Report on Phase 1 of Strategic Environmental Assessment for Dedicated Spatial Plan of Wind Power Plants, including Pre-selected Locations in Põhja-Pärnumaa Parish

Prepared by **Kobras OÜ in November 2024**

Ordered by **Local Government of Põhja-Pärnumaa Parish**

Translated by **NPO For Nature and People (MTÜ Looduse ja Inimeste Eest) with the assistance of AI translator (ChatGPT)**

4.6 IMPACT ON HUMAN HEALTH AND WELL-BEING

4.6.1 Noise

Noise is an unpleasant, disturbing, or otherwise health- and well-being-damaging sound. It is one of the most common and significant factors that degrade the quality of the living environment. Noise affects health and well-being in various ways—it can interfere with or make working, communication, and resting difficult, cause permanent ear damage leading to hearing impairment, induce stress, or trigger various functional disorders.
The transmission of noise to the affected object depends on wind speed and direction, air humidity, and thermal stratification. The propagation of sound waves in the near-ground atmospheric layer is significantly influenced by the terrain characteristics, particularly the nature of the surface—topography, vegetation, water bodies, and buildings.

4.6.1.1 Construction Noise

Noise associated with the construction of WPP's is similar to that of typical construction activities. Considering that all potentially suitable areas are located at least 1 km away from the nearest residence, it is unlikely that significant construction-related noise disturbances will occur for people.

4.6.1.2 Operational Noise

The noise sources in WPP's can be divided into two categories:

- Mechanical noise generated by the gearbox, motor, and other mechanisms of the wind turbine.
- Aerodynamic noise created by the rotor blades moving through the air.

Modern wind turbines have been designed with considerable attention to noise reduction. Mechanical noise has been significantly minimized through the use of various insulation materials and technical solutions. Similarly, technical measures have been implemented to reduce aerodynamic noise. However, since these are large technical devices, some level of noise emission is inherent during the operation of wind turbines.

The assessment of operational noise from wind turbines was conducted based on the **Atmospheric Air Protection Act** and the **Minister of the Environment Regulation No. 71 of 16 December 2016** on "Limit values for noise transmitted in ambient air and methods for measuring, determining, and assessing noise levels."

Wind turbine noise is classified as industrial noise.

According to the Atmospheric Air Protection Act, the limit values for noise transmitted in ambient air are as follows:

1. **Noise limit value** – the maximum permissible noise level, exceeding which causes significant environmental disturbance and necessitates the implementation of noise reduction measures.
2. **Target Noise Level** – the maximum permitted noise level for areas designated under new general plans.

For residential areas, the **noise limit value** for industrial noise is 60 dBA during the day and 45 dBA at night. The **target value** is 50 dBA during the day and 40 dBA at night.

A newly planned area, as defined in Regulation No. 71, is a previously undeveloped noise-sensitive area located outside densely populated or compactly built-up areas. The Ministry of the Environment has provided guidance (Ministry of the Environment, 2021b) and positions (letter No. 7-15/21/3300-2 dated 13.09.2021) recommending that WPP planning adhere to noise limit values. However, the Supreme Court has determined that WPP projects should comply with target values (referred to as "design values" in applicable legislation) (Supreme Court ruling No. 3-3-1-88-15, 2016).

Since wind turbines operate continuously, and their noise can be considered more disturbing than some other types of industrial noise, it is recommended that WPP plans and projects aim to achieve the **nighttime target value** of 40 dB in residential areas. This means that the total noise emitted by the entire WPP, not just an individual turbine, must not exceed 40 dB.

It is important to note that noise limit values apply to the average noise level during the day (7:00–23:00) and night (23:00–7:00). However, noise assessments for WPP's are based on worst-case scenarios, assuming turbines operate continuously.

It should also be noted that there is a distinction between noise levels exceeding regulatory limits and noise levels causing annoyance. Noise standards are designed to ensure noise levels do not harm human health. This does not mean that the noise source will be inaudible. In the case of annoyance, the noise source is audible and may be unpleasant, but it does not constitute a health-threatening situation. The perceived annoyance of noise depends significantly on individual perception. Various studies have proposed 35 dB as the annoyance threshold for WPP noise (Schmidt et al., 2014). However, as mentioned, individual sensitivity to wind turbine noise varies.

The noise generated by turbines depends on wind strength. With weaker winds, the rotational speed of the turbine is lower, resulting in a lower noise level. As wind speed increases, the rotational speed rises, but natural ambient noise also increases, partially masking the turbine noise.

For new plans, wind turbine noise is assessed through computational modeling. In this case, the specialized software **WindPRO 3.6** was used. The calculations were based on the international standard ISO 9613-2: "Acoustics – Attenuation of sound propagation outdoors, Part 2: General method of calculation," which is the recommended industrial noise calculation method for European Union member states without national calculation methods (European Parliament and Council Directive 2002/49/EC, 25 June 2002, concerning the assessment and management of environmental noise). This standard is widely used for evaluating noise propagation from WPP's globally.

Estonia has not established detailed requirements for input parameters in wind turbine noise modeling. In this case, noise propagation was modeled under unfavorable conditions – with a tailwind maximally favorable for noise transmission in all directions. According to technical data from turbine manufacturers, turbine noise emission typically increases up to wind speeds of 7–8 m/s. Additionally, at wind speeds above 8 m/s, natural wind noise begins to mask turbine noise.

The **WindPRO** calculation software allows for noise propagation assessments at various wind speeds; in this study, the worst-case conditions were considered.

The worst-case wind speed was used, meaning that noise maps were presented for conditions where noise levels were at their maximum (the program's automatic "Highest noise value" setting was applied). Noise modeling was conducted at a height of 2 m above the ground (the standard "ear" height used in Estonia for creating national noise maps). The calculation grid resolution was set at 10 m.

The meteorological coefficient was set to 1, and the ground roughness factor was set to 0.5 for the entire area. The terrain data were imported into the model based on elevation data from the Estonian Land Board (5 m resolution digital elevation model). Atmospheric conditions were modeled using WindPro's default settings (temperature 10°C and 70% humidity).

Objects that could directly block noise propagation, such as trees and forest areas, were not considered in the modeling. Similarly, existing buildings were not designated in the program as noise-blocking objects. In reality, if forest patches or auxiliary buildings lie between turbines and receptors, the actual noise levels experienced will be lower than those shown in the calculations. Therefore, the daily noise levels caused by the turbines are expected to be lower than the modeling results.

Considering research findings that wind turbine noise is inherently more disturbing than, for example, traffic noise, and the fact that ISO 9613-2 is not explicitly designed for noise assessments over long distances, a conservative approach to WPP noise assessments is justified.

Noise maps were created to depict A-weighted equivalent sound pressure levels **LpA,eq** in decibels, presented in 5 dB noise intervals. Noise levels at specific residential areas within the affected zone were not calculated (no receptor points were assigned). A more detailed noise assessment for each residential area within the impact zone is appropriate for the next phase of the special plan (e.g., detailed design or construction project preparation), once specific turbine locations are known.

In collaboration with stakeholders, the maximum potential number of turbines and their locations in potentially suitable areas were forecasted (illustrations in Schemes 72–74) to conduct noise modeling. The maximum number of turbines for each area is provided in **Table 12**. The turbine locations at this pre-selection stage are illustrative and will be refined in the next phase of the special planning process (detailed design or construction project preparation).

The noise map was created for a scenario in which all suitable areas under the Põhja-Pärnumaa Parish special plan were developed, accounting for potential cumulative impacts.

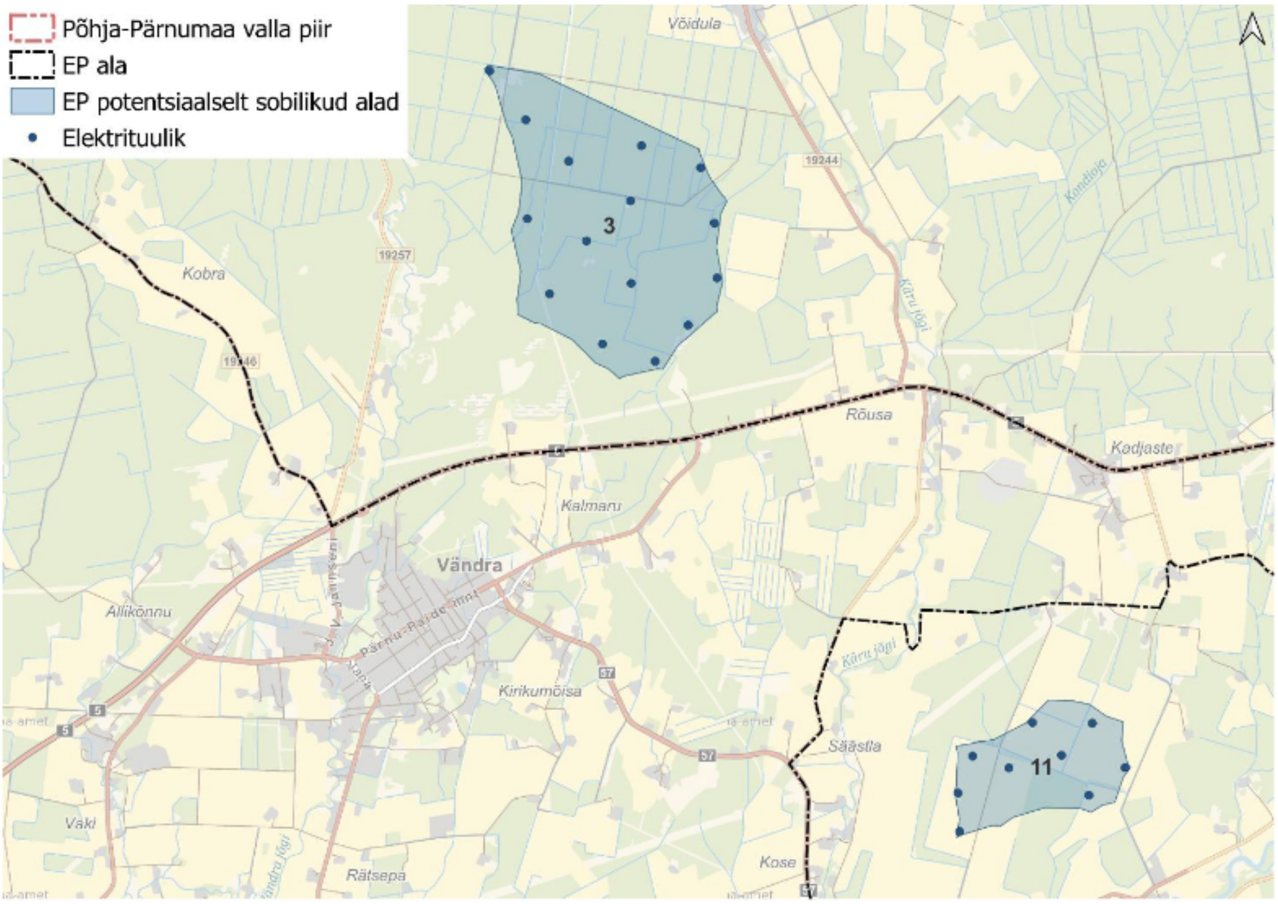
As input for noise modeling, a theoretical wind turbine with an emitted noise level of **108 dB** was used for potentially suitable areas under the special plan. According to the WindPro database, modern turbines generally do not emit such high noise levels; most turbine models have emitted noise levels between **105–107 dB**. As an exception, for the area marked as No. 11 in Schemes 72 and 73, an emitted noise level of **106 dB** was considered. The theoretical rotor diameter was assumed to be **180 m**, and the tower height was **200 m**.

