ZGI Ltd. Mostar,
Rudarska 247,
88000 Mostar, BiH
e-mail: info@zgi.eu,
web: www.zgi.eu
Phone.: +387 36 33 42 80

Client: STRABAG AG – Business unit Sarajevo
Company Adress:
Zmaja od Bosne 11,
71 000 Sarajevo,
Bosna i Hercegovina

Object: Residential building situated on plot [redacted] in cadastral municipality Brčko 2

Study on the assessment of the noise impact on the residential building

Residential building situated on plot [redacted] in cadastral municipality Brčko 2

Team leader:
[redacted] B.Sc.El.Eng.

Associates:
[redacted] B.Sc.OHS.
[redacted], B.Sc. CE.
[redacted] B.Sc. in Traffic Eng.
[redacted], M.Sc.chem
[redacted], M.Sc.chem
[redacted] M.Sc.chem
[redacted], M. sc. in Food Eng

Documentation number:
01-2-3-rev3-V/24

Director:
[redacted] B.Sc.El.Eng.

Date:
October, 2024.

Content

0. INTRODUCTION 4

1 METHODOLOGY FOR ENVIRONMENTAL NOISE ASSESSMENT 7

1.1 STAGES OF THE METHODOLOGY 7

2 THE POSITION OF THE OBJECT 9

3 REGULATORY FRAMEWORK AND GUIDELINES 10

4 BASELINE INFORMATION 16

5. NOISE IMPACTS ASSESSMENT 21

5 ATTACHMENT 31

List of figures:

Figure 1 The position of the object in the winder surroundings.....9

Figure 2 Measuring place 16

Figure 3 Arrival of the engine room of the train.....18

Figure 4 The arrival of a train with wagons 19

Figure 5 The passage of a train with wagons in front of the measuring point and the measuring instrument 19

Figure 6 An overview of the noise values during the passing of the train and comparison with the noise values of the zero state during the day and night 20

Figure 7 The schematic layout of the façade calculation points.....27

List of tables:

Table 1 Permissible outdoors noise level for planning of the new construction or noise sources 10

Table 2 Permissible noise level from outdoors sources in the premises depending on their intended use 11

Table 3 The prescribed acoustic zones and the highest permissible levels of outdoor noise 12

Table 4 Noise level gudilines by IFC EHS 13

Table 5 The WHO guidelines values for community noise in specific environments 14

Table 6 The calculated values of railway noise levels at facade points 28

Table 7 The calculated values of railway noise levels at facade points 29

0. INTRODUCTION

The objective of the study is to explore options for mitigating the impact of railway noise to protect vulnerable individuals living in the residential building situated on plot [redacted] in cadastral municipality Brčko 2. The Investor and EBRD have agreed not to disclose the medical details of the affected individuals, recognizing their vulnerability due to health conditions. Based on this assessment, appropriate measures will be planned to alleviate the adverse effects of railway noise.

The input data for the preparation of the Study on the assessment of the impact of noise on the object were taken from the "Main project of the industrial track Railway station Brčko Novo - Luka Brčko - Book I (ET 350/12) - attachment 2. Technical report" and Official letter No. 781/24 dated April 24, 2024, received from the Public Enterprise Port of Brčko.

The Port of Brčko and the Brčko Industrial Zone contain a number of existing transshipment and prospective production and processing capacities, which represent the most significant potential for the economic and social development of the Brčko District of BiH. Also, these capacities provide an opportunity for the development of a wider region that gravitates to the District area. Among these capacities, the most important are the Port of Brčko, "Bimal" (edible oil production), "Studen-Agrana" sugar refinery, "Novi Bimeks" (meat production, etc.). The common characteristic of all entities (ports and production-processing capacities) is their connection with industrial tracks, which resulted in the construction of a new industrial railway.

According to the input data from the project, the aim and purpose of the railway construction project is to ensure a direct connection between the Brčko Port and the Brčko Novo railway station. The new industrial railway is approximately 2.87 km long and allows a maximum speed of 35 km/h.

The previous noise measurements related to the given project were given through the Decision on Issuing the Environmental Permit, No.: UP-I-22-002157/21, dated 10.12.2021. issued by the Department for Spatial Planning and Property - Legal Affairs of the Brčko District Government. According to the aforementioned Decision, the noise level in the environment was tested on July 26, 2012. year by the Institute of Protection, Ecology and Informatics Banja - Luka. This measurement included 4 measuring points and the limit values were taken in accordance with the Ordinance on permissible limits of sound intensity

and noise (Official Gazette of SR BiH [redacted]89). As such, the measurements could not be taken as input data for the preparation of the study, and as part of the preparation of the study, a measurement of the noise level was made for a specific project task (to assess the noise level of the residential building that is the subject of the Study).

Study documentation prepared by :

[redacted]

Document preparation date : October, 2024.

1 METHODOLOGY FOR ENVIRONMENTAL NOISE ASSESSMENT

The primary objective of the Methodology for Environmental Noise Assessment is to evaluate the potential impact of railway traffic on the new track between Brčko Novo station and Brčko port on the noise levels at the residential property located on parcel [redacted] in the cadastral municipality of Brčko 2 (exposure). If necessary, noise barriers will be planned based on this assessment to mitigate the negative impact of railway noise on the people living there.

1.1 Stages of the methodology

The noise analysis will be conducted in accordance with national and international laws and standards, as well as EBRD noise assessment regulations and guidelines. The proposed methodology will ensure that all noise impacts associated with operation of Brčko Novo station – Brčko port railway line are identified, described, and assessed. The basic phases of the proposed methodology are:

1. Review of Bosnian-Herzegovinian and International legislation, standards, and other documentation in the field of environmental noise assessment. Implementation of EBRD ESP policy.
2. Review of the relevant noise sections in the Pre-feasibility Study, ESIA Scoping Report, related studies and/or other relevant existing documents regarding the Brčko Novo station – Brčko port railway line.
3. The limit values of noise indicators will be determined in accordance with the valid legislation. The criterion that will be used for planning protective measures is the ability to maintain noise levels on the facade of the property within legal limits for the daytime and nighttime period.
4. A desktop baseline noise survey will be undertaken to identify existing noise sources. The results of already performed measurements in the corridor of the existing and/or new railway line will be collected and presented. An overview of the current situation and existing background will be presented.
5. Collection of available data in the field of noise assessment regarding the Brčko Novo station – Brčko port railway line. The Client will provide the required data.

6. Giving report on daytime environmental noise measurement (baseline measurement) and report on night time environmental noise measurement (baseline measurement) based on measuring defined by legislative requirements.
7. A Noise model will be constructed to predict operational noise levels associated with railway traffic on the Brčko Novo station – Brčko port railway line. Noise levels will be calculated using CNOSOSS-EU:2015 (Common Noise assessment methods) in accordance with the EU directive 2015/996 (Annex II of Directive 2002/49/EC).
8. The magnitude and scale of noise impacts on the residential property located on parcel [redacted] in the cadastral municipality of Brčko 2 (exposure) will be evaluated for the following impact characteristics: scale, duration, frequency, extent.
9. In order to reduce adverse impacts of traffic noise on environment and population, protection measures must be planned and implemented if noise levels permitted by the law are exceeded. The noise mitigation measures will be determined following environmental noise assessment. As a primary measure, noise barriers are planned.

The methodology represents a comprehensive and universal approach that is applied to the realization of a specific project.

By presenting the methodology, it was concluded that point 3 will be adjusted in accordance with the requirements of the EBRD, as communicated via email dated April 3, 2024. The EBRD requires that the noise level be adjusted in accordance with WHO guidelines (Guidance for the community noise), specifically to the noise level requirements for vulnerable subgroups (hospitals) in order to protect vulnerable individuals living near the project. In accordance with the previously mentioned requirements, the permissible noise level is 30 dB during the day and night within the residential building, and 45 dB at a distance of 1 meter from the facade of the residential building.

2 THE POSITION OF THE OBJECT

The position of the object in the wider surroundings is shown in Figure 1. In addition to the Brčko Novo - Brčko Port railway line (which is the subject of this study), potential sources of noise include the international railway line Brčko - Vinkovci, city streets, and industrial facilities in the vicinity.

Figure 1 The position of the object in the wider surroundings

The building is located on the right side of the Brčko Novo - Brčko Port railway line (which is the subject of this study) at km [redacted] and approximately 18 meters away from the centerline of the track. In relation to other potential noise sources, the building is approximately 25 meters away from the international railway line Brčko - Vinkovci, and approximately 75 meters and 95 meters away from the street leading to the port and [redacted], respectively. Industrial facilities are located in the immediate vicinity of the building. On the left side of the building is the "[redacted]" facility, while on the right side of the facility shown in Figure 1 is the "[redacted]" company.

3 REGULATORY FRAMEWORK AND GUIDELINES

In the Federation of Bosnia and Herzegovina, the legislative framework for noise regulation is delineated within the Law on Protection from Noise (Official Gazette FBiH, No. 110/12). This legal instrument defines permissible noise levels, noise protection measures and methods of measuring and recording noise. The regulation governs subjects of environmental noise protection, measures and conditions of protection from noise in the environment; environmental noise measurement; access to information about noise; monitoring and other issues relevant for environment protection and human health.

The permissible outdoor noise levels for the planning of new structures or noise sources, across various environments and timeframes, are shown in Table 1, while the permissible noise levels from outdoor sources within premises, depending on their intended use, are shown in Table 2.

Table 1 Permissible outdoors noise level for planning of the new construction or noise sources

Area (zone)	INTENDED USE OF AREA	The highest permissible level		
		L_{eq} (day)	L_{eq} (night)	$L_{1\%}$
		[dB(A)]	[dB(A)]	[dB(A)]
I	Hospital-medical	45	40	60
II	Tourist, recreation, rehabilitation	50	40	65
III	Exclusively residential, education/upbringing and health institutions, public green and recreation areas	55	45	70
IV	Trade, business, residential areas along traffic corridors, warehouses without heavy transportation	60	50	75
V	Business, administrative, trade, artisan, service (utilities)	65	60	80
VI	Industrial, warehouse, service and traffic are with no residential areas	70	70	85

Table 2 Permissible noise level from outdoors sources in the premises depending on their intended use

No.	INTENDED USE OF PREMISES	The highest permissible level T_{ref} = 15 min [dB(A)]		
		L_{eq} (day)	L_{eq} (night)	$L_{1\%}$
A	Hospitals, clinics, health care centers			
A1	Patients' rooms	35	30	45
A2	Doctors' offices	40	40	55
A3	Surgery ward without medical devices and equipment	35	35	50
B	Hotels, motels, dormitories, singles hotels and the like Hotel rooms 5 stars			
B1	From noise sources in the building and stationary sources outside the building	35	30	45
	From non-stationary noise sources outside the building	40	35	50
	Hotel rooms 4 stars	40	35	50
B2	From noise sources in the building and stationary sources outside the building From non-stationary noise sources outside the building Bedrooms in dormitories	45	40	55
B3	From noise sources in the building and stationary sources outside the building	40	35	55
	From non-stationary noise sources outside the building	45	35	55
C	Schools, universities, libraries and the like			
C1	Amphitheaters and classrooms	40	40	50
C2	Offices at universities	35	35	50
C3	Offices at schools	40	40	50
C4	Reading room, libraries	40	40	45
D	Sports gyms			
D1	Cinema halls	40	40	50
D2	Theaters	30	30	35
D3	Concert halls	30	30	35
E	Preschool facilities and the like			

E1	Rooms for children's rest from noise sources in the building and stationary sources outside the building	40	35	50
	From non-stationary noise sources outside the building	45	35	50
E2	Rooms for the work with children	45	45	50
F	Residential facilities			
F1	Bedrooms and living rooms From noise sources in the building and stationary sources outside the building	40	30	45
F2	From non-stationary noise sources outside the building	45	35	50

Based on the provisions of the Law on Protection from Noise (Official Gazette FBiH, No. 110/12), the subject object falls into Area IV (Table 1) and class F2 (Table 2). The permissible daytime outdoor noise level is 60 dB(A), while the permissible daytime noise level from outdoor sources in the subject object is 45 dB(A).

In Brčko District, the Law on environmental protection (Official Gazette DB, No. 24/04) includes several provisions on noise. The Regulation on Permitted Limits of Noise (Official Gazette SRBiH, [redacted]89) is still in use. The prescribed acoustic zones and the highest permissible levels of outdoor noise are shown in Table 3.

Table 3 The prescribed acoustic zones and the highest permissible levels of outdoor noise

Area (zone)	INTENDED USE OF AREA	The highest permissible level			
		L_{eq} (day)	L_{eq} (night)	$L_{10\%}$	$L_{1\%}$
		[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]
I	Hospital-medical	45	40	55	60
II	Tourist, recreation, rehabilitation	50	40	60	65
III	Exclusively residential, education/upbringing and health institutions, public green and recreation areas	55	45	65	70
IV	Trade, business, residential areas along traffic corridors	60	50	70	75
V	Business, administrative, trade, artisan, service (utilities)	65	60	75	80
VI	Industrial, warehouse, service and traffic are with no residential areas	70	70	80	85

Like with federal laws, the allowed noise levels in Brčko District stay the same. The subject object also falls within Zone 4, where the permissible outdoor noise levels during the day are 60 dB(A).

The IFC EHS Guidelines address impacts of noise beyond the property boundary of the subject object. Noise impacts are assessed against the World Health Organization's (WHO) guideline levels as presented in Table 4. Noise impacts should not exceed the levels presented in Table 4 or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

Table 4 Noise level guidelines by IFC EHS

Description of Receptor Categories	IFC / WB Group Guidelines [dB(A)]	
	Day	Night
	07:00 – 22:00	22:00 -07:00
Residential, Institutional, Educational	55	45
Industrial / Commercial	70	70

According to the IFC general EHS guidelines, "when host country regulations differ from the levels and measures presented in the IFC general EHS guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, a justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment ".

The WHO Environmental Noise Guidelines for the European Region provide guidance on protecting human health from harmful exposure to environmental noise. In WHO noise quality guidelines, values are summarized with regard to specific environments and effects. For each environment and situation, the guideline values take into consideration the identified health effects and are set, based on the lowest levels of noise that affect health (critical health effect). Guideline values typically correspond to the lowest effect level for general populations, such as those for indoor speech intelligibility. The guideline values for noise represent the threshold at which health effects from noise exposures begin to occur. Guidelines values for community noise in specific environments are presented in Table 5.

