AYGM

HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Environmental and Social Impact Assessment



70069878-ESIA
DECEMBER 2021

PUBLIC

7

NOISE AND VIBRATION

PUBLIC

7 NOISE AND VIBRATION

7.1 INTRODUCTION

7.1.1. This chapter reports the findings of the assessment of the potential effects of the Project in relation to noise and vibration during both the construction and operational phases. For both phases, source and significance of potential effects are identified, and the measures that will be employed to minimise these described.

7.2 LEGISLATIVE FRAMEWORK, POLICY AND GUIDANCE

7.2.1. The noise and vibration assessment has taken account of the relevant legislative, policy and guidance framework internationally and nationally. The relevant legislation, policies and guidance, in addition to those listed in **Chapter 4: EBRD Performance Requirements, EU Standards, Legislative and Policy Context**, are summarised below.

- International:
  - Environmental Noise Directive (2002/49/EC)
- National:
  - Regulation on the Assessment and Management of Environmental Noise (2010)
- Guidance:
  - Description, Measurement and Assessment of Environmental Noise (ISO 1996-2:2017)
  - World Bank Group Environmental, Health and Safety Guidelines: Noise Management (2007)
  - Noise and Vibration Control on Construction and Open Sites (BS5228:2009 and A1:2014)
  - Guidance on Sound Insulation and Noise Reduction for Buildings (BS8233:2014)
  - Guide to Evaluation of Human Exposure to Vibration in Buildings: Vibration Sources Other Than Blasting (BS6472-1:2008)
  - Guide to Evaluation of Human Exposure to Vibration in Buildings: Blast-induced vibration (BS6472-2:2008)
  - Acoustics – Attenuation of Sound During Propagation Outdoors (ISO 9613:1996)
  - Calculation of Railway Noise (1995)
  - Additional Railway Noise Source Terms (2007)

INTERNATIONAL

Environmental Noise Directive (2002/49/EC)[35]

7.2.2. The Environmental Noise Directive (END) is the main instrument to identify noise pollution levels and to identify actions. The aims of the END focus on:

[35] European Parliament and Council (2002). 2002/49/EC, relating to the assessment and management of environmental noise.

- The determination of exposure to environmental noise;
- Ensuring that information on environmental noise and its effects is made available to the public; and
- Preventing and reducing environmental noise where necessary and preserving environmental noise quality where it is good.

NATIONAL LEGISLATION

Regulation on the Assessment and Management of Environmental Noise (2010) [36]

7.2.1. The Regulation on the Assessment and Management of Environmental Noise, as amended in 2011 and 2015, transposes the END into Turkish law.

7.2.2. The Regulation is aimed at taking measures to prevent and reduce harmful effects of environmental noise on human health by determination of exposure to environmental noise, noise mapping, environmental noise assessment, public awareness regarding environmental noise and its effects on human health, preservation of environmental noise quality and adoption of action plans based upon noise-mapping results.

7.2.3. Table 5 of Annex VII provides environmental noise limits at sensitive receptors in relation to construction noise sources. Noise limits for rail projects are not specifically provided in the Regulations. Instead, the table in Annex VII provides a noise limit of L_{day} 75dB for roads projects and L_{day} 70dB for 'other sources.' The noise limit L_{day} 70dB for 'other sources' has been considered the most applicable, as it is the more stringent value to achieve.

7.2.4. Articles 18, 19, 20, 22 and Annex VII establish the noise limit for road, rail, aircraft and industrial premises. Article 19 of the Regulation relates to the criteria for noise levels from railways during operation. It states that the noise level at sensitive receptors due to emissions from operational railways shall not exceed the following values:

- Daytime (approximately 07:00 - 19:00), L_{day}: 65 decibels (dB);
- Evening (approximately 19:00 – 23:00), $L_{evening}$: 60dB; and
- Night-time (approximately 23:00 – 07:00), L_{night}: 55dB.

7.2.5. The above values have been taken as a free-field noise level $L_{Aeq,T}$ at 1m from facades for sensitive receptors.

GUIDANCE

Description, Measurement and Assessment of Environmental Noise (ISO 1996-2:2017)[37]

7.2.6. ISO 1996-2:2017 defines and prescribes international best practice during recording and reporting of environmental noise. It advises that the information to be reported should include the following: measurement technique (including type of instrumentation; measurement procedure and position of

[36] Ecolex (2020). Available at: https://www.ecolex.org/details/legislation/regulation-on-assessment-and-management-of-environmental-noise-lex-faoc164383/ (Accessed 10/07/20).
[37] ISO 1996-2:2017. Description, Measurement and assessment of Environmental Noise.

measurements); prevailing conditions during the measurements; and any relevant qualitative data, such as the nature of the sound source.

World Bank Group Environmental, Health and Safety Guidelines: Noise Management (2007)[38]

7.2.7. These international guidelines provide noise level guidelines which are normally used to assess the potential noise impact arising from a noise source of an industrial nature. It states that the noise impact should not exceed the levels presented in **Table 7-1** or result in a noise level not greater than background levels ($L_{eq,T}$) plus 3dB at the nearest receptor. These guideline levels have been applied as they are more stringent than those in the Turkish Regulation on the Assessment and Management of Environmental Noise 2010 (cited above).

Table 7-1 - World Bank Group Noise Level Guidelines

Receptor	Criteria $L_{Aeq,1hr}$[39]
Residential, Institutional, Educational	55dB L_{day} (07:00 – 22:00); 45dB L_{night} (22:00 – 07:00)

Noise and Vibration Control on Construction and Open Sites (BS5228:2009 and A1:2014)[40]

7.2.8. Complementing the national regulations, BS5228:2009, A1:2014, titled 'Noise and Vibration Control on Construction and Open Sites', has been applied, as it has an approved methodology for predicting noise levels from construction sites, and assessing its effects on those exposed to it. It is considered suitable as it the industry approved code of practice in the United Kingdom, and it complies with EU requirements for assessing noise from construction phases.

7.2.9. BS5228 provides guidance on the potential significance of construction impact. One of the methods is based on fixed noise limits ($L_{eq,T}$) as described in Advisory Leaflet 72[41], which is typically used for projects of significant size, such as the construction of a new railway. The note advises to limit the noise levels between 7:00 – 19:00 hours to 70dB(A) in rural, suburban and urban areas away from main roads and to 75dB(A) in urban areas near main roads and heavy industrial areas. Based on this, noise level of 70dB(A) on noise sensitive receptors have been used as a threshold for potential significant construction noise effect. It should be noted that this noise limit is in accordance with Annex VII of the Regulations on the Assessment and Management of Environment Noise (2010), described in paragraphs 7.2.1 to 7.2.5.

7.2.10. BS5228 describes the approach to assessing effects of vibration from construction sites and describes criteria for the human response to vibration and also guideline levels relating to transient vibration and cosmetic damage in buildings. The threshold of perception is described as being in the

[38] World Bank Group (2007). Environmental, Health and Safety Guidelines: Noise Management.
[39] The A-weighted, equivalent continuous sound level in decibels measured over a 1hr period.
[40] BSI (2009 & 2014). BS5228:2009 and A1:2014: Noise and Vibration Control on Construction and Open Sites.
[41] Department of the Environment (1976). Noise control on building sites, Advisory Note 72.

range of 0.14 mm/s and 0.3mm/s, and human sensitivity is greater in the vertical direction. **Table 7-2** summarises the BS5228 guidance on the effects of vibration levels on humans.

Table 7-2 - Guidance on Effects of Vibration Levels

Vibration level (mm/s)	Effect
0.14	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3	Vibration might be just perceptible in residential environments.
1.0	It is likely that vibration of this level in residential environments will cause complaints, but vibration can be tolerated if prior warning and explanation has been given to residents.
10	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.

7.2.11. BS5228 references BS7385-2 'Evaluation and measurement for vibration in buildings. Guide to damage levels from ground-borne vibration'. The criteria (shown in Table 7-3) relates to the thresholds of cosmetic damage due to vibration and is based upon systematic studies using a carefully controlled vibration source in the vicinity of buildings.

Table 7-3 - Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	**15 Hz and above**
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above
Unreinforced or light framed structures Residential or light commercial buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Note 1: Values referred to are at the base of the building. Note 2: For un-reinforced or light framed structures and residential or light commercial buildings, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded.		

7.2.12. BS 7385-2 states that the probability of damage from transient vibration tends towards zero at 12.5 mm/s peak component particle velocity. For continuous vibration, such as from vibratory rollers or tunnel boring, the threshold is around half this value.

Guidance on Sound Insulation and Noise Reduction for Buildings (BS8233:2014)[42]

7.2.13. BS8233:2014 'Guidance on Sound Insulation and Noise Reduction for Buildings' outlines suggestions for criteria for many common situations, such as suitable sleeping / resting conditions and proposes noise levels that normally satisfy these criteria for most people. This is primarily intended to guide the design of new or refurbished buildings rather than the assessment of changes to external noise sources. However, it can be used as a guide to understand the likely internal noise levels once the Project is in operation.

7.2.14. Acceptable noise criteria for bedrooms are generally used to provide conservative criteria for internal levels. For the purposes of this assessment a noise attenuation of 15dB has been assumed for a partially open window. **Table 7-4** reproduces Table 4 from BS8233:2014 and outlines the internal ambient noise limits appropriate for residential properties.

Table 7-4 - Indoor Ambient Noise Levels for Residential Properties

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35dB $L_{Aeq,16hr}$	-
Dining	Dining Room / area	40dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35dB $L_{Aeq,16hr}$	30dB $L_{Aeq,8hr}$

7.2.15. Criteria for external amenity space such as gardens and patios are outlined in BS8233:2014 as 50dB $L_{Aeq,T}$ with an upper guideline value of 55dB $L_{Aeq,T}$. These values are derived from guidance produced by the World Health Organisation within 'Guidelines for Community Noise' and are outlined as a lower and upper limit, which would be acceptable in noisier environments.

Guide to Evaluation of Human Exposure to Vibration in Buildings: Vibration Sources Other Than Blasting (BS6472-1:2008)[43]

7.2.16. BS 6472-1:2008 provides guidance on predicting human response to structural vibration in buildings and describes how to determine the frequency weighted vibration dose value (VDV). Methods of assessing continuous, intermittent and impulsive vibration are presented within a frequency range of 0.5 Hertz (Hz) to 80Hz.

[42] BSI (2014). BS8233:2014: Guideline on Sound Insulation and Noise Reduction for Buildings.
[43] BSI (2008). BS6472-1. Guide to Evaluation of Human Exposure to Vibration in Buildings: Vibration Sources Other Than Blasting.

7.2.17. The vibration dose value can be used to estimate the probability of adverse comment which might be expected from human beings. Adverse comment about building vibration is likely when the vibration levels to which occupants are exposed are only slightly above thresholds of perception. Table 7-5 reproduces Table 1 from BS6472-1:2008 and describes the VDV ranges which may result in adverse comment by those who experience it.

Table 7-5 - Vibration Dose Value Ranges Which Might Result in Various Probabilities of Adverse Comment Within Residential Buildings

Place and Time	Low Probability of Adverse Comment ($ms^{-1.75}$)	Adverse Comment Possible ($ms^{-1.75}$)	Adverse Comment Probable ($ms^{-1.75}$)
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8hr night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

7.2.18. BS6472-1:2008 states that:

"These values represent the best judgement currently available and may be used for both vertical and horizontal vibration, provided that they are correctly weighted. It is inevitable that the criteria have to be presented as ranges rather than discrete values. This stems largely from the widely differing susceptibility to vibration evident among members of the population, but also from their differing expectations of the vibration environment. Parallel effects can also exert some influence. Because there is a range of values for each category, it is clear that the judgement can never be precise."

Guide to Evaluation of Human Exposure to Vibration in Buildings: Blast-induced vibration (BS6472-2:2008)[44]

7.2.19. BS6472-2 relates to the impacts of vibration arising as a result of blasting. The application of the standard is primarily for mineral extraction activities, however, it can be extended to civil engineering works **Table 7-6** reproduces Table 1 from BS6472-2 and describes the maximum satisfactory magnitudes for vibration as a result of blasting, as measured outside buildings and in relation to human response.

[44] BSI (2008). BS6472-1. Guide to Evaluation of Human Exposure to Vibration in Buildings: Blast-induced vibration.

Table 7-6 - Maximum Satisfactory Magnitudes of Vibration with Respect to Human Response (for up to 3 Blast Vibration Events Per Day)

Place and Time	Time	Satisfactory Magnitude[a] PPV mms^{-1}
Residential	Day[D] Night[D] Other Times[d]	6.0 to 10.0[C] 2.0 4.5
Offices[B]	Any time	14.0
Workshops[B]	Any time	14.0

NOTE 1: This table recommends magnitudes of vibration below which the probability of adverse comment is low (noise caused by any structural vibration is not considered).

NOTE 2: Doubling the suggested vibration magnitudes could result in adverse comment and this will increase significantly if the magnitudes are quadrupled.

NOTE 3: For more than three occurrences of vibrations per day see the further multiplication factor in Section 5.2 of the Standard.

A) The satisfactory magnitudes are the same for the working day and the rest of the day unless stated otherwise.

B) Critical working areas where delicate tasks impose more stringent criteria than human comfort are outside the scope of this standard.

C) Within residential properties people exhibit a wide variation of tolerance to vibration. Specific values are dependent upon social and cultural factors, psychological attitudes and the expected degree of intrusion. In practice the lower satisfactory magnitude should be used with the higher magnitude being justified on a case-by-case basis.

D) For the purpose of blasting, daytime is considered to be 08h00 to 18h00 Monday to Friday and 08h00 to 13h00 Saturday. Routine blasting would not normally be considered on Sundays or Public Holidays, and Friday lunch-time, when many attend prayers, will also be avoided. Other times, covers the period outside of the working day, but exclude night-time, which is defined as 23h00 to 07h00.

Acoustics – Attenuation of Sound During Propagation Outdoors (ISO 9613:1996)[45]

7.2.20. ISO 9613:1996, titled Part 2 'Acoustics – Attenuation of Sound During Propagation Outdoors', specifies an international engineering method to calculate the attenuation of noise propagating outdoors under meteorological conditions favourable for propagation.

[45] ISO (1996). ISO9613-2 Acoustics – Attenuation of Sound During Propagation Outdoors.

7.2.21. The conditions for propagation are downwind, or equivalent, under a moderate ground-based temperature inversion, such as that encountered at night.

7.2.22. The method consists of octave band algorithms to calculate the propagation originated from a point source, or several sources, taking into account the following physical effects:

- Geometrical divergence;
- Atmospheric absorption;
- Ground effect;
- Reflection from surfaces; and
- Screening by obstacles.

Calculation of Railway Noise (1995)[46]

7.2.23. This technical memorandum provides a method to determine the eligibility for insulation for residential properties from railway. It also aims to provide guidance on the calculation of railway noise for more general applications such as the assessment of the noise from proposed railways.

7.2.24. The calculations in this Technical Memorandum take into account (amongst others) the rolling stock types and flows for daytime and night-time, speed, track type and the position of discontinuities (points, crossovers, etc.), track support structure correction, barrier correction, and distance from the alignment.

7.2.25. The Calculation of Railway Noise (CRN) is divided into 3 sections. The first section presents the steps for the prediction of railway noise at a distance considering factors such as the noise from individual trains, intervening ground cover and the alignment of the track. Sections 2 and 3 deal with additional procedures for railway in specific cases and the requirements for measurements.

Additional Railway Noise Source Terms (2007)[47]

7.2.26. This document aims to complement the list of rolling stock fleet advised in the CRN (1995). Rolling noise source term corrections are presented for several train types not originally published in CRN using measurement data. Source term corrections in this document were used to define the noise source levels for the high-speed trains for this assessment.

7.3 ASSESSMENT METHODOLOGY

SCOPE

7.3.1. The assessment focuses on the following key elements:

- Baseline noise survey: noise measurements were undertaken to establish the existing noise climate at sensitive locations near the Project;
- Construction noise and vibration: Noise and vibration predictions have been undertaken to determine likely significant effects as a result of the construction phase of the Project.

[46] Department of Transport UK (1995). Calculation of Railway Noise.
[47] Defra UK (2007). Additional railway noise source terms for 'Calculation of Railway Noise 1995'.

Assumptions have been made at this stage with regard to size, number, type and location of construction plant and vehicles to advise on the potential for significant effects; and

- Operational noise and vibration: Noise and vibration predictions have been undertaken to determine likely significant effects as a result of the operational phase of the Project. Projections have been provided for the type, number and speed of trains expected to use the Project during years 2026 and 2041. Design drawings provided by AYGM have been used to position the alignment of the Project.

BASELINE NOISE SURVEY

7.3.2. A baseline noise survey was undertaken between 1st and 10th July 2020 in accordance with ISO 1996-2:2017 at locations representative of noise-sensitive receptors potentially affected by the construction and operational phases of the Project. The noise survey included long-term (unattended) and short-term (attended) measurements. A site calibration check was undertaken before starting and after finishing all measurements, with no significant variation noted.

7.3.3. The noise level meters for long-term locations were setup to log continuously over 1 week, every 15-minutes. For short-term locations, 4 series of 15-minute measurements were undertaken during the daytime.

7.3.4. The sound level meters were set-up to record noise descriptors L_{Aeq}, L_{A90}, $L_{Amax(fast)}$ and L_{A10}. Sound recording was also setup to identify noise sources during unattended periods. Noise measurements were undertaken using a Class 1 Sound Level Meter, in free field conditions, more than 3.5m away from any reflective surface other than the ground.

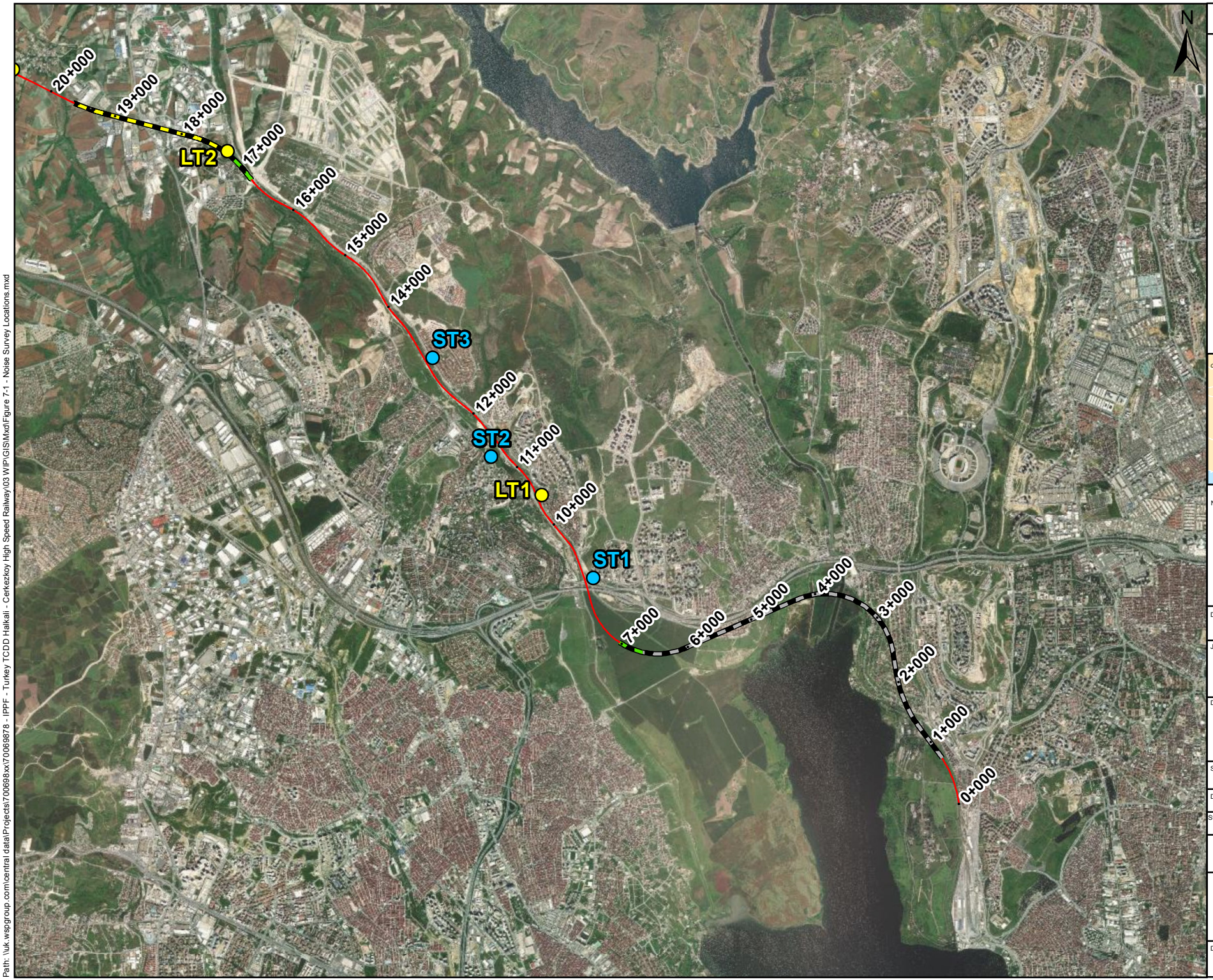
7.3.5. The sound level meters were installed with a windshield suitable for outdoor unattended measurements. Weather data, specifically rainfall, wind speed and direction, was collected from Çatalca Weather Station. This data was used to exclude noise measurements in periods of wind speeds higher than 5m/s. No periods of rain were observed during the survey.

7.3.6. A list of the noise survey locations along with the associated UTM35N coordinates is presented in **Table 7-7**. **Figure 7-1** has been prepared to illustrate their location in the context of the Project.

Table 7-7 - Noise Survey Locations

Survey Location	Point X UTM35N	Point Y UTM35N	Description
Long-term 1 (LT1)	642286	4548069	Representative of noise climate for properties in Bahçeşehir.
Long-term 2 (LT2)	642286	4548069	Representative of noise climate for properties in Ömerli.
Long-term 3 (LT3)	637725	4553056	Representative of noise climate for properties in Yeşilbayır.
Long-term 4 (LT4)	634614	4554240	Representative of noise climate for properties in Kaleiçi.
Long-term 5 (LT5)	621137	4560002	Representative of noise climate for properties in Kaleiçi.

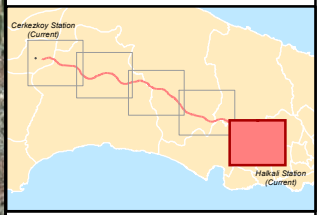
Survey Location	Point X UTM35N	Point Y UTM35N	Description
Long-term 6 (LT6)	614266	4563701	Representative of noise climate for properties in Kabakça.
Long-term 7 (LT7)	599871	4565089	Representative of noise climate for properties in Küçüksinekli.
Long-term 8 (LT8)	586992	4570318	Representative of noise climate for properties in İstasyon.
Short-term 1 (ST1)	643032	4546863	Representative of noise climate for properties in Bahçeşehir.
Short-term 2 (ST2)	641547	4548623	Representative of noise climate for properties in Bahçeşehir.
Short-term 3 (ST3)	640704	4550060	Representative of noise climate for properties in Bahçeşehir.
Short-term 4 (ST4)	623617	4556582	Representative of noise climate for properties in Çatalca.
Short-term 5 (ST5)	622780	4557950	Representative of noise climate for properties in Kaleiçi.
Short-term 6 (ST6)	615975	4562595	Representative of noise climate for properties in İnceğiz.
Short-term 7 (ST7)	609297	4563863	Representative of noise climate for properties in Bekirli.