The noise level is not directly dependent on the size of the turbine. Rather, for turbines with the same noise emission, the noise level reaching residential areas is somewhat lower for taller turbines, as the distance is greater.

Tabel 12. Lubatud maksimaalne tuulikute arv eriplaneeringu potentsiaalselt sobilikel aladel.

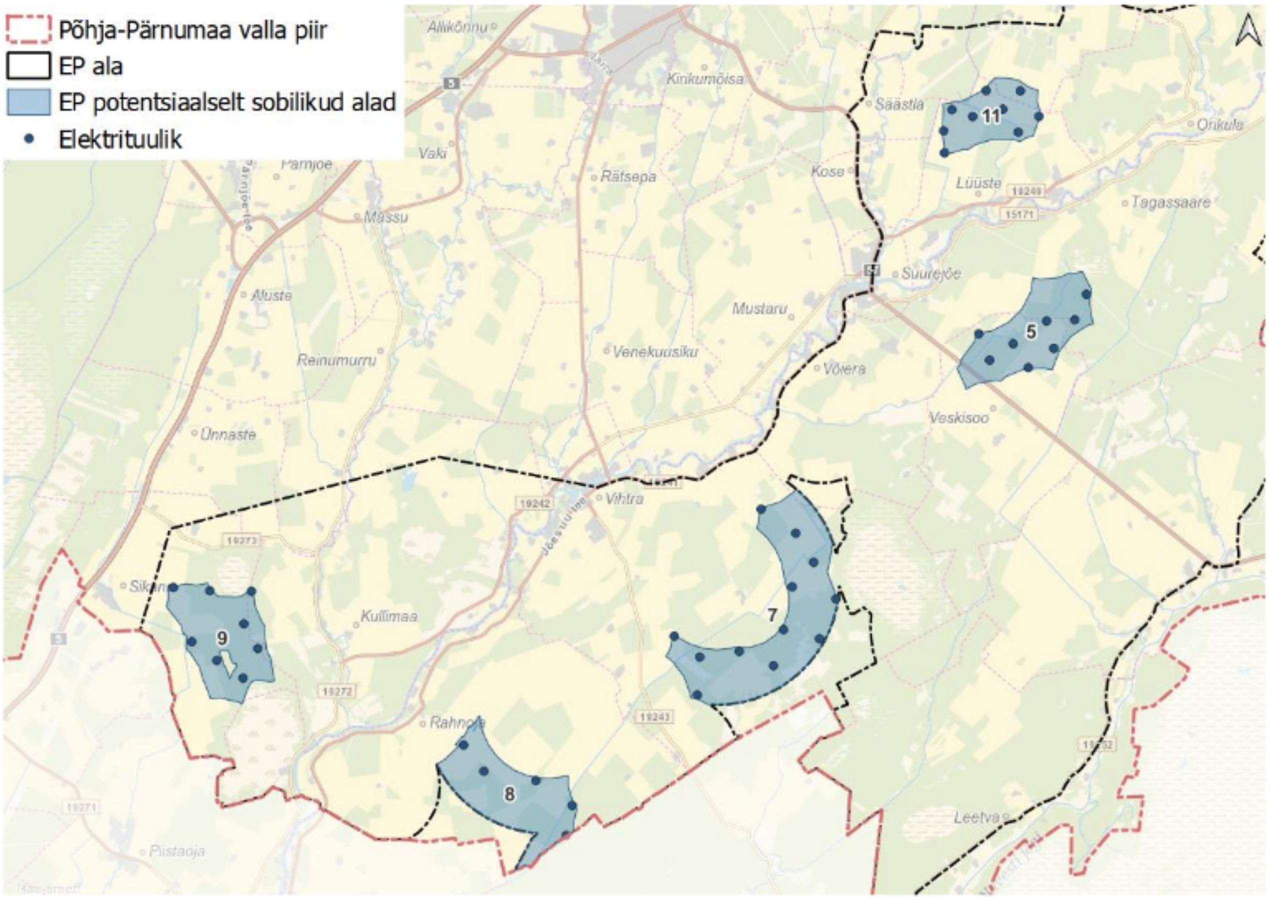
Pos nr	3	5	7	8	9	10	11	12
Maksimaalne tuulikute arv	15	8	12	5	8	8	9	9

Table 12. Allowed maximum amount of IWT's on special planning suitable areas



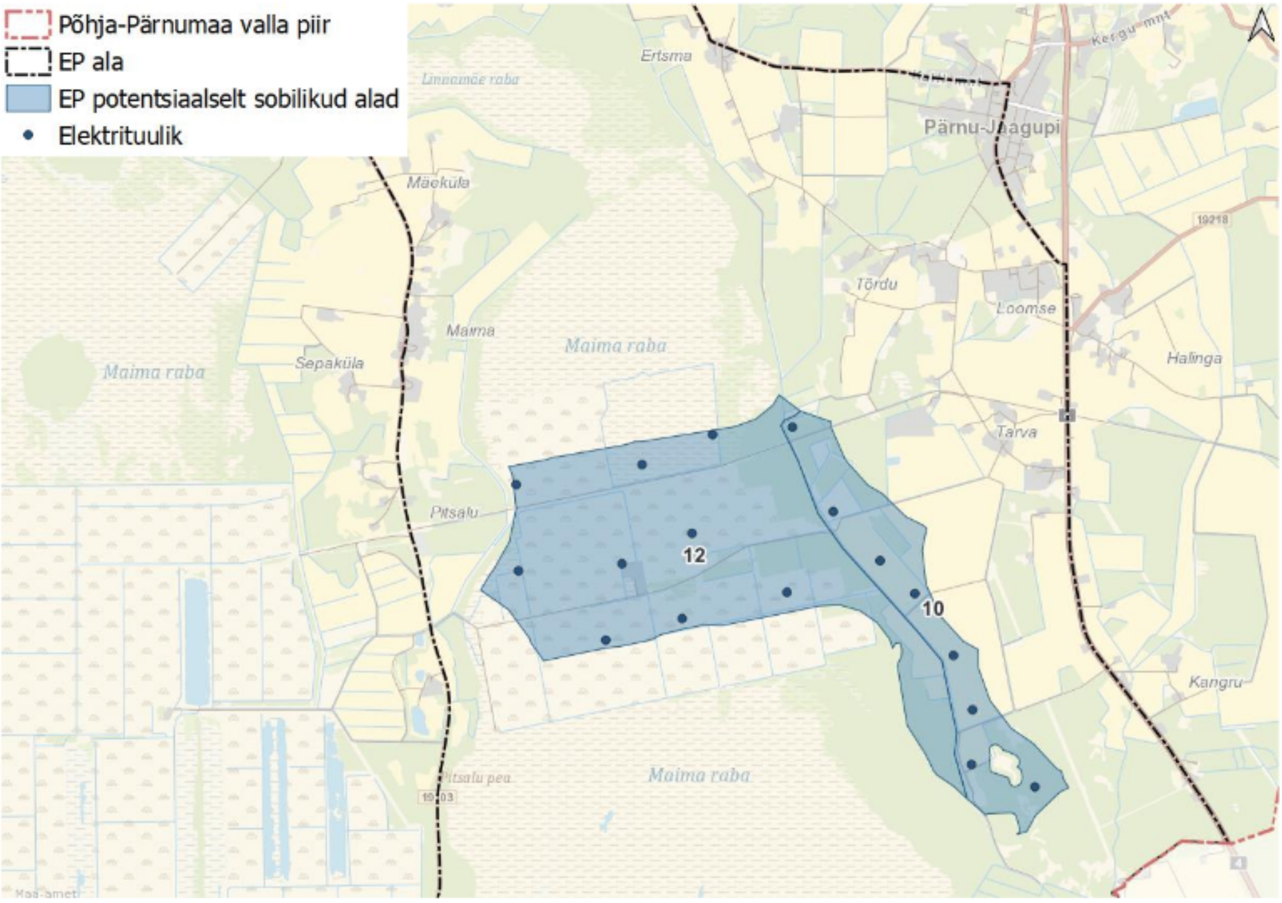
Skeem 72. Tuulikute arv ja võimalik paiknemine eriplaneeringu potentsiaalselt sobilikel aladel.

Scheme 72. Number of wind turbines and their potential locations in the areas deemed suitable under the special plan.



Skeem 73. Tuulikute arv ja võimalik paiknemine eriplaneeringu potentsiaalselt sobilikel aladel.

Scheme 73. Number of wind turbines and their potential locations in the areas deemed suitable under the special plan.



