Lal Lal Wind Farm Layout Amendment Assessment

Report for
The Sovereign Hills Museum Association
c/- Kellehers Australia
497 Swan Street
Burnley VIC 3121

October 2016

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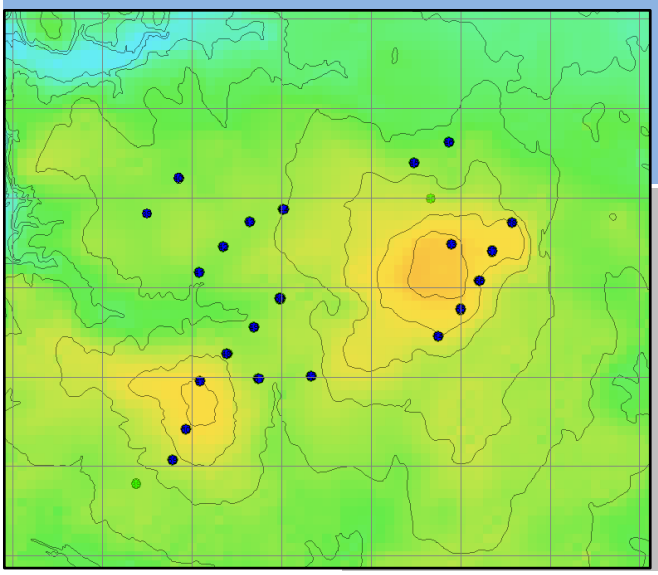

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1. Introduction

West Wind Energy (WWE) is seeking a planning amendment to its Lal Lal wind farm, seeking to:

- Increase turbine height from 130m to 161m in height;
- Remove the requirement for transformers to be located within the tower;
- Apply the more stringent noise requirements (NZS6808:2010) for wind farm noise; and
- Reduce the maximum number of turbines from 64 to 60 turbines.

The amendment is detailed in the West Wind website: http://w-wind.com.au/lal-lal-wind-farm/ and in the revised Permit Amendment Application published by Jacobs Group Australia on 15 August 2016 on behalf of WWE.

The Sovereign Hill Museums Association (Sovereign Hill) has suggested an amendment to West Wind Energy's Lal Lal Wind Farm turbine layout by relocating the two most north-westerly turbines in the southern 'Elaine' cluster, identified as ESWT01 & 02 in the provided documentation. Background is included in the letter submitted by Sovereign Hill in response to planning application PL-SP/05/0461A.

Three alternative locations have been put forward by Sovereign Hill in the 'Narmbool Plan'[1]. Kellehers Solicitors on behalf of Sovereign Hill Museums Association has asked Enhar to assess whether the use of these locations is likely to cause an adverse, neutral or positive effect on the ensuing energy yield, construction cost or operational cost of the wind farm. Kellehers Solicitors also asked Enhar to investigate shadow flicker impact at a resident on the Sovereign Hill property, referred to as H18aa on the Narmbool Plan. In summary, Kellehers Solicitors requested Enhar's assessment to consider potential relocation of two turbines and the consequent impact on:

1. Wind energy generation;
2. Likely estimated cost of construction;
3. Likely estimated maintenance costs;

Kellehers also asked Enhar to comment on:

4. Relevance and impact of changes to turbine blade length and hub height;
5. Whether shadow flicker at the Sovereign Hill farm workers house is now entirely removed.

Three areas for alternative turbine locations were identified in the 'Narmbool Plan' by Sovereign Hill as A (north-east), B (south-west) and C (roughly central). This map is included below in Appendix 1. Enhar used a georeferenced image of this map to place point locations representing the relocated turbines in a wind flow model. Subsequent correspondence from Kellehers to Enhar indicated that a meeting between WWE and Sovereign Hill occurred at which WWE advised areas A and B would not be feasible for additional turbines due to proximity to other dwellings and other objections. Enhar has therefore placed additional focus on area C, analysing a scenario where both turbines are relocated to this vicinity.

During the course of preparing Enhar's assessment, a revised Permit Amendment Application was published by Jacobs Group Australia on 15 August 2016 on behalf of WWE. The turbine positions contained in the 15 August 2016 amendment are considered the baseline against which Sovereign Hill's proposed alternative turbine positions are assessed. The noteworthy amendment for the Elaine cluster is that the proposed position of turbine ESWT02 has been moved 150m south.

When considering alternative turbine positions as requested by Sovereign Hill, Enhar's assessment focusses on the energy yield and does not evaluate other potential impacts of moving turbines such as changes to noise levels at dwellings, impacts on flora and fauna, aboriginal heritage, visual composition from other viewpoints, telecommunication pathways etc. The exception is shadow flicker at one residence (H18aa), which is evaluated in the latter part of this report.

[1] Map depicted in "Permit Amendment Layout + 1km Distance Contour – Elaine, LAL LAL WIND FARM showing alternative WTG locations", by West Wind Energy, file EWF-SM-0018, dated 17 Sept 2015, supplied by Kellehers to Enhar.

1.1. Details of Authors of report

Details of the two experts contributing to this report are provided below:

Name	**Richard Moreton**	**Demian Natakhan**
Role in report	Technical analysis and report drafting	Checking of analysis and report finalisation
Address of expert	30 Centennial Avenue, Brunswick West 3055	73 Harrison St, Brunswick East 3057
Qualifications and experience	BEng Mechanical Engineering The University Of Adelaide Experienced in technical services for onshore wind farm development in Australia and the UK.	BEng Environmental Systems Engineering, Lancaster University UK. MSc Renewable Energy Systems Technology, Loughborough University UK. Chartered Engineer with Institute of Energy (UK). Wind farm project experience in Australia and UK including wind resource monitoring, energy yield modelling, shadow flicker and noise impact assessment, construction management, environmental management.
Statement of experts area of expertise to make the report	Richard has expertise in wind farm analysis including energy yield modelling, wind data analysis, site optimisation, and visual impact assessment.	Demian has experience with wind farm yield modelling in respect to turbine location changes. He also has experience with financial modelling of wind farms and environmental impact assessment of wind farms.

There are no other contributors to this report.

Instructions which defined the scope of this report are attached in Appendix 2.

2. Initial Basic Appraisal

Upon initial inspection, Enhar formed the view that using any combination of the three initial suggested alternative locations would be unlikely to cause a significant reduction in overall site energy yield, or lead to an increase in construction or operational costs.

The terrain surrounding the suggested alternative locations seems acceptable, with base elevations that are on par with the original locations, providing good wind exposure for the turbines. There is no significant apparent difference in terrain complexity, regarding slope or vegetation coverage. Spacing relative to other adjacent wind turbines in the layout looks acceptable from a wake loss perspective, and is consistent with the rest of the layout. The same can be said regarding proximity to roads and other existing infrastructure based on satellite imagery of the new locations.

