Rochdale Holdings Pty Ltd A.B.N. 85 009 049 067 trading as:
HERRING STORER ACOUSTICS
Suite 34, 11 Preston Street, Como, W.A. 6152
P.O. Box 219, Como, W.A. 6952
Telephone: (08) 9367 6200
Facsimile: (08) 9474 2579
Email: hsa@hsacoustics.com.au

VERVE ENERGY

WARRADARGE WIND FARM

NOISE IMPACT ASSESSMENT

MARCH 2012

OUR REFERENCE:14014-9-11250

DOCUMENT CONTROL PAGE

NOISE IMPACT ASSESSMENT
WARRADARGE

Job No: 11250

Document Reference : 14014-9-11250

FOR

VERVE ENERGY

DOCUMENT INFORMATION			
Author:	George Watts	**Checked By:**	Tim Reynolds
Date of Issue :	16 March 2012		

REVISION HISTORY

Revision	Description	Date	Author	Checked
1	Incorporating comments from Verve Energy	13/01/2012	GW	TR
2	Incorporating comments from Verve Energy	23/01/2012	GW	TR
3	Incorporating new turbine type	08/02/2012	GW	TR
4	Incorporating background noise monitoring criteria	16/03/2012	GW	TR
5	Incorporating comments from Verve Energy	21/03/2012	GW	TR
6	Incorporating comments from Verve Energy	30/03/2012	HS	TR
7	Incorporating comments from Verve Energy	17/04/2012	GW	TR
8	Incorporating comments from Verve Energy	17/04/2012	GW	TR

DOCUMENT DISTRIBUTION

Copy No.	Version No.	Destination	Hard Copy	Electronic Copy
1	1	Verve Energy		✓
1	2	Verve Energy		✓
1	3	Verve Energy		✓
1	4	Verve Energy		✓
1	5	Verve Energy		✓
1	6	Verve Energy		✓
1	7	Verve Energy		✓
1	8	Verve Energy		✓
1	9	Verve Energy		✓

CONTENTS

APPENDICIES

1. INTRODUCTION

Herring Storer Acoustics was commissioned by Verve Energy to carry out a noise impact assessment for the proposed Warradarge Wind Farm development.

The proposed development site is located on private farming land in Warradarge, approximately 240km north of Perth and 18km east of Eneabba.

The proposed wind farm consists of up to 100 wind turbines, with a maximum generating capacity of 250 MW.

See Appendix A for locations of turbines and noise sensitive premises.

The noise impact assessment has been carried out in accordance with the EPA of South Australia *"Wind Farms – Environmental noise guidelines – July 2009"* (Guidelines) which is the guidelines recognised by the Department of Environment and Conservation for the assessment of wind farms.

2. SUMMARY

Noise levels were assessed at 13 identified receiver points, with these locations shown in Appendix A.

Noise emissions at domestic receiver points have been calculated to comply with the background noise criteria under all wind conditions.

Noise levels at one "non-domestic" receiver point have been calculated to exceed the background noise criteria. It is noted that the criteria is unlikely to be applicable at this location.

The following property lot numbers are understood to be owned by non-participants of the proposed development. The 39 dB(A) noise contour, being the minimum background noise criteria at this wind speed, encroaches on these properties for the noisiest operating condition (8m/s) as shown in Appendix B, Map 3A. There is a risk that residences, or other noise sensitive premises, may be constructed at a later date in the areas within the 39 dB(A) contour. The affected lot numbers are:

10849
10854
10877

It is recommended that Verve Energy consider if measures need to be put in place to minimise this risk.

Although not required under the EPA of South Australia *"Wind Farms – Environmental Noise Guidelines – July 2009"* (Guidelines), an assessment of low frequency and infrasound content has been conducted and included in Appendix C. Based on the assessment, low frequency noise and infrasound are considered highly unlikely to represent a problem in the vicinity of the proposed wind farm.

3. CRITERIA

According to the Western Australian Planning bulletin number 67 "Guidelines for Wind Farm Development" – May 2004, the noise impact of proposed wind farms in Western Australia should be assessed in accordance with the criteria and approach of assessing wind farms described in the EPA of South Australia *"Wind Farms – Environmental noise guidelines – July 2009"* (Guidelines).

The Guidelines recommend the following criteria for the assessment of noise levels associated with proposed wind farms;

> *The predicted equivalent noise level ($L_{Aeq\ ,10\ minutes}$), adjusted for tonality in accordance with the Guidelines, should not exceed :*
>
> - *35 dB(A) at relevant receivers in localities which are primarily intended for rural living, or*
> - *40 dB(A) at relevant receivers in localities in other zones, or*
> - *the background noise ($L_{A90,10\ minutes}$) by more than 5 dB(A).*
>
> *Whichever is the greater at all the relevant receivers for wind speeds from cut-in to rated power of the wind turbine and each integer speed in between.*
>
> *The criteria for background noise levels will vary with wind speed, as will wind turbine generated noise.*

In accordance with the Guidelines, a "rural living" zone is a rural-residential "lifestyle" area intended to have a relatively quiet amenity. The area should not be used for primary production other than to produce food, crops or keep animals for the occupiers' own use, consumption and/or enjoyment.

If there is any uncertainty about the zone, and whether the rural living criteria should be applied, the question should be resolved in consultation with the relevant environmental protection authority and council for the area concerned.

Through discussions with John MacPherson, Principal Environmental Noise Officer of the Department of Environment and Conservation, it is understood that the Department of Environment and Conservation has the expectation that the "rural living" zone is applicable for the receivers in the proposed development area.

This assessment has been based on the background noise monitoring criteria, which is presented in an accompanying report (Our Ref: 14290-2-11250-01).

It is noted that the Guidelines have been developed to minimise the impact on the amenity of premises that do not have an agreement with wind farm developers. Our assessment includes all identified residential premises in the surrounding area, some of which may have such an agreement.

4. MODELLING

Noise immissions at residential premises, due to the proposed wind farm, were determined by noise modelling, using the computer program “SoundPlan” version 7.1.

SoundPlan uses the theoretical sound power levels determined from measured sound pressure levels to calculate the noise level at any location.

The following input data was used in the SoundPlan model:

a) Topographical Information – Ground contours of the development area

b) Residential and Wind Turbine Locations – See Appendix A for location map and table of wind turbine locations and receiver point locations.

c) Sound Power Levels, varying with wind speed, of the wind turbines which are understood to be the noisiest turbines under consideration (Siemens SWt-3.0-101), at the highest hub height under consideration (100m) – See Table 4.1 below.

Table 4.1 – Siemens SWT-3.0-101, 100m hub, Sound Power Levels

Wind Speed (10m above ground), m/s	Sound Power Level, dB(A)
6	105.1
7	107.0
8	108.0
9	108.0
10	108.0

The Guidelines indicate that noise immissions should be modelled to reflect typical, (but not extreme) “worst case” meteorological conditions for sound propagation towards the receiver.

After a review of the literature available on the subject, noise level emissions were modelled using the ISO 9613-2:1996 algorithm, with the conditions listed in Table 4.2. These conditions, and calculating noise levels utilising a “G=0” ground absorption have been found to provide a generally realistic and conservative assessment of noise levels associated with wind turbines, generally over predicting (i.e. a conservative calculation) in the order of 2 – 3 dB.

Table 4.2 – Meteorological Conditions

Condition	Value
Temperature	15 ^{o}C
Relative humidity	70%
Atmospheric Pressure	101.325 kPa

Noise levels attributable to the proposed wind farm were calculated for integer wind speeds 6 – 8m/s at a height of 100m (hub height). The sound power levels of the turbines at wind speeds above 8m/s are the same as at 8m/s and are therefore represented by this wind speed. Noise levels for integer wind speeds below 6m/s are lower than those at 6m/s, hence noise emissions at 6m/s can be considered a conservative representation of lower wind speed noise levels.

The sound power level of the turbines were varied for each integer wind speed, however the weather conditions within the model remained constant at the conditions stipulated in Table 4.1 above.

5. RESULTS

Noise contour plots are attached in Appendix B.

The predicted noise levels at each identified receiver point are listed in Table 5.1 below for each of the wind speeds considered.

Table 5.1 – Predicted Noise Levels at Identified Receiver Locations

Receiver Point #	Domestic / Non – Domestic Building	Development Participant / Non-participant	Predicted Noise Level, L_{Aeq} [dB(A)]		
			6m/s	7m/s	8m/s
1	Domestic	Non - Participant	10	12	22
2	Domestic	Non - Participant	14	16	18
3	Domestic	Non - Participant	30	31	33
4	Domestic	Participant	21	23	26
5	Domestic	Participant	35	37	38
6	Domestic	Non - Participant	30	32	33
7	Domestic	Participant	27	29	31
8	Domestic	Participant	27	28	30
9	Domestic	Non - Participant	23	25	28
10	Non - Domestic	Participant	52	54	55
11	Domestic	Non - Participant	0	0	0
12	Non - Domestic	Non - Participant	26	28	30
13	Domestic	Non - Participant	13	15	22

6. ASSESSMENT

Table 6.1 summarises the background noise at each location for each integer wind speed.

TABLE 6.1 – BACKGROUND NOISE LEVELS, $L_{A90,10\ minutes}$ [dB(A)]

Location	WIND SPEED AT 10m ABOVE GROUND LEVEL (m/s)						
	3	4	5	6	7	8	9
1	32	32	32	33	35	37	39
2	32	32	33	33	34	34	35
3	33	34	34	35	36	37	39

The background noise criteria are listed for the three locations monitored below in Table 6.2.

Table 6.2 – Noise Criteria Based on Background Noise Levels, dB(A)

Background Noise Monitoring Location	Wind Speed at 10m Above Ground Level (m/s)						
	3	4	5	6	7	8	9
1	37	37	37	38	40	42	44
2	35	35	35	35	37	39	41
3	38	39	39	40	41	42	44

The nearest background noise monitoring location to the identified receiver locations has been utilised for our assessment, and are as listed in Table 6.3 below. The background noise monitoring locations were selected as representative of the receiver point locations that were calculated to receive noise emissions associated with the wind-farm closest to the base 35 dB(A) criteria during the initial noise impact assessment. For full details see our accompanying report (Our Ref: 14290-3-11250-01).

Table 6.3–Applicable Background Noise Level Criteria, dB(A)

Receiver Point #	Applicable Background Noise Monitoring Location	Wind Speed at 10m Above Ground Level (m/s)						
		3	4	5	6	7	8	9
1	1	37	37	37	38	40	42	44
2	1	37	37	37	38	40	42	44
3	1	37	37	37	38	40	42	44
4	1	37	37	37	38	40	42	44
5	2	35	35	35	35	37	39	41
6	2	35	35	35	35	37	39	41
7	3	38	39	39	40	41	42	44
8	3	38	39	39	40	41	42	44
9	2	35	35	35	35	37	39	41
10	3	38	39	39	40	41	42	44
11	3	38	39	39	40	41	42	44
12	3	38	39	39	40	41	42	44
13	3	38	39	39	40	41	42	44

Table 6.4 below summarises the level of exceedance to the noise criteria based on background noise monitoring, with the predicted levels exceeding the criteria highlighted in red and the level of exceedance listed in brackets adjacent. It is noted that whilst the non-domestic locations have been assessed, the criteria is not considered applicable at these locations.

