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STATEMENT OF ENVIRONMENTAL EFFECTS FOR A PROPOSED FROST FAN DEVELOPMENT

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FOR A
PROPOSED FROST FAN DEVELOPMENT

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ANNEXURES

1.0 EXECUTIVE SUMMARY

Global Ag Properties II Australia Pty Ltd (Global Ag) own and operate the property 'Huddersfield' at Darlington Point, which in recent years has been planted to a large almond orchard. Global Ag propose to install 142 frost fans in two stages on Huddersfield to mitigate frost risk.

This *Statement of Environmental Effects* sets out the proposed development, the legislative context and addresses the potential impacts of the development.

The key potential impact of the development is noise disturbance to surrounding dwellings. The *Environmental Noise Assessment* prepared to assess the proposed development states:

> *"Based on the predictions, the adopted criteria of 55 dB(A) for dwellings in the Primary Production Zone and 45 dB(A) for dwellings in the Village and Large Lot Residential zones will be achieved at all non-associated dwellings in the vicinity when the installation consists of fourteen "2600" type fans, one-hundred-and-twenty-eight "2430" type fans, with twenty-eight fans not installed, all operated at normal speeds in the locations identified in this report."*

This *Statement of Environmental Effects* has been prepared to support a development application to Murrumbidgee Council for the proposed development. Potential development impacts have been analysed. Aside from noise disturbance there are no other potential development impacts to be mitigated. Noise disturbance risks will be mitigated by:

- Frost fan installation in accordance with the *Environmental Noise Assessment*;
- A post development noise compliance check; and
- The preparation of a *Noise Management Plan*.

2.0 PROPOSED DEVELOPMENT

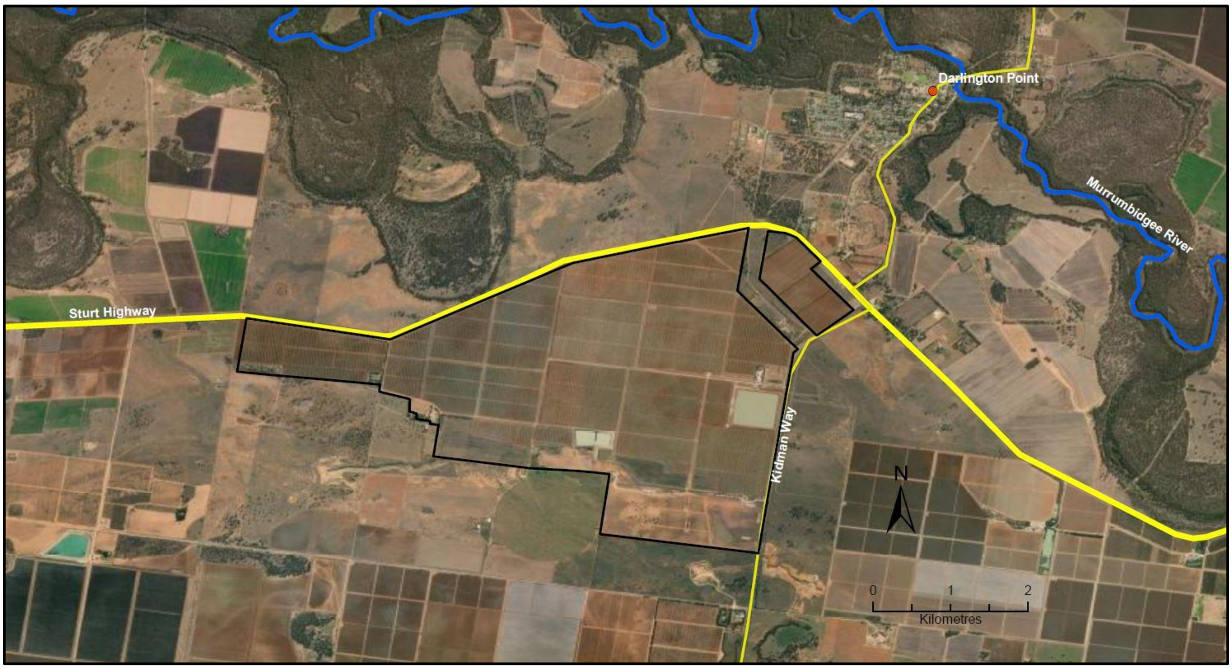
2.1 The Developer

The proposed frost fan development is situated on Huddersfield which is located south of Darlington Point on the south-west side of the junction of the Sturt Highway and Kidman Way. The property is owned and operated by Global Ag Properties II Australia Pty Ltd, PO Box 6138, Wagga Wagga NSW 2650.

2.2 Site Details and Surrounding Land Use

In the past three years Global Ag has planted Huddersfield to almond trees on land that was previously used for horticulture, irrigated annual cropping and dryland annual winter cropping. An aerial image of Huddersfield is provided as Figure 1.