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Legend

- Long Term Monitoring Location
- Short Term Monitoring Location
- Proposed Railway Route
- Tunnel (TBM - Double Tube)
- Tunnel (NATM)
- Tunnel (Cut - Cover)



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-1 - Noise Survey Locations

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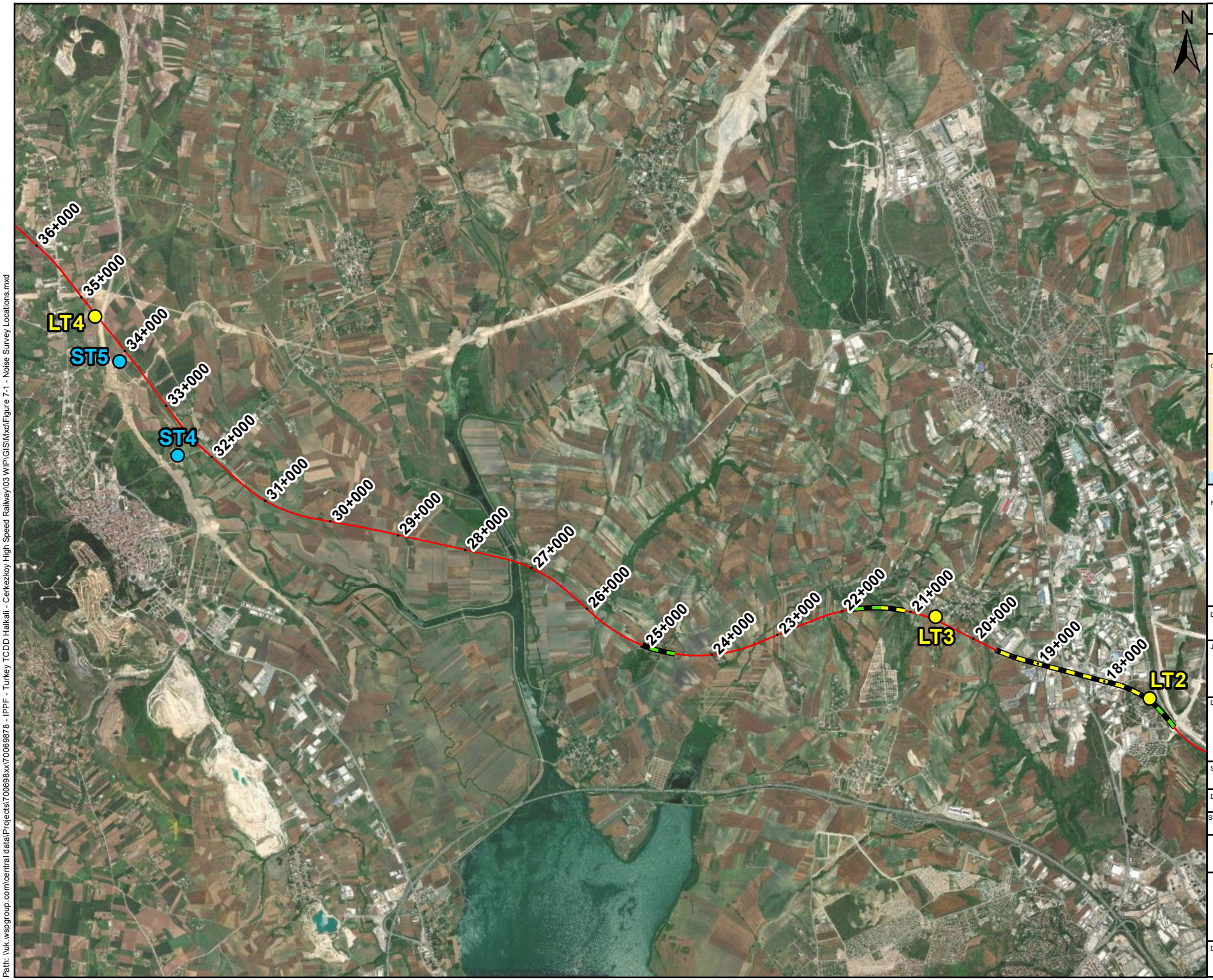
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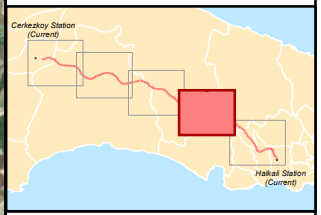
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- Long Term Monitoring Location
- Short Term Monitoring Location
- Proposed Railway Route
- Tunnel (NATM)
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Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

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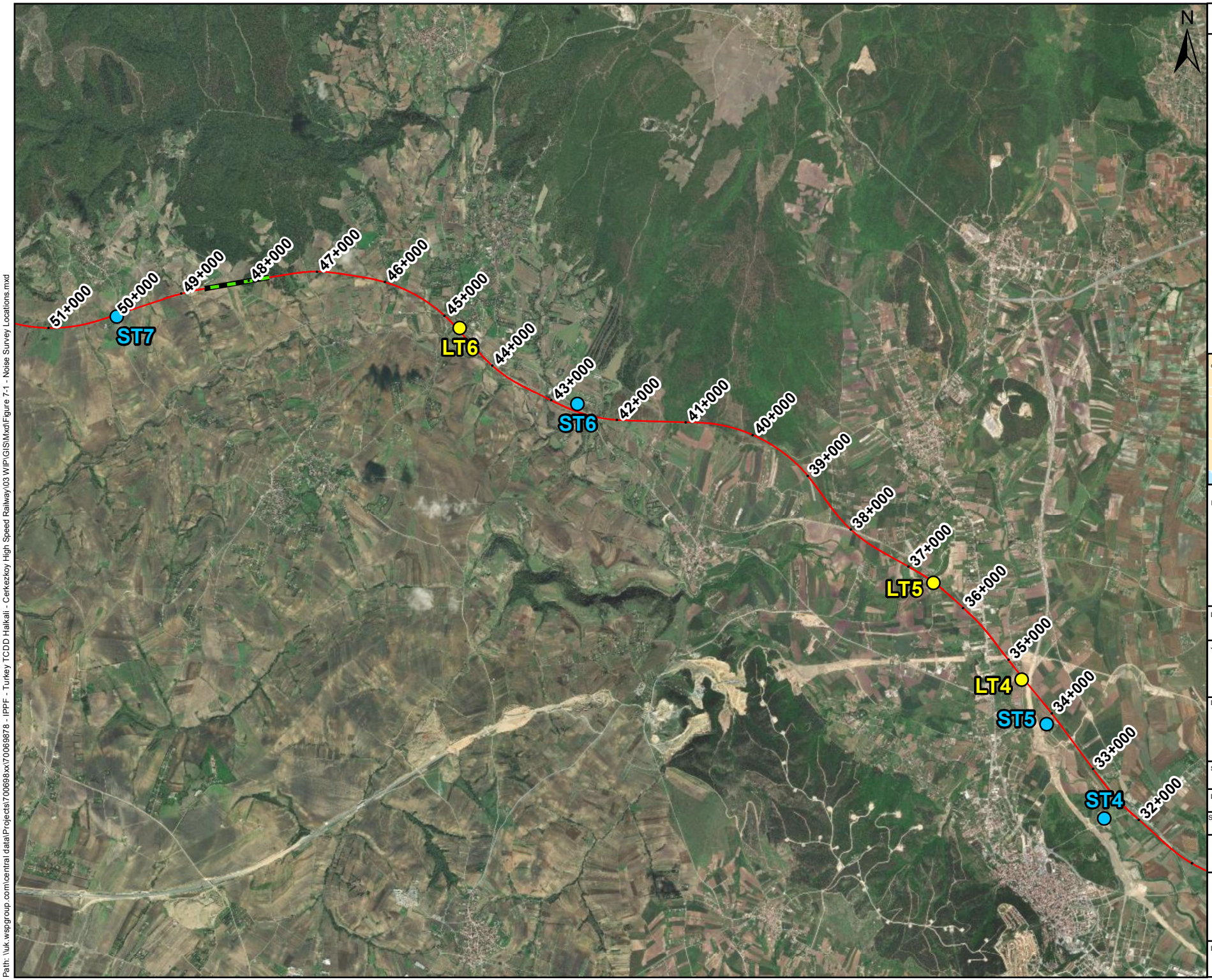
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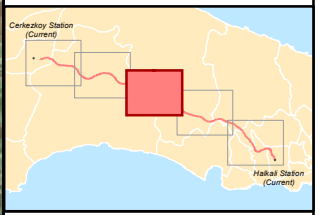
Path: \\uk.wspgroup.com\central data\Projects\70069878\xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\GIS\MXD\Figure 7-1 - Noise Survey Locations.mxd



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Legend

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- Short Term Monitoring Location
- Proposed Railway Route
- Tunnel (Cut - Cover)



Note:

Drawing Status: FINAL

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Drawing Title: Figure 7-1 - Noise Survey Locations

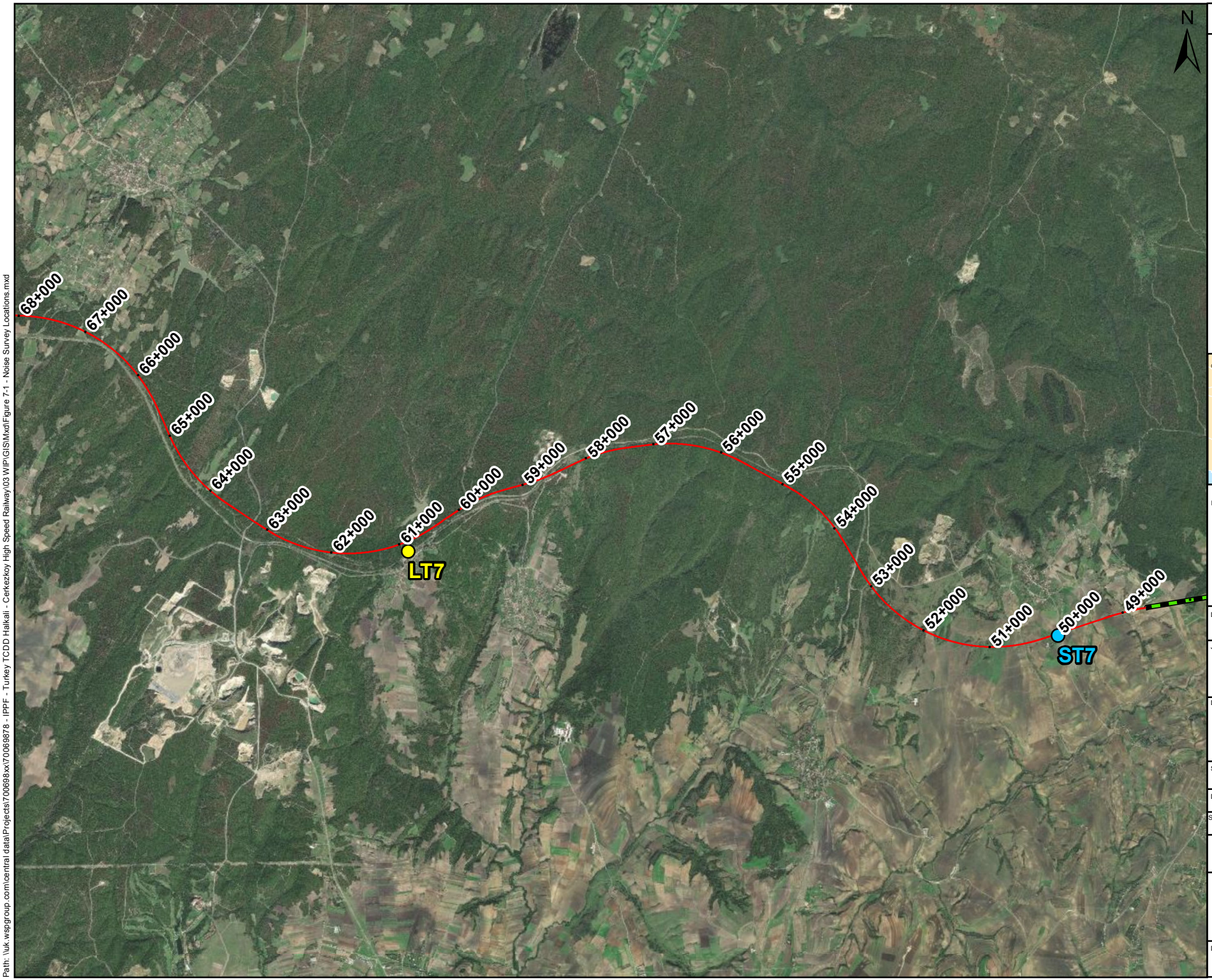
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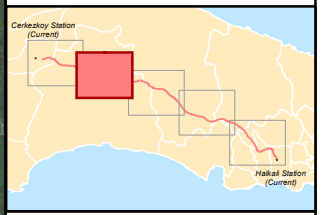
Path: \\uk.wspgroup.com\central data\Projects\700698\xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\GIS\Mxd\Figure 7-1 - Noise Survey Locations.mxd



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Legend

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- Proposed Railway Route
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Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-1 - Noise Survey Locations

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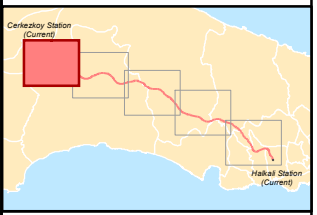
Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\GIS\Mxd\Figure 7-1 - Noise Survey Locations.mxd



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Legend

- Long Term Monitoring Location
- Proposed Railway Route



Note:

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Drawing Title: Figure 7-1 - Noise Survey Locations

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Km

Drawing Number: Figure 7-1 (5/5)

Path: \\uk.wspgroup.com\central data\Projects\70069878-xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\GIS\Mxd\Figure 7-1 - Noise Survey Locations.mxd

CONSTRUCTION NOISE ASSESSMENT

7.3.7. Construction activities inevitably lead to some degree of noise disturbance at locations near the construction activities. It is however a temporary source of noise. The noise levels generated by construction have the potential to impact upon nearby noise-sensitive receptors. Noise levels at any one location will vary as different combinations of plant machinery are used and throughout construction activities and the specific locations of these activities will also change.

7.3.8. Noise predictions have been undertaken in accordance with BS5228 to determine the likely noise impact during construction at the nearest noise sensitive receptors. Assumptions have been made on the likely phases during the construction period and the type, location and number of plant items operating in each of them. Noise predictions have been undertaken for a study area of 300m either side of the railway to represent a typical daytime operation. The sensitivity of all receptors in this study has been considered as 'High'.

7.3.9. The following core phases have been assumed:

- Phase 1: Site Preparation
- Phase 2: Earthworks
- Phase 3: Bridge and Viaduct Construction
- Phase 4: Tunnel Boring Machine
- Phase 5: Rail Track Construction

7.3.10. The configuration of plant items used in the noise predictions in each of the construction phases is presented in Appendix I.

7.3.11. The noise predictions have been compared against the noise limits stated in the Regulation on the Assessment and Management of Environmental Noise, and advice in BS5528. Community areas subject to noise levels exceeding $L_{Aeq,12h}$ 70dB have been determined in each of the core construction phases. The number of properties per community area that exceed this threshold, and will therefore potentially be subject to significant effects, have been counted. It is noted that in this exercise all properties within the expropriation corridor have been excluded.

7.3.12. This assessment does not follow the magnitude of impact and categorisation of significance defined in **Chapter 5: Approach to ESIA**. Instead, properties which are likely to be subject to noise levels which exceed this threshold have been identified, as they will potentially be subject to a significant effect.

CONSTRUCTION VIBRATION ASSESSMENT

7.3.13. A desktop assessment has been undertaken in order to determine impacts along the route due to vibration levels arising during the construction phase. This involves assessing annoyance from human receptors and also damage to building structures.

7.3.14. In order to identify human receptors along the Project, the same criteria have been adopted for vibration as the operational noise assessment. Publicly available data has been used to identify properties, hospitals, places of worship and educational facilities within a 100m study area from the centreline of the rail corridor for the tunnelling, piling and blasting, and 100m from the expropriation corridor for surface compaction. It is noted that in this exercise all properties within the expropriation corridor have been excluded as they will be expropriated (as detailed in the **RAP**).

7.3.15. The sensitivity of all receptors in this study has been considered as 'High'.

7.3.16. Activities most likely to generate potentially significant vibration levels during construction are:

- Tunnelling undertaken via boring machine;
- Blasting undertaken for the NATM tunnels;
- Surface compaction undertaken with vibratory rollers; and
- Piling activities undertaken during the construction of any structures along the route.

7.3.17. The methodology described in BS 5228-2 Annex E has been used to predict vibration levels at nearby sensitive receptors. Predictions are made in the form of a peak particle velocity (PPV), which is the maximum speed of a particle at the receptor point. The position and distance of the activities relative to the receptors have been calculated dependant on the earthwork and track contours, and location of structures along the Project. Parameters have been supplied based on professional experience employing a worst-case approach.

7.3.18. The classification of the magnitude of impact for construction vibration is shown in Table 7-8 and has been based on BS5228 guideline values relating to the human response to vibration and the initial onset of cosmetic damage. This assessment focuses on the absolute vibration level arising from construction only, rather than a change in the vibration level, therefore, the baseline vibration climate has not been taken into account. This is a conservative approach, which is representative of the worst-case scenario. This is because if receptors are already experiencing some existing vibration, the increase in the vibration level (magnitude of impact) that they will experience during construction, will be less than that assessed.

Table 7-8 - Magnitude of Impact for Construction Vibration

Magnitude	Vibration Level ((PPV) in mm/s)
Very Large	6
Large	1
Moderate	0.3
Slight / No Change	0.14

7.3.19. The level of vibration that may cause building damage is far in excess of those that may cause annoyance. If construction vibration is controlled to within the threshold of annoyance (1 mm/s), it is very unlikely that buildings could be damaged by vibration.

7.3.20. The onset of cosmetic damage described in Table 7-3 relates to intermittent vibration and identifies a threshold where cracks in plasterwork or decorative finishes can occur. Structural distress can also occur due to continuous vibration, at vibration levels of around 6mm/s PPV, which can be generated by construction equipment such as vibratory compaction or tunnel boring (this can occur at around half of the cosmetic damage guideline values). BS 7385-2 states that minor structural damage occurs at a vibration level twice that of cosmetic damage.

7.3.21. The prediction of vibration effects in relation to blasting activities has been considered in line with guidance described in BS5228-2 and BS6472-2. BS5228-2 describes a method to determine the distance that vibration (PPV) will be within the 6mm/s criteria described in BS6472-2 shown in **Table**

7-6. For a 100kg maximum instantaneous charge, receptors within a 200m area (slant distance) from the blasting site will exceed 6mm/s. As outlined in the **ESMP** a detailed analysis of vibration must be completed when the construction contractor is engaged and details of blasting activities are known, including location, the size and frequency of events.

OPERATIONAL NOISE ASSESSMENT

7.3.22. In addition to the baseline noise survey, a desktop study was undertaken to identify the noise-sensitive receptors potentially affected by the operation of the Project. Publicly available data was used to identify properties, hospitals, places of worship and educational facilities along a study area of 300m either side of the Project. A total of 2,308 receptor buildings have been included in the 3D noise model.

7.3.23. A sample of the main noise-sensitive receptor areas within the study have been selected as summarised in **Table 7-9** and shown in **Figure 7-1**. In the table, the approximate chainage of the Project has been included.

Table 7-9 - Noise-Sensitive Receptor Locations

Receptor Areas	Approximate Chainage
Halkali	0 – 5+600
Bahçeşehir	9+100 – 14+000
Ömerli	14+500 – 19+200
Yeşilbayır	19+500 – 22+600
Bahşayış	23+600 – 25+600
Ferhatpasa	28+800 – 29+400
Çatalca	31+100 – 33+000
Kaleiçi	33+800 – 36+900
Gökçeali	37+000 – 40+300
İnceğiz	41+200 – 43+000
Kabakça	43+300 – 47+400
Bekirli	47+900 – 50+400
Küçüksinekli	60+400 – 61+200
Çayırdere	66+600 – 68+500
İstasyon	73+400 – 76+700

7.3.24. A 3D noise model has been prepared using ArcGIS Desktop 10.5.1 and specialist software CadnaA 2020 incorporating the methodology for the Calculation of Railway Noise (1995)[46].

7.3.25. Plan and cross section design drawings have been used to define the horizontal and vertical alignment of the Project. Topographical data in the form of digital terrain model with 30m resolution grid was included. This information was supplemented with detailed data showing the embankments and cuttings as part of the Project.

7.3.26. Tunnels have been incorporated into the 3D noise model. Bridges and viaducts have also been defined in accordance with the CRN methodology. Potential noise impact arising from the tunnel ventilation system or wheel squeal from the trains have not been assessed, as the detailed design will be developed to ensure compliance with the TSIs, including the 'Rolling Stock – Locomotives and Passengers TSI' and the 'Noise TSI'. It is expected that the magnitude of impact due to this element would be **Minor Adverse**, **Not Significant**.

7.3.27. This iteration of the 3D noise model does not include any embedded noise mitigation in the form of noise barriers.

7.3.28. Multi-storey buildings have been added, where applicable, in populated areas to the eastern end of the Project near Istanbul. For all other buildings, a height of 6m has been assumed. At all buildings, a representative single receptor per floor facing the Project has been used for the noise predictions.

7.3.29. The noise sources included in the noise model correspond to the noise arising as a result of train pass-by movements expected during operation for daytime and night-time. The type of trains, along with the number of trains and cars used in the model, are tabulated in Appendix I.

7.3.30. The anticipated train movement data for the operational phase has been included in the model, the data relates to the following railway noise scenarios:

- Opening Year 2026 with the Project; and
- Design Year 2041 with the Project.

7.3.31. The significance criteria have been derived based on the tables for magnitude and significance of effects presented in **Chapter 5: Approach to ESIA**. For the purposes of this chapter, it has been assumed that all receptors assessed are high sensitivity. The World Bank Group Noise Level Guidelines[38] has been used as the basis for the magnitude of operational noise, and this is described in **Table 7-10**.

Table 7-10 - Description of the Magnitude of Operational Noise Impact

Magnitude of Impact	Criteria L_{Aeq}	Criteria L_{Amax}
Very Large	More than 5dB above World Bank Group Criteria.	Above 45dB and10 events per night
Large	Between 3dB and 5dB above World Bank Group Criteria.	
Moderate	Between 1dB and 3dB above World Bank Group Criteria.	

Magnitude of Impact	Criteria L_{Aeq}	Criteria L_{Amax}
Slight	Less than 1dB above World Bank Group Criteria.	Below 45dB and10 events per night
No Change	No alteration of noise climate compared to World Bank Group criteria.	

7.3.32. Based on high sensitivity for receptors, **Table 7-11** presents the classification for operational noise effects. Effects that are classified as moderate, large or very large are considered to be significant effects, whereas effects classified as minor or below are not considered to be significant, in accordance with **Chapter 5: Approach to ESIA**. This means that an increase of 1dB over the World Bank Criteria is considered in this chapter as a significant effect. In addition, maximum noise levels L_{Amax} over 45dB and over 10 events per night is also considered a significant effect.

Table 7-11 - Matrix for Classifying Operational Noise Effects

		Magnitude of Impact				
		No Change	**Slight**	**Moderate**	**Large**	**Very Large**
Environmental Sensitivity	**High**	Neutral	Minor	Minor or Moderate	Moderate or Large	Large or Very Large

7.3.33. Results of the 3D noise model have been also compared against the noise limits stipulated in the Regulation on the Assessment and Management of Environmental Noise[36] and recommendations in BS8233:2014. Potential exceedances against design target are noted, where applicable.

OPERATIONAL VIBRATION ASSESSMENT

7.3.34. The most important source of operational vibration are wheel and rail vibrations induced during contact when trains are passing. The amount of vibration transmitted into the ground is primarily controlled by the roughness of the wheel and rail, the speed of the train, and the stiffness and mass of each element. The wheels, axles, rails, rail pads, components and support structures interact, and the resulting vibration is transmitted into the ground and can then propagate out to sensitive receptors.

7.3.35. A desktop study was undertaken to identify receptors along the Project with the potential to be adversely affected by ground-borne vibration. The assessment has focused on the effect of vibration on human receptors, as the criteria for human receptors are much lower than the thresholds for cosmetic damage to buildings. Non-human receptor ground-borne vibration criteria are described below.

7.3.36. Should there be any nearby facilities with sensitive equipment, such as microscopes or other technological equipment requiring low levels of vibration, acceptable levels of vibration for different forms of sensitive equipment and operation should be based on the IEST Recommended Practice

012.3[48]. This ranges from VC-A (50 μms^{-1}), which includes equipment such as optical microscopes to 400X, optical microbalances proximity and projection aligners, to VC-G (0.781 μms^{-1}), which is appropriate for extremely sensitive equipment.

7.3.37. Cultural heritage assets that may be sensitive to vibration are described in **Chapter 9: Cultural Heritage**. The potential for cosmetic damage due to ground vibration arising from the operation of the Project has been assessed at these receptors in accordance with guideline values described in BS7385-2.

7.3.38. The human response to vibration is dependent on a number of factors including the circumstances in which vibration is occurring. For example, the tolerance to vibration in an office environment is likely to be higher than in a residential environment. Other social and cultural factors, psychological attitudes and the expected degree of intrusion can also determine the degree of sensitivity. The sensitivity of all receptors has been considered as 'High'.

7.3.39. The likelihood of an 'adverse comment' (a negative response) is described in BS6472-1:2008 has been used to determine the magnitude of impact of the vibration. **Table 7-5**, shown previously, describes the VDV ranges which would be likely to result in adverse comment within residential buildings. These values have also been adopted for other non-residential sensitive receptors, such as hospitals, places of worship and educational facilities.

