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Vesterhav Syd Wind Farm

**Noise Impact Assessment,
Following Bekendtgørelse nr. 135 07/02/2019**

27. APRIL 2020



Vesterhav Syd

RECIPIENT

Vattenfall Vindkraft
RU204A
SE-962 80
Jokkmokk

Attn. Merete Bertelsen

DATE

27 April 2020

PREPARED BY

EMD International A/S
Niels Jernes Vej 10
DK- 9220 Aalborg
T: + 45 96 35 44 44
E: emd@emd.dk

PRINCIPAL CONSULTANT

Thomas Sørensen
EMD-DK

APPROVED BY

Karina Bredelle
EMD-DK

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1	17.02.2020	190919_19105_C_2_TS_1	All	Final report, revised source noise data
2	14.04.2020	190919_19105_C_2_TS_2	All	Final report, accepted
3	27.04.2020	190919_19105_C_2_TS_3	All	Final report, revised source noise data

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1 Executive Summary

This report presents the results of the noise assessment for the Vesterhav Syd wind farm project in Denmark. The project consists of 20 Siemens-Gamesa SG-8.4-167-DD wind turbines with 109 m hub height.

The calculation methods follow the current Danish regulation (Bekendtgørelse nr. 135 07/02/2019 from the Danish Environmental Agency) [1].

The calculations are performed for both normal and low frequency noise. It is checked that the calculated noise level at neighbors to operating wind turbines situated in the zone inside of the exclusion line is below the allowed threshold. The exclusion line for the normal noise outlines the zone within which the noise contribution from the new wind farm is above the noise thresholds minus 15 dB (commonly used value). For the low frequency noise, the usual 15 dB delimitation interpreted from the guideline [2] has proven to be unnecessarily conservative. Instead, a 10 dB criteria has been applied.

Finally for both the normal and low frequency noise, the noise immersion of Vesterhav Syd wind farm complies with the Danish Regulation, bekendtgørelse nr. 135 07/02/2019.



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2 Method

The noise thresholds and propagation model are described in “Bekendtgørelse nr. 135 07/02/2019” from the Danish Environmental Protection Agency [1].

Two types of noise thresholds are considered: for the normal noise in the range 63 Hz to 10 kHz and for low frequency noise from 10 Hz to 160 Hz. In both cases the aggregated dB(A) value at the receptors are compared to the noise threshold.

The noise thresholds for normal noise and low frequency noise are described below.

The noise impact from WTGs are not allowed to exceed the following limits: (Wind speeds in 10 m height)

- 1) At outdoor areas maximum 15 m from neighbor settlements in the open land.
 - a) 44 db(A) at wind speed 8 m/s.
 - b) 42 db(A) at wind speed 6 m/s.
- 2) At outdoor areas in residential or recreational areas.
 - a) 39 db(A) at wind speed 8 m/s in residential areas.
 - b) 37 db(A) at wind speed 6 m/s in residential areas.

The low frequency noise impact from WTGs are not allowed to exceed 20 dB indoor at wind speeds 8 and 6 m/s

Figure 1 Noise threshold at dwellings for normal noise and low frequency noise

The propagation model takes into account that the wind turbines are defined as offshore turbines. For offshore wind turbines, a lower ground attenuation is used than for onshore wind turbines. A transition zone at the coastline (200m) is then included, behind which onshore ground attenuation is used. Any water surface behind the coastline (between coastline and receptor) is considered land surface, meaning that the ground attenuation does not change back to offshore conditions.

From offshore wind turbines there is an additional contribution from multiple reflections introduced in the 2019 noise regulation. At each dwelling, the combined multiple reflection component of the noise is calculated assuming wind direction from the closest offshore wind turbine and a reduction in the contribution from multiple reflections from offshore turbines that are at an angle to the direction from the closest offshore wind turbine. The multiple reflections build up across water and upon crossing the coastline the multiple reflection contribution is maintained but not increased any further. Reentering water surface does not change multiple reflections. Onshore wind turbines do not contribute with multiple reflection and are not considered when determining the wind direction.

The calculation of normal frequency range noise impact is an outdoor calculation. The calculation point for dwellings in open land is closest outdoor area surrounding the building, facing the highest noise impact, though no more than 15 m from the inhabited building. For zones with increased noise protection any location within the zone must comply with the noise threshold and the calculation point will be the section on the periphery that receives the highest noise impact.

The calculation of low frequency noise is an indoor noise calculation that differentiate between regular dwellings and cottage zones, taking into account different values of insulation for the two types of receptors. The calculation is thus more conservative for cottage zones with lower insulation attenuation than for regular dwellings.

The calculation point of low frequency noise at cottage zones is defined as the closest point of a cottage zone to a planned or operating turbine. Cottage zones are identified from the official zoning plan



“Kommuneplanrammer, vedtaget” available at kort.plandata.dk from Erhverstyrelsen (ministry of Industry). Cottages or light dwellings not located in this particular zoning are considered regular dwellings.

The calculation point of low frequency noise at regular dwellings is defined as the closest point of a dwelling to a planned or operating turbine. As it is the case with domestic turbines (less than 25 kW), the dwelling of the owner of a turbine shall not be considered according to “Bekendtgørelse nr. 135 07/02/2019”. Note that for domestic turbines, dwellings further than 500 m from the turbine have been ignored since the low frequency contribution becomes negligible (less than 10 dB(A)) at this distance.

According to the guideline for noise from wind turbines from the Environmental Agency [2], the noise impact from the planned wind farm will be irrelevant if it is less than 15 dB below the noise impact from operating wind turbines.

In order to identify which neighbors need to be re-assessed an exclusion line is drawn around the planned wind farm where the noise impact from the planned wind farm is 15 dB below threshold. A receptor outside this exclusion line will, if the noise received from wind turbines exceed the threshold, receive from the new wind farm less than 15 dB below what it is already receiving from operating wind turbines and can therefore be excluded from a reassessment. Reassessment of noise impact at neighbors will thus only have to be done inside the exclusion line.

The calculation of an exclusion line has been made in each of the cases (normal and low frequency noise). However, in the case of low frequency noise, the application of the 15 dB line would imply to evaluate the contribution of the low frequency noise from Vesterhav Syd to the low frequency noise from operating wind turbines close to summer houses more than 17 km away from Vesterhav Syd. This large distance seems too restrictive and not sensible (see section 5.1). Instead, a 10 dB exclusion line corresponding to a 10 dB difference between contributions from new and operating wind turbines is calculated. Details of the results are presented in the following sections.

The 15 dB (normal frequency range) and 10 dB (low frequency range) limitations of the exclusion lines related to the thresholds listed in Figure 1 are presented in Table 1.

Table 1. Value of the 15 dB and 10 dB delimitation of the exclusion lines for the different thresholds

Type of Demand	Threshold [dB(A)]	Exclusion line for threshold - 15 dB [dB(A)]	Exclusion line for threshold - 10 dB [dB(A)]
Normal noise, open land, 8m/s	44	29	/
Normal noise, open land, 6m/s	42	27	/
Normal noise, zones of increased noise protection, 8m/s	39	24	/
Normal noise, zones of increased noise protection, 6m/s	37	22	/
Low Frequency noise	20	(5)	10

Within the exclusion lines, the receptors to include in the calculation are identified as those where noise from operating turbine may approach the noise threshold relevant for the receptor in question.



It is more difficult to make a delimitation of which operating wind turbines can be excluded from the calculation. For receptors close to the new wind farm, the guideline [2] (which has until now been used as guideline for the interpretation of the regulations) states that individual operating wind turbines that contribute with less than 15 dB below the contribution of the combined new wind farm can be excluded. However, when considering neighbors to operating wind turbines, this guideline is less practical as the contribution from the new wind farm is relatively small, which would imply that operating turbines with even very small contributions cannot be excluded. In practice, a sensical evaluation of which operating turbines to include is made, including any turbines that could contribute significantly to the noise impact at the receptor. Those wind turbines may well be situated outside the exclusion line. In the present case, the offshore wind farm planned at Vesterhav Nord as well as Horns Rev3 is included although their contribution is minimal. The contributions from these wind farms are so small that normally they would be excluded. However, since the wind farms are located offshore and are subject to the new noise propagation model for offshore wind turbines, it has been the aim to avoid any doubt. By including Horns Rev 3 and Vesterhav Nord, the intention is to remove these as a potential item of contention.

All receptors and all wind turbines are calculated using the 2019 regulation no matter which regulation was used when they received their permit.

All the figures presented in this report uses symbols in red to represent a planned wind turbine (Vesterhav Syd), and blue to represent an operating turbine. Note that in this respect, Vesterhav Nord and Horns Rev 3 are also considered operating wind farms (with blue symbols).



3 Data Basis

The source noise levels of the wind turbines at Vesterhav Syd has been provided by Vattenfall in the form of a source noise specification from Siemens Gamesa [3], and are presented in Figure 2 and Figure 3. The noise data are based on measurements at Østerild National Test Center, conducted by SWECO, accredited by DANAK for noise measurements.

