		55.9			55.9	
	23.12.2009	12:45	20.01.2010	10:08	669.38	57	0.804			2 x cr		103.0			103.0	
	23.12.2009	13:45	20.01.2010	10:45	669.00	58	0.418			2 x cr		53.0			53.0	
	23.12.2009	11:15	20.01.2010	13:25	674.17	59	0.685			2 x cr		86.9			86.9	
	24.12.2009	12:20	21.01.2010	12:30	672.17	63	0.408			2 x cr		51.4			51.4	

Date of arrival: 25.01.2010 Detection limit 0.4 ug/m³ 14 days

The values are representativ for the immediate measuring site only. Conclusions to remote points with reservation.
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Estimate of uncertainty www.passam.ch/products.htm

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STS Nr. 149

Nitrogen dioxide (NO2) - Measurement by Diffusive Samplers

sampling method: diffusive sampler analytical method: Saltzmann SP01

ERM GmbH period 21.01.2010 til 17.02.2010
D- Neu-Isenburg Date of analysis: 22.02.2010 blanc 0.008 color reagent: 2.02.2010 SR 9°C ml/min 0.8536

Site	start		end		exposure	absorption brutto						concentration ug/m3			mean	rel. SD
Code DERM	date	time	date	time	time	code	value 1	code	value 2	code	value 3	value 1	value 2	value 3	ug/m3	%
	21.01.2010	09:45	17.02.2010	12:00	650.25	61	0.517		2 x color reagent			67.7			67.7	
	21.01.2010	11:30	17.02.2010	12:30	649.00	62	0.549			2 x cr		72.1			72.1	
	20.01.2010	11:55	18.02.2010	13:20	697.42	64	0.680			2 x cr		83.4			83.4	
	21.01.2010	10:50	17.02.2010	11:35	648.75	65	0.668			2 x cr		88.1			88.1	
	20.01.2010	13:10	18.02.2010	14:10	697.00	67	0.658			2 x cr		80.7			80.7	
	20.01.2010	13:55	18.02.2010	14:40	696.75	68	0.459			2 x cr		56.0			56.0	
	21.01.2010	12:30	17.02.2010	13:15	648.75	69	0.541			2 x cr		71.1			71.1	
	20.01.2010	11:20	18.02.2010	13:00	697.67	70	0.634			2 x cr		77.7			77.7	
	21.01.2010	09:20	17.02.2010	11:15	649.92	71	0.734			2 x cr		96.7			96.7	
	21.01.2010	12:20	17.02.2010	13:00	648.67	72	0.509			2 x cr		66.8			66.8	
	21.01.2010	13:10	17.02.2010	13:40	648.50	73	0.510			2 x cr		66.9			66.9	
	20.01.2010	13:35	18.02.2010	14:30	696.92	74	0.810			2 x cr		99.7			99.7	
	21.01.2010	13:00	17.02.2010	13:30	648.50	76	0.408			2 x cr		53.3			53.3	
	20.01.2010	12:30	18.02.2010	13:40	697.17	77	0.835			2 x cr		102.7			102.7	
	21.01.2010	12:20	17.02.2010	13:00	648.67	78	0.518			2 x cr		68.0			68.0	
	20.01.2010	11:45	18.02.2010	13:10	697.42	79	0.585			2 x cr		71.6			71.6	
	21.01.2010	09:07	17.02.2010	11:00	649.88	80	0.578			2 x cr		75.9			75.9	
	20.01.2010	13:25	18.02.2010	14:20	696.92	82	0.794			2 x cr		97.7			97.7	
	20.01.2010	10:45	18.02.2010	12:40	697.92	84	0.507			2 x cr		61.8			61.8	
	22.01.2010	10:45	19.02.2010	09:30	670.75	85	0.010			2 x cr						
	20.01.2010	12:05	18.02.2010	13:30	697.42	86	0.532			2 x cr		65.0			65.0	
	20.01.2010	10:20	18.02.2010	12:20	698.00	89	0.646			2 x cr		79.1			79.1	
	21.01.2010	12:45	17.02.2010	12:45	648.00	90	0.642			2 x cr		84.7			84.7	
			Blank													

Date of arrival: 22.02.2010 Detection limit 0.4 ug/m³ 14 days

The values are representativ for the immediate measuring site only. Conclusions to remote points with reservation. Estimate of uncertainty www.passam.ch/products.htm

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STS Nr. 149

Sulfure dioxide (SO_2) - Measurement by Diffusive Samplers

sampling method: diffusive sampler analytical method: ion chromatography SP10

ERM GmbH Period 25.11.2009 til 23.12.2009
D- Neu-Isenburg Date of analysis: 05.01.2010 blank [ppm] 0.05 volume [ml] 4 sampling rate 11.9 ml/min 20°C

Site Code DERM	start date	time	end date	time	exposure time	code	value 1	code	quantity SO_4 [ppm$_{Buffo}$] value 2	code	value 3	concentration SO2 [ug/m³] value 1	value 2	value 3	mean ug/m³	rel. SD %
	25.11.2009	12:00	23.12.2009	12:00	672.0	31	1.238					6.6			6.6	
	25.11.2009	15:00	24.12.2009	16:00	697.0	32	1.075					5.5			5.5	
	25.11.2009	15:30	24.12.2009	16:30	697.0	33	1.405					7.3			7.3	
	25.11.2009	17:15	23.12.2009	13:00	667.8	34	0.771					4.0			4.0	
	24.11.2009	16:35	24.12.2009	11:25	714.8	35	1.545					7.8			7.8	
	25.11.2009	13:30	24.12.2009	15:00	697.5	36	1.279					6.6			6.6	
	25.11.2009	10:25	24.12.2009	12:05	697.7	37	1.501					7.8			7.8	
	25.11.2009	13:45	23.12.2009	10:00	668.3	38	1.482					8.0			8.0	
	25.11.2009	12:45	23.12.2009	12:15	671.5	39	1.756					9.5			9.5	
	25.11.2009	11:00	24.12.2009	12:20	697.3	40	2.025					10.6			10.6	
	25.11.2009	12:30	23.12.2009	13:30	673.0	41	1.691					9.1			9.1	
	25.11.2009	13:00	24.12.2009	14:00	697.0	42	1.179					6.1			6.1	
	24.11.2009	15:30	24.12.2009	10:30	715.0	43	0.849					4.2			4.2	
	25.11.2009	13:30	23.12.2009	14:30	673.0	44	2.321					12.6			12.6	
	25.11.2009	16:00	23.12.2009	11:30	667.5	45	2.575					14.1			14.1	
	25.11.2009	15:00	23.12.2009	11:00	668.0	46	1.464					7.9			7.9	
	25.11.2009	14:00	24.12.2009	15:30	697.5	48	1.680					8.7			8.7	
	25.11.2009	12:00	24.12.2009	13:00	697.0	49	0.938					4.8			4.8	
	25.11.2009	10:00	24.12.2009	11:40	697.7	50	2.255					11.8			11.8	
	25.11.2009	15:30	23.12.2009	11:15	667.8	51	5.086					28.2			28.2	
	24.11.2009	16:00	24.12.2009	11:00	715.0	52	1.467					7.4			7.4	
	25.11.2009	18:00	23.12.2009	10:30	664.5	53	2.242					12.3			12.3	
	25.11.2009	16:45	23.12.2009	12:45	668.0	54	samplers were found on the ground, unmeasurable									
	25.11.2009	09:00	24.12.2009	17:30	704.5	55	1.587		Filter was wet			8.2			8.2	
	25.11.2009	14:45	23.12.2009	09:30	666.8	56	0.874		samplers were found on the ground			4.6			4.6	
	25.11.2009	10:20	24.12.2009	12:00	697.7	57	1.871					9.8			9.8	
	24.11.2009	16:30	24.12.2009	11:20	714.8	58	2.378					12.2			12.2	
	25.11.2009	12:30	23.12.2009	13:45	673.3	59	1.465					7.9			7.9	
	25.11.2009	14:30	23.12.2009	09:45	667.3	60	2.920					16.1			16.1	

Arrival date: 29.12.2009 detection limit 0.3 ug/m³ 14 days

The values are representativ for the immediate measuring site only. Conclusions to remote points with reservation.
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STS Nr. 149

Sulfure dioxide (SO_2) - Measurement by Diffusive Samplers

sampling method: diffusive sampler analytical method: ion chromatography SP10

ERM GmbH Period 24.12.2009 til 21.01.2010
D- Neu-Isenburg Date of analysis: 26.01.2010 blank [ppm] 0.05 volume [ml] 4 sampling rate 11.9 ml/min 20°C

Site Code DERM	start date	time	end date	time	exposure time	code	quantity SO_4 [ppm butle value 1	code	value 2	code	value 3	concentration SO2 [ug/m³] value 1	value 2	value 3	mean ug/m³	rel. SD %
	24.12.2009	12:00	21.01.2010	12:20	672.3	1	2.769					15.1			15.1	
	24.12.2009	13:00	21.01.2010	13:10	672.2	2	1.844					10.0			10.0	
	24.12.2009	10:00	21.01.2010	10:50	672.8	3	2.635					14.4			14.4	
	23.12.2009	09:45	20.01.2010	11:55	674.2	6	2.911					15.9			15.9	
	23.12.2009	10:00	20.01.2010	12:05	674.1	7	1.763					9.5			9.5	
	23.12.2009	09:30	20.01.2010	11:45	674.3	8	1.155					6.1			6.1	
	24.12.2009	17:30	22.01.2010	10:45	689.3	9	n.d.		no detection			<0.3			<0.3	
	23.12.2009	11:30	20.01.2010	13:35	674.1	10	1.972					10.7			10.7	
	24.12.2009	12:20	21.01.2010	12:30	672.2	11	1.671					9.0			9.0	
	24.12.2009	14:00	21.01.2010	13:40	671.7	12	2.422					13.2			13.2	
	24.12.2009	16:30	21.01.2010	09:07	664.6	14	1.576					8.6			8.6	
	23.12.2009	11:15	20.01.2010	13:25	674.2	15	3.270					17.8			17.8	
	23.12.2009	13:45	20.01.2010	10:45	669.0	16	1.063					5.7			5.7	
	24.12.2009	10:30	21.01.2010	09:45	671.3	17	1.253					6.7			6.7	
	23.12.2009	13:45	20.01.2010	10:45	669.0	18	0.943					5.0			5.0	
	23.12.2009	12:15	20.01.2010	14:15	674.0	19	1.773					9.6			9.6	
	23.12.2009	13:00	20.01.2010	10:20	669.3	20	0.776					4.1			4.1	
	23.12.2009	12:00	20.01.2010	13:55	673.9	21	1.402					7.5			7.5	
	24.12.2009	13:30	21.01.2010	13:00	671.5	22	2.338					12.7			12.7	
	24.12.2009	11:00	21.01.2010	11:05	672.1	23	1.672					9.0			9.0	
	23.12.2009	10:30	20.01.2010	12:30	674.0	24	2.005					10.8			10.8	
	24.12.2009	16:00	21.01.2010	09:20	665.3	25	1.999					10.9			10.9	
	23.12.2009	11:00	20.01.2010	13:10	674.2	26	2.144					11.6			11.6	
	24.12.2009	15:30	21.01.2010	12:50	669.3	28	1.913					10.4			10.4	
	23.12.2009	12:45	20.01.2010	10:08	669.4	29	3.197					17.6			17.6	
	23.12.2009	14:30	20.01.2010	11:20	668.8	30	3.021					16.6			16.6	

Arrival date: 25.01.2010 detection limit 0.3 ug/m³ 14 days

The values are representativ for the immediate measuring site only. Conclusions to remote points with reservation.
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STS Nr. 149

Sulfure dioxide (SO_2) - Measurement by Diffusive Samplers

sampling method: diffusive sampler analytical method: ion chromatography SP10

ERM GmbH Period 21.01.2010 til 17.02.2010
D- Neu-Isenburg Date of analysis: 3.03.2010 blank [ppm] 0.05 volume [ml] 4 sampling rate 11.9 ml/min 20°C

Site Code DERM	start date	time	end date	time	exposure time	code	value 1	quantity SO_4 [ppm$_{Buffer}$] code	value 2	code	value 3	concentration SO2 [µg/m³] value 1	value 2	value 3	mean ug/m³	rel. SD %
	21.01.2010	09:45	17.02.2010	12:00	650.3	61	2.248					12.6			12.6	
	21.01.2010	11:30	17.02.2010	12:30	649.0	62	0.298					1.4			1.4	
	20.01.2010	11:55	18.02.2010	13:20	697.4	65	1.594					8.3			8.3	
	21.01.2010	10:50	17.02.2010	11:35	648.8	66	1.642					9.2			9.2	
	20.01.2010	13:10	18.02.2010	14:10	697.0	67	2.557					13.4			13.4	
	20.01.2010	13:55	18.02.2010	14:40	696.8	70	2.305					12.1			12.1	
	21.01.2010	12:30	17.02.2010	13:15	648.8	71	2.212					12.5			12.5	
	20.01.2010	11:20	18.02.2010	13:00	697.7	72	1.480					7.7			7.7	
	21.01.2010	09:20	17.02.2010	11:15	649.9	73	2.278					12.8			12.8	
	21.01.2010	12:20	17.02.2010	13:00	648.7	74	2.511					14.2			14.2	
	21.01.2010	13:10	17.02.2010	13:40	648.5	76	2.243					12.6			12.6	
	20.01.2010	13:35	18.02.2010	14:30	696.9	77	2.769					14.6			14.6	
	21.01.2010	13:00	17.02.2010	13:30	648.5	79	1.532					8.5			8.5	
	20.01.2010	12:30	18.02.2010	13:40	697.2	80	4.896					26.0			26.0	
	21.01.2010	12:20	17.02.2010	13:00	648.7	81	1.611					9.0			9.0	
	20.01.2010	11:45	18.02.2010	13:10	697.4	82	1.824					9.5			9.5	
	21.01.2010	09:07	17.02.2010	11:00	649.9	83	2.593					14.6			14.6	
	20.01.2010	13:25	18.02.2010	14:20	696.9	84	13.198					70.5			70.5	
	20.01.2010	10:45	18.02.2010	12:40	697.9	85	2.377					12.5			12.5	
	22.01.2010	10:45	19.02.2010	09:30	670.8	86	1.339					7.2			7.2	
	20.01.2010	12:05	18.02.2010	13:30	697.4	87	1.293					6.7			6.7	
	20.01.2010	10:20	18.02.2010	12:20	698.0	89	12.031					64.1			64.1	
	21.01.2010	12:45	17.02.2010	12:45	648.0	90	0.101					0.3			0.3	

Arrival date: 22.02.2010 detection limit 0.3 ug/m³ 14 days

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Figure 2-3 Data sheets of passive air sampling analyses

Table 2-4 Summary of Passive Sampling Results

	Nitrogen dioxide (NO_2) (µg/m³) and sampler ID for the Laboratory in ()				Sulphur dioxide (NO_2) (µg/m³) and sampler ID for the Laboratory in ()			
	November 24 – December 24, 2009	December 24, 2009 - January 20, 2010	January 20 – February 19, 2010	**Average concentration in µg/m³ for the measuring period***	November 24 – December 24, 2009	December 24, 2009 - January 20, 2010	January 20 – February 19, 2010	**Average concentration in µg/m³ for the measuring period***
European Side								
Along the scheme/existing road								
Location 1	64 (6)	63 (49)	n.a.	**63**	7 (52)	9 (23)	n.a.	**8**
Location 2	64 (15)	n.a.	72 (62)	**68**	12 (58)	n.a.	8 (65)	**10**
Location 2b	58 (17)	n.a.	n.a.	**58**	8 (35)	n.a.	n.a.	**8**
Location 3	68 (3)	n.a.	n.a. (87)	**68**	12 (50)	n.a.	n.a. (64)	**12**
Location 4	64 (24)	59 (42)	68 (78)	**64**	10 (57)	15 (1)	13 (85)	**13**
Location 4b	58 (21)	n.a.	67 (72)	**62**	8 (37)	n.a.	15 (77)	**11**
Location 5	58 (28)	51 (63)	71 (69)	**60**	11 (40)	9 (11)	9 (81)	**10**
Location 6	n.a.	67 (35)	88 (65)	**78**	n.a.	14 (3)	26 (80)	**20**
North of the scheme, city area								
Location 7	66 (26)	61 (54)	68 (61)	**65**	4 (43)	7 (17)	n.a. (78)	**6**
Location 8	55 (1)	70 (34)	76 (80)	**67**	7 (33)	9 (14)	8 (72)	**8**
Location 9	66 (18)	91 (40)	97 (71)	**85**	6 (32)	11 (25)	12 (70)	**10**
Location 10	55 (60)	72 (33)	n.a.	**64**	9 (48)	10 (28)	13 (67)	**11**
Location 11	53 (2)	n.a.	85 (90)	**69**	7 (36)	n.a.	15 (83)	**11**
Location 12	43 (16)	59 (32)	67 (73)	**56**	5 (49)	10 (2)	13 (73)	**9**
Location 13	46 (12)	62 (38)	n.a.	**54**	6 (42)	13 (12)	n.a. (69)	**10**
Location 14	47 (4)	61 (46)	53 (76)	**54**	9 (41)	13 (22)	13 (76)	**12**
Asian side								
Along the scheme/existing road								
Location 21	79 (14)	50 (41)	83 (64)	**71**	16 (60)	16 (6)	n.a. (62)	**16**
Location 22	83 (19)	75 (39)	78 (70)	**79**	13 (44)	17 (30)	13 (61)	**14**
Location 23	87 (20)	89 (37)	81 (67)	**85**	8 (46)	12 (26)	10 (82)	**10**
Location 24	101 (8)	87 (59)	98 (82)	**95**	28 (51)	18 (15)	9 (66)	**18**
Location 25	106 (13)	95 (31)	100 (74)	**100**	14 (45)	11 (10)	64 (89)	**30**
Location 26	n.a.	103 (57)	n.a. (88)	**103**	n.a.	18 (29)	n.a. (88)	**18**

	Nitrogen dioxide (NO_2) (µg/m³) and sampler ID for the Laboratory in ()				**Sulphur dioxide (NO_2) (µg/m³) and sampler ID for the Laboratory in ()**			
	November 24 – December 24, 2009	December 24, 2009 - January 20, 2010	January 20 – February 19, 2010	**Average concentration in µg/m³ for the measuring period***	November 24 – December 24, 2009	December 24, 2009 - January 20, 2010	January 20 – February 19, 2010	**Average concentration in µg/m³ for the measuring period***
North of the scheme, city area								
Location 27	n.a.	69 (50)	72 (79)	**71**	5 (56)	6 (8)	9 (79)	**6**
Location 28	60 (30)	53 (58)	62 (84)	**58**	8 (59)	6 (16)	7 (86)	**7**
Location 28b	n.a.	52 (47)	n.a.	**52**	n.a.	5 (18)	n.a.	**5**
Location 29	63 (25)	65 (43)	79 (89)	**69**	4 (34)	4 (20)	7 (87)	**5**
South of the scheme, city area								
Location 30	52 (10)	56 (55)	65 (86)	**58**	8 (38)	10 (7)	14 (74)	**11**
Location 31	103 (11)	93 (45)	103 (77)	**100**	12 (53)	11 (24)	71 (84)	**31**
Location 32	62 (23)	73 (48)	n.a. (75)	**67**	10 (39)	10 (19)	n.a. (63)	**10**
Location 33	54 (27)	65 (36)	56 (68)	**58**	7 (31)	8 (21)	13 (71)	**9**
Monthly range (min – max)	**43 – 106**	**50 – 103**	**53 – 103**	**52 - 103**	**4 – 28**	**4 – 18**	**7 – 71**	**5 – 31**
Monthly average	**64**	**70**	**78**	**70**	**9.3**	**10.7**	**17.1**	**12**

n.a. – no analysis; e.g. sample lost, dirty

** Some samples were not analyzed since lost or found dirty. In these cases the average is based on less than three months.*

Some of the samplers got lost (taken off by animals or children) or were dirty when they fell on the ground.

At three sample locations, a second sampler was mounted in order to obtain a figure for the variance and reliability of the measurements. From these results, the uncertainty for NO_2 measurements can be estimated to be about 3 µg/m³ and 2 µg/m³ for SO_2.

The results of the passive sampling for NO_2 show concentrations along Kennedy Caddesi of between 50 and 70 µg/m³. Away from the main road the values vary from 40 up to 100 µg/m³. The overall average of the European measurements is about 65 µg/m³. The lowest concentrations were obtained at sampling locations 12 to 14. Since these locations were least affected by traffic, the respective average of 54 µg/m³ is taken as a conservative background value for areas unaffected by local traffic along the European part of the scheme.

For the Asian side, the measurements at the existing highway are more elevated, ranging between 50 and 106 µg/m³, and with an average of about 87 µg/m³. The offset measurements revealed results comparable to the European side except at Location 31 which was situated near the railway terminal. This appears to have been a local hotspot, maybe due to railway engine operation or other sources. For the Asian side, the lowest concentrations were obtained at sampling locations 28, 30 and 33. The respective average of 58 µg/m³ is therefore taken as the background value for the Asian part of the scheme.

The single SO_2 measurements show a wide range between 5 and 70 µg/m³. For the European side, the average is about 10 µg/m³ for both the Kennedy Caddesi and the offset locations.

On the Asian side, again, the concentrations along the highway were higher with an average of 16 µg/m³. For sampling locations offset to the North the average is 6 µg/m³ and about 10 µg/m³ to the South, indicating a background value of approximately 8 µg/m³. Again, Location 31 shows a relatively high concentration in one measurement.

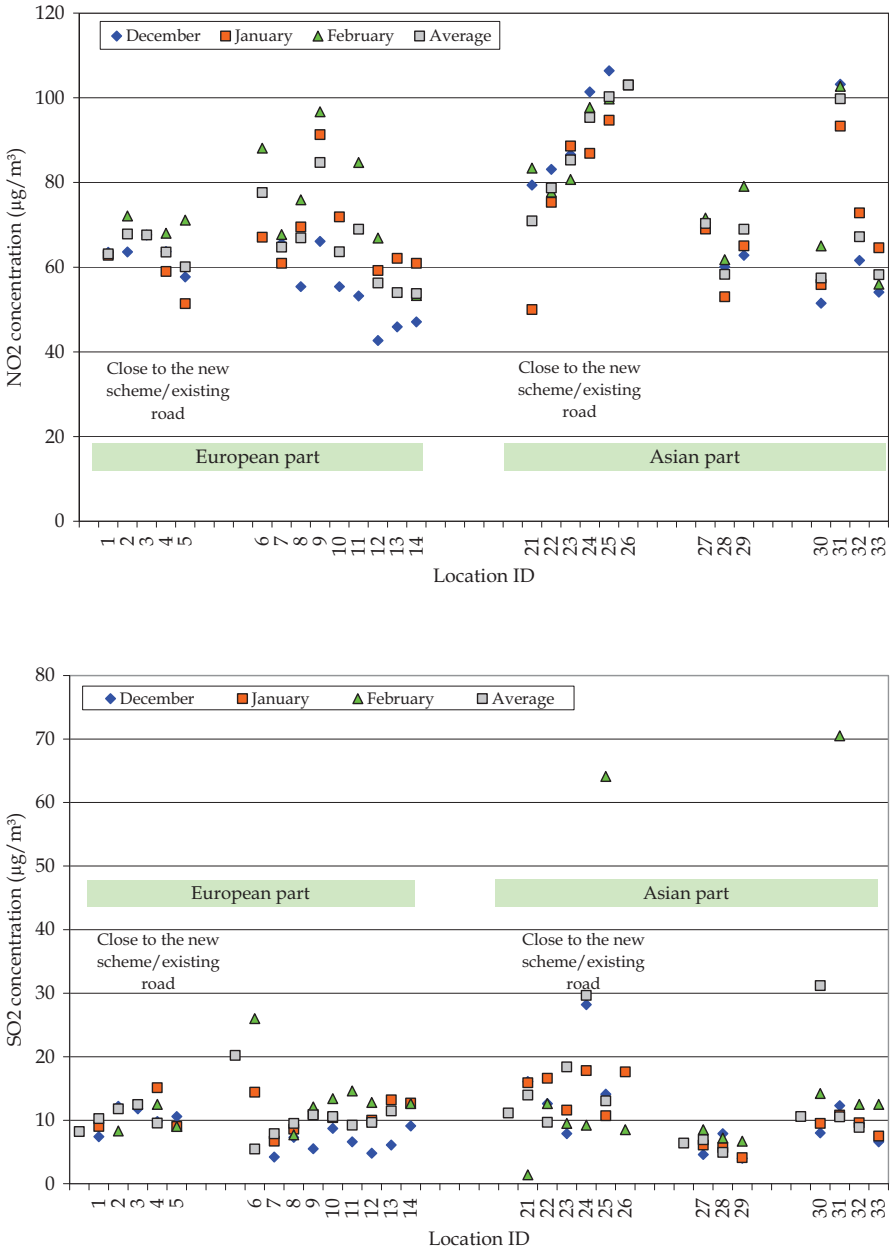


Figure 2-4 Results of NO_2 and SO_2 passive sampling (NO_2 above, SO_2 below)

2.3.3 *Active Sampling of PM10, Nitrogen Dioxide (NO_2), and Sulphur Dioxide (SO_2)*

In addition to the passive sampling, spot samples for particulate matter (PM_{10}), NO_2 and SO_2 were taken by means of an active sampling device at four locations in the general vicinity of the proposed tunnel portals. For active sampling, air is actively pumped through the equipment and analysed for the pollutants of interest by specific methods; e.g. fluorescence spectrometry. The pumping allows for higher volume flows and thus higher quantities of pollutants for analysis which is required for short-term measurements.

The four locations selected for the sampling are shown in Figure 2-1 and Figure 2-2. The locations were

- at the European part of the scheme (major types of sources):
    - #101 - Kumkapi fish market, 60 m south of Kennedy Cd (traffic, market, parking)
    - #102 - Kumkapi coastline, 100 m south of Kennedy Cd (traffic, parking, gas station)
- at the Asian part of the scheme:
    - #103 - Kirmizi Beyaz parking, intersection with Dr. EyüpAksoy; 120m south of D100 (high traffic)
    - #104 - BP gas station 2.5 km north of D100 (traffic, gas station, residential)

The measurements were performed 12 times at each location during the period March 17 to June 22, 2010 for 24 consecutive hours each recorded as one hour levels. Given the sampling in the city area, the locations are affected not only from traffic but also from other nearby sources. Furthermore, background pollution from distant sources in and outside of Istanbul might influence the measurements.

The measurements were performed by the accredited laboratory Ekotest and documented in reports dated June 4 and August 9, 2010. The results are summarized in Table 2-5.

Table 2-5 Summary of Active Sampling Results

Substance	Period	Concentration in µg/m³ at Location				Applicable** Turkish limit (2010)
		# 101	# 102	# 103	# 104	
PM10	Average*	74	63	65	65	114
	24 hrs max.	118	110	109	99	220
SO_2	Average*	7.2	7.0	7.1	7.8	150
	95-percentile +	11	11	14	18	340
	Max. hour	17	19	32	63	-
NO_2	Average*	33	33	39	45	84
	95-percentile +	88	98	87	108	300
	Max. hour	161	165	140	197	-

* Average over 24-hours sampling periods on 12 days in three months

** Current legislation stipulates a transition of limit values which are continuously reduced over a couple of years to adapt with new regulations. The average over the measurement period is compared to the annual average limit.

\+ The 95-percentile is the value which is met by 95% of all measurements which is used as standard to evaluate short-term levels.

With reference to the future short-term standards the following can be concluded.

- The measurement results for PM_{10} indicate that exceedance of the future standard is likely if emissions from general sources of dust are not reduced in the future. The Turkish standard of 50 µg/m³ for the daily average is valid from 2019 on.
- The results for SO_2 meet the future short-term standards (350 µg/m³ for the 1-hour maximum and 125 µg/m³ for the daily average; valid from 2019 on).
- For NO_2, the future short-term standard is also met (200 µg/m³ for the 1-hour maximum; valid from 2024 on).

The table shows that all Turkish limit values applicable in 2010 were met within the measuring period. Comparison of the average concentrations of the active sampling during the Spring with the annual average limits has to be prefaced as being indicative as the active sampling was discontinuous and only for a limited period. The main purpose of the active sampling was to obtain short-term results at locations close to the scheme to supplement the other baseline monitoring information.

2.3.4 *Summary of Air Quality Monitoring Results*

With regard to the Turkish and international standards, the following can be concluded from the passive and active baseline sampling.

- The existing situation reveals high levels for NO_2 at all sampling locations which suggests that the 2024 annual average limit in Turkey may be exceeded when it enters into force. Exceedance of the IFC/EU standards indicates the need for regional air quality improvement. As demonstrated by the results at the Metropolitan monitoring stations, elevated concentrations are a regional rather than a local characteristic of the current ambient air quality in Istanbul.

- The PM_{10} future standards will not be met if the current situation remains unchanged. Measures to reduce PM_{10} emissions from all types of source need to be implemented at a regional and national level.

- All the SO_2 levels reported here complied with Turkish and international standards.

Overall, the Project area shows air quality typical of a large city with heavy traffic levels.

2.4 *AIR DISPERSION MODELLING – METHODOLOGY AND USED DATA*

Substances of Interest

The following air pollutants were considered in the modelling:

- NOx – Nitrogen oxides: NO_2 - nitrogen dioxide and NO – nitric oxide

- CO – Carbon monoxide

- PM10 – Particulate matter (includes soot/black carbon and abrasion of wheel rubber and re-suspension of particles from the road surface); PM10 indicates that the particle size is below 10 µm

- SO_2 – Sulphur dioxide

- HC – unburned hydrocarbons (unspecific assortment of organic molecules, generated through combustion processes and fugitive fuel evaporation; a component of particular interest is benzene)

- CO_2 – Carbon dioxide (considered for emissions but not for dispersion modelling).

Type of Model

AUSTAL2000[10] was used as dispersion model that was developed on behalf of the German Environmental Agency. The model is a Lagrangian particle model and the official reference model for the German Instruction on Air Quality Control (TA Luft) and hence mandatory for air emissions of industrial point sources. Besides modelling of point source emissions, like dispersing from the ventilation shaft, line sources like roads can be included. The calculation model is set up, verified, and validated in conformance with the German guideline on atmospheric particle models - VDI 3945/3[11].

Lagrangian particle models are advanced models which consider local topography and meteorological conditions in more detail than the older Gaussian models. Comprehensive meteorological parameters are used in form of a dispersion class statistics utilizing the parameters wind direction, wind speed, and atmospheric stability. The model calculates a local three-dimensional wind field. Thus, the dispersion of substances follows the wind streams modulated by topography. This might be relevant in a complex terrain like it is found along the project scheme. In addition, the model allows accounting for high abundance of calm wind situations.

Emission sources can be defined as point, line, area, or volume source. The results of the dispersion calculation are substance-specific ground level concentrations in accordance with the EU air quality directive 2008/50/EC.

The modelling was performed by means of the software AUSTALView (Version 6.3, February 2010).

Traffic Data

The traffic figures for the modelling are based upon the Traffic and Revenue Analysis report (Jacobs 2010) and supplementary detailed data provided by Jacobs. Three scenarios were modelled:

- "2009": Current situation
- "2023 with-Project": Year 2023 with implementation of the Project
- "2023 without-Project": Year 2023 without the Project being implemented (but including other committed changes in the transport system).

(1) [10] http://www.austal2000.de/en/home.html

(1) [11] VDI – Society of German Engineers; the VDI publishes technical guidelines and norms comparable to ISO standards

The project scheme was separated into sections on which the predicted traffic flow is in the same order of magnitude. Consecutive parts of the scheme between connecting roads were taken as one section as long the traffic flow varies less than 10%, which variation does not significantly affect the location of modelled contours. The entire scheme and connecting roads were separated into 74 sections.

The traffic flow was provided by Jacobs as average annual daily traffic (AADT). These data were used for modelling of the average situation throughout the year in order to determine annual average concentrations. For short-term concentrations it had to be considered that the traffic flow is not constant but also shows peak traffic times. For the main road sections, the traffic load during these times is about 1.6-fold of the AADT (Jacobs).

For the future composition of the vehicle fleet, no significant change was presumed. Potential changes may result from gas fuelled or electrically driven vehicles which both would decrease emissions of pollutants. Such changes in the vehicle fleet, however, can not be predicted at present. Therefore, no such change was considered for the modelling which approach provides conservative results.

Air Emissions

The quantity of pollutant emission by vehicle engines depends on a variety of factors, which are:

- Type and power of engine
- Date of construction
- Type and composition of fuel
- Efficiency of combustion (e.g. age, wear)
- Presence of emission control equipment (i.e. catalyser)
- Actual speed of the vehicle
- Traffic flow
- Composition of traffic regarding vehicle types (e.g. abundance of trucks, average age and actual performance of engine types)
- Traffic flow characteristics on a specific road section (average speed, free flow, or traffic jam)
- Road gradient.