7.3.40. In order to identify sensitive receptors along the Project, the same criteria has been adopted for vibration as the operational noise assessment. Publicly available data has been used to identify properties, hospitals, places of worship and educational facilities within a 100m study area from either side of the alignment. It is assumed that all properties within the expropriation corridor will be demolished and have been excluded. The expropriation corridor is the 50m wide corridor, 25m either side of the Project centreline.

7.3.41. In order to predict ground-borne vibration levels from the Project, two approaches have been used, one for passenger services and one for freight services.

Passenger Services

7.3.42. Ground-borne vibration from passenger services have been predicted using a method developed as a part of the environmental assessment of High Speed 2 in the UK[49]. The method utilises an empirical model derived from the analysis of vibration due to the passage of high speed trains and other trains on surface sections of ballasted track in France and the UK. Adjustments for the following parameters are considered as a part of the calculation procedure:

- Operation profile (Train speed and flow);
- Existing ground conditions;
- Train type;
- Unsprung mass;

[48] Institute of Environmental Sciences and Technology (|EST) (2015). |EST-RP-CC 012.3 Contamination Control Division Recommended Practice, Considerations in Cleanroom Design.
[49] HS2: Environmental Statement Vol 5 Technical Appendices: Sound Noise and Vibration: Annex D1 - Operational Assessment: Groundborne Sound and Vibration, 2013.

- The track-form; and
- Train length.

7.3.43. The result is a vertical VDV calculated at the first floor of a building. The building transfer function adopted as a part of the calculation methodology was the result of an analysis of measurements completed by British Rail and London Underground Ltd and predicts the vibration at the first floor of a typical brick-built residential property. This transfer function is typical for most European countries and represents a cautious approach when assessing against other building types, such as concrete structures. As depicted in the **RAP** properties in the study area are primarily constructed of bricks/stone or concrete/cement, hence using the brick-built residential property vibration levels represents a conservative approach.

Freight Services

7.3.44. For freight, a common equation for the prediction of ground-borne vibration as described in Amick (1999)[50] has been used. This method takes into account the geometric spread and soil damping attenuation effect, shown below:

$$A_1 = A_0 \left(\frac{r_0}{r_1}\right)^n e^{-\alpha(r_1 - r_0)}$$

7.3.45. A_0 and A_1 represents the vibration amplitude at distance r_0 and r_1 respectively. α is the attenuation coefficient due to material damping for a specific soil, and n is the geometric attenuation coefficient. The values for each of these parameters can be difficult to determine: The amplitude depends on a number of factors including the type of train, the speed, length of the train, the unsprung mass of wheels, axles and any mounted equipment. The geometric attenuation coefficient represents the damping caused by geometric spreading and has been modelled for freight as a moving point source ($n = 0.5$). The material (soil) damping coefficient is frequency dependant and depends on the specific soil type which varies along the Project.

7.3.46. A worst-case, cautious approach has been utilised to determine values for some of these unknown variables. Past measurements undertaken by WSP have been used to estimate the VDV amplitude of individual freight services on the Project. An indicative, reasonably worst-case value (0.03) has also been employed for the material damping coefficient for soil types along the Project.

Assessment (Passenger Services and Freight Services)

7.3.47. The vibration dose over the day and night periods are calculated by summing individual train passes of passenger and freight services using the root-sum-quad method described in BS6472-1:2008. This method aims to slightly overestimate the discomfort caused by transitory vibration.

$$VDV_{day/night} = \left(\sum_{n=1}^{n=N} VDV_t^4\right)^{0.25}$$

[50] Hal Amick (1999). A Frequency-Dependent Soil Propagation Model.

7.3.48. Calculated VDVs at sensitive receptors along the Project have then been classified by the probability of adverse comment described in BS6472-1:2008 in Table 7-5. The magnitude of impact criteria for operational ground-borne vibration has been determined based on BS6472-1:2008 and is shown in **Table 7-12**. Significant effects are considered for impacts with a magnitude of moderate or above.

Table 7-12 - Magnitude of Impact for Ground-borne Vibration

Magnitude	Daytime Vibration level ($ms^{-1.75}$)	Night-time Vibration level ($ms^{-1.75}$)
Large / Very Large	>0.8	>0.4
Moderate	0.4 to 0.8	0.2 to 0.4
Slight / No Change	< 0.4	< 0.2

Re-radiated Noise

7.3.49. Re-radiated noise refers to noise that is experienced within a building due to radiation from vibration building elements (e.g. floors, walls and ceilings). Levels have been calculated for passenger and freight services. Predicted vibration external to the building has been used to estimate maximum noise event levels (dB $L_{Amax,s}$) at the first floor using the Kurzweil method (described in the ANC guidance). This method was derived empirically from measurements completed by the Federal Transport Authority (US Department for Transportation)[51]. The event levels represent a maximum re-radiated noise level of a single train passing, and the results are therefore the same for both the opening and future years.

7.3.50. The magnitude of impact criteria for operational re-radiated noise is shown in **Table 7-13** has been determined based on FTA guidance[52] .

7.3.51. The 43dB threshold represents a self-reported reduction in sleep quality, waking up in the night or too early in the morning. The significance of these noise events is largely dependent on the number of events during the night and the level and number of events in the existing noise climate. FTA guidelines recommend a criteria of 30 vibration events of the same kind per day, which relates to 10 events over the night-time.

[51] Wilson Ihrig and Associates. State of the art review: Prediction and control of ground-borne noise and vibration from rail transit trains – Final report – Dec 1983. UMTA-MA-06-0049-84-4. DOT-TSC-UMTA-83-3
[52] FTA-VA-90-1003-06 (2006). Transit Noise and Vibration Impact Assessment

Table 7-13 - Magnitude of Impact for Re-radiated Noise

Magnitude	Night-time indoor maximum noise events ($L_{AS,max}$)
Large / Very Large	≥43
Moderate	≥35, <43
Slight / No Change	<35

ASSUMPTIONS AND LIMITATIONS

7.3.52. Plant item configuration used in the noise predictions during the construction of the Project is presented in Appendix A. Tubular steel piling – hydraulic hammering, or equivalent, has been assumed for the construction of structures including the potential effect of tunnelling activities.

7.3.53. The train movement data for the operational assessment is presented in Appendix A, please note the data in the appendix corresponds to each way (trains running in one direction), therefore the total number of trains movements is double. The following further assumptions have been made to undertake the noise predictions:

- High speed trains have been represented as Class 377;
- The high-speed trains run at a maximum speed of 200km/h and freight trains at 120km/h;
- There will be no more than 16 high speed train movements per day by 2041;
- There will be no more than a total of 52 train movements per day by 2041, 16 of which correspond to freight trains during daytime and night-time (timings of the trains during the daytime and night-time will be determined by TCDD Transport both prior to and during operation);
- E43000 and E68000 trains (regional and international services) have been represented as Class 92 with a maximum speed of 200km/h;
- The high-speed passenger trains will typically consist of 6 cars and freight trains 20 cars; and
- The existing railway will remain for maintenance and emergency purposes only. Therefore, it has not been modelled in the scenarios with the Project.

7.3.54. The assessment presented in this chapter relies on the accuracy of the CAD data that is available for the Project, which will be revised as the design is finalised. These design revisions will be subject to a design change management process to confirm that this assessment remains valid. Sensitive receptor buildings with facades that are within 25m, but are outside or touching the expropriation boundary, have been included in this assessment.

7.3.55. It is important to note that prediction methodologies employed are based on generic transfer functions and may not fully capture the soil or building's response to rail induced vibration. The methods utilised provide a standardised approach to assessing adverse impacts due to the Project and are recognised to provide a good indication of whether vibration is likely to be an issue.

7.3.56. Measured VDV values for freight have been used to extrapolate vibration impacts at sensitive receptors along the Project. These measurements have not been undertaken on site, which incurs a significant uncertainty due to the large variability in the possible dynamic forces generated at the wheel-rail interface and the transfer functions of the trackform and soil types. These values and

other unknown variables have been supplied based on professional experience employing a worst-case approach. In this regard, it is expected that the results of this assessment present a greater impact than the actual operation of the Project.

7.4 BASELINE CONDITIONS

BASELINE NOISE SURVEY

7.4.1. Appendix K presents the noise monitoring forms which show a description of the locations and noise levels measured in each of the surveys. The photos illustrate the surrounding environment. **Table 7-14** shows a summary of the free-field noise levels recorded for the long-term locations.

Table 7-14 - Summary of Noise Survey Results: Long-Term

Survey Location	$L_{Aeq,12h}$ dB (07:00 – 19:00)	$L_{Aeq,4h}$ dB (19:00 – 23:00)	$L_{Aeq,8h}$ dB (23:00 – 07:00)
Long-term 1 (LT1) (Bahçeşehir)	69.3	68.5	62.9
Long-term 2 (LT2) (Ömerli)	60.2	56.8	53.7
Long-term 3 (LT3) (Yeşilbayır)	57.4	58.9	54.0
Long-term 4 (LT4) (Kaleiçi / Çatalca / Gökçeali)	54.9	54.6	51.3
Long-term 5 (LT5) (İnceğiz)	61.0	56.3	53.7
Long-term 6 (LT6) (Kabakça)	63.7	61.8	55.7
Long-term 7 (LT7) (Küçüksinekli)	55.9	55.9	51.2
Long-term 8 (LT8) (İstasyon)	54.8	53.4	52.0

7.4.2. A summary of the noise survey results for the short-term measurements is presented in **Table 7-15**.

Table 7-15 - Summary of Noise Survey Results: Short-Term

Survey Location	$L_{Aeq,15min}$ dB (readings within 07:00 – 22:00[53])
Short-term 1 (ST1) (Bahçeşehir)	59.5
Short-term 2 (ST2) (Bahçeşehir)	51.9

[53] Four short term noise measurements of 15 minutes were carried out within this time period. An average is presented in the table.

Survey Location	$L_{Aeq,15min}$ dB (readings within 07:00 – 22:00[53])
Short-term 3 (ST3) (Bahçeşehir)	68.1
Short-term 4 (ST4) (Çatalca)	51.2
Short-term 5 (ST5) (Çatalca)	53.3
Short-term 6 (ST6) (Kabakça)	62.5
Short-term 7 (ST7) Bekirli	51.6

7.4.3. The noise climate in most surveyed locations was observed to be typical of a rural nature with agricultural noise and occasional road traffic noise. Noise levels at LT1 and LT2 towards the east of the Project are influenced by constant road traffic noise.

7.4.4. The survey results indicate that the existing baseline noise climate generally exceeds guidelines values presented in the form of absolute noise levels by the World Bank Group. This is due to existing road traffic noise and train pass by events on the existing railway, as well as agricultural activity.

7.5 POTENTIAL IMPACTS AND EFFECTS

CONSTRUCTION NOISE

7.5.1. Noise predictions have been undertaken to determine the number properties subject to a noise level exceeding $L_{Aeq,12h}$ 70dB, therefore, subject to potential significant effects, during the construction of the Project. **Table 7-16** presents the results indicated per phase and community area prior to mitigation.

Table 7-16 - Construction Noise: Number of Properties with Significant Effect (prior to mitigation)

Receptor Areas	Phase 1: Site Preparation	Phase 2: Earthworks	Phase 3: Bridges and Viaduct	Phase 4: Tunnelling	Phase 5: Track Construction
Halkali	0	14	0	4	9
Bahçeşehir	31	60	0	0	39
Ömerli	11	16	0	11	8
Yeşilbayır	5	8	0	2	3
Bahşayış	2	3	0	0	1
Ferhatpasa	0	0	0	0	0
Çatalca	7	10	0	0	0

Receptor Areas	Phase 1: Site Preparation	Phase 2: Earthworks	Phase 3: Bridges and Viaduct	Phase 4: Tunnelling	Phase 5: Track Construction
Kaleiçi	19	24	8	0	15
Gökçeali	5	6	2	0	2
İnceğiz	4	7	2	0	2
Kabakça	19	30	0	0	15
Bekirli	7	10	0	0	0
Küçüksinekli	1	1	0	0	0
Çayırdere	5	7	0	0	2
İstasyon	13	17	4	0	39
Total (510)	129	213	16	17	135

7.5.2. It can be seen from Table 7-16 that most community areas have the potential to experience **significant adverse noise effects** during construction without mitigation. Phase 3 (bridges and viaducts) will have a lower impact due to the large distance from these structures to densely populated areas. The community areas of Bahçeşehir, Ömerli, Kaleiçi, Kabakça and İstasyon are likely to be worst affected by noise during construction, without mitigation.

7.5.3. Based on the assumptions made on this assessment, without mitigation, properties within the following distances are likely to experience a significant adverse effect during the construction of the Project.

- Phase 1: 35m from the edge of the earthworks;
- Phase 2: 45m from the edge of the earthworks;
- Phase 3: 100m from piling activities;
- Phase 4: 100m from the portal of the tunnel; and
- Phase 5: 60m from the centre of the track.

7.5.4. In respect of blasting activities, if required, most of the sound energy is concentrated below the audible frequency range, however, it has the potential to be perceived as concussion in a phenomenon called air over pressure. Routine blasting can generate air over pressure levels at adjacent locations of around 120 dB(linear), which is equivalent to wind velocity of 5m/s and above the threshold of perception. Once a Contractor is appointed, and the **CESMP** with the accompanying **Tunnel Construction Plan** is developed, then an appraisal should be completed (as required in the **ESMP**).

7.5.5. It is likely that a **significant effect** on noise levels will be experienced by receptors along the Project during construction, prior to the implementation of any mitigation measures. However, it is noted that this is unlikely to occur during the whole duration of the construction phase and it will be for limited

duration only. It is anticipated that the highest number of receptors adversely affected will occur at Bahçeşehir, Ömerli, Kaleiçi, Kabakça and İstasyon, particularly during earthwork activities.

CONSTRUCTION VIBRATION

7.5.6. The number of properties in each of the impact categories for construction vibration are shown in **Table 7-17**. The impacts are shown without mitigation and within receptor areas along the Project during tunnelling, earthworks or pilling.

Table 7-17 - Construction Vibration Impact

Magnitude of Impact / Receptor Areas	Number of Properties			
	Slight / No change	Moderate	Large	Very Large
Halkali	117	312	427	0
Bahçeşehir	123	95	3	0
Ömerli	49	61	18	0
Yeşilbayır	24	9	0	0
Bahşayış	5	1	0	0
Ferhatpasa	0	0	0	0
Çatalca	29	0	0	0
Kaleiçi	14	28	7	0
Gökçeali	10	6	1	0
İnceğiz	9	5	1	0
Kabakça	43	25	3	0
Bekirli	11	5	0	0
Küçüksinekli	1	0	0	0
Çayırdere	11	3	1	0
İstasyon	5	21	5	0
Total	451	571	466	0

7.5.7. Without mitigation, the magnitude of impacts relating to construction vibration have the potential to be large within receptor areas along the Project. A large impact relates to vibration that will likely cause annoyance and complaint; however it may be tolerated in certain situations (and for short periods) if advance warning is given to residents. Those most impacted by construction vibration are

the receptors that are located nearest to the proposed earthworks and structures that requiring piling (and the NATA tunnels that require blasting, as discussed in paragraph 7.5.9). Large impacts are also expected due to tunnel boring activities at Halkali. Cosmetic damage due to vibration impacts (above 6mm/s) are shown to be unlikely.

7.5.8. Cultural heritage assets along the route have also been assessed, and the likelihood of cosmetic damage to buildings and structures is low, with PPV levels predicted to be below 6mm/s. This would not include the impacts of blasting.

7.5.9. With regard to blasting activities, it is expected that there will be receptors within 200m of the tunnel areas. An assessment should be completed once more information is available relating to the location, size and number of blasting events.

7.5.10. It is likely that a **Large Adverse (Significant)** effect (disturbance) due to vibration levels will be experienced by receptors along the Project during construction, prior to the implementation of any mitigation measures.

OPERATIONAL NOISE

7.5.11. Operational noise predictions have been undertaken at all receptors in the 3D noise model. A sample of noise modelling results is presented in **Table 7-18**, for the day, evening and night periods. Values shown in this table correspond to a worst-case scenario with the highest noise levels within the community areas described in **Table 7-9**. Noise levels exceeding the limits in the Regulation on the Assessment and Management of Environmental Noise[36] are shaded in red and the number of properties likely to exceed the noise limits is presented in brackets.

7.5.12. The number of properties likely to exceed the noise limits are presented in **Appendix J**.

Table 7-18 - Summary of Operational Noise Modelling Results: Opening Year

Receptor Areas	$L_{Aeq,12h}$ dB (07:00 – 19:00)	$L_{Aeq,4h}$ dB (19:00 – 23:00)	$L_{Aeq,8h}$ dB (23:00 – 07:00)
Halkali	57.0	57.0	49.8
Bahçeşehir	59.0	59.0	51.8
Ömerli	58.0	58.0	50.8
Yeşilbayır	52.6	52.6	45.4
Bahşayış	53.0	53.0	45.8
Ferhatpasa	45.3	45.3	38.9
Çatalca	45.6	45.6	48.7
Kaleiçi	58.1	58.1	58.3 (6)
Gökçeali	55.2	55.2	50.8
İnceğiz	61.6	61.6 (1)	57.2 (1)

Receptor Areas	$L_{Aeq,12h}$ dB (07:00 – 19:00)	$L_{Aeq,4h}$ dB (19:00 – 23:00)	$L_{Aeq,8h}$ dB (23:00 – 07:00)
Kabakça	61.0	61.0 (1)	56.6 (1)
Bekirli	51.5	51.5	47.1
Küçüksinekli	48.4	48.4	44.0
Çayırdere	58.6	58.6	54.2
İstasyon	61.6	61.6 (1)	57.2 (1)

7.5.13. The noise modelling results for the opening year in **Table 7-18** generally comply with the noise limits stated in the Regulation on the Assessment and Management of Environmental Noise[36]. Values in red are likely to exceed the limits at the worst-case receptors, which are the receptors most exposed to the Project, chosen for Kaleiçi (evening), İnceğiz, Kabakça and İstasyon (evening and night). It should be noted that high speed trains are not proposed during the night-time, therefore, likely exceedances in this period are related to the operation of freight trains.

Table 7-19 - Summary of Operational Noise Modelling Results: Design Year

Receptor Areas	$L_{Aeq,12h}$ dB (07:00 – 19:00)	$L_{Aeq,4h}$ dB (19:00 – 23:00)	$L_{Aeq,8h}$ dB (23:00 – 07:00)
Halkali	59.7	59.7	49.8
Bahçeşehir	61.7	61.7 (5)	51.8
Ömerli	60.7	60.7 (1)	50.8
Yeşilbayır	55.3	55.3	45.4
Bahşayış	55.7	55.7	45.8
Ferhatpasa	48.0	48.0	38.9
Çatalca	49.0	49.0	52.0
Kaleiçi	61.1	61.1 (1)	61.7 (8)
Gökçeali	58.3	58.3	54.1
İnceğiz	64.7	64.7 (1)	60.5 (1)
Kabakça	64.1	64.1 (3)	59.9 (4)
Bekirli	54.6	54.6	50.4

Receptor Areas	$L_{Aeq,12h}$ dB (07:00 – 19:00)	$L_{Aeq,4h}$ dB (19:00 – 23:00)	$L_{Aeq,8h}$ dB (23:00 – 07:00)
Küçüksinekli	51.5	51.5	47.3
Çayırdere	61.7	61.7 (1)	57.5 (1)
İstasyon	64.7	64.7 (9)	60.5 (12)

7.5.14. The noise modelling results for the design year in **Table 7-19** during daytime generally comply with the noise limits stated in the Regulation on the Assessment and Management of Environmental Noise[36]. Worst-case receptors chosen for Bahçeşehir and Ömerli (evening), Kaleiçi, İnceğiz, Kabakça, Çayırdere and İstasyon (evening and night) are likely to experience absolute noise levels above the noise limit.

7.5.15. The predicted noise levels in both the opening and design years during the night are likely to exceed the recommended internal noise levels in BS8233:2014, $L_{Aeq,8h}$ 30dB indoors (equivalent to $L_{Aeq,8h}$ 45dB outdoors), as shown in **Table 7-4**, at most representative locations, if an open window is considered. The noise predictions for the daytime show that operational noise levels are likely to exceed the recommendations in BS8233:2014 on external amenity areas. However, survey results in **Table 7-14** and **Table 7-15** demonstrate that most representative locations are already subject to noise levels in excess of the upper level 55dB $L_{Aeq,1h}$.Typical increases in noise levels arising from the Project vary depending on the area during daytime and are presented in the next set of tables (unmitigated) and in Section 7.7 and Figure 7-2 (mitigated).

7.5.16. Noise modelling results for the opening year have been compared against the magnitude of noise impact criteria provided in **Table 7-10** for daytime and night-time in **Table 7-20** and **Table 7-21**. In both periods, the associated baseline noise level has been added to the operational noise level likely to arise from the Project to determine the residual noise level, presented in the second column of the table ($L_{Aeq,1h}$ dB Daytime). The baseline measurement location chosen to represent the receptor has been included in brackets. The World Bank Group criterion are presented to show either the absolute noise levels in **Table 7-1** or 3dB above the representative baseline condition. Specifically, at all locations, the representative baseline is higher than 55dB $L_{Aeq,Tr}$ for daytime and 45dB $L_{Aeq,T}$ for night-time, therefore the criteria are defined as 3dB above the baseline measurement results at each respective location. Where the criteria are being met, a magnitude of 'No Change' is allocated.

Table 7-20 - Summary of Operational Noise Magnitude for Daytime: Opening Year

Receptor Areas	$L_{Aeq,1h}$ dB Daytime	$L_{Aeq,1h}$ dB World Bank Group Criteria	Difference dB	Magnitude
Halkali (LT7)	59.5	58.9	0.6	Slight
Bahçeşehir (LT1)	66.4	68.5	-2.1	No Change

Receptor Areas	$L_{Aeq,1h}$ dB Daytime	$L_{Aeq,1h}$ dB World Bank Group Criteria	Difference dB	Magnitude
Ömerli (LT2)	62.2	63.2	-1.0	No Change
Yeşilbayır (LT3)	58.6	60.4	-1.8	No Change
Bahşayış (LT3)	58.7	60.4	-1.7	No Change
Ferhatpasa (LT4)	55.4	57.9	-2.5	No Change
Çatalca (LT4)	55.4	57.9	-2.5	No Change
Kaleiçi (LT4)	59.8	57.9	1.9	Moderate
Gökçeali (LT4)	58.1	57.9	0.2	Slight
İnceğiz (LT5)	64.3	64.0	0.3	Slight
Kabakça (LT6)	65.6	66.7	-1.1	No Change
Bekirli (LT7)	57.2	58.9	-1.7	No Change
Küçüksinekli (LT7)	56.6	58.9	-2.3	No Change
Çayırdere (LT6)	64.9	66.7	-1.8	No Change
İstasyon (LT6)	65.8	66.7	-0.9	No Change

7.5.17. Most receptor areas would either meet the World Bank Group criteria[38] or experience a **Slight** magnitude of impact, with properties at Kaleici experiencing a **Moderate** magnitude of impact during daytime in the opening year.

Table 7-21 - Summary of Operational Noise Magnitude for Night-time: Opening Year

Receptor Areas	$L_{Aeq,1h}$ dB Night-time	$L_{Aeq,1h}$ dB World Bank Group Criteria	Difference dB	Magnitude
Halkali (LT7)	53.6	54.2	-0.6	No Change
Bahçeşehir (LT1)	59.8	62.1	-2.3	No Change
Ömerli (LT2)	55.5	56.7	-1.2	No Change
Yeşilbayır (LT3)	58.8	57.0	-2.8	No Change

Receptor Areas	$L_{Aeq,1h}$ dB Night-time	$L_{Aeq,1h}$ dB World Bank Group Criteria	Difference dB	Magnitude
Bahşayış (LT3)	58.8	61.6	-2.8	No Change
Ferhatpasa (LT4)	51.5	54.3	-2.8	No Change
Çatalca (LT4)	53.2	54.3	-1.1	No Change
Kaleiçi (LT4)	59.1	54.3	4.8	Large
Gökçeali (LT4)	54.1	54.3	-0.2	No Change
İnceğiz (LT5)	58.8	56.7	2.1	No Change
Kabakça (LT6)	59.2	58.7	0.5	No Change
Bekirli (LT7)	52.6	54.2	-1.6	No Change
Küçüksinekli (LT7)	52	54.2	-2.2	No Change
Çayırdere (LT6)	58	58.7	-0.7	No Change
İstasyon (LT6)	59.5	58.7	0.8	Slight

7.5.18. Most receptor areas would meet the World Bank Group criteria[38] with 1 location experiencing a **Slight** impact during the night in the opening year. Properties in Kaleici are likely to experience an impact of **Large** magnitude when comparing against the criteria.

