Calculation of noise immission from wind turbines

Wind farm Faurefjellet

Client information

Project:	Wind farm Faurefjellet
Client:	Norsk Vind Energi AS
Client reference:	Per Ove Skorpen

Project information

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Company information

Name:	Akustikkonsulten i Sverige AB
Adress:	Ringvägen 45B, 118 63 Stockholm
Phone:	+46(0)8-29 89 00
E-mail:	info@akustikkonsulten.se

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

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Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Calculation conditions

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Wind Farm	WTG type	Number of WTG	Hub height [m]	Total height [m]	Noise emission [dBA]
Faurefjellet	Vestas V150-5.6MW	12	125	200	91,5-104,9

Calculation parameters	
Calculation program	SoundPLAN 8.1
Calculation standard	Nord2000
Search radius	30 000 m
Calculation height	1,5 m and 4,0 m
Air absorbtion	ISO 9613-1
Air pressure	1013,25 mbar
Relative humidity	70%
Temperature	15 °C
Temperature gradient	+0,05 °C/m
Roughness length	0,3 m
Wind speed at 10 m height	8 m/s
Standard deviation wind speed	0,5 m/s
Wind direction	Downwind and wind statistics
Turbulence strength parameter wind	0,12 m4/3/s2
Turbulence strength parameter temperature	0,008 K/s2
Effective flow resistivity forrest	Impedance class D
Effective flow resistivity other	Impedance class E
Effective flow resistivity mountain	Impedance class F
Effective flow resistivity water	Impedance class H
Coordinate system	UTM WGS84 Zone: 32
Height data	1 m height contours + DTM10

Calculation cases	
B01:	Noise from wind farm Faurefjellet for "Worst case" with downwind from all wind directions for 8 m/s at 10 m height WTG in operation 365 days a year (8769 hours).
B02:	Noise from wind farm Faurefjellet for 3-41 m/s at hub height for measured wind speed and wind direction distribution in 30° sectors according to Table 2. Noise emission for each wind speed at hub height according to Table 1, 91,8-104,9 dBA. This represents a yearly average of L_{den} based on wind speeds on site, "lokale vindforhold".

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Calculation conditions

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Information on calculation parameters

As the weather conditions varies during a normal year, weather parameters according to standard noise calculation methods are used, which are also identical to the values given in the ISA-Standard (International Standard Atmosphere) for air pressure and temperature. The applied relative humidity 70 % and temperature 15 °C is also recommended in the new Finish guidelines for calculation of wind turbine noise with Nord2000 as well as in the Danish regulations on industrial noise. In the Nordic calculation method for external industrial noise report *General Prediction Method, DAL-32*, the relative humidity 70 % and temperature 15 °C is used for planning purposes. DAL-32 is an approved method for calculation of wind turbine noise according to chapter 9.8.1 in the Norwegian guidelines on wind turbine noise M-128/2014, *Veileder til retningslinje for behandling av støy i arealplanlegging (T-1442/2016)* (revised January 2020).

It shall be noted that the calculations are performed for a positive temperature gradient which is comparable to moderate inversion. The used value +0,05 °C/m is also the highest approved value according to the measurement method for noise immission from wind turbines *Elforsk 98:24* as recommended for measurements in M-128/2014. The noise level at a positive temperature gradient is usually higher compared to a negative temperature gradient.

The effective flow resistivity in Nord2000 represent the ground impedance or hardness of the ground. In the guidelines for Nord2000 seven impedance classes are defined, impedance class A-H, where A represents the softest ground for example snow and H represents the hardest ground for example water. In the performed calculations areas with different impedance classes has been specified based on maps and satellite images as well as information from the client. The different areas are shown in page 13 in a ground absorption map.

The calculations are performed with the assumption that the noise sensitive areas (NSA) are located 1,5 m and 4,0 m above ground. The height of 4,0 m should be considered decisive according to M-128/2014. Although it shall be noted that sound immission measurements according to the measurement standard *Elforsk 98:24*, recommended in chapter 9.8.5 in M-128/2014, should be performed at 1,2-1,5 m above ground. According to the European directive on environmental noise it is also possible to use calculations on 1,5 m above ground for recreational areas and areas with one-story housing as an additional indicator. The result on 1,5 m above ground should also be considered more representative to the exposure of noise outside of a dwelling.

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Method description

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Method description

The calculations are performed with the Nordic environmental noise prediction method Nord2000 which is an approved method for calculation of wind turbine noise according to chapter 9.8.1. in the guidelines M-128/2014. Nord2000 takes into account different aspects of noise spreading for example ground impedance, topography and wind direction. The calculations are performed both as "Worst case støyberegninger" (**Case B01**) and "Støyutredning basert på lokale vindforhold" (**Case B02**) in accordance with chapter 9.8.2-9.8.3 in M-128/2014.

The "Worst case støyberegninger" assumes specific weather conditions with a conservative transmission loss, high noise emission and the wind turbines in operation 8760 hours a year (365 days). This is equal to the noise immission during a day with downwind conditions and wind speed 8 m/s at 10 m height. The Calculations according to "Støyutredning basert på lokale vindforhold" are based on long term wind measurements and also considering the wind speed dependence of the noise emission, both high and low noise emission depending on the wind speed. Such calculations represent a more accurate value of a yearly average L_{den}. The level of L_{den} based on "lokale vindforhold" is, according to Akustikkonsultens experience, always lower than L_{den} for "worst case". This is also mentioned in chapter 9.8.3 in M-128/2014 were for example calculations considering different wind directions (Vindretning) is said to affect the calculation result with ±1-2 dB while different wind speed and noise emission (Vindhastighet og kildestøy) could affect the calculation result with up to 8 dB, both cases in comparison to "worst case" calculations.

Unfortunately, M-128/2014 do not present any detailed instructions on how to perform calculations assuming "lokale vindforhold". Akustikkonsulten suggests the method below to perform "Støyutredning basert på lokale vindforhold" based on long term wind measurements.

1. Sort the wind speed data so it corresponds to the wind speed dependency of the noise emission. For example, the cut-in wind speed, when the blades start to rotate and emit noise, is normally around 3 m/s at hub height for modern wind turbines. Based on wind and noise data for the current project the wind turbines has been assumed to not emit noise for wind speeds below 3 m/s, approx. 7,7 % of the year, and the highest noise emission 104,9 dBA occurs from wind speed 11 m/s at hub height and above, approx. 26,1 % of the year. For wind speeds between 3-10 m/s the noise emission is assumed to vary between 91,8-104,1 dBA. The wind speed dependent noise emission is given in Table 1 for the used noise setting.
2. Divide the wind direction data in 30° sectors and calculate the percentual distribution for the wind speeds between 3 m/s to ≥11 m/s separately, similar to a wind rose, according to Table 2. The percentage for each wind direction is used for the calculations in step 4, were NSA in a dominant wind direction gets more noise during a year.
3. Calculate the noise immission for each wind direction in 30° sectors for wind speeds between 3 m/s to ≥11 m/s, a total of 96 calculations. The 12 results, for each wind speed, are then weighted using the wind direction distribution calculated in step 2.
4. The last step is to calculate the yearly average based on the result in step 2-3. The yearly average is weighted using the wind speed distribution between 0-41 m/s according to Table 2. The result is given in calculation **Case B02**.

The calculations in **Case B02** are performed according to the method described above.

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Calculation uncertainty

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Calculation uncertainty

The use of the prediction model Nord2000 on wind turbine noise has been evaluated and validated by a Danish research project *PSO-07 F & U project no 7389. Noise and energy optimization of wind farms. Validation of the Nord2000 propagation model for use on wind turbine noise., Delta, rapport AV 1236/09 Hörsholm, Danmark 2009*. In general, the conclusion is that the calculation results of Nord2000 show good agreement with sound measurements, for simple plain terrain with simple meteorological parameters as well as for complex hilly terrain with complex meteorological conditions. In comparison with ISO 9613-2, Nord2000 is an improvement, especially for the more complex situations.

Based on the above study it is believed that, with a confidence interval of 90 %, the calculated value is within the interval of (-5, +3 dB) from a measured value for complex norweigan terrain for distances up to 4 km from the wind farm. This confidence interval includes the uncertainty on the noise emission. It shall be noted that the uncertainty increases with the distance from the wind farm. This uncertainty is also expected to include a variation of the meteorological parameter's temperature, air pressure and humidity relative to the assumed values.