The road required to access these locations appears to be comparable in length to that for the original locations. Thus, it is expected that there will not be a significant increase in road construction cost.

Assuming similar ground conditions in the alternative locations, foundation construction costs are also expected to be comparable. In using the alternative turbine locations, there appear to be no factors which would give rise to any significantly increased operational cost.

The expected net result was that there will be perhaps a small reduction in annual energy yield, due to a small increase in turbine wake induced energy loss; a turbine that is downwind of another nearby turbine can expect a reduced wind speed and hence reduced energy production. Locations A and C in particular place the turbines in closer proximity to surrounding turbines relative to their original positions. This is less of an issue for location B, making B the best apparent option of the initial three. Location C appears to be the worst in this regard, however it still appears able to accommodate one or two turbines with adequate spacing. The loss in revenue due to a reduction in energy production is dependent on the amount agreed in a power purchase agreement, typically expressed in $/MWh, and would be of a similar proportion to the overall energy change, which is expected to be a small fraction of the overall yield and project income.

From an energy yield perspective, the initial order of preference for the three possible scenarios was as follows;
1. A & B
2. B & C
3. A & C

After it was established that locations A and B were no longer deemed suitable for relocation, the backup scenario was to have both turbines relocated to within area C. This scenario would be expected to result in a slightly greater loss in energy due to turbine wake effects compared to the other scenarios, but could still be considered viable.

In regard to shadow flicker at residence H18aa, initial review of material provided indicated that the actual hours of shadow occurrence would be expected to be close to the recommended limit of 30 hours per year (worst case meteorological conditions). There is a significant degree of uncertainty associated with shadow flicker models, which is expected to be of a similar order to the reduction claimed through the micro siting proposed. Therefore, the likelihood that the actual shadow hours will be below recommended thresholds increases through the movement of turbine ESWT02 150m southwards, however some uncertainty in this outcome remains.

The following sections outline a more detailed assessment conducted by Enhar which confirms the initial appraisal conclusions.

3. Appraisal Validation

3.1. Wind Flow Model

In order to achieve greater confidence and specificity regarding the extent of the energy yield impact for each proposed amendment scenario, a basic wind flow model has been built for the Lal Lal site, to allow for an energy yield simulation based on representative turbine specifications, and accounting for terrain and turbine wake effects. The following assessment is intended to be indicative only, valid as an analysis of the relative change caused by moving two turbines, rather than to provide accurate bankable results on overall wind farm yield. Wherever sufficient data have not been available, Enhar has used what it believes to be realistic and conservative engineering judgements to achieve final yield estimates.

The terrain model has been built using freely available terrain data from the Victorian Government Land Services Spatial Datamart. This included GIS vector files for elevation contours at 10m resolution, from which an elevation raster of 25m resolution was derived. Also included were vector files for vegetation cover, which were used to create roughness and displacement height layers. The terrain files accessed extend at least 5km from any given turbine location. The following images show a view of the whole site, with terrain elevation (Figure 1-1) and roughness (Figure 1-2). Vegetation areas were assigned a roughness length of 0.5m and a displacement height of 10m, with areas of water assigned a roughness length of 0.0002m. Standard default roughness was defined as 0.05m.

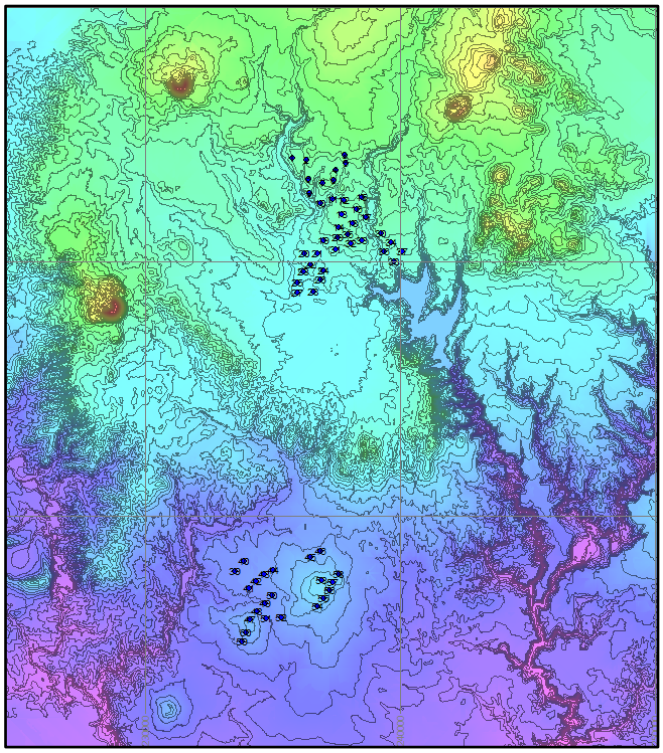


Figure 3-1: Terrain model and turbine locations

Wind farm modelling was undertaken by Enhar in OpenWind, which is an internationally used tool for wind farm site design and energy modelling. The proponent has used WindPRO, another industry standard model with similar functionality.