7.5.19. The maximum noise levels arising from the freight trains at night-time have the potential to exceed an internal noise level of 42dB at properties within the study area, indicated in the Night Noise Guidelines for Europe, WHO, 2009[54], which specifies this as the sleep quality threshold for transportation noise. However, it is considered that due to the low number of events expected during opening year (i.e. 4 freight trains during night-time), then this would not give rise to a significant effect. As a guide, ProPG Planning and Noise 2017, which is guidance for new residential development in the UK, advises that sites with internal noise levels L_{Amax} 45dB can be categorised as having a negligible risk when the number of noise events is less than 10 times per night. The number of events per night would not exceed 10 trains.

7.5.20. The operational noise effects have been determined based on the classification given in **Table 7-11**. Results are shown in **Table 7-22**.

[54] World Health Organization, Night Noise Guidelines for Europe, 2009, Copenhagen

Table 7-22 - Summary of Operational Noise Effects: Opening Year

Receptor Areas	Daytime	Night-time
Halkali (LT7)	Minor	Neutral
Bahçeşehir (LT1)	Neutral	Neutral
Ömerli (LT2)	Neutral	Neutral
Yeşilbayır (LT3)	Neutral	Neutral
Bahşayış (LT3)	Neutral	Neutral
Ferhatpasa (LT4)	Neutral	Neutral
Çatalca (LT4)	Neutral	Neutral
Kaleiçi (LT4)	Moderate	Large
Gökçeali (LT4)	Minor	Neutral
İnceğiz (LT5)	Minor	Neutral
Kabakça (LT6)	Neutral	Neutral
Bekirli (LT7)	Neutral	Neutral
Küçüksinekli (LT7)	Neutral	Neutral
Çayırdere (LT6)	Neutral	Neutral
İstasyon (LT6)	Neutral	Minor

7.5.21. **Table 7-22** shows that the likely unmitigated effects as a result of the operation of the Project in the Opening Year are expected to be generally **Neutral / Minor (Not Significant)**. Properties at Kaleici are likely to experience a **Moderate and Adverse Large (Significant)** operational noise effect without mitigation.

7.5.22. **Appendix J** shows the number of properties likely to experience a noise impact. The tables show that the number of properties likely to experience a significant adverse noise effect (i.e. noise magnitude of adverse moderate or above) is 2 for daytime and 7 for night-time in Kaleici.

7.5.23. Noise modelling results for the design year have been compared against the magnitude of noise impact criteria provided in **Table 7-10** for daytime and night-time in **Table 7-23** and **Table 7-24**.

Table 7-23 - Summary of Operational Noise Magnitude for Daytime: Design Year

Receptor Areas	$L_{Aeq,1h}$ dB Daytime	$L_{Aeq,1h}$ dB World Bank Group Criteria	Difference dB	Magnitude

Halkali (LT7)	61.2	58.9	2.3	Moderate
Bahçeşehir (LT1)	67.0	68.5	-1.5	No Change
Ömerli (LT2)	63.5	63.2	0.3	Slight
Yeşilbayır (LT3)	59.5	60.4	-0.9	No Change
Bahşayış (LT3)	59.6	60.4	-0.8	No Change
Ferhatpasa (LT4)	55.7	57.9	-2.2	No Change
Çatalca (LT4)	55.9	57.9	-2.0	No Change
Kaleiçi (LT4)	62.0	57.9	4.1	Large
Gökçeali (LT4)	59.9	57.9	2.0	Moderate
İnceğiz (LT5)	66.2	64.0	2.2	Moderate
Kabakça (LT6)	66.9	66.7	0.2	Slight
Bekirli (LT7)	58.3	58.9	-0.6	No Change
Küçüksinekli (LT7)	57.2	58.9	-1.7	No Change
Çayırdere (LT6)	65.8	66.7	-0.9	No Change
İstasyon (LT6)	67.2	66.7	0.5	Slight

7.5.24. Most receptor areas would meet the World Bank Group Noise Level Guidelines[38] or have a **Slight** magnitude impact during daytime in the design year. Properties in Kaleiçi are likely to experience a magnitude of **Large** in comparison to the criteria. Properties in Halkali, Gökçeali and İnceğiz are likely to experience an impact of **Moderate** magnitude.

Table 7-24 - Summary of Operational Noise Magnitude for Night-time: Design Year

Receptor Areas	$L_{Aeq,1h}$ dB Night-time	$L_{Aeq,1h}$ dB Worldbank Group Criteria	Difference dB	Magnitude
Halkali (LT7)	53.6	54.2	-0.6	No Change
Bahçeşehir (LT1)	59.8	62.1	-2.3	No Change
Ömerli (LT2)	55.5	56.7	-1.2	No Change
Yeşilbayır (LT3)	58.8	57.0	-2.8	No Change

Receptor Areas	$L_{Aeq,1h}$ dB Night-time	$L_{Aeq,1h}$ dB Worldbank Group Criteria	Difference dB	Magnitude
Bahşayış (LT3)	58.8	61.6	-2.8	No Change
Ferhatpasa (LT4)	51.5	54.3	-2.8	No Change
Çatalca (LT4)	54.7	54.3	0.4	Slight
Kaleiçi (LT4)	62.1	54.3	7.8	Very Large
Gökçeali (LT4)	55.9	54.3	1.6	Moderate
İnceğiz (LT5)	61.3	56.7	4.6	Large
Kabakça (LT6)	61.3	58.7	2.6	Moderate
Bekirli (LT7)	53.8	54.2	-0.4	No Change
Küçüksinekli (LT7)	52.7	54.2	-1.5	No Change
Çayırdere (LT6)	59.7	58.7	1.0	Slight
İstasyon (LT6)	61.7	58.7	3.0	Moderate

7.5.25. Most receptor areas would meet the World Bank Group Noise Level Guidelines[38] or have a **Slight** magnitude of impact during night-time in the design year. Properties in Gökçeali, Kabakça and İstasyon are likely to experience a magnitude of **Moderate** impact. Properties in İnceğiz and Kaleiçi are likely to experience an impact of **Large** and **Very Large** magnitude, respectively.

Table 7-25 - Summary of Operational Noise Effects: Design Year

Receptor Areas	Daytime	Night-time
Halkali (LT7)	Minor	Neutral
Bahçeşehir (LT1)	Neutral	Neutral
Ömerli (LT2)	Neutral	Neutral
Yeşilbayır (LT3)	Neutral	Neutral
Bahşayış (LT3)	Neutral	Neutral
Ferhatpasa (LT4)	Large	Neutral
Çatalca (LT4)	Moderate	Minor

Receptor Areas	Daytime	Night-time
Kaleiçi (LT4)	Moderate	Very Large
Gökçeali (LT4)	Minor	Moderate
İnceğiz (LT5)	Neutral	Large
Kabakça (LT6)	Neutral	Moderate
Bekirli (LT7)	Neutral	Neutral
Küçüksinekli (LT7)	Minor	Neutral
Çayırdere (LT6)	Minor	Minor
İstasyon (LT6)	Neutral	Moderate

7.5.26. **Table 7-25** shows that the likely unmitigated noise effects as a result of the operation of the Project are expected to be generally **Neutral / Minor (Not Significant)**. Properties at Kaleici and İnceğiz are likely to experience a **Very Large Adverse and Large Adverse (Significant)** operational noise effect without mitigation. Properties at Catalca, Gökçeali, Kabakça and İstasyon are likely to experience a **Moderate Adverse (Significant)** operational noise effect without mitigation. This corresponds to an assessment undertaken on a sample of representative buildings within these community areas with direct line of sight to the Project.

7.5.27. **Appendix J** shows the number of properties likely to experience a noise impact. The tables in the appendix show that the number of properties likely to experience an adverse noise effect (i.e. noise magnitude of moderate adverse or above) per community area is Kaleiçi (9), İnceğiz(1), Halkali (7) and Gökçeali (3) for daytime. For night-time, adverse noise effects are seen at Kaleiçi (13), Kabakça (2), İstasyon (4), İnceğiz(1), Gökçeali (2) and Çayırdere (1).

7.5.28. As described in **Chapter 2: Description of the Project**, substations improvements will be required. The specification for the transformers will be determined as part of the detailed design. When procuring the equipment, this must ensure that a noise level of 35dB, at third octave bands centred in 100Hz and 200Hz, is not exceeded at 1m from the façade of the nearest property.

OPERATIONAL VIBRATION

7.5.29. The number of properties in each of the respective BS6472-1:2008 vibration value ranges are presented in **Table 7-26** to **Table 7-29**.

Table 7-26 - Sensitive Receptors within BS6472 VDV Value Ranges in 2026 (Day)

Magnitude of Impact	Slight / No change	Moderate	Large / Very Large
Place and Time	**Low Probability of Adverse Comment**	**Adverse Comment Possible**	**Adverse Comment Probable**
Halkali	725	0	0
Bahçeşehir	142	0	0
Ömerli	94	0	0
Yeşilbayır	14	0	0
Bahşayış	4	0	0
Ferhatpasa	0	0	0
Çatalca	14	0	0
Kaleiçi	34	1	0
Gökçeali	8	0	0
İnceğiz	6	0	0
Kabakça	38	1	0
Bekirli	6	0	0
Küçüksinekli	0	0	0
Çayırdere	5	0	0
İstasyon	26	0	0

Table 7-27 - Sensitive Receptors within BS6472 VDV Value Ranges in 2026 (Night)

Magnitude of Impact	Slight / No change	Moderate	Large / Very Large
Place and Time	**Low Probability of Adverse Comment**	**Adverse Comment Possible**	**Adverse Comment Probable**
Halkali	725	0	0

Magnitude of Impact	Slight / No change	Moderate	Large / Very Large
Place and Time	**Low Probability of Adverse Comment**	**Adverse Comment Possible**	**Adverse Comment Probable**
Bahçeşehir	141	1	0
Ömerli	94	0	0
Yeşilbayır	14	0	0
Bahşayış	4	0	0
Ferhatpasa	0	0	0
Çatalca	14	0	0
Kaleiçi	28	6	1
Gökçeali	8	0	0
İnceğiz	5	1	0
Kabakça	36	2	1
Bekirli	6	0	0
Küçüksinekli	0	0	0
Çayırdere	4	1	0
İstasyon	21	5	0

Table 7-28 - Sensitive Receptors within BS6472 VDV Value Ranges in 2041 (Day)

Magnitude of Impact	Slight / No change	Moderate	Large / Very Large
Place and Time	**Low Probability of Adverse Comment**	**Adverse Comment Possible**	**Adverse Comment Probable**
Halkali	725	0	0
Bahçeşehir	142	0	0
Ömerli	94	0	0

Magnitude of Impact	Slight / No change	Moderate	Large / Very Large
Place and Time	**Low Probability of Adverse Comment**	**Adverse Comment Possible**	**Adverse Comment Probable**
Yeşilbayır	14	0	0
Bahşayış	4	0	0
Ferhatpasa	0	0	0
Çatalca	14	0	0
Kaleiçi	32	3	0
Gökçeali	8	0	0
İnceğiz	6	0	0
Kabakça	38	1	0
Bekirli	6	0	0
Küçüksinekli	0	0	0
Çayırdere	5	0	0
İstasyon	26	0	0

Table 7-29 - Sensitive Receptors within BS6472 VDV Value Ranges in 2041 (Night)

Magnitude of Impact	Slight / No change	Moderate	Large / Very Large
Place and Time	**Low Probability of Adverse Comment**	**Adverse Comment Possible**	**Adverse Comment Probable**
Halkali	725	0	0
Bahçeşehir	141	1	0
Ömerli	94	0	0
Yeşilbayır	14	0	0
Bahşayış	4	0	0

Magnitude of Impact	Slight / No change	Moderate	Large / Very Large
Place and Time	**Low Probability of Adverse Comment**	**Adverse Comment Possible**	**Adverse Comment Probable**
Ferhatpasa	0	0	0
Çatalca	14	0	0
Kaleiçi	27	5	3
Gökçeali	8	0	0
İnceğiz	5	1	0
Kabakça	36	2	1
Bekirli	6	0	0
Küçüksinekli	0	0	0
Çayırdere	4	1	0
İstasyon	21	5	0

7.5.30. In the opening year in 2026, all receptors will have a low probability of adverse comment during the daytime which reflects a slight impact from ground-borne vibration from the Project. During the night-time, both in Kaleiçi and Kabakça, 1 residential property may experience a large impact. Moderate night-time impacts due to ground-borne vibration may occur in Bahçeşehir, Kaleiçi, İnceğiz, Kabakça, Çayırdere and İstasyon.

7.5.31. In 2041, the majority of receptors will have a slight impact from ground-borne vibration from the Project during the daytime. 3 receptors at Kaleiçi and Kabakça may experience moderate adverse impacts during the daytime. During the night-time, 3 properties in Kaleiçi and 1 property in Kabakça may experience large adverse impacts. Moderate adverse night-time impacts may occur in Bahçeşehir, Kaleiçi, İnceğiz, Kabakça, Çayırdere and İstasyon.

7.5.32. Large adverse ground-borne vibration impacts at Kaleiçi and Kabakça will occur at night at receptors in close proximity to the Project (under 20m), due to passing freight trains at night. These impacts are more likely to affect residential properties (as they will be occupied at night), and the impacts will be of a transitory nature (i.e. the vibration from passing freight trains will occur for a short duration over period within which the train is passing). At these receptors, this will occur up to 8 times a night by 2041.

7.5.33. In İstasyon, Kabakça and in Kaleiçi, residential properties near to the existing railway currently experience 3 freight train movements a night and therefore the assessed impacts are likely to be an overestimate in these locations. However, the increase by 5 to 8 freight services by 2041 and the

proximity of residential properties to the Project in Kaleiçi and Kabakça, indicate that impacts are likely to result in an adverse comment from residents.

7.5.34. The criteria relating to VC-A in the IEST vibration guidelines for the use of sensitive equipment is likely to be exceeded within 60m of the Project.

7.5.35. With regard to the assessed cultural heritage assets, it is unlikely that operational vibration impacts will cause cosmetic damage to buildings and PPV is predicted to be below the criteria for unreinforced or light framed structures (as described in BS7385-2).The moderate adverse impacts at Bahçeşehir, Kaleiçi, İnceğiz, Kabakça, Çayırdere and İstasyon are unlikely to be significant as freight trains operate around one service per hour at night by 2041. The close proximity of receptors in Kaleci and Kabakca to the Project mean that the anticipated large impacts have the potential to have a Moderate Adverse (Significant) effect.

RE-RADIATED NOISE

7.5.36. Re-radiated noise impacts are presented in **Table 7-30** within receptor areas along the Project. These are described for night-time for both the opening and future years.

Table 7-30 - 2026/2041 Night-time Re-radiated Noise Impact

Magnitude of Impact / Receptor Areas	Slight / No change	Moderate	Large / Very Large
Halkali	537	188	0
Bahçeşehir	131	10	1
Ömerli	91	3	0
Yeşilbayır	13	1	0
Bahşayış	4	0	0
Ferhatpasa	0	0	0
Çatalca	14	0	0
Kaleiçi	26	3	6
Gökçeali	8	0	0
İnceğiz	5	0	1
Kabakça	36	2	1
Bekirli	6	0	0
Küçüksinekli	0	0	0
Çayırdere	4	1	0

Magnitude of Impact / Receptor Areas	Slight / No change	Moderate	Large / Very Large
İstasyon	17	7	2

7.5.37. Large adverse re-radiated noise impacts are predicted in Bahçeşehir, Kaleiçi, İnceğiz, Kabakça and İstasyon, where receptors are likely to be within 25m of the Project. Moderate adverse re-radiated noise impacts are predicted in Halkali, Bahçeşehir, Ömerli, Yeşilbayır, Kaleiçi, Kabakça, Çayırdere, İstasyon.

7.5.38. Sensitive receptors in these areas may experience awakening due to re-radiated noise from passing freight trains at night, however the maximum number of movements from freight over the night-time period is four in 2026 increasing to 8 in 2041. It is unlikely that moderate impacts from reradiated noise will result in a significant effect, apart from at residential properties occupied by 'vulnerable groups', as described in **Chapter 15: Social**. However, in areas in which receptors are within 25m of the Project, large impacts are likely to result in a **Moderate Adverse (Significant) effect**.

7.6 MITIGATION AND ENHANCEMENT MEASURES

CONSTRUCTION NOISE AND VIBRATION

7.6.1. As set out in the **ESMP**, a **CESMP** will be prepared by the Contractor, which outlines how the construction phase of the Project will be managed to minimise the effects on the surrounding environment.

7.6.2. The Contractor will apply good practice measures to minimise any residual effects. The general methods of noise control include:

- Avoid necessary revving engines and switch off equipment when it is not required;
- Keep haul / access roads in close proximity to the Project well maintained;
- Use rubber linings for dumpers to reduce noise impact;
- Minimise drop height of materials;
- Start-up plant and vehicles sequentially rather than all together;
- Use of reversing alarms that do not have a tonal component (i.e. broadband), if applicable. In this type of alarm, the sound energy would be spread homogenously across the frequency spectrum minimising the possibility of acoustic feature in the reversing alarm;
- Sources of significant noise should be enclosed, as far as reasonably possible;
- Loading and unloading should be done away from noise-sensitive areas, where possible;
- Locate of any stationary plant (i.e. pumps, compressor, concrete mixing, etc) away from noise-sensitive receptors, where possible;
- Ensure regular and effective maintenance for the plant and any sound-reducing equipment; and
- Install temporary local noise barriers for noisy equipment.

7.6.3. It is recommended that guidance in the Directive 2000/14/EC of the European Parliament and the Council of the European Union is followed in respect to outdoor equipment noise. The Directive:

- presents noise limits in the form of guaranteed sound power levels for equipment which should not be exceeded during the construction phase of the Project;

- includes guidance on the conformity assessment procedures which the equipment should pass before placing into the market and procured for the Project; and
- States the following respect to marking of plant items used during construction:

  "Marking of equipment for use outdoors with its guaranteed sound. power level is essential in order to enable consumers and users to make an informed choice of equipment and as a basis for regulation on use or economic instruments to be adopted at the local or national level. This marking must be clear and unambiguous. The indicated values should be guaranteed by the manufacturer. It is appropriate that the indication of the noise emission in the form of the guaranteed sound power level should accompany the CE marking. A unified, fixed procedure to assess noise emission values is an indispensable condition for reliable marking."

7.6.4. Normal construction activities will not take place at night, except for specific activities which have to continue or emergency work. A risk assessment for night-time working, including noise mitigations will be prepared before undertaking night-time work. Piling activities should not be undertaken during night-time. The **SEP** includes measures for to provide affected communities with advance notification of construction activities, including those that generate noise and vibration, and/or will take place at night.

7.6.5. Site hoarding can provide effective noise reduction for sensitive receptors who are located at a low level from the ground. This would provide a noise reduction of around 10dB to nearby ground floor properties. However, site hoarding would provide no noise reduction to receptors in upper floors of properties that have direct line of sight to the construction works. This mitigation measure will be implemented in areas with potentially significant effects, particularly Bahçeşehir, Kaleiçi, İnceğiz, Kabakça and İstasyon, as required in the **ESMP**. The panels used as site hoardings will be continuous with no gaps to obstruct the line of sight and they will have a surface mass of at least 7kg/m^2.

7.6.6. The mitigation of adverse effects will be required, during the following construction phases, where key activities are undertaken near properties. The distances (or shorter) and key activities for each construction phase are as follows:

- Phase 1: 35m from the edge of the earthworks;
- Phase 2: 45m from the edge of the earthworks;
- Phase 3: 100m from piling activities;
- Phase 4: 100m from the portal of the tunnel; and
- Phase 5: 60m from the centre of the track.

7.6.7. A noise and vibration monitoring programme will be undertaken at sensitive receptor locations, as set out in the **ESMP**. This will ensure that the design limits, as set out in this Chapter, are not exceeded.

7.6.8. General methods of vibration control include:

- The selection of low or non-vibratory piling equipment such as rotary or bored piling.
- Reducing the requirement for vibratory compaction and using static force compaction, such as smooth-wheeled or sheepsfoot rollers.
- No start up or shut-down of vibratory plant within 50m of receptors.
- The reduction of working hours to during less sensitive hours during the day.
- Communication with residents to highlight potential periods of disruption in order minimise the number of complaints.

- Temporary rehousing in areas in which large adverse impacts are unable to be avoided. Depending on frequency and duration of noisy activities, this approach should be looked at for high-intensity activity periods along the programme such as piling and viaduct/bridge construction, particularly at properties within 30m and where other means of mitigation is not viable.

7.6.9. Temporary rehousing will be offered, particularly for the 427 residential properties within a 60m slant distance (from the façade of the dwelling to the edge of the tunnel) within Halkali. Temporary rehousing will be offered to those who would like it (it will not be compulsory) when a significant effect will occur for a duration exceeding:

- 10 or more days or nights in any 15 consecutive days or nights; or
- A total of number of days exceeding 40 in any 6 consecutive months.

7.6.10. The Contractor, once appointed, will develop and review the construction programme to identify potential periods and location where it may be necessary to offer temporary housing, and they will discuss this offer with affected communities in advance, as required in the **SEP**.

OPERATIONAL NOISE AND VIBRATION

7.6.11. Operational mitigation measures are outlined below:

- Cuttings: The Project benefits from cuttings at some sensitive locations. These structures are likely to provide a noise level reduction between 5 to 10dB, provided that the line-of-sight is obstructed.
- Noise Barriers: The benefits of installing noise barriers (earth bunding or acoustic fencing or a combination) at specific locations would be a worthwhile control measure in specified areas. This mitigation strategy could provide a noise level reduction between 5 to 10dB, where properties are close to the railway and the line-of-sight is obstructed. Lesser reductions would apply under other circumstances.

7.6.12. Due to the potential for significant operational noise effects, noise barriers have been modelled for inclusion in the design in the locations shown in Table 7-31.

Table 7-31 – Approximate Barrier Extent for Localised Areas

Receptor Areas	Approximate Barrier Length	Approximate Barrier Height
Halkali	500m north of the track (chainage 0+000 – 0+500)	3m
Bahçeşehir	200m north of the track (chainage 10+400 – 10+600)	3m
Ömerli	200m south of the track (chainage 16+200 – 16+400)	3m
Çatalca	200m north of the track (chainage 32+700 – 32+900)	3m
Kaleiçi	200m south of the track (chainage 33+800 – 34+000)	3m

	300m south of the track (chainage 34+600 – 34+900)	4m
	220m south of the track (chainage 34+680 – 34+900)	4m
	550m north of the track (chainage 34+900 – 35+450)	2m
	200m south of the track (chainage 35+700 – 35+900)	3m
	200m south of the track (chainage 36+400 – 36+600)	3m
Gökçeali	200m south of the track (chainage 37+200 – 37+400)	2m
	280m north of the track (chainage 37+970 – 38+250)	2m
İnceğiz	200m south of the track (chainage 43+000 – 43+200)	4m
Kabakça	200m north of the track (chainage 43+600 – 43+800)	3m
	200m north of the track (chainage 45+900 – 46+100)	3m
İstasyon	200m on both sides of the tracks (chainage 73+500 and 73+700)	2m
	500m south of the track (chainage 73+800 and 74+300)	2m
	200m north of the track (chainage 74+500 and 74+700)	2m
	850m north of the track (chainage 75+750 and 76+600)	3m

7.6.13. Noise barriers should comply with the design requirements set in BS EN 1793:1998, Road traffic for noise reducing devices – Test method for determining the acoustic performance, Part 2, or equivalent. The airborne sound insultation for the barrier panels should be at least 24 dB.

7.6.14. It is recommended that the Contractor undertakes optimisation of the noise barriers, to refine their dimensions and locations as part of the detailed design process. Finalised information regarding the topography and design of the track should be also updated. It is recommended that the operational

noise model is validated with noise measurements for the same trains (as those that will selected for use during operation), in similar conditions of track and speed. It will be also necessary to further understand the location of habitable rooms, within properties, and status (e.g. vulnerability) of sensitive receptors.

7.6.15. Where significant effects remain after the implementation of a noise barrier and/or noise limits stated in the Regulation on the Assessment and Management of Environmental Noise (2010)[36] are not met, enhancement of the existing window glazing can be explored with the Ministry of Environment and Urbanisation. This option should be assessed taking into consideration alternative means of ventilation and in recognition that the further noise reduction will depend on the specification and state of the current windows.