Table 6.4 – Assessment of Noise Levels at Identified Receiver Locations

Receiver Point #	Domestic / Non – Domestic Building	Development Participant / Non-participant	Predicted Noise Level, L_{Aeq} [dB(A)]			Noise Criteria Based on Background Noise Level, L_{Aeq} [dB(A)]		
			6m/s	7m/s	8m/s	6m/s	7m/s	8m/s
1	Domestic	Non - Participant	10	12	22	38	40	42
2	Domestic	Non - Participant	14	16	18	38	40	42
3	Domestic	Non - Participant	30	31	33	38	40	42
4	Domestic	Participant	21	23	26	38	40	42
5	Domestic	Participant	35	37	38	35	37	39
6	Domestic	Non - Participant	30	32	33	35	37	39
7	Domestic	Participant	27	29	31	40	41	42
8	Domestic	Participant	27	28	30	40	41	42
9	Domestic	Non - Participant	23	25	28	35	37	39
10	Non - Domestic	Participant	52 (12)	54 (13)	55 (13)	40	41	42
11	Domestic	Non - Participant	0	0	0	40	41	42
12	Non - Domestic	Non - Participant	26	28	30	40	41	42
13	Domestic	Non - Participant	13	15	22	40	41	42

(#) Criteria exceeded by

As can be seen from the above tables, calculated noise levels at all “domestic” receiver points have been calculated to comply with the background noise criteria.

Noise levels at Receiver Point 10 have been calculated to exceed the background noise criteria. The receiver point is non-domestic and owned by a participant of the development and we have been informed that they will remain non-domestic throughout the life of the wind farm.

Inspection of the noise contour map for the 8m/s wind speed scenario (noisiest operating condition – see Appendix B, Map 3A) indicated that there are some land areas within the 39 dB(A) contour, being the minimum background noise criteria at this wind speed, that are owned by non-participants of the wind farm development. This presents a risk that future residences, or other noise sensitive premises, could be built at a later date in these areas. The lots affected are:

10849
10854
10877

It is recommended that Verve Energy consider if measures need to be put in place to minimise this risk.

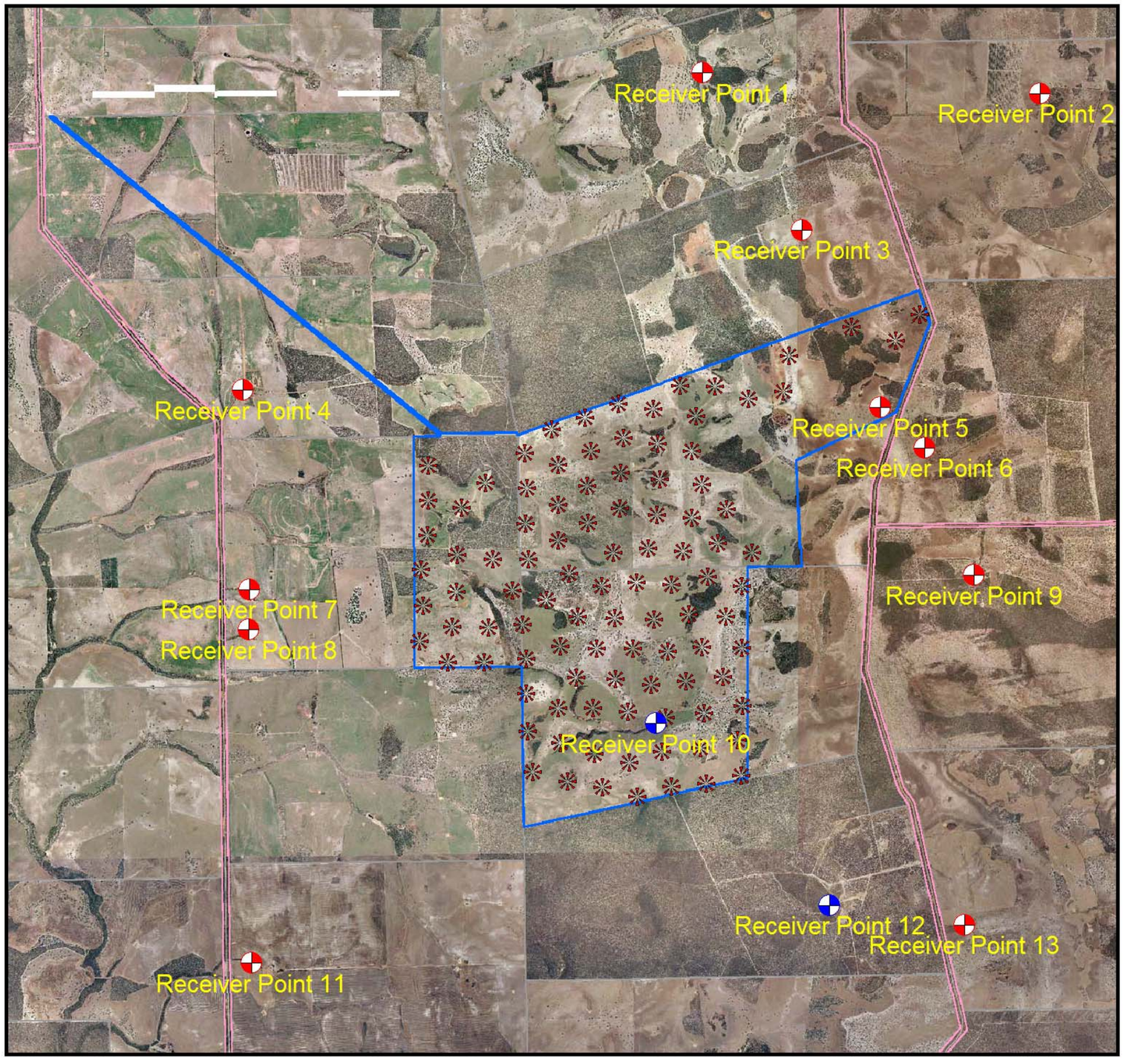
An assessment of low frequency and infrasound content has been conducted and included in Appendix C. Based on the assessment low frequency noise and infrasound are considered highly unlikely to represent a problem in the vicinity of the proposed wind farm.

7. CONCLUSION

Noise emissions at domestic receiver points have been calculated to comply with the background noise criteria under all wind conditions. It is noted that this conclusion applies to this turbine layout for the wind turbines considered (Siemens-3.0-101, at 100m hub height) and any other quieter turbines that may be considered. This includes operating in quieter “Noise Modes” or turbines with lower hub heights.

APPENDIX A

RESIDENTIAL AND WIND TURBINE LOCATIONS



Verve Energy
Warradarge Wind Farm
Receiver Point Locations

100 Wind Turbines
SWT-3.0 101
100m Hub Height
Receiver Point Locations

Locality Map

verve ENERGY

N

Length scale 1:70000

0 0.25 0.5 1 1.5 2 2.5 3 km

Signs and symbols

- Domestic Building
- Wind Turbine
- Non Domestic Building

Job No : 11250
Calc Ref : Receiver Points Geofile

TABLE 1 – WIND TURBINE LOCATIONS

Turbine Number	Easting(m)	Northing (m)	Height of ground level at base of tower (m)	Turbine Number	Easting(m)	Northing (m)	Height of ground level at base of tower (m)
1	358,808	6,688,679	276.2	51	355,905	6,684,243	285.2
2	357,690	6,688,480	280.7	52	350,669	6,684,517	264.4
3	358,420	6,688,253	279.2	53	351,249	6,684,152	291.2
4	356,679	6,688,004	240.0	54	352,160	6,684,181	325.6
5	356,575	6,687,423	237.0	55	352,762	6,683,799	324.0
6	356,015	6,687,309	241.3	56	353,229	6,683,746	302.4
7	355,466	6,687,506	262.3	57	353,825	6,683,721	297.3
8	354,894	6,687,515	285.1	58	354,472	6,683,697	321.5
9	353,892	6,687,225	300.0	59	355,035	6,683,788	325.2
10	354,463	6,687,134	292.4	60	355,640	6,683,746	290.6
11	355,159	6,687,018	285.7	61	350,707	6,683,933	261.0
12	353,345	6,687,002	306.3	62	351,179	6,683,585	272.6
13	353,975	6,686,666	317.8	63	351,763	6,683,572	299.2
14	354,534	6,686,567	299.3	64	352,322	6,683,622	327.9
15	355,093	6,686,455	289.1	65	352,943	6,683,262	310.1
16	352,798	6,686,803	315.8	66	353,540	6,683,224	300.8
17	353,436	6,686,447	333.2	67	354,124	6,683,224	321.1
18	353,925	6,686,091	323.9	68	354,695	6,683,175	326.8
19	354,563	6,685,991	295.8	69	355,259	6,683,249	311.2
20	355,259	6,685,908	266.0	70	355,905	6,683,241	309.0
21	352,359	6,686,422	343.4	71	350,644	6,683,349	252.0
22	352,906	6,686,231	336.8	72	351,104	6,683,001	263.1
23	353,378	6,685,883	325.8	73	351,701	6,683,001	293.5
24	353,908	6,685,519	314.4	74	352,384	6,683,063	309.8
25	354,521	6,685,411	291.5	75	353,204	6,682,752	305.3
26	355,093	6,685,362	277.0	76	353,838	6,682,727	322.9
27	355,656	6,685,502	277.8	77	354,422	6,682,640	338.1
28	350,781	6,686,219	277.5	78	354,993	6,682,690	341.3
29	351,725	6,685,933	318.1	79	355,598	6,682,769	313.3
30	352,396	6,685,846	349.6	80	352,384	6,682,491	287.2
31	352,906	6,685,569	337.5	81	352,906	6,682,255	304.1
32	353,395	6,685,279	307.7	82	353,478	6,682,255	329.0