Skeem 74. Tuulikute arv ja võimalik paiknemine eriplaneeringu potentsiaalselt sobilikel aladel.
Scheme 74. Number of wind turbines and their potential locations in the areas deemed suitable under the special plan.

Additionally, a noise map was created for a scenario where, in addition to the areas planned under Põhja-Pärnumaa Parish special plan, the areas designated by the Tootsi Suursoo WPP thematic plan and the Tori Northern Area special plan, as well as the development areas P7, P9, P10, P11, and P25 from the Pärnu County Wind Energy Thematic Plan, are fully realized (see Scheme 75 and Table 13). For the Tori Northern Area special plan, theoretical turbines with a rotor diameter of 180 meters and a tower height of 200 meters were used in noise modeling.
According to the Pärnu County Wind Energy Thematic Plan, the rotor diameter of turbines in development areas P7, P9, P10, P11, and P25 was set at 180 meters, with a tower height of 160 meters. For both plans, the noise emission of turbines was considered to be 108 dB(A). As an exception, for area P9, a noise level of 106.9 dB(A) was used, based on the detailed plans for the P9 and P10 WPP's.

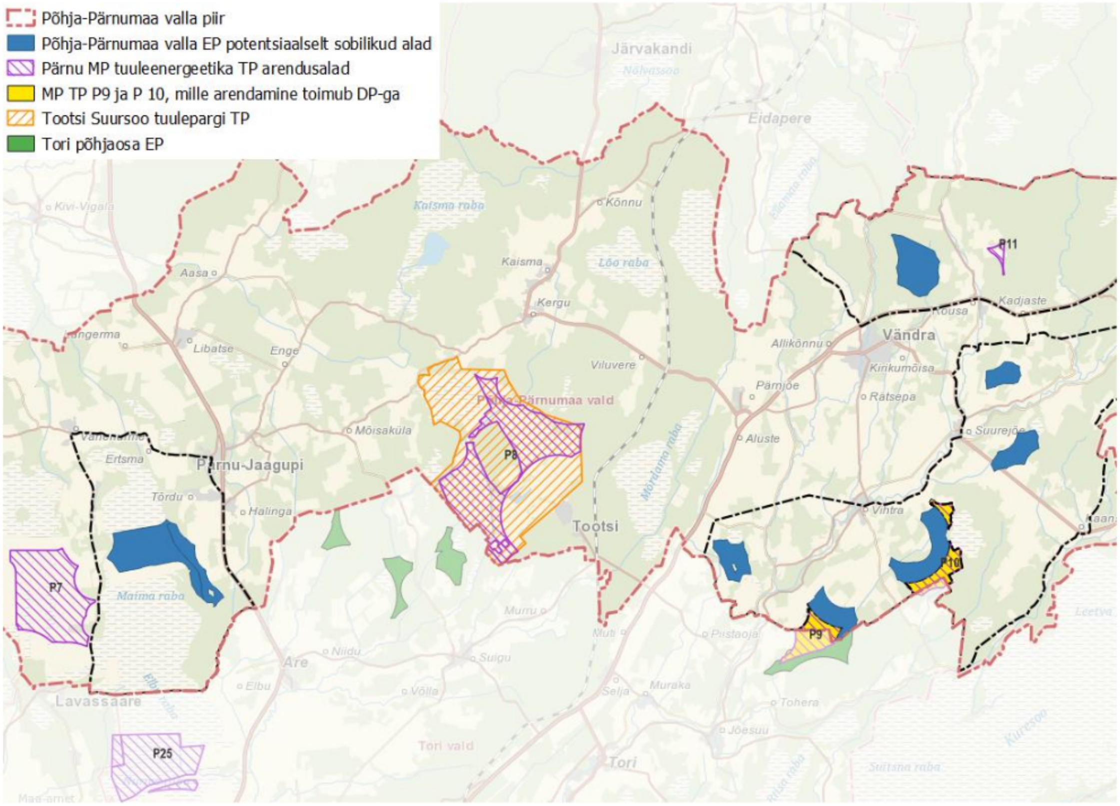
Regarding the Tootsi Suursoo WPP, it is known that Nordex turbines are planned to be used, with a rotor diameter of 163 meters and a height of 164 meters. The noise emission level of a Nordex turbine is 106.4 dB(A). The results of the noise modeling are presented in Appendix 3.

Tabel 13. Müra modelleerimisel aluseks võetud tuulikute arv teiste planeeringute puhul.

Planeering	Tootsi Suursoo tuulepargi TP	Tori põhjaosa EP	P7	P9	P10	P11	P25
Tuulikute arv	38	23	23	11	9	2	18

Table 13. Basis for noise modelling based on the amount of IWT's from other plannings

Planeering – planning
Tuulikute arv – Amount of IWT's



Skeem 75. Eriplaneeringu potentsiaalselt sobilike alade paiknemine koos teiste Põhja-Pärnumaa vallas ja selle läheduses planeeritavate tuulepargialadega.

Scheme 75. Locations of areas potentially suitable under the special plan, alongside other planned WPP areas within and near Põhja-Pärnumaa Parish.

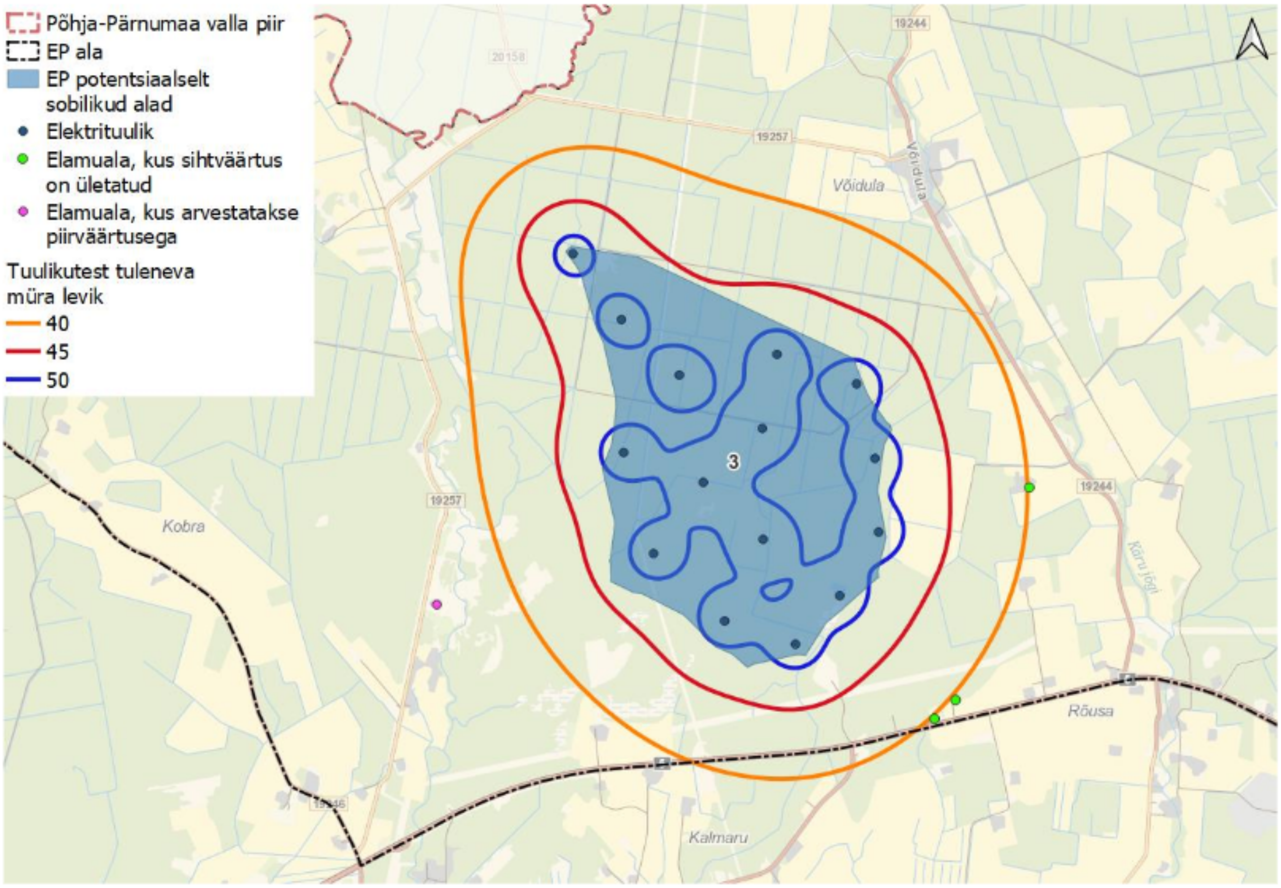
Results

Noise modeling revealed that if all areas are developed to the maximum extent indicated in Table 12, the nighttime noise target value (40 dB) may potentially be exceeded (or reached) in residential areas surrounding potential suitable area no. 3 (see Scheme 76). For the other potential suitable areas (5, 7, 8, 9, 10, 11, and 12), no exceedance of the nighttime noise target value in residential areas was observed.

In this case, residential areas where the noise limit value is applied instead of the target value due to agreements with landowners were not considered in the analysis. For all areas, the nighttime noise limit value (45 dB) is ensured in residential areas.