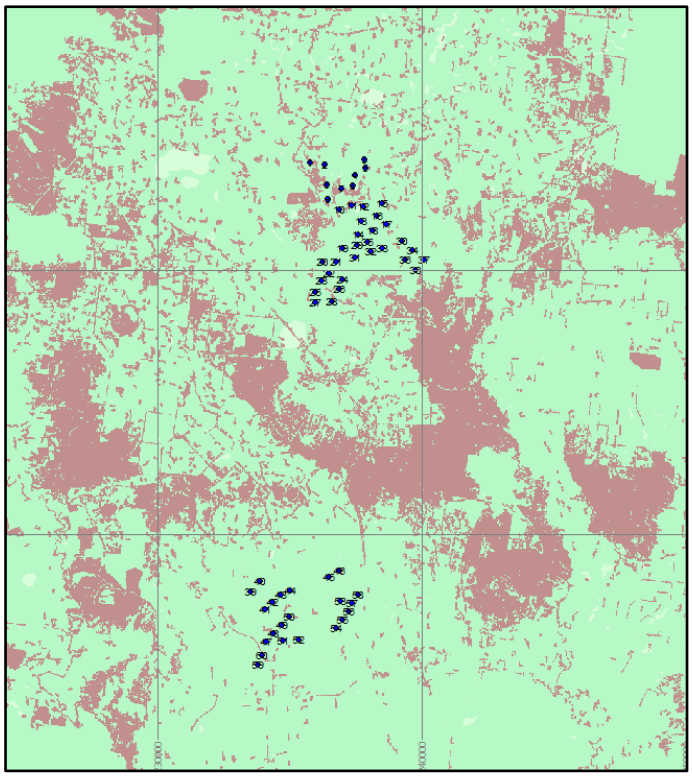


Figure 3-2: Surface roughness model and turbine locations

Enhar understands there is an 80m on-site wind monitoring mast located close to turbine ESWT04. Mast measured data is commercial in confidence, therefore Enhar has not reviewed the site-measured data and has instead used a local wind frequency distribution based on the nearest Bureau of Meteorology AWS station, located at Ballarat Aerodrome, approximately 25km north-west of the Yendon cluster. Such a distance would not be suitable for a bankable assessment with such high extrapolation error, however it is considered sufficient for this comparison analysis. Enhar has used WWE's calculated annual energy yield value of 504 Giga-Watt hours (GWh) quoted in a WWE project update 9 Aug 2016 to derive a hypothetical wind speed used for scaling the Ballarat Aerodrome frequency distribution in order to achieve comparable results. Enhar's model for the same turbine layout now gives a result within 1% of WWE's value. The wind direction distribution from Ballarat Aerodrome indicates a strong north-south prevailing wind direction as illustrated below, with wind roses for frequency (left) and power density (right). A standard shear exponent of 0.143 was assumed when extrapolating from the 10m mast height to the 104m hub height.

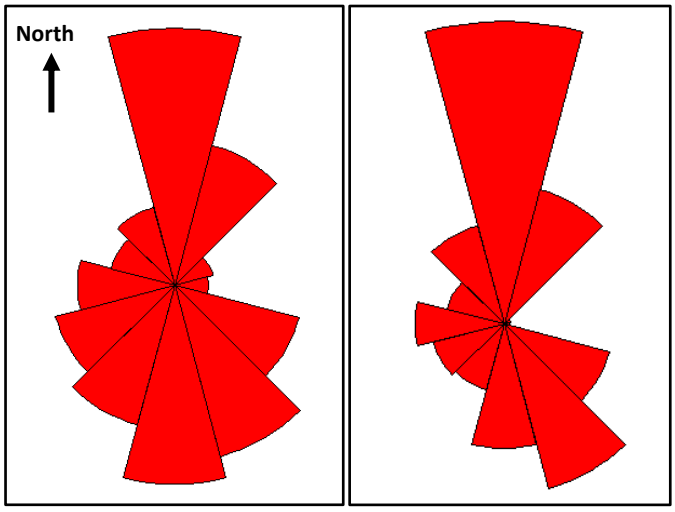


Figure 3-3: Ballarat Aerodrome wind roses showing frequency (left) and power density (right)

The comparative analysis of energy yield under the various amendments is considered to be sufficiently accurate to draw conclusions for the purposes of this assessment.

The turbines were modelled based on data provided in sales brochures by the manufacturer for the Senvion 3.2M114, using a power curve and thrust curve for standard air density. Standard deviation of wind speed data were not available, and thus did not allow for accurate evaluation of turbulence intensity (TI). OpenWind uses a default global TI value of 10%, however Enhar applied a value of 12% to be slightly more conservative based on a judgement of the surrounding terrain.

Table 3-1: Turbine power curve specifications

OpenWind File Name/ Wind Speed (m/s)	Senvion 3.2M114_3170kW_104mHH	
	Power Output (kW)	Thrust Curve
0	0	0
1	0	0
2	0	0
3	18	1.05
4	144	0.85
5	319	0.8
6	590	0.8
7	969	0.8
8	1460	0.8
9	2017	0.72
10	2576	0.64
11	3009	0.57
12	3170	0.4
13	3170	0.3
14	3170	0.24
15	3170	0.19
16	3170	0.16
17	3170	0.13
18	3170	0.11
19	3170	0.1
20	3170	0.08
21	3170	0.07
22	3170	0.06

As noted above, the software used was OpenWind, by AWS Truepower, using the WindMap flow model, and Modified Park wake model. The WindMap generated was of 100m resolution, deemed sufficient for this indicative analysis, and extended upwards of 2km from any given turbine location. A view of the wind map over the Elaine cluster area is shown in the figure below, along with the WWE layout (blue) and a suggested amendment scenario for area C (green). Wind speed in this area at the proposed 104m hub height appears to vary from around 6.7m/s (green-blue) to around 7.2m/s (yellow-orange);

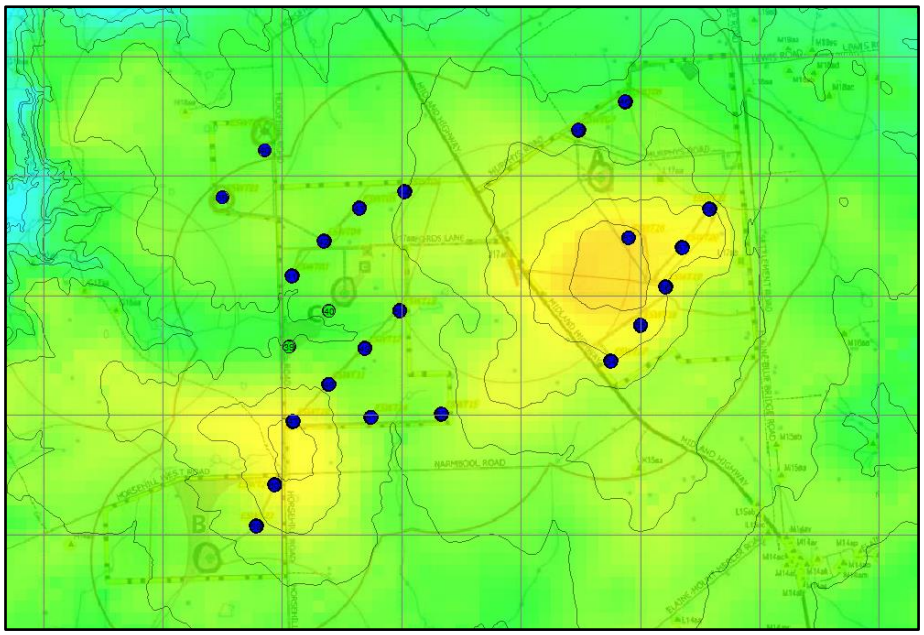


Figure 3-4: Wind map and Elaine cluster wind turbines

3.2. Energy Yield Comparative Assessment

Energy yield calculations are typically expressed in terms of 'probability of exceedance'. For a 'P50' energy yield value, there is deemed to be a 50% chance that the actual site will outperform said value. To evaluate an indicative P50 energy yield result, i.e. the expected performance of the site, a series of standard conservative technical loss factors were applied to the raw model results. This allows the impact of the wake loss impacts to be more accurately represented. For wake loss calculations, only internal effects were analysed; it was assumed there were no neighbouring wind farm sites now or in the future that would have an impact on the Lal Lal site's energy yield. No other curtailments were assumed. The example shown below is for the current WWE amended site layout:

Table 3-2: Loss factors applied to energy yield simulations

Category Name	Value	Sub Category Name	Value
Availability	**96.1%**	Turbine (downtime, maintenance) Balance of plant Grid	96.5% 99.8% 99.8%
Wake effects	**91.6%**	Internal wake effects External wake effects Future wake effects	91.6%
Turbine Performance	**94.9%**	Power curve (manufacturer warranty) Wind flow (turbulence, inflow angle, shear) High wind hysteresis	95.0% 99.9% 100.0%
Electrical	**98.5%**	Electrical losses Facility parasitic consumption	98.5% 100.0%
Environmental	**98.5%**	Performance degradation (soiling, icing) Shutdown due to icing, weather etc. Site access and other force majeure events Tree growth or felling	99.0% 99.5% 100.0% 100.0%
Curtailment	**100.0%**	Wind sector management Grid and ramp-rate Offtaker curtailment Environmental (noise, visual, bird/bat)	100.0% 100.0% 100.0% 100.0%
Total Efficiency	**81.0%**		

Final results are summarised in the table below:

Table 3-3: Energy Yield simulation results

RESULTS	Gross Energy Yield (GWh)	Wake Loss Factor	Total Efficiency	P50 Energy Yield (GWh)	Capacity Factor
Original Layout	**625.79**	90.8%	80.0%	**500.63**	30.0%
Current Layout	**626.09**	90.6%	79.8%	**499.77**	30.0%
Amended Layout CC	**625.70**	90.3%	79.6%	**497.78**	29.9%
Amended Layout AC	**626.07**	90.5%	79.7%	**498.76**	29.9%
Amended Layout AB	**626.11**	90.8%	79.9%	**500.45**	30.0%
Amended Layout BC	**625.92**	90.6%	79.8%	**499.64**	30.0%
Amended CC/Current	99.94%	99.66%		99.60%	
Amended AC/Current	100.00%	99.80%		99.80%	
Amended AB/Current	100.00%	100.14%		100.14%	
Amended BC/Current	99.97%	100.00%		99.97%	

Table 3-4: Wind speed results at suggested turbine locations

	Wind Speed (m/s)	
Location	**Free Stream**	**Wake affected**
C1	6.94	6.49
C2	6.93	6.32
A	7.04	6.68
B	6.98	6.92
C	6.97	6.45

Note in the wind speed table above, location C refers to the original suggested location, while locations C1 and C2 represent the two locations chosen to allow area C to accommodate both relocated turbines. These results reinforce the initial judgement that the proposed amendments would likely result in only a negligible change in energy yield, and that the scenario 'AB' would have produced the highest annual energy yield out of all scenarios initially considered. It is worth noting that even the lowest performing scenario, 'CC', is still very similar in performance to the current layout, causing an energy loss of approximately 0.4% of overall yield. In the context of other impacts on energy yield, this is not considered to be a major impact. The overall wind farm yield increases in the amended application for larger turbines would be approximately 49.6% in a CC scenario vs 50% in the latest WWE amendment, compared to WWE's earlier 64 turbine layout.

For an estimate of impact on financial returns, if a power purchase price of $40/MWh is assumed, then scenario CC would result in an annual revenue loss of approximately ~$80,000 compared to the latest WWE layout. The reduction in Large Generation Certificate (LGC) income if assumed to be an average of $40/MWh over the first years of the project, would bring total loss of revenue to ~$160,000/year noting these estimates are purely indicative and not based on detailed financial modelling.

3.2.1. Impact of increase in turbine height and blade length

The increase in turbine hub height and blade length provides a significantly higher overall energy yield due to the higher wind speeds available at higher hub heights, and the larger swept area of the longer-bladed turbines. The following extract from WWE Newsletter August 2016 indicates that the forecast generation has increased from 336 GWh/yr to 504 GWh/year, an increase of 50%.

Table 3-5: Wind farm yield increase due to amended turbine height and blade length [source: WWE Newsletter August 2016]

Parameter	Existing approval	Approval sought
Proposed wind turbine numbers	64	60
Generation capacity MW	Up to 150	Up to 216
Gwh per year	App. 336	Approx. 504

For reference, the turbine coordinates (in MGA94 projection, zone 55) and the Sovereign Hill proposed amendment are specified in the table below:

Table 3-6: Turbine coordinates in Elaine cluster with amendments proposed

Turbine ID	Coordinates		Amendment
	Easting	Northing	Remove/ Keep/ Add
ESWT01	233500	5817822	Remove
ESWT02	233855	5818367	N/A
ESWT02 (WWE amended)	233855	5818217	Remove
A	236672	5817989	N/A
B	233379	5814804	N/A
C	234526	5817029	N/A
C1	234059	5816571	Add
C2	234392	5816872	Add
ESWT03	234084	5817161	Keep
ESWT04	234351	5817454	Keep
ESWT05	234648	5817731	Keep
ESWT06	235025	5817868	Keep
ESWT07	236483	5818385	Keep
ESWT08	236876	5818621	Keep
ESWT10	234095	5815947	Keep
ESWT11	234393	5816255	Keep
ESWT12	234695	5816555	Keep
ESWT13	234986	5816872	Keep
ESWT14	234746	5815979	Keep
ESWT15	235337	5816007	Keep
ESWT16	236903	5817482	Keep
ESWT17	236754	5816449	Keep
ESWT18	237003	5816752	Keep
ESWT19	237212	5817071	Keep
ESWT20	237353	5817401	Keep
ESWT21	237579	5817722	Keep
ESWT23	233785	5815068	Keep
ESWT24	233936	5815414	Keep

3.3. Construction Cost Considerations

3.3.1. Road measurements

Road lengths were measured from a georeferenced screenshot of the map document provided by the client ('Permit Amendment Layout + 1km Distance Contour – Elaine'). For the current turbine layout, turbines ESWT 01 & 02 require access tracks totalling roughly 1590m in length. Note that this total length includes approximately 520m of existing road that would still need modification to accommodate construction access. If these two turbines are to be relocated, then these roads would not need to be built/modified, however additional roads would be needed to accommodate the new proposed locations.

Looking at the provided map for the proposed amendments, and assuming that direct road routes are viable in all cases, the following new road lengths were measured:

Location C1: 425m (measured from ESWT03)
Location C2: 435m (measured from location C1)
Location A: 170m (measured from road intersection between ESWT07 and ESWT16)
Location B: 480m (measured from ESWT23)
Location C: 370m (measured vertically down from road above)

For the CC amendment scenario, approximately 860m of new road is measured, resulting in a net reduction of road length by 730m.

For the AC amendment scenario, approximately 540m of new road is measured, resulting in a net reduction of road length by 1050m.