Table 5 The WHO guidelines values for community noise in specific environments

Specific Environment	Standard limits as per WHO guidelines	Time Base	$L_{Amax,\ fast}$
	L_{Aeq} [dB(A)]	[hours]	[dB(A)]
Outdoor living area (daytime)	50 - 55	16	-
Dwelling, indoors (daytime)	35	16	-
Inside bedrooms (night-time)	30	8	45
Outside bedrooms (night-time)	45	8	60
School class rooms and pre-schools, indoors	35	During class	-
Pre-school bedrooms, indoors	30	Sleeping time	45
School, playground outdoor	55	During play	-
Hospital, ward rooms, indoors (night-time)	30	8	40 -
Hospital, ward rooms, indoors (daytime time)	30	16	
Hospitals, treatment rooms, indoors	As low as possible	-	-
Industrial, commercial, shopping and traffic areas, indoors and outdoors	70	24	110

The WHO guidelines for community noise and subject object recommend less then 55 dB(A) for daytime outdoor noise and 35 dB(A) for indoor daytime noise.

The Investor and the EBRD have requested the application of noise standards relevant to "Hospitals" (Table 5) in order to protect vulnerable individuals residing in the vicinity of the project. These standards specify limits of 30 dB(A) L_{Aeq} during the daytime period to be achieved inside the object. Assuming that noise reduction from outside to inside with the window partly open is 15dB (as stated in WHO guidelines), the standards that's should be achieved outside the façade of the building should be **45 dB(A)**.

The outdoor-to-indoor attenuation depends on various factors, including the window's position, the room's type and volume, and the building's age. This attenuation needs to be assessed for each specific object. This assessment must be completed in the subsequent phases of technical documentation development.

Building acoustics is not the subject of this study, so for further calculations, an outdoor to indoor attenuation value of 15 dB is adopted.

4 BASELINE INFORMATION

To assess the impact of noise on the object, the following activities were carried out:

1. Visiting the location and creating a measurement plan for measuring environmental noise
2. Measurement of the zero state of environmental noise (day and night noise) without railway traffic
3. Measurement of noise from railway traffic
    a. Measurement during the passage of the engine room of the train
    b. Measurement during the passage of a train with a load of 11 wagons.

During the initial tour of the location, it was determined that the residential building in question is located at a distance of 18 meters from the railway line. The distance from the nearby road where the overpass was built is approx. 95 m, while the distance from the nearby road leading to the harbor is approx. 75 m. The company "[redacted]" is approx. 30 m from the object in question, while the company "[redacted] approx. 15 m from the object in question.

Figure 2 Measuring place

A field visit to measure environmental noise was made on April 15, 2024. years. On the same day, measurements of the night environmental noise were made. On April 16, 2024, the measurement of daily environmental noise and noise from railway traffic was made.

On the basis of day and night noise measurements, reports were made under the following numbers:

1. Report on measurement of daily environmental noise, No.: 01-2-134-IV/24
2. Report on the measurement of night environmental noise, No.: 01-2-1-134-IV/24

According to the situation on the ground, the main source of noise during both day and night measurements is road traffic from nearby roads. The higher frequency of vehicles is on the road approx. 100m from the object in question, i.e. traffic from „Bijeljinska street".

The measurement was made according to the standards: BAS ISO 1996-1 and BAS ISO 1996-2, and the compliance of the obtained values was made according to Table 1 and Table 3. In accordance with the aforementioned, the broader location of the object in question can be classified in the IV category specified in the tables, whereby the limit value for daytime measurement is 60 dB, while the limit value for night measurement is 50 dB.

The mean value obtained for the daytime measurement is 49.2 dB, while the value obtained for the night measurement is 48.5 dB.

During the environmental noise measurements on private property, the chosen measurement site was located 12 meters away from the railway line, identified as the primary source of noise. The main noise source was a freight train heading towards the Port of Brčko.

Figure 3 Arrival of the engine room of the train

During the measurements, the activity of the freight train's engine room was recorded as it approached this measurement site. When the engine room was directly in front of the measurement site, the highest noise level of 74.1 decibels (dB) was measured. As the engine room approached, lower noise levels were recorded, with a minimum of 58.6 dB.

Approximately 40 minutes later, the return of the same train was noted, now with a total of 11 attached wagons, returning from the direction of the Port of Brčko. The train's passage on the newly constructed track created continuous noise. As the train approached, the noise level was 60.4 dB, increasing as the train moved closer to the measurement site.

Figure 4 The arrival of a train with wagons

During the 40 seconds it took for the train to pass by the measurement site, the noise level ranged from 70 to 75.5 dB, peaking at 75.5 dB when the train was closest to the measurement site.

Figure 5 The passage of a train with wagons in front of the measuring point and the measuring instrument

These measurements provide a detailed insight into the different noise levels generated by the train during the different phases of passing by the measurement site. These data are extremely important for assessing the potential impact of noise on the environment and the local community. Based on this information, a number of noise mitigation measures can be planned and implemented, such as the installation of sound barriers or the improvement of insulating materials at critical points along the railway line, in order to reduce noise and improve the quality of life in the surrounding areas.

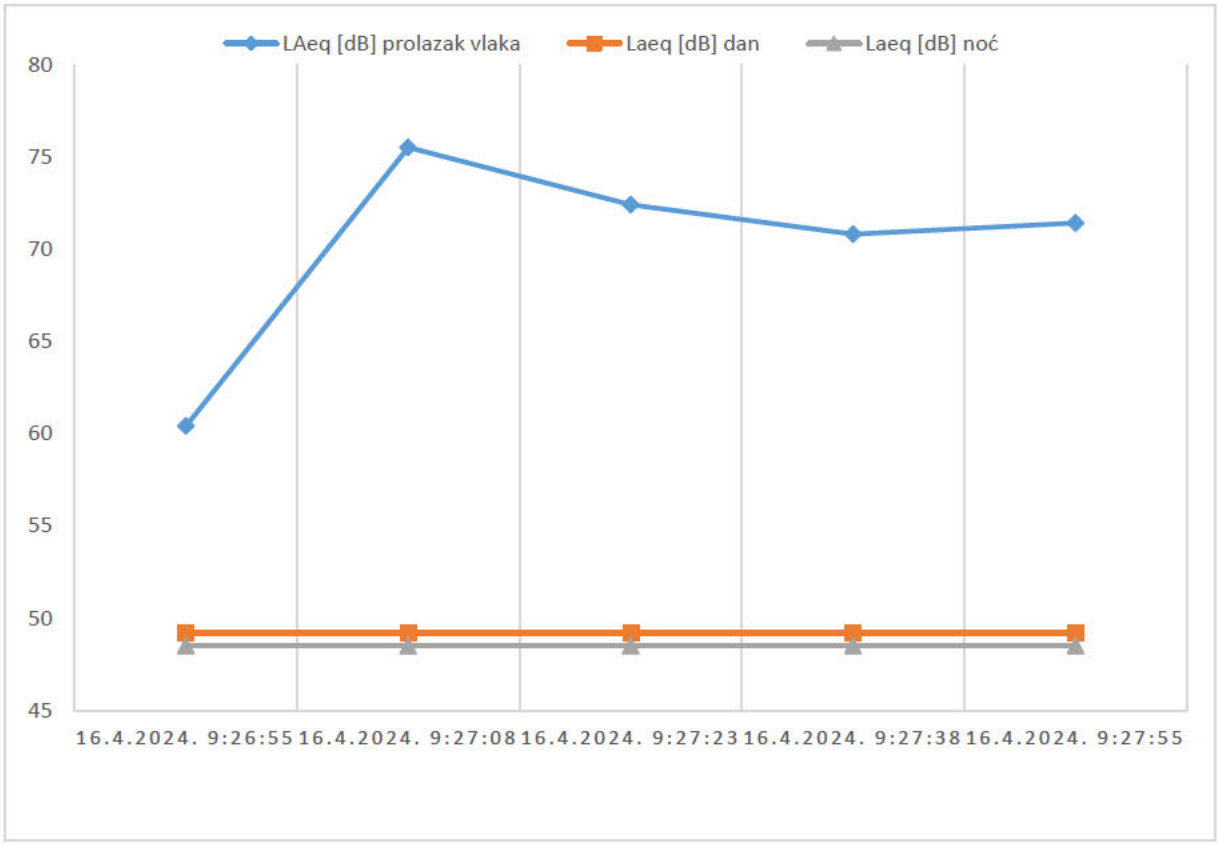


Figure 6 An overview of the noise values during the passing of the train and comparison with the noise values of the zero state during the day and night

5. NOISE IMPACTS ASSESSMENT

The noise indicators were calculated and presented in the form of noise maps using the "Predictor-LimA - Type 7810" software package developed by Softnoise. The calculation of noise generated by rail traffic was done using the "CNOSSOS-EU - Common Noise Assessment Methods," which is compliant with Directives 2002/49/EC and 2015/996/EC.

The CNOSSOS-EU (Common Noise assessment methods) method was developed in accordance with article 6.2 of the Directive 2002/49/EC and it is used for calculation of noise generated by road traffic, railway traffic and industrial plants and facilities. Detailed description of common noise description method for EC (CNOSSOS-EU) is given in the text of the Directive on establishment of common methods for noise assessment in accordance with Directive 2002/49/EC of the European Parliament and Council number 2015/996/EC dated May 19, 2015 (Official Journal of the European Union, L168 dated 01/07/2015).

Noise calculations shall be defined in the frequency range from 63 Hz to 8 kHz. Frequency band results shall be provided at the corresponding frequency interval. Calculations are performed in octave bands for railway traffic, except for the railway noise source sound power, which uses third octave bands. For railway traffic, based on these octave band results, the A-weighted long term average sound pressure level for the day (day is defined as a reference time period between 6.00 h and 18.00 h), evening (evening is defined as a reference time period between 18.00 h and 22.00 h) and night period and night is defined as a reference time period between (22.00 h and 6.00 h), as defined in Annex I and referred to in Art. 5 of Directive 2002/49/EC, is computed by summation over all frequencies:

$$L_{Aeq,T} = 10 * \lg \sum_{i=1} 10^{(L_{eq,Ti}+A_i)/10}$$

where:

$L_{eg,T}$ - equivalent continuous sound pressure level,

A_i - denotes the A-weighting correction according to IEC 61672-1,

i - frequency band index, and

T - is the time period corresponding to day, evening or night.

The model for railway traffic noise, describes the noise sound power emission of a specific combination of vehicle type and track type which fulfils a series of requirements described in the vehicle and track classification, in terms of a set of sound power per each vehicle ($L_{W,0}$). The noise emission of a traffic flow on each track shall be represented by a set of two source lines characterized by its directional sound power per meter per frequency band. This corresponds to the sum of the sound emissions due to the individual vehicles passing by in the traffic flow and, in the specific case of stationary vehicles, taking into account the time spent by the vehicles in the railway section under consideration.

For the purposes of this noise calculation method, a vehicle is defined as any single railway sub-unit of a train (typically a locomotive, a self-propelled coach, a hauled coach or a freight wagon) that can be moved independently and can be detached from the rest of the train. For the purpose of this calculation method, a train consists of a series of coupled vehicles.

The number of vehicles for each type shall be determined on each of the track sections for each of the time periods to be used in the noise calculation. It shall be expressed as an average number of vehicles per hour, which is obtained by dividing the total number of vehicles travelling in a given time period by the duration in hours of this time period.

Classification and descriptors for railway vehicles should be done by vehicle type, number of axles per vehicle, brake type and wheel measure.

The tracks are classified on the basis of elements contributing to and characterizing their acoustic properties. Some of the elements have a considerable influence on acoustic properties, while others have only secondary effects. In general, the most relevant elements influencing the railway noise emission are: railhead roughness, rail pad stiffness, track base, rail joints and radius of curvature of the track. A track section is defined as a part of a single track, on a railway line or station or depot, on which the track's physical properties and basic components do not change.

The different equivalent noise line sources are placed at different heights and at the center of the track. All heights are referred to the plane tangent to the two upper surfaces of the two rails. The equivalent sources include different physical sources (index). These physical sources are divided into different categories depending on the generation mechanism and are: rolling noise (including not only rail and track base vibration and wheel vibration but also, where present, superstructure noise of the freight vehicles); traction noise;

aerodynamic noise; impact noise (from crossings, switches and junctions); squeal noise and noise due to additional effects such as bridges and viaducts.

If a steady flow of *Q* vehicles per hour is assumed, with an average speed *v*, on average at each moment in time there will be an equivalent number of *Q/v* vehicles per unit length of the railway section. The noise emission of the vehicle flow in terms of directional sound power per meter $L_{W',eq,line}$ (expressed in dB/m) is integrated by:

$$L_{w',eq,line,i(\psi,\varphi)} = L_{W,0,dir,i(\psi,\varphi)} + 10 * \lg(\frac{Q}{1000v})$$

where:

Q - is the average number of vehicles per hour on the j-th track section for vehicle type t, average train speed s and running condition c,

v - is their speed on the j-th track section for vehicle type t and average train speed s, and

$L_{W,0,dir}$ - is the directional sound power level of the specific noise (rolling, impact, squeal, braking, traction, aerodynamic, other effects) of a single vehicle in the directions ψ, φ defined with respect to the vehicle's direction of movement.

In order to determine the equivalent sound pressure levels at the place of receiver point (noise immission), noise attenuation during outdoor propagation is calculated based on the sound power of noise sources (noise emission). As sound propagates outdoors, it is attenuated or modified by: geometrical spreading, atmospheric absorption, interaction by reflection or absorption by the ground or ground cover and refraction and/or diffraction by a non-uniform atmosphere and by obstacles.

The CNOSSOS-EU method predicts the equivalent continuous sound pressure level at a receiver point corresponding to two particular types of atmospheric conditions: downward-refraction propagation conditions (positive vertical gradient of effective sound celerity) from the source to the receiver and homogeneous atmospheric conditions (null vertical gradient of effective sound celerity) over the entire area of propagation. The method of calculation does not provide results in upward-refraction propagation conditions (negative vertical gradient of effective sound speed) but these conditions are approximated by homogeneous conditions.

To calculate the attenuation due to atmospheric absorption in the case of transport infrastructure, the temperature and humidity conditions are calculated according to ISO 9613-1:1996.

The method provides results per octave band, from 63 Hz to 8 000 Hz. The calculations are made for each of the center frequencies.

The acoustic simulations and calculation of noise indicators by using “Predictor-LimA Software Suite - Type 7810” software package was performed with the maximum dynamic error of 0.0 dB.

For acoustic modelling and calculation, it is necessary to provide data about the terrain topography, soil types in terms of sound absorption, about influence of obstacles to the propagation of sound, about the track alignment including formation width, technical characteristics of railway line, railway transport data, acoustic zones through which a new railway line passes and meteorology condition.

The geodetic survey data is available only for a relatively narrow strip of land along the railway route. The missing data about topography (3D terrain model) is substitute by EU-DEM model data. The EU-DEM provides Pan-European elevation data at 1 arc-second (+/- 30 meters) postings. The EU-DEM provides full coverage of the EEA countries consisting of 33 member states and 6 cooperating ones (including Bosnia and Herzegovina). The Digital Elevation Model over Europe from the GMES RDA project (EU-DEM) is a Digital Surface Model (DSM) representing the first surface as illuminated by the sensors. The EU-DEM is a hybrid product based on SRTM and ASTER GDEM data fused by a weighted averaging approach.