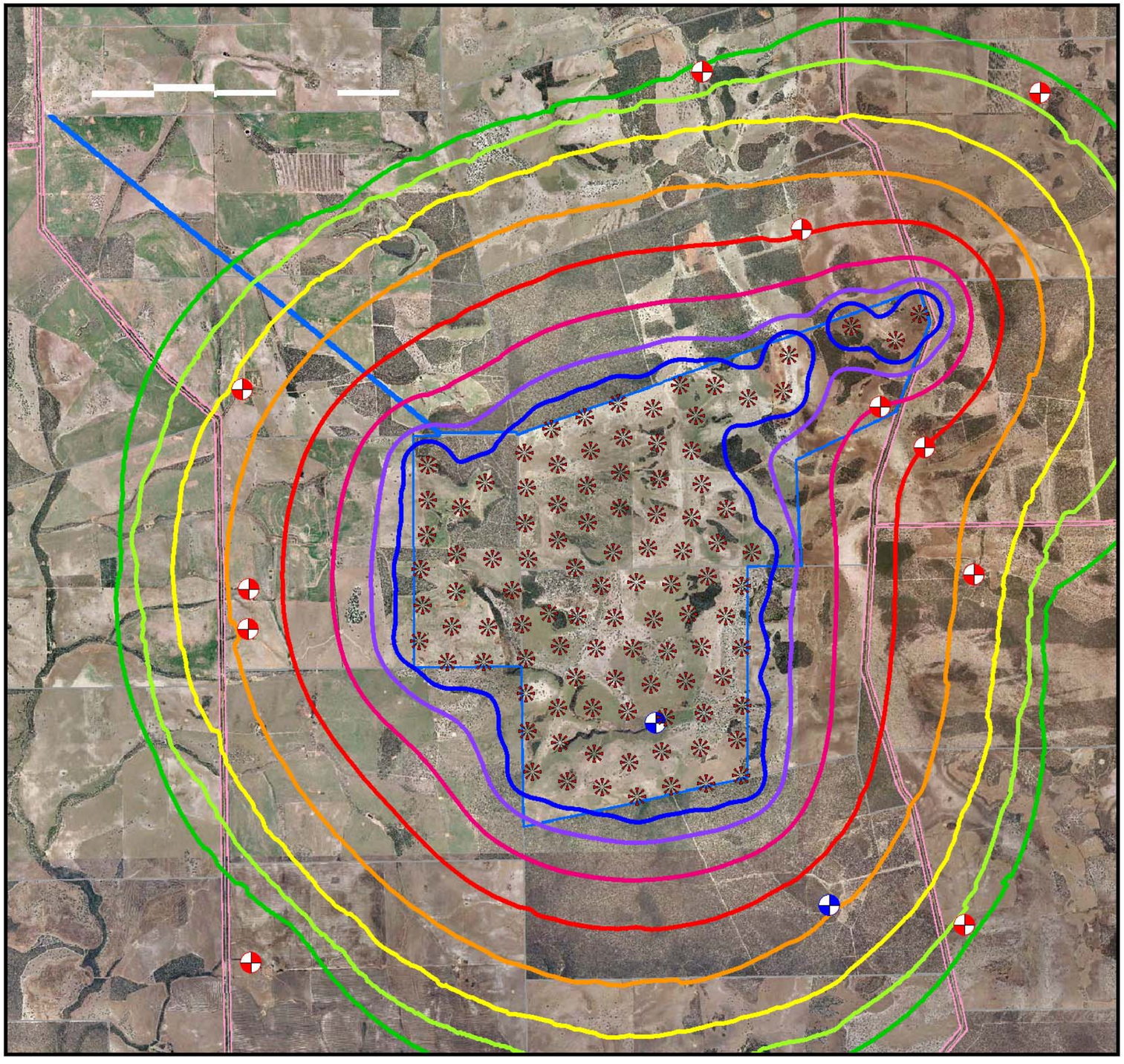
Turbine Number	Easting(m)	Northing (m)	Height of ground level at base of tower (m)	Turbine Number	Easting(m)	Northing (m)	Height of ground level at base of tower (m)
33	353,809	6,684,790	288.9	83	354,049	6,682,193	336.4
34	354,377	6,684,863	281.1	84	354,658	6,682,106	342.3
35	354,944	6,684,815	289.0	85	355,283	6,682,172	311.2
36	355,515	6,684,947	293.0	86	355,921	6,682,288	296.8
37	356,070	6,684,790	273.6	87	352,409	6,681,882	292.1
38	350,781	6,685,647	271.1	88	352,943	6,681,684	312.6
39	351,328	6,685,523	294.0	89	353,502	6,681,510	305.4
40	352,367	6,685,270	319.8	90	354,062	6,681,373	308.7
41	352,906	6,684,989	328.4	91	354,596	6,681,547	320.9
42	350,769	6,685,076	269.7	92	355,234	6,681,601	317.6
43	351,253	6,684,753	282.3	93	355,830	6,681,733	315.2
44	351,837	6,684,691	299.9	94	352,496	6,681,211	285.2
45	352,417	6,684,682	321.8	95	353,055	6,681,062	281.5
46	353,188	6,684,544	309.0	96	353,627	6,680,963	292.4
47	353,618	6,684,243	290.2	97	354,198	6,680,814	322.8
48	354,182	6,684,301	299.2	98	354,753	6,680,971	336.9
49	354,753	6,684,276	315.6	99	355,325	6,681,021	340.0
50	355,350	6,684,401	303.8	100	355,888	6,681,149	314.3

TABLE 2 – RECEIVER POINT LOCATIONS

Receiver Point #	Domestic / Non – Domestic	Participant / Non-participant	Easting (m)	Northing (m)	Height of ground level at receiver point (m)
1	Domestic	Non - Participant	355,265	6,692,624	244.34
2	Domestic	Non - Participant	360,775	6,692,288	303.25
3	Domestic	Non - Participant	356,887	6,690,058	257.52
4	Domestic	Participant	347,762	6,687,442	244.5
5	Domestic	Participant	358,165	6,687,158	254.86
6	Domestic	Non - Participant	358,889	6,686,500	263.1
7	Domestic	Participant	347,863	6,684,189	230
8	Domestic	Participant	347,860	6,683,532	240
9	Domestic	Non - Participant	359,703	6,684,420	270
10	Non - Domestic	Participant	354,506	6,682,004	340
11	Domestic	Non - Participant	347,902	6,678,091	209.6
12	Non - Domestic	Non - Participant	357,345	6,679,036	292.11
13	Domestic	Non - Participant	359,540	6,678,713	310

APPENDIX B

PREDICTED NOISE LEVEL CONTOURS



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
SWT-3.0 - 101
100m Hub Height
Wind Speed : 6m/s (@10m AG)

Map
1

verve ENERGY

Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{Aeq} dB(A)

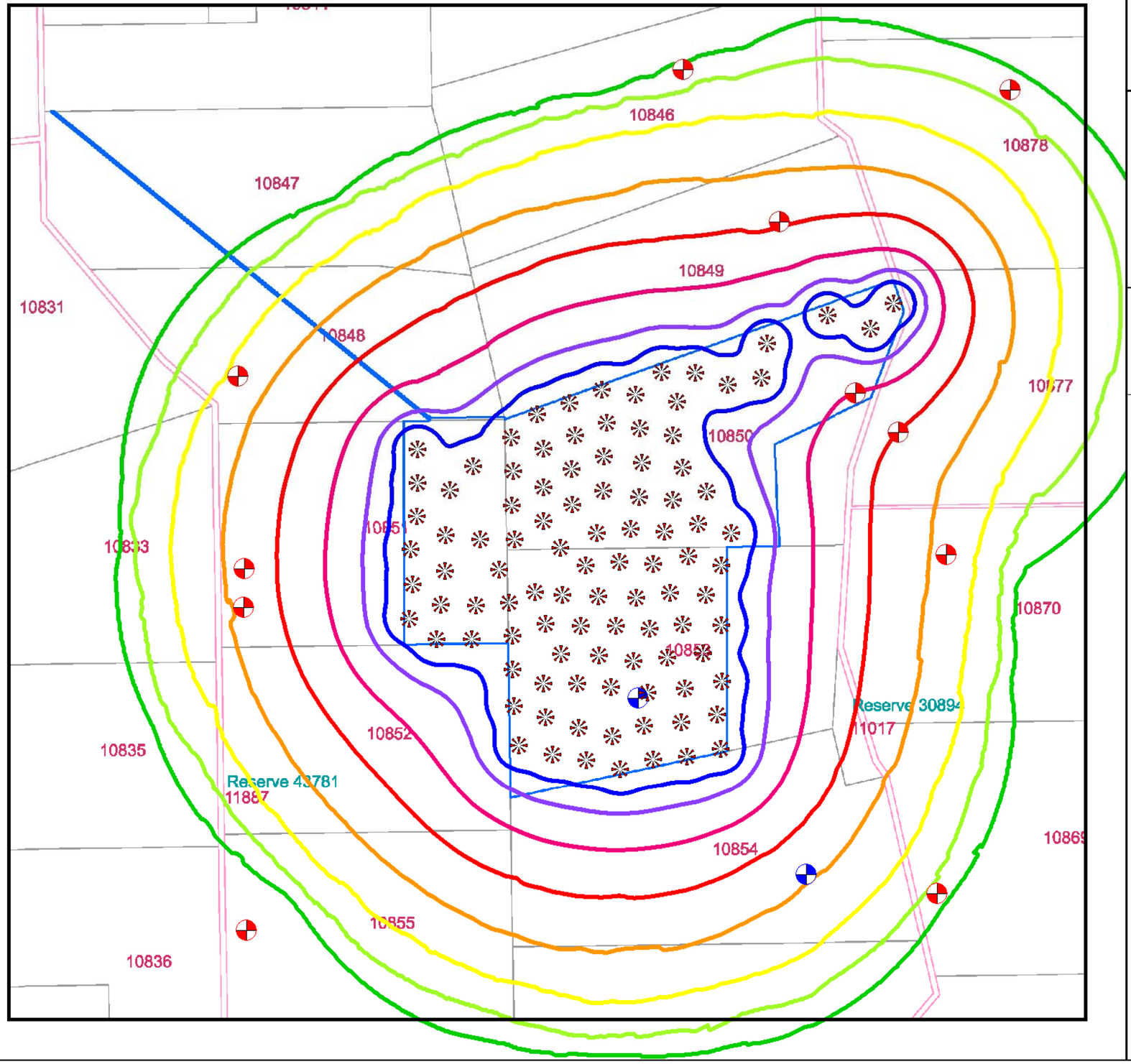
- = 10
- = 15
- = 20
- = 25
- = 30
- = 35
- = 40
- = 45

Signs and symbols

- Domestic Building
- Wind Turbine
- Non Domestic Building

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 63



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
SWT-3.0 - 101
100m Hub Height
Wind Speed : 6m/s (@10m AG)