WTG: Siemens SWT-8.0-167 8000 167.0 !O!
Noise: Standard+PB+HWRT - measured Østerild - 2020-03
Source Source/Date Creator Edited
Sweco 02/03/2020 USER 06/04/2020 10.02
Report No.: P6-006-20

Status	Hub height [m]	Wind speed [m/s]	Low frequency data													
			LwA,ref [dB(A)]	10,0 Hz [dB]	12,5 Hz [dB]	16,0 Hz [dB]	20,0 Hz [dB]	25,0 Hz [dB]	31,5 Hz [dB]	40,0 Hz [dB]	50,0 Hz [dB]	63,0 Hz [dB]	80,0 Hz [dB]	100,0 Hz [dB]	125,0 Hz [dB]	160,0 Hz [dB]
From Windcat	109,10	6,0	93,9	47,0	53,2	58,9	65,0	69,2	73,2	77,0	80,0	84,9	84,0	85,5	87,7	88,7
From Windcat	109,10	8,0	98,5	50,6	57,1	63,1	68,6	74,4	78,0	81,8	84,8	87,1	92,3	90,0	91,9	92,5

Figure 2. Source noise level (low frequency range)

WTG: Siemens SWT-8.0-167 8000 167.0 !O!
Noise: Standard+PB+HWRT - measured Østerild - 2020-03
Source Source/Date Creator Edited
Sweco 02/03/2020 USER 06/04/2020 10.02
Report No.: P6-006-20

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data							
					63 [dB]	125 [dB]	250 [dB]	500 [dB]	1000 [dB]	2000 [dB]	4000 [dB]	8000 [dB]
From Windcat	109,10	6,0	108,4	No	88,2	92,3	96,9	100,0	103,1	104,1	97,9	81,4
From Windcat	109,10	8,0	111,7	No	94,0	96,4	99,5	103,0	106,2	107,4	101,6	84,4

Figure 3. Source noise level (normal frequency range)

The Vesterhav Nord wind farm consists of the same wind turbine type, using the same Power Boost (PB) operation mode as Vesterhav Syd.

The Horns Rev 3 wind farm consists of 69 MHI Vestas V164 8.3MW wind turbines. Source noise values for these turbines has only been obtained as dB(A) sum values. These have been fitted to an octave band distribution typical for offshore wind turbines. This approach is not standard for noise calculations in Denmark, but given the marginal contribution of Horns rev 3, it was deemed a reasonable approach.

The operating onshore wind turbines are identified through the national register of wind turbines (Energistyrelsens stamdataregister). Specifically, for this calculation only 5 onshore wind turbines are included.

Three of these consist of three Vestas V112 wind turbines west of Hvide Sande town. The source noise data for these are based on measurements conducted by Grontmij, 2012 (Report P6.034.12).



One is a Vestas V52 located east of Hvide Sande town. The source noise data for this turbine is based on measurements conducted by Sweco, 2017 (Report P6.005.17). Any further noise reduction uses the standard specifications from Vestas.

The last existing wind turbine is a Solid Wind Power SWP-25 located north of Hvide Sande by. The source noise data for this is based on measurements conducted by DELTA, 2014 (Report DANAK 100/1771 Rev. 1-E).

The total source noise levels of all existing wind turbines are presented in Appendix A and Appendix B.



4 Normal Noise

4.1 15 dB Exclusion Line

Operating turbines have been identified in the vicinity of Vesterhav Syd wind farm (Figure 4 and Figure 5).

Any area to which the Vesterhav Syd turbines contribute with a noise impact of less than 15 dB below the relevant threshold is not considered for reassessment and therefore not included in the calculation. For dwellings in the open land, these areas must be within the red lines, for zones with increased noise protection these areas must be within the blue lines.

The figures also include the noise receptors facing Vesterhav Syd directly.

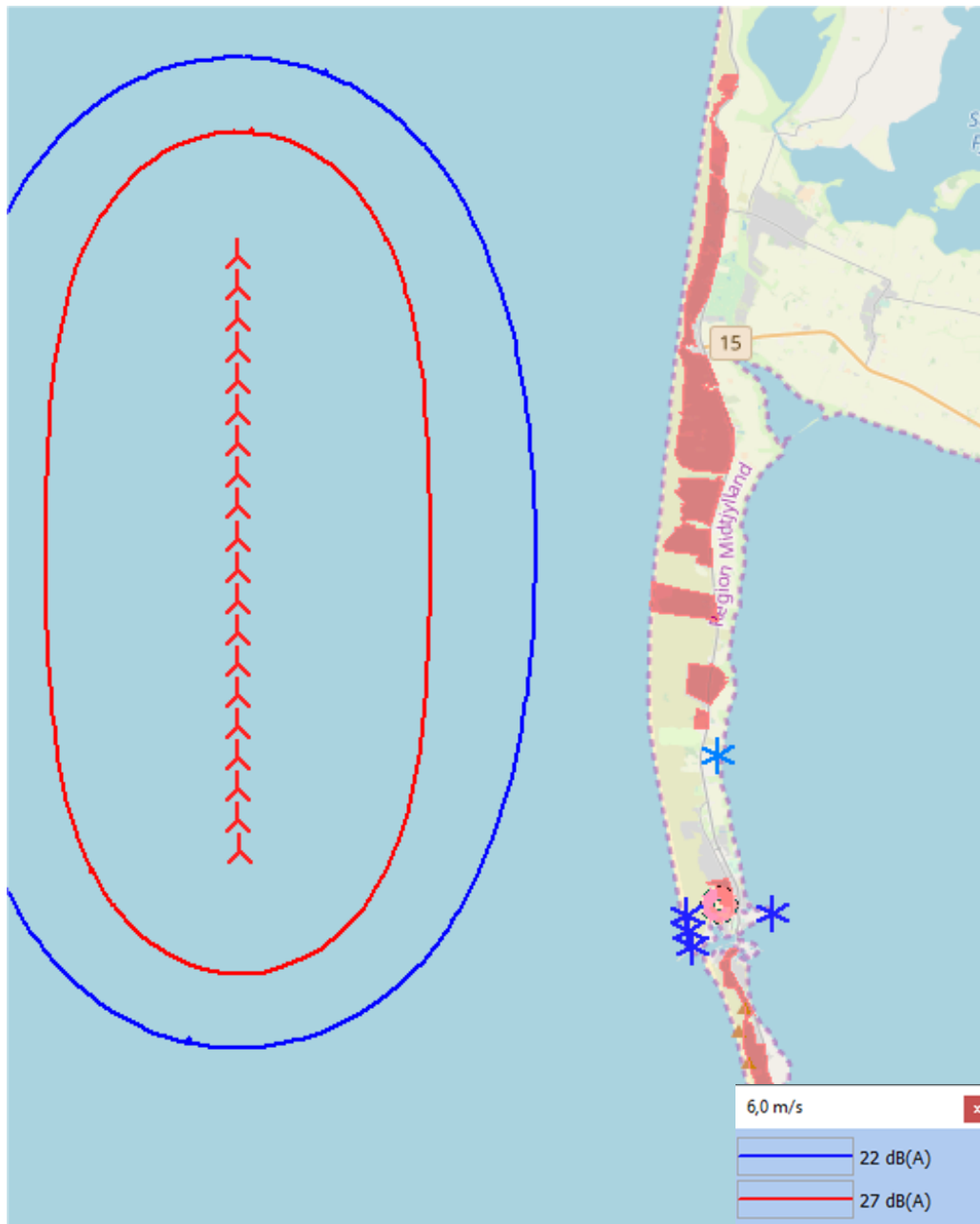


Figure 4. 15 dB exclusion lines at 6 m/s for normal noise.



Figure 5. 15 dB exclusion lines at 8 m/s for normal noise.

4.2 Results Near Operating Wind Turbines

All neighbours to operating wind turbines are located outside the exclusion zones. Therefore no neighbours to operating wind turbines need to be reassessed.

4.3 Results Normal Noise

Since the calculated noise lines at noise threshold values (39 and 37 dB(A) respectively) are not reaching the coast, it can be concluded that the limits for the normal noise are (Figure 6) not exceeded. The highest noise level for a protected area along the coast is at Holmsland Klit cottage area with 24.5 dB(A) at 8 m/s while the Hvide Sande municipality area receives 36.9 dB(A) at 6 m/s, mostly from operating turbines.

The detailed calculation is presented in Appendix A.

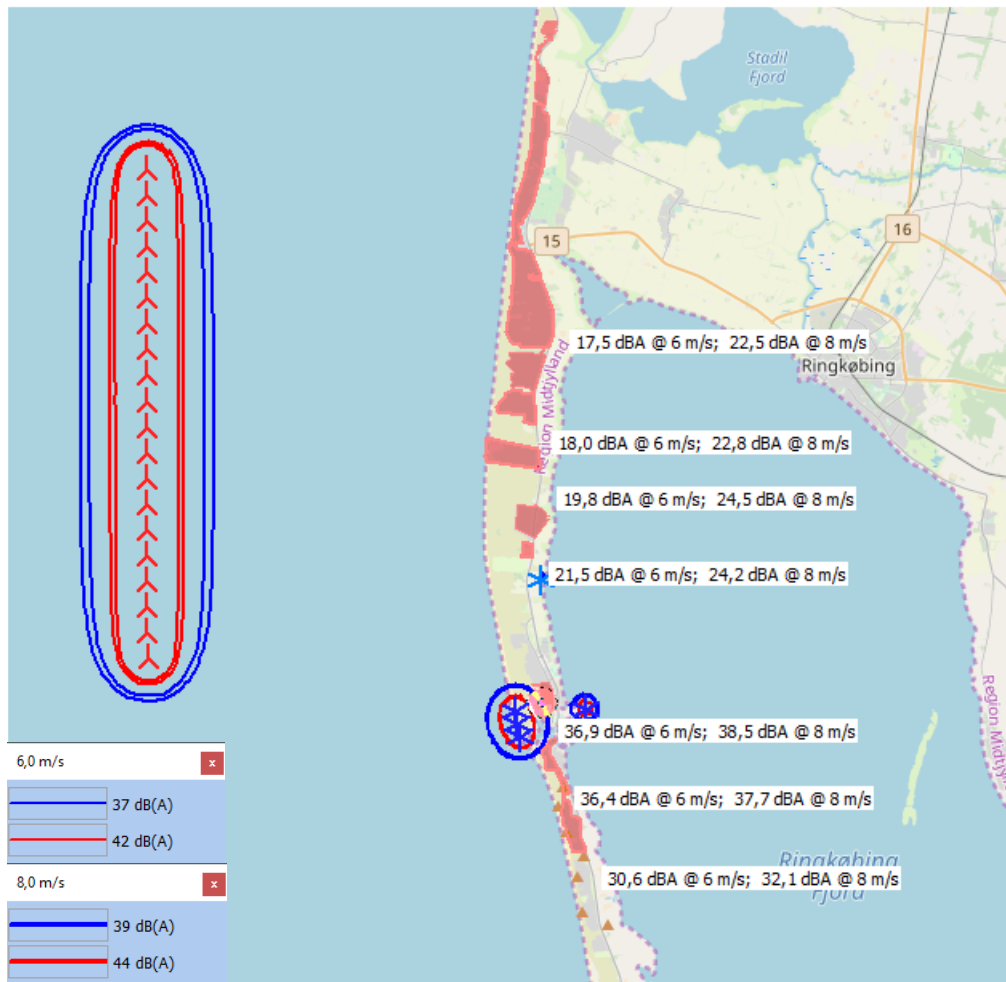


Figure 6. Normal range noise calculation at 6 and 8 m/s.