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Wind shadow

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Wind shadow

The former guide lines for wind turbine noise in Norway, *Veileder til Miljøverndepartementets retningslinje for behandling av støy i arealplanlegging (støyretningslinjen) (TA-2115/2005)*, had special recommendations for dwellings situated in wind shielded areas (wind shadow). But in the latest revision of the guidelines M-128/2014, dated January 2020, no special noise limits are given for these situations. The following recommendation is mentioned about wind shadow:

"Hvis en vindturbin er plassert høyt i terrenget og støymottaker ligger i le i dalformasjoner, kan maskeringen fra vindsuset reduseres vesentlig fordi mottaker er skjermet for vinden. Mottakeren ligger da i vindskygge, og vil høre støy fra vindturbinene bedre. Det finnes ikke spesielle støykrav ved vindskygge, men spesielt i detaljprosjekteringsfasen bør utreder være oppmerksom på støyfølsom bebyggelse som ligger i vindskygge. I slike tilfeller kanstøy fra vindturbiner ofte høres best ved vindstyrker i 10 –12 m/s. Dette bør da legges til grunn for støyberegninger. "

All noise calculations and reports produced by Akustikkonsulten undergoes a quality assurance check in accordance with Akustikkonsultens quality system. It could be noted that Akustikkonsulten is one of few noise consultants in the Nordic region that are accredited (by SWEDAC and in compliance with ILAC, International Laboratory Accreditation Cooperation) according to ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories as well as for the measurement standard for noise emission from wind turbines IEC 61400-11. Akustikkonsultens consultants have more than 10 years of experience from noise calculations of wind turbine noise and have performed calculations for more than 500 wind farms over the years.

The performed "worst case" calculations are to be considered as conservative compared to the calcualtions based on "lokale vindforhold". In addition, the highest noise emission for wind speeds between 3 m/s-20 m/s at hub height is assumed in the "worst case" calculations, as recommended in M-128/2014 when there could be a risk for wind shadow. This noise emission also corresponds to the warranted noise emission according to the wind turbine manufacturer.

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Noise data

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Table 1

WTG type	Noise setting	Wind speed at hub height [m/s]	Noise emission [dBA]
Vestas V150-5.6MW	Mode 0 STE[3)]	4[1)]	91,8
	Mode 0 STE[3)]	5	94,1
	Mode 0 STE[3)]	6	96,9
	Mode 0 STE[3)]	7	100,0
	Mode 0 STE[3)]	8	102,7
	Mode 0 STE[3)]	9	104,0
	Mode 0 STE[3)]	10	104,1
	Mode 0 STE[3)]	≥11[2)]	104,9

Reference noise data: Frequency spectrum 1/3-octave bands between 20 Hz and 10 000 Hz has been taken from the WTG manufacturer document 0079-5099_02 dated 2019-05-20 supplied by the client. The noise emission is given for wind speeds between 3 m/s up to 20 m/s.

The highest noise emission for any wind speeds, between 3-20 m/s, is used in the calculation corresponding to the wind speed 11 m/s at hub height.

[1)]Used for wind speed 3-4 m/s
[2)]Used for wind speed ≥11 m/s
[3)]STE - Blades with serrated trailing edges

Disclaimer: The calculations are valid for the used noise emission and frequency spectrum. Akustikkonsulten gives no guaranty on the actual noise emission level nor frequency spectrum.

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Wind data

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Table 2

Wind speed at hh [m/s]	Total [%]	0° [%]	30° [%]	60° [%]	90° [%]	120° [%]
0-2	7,7	0,5	0,3	0,3	0,7	0,7
3-4	14,0	1,1	0,7	0,5	0,8	0,9
5	9,1	0,6	0,4	0,3	0,5	0,7
6	9,7	0,5	0,2	0,3	0,5	0,8
7	9,5	0,3	0,1	0,3	0,6	0,9
8	9,0	0,2	0,0	0,2	0,6	1,0
9	8,0	0,1	0,0	0,2	0,6	1,0
10	6,8	0,0	0,0	0,1	0,6	1,0
11-41	26,1	0,0	0,0	0,3	4,2	6,9
All wind speeds	**100,0**	**3,4**	**1,8**	**2,4**	**9,1**	**13,8**
Wind speed at hh [m/s]	**150° [%]**	**180° [%]**	**210° [%]**	**240° [%]**	**270° [%]**	**300° [%]**
0-2	0,8	0,6	0,8	0,7	0,7	0,9
3-4	1,4	1,3	1,2	1,0	1,1	1,7
5	1,1	0,9	0,7	0,5	0,6	1,1
6	1,3	0,9	0,7	0,5	0,6	1,1
7	1,4	1,0	0,6	0,5	0,6	1,1
8	1,4	0,8	0,6	0,4	0,5	1,0
9	1,4	0,8	0,5	0,4	0,5	0,8
10	1,2	0,6	0,5	0,3	0,4	0,7
11-41	3,7	1,7	1,3	1,3	1,4	2,4
All wind speeds	**13,7**	**8,5**	**7,0**	**5,6**	**6,4**	**10,9**
Wind speed at hh [m/s]	**330° [%]**					
0-2	0,8					
3-4	2,4					
5	1,9					
6	2,2					
7	2,2					
8	2,1					
9	1,7					
10	1,3					
11-41	2,8					
All wind speeds	**17,4**					

Wind distribution used in calculation

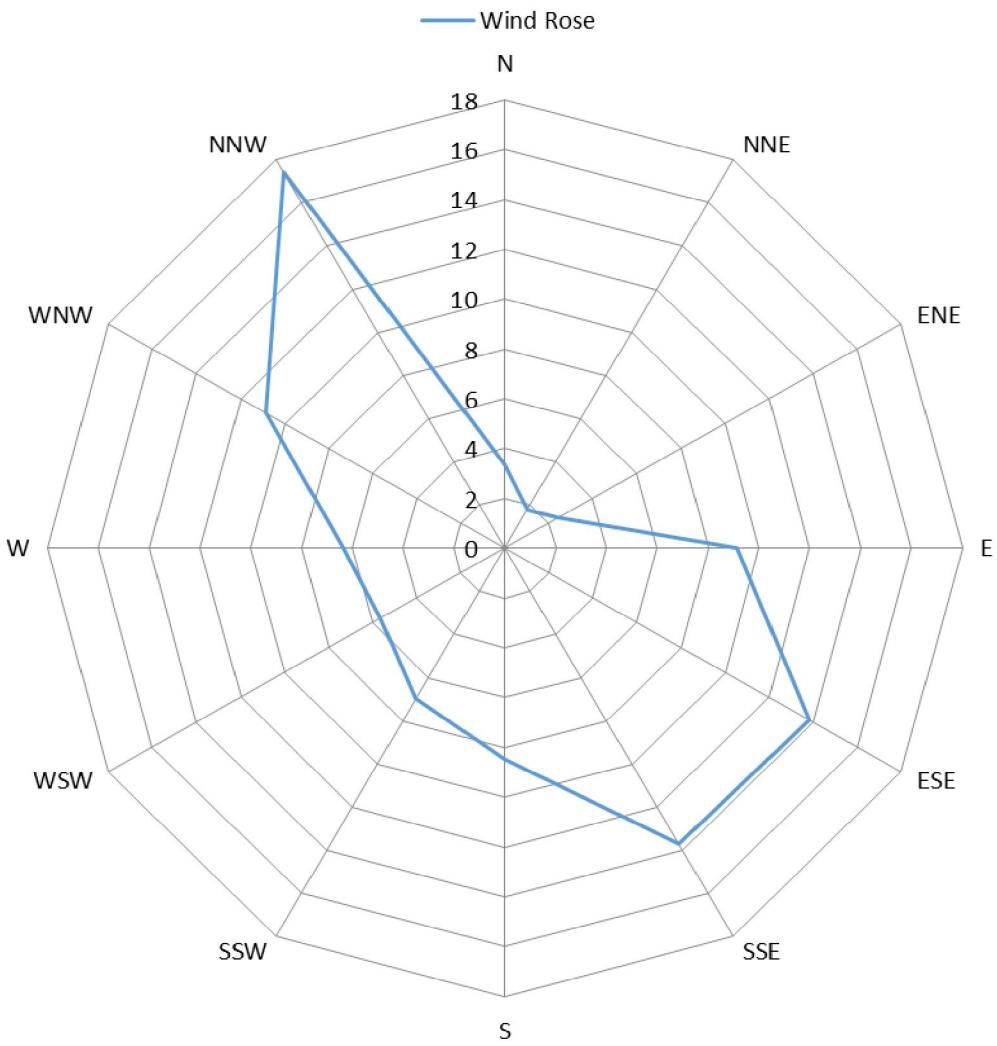
Case B02: Both wind speed and wind direction distribution is used for wind speed 0-41 m/s, red values. This case represents an accurate yearly average of L_{den}.