The EU-DEM fundamental accuracy for Bosnia and Herzegovina has the mean error of -1.88 m, the standard deviation of 1.90 m and the vertical accuracy of 2.68 m RMSE (Root mean square error). The EU DEM data accuracy is sufficient for the study level acoustic calculations and analyses.

For the purpose of the calculation, it is assumed that covered area has an absorption coefficient of 0 (which defines the composition of the ground). The adopted absorption coefficient represents compacted field and gravel, or hard ground with minimal absorption (worst case scenario).

The 3D model of the railway substructure is formed based on the railway main design (Technical report - Book I, ET-350/12 01). The technical characteristics of the railway line and the railway transport data were taken from the railway main design and accompanying projects.

During the discussion at the meeting held on April 24th, 2024, it was established that the actual state of traffic on the railway in question has a much lower frequency than the frequency of traffic specified in the Main Project. Following on from the conclusion, it was agreed to make calculations and assess the possibility of reducing the impact of railway noise on a residential building for both cases, as well as to make a comparison both for the assessment of the possibility of reducing noise on the building and for noise protection measures, which will be presented in this document.

The projected daily rail traffic consists of 12 trains, with 6 traveling from Brčko Novo station to Brčko port, and 6 traveling from Brčko port to Brčko Novo station. The average freight trains with locomotive (diesel-electric type 661) hauling will have 18 wagons. We do not have information on when the traffic volume on the railway is expected to reach these values in the future (or if it will even reach them). This is the scenario of future conditions.

The current volume of traffic on the railway line does not correspond to the projected one. Through official letter number 781/24 dated February 24, 2024, the Public Enterprise Port of Brčko provided information stating that during the period from May 2023 to April 2024 (12 months), a total of 42 trains with an average of 14 wagons each were in operation. With this traffic dynamics, a train arrives at and departs from the Port of Brčko approximately once every eight days. For the purpose of analysis, it is assumed that a maximum of two trains operate in one day (one to the port and one from the port). This is the scenario of current conditions.

In the study on the assessment of the noise impact on the residential building, both scenarios will be considered.

The maximum speed on the railway line is 35 km/h. All the freight wagons are fitted with iron cast brake pads.

Trains operate exclusively from 6:30 to 18:30 in accordance with the operating hours of Brčko Novo station. The reference period for the study is the daytime period. *All noise*

levels have been calculated with reference to a 16-hour duration, and all necessary adjustments have been made accordingly.[1]

The minimum curve radius is 180 meters. The track is laid with UIC49 rail on wooden sleepers and ballast.

It is assumed, according to the CNOSSOS-EU model, that the meteorological conditions are homogeneous in which sound rays are straight segments (the worst-case scenario). On the other side, the object is close to the railway track (approximately 18 meters), so meteorological parameters are not expected to have a significant impact on the calculation.

Only the noise generated by rail traffic on Brcko Novo – Brcko port route was considered in calculations of noise indicators and in further analyses.

In order to assess the impact of railway traffic on the object, calculation points are placed at a distance of 1 meter on all facades, at every meter of height (from foundation to the roof). The schematic layout of the facade calculation points, along with their labels, is shown in the figure 7. The calculation was performed on a total of 156 points. During the calculation, reflection from the facade on which the point is located was not taken into account.

[1] According to the requirements of the EBRD as established at the meeting held via an online platform on August 29, 2024, from 11:00 AM to 12:00 PM. Following the meeting, an official written record of the audit requirements requested by the EBRD was drafted (ZAP-24-0001/1).

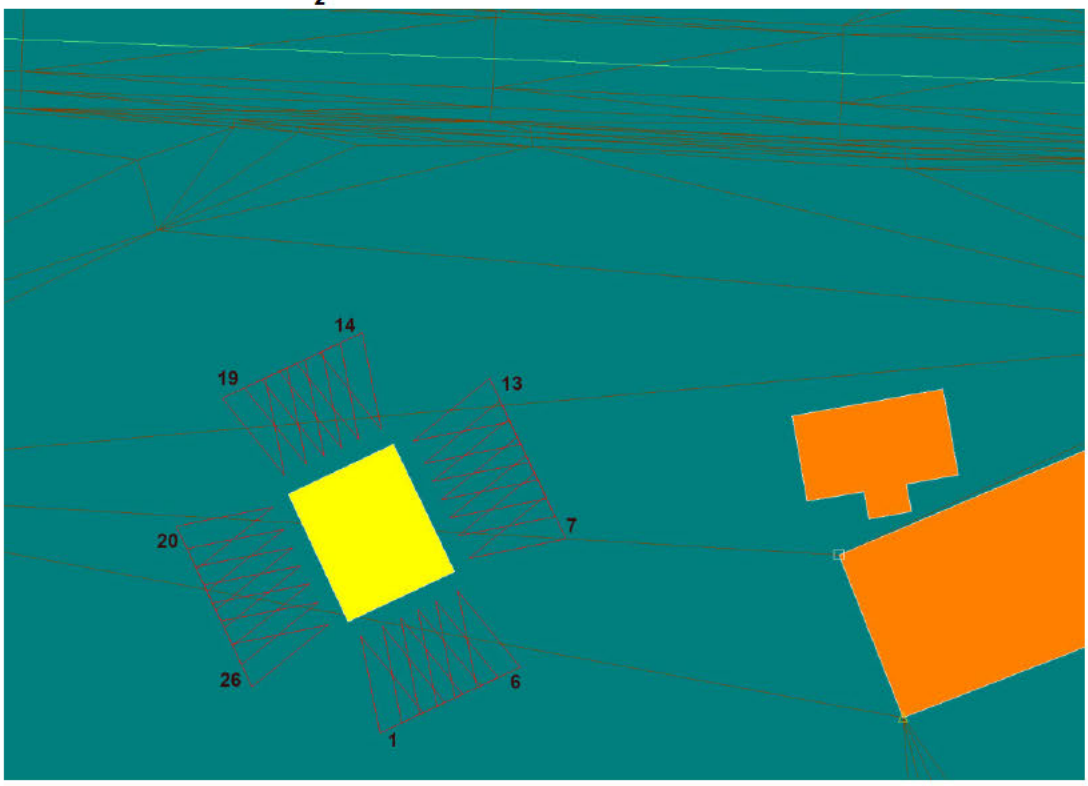


Figure 7 The schematic layout of the façade calculation points

The calculated values of railway noise levels for each facade point and scenario of current conditions are shown in Table 6, while for the scenario of future conditions, they are shown in Table 7. The calculated values in Table 6 and Table 7 that exceed the study threshold value are shaded.

Table 6 The calculated values of railway noise levels at facade points (scenario of current conditions)

FACADE LOCATION		1	2	3	4	5	6	--
HEIGHT LOCATION	1	39.4	36.4	37.1	38.2	40.4	45.6	--
	2	39.5	36.6	37.2	38.3	40.6	45.7	--
	3	39.6	36.8	37.4	38.5	40.7	45.8	--
	4	39.8	37.1	37.7	38.7	40.9	45.9	--
	5	40.2	37.9	38.4	39.3	41.2	46.1	--
	6	41.7	40.6	39.9	40.6	42.1	46.2	--
FACADE LOCATION		7	8	9	10	11	12	13
HEIGHT LOCATION	1	47.6	47.9	48.1	48.4	48.7	49.0	49.2
	2	47.7	48.0	48.3	48.6	48.9	49.2	49.4
	3	47.9	48.1	48.4	48.7	49.0	49.4	49.6
	4	48.0	48.2	48.5	48.8	49.1	49.5	49.7
	5	48.1	48.3	48.6	48.9	49.2	49.6	49.8
	6	48.1	48.4	48.7	49.0	49.3	49.6	49.8
FACADE LOCATION		14	15	16	17	18	19	
HEIGHT LOCATION	1	49.5	49.5	49.5	49.3	49.2	49.0	--
	2	49.7	49.7	49.7	49.5	49.4	49.2	--
	3	49.8	49.9	49.8	49.7	49.5	49.3	--
	4	49.9	50.0	49.9	49.8	49.6	49.4	--
	5	50.0	50.1	50.0	49.8	49.7	49.5	--
	6	50.0	50.1	50.0	49.9	49.8	49.5	--
FACADE LOCATION		20	21	22	23	24	25	26
HEIGHT LOCATION	1	47.9	45.5	44.3	43.6	43.1	42.7	42.5
	2	48.1	45.7	44.5	43.7	43.2	42.8	42.6
	3	48.2	45.8	44.6	43.8	43.3	42.9	42.7
	4	48.3	45.9	44.7	44.0	43.4	43.1	42.8
	5	48.4	46.1	44.9	44.1	43.6	43.2	43.0
	6	48.5	46.2	45.1	44.4	43.9	43.6	43.3

In the scenario of current conditions, exceedances of the adopted threshold level of 45 dB during the daytime period range up to 5.1 dB.

Table 7 The calculated values of railway noise levels at facade points (scenario of future conditions)

FACADE LOCATION		1	2	3	4	5	6	--
HEIGHT LOCATION	1	48.3	45.3	46.0	47.1	49.3	54.5	--
	2	48.4	45.5	46.1	47.2	49.5	54.6	--
	3	48.5	45.7	46.3	47.4	49.6	54.7	--
	4	48.7	46.0	46.6	47.6	49.8	54.8	--
	5	49.1	46.8	47.3	48.2	50.1	55.0	--
	6	50.6	49.5	48.8	49.5	51.0	55.1	--
FACADE LOCATION		7	8	9	10	11	12	13
HEIGHT LOCATION	1	56.5	56.8	57.0	57.3	57.6	57.9	58.1
	2	56.6	56.9	57.2	57.5	57.8	58.1	58.3
	3	56.8	57.0	57.3	57.6	57.9	58.3	58.5
	4	56.9	57.1	57.4	57.7	58.0	58.4	58.6
	5	57.0	57.2	57.5	57.8	58.1	58.5	58.7
	6	57.0	57.3	57.6	57.9	58.2	58.5	58.7
FACADE LOCATION		14	15	16	17	18	19	
HEIGHT LOCATION	1	58.4	58.4	58.4	58.2	58.1	57.9	--
	2	58.6	58.6	58.6	58.4	58.3	58.1	--
	3	58.7	58.8	58.7	58.6	58.4	58.2	--
	4	58.8	58.9	58.8	58.7	58.5	58.3	--
	5	58.9	59.0	58.9	58.7	58.6	58.4	--
	6	58.9	59.0	58.9	58.8	58.7	58.4	--
FACADE LOCATION		20	21	22	23	24	25	26
HEIGHT LOCATION	1	56.8	54.4	53.2	52.5	52.0	51.6	51.4
	2	57.0	54.6	53.4	52.6	52.1	51.7	51.5
	3	57.1	54.7	53.5	52.7	52.2	51.8	51.6
	4	57.2	54.8	53.6	52.9	52.3	52.0	51.7
	5	57.3	55.0	53.8	53.0	52.5	52.1	51.9
	6	57.4	55.1	54.0	53.3	52.8	52.5	52.2

In the scenario of future conditions, exceedances of the adopted threshold level of 45 dB during the daytime period range from 0.3 dB to 14.0 dB.

In the scenario of current conditions, noise levels are lower by 8.9 dB compared to the scenario of future conditions, given that the traffic volume is six times lower (two trains instead of twelve).

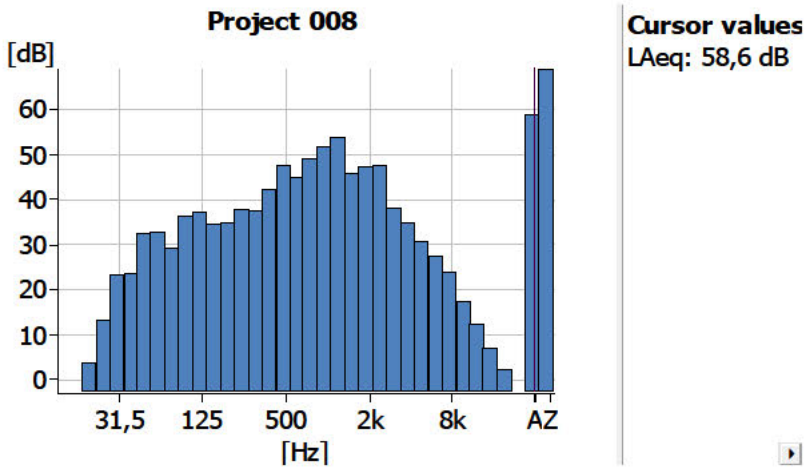
The calculated noise levels in the day periods for the scenario of future conditions are graphically presented (noise map) in Drawing C1.1 in the Graphic Annex, while for the scenario of current conditions, they are graphically presented (noise map) in Drawing C1.2 in the Graphic Annex.

Noise indicators for graphical presentation are calculated on a grid with dimensions of 1.0 x 1.0 meters and a height of 2.25 meters.