Figure 1: Huddersfield

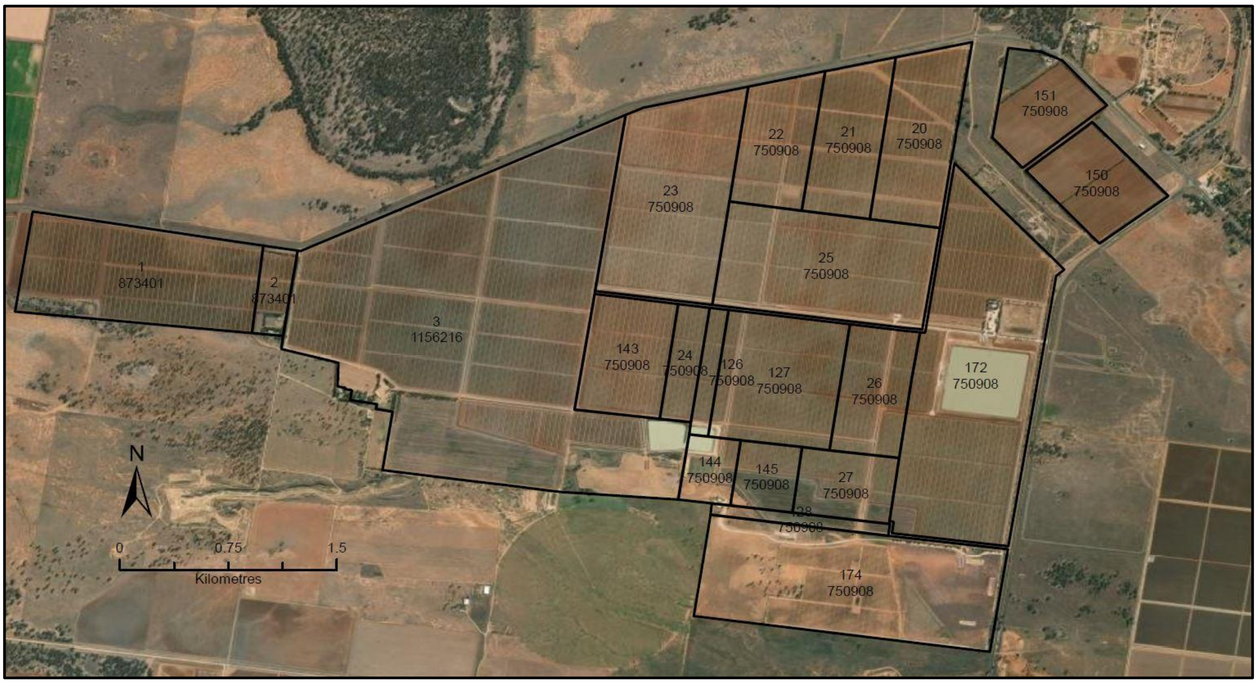


The key features which can be observed in Figure 1 include:

- Property boundary in black;
- Sturt Highway running along the northern boundary of the property;
- Kidman Way running along the eastern boundary of the property;
- Darlington Point located about 1.5km north east of the property;
- Murrumbidgee River running west on the northern side of Darlington Point; and
- Various surrounding land uses, predominantly centre pivot and flood irrigation development, dryland farming, native pastures and remnant vegetation.

An aerial image of Huddersfield showing cadastral boundaries is provided as Figure 2.

Figure 2: Aerial Image



The information depicted in Figure 2 includes the lot and deposited plan numbers. The proposed frost fan development will be located on the land listed in Table 1 below.

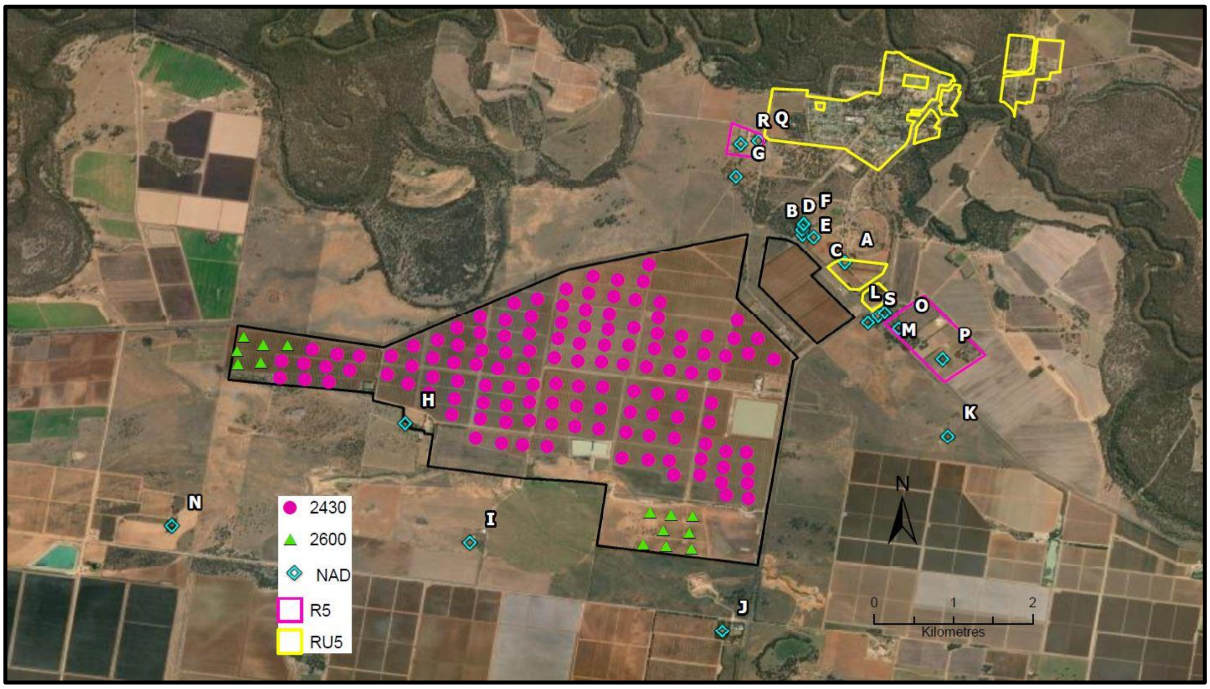
Table 1: Land Details

Lot No	Deposited Plan No
1	873401
3	1156216
21	750908
22	750908
23	750908
24	750908
25	750908
26	750908
27	750908
126	750908
127	750908
143	750908
145	750908
172	750908
174	750908

2.3 Project Description

The proposed development is the installation of 142 frost fans across Huddersfield as depicted in Figure 3.