Reference wind data: The wind speed distribution is compiled and supplied by Meventus AS. The data corresponds to long term corrected values for 125 m height.

Disclaimer: The calculations are valid for the used wind speed distribution. Akustikkonsulten gives no guaranty that the real wind distribution is the same.

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Wind data



Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

WTG data - Case B01

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Wind Farm Faurefjellet							
WTG	**X [m]**	**Y [m]**	**Hub height [m]**	**Hub height level [mas]**	**Ground level [mas]**	**Noise emission [dBA]**	**Noise setting**
T01	334390	6509650	125	600	475	104,9	Mode 0
T02	334090	6509310	125	602	477	104,9	Mode 0
T03	331231	6507903	125	539	414	104,9	Mode 0
T04	332010	6508530	125	564	439	104,9	Mode 0
T05	332886	6509143	125	587	462	104,9	Mode 0
T06	331602	6508313	125	545	420	104,9	Mode 0
T07	332634	6508870	125	566	441	104,9	Mode 0
T08	331778	6507306	125	512	387	104,9	Mode 0
T09	331842	6509220	125	566	441	104,9	Mode 0
T10	333510	6509840	125	581	456	104,9	Mode 0
T11	332273	6509247	125	571	446	104,9	Mode 0
T12	331695	6507803	125	476	351	104,9	Mode 0

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

WTG data - Case B02

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Wind Farm Faurefjellet							
WTG	**X [m]**	**Y [m]**	**Hub height [m]**	**Hub height level [mas]**	**Ground level [mas]**	**Noise emission [dBA]**	**Noise setting**
T01	334390	6509650	125	600	475	91,8-104,9	Mode 0
T02	334090	6509310	125	602	477	91,8-104,9	Mode 0
T03	331231	6507903	125	539	414	91,8-104,9	Mode 0
T04	332010	6508530	125	564	439	91,8-104,9	Mode 0
T05	332886	6509143	125	587	462	91,8-104,9	Mode 0
T06	331602	6508313	125	545	420	91,8-104,9	Mode 0
T07	332634	6508870	125	566	441	91,8-104,9	Mode 0
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Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Ground absorption map

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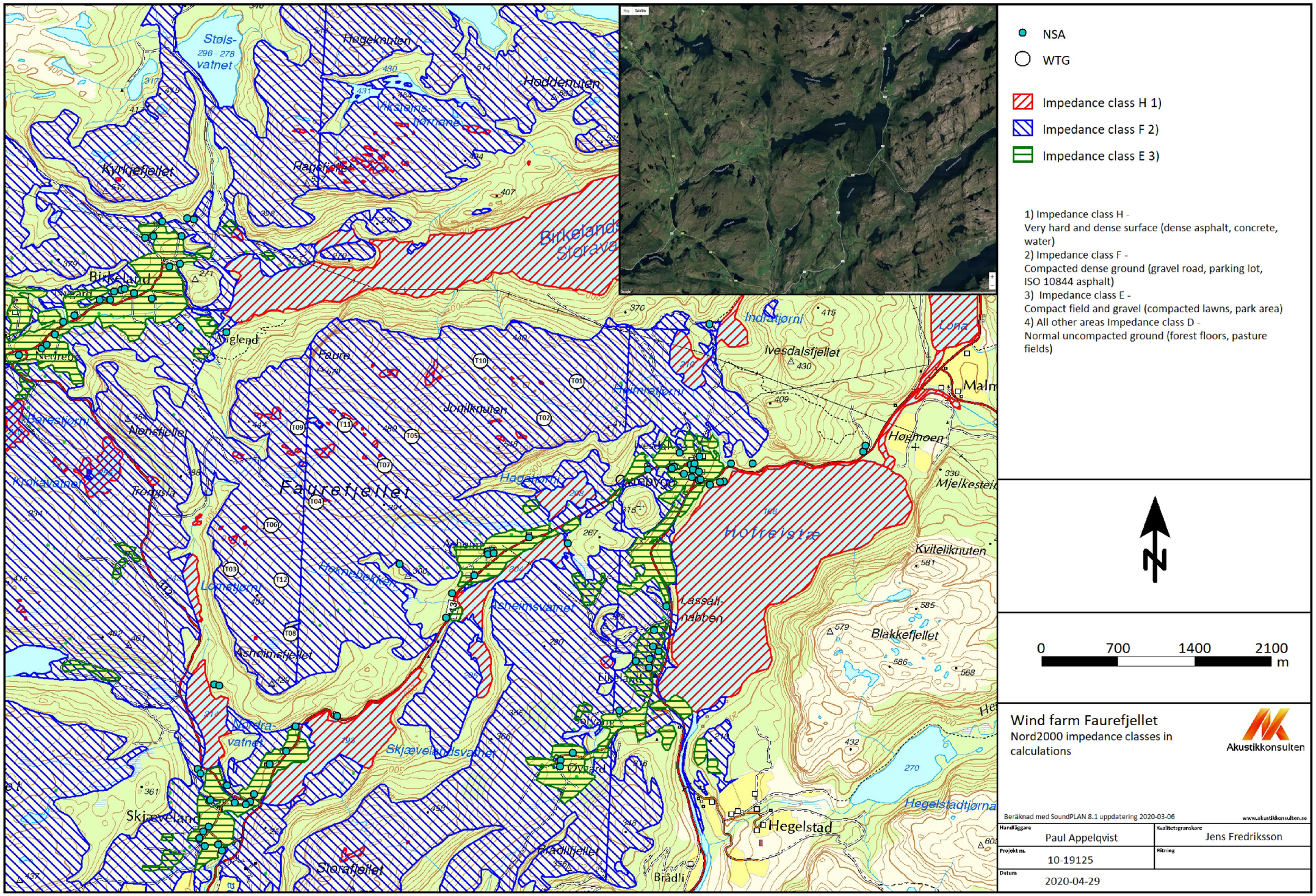

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Ground model

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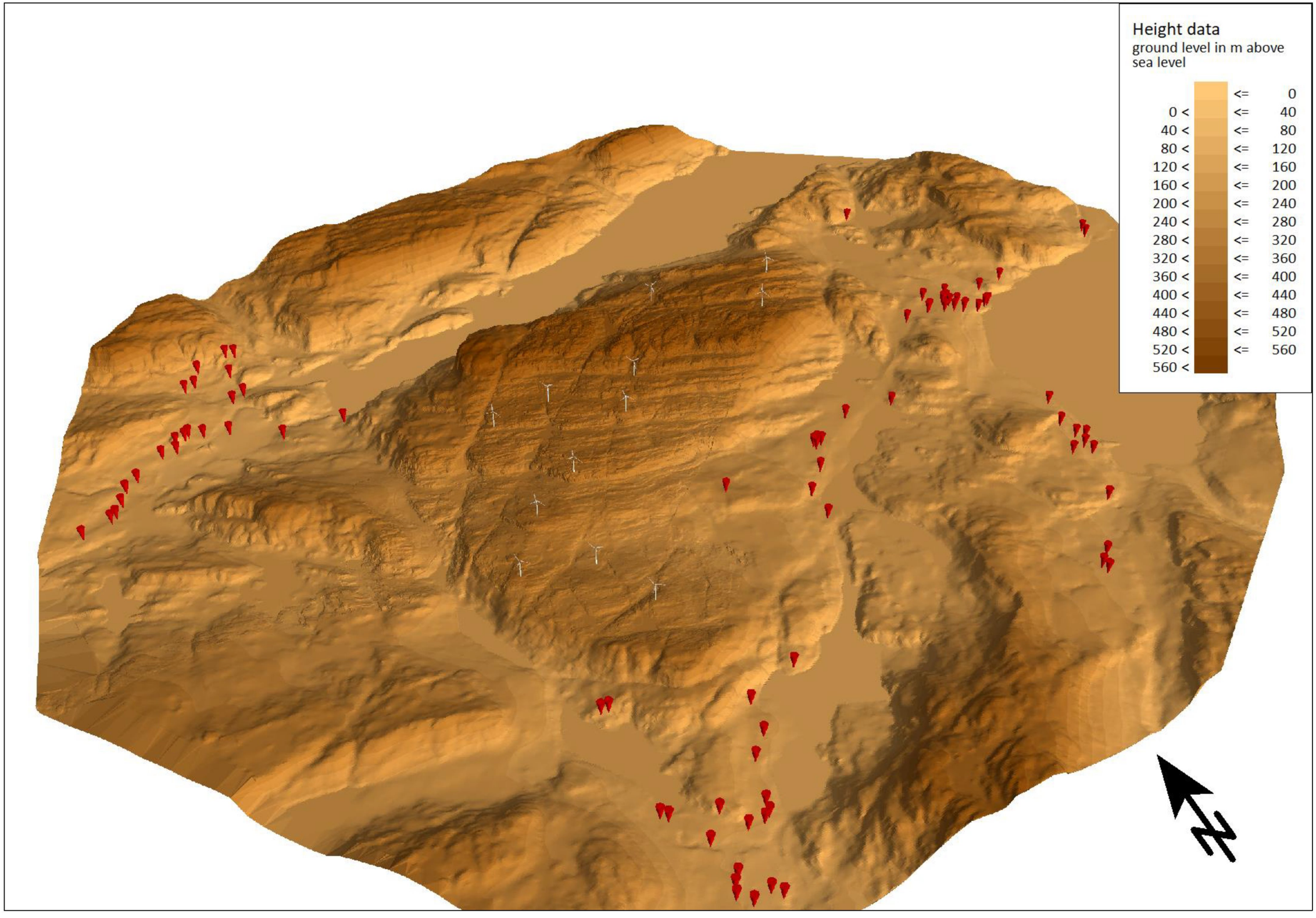