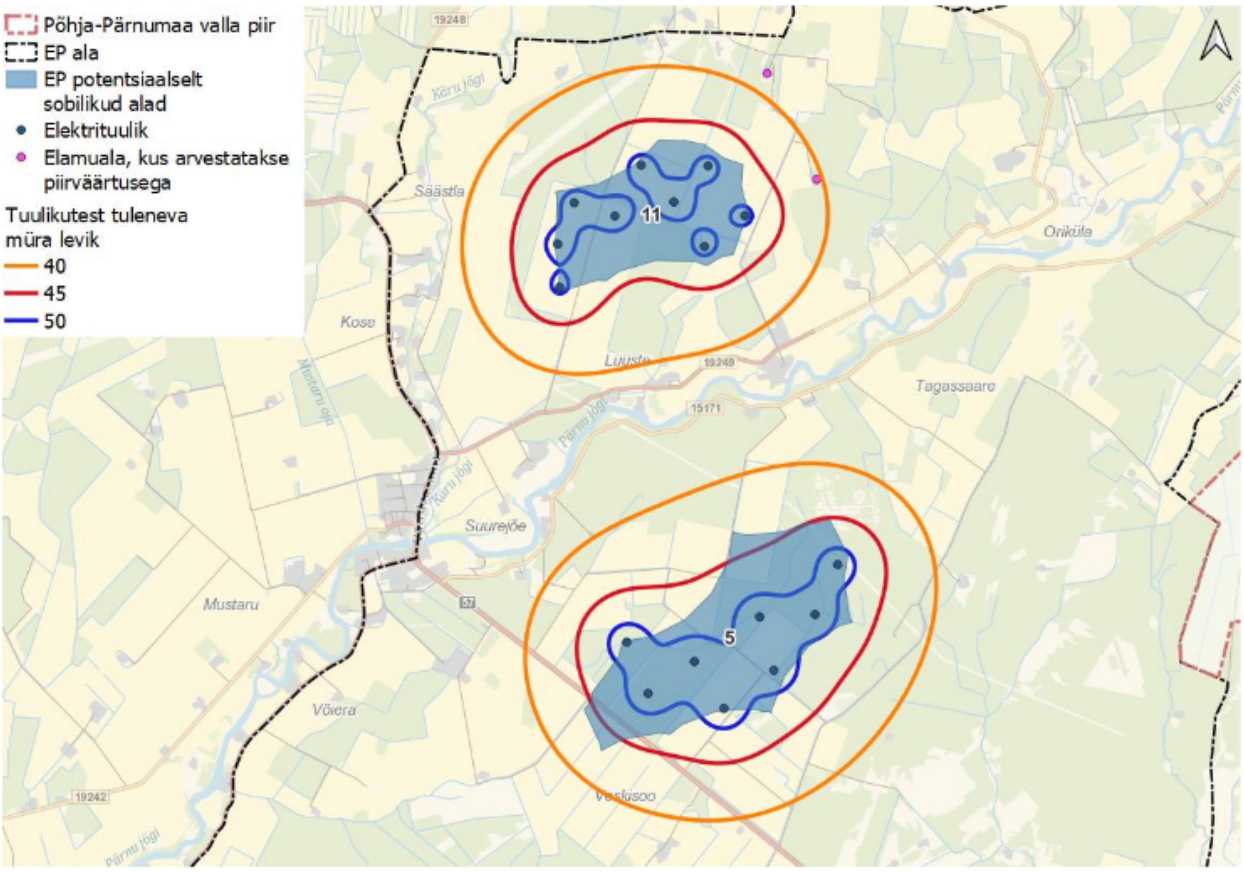
In the development of potential suitable area no. 3, the nighttime noise target value is exceeded (or reached) in 3 residential areas. Residential areas are defined as land designated for residential purposes and the yard areas of residences located on agricultural land.

In a scenario where all potential suitable areas within the Põhja-Pärnumaa Parish special plan are developed, cumulative noise effects occur between areas 10 and 12. The remaining areas are located sufficiently far apart to avoid cumulative noise impacts. Despite the cumulative effect between areas, the nighttime noise target value is not exceeded in residential areas.



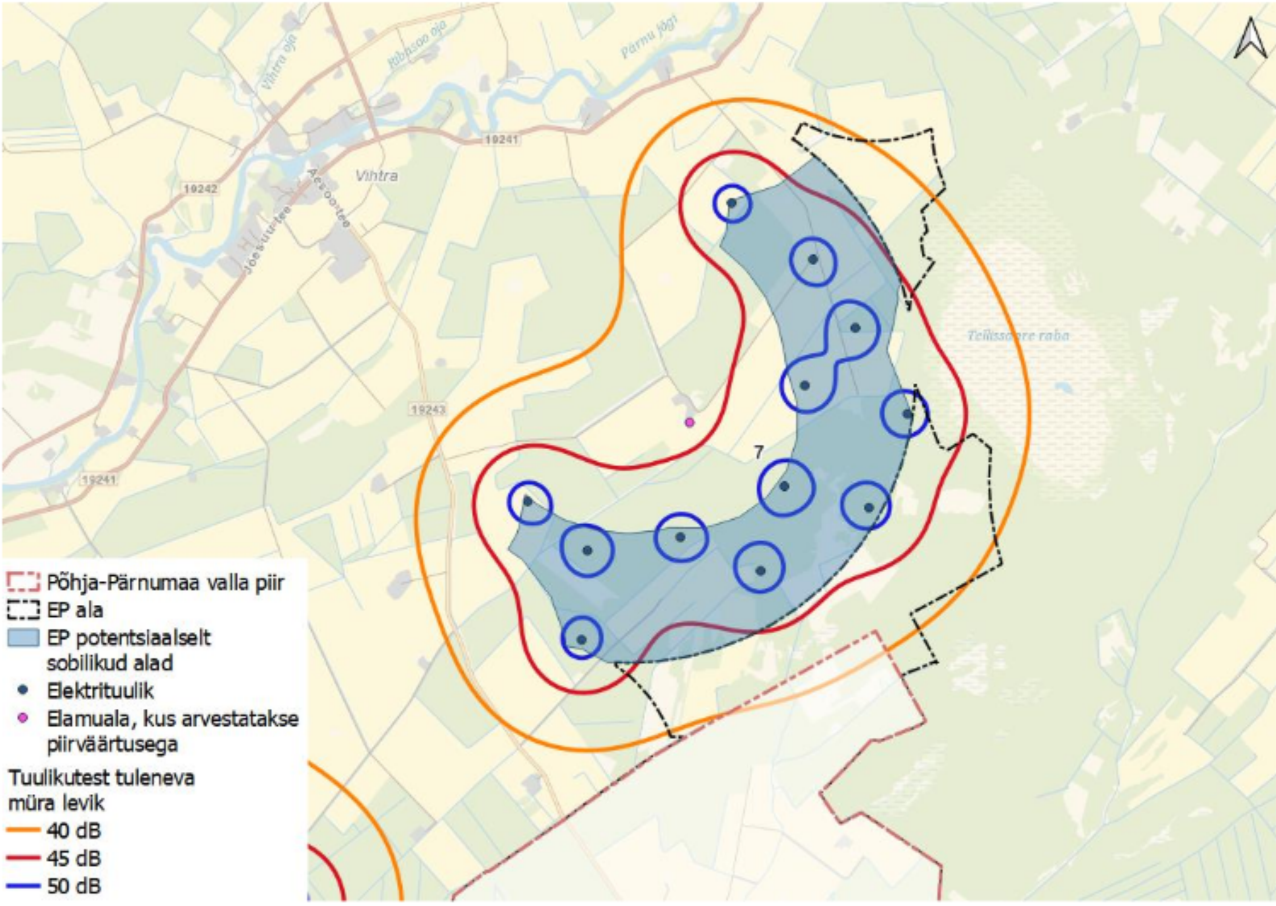
Skeem 76. Potentsiaalselt sobiliku ala 3 müra leviku modelleerimise tulemused tuulepargi maksimaalse arenduse korral.

Scheme 76. Noise propagation modeling results for Potentially Suitable Area 3 under the maximum development scenario of the WPP.



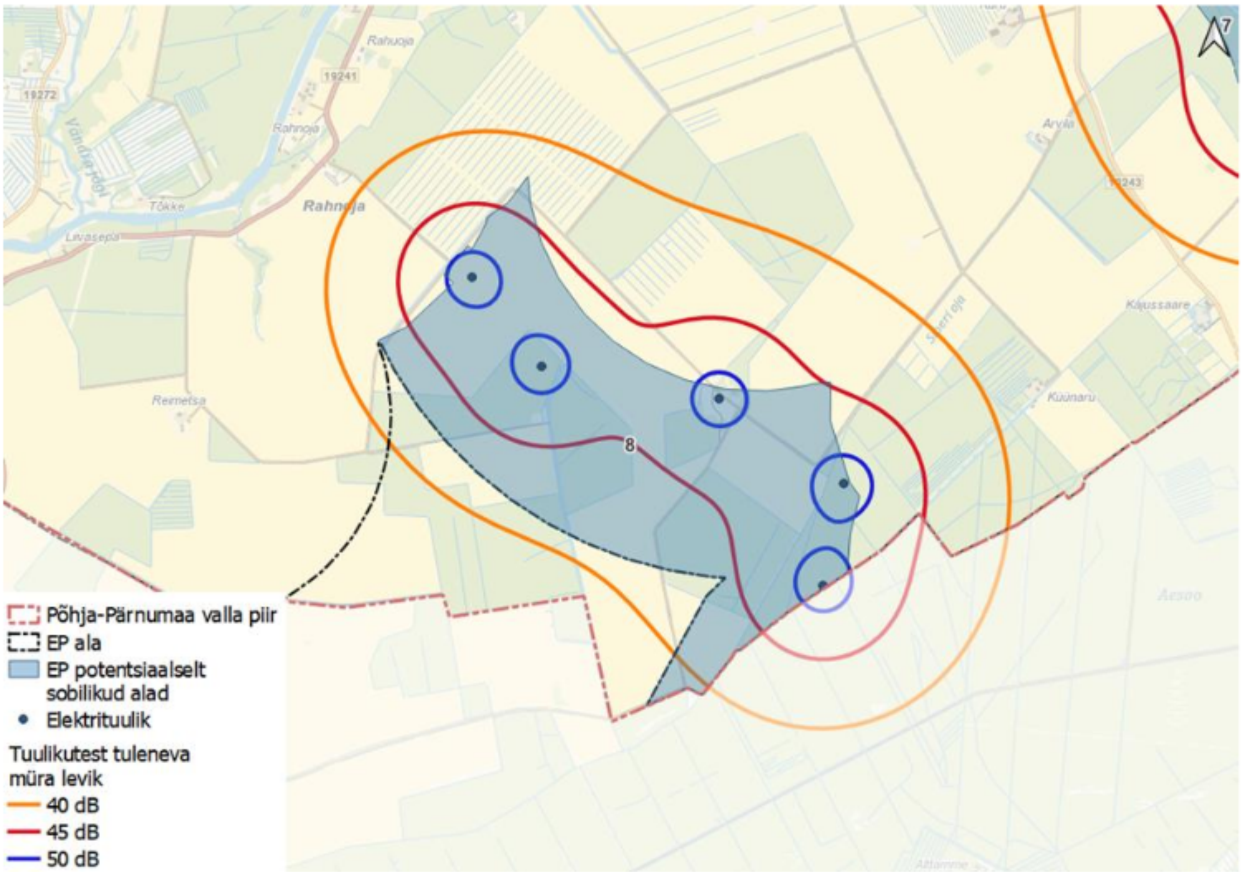
Skeem 77. Potentsiaalselt sobilike alade 5 ja 11 müra leviku modelleerimise tulemused tuuleparkide maksimaalse arenduse korral.