Figure 3: Frost Fan Locations and Nearby Dwellings



A full page copy of Figure 3 is provided as Annexure 1. Features depicted in Figure 3 include:

- The location of each of the proposed 142 frost fans;
- The type of fan and stage (development phase, number 1 or 2) when the fans will be installed;
- The location of the RU5 village and R5 large lot residential zones to the north-east; and
- The location of the nearest non-associated dwellings (NAD) noted as letters A to S .

Frost fans are large stationary fans used to pull warmer air down to the orchard during periods of potential frost at a critical time in the almond tree's late winter and spring growth. The frost fans are 10.7 metres tall (to the fan shaft) and have two or three fibreglass blades with a diameter of 6.0 metres, and are mounted on a concrete base. Details of the fans are provided in Table 2 and Annexure 2.

Table 2: Fan Details

Model	2430	2600
Number of blades	3	2
Fan rpm	373	549
Engine rpm	2010	2270

To maximise air movement, the fans oscillate slowly over 360 degrees creating constantly changing wind direction.

The proposed frost fans will be mounted on a 5.35m³ concrete base. Plans of the frost fans and engineering specifications for the concrete pads are included as Annexure 3.

Each proposed frost fan is driven by a diesel powered Caterpillar 4.4 (110hp) or 7.1 (173hp) engine located within noise attenuated housing with an integrated acoustic muffler. These engines are installed on the concrete pad at the base of the tower. The engines have an auto start system to start and stop at pre-determined temperatures (usually 1.6°C and 3°C respectively) which are accurate to ±0.3°C. The engines are also connected to local anemometers which shut the fans down when the local wind speed exceeds about 8km/h.

The proposed development is to be installed in two stages with 46 fans in Stage 1 and the remaining 96 fans installed in Stage 2. The proposed development includes 14 two bladed frost fans (model 2600) and 128 three bladed (noise reduction model 2430) frost fans as set out in Table 3 below.

Table 3: Development Summary

Stage	**1**		**2**	
Model	2430	2600	2430	2600
Number of fans	40	6	88	8

Maps of the fans to be installed in Stage 1 and Stage 2 are included in Annexure 1. About 920ha will be covered by the 142 proposed frost fans which equates to one fan per 6.5ha. Each fan is 200m to 250m apart.

3.0 LEGISLATIVE POLICY

This section of the *Statement of Environmental Effects* addresses planning legislation and policy which is relevant to the Huddersfield proposed frost fan development.

3.1 Murrumbidgee Local Environmental Plan, 2013

Huddersfield is located in the Murrumbidgee Local Government Area (LGA) on land zoned RU1 Primary Production. The *Murrumbidgee Local Environmental Plan, 2013* permits intensive plant agriculture without consent on RU1 Primary Production land. Farm buildings are permitted with consent on RU1 Primary Production land. The proposed frost fans are classified as farm buildings and therefore the proposed frost fan development is permissible with consent.

The objectives of the RU1 Primary Production zone under the *Murrumbidgee Local Environmental Plan, 2013* are:

"▪ *To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.*

▪ *To encourage diversity in primary industry enterprises and systems appropriate for the area.*

▪ *To minimise the fragmentation and alienation of resource lands.*

▪ *To minimise conflict between land uses within this zone and land uses within adjoining zones."*

The proposed frost fan development is consistent with the objectives of the RU1 Primary Production zone as it provides frost risk mitigation to "*encourage sustainable primary industry production*". Almonds are a relatively new crop to the Murrumbidgee LGA and the almond development on Huddersfield represents "*diversity in primary production enterprises*". The purpose of this *Statement of Environmental Effects* is to address any potential impacts of the proposed development and "*to minimise conflict between land uses*" in the RU1 Primary Production zone and adjoining zones at Darlington Point.

3.2 Darlington Point and Coleambally Development Control Plan

The *Darlington Point and Coleambally Development Control Plan* addresses the town of Darlington Point but not the surrounding rural land. There is no other Development Control Plan relevant to the proposed frost fan development.

3.3 Darlington Point Township Structure Plan

The 2017 *Darlington Point Township Structure Plan* sets out the growth plans for Darlington Point which includes an industrial area either side of the Sturt Highway and Kidman Way intersection. Some of the proposed industrial area adjoins Huddersfield. The Structure Plan also retains the existing R5 Large Lot Residential area on the eastern side of the Kidman Way (north of the Sturt Highway) and the golf course located on the southern side of the town. A copy of the Structure Plan is included as Annexure 4. The golf course and industrial land will provide a buffer between residential areas and the proposed frost fan development.

3.4 Protection of the Environment and Operations Act, 1997

The NSW *Protection of the Environment and Operations Act, 1997* is designed to protect, restore and enhance the quality of the environment in NSW. The Act sets out a definition of offensive noise which the proposed frost fans could potentially generate. Part 5.5 Noise Pollution Section 139 states:

> *"**Operation of Plant***
>
> *The occupier of any premises who operates any plant (other than control equipment) at those premises in such a manner as to cause the emission of noise from those premises is guilty of an offence if the noise so caused, or any part of it, is caused by the occupier's failure—*
>
> *(a) to maintain the plant in an efficient condition, or*
>
> *(b) to operate the plant in a proper and efficient manner."*

The *Protection of the Environment and Operations Act, 1997* also includes the following definitions:

> ***"noise pollution** means the emission of offensive noise."*
>
> and
>
> *"**offensive noise** means noise—*
>
> *(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances—*
>
> *(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
>
> *(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
>
> *(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations."*

The proposed frost fan development has been designed to comply with the *Protection of the Environment and Operations Act, 1997*.

3.5 EPA – Noise Guide for Local Government

The NSW Environmental Protection Authority published a *Noise Guide for Local Government* in 2013 which includes frost fans as a noise source for which council is the appropriate regulatory authority.