5 Low Frequency Noise

5.1 15/10 dB Exclusion Lines

The 10 dB and the 15 dB exclusion lines for low frequency noise around Vesterhav Syd are plotted on a map respectively in Figure 7 and Figure 8.

For the calculation of low frequency noise, a 15 dB exclusion criteria means that the zone within the exclusion line will include a large part of Western Jutland. Inside this very large zone, receptors near operating wind turbines will need to be reassessed. Particularly for low frequency noise in cottage zones, this area becomes very large (more than 17 km from Vesterhav Syd). It is our evaluation that it will not be relevant for the environmental impact to consider noise impact from Vesterhav Syd this far away from the wind farm.

The reasons for this are:

1. A low frequency noise contribution between 5 and 10 dB(A) will not likely be noticeable and is therefore not environmentally relevant.
2. A margin of 10 dB between the contribution from Vesterhav Syd and the contribution from the operating wind turbines is considered to provide an adequate protection of neighbors to operating wind turbines. Neighbors to operating wind turbines will indeed not notice any increase in low frequency noise impact with the addition of Vesterhav Syd wind farm when such a 10 dB margin is met.

We have therefore instead considered a less conservative 10 dB exclusion line. Outside this line, the contribution from Vesterhav Syd is below 10 dB and thus at receptors where the combined low frequency noise impact reaches threshold, the margin between operating and new wind turbines is less than 10 dB.

A 10 dB(A) noise line delimiting a 10 dB exclusion line is thus calculated (Figure 8).

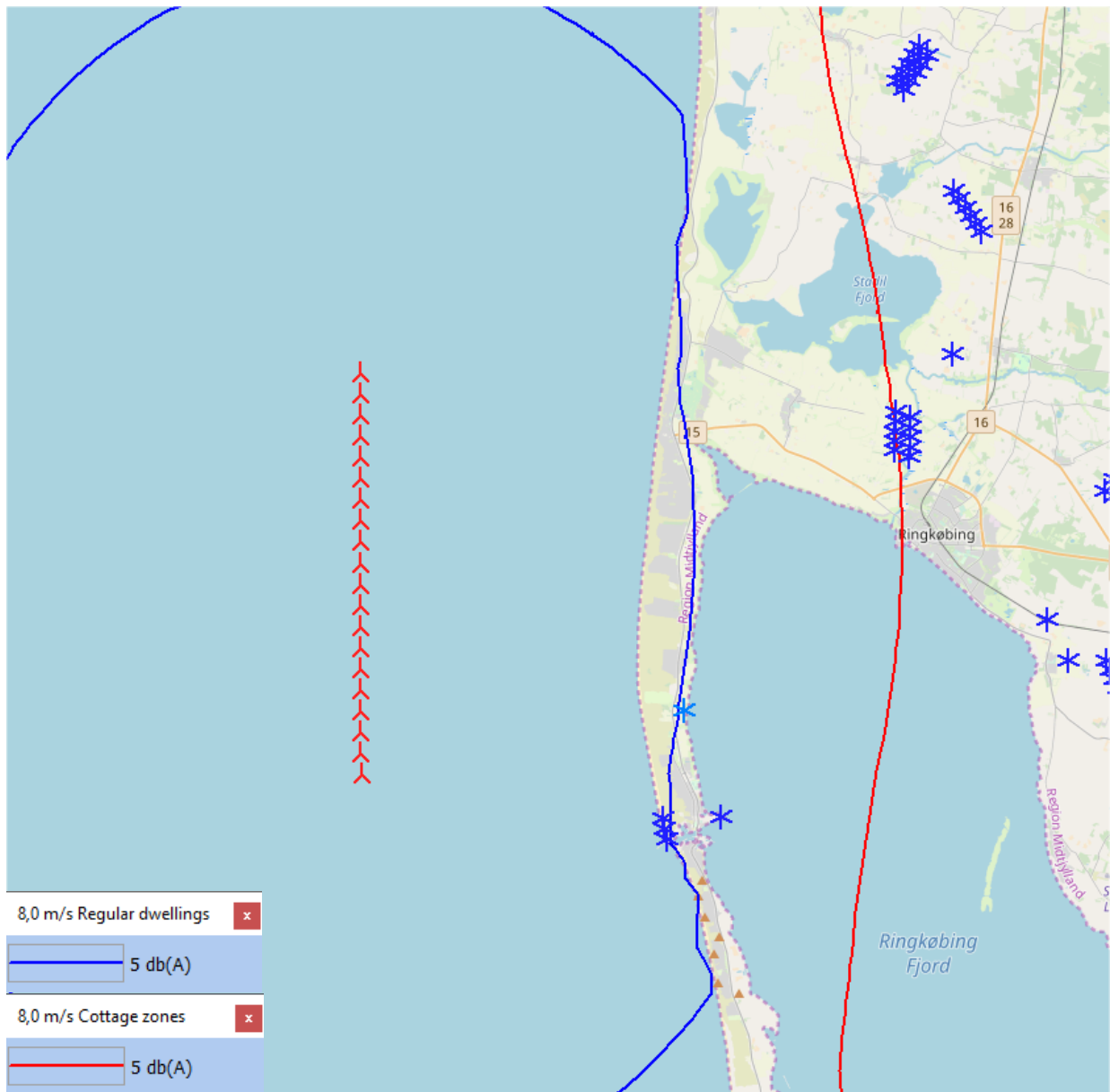


Figure 7. Delimitation of the 15 dB exclusion line for regular dwellings (blue) and cottage zones (red) at 8 m/s (calculated for low frequency noise) with already operating turbines.

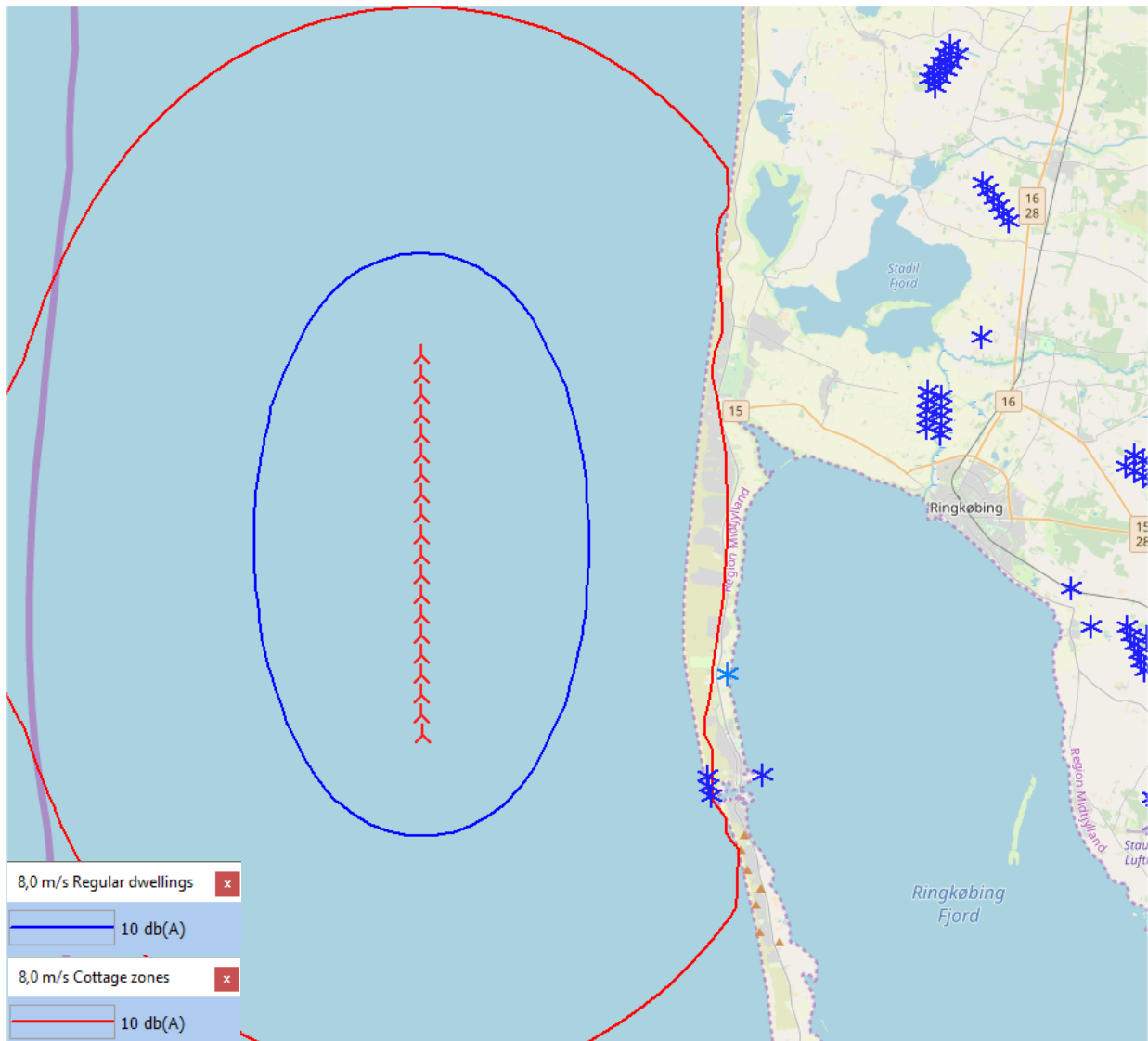


Figure 8. Delimitation of the 10 dB exclusion line for regular dwellings (blue) and cottage zones (red) at 8 m/s with already operating turbines.