Traffic flow, speed, and road gradient can be specified for the road sections. The others of the above factors can be accounted for only in terms of averages and assumptions. This, however, is feasible since the actual engine types using the road today and in the future are not known. A standard engine mix was

therefore assumed (cf. below). The mix was used for all three scenarios. The dominant factor affecting the emission of pollutants is the year of construction of the engine. Due to improving requirements on emission control of vehicle exhaust, the relevant emissions will be reduced as already was in the past.

Based on the data of Jacobs about 10% of the vehicles are heavy duty trucks of more than 3.5 tons or busses. For the future scenario no change in this figure was anticipated. A variation of the heavy vehicle share by few percent would not have a significant effect on the dispersion modelling results.

For the engines it was assumed that about 40% of the passenger cars have diesel engines.

For the age composition of the vehicle fleet, it was presumed that the vehicles operated in Turkey in 2009 were on average 5 years older than in Western European countries. For 2023 there is no difference anticipated due to the expected growth of the Turkish economies and associated modernisation of the vehicle fleet.

Driving speed on the major roads was set to 80 km/h for passenger cars and trucks. This is a conservative approach for trucks which at some sections might drive 10-20 km/h slower.

Most of the roads of the scheme have a minor gradient. Only the tunnel has a 5% gradient which is relevant in regard of vehicle engine emissions.

Based on the traffic flow figures, the air emissions were calculated from specific emissions (grams per km and vehicle) provided in the EMEP/EEA Air Pollutant Emission Inventory Guidebook[12], Part B: Sectoral Guidance, Chapter 1.A.3.b on Road Transport published by the European Environment Agency (EMEP/EEA 2009).

In Table 2-6 the emission factors are summarized that were used for the modelling. These emissions are given as mass per vehicle and kilometre.

For the tunnel section, higher emission factors were taken since slope and decline change the emissions. PM10 emissions from vehicle traffic originate from various sources. In addition to the combustion products from the engine, particulates are generated from tyre wear, braking, and road wear. While the emissions from engines will change due to improvement of techniques, the emissions from wear will not change significantly according to the current knowledge. Therefore, the both types of emission generation were considered. PM10 particles are dispersed almost like gaseous substances. For the tunnel it

(1) [12] http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009

was assumed that no deposition occurs, which is a conservative estimate in regard of PM10 dispersion.

Nitrogen oxides (NOx) in the combustion process are mostly generated as nitric oxide (NO). For past years, the initial fraction of NO_2 from combustion processes was about 5%. In recent years, however, this fraction was observed to increase up to around 10%, due to after-treatment systems on diesel exhausts. In order to avoid underestimation, a fraction of 15% was applied for the modelling. NO is oxidized to nitrogen dioxide in the atmosphere driven by the presence of ozone. On the other side, NO_2 is reduced to NO in the presence of sunlight. With growing distance to the road, the share increases depending on the above factors. In areas with high NOx concentration, the oxidization process is less efficient than under low NOx conditions. The average lifetime for NO oxidization ranges between about 0.3 and 3 hours. For the near road situation the conversion is of minor relevance. The model, however, considers NO conversion. Inside the tunnel, the distance to the shaft provides time for this conversion. But the required presence of ozone is limited, since it will be used-up after a short distance from the tunnel portal. However, as conservative approach, a NO-to-NO_2 conversion of 50% was taken for the modelling of tunnel shaft emissions.

Benzene as the most relevant hydrocarbon can be calculated with 4.5% of the hydrocarbons (EMEP/EEA 2009).

In the past, sulphur dioxide (SO_2) was a relevant pollutant from vehicle engines. After reduction of the sulphur content in fuel, the SO_2 emissions today are very low (cf. Table 2-6).

Table 2-6 Emission factors

Substance	Emission factor in g/(km*vehicle)		
	2005	2023	2023 for tunnel (5% gradient)
CO	1.9	0.88	1.9
Nitrogen oxides (NOx; as NO_2 equivalent)	1.51	0.63	0.7
Nitrogen dioxide	0.23	0.10	0.35
PM10 (engine)	0.042	0.015	0.017
PM10 (tyre, brake, road wear)	0.017	0.017	0.019
Hydrocarbons (HC)	0.20	0.12	0.17
Benzene	0.009	0.006	0.008
Sulphur dioxide (SO_2)	0.006	0.005	0.006
Carbon dioxide (CO_2)	268	248	220

With regard to future air emissions from vehicle engines, further development in emissions control can be expected. A significant modernisation of the vehicle fleet in Turkey is assumed until 2023 by continuous substitution of older vehicles. Due to technological improvements in engine technology to being introduced by the manufacturers in order to comply with emission control requirements set forth in the European Union, vehicle emissions will be reduced. According to the European Directive 89/69/EC the Euro 3 specifications were implemented for new vehicles in 2000. More stringent requirements of Euro 4 were valid from 2005 on. Specified by the European Regulation No 715/2007, Euro 5 becomes effective in January 2010 for new passenger cars and in 2012 for heavy duty vehicles. Euro 6 will follow 5 years later. For the modelling of the future ambient air increment from traffic it is assumed that most of the vehicles in 2023 will meet the Euro 5 and Euro 6 requirements.

In general, the assumptions used in the assessment are considered to lead to over-prediction of traffic emissions and therefore to provide a conservative assessment of the impact of the Project.

Emissions of the Ventilation Shaft

The ventilation shafts are included in the modelling as point sources. There are two shafts one for each tube, meaning that for example the shaft at the Asian side is venting the air of the eastbound traffic. Design of the shafts and integral vehicle engine emissions are summarized in Table 2-7. Since the air is

vented in direction to the shafts, no significant quantity of air will be leaving the tunnel through the portals. For the pollutants emitted inside the tunnel, it has to be considered that the engines' specific emissions will be elevated compared to a no-gradient section due to the tunnel's continuous gradient of ±5%. Truck traffic through the tunnel will be prohibited in general and has not to be considered as tunnel related emission source.

In order to account for potential NO-to-NO_2 conversion inside the tunnel, conversion was conservatively assumed to 50% of the emitted NO. The actual rate might be less since the process depends on the presence of ozone which is limited inside the tunnel.

Although the ventilation shafts are not industrial plants or industrial emissions, emission limits for industrial point sources are the most useful standards to use for reference purposes. All emission concentrations are below the limits applicable to emissions from industrial plants.

Table 2-7 Shaft design and emission data for an AADT of 65,000 vehicles/day in each direction

Shaft height	5 m		
Diameter of shaft outlet	5 m		
Ventilated air	160 m³/s (European side) 180 m³/s (Asian side)		
Emissions	Emissions in kg/h (per each shaft)	Concentration in mg/m³ (for European side)	For comparison *: Turkish emission limits for industrial plants (mg/m³)
CO	26	45	50
NOx	9.2	16	50
NO_2	4.6	8	-
PM10	0.33	0.6	5
HC	2.2	3.8	-
Benzene	0.11	0.19	-
SO_2	0.07	0.12	5
CO_2	3 600	6 300	-

* Note: Ventilation shafts do not present an industrial plant. The limit values can, however, be adopted as reference value.

Geographical Data

Air dispersion is affected by the topography that is present in the calculation area. For the modelling, cadastral data made available from the Istanbul municipality were used. The data included three-dimensional information on ground levels in the project area. Additional information was contained on building heights. From these data, a digital terrain model was generated by the software.

Calculation Mesh

Modelling was performed for a mesh size of 50 m. In order to estimate the reliability of the resulting contours, one section of the scheme was additionally calculated with a 25 m mesh. The comparison revealed that the contours showed only minor variations below 10 m, if noticeable at all.

Meteorological Data

Meteorological data representative for the project area are fed into the dispersion model by means of a three-dimensional statistics in the special format required by the software. [13]

Istanbul-Atatürk meteorological station was used as reference due to the availability of the various meteorological parameters required from the dispersion model. Details are provided in Annex K1. For the modelling, meteorological data of the years 2001 to 2009 were taken. The wind rose is shown in Figure 1-2.

The statistics of the Atatürk station were transposed within AUSTAL to the area of interest by wind field simulation. This means that the statistical data of the station were modulated via the regional topography. By this approach, the station's statistics can be adapted to the area of the scheme. Figure 2-5 illustrates examples of wind stream pattern for a wind blowing from the South.

(2) [13] This data format represents the relative probability of all possible combinations of wind direction (36 wind direction classes), wind speed (9 classes) and stability of the atmosphere (six stability classes ranging from very stable to very unstable). In optimum data availability situation the statistics comprises these data for each hour of a year.

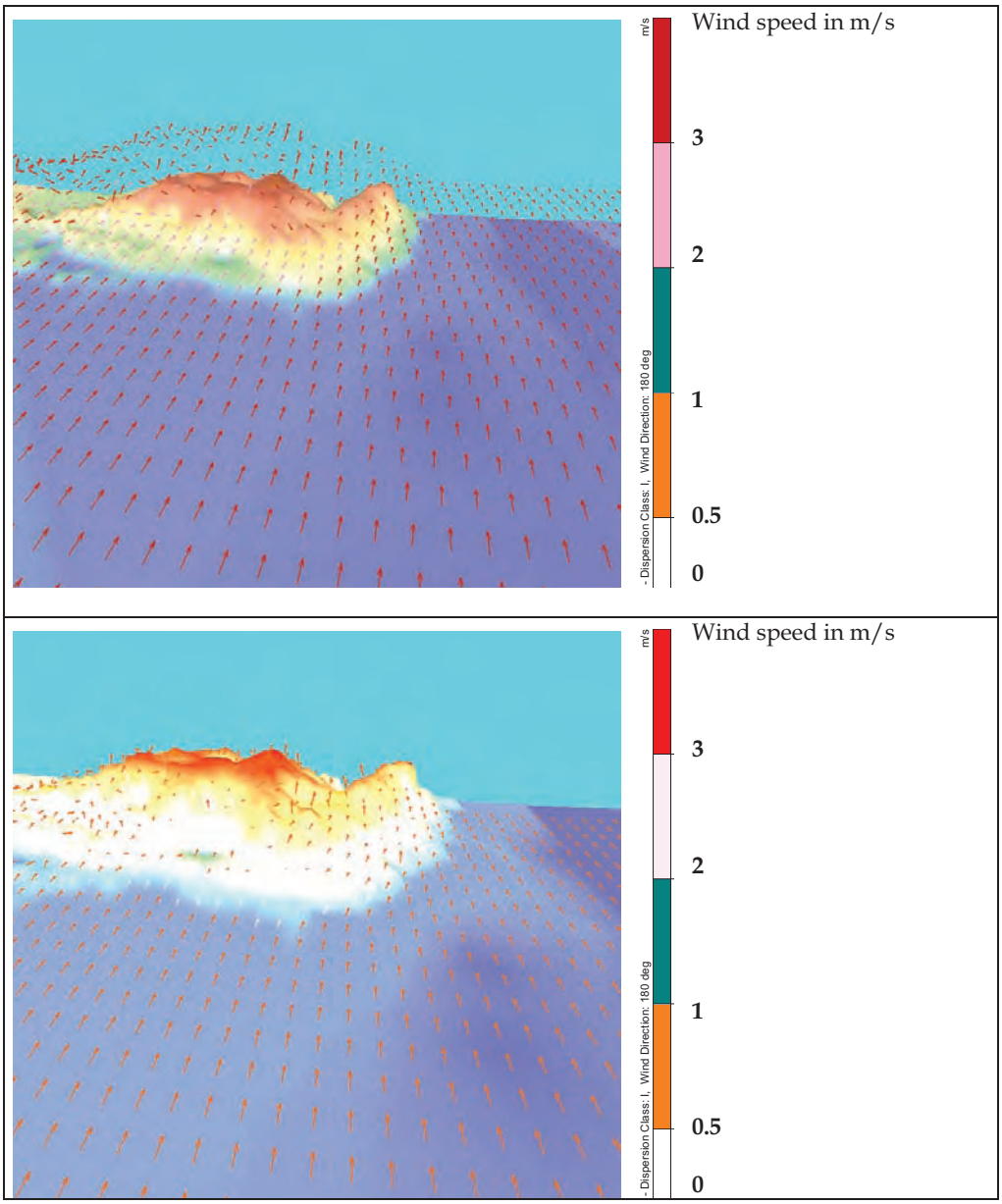


Figure 2-5 ***Illustrative wind stream pattern of the wind field simulation in the AUSTAL model***

2.5 *RESULTS OF THE AIR DISPERSION MODELLING*

Atmospheric dispersion modelling of current road traffic emissions has been carried out in order to estimate the contribution traffic makes to existing ambient air quality (ground level concentrations) and to verify the estimates of underlying background concentrations made from measurement data.

The figures at the end of this section (Annex K-1 through Annex K-14) show the modelling results for:

1. Annual average for NO_2 concentration
   (a) 2009 scenario

(b) 2023 with-Project scenario
(c) 2023 without-Project scenario
(d) Difference between the 2023-without and the 2023-with Project scenario in order to illustrate the Project's effect for the year 2023

2. Maximum 1-hour concentration which is exceeded in 18 hours of the year for NO_2
(a) through (c) as before for the average traffic flow.

In Annex K-1 through Annex K-7 the results for the European side of the Project are shown. Annex K-8 through Annex K-14 present the Asian side.

For the short-term concentrations (1-hour maximum) higher values may be possible in case that a peak traffic hour coincides with meteorological conditions which are most adverse for dispersion (e.g. inversions). This worst case will be a rare situation since such meteorological conditions occur mostly during the second half of the night when maximum traffic flow is unlikely. The worst case therefore is not very likely to occur.

Table 2-8 to Table 2-10 below list results of the dispersion modelling for ground level concentrations at selected reference points which are near the two shafts and two cross sections located at Kennedy Caddesi (scheme-km 2+100) and near Dogus University (scheme-km 12+400). For Kennedy Cd. the distances increase to the West of the scheme and at Dogus University they increase to the South. The distance of 25 m from the centreline represents the boardwalk at 4 lane sections or the outer lane at 6 lane sections. Maximum concentrations directly at the road (centreline) can not be predicted with the model. For the shafts, the maximum concentrations are found less than 25 m distant to the shafts.

The data presented in the tables take into account both the expected development of vehicle emissions and the change in traffic for the year 2023.

For the short-term concentrations the tables provide the 19th highest 1-hour concentrations which indicate the allowed number of 18 exceedings (2008/50/EC). Daily averages were calculated in the same way which is a very conservative over-estimate of the daily (24-hours) average, since the 18 highest 1-hour values are discontinuously scattered over the year and not a continuous series of 18 hours. Furthermore, the allowed 35 exceedings were not taken into consideration.

Table 2-8 Calculated contribution of traffic-related emissions to nitrogen dioxide (NO_2) ground level concentrations at selected reference locations

Location /Scenario	Maximum Concentration (µg/m³)	Concentration at distance to scheme centreline (µg/m³)				
		25m	50m	100m	200m	400m
Annual Average		**Air Quality Standards *: 60 / 40**				
Km 2 +100						
2009	-	31.8	8.6	4.7	2.5	1.4
2023 without	-	21.3	5.8	3.2	1.8	1.0
2023 with	-	32.2	9.0	4.9	2.7	1.5
Shaft (Europe)						
2009	4.1	4.2	-	-	-	-
2023 without	4.6	4.7	-	-	-	-
2023 with	44.6	5.5	-	-	-	-
Dogus University						
2009	-	22.1	12.7	5.5	3.2	2.2
2023 without	-	18.9	10.7	4.8	2.7	1.8
2023 with	-	29.3	16.7	7.1	3.9	2.5
Shaft (Asia)						
2009	1.1	1.0	-	-	-	-
2023 without	1.5	1.1	-	-	-	-
2023 with	50.9	4.1	-	-	-	-
**Maximum Hourly Concentration with 18 exceedings ** **		**Air Quality Standards *: 200 / 200**				
Km 2+100						
2009	-	215	101	79	61	52
2023 without	-	149	67	49	47	47
2023 with	-	214	110	82	76	63
Shaft (Europe)						
2009	59	87	-	-	-	-
2023 without	59	83	-	-	-	-
2023 with	120	98	-	-	-	-
Dogus University						
2009	-	159	131	83	73	67
2023 without	-	140	114	68	59	51
2023 with	-	196	159	94	69	58
Shaft (Asia)						
2009	53	62	-	-	-	-
2023 without	60	61	-	-	-	-
2023 with	155	70	-	-	-	-

* Turkish limit value (2014) / International standard (IFC)

Table 2-9 Calculated contribution of traffic-related emissions to PM10 ground level concentrations at selected reference locations

Location /Scenario	Maximum Concentration (µg/m³)	Concentration at distance to scheme centreline (µg/m³)				
		25m	50m	100m	200m	400m
Annual Average		**Air Quality Standards *: 60 / 40**				
Km 2 +100						
2009	-	7.8	1.9	0.9	0.5	0.2
2023 without	-	6.8	1.6	0.8	0.4	0.2
2023 with	-	10.4	2.5	1.3	0.6	0.3
Shaft (Europe)						
2009	0.8	0.9	-	-	-	-
2023 without	1.3	1.3	-	-	-	-
2023 with	4.6	1.5	-	-	-	-
Dogus University						
2009	-	5.2	2.8	1.1	0.6	0.4
2023 without	-	5.9	3.2	1.3	0.6	0.4
2023 with	-	9.2	5.0	1.9	0.9	0.5
Shaft (Asia)						
2009	0.2	0.1	-	-	-	-
2023 without	0.4	0.3	-	-	-	-
2023 with	4.7	0.5	-	-	-	-
Maximum Daily value based on the Maximum Hourly value which is 24 times over the Year (for comparison Air Quality Standards *: -50 / 50)						
Km 2+100						
2009	-	46	17	12	9	6
2023 without	-	38	15	10	7	6
2023 with	-	59	23	16	11	9
Shaft (Europe)						
2009	9	13	-	-	-	-
2023 without	11	17	-	-	-	-
2023 with	20	13	-	-	-	-
Dogus University						
2009	-	31	24	11	10	8
2023 without	-	25	26	12	9	8
2023 with	-	50	39	18	11	9
Shaft (Asia)						
2009	6	6	-	-	-	-
2023 without	10	10	-	-	-	-
2023 with	16	10	-	-	-	-

* Turkish limit value (2019) / International standard (IFC)

Since PM10 is dispersed almost like a gas, the concentrations for the other pollutants decrease with distance similar to those for PM10. The contents of Table 2-10, therefore, has been limited to the maximum values as being the most relevant for evaluation.

Table 2-10 ***Calculated contribution of traffic-related concentrations to ground level concentrations for carbon monoxide (CO), sulphur dioxide (SO_2), hydrocarbons (HC) and Benzene (Bz) at selected reference locations***

Location	Scenario	Maximum Concentration (µg/m³)			
		CO	SO_2	HC	Benzene
Annual Average					
Km 2 +100	2009	254	1.0	26	1.2
	2023 without	181	1.3	24	1.1
	2023 with	275	1.6	37	1.7
Shaft (Europe)	2009	27	0.1	3	0.2
	2023 without	33	0.2	4	0.2
	2023 with	364	2.1	32	1.5
Dogus University	2009	171	0.5	17	0.8
	2023 without	158	0.9	21	0.9
	2023 with	245	1.4	33	1.5
Shaft (Asia)	2009	6	0.02	0.5	0.03
	2023 without	10	0.05	0.9	0.05
	2023 with	371	1.1	32	1.5
Air Quality Standards *		-	150 / -	-	- / 5
Maximum Hourly value with 18 exceedings, indicating also a maximum daily average					
Km 2 +100 (at 25m)	2009	1440	5	149	7
	2023 without	1060	5	145	7
	2023 with	1660	8	225	11
Shaft – Europe (maximum)	2009	286	1	30	1
	2023 without	330	2	45	2
	2023 with	1030	3	92	4
Dogus University (at 25m)	2009	990	3	102	5
	2023 without	970	5	132	6
	2023 with	1390	7	188	9
Shaft – Asia (maximum)	2009	190	1	20	1
	2023 without	290	1	40	2
	2023 with	840	2	74	4
Air Quality Standards *		10000 / 10000 (8h and 24h)	500 / 350	-	-

* Turkish limit value (2014) / International standard (IFC)

In general, the predicted average concentration decreases significantly with increasing distance. At 400 m distance the annual mean has dropped by more than 90%. For the 1-hour concentration of the most adverse hour of the year, the reduction effect is less; around 50%. When taking into account the European regulation where the 18 highest values of the year can be excluded, the concentration at 400 m is reduced by about 75%.

By comparing the contributions from the traffic to ambient air quality concentrations provided in the tables with the ambient air quality standards,

the following can be concluded for the selected sections of Kennedy Caddesi and D100.:

- **CO**: The 8-hour standard of 10,000 µg/m³ will not be exceeded in the future scenarios, since even the calculated 1-hour maximum for the with-Project scenario is 2,900 µg/m³. The maximum Project-related difference will be below 1,700 µg/m³. There will therefore be no significant impact on CO concentrations.

- **NO_2**: The air quality standard for NO_2 in Turkey will be 200 µg/m³ for the 1-hour and 40 µg/m³ for the annual standard from 2024 on, which equal the IFC and EU standard values. On the European side the maximum future contribution to the ambient annual average at 50 m from the road centreline will be 6 µg/m³ for 2023 without-Project and 9 µg/m³ with-Project. The increase due to the Project (3.2 µg/m³) will not exceed 10% of the standard at this distance. This 10% threshold may, however, be exceeded at shorter distances up to about 45 m from the centreline. With a typical 4-lane design and a 13 m distance between centreline and roadside, the 10% threshold could therefore be exceeded at up to 32 m from the roadside.

  At the Asian side the future contribution at 50 m will be about 11 µg/m³ for the 2023-without Project scenario and 17 µg/m³ with the Project. The increment of 6 µg/m³ exceeds 10%of the short-term standard at 50 m, it can be exceeded at distances up to 75 m. Since the Asian part of the scheme has 6 lanes, the distance from the roadside at which 10% of the standard could be exceeded in this case is 57 m.

- **PM_{10}**: From 2019 on the Turkish air quality standard for PM_{10} will be 40 µg/m³ for the annual average and 50 µg/m³ for the daily average. The maximum future contribution of traffic to the annual average in the with-Project scenario is11 µg/m³ at 25 m. The difference between the scenario with and without Project is 3.6 µg/m³, which is 9% of the standard.

  For the daily average, the maximum at 25 m is calculated to be about 55 µg/m³. The maximum difference between the 2023 scenarios is 19 µg/m³. As mentioned above, the calculation of the daily average is based on exclusion of the 18 highest 1-hour values (99.8% of the hours are lower than this value) which is very conservative if taken for the daily average. Furthermore the daily average may be exceeded at 35 days of the year (90.5% of the hours are lower than this value).

- **Hydrocarbons - benzene**: Benzene is considered a key component of hydrocarbons generated from vehicle engine combustion. An air quality standard of 5 µg/m³ for the annual average is defined in the European Union. With the calculated maximum contribution of 1.7 µg/m³ at 25 m distance to the road centreline, this standard will be met.

The impact generated by the emissions from the **ventilation shaft** is limited. The maximum annual average for NO_2 is 51 µg/m³ at the centre point of the shaft. Therefore, the ambient air quality standard of 40 µg/m³ could be exceeded close to the shaft. However, the concentration reduces quickly to about 6 µg/m³ at about 25 m from the shaft centre point. Within this area, people are not expected to be continuously present and adverse impacts on health are not therefore predicted. The shaft's contribution to ambient PM_{10} levels at 25 m distance is less than 1 µg/m³ for the annual average and below 5 µg/m³ for the maximum daily average. Therefore, no significant effect is anticipated from the ventilation shaft PM_{10} emissions.

Various assumptions had to be made for the modelling which may cause uncertainty of the modelling results:

- traffic data: Data of the Jacobs traffic analysis report were used and are assumed to predict the future situation with sufficient accuracy
- emission factors: vehicle fleet composition affects the emission factor for the average vehicle; for the driving speed 80 km/h was taken which causes higher emissions compared to the actual speed which on average will be slower; the uncertainty of the emission factors approach is estimated to 20%;
- meteorological data: since the data were determined from a 9-year period, they reflect both the average situation and short-term unfavourable dispersion conditions providing for sufficient accuracy;
- calculation accuracy of the annual mean: the uncertainty of the modelled data was about 2% to 4%.

In total, the modelling results have an accuracy of 20-25% for the annual mean concentrations. For the 1-hour maximum of the year the variations can be some 50-60%. This is in conformance with the requirements of EU air quality directive 2008/50/EC.

In general, conservative figures were chosen which rather may lead to over than under-estimation.

Maps with the calculated predictions for the entire scheme are presented at the end of this Annex. The maps show the results for NO_2 since the impacts of the other substances are less extended and hence, covered by the maps for NO_2.

The above conclusions are drawn without consideration of an underlying background concentrations. Given the currently degraded ambient air quality

being detected at the IBB monitoring stations, efforts will be required to reduce all types of emission sources in Istanbul in order to meet future Turkish air quality standards. It is not possible to estimate the extent to which these might be successful up to the year 2023 and therefore whether air quality standards will be met. Given the unpredictable nature of these other background sources, no reliable estimates of the future background concentrations can be provided.

If, however, as a worst case assumption the underlying background concentration of NO_2 is taken to remains at the current level of about 54 to 58 µg/m³ in the future (as determined in Section 2.3.2), the future maximum concentration for the annual average at 25 m distance at the most affected location addressed in Table 2-8 results in a concentration of 86 µg/m³ with the Project and 76 µg/m³ without the Project (a difference of 10 µg/m³). At 50 m distance this reduces to about 63 and 60 µg/m³ respectively (a difference of 3 µg/m³). As mentioned before, the standard will be exceeded both with and without the Project unless NO_2 emissions reduction measures are implemented on the municipal and national level. At distances beyond 50 m, the effect of the Project will not significantly affect the exceeding of the standard.

For PM_{10}, the continuous monitoring by the Municipality reveals a current level of about 42 µg/m³ for the annual average concentration (cf. Table 2-9). Taking this level as the underlying background value and presuming that this remains unchanged until 2023, the annual average of 40 µg/m³ will be exceeded both with and without the Project. The sum of this background level and the contribution from traffic at 25 m distance at the most affected location in Table 2-9 is 52 µg/m³ with the Project and 49 µg/m³ without the Project (a difference of 3 µg/m³). After 50 m the respective levels reduce to 45 and 44 µg/m³ with only a minor difference. At distances beyond 25 m the Project will not significantly affect the exceeding of the standard.

In conclusion, based on a level of 10% threshold of the standard, it is evident that in some cases local impacts on air quality will occur, since emissions with the tunnel will be higher along the Project route. The significance of these will depend on whether sensitive receptors whose health could be adversely affected are present in these locations.

References:

Traffic and Revenue Analysis report by Jacobs (Jacobs)
(Jacobs) – Istanbul Strait Road Tunnel Crossing, Traffic and revenue analysis, Jacobs Consultancy, Final of February 2010; Original traffic load data for separated road sections that were provided to ERM by Jacobs in February and March 2010 as excerpt of the Jacobs model runs

IBB link http://www.havaizleme.gov.tr

EMEP/EEA 2009 - EMEP/EEA Air Pollutant Emission Inventory Guidebook, Part B: Sectoral Guidance, Chapter 1.A.3.b on Road Transport published by the European Environment Agency.

HBEFA – Handbook of Emission Factors, Version 2.1 (2004), prepared on behalf or the German Federal Environment Agency

Figures of Annex K:

Annex K-1
Annual average of NO_2 concentration – 2009 scenario; European side

Annex K-2
Annual average of NO_2 concentration – 2023-with Project scenario; European side

Annex K-3
Annual average of NO_2 concentration – 2023-without Project scenario; European side

Annex K-4
Annual average of NO_2 concentration –Tunnel effect; difference of 2023-with minus 2023-without Project ; European side

Annex K-5
Maximum 1-hour concentration of the year with 18 exceedings for NO_2 – 2009 scenario; European side

Annex K-6
Maximum 1-hour concentration of the year with 18 exceedings for NO_2– 2023 with Project scenario; European side

Annex K-7
Maximum 1-hour concentration of the year with 18 exceedings for NO_2– 2023 without Project scenario; European side

Annex K-8
Annual average of NO_2 concentration – 2009 scenario; Asian side

Annex K-9
Annual average of NO_2 concentration – 2023-with Project scenario; Asian side

Annex K-10
Annual average of NO_2 concentration – 2023-without Project scenario; Asian side

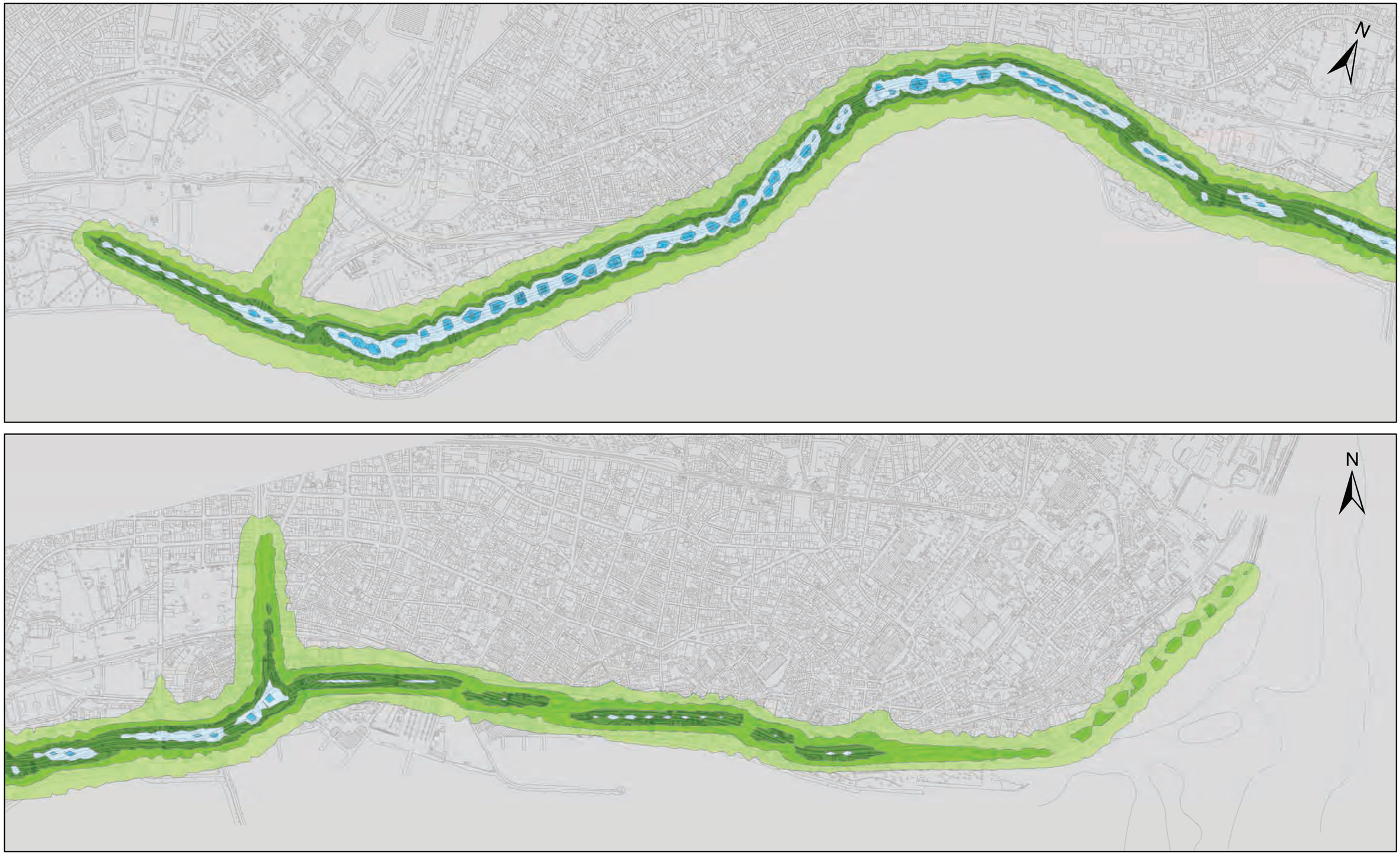
Annex K-11
Annual average of NO_2 concentration –Tunnel effect; difference of 2023-with minus 2023-without Project ; Asian side

Annex K-12
Maximum 1-hour concentration of the year with 18 exceedings for NO_2 – 2009 scenario; Asian side

