

DOI: [10.22620/agrisci.2023.37.002](https://doi.org/10.22620/agrisci.2023.37.002)

## AN OPTIMISED DESIGN FOR TRANSPORT NOISE POLLUTION REDUCTION IN THE CHILDREN'S AREA AND RECREATION SPOTS

Mariya P. Grozeva

Agricultural University – Plovdiv, Bulgaria

E-mail: [l.arch.grozeva@gmail.com](mailto:l.arch.grozeva@gmail.com)

### Abstract

Over the years, the issue of improving the urban environment remains relevant, especially in the design of children's playgrounds and recreation areas. In addition to the analysis of available vegetation and terrain conditions, the noise pollution of the environment should also be considered in order to take into account suitable measures for its reduction. The most effective ecological and aesthetic method is the establishment of plant barriers to reduce the noise discomfort. The aesthetically designed vegetative isolation barriers, in addition to the healing effect on the microclimate of the territory, also contribute to the visual aesthetics: bringing in decorative plant species that bloom, have spectacular foliage, have an interesting habit, or the delicate use of aromatic plants and those with phytoncide activity. In recent years, there has been a trend towards expanding urban areas and the concentration of population in urban agglomerations, which leads to many environmental problems. One of them is the lack of territories with trees and shrubs of the forest park type, providing acoustic and aesthetic comfort to the population. The ecological balance of urban territories necessitates a long-term ecological strategy for the creation of similar territories in the urban development plans.

**Keywords:** noise protection, vegetation in an urban environment, park planning

### INTRODUCTION

In modern trends for the design of children's recreation areas, noise pollution of the environment, as a result of human intervention, is an extremely important problem and should be taken into account (Novaco et al., 1978; Levy et al. 2010; De Palma & Lindsey, 2011; Fuks K., et al., 2011). Gliszczynski & Bohdal (2016) considered that the use of decorative vegetation is an effective solution for reducing the increased levels of traffic noise in urbanized and non-urbanized areas. The modern design of noise-protective plant barriers should be developed in the direction of efficiency, aesthetics and environmental friendliness, but also taking into account the available environmental conditions (Galev, 2019). The problem of reducing the vehicular traffic noise levels in the urban areas has several aspects

(Cannelli 1974, Bjork, 1994, Jim & Chen, 2003, Danilina et al., 2021).

The present report deals primarily with the urban planning approach. When designing modern urban spaces, they should also be examined in terms of noise discomfort, so that measures can be taken to reduce the harmful effects of car traffic (Directive 2002/49/EC).