7.6.16. Noise mitigation for the substation improvements will be implemented, if the noise limit is exceeded. This could include transformer noise enclosures, achieving a likely noise reduction of 20dB, or a local noise barrier between the transformer and the nearest property, achieving a likely noise reduction of 10dB. When procuring the transformers, it will be ensured that a noise level of 35dB, at third octave bands centred in 100Hz and 200Hz, is not exceeded at 1m from the façade of the nearest property.

7.6.17. Mitigation for significant operational vibration may be avoided if the expropriation corridor is increased to 25m from the rail corridor at all location. In areas in where receptors are located within 25m, the following measures can attenuate the propagation of vibration into buildings, and the measures are presented in order of effectiveness from Federal Transit Administration guidance[55]:

- Altering the trackform from B70 reinforced concrete sleepers and ballast to a floating slab trackbed (-15dB).
- Including vibration attenuating ballast mats between the ballast and concrete foundation layer (-10dB).
- High-resilience fasteners on the track or resilient supported ties (-5dB).

7.7 RESIDUAL EFFECTS

CONSTRUCTION NOISE AND VIBRATION

7.7.1. It is expected that once good practice measures are implemented the majority of activities will not give raise to significant effects. However, during periods of intense construction activities, the threshold of L_{Aeq} 70dB is likely to be exceed and there is likely to remain significant effects particularly on Bahçeşehir, Kaleiçi, İnceğiz, Kabakça and İstasyon, for the short duration of those activities. The construction of the Project will occur in sections, therefore, noise generating activities such as piling, earth movement and track construction have the potential to affect receptor areas for a limited period of time only, and this duration will constitute a small proportion of the entire construction programme.

[55] 'Transit Noise and Vibration Impact Assessment' Office of Planning and Environment Federal Transit Administration (FTA). May 2006.

7.7.2. A further site visit was undertaken in August 2021 to determine the use and number of floors for buildings where significant effects were identified prior to mitigation. The outcome of this survey was used to refine the assumptions regarding noise sensitive receptors and to re-run the mitigated noise model.

7.7.3. The performance of the noise barriers has been modelled and a representation of their effectiveness is illustrated in **Figure 7-2** for the design year 2041, as a worst-case. It can be seen from the figure that there are no properties with potential for significant operational noise effects, once the barriers are implemented. Tables are also presented in **Appendix J**, indicating the number of properties affected for the scenarios With Mitigation and No Mitigation.

7.7.4. Noise contours for the mitigated scenario in the design year are presented in **Figure 7-3**.

7.7.5. Noise modelling results for the design year (mitigated) have been compared against the magnitude of noise impact criteria provided in **Table 7-10** for daytime and night-time in **Table 7-32** and **Table 7-33**.

Table 7-32 - Summary of Operational Noise Magnitude for Daytime: Design Year - Mitigated

Receptor Areas	$L_{Aeq,1h}$ dB Daytime	$L_{Aeq,1h}$ dB Worldbank Group Criteria	Difference dB	Magnitude
Halkali (LT7)	57.9	58.9	-1.0	No Change
Bahçeşehir (LT1)	66.5	68.5	-2.0	No Change
Ömerli (LT2)	61.8	63.2	-1.4	No Change
Yeşilbayır (LT3)	59.5	60.4	-0.9	No Change
Bahşayış (LT3)	59.6	60.4	-0.8	No Change
Ferhatpasa (LT4)	55.5	57.9	-2.4	No Change
Çatalca (LT4)	55.6	57.9	-2.3	No Change
Kaleiçi (LT4)	56.9	57.9	-1.0	No Change
Gökçeali (LT4)	57.8	57.9	-0.1	No Change
İnceğiz (LT5)	62.4	64.0	-1.6	No Change
Kabakça (LT6)	64.9	66.7	-1.8	No Change
Bekirli (LT7)	58.3	58.9	-0.6	No Change
Küçüksinekli (LT7)	57.2	58.9	-1.7	No Change

Çayırdere (LT6)	64.8	66.7	-1.9	No Change
İstasyon (LT6)	64.7	66.7	-2	No Change

7.7.6. **Table 7-32** shows that with the introduction of noise barriers all receptor areas will experience no change in their existing daytime noise due to the Project.

Table 7-33 - Summary of Operational Noise Magnitude for Night-time: Design Year - Mitigated

Receptor Areas	$L_{Aeq,1h}$ dB Night-time	$L_{Aeq,1h}$ dB IFC Criteria	Difference dB	Magnitude
Halkali (LT7)	51.9	54.2	-2.3	No Change
Bahçeşehir (LT1)	59.6	62.1	-2.5	No Change
Ömerli (LT2)	54.5	56.7	-2.2	No Change
Yeşilbayır (LT3)	58.8	61.6	-2.8	No Change
Bahşayış (LT3)	58.8	61.6	-2.8	No Change
Ferhatpasa (LT4)	51.5	54.3	-2.8	No Change
Çatalca (LT4)	53.7	54.3	-0.6	No Change
Kaleiçi (LT4)	55.3	54.3	1.0	Slight
Gökçeali (LT4)	53.9	54.3	-0.4	No Change
İnceğiz (LT5)	56.2	56.7	-0.5	No Change
Kabakça (LT6)	58.1	58.7	-0.6	No Change
Bekirli (LT7)	53.8	54.2	-0.4	No Change
Küçüksinekli (LT7)	52.7	54.2	-1.5	No Change
Çayırdere (LT6)	58.0	58.7	-0.7	No Change
İstasyon (LT6)	57.9	58.7	-0.8	No Change

7.7.7. **Table 7-33** shows that with the introduction of noise barriers at clusters of properties the majority of receptor areas will experience no change in their existing night-time noise due to the Project. One property in Kaleiçi is likely to experience an adverse noise impact of **Slight** magnitude during night-time following the noise barrier mitigation.

7.7.8. The operational noise effects have been determined based on the classification given in **Table 7-11**, the results are shown in **Table 7-34**.

Table 7-34 - Summary of Operational Noise Effects: Design Year - Mitigated

Receptor Areas	Daytime	Night-time
Halkali (LT7)	Neutral	Neutral
Bahçeşehir (LT1)	Neutral	Neutral
Ömerli (LT2)	Neutral	Neutral
Yeşilbayır (LT3)	Neutral	Neutral
Bahşayış (LT3)	Neutral	Neutral
Ferhatpasa (LT4)	Neutral	Neutral
Çatalca (LT4)	Neutral	Neutral
Kaleiçi (LT4)	Neutral	Minor
Gökçeali (LT4)	Neutral	Neutral
İnceğiz (LT5)	Neutral	Neutral
Kabakça (LT6)	Neutral	Neutral
Bekirli (LT7)	Neutral	Neutral
Küçüksinekli (LT7)	Neutral	Neutral
Çayırdere (LT6)	Neutral	Neutral
İstasyon (LT6)	Neutral	Neutral

7.7.9. **Table 7-34** shows that the likely mitigated noise effects as a result of the operation of the Project are expected to be **Neutral / Minor (Not Significant)**.

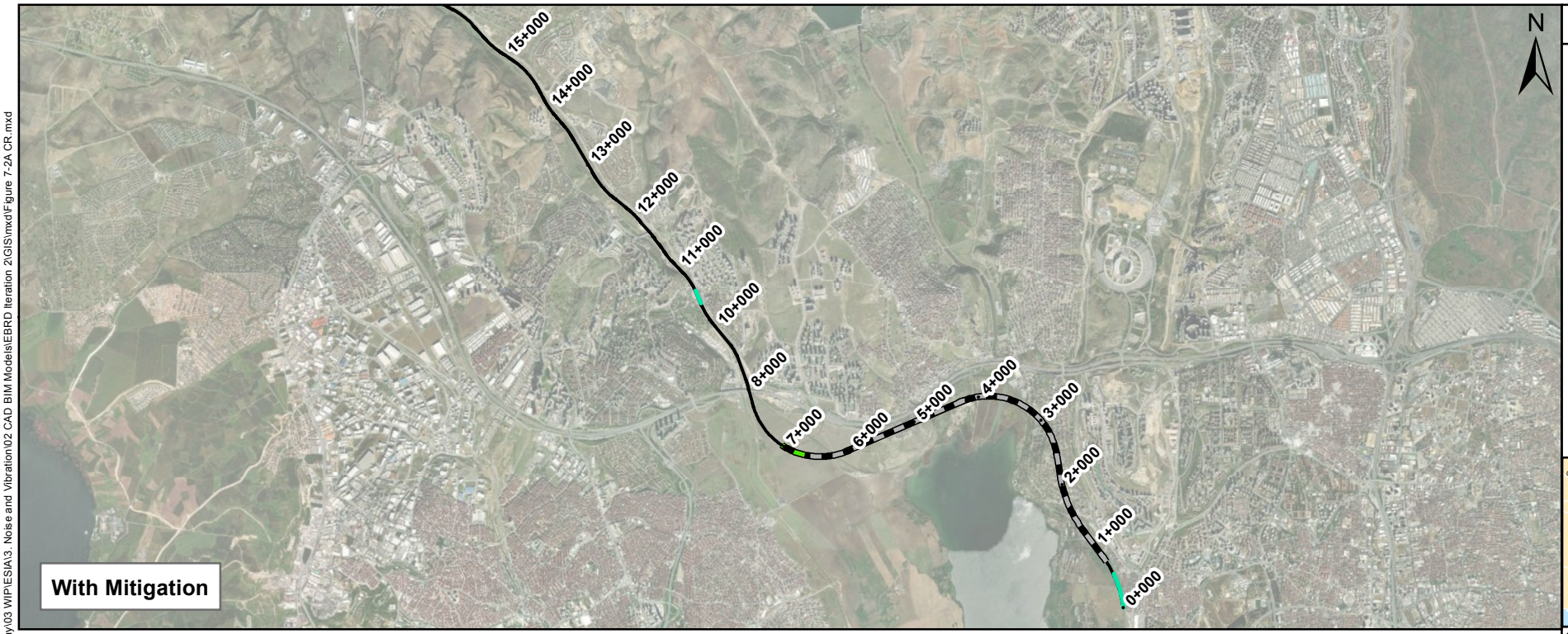
7.7.10. **Appendix J** shows the number of properties likely to experience a noise impact. The tables in the appendix show that the there are no properties likely to experience an adverse noise effect (i.e. noise magnitude of adverse moderate or above) once the noise barrier mitigation is implemented.

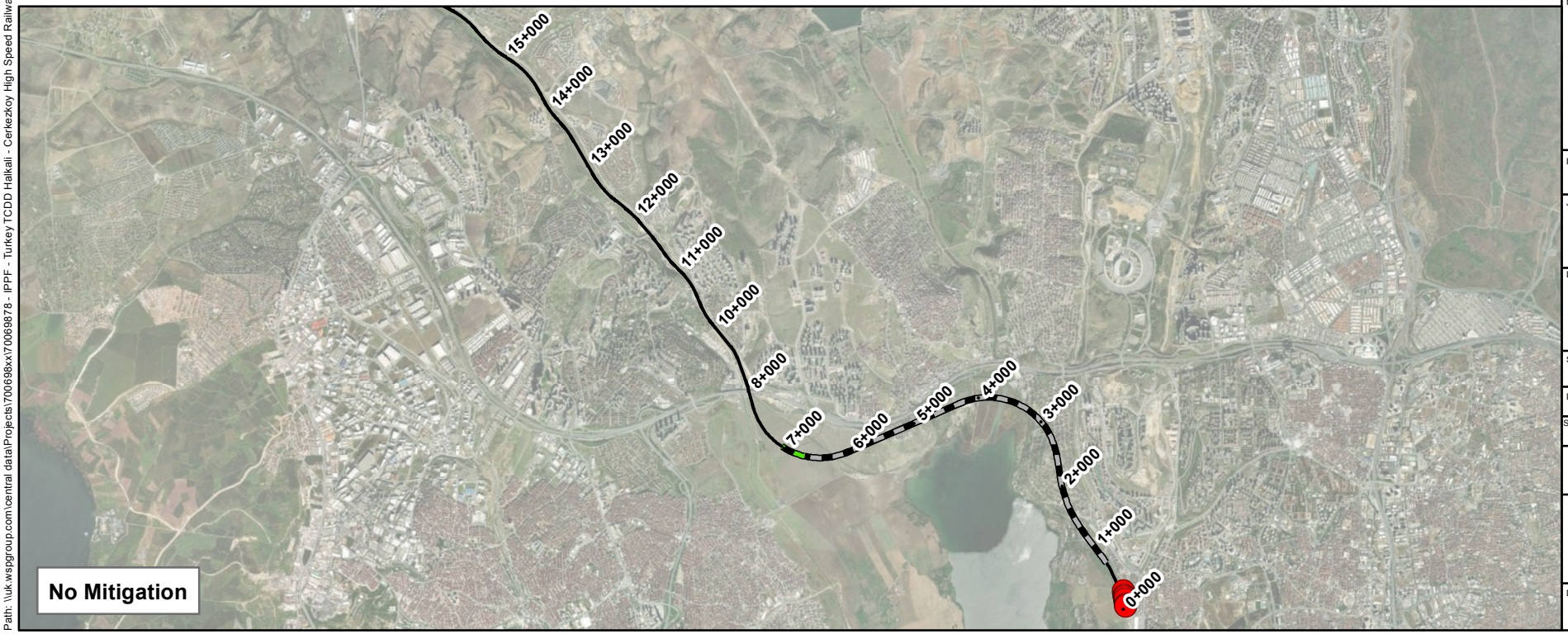
7.7.11. Comparing the number of properties in **Appendix J** both without and with mitigation, it can be seen that the noise barriers would reduce the number of receptors significantly affected by noise. In some instances, the unmitigated noise levels would achieve a no change magnitude, however, close to the threshold of minor magnitude by a small margin. The noise barriers presented in **Table 7-31** include barriers in these areas with a view to being revisited by the Contractor during detailed design. Optimisation of the height and length of the noise barriers will be undertaken prior to implementation as part of the detailed design for the Project.

7.7.12. At Kaleici where there is a likely **Slight** adverse effect has been identified at one property, localised means of mitigation such as secondary glazing, with appropriate alternative ventilation systems, or

property boundary noise barriers will be defined and discussed with the owners and residents of this property.

7.7.13. The noise mitigation detailed above is applicable for existing residential properties. New residential developments that may be constructed near the Project in the future will need to comply with the noise mitigation requirements stated in The Regulation on Preventing Building Noise Pollution, Turkey 2017. These Regulations set out requirements for sound insulation systems in new buildings.

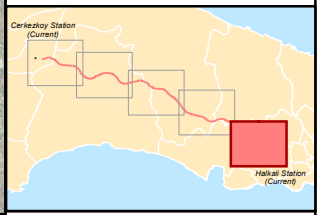




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Legend

- Barriers
- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)



Note:

Drawing Status
FINAL

Job Title:
HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title
Figure 7-2A - Significant Operational Noise Effects Daytime

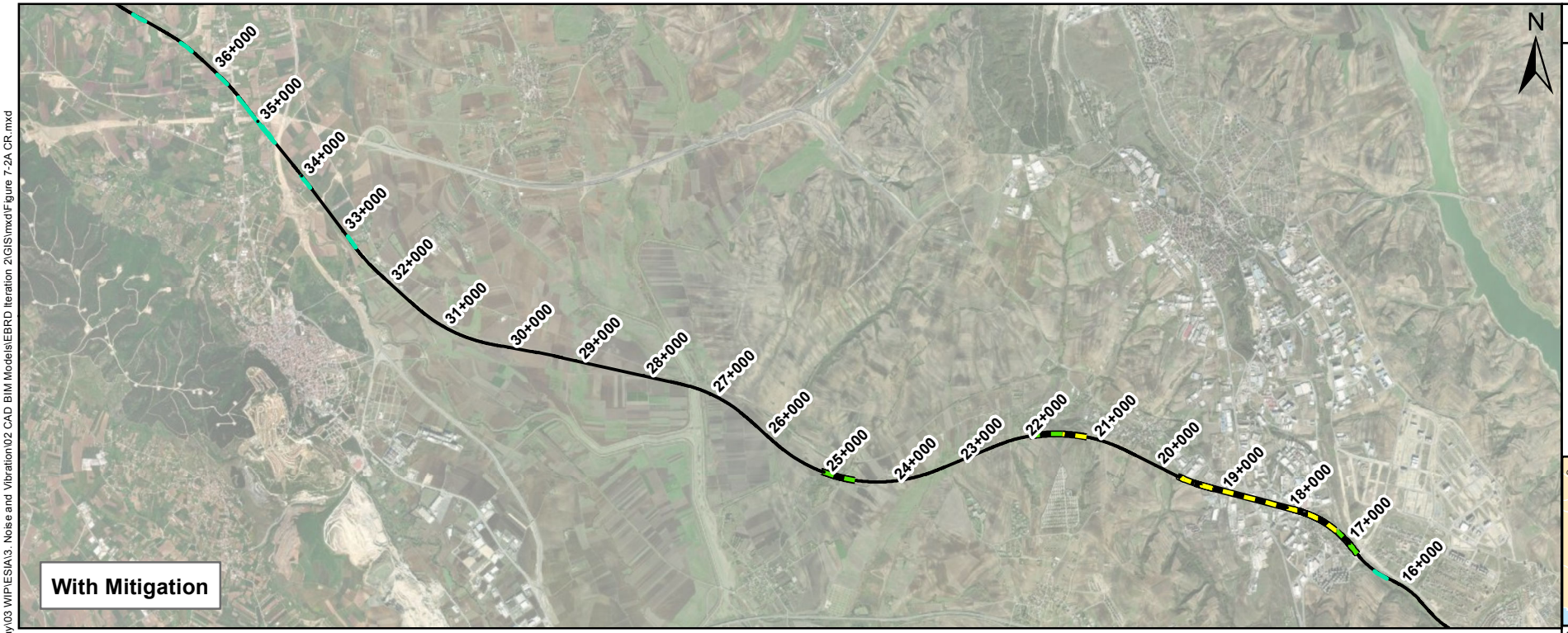
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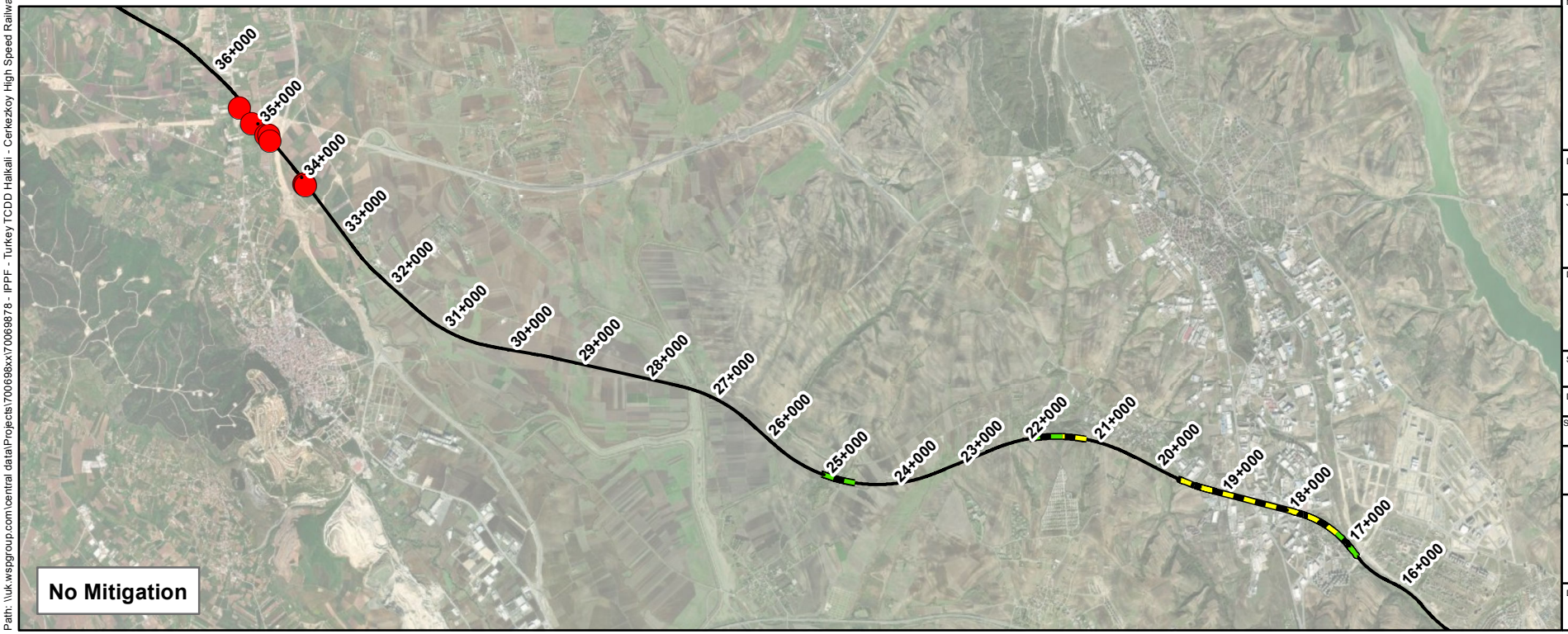
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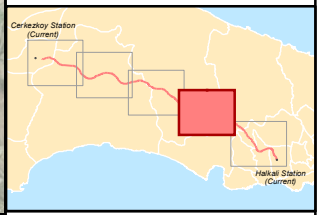


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Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-2A - Significant Operational Noise Effects Daytime