Annex K-13
Maximum 1-hour concentration of the year with 18 exceedings for NO_2– 2023 with Project scenario; Asian side

Annex K-14
Maximum 1-hour concentration of the year with 18 exceedings for NO_2– 2023 without Project scenario; Asian side

Annex K-1 - Annual average of NO2 concentration - 2009 scenario; European side



Concentration in µg/m³

00 < 05	10 < 15	20 < 25	30 < 35	40 < 45
05 < 10	15 < 20	25 < 30	35 < 40	45 < 50

0 0,25 0,5 km

1:10.000

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Annex K-2 - Annual average of NO2 concentration - 2023-with Project scenario; European side

Concentration in µg/m³

00 < 05	10 < 15	20 < 25	30 < 35	40 < 45
05 < 10	15 < 20	25 < 30	35 < 40	45 < 50

0 0,25 0,5 km

1:10.000

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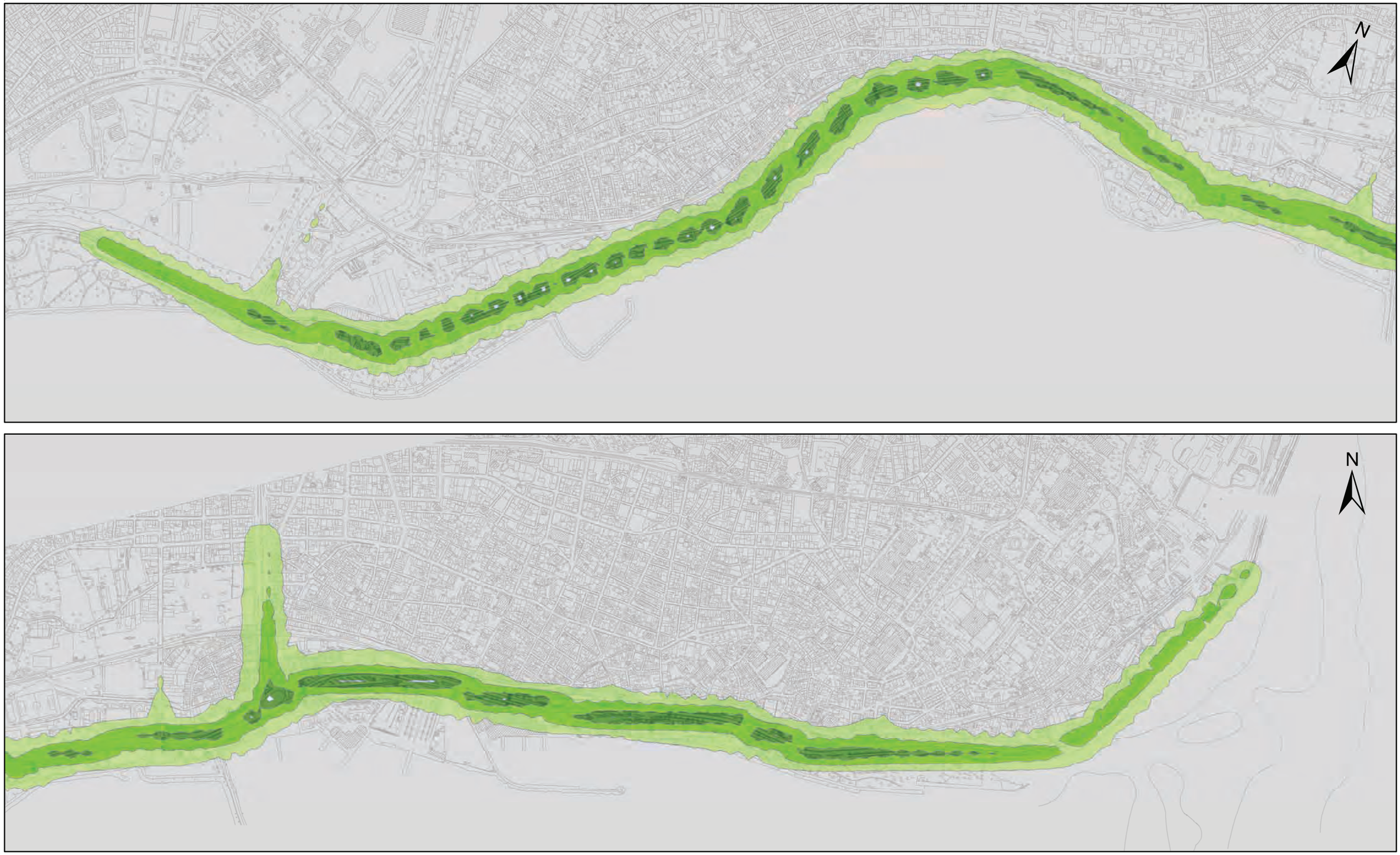
Annex K-3 - Annual average of NO2 concentration - 2023-without Project scenario; European side



Concentration in µg/m³

00 < 05	10 < 15	20 < 25	30 < 35	40 < 45
05 < 10	15 < 20	25 < 30	35 < 40	45 < 50

0 0,25 0,5 km

1:10.000

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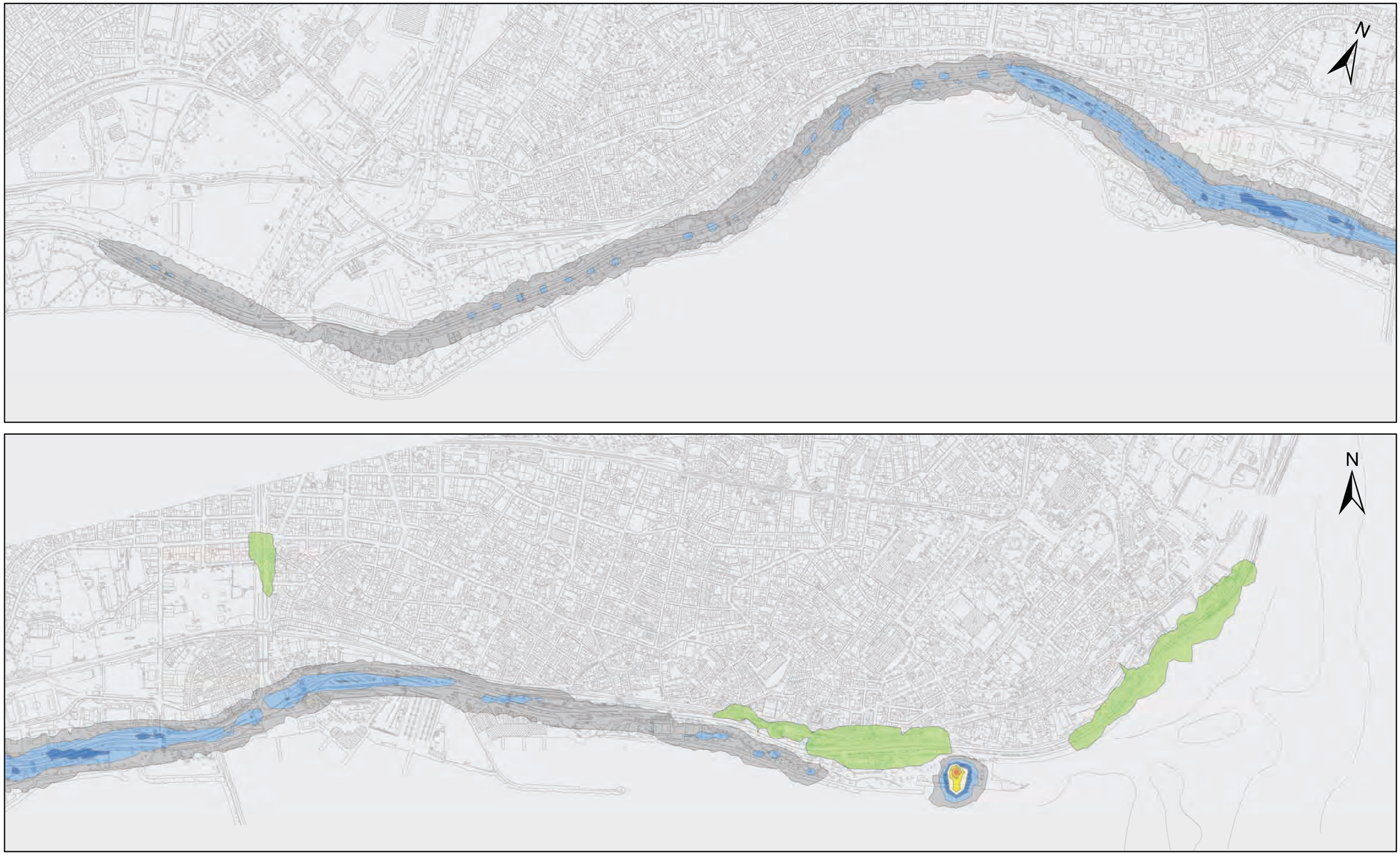
Annex K-4 - Annual average of NO2 concentration - Tunnel effect; difference of 2023-with minus 2023-without Project ; European side



Concentration in µg/m³

-5 < 00	05 < 10	15 < 20	25 < 30	35 < 40	45 < 50
00 < 05	10 < 15	20 < 25	30 < 35	40 < 45	

0 0,25 0,5 km

1:10.000

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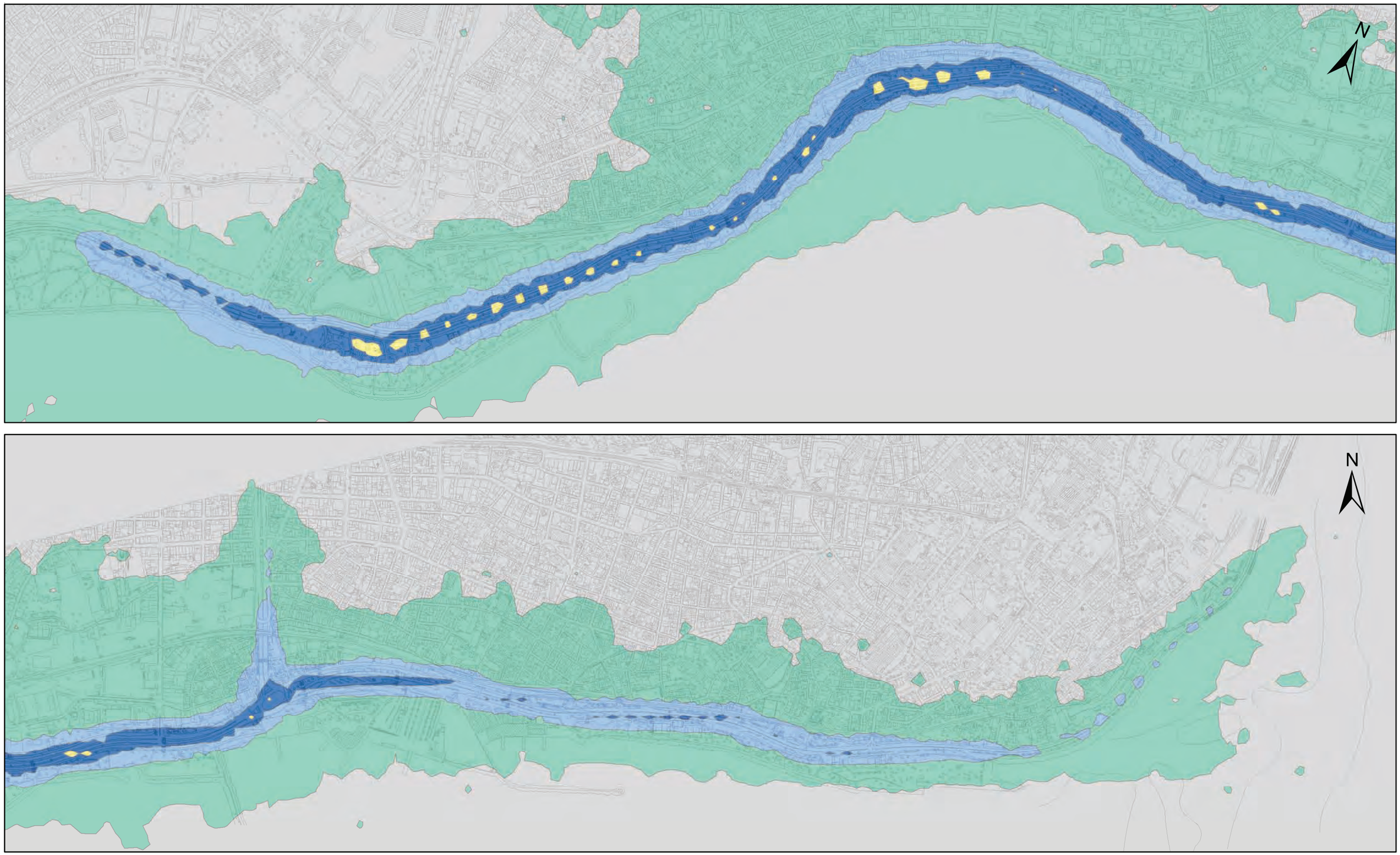
Annex K-5 - NO2 1-hour concentration with 18 exceedings per year - 2009 scenario; European side



Concentration in µg/m³

00 < 050	100 < 150	200 < 250	300 < 350	>= 400
50 < 100	150 < 200	250 < 300	350 < 400	

0 0,25 0,5 km

1:10.000

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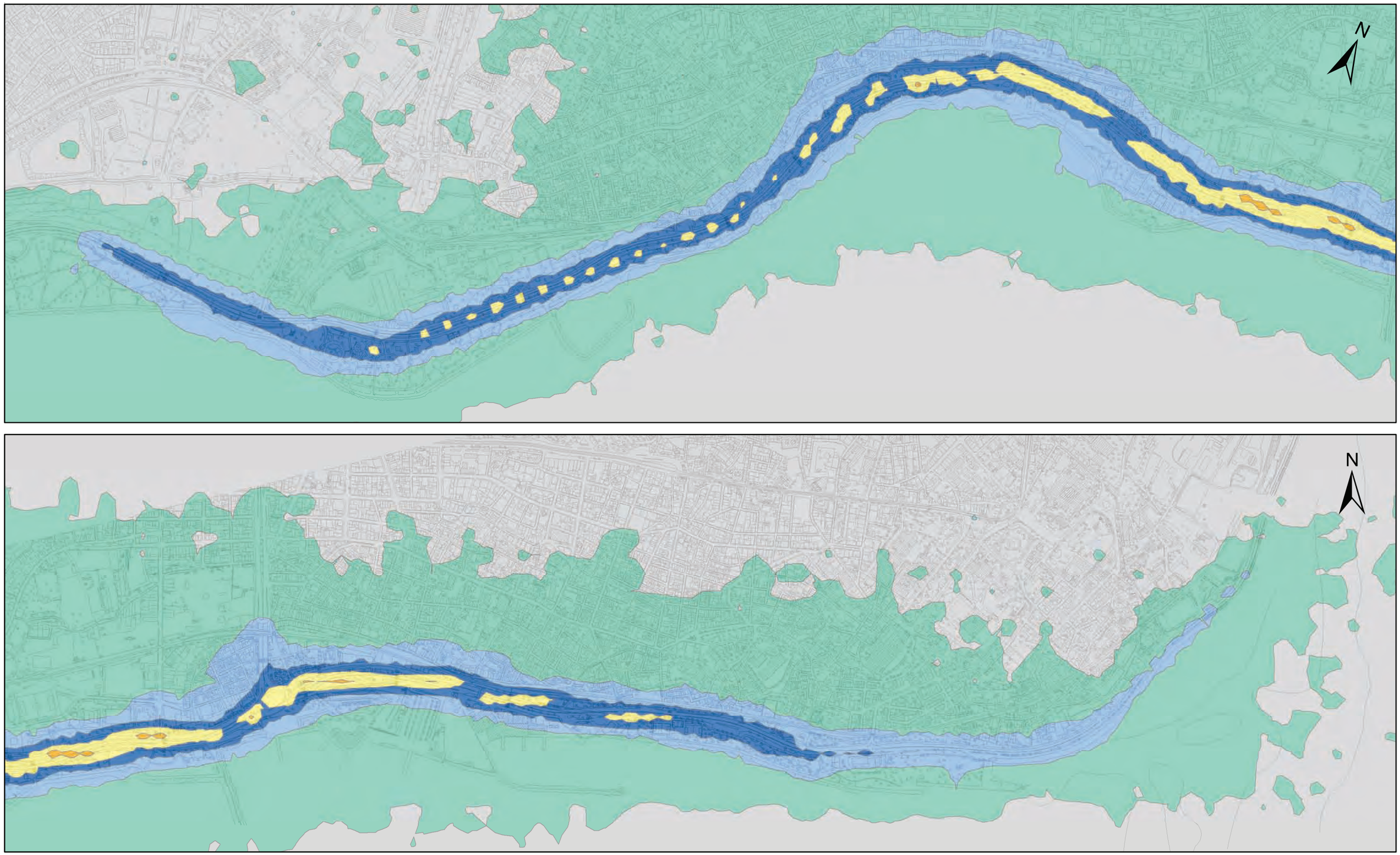
Annex K-6 - NO2 1-hour concentration with 18 exceedings per year - 2023 with Project scenario; European side



Concentration in µg/m³

00 < 050	100 < 150	200 < 250	300 < 350	>= 400	
50 < 100	150 < 200	250 < 300	350 < 400		

0 0,25 0,5 km

1:10.000

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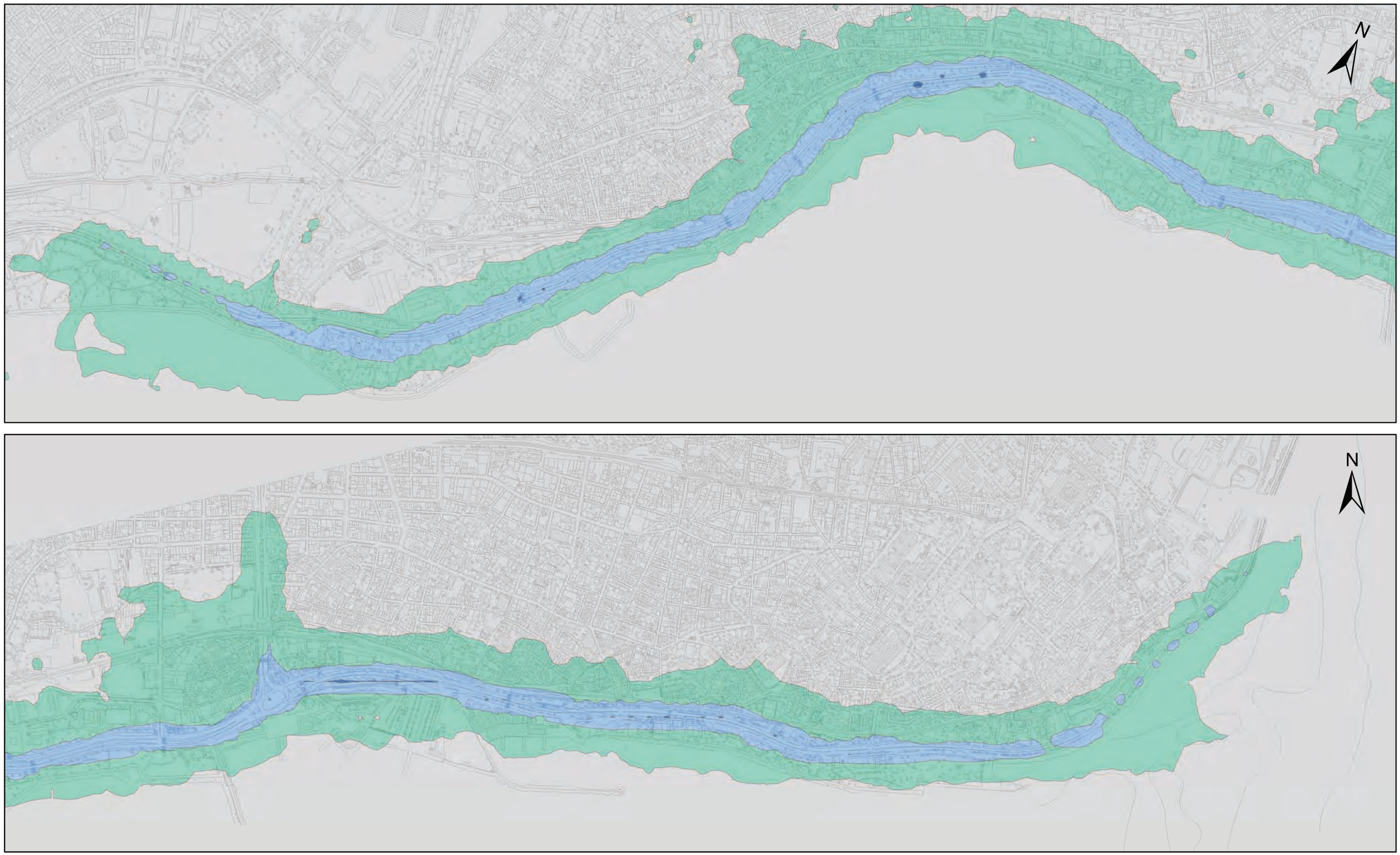
Annex K- 7 - NO2 1-hour concentration with 18 exceedings per year - 2023 without Project scenario; European side



Concentration in µg/m³

00 < 050	100 < 150	200 < 250	300 < 350	>= 400	
50 < 100	150 < 200	250 < 300	350 < 400		

0 0,25 0,5 km

1:10.000

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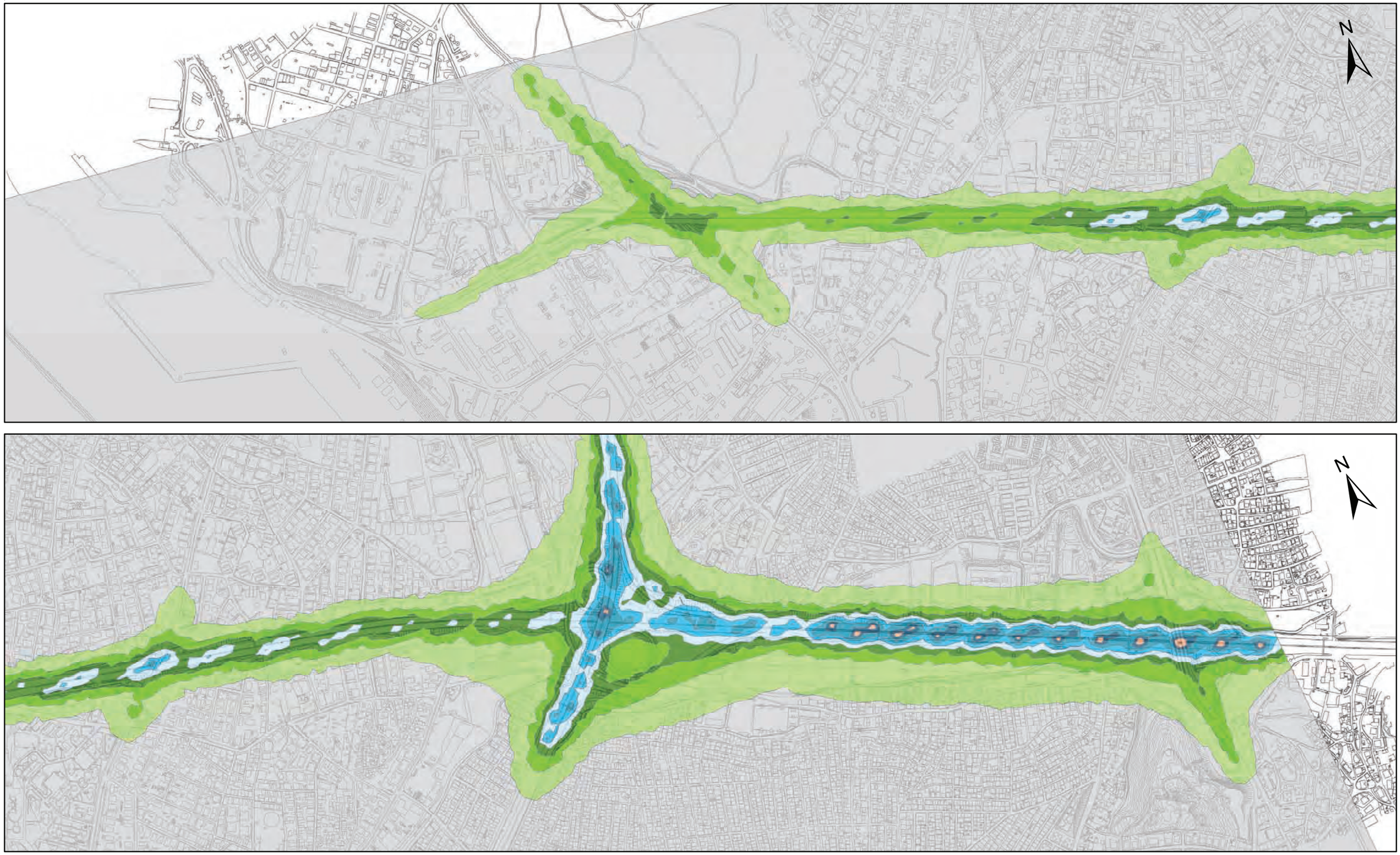
Annex K- 8 - Annual average of NO2 concentration - 2009 scenario; Asian side



Concentration in µg/m³

00 < 05	10 < 15	20 < 25	30 < 35	40 < 45
05 < 10	15 < 20	25 < 30	35 < 40	45 < 50

0 0,25 0,5 km

1:10.000

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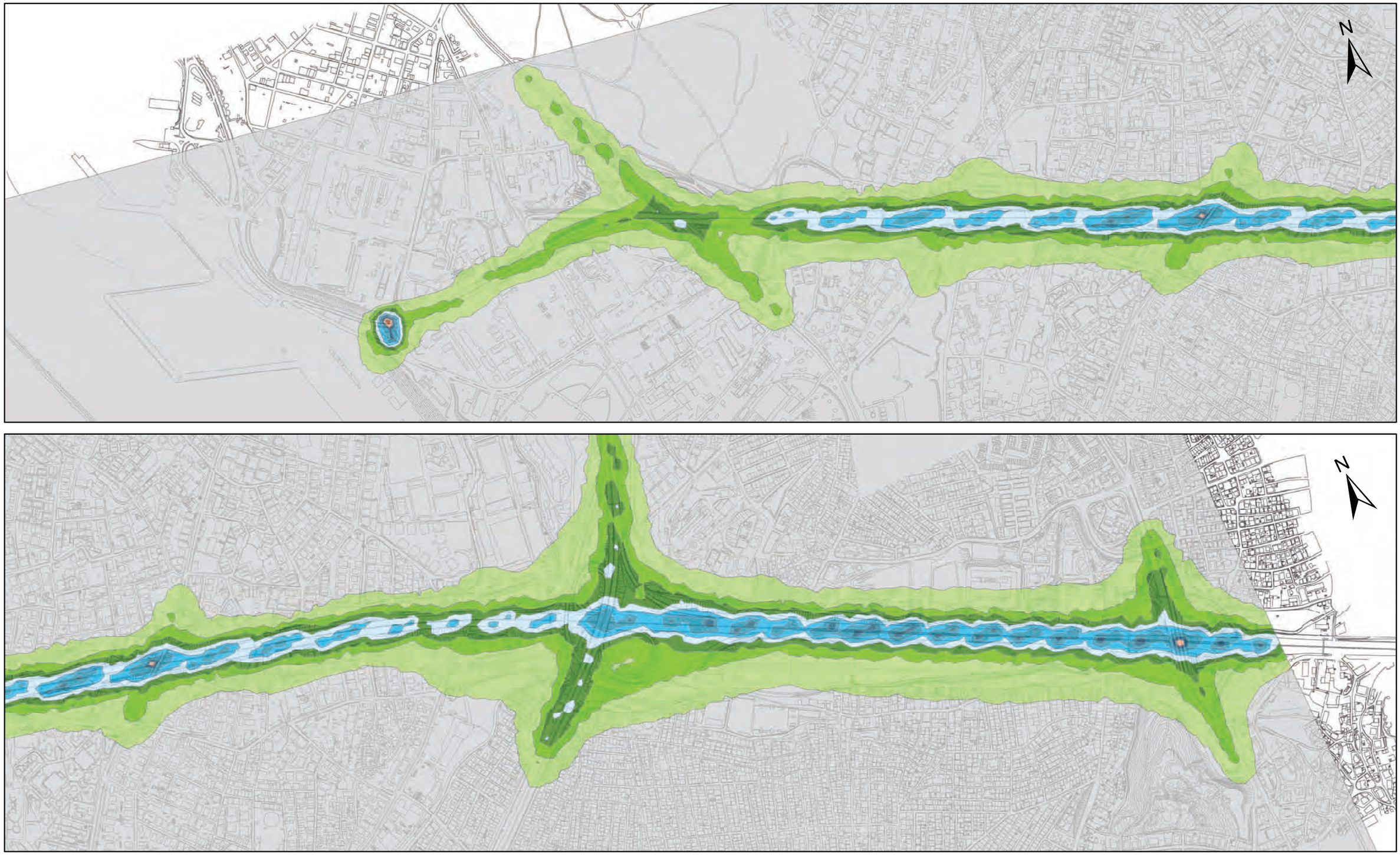
Annex K- 9 - Annual average of NO2 concentration - 2023-with Project scenario; Asian side



Concentration in µg/m³

00 < 05	10 < 15	20 < 25	30 < 35	40 < 45
05 < 10	15 < 20	25 < 30	35 < 40	45 < 50

0 0,25 0,5 km

1:10.000

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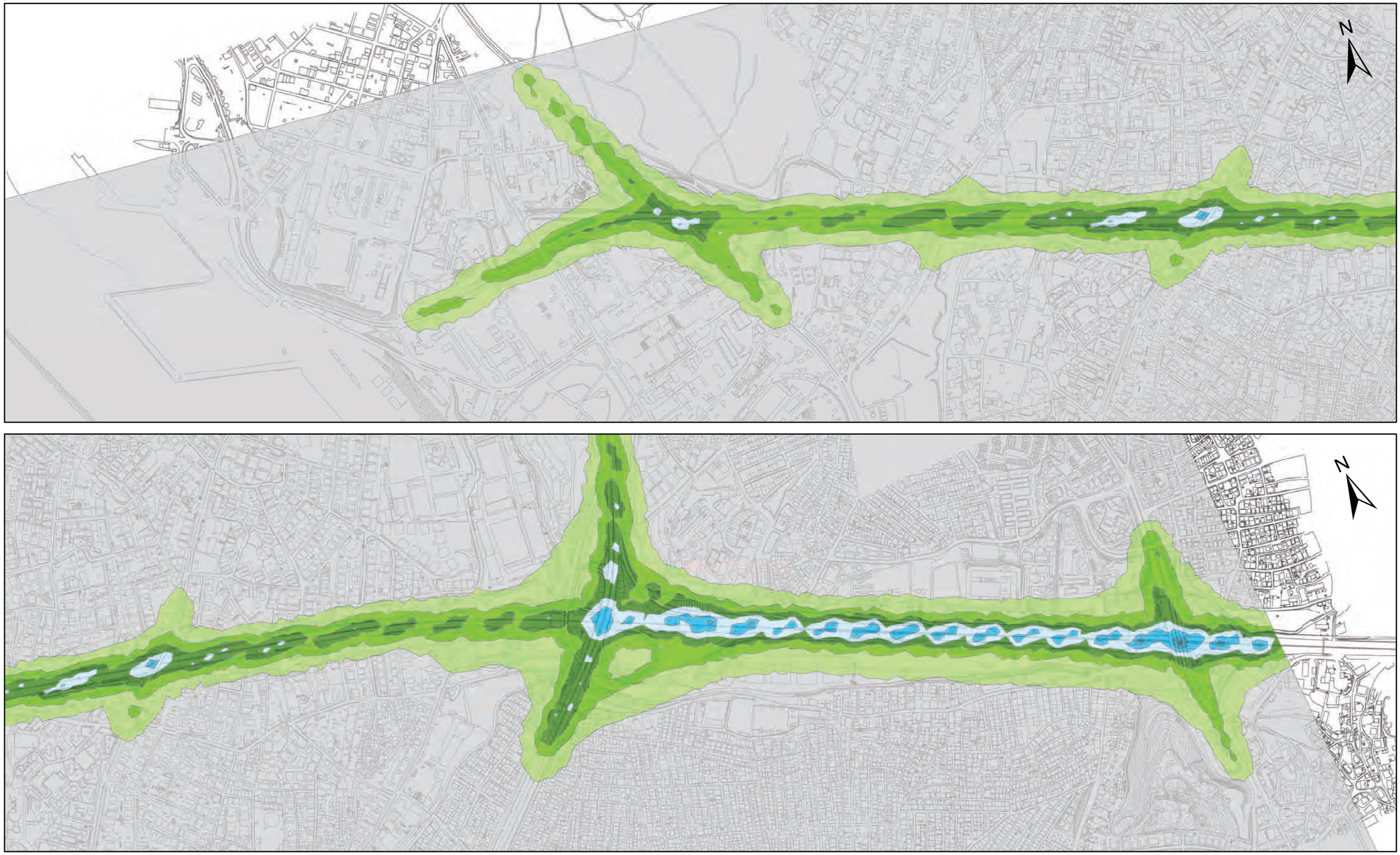
Annex K-10 - Annual average of NO2 concentration - 2023-without Project scenario; Asian side