Map
1A

verve ENERGY

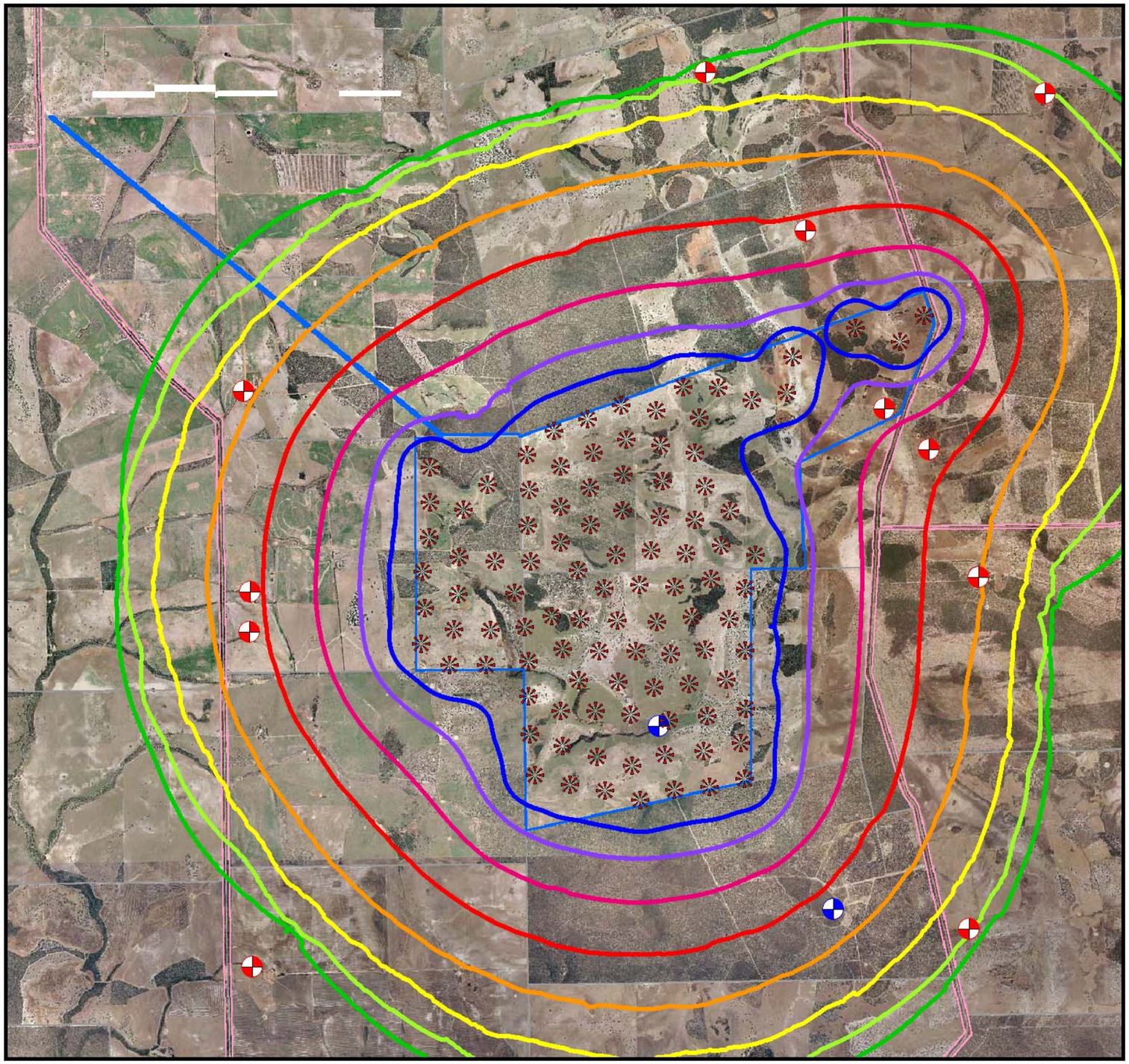
Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{Aeq} dB(A)
- = 10
- = 15
- = 20
- = 25
- = 30
- = 35
- = 40
- = 45

Signs and symbols
- Domestic Building
- Wind Turbine
- Non Domestic Building

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 63



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
SWT-3.0 - 101
100m Hub Height
Wind Speed : 7m/s (@10m AG)

Map
2

verve ENERGY

N

Length scale 1:70000
0 0.2 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{Aeq} dB(A)

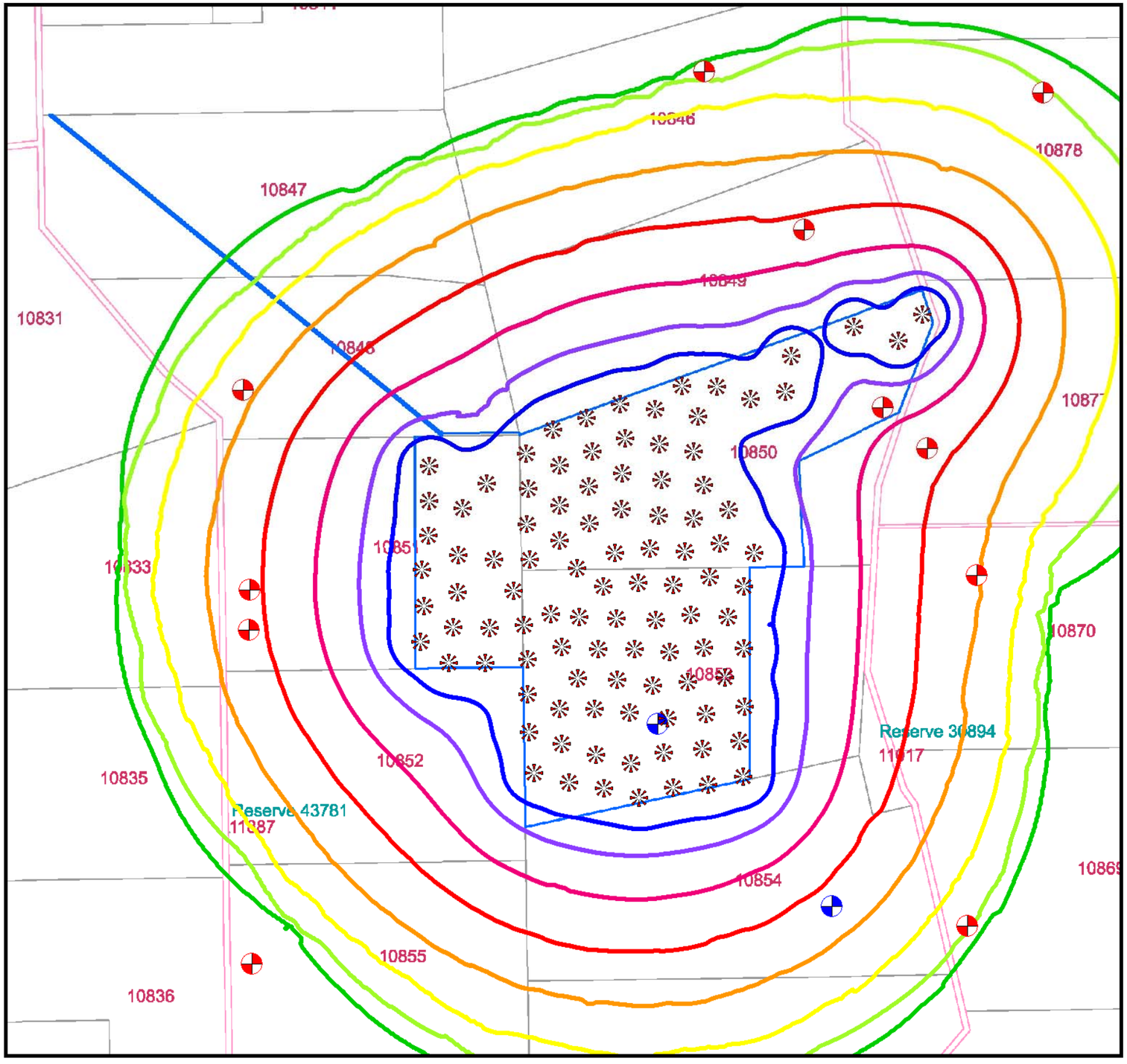
- = 10
- = 15
- = 20
- = 25
- = 30
- = 35
- = 40
- = 45

Signs and symbols

- Domestic Building
- Wind Turbine
- Non Domestic Building

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 73



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
SWT-3.0 - 101
100m Hub Height
Wind Speed : 7m/s (@10m AG)

Map
2A

verve ENERGY

Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

N

Noise levels
in L_{Aeq} dB(A)

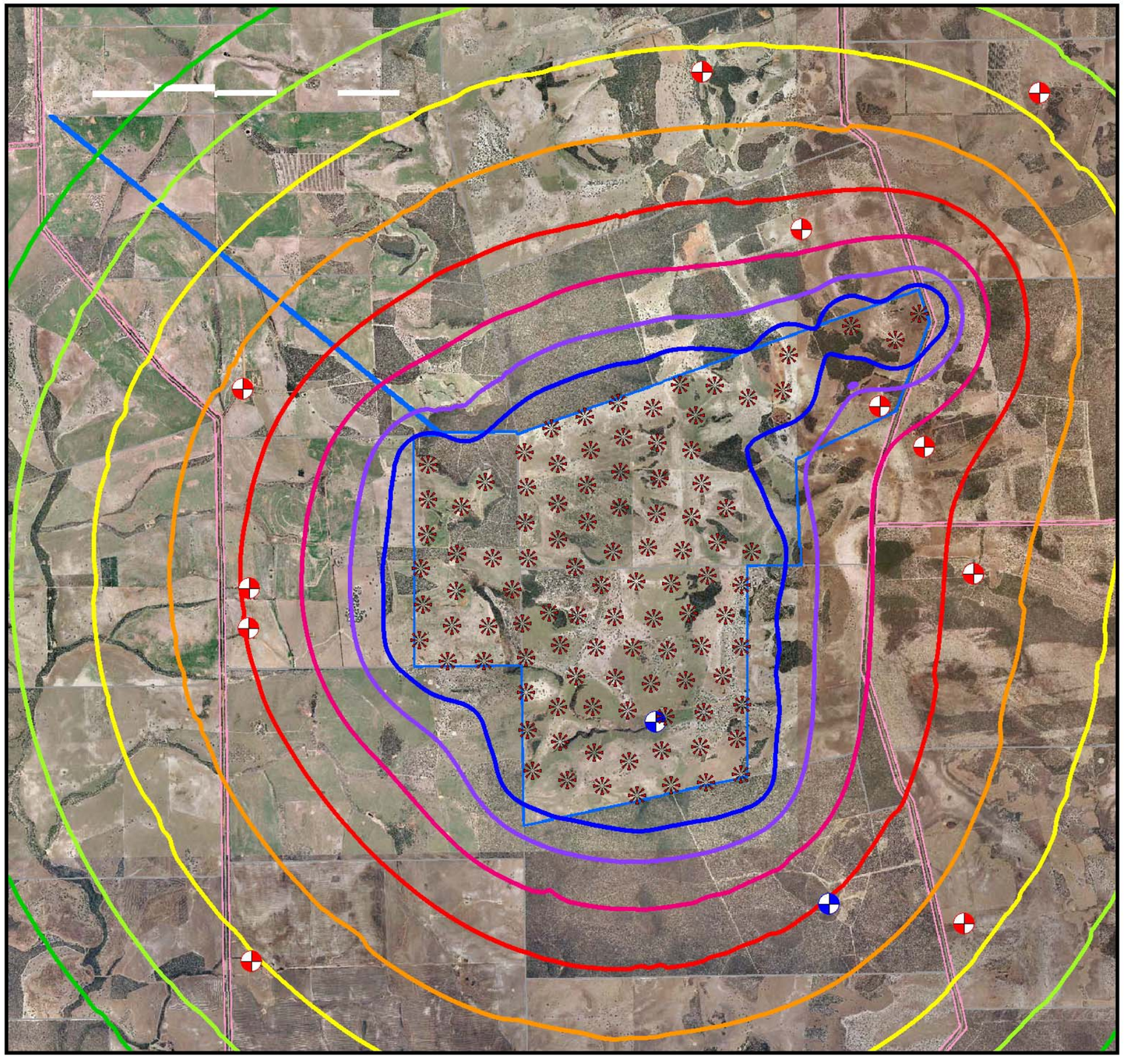
- = 10
- = 15
- = 20
- = 25
- = 30
- = 35
- = 40
- = 45