The Noise Guide states:

> *"Noise pollution can be defined as unwanted noise that unreasonably intrudes on daily activities."*
>
> and
>
> *"Noise is identified as 'intrusive' if it is noticeably louder than the background and considered likely to disturb or interfere with those who can hear it."*

Table 1.3 of the Noise Guide sets out "Approaches to managing common neighbourhood noise issues". Council is listed as the appropriate regulatory authority (ARA).

Table 1.3 of the Noise Guide states the assessment required for frost fans is:

> *"Offensive noise test (2.1.4) or assessment against any relevant government policy."*

The suggested noise management/regulation is:

> *"Negotiate implementation of reasonable and feasible best practices.*
>
> *Noise control notice (4.2.1) or prevention notice (4.2.4)."*

Example guidelines listed in the Noise Guide are the EPA Victoria guideline publication *1043.1,* which is addressed in Section 3.6 (below), and Griffith City Council Frost Fans Policy which is addressed in Section 3.7 (below).

3.6 EPA Victoria – Noise from Frost Fans

In May 2012, EPA Victoria released Publication No. 1043.1 *Noise from Frost Fans*. This document states:

> *"A severe frost can reduce yields by more than 50 per cent (sometimes up to 100 per cent), creating management problems for the current as well as future seasons. Frost fans are commonly used as a means of protection against frost, but they may cause conflict between residents and growers because of the noise they create."*

and

> *"As frost fans are primarily used at night, the minimisation of sleep disturbance effects is a key issue addressed by this information bulletin. In areas with low levels of background noise, the intrusiveness of noise from frost fans can degrade the amenity at surrounding houses."*

and

> *"The most frost-sensitive period for crops varies according to the type of the crop. For deciduous fruit trees such as apricots, peaches, plums, nectarines and almonds, the main damage from frost occurs at flowering and during very early fruit development".*

and

> *"Frost fans are large fans used to circulate air over a wide area where crops such as citrus, stone fruit or vines are grown.*
>
> *The fans are used on occasions when there is a risk of frost damage to the plants and fruit.*
>
> *Frost fans work by drawing warmer air from above the orchard (above the inversion layer) and blowing it through the orchard during the frost danger period."*

and

> *"Noise from frost fans comes from the turning of the fan and the motor that drives the fan. Often the noise can be heard many hundreds of metres from a frost fan.*
>
> *As the risk of frost occurs at night and in the early morning when the air is still, frost fans are in operation when people are generally sleeping or carrying out 'quiet' activities. This coincides with the period when noise from other sources (background noise) is at a minimum. In quiet areas, the noise from frost fans can distract the attention of residents from activities such as reading, relaxing or watching television. It can cause sleep disturbance or cause people to change their sleeping habits to avoid sleep disturbance.*

To lessen the amount of disturbance caused by frost fans, it is important that their use and associated noise is minimised while still allowing the protection of crops. To achieve this required outcome, this information bulletin provides recommended indoor and outdoor noise levels that should be met at the location likely to be impacted by the noise (see section 6.2). Outdoor levels must be met and indoor levels must also be assured where there is a high risk of them being exceeded."

and

"In order to minimise noise impact, frost fans should only be used when there is a need for protection against frost damage. The timing and duration of the use of the fans can vary, depending on the type of plants and local climatic conditions."

and

"Frost fans should only be used when the temperature around the plants is below 0 to 1°C and the trees/crop are at a critical growth stage".

Recommended outdoor noise levels are addressed in Section 3.7 of this report. In order to minimise offsite noise impacts the proposed frost fans should be used at a minimum during periods of potential frost in the spring bloom period from late July to September.

3.7 Griffith City Council Frost Control Fan Local Policy

Griffith City Council has released a *Frost Control Fan Local Policy.* The most recent version of this policy was adopted by Council on 24 March, 2020. This Policy states permanent frost control fans require development consent and are only permitted on land where intensive plant agriculture is permissible without consent. Murrumbidgee Council has no comparable frost control fan policy, but given the Griffith LGA is located just 2.5km north of the development, this Policy is relevant to the proposed development.

The *Frost Control Fan Local Policy* sets out the information required for submission with a development application. This includes:

- Site plans (refer to Figure 3 and Annexure 1);
- Structural engineer's certification and drawings (refer to Annexure 3);
- Anticipated operation temperatures (start at 1.6°C and stop at 3°C);
- Frost frequency (refer to Section 4.1);
- Acoustic report to show the extent of modelled sound level contours (refer to Annexure 6);
- Manufacturer's noise test report (refer to Annexure 7);
- Compliance check requirements (refer to Section 5.3); and
- Noise Management Plan preparation and requirements (refer to Section 5.3).

The *Frost Control Fan Local Policy* also sets out the following noise limit criteria:

Table 4: Noise Limits

Location of affected residence	Outdoor Criteria (LAeq)	Indoor Criteria (LAeq)
Noise sensitive zone	45 dB(A) (max)	25 DB(A) (max)
Non-noise sensitive zone	55 dB(A) (max)	35 dB(A) (max)

Noise sensitive zones include RU5 village and R5 Large Lot residential zones as depicted in Figure 3. Non-noise sensitive zones includes RU1 Primary Production zone which is the majority of the area depicted in Figure 3.

An *Environmental Noise Assessment* has been prepared for the proposed development and complies with the criteria in Table 4 (above) and is addressed in Section 4.2 of this report.

The *Frost Control Fan Local Policy* sets out the standards that will apply to the operation of all frost control fans including requirements for auto ignition, thermostatic controls and noise attenuating housing with integrated acoustic muffler for the engine. The proposed development will comply with these requirements.