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Distance NSA-WTG

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			Horizontal distance NSA-WTG [m]											
NSA	**X [m]**	**Y [m]**	**T01**	**T02**	**T03**	**T04**	**T05**	**T06**	**T07**	**T08**	**T09**	**T10**	**T11**	**T12**
A	332771	6507954	2345	1892	1541	954	1195	1223	**926**	1186	1570	2026	1386	1087
AA	330234	6510503	4243	4036	2785	2655	2980	2582	2903	3550	**2057**	3342	2395	3070
AB	335517	6508740	**1449**	1537	4367	3513	2662	3938	2886	4005	3706	2289	3283	3935
AC	330264	6510515	4216	4011	2785	2644	2959	2577	2885	3548	**2041**	3315	2376	3066
AD	330513	6510424	3954	3746	2621	2414	2697	2375	2629	3365	**1793**	3053	2117	2875
AE	330609	6511139	4064	3932	3295	2961	3028	2995	3041	4007	**2281**	3179	2520	3508
AF	330893	6511157	3808	3692	3272	2855	2833	2931	2874	3951	**2157**	2930	2356	3449
AG	330834	6511167	3866	3748	3288	2887	2882	2956	2918	3975	**2192**	2987	2399	3472
AH	330956	6506008	5006	4552	1915	2733	3681	2394	3318	**1536**	3332	4605	3497	1941
AI	333251	6507684	2272	1830	2032	1502	1504	1765	**1337**	1521	2084	2172	1844	1561
AJ	330674	6510719	3867	3695	2871	2564	2716	2579	2695	3587	**1900**	2969	2173	3090
AK	335729	6508724	**1628**	1741	4572	3724	2874	4147	3098	4198	3919	2484	3495	4138
AL	330351	6510472	4122	3915	2716	2554	2862	2495	2789	3473	**1947**	3222	2279	2988
AM	330135	6510411	4323	4105	2737	2656	3029	2560	2936	3513	**2081**	3423	2434	3039
AN	335605	6508690	**1548**	1637	4444	3599	2756	4021	2976	4070	3800	2390	3378	4009
AO	335797	6508891	**1599**	1758	4672	3804	2922	4235	3163	4320	3969	2476	3542	4244
AP	331443	6505814	4837	4385	2100	2775	3628	2504	3280	**1529**	3429	4526	3532	2005
AQ	335693	6508715	**1604**	1710	4535	3688	2839	4111	3063	4161	3884	2456	3461	4101
AR	330449	6510986	4161	4008	3181	2910	3055	2911	3042	3913	**2249**	3268	2520	3418
AS	331412	6505743	4913	4460	2168	2850	3706	2577	3357	**1605**	3503	4603	3608	2079
AT	332203	6506541	3801	3351	1673	1998	2690	1871	2369	**875**	2703	3548	2707	1360
AU	330784	6511004	3852	3715	3133	2761	2807	2813	2824	3829	**2074**	2964	2303	3328
AV	335206	6507563	2241	**2073**	3990	3339	2807	3681	2885	3438	3750	2839	3382	3519
AW	330525	6511003	4095	3947	3179	2885	3006	2898	3000	3904	**2217**	3204	2478	3407
AX	331032	6505511	5330	4877	2400	3173	4078	2859	3721	**1944**	3796	4988	3937	2386
AY	331587	6506091	4530	4078	1847	2475	3317	2222	2970	**1230**	3139	4213	3230	1715
AZ	331368	6505722	4956	4504	2185	2880	3743	2602	3393	**1636**	3530	4642	3639	2107
B	333610	6508081	1752	1319	2386	1662	1285	2021	**1255**	1989	2103	1762	1774	1935
BA	330983	6505466	5396	4943	2450	3232	4140	2914	3783	**2004**	3851	5051	3995	2443

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Distance NSA-WTG

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			Horizontal distance NSA-WTG [m]											
NSA	**X [m]**	**Y [m]**	**T01**	**T02**	**T03**	**T04**	**T05**	**T06**	**T07**	**T08**	**T09**	**T10**	**T11**	**T12**
BB	331736	6506213	4342	3890	1764	2333	3148	2104	2805	**1094**	3009	4038	3081	1591
BC	329301	6509896	5095	4825	2774	3034	3663	2793	3487	3584	**2629**	4209	3042	3180
BD	335992	6508887	**1774**	1948	4862	3998	3117	4427	3358	4501	4163	2659	3736	4432
BE	330944	6505406	5467	5014	2513	3301	4211	2981	3854	**2075**	3918	5123	4064	2512
BF	329804	6510266	4627	4391	2760	2807	3280	2655	3156	3558	**2291**	3730	2671	3105
BG	331155	6505289	5430	4978	2615	3352	4225	3057	3874	**2111**	3991	5124	4113	2571
BH	331045	6505761	5130	4676	2150	2932	3851	2612	3492	**1710**	3550	4766	3696	2143
BI	331119	6505347	5405	4953	2558	3305	4187	3005	3835	**2067**	3940	5090	4067	2523
BJ	330996	6505329	5495	5042	2585	3358	4257	3045	3902	**2126**	3982	5164	4121	2571
BK	334354	6506199	3451	3122	3558	3306	3290	3470	3177	**2804**	3929	3738	3691	3105
BL	329509	6509960	4891	4627	2683	2881	3474	2663	3310	3492	**2448**	4003	2854	3071
BM	329629	6510092	4781	4529	2713	2848	3392	2657	3244	3519	**2379**	3889	2776	3083
BN	329554	6509994	4848	4587	2680	2859	3439	2650	3279	3489	**2415**	3959	2820	3063
BO	334243	6506126	3527	3188	3497	3281	3308	3429	3181	**2733**	3916	3786	3691	3050
BP	334926	6507054	2651	**2406**	3791	3268	2920	3554	2924	3158	3769	3125	3442	3317
BQ	334236	6506071	3582	3242	3519	3317	3356	3459	3225	**2751**	3956	3838	3734	3075
BR	329703	6510205	4720	4477	2763	2851	3355	2681	3221	3565	**2355**	3824	2743	3121
BS	335049	6506993	2738	**2508**	3925	3406	3050	3691	3059	3286	3904	3236	3576	3450
BT	334777	6506591	3083	**2804**	3781	3379	3176	3612	3128	3083	3940	3487	3650	3312
BU	335053	6507074	2660	**2435**	3911	3373	2996	3667	3013	3283	3862	3167	3529	3436
BV	335134	6507145	2613	**2404**	3976	3417	3008	3720	3037	3360	3891	3146	3550	3501
BW	330767	6510745	3785	3620	2880	2540	2656	2571	2646	3585	**1866**	2888	2124	3085
BX	335085	6507187	2559	**2345**	3920	3355	2943	3660	2973	3309	3828	3085	3486	3446
BY	331084	6506836	4341	3893	1077	1931	2927	1565	2557	**838**	2502	3861	2688	1144
BZ	331195	6510109	3228	3003	2206	1777	1947	1842	1899	2863	**1100**	2331	1380	2360
C	333576	6508073	1775	1340	2351	1631	1273	1989	**1234**	1955	2079	1768	1754	1900
CA	331269	6505735	5007	4554	2168	2892	3772	2599	3419	**1651**	3532	4677	3653	2111
CB	331826	6506447	4103	3650	1573	2091	2897	1879	2554	**860**	2773	3788	2835	1362
CC	337004	6508998	**2694**	2931	5876	5016	4121	5445	4372	5493	5167	3594	4738	5442