Concentration in µg/m³

00 < 05	10 < 15	20 < 25	30 < 35	40 < 45
05 < 10	15 < 20	25 < 30	35 < 40	45 < 50

0 0,25 0,5 km

1:10.000

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Annex K- 11 - Annual average of NO2 concentration - Tunnel effect; difference of 2023-with minus 2023-without Project ; Asian side

Concentration in µg/m³

-5 < 00	05 < 10	15 < 20	25 < 30	35 < 40	45 < 50	
00 < 05	10 < 15	20 < 25	30 < 35	40 < 45		

0 0,25 0,5 km

1:10.000

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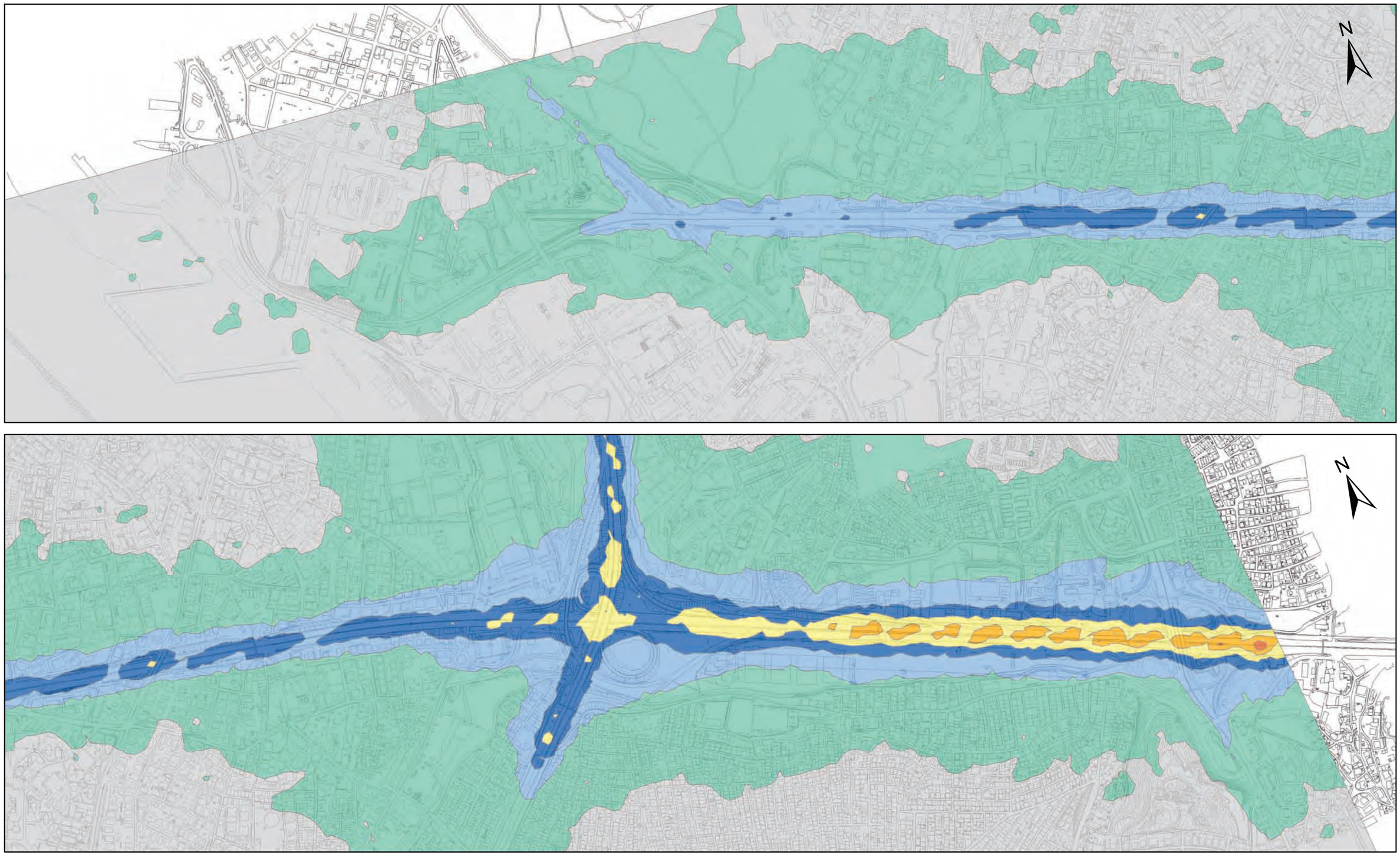
Annex K-12 - NO2 1-hour concentration with 18 exceedings per year - 2009 scenario; Asian side



Concentration in µg/m³

00 < 050 | 100 < 150 | 200 < 250 | 300 < 350 | >= 400
50 < 100 | 150 < 200 | 250 < 300 | 350 < 400

0 0,25 0,5 km

1:10.000

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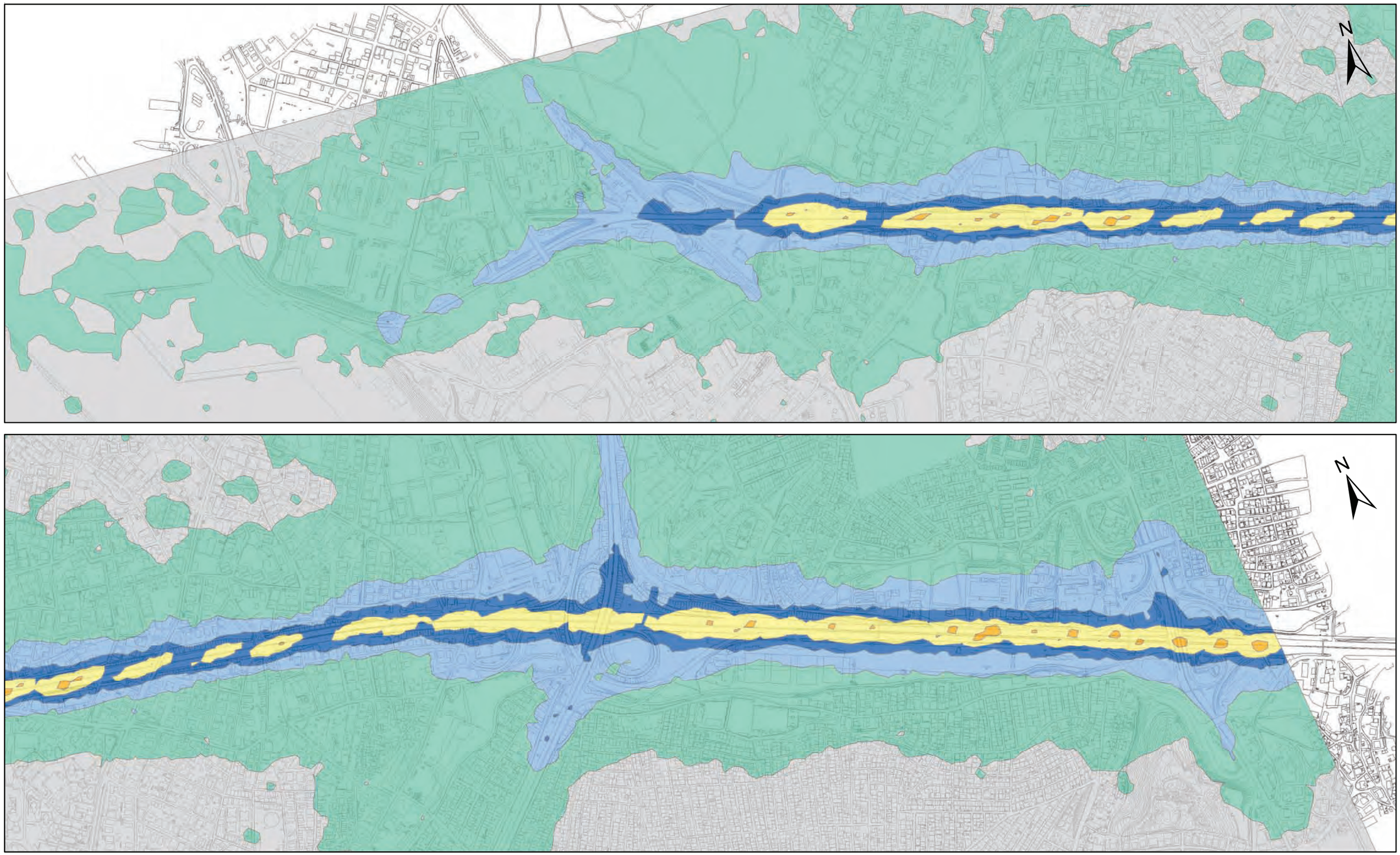
Annex K-13 - NO2 1-hour concentration with 18 exceedings per year - 2023 with Project scenario; Asian side



Concentration in µg/m³

00 < 050	100 < 150	200 < 250	300 < 350	>= 400	
50 < 100	150 < 200	250 < 300	350 < 400		

0 0,25 0,5 km

1:10.000

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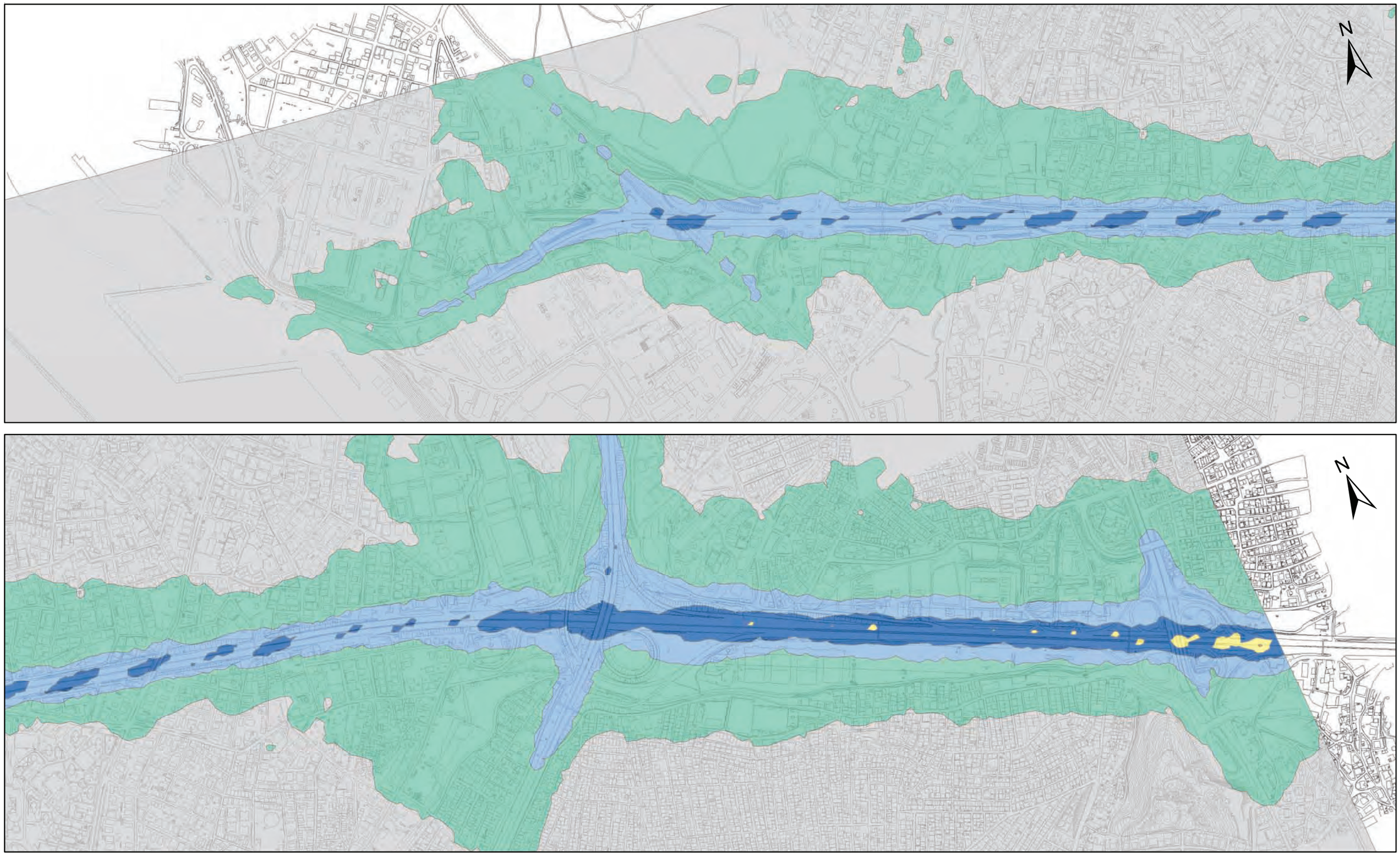
Annex K- 14 - NO2 1-hour concentration with 18 exceedings per year - 2023 without Project scenario; Asian side



Concentration in µg/m³

00 < 050	100 < 150	200 < 250	300 < 350	>= 400	
50 < 100	150 < 200	250 < 300	350 < 400		

0 0,25 0,5 km

1:10.000

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Annex L

Noise

CONTENTS

L1 INTRODUCTION

This Annex provides results of the environmental noise measurements and the sound propagation modelling performed for the Eurasia Tunnel ESIA.

The structure of the Annex is as follows:

1. Description and documentation of environmental noise measurements
2. Sound propagation modelling – methodology and used data
3. Results of sound propagation modelling

Sound is a change of air pressure affecting the ear. **Sound pressure levels** are measured in decibels (dB) which is the logarithm of the ratio of the actual air pressure over a reference air pressure. Human hearing perceives identical sound pressure levels of different frequencies with different strength. For the adaption to human hearing, it is therefore common to use a frequency weighted scale designed so that the level will match the subjectively perceived level. This is commonly done by implementing the so-called A-weighting scheme indicated by the unit **dB(A)**.

Due to the logarithmic nature of the scale the doubling of a source does not result in an impression of doubled loudness. This is reflected in findings of physiological studies where human perception was compared against decibel level increases:

$\leq$ 3 dB(A)	imperceptible increase
3 – 5 dB(A)	threshold of perceptibility, minor increase
6 - 9 dB(A)	moderate increase
$\geq$ 10 dB(A)	significant increase, representing a subjective doubling of loudness.

Since sound pressure levels often vary over time, they are commonly shown as the so-called **Equivalent Continuous Sound Pressure Level (L_{eq})** which is the energetic average over the observation time:

L_{eq} -parameter normally used for specification of noise standards

L_d -indicates L_{eq} for the related time period of the day time hours (e.g. 7:00 to 19:00)

L_e -indicates L_{eq} for the related time period of the evening hours (e.g. 19:00 to 21:00)

L_n -indicates L_{eq} for the related time period of the night time hours (e.g. 21:00 – 7:00)

In this assessment, all sound pressure levels L are provided as L_{eq} levels.

The strength of a source is given as **Sound Power Level L_w**.

L2 ENVIRONMENTAL NOISE MEASUREMENTS 2009

The Project corridor is situated in a densely urbanized area with many sources of noise, particularly traffic. At some places, noise will also be caused by activity in markets, playgrounds, sports areas and meeting places. In addition to, nature can contribute to the overall sounds and noise, for example through wind blowing or waves on the shore.

In order to obtain local data for the environmental noise situation, a baseline monitoring survey has bee n conducted. Spot sample measurements were taken at nine locations along the alignment and in its vicinity during November 2009. Nine single measurements on randomized dates and times were carried out at each location and included measurements during daytime, evening, and night time.

The sampling locations are shown in Figure 1and Figure 2. Details of the measurements are provided on the following pages which comprise measurement protocols with photography and brief description of the locations.

Figure 1 Noise Spot-Sampling Locations European side with Measured Noise Levels for Daytime (L_d) and Night time (L_n)

Figure 2 Noise Spot-Sampling Locations Asian side with Measured Noise Levels for Daytime (L_d) and Night time (L_n)

NOISE MEASUREMENT PROTOCOL

Project : EURASIA TUNNEL

Measurement Height : 1,5 mt. above groung with tripod
Manufacturer of sound meter : CASELLA
Type of sound meter : Type I
Serial Number of sound meter : 308197
Measuring Team : Ayse BERKAY
Murat UZUN
Hasan ACAR

General settings of the Sound Level Meter: : Wind shield was always used :
Sound pressure level : A-weighted (device has also Z and C weighted measuring authomatically)
Microphone Locations :
Pointing Direction :

	Measurement Run	Measurement Date	Measurement Time	Duration, minutes	Calibration Date	LAeq, dB(A)	LApk, dB(A)	Ambient Temperature, °C	Relative Humidity, %	Wind speed	Wind direction	Other meteorological information	Comments
Measuring Point#1 : Kumkapi Fish Market Corner													
low traffic	1	03.11.2009	14:11	10:05	03.11.2009	75.6	107.8	10.9	59	3	E	very light rain showers	Noise near traffic light and a fish market place
	2	18.11.2009	20:56	11:29	17.11.2009	76.5	98	11.9	72	2	NW	Mist	
	3	24.11.2009	22:43	10:28	20.11.2009	75.2	100.2	12.1	97	1	W	Mist	
high traffic	1	06.11.2009	10:05	10:06	06.11.2009	73	102.4	16.5	70	3	E		
	2	17.11.2009	10:04	11:48	17.11.2009	77.1	101.7	13	77	3	S	Mist	
	3	23.11.2009	09:31	10:17	20.11.2009	73.2	104.5	11.1	100	3	W	Mist	
night time	1	06.11.2009	00:21	06:06	06.11.2009	72.2	97.2	15.7	69	3	SW		
	2	20.11.2009	23:58	06:04	20.11.2009	75.4	98	12.8	98	3	W	Mist	
	3	26.11.2009	00:05	10:43	26.11.2009	74	103	7.8	100	2	N	Mist	
Nearby Noise Sources: Automobiles, train road, heavy populated birds (because of fish market) Reasons for noise peaks during recording: Main reason for the peaks are authomobiles. Microphone Locations: See photo point#6 Pointing Direction: See photo point#6													
Measuring Point#2: Kennedy Avenue-Proposed Project Toll Collection (before enterance to underground)													
low traffic	1	03.11.2009	15:29	10:04	03.11.2009	64.9	96.5	10.9	59	3	E		Noise near playground and public park
	2	18.11.2009	21:12	10:54	17.11.2009	67.8	97.4	11.9	72	2	NW	Mist	
	3	24.11.2009	22:57	10:10	20.11.2009	66.5	89.5	12.1	97	1	W	Mist	
high traffic	1	06.11.2009	10:19	10:11	06.11.2009	73.6	99.7	16.5	70	3	E		
	2	17.11.2009	10:22	11:02	17.11.2009	69.5	90.6	13	77	3	S	Mist	
	3	23.11.2009	09:47	11:36	20.11.2009	70.9	92.2	11.1	100	3	W	Mist	
night time	1	06.11.2009	00:31	05:33	06.11.2009	69.7	95.8	15.7	69	3	SW		
	2	21.11.2009	00:07	08:07	20.11.2009	67.7	89.4	10.5	95	2	W	Mist	
	3	26.11.2009	00:18	11:34	26.11.2009	66.9	97.7	7.8	100	2	N	Mist	
Nearby Noise Sources: Automobiles Reasons for noise peaks during recording: Main reason for the peaks are authomobiles. Microphone Locations: See photo point#8 Pointing Direction: See photo point#8													

	Measurement Run	Measurement Date	Measurement Time	Duration, minutes	Calibration Date	LAeq, dB(A)	LApk, dB(A)	Ambient Temperature, °C	Relative Humidity, %	Wind speed	Wind direction	Other meteorological information	Comments
Measuring Point #3: Kennedy Avenue-Public park near the ventilation shaft													
low traffic	1	03.11.2009	15:52	10:06	03.11.2009	64.6	89.8	10.9	59	3	E		Noise in public park
	2	18.11.2009	21:26	10:12	17.11.2009	59.2	102.2	11.9	72	2	NW Mist		
	3	24.11.2009	23:11	13:12	20.11.2009	66.5	90.9	12.1	97	1	W Mist		
high traffic	1	06.11.2009	10:32	10:18	06.11.2009	66.8	94.1	16.5	70	3	E		
	2	17.11.2009	10:37	10:13	17.11.2009	60	81.3	13	77	3	S Mist		
	3	23.11.2009	10:08	11:49	20.11.2009	62.1	85.2	11.1	100	3	W Mist		
night time	1	06.11.2009	00:40	05:27	06.11.2009	66.2	117.1	15.7	69	3	SW		
	2	21.11.2009	00:19	07:07	20.11.2009	65.2	90.7	10.5	95	2	W Mist		
	3	26.11.2009	00:33	10:27	26.11.2009	62.6	87.2	7.8	100	2	N Mist		
Nearby Noise Sources: Automobiles Reasons for noise peaks during recording: Main reason for the peaks are authomobiles. Microphone Locations: See photo point#10 Pointing Direction: See photo point#10													
Measuring Point #6: Topkapi Palace Entrance Square													
low traffic	1	03.11.2009	16:45	10:04	03.11.2009	58.3	95.2	10.9	59	3	E		Noise from Touristic area
	2	18.11.2009	21:44	11:00	17.11.2009	47.1	84.7	11.9	72	2	NW Mist		
	3	24.11.2009	22:00	10:32	20.11.2009	49.3	89	12.1	97	1	W Mist		
high traffic	1	06.11.2009	10:49	11:44	06.11.2009	56.8	89.7	16.5	70	3	E		
	2	17.11.2009	10:54	11:48	17.11.2009	53.9	102.7	13	77	3	S Mist		
	3	23.11.2009	10:26	10:31	20.11.2009	55.2	88.5	11.1	100	3	W Mist		
night time	1	05.11.2009	23:22	06:06	05.11.2009	53.5	98.8	14.7	79	4	S		
	2	21.11.2009	00:32	06:46	20.11.2009	48.1	77.4	10.5	95	2	W Mist		
	3	26.11.2009	00:49	10:03	26.11.2009	55	102.4	7.8	100	2	N Mist		
Nearby Noise Sources: Touris groups and automobiles. Reasons for noise peaks during recording: Main reason for the peaks are authomobiles. Microphone Locations: See photo point#24 Pointing Direction: See photo point#24													
Measuring Point #5: Park close to Sultan Ahmet Mosque													
low traffic	1	03.11.2009	16:17	10:14	03.11.2009	60.5	92.8	10.9	59	3	E		Noise from Touristic area
	2	18.11.2009	22:01	10:28	17.11.2009	55	84.4	11.9	72	2	NW Mist		
	3	24.11.2009	21:40	11:08	20.11.2009	63.9	99.9	12.1	97	1	W Mist		
high traffic	1	06.11.2009	11:13	10:03	06.11.2009	62.2	104	16.5	70	3	E		
	2	17.11.2009	11:14	10:51	17.11.2009	60.7	88.3	13	77	3	S Mist		
	3	23.11.2009	10:48	10:22	20.11.2009	61.2	94.5	11.1	100	3	W Mist		
night time	1	05.11.2009	23:38	07:28	05.11.2009	56.5	84.7	14.7	79	4	S		
	2	21.11.2009	00:46	09:01	20.11.2009	50.5	77.7	10.5	95	2	W Mist		
	3	26.11.2009	01:04	10:03	26.11.2009	57.9	94.7	7.8	100	2	N Mist		
Nearby Noise Sources: Touris groups and automobiles. Reasons for noise peaks during recording: Main reason for the peaks are authomobiles. Microphone Locations: See photo point#9 Pointing Direction: See photo point#9													
Measuring Point #4: Tiyatro Street-Princess Hotel and Mosque Corner													
low traffic	1	03.11.2009	14:43	10:03	03.11.2009	72.6	97.2	10.8	59	3	E		Heavy activity at every hour a day about traffic
	2	18.11.2009	22:23	10:43	17.11.2009	63.5	117.2	11.9	72	2	NW Mist		
	3	24.11.2009	22:23	10:16	20.11.2009	60.3	90.5	12.1	97	1	W Mist		
high traffic	1	06.11.2009	11:31	10:18	06.11.2009	77.2	107.7	16.5	70	3	E		
	2	17.11.2009	11:45	10:09	17.11.2009	67.2	102.3	13	77	3	S Mist		
	3	23.11.2009	11:20	10:06	20.11.2009	65	99.1	11.1	100	3	W Mist		
night time	1	05.11.2009	23:54	06:00	05.11.2009	67.4	100.8	14.7	79	4	S		
	2	21.11.2009	01:04	06:10	20.11.2009	57.2	87.2	10.5	95	2	W Mist		
	3	25.11.2009	23:45	10:19	20.11.2009	63.1	90.4	7.8	100	2	N Mist		
Nearby Noise Sources: Touris groups and automobiles. Reasons for noise peaks during recording: Main reason for the peaks are authomobiles and Hotel quest transfers. Microphone Locations: See photo point#7 Pointing Direction: See photo point#7													

	Measurement Run	Measurement Date	Measurement Time	Duration, minutes	Calibration Date	LAeq, dB(A)	LApk, dB(A)	Ambient Temperature, °C	Relative Humidity, %	Wind speed	Wind direction	Other meteorological information	Comments
Measuring Point #2: E5 Motorway near Haydarpaşa Numune Hospital													
low traffic	1	05.11.2009	12:05	10:04	05.11.2009	77.9	102.4	17.3	62	4	S		Active in every hour a day about traffic
	2	19.11.2009	20:48	11:29	17.11.2009	77.4	101.6	13.3	84	2	NW Mist		
	3	24.11.2009	20:16	10:14	20.11.2009	78.9	109.2	12.1	97	1	W Mist		
high traffic	1	05.11.2009	17:56	10:59	05.11.2009	78.3	106.2	17.3	62	4	S		
	2	20.11.2009	09:28	12:16	20.11.2009	79.7	102.9	12.2	98	4	W Mist		
	3	24.11.2009	09:38	10:48	20.11.2009	79.6	102.5	10.2	92	1	W Mist		
night time	1	06.11.2009	01:25	05:06	06.11.2009	70.4	102.6	15.7	69	3	SW		
	2	21.11.2009	01:38	06:17	20.11.2009	69.4	96.7	10.5	95	2	W Mist		
	3	26.11.2009	01:36	10:02	26.11.2009	73.2	106.7	7.8	100	2	N Mist		
Nearby Noise Sources: Automobiles Reasons for noise peaks during recording: Main reason for the peaks are authomobiles. Microphone Locations: See photo point#13 Pointing Direction: See photo point#13													
Measuring Point #1: Selimiye Military Base opposite corner													
low traffic	1	05.11.2009	12:29	10:02	05.11.2009	73.7	100.7	17.3	62	4	S		Active in every hour a day about traffic
	2	19.11.2009	21:06	11:15	17.11.2009	74.7	108.5	13.3	84	2	NW Mist		
	3	24.11.2009	20:32	10:25	20.11.2009	75.6	104.9	12.1	97	1	W Mist		
high traffic	1	05.11.2009	18:13	10:03	05.11.2009	72.8	107.8	17.3	62	4	S		
	2	20.11.2009	09:47	10:26	20.11.2009	76.1	108.8	12.2	98	3	W Mist		
	3	24.11.2009	09:57	10:35	20.11.2009	78.3	118	10.2	92	1	W Mist		
night time	1	06.11.2009	01:35	05:05	06.11.2009	58.9	101.8	15.7	69	3	SW		
	2	21.11.2009	01:50	08:45	20.11.2009	65.9	106.2	10.5	95	2	W Mist		
	3	26.11.2009	01:51	10:02	26.11.2009	67.5	104.3	7.8	100	2	N Mist		
Nearby Noise Sources: Automobiles Reasons for noise peaks during recording: Main reason for the peaks are authomobiles. Microphone Locations: See photo point#11 Pointing Direction: See photo point#11													
Measuring Point #3: E5 Motorway - Opposite Medipol Hospital													
low traffic	1	05.11.2009	12:46	10:10	05.11.2009	77.9	104.5	17.3	62	4	S		Heavy activity in every hour a day about traffic
	2	19.11.2009	21:28	10:05	17.11.2009	79.7	107.6	13.3	84	2	NW Mist		
	3	24.11.2009	20:48	10:11	20.11.2009	80.5	110.1	12.1	97	1	W Mist		
high traffic	1	05.11.2009	17:36	10:08	05.11.2009	76.8	103.9	17.3	62	4	S		
	2	20.11.2009	10:03	10:12	20.11.2009	80.3	101.4	12.2	98	3	W Mist		
	3	24.11.2009	10:12	12:06	20.11.2009	81.5	105.5	10.2	92	1	W Mist		
night time	1	06.11.2009	01:44	05:14	06.11.2009	73	115	15.7	69	3	SW		
	2	21.11.2009	02:03	06:09	20.11.2009	74	99.2	10.5	95	2	W Mist		
	3	26.11.2009	02:04	10:03	26.11.2009	73.5	99.3	7.8	100	2	N Mist		
Nearby Noise Sources: Automobiles Reasons for noise peaks during recording: Main reason for the peaks are authomobiles. Microphone Locations: See photo point#15 Pointing Direction: See photo point#15													

Measuring Point #1: Kumkapı Fish Market Corner

Distance between the microphone location and the Highway= 2 meters.

The point is at the west corner of Kumkapı Fish Market.

There is an entrance for cars to the market place with a subordinate road in order to make U-turn from the traffic lights.

Measuring Point #2: Kennedy Avenue-Proposed Project Toll Collection (before entrance to underground)

Distance between the microphone location and the Highway= 30 meters

The point is at the park site just close to the main project road.

ELC; 10-12-2009

Measuring Point #3: Kennedy Avenue-Public park near the ventilation shaft

Distance between the microphone location and the Highway= 20 meters.

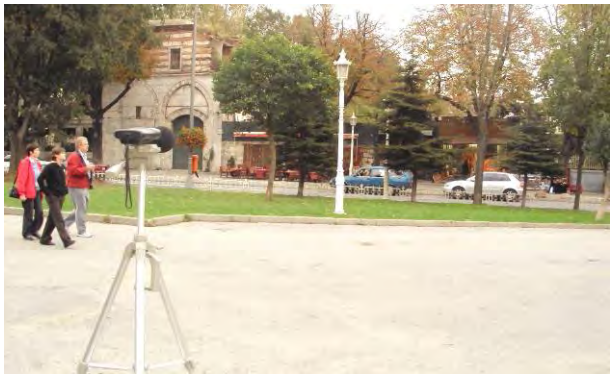
The point is at the park site just close to the main project road.

Measuring Point #4: Tiyatro Street-Princess Hotel and Mosque Corner

Distance between the microphone location and the local street = 0 meter (microphone is on the street). The point is approximately 500 meters far away from the main project road. Location has a Hotel, a Mosque and so many shops and heavy activity due to that details all the time. Distance between the microphone location and the Highway= 540 meters.

Measuring Point #5: Park close to Sultan Ahmet Mosque

Distance between the microphone location and the Highway= 370 meters.
Distance between the microphone location and the local street = 20 meters (microphone is in the park), The point is inside a park close to the Sultanahmet Mosque. People use this park to cross the area.´



Measuring Point #6: Topkapı Palace Entrance Square)

Distance between the microphone location and the Highway= 310 meters
Distance between the microphone location and the local street = 34 meters
The point is at the entrance of Topkapı Palace. Relatively, the location is a quiet area but touris groups are active in that place.

Measuring Point #11: Selimiye Military Base opposite corner

Distance between the microphone location and the Highway= 2 meters.
The point is just beside of the main D-100 highway. There are heavy traffic due to customs house, harbour and a main intercity bus station. Opposite side of the point is an army base. There are minibus station at the back side of the point and the connection road with the station. Location is active almost all the time.

Measuring Point #12: E5 Motor way near Haydarpaşa Numune Hospital

Distance between the microphone location and the Highway= 30 meters
The point is at the park site just close to the main project road.

Measuring Point #13: E5 Motor way - Opposite Medipol Hospital

Distance between the microphone location and the Highway= 0 meter (microphone is on the highway)The point is on the D-100 highway. Location has heavy traffic due to the connection to customs house, harbour and main intercity bus station.

ELC; 10-12-2009

L3 SOUND PROPAGATION MODELLING – METHODOLOGY AND USED DATA

The noise modelling is based on the following approach:

- information on traffic flows with and without the Project has been obtained from the transport studies undertaken by Jacobs and these have been used to estimate the level of sound emissions;
- computer models have been used to calculate the noise exposure in the vicinity of the Project scheme.