Scheme 77. Noise propagation modeling results for Potentially Suitable Areas 5 and 11 under the maximum development scenario of the WPP.



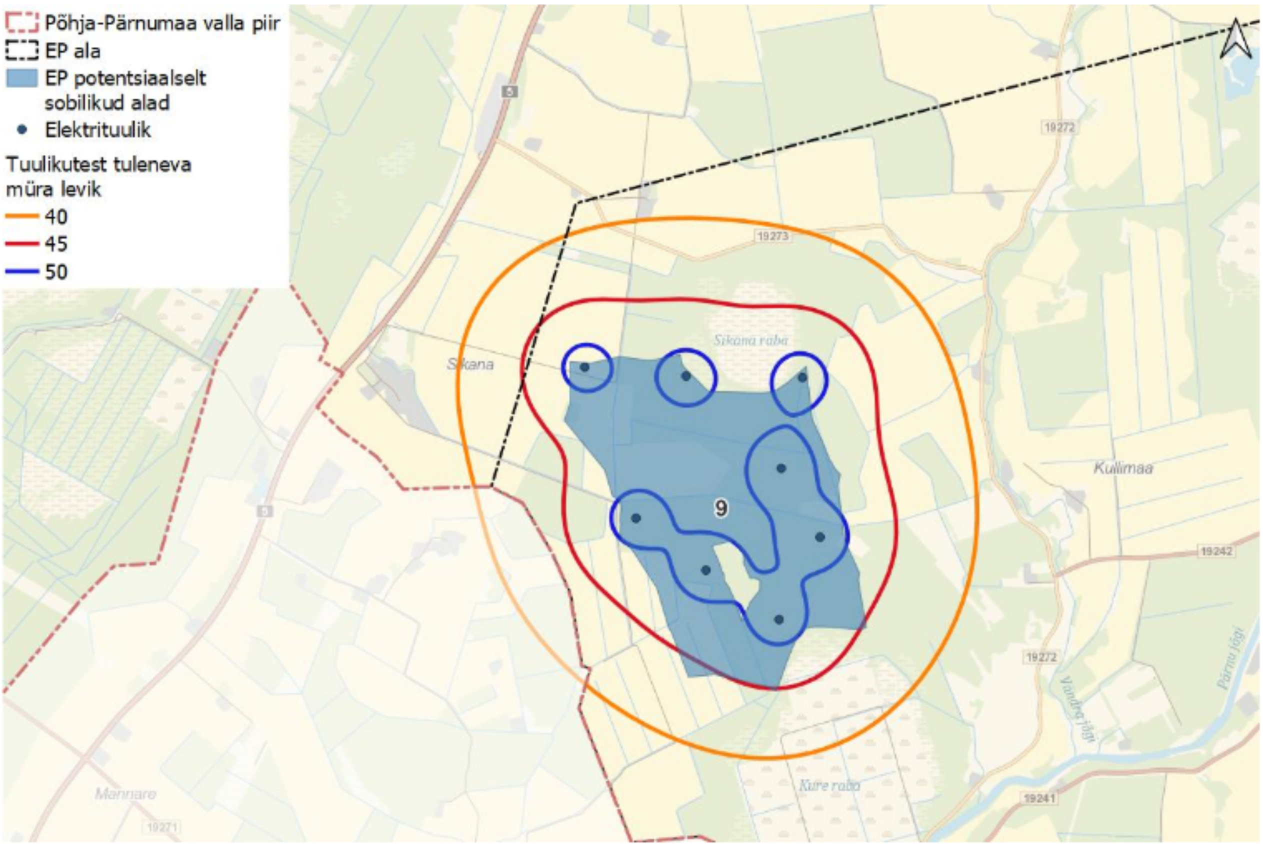
Skeem 78. Potentsiaalselt sobiliku ala 7 müra leviku modelleerimise tulemused tuulepargi maksimaalse arenduse korral.

Scheme 78. Noise propagation modeling results for Potentially Suitable Area 7 under the maximum development scenario of the WPP.



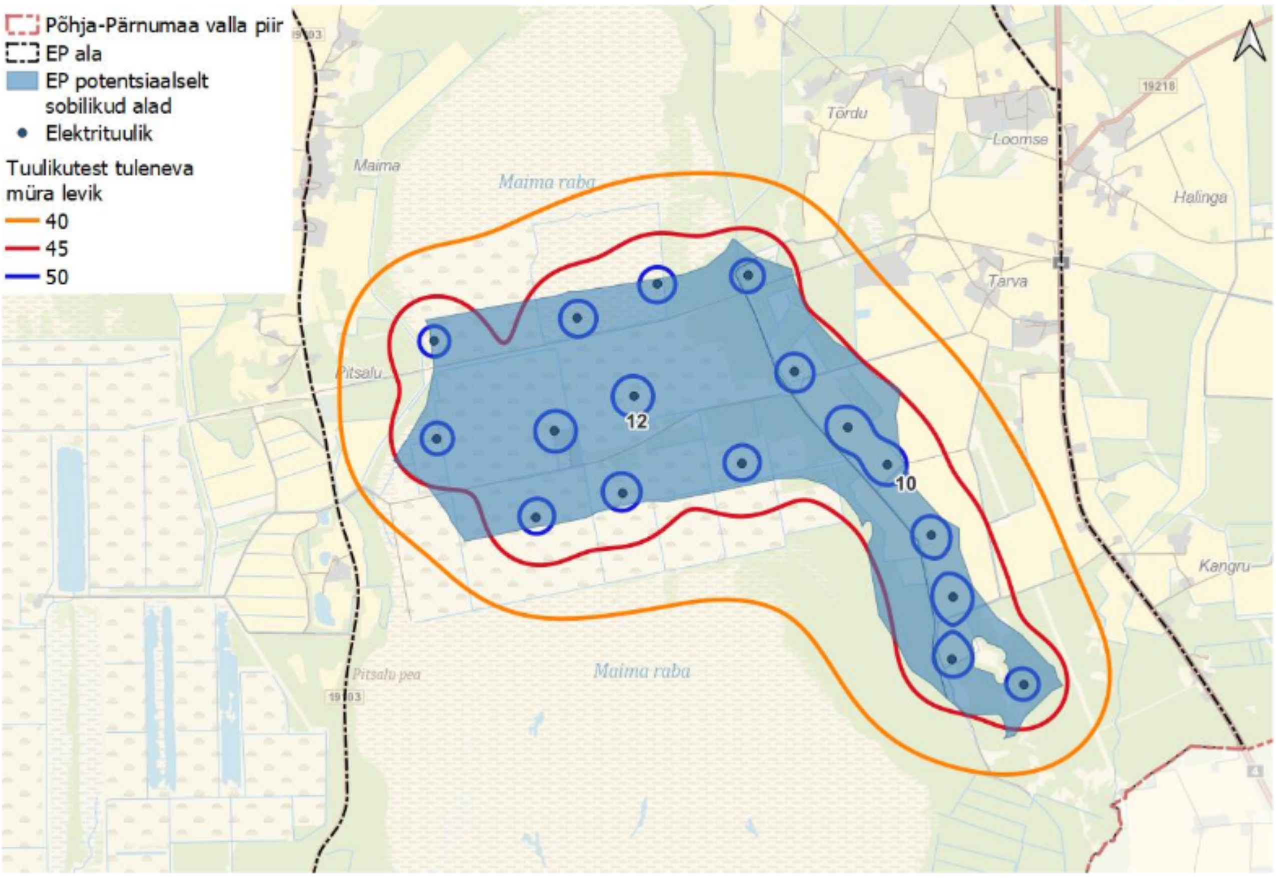
Skeem 79. Potentsiaalselt sobiliku ala 8 müra leviku modelleerimise tulemused tuulepargi maksimaalse arenduse korral.

Scheme 79. Noise propagation modeling results for Potentially Suitable Area 8 under the maximum development scenario of the WPP.



Skeem 80. Potentsiaalselt sobiliku ala 9 müra leviku modelleerimise tulemused tuulepargi maksimaalse arenduse korral.

Scheme 80. Noise propagation modeling results for Potentially Suitable Area 9 under the maximum development scenario of the WPP.



Skeem 81. Potentsiaalselt sobilike alade 10 ja 12 müra leviku modelleerimise tulemused tuuleparkide maksimaalse arenduse korral.