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Distance NSA-WTG

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			Horizontal distance NSA-WTG [m]											
NSA	**X [m]**	**Y [m]**	**T01**	**T02**	**T03**	**T04**	**T05**	**T06**	**T07**	**T08**	**T09**	**T10**	**T11**	**T12**
CD	337021	6509053	**2698**	2942	5903	5038	4136	5469	4391	5526	5182	3598	4752	5471
CE	331128	6506824	4316	3867	1084	1921	2910	1563	2541	**809**	2500	3843	2680	1131
CF	331200	6505894	4928	4475	2009	2758	3660	2452	3303	**1526**	3387	4572	3521	1972
CG	335096	6507338	2417	**2214**	3906	3308	2853	3627	2900	3318	3759	2962	3408	3433
D	333578	6508044	1800	1366	2351	1642	1299	1994	**1254**	1945	2097	1797	1775	1898
E	333953	6508203	1512	**1115**	2738	1970	1422	2354	1478	2353	2343	1696	1978	2293
F	333629	6508057	1765	1335	2403	1687	1316	2043	**1285**	1998	2132	1787	1804	1951
G	333454	6507850	2029	1593	2224	1596	1412	1909	**1309**	1762	2116	1991	1829	1760
H	335040	6508832	**1045**	1063	3921	3045	2176	3477	2406	3601	3221	1832	2798	3500
I	335278	6508857	**1191**	1271	4158	3284	2409	3716	2644	3828	3455	2023	3030	3735
J	333198	6507458	2495	2056	2017	1600	1714	1811	1520	**1428**	2223	2402	2014	1542
K	335255	6508845	**1182**	1254	4133	3260	2388	3692	2621	3802	3434	2009	3009	3709
L	335328	6508988	**1148**	1279	4238	3349	2447	3787	2697	3928	3494	2008	3066	3821
M	335367	6508791	**1301**	1378	4230	3367	2506	3795	2734	3884	3551	2133	3127	3803
N	330776	6510152	3649	3419	2295	2038	2339	2016	2257	3017	**1416**	2752	1749	2522
O	335425	6508880	**1290**	1403	4306	3433	2553	3865	2791	3972	3599	2142	3173	3882
P	335449	6508835	**1336**	1440	4320	3452	2581	3882	2815	3977	3627	2184	3203	3893
Q	335463	6508887	**1317**	1437	4345	3471	2590	3903	2829	4010	3636	2173	3210	3921
R	334309	6508148	1504	**1182**	3088	2331	1736	2712	1824	2667	2690	1871	2314	2637
S	335506	6508953	**1316**	1460	4402	3521	2627	3956	2873	4076	3674	2184	3246	3981
T	335600	6510183	**1322**	1744	4928	3952	2906	4414	3244	4784	3879	2118	3456	4573
U	335437	6508765	**1371**	1453	4293	3435	2579	3862	2805	3939	3624	2207	3201	3864
V	335503	6508812	**1393**	1498	4368	3504	2638	3933	2870	4018	3684	2243	3259	3939
W	330166	6510487	4306	4097	2795	2689	3034	2605	2951	3566	**2101**	3406	2445	3089
X	330930	6506048	4995	4542	1879	2707	3661	2363	3297	**1517**	3301	4586	3469	1914
Y	330035	6510415	4422	4203	2782	2730	3122	2622	3024	3564	**2166**	3522	2524	3095
Z	335501	6508731	**1442**	1525	4350	3497	2647	3921	2870	3986	3692	2279	3269	3918

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Distance NSA-WTG

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Information on distance
The distance corresponds to the horizontal distance in m between the NSA and the WTG.

The WTG with the shortest distance to each NSA are marked with blue color in the table.

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Point calculations

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					L_{den} [dBA]	
NSA	**X [m]**	**Y [m]**	**Z_{ground} [mas]**	**Calculation height [m]**	**B01**	**B02**
A[1)]	332771	6507954	294	1,5 m	48	45
A[1)]	332771	6507954	294	4,0 m	48	45
AA	330234	6510503	211	1,5 m	38	34
AA	330234	6510503	211	4,0 m	38	34
AB	335517	6508740	197	1,5 m	39	35
AB	335517	6508740	197	4,0 m	39	35
AC	330264	6510515	214	1,5 m	38	34
AC	330264	6510515	214	4,0 m	38	34
AD	330513	6510424	190	1,5 m	38	34
AD	330513	6510424	190	4,0 m	39	35
AE	330609	6511139	231	1,5 m	37	34
AE	330609	6511139	231	4,0 m	38	34
AF	330893	6511157	246	1,5 m	38	34
AF	330893	6511157	246	4,0 m	38	34
AG	330834	6511167	261	1,5 m	37	33
AG	330834	6511167	261	4,0 m	38	34
AH	330956	6506008	216	1,5 m	38	33
AH	330956	6506008	216	4,0 m	39	34
AI	333251	6507684	215	1,5 m	39	34
AI	333251	6507684	215	4,0 m	41	35
AJ	330674	6510719	198	1,5 m	38	33
AJ	330674	6510719	198	4,0 m	38	34
AK	335729	6508724	173	1,5 m	39	35
AK	335729	6508724	173	4,0 m	39	35
AL	330351	6510472	203	1,5 m	38	34
AL	330351	6510472	203	4,0 m	38	35
AM	330135	6510411	202	1,5 m	37	33
AM	330135	6510411	202	4,0 m	38	33
AN	335605	6508690	176	1,5 m	37	30

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Point calculations

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					L_{den} [dBA]	
NSA	**X [m]**	**Y [m]**	**Z_{ground} [mas]**	**Calculation height [m]**	**B01**	**B02**
AN	335605	6508690	176	4,0 m	38	33
AO	335797	6508891	184	1,5 m	39	35
AO	335797	6508891	184	4,0 m	39	35
AP	331443	6505814	204	1,5 m	38	31
AP	331443	6505814	204	4,0 m	38	31
AQ	335693	6508715	178	1,5 m	39	35
AQ	335693	6508715	178	4,0 m	39	35
AR	330449	6510986	224	1,5 m	38	34
AR	330449	6510986	224	4,0 m	38	34
AS	331412	6505743	199	1,5 m	37	31
AS	331412	6505743	199	4,0 m	37	31
AT	332203	6506541	207	1,5 m	40	30
AT	332203	6506541	207	4,0 m	40	30
AU	330784	6511004	206	1,5 m	36	31
AU	330784	6511004	206	4,0 m	36	32
AV	335206	6507563	187	1,5 m	37	34
AV	335206	6507563	187	4,0 m	38	34
AW	330525	6511003	217	1,5 m	38	34
AW	330525	6511003	217	4,0 m	38	34
AX	331032	6505511	201	1,5 m	36	31
AX	331032	6505511	201	4,0 m	36	32
AY	331587	6506091	206	1,5 m	39	29
AY	331587	6506091	206	4,0 m	38	29
AZ	331368	6505722	199	1,5 m	37	31
AZ	331368	6505722	199	4,0 m	37	31
B	333610	6508081	220	1,5 m	45	41
B	333610	6508081	220	4,0 m	45	41
BA	330983	6505466	200	1,5 m	36	31
BA	330983	6505466	200	4,0 m	36	32

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Point calculations

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					L_{den} [dBA]	
NSA	**X [m]**	**Y [m]**	**$Z_{,ground}$ [mas]**	**Calculation height [m]**	**B01**	**B02**
BB	331736	6506213	204	1,5 m	38	28
BB	331736	6506213	204	4,0 m	38	27
BC	329301	6509896	236	1,5 m	35	31
BC	329301	6509896	236	4,0 m	36	31
BD	335992	6508887	206	1,5 m	37	32
BD	335992	6508887	206	4,0 m	37	33
BE	330944	6505406	201	1,5 m	36	31
BE	330944	6505406	201	4,0 m	36	32
BF	329804	6510266	211	1,5 m	37	33
BF	329804	6510266	211	4,0 m	37	33
BG	331155	6505289	186	1,5 m	35	30
BG	331155	6505289	186	4,0 m	36	31
BH	331045	6505761	200	1,5 m	37	32
BH	331045	6505761	200	4,0 m	37	32
BI	331119	6505347	191	1,5 m	36	31
BI	331119	6505347	191	4,0 m	36	31
BJ	330996	6505329	196	1,5 m	36	31
BJ	330996	6505329	196	4,0 m	36	31
BK	334354	6506199	224	1,5 m	36	31
BK	334354	6506199	224	4,0 m	36	31
BL	329509	6509960	221	1,5 m	36	31
BL	329509	6509960	221	4,0 m	36	31
BM	329629	6510092	206	1,5 m	36	32
BM	329629	6510092	206	4,0 m	37	32
BN	329554	6509994	214	1,5 m	36	31
BN	329554	6509994	214	4,0 m	36	31
BO	334243	6506126	236	1,5 m	36	31
BO	334243	6506126	236	4,0 m	36	31
BP	334926	6507054	207	1,5 m	37	31