Three scenarios have been modelled:

- "2009": Current situation
- "2023 with-Project": Year 2023 with implementation of the Project
- "2023 without-Project": Year 2023 without the Project being implemented (but including other committed changes in the transport system).

3.1 COMPUTATION METHOD

The noise modelling has been carried out using standard software SoundPLAN (Version 7). The calculations were carried out using the French national "NMPB-Routes-96" computation method which is recommended by the European Commission for the assessment of environmental noise as stipulated in Directive 2000/49/EC (relating to the assessment and management of environmental noise). On August 6, 2003 as additional guidance the European Commission has published a Recommendation for the computation of noise (2003/613/EC).

Noise emissions used for the NMPB-model are based on the 'Guide du bruit des transports terrestres, fascicule prévision des niveaux sonores, CETUR 1980'.

Directive 2002/49/EC requires calculation of equivalent noise levels L for day time, evening and night time as long-term noise levels according to ISO 1996-2:1987. They are determined over all day, evening and night periods of a year. The method considers the following parameters:

- Vehicle types: "light vehicles" and "heavy vehicles"
- Average vehicle speed

- Number of vehicles as Annual Average Daily Traffic (AADT) for the three reference periods: day time, evening ours, night time
- Traffic flow type in order to account for pulsated or continuous traffic motion
- Gradient of the road
- Road surface where "smooth asphalt, concrete or mastic" is the reference surface
- Ground effect in order to consider reflecting ground (e.g. paved area, densely built-up areas) or absorbent ground (e.g. grassland, park, garden, woodland)
- Reflections on vertical obstacles

The noise contours obtained with the modelling and presented in the ESIA refer to a receptor height of 2 m unless otherwise stated. The noise modelling area covered a strip of about 400 m to both sides of the scheme.

3.2 TRAFFIC DATA

The sound emission of vehicles depends on a variety of factors. Sound emissions of a single vehicle may depend on but are not limited to:

- Type of vehicle
- Number and type of tyres
- Actual speed of the vehicle
- Air drag of the vehicle

Sound emissions of the total traffic flow depend on e.g.:

- Traffic flow (number of vehicles per hour or day)
- Traffic flow characteristics on a specific road section (average speed, free flow, or traffic jam)
- Composition of vehicle types (abundance of trucks)
- Road characteristics (e.g. type of surface, gradient)

For the modelling, the project scheme was separated into sections between connecting roads where the traffic flow figures change. Joining sections of connecting roads have been included in order to provide an impression of the situation on these roads.

Traffic flow for the three averaging periods (day, evening, night) was calculated from the figures provided by Jacobs. The parameters provided for each traffic flow direction were as follows:

- traffic flow of the average weekday inter-peak hour (IP-hour)
- traffic flow of the average weekday A.M. peak hour (AMP-hour, morning peak)
- average annual daily traffic (AADT)

According to Jacobs the AADT forecasts were calculated from the IP- and AMP-hours with the following factors:

AADT = 0.971 x (8 x IP-hour + 5.22 x IP-hour + 5.062 x AMP-hour)

- with 0.971 as the ratio of the annual average day traffic (AADT) over the annual average weekday traffic (AAWT)
- with 8 to include the IP-hours between 9:30 and 17:30
- with 5.22 for the night-time off-peak period from 20:00 to 07:00 (meaning 0.4745 per night-time off-peak hour)
- with 5.062 for the 2.5 AMP-hours in the morning (7:00 - 9:30) and for 2.5 afternoon peak hours (PMP; 17:30 – 20:00)

Based on the data sets for each section and the three noise modelling scenarios as provided by Jacobs, the average day time, evening hours, and night time traffic flows for the modelling were calculated as follows:

- Day time hours from 7:00 to 19:00:

Average day time hour traffic flow = (2.5×AMP + 8×IP + 1.5×PMP) / 12

- Evening hours from 19:00 to 23:00:

Average evening hour traffic flow = (1×PMP + 3×0.4745×IP) / 4

- Night time hours from 23:00 to 7:00:

Average night time hour traffic flow = 8×0.4745×IP / 8

When looking at the directional traffic flow, the morning peak traffic (AMP) in downtown direction (inbound) is higher than for the outbound direction, whereas during the afternoon peak traffic the outbound traffic is higher. In order to account for this, the inbound afternoon peak (PMP; which was not

determined by Jacobs as absolute figures) was assumed to equal the morning outbound (AMP) traffic flow. This approach is considered reasonable since the majority of morning traffic will return in the afternoon.

According to the NMPB computation method, for each road section and traffic flow direction, the number of vehicles was considered separated for "light vehicles" (passenger cars, mini busses, mini trucks) and "heavy vehicles" (heavy duty vehicles, busses, big trucks). The driving speed on the major roads was set to 80 km/h for passenger cars and trucks; for slip lanes, U-turns, and secondary roads the speed was set to 50 km/h. Traffic flow type was considered continuous at the main lanes, whereas traffic on slip lanes, U-turns, and secondary roads were considered to be pulsated due to acceleration and deceleration. The gradient of the road is considered automatically by the model based on the terrain. Terrain data were obtained from the Istanbul Municipality which also included the buildings located along the scheme and within distances of about 400 m to 800 m.

The modelling has been based on a number of assumptions:

- Actual traffic flows in the future may differ from the predicted, but the figures used are the best available.
- Changes in the road network elsewhere in the city and traffic management measures may lead to a different pattern of traffic movements than that assumed for the study. The traffic forecasts do take into account changes in the transport system which are already planned, for example the effects of the Metro tunnel and privatisation of the bridges.
- Noise emission levels from vehicles and tyres are assumed to remain the same as today.
- The road surfaces described for the Project are assumed to correspond with the NMPB standard road surface ('smooth asphalt, concrete or mastic').

The assumption relating to vehicle and road surface characteristics is considered to provide a conservative assessment of the impact from individual vehicles.

For the future composition of the vehicle fleet no significant changes of sound emission characteristics was assumed. Future design of vehicles and tyres are likely to reduce sound emissions from individual vehicles but these effects have not been taken into account as their effects on sound generation can not

be predicted at present. The forecasts of future vehicle noise pressure levels are therefore likely to be conservative.

3.3 SOUND EMISSIONS OF THE TUNNEL SECTION INCLUDING THE VENTILATION SHAFTS

The tunnel itself is no source of sound emissions since the sound generated inside a tunnel is absorbed by the tunnel walls and air turbulences inside the tunnel. Furthermore, the tunnel walls enclose the noise source completely so that no sound will be perceivable outside the tunnel walls. However, sound will be emitted from the tunnel portals where these damping effects cease. Therefore, the emissions from the portals are considered in the model. The emissions, however, have no strong contribution to the noise of the road traffic itself due to the location of the portals below ground and the shielding effect of the road cut walls.

The ventilation shafts are included in the modelling as point sources. They are equipped with a ventilation system comprising three exhaust fans with a combined sound power level of about 131 dB(A) [1]. In order to abate sound pressure levels from these outside the vent shaft structure, sound attenuation equipment will be installed inside the shaft providing a reduction by 42 dB(A). Due to this sound attenuation, the noise pressure level at a distance of 10 m from the shaft at ground level will be below 53 dB(A).

(1) [1] Sound power level is the parameter to describe the strength of a sound source, whereas a sound pressure level describes the impact on a receptor. Environmental noise is expressed as sound pressure level.

L4 SOUND PROPAGATION MODELLING

4.1 RESULTS

Based on the traffic flow figures for the three scenarios, noise levels along the alignment were predicted for the daytime, evening, and night time. The adjacent sections of major connecting roads are also included to allow assessment of future potential changes on the wider network in consequence of the Project.

For the operation of the tunnel an average daily traffic flow of 130,000 vehicles was taken which represents the maximum design flow in the tunnel. Heavy vehicle traffic through the tunnel will not be permitted.

The results of the modelling are provided in the figures attached to this Annex. Figures 1 through 8 show the noise contour plots for the European side and figures 9 through 16 for the Asian side:

Figure No		Scenario	Content
Europe	Asia		
1	9	2009 - current scenario	Noise contours - daytime
2	10	ditto	Noise contours – night time
3	11	2023 with Project	Noise contours - daytime
4	12	ditto	Noise contours – night time
5	13	2023 without Project	Noise contours - daytime
6	14	ditto	Noise contours – night time
7	15	Difference plot 2023	Noise contours - daytime
8	16	ditto	Noise contours – night time

Since traffic flows will increase not only through operation of the tunnel but also due to general increase of traffic over time, the ESIA refers to the future situation without tunnel as the baseline for defining the impacts of the Project. In order to show this effect, Figures 8, 9, and 15, 16 show dB(A) difference plots calculated from the dB(A) levels of the 2023 scenario "with Project" minus the scenario "without Project". In this context it has to be stressed that

differences in the dB-scale require special interpretation since a dezibel difference is independent from the absolute level and thus does not stand for an impact. Dezibel differences need always to be discussed with reference to the absolute level at the respective location.

As a general guidance regarding the scaling and colours used in the noise contour plots the following is stated:

- Noise contour scales are provided in steps of 3dB(A)
    - Green colour indicates that none of the Turkish noise limits is exceeded
    - Light yellow colour indicates that the Turkish noise limit for sensitive receptors (e.g. school, hospital) is exceeded (65 dB(A) at daytime and 55 dB(A) at night time[2])
    - Yellow colour indicates that the Turkish noise limit for areas of mostly residential use is exceeded (68 dB(A) at daytime and 58 dB(A) at night time)
    - Reddish colours indicate exceedance of Turkish noise limits for commercial areas
- Difference plots show scales in steps of 1 dB(A)
    - Green colour indicates an unchanged or reduced noise level
    - Blue colours indicate an increase between 0 dB(A) and 3 dB(A), the latter being the threshold of perceptibility
    - White-yellow-red colours indicate higher increments

In general the contour plots show that the standards are only exceeded close to the Project scheme. The propagation of sound into the built-up areas is limited by sound shielding effects from buildings in the first rows. For the first row of buildings the noise standard can be exceeded if situated close to the scheme, whereas the level at the second row of buildings meets the standard unless there is open space between the first row buildings enabling the sound wave to propagate through.

The effect of the ventilation shafts is only minor due to the installed sound attenuation for the fans. At a distance of 10 m from the shaft at the ground level of noise pressure will be below 53 dB(A). This will be a minor

(2) [2] According to the type of project, the Turkish noise limits for upgrading of existing roads apply.

contribution to environmental noise since it will be masked by the traffic noise of the roads which ranges between 56 and 62 dB(A).

4.2 *MODELLING LIMITATIONS AND ACCURACY*

The calculated modelling results directly depend on the input data. The actual traffic forecast figures in the future may differ from the predicted, but the figures used for the modelling are the best available. The transformation from IP and AMP data sets into day, evening and night time periods made some assumptions necessary. This resulted in uncertainties for the directional traffic flow figures in the range of 10% to 15%. The bidirectional figures, however, showed deviations below 0.5%. Also for connecting roads with low traffic flow, the uncertainty was about 10%. Such uncertainties could cause deviations below 0.5 dB(A) which only would have minor effect on the results.

Other reasons for potential uncertainties that can not be quantified are:

- Actual topography and existing buildings may differ from the available terrain and building data which could cause inaccurate noise levels on the local scale. Future buildings could not be considered.
- The actual levels of the final road may differ from the current design which can cause higher noise levels in case of elevated alignment, or lower levels in case of a cut.

In conclusion, the uncertainties can be considered to being limited to a level not being relevant for the interpretation of the modelling results.

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Annex M

Biodiversity and Nature Conversation

Table M-1: Fauna Species observed during Field Visit on the European Side

Scientific Name	English Name	Status	IUCN	Bern
GASTROPODA				
Order: NEOTAENIOGLASSA				
Familia: Pomatiidae				
Pomatias elegans	Round-mouthed snail	Native	-	-
Order: STYLOMMATOPHORA				
Familia: Pleurodiscidae				
Pleurodiscus balmei	-	Native	-	-
Familia: Helicidae				
Cornu aspersum	Garden snail	Native	-	-
INSECTA				
Order: LEPIDOPTERA				
Familia: Pieridae				
Colias crocea	Dark Clouded Yellow	Native	-	-
Pieris brassicae	Large White	Native	-	-
Pieris rapae	Small White	Native	-	-
Familia: Lycaenidae				
Lycaena phlaeas	Small Copper	Native	-	-
Familia: Nymphalidae				
Vanessa atalanta	Red Admiral	Native	-	-
Familia: Sphingidae				
Macroglossum stellatarum	Hummingbird Hawk-moth	Native	-	-
Order: HYMENOPTERA				
Familia: Apidae				
Apis mellifera	European honey bee	Native	-	-
Familia: Formicidae				
Tetramorium caespitum	Pavement ant	Native	-	-
Pheidole pallidula	-	Native	-	-

Scientific Name	English Name	Status	IUCN	Bern
REPTILA				
Order: TESTUDINATA				
Familia: Lacertidae				
Lacerta viridis	European green lizard	Native	LC	Appx II
Podarcis muralis	Wall Lizard	Native	LC	Appx II
AVES				
Order: PODICIPEDIFORMES				
Familia: Podicipedidae				
Tachybaptus ruficollis	Little Grebe	Resident	LC	Appx II
Order: PELECANIFORMES				
Familia: Phalacrocoracidae				
Phalacrocorax carbo	Great Cormorant	Resident	LC	Appx II
Order: ANSERIFORMES				
Familia: Anatidae				
Anas platyrhynchos	Mallard	Winter visitor, Resident	LC	-
Order: FALCONIFORMES				
Familia: Falconidae				
Falco tinnunculus	Common Kestrel	Resident	LC	Appx II
Order: GRUIFORMES				
Familia: Rallidae				
Fulica atra	Common Coot	Resident	LC	-
Order: CHARADRIIFORMES				
Familia: Laridae				
Larus melanocephalus	Mediterranean Gull	Winter Visitor	LC	Appx II
Larus ridibundus	Common Black-headed Gull	Resident	LC	Appx II
Larus cachinnans	Yellow-legged Gull	Resident	LC	Appx III
Order: COLUMBIFORMES				
Familia: Columbidae				
Columba livia	Rock Pigeon (Dove)	Resident	LC	-

Scientific Name	English Name	Status	IUCN	Bern
Streptopelia decaocto	Eurasian Collared Dove	Resident	LC	-
Streptopelia turtur	Turtle Dove	Sommer Migrant	LC	-
Streptopelia senegalensis	Laughing Dove	Resident	LC	Appx II
Order: PASSERIFORMES				
Familia: Motacillidae				
Motacilla cinerea	Grey Wagtail	Passage Migrant	LC	
Motacilla alba	White (Pied) Wagtail	Passage Migrant	LC	Appx II
Familia: Troglodytidae				
Troglodytes troglodytes	Winter Wren	Resident	LC	-
Familia: Turdidae				
Erithacus rubecula	European Robin	Resident	LC	-
Phoenicurus ochruros	Black Redstart	Sommer Migrant	LC	-
Phoenicurus phoenicurus	Common Redstart	Sommer Migrant	LC	-
Familia: Sylviidae				
Phylloscopus collybita	Common Chiffchaff	Passage Migrant, Sommer Migrant	LC	Appx II
Phylloscopus trochilus	Willow Warbler	Passage Migrant	LC	Appx II
Familia: Paridae				
Parus lugubris	Sombre Tit	Vagrant	LC	
Parus caeruleus	Blue Tit	Resident	LC	Appx II
Parus major	Great Tit	Resident	LC	Appx II
Familia: Corvidae				
Corvus monedula	Eurasian Jackdaw	Resident	LC	Appx III
Corvus frugilegus	Rook	Winter Visitor	LC	Appx III
Corvus corone	Hooded Crow	Resident	LC	Appx III
Familia: Sturnidae				
Sturnus vulgaris	Common Starling	Resident	LC	Appx III

Scientific Name	English Name	Status	IUCN	Bern
Familia: Passeridae				
Passer domesticus	House Sparrow	Resident	LC	Appx III
Familia: Fringillidae				
Fringilla coelebs	Chaffinch	Resident	LC	Appx III
Carduelis chloris	European Greenfinch	Resident	LC	Appx II
Carduelis carduelis	European Goldfinch	Resident	LC	Appx II
Carduelis spinus	Eurasian Siskin	Resident	LC	Appx II
MAMMALIA				
Order: CHIROPTERA				
Familia: Rhinolophidae				
Rhinolophus hipposideros	Lesser horseshoe bat	Native	LC	-
Familia: Vespertilionidae				
Pipistrellus pipistrellus	Common Pipistrelle	Native	LC	-
Order: RODENTIA				
Familia: Muridae				
Rattus rattus	House Rat	Introduced	LC	-
Mus musculus	House Mouse	Native	LC	-
Order: CARNIVORA				
Familia: Mustelidae				
Martes martes	European Pine Marten	Native	LC	Appx III
Familia: Canidea				
Canis familiaris	Domestic Dog	Native	-	-
Familia: Felidae				
Felis catus	Domestic Cat	Native	-	-

Table ML-2: Fauna Species observed during Field Visit on the Asian Side

Scientific Name	English Name	Status	IUCN	Bern	Habitat Type
GASTROPODA					
Order: STYLOMMATOPHORA					
Familia: Hygromiidae					
Helicella itala	Western Health Snail	Native	-	-	• Amenity grassland and ornamental planting
Order: SIGMURETHRA					
Familia: Helicidae					
Helix pomatia	Roman Snail,	Native	-	-	• Amenity grassland and ornamental planting
INSECTA					
Order: LEPIDOPTERA					
Familia: Pieridae					
Colias crocea	Dark Clouded Yellow	Native	-	-	• Other grassland and scrub
Pieris brassicae	Large White	Native	-	-	• Other grassland and scrub
Familia: Nymphalidae					
Vanessa atalanta	Red Admiral	Native	-	-	• Other grassland and scrub
Familia: Sphingidae					
Macroglossum stellatarum	Hummingbird Hawk-moth	Native	-	-	
Order: HYMENOPTERA					
Familia: Apidae					
Apis mellifera	European honey bee	Native	-	-	• Amenity grassland and ornamental planting; • other planted grassland and landscaped planting; • other grassland and scrub; • other

Scientific Name	English Name	Status	IUCN	Bern	Habitat Type
Familia: Vespidae					
Vespa crabro	European hornet	Native	-	-	• Amenity grassland and ornamental planting; • other planted grassland and landscaped planting; • other grassland and scrub; • other
Familia: Formicidae					
Iridomyrmex purpureus	Meat ant	Native	-	-	• Amenity grassland and ornamental planting; • other planted grassland and landscaped planting; • other grassland and scrub; • other
REPTILA					
Order: TESTUDINATA					
Familia: Lacertidae					
Lacerta viridis	European green lizard	Native	LC	Appx II	• Amenity grassland and ornamental planting; • other planted grassland and landscaped planting; • other
AVES					
Order: PELECANIFORMES					
Familia: Phalacrocoracidae					
Phalacrocorax carbo	Great Cormorant	Resident	LC	-	
Order: ACCIPITRIFORMES					
Familia: Accipitridae					
Accipiter nisus	Eurasian Sparrowhawk	Passage Migrant, Resident	LC	Appx II	
Order: GRUIFORMES					
Familia: Rallidae					
Fulica atra	Common Coot	Resident	LC	-	

Scientific Name	English Name	Status	IUCN	Bern	Habitat Type
Order: CHARADRIIFORMES					
Familia: Laridae					
Larus melanocephalus	Mediterranean Gull	Winter Visitor	LC	Appx II	
Larus minutus	Little Gull	Winter Visitor	LC	Appx II	
Larus ridibundus	Common Black-headed Gull	Resident	LC	Appx II	
Larus cachinnans	Yellow-legged Gull	Resident	LC	Appx III	
Order: COLUMBIFORMES					
Familia: Columbidae					
Columba livia	Rock Pigeon (Dove)	Resident	LC	-	• Amenity grassland and ornamental planting; • other planted grassland and landscaped planting; • other grassland and scrub; • other
Streptopelia senegalensis	Laughing Dove	Resident	LC	Appx II	• Amenity grassland and ornamental planting; • other planted grassland and landscaped planting; • other grassland and scrub; • other
Order: PICIFORMES					
Familia: Picidae					
Dendrocopos syriacus	Syrian Woodpecker	Resident	LC	Appx II	• other
Order: PASSERIFORMES					
Familia: Motacillidae					
Motacilla alba	White (Pied) Wagtail	Passage Migrant	LC	Appx II	• Amenity grassland and ornamental planting; • other planted grassland and landscaped planting

Scientific Name	English Name	Status	IUCN	Bern	Habitat Type
Familia: Sylviidae					
Phylloscopus collybita	Common Chiffchaff	Passage Migrant, Sommer Migrant	LC	Appx II	• Amenity grassland and ornamental planting
Familia: Paridae					
Parus caeruleus	Blue Tit	Resident	LC	Appx II	• Amenity grassland and ornamental planting
Parus major	Great Tit	Resident	LC	Appx II	• Amenity grassland and ornamental planting
Familia: Corvidae					
Corvus monedula	Eurasian Jackdaw	Resident	LC	Appx III	• Amenity grassland and ornamental planting; • other
Corvus frugilegus	Rook	Winter Visitor	LC	Appx III	• Amenity grassland and ornamental planting; • other
Corvus corone	Hooded Crow	Resident	LC	Appx III	• Amenity grassland and ornamental planting; • other
Familia: Sturnidae					
Sturnus vulgaris	Common Starling	Resident	LC	Appx III	• Amenity grassland and ornamental planting; • other planted grassland and landscaped planting; • other grassland and scrub; • other
Familia: Passeridae					
Passer domesticus	House Sparrow	Resident	LC	Appx III	• Amenity grassland and ornamental planting; • other planted grassland and landscaped planting; • other grassland and scrub; • other
Familia: Fringillidae					
Fringilla coelebs	Chaffinch	Resident	LC	Appx III	• other

Scientific Name	English Name	Status	IUCN	Bern	Habitat Type
MAMMALIA					
Order: CHIROPTERA					
Familia: Vespertilionidae					
Pipistrellus pipistrellus	Common Pipistrelle	Native	LC	-	• Amenity grassland and ornamental planting; • other
Order: RODENTIA					
Familia: Sciuridae					
Sciurus anomalus	Caucasian Squirrel	Native	LC	Appx II	• other
Familia: Muridae					
Rattus rattus	House Rat	Introduced	LC	-	• Running water; • other
Mus musculus	House Mouse	Native	LC	-	• Running water
Order: CARNIVORA					
Familia: Canidea					
Canis familiaris	Domestic Dog	Native	-	-	• Amenity grassland and ornamental planting; • other planted grassland and landscaped planting; • other
Familia: Felidae					
Felis catus	Domestic Cat	Native	-	-	• Amenity grassland and ornamental planting; • other grassland and scrub; • other

Table M-3: Fauna Species according to literature review on the Asian Side

Scientific Name	English Name	Status	IUCN	Bern
INSECT				
Order: ORHOPTERA				
Familya: Gryllotalpidae				
Gryllotalpa gryllotalpa	European mole cricket	Native	-	-
Order: COLEOPTERA				
Familya: Chrysomelidae				
Agelistica alni	Alder leaf beetle	Native	-	-
Chrysomela populi	Red Poplar Leaf Beetle	Native	-	-
Crepidodera aurata	Willow Flea Beetle	Native	-	-
Familya: Cerambycidae				
Cerambyx cerdo	Great Capricorn Beetle	Native	VU	-
Familya: Lucanidae				
Dorcus parallelipipedus	Lesser stag beetle	Native	-	-
Familya: Scarabaeidae				
Melolontha melolontha	Cockchafer	Native	-	-
Polyphylla fullo	June beetle	Native	-	-
Order: LEPIDOPTERA				
Familya: Tortricidae				
Archips xylosteana	Variegated Golden Tortrix	Native	-	-
Tortrix viridana	European oak leaf roller	Native	-	-
Familya: Geometridae				
Deuteronomos quercaria	-	Native	-	-
Erannis defoliaria	Mottled Umber	Native	-	-
Familya: Noctuidae				
Agrotis ipsilon	Dark Sword-grass	Native	-	-
Autographa gamma	Silver Y	Native	-	-
Catocala conversa	-	Native	-	-
Catocala elocata	French Red Underwing	Native	-	-
Noctua comes	Lesser Yellow Underwing	Native	-	-

Scientific Name	English Name	Status	IUCN	Bern
Noctua pronuba	Large Yellow Underwing	Native	-	-
Familya: Lymantridae				
Euproctis chrysorrhoea	Brown-tail	Native	-	-
Lymantria dispar	Gypsy moth	Native	-	-
Familia: Papilionidae				
Iphiclides podalirius	Scarce Swallowtail	Native	-	-
Papilio machaon	Old World Swallowtail	Native	-	-
Familya: Pieridae				
Aporia crataegi	Black-veined White	Native	-	-
Pieris rapae	Small White	Native	-	-
Pontia edusa	Eastern Bath White	Native	-	-
Familia: Lycaenidae				
Lycaena phlaeas	Small Copper	Native	-	-
Lampides boeticus	Peablue or Long-tailed Blue	Native	-	-
Leptotes pirithous	Lang's short tailed Blue	Native	-	-
Celastrina argiolus	Holly Blue	Native	-	-
Plebeius argus	Silver-studded Blue	Native	-	-
Polyommatus icarus	Common Blue	Native	-	-
Familya: Nymphalidae				
Vanessa cardui	Painted Lady	Native	-	-
Vanessa polychloros	Great tortoise-shell	Native	-	-
Polygonia egea	Southern Comma	Native	-	-
Argynnis pandora	Cardinal	Native	-	-
Maniola jurtina	Meadow Brown	Native	-	-
Tyhmelicus sylvestris	Small skipper	Native	-	-
Order: HYMENOPTERA				
Familya: Cynipidae				
Andricus kollari	Oak marble galls	Native	-	-
AMPHIBIANS				
Order: ANURA				
Familia: Bufonidae				

Scientific Name	English Name	Status	IUCN	Bern
Bufo bufo	Common Toad	Native	LC	-
Bufo viridis	European Green Toad	Native	LC	Appx II
Familia: Ranidae				
Rana ridibunda	Marsh Frog	Native	LC	-
REPTILIAN				
Order: TESTUDINATA				
Familia: Lacertidae				
Lacerta trilineata	Balkan Green Lizard	Native	LC	Appx II
Podarcis muralis	Wall Lizard	Native	LC	Appx II
Podarcis sicula	Istanbul Lizard	Native	LC	Appx II
BIRD SPECIES				
Order: PROCELLARIIFORMES				
Familia: Procellariidae				
Puffinus yelkouan	Yelkouan Shearwater	Resident	NT	Appx II
Order: PELECANIFORMES				
Familia: Phalacrocoracidae				
Phalacrocorax aristotelis	European Shag	Winter Visitor	LC	-
Familia: Pelecanidae				
Pelecanus onocrotalus	Great White Pelican	Passage Migrant	LC	Appx II
Order: CICONIIFORMES				
Familia: Ardeidae				
Ardea cinerea	Grey Heron	Resident	LC	-
Familia: Ciconiidae				
Ciconia nigra	Black Stork	Passage Migrant	LC	Appx II
Ciconia ciconia	White Stork	Passage Migrant	LC	Appx II
Order: ACCIPITRIFORMES				
Familia: Accipitridae				
Pernis apivorus	European Honey Buzzard	Passage Migrant	LC	-

Scientific Name	English Name	Status	IUCN	Bern
Milvus migrans	Black Kite	Passage Migrant	LC	-
Circaetus gallicus	Short-toed Snake-eagle	Passage Migrant	LC	-
Accipiter brevipes	Levant Sparrowhawk	Passage Migrant	LC	-
Buteo buteo	Common Buzzard	Passage Migrant	LC	-
Aquila pomarina	Lesser Spotted Eagle	Passage Migrant	LC	-
Hieraaetus pennatus	Booted Eagle	Passage Migrant	LC	-
Order: FALCONIFORMES				
Familia: Falconidae				
Falco subbuteo	Eurasian Hobby	Passage Migrant	LC	Appx II
Falco peregrinus	Peregrine Falcon	Passage Migrant	LC	Appx II
Order: CHARADRIIFORMES				
Familia: Laridae				
Larus fuscus	Lesser Black-backed Gull	Summer Migrant	LC	Appx III
Larus marinus	Great Black-backed Gull	Winter Visitor	LC	Appx III
Familia: Sternidae				
Sterna sandvicensis	Sandwich Tern	Winter Visitor	LC	Appx II
Sterna hirundo	Common Tern	Winter Visitor	LC	Appx II
Order: PSITTACIFORMES				
Familia: Psittacidae				
Psittacula krameri	Rose-ringed (Ring-necked) Parakeet	Resident	LC	-
Order: STRIGIFORMES				
Familia: Strigidae				
Athene noctua	Little Owl	Resident	LC	Appx II
Order: CAPRIMULGIFORMES				
Familia: Caprimulgidae				
Caprimulgus europaeus	Eurasian Nightjar	Passage Migrant	LC	Appx II
Order: APODIFORMES				
Familia: Apodidae				
Apus apus	Common Swift	Summer migrant	LC	-

Scientific Name	English Name	Status	IUCN	Bern
Apus pallidus	Pallid Swift	Summer migrant	LC	Appx II
Apus melba	Alpine Swift	Summer migrant	LC	Appx II
Order: CORACIIFORMES				
Familia: Meropidae				
Merops apiaster	European Bee-eater	Passage Migrant	LC	Appx II
Order: PICIFORMES				
Familia: Picidae				
Dendrocopos minor	Lesser Spotted Woodpecker	Resident	LC	Appx II
Order: PASSERIFORMES				
Familia: Hirundinidae				
Hirundo rustica	Barn Swallow	Summer migrant	LC	Appx II
Delichon urbica	Northern House-martin	Summer Migrant	LC	Appx II
Familia: Motacillidae				
Motacilla flava	Yellow Wagtail	Passage Migrant	LC	Appx II
Motacilla cinerea	Grey Wagtail	Passage Migrant	LC	Appx II
Familia: Turdidae				
Phoenicurus ochruros	Black Redstart	Passage Migrant	LC	Appx II
Familia: Sylviidae				
Hippolais icterina	Icterine Warbler	Passage Migrant	LC	-
Phylloscopus trochilus	Willow Warbler	Passage Migrant	LC	-
Regulus regulus	Goldcrest	Resident		Appx II
Familia: Oriolidae				
Oriolus oriolus	Eurasian Golden-oriole	Passage Migrant	LC	Appx II
Familia: Corvidae				
Pica pica	Black-billed Magpie	Resident	LC	Appx III
MAMMALS				
Order: INSECTIVORA				
Familia: Erianaceidae				

Scientific Name	English Name	Status	IUCN	Bern
Erinaceus concolor	Southern White-breasted Hedgehog	Native	LC	-
Order: CHIROPTERA				
Familia: Rhinolophidae				
Rhinolophus hipposideros	Lesser horseshoe bat	Native	LC	-
Familia: Vespertilionidae				
Myotis blythii	Lesser Mouse-eared Bat	Native	LC	-
Order: RODENTIA				
Familia: Muridae				
Rattus norvegicus	Brown Rat	Introduced	LC	-
Order: CARNIVORA				
Familia: Mustelidae				
Martes martes	European Pine Marten	Native	LC	Appx III

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Annex N

Archaeological

N-1 OVERVIEW HISTORY OF ISTANBUL

Most of the pre-historical settlements of Istanbul are concentrated on the Asian side of the city. Among these, the one known as "culture of Fikirtepe" is not only the oldest Neolithical (8,000-6,000 B.C.) ceramic producing one in Istanbul but in the entire region of Marmara.[1]

The most important settlement on European side is the "cave of Yarımburgaz" which was inhabited as early as 600 B.C. and was one of the oldest settlements in the Near East.[2] This cave continued to be inhabited as late as the Byzantine period and fell into disuse during the Ottoman era.[3]

Last major changes in the geography of the area occurred after the Last Ice Age, around 8,000 B.C. During this period the coastlines of Istanbul close to today was shaped and the bays between Yenikapı and Yeşilköy were filled with alluvial soil.[4]

Excavations at Marmaray / Yenikapı uncovered a 6th millennium B.C. settlement which is very important for the history of the city and was unknown prior to the excavations. Houses of this settlement were made of mud and wooden beams.[5]

Rapid cultural development between 4,000 and 1,000 B.C. in the Near East, Aegean and Anatolia had impact on several sites of Istanbul such as Bakırköy (Ayamama), Sultanahmet (Hippodrome). It is also understood from the examples like Silivri (Sülüklü area) and Sultanahmet (annex building construction of Istanbul Archaeological Museums) that the wave of

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[1] Mehmet Özdoğan, " Tarih öncesi dönemde İstanbul", Semavi Eyice armağanı – İstanbul yazıları, İstanbul 1992, s. 42

[2] Ufuk Esin, " İstanbul'un en eski buluntu yerleri ve kültürleri", Semavi Eyice armağanı – İstanbul yazıları, İstanbul 1992, s. 68

[3] Mehmet Özdoğan, " Tarih öncesi çağlarda İstanbul", Dünya kenti İstanbul, yay. Afife Batur, İstanbul 1996, s. 95

[4] Sırrı Erinç, " İstanbul boğazı ve çevresi. Doğal ortam: Etkiler ve olanaklar", İstanbul Üniversitesi Coğrafya Enstitsü dergisi sayı 20-21 (1974-77), s. 10

[5] Zeynep Kızıltan, "Marmaray projesi ve İstanbul'un gün ışığına çıkan 8000 yılı", Gün ışığında İstanbul'un 8000 yılı: Marmaray, Metro, Sultanahmet kazıları, İstanbul 2007, s. 18

immigration which influenced Balkans around 1,000 B.C., had reached Istanbul as well.[6]

In the following period, the city of Byzantion was established. The city-state is thought to have been established on the location where Topkapı palace is today around 660 B.C. by a certain Byzas.[7]

The name of the founder is considered to be Thracian.[8] Since Thracian tribes of Phrygians and Bithyns came and settled from the Balkans and Southeastern Europe around 1,200 and 700 B.C. respectively,[9] it is also possible that Byzantion was established by Thracians as well.