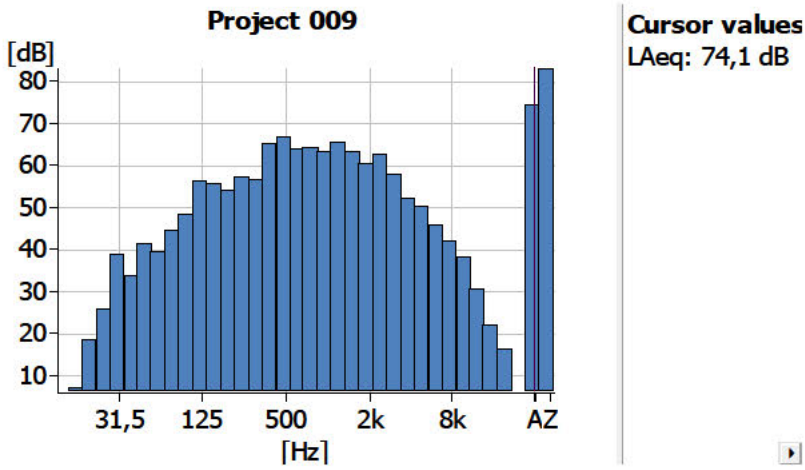
5 ATTACHMENT

5.1. Presentation of the Third octave analysis of noise during the passing of a train

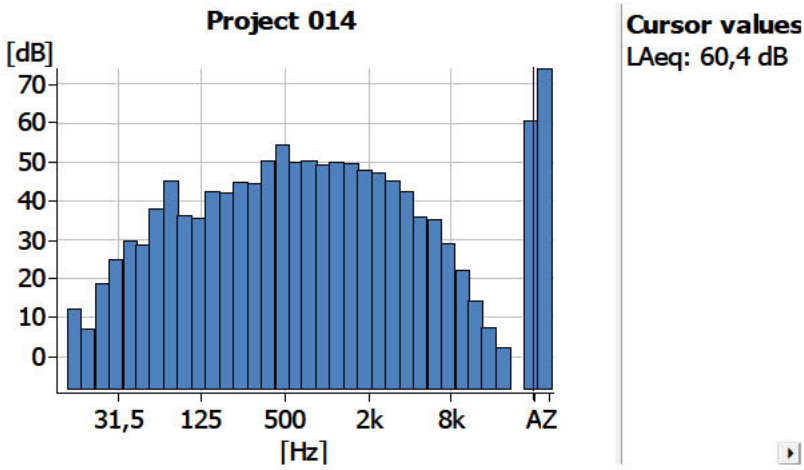
Arrival of the engine room

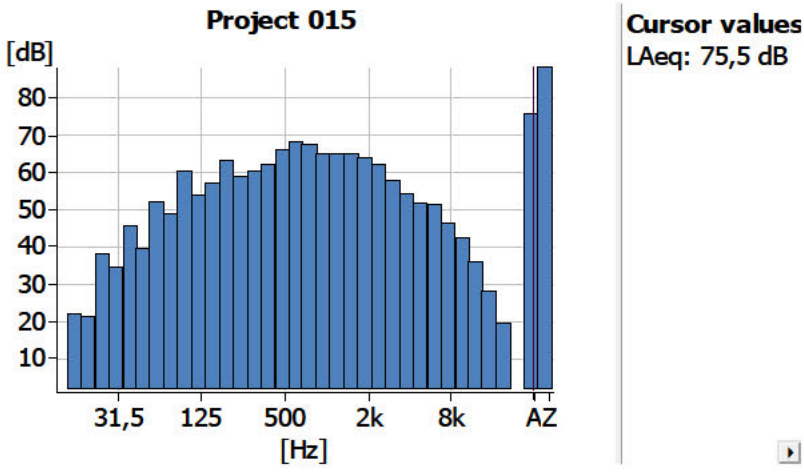


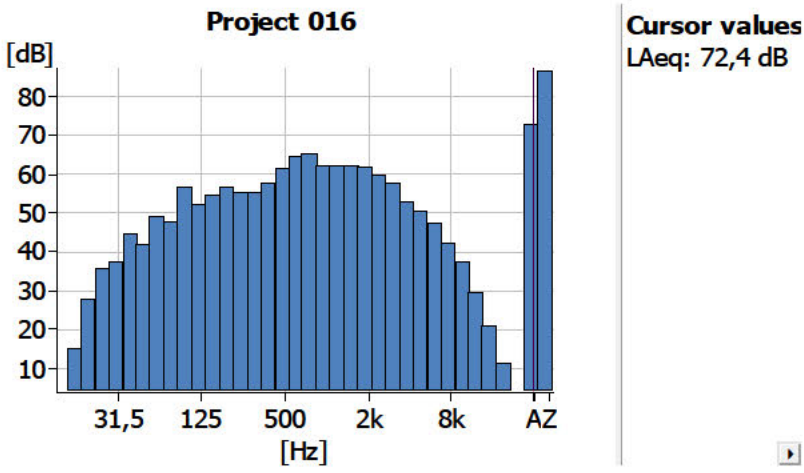
Passing the engine room in front of the sound meter

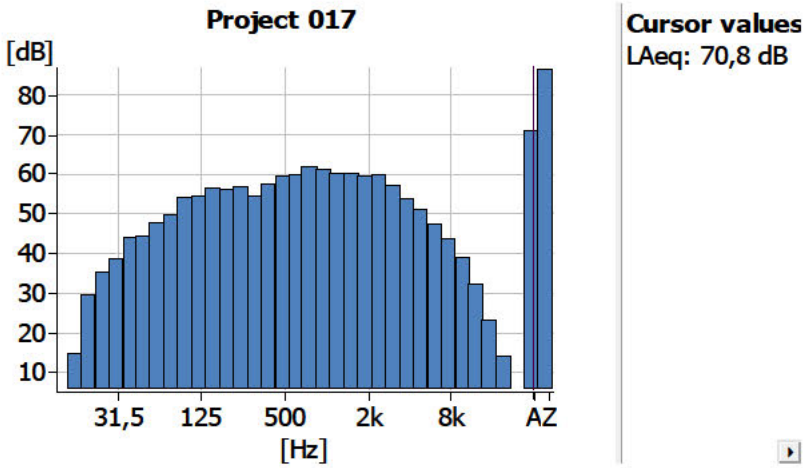


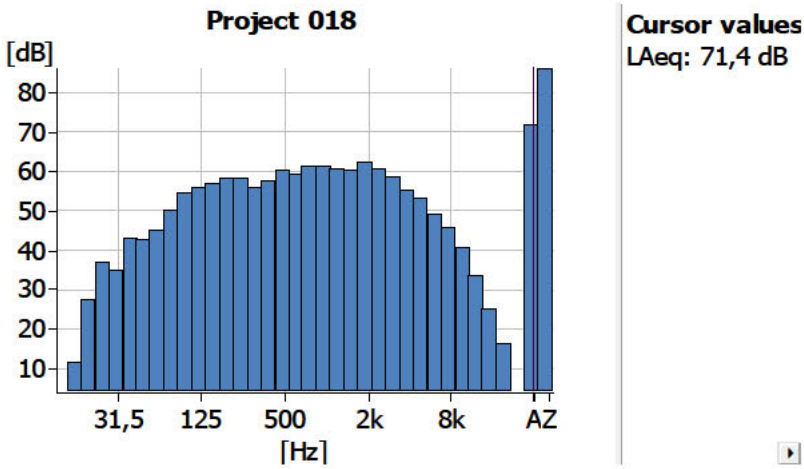
Arrival of the train with the 11 wagons. Passage time 40 seconds








Project 017
[dB]
80
70
60
50
40
30
20
10
31,5
125
500
2k
8k
AZ
[Hz]
Cursor values
LAeq: 70,8 dB


Project 018
[dB]
80
70
60
50
40
30
20
10
31,5
125
500
2k
8k
AZ
[Hz]
Cursor values
LAeq: 71,4 dB

5.2. Graphical Representation of Calculated Noise Levels During Daytime Periods for Current Conditions Scenario (Noise Map) C 1.1

5.3. Graphical Representation of Calculated Noise Levels During Daytime Periods for Future Conditions Scenario (Noise Map) C 1.2

ZGI Ltd. Mostar,
Rudarska 247,
88000 Mostar, BiH
e-mail: info@zgi.eu,
web: www.zgi.eu
Phone.: +387 36 33 42 80

Client: STRABAG AG – Business unit Sarajevo
Company Adress:
Zmaja od Bosne 11,
71 000 Sarajevo,
Bosnia and Hercegovina

Object: Residential building situated on plot [redacted] in cadastral municipality Brčko

Assessment of the possibility of reducing the impact of railway noise and planning noise protection measures

Residential building situated on plot [redacted] in cadastral municipality Brčko 2

Team leader:
[redacted], B.Sc.El.Eng.

Associates:
[redacted] B.Sc.OHS.
[redacted], B.Sc.CE.
[redacted] B.Sc. in Traffic Eng.
[redacted] M.Sc.chem
[redacted] M.Sc.chem
[redacted], M.Sc.chem
[redacted], M. sc. in Food Eng

Documentation number:
01-2-4-rev4-V/24

Director:
[redacted] B.Sc.El.Eng.

Date:
October, 2024.

Content

0. INTRODUCTION 4

1 NOISE PROTECTION MEASURES 7

2 SUMMARIZE 17

3 MONITORING PROGRAM 22

4 GRAPHIC ANNEX 23

4.1 C1.1 NOISE MAP WITHOUT NOISE BARRIER (SCENARIO OF CURRENT CONDITIONS) 23

4.2 C1.2 NOISE MAP WITHOUT NOISE BARRIER (SCENARIO OF FUTURE CONDITIONS) 23

4.3 C2.1 NOISE MAP WITH NOISE BARRIER (SCENARIO OF CURRENT CONDITIONS) 23

4.4 C2.2 NOISE MAP WITH NOISE BARRIER (SCENARIO OF FUTURE CONDITIONS) 23

Table list:

Table 1 Main data about “maximum” noise barriers 9

Table 2 Main data about noise barrier 10

Table 3 The calculated values of railway noise levels at facade points After the implementation of noise barrier 11

Table 4 Main data about noise barrier (scenario of future conditions) 13

Table 5 The calculated values of railway noise levels at facade points after the implementation of noise barrier 14

Table 6 Required characteristics of the noise barrier for each scenario and the adopted threshold values 17

Table 7 The WHO guidlines values for community noise in specific environmets 20

0. INTRODUCTION

The study on the assessment of the impact of noise on the building had to investigate the impact of noise on a residential building located on [redacted] cadastral municipality Brčko 2. Based on the Study, this document provides an assessment of the possibility of reducing the impact of railway noise for a residential building and consideration of appropriate measures to mitigate the negative impacts of railway noise.

The input data for the preparation of the Study on the assessment of the impact of noise on the object were taken from the "Main project of the industrial track Railway station Brčko Novo - Luka Brčko - Book I (ET 350/12) - attachment 2. Technical report" and Official letter No. 781/24 dated April 24, 2024, received from the Public Enterprise Port of Brčko.

As stated in the Study on assessing the impact of noise on the facility, the Investor and the EBRD requested the application of noise standards relevant to "Hospitals" (Table 3) in order to protect vulnerable people living near the project. These standards specify limits of 30 dB(A) L_{Aeq} during the daytime period to be achieved within the facility. Assuming that the noise reduction from outside to inside with a partially open window is 15 dB (as specified in the WHO guidelines), the standards that should be achieved outside the building facade should be 45 dB(A).

In accordance with the above assessment, calculations were made based on the technical characteristics of the railway line and data on railway traffic which were taken from the main design of the railway, accompanying projects and documents.

The presentation of the working version of the Study on the assessment of the impact of noise on the object and the working version of the assessment of the possibility of reducing the impact of railway noise and the planning of noise protection measures were explained at the meeting held on April 24th, 2024.

During the discussion at the meeting, it was established that the actual state of traffic (scenario of current conditions) on the railway in question has a much lower frequency than the frequency of traffic specified in the Main Project (scenario of future conditions). Following on from the conclusion, it was agreed to make calculations and assess the possibility of reducing the impact of railway noise on a residential building for both cases, as well as to make a comparison both for the assessment of the possibility of reducing noise

on the building and for noise protection measures, which will be presented in this document.

The measures to mitigate the negative impact of railway noise will be considered for both scenarios adopted in the Study. The scenario of current conditions represents the scenario with the actual volume of traffic based on the field data (2 trains with an average composition of 14 wagons). The scenario of future conditions represents the scenario with the maximum volume of traffic forecasted in the project documentation (12 trains with an average composition of 18 wagons).

The maximum speed on the railway line is 35 km/h. Trains operate exclusively from 6:30 to 18:30 in accordance with the operating hours of Brčko Novo station. The reference period for the study is the daytime period *(16 hours).*[1] All the freight wagons are fitted with iron cast brake pads.

[1] According to the requirements of the EBRD as established at the meeting held via an online platform on August 29, 2024, from 11:00 AM to 12:00 PM. Following the meeting, an official written record of the audit requirements requested by the EBRD was drafted (ZAP-24-0001/1).

Documentation prepared by :

[redacted]

Document preparation date : October, 2024.

1 NOISE PROTECTION MEASURES

The noise barriers are considered to be the primary measure for protection against noise levels that exceed the values stipulated in the applicable legislation. To ensure greater efficiency, noise barriers must be placed close to the noise source. In the case of the railway, minimum distances are calculated from the axis of the track and depended on the position of the noise barriers in regard to the track and the projected speed and range from 3.30 meters (V ≤ 160 km/h) to 4.00 meters (V > 160 km/h).

The noise barriers have a noise reduction potential by 5-15 dB. The efficiency of used noise barriers depends on numerous factors such as: wall height, distance to a building, height difference between the barrier and building, etc. The efficiency of installed noise barriers decreases with the increase in the number of floors indicating that protection of higher floors is more difficult.

Every planned noise barrier must be subject to cost-benefit analyses against housing facilities and other sensitive structures which the same protects. Regarding the effectiveness of noise barriers, at least one protected object must have noise reduction greater than 5 dB.

The design of noise barrier shall comply with provisions of the National and European legislation, as well as corresponding standards:

- COMMISSION REGULATION (EU) No. 1304/2014 on the technical specification for interoperability relating to the subsystem “rolling stock — noise”;
- BAS EN 16272-1, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 1: Intrinsic characteristics - Sound absorption in the laboratory under diffuse sound field conditions;
- BAS EN 16272-2, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 2: Intrinsic characteristics - Airborne sound insulation in the laboratory under diffuse sound field conditions;

- BAS EN 16272-3-1, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 3-1: Normalized railway noise spectrum and single number ratings for diffuse field applications;
- BAS EN 16272-3-2, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 3-2: Normalized railway noise spectrum and single number ratings for direct field applications;
- BAS EN 16727-1, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 1: Mechanical performance under static loadings - Calculation and test method;
- BAS EN 16727-2-1, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 2-1: Mechanical performance under dynamic loadings due to passing trains - Resistance to fatigue;
- BAS EN 16727-2-2, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 2-2: Mechanical performance under dynamic loadings caused by passing trains - Calculation method;
- BAS EN 16727-3, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 3: General safety and environmental requirements;
- BAS EN 16951-1, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Procedures for assessing long term performance - Part 1: Acoustic characteristics;
- BAS EN 16951-2, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Procedures for assessing long term performance - Part 2: Non-acoustic characteristics.

Additional guidelines recommended below will also be followed:

- DB Netz AG Guideline 804: Railway bridges (and other civil engineering structures);
- ZT-LSW 06: Additional technical contractual requirements for noise barriers;
- RVE 04.01.01 Noise barriers – calculation and design;

The acoustic panels that will be used for noise barriers shall have sound absorption of minimum 12 dB (class A4 in accordance with BAS EN 16272-1) and soundproofing of minimum 25 dB (class B3 in accordance with BAS EN 16272-2).

The acoustic panels shall have service life of minimum 20 years without major changes in their acoustic and non-acoustic performances.

Based on the terrain conditions, a noise barrier was considered on the right side of the railway track, extending from chainage km 1+685 to km 1+906. The noise barrier is planned to run parallel to the railway track at a distance of 3.6 meters (near the noise source). At the beginning, there is an overpass whose structure we didn't want to compromise by installing the barrier, while at the end, there is a level crossing where visibility needs to be ensured for traffic safety. If a noise barrier is constructed, it will be necessary to modify the railway drainage system.

The maximum possible length of the barrier is 220 meters, with a maximum height of 5 meters (relative to Head of Rail). The basic data on the 'maximum' possible noise barrier are shown in Table 1. In the following text, all heights of the noise barriers are given relative to the top of the rail.