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Point calculations

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					L_{den} [dBA]	
NSA	**X [m]**	**Y [m]**	**Z_{ground} [mas]**	**Calculation height [m]**	**B01**	**B02**
BP	334926	6507054	207	4,0 m	37	31
BQ	334236	6506071	235	1,5 m	36	30
BQ	334236	6506071	235	4,0 m	36	31
BR	329703	6510205	208	1,5 m	36	32
BR	329703	6510205	208	4,0 m	36	32
BS	335049	6506993	191	1,5 m	36	31
BS	335049	6506993	191	4,0 m	36	31
BT	334777	6506591	201	1,5 m	36	30
BT	334777	6506591	201	4,0 m	36	31
BU	335053	6507074	194	1,5 m	36	30
BU	335053	6507074	194	4,0 m	36	30
BV	335134	6507145	184	1,5 m	36	29
BV	335134	6507145	184	4,0 m	36	29
BW	330767	6510745	205	1,5 m	35	29
BW	330767	6510745	205	4,0 m	34	29
BX	335085	6507187	192	1,5 m	35	28
BX	335085	6507187	192	4,0 m	35	28
BY	331084	6506836	239	1,5 m	39	28
BY	331084	6506836	239	4,0 m	38	29
BZ	331195	6510109	197	1,5 m	27	20
BZ	331195	6510109	197	4,0 m	30	25
C	333576	6508073	220	1,5 m	45	41
C	333576	6508073	220	4,0 m	45	42
CA	331269	6505735	199	1,5 m	36	28
CA	331269	6505735	199	4,0 m	36	28
CB	331826	6506447	204	1,5 m	27	18
CB	331826	6506447	204	4,0 m	27	18
CC	337004	6508998	175	1,5 m	33	25
CC	337004	6508998	175	4,0 m	33	25

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Point calculations

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					L_{den} [dBA]	
NSA	**X [m]**	**Y [m]**	**Z_{ground} [mas]**	**Calculation height [m]**	**B01**	**B02**
CD	337021	6509053	187	1,5 m	33	26
CD	337021	6509053	187	4,0 m	33	26
CE	331128	6506824	242	1,5 m	30	22
CE	331128	6506824	242	4,0 m	31	23
CF	331200	6505894	223	1,5 m	27	20
CF	331200	6505894	223	4,0 m	29	22
CG	335096	6507338	194	1,5 m	27	19
CG	335096	6507338	194	4,0 m	27	19
D	333578	6508044	220	1,5 m	45	41
D	333578	6508044	220	4,0 m	45	41
E	333953	6508203	214	1,5 m	44	40
E	333953	6508203	214	4,0 m	44	41
F	333629	6508057	220	1,5 m	44	41
F	333629	6508057	220	4,0 m	45	41
G	333454	6507850	216	1,5 m	44	40
G	333454	6507850	216	4,0 m	44	41
H	335040	6508832	225	1,5 m	41	35
H	335040	6508832	225	4,0 m	41	35
I	335278	6508857	218	1,5 m	42	38
I	335278	6508857	218	4,0 m	42	38
J	333198	6507458	211	1,5 m	43	39
J	333198	6507458	211	1,5 m	43	40
K	335255	6508845	219	4,0 m	42	38
K	335255	6508845	219	1,5 m	42	38
L	335328	6508988	216	4,0 m	42	37
L	335328	6508988	216	1,5 m	42	38
M	335367	6508791	215	4,0 m	41	37
M	335367	6508791	215	1,5 m	41	38
N	330776	6510152	214	4,0 m	40	36

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Point calculations

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					L_{den} [dBA]	
NSA	**X [m]**	**Y [m]**	**$Z_{,ground}$ [mas]**	**Calculation height [m]**	**B01**	**B02**
N	330776	6510152	214	1,5 m	41	36
O	335425	6508880	211	4,0 m	41	37
O	335425	6508880	211	1,5 m	41	37
P	335449	6508835	209	4,0 m	40	37
P	335449	6508835	209	1,5 m	41	37
Q	335463	6508887	209	4,0 m	41	37
Q	335463	6508887	209	1,5 m	41	38
R	334309	6508148	204	4,0 m	42	39
R	334309	6508148	204	1,5 m	43	39
S	335506	6508953	206	4,0 m	41	37
S	335506	6508953	206	1,5 m	41	38
T	335600	6510183	219	4,0 m	40	36
T	335600	6510183	219	1,5 m	40	36
U	335437	6508765	208	4,0 m	40	36
U	335437	6508765	208	1,5 m	40	37
V	335503	6508812	204	4,0 m	40	36
V	335503	6508812	204	1,5 m	40	37
W	330166	6510487	213	4,0 m	38	34
W	330166	6510487	213	1,5 m	38	34
X	330930	6506048	217	4,0 m	39	35
X	330930	6506048	217	1,5 m	40	35
Y	330035	6510415	205	4,0 m	38	34
Y	330035	6510415	205	1,5 m	38	34
Z	335501	6508731	198	4,0 m	38	34
Z	335501	6508731	198	1,5 m	39	35

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Point calculations

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Information on results

The calculations are performed with the assumption that the noise sensitive area (NSA) are located 1,5 m and 4,0 m above ground. The height of 4,0 m should be considered decisive according to the Norweigan guidelines on noise. According to the European directive on environmental noise it is also possible to use calculations on 1,5 m above ground for recreational areas and areas with one-storey housing as an additional indicator. For indexing of NSA see the noise maps.

Note that if the point calculation and noise map show contradictory results, it is primary the point calculation that should be used. The noise map should be considered as a complement to the point calculation.

The calculation result is rounded to the nearest integer value according to the guidelines *Veileder til retningslinje for behandling av støy i arealplanlegging (T-1442/2016)*:

"Når det skal rundes av til nærmeste hele tall ser vi på første siffer rett etter kommaet.
-er sifferet 0, 1, 2, 3 eller 4 tar vi vekk alle desimalsifrene og beholder det hele tallet slik som det var
-er sifferet 5, 6, 7, 8 eller 9 tar vi vekk alle desimalsifrene og øker det hele tallet med 1

Eksempel; 54,499 = 54
54,511 = 55"

L_{den} has been calculated with a penalty of 5 dB for L_e (evening 19-23) and 10 dB for L_n (night 23-07) which is resulting in an addition of 6,4 dBA to the calculated equivalent sound level.

The noise limit has been assumed to be L_{den}=45 dBA according to T-1442 and if the calculated value is above the limit 45 dBA it is marked with red.

[1)]The property owner at NSA A have an agreement with Norsk Vind Energi AS and the NSA should not be considered in regards of the noise limit L_{den}=45 dBA.