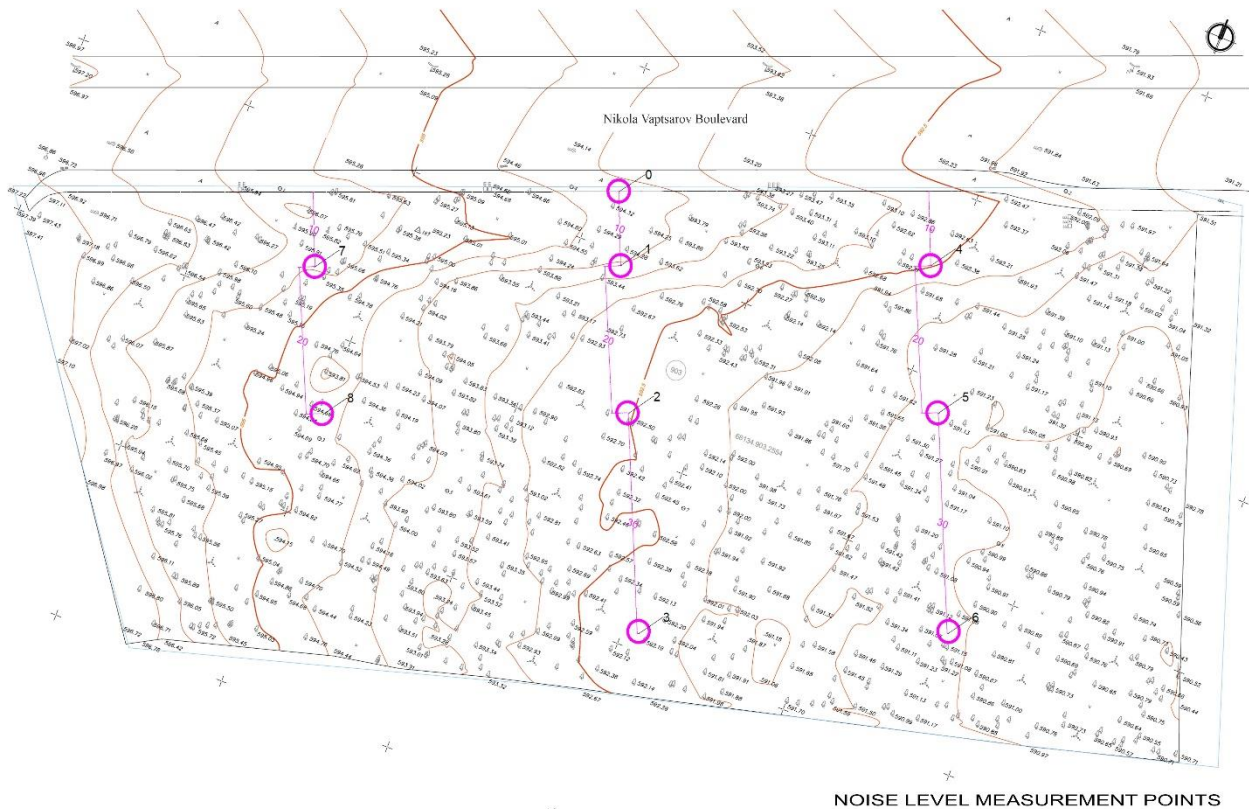
### MATERIALS AND METHODS

In 2022 measurements were made by manually recording noise values with an ambient sound level meter. The device is a noise level meter SL300 and complies with DIN EN 616721 standard for measuring the noise level and controlling its quality in a variety of locations. Technical data:

- Accuracy: +/- 1.4 dB
- Range: 31.5 Hz – 8 kHz

- Dynamic range: 50 dB
- Reaction time: FAST - fast 125ms / SLOW - slow 1s
- Microphone: electret, condenser
- Display: indication with 0.1dB extension

- Operating temperature and relative air humidity: 0-40°C, 10-90% RH
- Eight measurement points were selected (Fig. 1) of the noise protection properties of the existing landscaping, in the immediate vicinity of an arterial street - "N. Vaptsarov" Blvd.



**Fig. 1** – Measuring points.

The selection of the locations of the points is based on their symmetrical distribution on the terrain and in the naturally formed meadows and the location of the recreation areas and children's areas. The tests were carried out with a sound meter at characteristic places /points/ at the beginning /at the "face" of the considered property/, inside it /at the recreation areas/ and at the bottom of the plot - reflected on a diagram with numbering. The data from the measurements are also plotted in tabular form. The points are located as follows:

- 10 m from the noise source
  - 30 m from the noise source
  - 60 m from the noise source
- As a zero point, a midpoint for the

terrain was chosen and located in the immediate vicinity of "N. Vaptsarov" Blvd. at the sidewalk, and the following parameters were recorded:

- Traffic flow
- Type of flooring
- Type of road
- Meteorological situation
- Measurements – start and end time
- Measurement duration
- Noise levels
- Number of motor vehicles
- Average vehicle speed