For the AB amendment scenario, approximately 650m of new road is measured, resulting in a net reduction of road length by 940m.

For the BC amendment scenario, approximately 850m of new road is measured, resulting in a net reduction of road length by 740m.

Thus it can be concluded that neither of the three proposed amendment scenarios will lead to increased construction costs relating to roads. A reduction in cost of road construction and maintenance can be expected corresponding to the reduction in road length.

Enhar has not assessed impacts on the length of electrical cable between turbines or trench lengths and cable installation costs. If, however, the electrical cables are to be buried adjacent to the roads, the net length of cable and the relative costs will broadly follow the same trend as road lengths and costs.

3.4. Operational cost considerations

The proposed alternative turbine locations do not appear to introduce any additional operational costs. The impact on average turbulence levels at wind turbines from wake turbulence is likely to be negligible.

3.5. Shadow Flicker Analysis

Sovereign Hill has raised concerns regarding shadow flicker at property H18aa due to turbine ESWT02. Currently, the WWE amended layout has accommodated a shift in the location of said turbine by 150m south, to mitigate the issue of shadow flicker, however the client is concerned that the amended location for this turbine may still result in excess of the 30 hour recommended limit for annual shadow flicker at property H18aa[2]. Like any models, shadow flicker models contain uncertainty therefore it is informative to run multiple models to compare the results.

Enhar performed a shadow flicker analysis using WindFarm software to investigate this issue. Windfarm is an internationally used industry standard modelling tool for wind farm energy yield analysis and visual, noise and shadow flicker impacts. It is programmed and sold by Resoft in the UK. WWE's planning permit amendment attaches shadow flicker modelling by Jacobs using WindPRO software, another globally adopted industry standard tool with similar functionality.

When modelling the property concerned as a shadow receptor, Enhar assumed the property has a window on each side of the house including the east and south walls, each with 1m x 1m dimensions and a centre height of 2m. In relation to tree screening, Kellehers provided Enhar with the following image from Sovereign Hill showing the location of trees around the property.

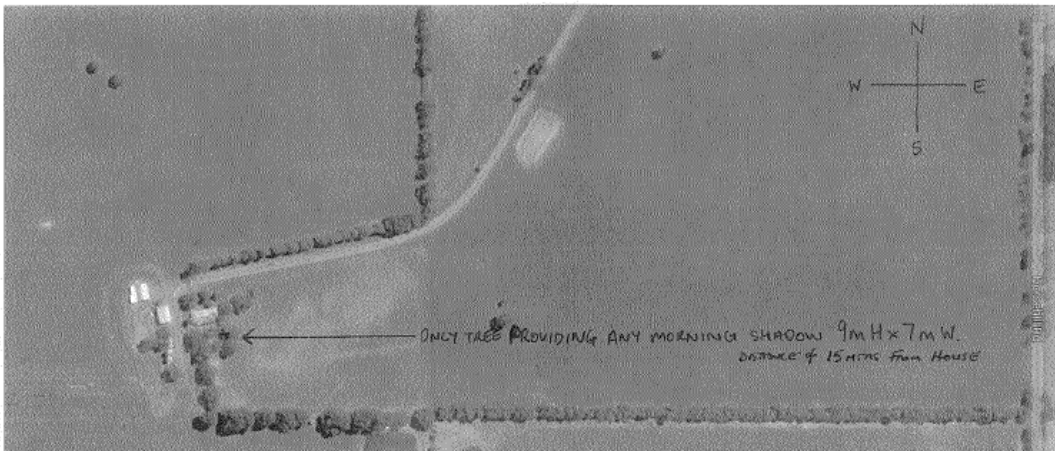


Figure 3-5: Trees adjacent to residence H18aa

A photograph of the view from the east-facing window location was also supplied by Kellehers to Enhar and is shown in Figure 3-6 below.

[2] Recommended limits are provided in Table E-1 in Chapter E of the draft Australian National Wind Farm Development Guidelines, 2010.

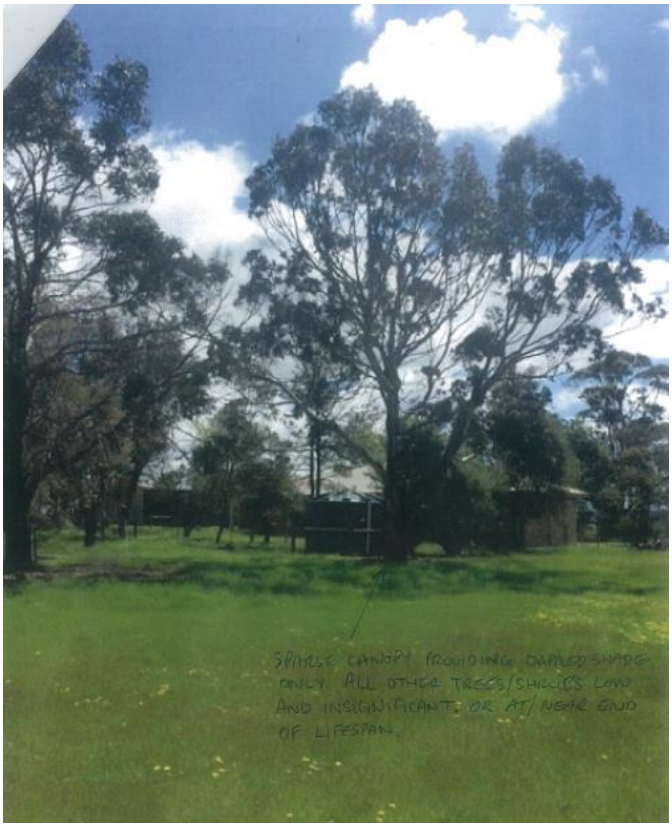


Figure 3-6: View from near the window of H18aa towards nearest turbine ESWT02 location

Given that the canopy of the largest tree in this direction is sparse (semi-transparent) rather than dense (fully opaque), it is possible that shadow flicker from a turbine behind the tree will reach the window of the property despite the partial screening provided by the tree. Enhar has not prepared a visual simulation of turbine appearance from this location, however it is conservatively assumed the turbine is visible.

In line with the allowable mitigations in Table E-3 of the Draft Australian Wind Farm Guidelines, it can therefore be assumed that worst case astronomical condition shadow flicker hours are not reduced through the presence of trees in this location since they are not expected to completely block the view of the turbine.

For the given turbine geometry, and the same elevation grid data used for the energy yield analysis, Enhar calculated approximately 33 hours shadow flicker per year, for both the east and south windows, spread over 66 days of the year for an average of 0.5 hours for those days. This result suggests the extent of shadow flicker at property H18aa due to ESWT02 may exceed the recommended guideline levels. It is worth noting again that trees have not been accounted for in this model. Inspection of the property concerned via aerial imagery shows some trees adjacent to the property which would likely provide natural screening against shadow flicker. However, no onsite survey has been conducted by Enhar to confirm tree positions and sizes, therefore worst case scenario is assumed with no screening.