Some operating turbines can be found within the two 10 dB exclusion lines. The largest zone is delimited by the red line and the coast. In this zone, cottage zones near operating turbines must be reassessed and the relevant operating wind turbines included in the calculation. The second zone, between the coast and the blue line, concerns the regular dwellings. In this zone any dwelling or noise sensitive area near operating turbines must be reassessed and the relevant operating wind turbines be included in the calculation. Only the five operating wind turbines near Hvide Sande town are relevant for the two types of receptors.

5.2 Results Near Operating Wind Turbines

The cottage zones within the 10 dB exclusion line have been identified and are presented in Figure 9. Those on the coastline and near operating wind turbines are selected for the analysis, including standard dwellings near operating turbines within the corresponding exclusion line (Figure 10). For clarity, cottage zones are given a green

color. As the exclusion line for standard dwellings does not reach the coastline, no standard dwellings next to operating wind turbines need to be reassessed. Those which are included in the assessment are so because they are closest neighbors on the coastline to the new wind farm. The exclusion line for cottage zones does reach the coastline, but cottage zones next to operating wind turbines are outside the exclusion line. Therefore these are only assessed as neighbors to the new wind farm.

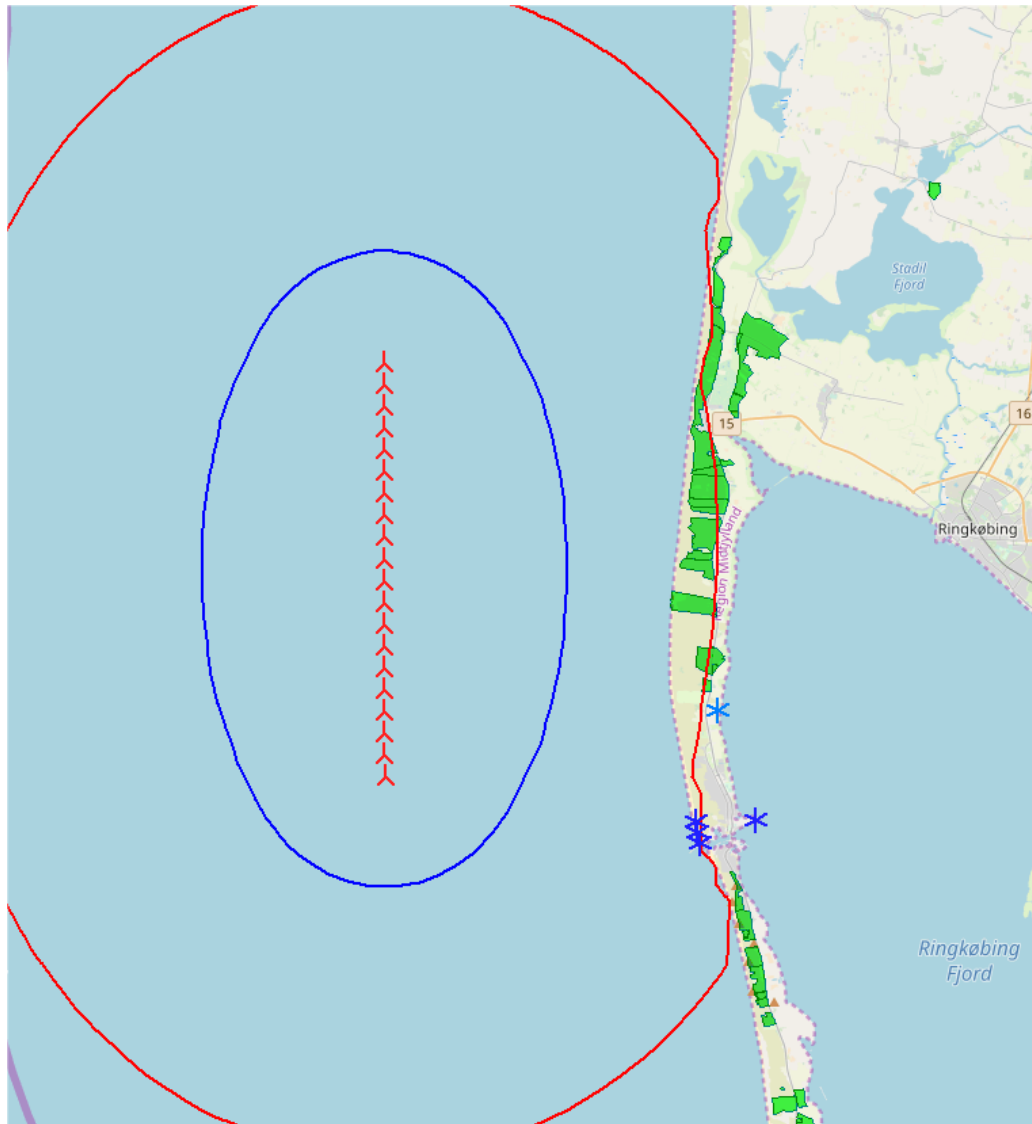


Figure 9. Overview map of cottage zones (green) within/close to the 10 dB line at 8 m/s.



Figure 10. Overview map with the identified areas where the impact at neighbors to operating wind turbines should be considered (Cottage zones marked with green color).

A detailed map of the Hvide Sande area is presented in the following figure (Figure 11), including the result of the cumulative noise impact (Vesterhav Syd, Vesterhav Nord, Horns Rev 3 and operating turbines) for the most relevant points of each receptor. Note again that the noise receptors are considered in their capacity as neighbors to the new farm, although the impact presented is cumulative impact. Critical noise impact at these dwellings would be caused by the operating turbines and trigger an exclusion (10 dB criteria).

North of Hvide Sande there is a small 25 kW wind turbine near a cottage zone, but the low frequency noise from this wind turbine is so low that noise contours are not even visible on the map. The same is the case for the Vestas V52 turbine east of Hvide Sande (The 400 m resolution in calculating the iso line noise map may be too crude for the noise lines from this turbine to be visible however the noise impact from these turbines are included in the calculation for the relevant dwellings). The neighbouring zones to the V52 wind turbine east of Hvide Sande are outside the exclusion line for regular dwellings and are therefore not reassessed. The noise lines around the V112 wind turbines are not approaching the cottage zones.

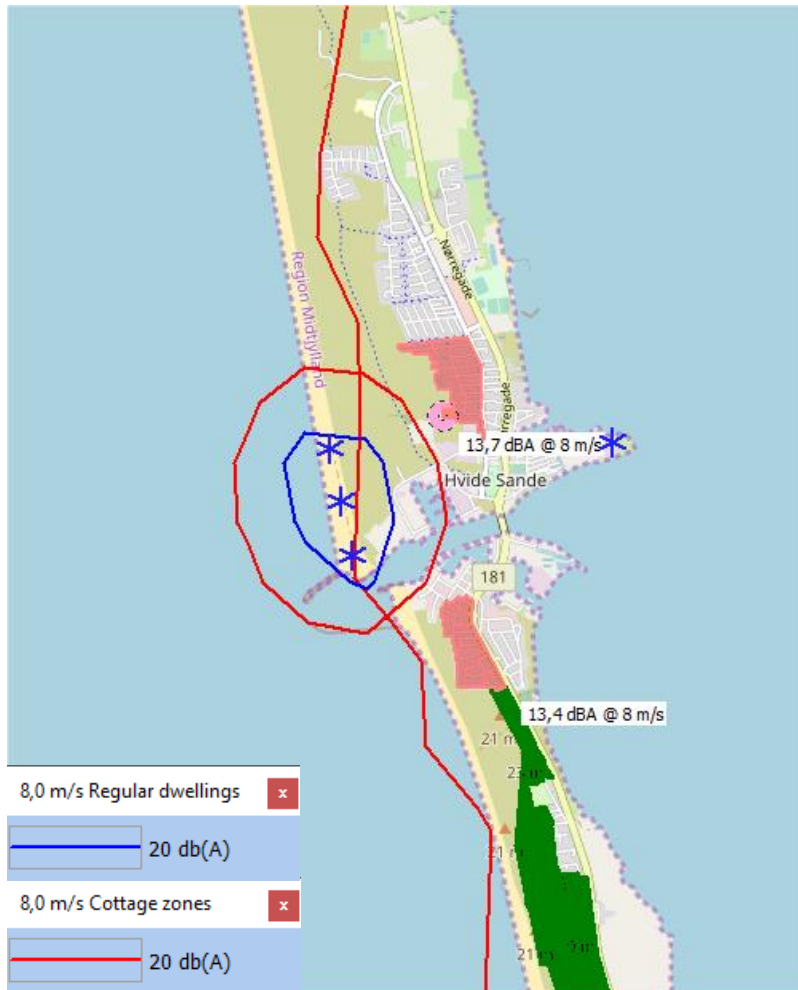


Figure 11. Calculated low frequency noise from new and operating turbines at relevant calculation points – Hvide Sande. Low frequency threshold for standard dwellings (blue lines) and cottage zones (red lines) is shown. The red line traversing the map from north to south is the 10 dB exclusion line for cottage zones.

5.3 Results Low Frequency Noise

Applying a 10 dB exclusion line to delimit the need for reassessment of low frequency noise from operating turbines has resulted in all neighbours to operating wind turbines being outside the exclusion line. No dwellings have been considered particularly as neighbour to operating wind turbine, but only as neighbour to the new wind farm. However, the cumulative noise from operating and new wind turbines has been assessed for these.

In terms of the calculation points on the coastline, the 20 dB threshold for regular dwellings or cottage zones does not reach the coastline. At Holmsland Klit cottage area, the low frequency noise impact at 8 m/s is 13.5 dB as the highest calculated mainly due to Vesterhav Syd. South of Hvide Sande, a total low frequency noise impact of 14.6 dB is calculated in a cottage zone, mostly from operating turbines.