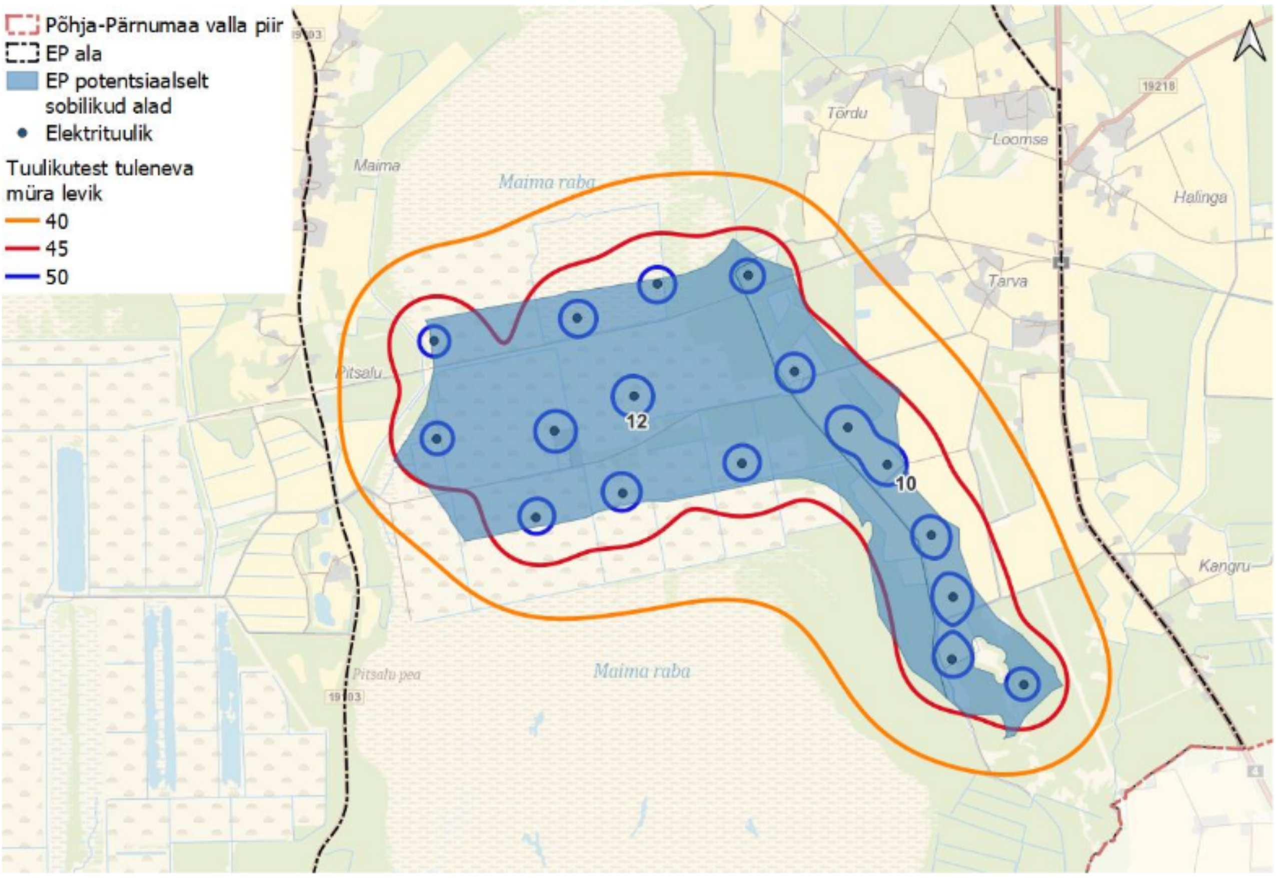
Scheme 81. Noise propagation modeling results for Potentially Suitable Areas 10 and 12 under the maximum development scenario of the WPP.

A noise map was created for the scenario where, in addition to the areas planned under the Põhja-Pärnumaa Parish's special plan, all other WPP areas planned within Põhja-Pärnumaa Parish and its vicinity are realized (Schemes 82–84). The map indicates two main regions where the cumulative impact of different plans worsens the noise situation: **Tellissaare Bog** and **Pitsalu Village Area**. In the Pitsalu Village area, cumulative impacts arise between potential suitable area 12 and development area P7 of the Pärnu County wind energy thematic plan, affecting approximately three residential areas (plots **Anni (18801:003:0075)**, **Annuse (18801:003:0136)**, and **Liiva (18801:003:0021)**).

In the Tellissaare Bog area, cumulative noise impacts occur between potential suitable areas 7 and 8 and development areas P9 and P10 of the Pärnu County wind energy thematic plan. When potential suitable area 7 and development area P10 are developed, the nighttime noise target value in Põhja-Pärnumaa Parish is exceeded for approximately five residential areas. Additionally, the combined impact of potential suitable area 8 and development area P9 results in the target value being exceeded for approximately two residential areas.

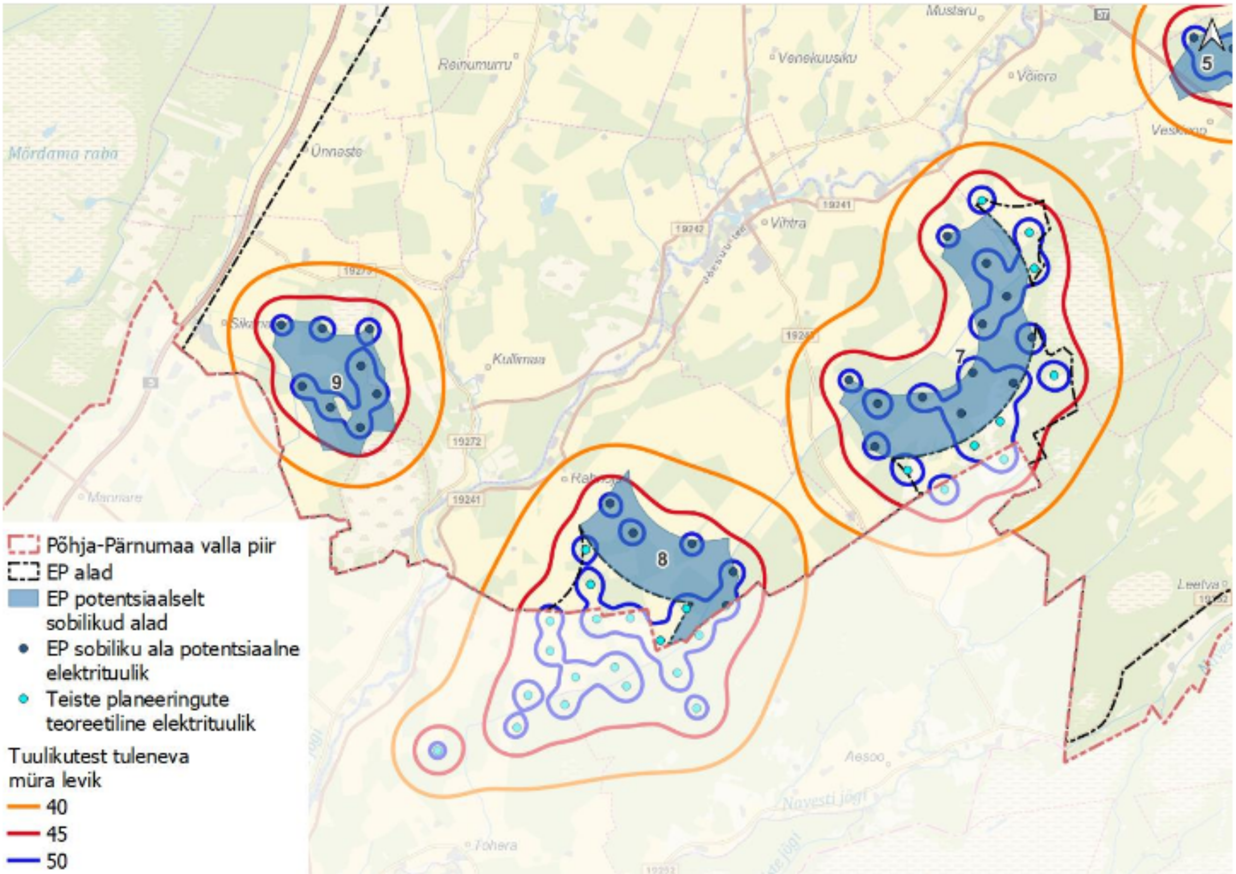
In such a case, the **Kruse cadastral unit (93005:002:0103)** may also experience an exceedance of the nighttime noise limit value applicable to residential land. Noise modeling results show that the 45 dB limit is barely met on the Kruse residential land area.

Exceeding the noise limit poses a risk to human health and constitutes a significant negative impact.



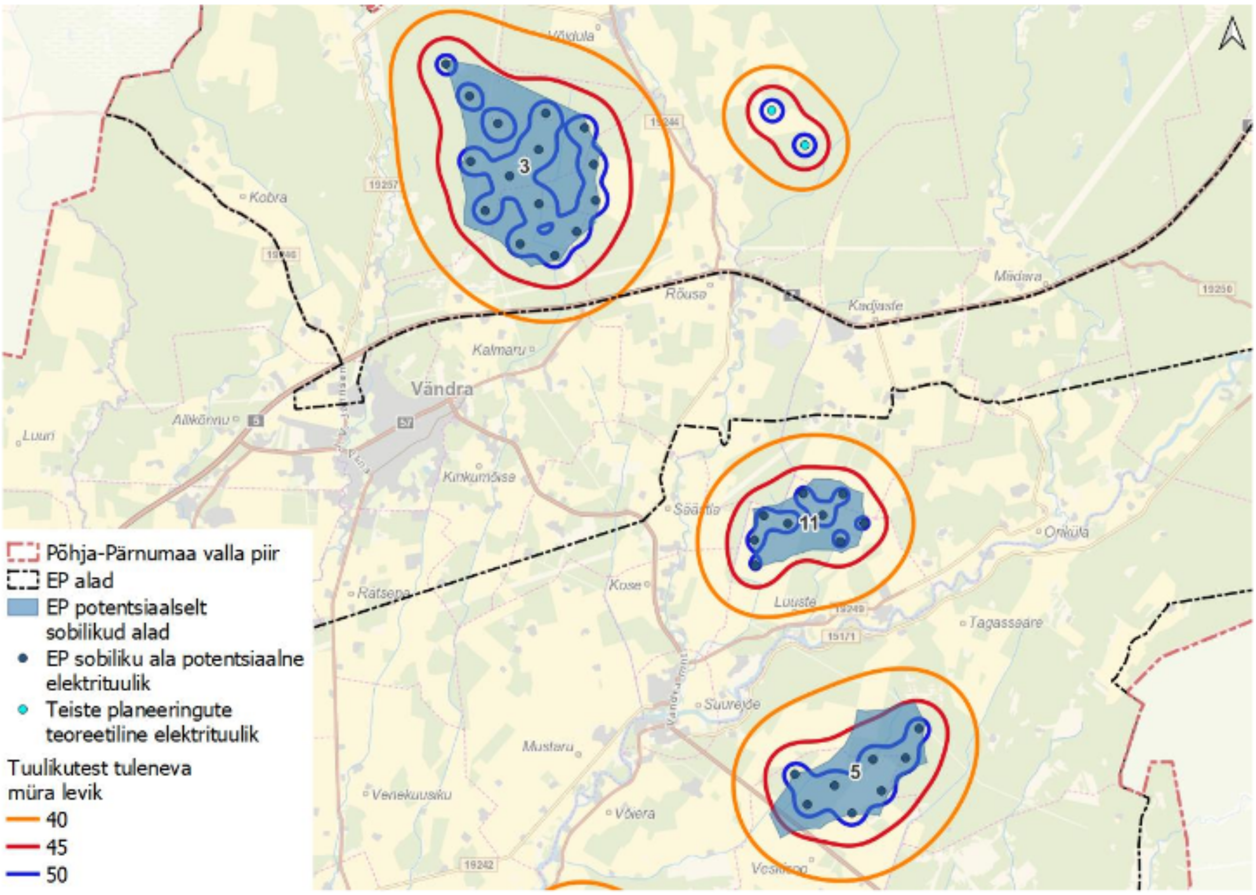
Skeem 81. Potentsiaalselt sobilike alade 10 ja 12 müra leviku modelleerimise tulemused tuuleparkide maksimaalse arenduse korral.