The location ESWT02 is one of the two locations which Sovereign Hill is seeking to relocate, such as to area C in the Narmbool plan. Relocating the turbine to area C would remove all shadow flicker at H18aa. Alternatively, the turbine could be moved further south within the current land parcel whilst still being adequately spaced relative to neighbouring turbines for wake loss purposes. The image below shows the calculated shadow flicker contours overlayed on georeferenced imagery from Google Earth.

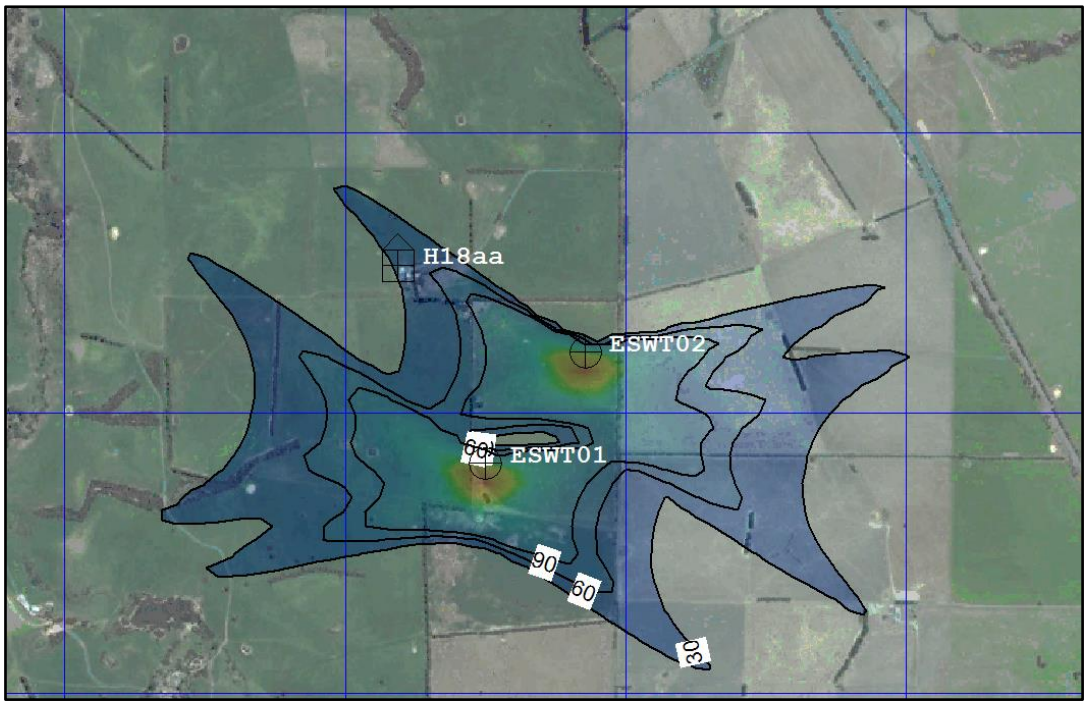


Figure 3-7: Shadow flicker contours (hours/year) for turbines ESWT 02 and 01, with property H18aa

The colour gradient within the shadow contours ranges from 30 hours (blue) up to 800 hours (red).

The following graph shows the times of day and year during which property H18aa is affected by shadow flicker from turbine ESWT02 after WWE's amendment. The y-axis represents hour of day while the x-axis represents day of year. The red shaded area in the graph therefore suggests that shadow flicker occurs at this property from approximately late October to late January in the early hours of the morning, around 5:30am to 6:00am. The south and east windows are affected in roughly equal measure. Results are tabulated below for the affected windows of the house.

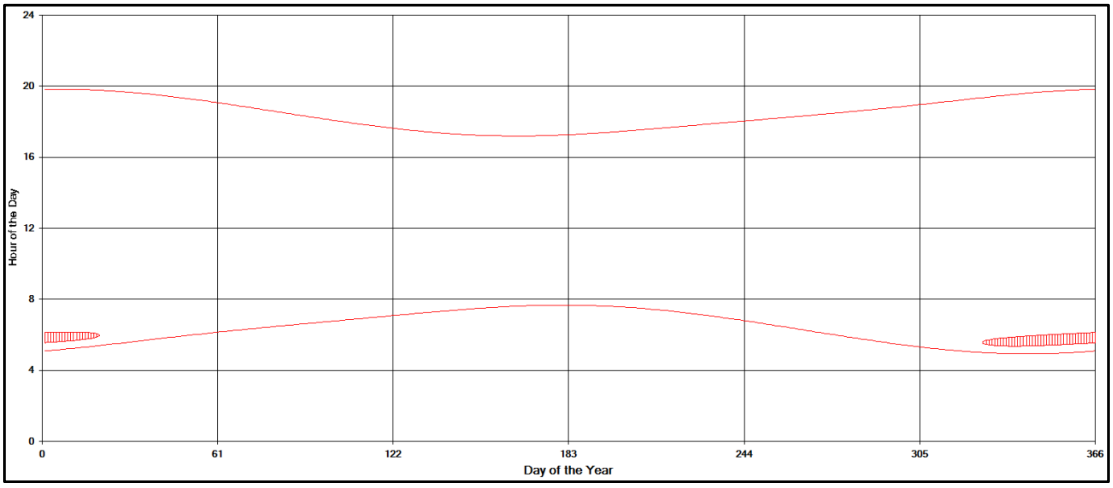


Figure 3-8: Shadow flicker times at property H18aa due to ESWT02

Table 3-7: Shadow flicker results for property H18aa due to turbine ESWT02

Window	Days Per Year	Max Hours Per Day	Mean Hours Per Day	Total Hours
East	66	0.65	0.5	33.1
South	66	0.65	0.5	33.0

Following from this result, Enhar found that moving ESWT02 further directly south by ~180m would reduce the number of shadow flicker hours for the year to below 30 hours at property H18aa, according to the WindFarm model used. This shift is illustrated in the image below with the green marker representing the suggested southward relocation. With these new coordinates of 233855 E, 5818037 N, ESWT02 appears still within the apparent project boundary, with a comfortable separation distance from the nearest turbine, ESWT01, along with no significant change in overall energy yield for the site. Enhar chose an elliptical spacing buffer of 5 x 3 rotor diameters for the turbine, based on the assumed prevailing wind direction.