It can thus be concluded that the thresholds for the low frequency noise are complied with.

The details of the calculation are presented in Appendix B.

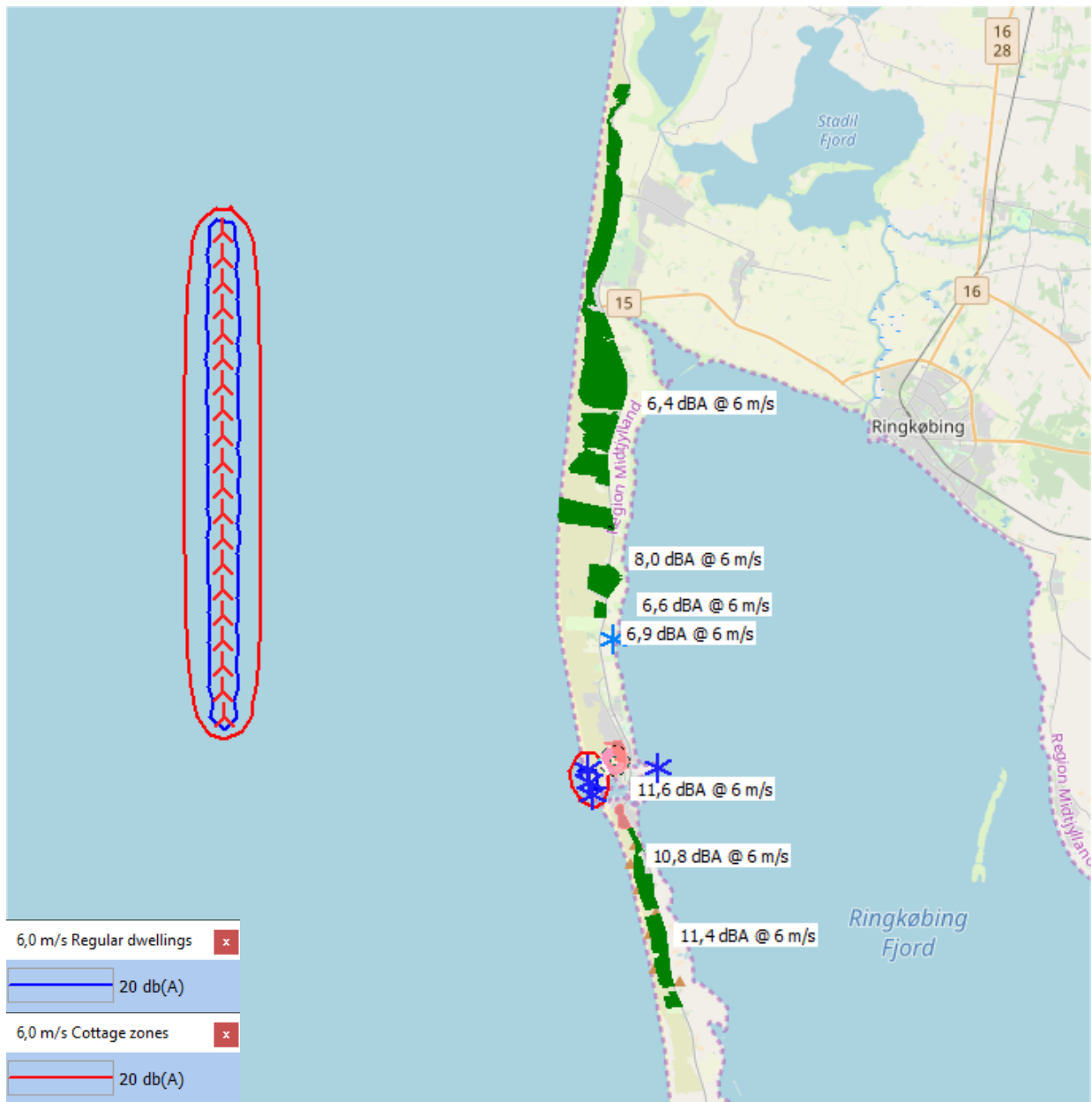


Figure 12. Low Frequency noise calculation results for regular dwellings (blue lines) and cottage zones (red lines) at 6 m/s. Cottage zones are marked with green color for clarity.

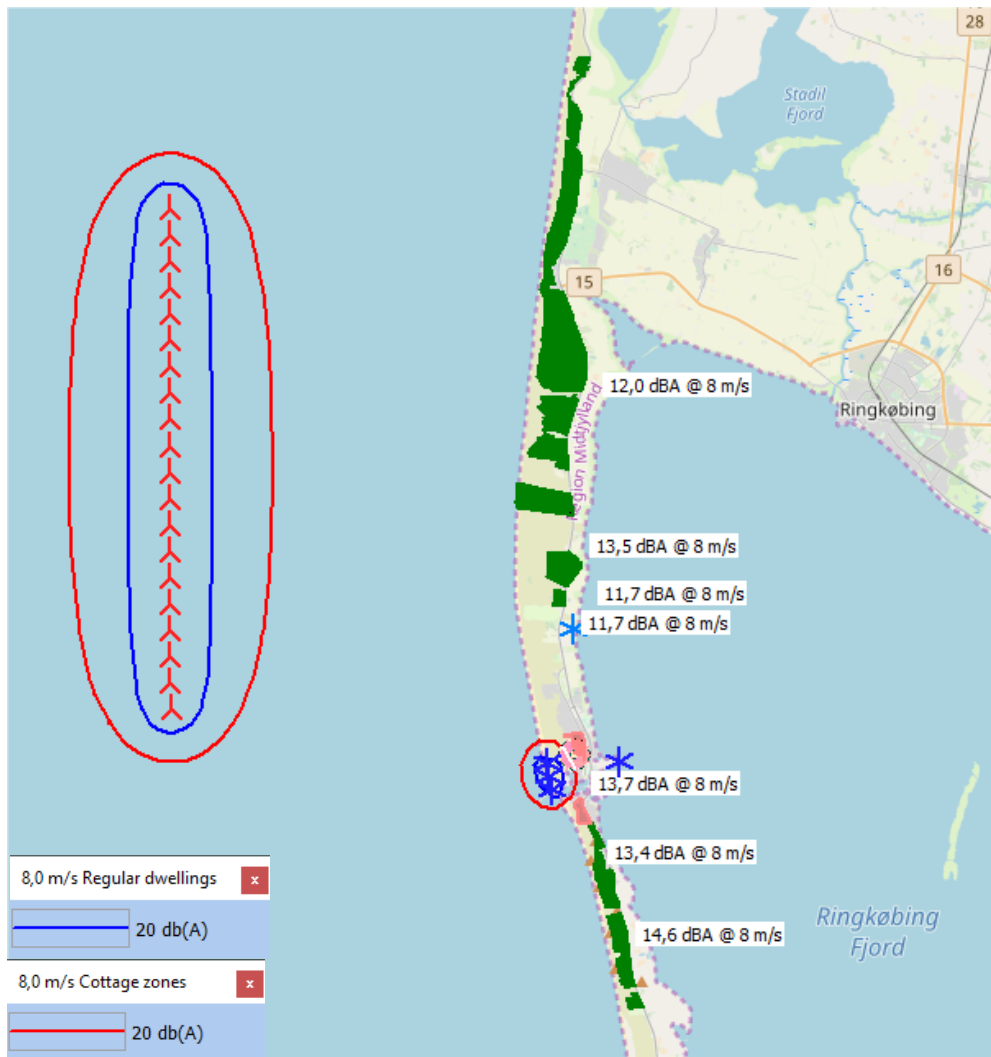


Figure 13. Low Frequency noise calculation results for regular dwellings (blue lines) and cottage zones (red lines) at 8 m/s. Cottage zones are marked with green color for clarity.



6 References

- [1] D. M. o. F. a. t. Environment, "Bekendtgørelse nr. 135 af 07/02/2019, Bekendtgørelse om støj fra Vindmøller, j.nr. 2018-5949," Lovtidende, 2019.
- [2] T. D. E. P. A. (Miljøstyrelsen), "Støj fra vindmøller, Vejledning fra Miljøstyrelsen nr. 1, 2012.," Miljøministeriet, 2012.
- [3] SWECO, "Wind Turbine Noise Measurement, IEC 61400-11 ED. 3.1, SG-8.6-167 DD Rev. 1 + PB + HWRT," 2020.



Appendix A. WindPRO calculation: Normal noise



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DECIBEL - Main Result

Calculation Vesterhav syd normal VS measured + VN measured r1

Noise calculation model: Danish 2019

The calculation is based on 'BEK nr 135 af 07/02/2019' from the Danish Environmental Agency. For wind turbines classified as offshore wind turbines multiple reflections (Ln) are applied.

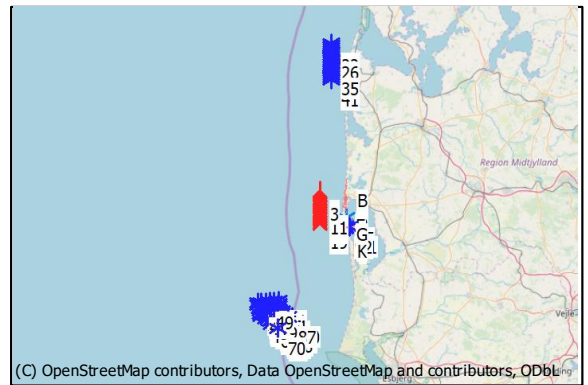
The noise impact from WTGs are not allowed to exceed the following limits: (Wind speeds in 10 m height)

- 1) At outdoor areas maximum 15 m from neighbor settlements in the open land. a) 44 db(A) at wind speed 8 m/s. b) 42 db(A) at wind speed 6 m/s. 2) At outdoor areas in residential or recreational areas. a) 39 db(A) at wind speed 8 m/s in residential areas. b) 37 db(A) at wind speed 6 m/s in residential areas.