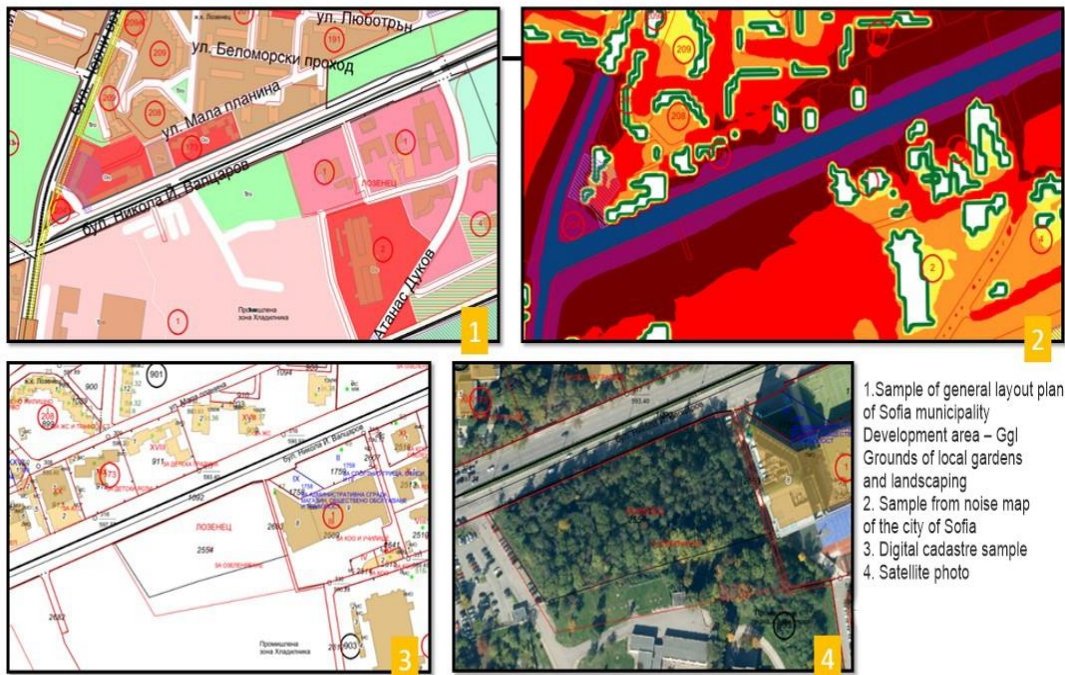
For the measurements inside the property, measurements were made in the following directions:

- Time of measurement
- Terrain profile
- Reported noise level
- Reference values
- Species composition of the vegetation within a radius of 5 m.
- Vegetation condition, foliage criterion

## RESULTS AND DISCUSSION

The studies have shown that the noise discomfort levels are elevated at the point of measurement and a reduction is required. Measurements inside the property were carried out over two seasons, so that the noise levels were taken into account when the vegetation was leafy or leafless. The project for the

children's zone and the recreation corners is located in PI 68134.903.2554 under the current KKKR for the city of Sofia, Lozenets district, HPP “Holders – Vitosha” - Part North, Lozenets District - Municipal Property. Location: From the north it borders on a sidewalk, along "N. Vaptsarov" Blvd., from the west – on the fence of Lozenets “Educational and Sports Complex”, from west, south and east with fences built. The total area of the landed property is 11.5 decares, according to cadastral data. The terrain under consideration is in the development zone: TGO - terrains of local gardens and landscaping, according to the General Plan of the Sofia Municipality. According to the noise map of the city of Sofia (Fig. 2) four strips of 3.5 m and a dividing green strip of 3 m wide.



**Fig. 2.** Noise map of the city of Sofia

The existing situation in terms of vegetation: there is numerous self - rated vegetation of non -metropogenic origin, unsupported and in poor physiological condition. In the face of the property from "N. Vaptsarov" Blvd., a MGT stop, which is without a stopping, benches or plant insulation, which leads to pollution on part of the territory immediately located behind the stop. For the

purposes of the project, an expert evaluation of the existing vegetation has been prepared, which has also been expanded with the examination of species in terms of morphological and biological features in order to assess the acoustic properties of the plant species. /Fig. 3 - Scheme Expert evaluation of tree vegetation/ after a thorough review of the terrain, the existing tree species were described,



analyzed and categorized in a tabular form and graphically illustrated in the scheme of wood vegetation under Article 19 of the Law on the Structure and Construction of the Metropolitan Municipality (ZUZSO) as follows:

- Name of plant species
- Height of the plant species
- Age
- Stem diameter at 1.30m,

- Condition: - "bad" - dried- red circle with stroke; - "medium" - drying, diseases, refraction on the stem - orange circle with stroke; - "good" - with aesthetic disadvantages - a bright green circle with stroke; - "very good"- firm with a preserved decorative value- dark green circle with stroke;
- Origin
- Phytosanitary condition

**Table. 1.** Measurements of acoustic discomfort at zero point

Traffic -powered - permanent	Pavement - smooth asphalt	Road - two –way	Weather - dry, no wind
Measurement			
Starting time 8.00 p.m.	Final hour 8.30	Duration 30 min	
Noise level			
Average DB (A) - 72,4	Average DB (A) - 71,6	Lowest levels DB (A) - 70.1	Highest levels DB (A) 73,3
Measurement			
Starting time 12.00 p.m.	Final hour 12.30	Duration 30 min	
Noise level			
Average DB (A) - 73,2	Average DB (A) - 72,9	Lowest levels DB (A) - 71,5	Highest levels DB (A) 73,4
Traffic Counting 8h			
Pcs/h		Lowest V av. km/h	The highest V av. km/h
896		40	60

In total, 881 trees were filmed and described within the site (Fig. 3). The inspections were conducted in a leafy state, which allows the proper assessment of the condition of the plant species. Vegetation has a variety of species, age and condition, predominant deciduous trees. The woody vegetation is generally in a non-satisfactory physiological state.

Part of the species described in the table to the expert requirement requires sanitary pruning of the dried branches, which would pose a danger to passing citizens under the tree. Other types require full remediation as they are dry or sick. Due to the close distances between the trees, most of the tree species have an eastern habitus, with a self-demon and asymmetrical crown, which is characteristic of forest plantations. The overall type of plant

volumes is defined as vegetation with medium level of decorative qualities.

With regard to data from the morphological and physiological features of the existing tree species, they are defined as non-navigate and medium-sized noise protection properties (Table 4 -morphological and physiological features of tree vegetation)./