Signs and symbols

- Domestic Building
- Wind Turbine
- Non Domestic Building

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 73



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
SWT-3.0 - 101
100m Hub Height
Wind Speed : 8m/s (@10m AG)

Map
3

verve ENERGY

Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

N

Noise levels
in L_{Aeq} dB(A)

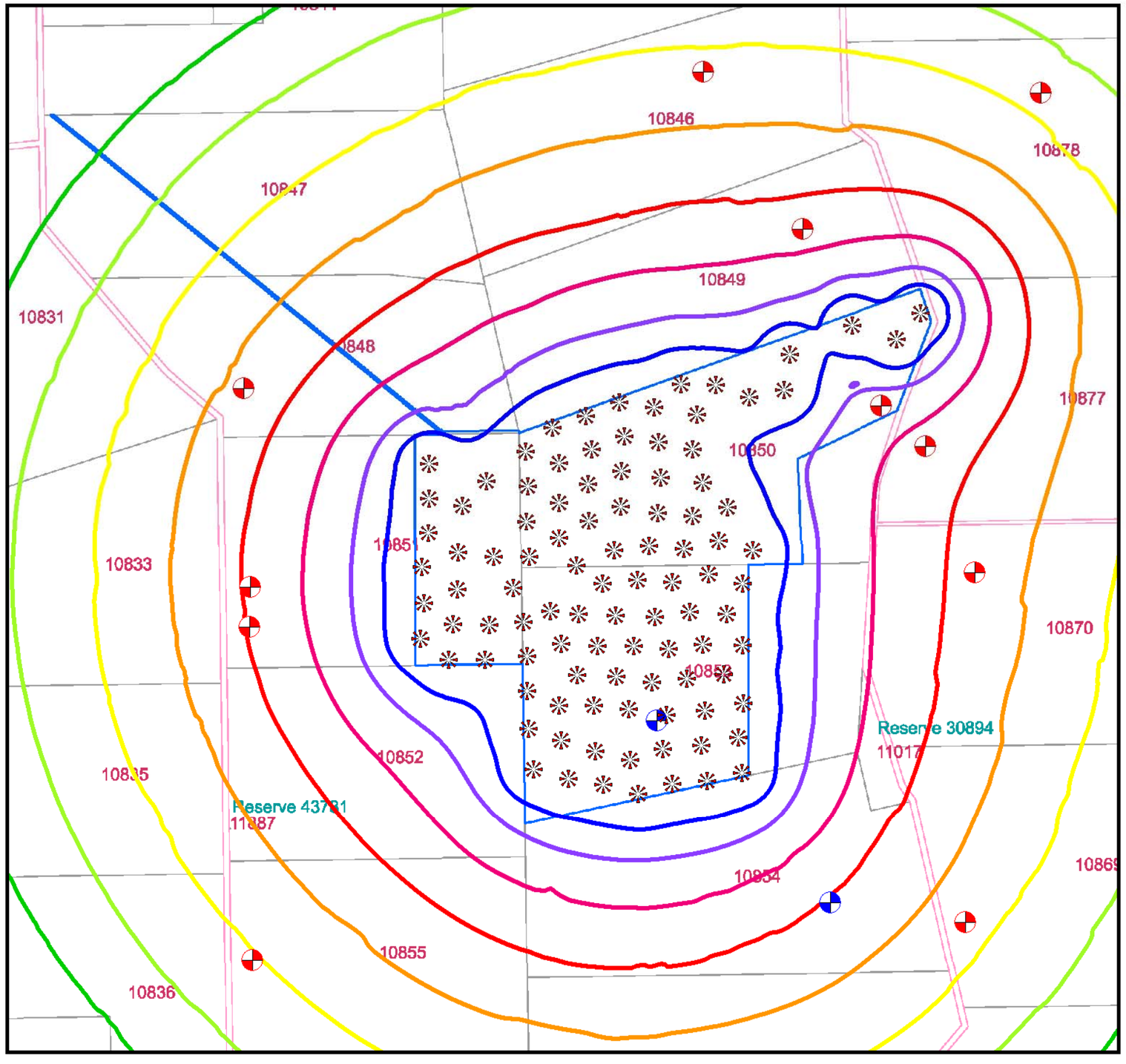
= 10
= 15
= 20
= 25
= 30
= 35
= 40
= 45

Signs and symbols

Domestic Building
Wind Turbine
Non Domestic Building

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 86



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
SWT-3.0 - 101
100m Hub Height
Wind Speed : 8m/s (@10m AG)

Map
3A

Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{Aeq} dB(A)
= 10
= 15
= 20
= 25
= 30
= 35
= 40
= 45

Signs and symbols
Domestic Building
Wind Turbine
Non Domestic Building

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 86

APPENDIX C

LOW FREQUENCY AND INFRASOUND ASSESSMENT

LOW FREQUENCY AND INFRASOUND ASSESSMENT

An assessment of low frequency and infrasound noise levels associated with the proposed wind farm has been carried out, with the calculated low frequency noise levels compared with the hearing threshold levels for each frequency. This is not an assessment required under the EPA of South Australia "Wind Farms – Environmental Noise Guidelines – July 2009" (Guidelines). It was requested to be carried out by John MacPherson, Principal Environmental Noise Officer of the Department of Environment and Conservation, and the developer has agreed to carry out the assessment – as recommended in the Draft National Wind Farm Development Guidelines of 2010.

The linear sound power level, at wind speeds of 12m/s (@ 10m above ground level) for 10 – 40 Hz has been used to calculate the low frequency noise level associated with the proposed wind farm development. The sound power levels for Vesta 112 3MW Turbines, at a hub height of 84m has been utilised for this assessment as low frequency data was not available for Siemens SWT-3.0-101 turbines.

The sound power level (in linear dB) and the corresponding hearing threshold, are listed below in Table 1. It is noted that an estimate of sound power levels at 2Hz has been included, based on a sound power level typically 10 dB(A) higher above the level at 10 Hz.

TABLE 1 – LOW FREQUENCY AND INFRASOUND NOISE LEVELS

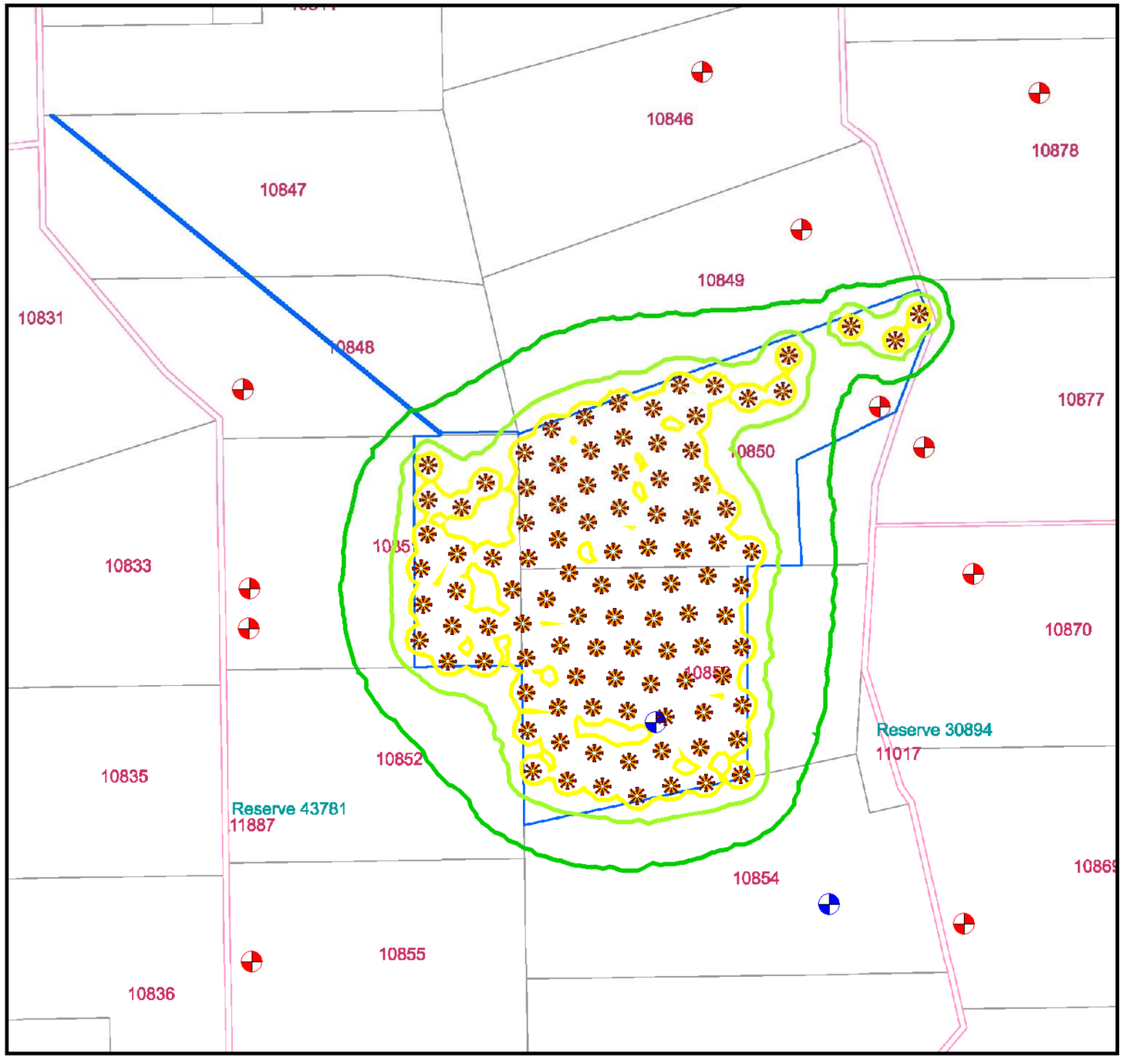
Frequency (Hz)	Linear Sound Power Level, dB	Hearing Threshold, dB
2	184.1	140
10	119.2	95
12.5	115.9	87
16	114.4	79
20	116.7	71
25	114.4	63
31.5	110.8	55.5
40	110.1	48

The noise propagation of the individual third octave band frequencies were calculated, with results shown in Figures 1 – 8 below. It is noted that the corresponding threshold of hearing level has been included on each contour map.

As can be seen from the contour maps, the low frequency / infrasound noise levels are generally below the hearing threshold for that frequency within the boundaries of the participating properties, and well below the hearing threshold at the identified receiver points.

It is noted the contour line for the threshold of hearing does not appear on all of the figures due to the scale of the contour maps and the close distance at which the threshold of hearing contour is to the wind turbines.

Therefore, low frequency noise and infrasound are considered highly unlikely to represent a problem in the vicinity of the proposed wind farm.