According to ancient sources, Byzantion was established by Megarianns seventeen years after Khalkedon (modern day Kadıköy).[10] Since the date of establishment for Khalkedon is considered to be 685 B.C.[11] Byzantion is likely to have been established by around 658 B.C. Traditionally the establishment year for Byzantion is 660 B.C.[12]

The earliest scientific evidence for Byzantion came from the area of Sarayburnu under Topkapı Palace in the form of Proto-Korinthian pottery sherds dated to 7th century B.C.[13]

Byzantion was occupied by Persians under Darius I in 512 B.C.[14]

Fishing was the main source of income for Byzantion.[15] Due to its big fishing industry and strategic location, Byzantion benefitted from large (fishing)

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[6] Mehmet Özdoğan, " Tarih öncesi çağlarda İstanbul", Dünya kenti İstanbul, yay. Afife Batur, İstanbul 1996, s. 100

[7] Doğan Kuban, "Bizantion", Dünden bugüne İstanbul ansiklopedisi, c. II, İstanbul 1994, s. 258

[8] Oğuz Tekin, Eskiçağda İstanbul, İstanbul 2005, 3. baskı, s. 5

[9] Afif Erzen, İlkçağ tarihinde Trakya: Başlangıçtan Roma çağı'na kadar, İstanbul 1994, s. 75

[10] Herodotus, Herodot Tarihi, çev. Müntekim Ökmen, 3. baskı, İstanbul 1993, IV. 144

[11] Plinius, Naturalis Historia, tr. H.R. Rackham, London 1958, V. 42.

[12] Doğan Kuban, "Bizantion", Dünden bugüne İstanbul ansiklopedisi, c. II, İstanbul 1994, s. 258

[13] Aziz.Ogan, "1937 Yılında TTK tarafından yapılan Topkapı Sarayı hafriyatı" Belleten 4 (1940), s. 318–327

[14] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 16

[15] Strabon, Geographika, çev. Horace L. Jones, London 1917, VII. 6.2.

related-incomes during the 5th and 4th centuries B.C. with which they were able to pay heavy taxes not to be overrun and avoid domestic politics of the mainland Greek city-states. [16]

Xenophon, an Athenian commander who participated in the civil war of Persia as a mercenary, explains that as they were returning home their soldiers were called to gather in the square called " Thrakion" in the city of Byzantion in the year 400 B.C.[17]

After occupying Khalkedon and signing a political unity agreement with Selymbria, Byzantion reached the borders of the Kingdom of Macedonia.

The friendly relation at the beginning came to an end upon Philip II's unsuccesful siege on the city in 340-339 B.C.[18]

Immigration from various Celtic tribes changed the population balance in the Greek world also they reached at Byzantion under the leadership of Leonnorias and Luturios in 278-277 B.C. In return for a promise of looting any city other than the Bithynian ones they were directed to Anatolia by the Bithynian king Nikomedes I. [19]

Byzantion became part of Roman state in 146 B.C. and was included in the province of Bithynia in 74 B.C.[20]

Under Roman rule, public buildings such as temples, squares, cisterns and fountains were built. Byzantion surrendered to the Roman general Septimius Severus in 195 A.D. after a two year siege.[21]

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[16] Wolfgang Müller-Wiener, Bizans'tan Osmanlı'ya İstanbul limanı, çev. Erol Özek, İstanbul 1998, s. 3

[17] Ksenophon, Anabasis-onbinlerin dönüşü , çev. Tanju Gökçöl, 2.baskı, İstanbul 1998, VI. 24.

[18] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 16-17

[19] Stephen Mitchell, Anatolia: Land, men, and gods in Asia Minor. The Celts and the impact of Roman rule, vol. I, Oxford 1995, s. 15-16

[20] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 18

[21] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 19

In the middle of 3rd century A.D. Byzantion was partially destroyed by the Goths. After their defeat by Claudius II in 269/270 they were never able to be a threat to the city.[22]

Constantine I becoming the sole city ruler, following a long civil war, chose this city as the new capital on 4 November 326. The official inauguration of the city was on 11 May 330.[23]

[22] Oğuz Tekin, Eskiçağda İstanbul, İstanbul 2005, 3. baskı, s. 35

[23] Jacob Burckhardt, The age of Constantine the Great, tr. Moses Hadas, New York 1989, s. 347-348

N-2 CITY WALLS

Greatest part of the defence of the city was played by the city walls which have been perfected by time except for the sections by the sea. Development of the sea walls came at a later stage.

2.1 CITY WALL SECTIONS ON LAND

It is believed that the city-state of Byzantion had city walls from the beginning. It was reported by Xenophon in 400 B.C. that the Athenian mercenaries returning from Persia entered the city by going over its walls because of a misunderstanding.[24]

Roman general Septimius Severus, upon capturing Byzantion in 195 A.D., punished the citizens who were supporting the losing party but he then restored the city walls.[25]

City walls were partially damaged during the raids of Goths between 258-269 and were restored immediately. They were restored soon afterwards between 285-289 as well.[26]

The city walls which were already in existence since the time of the legendary founder Byzaz were enlarged by Constantine I after having the city raised to the capital city in 328.[27]

Although limits of the Constantinian walls are not known, it is believed that their westward limit was in the area of Isakapısı, around Cerrahpaşa hospital, which was in existence until 1509.[28]

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[24] Ksenophon, Anabasis-onbinlerin dönüşü , çev. Tanju Gökçöl, 2.baskı, İstanbul 1998, VII. 1.

[25] Doğan Kuban, "Bizantion", Dünden bugüne İstanbul ansiklopedisi, c. 2, İstanbul 1994, s. 259

[26] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 18

[27] Chronicon Paschale 284-628 A.D., tr. Michael Whitby-Mary Whitby, Liverpool 2007, Olympiad 277

[28] Semavi Eyice, " İlk kuruluştan Türk devrinin başlarına İstanbul", İstanbul Armağanı I Fetih ve Fatih, yay. Mustafa Armağan, İstanbul 1995, s. 15

Other evidence suggests that part of the Constantinian city walls have been unearthed during the excavations of Marmaray / Yenikapı.[29]

A large portion of the land walls were built during the reign of Theodosius II between 412-414. [30]

2.1.1 City Wall Sections by the Sea of Marmara

The 8.5 kms long sea walls had 188 towers and 13 gates by the beginning of the 15th century.[31]

Although it was suggested by some scholars that the city had sea walls from its beginning[32] it was not necessary to have them because of the strong currents and winds which prevent any landing. Danger was then expected from the land side of the city.

The oldest evidence for the sea walls being non-existent is from the year 400 B.C. Since Athenian mercenaries prevented the entry of the defending Spartan commander of Byzantion through the city walls, he had to enter the city from the sea by a short journey on a rowing-boat.[33]

Despite being suggested that the sea walls were built by Constantine I[34] consensus is that they were built by 439.[35]

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[29] M. Metin Gökçay, " Yenikapı kazılarında ortaya çıkarılan mimari buluntular", Gün ışığında İstanbul'un 8000 yılı: Marmaray, Metro, Sultanahmet kazıları, İstanbul 2007, s. 172

[30] Clive Foss-David Winfield, Byzantine fortifications, Praetoria 1986, s. 42

[31] Bryon Tsangadas, The fortifications and defense of Constantinople, New York 1980, s. 48

[32] Feridun Dirimtekin, Fetihten önce Marmara surları, İstanbul 1953, s. 1

[33] Ksenophon, Anabasis-onbinlerin dönüşü , çev. Tanju Gökçöl, 2.baskı, İstanbul 1998, VII. 1.

[34] Edwin A. Grosvenor, Constantinople, vol. I, London 1895, s. 561

[35] Cyril Mango, "Constantinople, Monuments of: Walls", The Oxford dictionary of Byzantium, vol I, New York- Oxford 1991, s. 519

2.1.2 Causes of impacts and damage to sea walls and repairs

Soon after the sea walls were built, a major earthquake damaged them and they were later restored in 447.[36] The restoration inscripton was visible until mid-19th Century (around Yenikapı) but disappeared since then.[37]

Earthquakes of 542, 554 and 557 not only damaged parts of the city but sea walls as well.[38]

During the Arabic sieges of 669 and 675 it is nearly certain that the sea walls were damaged because of the use of large naval power.[39]

Sea walls were restored by the emperors Tiberios III and Leo III at the end of 7th and at the beginning of the 8th century to counter the threats from the Arabs.[40]

Sea walls have been reinforced as a precaution against the Arabs who laid siege on the city in 717-718.[41]

It is understood from the repair works which have been inscribed on the sea walls that, sections of sea walls and some towers collapsed after the earthquake of 740.[42]

Because of the arctic winter of 763 sections of Black Sea were frozen and large blocks of ice damaged sea walls.[43]

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[36] Alexander van Millingen, The walls of the City and adjoining historical sites, London 1899, s. 180

[37] Patriarch Constantius, Constantiniade ou description de Constantinople ancienne et moderne, İstanbul 1846, s. 21

[38] Bryon Tsangadas, The fortifications and defense of Constantinople, New York 1980, s. 61

[39] Necdet Öztürk, "Fetih öncesi İstanbul kuşatmaları", İstanbul Armağanı I Fetih ve Fatih, yay. Mustafa Armağan, İstanbul 1995, s. 39

[40] Feridun Dirimtekin, Fetihten önce Marmara surları, İstanbul 1953, s. 2-3

[41] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 312

[42] Bryon Tsangadas, The fortifications and defense of Constantinople, New York 1980, s. 62

[43] Alexander van Millingen, The walls of the City and adjoining historical sites, London 1899, s. 181

As it is marked by the repair inscriptons on the sea walls, the most extensive repair works were done by the emperor Michael II and his son Theophilus between 829-842.[44]

After a fire in 1024 the walls and towers in the area of Ahırkapı were restored by emperor Basil II.[45]

It was suggested that the sea walls were moved further towards sea in the 11th century[46] because of siltation in the Mangana area, which could have provided a landing point to the city.

Repair works have been inscribed on sea walls in the area of Narlı kapı in 1164.[47]

Michael VIII not only restored sea walls after re-capturing the city from the 4th Crusaders in 1261 but also intended to move them further into the sea to prevent any landing ground available but he did not manage to relocate the sea wall.[48]

In 1308 a vast restoration was held in the sections which had not been repaired for long time.[49]

On 12 February 1332 a storm caused significant damage to the walls with waves passing over the sea walls and reached far into inland areas.[50]

Important historical details were obtained from a document dated to 1351. According to this, emperor John VI Kantakuzenos ordered the houses built before the sea walls to be pulled down and sea walls rasied in height in order

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[44] Clive Foss-David Winfield, Byzantine fortifications, Praetoria 1986, s. 70

[45] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 314

[46] Semavi Eyice, Tarih Boyunca İstanbul, İstanbul 2006, s. 44

[47] Clive Foss-David Winfield, Byzantine fortifications, Praetoria 1986, s. 71

[48] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 314

[49] Clive Foss-David Winfield, Byzantine fortifications, Praetoria 1986, s. 72

[50] Alexander van Millingen, The walls of the City and adjoining historical sites, London 1899, s. 190

to remove a possible landing spot to the approaching Genoese.[51] Based on this one might suggest that the points where sea and walls met was silted and squatters settled there.

Two pre-Ottoman repairs, were done by the translator Lukas Notaras (who also served at the Ottoman court, and Serbian ruler George Brankovic). The former was responsible for the restoration of the area betwen Ahır kapı and Çatladı kapı; the latter restored a tower in 1448 between Kum kapı and Yenikapı. Both have been inscribed on the sea walls.[52]

After the Ottoman conquest and during the construction of Kadırga harbour, sea walls have been strengthened by the addition of the new towers.[53]

A decree of Suleiman the Magnificent (dated 1558) informs us about houses in the area of the sea walls and banning them to be closer than 3 metres to the walls.[54] Despite renewed decrees, houses continued to be built on and next to the city walls. [*PHOTOGRAPH 1*]

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[51] Alexander van Millingen, The walls of the City and adjoining historical sites, London 1899, s. 190

[52] Alexander van Millingen, The walls of the City and adjoining historical sites, London 1899, s. 192-193

[53] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 316

[54] Ahmed Refik, Onuncu asr-ı hicride İstanbul hayatı (1495-1591), İstanbul 1988, s. 58-59

PHOTOGRAPH 1: Pasquale Sebah 1890

During the reign of Sultan Mehmet IV in 1635 sea walls were restored and whitewashed on both sides.[55]

Houses, built in the silted areas before the walls, were pulled down in 1655 because of a possible Venetian attack and the walls whitewashed in order to make them more glorius.[56]

A French traveller, who spent nine months in the city in 1656, notes that along the sea walls especially where there were small bays there was a fill of land up to fifty steps.[57]

[55] P. Ğugas İncicyan, 18. Asırda İstanbul, çev. Hrand Andreasyan, İstanbul 1976, s. 6

[56] P. Ğugas İncicyan, 18. Asırda İstanbul, çev. Hrand Andreasyan, İstanbul 1976, s. 6

[57] Jean Thevenot, Thevenot Seyahatnamesi, çev. Ali Berktay, İstanbul 2009, s. 47

Another imperial decree concerning the houses along the sea walls dated to 1718 /1719 orders the houses to be 4 metres away from the walls.[58]

In 1722 / 1723 the section between Yalı köşkü and Narlı kapı have been re-erected.[59]

Due to an earthquake three towers of Yedikule collapsed. Most probably sea walls had a damage as well.[60]

In 1776 in Kumkapı area, in 1783 in Bahçekapı area restorations were held.[61]

In 1807 sea walls were restored to protect against the English[62].

During the construction of Rumeli railroad, parts of sea walls in the areas of Çatladı kapı, Kumkapı, Yenikapı and Davutpaşa were destroyed. Destruction continued during the construction of the second railroad in 1910. The gate of Samatya was destroyed in 1913/1914.[63] The greatest damage to the city walls at
Marmara was caused to the construction by coastal road of Sirkeci-Florya between 1957-1959.[64]

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[58] Ahmed Refik, On ikinci asr-ı hicride İstanbul hayatı (1689-1785), İstanbul 1988, s. 67-68

[59] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 318

[60] C.C. Carbognano, 18.yüzyılın sonunda İstanbul, çev. Erendiz Özbayoğlu, İstanbul 1993, s. 40

[61] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 318

[62] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 318

[63] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 318

[64] " Sirkeci – Florya sahil yolu", Dünden bugüne İstanbul ansiklopedisi, c. VII, İstanbul 1994, s. 12-13

N-3 ARCHAEOLOGICAL CONTEXT OF THE EUROPEAN SIDE

3.1 KAZLIÇEŞME

The fountain, which gave name to the area of Kazlıçeşme (meaning fountain with a goose), was made by a certain Mehmet in the year 1537.[65]

The goose in the fountain is Byzantine and dated to 10th to 11th centuries.[66] It was removed from its original place and were kept at the local Municipality of Zeytinburnu since 1999. *[PHOTOGRAPH 2 a-b]*

PHOTOGRAPH 2 a

[65] Hasan Yelmen, " Kazlıçeşme", Dünden bugüne İstanbul ansiklopedisi, c. VII, İstanbul 1994, s. 513

[66] Henry Maguire, " Gardens and parks of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 256

PHOTOGRAPH 2 b

It is believed that prior to the Ottoman conquest, there was a Byzantine park with the name of Aretai.[67] An important source of 12th century Anna Komnena informs us that there were houses for short term stay built by the emperor Romanos Diogenes.[68]

Much of the coastal area around Kazlıçeşme was infilled in moden times, as it is clearly seen on the aerial photographs of 1946, 1966 and 1982. [*PHOTOGRAPH 3 a-b*]

It is known that during the construction of Yedikule Castle by the sultan Mehmet II, the area of Kazlıçeşme was reserved for tanneries and slaughterhouses.[69]

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[67] Henry Maguire, " Gardens and parks of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 257

[68] Anna Komnena, Alexiad, çev. Bilge Umar, İstanbul 1996, s. 83

[69] Necdet Sakaoğlu-Nuri Akbayar, The thousand year old story of leather in Anatolia, İstanbul 2002, s. 312

In 17th century tanneries of this area were able to produce shoes and writing material.[70]

According to a 1781/1782 dated Ottoman document, the area of Kazlıçeşme contained approximately 360 tanneries and 33 slaughterhouses.[71]

The existence of palace-like buildings in the same area is mentioned in sources from the second half of the 10th century. The park and its contact with hexagonal tower on the walls [72] brings to mind the possibility of Mermerkule area.

Over time, the workshops expanded and included different professions and cornered a large area as far as the sea and Yedikule. *[DRAWING 1]*

[70] Eremya Çelebi Kömürcüyan, İstanbul tarihi: 17. asırda İstanbul, çev. Hrand D. Andreasyan, İstanbul 1988,s.25

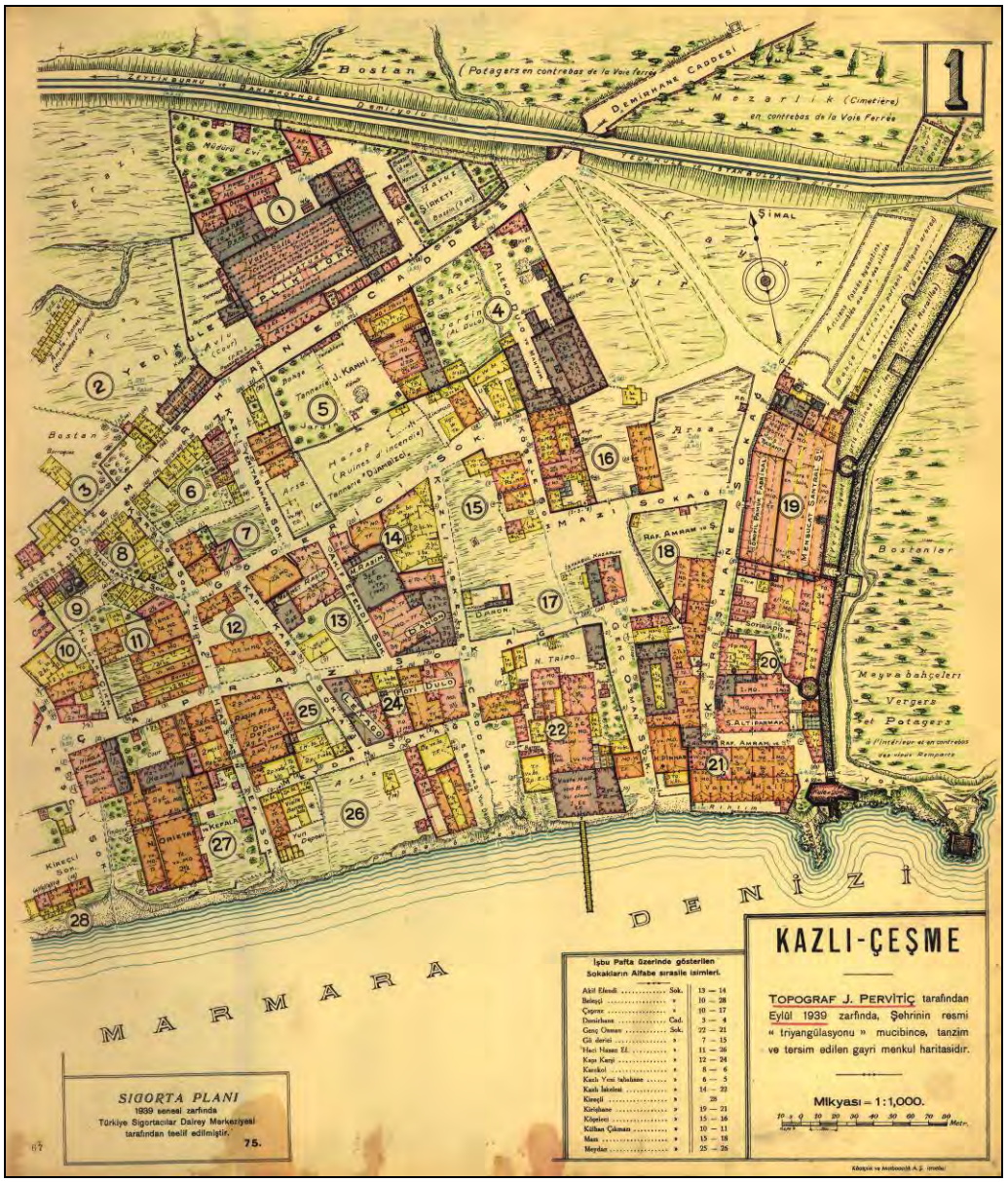
[71] Ahmed Refik, On ikinci asr-ı hicride İstanbul hayatı (1689-1785), İstanbul 1988, s. 230-232

[72] Henry Maguire, " Gardens and parks of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 255-257

PHOTOGRAPH 3 a

PHOTOGRAPH 3 b

DRAWING 1: Pervititch 1939



In 1993 tanneries and leather workshops relocated away from the area after centuries or being sited in Kazlıçeşme.

In the southwestern part of Kazlıçeşme there was one of the first industrial establishments of the Ottoman empire - an iron furnace - hence the street named after it as Demirhane (house of iron). The factory was partially active

in 1846 and continued its production until early 20th century when it fell into disuse.[73]

It is considered that this area had an imperial park during the Byzantine empire under the name of "Aretai".[74] It was reported by one of the most important sources of 12th century Anna Komnena that emperor Romanos Diogenes had houses built for short stay in this area.[75]

3.2 MERMERKULE

Based on 10th and 12th century sources and, in particular, the connection of park with a hexagonal tower[76] might be taken as evidence of Mermerkule area.

It was suggested that Mermerkule was a mansion built during the first decade of the 15th century for Kantakuzenos family.[77] A 19th century photograph [*PHOTOGRAPH 4*] and map [*DRAWING 2*] of the same period supports this view.

[73] Mücteba İlgürel, " Zeytinburnu'nda bir demir fabrikası", Tarih boyunca İstanbul semineri, İstanbul 1989, s. 162-163

[74] Henry Maguire, " Gardens and parks of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 257

[75] Anna Komnena, Alexiad, çev. Bilge Umar, İstanbul 1996, s. 83

[76] Henry Maguire, " Gardens and parks of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 255-257

[77] Urs Peschlow, " Mermerkule: Ein spatbyzantinischer palast in Konstantinopel", Festschrift für Horst Hallensleben zum 65. Geburtstag, Amsterdam 1995, s. 97

PHOTOGRAPH 4: Gülmez brothers 1890

DRAWING 2: "German Blue's" 1913

Researchers restoring the city walls in the vicinity suggested that, based on the mural techniques, Mermerkule belongs to the Late Byzantine period, namely 14-15th centuries.[78]

It is likely that an earlier structure from the 10th century was almost entirely re-made in the later periods together with the ongoing restorations of the sea walls.

In 17th century between Mermerkule and Narlıkapı there were restaurants on the water.[79]

3.3 YEDIKULE

During the construction of a gas factory at the end of 19th century in Yedikule, stamped bricks with the name of emperor Basil I (reigned between 867-886) and some Byzantine structures were found together with the columns scattered along the coast. Basing on these it was suggested that at this spot was the church of Saint Diomedes.[80]

3.4 KOCA MUSTAFA PAŞA

Koca Mustafa Paşa, after whom the area is named, started his career in the Ottoman court during the reign of Mehmet II and became the Grand Vizier in 1511. He constructed a complex of buildings including a mosque and a medrese.[81] The mosque of this complex was a former Byzantine church of Hagios Andreas en te krisei of 14th century.[82]

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[78] Metin Ahunbay-Zeynep Ahunbay, " Recent work on the land walls of Istanbul: Tower 2 to tower 5", Dumbarton Oaks Papers 54 (2000), s. 233

[79] Eremya Çelebi Kömürcüyan, İstanbul tarihi: 17. asırda İstanbul, çev. Hrand D. Andreasyan, İstanbul 1988, s. 2

[80] Alexander van Millingen, The walls of the City and adjoining historical sites, London 1899, s. 265

[81] Mehmet Yılmaz, " Mustafa paşa (Koca)", Yaşamları ve yapıtlarıyla Osmanlılar ansiklopedisi, 2. baskı İstanbul 2008, c.II, s. 311

[82] Alexandros G. Paspati, Byzantinai meletai topografikai kai istorikai meta pleiston eikonon, İstanbul 1877, s. 318

An Armenian hospital was constructed in 1743 outside the sea walls.[83] A church, dedicated to Saint John, (Surp Hovhannes in Armenian) was constructed in 1807.[84]

3.5 SAMATYA

The name of Samatya is derived from Psamathion in Byzantine times, meaning "sandy".[85]

Another Byzantine neighborhood which was not far from here and also by the sea, Rabdos, is known from the sources until 10th century.[86] This neighborhood was probably destroyed in one of the earthquakes and that might be the reason for historical sources to contain little information on this area.

Limits of the Constantinian walls are not known, but it is believed that their westward limit was in the area of Isakapısı, around Cerrahpaşa hospital, which was in existence until 1509.[87]

A Byzantine church (whose original name remains unknown) was built at the end of 13th and the 14th centuries.[88]

During the construction of Istanbul University Education and Research hospital in 1960's, a large 'hoard' was discovered. It was not unexpected asthis is the area of the palace of Helen, mother of emperor Constantine I (Helenianai).[89]

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[83] Eremya Çelebi Kömürcüyan, İstanbul tarihi: 17. asırda İstanbul, çev. Hrand D. Andreasyan, İstanbul 1988, s. 70

[84] Teni Batar, İstanbul Ermeni kiliseleri üzerine bir araştırma ve Narlıkapı Surp Hovhannes Ermeni kilisesi, yayınlanmamış yüksek lisans tezi, İstanbul 2007, s. 55

[85] " Samatya ",Dünden bugüne İstanbul ansiklopedisi, c. VI, İstanbul 1994, s. 430

[86] Albrecht Berger, " Rabdos mahallesi", Dünden bugüne İstanbul ansiklopedisi, c. VI, İstanbul 1994, s. 293

[87] Semavi Eyice, " İlk kuruluştan Türk devrinin başlarına İstanbul", İstanbul Armağanı I Fetih ve Fatih, yay. Mustafa Armağan, İstanbul 1995, s. 15

[88] Thomas F. Mathews, The Byzantine churches of Istanbul: A photographical survey, University Park-London 1976, s. 168

[89] Albrecht Berger, " Helenianai sarayı", Dünden bugüne İstanbul ansiklopedisi, c. IV, İstanbul 1994, s. 47

Substructures related to this palace (hidden under a modern apartment buildings) were discovered during an archaeological survey of 2005 and part of the sewer of the palace were discovered under the road connecting hospital to the coastal road.[90]

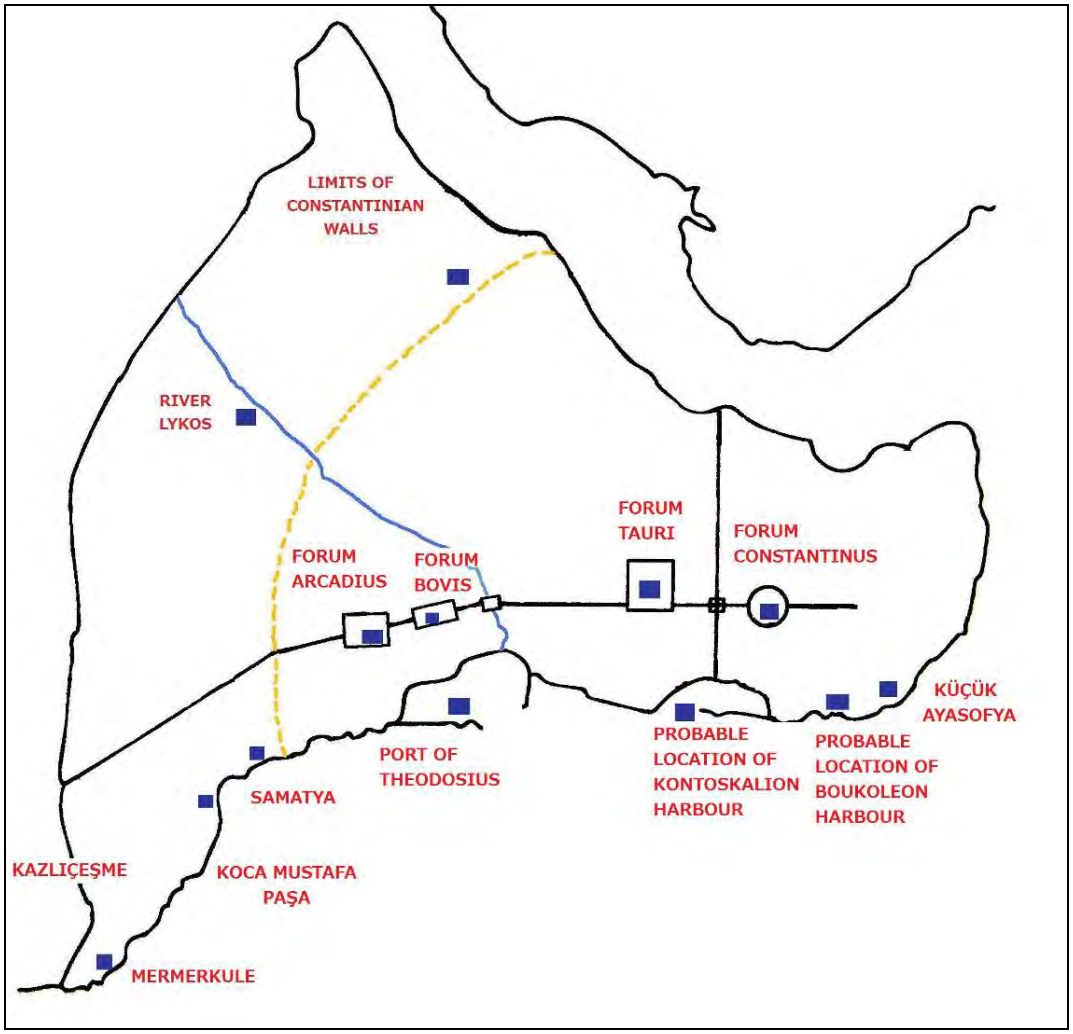
3.6 YENIKAPI

A Byzantine gate with an unknown name was widened up during the Ottomans and began to be called as Yenikapı (New Gate).[91] [*DRAWING 3*]

[90] Haluk Çetinkaya, " İstanbul'dan arkeolojik iki haber", Sanat tarihi araştırmaları dergisi 14 (1998), s. 51

[91] Bryon Tsangadas, The fortifications and defense of Constantinople, New York 1980, s. 40

DRAWING 3: Istanbul around the year 1000 (based on Magdalino)



According to an inscription on a gate (which does not exist anymore), sections of the sea walls were restored by the Prefect Constantine in the middle of 5th century.[92]

[92] Patriarch Constantius, Constantiniade ou description de Constantinople ancienne et moderne, İstanbul 1846, s. 21

3.7 LANGA

The former name of this neighborhood of Langa was probably Vlanga or Ulanka. The name Langa has been known from the sources as early as 12th century.[93]

The neighborhood was named after the harbour with the name of Kontoskalion. During the Ottoman period vessels which carried sand to this harbour gave name to the gate and the neighborhood, Kumkapı (gate of sand).[94]

According to a document dated to 1585 garbage of the Old and New barracks of the Janissaries were dumped into the sea near Langa and Yenikapı.[95]

3.8 KUMKAPI

In a conflagration of 1652, around 100 shops and 15,000 houses were burnt in Kumkapı and Kadırga harbour.[96]

Another conflagration swept accross between Yedikule and Kumkapı destroying approximately 30,000 houses and 8 churches in 1660.[97]

A French traveller, in the second part of the 17th century, described a square tower within the sea roughly 20 metres away from the sea walls called "Belisarios tower".