The *Frost Control Fan Local Policy* states:

> *"Intrusive noise is generally considered to be 5 decibels above background noise level and in rural areas at night, background noise levels can be quite low (eg 30dB(A)."*

Frost fans have the potential to create intrusive noise and this development has been modified to mitigate offsite noise impacts (refer to Section 4.2 below).

3.8 Biodiversity Conservation Act, 2016

The proposed frost fan development is located on highly modified irrigation land that is not identified as Terrestrial Biodiversity in the *Murrumbidgee Local Environmental Plan, 2013*. The installation of the proposed frost fans will not necessitate the removal of native vegetation, and therefore does not require consent under the *Biodiversity Conservation Act, 2016*.

3.9 Threatened Species Conservation Act, 1995

The proposed frost fan development is located entirely within highly modified irrigation land. There are not expected to be any additional impacts on threatened species or their habitats beyond that which already exists.

3.10 Commonwealth Environmental Protection and Biodiversity Act, 1999

As the proposed frost fan development is on pre-existing, and highly modified, irrigation lands there are not expected to be any triggers requiring licensing or approvals under the *Commonwealth Environmental Protection and Biodiversity Act, 1999*.

3.11 National Parks and Wildlife Act, 1974

The *National Parks and Wildlife Act, 1974* sets out protection requirements for places, objects and features of significance to Aboriginal people. The proposed development is entirely located on highly modified irrigation lands. Given the disturbed nature of the subject land, no potential impacts are anticipated on places, objects or features of significance to Aboriginal people.

A search of the Aboriginal Heritage Information Management System (AHIMS) database found no recorded sites on or near Huddersfield.

3.12 Hydrology

The proposed development is not located in a floodway or in an area identified as "Riparian Lands and Watercourses" or "Wetlands" in the *Murrumbidgee Local Environmental Plan, 2013*.

3.13 Geohydrology

The proposed development is located in an area identified as having groundwater vulnerability in the *Murrumbidgee Local Environmental Plan, 2013*. However, the proposed development will not result in any groundwater impacts.

4.0 SITE INVESTIGATION

4.1 Climate

To ascertain the need for and location of the proposed frost fans, a *Frost Assessment and Mitigation* report was prepared in October 2019 by Climate Consulting. A copy of this report is attached as Annexure 5. This report analyses the local climate including detailed field measurements and an assessment of the nearest Bureau of Meteorology weather station located at Griffith. The field assessment used six climate towers and 139 remote temperature data loggers' data in August and September 2019. The report concluded:

> *"Analysis has revealed a spatial variation in near-surface minimum temperature of 2.8°C. This will result in isolated incidents of frost to cooler parts of the property on many occasions. Extrapolations using historical temperature data from Griffith suggests that much of Huddersfield has a high risk of early spring frost. While inversion development supports the use of wind machines as an effective method of frost mitigation, protection of coolest areas cannot be guaranteed at near-surface temperature below -3.0°C. These temperatures have an expected return period of one year in five.*
>
> *The final section of the report recommends that optimal frost mitigation will encompass the entire orchard and consist of up to 170 wind machines. The final number of machines may change to reflect wind machine make, model and density."*
>
> and
>
> *"Although the frost risk profile map shows a range of frost risk to the property (moderate-high to very high), it must be realised that without frost mitigation spring frost would have affected the entire property on 8 of the past 16 years.*
>
> *Inversion strengths are rated as good to very good and are satisfactory for the installation wind machines as a method of frost mitigation. Wind machines are expected to significantly reduce frost risk, with nominal near-surface temperature increases (within a wind machine warming footprint) of 1.7 – 2.0°C. Greater temperature modifications could be expected over cooler areas with slightly less over warmer areas. The effect of a wind machine is to "level the playing field" so that as much of the orchard as possible records a uniform temperature, preferably raised above zero during frost.*
>
> *Provided that good inversion conditions are present, a wind machine could be expected to effectively protect 4.5 – 5.5 ha from a near-surface temperature of minus 3.0°C. Extrapolation of temperature records from Griffith AWS suggests that a frost of this magnitude or greater has likely return period of once in 5 years. At lower temperatures the area of effective warming footprint will reduce and damage may occur to crop in between wind machine warming footprints and around the margins of some block boundaries. Data from Griffith AWS suggests that temperatures below -3.0°C would have been recorded at Huddersfield near the end of August for years 2017, 2018 and 2019."*

and

> *"Figure 13 shows the number of times frost protection is likely to have been required over cooler parts (blue shaded areas on frost risk map) of Huddersfield for the years 2004 - 2019. The frequency ranges from a low of 0 incidences in 2009 and 2014 to 9 occasions in 2012 and 2017."*

Figure 13 in the Climate Consulting report (refer to Annexure 5) shows a total of 60 frost events over the 16 year period, which is an average of about four per year and a range of 0 to 9.

The Bureau of Meteorology frost potential maps[1] indicate the region experiences:

- Two to five days per month in August and zero to two days per month in September when the minimum temperature is less than 0°C, the mid point of this being 4.5 days (3.5 + 1) and the maximum being seven days; and
- Five to ten days per month in August and two to five days per month in September when the minimum temperature is less than 2°, the mid point of this being 11 days (7.5 + 3.5) and the maximum being 15 days.

Therefore, the frost fans could be expected to be operated from zero to 15 days per year.

Almond trees are very susceptible to frost from late July to September. Hence, the compelling need for the proposed frost fan development to mitigate the significant frost risk identified in the Climate Consulting report.