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
V112-3.0 MW
84m Hub Height
Wind Speed : 12m/s (@10m AG)
Noise Mode 0

2 Hz Third Octave Band
Centre Frequency

Map
1

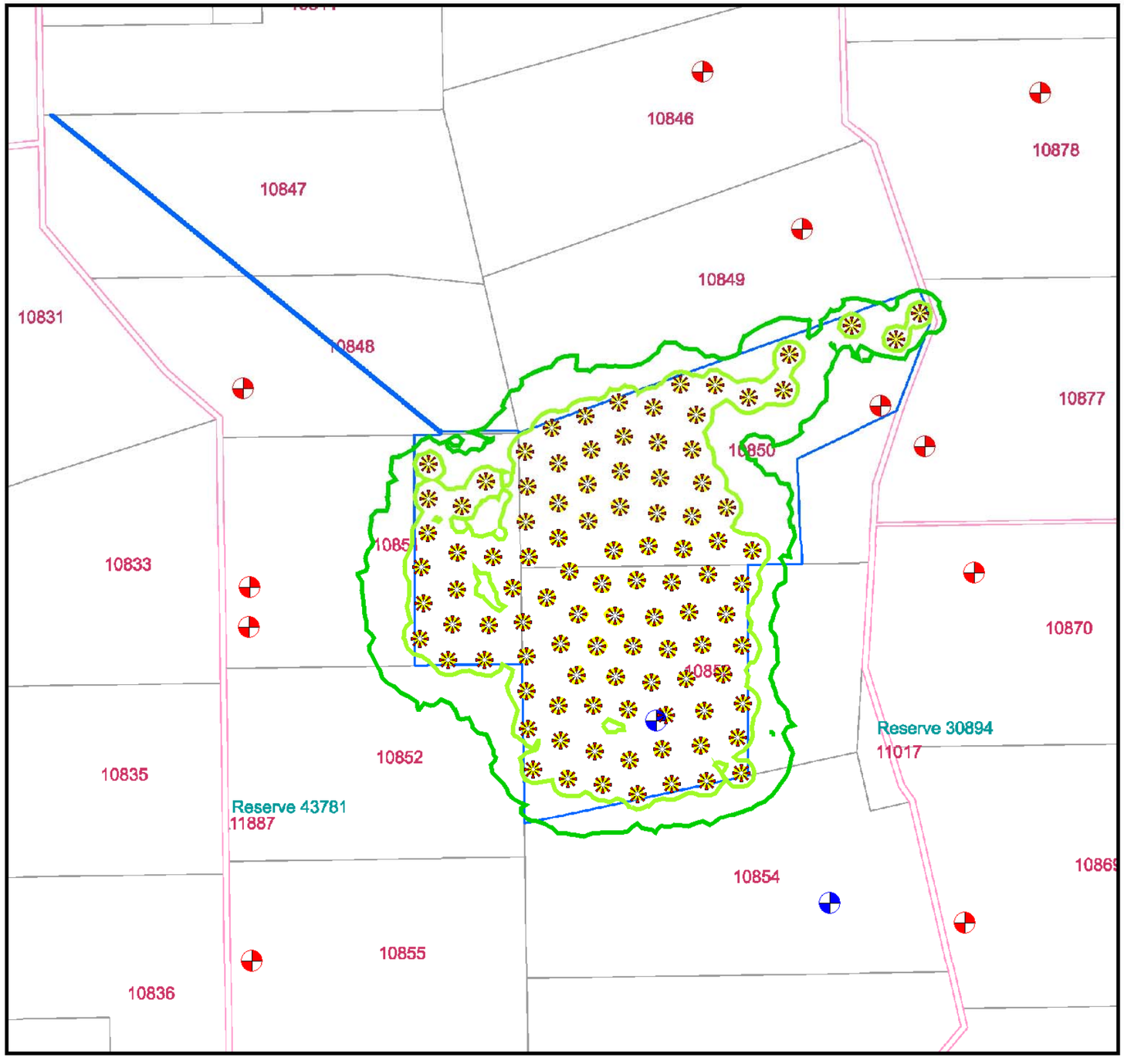
Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{eq} dB
= 120
= 125
= 130
= 135
= 140
= 145

Signs and symbols
Non Domestic Building
Wind Turbine
Domestic Building
Threshold of Hearing @2 Hz - 140dB

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 102



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
V112-3.0 MW
84m Hub Height
Wind Speed : 12m/s (@10m AG)
Noise Mode 0

10 Hz Third Octave Band
Centre Frequency

Map 2

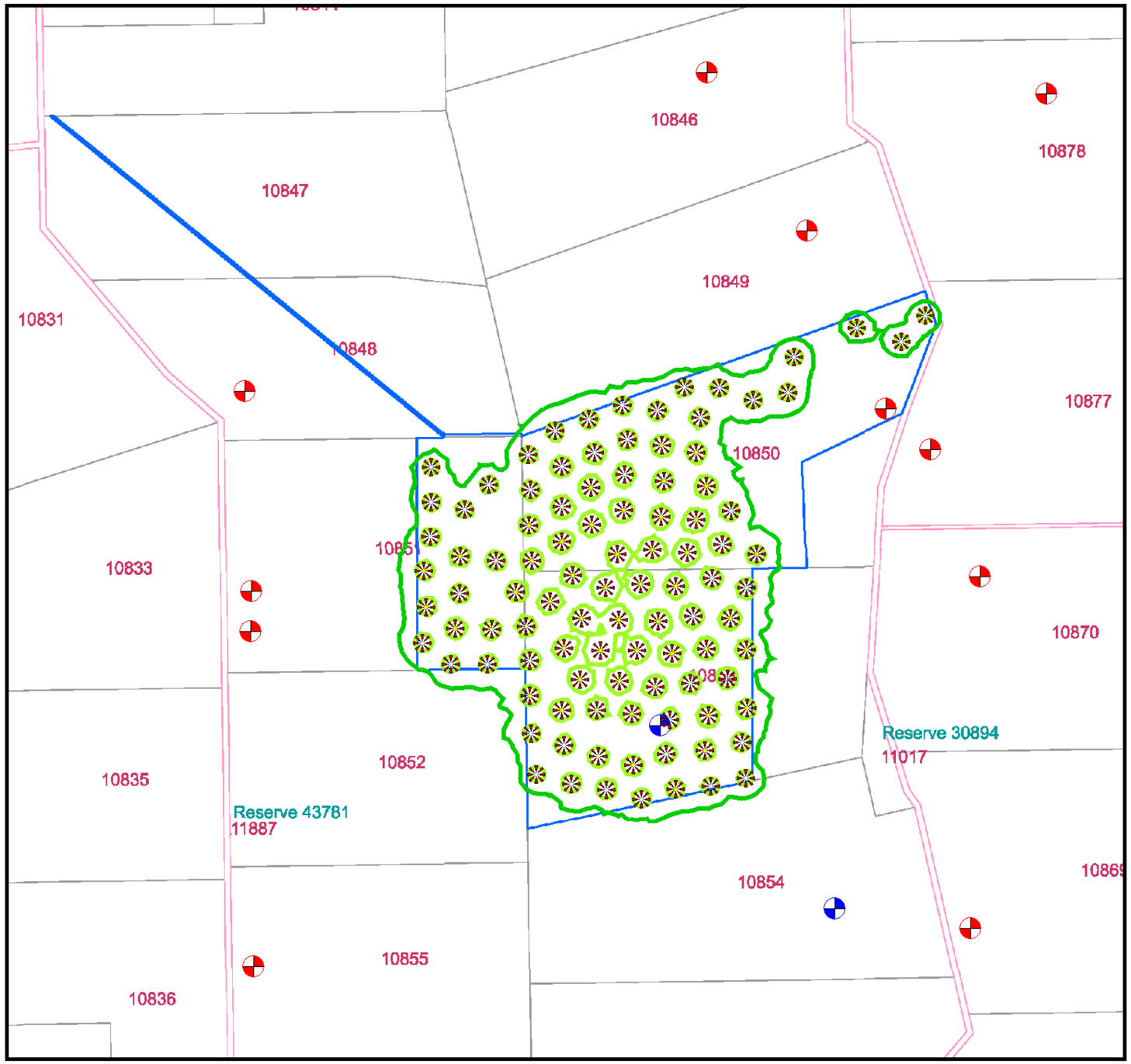
Length scale 1:70000
0 0.2 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{eq} dB
= 60
= 65
= 70
= 75
= 80
= 85

Signs and symbols
Non Domestic Building
Wind Turbine
Domestic Building
Threshold of Hearing @10 Hz - 95dB

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 101



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
V112-3.0 MW
84m Hub Height
Wind Speed : 12m/s (@10m AG)
Noise Mode 0

12.5 Hz Third Octave Band
Centre Frequency

Map
3

verve ENERGY

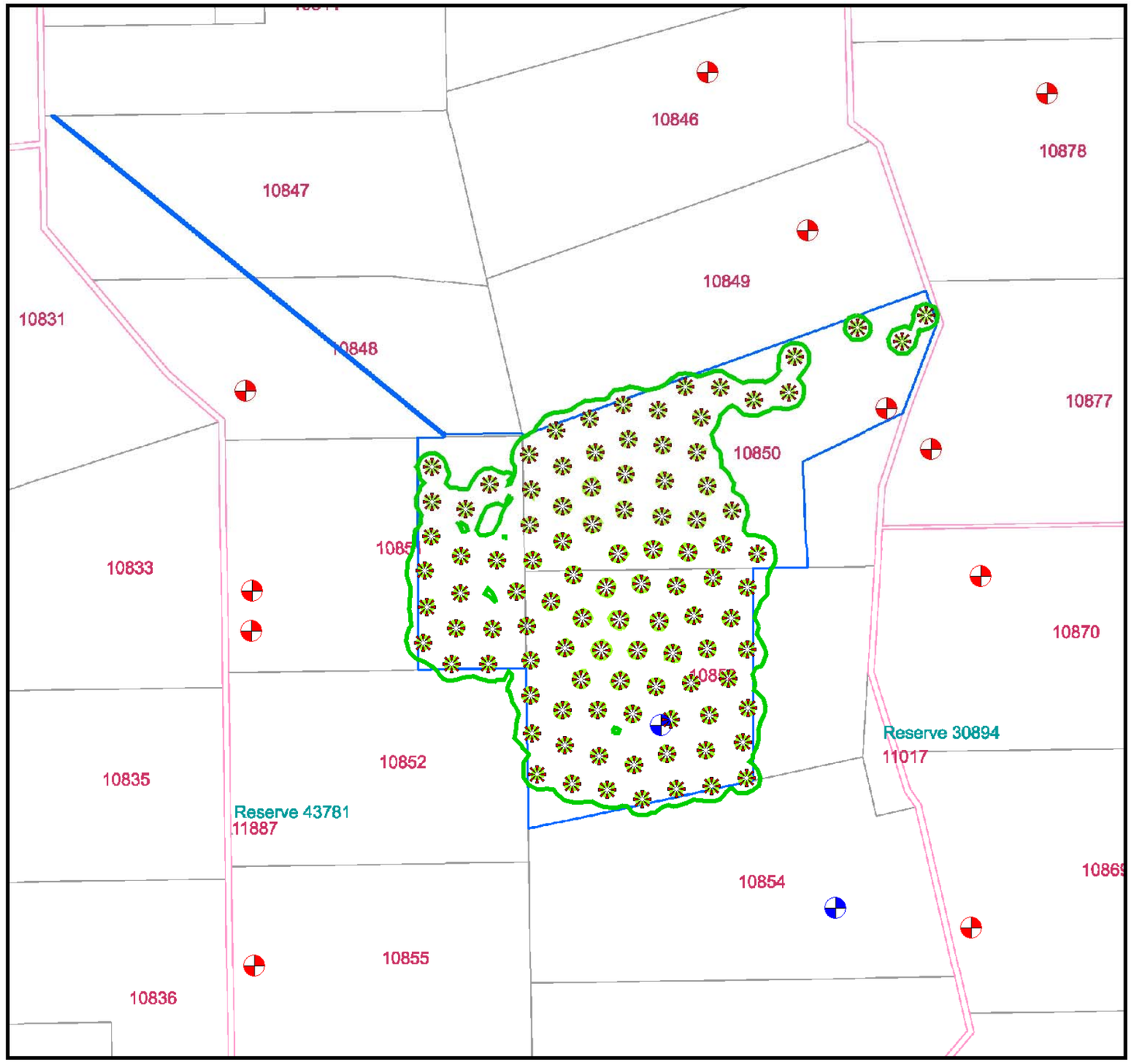
Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{eq} dB
= 60
= 65
= 70
= 75
= 80
= 85