Table 1 Main data about “maximum” noise barriers

Barrier No.	Railway line chainage		Position in relation to railway line	Height	Length	Area
	start point [km]	end point [km]		[m]	[m]	[m^2]
1	1+685	1+906	Right	5.0	220	1100
Total					**220**	**1100**

a) Scenario of current conditions

The first step in optimizing the noise barrier is to determine its maximum potential effects. The calculation has been carried out for a barrier of maximum length and height. The obtained results showed that it is sufficient to protect the subject facility in accordance with the adopted study threshold value of 45 dB(A).

The second step is to optimize the noise barrier to determine the minimum required length and height that will ensure that, during railway traffic, the noise level at the building facade does not exceed the adopted threshold value of 45 dB(A) in the reference day period *(T = 16 hours)*.

Calculations and optimization have been carried out with the adopted threshold value of 45 dB(A). Main data regarding the planned noise barrier, such as their starting and ending points, height, length, and area, are provided in Table 2. Layout of noise barrier and graphic presentation of noise levels obtained during daytime and with the application of noise barrier are provided in Drawing C2.1 in the Graphic Annex.

Table 2 Main data about noise barrier

Barrier No.	Railway line chainage		Position in relation to railway line	Height [m]	Length [m]	Area [m^2]
	start point [km]	end point [km]				
1	1+745	1+805	right	2.5	60	150
Total					**60**	**150**

The overview of noise levels by facade calculation points after the application of noise barrier (Table 2) is provided in Table 3. The calculated values in Table 3 that exceed the study threshold value 45 dB(A) are shaded.

Table 3 The calculated values of railway noise levels at facade points After the implementation of noise barrier [dB]

	Facade location	**1**	**2**	**3**	**4**	**5**	**6**	--
HEIGHT	**1**	38.6	36.2	36.7	36.8	36.8	38.0	--
LOCATION	**2**	38.7	36.3	36.8	36.9	37.0	38.3	--
	3	38.9	36.5	37.0	37.1	37.2	38.6	--
	4	39.0	36.8	37.2	37.3	37.4	39.0	--
	5	39.3	37.4	37.7	37.8	37.9	39.4	--
	6	40.1	39.0	38.8	38.7	38.8	40.0	--
	Facade location	**7**	**8**	**9**	**10**	**11**	**12**	**13**
HEIGHT	**1**	39.1	39.3	39.4	39.8	40.3	40.5	41.2
LOCATION	**2**	39.4	39.7	39.9	40.3	40.8	41.2	41.9
	3	39.8	40.0	40.3	40.7	41.2	41.6	42.3
	4	40.2	40.5	40.7	41.1	41.7	42.1	42.8
	5	40.7	41.0	41.3	41.7	42.2	42.6	43.3
	6	41.2	41.5	41.7	42.2	42.7	43.1	43.8
	Facade location	**14**	**15**	**16**	**17**	**18**	**19**	
HEIGHT	**1**	41.2	41.3	41.3	41.0	40.7	40.5	--
LOCATION	**2**	41.8	41.9	41.9	41.6	41.2	40.9	--
	3	42.3	42.4	42.3	42.0	41.6	41.4	--
	4	42.8	42.9	42.8	42.5	42.1	41.8	--
	5	43.4	43.5	43.4	43.0	42.7	42.4	--
	6	44.0	44.0	43.8	43.5	43.2	42.9	--
	Facade location	**20**	**21**	**22**	**23**	**24**	**25**	**26**
HEIGHT	**1**	39.5	38.6	38.4	38.4	38.3	38.4	38.5
LOCATION	**2**	39.8	38.9	38.6	38.5	38.5	38.5	38.7
	3	40.2	39.2	38.9	38.7	38.7	38.7	38.9
	4	40.7	39.5	39.1	39.0	38.9	38.9	39.1
	5	41.1	39.9	39.5	39.3	39.2	39.2	39.4
	6	41.6	40.3	40.0	39.8	39.8	39.8	39.8

The results in Table 3 indicate that the noise barrier (Table 2) can ensure that the façade levels comply with the adopted threshold value of 45 dB(A). The effectiveness of the barrier is high, ranging from 0.2 dB to 8.7 dB. The values obtained from the calculation are within the expected capabilities of the barrier on the site.

The presentation of the effects of the noise barrier implementation in the existing condition scenario is given in Table 4.

Table 4 Effect of the noise barrier implementation (existing condition scenario) [dB]

	Facade location	**1**	**2**	**3**	**4**	**5**	**6**	--
HEIGHT LOCATION	**1**	-0.8	-0.2	-0.4	-1.4	-3.6	-7.6	--
	2	-0.8	-0.3	-0.4	-1.4	-3.6	-7.4	--
	3	-0.7	-0.3	-0.4	-1.4	-3.5	-7.2	--
	4	-0.8	-0.3	-0.5	-1.4	-3.5	-6.9	--
	5	-0.9	-0.5	-0.7	-1.5	-3.3	-6.7	--
	6	-1.6	-1.6	-1.1	-1.9	-3.3	-6.2	--
	Facade location	**7**	**8**	**9**	**10**	**11**	**12**	**13**
HEIGHT LOCATION	**1**	-8.5	-8.6	-8.7	-8.6	-8.4	-8.5	-8.0
	2	-8.3	-8.3	-8.4	-8.3	-8.1	-8.0	-7.5
	3	-8.1	-8.1	-8.1	-8.0	-7.8	-7.8	-7.3
	4	-7.8	-7.7	-7.8	-7.7	-7.4	-7.4	-6.9
	5	-7.4	-7.3	-7.3	-7.2	-7.0	-7.0	-6.5
	6	-6.9	-6.9	-7.0	-6.8	-6.6	-6.5	-6.0
	Facade location	**14**	**15**	**16**	**17**	**18**	**19**	**--**
HEIGHT LOCATION	**1**	-8.3	-8.2	-8.2	-8.3	-8.5	-8.5	--
	2	-7.9	-7.8	-7.8	-7.9	-8.2	-8.3	--
	3	-7.5	-7.5	-7.5	-7.7	-7.9	-7.9	--
	4	-7.1	-7.1	-7.1	-7.3	-7.5	-7.6	--
	5	-6.6	-6.6	-6.6	-6.8	-7.0	-7.1	--
	6	-6.0	-6.1	-6.2	-6.4	-6.6	-6.6	--
	Facade location	**20**	**21**	**22**	**23**	**24**	**25**	**26**
HEIGHT LOCATION	**1**	-8.4	-6.9	-5.9	-5.2	-4.8	-4.3	-4.0
	2	-8.3	-6.8	-5.9	-5.2	-4.7	-4.3	-3.9
	3	-8.0	-6.6	-5.7	-5.1	-4.6	-4.2	-3.8

4	-7.6	-6.4	-5.6	-5.0	-4.5	-4.2	-3.7
5	-7.3	-6.2	-5.4	-4.8	-4.4	-4.0	-3.6
6	-6.9	-5.9	-5.1	-4.6	-4.1	-3.8	-3.5

b) Scenario of future conditions

The first step in optimizing the noise barrier is to determine its maximum potential effects. The calculation has been carried out for a barrier of maximum length and height. The obtained results showed that it is sufficient to protect the subject facility in accordance with the adopted threshold value of 45 dB(A) in the study.

The second step is to optimize the noise barrier to determine the minimum required length and height that will ensure that, during railway traffic, the noise level at the building facade does not exceed the adopted threshold value of 45 dB(A) in the reference day period *(T = 16 hours)*.

Calculations and optimization have been carried out with the adopted threshold value of 45 dB(A). Main data regarding the planned noise barrier, such as their starting and ending points, height, length, and area, are provided in Table 5. Layout of noise barrier and graphic presentation of noise levels obtained during daytime and with the application of noise barrier are provided in Drawing C2.2 in the Graphic Annex.

Table 5 Main data about noise barrier (scenario of future conditions)

Barrier No.	Railway line chainage		Position in relation to railway line	Height [m]	Length [m]	Area [m²]
	start point [km]	end point [km]				
1	1+685	1+906	Right	2.5–5.0	220	980
Total					**220**	**980**

The overview of noise levels by facade calculation points after the application of noise barrier (Table 5) is provided in Table 6. The calculated values in Table 6 that exceed the study threshold value 45 dB(A) are shaded.

Table 6 The calculated values of railway noise levels at facade points after the implementation of noise barrier

	Facade location	1	2	3	4	5	6	--
HEIGHT LOCATION	1	42.1	41.2	41.1	40.8	40.4	39.4	--
	2	42.3	41.4	41.2	40.9	40.5	39.6	--
	3	42.6	41.7	41.5	41.2	40.8	40.0	--
	4	42.8	42.0	41.8	41.5	41.1	40.5	--
	5	43.1	42.4	42.2	42.0	41.6	41.1	--
	6	43.8	43.3	42.7	42.5	42.2	41.7	--
	Facade location	**7**	**7**	**8**	**9**	**10**	**11**	**12**
HEIGHT LOCATION	1	40.0	40.0	40.2	40.6	41.0	41.3	41.9
	2	40.3	40.3	40.5	40.9	41.3	41.6	42.2
	3	40.6	40.6	40.9	41.3	41.7	42.1	42.7
	4	41.2	41.1	41.4	41.8	42.2	42.6	43.2
	5	41.7	41.7	42.0	42.4	42.8	43.1	43.7
	6	42.2	42.3	42.5	42.9	43.3	43.6	44.1
	Facade location	**14**	**14**	**15**	**16**	**17**	**18**	**19**
HEIGHT LOCATION	1	42.0	42.4	42.3	42.2	42.1	41.9	--
	2	42.3	42.8	42.8	42.7	42.6	42.4	--
	3	42.8	43.2	43.2	43.1	43.0	42.8	--
	4	43.3	43.6	43.6	43.5	43.4	43.2	--
	5	43.8	44.1	44.1	44.0	43.8	43.6	--
	6	44.2	44.4	44.4	44.3	44.1	43.9	--
	Facade location	**20**	**20**	**21**	**22**	**23**	**24**	**25**
HEIGHT LOCATION	1	41.2	40.7	40.8	41.4	41.6	41.7	42.2
	2	41.8	41.4	41.4	41.5	41.7	41.9	42.4
	3	42.1	41.6	41.6	41.8	41.9	42.1	42.7
	4	42.3	41.9	41.9	42.0	42.1	42.3	42.9
	5	42.6	42.1	42.2	42.3	42.3	42.5	43.1
	6	42.9	42.4	42.5	42.7	42.9	43.1	43.5

The results in Table 5 indicate that the noise barrier (Table 4) can ensure that the façade levels comply with the adopted threshold value of 45 dB(A). The effectiveness of the barrier is high, ranging from 4.0 dB to 16.8 dB. The values obtained from the calculation are at the upper limit of the barrier's capabilities on the site.

The presentation of the effects of the noise barrier implementation in the future condition scenario is given in Table 7.

Tablica 1 Effect of the noise barrier implementation (future condition scenario) [dB]

POLOŽAJ NA FASADI		1	2	3	4	5	6	--
VISINSKI POLOŽAJ	1	-6.2	-4.1	-4.9	-6.3	-8.9	-15.1	--
	2	-6.1	-4.1	-4.9	-6.3	-9.0	-15.0	--
	3	-5.9	-4.0	-4.8	-6.2	-8.8	-14.7	--
	4	-5.9	-4.0	-4.8	-6.1	-8.7	-14.3	--
	5	-6.0	-4.4	-5.1	-6.2	-8.5	-13.9	--
	6	-6.8	-6.2	-6.1	-7.0	-8.8	-13.4	--
POLOŽAJ NA FASADI		7	8	9	10	11	12	13
VISINSKI POLOŽAJ	1	-16.5	-16.8	-16.8	-16.7	-16.6	-16.6	-16.2
	2	-16.3	-16.6	-16.7	-16.6	-16.5	-16.5	-16.1
	3	-16.2	-16.4	-16.4	-16.3	-16.2	-16.2	-15.8
	4	-15.7	-16.0	-16.0	-15.9	-15.8	-15.8	-15.4
	5	-15.3	-15.5	-15.5	-15.4	-15.3	-15.4	-15.0
	6	-14.8	-15.0	-15.1	-15.0	-14.9	-14.9	-14.6
POLOŽAJ NA FASADI		14	15	16	17	18	19	--
VISINSKI POLOŽAJ	1	-16.4	-16.0	-16.1	-16.0	-16.0	-16.0	--
	2	-16.3	-15.8	-15.8	-15.7	-15.7	-15.7	--
	3	-15.9	-15.6	-15.5	-15.5	-15.4	-15.4	--
	4	-15.5	-15.3	-15.2	-15.2	-15.1	-15.1	--
	5	-15.1	-14.9	-14.8	-14.7	-14.8	-14.8	--
	6	-14.7	-14.6	-14.5	-14.5	-14.6	-14.5	--
POLOŽAJ NA FASADI		20	21	22	23	24	25	26
VISINSKI POLOŽAJ	1	-15.6	-13.7	-12.4	-11.1	-10.4	-9.9	-9.2
	2	-15.2	-13.2	-12.0	-11.1	-10.4	-9.8	-9.1
	3	-15.0	-13.1	-11.9	-10.9	-10.3	-9.7	-8.9

4	-14.9	-12.9	-11.7	-10.9	-10.2	-9.7	-8.8
5	-14.7	-12.9	-11.6	-10.7	-10.2	-9.6	-8.8
6	-14.5	-12.7	-11.5	-10.6	-9.9	-9.4	-8.7

2 SUMMARIZE

Two scenarios of railway traffic were analyzed for their impact, and protection measures were planned for each, namely:

a) the scenario of current conditions, which reflects real-life traffic volume, and

b) the scenario of future conditions, which assumes the maximum projected traffic volume.

In both scenarios considered, it is possible to ensure that, during the operation of railway traffic on the Brčko Novo – Luka Brčko railway line, noise levels at the facade of the building (parcel number 46, cadastral municipality Brčko 2) do not exceed 45 dB(A) in the reference day period *(T = 16 hours)* by using appropriate noise barriers. The overview of the required characteristics of the noise barrier for each scenario and the adopted threshold values is presented in Table 6.

Table 7 Required characteristics of the noise barrier for each scenario and the adopted threshold values

SCENARIO	Railway line chainage		Position in relation to railway line	Height	Length	Area
	start point [km]	end point [km]		[m]	[m]	[m^2]
current conditions	1+745	1+805	Right	2.5	60	150
future conditions	1+685	1+906	Right	2.5–5.0	220	980

The barriers shown in Table 6 will serve exclusively for protection from railway traffic that will occur on the route from Brčko Novo to Luka Brčko in accordance with the defined input settings. The building, particularly the people living in it, will not be fully protected from the traffic on the Brčko – Vinkovci railway line. Additionally, they will not be fully protected from the warning signal used by the train driver to alert road traffic participants of the approaching train at a level crossing without ramps.