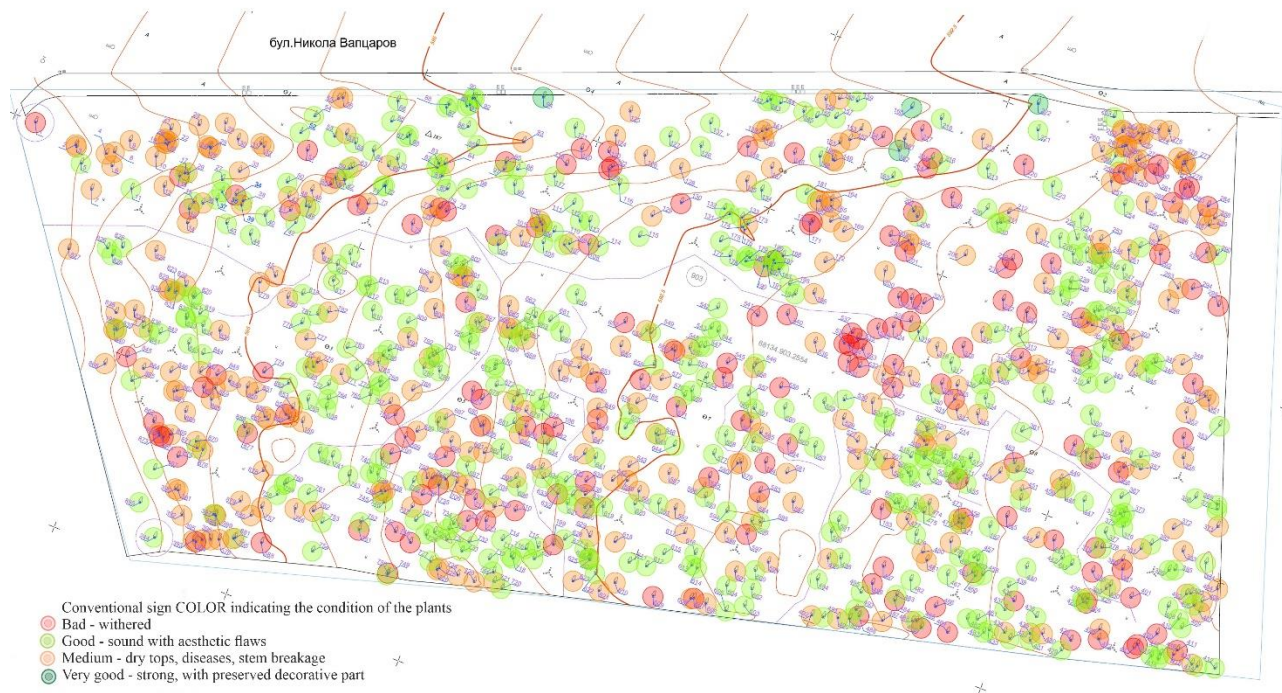
**Project decision**

The project development sets the following objectives for designing the space:

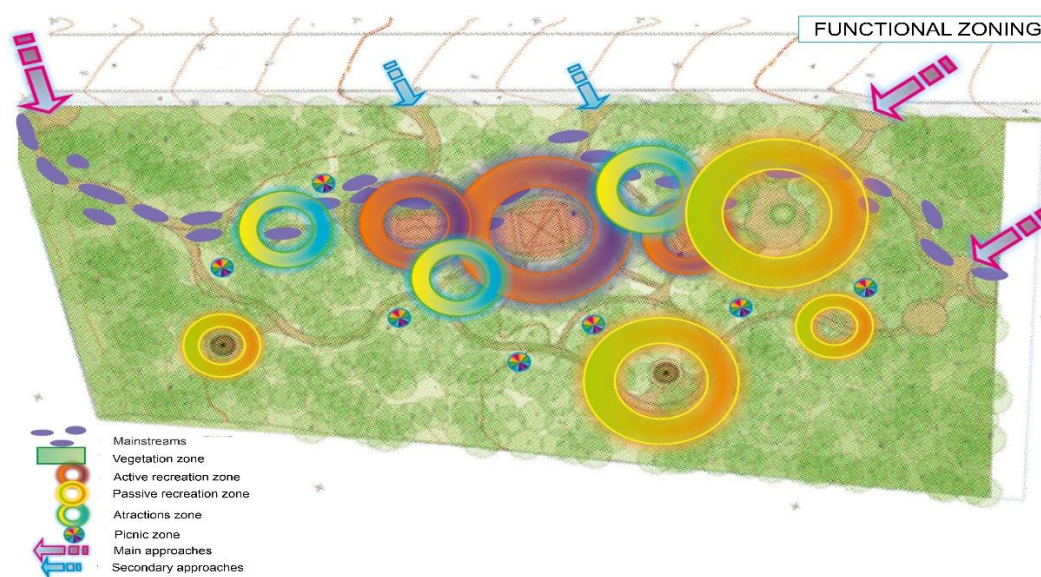
- Environment and delicate intervention in the existing landscape;
- Natural style of the composition of the allege net, the type of flooring and park furniture;
- Reducing the noise discomfort by placing the sites inside the site and introducing new vegetation.