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Noise map - Case B01:1 4,0 m

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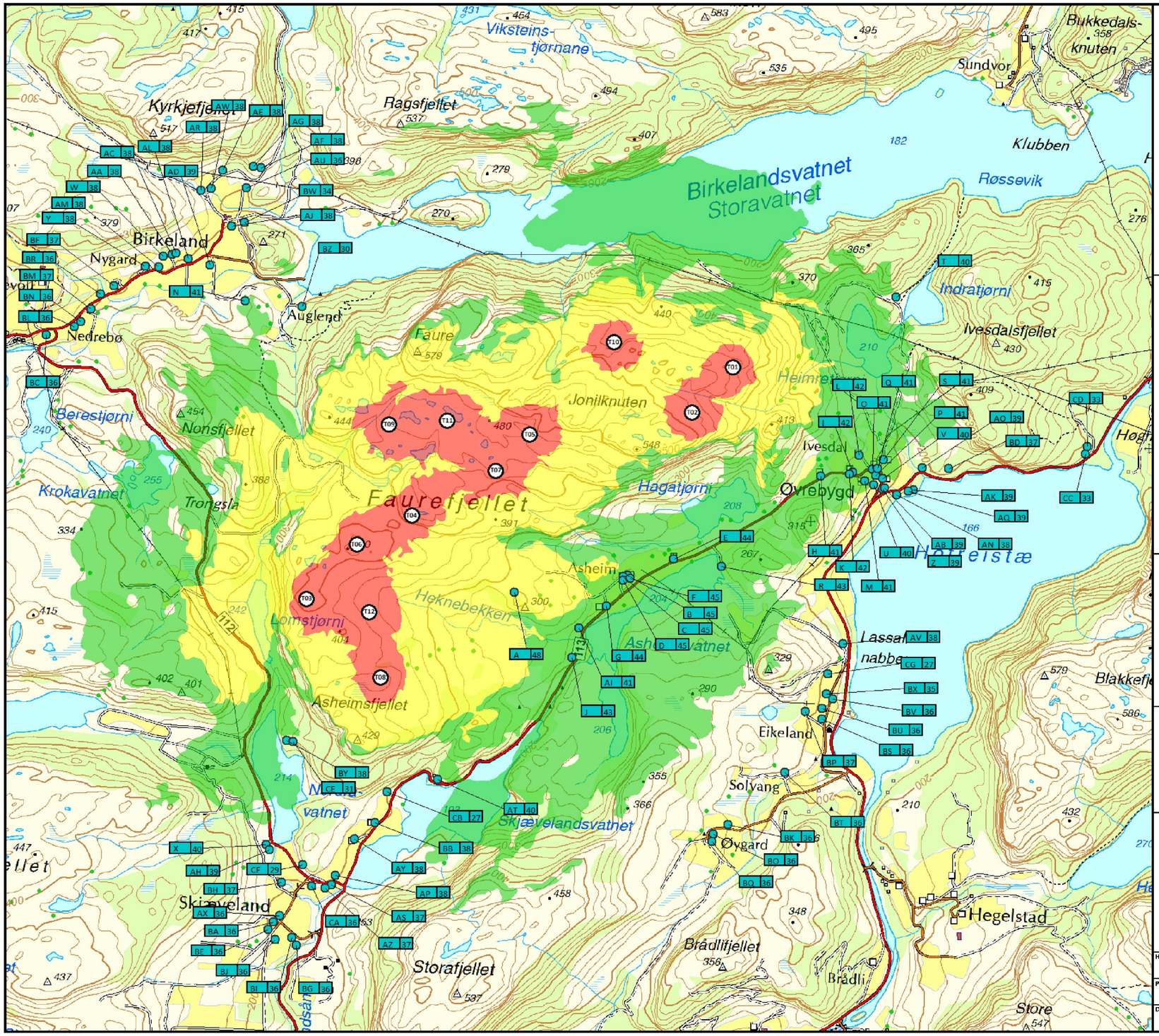

Yearly Average, L_{den}, in dBA
Result 4,0 m above ground

40 <=		<	45
45 <=		<	55
55 <=			

NSA

WTG

NSA	L_{Aeq} [dBA]	Index NSA

N

0 700 1400 2100 m

Wind farm Faurefjellet
12 Wind Turbines (WTG) - Vestas V150-5.6 MW
Case B01 - Worst Case

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Beräknad med SoundPLAN 8.1 uppdatering 2020-03-06 www.akustikkonsulten.se

Handläggare	Kvalitetsgranskare
Paul Appelqvist	Jens Fredriksson
Projekt nr.	**Ritning**
10-19125	B01:1
Datum	
2020-04-29	

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Noise map - Case B01:2 1,5 m

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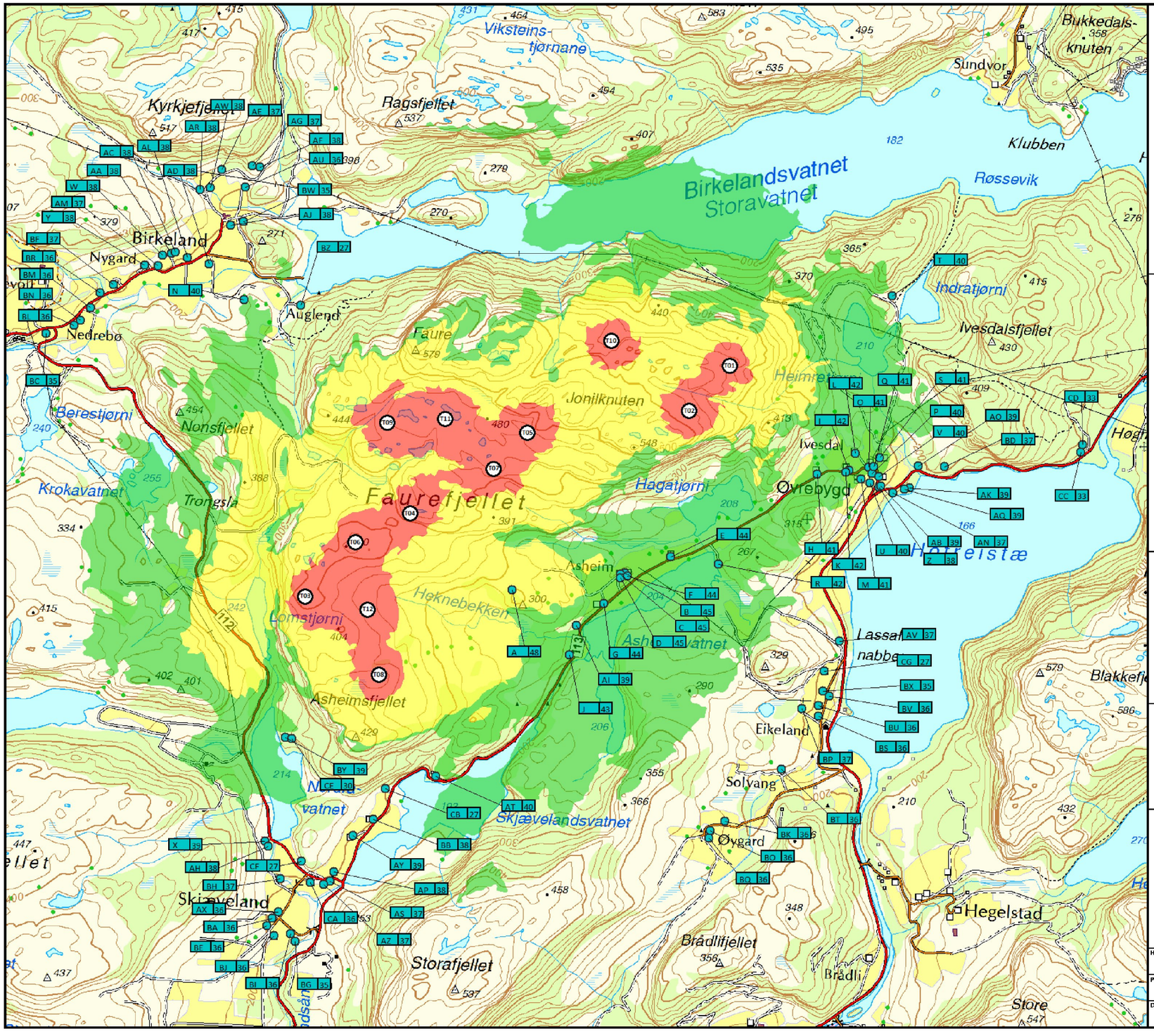

Yearly Average, L_{den}, in dBA
Result 1,5 m above ground

40 <=		<	45
45 <=		<	55
55 <=			

NSA
WTG

NSA	L_{Aeq} [dBA]	Index NSA

N

0 700 1400 2100 m

Wind farm Faurefjellet
12 Wind Turbines (WTG) - Vestas V150-5.6 MW
Case B01 - Worst Case

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Handläggare	Kvalitetsgranskare
Paul Appelqvist	Jens Fredriksson
Projekt nr.	**Ritning**
10-19125	B01:2
Datum	
2020-04-29	

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Noise map - Case B02:1 4,0 m