The mean recorded baseline noise levels during the daytime was 49dB LAeq,T from pre-existing road and rail noise sources. In the unmitigated scenario, worst case façade noise

levels, from the Brčko Novo to Luka Brčko railway line, under the current operating scenario, are predicted to be 50 dB LAeq,16hr. The resultant total daytime noise level at the property would be 53 dB LAeq,16hr representing a noise increase of 3dB LAeq,16hr. With the mitigation in place, the predicted noise level from the Brčko Novo to Luka Brčko railway line would reduce to 44 dB LAeq,16hr and the total noise level would reduce back to 50 dB LAeq,16hr.

For the future scenario, the contribution from the Brcko Novo to Luka Brčko railway line would dominate with a predicted noise level of 59 dB LAeq,16hr at the worst affected façade. This would represent a 10dB increase over the baseline noise levels. With mitigation in place, the predicted noise level from the Brčko Novo to Luka Brčko railway line would reduce to 44 dB LAeq,16hr and the total noise level would be equal to 50 dB LAeq,16hr. This is based on the assumption that the proposed mitigation provides no benefit in mitigating the Brčko - Vinkovci railway line.

However, under the future scenario, the noise barrier would be 980m long and between 2.5 and 5m high. Other factors, including cost and visual impact should be taken into account in making a decision on whether this represents a sustainable solution compared to the impacts that is serves to mitigate.

An alternative approach would be to provide sound insulation and alternative ventilation means (to avoid needing to open windows) to the impacted property. This would serve to reduce noise levels from all surrounding noise sources and would likely represent a more sustainable solution (considering cost and other factors) especially when considering the larger noise barrier proposed in the future scenario. Passive measures include replacing doors and windows with better sound insulation, as well as adequately soundproofing the facades. Along with these measures, it is necessary to ensure a closed fresh air supply system. However, a disadvantage of such an approach is that the noise level outside the building and/or in the yards is not reduced.

The replacement of joinery and/or repair of facades will only be carried out if they do not meet the required specifications for acoustic insulation. In this case, it is necessary to provide only a system for supplying fresh air.

With closed windows and doors, noise levels in residential premises shall not exceed 30 dB(A) during the day, fully in accordance with the Investor and the EBRD request. Reference values for “hospital” and other kind of properties are given in the Table 8. Insulation of house joinery and facade have a noise reduction potential by 10-30 dB.

Table 8 The WHO guidlines values for community noise in specific environmets

Specific Environment	Standard limits as per WHO guidelines	Time Base	$L_{Amax,\ fast}$
	L_{Aeq} [dB(A)]	[hours]	[dB(A)]
Outdoor living area (daytime)	50 - 55	16	-
Dwelling, indoors (daytime)	35	16	-
Inside bedrooms (night-time)	30	8	45
Outside bedrooms (night-time)	45	8	60
School class rooms and pre-schools, indoors	35	During class	-
Pre-school bedrooms, indoors	30	Sleeping time	45
School, playground outdoor	55	During play	-
Hospital, ward rooms, indoors (night-time)	30	8	40 -
Hospital, ward rooms, indoors (daytime time)	30	16	
Hospitals, treatment rooms, indoors	As low as possible	-	-
Industrial, commercial, shopping and traffic areas, indoors and outdoors	70	24	110

The newly built noise barriers shall be visually inspected to prove that they are free of any defect or damage. The acoustic verification of the noise barrier must be conducted after its installation. Measurements shall be performed in compliance with ISO 10847 standard. An adequate number of measurements will be carried out to demonstrate the effectiveness of the new noise barriers based on the obtained results. Moreover, all noise barriers shall be subjected to measurements to obtain values for sound diffraction and reflection, and isolation of airborne sound fully in compliance with BAS EN 16272-4, BAS CEN/TS 16272-5 and BAS EN 16272-6 standards.

The condition of tracks and rolling stock has the biggest impact on railway noise emission and therefore the regular maintenance is planned as one of the most important noise suppression measures. The planned noise barriers will fulfil their main function only if the tracks and rolling stock are in good condition and undergo regular maintenance.

3 MONITORING PROGRAM

The Investor will develop an Operational Noise Management Plan in order to prevent negative impacts along the railway alignment. The Plan will include the following measures:

- The noise monitoring shall be performed in the area surrounding the residential building located on plot [redacted] in cadastral municipality Brčko 2, in the immediate vicinity of the railway line. Measurements of noise level shall be performed in compliance with stipulations stated in BAS ISO 1996-1 and BAS ISO 1996-2 standards. Each measurement session should be carried out in coordination with the train operations schedule. Parameters of environmental noise levels that are to be monitored are as follows: Equivalent noise level $L_{Aeq,T}$ [dB], Referent noise level $L_{Raeq,T}$ [dB] and Residual noise level [dB]. The noise monitoring should be conducted at least once every three years.
- The noise barriers characteristics shall be controlled at least once in five years. Control shall be performed in accordance with: ISO 10847, BAS EN 16272-4, BAS CEN/TS 16272-5, BAS EN 16272-6 and BAS CEN/TS 16272-7. In case the noise barriers are formed of materials having lower acoustic resistance (wood for example), checks shall be performed after one year, then once in a three-year period and finally once in five years after installation.
- Visual control of noise barriers shall be carried out at least once a calendar year. During inspection of noise barrier, the manufacturer's requirements and recommendations shall be strictly observed.

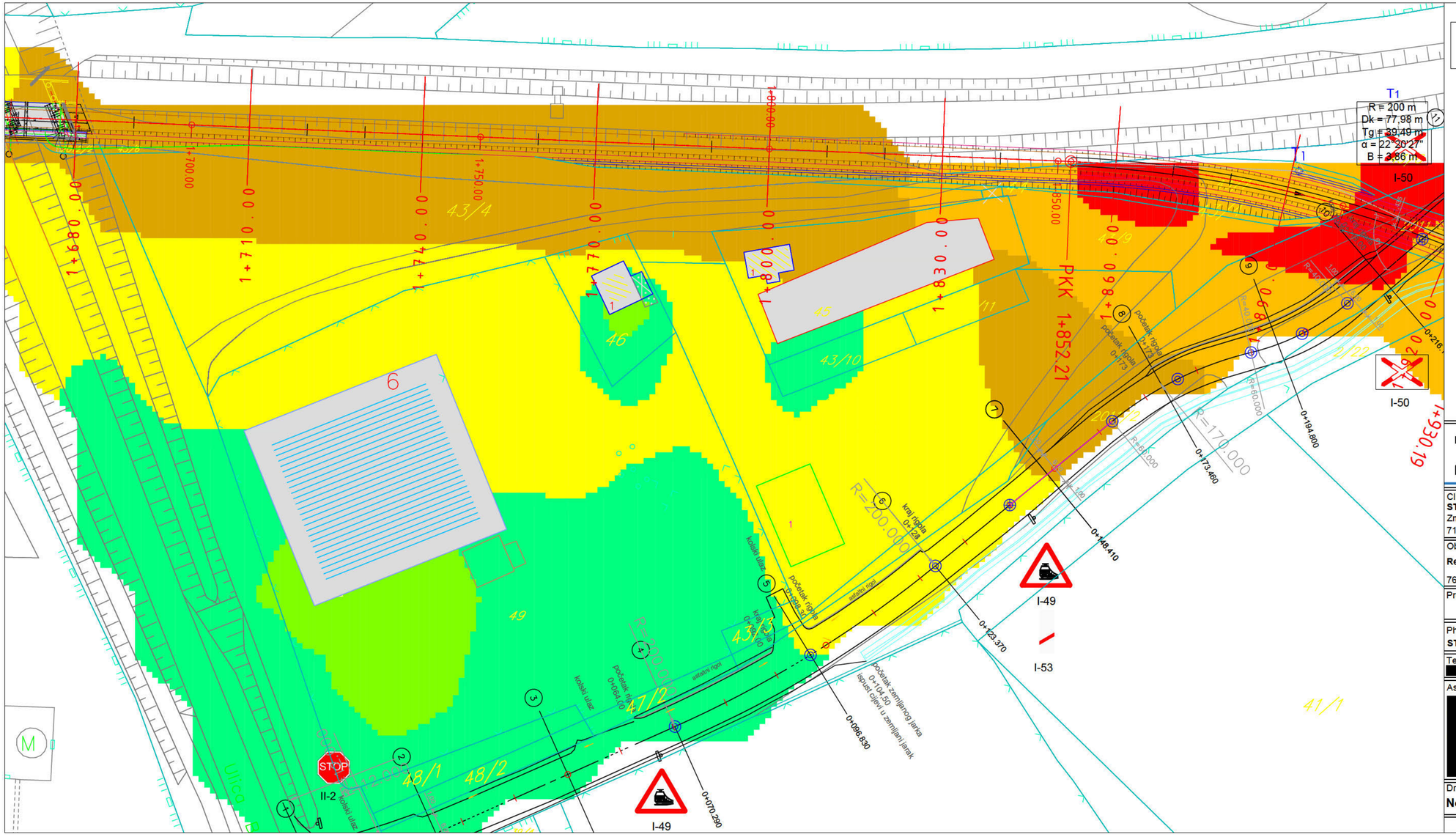
4 GRAPHIC ANNEX

4.1 C1.1 Noise map without noise barrier (scenario of current conditions)

4.2 C1.2 Noise map without noise barrier (scenario of future conditions)

4.3 C2.1 Noise map with noise barrier (scenario of current conditions)

4.4 C2.2 Noise map with noise barrier (scenario of future conditions)



ZGI d.o.o. Mostar
Rudarska 247, 88000 Mostar, BiH
e-mail: info@zgi.eu, projektiranje@zgi.eu
web: www.zgi.eu
tel: +387 36 33 42 80

Client:
STRABAG AG - Business unit Sarajevo
Zmaja od Bosne 11
71000 Sarajevo, BiH

Object:
Residential building on the [redacted] in cadastral municipality Brčko 2
76000 Brčko, BiH

Project: **Study on the assesment of the noise impact of on the residential building**

Phase: **STUDY**

Team leader: [redacted]

Date: **09/2024.**

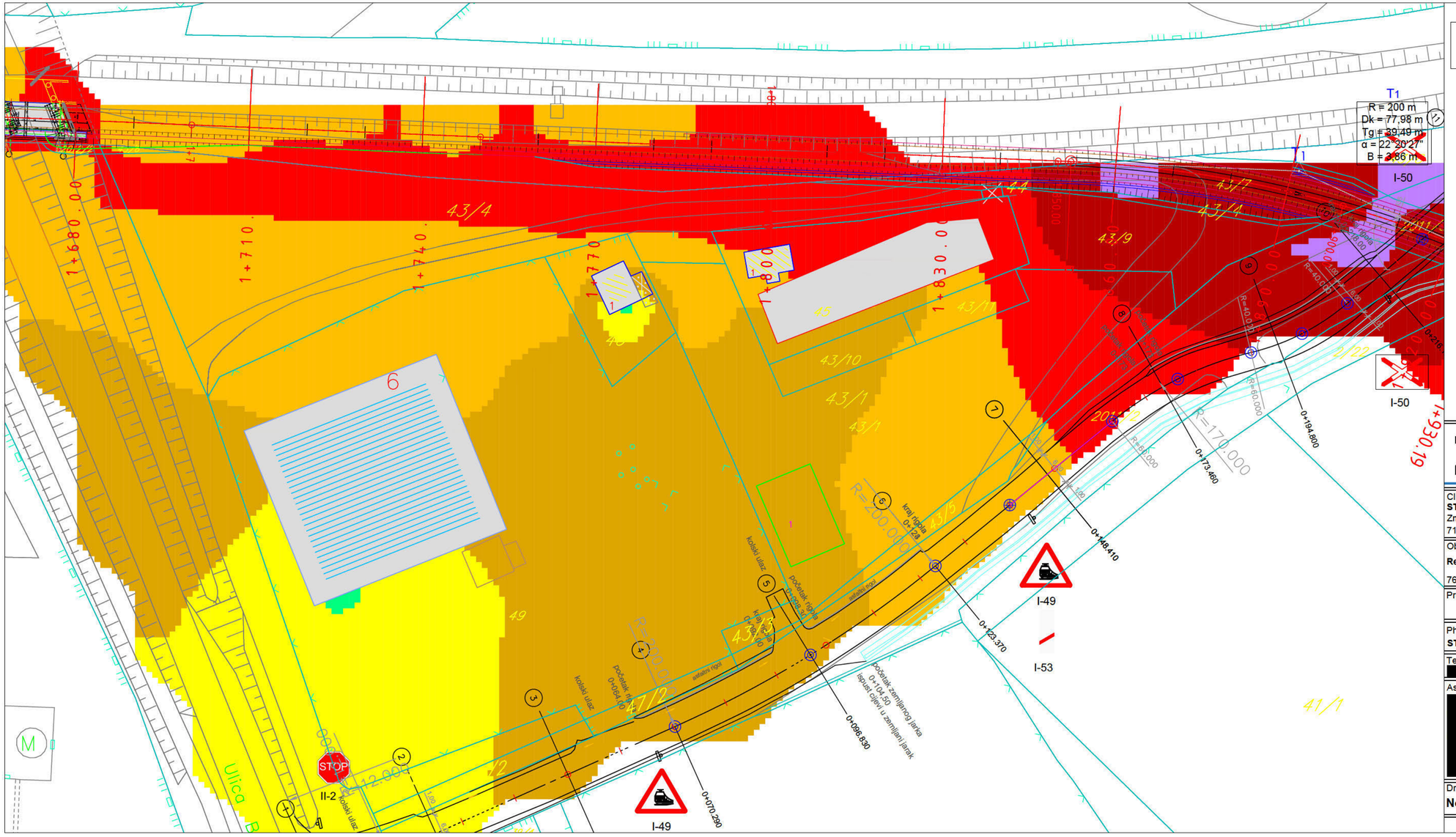
Associates: [redacted]

Documentation number: **01-2-3-rev1-V/24**

Number: **C1.1**

Scale: **1:500**

Drawing: **Noise map without noise barrier (scenario of current conditions)**



ZGI d.o.o. Mostar
Rudarska 247, 88000 Mostar, BiH
e-mail: info@zgi.eu, projektiranje@zgi.eu
web: www.zgi.eu
tel: +387 36 33 42 80

Client:
STRABAG AG - Business unit Sarajevo
Zmaja od Bosne 11
71000 Sarajevo, BiH

Object:
Residential building on the [redacted] in cadastral municipality Brčko 2
76000 Brčko, BiH

Project: **Study on the assesment of the noise impact of on the residential building**

Phase: **STUDY**

Team leader: [redacted]