Signs and symbols
Non Domestic Building
Wind Turbine
Domestic Building
Threshold of Hearing @12.5Hz - 87dB

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 101



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
V112-3.0 MW
84m Hub Height
Wind Speed : 12m/s (@10m AG)
Noise Mode 0

16 Hz Third Octave Band
Centre Frequency

Map
4

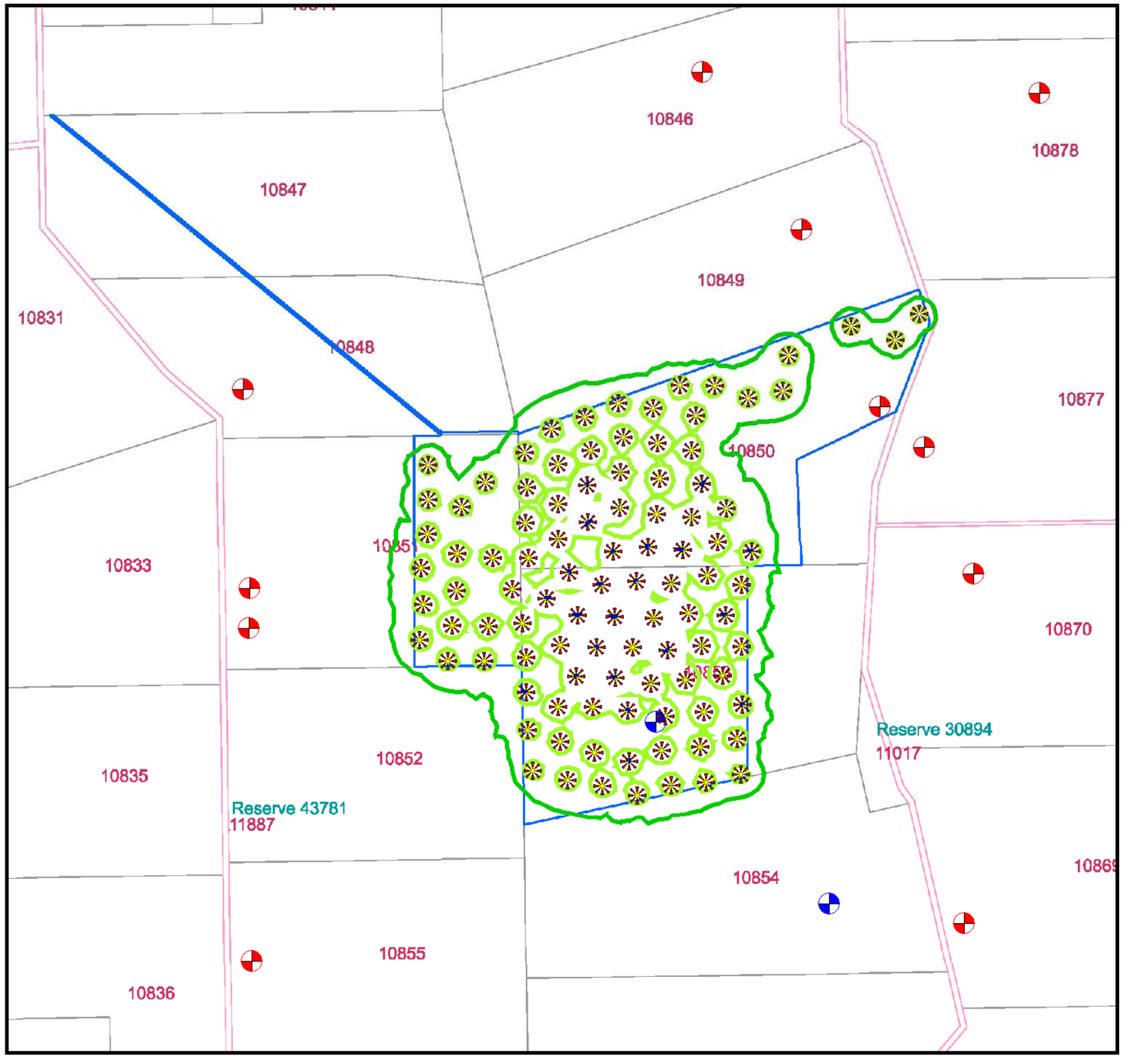
Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{eq} dB
= 60
= 65
= 70
= 75
= 80
= 85

Signs and symbols
Non Domestic Building
Wind Turbine
Domestic Building
Threshold of Hearing @16 Hz - 79 dB

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 101



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
V112-3.0 MW
84m Hub Height
Wind Speed : 12m/s (@10m AG)
Noise Mode 0

20 Hz Third Octave Band
Centre Frequency

Map
5

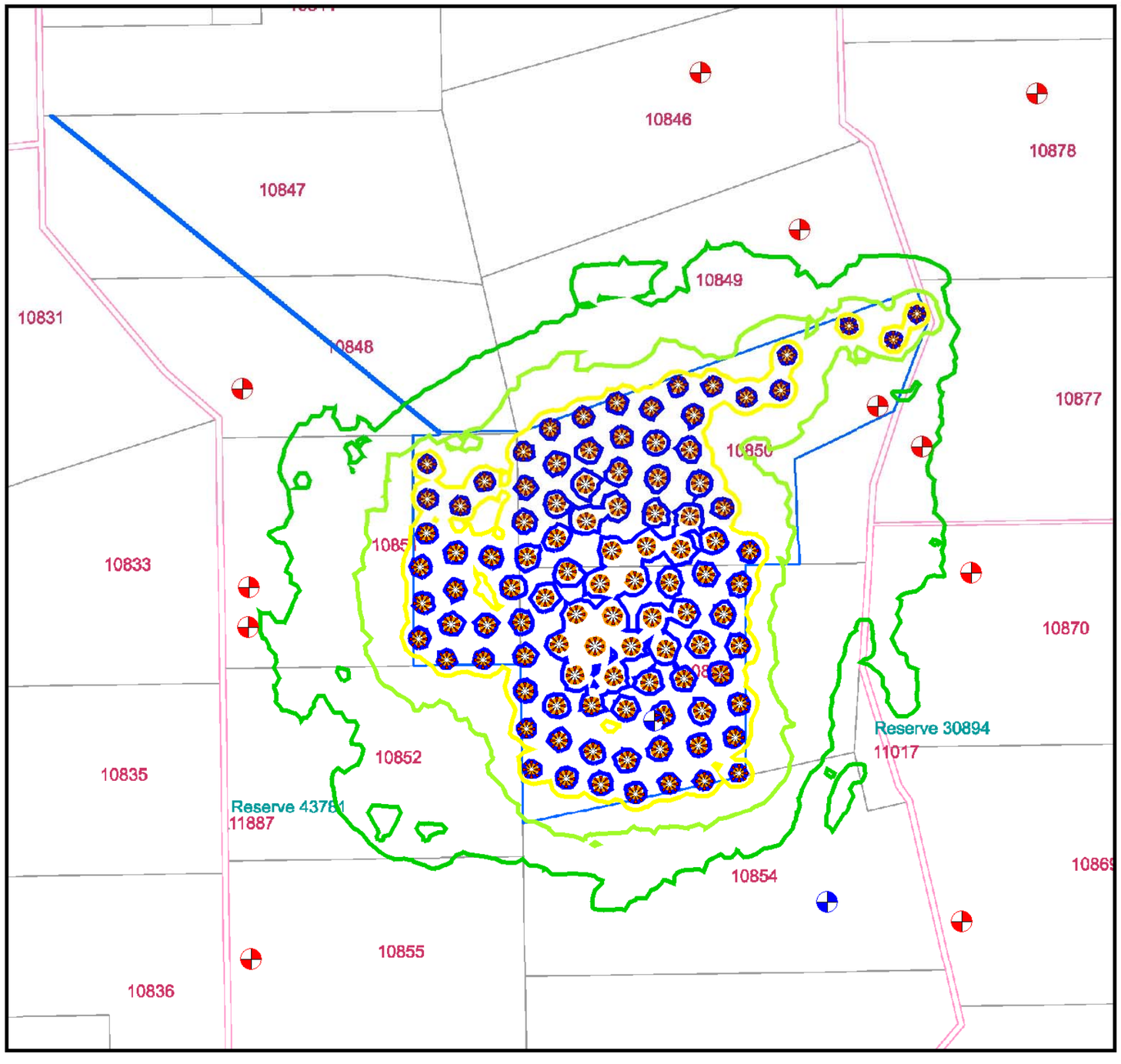
Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{eq} dB
= 60
= 65
= 70
= 75
= 80
= 85

Signs and symbols
Non Domestic Building
Wind Turbine
Domestic Building
Threshold of Hearing @20 Hz - 71 dB

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 101



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
V112-3.0 MW
84m Hub Height
Wind Speed : 12m/s (@10m AG)
Noise Mode 0