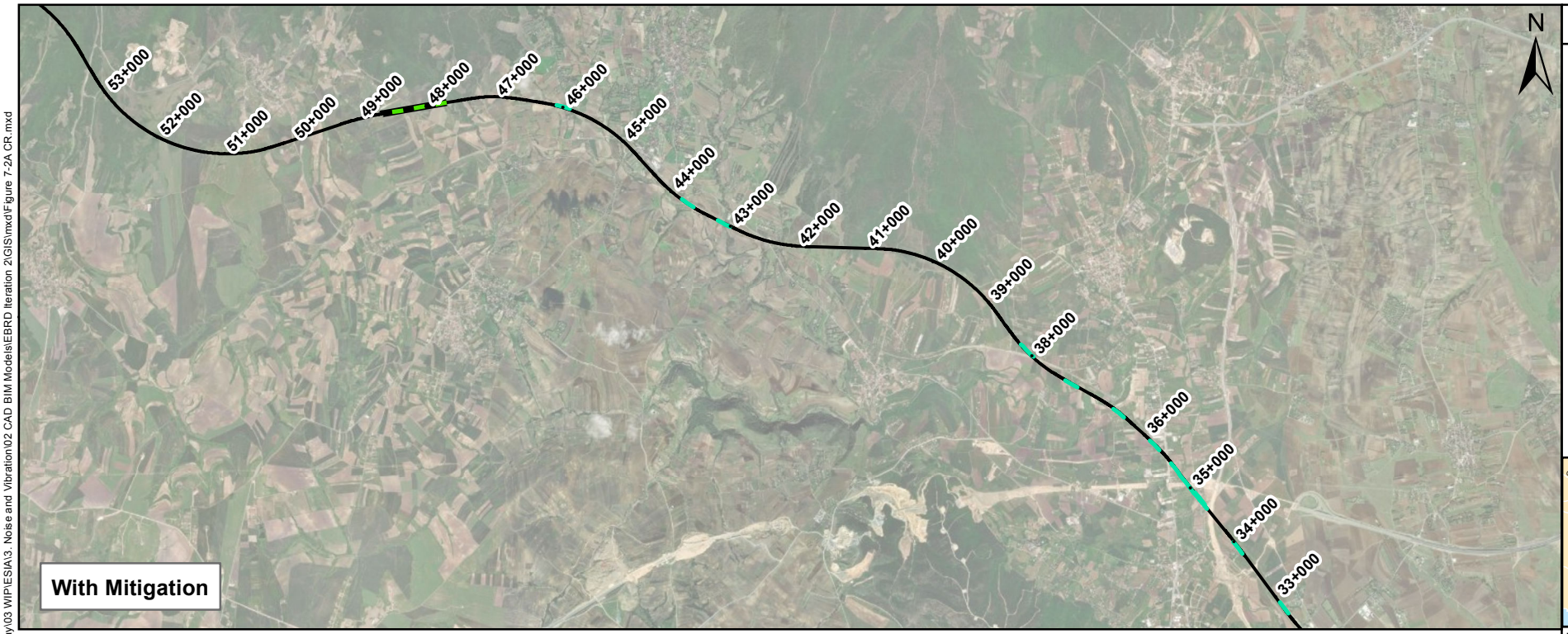
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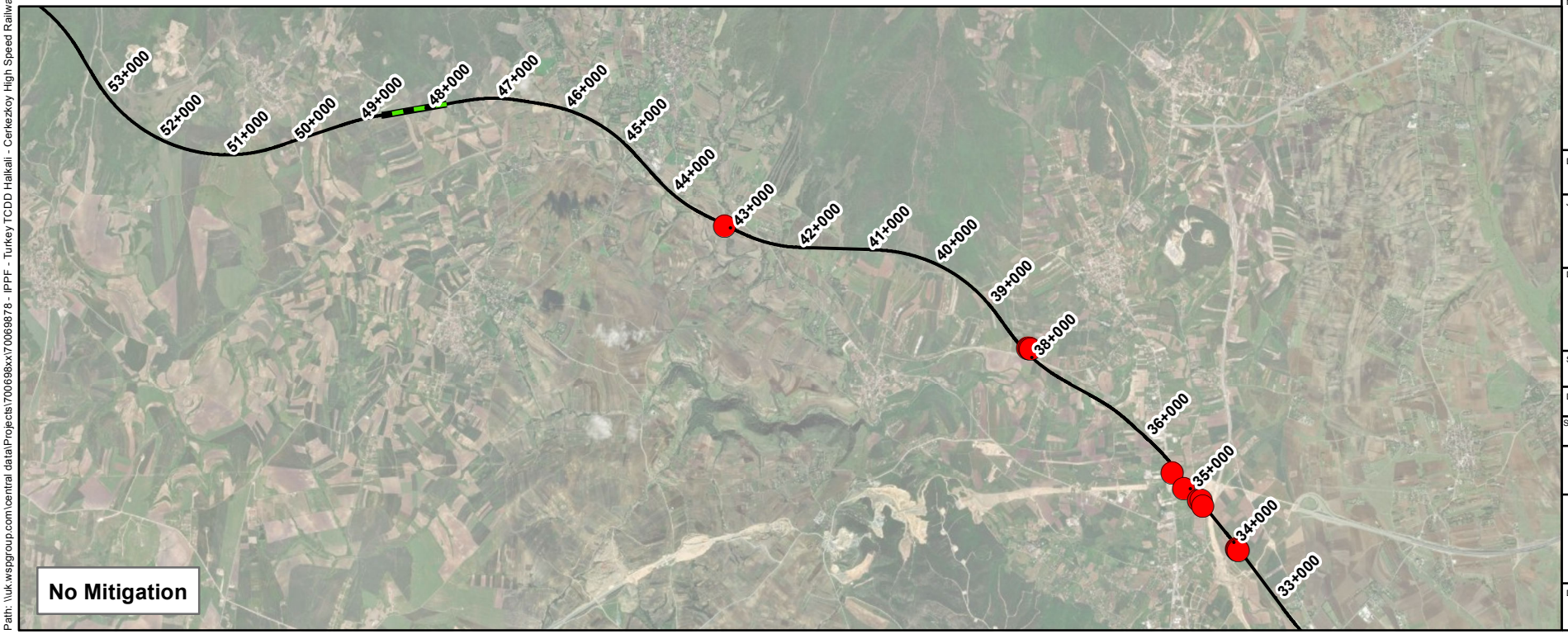
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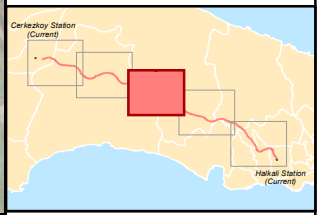




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Legend

- Barriers
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Note:

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Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-2A - Significant Operational Noise Effects Daytime

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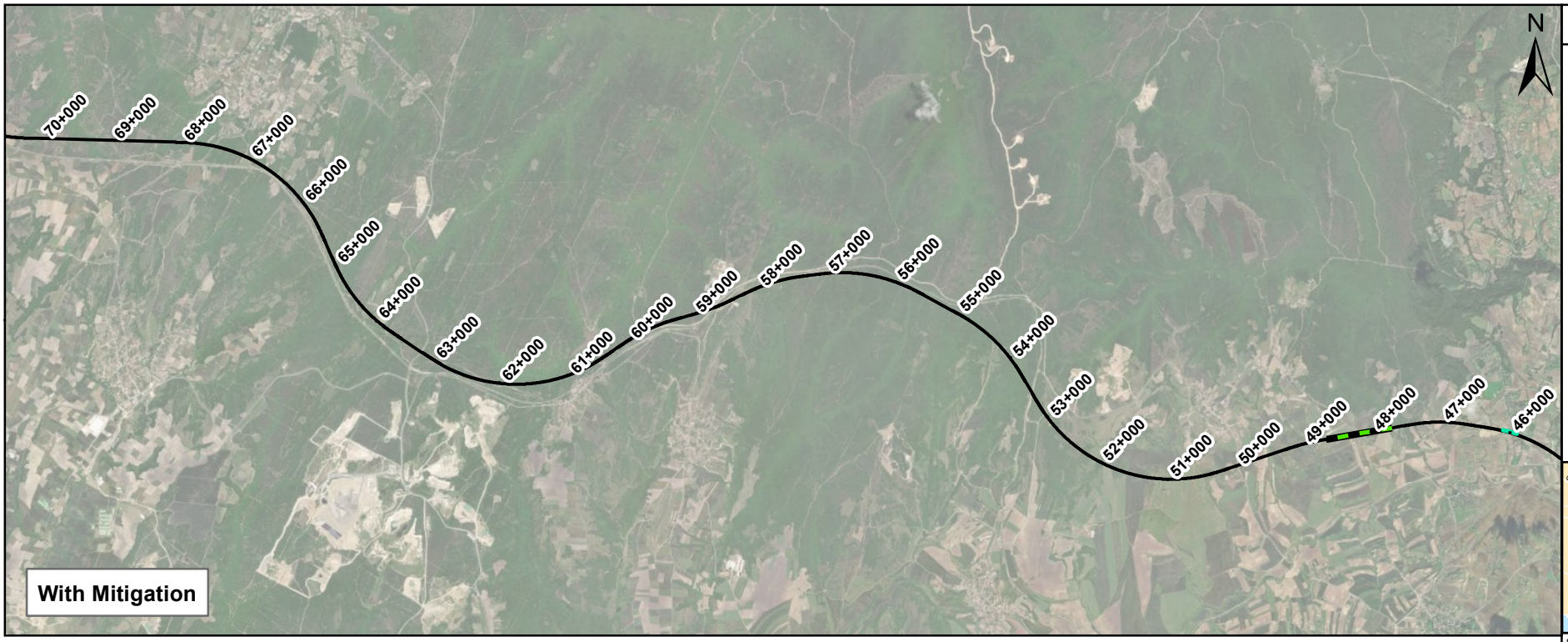
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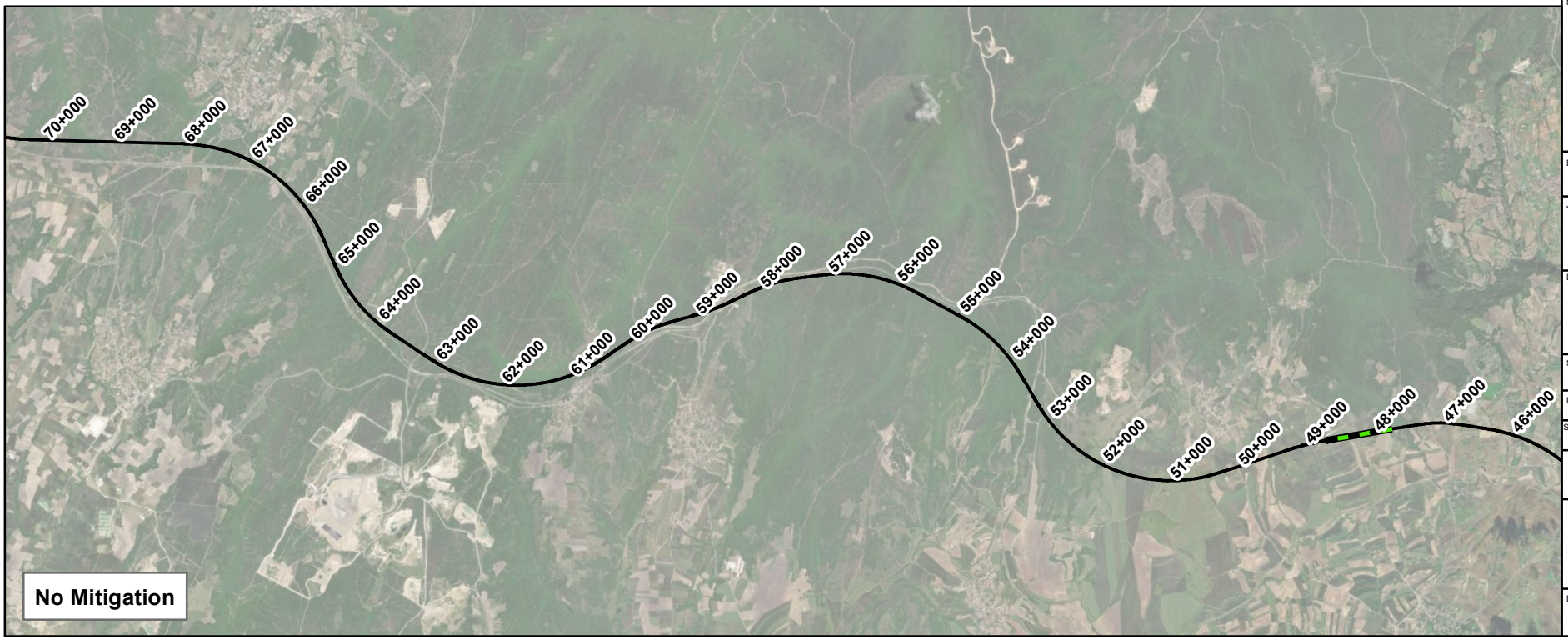
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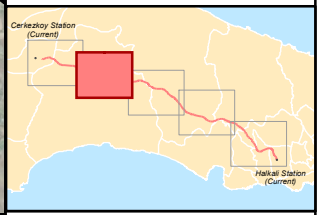




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Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-2A - Significant Operational Noise Effects Daytime

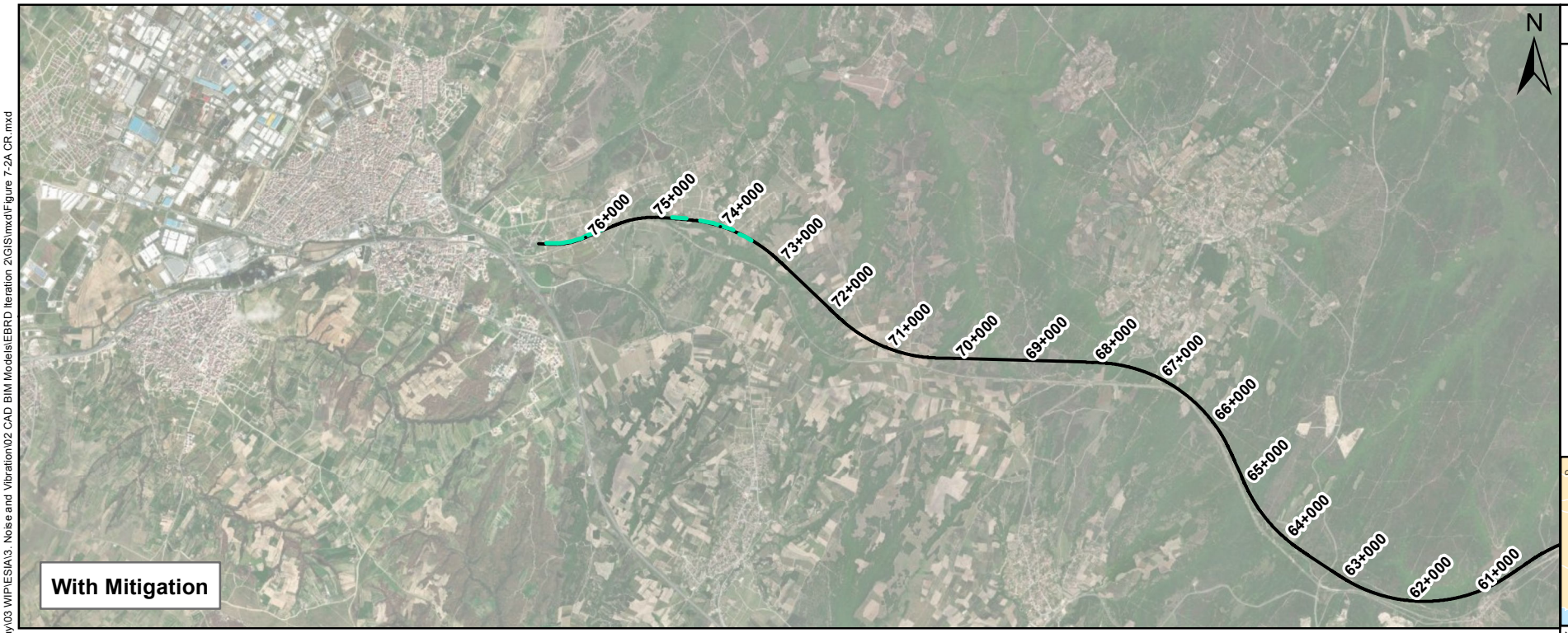
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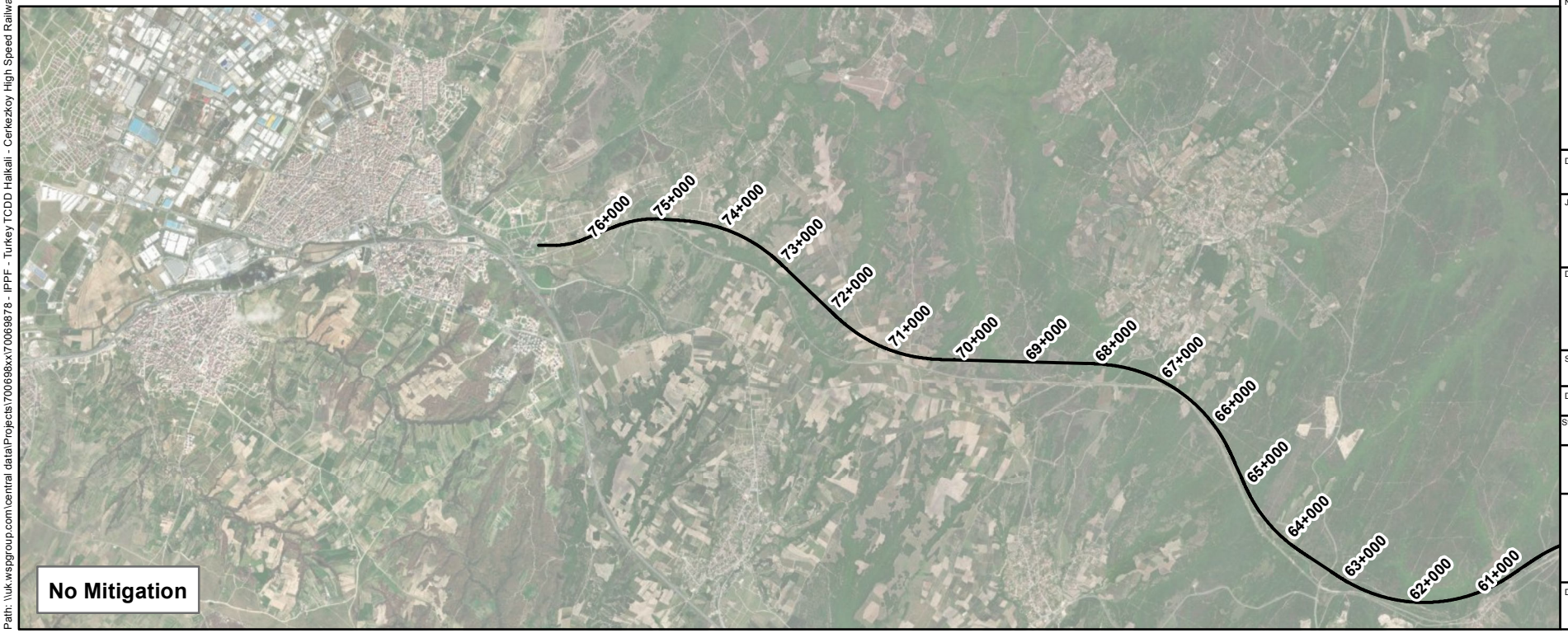
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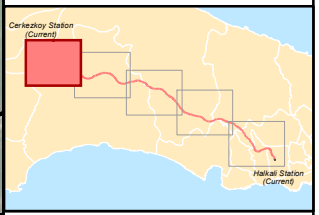




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Job Title:
HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title
Figure 7-2A - Significant Operational Noise Effects Daytime

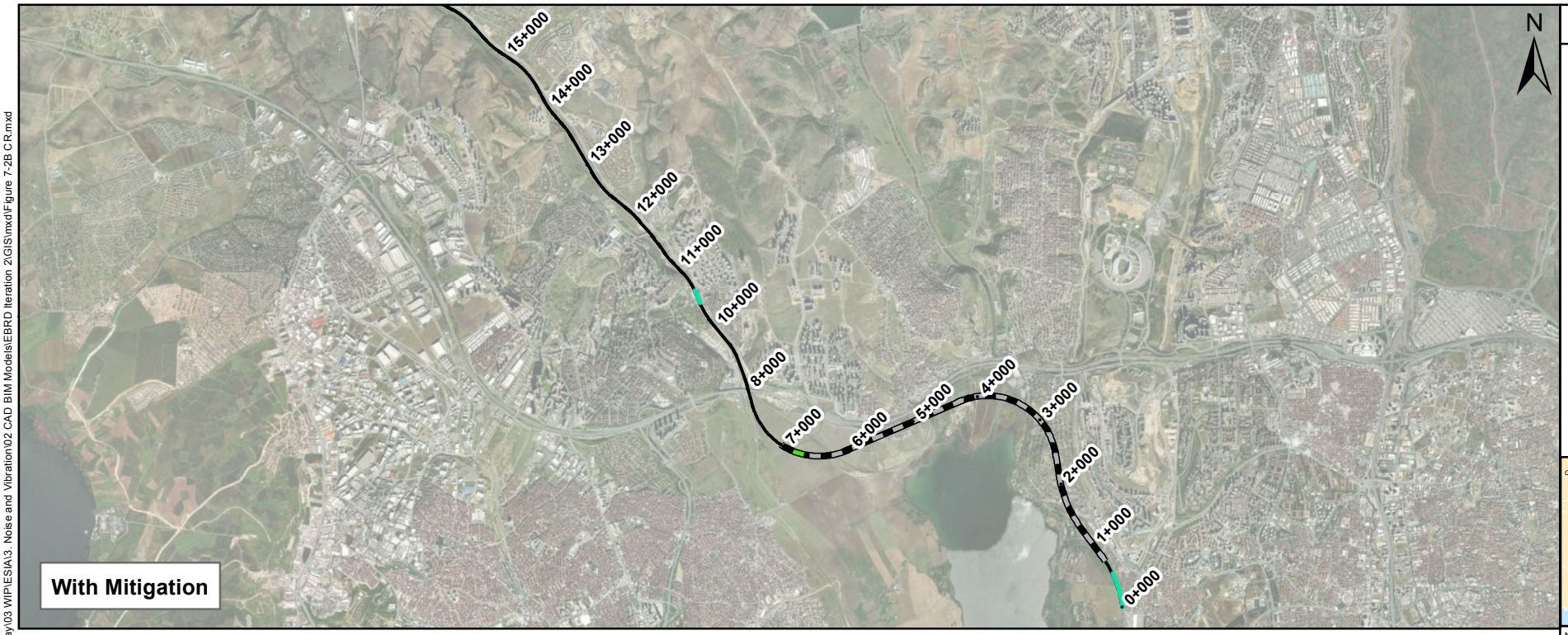
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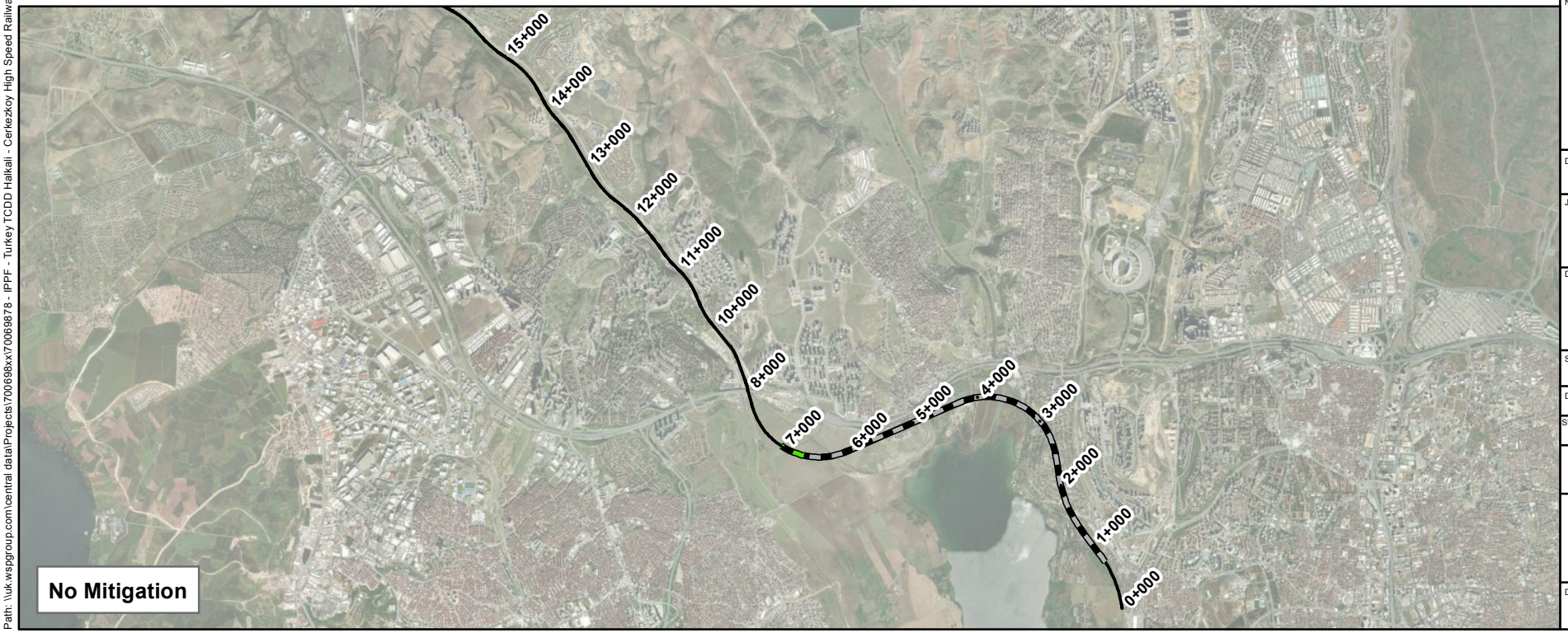
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CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	12/11/2021

0 0.375 0.75 1.5 2.25 3
Km

Drawing Number
Figure 7-2A (5 / 5)

Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-2A CR.mxd

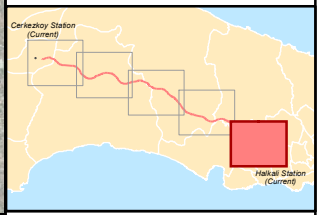




THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Barriers
- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)



Note:

Drawing Status
FINAL

Job Title:
HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title
Figure 7-2B - Significant Operational Noise Effects Night-time