The low frequency noise impact from WTGs are not allowed to exceed 20 dB indoor at wind speeds 8 and 6 m/s

The limits are not to be taken into account for houses belonging to WTG owner

All coordinates are in UTM (north)-ETRS89 Zone: 32



WTGs

Table with columns: Easting, Northing, Z, Row data/Description, WTG type (Valid, Manufact), Type-generator, Power, rated, Rotor diameter, Hub height, Offshore, Name, Noise data (Cesnr, Name), Fict wind speed, LwaRef, Last wind speed, LwaRef, Pure tones. The table lists 62 individual wind turbine entries with their respective specifications and noise data.

To be continued on next page...





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DECIBEL - Main Result

Calculation Vesterhav syd normal VS measured + VN measured r1

...continued from previous page

Table with columns: Easting, Northing, Z, Row data/Description, WTG type, Type-generator, Power, Rotor, Hub, Noise data, First wind speed, LwaRef, Last wind speed, LwaRef, Pure tones. Contains 95 rows of turbine data.

Calculation Results

Sound level

Table with columns: No., Name, Easting, Northing, Z, Immission height, Wind speed, Demands, Sound level, Demands fulfilled?. Lists noise levels for various areas like Hvide Sande boligområde.

Distances (m)

Table with columns: WTG, A, B, C, D, E, F, G, H, I, J, K, L. Shows distances between turbines.

To be continued on next page...





Project:

Vesterhav (19105)

Description:

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EMD International A/S
Niels Jernes Vej 10
DK-9220 Aalborg Ø
+45 9635 4444
Thomas Sørensen / ts@emd.dk
GCalcId: 06/04/2020 14.35/3.3.274

DECIBEL - Main Result

Calculation Vesterhav syd normal VS measured + VN measured r1

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L
77	45818	59317	53347	52331	51588	50326	49170	48643	43186	44920	44445	45818
78	46523	60182	54171	53145	52403	51132	49945	49406	43816	45607	45123	46523
79	47399	61226	55174	54137	53395	52116	50895	50343	44610	46463	45969	47398
80	48252	62237	56147	55099	54359	53072	51819	51254	45387	47299	46795	48252
81	42527	55942	49984	48973	48230	46972	45832	45312	39961	41643	41176	42526
82	43388	56910	50927	49909	49166	47902	46742	46214	40767	42491	42017	43388
83	44454	58155	52129	51099	50357	49084	47888	47346	41744	43536	43051	44454
84	45184	59012	52955	51917	51175	49895	48674	48122	42411	44251	43758	45183
85	45896	59842	53757	52711	51970	50685	49440	48879	43064	44950	44449	45895
86	46570	60636	54522	53468	52728	51437	50167	49597	43680	45611	45103	46570
87	43341	57274	51187	50141	49400	48115	46872	46313	40535	42400	41903	43341
88	44137	58188	52073	51020	50280	48989	47722	47153	41270	43182	42677	44136
89	44875	59037	52897	51836	51097	49801	48511	47933	41952	43907	43395	44875
90	42498	56700	50545	49481	48743	47445	46145	45565	39573	41529	41016	42498
91	852	16125	9666	8538	7651	6458	4724	4242	1786	1170	1419	1146
92	784	16154	9689	8486	7590	6426	4591	4052	1936	1223	1287	784
93	1105	16865	10400	9196	8298	7127	5292	4765	1284	719	696	1104
94	885	16509	10044	8840	7943	6775	4940	4408	1601	963	968	884
95	2754	12644	6172	4988	4087	2899	1093	607	5105	4259	4481	3282





Project:

Vesterhav (19105)

Description:

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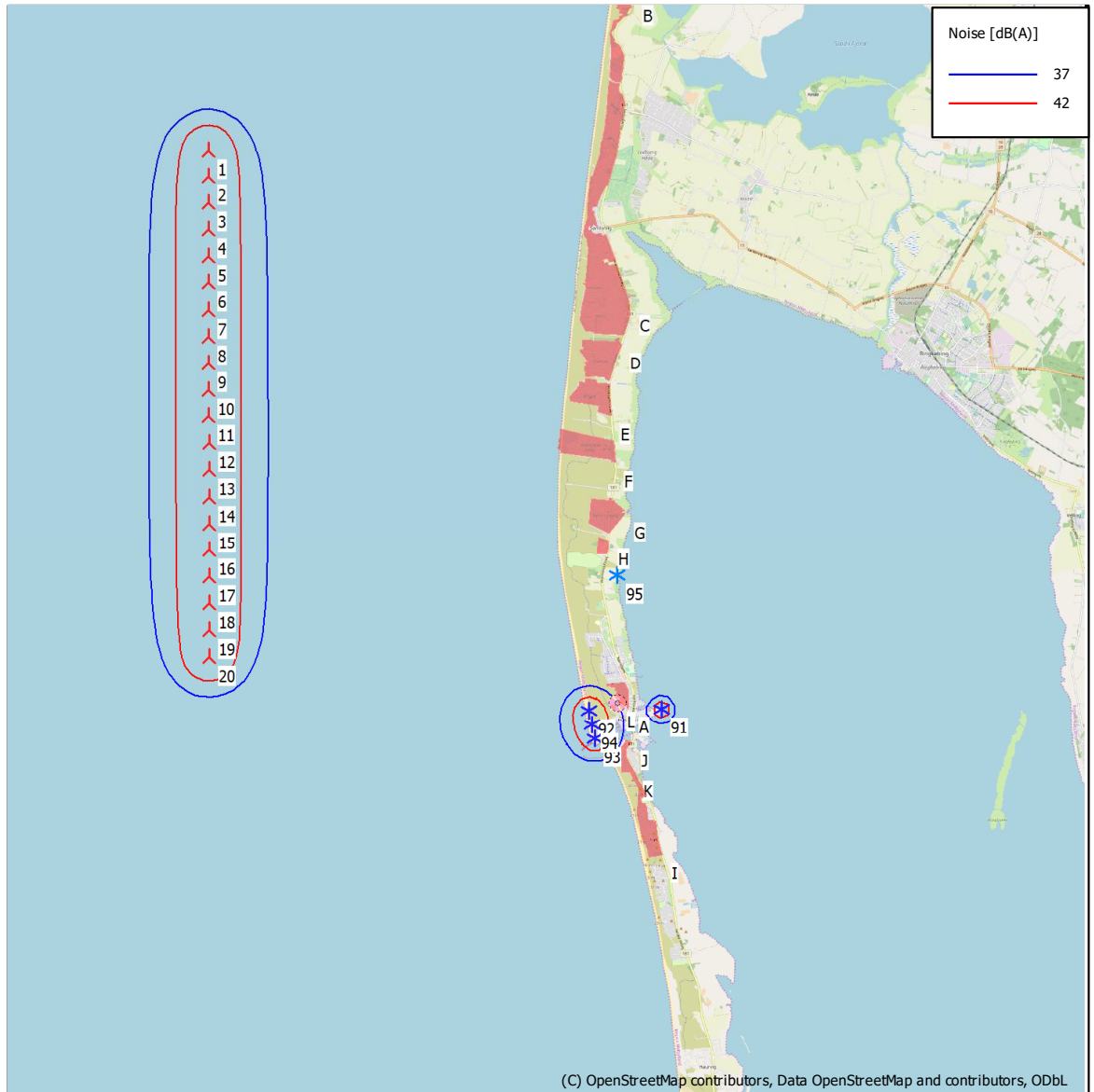
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DECIBEL - Map 6,0 m/s

Calculation Vesterhav syd normal VS measured + VN measured r1



Map: EMD OpenStreetMap , Print scale 1:150.000, Map center UTM (north)-ETRS89 Zone: 32 East: 443.703,1 North: 6.211.670,0
 Noise calculation model: Danish 2019. Wind speed: 6,0 m/s
 Height above sea level from active line object





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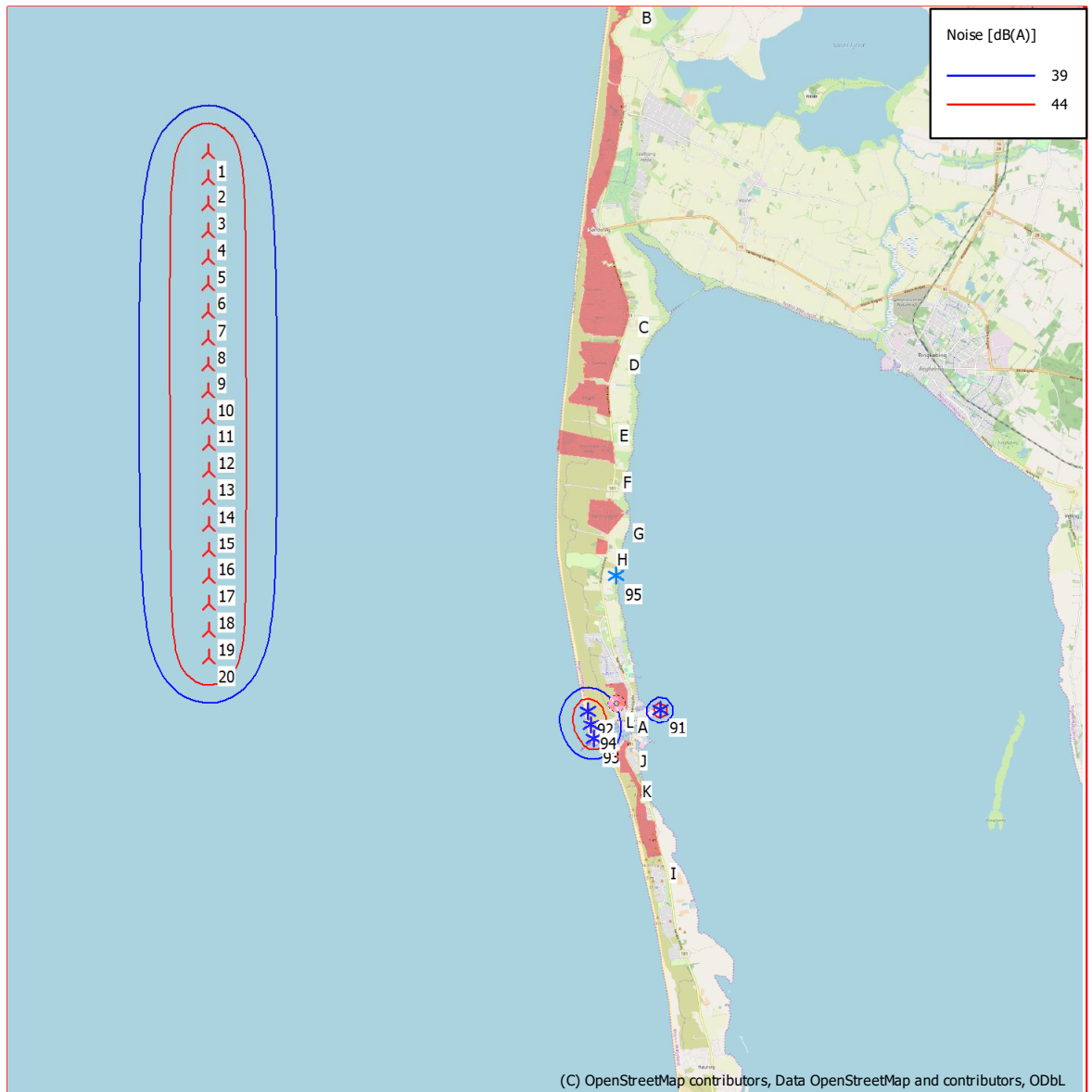
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DECIBEL - Map 8,0 m/s