4.2 Acoustic Report

The Climate Consulting report recommended the installation of 170 frost fans on Huddersfield (as set out in Section 4.1 above). To determine the potential noise impacts of this development, an *Environmental Noise Assessment* was prepared by Chris Turnbull of Sonus in October 2021 and is attached as Annexure 6. The Sonus Assessment was based on meeting the noise criteria set out in Table 4 (above) and the SSA Acoustics *Noise Test Reports* for both fan models (included as Annexure 7). The Sonus Assessment considered the two frost fan models detailed in Annexure 2 of this report and concluded:

> *"The make-up of the one-hundred-and-seventy fan installation has been determined such that all fans can be operated at normal speed and based on the understanding that stage two will consist primarily of "2430" type fans. In addition, stage one of the installation has been designed in order to not prejudice the future inclusion of stage two. In order to meet the criteria, twenty-eight of the proposed frost control fans will need to be removed from the proposal and not installed. This will result in a total of one-hundred-and-forty-two fans for the full installation, with forty-six fans to be installed as stage one and the remaining ninety-six as stage two. This will be comprised of a total of fourteen "2600" type frost control fans and one-hundred-and-twenty-eight "2430" frost control fans, all of which can be operated at normal speed."*

[1] http://www.bom.gov.au/jsp/ncc/climate_averages/frost/index.jsp

The Sonus Assessment has identified the location of all non-associated dwellings (NAD) within the vicinity of the proposed development. The predicted noise levels at each of these dwellings (after Stage 2 is complete) for the originally planned 170 fans and the now proposed 142 fans is set out in Table 5 below.

Table 5: Noise Assessment

Residence	Predicted Noise Level	Installation as Recommended, with 142 fans	Originally planned Installation of 170 fans	Criterion	Residence	Predicted Noise Level	Installation as Recommended, with 142 Fans	Originally planned Installation of 170 fans	Criterion
NAD A	45 dB(A)	53 dB(A)	61 dB(A)	45 dB(A)	NAD K	43 dB(A)	44 dB(A)	50 dB(A)	55 dB(A)
NAD B	45 dB(A)	55 dB(A)	63 dB(A)	55 dB(A)	NAD L	45 dB(A)	51 dB(A)	59 dB(A)	55 dB(A)
NAD C	45 dB(A)	54 dB(A)	62 dB(A)	55 dB(A)	NAD M	45 dB(A)	50 dB(A)	58 dB(A)	55 dB(A)
NAD D	45 dB(A)	54 dB(A)	62 dB(A)	55 dB(A)	NAD N	43 dB(A)	43 dB(A)	47dB(A)	55 dB(A)
NAD E	45 dB(A)	53 dB(A)	61 dB(A)	55 dB(A)	NAD O	44 dB(A)	49 dB(A)	56 dB(A)	45 dB(A)
NAD F	45 dB(A)	52 dB(A)	61 dB(A)	55 dB(A)	NAD P	43 dB(A)	45 dB(A)	52 dB(A)	45 dB(A)
NAD G	44 dB(A)	48 dB(A)	56 dB(A)	55 dB(A)	NAD Q	42 dB(A)	45 dB(A)	52 dB(A)	45 dB(A)
NAD H	55 dB(A)	58 dB(A)	66 dB(A)	55 dB(A)	NAD R	42 dB(A)	45 dB(A)	53 dB(A)	45 dB(A)
NAD I	48 dB(A)	48 dB(A)	55 dB(A)	55 dB(A)	NAD S	46 dB(A)	53 dB(A)	61 dB(A)	55 dB(A)
NAD J	50 dB(A)	50 dB(A)	53 dB(A)	55 dB(A)					

On the basis of the Sonus Assessment, 28 of the frost fans have been removed from the development, leaving 142 fans now proposed, with 46 in Stage 1 and 96 in Stage 2 as detailed in Table 3 above. 128 (90%) of the proposed fans are Model 2430 which is the three bladed noise reduction fan.

Appendix C of the Sonus Assessment (refer to Annexure 6) includes a contour map showing the location of the 55 dB(A) and 45 dB(A) contours for the 142 proposed frost fans. A copy of Appendix C is provided as Figure 4 below. This map shows minor encroachment of the 45dB(A) contour in the RU5 village zone. This area is planned to be rezoned from village to industrial (refer to Annexure 4).

Figure 4: Sonus Appendix C

APPENDIX C: *Frost Control Fan Noise Contours*

Figure 4 and Table 5 indicate the proposed development complies with the noise limits set out in Table 4 above.

4.3 Native Vegetation

The site for the proposed frost fan development is wholly located within highly modified irrigation lands that have been planted to almond orchards. No native vegetation is required to be removed for the proposed development.

4.4 Fauna

The site for the proposed frost fan development is entirely located within highly modified irrigation lands that have been planted to almond orchards. Given the highly modified nature of the site no fauna impacts are expected by the proposed development.

4.5 Cultural Heritage

The proposed development is wholly located within highly modified irrigation lands that have been planted to almond orchards in the last few years. In preparing this report an Aboriginal Heritage Information Management System (AHIMS) database search was conducted for all lots on Huddersfield (as depicted in Figure 2) which found no sites identified on or near the property. Each of the proposed frost fans will be installed on a 6.5m² concrete pad, so the entire development will cover an area of less than 0.1ha.

4.6 Dust

As the centre of each fan is nearly 11m above the ground (with a blade diameter of 6m) and will only operate a few discrete times a year above a fully mature almond orchard, no dust generation is expected from the operation of the frost fans. Some dust may arise during the transport of the proposed frost fans to each site, but this dust generation will be in line with routine farm operations and not create any significant off-farm impacts.

4.7 Odour

No odour impacts are likely to arise during the construction and/or operation of the proposed frost fans.

4.8 Traffic

During the construction of the proposed frost fans, there will be a modest increase in traffic from staff and machinery accessing the site and the supply of the proposed fans and other materials to the site. The proposed development installation is expected to take ten weeks (in two stages) with up to 80 truck movements (in total or eight per week) and six on-site installers with up to six vehicle movements per day during installation.