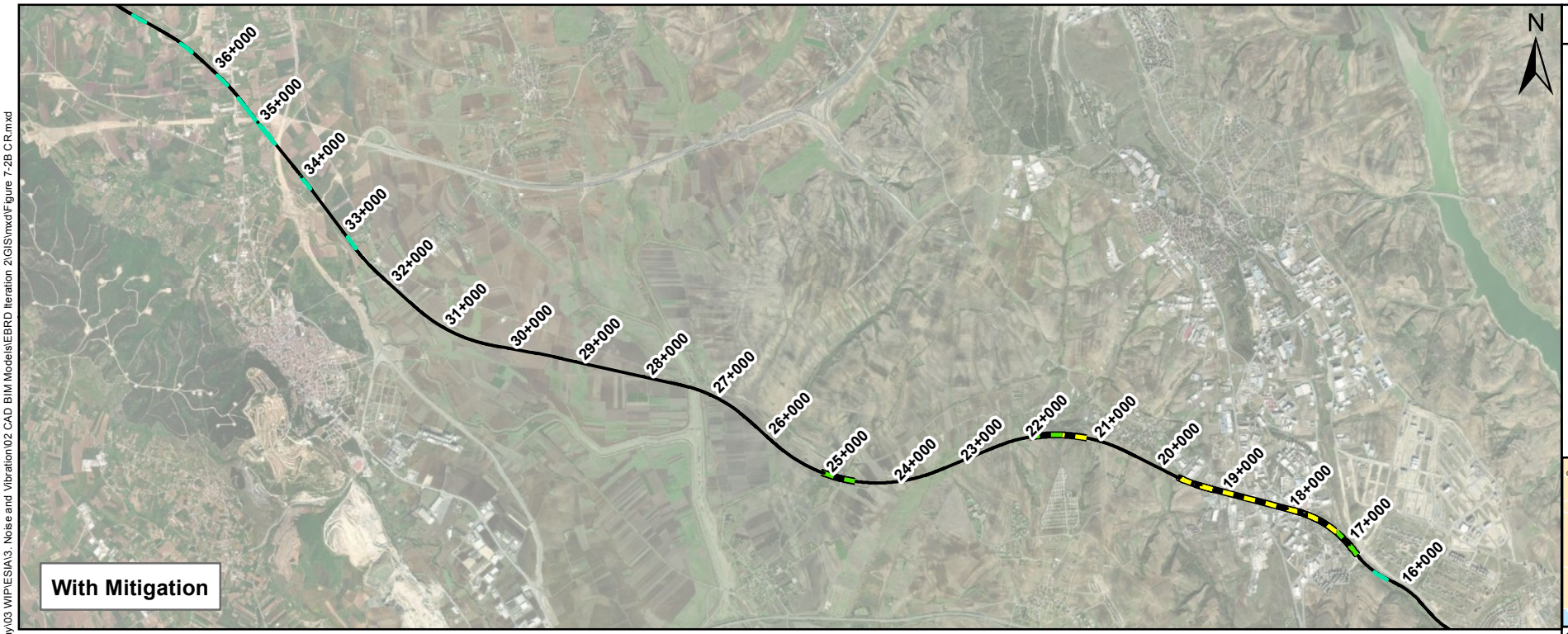
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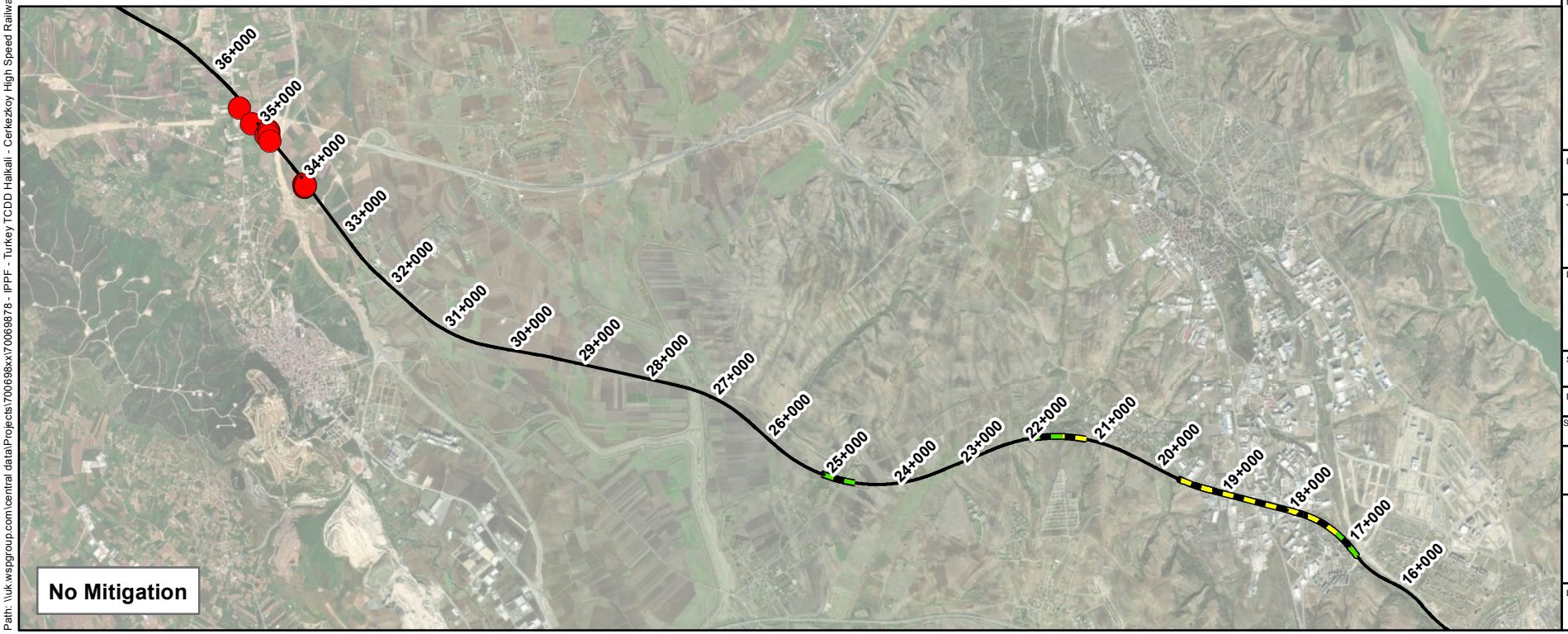
Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	12/11/2021

0 0.375 0.75 1.5 2.25 3
Km

Drawing Number
Figure 7-2B (1 / 5)

Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-2B CR.mxd



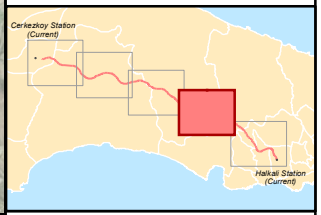


N

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Barriers
- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-2B - Significant Operational Noise Effects Night-time

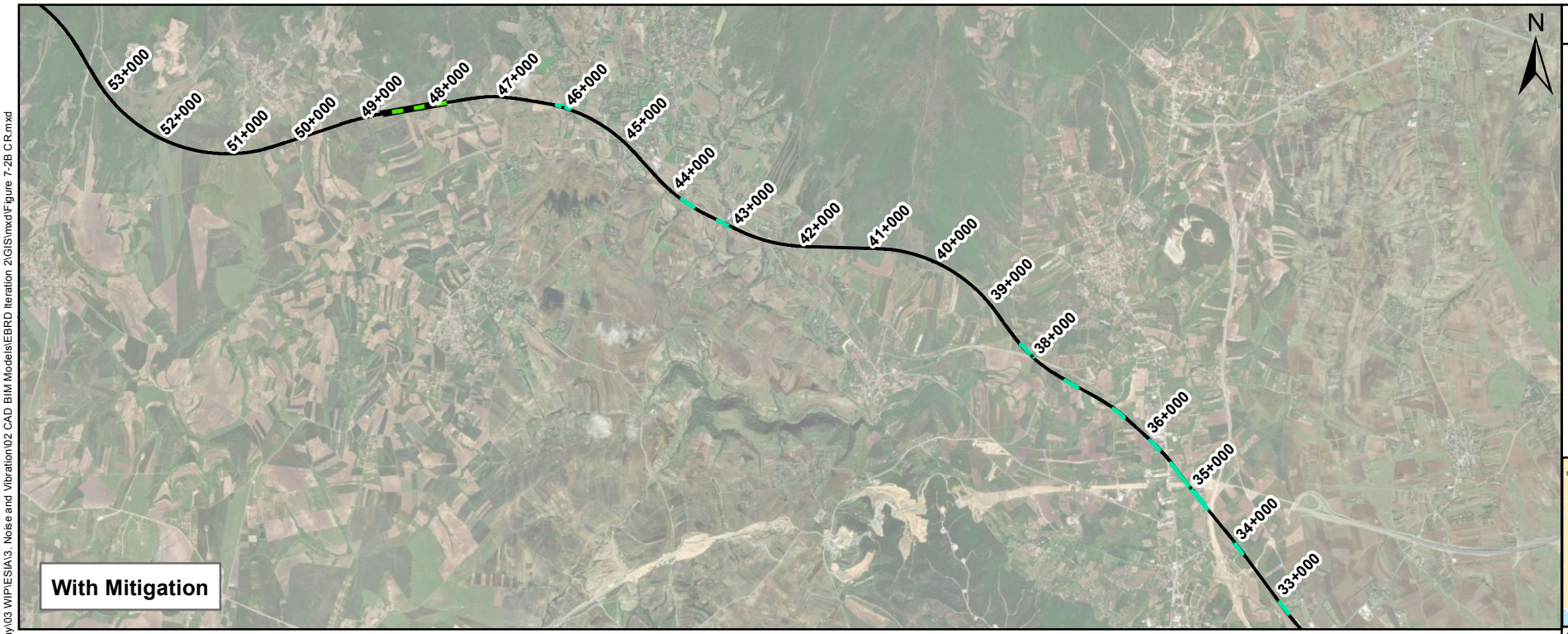
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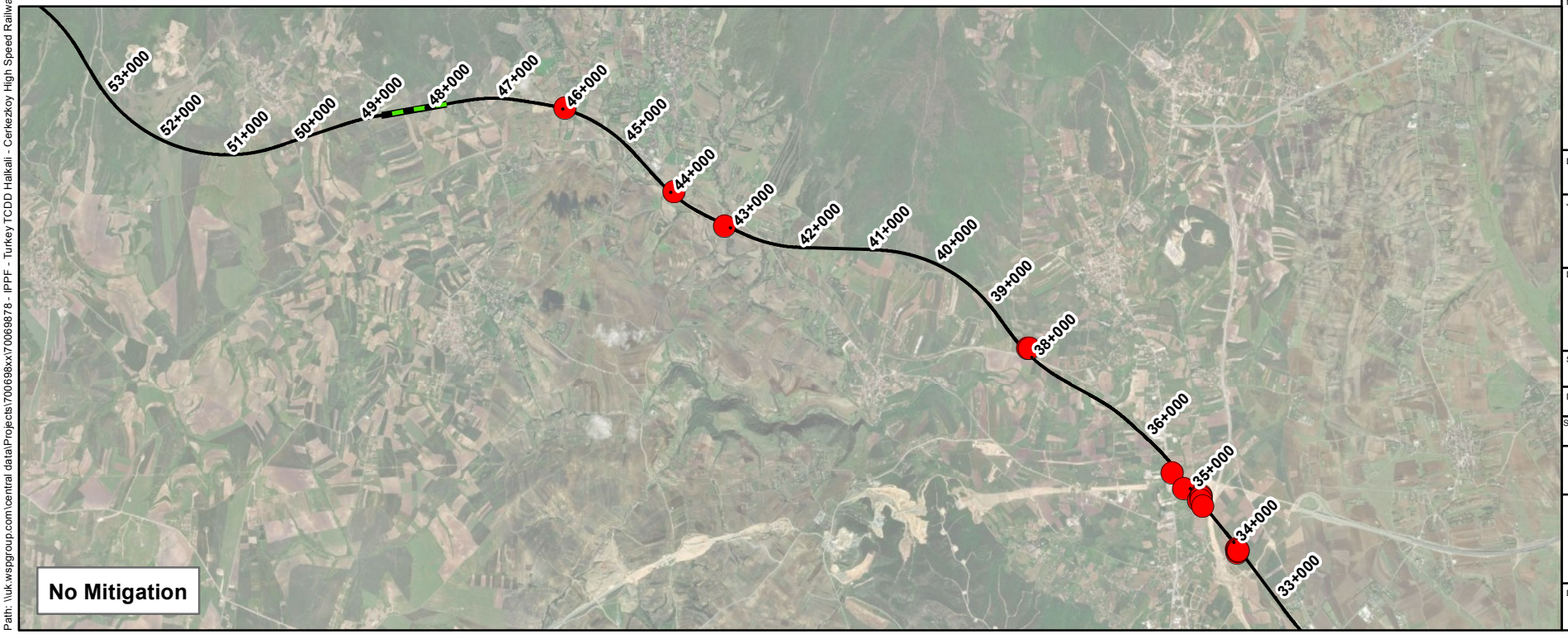
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CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	12/11/2021

0 0.375 0.75 1.5 2.25 3
Km

Drawing Number: Figure 7-2B (2 / 5)

Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-2B CR.mxd



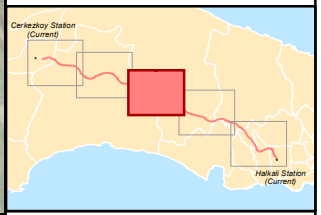


N

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Barriers
- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-2B - Significant Operational Noise Effects Night-time

Scale at A4: 1:90,000

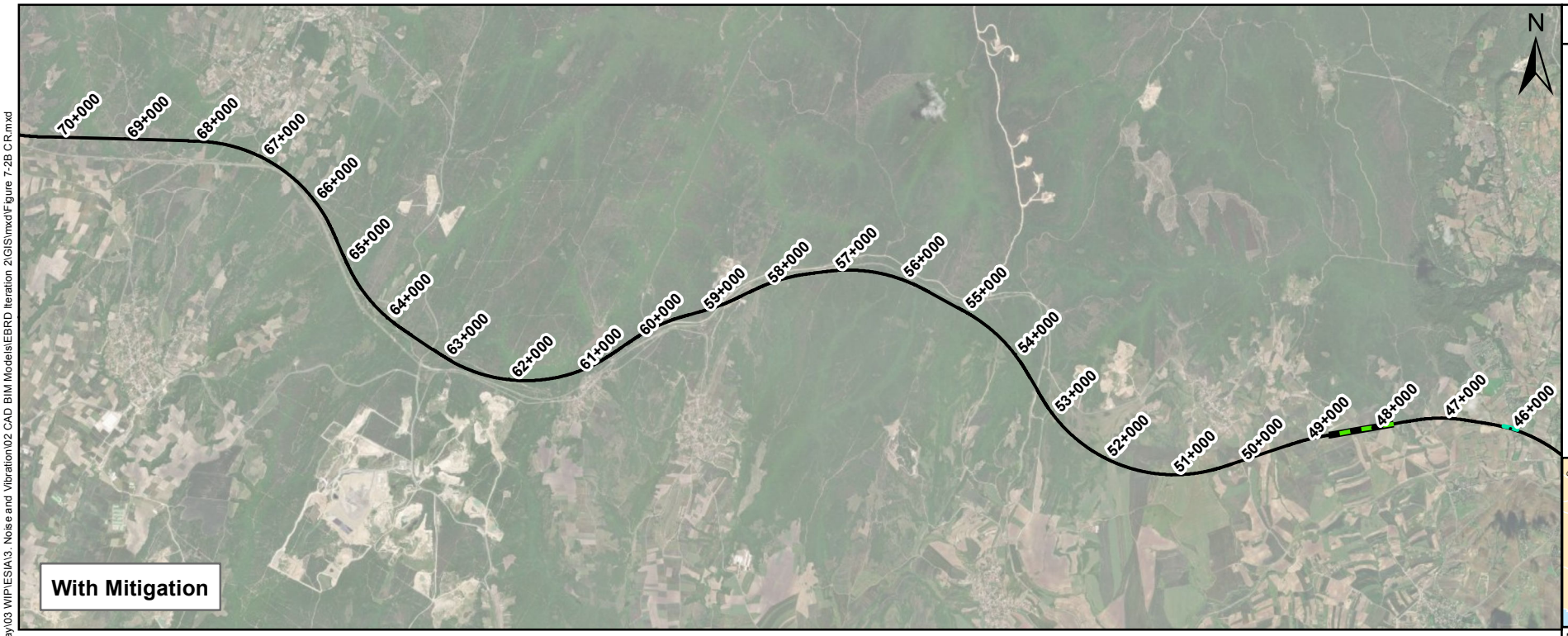
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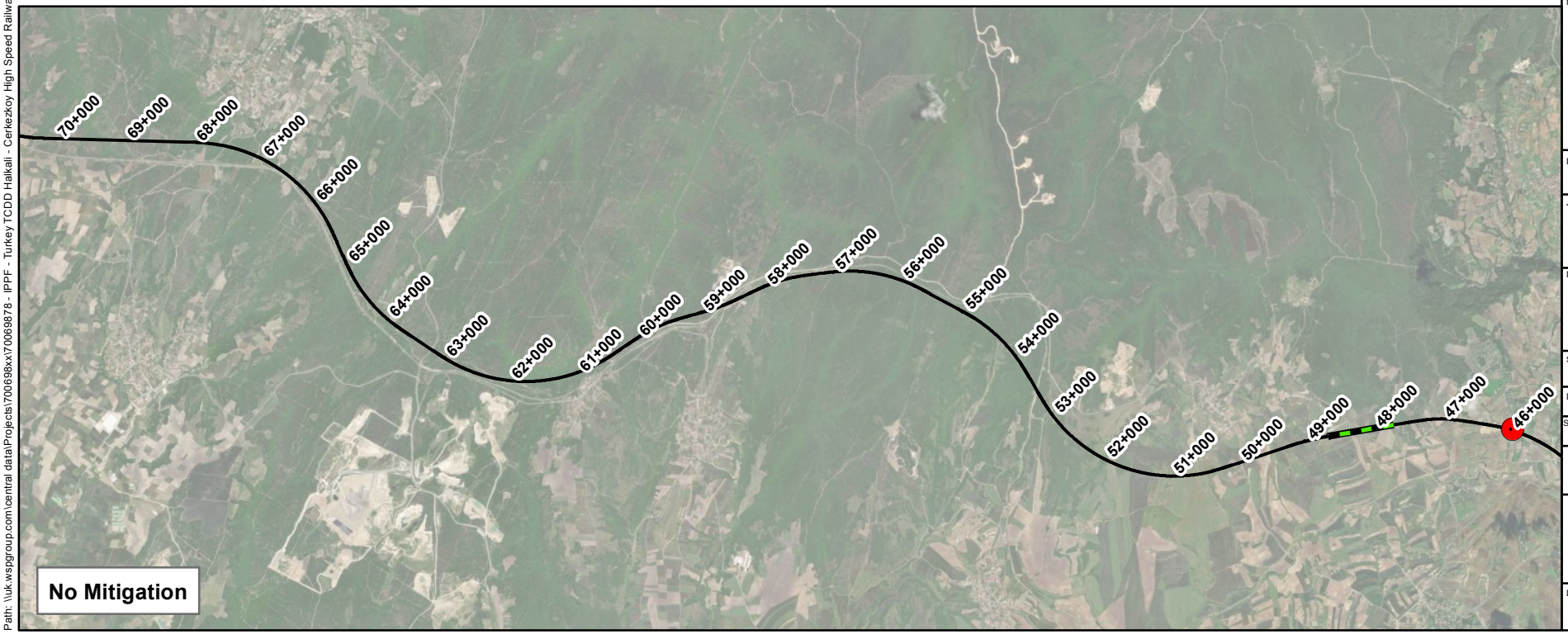
0 0.375 0.75 1.5 2.25 3
Km

wsp

Drawing Number: Figure 7-2B (3 / 5)

Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-2B CR.mxd



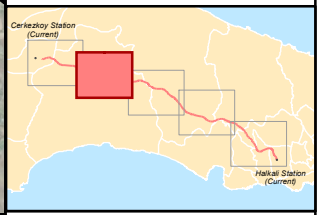


N

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Barriers
- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)



Note:

Drawing Status
FINAL

Job Title:
HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title
Figure 7-2B - Significant Operational Noise Effects Night-time

Scale at A4
1:90,000

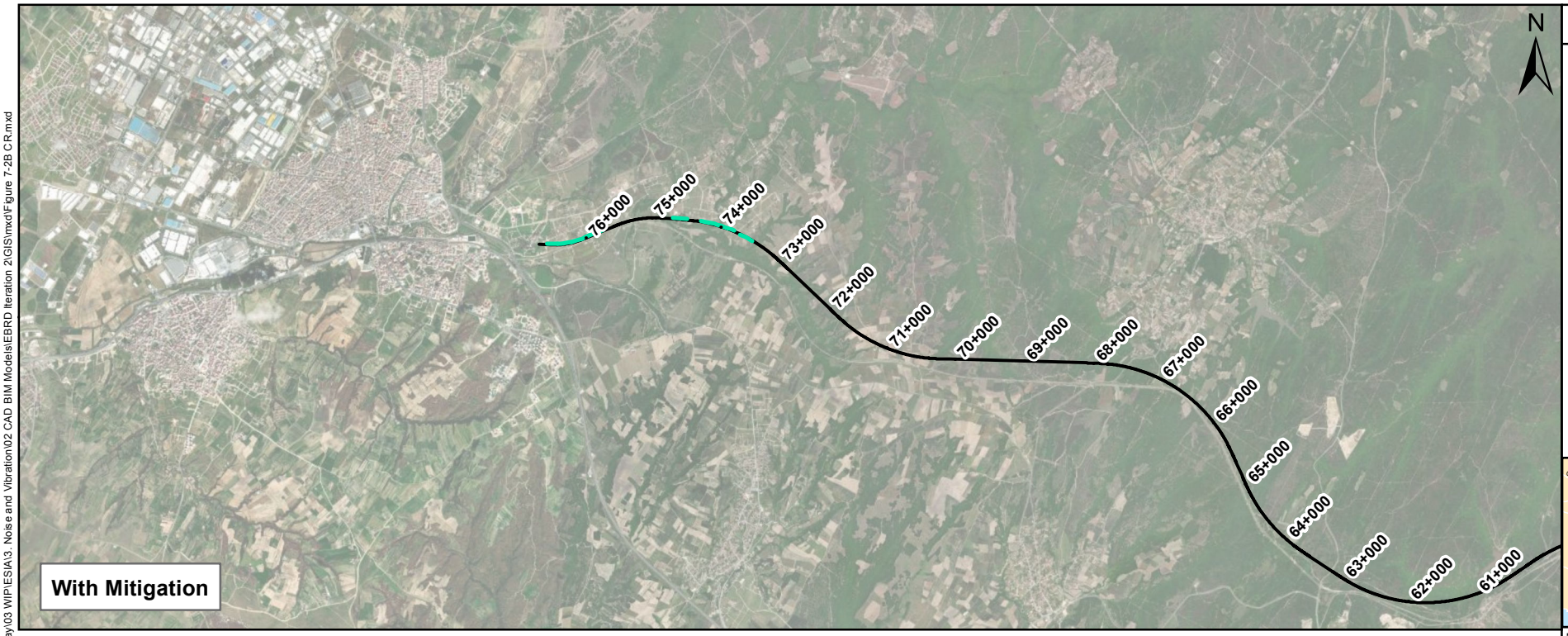
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CR			
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EO	EO	DG	12/11/2021

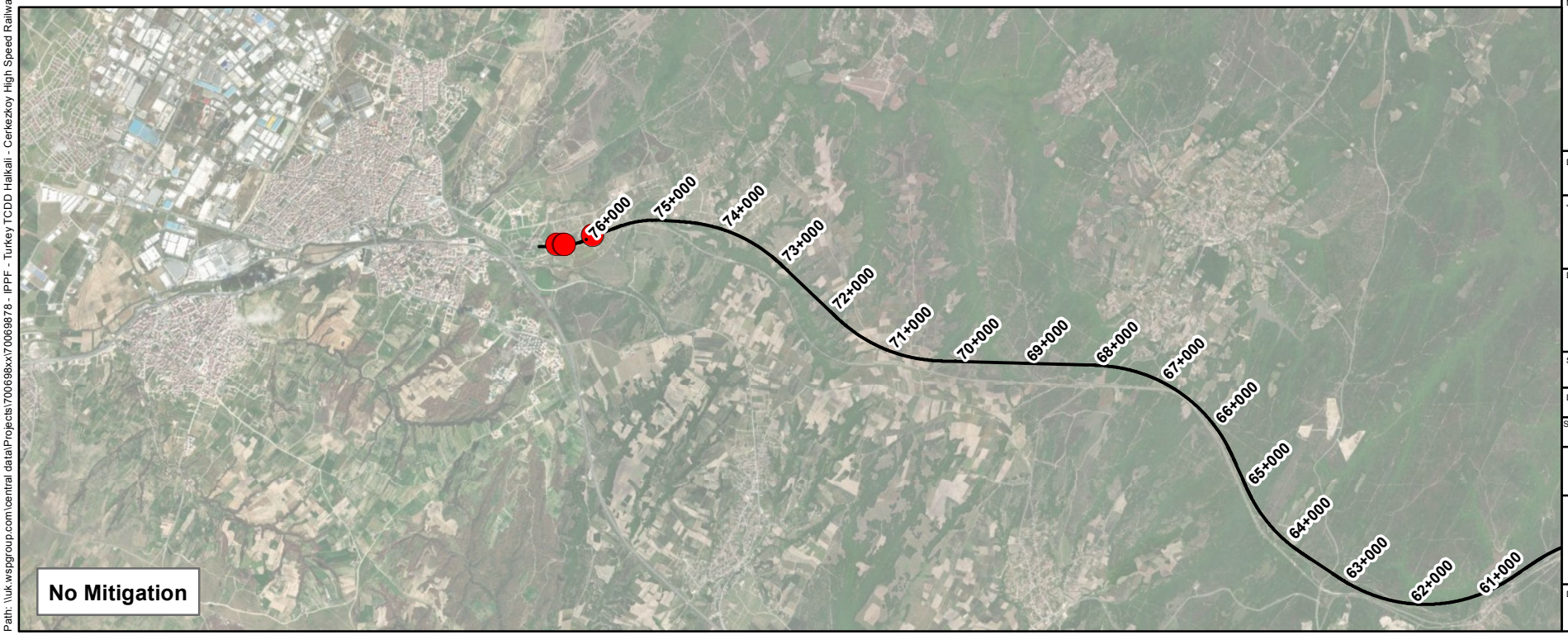
0 0.375 0.75 1.5 2.25 3
Km

wsp

Drawing Number
Figure 7-2B (4 / 5)

Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-2B CR.mxd

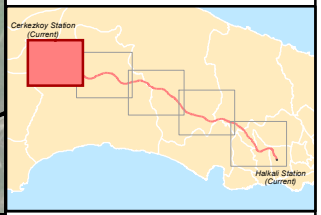




THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Barriers
- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)



Note:

Drawing Status
FINAL

Job Title:
HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title
Figure 7-2B - Significant Operational Noise Effects Night-time

Scale at A4
1:90,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	12/11/2021

0 0.375 0.75 1.5 2.25 3
Km

Drawing Number
Figure 7-2B (5 / 5)

Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-2B CR.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

Proposed Railway Route

- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

- 0 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

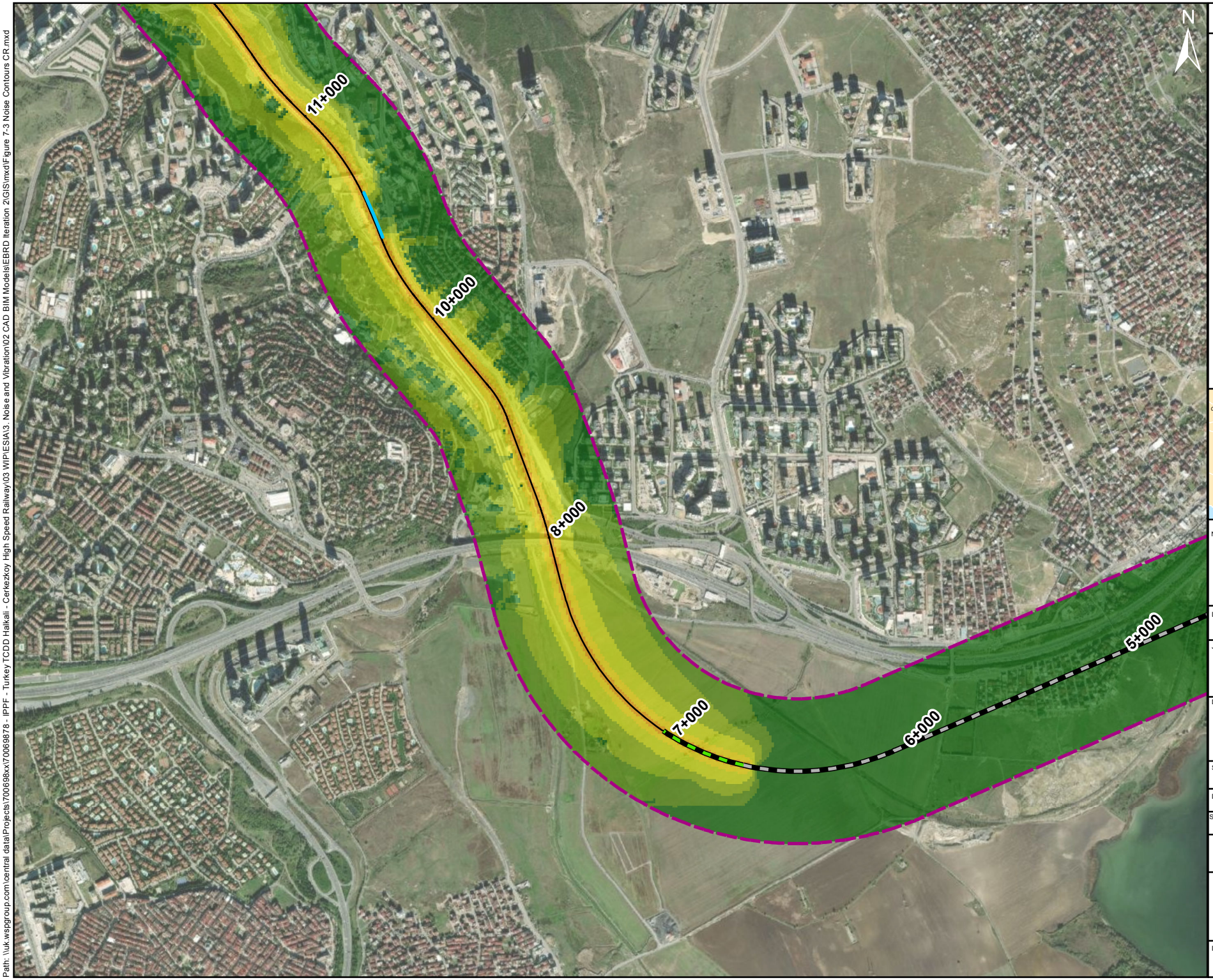
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CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

wsp

Drawing Number: Figure 7-3 (1 / 16)

Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

Proposed Railway Route

- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

- 0 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

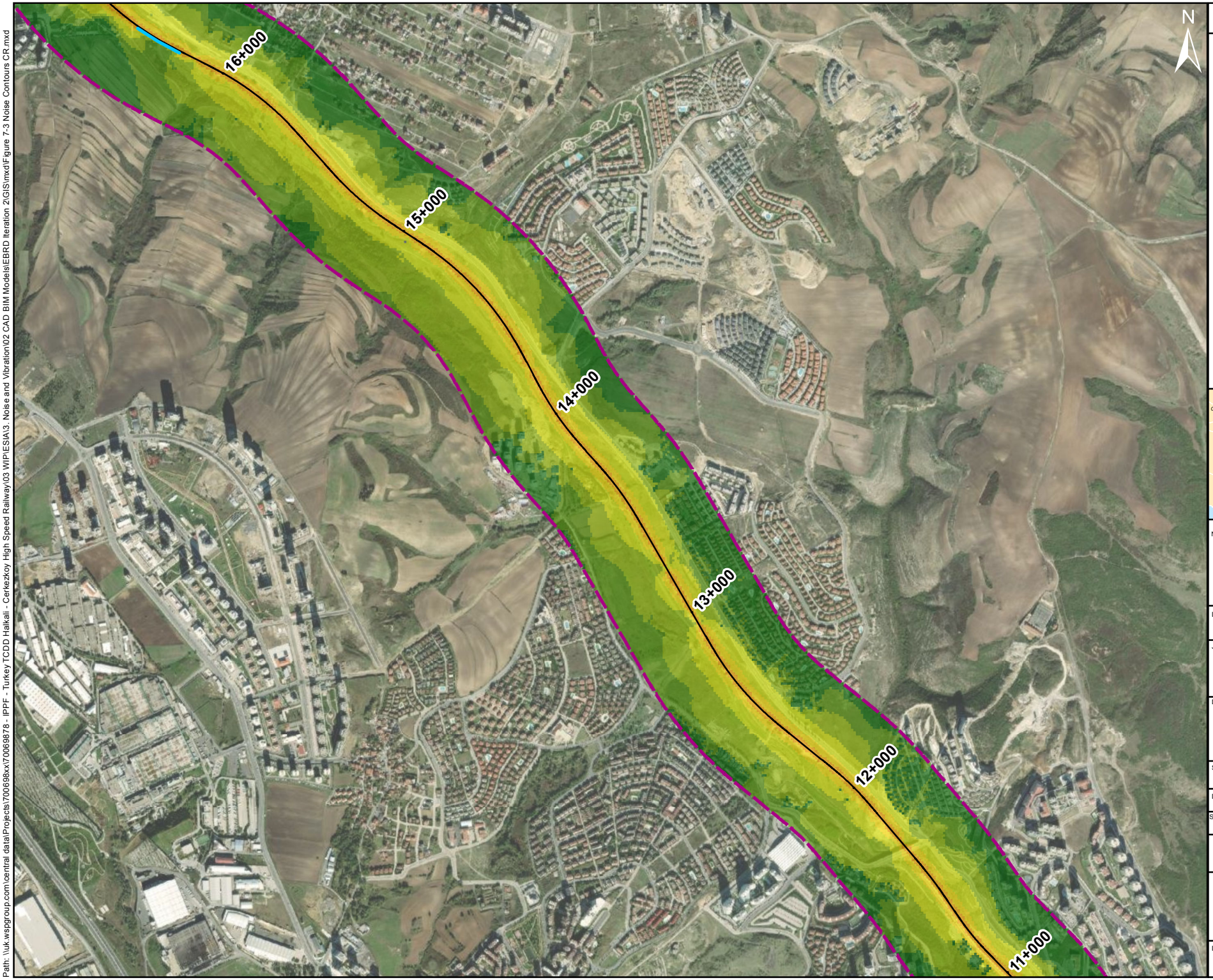
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Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

wsp

Drawing Number: Figure 7-3 (2 / 16)



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

Noise Barrier

Study Area

Proposed Railway Route

Proposed Railway Route

Tunnel (TBM - Twin Bore)

Tunnel (NATM)

Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

0 - 45

45 - 50

50 - 55

55 - 60

60 - 65

65 - 70

70 - 75

75 - 80



Note:

Drawing Status

FINAL

Job Title:

HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title

Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4

1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600

m

wsp

Drawing Number

Figure 7-3 (3 / 16)

Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

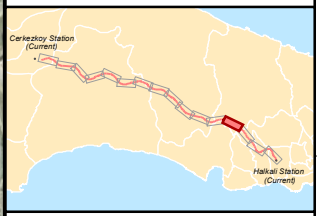
Proposed Railway Route

- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

- 0 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

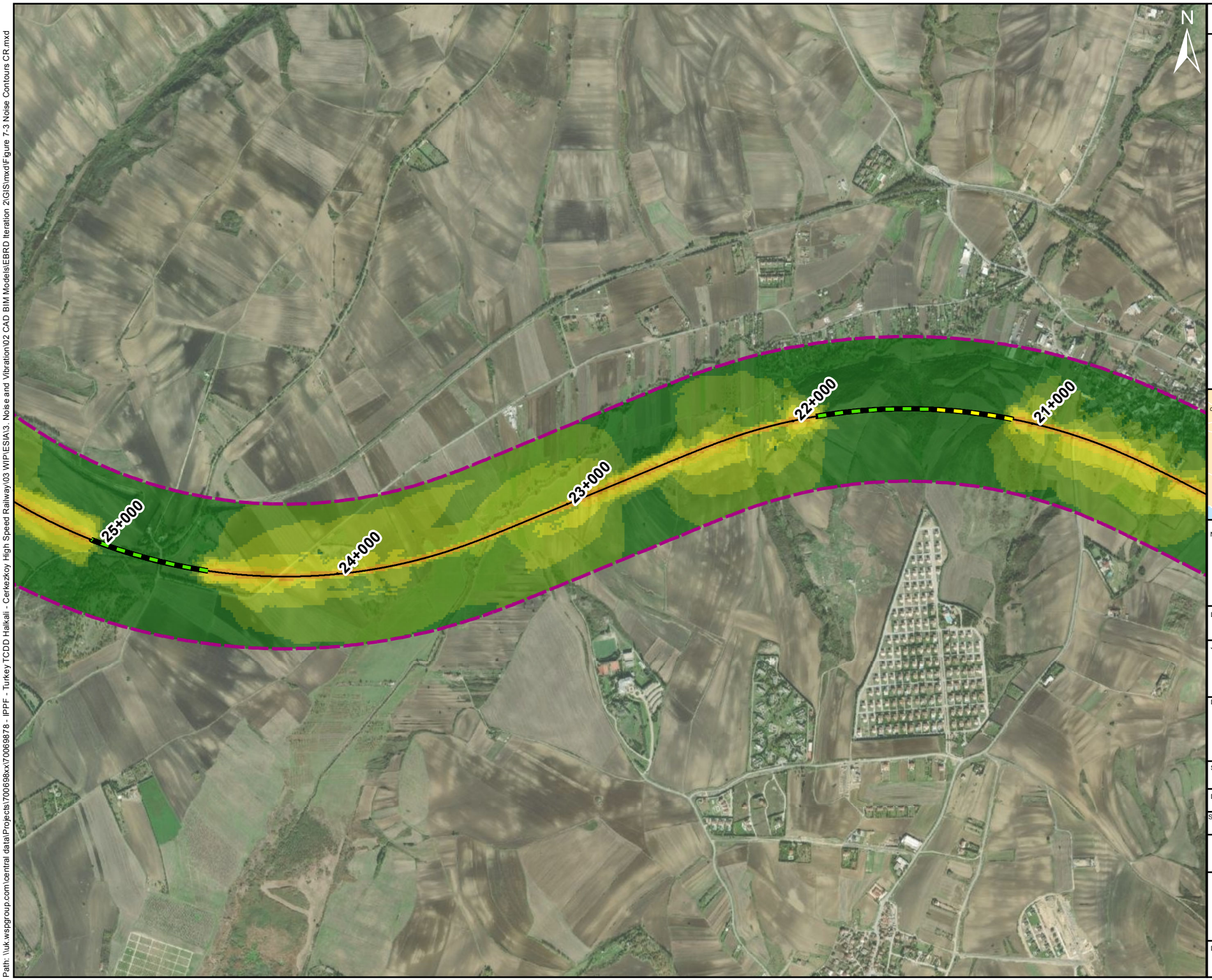
Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

wsp

Drawing Number: Figure 7-3 (4 / 16)

Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

Proposed Railway Route

- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

- 0 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

wsp

Drawing Number: Figure 7-3 (5 / 16)

Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

Proposed Railway Route

- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

- 0 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

Drawing Number: Figure 7-3 (6 / 16)



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

Proposed Railway Route

- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

- 0 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

wsp

Drawing Number: Figure 7-3 (7 / 16)

Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

Proposed Railway Route

- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

- 0 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

wsp

Drawing Number: Figure 7-3 (8 / 16)



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

Proposed Railway Route

- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

- 0 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

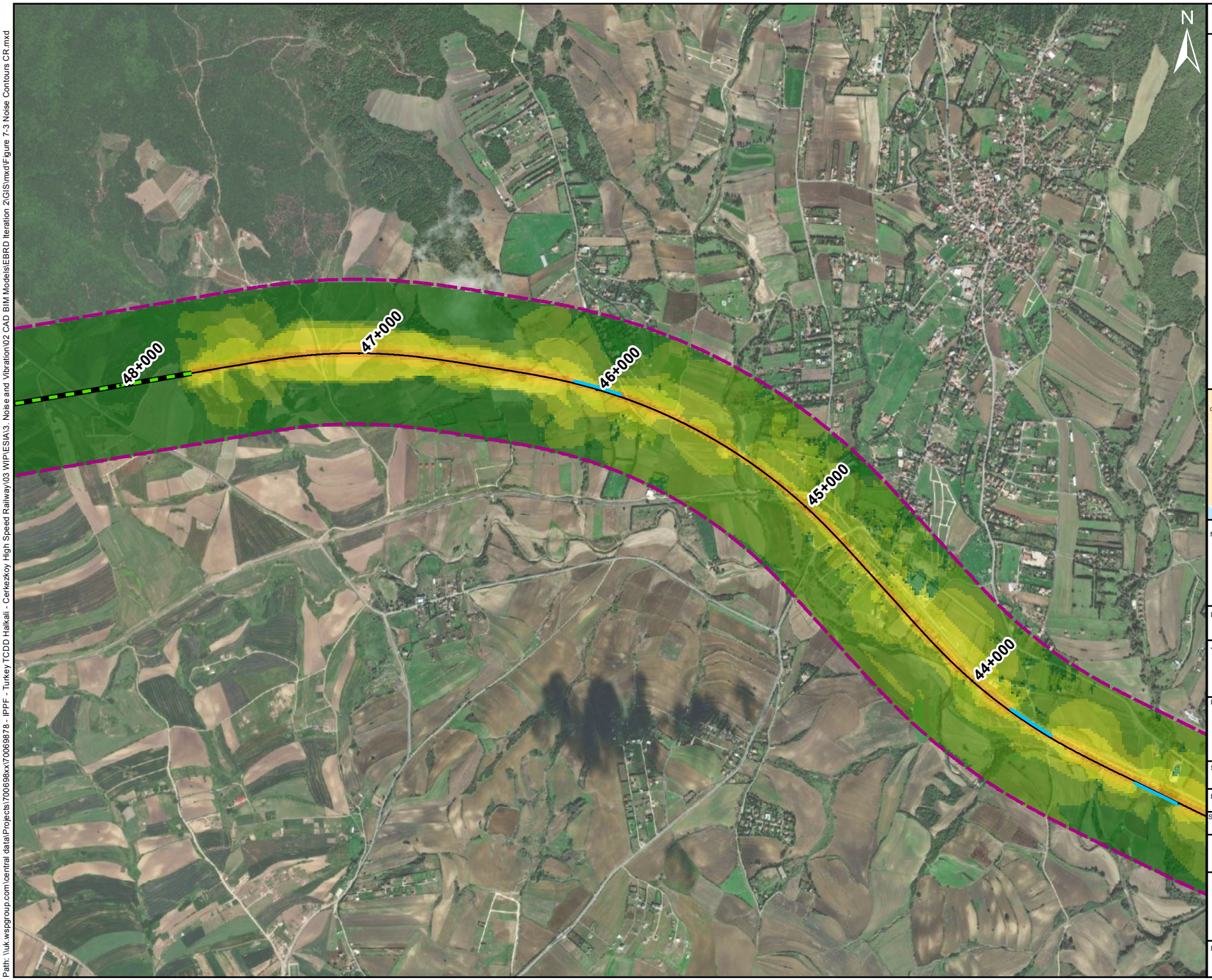
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CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

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m

wsp

Drawing Number: Figure 7-3 (9 / 16)

Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

Proposed Railway Route

- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

- 0 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

Drawing Number: Figure 7-3 (10 / 16)

Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

Proposed Railway Route

- Proposed Railway Route
- Tunnel (TBM - Twin Bore)
- Tunnel (NATM)
- Tunnel (Cut - Cover)

Noise Contours with Mitigation

LAeq,18h (dB)

- 0 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

Drawing Number: Figure 7-3 (11 / 16)

Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

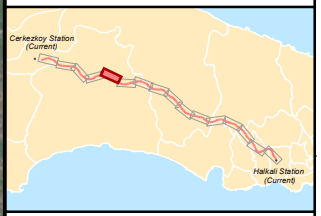
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Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

wsp

Drawing Number: Figure 7-3 (12 / 16)

Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

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- Study Area

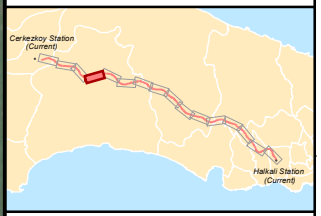
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- 75 - 80



Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

Drawing Number: Figure 7-3 (13 / 16)

Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

Proposed Railway Route

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Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

Drawing Number: Figure 7-3 (14 / 16)



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Legend

- Noise Barrier
- Study Area

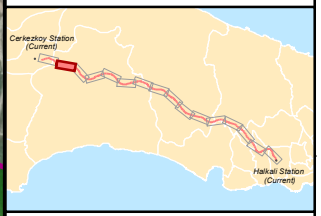
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Note:

Drawing Status: FINAL

Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

wsp

Drawing Number: Figure 7-3 (15 / 16)

Path: \\uk.wspgroup.com\central data\Projects\70069878xx\70069878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Noise Barrier
- Study Area

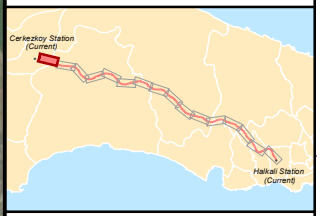
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Job Title: HALKALI-ISPARTAKULE-CERKEZKOY RAILWAY LINE

Drawing Title: Figure 7-3 Noise Contours 2041 with Mitigation

Scale at A4: 1:20,000

Drawn			
CR			
Stage 1 check	Stage 2 check	Originated	Date
EO	EO	DG	16/11/2021

0 75 150 300 450 600
m

wsp

Drawing Number: Figure 7-3 (16 / 16)

Path: \\uk.wspgroup.com\central data\Projects\700698xx\700698878 - IPPF - Turkey TCDD Halkali - Cerkezkoy High Speed Railway\03 WIP\ESIA\3. Noise and Vibration\02 CAD BIM Models\EBRD Iteration 2\GIS\mxd\Figure 7-3 Noise Contours CR.mxd

OPERATIONAL VIBRATION

7.7.14. Residual operational vibration effects are the same as those reported earlier in the chapter. Mitigation for significant operational vibration may be avoided if the expropriation corridor is increased to 25m from the Project in all locations. In areas where receptors are located within 25m, mitigation will be implemented, the measures are described in **Section 7.6**. It is expected that significant effects will be avoided by implementing these measures.

7.8 SUMMARY

Table 7-35 - Summary of Potential Impacts, Effects and Mitigation (Noise and Vibration)

Topic	Baseline Summary	Phase	Potential Impact(s)	Effect (without mitigation)	Mitigation Measures	Residual Effects (after mitigation)
Noise	Noise levels typical of rural and suburban areas, results in Table 7-14 and Table 7-15.	Construction	Some properties are likely to be subject to noise levels in excess of $L_{Aeq,12h}$ 70dB in all communities assessed.	All communities are likely to experience significant effects particularly Bahçeşehir, Kaleiçi, İnceğiz, Kabakça and İstasyon	Good practice measures and site hoarding at Bahçeşehir, Kaleiçi, İnceğiz, Kabakça and İstasyon.	**Significant** (during periods of intense activity only)
	Noise levels typical of rural and suburban areas, results in Table 7-14 and Table 7-15.	Operation	Some properties in Çatalca, Gökçeali, Kabakça and İstasyon are likely to experience a moderate adverse impact. Some properties at Kaleici are likely to experience a very large impact. Some properties at İnceğiz are likely to experience a very large impact.	Some properties in Catalca, Gökçeali, Kabakça and İstasyon are likely to experience a **Moderate Adverse (Significant)** effect. Some properties in Kaleici and İnceğiz are likely to experience a **Very Large Adverse and Large Adverse (Significant)**, respectively.	Noise barriers, cuttings and secondary window.	**Not Significant**
Vibration	It is assumed for this assessment that perceptible levels of vibration are absent at sensitive receptors near to the Project.	Construction	Properties along the Project are likely to experience a large or moderate impact.	It is likely that a **Large Adverse (Significant)** effect will be experienced by some receptors near to the Project in Halkali, Bahçeşehir, Ömerli, Kaleiçi, Gökçeali, İnceğiz, Kabakça, Çayırdere and İstasyon.	Selection of non-vibratory construction equipment. Temporary rehousing will be offered, if necessary and effects unable to be mitigated with above actions.	**Significant** (during periods of intense activity only)
	It is assumed for this assessment that perceptible levels of vibration are absent at sensitive receptors near to the Project.	Operation	Properties within 25m in Kabakça and Kaleiçi are likely to experience a large adverse impact due to freight movement at night.	Properties within 25m in Kabakça and Kaleiçi are likely to experience a **Moderate Adverse (Significant)** effect, with Neutral to Moderate effects experienced elsewhere.	Mitigation for significant operational vibration may be avoided if the expropriation buffer is above 25m. Within 25m, modify trackform as described in Section 0.	**Not Significant**
Reradiated noise	It is assumed for this assessment that perceptible levels of reradiated noise are absent at sensitive receptors near to the Project.	Operation	Properties within 25m in Bahçeşehir, Kaleiçi, İnceğiz, Kabakça and İstasyon are likely to experience a large adverse impact due to freight train movement at night.	Properties within 25m in Bahçeşehir, Kaleiçi, İnceğiz, Kabakça and İstasyon are likely to experience a **Moderate Adverse (Significant)** effect, with Neutral to Moderate effects experienced elsewhere.	Increasing expropriation corridor in these areas or alter trackform as described in Section 0.	**Not Significant**