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[93] İlber Ortaylı, " Langa", Dünden bugüne İstanbul ansiklopedisi, c. V, İstanbul 1994, s. 195

[94] Nur Akın, " Kumkapı", Dünden bugüne İstanbul ansiklopedisi, c. V, İstanbul 1994, s. 120

[95] Ahmed Refik, Onuncu asr-ı hicride İstanbul hayatı (1495-1591), İstanbul 1988, s. 65

[96] Alfons Maria Schneider, "Brände in Konstantinopel",Byzantinische Zeitschrift 41 (1941), s. 393

[97] P. Ğugas İncicyan, 18. Asırda İstanbul, çev. Hrand Andreasyan, İstanbul 1976, s. 85

Not far from this tower was the harbour used by the emperor Theodosios and his son Arcadios.[98] The so-called tower of Belisarius was known to the Armenians as the tower of the priest.[99]

It has been reported that the area known as tower of Belisarius was filled with the debris from the construction of the Laleli mosque by Sultan Ahmet III in 1782. The newly reclaimed land was inhabited by the Armenians only.[100]

Filling of the areas between Kumkapı and Samatya and by the sea is confirmed by another source from the 17th century.[101]

The existence of 11 shops belonging to Christian stonesmiths in both Kumkapı and Yenikapı might indicate that they were using stones brought from the sea for the new public projects.[102]

Around 4,000 Armenian houses were burnt in the fire of 1778.[103]

In the Great Istanbul fire of 1782 houses, coffee houses and fabric workshops were burnt.[104] These fabric workshops have been in the same area for a long time and numbered approximately 15 in 1729.[105] [*PHOTOGRAPH 5]*

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[98] Josephus Grelot, İstanbul seyahatnamesi, çev. Maide Selen, İstanbul 1998, s. 67

[99] Eremya Çelebi Kömürcüyan, İstanbul tarihi: 17. asırda İstanbul, çev. Hrand D. Andreasyan, İstanbul 1988,s.78

[100] P. Ğugas İncicyan, 18. Asırda İstanbul, çev. Hrand Andreasyan, İstanbul 1976, s. 4-5

[101] Eremya Çelebi Kömürcüyan, İstanbul tarihi: 17. asırda İstanbul, çev. Hrand D. Andreasyan, İstanbul 1988, s. 78-79

[102] Yay. Ahmet Tabakoğlu, Ahkam defterleri: İstanbul esnaf tarihi (1764-1795), c. I, İstanbul 1998, s. 78-79

[103] P. Ğugas İncicyan, 18. Asırda İstanbul, çev. Hrand Andreasyan, İstanbul 1976, s. 85

[104] Eremya Çelebi Kömürcüyan, İstanbul tarihi: 17. asırda İstanbul, çev. Hrand D. Andreasyan, İstanbul 1988,s.79

[105] Ahmed Refik, On ikinci asr-ı hicride İstanbul hayatı (1689-1785), İstanbul 1988, s. 104-105

PHOTOGRAPH 5: Gülmez brothers 1890

During the construction of the coastline road in 1956, the mosque of Malkoç Süleyman ağa (built in 17th century and restored in 1886 by Sheikh Ali Hoca) was destroyed.[106]

Sea walls were partially destroyed due to dumping of construction, garbage, fire and earthquake debris; construction of the railroad and coastline road.

In the area between Samatya and Langa, there were gardens for growing vegetables until the beginning of 20th century. The coastal area contained many fishermen shelters.[107]

Until the second half of 19th century all vessels carrying fruit and vegetables from Asia were anchoring at Yenikapı. The area of Kumkapı was providing the second landing spot and but was also used as a dumping ground.[108]

[106] İlber Ortaylı, " Langa", Dünden bugüne İstanbul ansiklopedisi, c. V, İstanbul 1994, s. 195

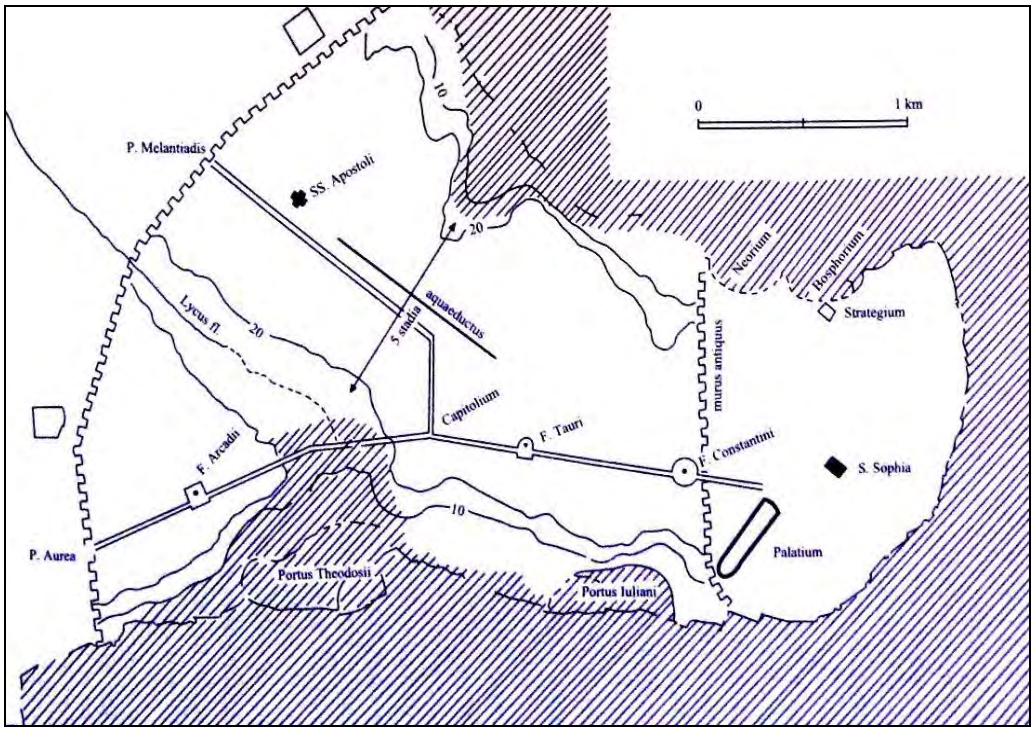
[107] P. Ğugas İncicyan, 18. Asırda İstanbul, çev. Hrand Andreasyan, İstanbul 1976, s. 161

[108] P. Ğugas İncicyan, 18. Asırda İstanbul, çev. Hrand Andreasyan, İstanbul 1976, s. 163

3.9 PORT OF IULIANUS/ SOPHIA/ KONTOSKALION

The earliest port on the southern shore of the city was constructed by emperor Julian. [*DRAWING 4*] It is likely that the already existing pier was enlarged since the emperor issued a decree concerning " facilitating construction activities" in 362. The date of the harbour was 362.[109] A colonnaded street providing access to harbour was also constructed by the same emperor.[110]

DRAWING 4: 4th century city according to Mango



The likely reason to create two harbours on the southern shore of the city after two centuries of its establishment is probably due to population increase.[111]

Emperor Anastasius, after a fire in 465, added a breakwater and deepened the harbour of Iulianus.[112]

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[109] Nezahat Baydur, İmparator İulianus, İstanbul 1982, s. 92-93

[110] Nezahat Baydur, İmparator İulianus, İstanbul 1982, s. 92

[111] Cyril Mango, Le developpement urbain de Constantinople (IVe-VIIe siecles), 2. ed. Paris 1990, s. 37-38

[112] Wolfgang Müller-Wiener, Bizans'tan Osmanlı'ya İstanbul limanı, çev. Erol Özbek, İstanbul 1998, s. 8

It is known from sources that around the year 425 there was a neighborhood built on a reclaimed land, named Kainopolis,in the west of the harbour of Iulianus.[113]

A conflagration in 560 caused significant damage to the harbour.[114]

After another fire in 561 the harbour was renewed by Emperor Justin II and was named after his wife Sophia. Thus, the harbours of Iulianos and Sophia are the same.[115] Probably around this time the harbour was dredged.[116]

The palace of Emperor Justin II, and two churches dedicated to the Archangel Michael and Saint Thecla respectively were in the vicinity of the harbour.[117]

Dredging of the harbour of Neorion in 698, located at the mouth of the Golden Horn, indicates that there was a need for new harbours. Soon after dredging, a plague occurred which was taken as a bad omen by the public.[118]

Harbour of Iulianus became the main one for wholesale trade in 8th-9th centuries.[119]

It is considered that this harbour was re-named Konstoskalion and became one of the bases for the Byzantine navy.[120]

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[113] Cyril Mango, Le developpement urbain de Constantinople (IVe-VIIe siecles), 2. ed. Paris 1990, s. 17-18

[114] Alfons Maria Schneider, "Brände in Konstantinopel",Byzantinische Zeitschrift 41 (1941), s. 385

[115] Albrecht Berger, Untersuchungen zu den Patria Konstantinopoleos, Bonn 1988, s. 568-570

[116] Albrecht Berger, " Der Langa bostanı in Istanbul", Istanbuler Mitteilungen 43 (1993), s. 469

[117] Paul Magdalino, " Maritime neighborhoods of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 213

[118] Paul Magdalino, " Maritime neighborhoods of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 218

[119] Paul Magdalino, " Maritime neighborhoods of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 212

[120] Wolfgang Müller-Wiener, Bizans'tan Osmanlı'ya İstanbul limanı, çev. Erol Özbek, İstanbul 1998, s. 9

After re-conquering the city in 1261, Konstoskalion was made the main naval base by Emperor Michael VIII Palaeologos.[121]

In 1462 the harbour was known as Kadırga (galley) and a renovation was held under the Ottomans. due to disuse and odour issues, the harbour was filled at the end of 16th century upon the order of the Grand Vizier Sokollu Mehmet paşa, who also had his palace in the area.[122]

On the reclaimed land as of 1660 gypsies settled on squatter houses.[123]

A breakwater (added as part of Ottoman renovation) became visible after a fire in 1819.[124] The breakwater was visible even on the postcards from the beginning of the 20th century along the coast of Kumkapı.

3.10 PORT OF THEODOSIUS

This Port [*DRAWING 4*] was created on the deep bay where River Lykos meets the sea, at the end of 4th century by the emperor Theodosius I, and named after him.[125]

One of the two granaries known from the earlier times (horrea Alexandrina and horreum Theodosianum) was renamed as Lamia, and was still in use in 10th century.[126]

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[121] Wolfgang Müller-Wiener, Bizans'tan Osmanlı'ya İstanbul limanı, çev. Erol Özbek, İstanbul 1998, s. 30

[122] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 316

[123] P. Ğugas İncicyan, 18. Asırda İstanbul, çev. Hrand Andreasyan, İstanbul 1976, s. 8

[124] Nur Akın, " Kumkapı", Dünden bugüne İstanbul ansiklopedisi, c. V, İstanbul 1994, s. 120

[125] Wolfgang Müller-Wiener, Bizans'tan Osmanlı'ya İstanbul limanı, çev. Erol Özbek, İstanbul 1998, s. 8

[126] Paul Magdalino, " Maritime neighborhoods of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 213

It is suggested that a large part of the harbour was silted but remained partially in use until 13th century.[127] However, recent archaeological excavations indicate the use of the harbour of Theodosius until 11th century. After 12th century it became a dumping ground.[128]

A very large pile of bones in the harbour was described by travellers as being still visible in the Medieval period. The reason why there were human bones could be explained by the slaughter of the Latins in 1182 after which corpses were dumped. This explains why the existing cemeteries were not used.[129]

3.11 PORT OF ELEUTHERIOS/ KAISARIOS

The name Eleutheron for this harbour was most probably a result of misleading French sources (Gylles), who was here in the first half of the 16th century. However, this same source was also the first to inform us that the harbour of Eleutheron was in Langa.[130]

It is likely, based on contemporary sources, for the palace and harbour of Eleutheron was located to the east of the harbour of Theodosius.[131]

From historical sources, it is known that there was a statue of Eleutherios with a trowel in his hand and a basket on his back on the harbour. [132]

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[127] Cyril Mango, " The shoreline of Constantinople in the fourth century", Byzantine Constantinople: Monuments, Topography and everyday life papers from the International Workshop held at Boğaziçi University, Istanbul,7-10 April 1999, Leiden 2001, p. 25

[128] Sait Başaran, " Demirden yollar ve Marmara kıyısında eski bir liman", Yenikapı'nın eski gemileri, c. I, İstanbul 2007, s. 21

[129] Paul Magdalino, " Constantinopolitana", Aetos: Studies in honour of Cyril Mango presented to him on April 14 1998, eds. Ihor Sevcenko-Irmgard Hutter, Stuttgart 1998, s. 230-232

[130] Petrus Gyllius, İstanbul'un tarihi eserleri, çev. Erendiz Özbayoğlu, İstanbul 1997, s. 189

[131] Albrecht Berger, Untersuchungen zu den Patria Konstantinopoleos, Bonn 1988, s. 581-582

[132] Alexander van Millingen, The walls of the City and adjoining historical sites, London 1899, s. 297

Harbour of Eleutheron was filled with debris brought from the construction of the forum of Theodosius.[133]

There were mansions of Empress Pulcheria and a noble lady called Arcadia in the area of the harbour of Eleutheron. The House of Lady Arcadia was still in existence in the 8th century and it was neighboring the palace of Empress Irene.[134]

Harbour of Eleutheron most probably began to be known as Kaisarios Harbour after the Medieval period.[135]

3.12 THE PALACE AND HARBOUR OF BOUKOLEON

5th Century sources mention a palace constructed by Emperor Theodosius II in the area. According to other sources, another palace was built at the same area in the third quarter of the 10th century.[136]

The earliest mention of the palace and the harbour is the Book of Ceremonies of Emperor Constantine Porphyrugenitus from the 10th century.[137]

A book written by Anna Comnena in early 12th century indicates that the name of the harbour and the palace is derived from a statue group of an ox and a lion fight.[138]

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[133] Paul Magdalino, " Maritime neighborhoods of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 216

[134] Paul Magdalino, " Maritime neighborhoods of Constantinople", Dumbarton Oaks Papers 54 (2000), s. 216

[135] Albrecht Berger, Untersuchungen zu den Patria Konstantinopoleos, Bonn 1988, s. 581

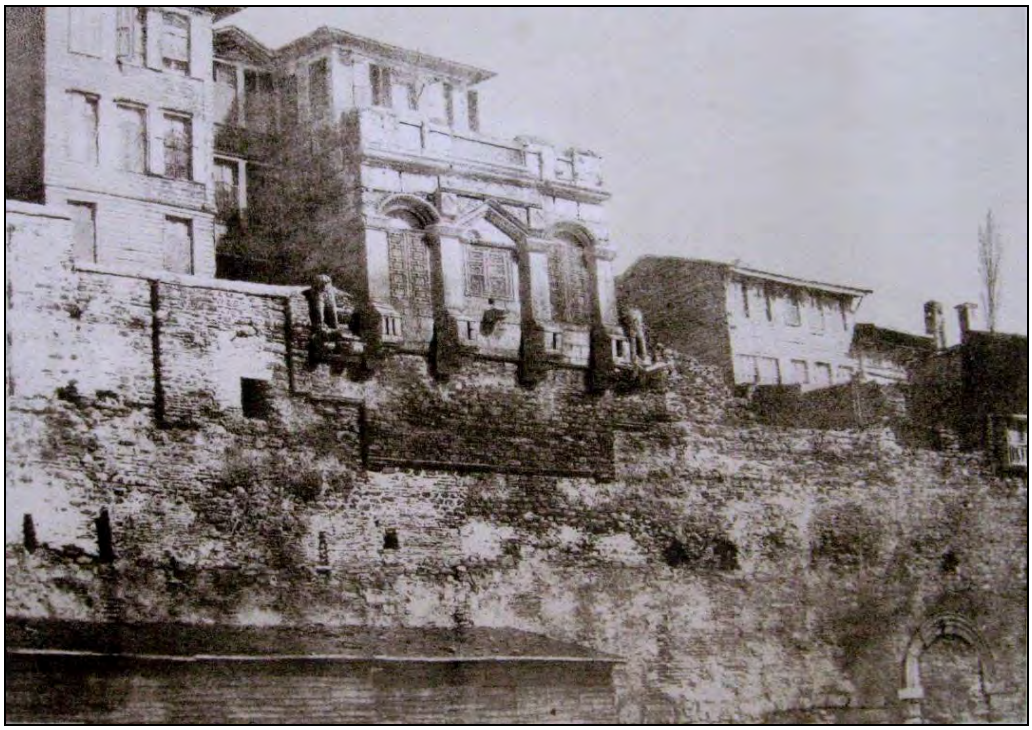
[136] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 225

[137] Konstantinus Porphyrugenitii, De cerimoniis: Aulae Byzantinae, ed. B.G. Niebuhr, Bonnae 1829, s. 601

[138] Anna Komnena, Alexiad, çev. Bilge Umar, İstanbul 1996, s. 97

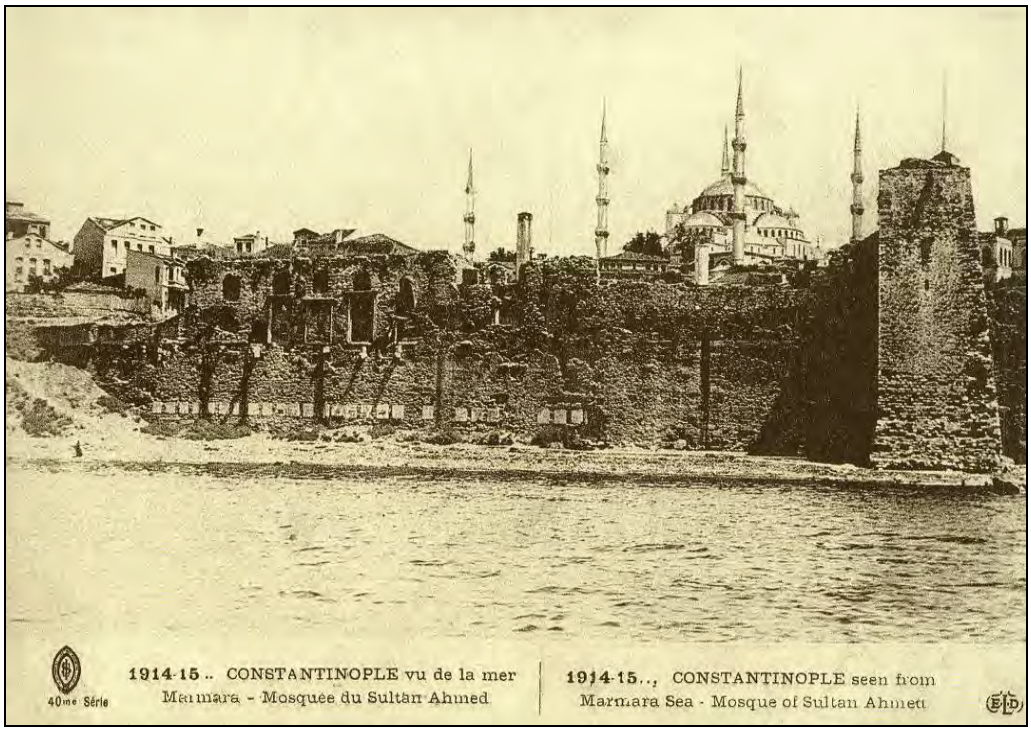
It has been recorded by the 18th and 19th century researchers and travellers that, in addition to the aforementioned statues, there were other statues of marble lions and three-sectioned arched opening on the balcony. These arches were still visible around 1850. [*PHOTO 6*]

PHOTOGRAPH 6: Pierre Tremaux 1850 photolithograf



In a photograph of 1914 the entire front of the so-called "house of Justinian" is visible. [*PHOTO 7*]

PHOTOGRAPH 7



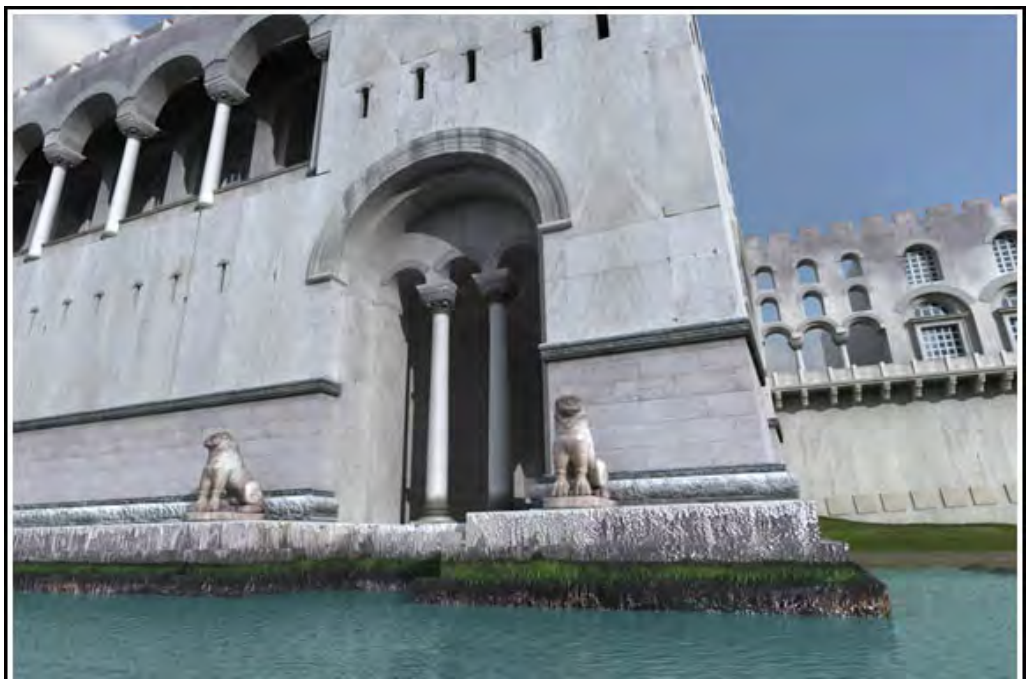
It has been suggested that the so-called "House of Justinian" was not built in the 6th century during the reign of that emperor but in 9th century instead.[139]

[139] G.U.S. Corbett, " The building to the North of the Boukoleon harbour called the House of Justinian", The Great Palace of the Byzantine emperors, 2nd report, ed. D. T. Rice, Edinburg 1958, s. 173

Modern impressions of the port and the palace are also available. [*DRAWING 5 a-b*]

DRAWING 5a: Tayfun Öner-from Byzantium 1200

DRAWING 5b: Tayfun Öner-from Byzantium 1200



The arches have disappeared (due to the construction of the railroad in 1871) and the lion statues were brought to the Istanbul Archaeological Museums.[140]

Harbour of Boukoleon was directly attached to the Great Palace. There were also statues of lions, bulls, bears and ostriches before marble steps of the harbour.[141]

Most likely, these statues were destryed after the earthquake of 1509. Descriptions provided by Pietro Zen, an Italian envoy, in 1532 where he mentions of lion and bull statues only, would support this view.[142]

In the second half of 13th century the palace was converted into a palace church under the name of Saint Michael during the Latin occupation.[143]

The palace was abandoned in 14th century.[144]

The harbour (only reserved for the use of the Byzantine court) was also the arrival point of foreign dignitaries such as Kılıçaslan II who visited Constantinople in 1162 and Amaury, king of Jerusalem, who arrived in 1171.[145]

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[140] Cyril Mango, " Constantinopolitana", Jahrbuch des Deutschen Archaeologischen Instituts 80 (1965), s. 318

[141] Bryon Tsangadas, The fortifications and defense of Constantinople, New York 1980, s. 54

[142] Alexander van Millingen, The walls of the City and adjoining historical sites, London 1899, s. 270

[143] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 227

[144] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 228

[145]Wolfgang Müller-Wiener, Bizans'tan Osmanlı'ya İstanbul limanı, çev. Erol Özbek, İstanbul 1998, s. 188 d.n. 33

Destruction of both palace and the harbour began with the construction of the railroad in 1871, followed by the fire in 3 June 1912[146] completed with the construction of the coastline road in 1957.[147] The harbour of Boukoleon disappeared since then.

It has been reported that a researchers have beenable to obtain cores after two drills in 2002 in the section known as " the house of Justinian".[148] These revealed that there were three levels of fills: down to 4 metres, between 4-7 metres, and then between 7-10 metres. The fill-level 7-10 metres contained sand and broken bricks, suggesting that this was the level of the port.[149]

3.13 CHURCH OF SS. SERGIUS AND BACCHUS (MOSQUE OF KÜÇÜK AYASOFYA)

Emperor Justinian I had a church dedicated to the Apostles Peter and Paul prior to the construction of Ss Sergius and Bacchus.[150] Construction of the Church of Apostles Peter and Paul probably was between 518-520 before he had any high level titles.[151] A letter dated 519 reveals that Justinian asked for some relics from the Pope and that this was granted.[152] Contemporary historian Procopius mentions this church being an oblong basilica.[153]

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[146] Alfons Maria Schneider, "Brände in Konstantinopel",Byzantinische Zeitschrift 41 (1941), s. 401

[147] " Sirkeci-Florya sahil yolu", Dünden bugüne İstanbul ansiklopedisi, c. II, İstanbul 1994, s. 12

[148] Euegenia Bolognesi Recchi Franceschini, " The monumental itinerary of the Palatine harbour of the Boukoleon", 22. Araştırma sonuçları toplantısı, c I, Ankara 2004, s. 55

[149] Euegenia Bolognesi Recchi Franceschini, " The monumental itinerary of the Palatine harbour of the Boukoleon", 22. Araştırma sonuçları toplantısı, c I, Ankara 2004, s. 56

[150] Procopius, De aedificiis, tr. H.B. Dewing, London-Massachusets 1954, I. iii. 12

[151] Thomas F. Matthews, The Byzantine churches of Istanbul, University Park-London 1976, s. 242

[152] Cyril Mango, "The church of Saints Sergius and Bacchus at Constantinople and the alleged tradition of octagonal palace churces", Jahrbuch der Österreichischen Byzantinistik 21 (1972), s. 123

[153] Procopius, De aedificiis, tr. H.B. Dewing, London-Massachusets 1954, I. iv. 6

Justinian lived seven years before becoming Emperor in a palace called Hormisdas, whose name was derived from a Persian prince, who took refuge at the Byzantine court in the 4th century. [154]

Upon becoming Emperor he connected this palace to the Great Palace, He also built the Church of Ss Sergius and Bacchus, which had a common entrance with the Church of Apostles Peter and Paul.[155]

The Church of Ss Sergius and Bacchus has caused considerable debate regarding its construction and it has been determined that it was not built for the monophysite refugees.[156]

The background to dedicating a church to Apostles Peter and Paul is that Emperor Justinian's name was Petrus Sabattius prior to his ascension to the throne. However there was a different motive for dedicating the church to the Saints Sergius and Bacchus: his maternal uncle and himself were believed to be involved in a plot against the Emperor Anastasius and were saved miraculously by the intervention of the Saints Sergius and Bacchus.[157]

Exact location of the Church of Apostles Peter and Paul is not known. But since the Church of Saints Sergius and Bacchus has a set of large arches on its southern wall, this was taken as a sign of a common wall and the church of Peter and Paul should have been at the place where the railroad is today.[158] However, it is rather curious that the Church of Apostles Peter and Paul was destroyed without any remaining evidence.

The Church of Ss Sergius and Bacchus became a pilgrimage site because it housed important relics. After the Ottoman conquest it was converted into a mosque around 1510.[159]

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[154] Brian Croke, " Justinian, Theodora and the church of Saints Sergius and Bacchus", Dumboarton Oaks Papers 60 (2006), s. 29

[155] Procopius, De aedificiis, tr. H.B. Dewing, London-Massachusets 1954, I. iv. 1

[156] Richard Krautheimer, " Again Saints Sergius and Bacchus at Constantinople", Jahrbuch der Österreichischen Byzantinistik 23 (1974), s. 252

[157] Alexander van Millingen, Byzantine churches in Constantinople, London 1912, s. 64

[158] Thomas F. Matthews, The Byzantine churches of Istanbul, University Park-London 1976, s. 242

[159] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 182

Recent restorations indicate that there was a fill of around 1 metre from the 17th century inside the building.

Construction of the railroad in 1870-1871 had a very negative impact on the already damaged building.[160] There was a short distance between the building and the sea walls prior to the construction of the railroad. [*PHOTO 8*]

PHOTOGRAPH 8: Abdullah brothers 1865

The two-stage construction of the railroad (in 1870 and 1910damaged the building. Construction of the coastal road in 1957 caused the destruction of a medrese and a stable, which were next to the seawalls. [*PHOTO 9*]

[160] Wolfgang Müller-Wiener, İstanbul'un Tarihsel Topografyası: 17. yüzyılın başlarına kadar Byzantion-Konstantinopolis-İstanbul, çev. Ülker Sayın, İstanbul 2001, s. 182

PHOTOGRAPH 9: Aerial photo 1946

N-4 ARCHAEOLOGICAL CONTEXT THE ASIAN SIDE

4.1 INTRODUCTION

This section presents information on the archaeologial and built heritage of the Asian Side.

There is no known settlement of historical value on the existing coastal road, which was completed in 1956 under the name of London Road and known currently as D 100, which will be part of the forthcoming project.

The only exception is the Byzantine ruins which were discovered in September 2006 during a road-widening construction and dated to the 11th-12th century on the northern section of D 100 road towards the direction of Kadıköy and across Devlet Malzeme Ofisi. [*PHOTOGRAPH 1*]

Photograph 1

The above mentioned ruins have disappeared since the date of discovery.

Due to this the report concentrates on the ventilation shaft and tunnel construction sites and historical development of the areas where they are located.

Since the Asiatic side tunnel entry and the ventilation shafts are under the jurisdiction of modern Üsküdar, the report below was prepared from the historical and archaeological perspectives of the area.

4.2 FORMER NAMES OF ÜSKÜDAR: DAMALIS/ KHRYSOPOLIS/ SCUTARI/ ÜSKÜDAR

The origin of the current name of the neighbourhood Üsküdar is not certain. Former names of the neighbourhood will be studied since they may contribute building up the past of the area with their monuments and history.

The earliest name of the area is Damalis. It has been suggested that it was named after the wife of Chares, admiral of the Athenian fleet which won several sea-battles in the sea of Marmara and laid siege on Byzantion in 409 B.C.E. Because lady Damalis died on the spot where the fleet anchored the area started to be known with her name.

The oldest written source is Anabasis of Xenophon which tells the adventures of the Greek mercenaries as they were returning to their homeland after having participated in a rebellion against the Persian king. The journey began in 401 B.C.E. and a year after they arrived at Khrysopolis, which was across Byzantion, and they stayed a week to sell their booties.

The area was called as Khyrsopolis, which means Golden City, in the 5th Century B.C.E. There were two suggestions for the name. First; this was the point of tax collection of the Persians and since they collected taxes in gold it was called as Golden City. Second; it was named after the son of the legendary Greek commander Agamemnon – Khyrsos - who died here.

Another name is first mentioned by Villehardouin who came with the 4. Crusaders in 26 June 1203 telling that they landed in the area called Scutari which belonged to the emperor Alexius and camped on the hills of the area.

It has been suggested that the name was derived from skitos (leather) and skutarii (shield bearer) body guards of the emperor since they had their barracks in the area. The name skutariotes was most commonly used by the clergymen between 12-15th centuries. Basing on this it might be suggested that the name Skutari was in use since the 12th century.

The name Skutari was probably corrupted and became Üsküdar in Turkish. There is also an other possibility: the source for the name may be is Eskudar, a mixture of Persian-Turkish meaning Messenger.

4.3 IMPORTANT HISTORICAL EVENTS WHICH TOOK PLACE IN ÜSKÜDAR

The area of Üsküdar played an important role in Roman history since it was the battleground between Constantine I (who would also be the founder of Constantinople) and Licinius. In 324, during this battle, Licinius lost one hundred thousand soldiers (out of one hundred and thirty thousand) as well as the battle.

A small band of Arabs who raided coasts of Mediterranean in 710-711 came as far as Üsküdar.

Located just across Constantinople, Üsküdar has been a strategically the last crossing point. As it was the case during the rebellions of Leo III (who overthrew Theodosius III) in 717 and Basil II (who asked for support from Russians against rebel commander Bardas Phokas) in 988.