4.9 Amenity

The proposed frost fans will be 200m to 250m apart and located within a large mature almond orchard, examples of which are provided in the following photographs. The photographs show the frost fans are sparsely dispersed across the orchard and create minimal visual impacts.

5.0 MITIGATION

5.1 Planning Phase

This *Statement of Environmental Effects* has noted the proposed development has the potential for significant noise impacts (disturbance). This *Statement of Environmental Effects* has not identified any other significant potential impacts arising from the proposed development.

To assess the need for the development, detailed local climate modelling was undertaken by Climate Consulting (refer to Annexure 5). The Climate Consulting report recommended the installation of 170 frost fans in order to mitigate significant frost risk.

To ensure the proposed development would not exceed off-site noise requirements in accordance with the Griffith City Council *Frost Control Fan Local Policy*, a detailed Environmental Noise Assessment was undertaken (refer to Annexure 6). This assessment concluded 28 of the planned fans should be removed and the majority (128) of the 142 proposed fans be installed as a noise reduction fan to comply with noise limits as set out in Table 4 (above). Subsequent to these modifications the Environmental Noise Assessment has found the predicted noise levels at the 19 non-associated dwellings within the vicinity of the site all comply with the 55dB(A) predicted noise level limit.

5.2 Installation Phase

The key potential impacts during installation of the proposed frost fans are dust and traffic. The dust generated from staff and equipment moving to and from each location will be minimal over and above that arising from existing farm operations. The majority of the dust generated by vehicle movement is likely to be mitigated by the almond orchard.

The traffic impacts will be minimal as the installation of the fans will occur over 10 weeks (in two stages) with all vehicles and trucks accessing the property from the Sturt Highway and Kidman Way using existing operational farm access points.

5.3 Operational Phase

The proposed frost fans will be operated using auto-ignition thermostatic controls with anemometers to ensure the frost fans only start when the temperature falls below 1.6°C, and stop at 3°C and/or wind speeds of greater than 8km/h. The proposed frost fans will be driven by diesel engines with noise attenuating housing and integrated acoustic mufflers to minimise noise impacts. No other operational impacts are anticipated.

Compliance checks will be carried out post development after Stage 1 and Stage 2 to ensure noise levels comply with noise limits as set out in Table 4 above. The compliance check after Stage 1 will groundtruth the conclusions of the Environmental Noise Assessment (refer to Annexure 6).

A Noise Management Plan will be prepared in accordance with the criteria set out in the Griffith City Council *Frost Control Fan Local Policy* (refer to Section 3.7 above). The Noise Management Plan will ensure appropriate mitigation systems are in place during operation to manage any potential impacts. Mitigation will include reducing fan speeds (as the blades at full speed emit the majority of the noise).

6.0 RELEVANT APPROVALS

The proposed frost fans require development consent from Murrumbidgee Council, and this *Statement of Environmental Effects* will accompany the Development Application for the proposed frost fans. There are no other approvals required for the installation and operation of the proposed frost fans.