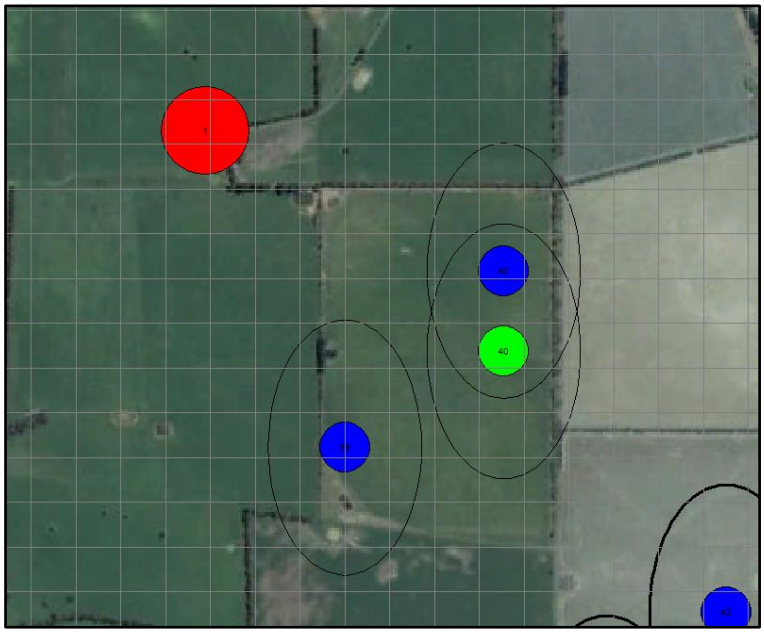


Figure 3-9: Suggested amendment for reducing shadow flicker hours at property H18aa to below 30 hours due to turbine ESWT02.

Table 3-8: Coordinates summary for property H18aa and turbine ESWT02

	Easting (m)	Northing (m)
Property H18aa	233189	5818529
ESWT02 WWE amendment	233855	5818217
ESWT02 relocated by Enhar for shadow flicker mitigation	233855	5818037

Table 3-9: Shadow flicker results for property H18aa after shifting ESWT02 further south

Window	Days Per Year	Max Hours Per Day	Mean Hours Per Day	Total Hours
East	60	0.60	0.5	29.8
South	60	0.60	0.5	29.8

As noted above, shadow flicker models contain uncertainty. The margin of <1 hour shadow per year is expected to be easily within the size of the uncertainty bands of the model. To create high certainty of achieving less than 30 hours a further buffer is recommended. If shadow flicker observations become an issue during the operation of a wind farm, additional mitigation can be achieved by the use of shadow-flicker control within specific turbines which shuts down turbines at specific times to prevent shadow flicker.

3.6. Disclaimer

The design and adjustment of wind turbine layouts for wind farms is a complex process with many interactive factors. Turbine movements can reduce certain environmental or amenity impacts but simultaneously cause increases in other impacts. The scope of this report was solely to assess the relative impact on energy yield and to comment on any major cost impacts from the amendment of two turbine locations. Other planning, environmental engineering and amenity factors are not considered in this study, with the exception of shadow flicker impacts at one house 18aa, and the above conclusions on energy and costs should not to be taken to exclude other possible impacts of relocating turbines as suggested.

Enhar has not conducted site survey inspections and has relied purely on desk based data analysis and site information provided by Kellehers and Sovereign Hill. Site inspections would be required by appropriate personnel to finalise any revised turbine positions in light of on-the-ground factors which may not be evident from the available maps.

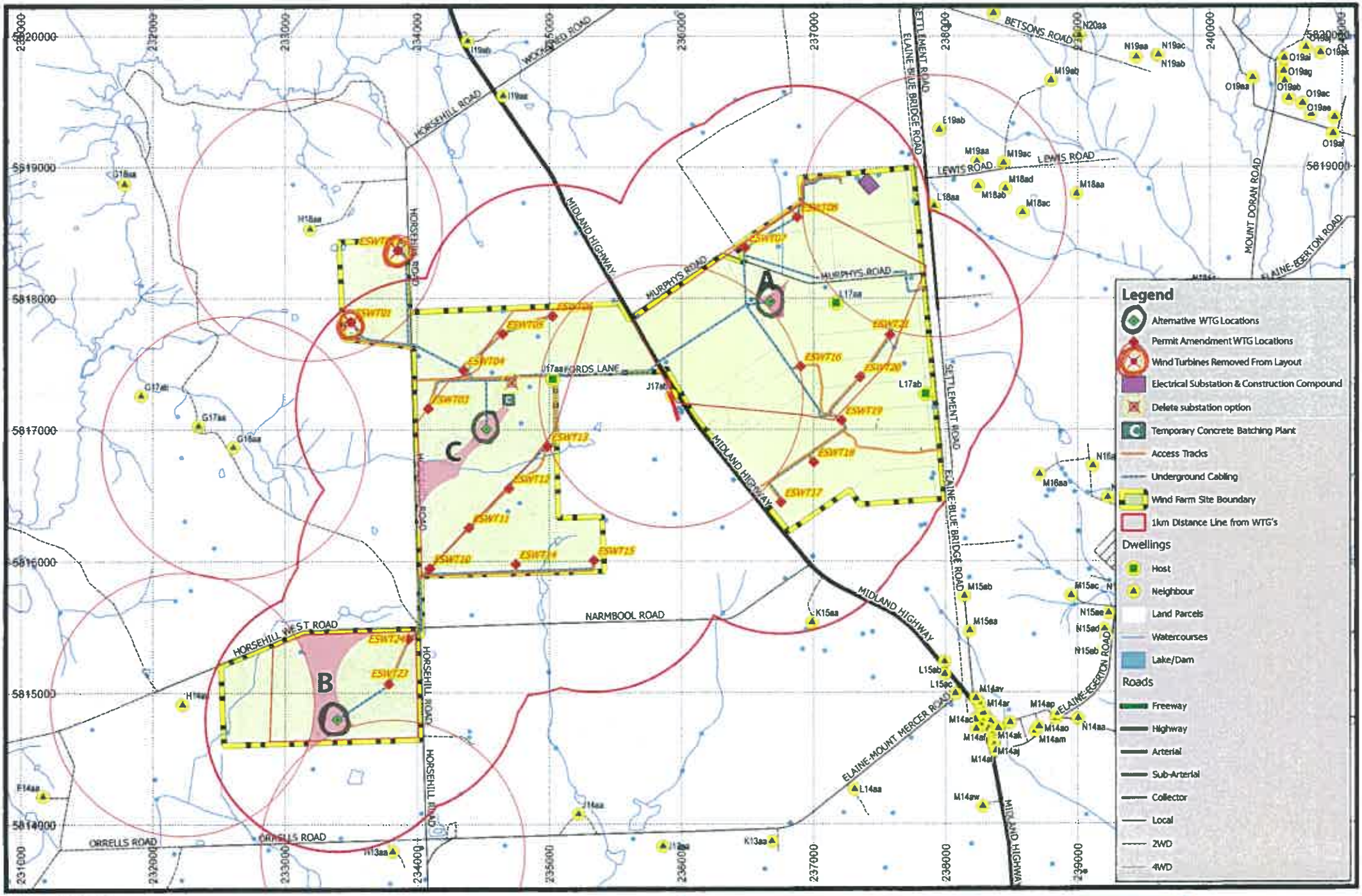
3.7. Declaration

In relation to the specific brief which Enhar has been given, Enhar is able to make the following declaration in the context of this report being used at a Panel hearing:

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

Demian Natakhan on 31/10/2016

Appendix 1 – Narmbool Plan showing alternative turbine positions



Permit Amendment Layout + 1km Distance Contour – Elaine

LAL LAL WIND FARM showing alternative WTG locations

WestWind ENERGY

Appendix 2 – Instructions defining scope of report

KELLEHERS
AUSTRALIA

BARRISTERS & SOLICITORS

Town Planning, Environmental Law,
Local Government, Government Relations,
Property Law

ABN 47 350 401 635

3 August 2016
Our ref: 150566

Mr D Natakhan
Director
Enhar Pty Ltd
Sustainable Energy Consulting
Suite G-03
60 Leicester Street
CARLTON 3053

Dear Mr Natakhan

Re: Narmbool, HorseHill Road via Elaine

Following our discussions last week, we confirm that we act on behalf of The Sovereign Hill Museums Association (ABN 87 565 053 651) (SH), the owner and occupier of the above property.

On 30 April 2009, the Minister for Planning approved Planning Permit No: PL-SP/05/0461 for the use and development of a wind energy facility comprising 64 wind turbines and their associated infrastructure and other works including: the construction of access tracks; underground cabling; two permanent amenities buildings; two electrical substations; two permanent meteorological monitoring facilities and associated equipment; car parking and bicycle facilities, temporary construction facilities (including an ancillary concrete batching plant), business identification signs and alterations to access points to roads in a Road Zone. The permit was subject to 29 conditions. You will see that the proposal comprises two apparently quite distinct and unconnected energy facilities – one at Elaine and one at Yendon. Our client's property is proximate only to the proposed Elaine facility.

In February 2015, application was made to amend this Permit. We do not presently have a copy of this amendment application, but will provide same subsequently to ensure your file is complete. However, by letter dated 23 September 2015 an application was made on behalf of West Wind Energy (WWE) to amend the February 2015 amendment application and a report from Jacobs accompanied that amended application. This letter stated that the information contained in this report 'supersedes the previous permit amendment application documents submitted…' We do not hold a Jacobs report dated on or about 23 September 2015. We are confirming whether such exists and will provide you with a copy of same as soon as we hold it. However, attached is a copy of a report by Jacobs titled 'Planning Report and Consolidated Attachments' dated October 2015. Within this report is a plan showing the proposed Amended Layout plans for each section.

During the earlier part of 2016, our client was approached by WWE and discussions occurred that included the preparation by SH of a plan showing an amended turbine layout at Elaine that would be acceptable to it (Narmbool Plan).

As you know, the matter came before Planning Panels last Friday for a Directions Hearing. The outcome of this hearing was that WWE intends to lodge yet further amendments to its amendment application and the upcoming August hearing was canceled.

At this stage, we seek your assistance in comparing the wind energy facility as proposed in the current amendment to a facility in the form shown on the Narmbool Plan and, if comparison can easily be made, with the facility as approved in 2009 in regard to the following:

1. Wind energy generation;
2. Likely estimated cost of construction;
3. Likely estimated maintenance costs;
4. Any other matters relevant to wind farm operations as you consider relevant.

Could you also note, if same arise in the above, any other matters of potential concern in comparing the current amendment to the Narmbool Plan. At this stage, we do not require comparisons other than as to the above 4 factors, save general comments on any obvious matters that arise. We are also concerned to remain within or below budget, so would only wish to brief you regarding a photomontage after the above analysis is completed.

You have our client's signed fee agreement and confirm again that you will invoice our client c/- this office.

Attached please find the following:

A. Chronology;
B. 2009 Planning Permit No PL-SP/-5/0461;
C. Plans:
    1. Original WWE Elaine Plan;
    2. Original WWE Yendon Plan;
    3. Sovereign Hill's proposed Narmbool Plan;
D. Jacobs Report dated October 2015:
    1. Main body of report;
    2. Attachment C to report, with revised permit wording and revised layout plans;
E. Objection by Sovereign Hill dated 21/12/2015;
F. Objection to the Elaine section – Craig Perrett email 7/12/2015 and written objection attached;
G. Objection to the Elaine section – Brian and Helen Dunne 17/12/2015; and
H. General submissions regarding the amendment application overall – Moorabool Shire Council (2 letters dated 18/12/2015 and email from Stella Patience 20/12/2015).

We have copies of the zones and maps, but given their extensive nature, we refer you to the Department of Planning and Community Development website (http://planning-schemes.delwp.vic.gov.au/schemes/moorabool) for copies. We are also able to provide these, if it would assist.

If you require any additional background information or find any queries arise from this brief, please do not hesitate to contact our office.

Yours faithfully

KELLEHERS AUSTRALIA

LK/lm/rn
Enc
Cc Mr R Moreton

KELLEHERS
AUSTRALIA

BARRISTERS & SOLICITORS

Town Planning, Environmental Law,
Local Government, Government Relations,
Property Law

ABN 47 350 401 635

16 August 2016
Our ref: 150566

Mr D Natakhan
Director
Enhar Pty Ltd
Sustainable Energy Consulting
Suite G-03
60 Leicester Street
CARLTON 3053

Dear Mr Natakhan

Re: Narmbool, HorseHill Road via Elaine

Following our discussions last week, we confirm that WWE appears to have lodged variations to its plans with DELWP yesterday. WWE's website shows these documents as now available via the following link:

https://drive.google.com/file/d/0B-AHpHMOXPv4eGxfblh1S1RRTms/view?pref=2&pli=1

We request that you now review your analysis in the light of the variation with, once again, regard to:

1. Wind energy generation;
2. Likely estimated cost of construction;
3. Likely estimated maintenance costs;
4. Any other matters relevant to wind farm operations as you consider relevant;
5. Relevance, and what, of flexibility of turbine length/hub height.

Can you also provide comment as to the claims in this documentation that any impact of shadow flicker at our client's farm workers house is now entirely removed. Is this correct?

Please note that we are still seeking confirmation from DELWP that these are the variation plans according to its records.

If this letter or the linked variation application give rise to any queries, please do not hesitate to contact our office.

Yours faithfully

KELLEHERS AUSTRALIA
LK/lm/rn