**Expert Assessment**

Children's zone and recreation areas in PI 68134.903.2554 according to the current KKKR for the city of Sofia, Lozenets district, M.N.ZP Hladilnika - Vitosha - part north, LOZENETS Sofia District



**Fig. 3. Expert Assessment.**



**Fig. 4 - Functional zoning.**

Based on the studies and fields, a scheme of functional zoning (Fig. 4) was prepared, which included the following zones and directions:

- Main directions of pedestrian traffic
- Vegetable arrays

- Zone Active Recreation
- Passive relaxation zone
- Zone attractions picnic zone
- Main approaches
- Secondary approaches



The main activities envisaged with the project development (Fig. 6) were:

- Ennoblement of the territory, through melioration events;
- Creation of alleys in environmentally friendly style;
- Sipitsa pavement will provide a surface with a grip such as anti-slip prevention, wood

mulch flooring is intended for impact absorbing in the play areas;

- Providing an accessible environment, with a maximum slope of 5%;
- Positioning of new entrances with signs;
- Introduction of new forest park furniture from natural materials - bicycle pans, benches and waste bins, arbors, bridges;



**Fig. 5 – Project.**

Alleys with a total area of 1 675 m<sup>2</sup> and playgrounds with an area of 340 m<sup>2</sup> have been newly designed. The new alley network would provide a walking route and a space for sports activities. The aim is to stimulate the motor activity of children and young people, as well as older passers-by. The designed sites would also serve as places for social contacts, an individual or group visit and a place for relaxation (Ordinance No.1 2009). An entrance, shaped by a circular playground with arcuate wooden benches, would be created at the fence of the Lozenets “Educational Complex EAD”. The

remaining entrances are located on existing widening. The width of the alleys is 1.50 - 2.00 m. Wooden bridges are provided along the route, for diversification and games. Benches or wooden arbors are placed in the widening of the alleys and in the especially separate recreation sites. The corners are intended for short-term relaxation, meetings, or social contacts. Picnic tables in the forest environment are also provided.

The selected park furniture and children's facilities will create a balanced forestry environment in the existing territory

through a delicate visual intervention in the landscape. The park elements are of environmentally friendly style, with natural materials and are large-scale sized by the existing landscape. The waste bins are placed evenly throughout the site, especially at recreation sites (arbors, benches) and on the entrances and exits of the park.

The parking solution does not affect the permanent tree vegetation, except for the species which would be manipulated, due to their poor physiological condition according to the expert evaluation. The project envisages the introduction of additional flowering species in order to increase color and improve biodiversity. Their spin is in accordance with the assets of the environment, namely the vegetation should have relatively non-consistent and decorative qualities. Species such as *Cercis siliquastrum*, *Gleditsia triacanthos* `Sunburst`, *Physocarpus opulifolius* `Diablo`, *Spiraea japonica* `Golden princess`, *Anemone x hybrida*, *Aster oblongifolius*, *Athyrium niponicum*, *Carex humilis*, *Carex oshimensis* `Everest`, *Geranium x catabrigiense*, *Heuhera sp.*, *Hamamelis intermedia*. The existing vegetation and the newly planted *Ligustrum ovalifolium* plants in combination with an openwork fence with decorative panels will help reduce noise discomfort. The enclosure of the site will minimize vandalistic behavior.

## CONCLUSION

The following conclusions have been made on the basis of the studies and the results obtained:

- As a result of the measurements in the urban environment with a constant source of noise from the vehicles moving along N. Vaptsarov Blvd. it has been proved that: 1) the levels of acoustic discomfort at the zero point are highly elevated; 2) the acoustic discomfort levels gradually decrease inside the site.

- In the placement of children's areas and recreation areas, we should take into account the

factors of the environment in order to achieve maximum comfort for the users;

- Green plantations fulfill the functions of a sanitary barrier between the street lane and the territory of the inspection, but their appearance, physiological condition, longevity, other morphological features and the need for maintenance, determine the degree of their impact on the urban environment.

- Traditional methods for designing green spaces, parks, recreation areas to provide the necessary level of therapeutic potential should be examined in more detail with regard to the existing environment.

- The degree of concentration of the phytomass, the surface layer of the soil and the thickness of the layer of fallen leaves contribute to the increase in the noise protection of the green areas;

- Additional landscaping is required to reduce noise, site isolation, play and recreation spaces;

- Additional landscaping is required to increase color and attractiveness;

- It is imperative to reduce the vandalism by rising the sloping and cleansing of poor-quality vegetation, as well as those in not good condition according to expert evaluation.

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