Date: **09/2024.**

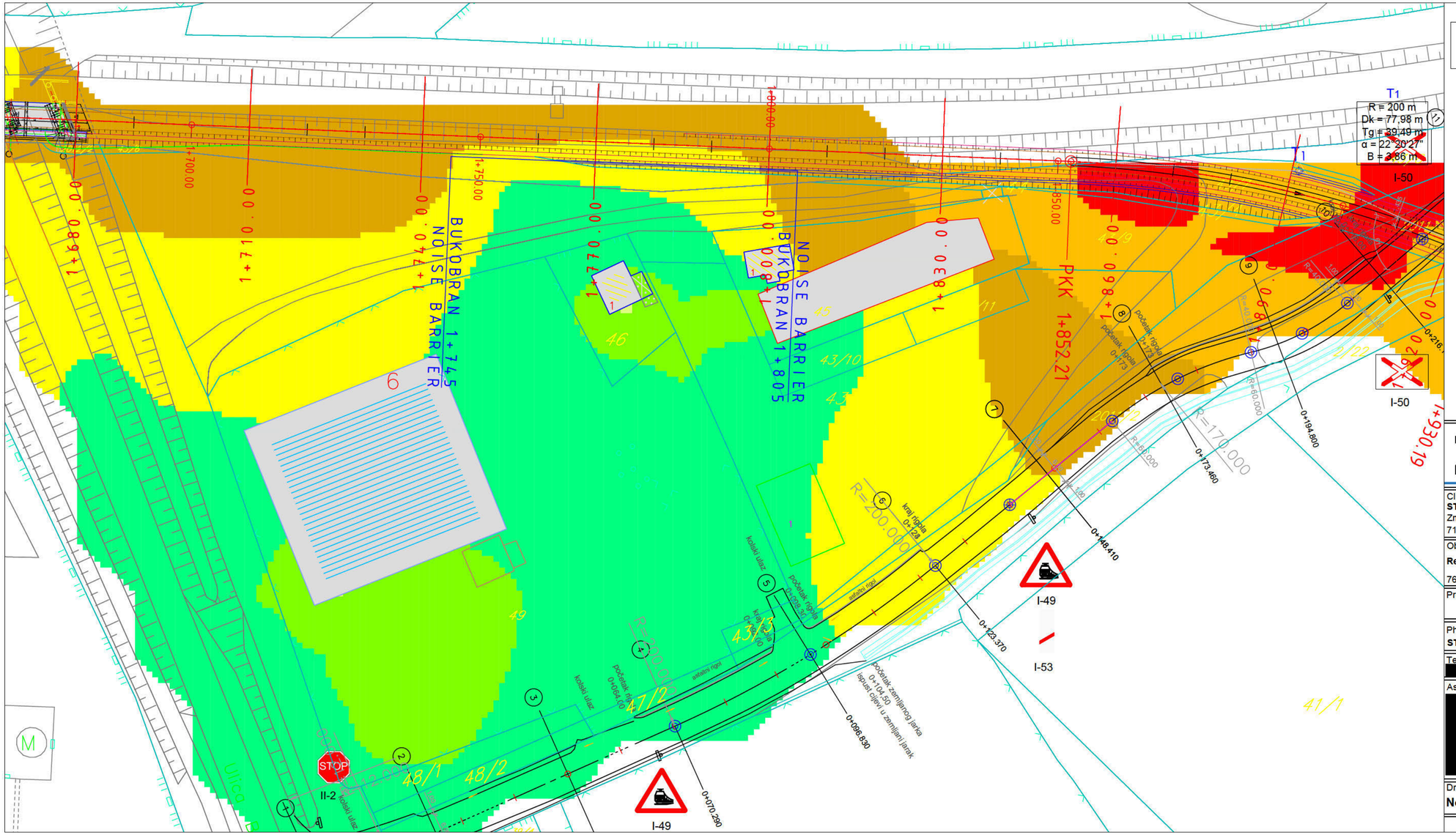
Associates: [redacted]

Documentation number: **01-2-3-rev1-V/24**

Number: **C1.2**

Scale: **1:500**

Drawing:
Noise map without noise barrier (scenario of future conditions)



ZGI d.o.o. Mostar
Rudarska 247, 88000 Mostar, BiH
e-mail: info@zgi.eu, projektiranje@zgi.eu
web: www.zgi.eu
tel: +387 36 33 42 80

Client:
STRABAG AG - Business unit Sarajevo
Zmaja od Bosne 11
71000 Sarajevo, BiH

Object:
Residential building on the [redacted] in cadastral municipality Brčko 2
76000 Brčko, BiH

Project: **Assessment of the possibility of reducing the impact of railway noise and planning of noise protection measures**

Phase:
STUDY

Team leader: [redacted]

Date:
09/2024.

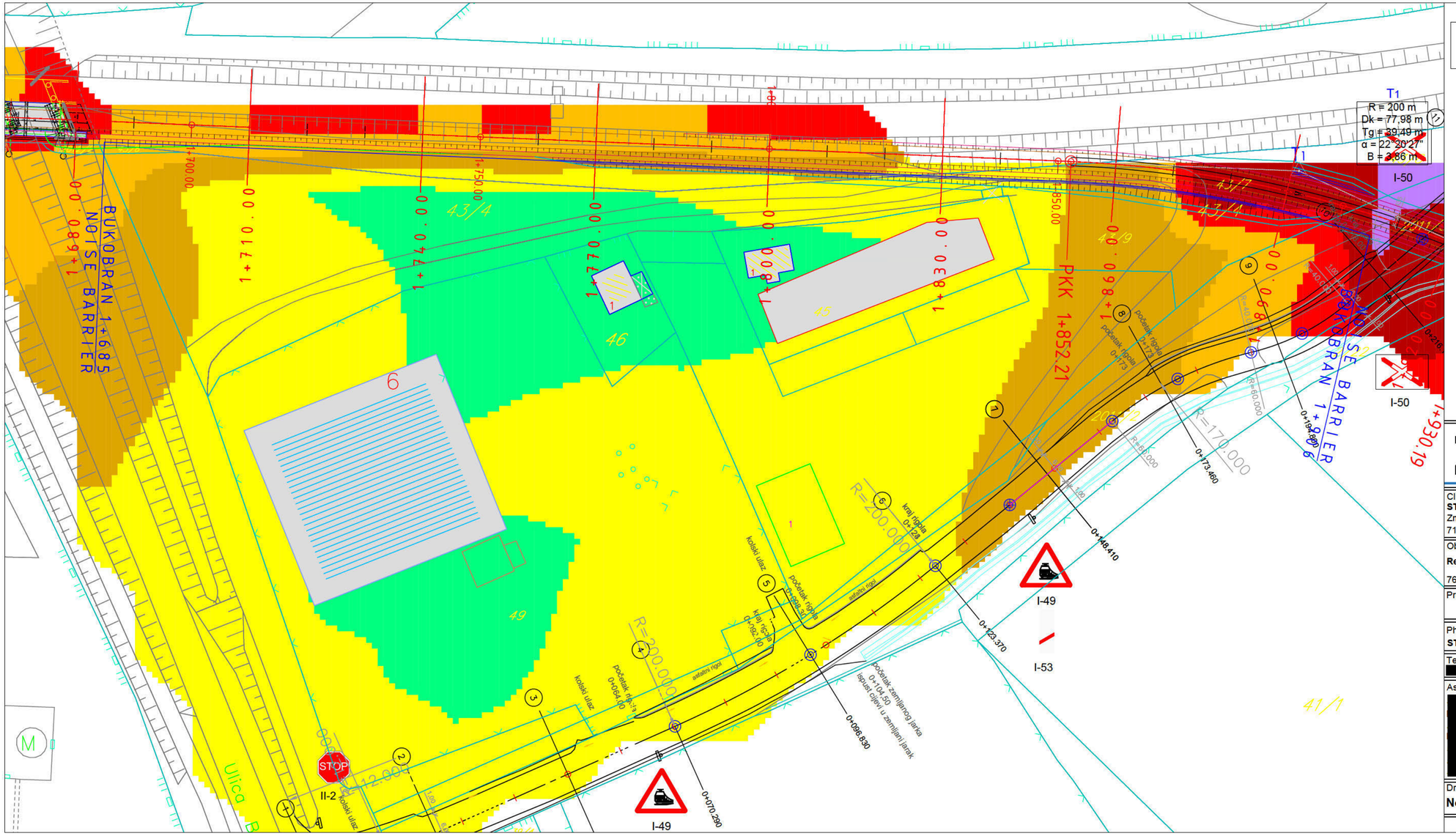
Associates: [redacted]

Documentation number:
01-2-4-rev1-V/24

Number:
C2.1

Scale:
1:500

Drawing:
Noise map with noise barrier (scenario of current conditions)



ZGI d.o.o. Mostar
Rudarska 247, 88000 Mostar, BiH
e-mail: info@zgi.eu, projektiranje@zgi.eu
web: www.zgi.eu
tel: +387 36 33 42 80

Client:
STRABAG AG - Business unit Sarajevo
Zmaja od Bosne 11
71000 Sarajevo, BiH

Object:
Residential building on the [redacted] in cadastral municipality Brčko 2
76000 Brčko, BiH

Project: **Assessment of the possibility of reducing the impact of railway noise and planning of noise protection measures**

Phase:
STUDY

Team leader:
[redacted]

Date:
09/2024.

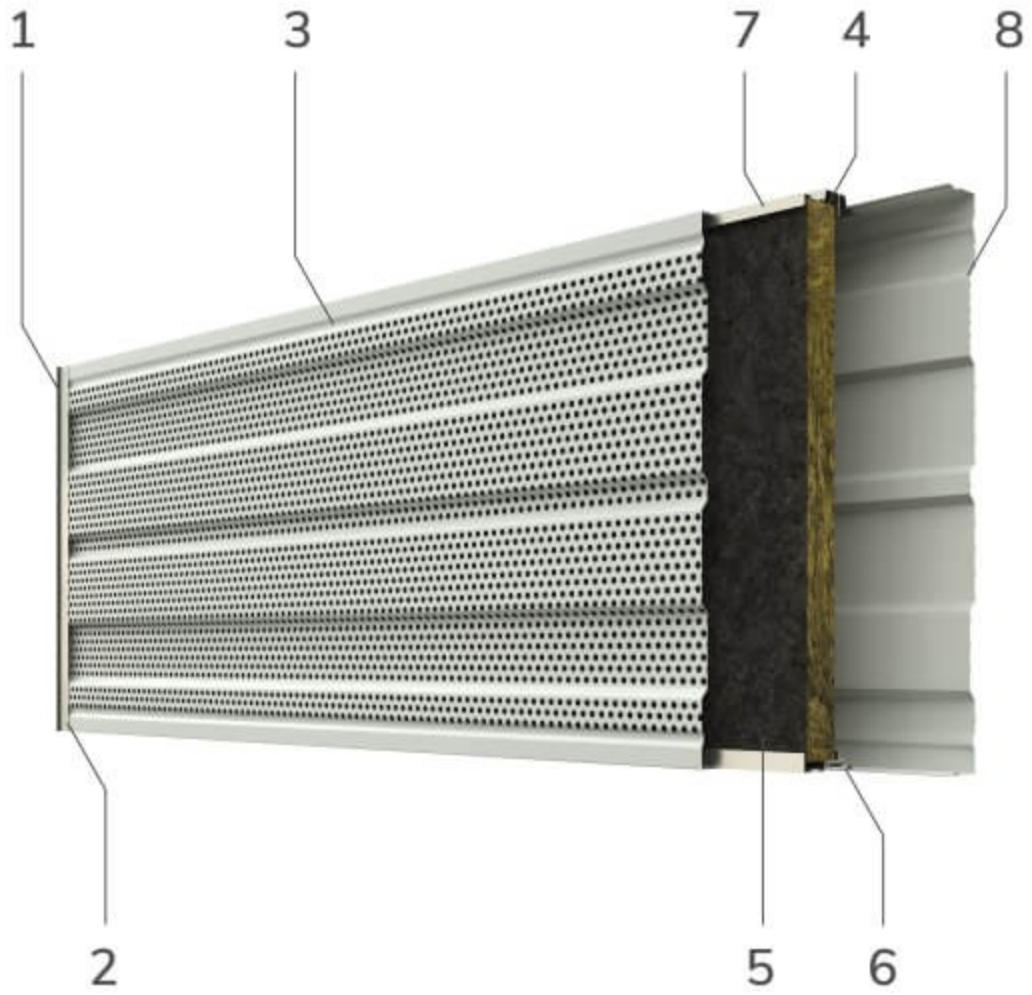
Associates:
[redacted]

Documentation number:
01-2-4-rev1-V/24

Number:
C2.2

Scale:
1:500

Drawing:
Noise map with noise barrier (scenario of future conditions)



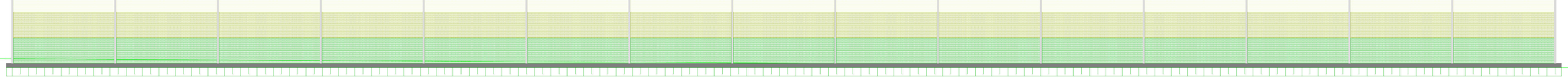
COMPONENTS OF PANEL AL-1S

1. **Rubber seal on the side cover**
2. **Side aluminum profile - cover (unpainted)**
3. **Front aluminum sheet - perforated**
4. **Hydrophobic mineral wool**
5. **Protective polypropylene layer on the mineral wool**
6. **Bottom aluminum profile "groove" (unpainted)**
7. **Top aluminum profile "tongue" (unpainted)**
8. **Rear aluminum sheet (not perforated, solid sheet)**

Specification

Standard height: 500 mm
Maximum length: 5,000 mm
Standard widths: 125 mm and 107 mm
Standard thicknesses of aluminum sheet: 1 mm, 1.25 mm
Absorption material: Mineral wool with a thickness of 50 mm, density of 90-100 kg/m³
Front sheet: Perforated, perforation diameter of 8 mm
Rear sheet: Non-perforated
Side closure: Extruded aluminum profile with a thickness of 1.3 mm
Installation options: Can be installed between HE 140, 160, 180

izgled

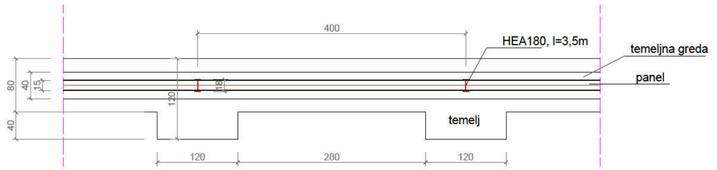


PLANINVEST
d.o.o. za projektovanje inženjering

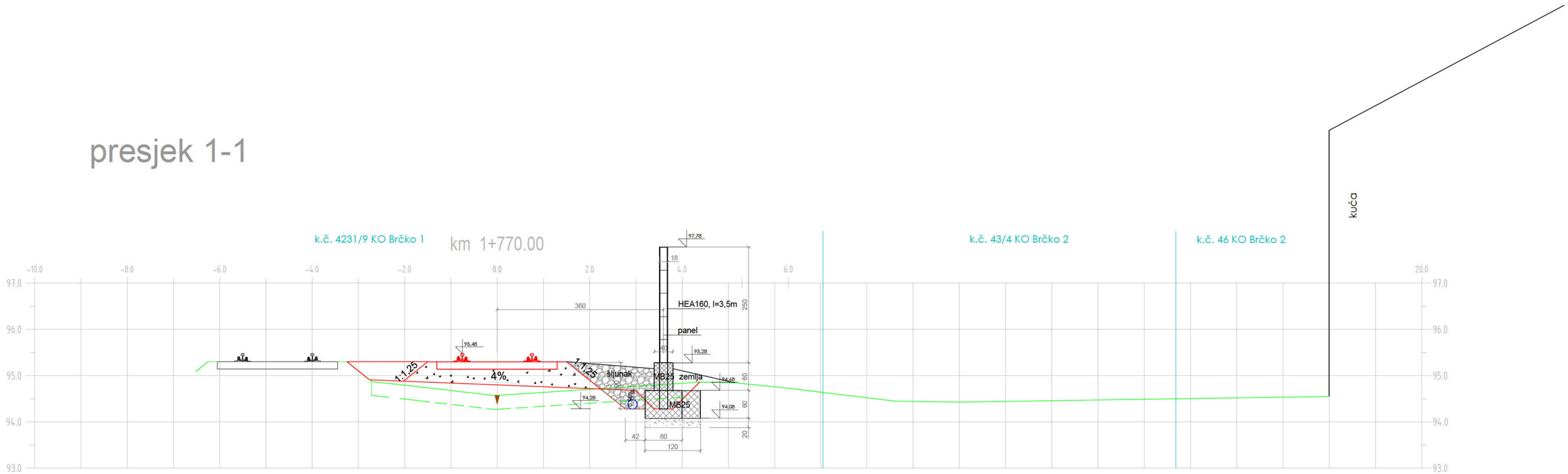
[redacted]