Scheme 81. Noise propagation modeling results for Potentially Suitable Areas 10 and 12 under the maximum development scenario of the WPP.



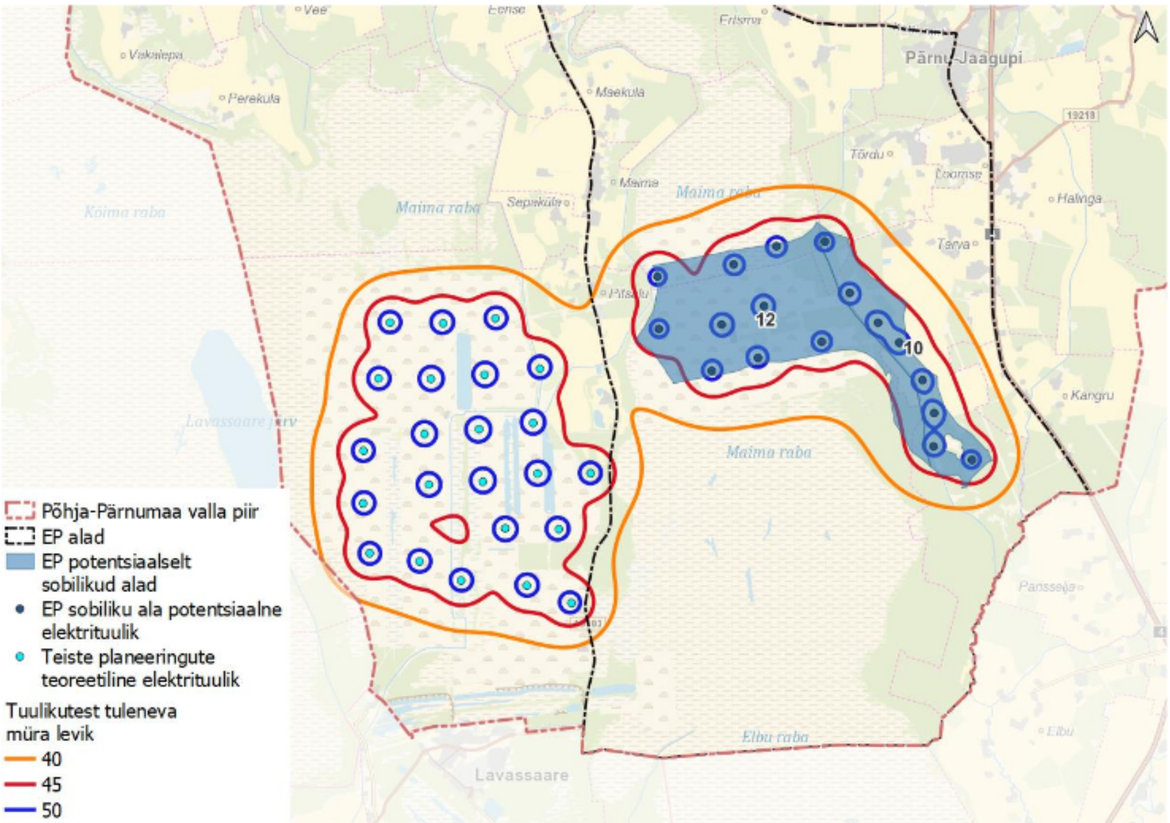
Skeem 82. Põhja-Pärnumaa eriplaneeringu potentsiaalselt sobilike alade ja teiste planeeringute tuulepargialade omavahelise kumulatiivse müra modelleeringu tulemused.

Scheme 82. Results of the cumulative noise modeling between the Potentially Suitable Areas of the Põhja-Pärnumaa Special Plan and WPP areas from other plans.



Skeem 83. Põhja-Pärnumaa eriplaneeringu potentsiaalselt sobilike alade ja teiste planeeringute tuulepargialade omavahelise kumulatiivse müra modelleeringu tulemused.

Scheme 83. Results of the cumulative noise modeling between the Potentially Suitable Areas of the Põhja-Pärnumaa Special Plan and WPP areas from other plans.



Skeem 84. Põhja-Pärnumaa eriplaneeringu potentsiaalselt sobilike alade ja teiste planeeringute tuulepargialade omavahelise kumulatiivse müra modelleeringu tulemused.

Scheme 84. Results of the cumulative noise modeling between the Potentially Suitable Areas of the Põhja-Pärnumaa Special Plan and WPP areas from other plans.

When considering the noise modeling results, it is important to recognize that the modeling did not account for noise-dampening objects, including vegetation. Several potential areas in the special plan are located in forested regions, which means that, in reality, the noise levels caused by wind turbines in residential areas are lower than what is reflected on the noise maps. Additionally, the noise from wind turbines has been overestimated in the modeling process.
The noise level near the closest noise-sensitive buildings largely depends on the placement of the turbines. For **potential area 3**, the residential areas where the nighttime target value is exceeded are marginally affected. Therefore, during the next phase of the special plan (preparation of a detailed solution or construction project), adjustments to the turbine locations can ensure compliance with the target value for these residential areas.

Since the turbine layout at the site pre-selection stage is indicative, a new noise level model must be conducted during the detailed solution or construction project phase of the special plan. This new modeling must be based on the actual planned turbine locations and the best available knowledge at the time regarding the calculation of wind turbine noise.

It must be ensured that only new (not used) turbines are utilized in the WPP's. Additionally, the noise emissions of the turbines placed in the area must not exceed **108 dB**, and for area **11**, this limit is **106 dB**. The turbine placement in the detailed solution or construction project of the special plan must be optimized to ensure that the nighttime target value for industrial noise is met on residential land, in accordance with the Minister of the Environment's regulation No. 71 of December 16, 2016.

Exceptions include the **Kruse cadastral unit (identifier: 93005:002:0103)** in **Vihtra village**, **Koiva (93002:004:0135)** in **Kadjaste village**, and **Uue-Auru (93002:004:0034)** in **Oriküla** (Geoportal of the Land Board, December 16, 2022). For these cadastral units, the nighttime **limit value** for industrial noise must be ensured. The owners of the **Koiva** and **Uue-Auru** cadastral units are given their consent to Enefit Green, which is interested in developing **area 11**, to install wind turbines at distances of **800 meters** and **600 meters** from residential buildings located on the cadastral units (800 meters for the **Koiva** cadastral unit and 600 meters for the **Uue-Auri** cadastral unit).

6.1.3 Low-Frequency Noise

The human hearing threshold begins at medium frequencies (500–4000 Hz) with a sound pressure level of 0–20 dB. For low-frequency ranges (0–200 Hz), the sound pressure must be significantly higher for the sound to be perceived—around 80 dB near 20 Hz and about 107 dB at 4 Hz. This principle must be considered when discussing the low-frequency noise impact of WPP's. Low-frequency components are present in most sounds, caused by both human-made sources (e.g., traffic) and natural sources (e.g., wind). For low-frequency sound to be disruptive or harmful to health, its sound pressure level is crucial.

Wind turbines, like many other sound sources, produce low-frequency sounds. However, current measurements and studies conducted at WPP's have not detected low-frequency sounds at levels where they would be audible or cause health effects. Studies to date indicate that the low-frequency sounds caused by wind turbines are at a level comparable to ordinary environmental background noise (Leventhall, 2006).

Low-frequency noise has consistently been a significant topic concerning wind turbines, as noise propagation can cover a large area. During propagation, the normal and higher frequency components of sound attenuate faster in air than low-frequency components (Hansen et al., 2017).

One of the most comprehensive studies on low-frequency noise related to wind turbines was conducted in Finland and published in English in 2020 (Maijala et al., 2020). The study, commissioned by the Finnish government, was carried out by the VTT Technical Research Centre of Finland. It combined long-term measurements (308 days) of sound levels at WPPs, as well as hearing tests and surveys among residents living near WPPs. The aim was to determine the characteristics of low-frequency noise produced by turbines and its potential effects on humans.

The study was prompted by complaints from some residents near WPPs, who attributed health issues—particularly sleep disturbances—to the presence of turbines. According to the study, 5% of residents near WPPs included in the survey (so-called "symptomatic respondents") associated their health problems with low-frequency noise from turbines. Most symptomatic respondents lived within 2.5 km of the WPP, which was defined as the near area in the study. Among these residents, 15% identified as symptomatic.

Measured low-frequency noise in WPP areas generally ranged between 0.1–1 Hz, which is below the human hearing threshold (16–20 Hz). The lower the sound frequency, the higher the sound pressure must be for the sound to be audible.

The study identified a new aspect: wind turbines can produce occasional low-frequency noise peaks (short bursts of sound pressure up to 102 dB). These peaks might theoretically be audible to some individuals. However, it could not be demonstrated that individuals who reported health effects attributed to wind turbines were better able to perceive low-frequency noise. Hearing tests attempted to detect nervous system responses to low-frequency noise among individuals reporting health problems, but no such connection was found.