In 1077 Nicephoros Botaniates asked for help from Seljuks against rebellious commander Michael Ducas and succeeded in securing his throne. Seljuk leader Süleyman Şah had the control of the entire Kocaeli peninsula and reached as far as Kadıköy and Üsküdar; and even set customs offices along the Anatolian coasts of Byzantine lands.

During the 2nd Crusade, a very large German army under the command of Conrad caused panic around Constantinople during the summer months of 1147. After minor skirmishes, they were expelled and continued their way crossing to Damalis.

In May 1329, Byzantine Emperor Andronicos III crossed to Üsküdar with his army intending to halt the Turkish advance in the western regions of Byzantine empire. Upon the defeat of Pelekanon he barely escaped to Üsküdar and from there to the capital. After this battle towns like Izmit and Iznik were captured by the Ottomans.

Üsküdar was captured in 1352 by the Ottomans during the reign of Sultan Orhan.

In 1411 Ottoman Sultan Çelebi Mehmet signed an agreement with the Byzantine Emperor Manuel I Palaeologos as a precaution against Musa çelebi who declared himself Sultan in Edirne.

4.4 BYZANTINE BUILDINGS WHOSE PAST EXISTENCE IS KNOWN BUT NO LONGER IN EXISTENCE

4.4.1 Monasteries

Existence of Byzantine monasteries in the area is suggested by historical sources. The latest (most recent) of these monasteries is from the 14th century. There is no certain description of whereabouts of them or a suggestion about it. The oldest of the monasteries is from the 6th century and is called Philippikos. It is known that here was a large palace with the same name attached to it. The monastic settlement continued its existence as late as the 10th century.

4.4.2 Palaces

Historian Kömürciyan in 17th century mentions a hearsay describing a palace of a certain Emperor Constantine in the area of Haydarpaşa.

Quotes from von Hammer Şehsuvaroğlu suggested that the areas of Harem-Salacak were Byzantine summer resorts and there was the palace present called Haraeum and the gardens.

Prior to 1118 (during the reign of Byzantine Emperor Alexios I Komnenos) a certain Kamytzes, who was captured by the Turks, was able to escape and reached the imperial palace at Damalis. From his short description it is understood that there was a Byzantine imperial palace by the sea but it is impossible to locate it.

4.5 EVIDENCE OF BYZANTINE SETTEMENT AND EXISTING BYZANTINE BUILDINGS

4.5.1 Evidence of a Byzantine settlement

There is no evidence of Byzantine ruins in the area occupied by the Project. Existence of column shafts and capitals in the cemetery of Karacaahmet (further inland) indicates an early Byzantine settlement. Similar to those are the column shafts and capitals in the mosque and vicinity of Ayazma camii. These were the only architectural fragments from the Byzantine period found until recently.

Recently archaeological excavations as part of Marmaray project were undertaken in Üsküdar. During the excavations minor finds uncovered were

Roman period oil lamps, a few pieces of sculptures, marble column base, shaft and capitals. A Roman vaulted structure most probably part of a canal project was one of the major finds.

4.6 EXISTING BYZANTINE BUILDING

A single aisled structure with a single apse in the north with around twenty skeletons buried both underneath the walls and inside the structure was uncovered. Basing on the mural technique it was dated to 11th-12th centuries.

4.7 AYAZMA-ÜSKÜDAR-KAVAK PALACES/ ŞEMSIPAŞA-ŞEREFÂBÂD PALACES/ BARRACKS OF SELIMIYE

4.7.1 *Ayazma-Üsküdar-Kavak Palaces*

Üsküdar started to develop after the conquest of Constantinople. As a result, this masjids of Salacak and Toygartepe Durbali were built in 1455 followed by the mosques of Hamza Fakih in 1460 and Rum Mehmet paşa in 1471.

Erdoğan mentions the Privy gardens in Üsküdar, based on a 1583 document. He also refers to the existence of a palace between Harem and Salacak during the reign of Sultan Süleyman the Magnificent under architect Sinan. Privy gardens were also praised by the famous traveller Evliya Çelebi.

It is known that the daughter of Sultan Süleyman the Magnificent was staying in a palace located on Sultan Tepesi (Sultan's Hill).

According to a 1656 document the palace in Üsküdar was used as a summer residence.

The palace in the area was called as Üsküdar palace for two centuries which started to be called afterwards as Kavak palace. It is clearly identified in several paintings such as the anonymous 1701, 1746 Guer, pre-1773 Le Rouge and 1787 father-son Basseggio's.

A book dated to 1794 mentioned that the sultan was present in the Kavak palace whenever he was leading his armies against Iran or watching his armies manuvering.

According to Süheyl Ünver, the right hand side of Harem area was called Kavak and the left hand side of it was called as Üsküdar palace.

4.7.2 Şemsipaşa-Şerefâbâd Palaces

In a water distribution map from 1753, the palace of Şerefâbâd was depicted. Construction of the pipe system began in 1718 and when finished, water came out of the sprinklers of the palace. In a map the palace was located in the area of Doğancılar, which is located inland and on top of a hill. Until 1960's, large pieces of walls were visible in the area. Based on these, one may assume that the Palace of Şerefâbâd was, at least partially, on top of a hill.

The Palace was constructed around 1580 by Şemsi paşa and known with the name of the founder for some time. It was also called as Acem kasrı (Persian mansion) since it was acting as the audience hall for the Persian ambassadors. At the beginning of 18th century during the reign of Sultan Ahmed III it was pulled down by the orders of Damat İbrahim paşa and on the very spot a large mansion was constructed. This is the one called as Şerefâbâd.

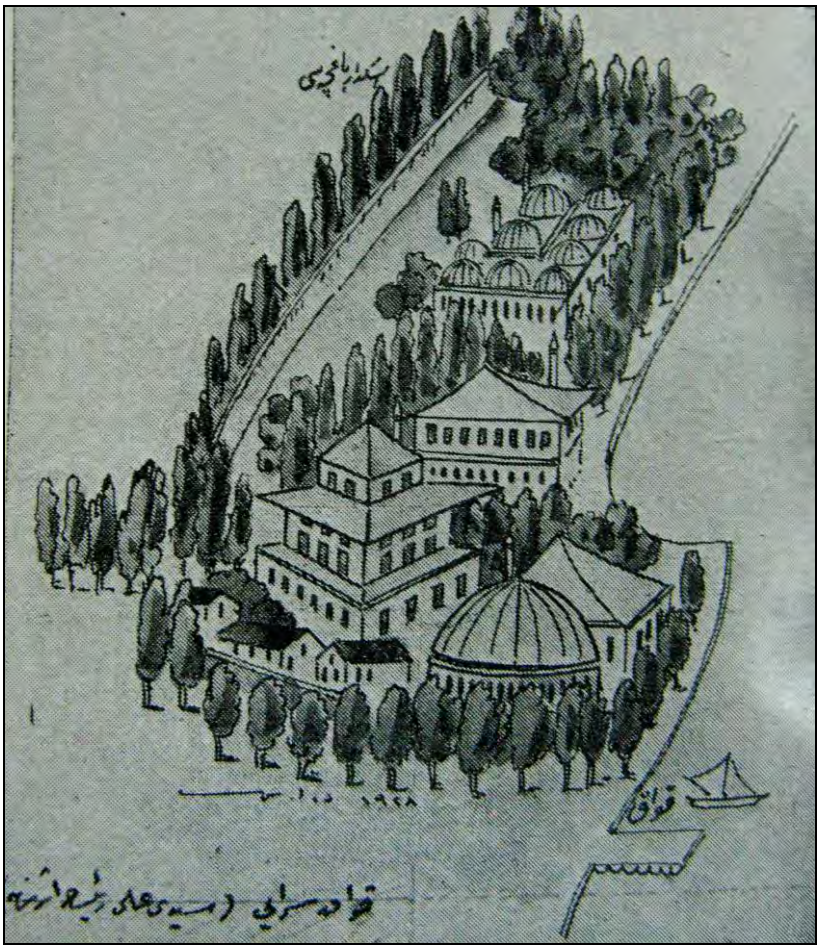
The Palace must have been destroyed after 1850's. In photographs dated around 1865 there was nothing other than a large pool and a pier. The pier was filled around 1945 and the new coastal road divided the ruins into two. The large pool was filled in by the local municipality at the beginning of 20th century. Filling of the coast is clearly marked in an aerial photograph provided by the Metropolitan Municipality [*PHOTOGRAPH 2*]

Photograph 2

Mueller-Wiener made use of the descriptions and depictions of the palace and created a plan of the layout.

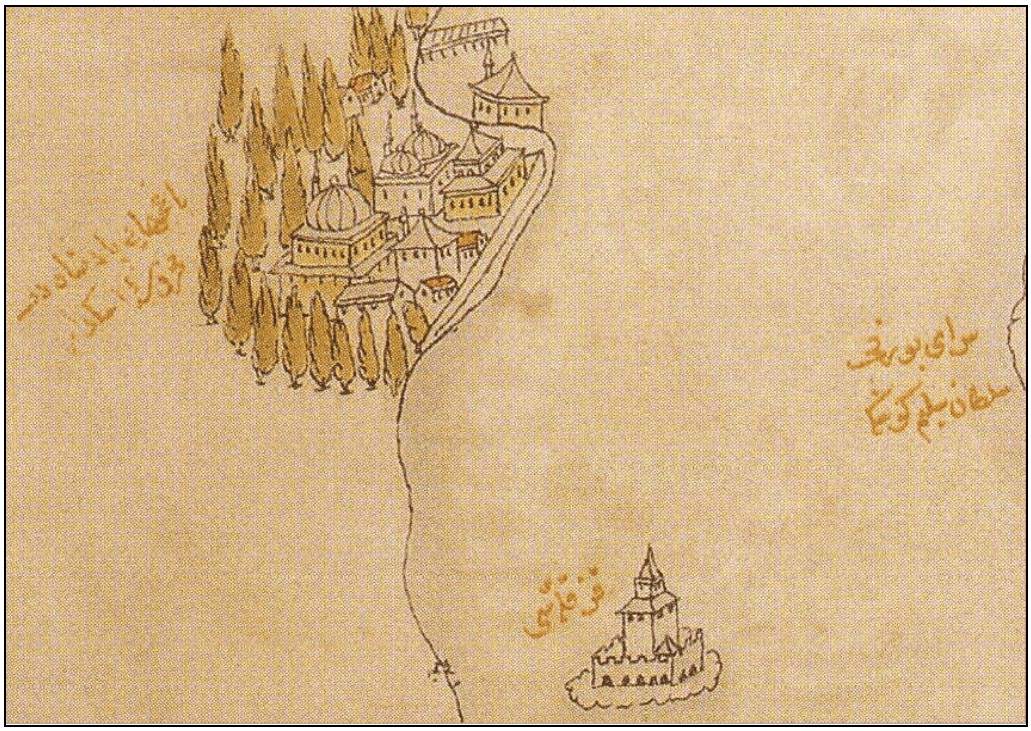
In a map of Seyyid Ali Reis (Piri Reis), dated to 1544, the location of the palace and separate pavillions by the coast of Üsküdar are clearly seen. [*DRAWING 1*]

Drawing 1



A copy of this original document in a private collection from the 17th century not only depicts the palace complex together with the Leander's tower but also some other buildings along the coast as well. [*DRAWINGS 2 & 3*]

Drawing 2



Drawing 3

It is reported by historian Kömürciyan that in the middle of 17th century around the mosque of Şemsi paşa there were plenty of Jewish houses and tanners. Although the existence of tanners since the end of 16th century was known from documents, it was not known that there were by the sea. This may suggest that there would not be any palace in the vicinity of these tanneries due to unpleasent odours. Details provided by historian İncicyan may assist this historical query. According to him, from 17th century onwards the Kavak palace was not that much in favor and nearly abandoned. As a result of this, some squatter houses and shops then entered the area. A similar situation was experienced at the Topkapı palace. Soon after moving to Dolmabahçe palace in the middle of 19th century, squatter houses were built next to the enclosing wall of the palace of Topkapı (evidence of which remains today).

The Kavak palace had a fire in 1779 and was pulled down upon the orders of Sultan Selim III in 1794.

A document of 30 October 1800 mentions that the area of Kavak Palace is no longer imperial property but instead belongs to the Foundation of Selimiye who built the military barracks. Some marble of the Kavak Palace was moved to the palace of Topkapı and the rest was used in the construction of the barracks.

A detailed study of the sources of the period indicates that Şemsipaşa and Şerefâbâd Palaces are the same, as are the Ayazma-Kavak and Üsküdar Palaces. Similar to this was experienced at the palace of Topkapı. For public the palace was called as 'zeytunluk sarayı' (olive orchard palace) but on official documents until the beginning of 19th century it was mentioned as 'saray-ı cedid-i amire' (new palace).

4.7.3 Barracks of Selimiye

One of the largest standing buildings of the area is the barracks of Selimiye. The construction started in 1800 and since the final delivery account books were dated to 1803, it would be safe to suggest that it was completed at that time.

After the upheaval of Janissaries in 1807 Nizam-ı Cedid army (New Order army) was abolished. Barracks of Selimiye (or as it was mentioned in the sources, as barracks of Üsküdar) was intended to be converted and parts of the building complex began to be dismantled so as to pay the debts to local merchants. In 16 November 1808, in another upheaval of the Janissaries, the barracks were burnt down.

Despite being burnt, some secondary buildings remained in use in the new barrack, which was started by the Sultan Mahmut II (soon after abolishing the Janissaries in 1826). The construction came to completion in 1828.

ANNEX O

Social Impacts and Scoping Checklist

Introduction

This Annex is a social impact screening checklist prepared during the scoping stage of the ESIA process in October 2009. The checklist is based on Table 1 of the IFC document, *Good Practice Note: Addressing the Social Dimensions of Private Sector Projects*. The information provided in the checklist was based on the Project information available at that time in the ESIA process and was aimed at identifying potentially significant impacts that should be investigated during the ESIA. It does not represent the final assessment of the impacts of the Project.

Some of the scoping findings in the checklist have been superseded by the findings of the ESIA process reported in Volume II of the ESIA. The mitigation measures identified in the checklist were possible options to be examined if needed. The various mitigation measures identified through the ESIA and presented in the ESMP in Annex D replace the mitigation measures identified in the checklist below.

Summary of Social Impacts Screening Process

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Population and demographics			
Temporary and permanent changes in the study area's population due to in-migration	**Yes –** most of the construction workforce will be sourced from Istanbul so any impacts are likely to be small. No impacts predicted during operation as the project will not result in an increase in the local or regional population.	Some construction workers will be provided with accommodation (including food, accommodation and entertainment). This will be located and managed such that it does not impact on any local communities. Additionally, PS2 and PS4 shall be applied.	12
Changes in the demographic properties of the population in the study area	**Yes –** may be an increase in the 18 – 45 (approx.) age demographic cohort as a result of the construction workforce (a proportion of which will be accommodated in a construction workers compound).	Some construction workers will be provided with accommodation (including food, accommodation and entertainment). This will be located and managed such that it does not impact on any local communities. Additionally, PS2 and PS4 shall be applied.	12
Seasonal movements in population	No - No seasonal population impacts predicted during operation as the project will not result in an increase in the local or regional population.		-
Economic and employment			
Direct and indirect employment creation (construction and operation) in the study area	**Yes –** positive impacts expected as construction and operational jobs will be created.	PS2 shall be applied.	12
Direct and indirect loss of existing employment and businesses in the study area	**Yes –** due to the loss of existing employment and local businesses directly impacted by the alignment.	PS5 shall be applied and this will ensure that any business to be directly impacted and resettled will be financially compensated and an alternative location provided (or financial compensation provided in lieu of this).	12

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Wider (regional) economic impacts	**Yes –** positive impacts expected. The project is expected to increase the overall capacity of the regional road network through the provision of an additional vehicular crossing of the Bosphorus. This will reduce regional economic costs associated with driver delay and traffic congestion.		12
Potential for sourcing local goods and services	**Yes –** positive impacts expected. The construction of the project will involve the direct purchasing of some local good and services. Given the project's proximity to Istanbul, it is also expected that direct purchasing from the local economy will take place, regardless of any specific commitment to locally source goods and services.	Commitment to procure local good and services to the benefit of the local and regional economy.	5
Economic (fiscal) benefits (including tax and revenue benefits)	**Yes –** positive impacts expected. The local and regional economy will benefit due to the direct economic activity generated by the construction of the project (employee remuneration; purchase of goods, materials and services etc.) and also the secondary/induced economic activity and also from the subsequent government taxes generated by all direct and induced economic expenditure.		12
Inflationary impacts	No – the project is located in Istanbul which has a large and functioning economy. This project will not lead to any inflationary effects.		-
Competition for economic resources	No – the project, in the context of the Turkish economy (and also that of the Istanbul region), will not result in competition of economic resources nor the diversion of public funds away from other projects.		-

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Equitable access to opportunities and accrual of benefits	No – the project will be open (following the provision of the toll fee) to all car and mini-bus users (HGVs will not be permitted) and will provide significant direct journey and time saving benefits to all tunnel users. Additionally, the project will increase the road capacity on the regional road network, providing indirect benefits for all users of the regional road network.		-
Employment conditions			
Compliance with all local and national employment laws and regulations	**Yes** – the project will fully comply with all local and national employment and labour laws and regulations.	Additionally, PS2 will be applied during the construction and operation of the project.	14
Safe and acceptable physical working conditions (inc. construction and operational H&S and training)	**Yes** – the project will fully comply with all local and national employment and labour laws and regulations.	Additionally, PS2 will be applied during the construction and operation of the project.	14
Equitable remuneration/income and associated benefits	**Yes** – PS2 will be applied.	PS2 will be applied.	14
Ethical and fair conditions and terms of employment	**Yes** – PS2 will be applied.	PS2 will be applied.	14
Acceptable provision and standard of workers accommodation compounds	**Yes** – PS2 will be applied.	PS2 will be applied.	14
Non use of child labour or forced and bonded employment	No – no child labour or forced or bonded employment will be used.		-
Workers grievance mechanism	**Yes** – PS2 will be applied.	PS2 will be applied.	14
Natural resource management and access to resources			

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Direct land uses changes in the study area	**Yes –** the project will result in changes to the existing land use patterns both along and immediately adjacent to the alignment.	The design has minimised land take, where possible, and tried to maximise the use of the existing roadway. Any lands to be temporarily required for construction shall be reinstated and returned to their former uses upon completion.	4
Rights and access to land uses in the study area	**Yes –** the project will require a limitation of access to the various public open spaces and parks (the majority of which are on the European side). The project will also require the permanent expropriation of some of these lands to facilitate the project.	During construction, limited and alternative access will be maintained to the coastal walk on the European side (although much of the public parks will be off-limits to the public for health and safety and also security reasons). PS5 will be applied during the expropriation process. Additionally, there is a commitment to improve the remaining (post-construction) public facilities and recreational infrastructure. Pedestrian access arrangements over the existing roadway will be provided for the new road, thus maintaining access to the public parks and facilities.	4
Access to common natural resources in the study area	No – the project will not impact on the availability and access to common natural resources, given its urban location and the size of the regional Istanbul economy.		-
Resettlement and expropriation			
Direct and indirect resettlement and expropriation of residential populations	**Yes –** it is possible that some residential land and properties will be expropriated.	Compensation and resettlement will be undertaken in accordance with PS5. A Resettlement Policy Framework will be developed as part of the ESMP setting out how resettlement for permanent acquisition will be managed and mitigated.	4

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Direct and indirect resettlement and expropriation of businesses and areas of employment	**Yes –** the project will require both temporary and permanent land expropriation of businesses and areas of employment. The majority of these lands to be acquired are in public ownership. However, some existing businesses will be expropriated.	PS5 will be applied during the expropriation process. Lands being temporarily acquired (to facilitate construction) will be returned to their former uses post-construction. A Resettlement Policy Framework will be developed as part of the ESMP setting out how resettlement for permanent acquisition will be managed and mitigated.	4
Loss of public and common lands (including access to)	**Yes –** the project will require both temporary and permanent land expropriation of public and common lands.	During construction, limited and alternative access will be maintained to the coastal walk on the European side (although much of the public parks will be off-limits to the public). There is a commitment to improve the remaining (post-construction) public facilities and recreational infrastructure. Pedestrian access arrangements over the existing roadway will be provided for the new road, thus maintaining access to the public parks and facilities.	4
Social services and infrastructure			
Health and medical facilities	No – the project will not impact on the existing health and medical facilities of the study area or of Istanbul. H&S (including limited medical support facilities) will be provided during the construction process. No permanent population increases will arise from the project so no additional demands on the health infrastructure will arise.		-
Education	No – the project will not result in any permanent population increases so no additional demands on the educational infrastructure will arise.		-

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Water	**Yes –** the project will not result in any permanent population increases so no additional demands on the water infrastructure will arise. However, the construction process will require water and there will also be operational water requirements.	PS3 shall be applied during the construction process. A key source of water will be the TBM but this shall have a water recycling system as part of its operation and this shall recycle a large proportion of water, thereby greatly reducing both water demands and also contaminated water requiring treatment and disposal.	7
Sanitation	**Yes –** the project will not result in any permanent population increases so no additional demands on the sanitation infrastructure will arise. However, the construction process will require sanitation and there will also be operational sanitation requirements.	PS3 shall be applied during the project.	7
Power	**Yes –** the project will not result in any permanent population increases so no additional demands on the power infrastructure will arise. However, the construction process will require power and there will also be operational power requirements.	PS3 shall be applied during the project.	2 and 5
Transportation infrastructure	**Yes –** the project will result in an additional vehicular crossing of the Bosphorus and will also provide greater regional traffic capacity (and reduce congestion on the existing Bosphorus crossings).	Traffic Management Plans will be developed as part of the ESIA process and these will minimise the negative impacts on traffic.	2
Waste management	**Yes –** the project will not result in any permanent population increases so no additional demands on the waste management infrastructure will arise. However, the construction process will generate construction wastes and there will also be operational waste management to be addressed.	PS3 shall be applied during the project. Construction spoils shall be disposed of in an authorised and licensed municipality facility to the north of Istanbul.	5

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Communications infrastructure	**Yes –** the project will not result in any permanent population increases so no additional demands on the communication infrastructure will arise.		2
Housing	**Yes –** a temporary workers compound shall be provided during construction but this shall be removed upon completion of the project. Additionally, the project will not result in any permanent population increases so no additional housing demands will arise.	PS 2 shall be applied during construction.	2 and 14
Community facilities (e.g. village halls and community buildings)	No – the project will not be impact on any community facilities (impacts to public parks, open spaces and recreational facilities are addressed below).		-
Religious and places of worship	**Yes –** the project may impact on some religious structures or places of worship.	Minimise or avoid impacting on such sensitive land uses. Where this is not avoidable, then replacement of these facilities will be undertaken.	4
Recreational and sports facilities	**Yes –** the project will result in the permanent loss of public open spaces and recreational facilities and there will also be additional and temporary loss of access to public open spaces during construction.	During construction, limited and alternative access will be maintained to the coastal walk on the European side (although much of the public parks will be off-limits to the public). There is a commitment to improve the remaining (post-construction) public facilities and recreational infrastructure. Pedestrian access arrangements over the existing roadway will be provided for the new road, thus maintaining access to the public parks and facilities.	4
Vulnerable groups			
Indigenous peoples	No – there are no indigenous peoples within the study area, which is part of the city of Istanbul.		-

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Ethnic or religious minorities	No – there are no ethnic or religious minorities that will be impacted by the project.		-
Women	No – there are specific women populations that will be impacted by the project.		-
Youth and elderly	No – there are no specific youth or elderly populations that will be impacted by the project.		-
Limited mobility	**Yes** – the project will not negatively impact on any specific population of limited mobility and it is proposed that the project will enhance local accessibility for people of limited mobility. The project will also comply with all relevant mobility legislation and design standards.		4
Land users without formal rights	**Yes** – there are some illegal and unofficial businesses that will be expropriated as a result of the project. Although these users have – in legal terms – no rights; they shall be treated as having consent regarding use of the lands being expropriated.	PS5 shall be applied.	4

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Cultural and built heritage			
Direct and indirect impacts on designated historic buildings and structures	**Yes –** the project has the potential to directly impact on a number of protected historic structures close to the alignment during both construction and operation. Additionally, indirect effects may arise over a wider area (and thus on more distant protected and historic structures) from changes to the traffic patterns during the construction and operation of the project.	PS8 shall be applied during the construction and operation of the project. In addition, specific constructional and operational monitoring will be undertaken at the protected historic structures. If monitoring determines that direct impacts are arising, remedial action will be undertaken (such as selecting a less harmful construction technique or developing additional structural insulation and protection measures). Consultation with UNESCO and other municipality authorities will be undertaken regarding the construction of the scheme and its design.	11
Direct and indirect impacts on sites of cultural importance	**Yes –** the project is close to the UNESCO-listed historic peninsula of Istanbul. The potential exists for the project to have both direct and indirect impacts on this internationally important cultural site during construction and operation of the project.	PS8 shall be applied during the construction and operation of the project. Consultation with UNESCO and other municipality authorities will be undertaken regarding the construction of the scheme and its design. Specific measures include the preparation of a set of construction and operational traffic management principles (which will form the basis for a Construction Traffic Management Action Plan and an Operational Traffic Management Plan). A key objective of both of these plans is to reduce the level of traffic in the historic peninsula. Additionally, the construction process will be developed such that it does not impact in anyway on any buildings and structures of historical importance.	11

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Direct and indirect impacts on archaeological resources (both known and unknown/potential)	**Yes –** the project is close to the UNESCO-listed historic peninsula of Istanbul. The potential exists for the project to have both direct and indirect impacts on known and unknown archaeological resources during construction of the project.	PS8 shall be applied during the construction and operation of the project. Consultation with UNESCO and other municipality authorities will be undertaken regarding the potential for impacts on known and unknown archaeological resources. Geophysical studies have been undertaken as part of the ESIA process to provide additional information on the buried archaeological resources. The implementation of PS8 will include a 'Chance Finds Procedure'.	11
Social and equity issues			
Competition for employment, natural resources (land, water, materials etc.) and access to infrastructure	No – the project will not result in increased competition for employment or materials and resources, given its urban location and the size of the regional Istanbul economy.		-
Differential wage incomes (and other benefits) and wealth accumulation	**Yes –** the project shall pay fair labour rates and the majority of the workforce will be sourced from Istanbul and the wider region. The project will comply with all national and local labour and employment laws.	PS2 will be applied.	14
Perception of unequal treatment	No – Regarding construction, all national and local labour and employment laws will be complied with. The project will be open (following the provision of the toll fee) to all car and mini-bus users (HGVs will not be permitted) and will provide direct journey and time saving benefits to all direct users. Additionally, the project will increase the road capacity on the regional road network, providing benefits for all users of the road network.		-

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Community rivalry, jealousies and tension	No – construction workers will not be sourced from any specific locality or community. The project will be open to all users upon completion (with the payment of the appropriate toll fee).		-
Social conflicts	No – the project will result in regional benefits through the provision of an additional vehicular crossing of the Bosphorus and also provide additional regional road capacity and indirectly reduce congestion on the regional road network.		-
Distribution of and access to the benefits (e.g. employment, revenue, usage, outputs) from the project	No – the project will result in regional benefits through the provision of an additional vehicular crossing of the Bosporus and also provide additional regional road capacity and reduce congestion on the regional road network. Construction and operational employment will not be confined to any particular ethnic or spatial groups.		-
Lifestyles, culture and identity			
Social cohesion and disruption (separation of families and local communities)	No – the project will not result in any permanent population increases so there will be no impacts to the study area's social cohesion. A construction worker compound will be provided, but this will be carefully managed and monitored and will not impact on the adjacent community. In any case, the majority of workers will be sourced locally (and reside) in Istanbul.		-
Change in production systems and traditional livelihoods	No – the project is not impacting on any agricultural or similar activities.		-

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Social ills: alcoholism, drugs, prostitutions, crime, black market activity, HIV/AIDS	No – the project will not result in any permanent population increases so there will be no increase in social ills and problems. A construction worker compound will be provided, but this will be carefully managed and monitored and will not impact on the adjacent community.		-
Socio-economic impacts of the project (both construction and operation)	**Yes –** The project will result in positive socio-economic impacts for the workforce, the regional economy and wider benefits such as shorter journeys times and reduced traffic congestion.		12
Social and cultural disruption due to population changes (construction and operation)	No – the project will not result in any permanent population increases so there will be no increase in social and cultural disruption. A construction worker compound will be provided, but this will be carefully managed and monitored and will not impact on the adjacent community.		-
Change in relationships between population, demographic, socioeconomic or ethnic groups	No – the project will not result in any permanent population increases so there will be no increase in inter-population and inter-demographic conflicts and changes. A construction worker compound will be provided, but this will be carefully managed and monitored and will not impact on the adjacent community.		-
Disturbance impacts (noise, dust etc.) during construction and operation	**Yes –** the project will result in disturbance impacts on the local population during construction and operation of the project.	PS1, PS3 and PS4 will be implemented during the construction and operation of the project. An overall ESMP Framework shall be developed and this will outline how all environmental impacts – including those which can impact on the local community – will be discussed.	13

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Health and wellbeing			
Changes in nutritional status	No – the project will not result in any permanent population increases so there will be changes in nutritional status. A construction worker compound will be provided, but this will be carefully managed and monitored and will not impact on the adjacent community.		-
Mortality and morbidity levels	No – the project will not result in any permanent population increases so there will be no increase in mortality and morbidity levels. A construction worker compound will be provided, but this will be carefully managed and monitored and will not impact on the adjacent community.		-
HIV/AIDS, STDS and other communicable diseases	No – the project will not result in any permanent population increases so there will be no increase in communicable diseases. A construction worker compound will be provided, but this will be carefully managed and monitored and will not impact on the adjacent community.		-
Endemic diseases (e.g. malaria, bilharzia, TB etc)	No – the project will not result in any permanent population increases so there will be no increase in endemic diseases. A construction worker compound will be provided, but this will be carefully managed and monitored and will not impact on the adjacent community.		-

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Impacts on existing health infrastructure due to in-migration	No – the project will not result in any permanent population increases so there will be no increase in the demands on health infrastructure. A construction worker compound will be provided, but this will be carefully managed and monitored and will not impact on the adjacent community.		-
Health impacts due to the construction and operation of the project (e.g. soil contamination, air pollution etc.)	**Yes –** the project will result in emissions (principally noise and air quality) to the environment which has the potential to impact on the local community. Excavation of construction material may also uncover contaminated material, also a risk to public health.	PS1, PS3 and PS4 will be implemented during the construction and operation of the project. An overall ESMP Framework shall be developed and this will outline how all environmental impacts – including those which can impact on the local community – will be discussed.	13
Induced and secondary social impacts			
Changes in land values post construction	**Yes –** the project will provide a significant improvement in transport infrastructure and accessibility in the study area. This is likely to increase land values within the vicinity of the project.	PS5 will be implemented.	4
Changes in local and regional land uses post construction	**Yes –** the project will not directly change the land uses adjacent to the final alignment (although there will be land uses directly changing as a result of the project). However it is likely that there may be some future land use changes planned by the municipality to reflect the additional crossing of the Bosporus.		4

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Spontaneous settlement (including impacts on existing services and infrastructure)	No – the project will not result in any permanent population increases so there will be no spontaneous settlement. A construction worker compound will be provided, but this will be carefully managed and monitored and will not impact on the adjacent community.		-
Relocation and economic displacement resulting from another project or existing activity (which may interact with this project)	No – the project will not is located in Istanbul and the entire city and region is subject to constant change and ongoing development projects. These will not result in economic or demographic displacement which could impact on the project.		-
Community organisations and consultation			
Local Government capacity (technical and availability)	**Yes** - The various public authorities (both at a national, regional and local level) are adequately resourced to participate in the ESIA process. Consultation with these authorities has started in October 2009 and a summary of submissions can be found in the main ESIA Report.		3
Community-based organisations to represent the local community	**Yes** - Public consultation on the draft ESIA will be undertaken and submission invited from any interested groups and organisations.		3
NGOs	**Yes** - Public consultation on the draft ESIA will be undertaken and submission invited from any interested groups and organisations.		3
Religious and political organisations	**Yes** - Public consultation on the draft ESIA will be undertaken and submission invited from any interested groups and organisations.		3

Potential Impact	Requires consideration in ESIA ?	Possible options for mitigation if required	Chapter in ESIA Report
Organisational and negotiation skills vacuum	No – the project is located in the city of Istanbul and in an area which is well developed with an urban context and contains no specialist ethnic groups or peoples who are of limited educational ability. There is no organisational or negotiation skills vacuum.	PS1 and PS4 will be implemented.	-

Annex P

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