Investitor:	Vlada Brčko distrikta BiH
Naziv projekta:	izgradnja zida protiv buke na stacionaži [redacted] kolosijeka željeznička stanica Brčko Novo - Luka Brčko
Nivo projekta:	Glavni projekat
Naziv lista:	Izgled za zaštitu od buke
Oznaka projekta:	24-10-A-191
Datum:	novembar 2024
Razmjera:	1 : 50
Broj lista:	3
M.P.	

osnova



presjek 1-1



PLANINVEST d.o.o. za građevinski inženjering	Investitor: Vlada Brčko distrikta BiH		Naziv projekta: izgradnja zida protiv buke na stacionaži [redacted] kolosijeka željeznička stanica Brčko Novo - Luka Brčko
Odgovorni projektant: Miodrag Simić, dipl.građ.inž.	Nivo projekta: Glavni projekat		Sadržaj: Normalni poprečni profil
	Oznaka projekta: 24-10-A-191	Datum: novembar 2024	Razmjera: 1 : 50 / Broj lista: 2

M.P.

LEGENDA

- osa barijere
- paneli barijere
- nosač barijere
- ivica temelja i grede
- poluperforirana drenažna cijev
- parcele granice
- osa pruge
- šine
- škarpe pruge
- dno postojećrg jarka
- postojeća kanalizacija

PLANINVEST d.o.o. za gradjevinski inženjering	Investitor: Vlada Brčko distrikta BiH	Naziv projekta: izgradnja zida za zaštitu od buke na stacionaži [redacted] kolosijeka železnička stanica Brčko Novo - Luka Brčko
Odgovorni projektant: [redacted]	Nivo projekta: Glavni projekat	Sadržaj: Situacioni plan zida za zaštitu od buke
	Oznaka projekta: 24-10-A-191 / Datum: novembar 2024	Razmjera: 1 : 200 / Broj lista: 1 / M.P.

TECHNICAL REPORT

accompanying the Main Design for the Construction of a Noise Barrier Along Railway Track 1, from Brčko Novo Railway Station to the Industrial Zone between Stationing Point 1+745 and Stationing Point 1+805, adjacent to Parcel [redacted] Cadastral Municipality Brčko 2 (site exposure)

INTRODUCTION

At the request of the Investor, we have begun designing a noise barrier between the new railway track and the residential building on Parcel [redacted] Cadastral Municipality Brčko 2 (site exposure). The new railway track was constructed next to the existing track, which runs from the railway station towards the bridge over the Sava River. The new track is positioned closer to the building than the existing one, which created the need to reduce the noise level in the residential building from the source of noise – the passing trains.

LOCATION

The object in question i.e., noise barrier is to be constructed along Railway Track 1, which runs from Brčko Novo Railway Station to the industrial zone, between stationing point 1+745 and stationing point 1+805, covering a length of 60 meters, next to Parcel [redacted] Cadastral Municipality Brčko 2 (site exposure). The distance from the existing residential building to the centerline of the railway track is 18 meters.

LEGISLATION

In developing the design, the following legal regulations and literature were consulted:

- World Health Organization recommendations
- Directive 2002/49/EC of the European Parliament and Council of June 2002
- Environmental Protection Act of the Brčko District of BiH
- Noise Protection Act of the Federation of BiH
- Environmental Protection Act of the Republika Srpska and the Noise Protection Regulation
- Noise Impact Assessment Study for the Building, prepared by ZGI Ltd. Mostar, October 2024
- Assessment of the Potential for Reducing Railway Noise Impact and Planning Noise Protection Measures, prepared by ZGI Ltd. Mostar, October 2024
- Guidelines for the Design, Construction, Maintenance, and Supervision of Roads in BiH, Volume I, Part 1, Chapter 6, Roads and the Environment
- Regulation on the Application of Unified Technical Standards (JTP) for the Subsystems "Railway Vehicles – Noise" (JTP BUKA) in Railway Systems in Bosnia and Herzegovina (Official Gazette of BiH 3/18), Annex 1.
- Gradske saobraćajnice [City roads], M. Maletin

LOCATION

The location of the building in its broader environment is shown in Figure 1. Apart from the Brčko Novo - Brčko Luka railway line (the focus of this study), potential sources of noise include the international Brčko - Vinkovci railway line, local roadways, and nearby industrial facilities.

The building is situated on the right side of the Brčko Novo – Brčko Luka railway line (the focus of this Study) at km [redacted], roughly 18 meters from the track centerline. Relative to other potential noise sources, the building is approximately 25 meters from the international Brčko – Vinkovci railway line, about 75 meters from the road leading to the port, and around 95 meters from [redacted]. There are industrial facilities in the immediate vicinity of the building. To the left is [redacted]", while to the right, as shown in Figure 1, is the company "[redacted]".

TECHNICAL REQUIREMENTS

The assessment of railway noise reduction options and the planning of noise protection measures have provided the technical requirements for the design and construction of the wall. The maximum noise level at the building's facade should not exceed the set limit of 45 dB(A), ensuring an acceptable indoor noise level of 30 dB(A) during the day—this reference value aligns with hospital standards to protect vulnerable residents. The wall should be placed 3.60 meters from the track centerline. The acoustic panels used for noise barriers must have a minimum sound absorption of 12 dB (class A4 according to BAS EN 16727-1) and a minimum sound insulation of 25 dB (class B3 according to BAS 16272-2). These panels should have a lifespan of at least 20 years without significant changes to their acoustic and non-acoustic properties.
Based on current noise levels, the wall should be constructed to a height of 2.5 meters from stationing point 1+745 to stationing point 1+805.

SOURCES OF NOISE

The current traffic consists of two trains, each with an average composition of 14 cars. Trains operate exclusively during the day, from 6:30 AM to 6:30 PM, in line with the operating hours of the Brčko Novo station. The maximum allowable speed on the railway line is 35 km/h.

The noise sources during the train's movement at this location include rolling noise (caused by wheel and rail surface roughness), traction noise (from the transmission mechanism, engine operation, exhaust system, and fans), aerodynamic noise, and squealing. All noise sources are at heights between 0.50 meters and 4.00 meters. The maximum noise level is 63 Hz.

TECHNICAL SOLUTION

The noise protection wall is to be constructed from aluminum panels, secured with vertical steel supports anchored to a concrete base. The wall should be built to a height of 2.5 meters, extending from stationing point 1+745 to stationing point 1+805. The wall's axis is positioned 3.60 meters from the centerline of the track.

Each panel measures 3960 x 500 x 120(150) mm, designed for a column spacing of 4.00 meters. The panels are vertically connected using a tongue-and-groove system, with specially profiled sheets 1.3 mm thick, enclosing the top and bottom of the panel. The front side of each panel, facing the railway track, includes a stone wool layer for sound absorption. The front surface of the stone wool layer is protected by black fiberglass felt to guard against the effects of precipitation and other environmental factors. The layers within the panel are spaced using specialized spacer pins. The external protection of the panel is achieved by applying a 60 mm thick layer of polyester powder. The panels are vertically secured to the HE 180 support columns using profiled neoprene. The dimensions and composition of the panels fully meet the relevant standards and quality requirements. The foundation strips are 80 cm wide, with expansions at the column locations extending to 120 cm, made of MB25 concrete. The foundation depth is 60 cm, and the total length is 61.20 meters. The foundation beams are 40 cm wide and 60 cm high, made from MB25 concrete, with a total length of 60.40 meters. The concrete elements are reinforced with rebar mesh and ribbed steel reinforcement.

Panel installation instructions

It is essential to verify that the steel columns are correctly aligned (vertically, in direction, etc.). Table A in the appendix provides the values and tolerances for constructing both individual components and the overall structure. The concrete foundation and beam must be reinforced as per the design, with the upper edge of the beam level at the top of the column foundations. Both the concrete foundation and beam should be installed horizontally and securely anchored. Position the bottom (lowest) element of the noise protection panels between the steel columns (from above). Install a foam rubber strip, measuring 40 x 25 mm, in the groove of the noise protection element. Finally, proceed with the installation of the remaining panels. Note: When installing the concrete elements and panels, special care should be taken to avoid damaging the

protective anti-corrosion coating on the columns and other components of the structure.

The newly constructed noise barriers must be visually inspected to ensure they are free from defects or damage. Acoustic testing of the noise barriers should be conducted after installation. The measurements will be performed in accordance with ISO 10847 standards. A sufficient number of measurements will be carried out to demonstrate the effectiveness of the new noise barriers based on the results obtained. All noise barriers will be subjected to measurements to assess values for sound diffraction, reflection, and airborne sound insulation, fully in accordance with the BAS EN 16272-4, BAS CEN/TS 16272-5, and BAS EN 16272-6 standards.

The condition of the railway tracks and rolling stock has the greatest impact on noise emission, which is why regular maintenance is considered one of the most important measures for noise mitigation. The planned noise barriers will only perform their primary function if the tracks and rolling stock are properly maintained and kept in good condition.

Brčko, October 2024

Responsible designer

European Bank for Reconstruction and Development | Independent Project Accountability Mechanism

Annex 3. Summary of joint meeting of Parties for IPAM Case 2023/07 – Port of Brcko

On Tuesday 5 November 2024, IPAM facilitated a joint meeting of the Parties involved in the Problem Solving for Case 2023/07 Port of Brcko and other relevant stakeholders (See Table 2 for list of attendance). The goal of the meeting was to reach an agreement on the actions required to address the concerns raised by the Requester of Case 2023/07 and document them in the Problem Solving Agreement.

The noise mitigation measures agreed by the Parties are as follows:

Based on the findings of the noise assessment conducted in October 2024 in the vicinity of the Requester's property (Annex 1 to the agreement) indicate that current noise levels exceed the 45 dB threshold (recommended by WHO) by 5.1 dB with the passage of two trains daily. The following actions have been agreed:

Port of Brcko responsibilities

1. The Port of Brčko committed to build a noise barrier of **60 m long and 2.5 m high along the railway section adjacent to the Requester's property to mitigate** the impacts of noise coming from two trains moving towards and from the Port daily.
2. The noise barrier will be built of high-absorption aluminum panels, designed to reduce noise levels by 5–15 dB to meet the noise mitigation requirements, as described in Annex 2 of the Agreement.
3. The noise barrier will be installed at 3.6 m from the railway's centerline, located on public land in an existing trench to support adequate drainage and avoid obstructions.
4. The noise barrier will be designed to allow for the possibility for future expansion.
5. If the traffic projections materialize, an extension of the noise barrier would be built, increasing length up to 220 m and up to 5 m in high to ensure protection from noise in case of increased train traffic[1] expected in about 5 years' time.

Requester responsibilities

1. The Requester will allow access through his backyard for the construction of the noise barrier, on the condition that any damage to the ground caused by the passage of heavy vehicles (such as trucks or excavators) is repaired, and the site is restored to its original state.
2. The Requester would have to contact the Port of Brcko authorities if, and when, an increase in traffic would require revising the noise mitigation measures.

[1] Port of Brcko authorities signalled that it is estimated that traffic may increase from 2 to 12 trains per day within the next five years. In this situation, noise levels could increase by up to 14 dB. To mitigate this, ZGI has proposed constructing a longer noise barrier of 220 meters in length and 5 meters in height, covering a total area of 1,110 m^2.

Table 1. Agreed Timeline of Activities

Action	Responsible Party	Agreed Timeline
Agreement		
Summary of joint meeting drafted to reflect the Parties' decisions and attached to the Agreement as Annex 3.	IPAM	18 November 2024
The Problem Solving Agreement is signed by all Parties and IPAM has sent a signed copy to each.	IPAM	30 November 2024
Parties agreed for IPAM to disclose the signed agreement and its annexes in the IPAM Case Registry.	Port of Brcko, Requester	30 November 2024
Construction of the noise barrier		
The Project Implementation Unit approves the construction of the noise barrier	Port of Brcko	30 November 2024
The Brcko Government approves the construction of the noise barrier	Port of Brcko	31 January 2025
All necessary permits are obtained (location permit, construction permit, etc.)	Port of Brcko	31 March 2025
Noise barrier project is completed as per the agreed specifications	Port of Brčko, Contractor, Supervisor	30 June 2025
Monitoring of the Agreement by IPAM		
Monthly communication with Parties for updates on progress.	IPAM	From November 2024 until completion
Problem-Solving Interim Monitoring Report prepared, circulated and disclosed in IPAM Case Registry.	IPAM	31 May 2025
Monitoring site visit to Brcko to confirm completion of project, gather videographic evidence and sign completion minutes	IPAM, Port of Brčko, Requester	31 July 2025
Final Problem-Solving Monitoring Report is issued, and case is closed	IPAM	31 August 2025

N.B. The agreed deadlines may shift due to unforeseen circumstances. If this happens, IPAM will engage with Parties and agree on revised deadlines.

Table 2. List of meeting participants (list not for public disclosure)

Participants	Institution
[redacted]	Requester
[redacted]	Port of Brcko
[redacted]	Port of Brcko
[redacted]	Construction Supervisor for Port of Brcko
[redacted]	Strabag, Contractor for Port of Brcko
[redacted]	Subcontractor for Strabag
[redacted]	Zagreb Inspect – ZGI Laboratory
[redacted] (virtually)	EBRD Project team
[redacted]	IPAM
[redacted]	IPAM