Calculation: Vesterhav syd normal VS measured + VN measured r1



▲ New WTG

★ Existing WTG

■ Noise sensitive area

Noise calculation model: Danish 2019. Wind speed: 8,0 m/s
Height above sea level from active line object



Appendix B. WindPRO calculation: Low Frequency noise



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DECIBEL - Main Result

Calculation Vesterhav Syd LF VS measured + VN measured r1

Noise calculation mode: Danish low frequency 2019

The calculation is based on "BEK nr 135 af 07/02/2019" from the Danish Environmental Agency. For wind turbines classified as offshore wind turbines multiple reflections (Lm) are applied.

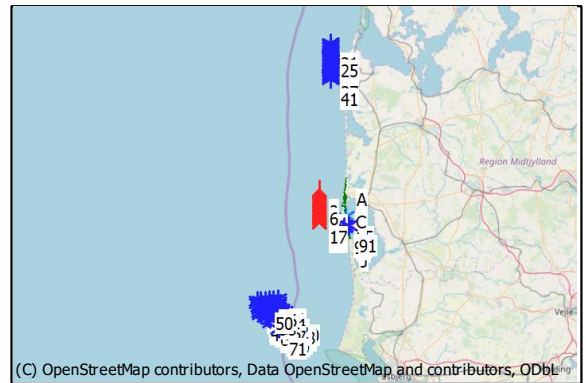
The noise impact from WTGs are not allowed to exceed the following limits: (Wind speeds in 10 m height)

- 1) At outdoor areas maximum 15 m from neighbor settlements in the open land. a) 44 dB(A) at wind speed 8 m/s. b) 42 dB(A) at wind speed 6 m/s. 2) At outdoor areas in residential or recreational areas. a) 39 dB(A) at wind speed 8 m/s in residential areas. b) 37 dB(A) at wind speed 6 m/s in residential areas.

The low frequency noise impact from WTGs are not allowed to exceed 20 dB indoor at wind speeds 8 and 6 m/s

The limits are not to be taken into account for houses belonging to WTG owner Den lavfrekvente støj beregnes indendørs og må ikke overstige 20 dB ved vindhastigheder på 6 og 8 m/s i 10 m højde

All coordinates are in UTM (north)-ETRS89 Zone: 32



WTGs

Table with columns: Easting, Northing, Z, Row data/Description, WTG type, Valid, Manufact., Type-generator, Power, Rotor diameter, Hub height, Offshore, Creator/Name, Noise data, First wind speed, LwaRef, Last wind speed, LwaRef. Contains 63 rows of turbine data.

To be continued on next page...





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Vesterhav (19105)

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DK-9220 Aalborg Ø
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DECIBEL - Main Result

Calculation Vesterhav Syd LF VS measured + VN measured r1

...continued from previous page

Table with columns: Easting, Northing, Z, Row data/Description, WGT type, Valid, Manufact., Type-generator, Power, Rotor, Hub, Offshore, Noise data, First wind speed, LwaRef, Last wind speed, LwaRef. Contains detailed noise data for various turbine locations.

Calculation Results

Sound level

Noise sensitive area

Table with columns: No., Name, Easting, Northing, Z, Imission height, Wind speed, Demands Noise, Sound level, Demands fulfilled?. Lists noise sensitive areas A through M with their respective coordinates and noise levels.

Distances (m)

Table with columns: WGT, A, B, C, D, E, F, G, H, I, J, K, L, M. Shows distances between turbine locations A through M.

To be continued on next page...





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DECIBEL - Main Result

Calculation Vesterhav Syd LF VS measured + VN measured r1

...continued from previous page

Table with 14 columns (WTG, A, B, C, D, E, F, G, H, I, J, K, L, M) and 72 rows of numerical data representing wind turbine performance metrics.

To be continued on next page...





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DECIBEL - Main Result

Calculation Vesterhav Syd LF VS measured + VN measured r1

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M
73	54283	48457	47479	46738	45508	44467	43985	39052	38014	37734	41383	41382	40120
74	55290	49439	48455	47713	46477	45416	44926	39897	38824	38533	42283	42283	41000
75	56270	50391	49400	48658	47416	46334	45835	40707	39599	39298	43151	43150	41846
76	57221	51314	50316	49573	48325	47220	46713	41483	40339	40027	43985	43984	42659
77	59317	53347	52331	51588	50326	49170	48643	43186	41962	41627	45818	45818	44445
78	60182	54171	53145	52403	51132	49945	49406	43816	42547	42199	46523	46523	45123
79	61226	55174	54137	53395	52116	50895	50343	44610	43292	42930	47399	47398	45969
80	62237	56147	55099	54359	53072	51819	51254	45387	44023	43649	48252	48252	46795
81	55942	49984	48973	48230	46972	45832	45312	39961	38783	38463	42527	42526	41176
82	56910	50927	49909	49166	47902	46742	46214	40767	39555	39225	43388	43388	42017
83	58155	52129	51099	50357	49084	47888	47346	41744	40478	40132	44454	44454	43051
84	59012	52955	51917	51175	49895	48674	48122	42411	41106	40749	45184	45183	43758
85	59842	53757	52711	51970	50685	49440	48879	43064	41724	41356	45896	45895	44449
86	60636	54522	53468	52728	51437	50167	49597	43680	42304	41926	46570	46570	45103
87	57274	51187	50141	49400	48115	46872	46313	40535	39216	38855	43341	43341	41903
88	58188	52073	51020	50280	48989	47722	47153	41270	39913	39541	44137	44136	42677
89	59037	52897	51836	51097	49801	48511	47933	41952	40559	40178	44875	44875	43395
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91	16125	9666	8538	7651	6458	4724	4242	1786	3991	6083	852	1146	1419
92	16154	9689	8486	7590	6426	4591	4052	1936	4304	6428	784	784	1287
93	16865	10400	9196	8298	7127	5292	4765	1284	3581	5702	1105	1104	696
94	16509	10044	8840	7943	6775	4940	4408	1601	3942	6064	885	884	968
95	12644	6172	4988	4087	2899	1093	607	5105	7538	9643	2754	3282	4481



Project:

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Description:

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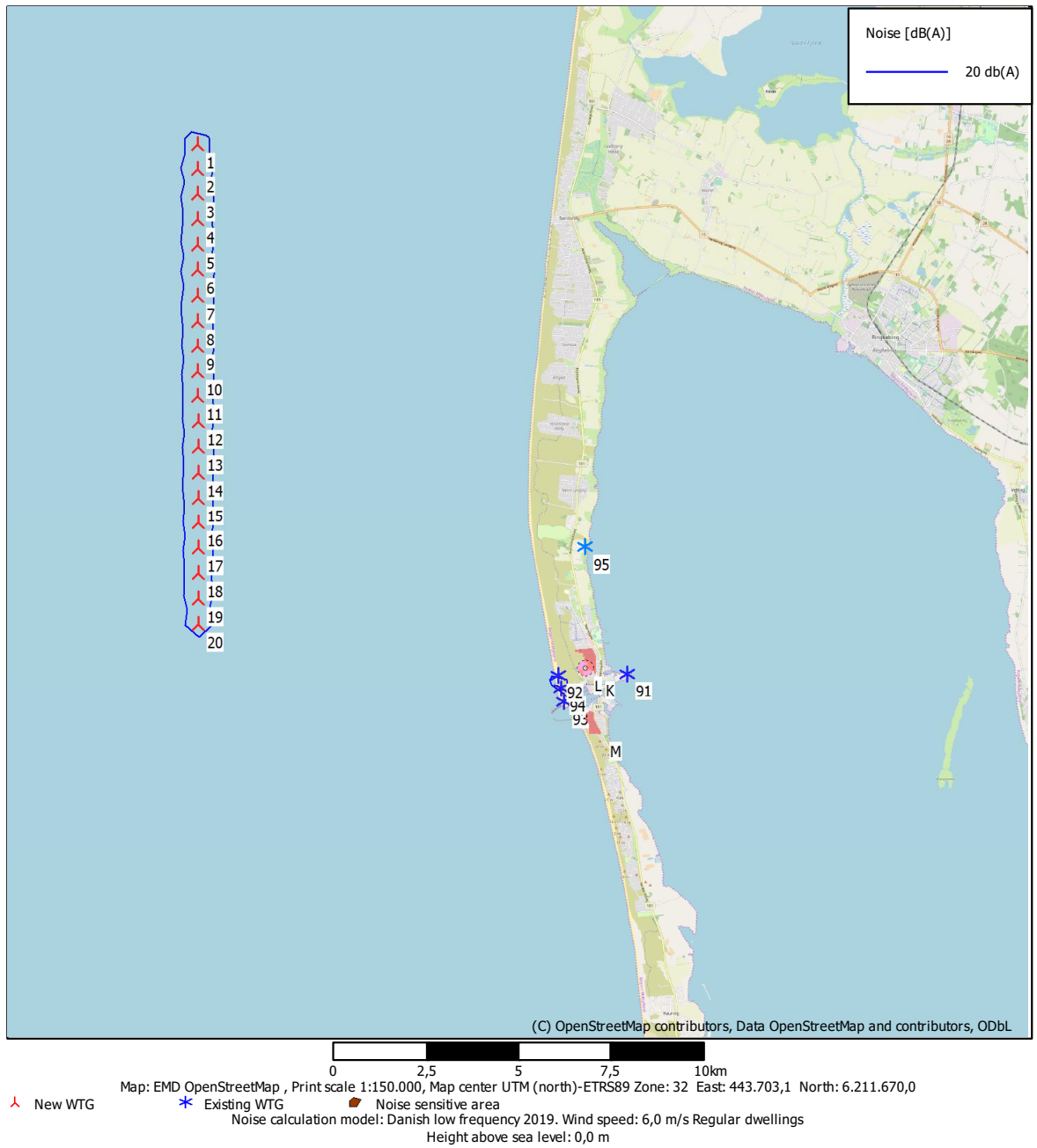
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DECIBEL - Map 6,0 m/s Regular dwellings