25 Hz Third Octave Band
Centre Frequency

Map
6

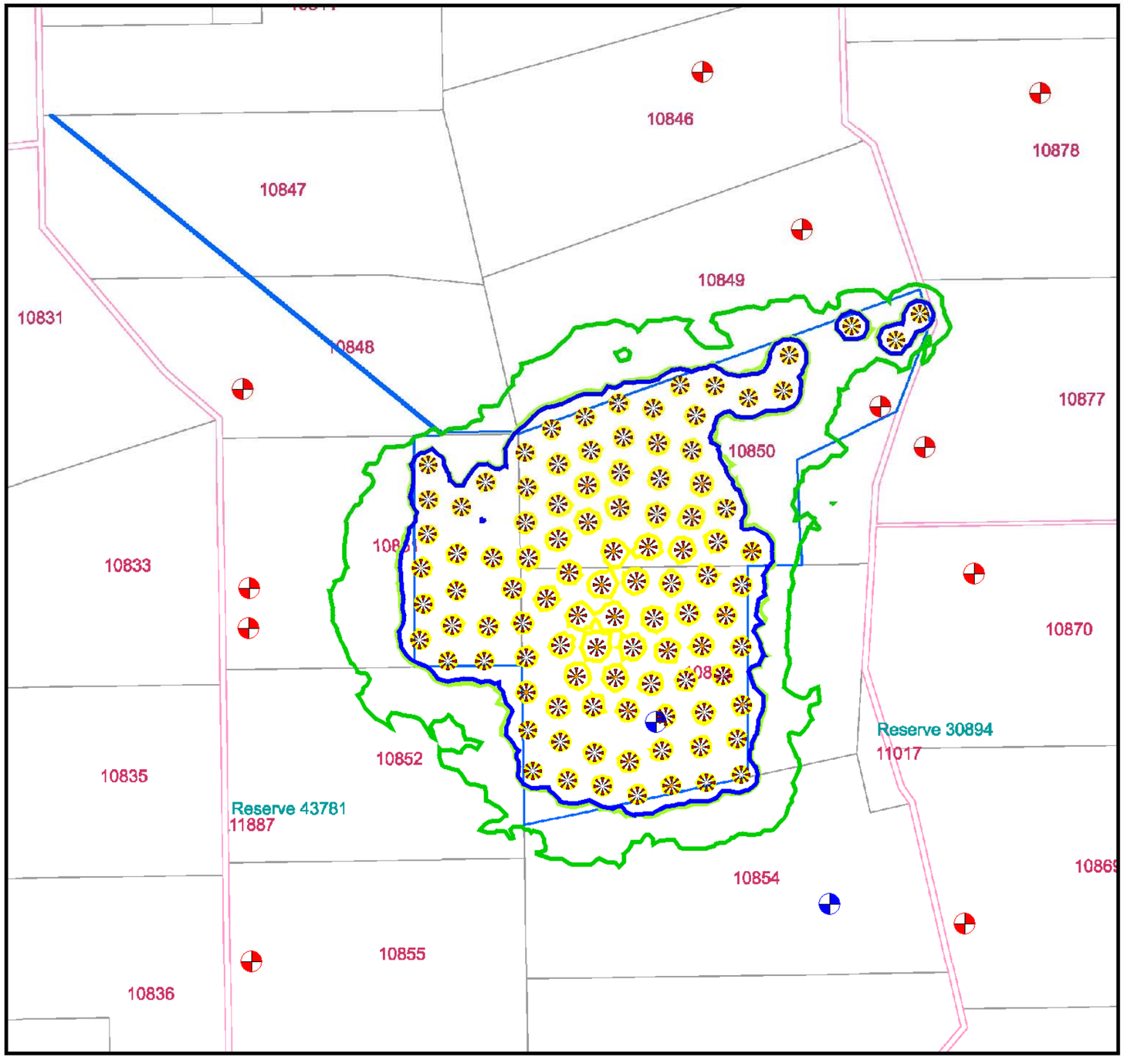
Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{eq} dB
= 50
= 55
= 60
= 65
= 70
= 75

Signs and symbols
Non Domestic Building
Wind Turbine
Domestic Building
Threshold of Hearing @25 Hz - 63 dB

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 100



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
V112-3.0 MW
84m Hub Height
Wind Speed : 12m/s (@10m AG)
Noise Mode 0

31.5 Hz Third Octave Band
Centre Frequency

Map 7

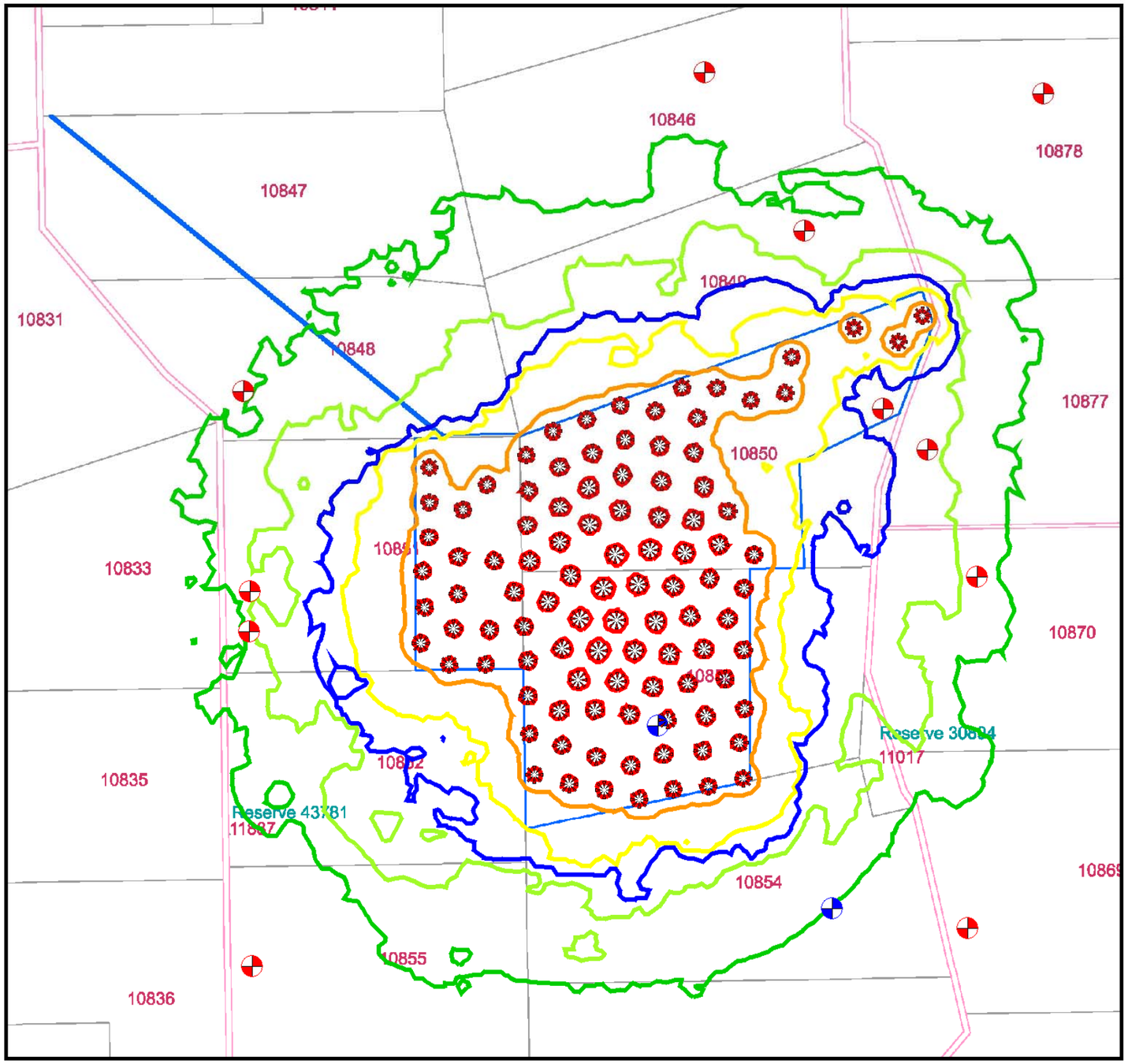
Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{eq} dB
= 50
= 55
= 60
= 65
= 70
= 75

Signs and symbols
Non Domestic Building
Wind Turbine
Domestic Building
Threshold of Hearing@31.5Hz-55.5 dB

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 101



Verve Energy
Warradarge Wind Farm
Noise Contour Map

100 Wind Turbines
V112-3.0 MW
84m Hub Height
Wind Speed : 12m/s (@10m AG)
Noise Mode 0

40 Hz Third Octave Band
Centre Frequency

Map
8

Length scale 1:70000
0 0.25 0.5 1 1.5 2 2.5 3 km

Noise levels
in L_{eq} dB
= 40
= 45
= 50
= 55
= 60
= 65

Signs and symbols
Non Domestic Building
Wind Turbine
Domestic Building
Threshold of Hearing @40 Hz - 48 dB

Noise Model Parameters
ISO 9613-2:1996 Algorithm
Temperature : 15ºC
Relative Humidity : 70%
Atmospheric Pressure : 101.325 kPA

Job No : 11250
Calc Ref : 100

APPENDIX D

COMPLIANCE CHECKLIST

Compliance Checklist

Table 1, below, provides a checklist of the information and documentation required to undertake noise modelling for the Warradarge Wind Farm proposal against the South Australian Noise Guidelines, in the absence of WA specific noise guidelines for wind farms:

TABLE 1 –WIND FARM ENVIRONMENTAL NOISE GUIDELINES COMPLIANCE CHECKLIST (SOUTH AUSTRALIA) (SOURCE: EPA SA 2012)

COMPLIANCE CHECKLIST EXTRACT	COMPLIANCE	DISCUSSION
Predicted Noise from the Wind Farm		
Make and model of WTGs to be used	✓	Siemens SWT-3.0-101), at the highest hub height under consideration (100m). This represents the noisiest turbine possible for the proposed wind farm.
Octave one-third octave band sound power levels and associated wind speed of WTGs to be used	✓	The one-third octave band data sound power levels for Vesta 112 3MW Turbines, at a hub height of 84m has been utilised for the low frequency assessment. One third octave band data was not as low frequency data was not available for Siemens SWT-3.0-101 turbine.
Positions of all WTGs shown on a map	✓	See Appendix A of 14014-8-11250
Table of WTGs and relevant receivers coordinates	✓	See Appendix A of 14014-8-11250
Description of zone category, zone maps for all receivers.	×	All areas assumed to be “rural living”
Predicted noise levels for those premises in worst-case wind direction for wind speeds from cut-in speed to the speed of WTG rated power	✓	
Model used and method for deriving noise levels	✓	
Indication of accuracy of wind farm noise prediction	✓	
Amount of noise reduction	×	Noisiest operating condition utilised for modelling, hence no noise reduction (other than distance)
Topographic map of wind farm and affected premises showing labelled noise contour lines	✓	See Appendix A of 14014-8-11250
Location of wind measuring position(s) used for noise assessment and compliance purposes	✓	See Appendix A of Background Noise Monitoring Report (our Ref: 14290-4-11250-01)

TABLE 1 –WIND FARM ENVIRONMENTAL NOISE GUIDELINES COMPLIANCE CHECKLIST (SOUTH AUSTRALIA) (SOURCE: EPA SA 2012) (CONT.)

COMPLIANCE CHECKLIST EXTRACT	COMPLIANCE	DISCUSSION
Measurement and Assessment of Background Noise		
Description of noise measuring equipment used (make, model, type)	✓	
Noise measurement position including height above ground, wind speed and distance to nearest building structure.	✓	
Description and photograph of measurement position showing nearby trees and building structures.	✓	See Appendix B of Background Noise Monitoring Report (our Ref: 14290-4-11250-01)
Angle direction between the line connecting the noise measurement point and nearest WTG	×	Information not needed for this area as background noise levels do not change with wind direction
Atmospheric conditions	✓	
Wind speed data at noise measurement site	✓	
Time and duration of monitoring	✓	
Sampling time for wind and noise measurements	✓	
Total number of data pairs measured and number of data pairs measured at worst wind conditions between cut-in speed to the speed of WTG rated power	✓	
Description of regression analysis method	✓	
Graphical plot of data in Section 3.4 of Guidelines	✓	
Correlation coefficient and equation for the regression curve	✓	