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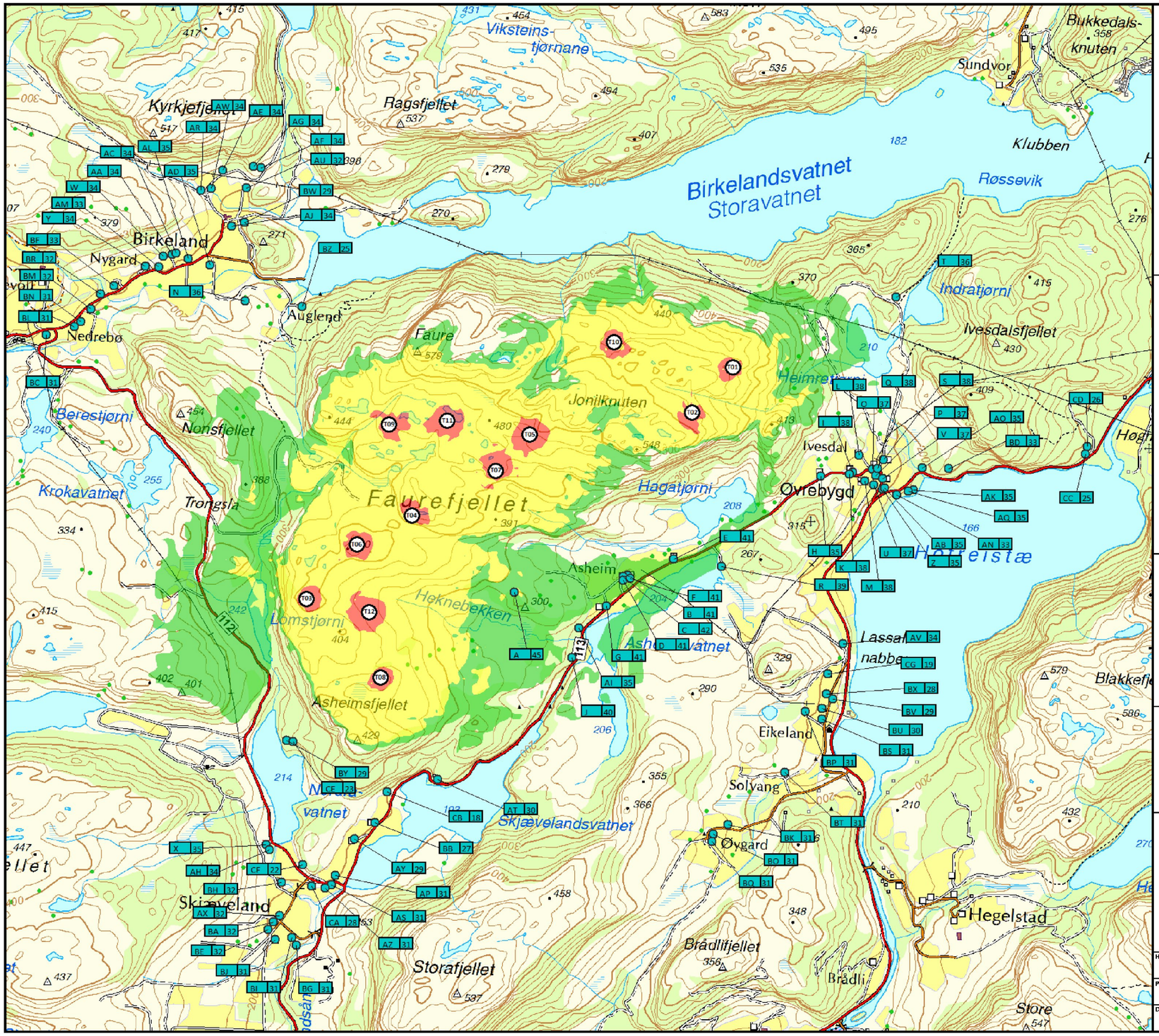

Yearly Average, L_{den}, in dBA
Result 4,0 m above ground

40 <=		<	45
45 <=		<	55
55 <=			

NSA
WTG

NSA	L_{Aeq} [dBA]	Index NSA

N

0 700 1400 2100 m

Wind farm Faurefjellet
12 Wind Turbines (WTG) - Vestas V150-5.6 MW
Case B02 - Lokale vindforhold

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Handläggare	Kvalitetsgranskare
Paul Appelqvist	Jens Fredriksson
Projekt nr.	**Ritning**
10-19125	B02:1
Datum	
2020-04-29	

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Date: 2020-04-29
Project: Wind farm Faurefjellet

Noise map - Case B02:2 1,5 m

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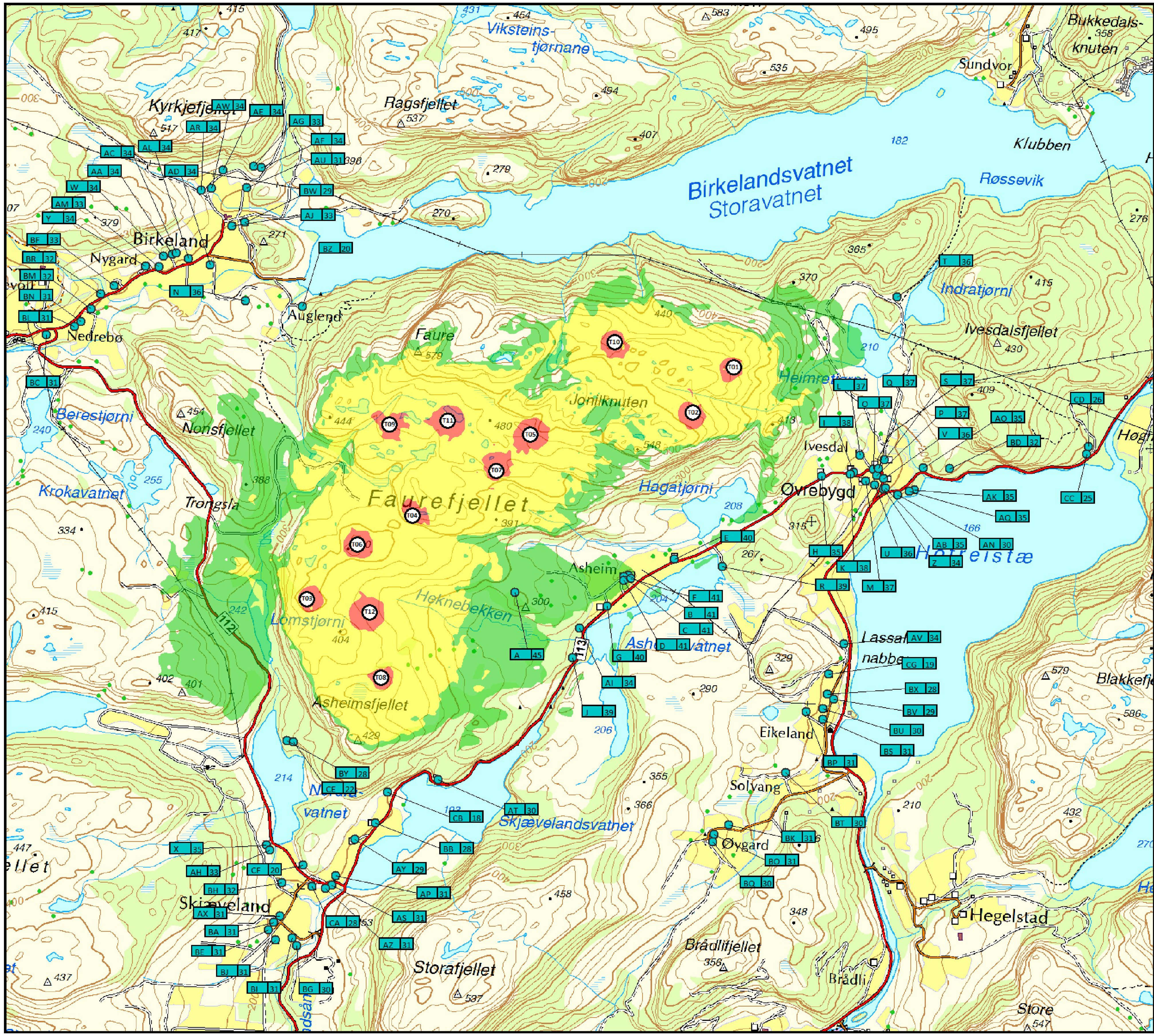

Yearly Average, L_{den}, in dBA
Result 1,5 m above ground

40 <=	<	45
45 <=	<	55
55 <=		

NSA

WTG

NSA | L_{Aeq} [dBA] — Index NSA

0 700 1400 2100 m

Wind farm Faurefjellet
12 Wind Turbines (WTG) - Vestas V150-5.6 MW
Case B02 - Lokale vindforhold

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Handläggare	Kvalitetsgranskare
Paul Appelqvist	Jens Fredriksson
Projekt nr. 10-19125	Ritning B02:2
Datum 2020-04-29	

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se