Calculation\vesterhav Syd LF VS measured + VN measured r1





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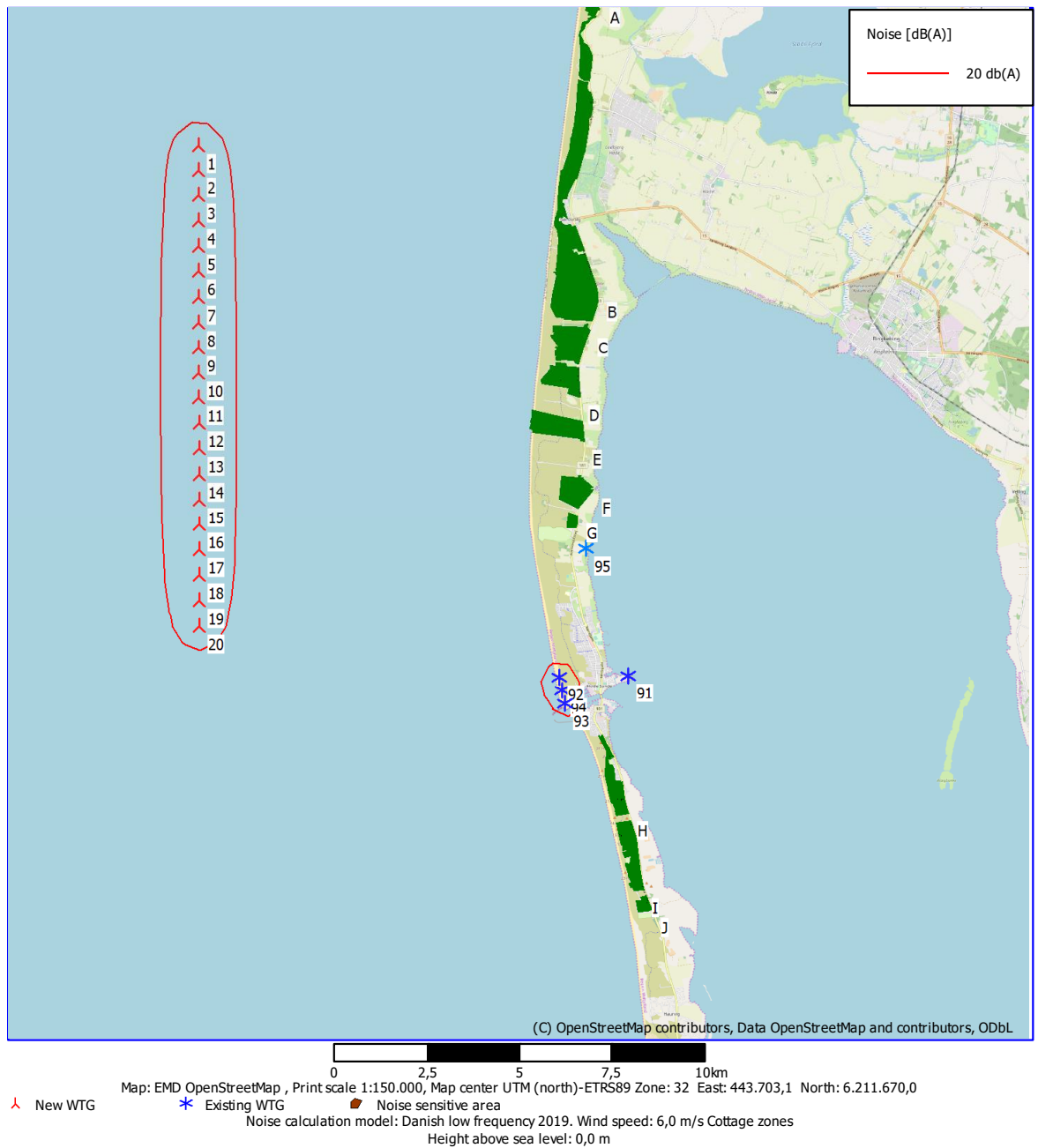
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DECIBEL - Map 6,0 m/s Cottage zones

Calculation: Vesterhav Syd LF VS measured + VN measured r1





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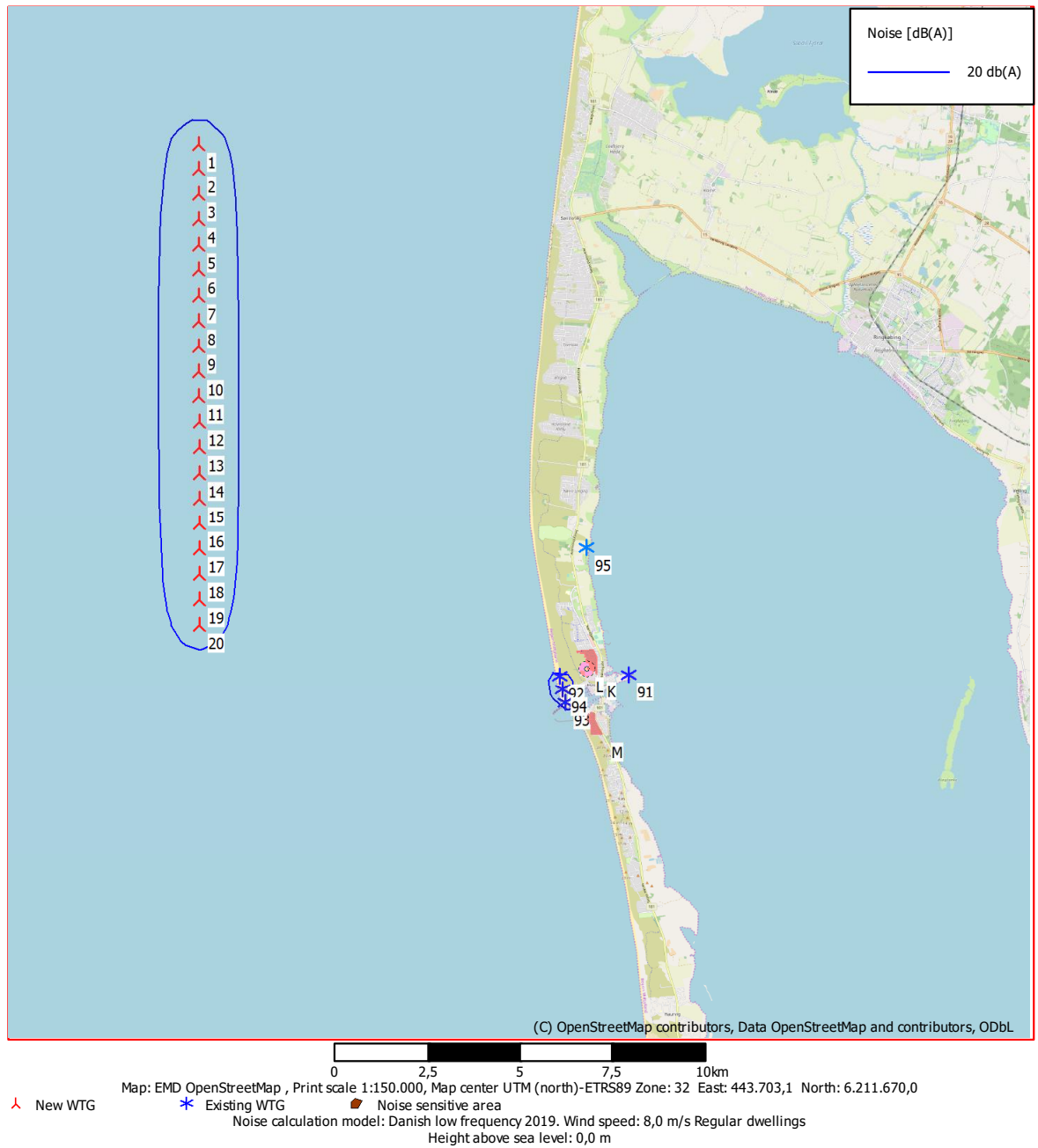
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DECIBEL - Map 8,0 m/s Regular dwellings

Calculation: Vesterhav Syd LF VS measured + VN measured r1





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DECIBEL - Map 8,0 m/s Cottage zones

Calculation: Vesterhav Syd LF VS measured + VN measured r1