No reactions in the nervous system or other physiological parameters of these individuals were observed when they were exposed to low-frequency noise from turbines.

The study also found that within a 1.5 km radius of a WPP, changes in the sound spectrum could be noted, resulting in a more "urban" profile—increasing the proportion of low-frequency noise in the frequency distribution. The resulting sound spectrum becomes very similar to that in urban environments.

The study concluded that low-frequency noise from wind turbines cannot be linked to the health effects reported by individuals. However, a hypothesis was raised that the fluctuation in the amplitude of the turbine sound could potentially be more significant than low-frequency noise itself. One of the most recent studies on turbine infrasound was published in 2023, which investigated the long-term impact of infrasound on human health. The Woolcock Institute of Medical Research in Australia studied how infrasound from wind turbines affected 37 healthy adults over a 72-hour period. During the experiment, participants were placed in a sleep laboratory where unique sounds were played to them, including infrasound levels that mimic the infrasound produced by wind turbines. A control group was also included in the study, which was not exposed to infrasound but was exposed to traffic noise. At the end of the three-day experiment, it was concluded that infrasound had no effect on various health indicators of the participants (e.g., sleep, blood pressure, balance, hearing, etc.) (Marshall et al., 2023).

The noise levels for low-frequency noise are set by the Minister of Social Affairs in Regulation No. 42 of 04.03.2002 "Noise Norms for Living and Recreation Areas, Residential Buildings, and Shared Buildings, and Methods for Measuring Noise Levels" (Annex, Table 14). The noise levels in the annex refer to the sound pressure levels for assessing the disturbance caused by low-frequency noise in living and sleeping areas of residential buildings, and equivalent spaces during the night. These are not outdoor norms, but rather those that apply inside buildings.

Tabel 14. Madalsagedusliku heli väärtused eluruumides.

1/3 oktaavriba kesksagedus, Hz	10	12,5	16	20	25	31,5	40	50	63	80	100	125	160	200
Helirõhutase Lp,eq, dB	95	87	79	71	63	55,5	49	43	41,5	40	38	36	34	32

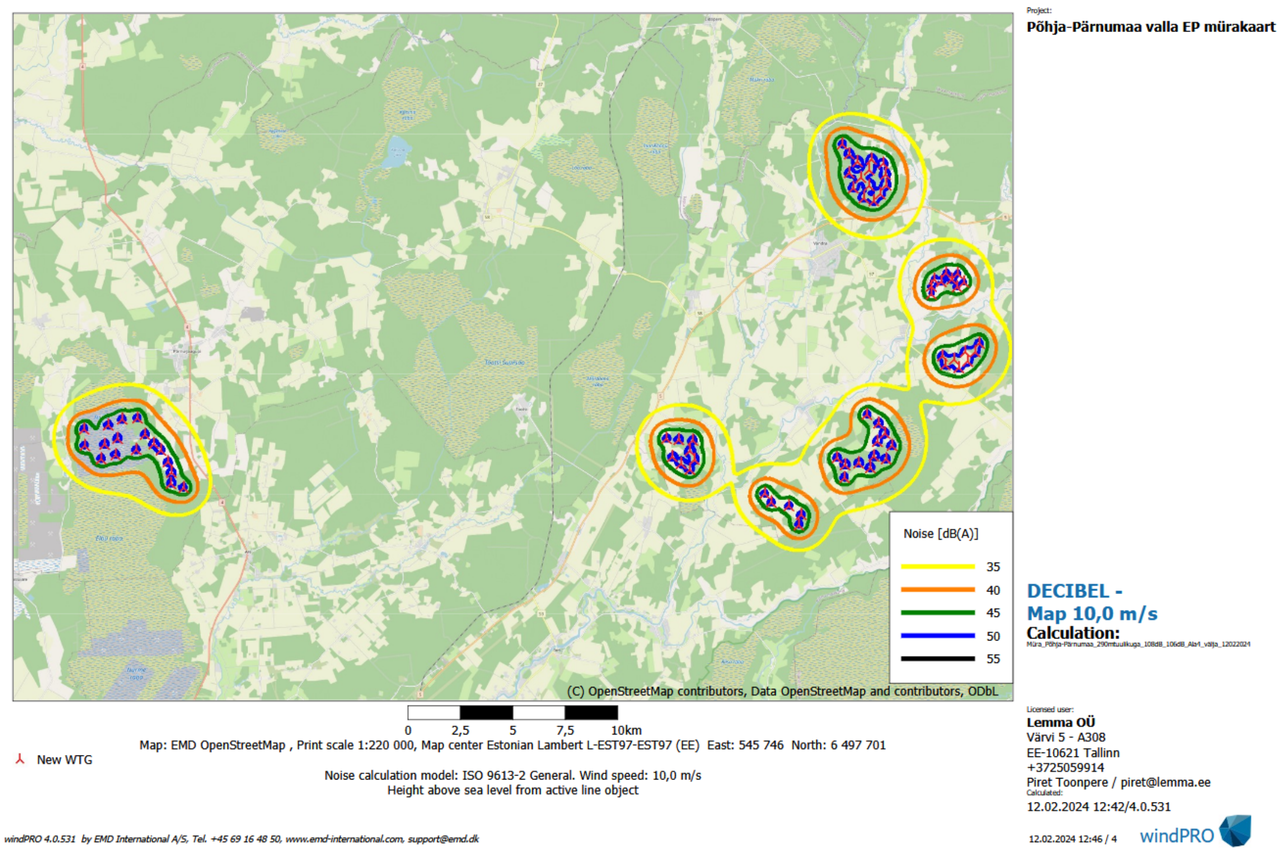
Tabel 14. Low frequency noise values inside living quarters.

1/3 oktaaviriba kesksagedus Hz – 1/3 of octave band center frequency.

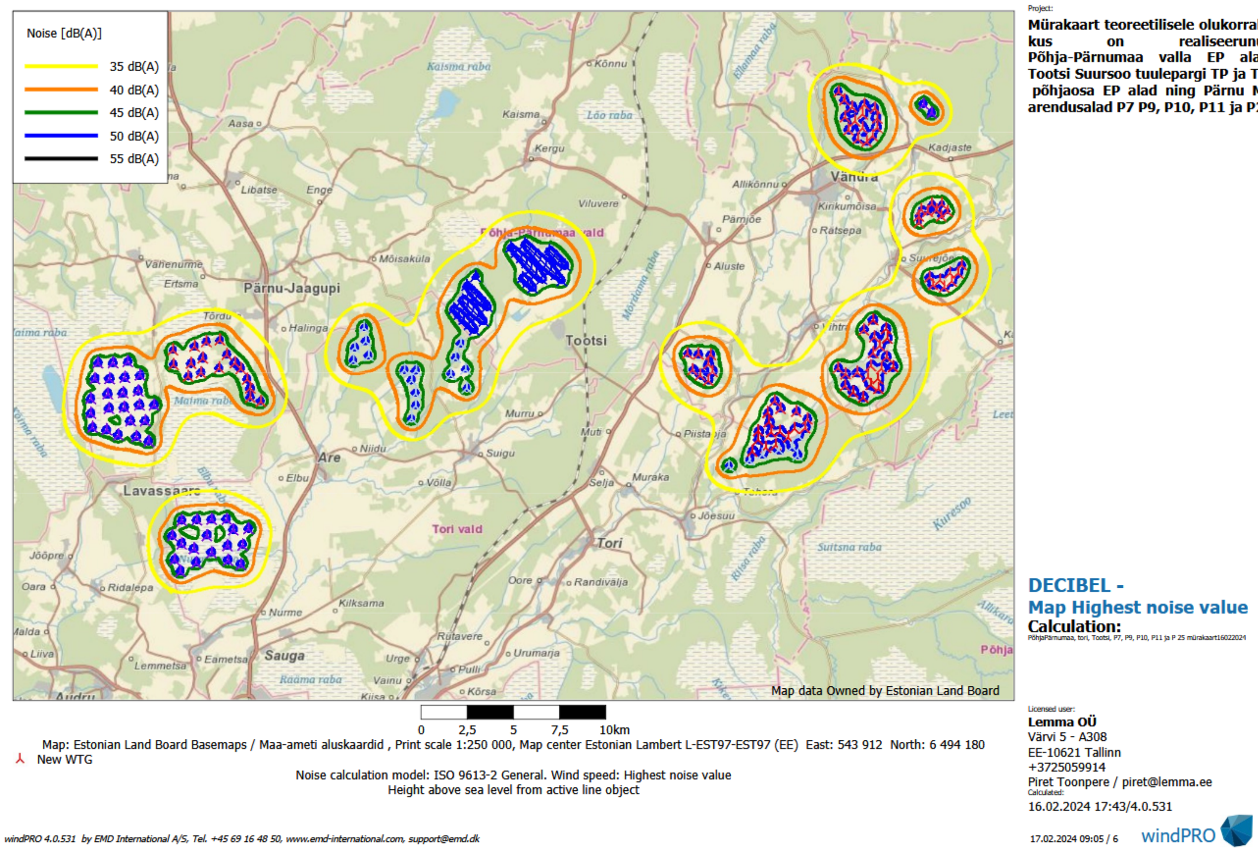
Helirõhutase - SPL

In Estonia, there are no national guidelines on how to calculate the propagation of low-frequency noise from wind turbines and its compliance with the values applicable in indoor spaces. However, in Finland, such an assessment guideline exists (Ympäristöhallinnon Ohjeita 2, 2014). Based on low-frequency noise modeling for other WPPs using this guideline, it has been found that at a distance of 1 km from the wind turbines, residential areas are not expected to exceed the recommended low-frequency noise value in living spaces (LEMMA OÜ, 2022). In this case, the potentially suitable areas are located at least 1 km away from residential buildings, so it can be assumed that the low-frequency noise values in living spaces are ensured.

Annex 3



Special planning noise map of Põhja-Pärnumaa Parish.



"Noise map for a theoretical scenario where the areas of Põhja-Pärnumaa Parish's special plan (EP), Tootsi Suursoo WPP (TP), and the northern part of Tori's special plan (EP), as well as the development areas P7, P9, P10, P11, and P2 of the Pärnu County plan (MP), have been realized."