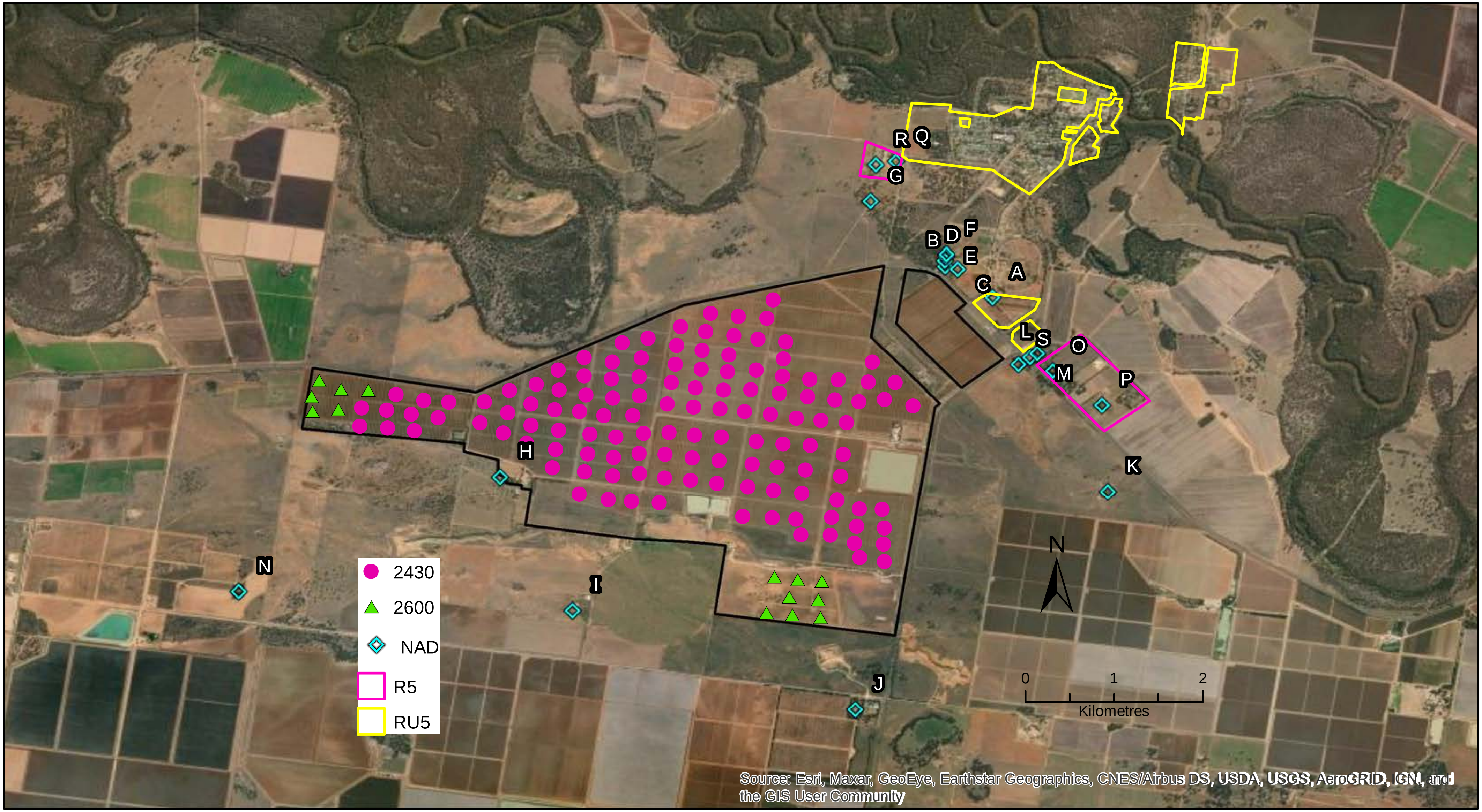
Annexure 1

Plans of Proposed Development

GLOBAL AG - HUDDERSFIELD
PROPOSED FROST FAN DEVELOPMENT

Note: Riverina Agriconsultants and its employees do not guarantee that this publication is wthout flaw of any kind or is wholly appropriate for your particular purposes, and therefore disclaims all liability for relying on any information in this publication.
Date: 19/11/2021
Project: Huddersfield
Created By: GIS Administrator - J Kajewski

riverina agriconsultants



GLOBAL AG - HUDDERSFIELD
PROPOSED FROST FAN DEVELOPMENT STAGE 1

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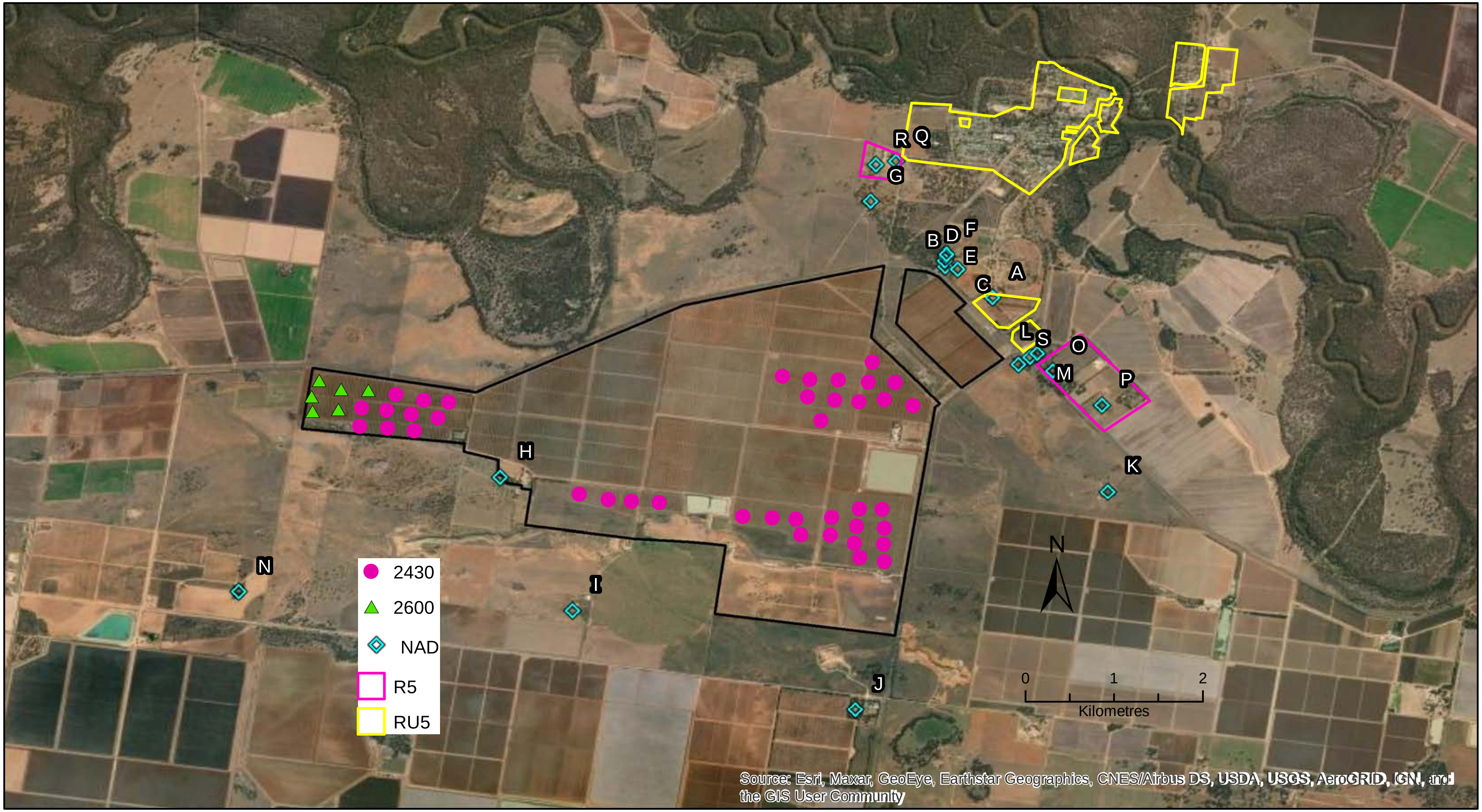

GLOBAL AG - HUDDERSFIELD
PROPOSED FROST FAN DEVELOPMENT STAGE 2

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Project: Huddersfield
Created By: GIS Administrator - J Kajewski

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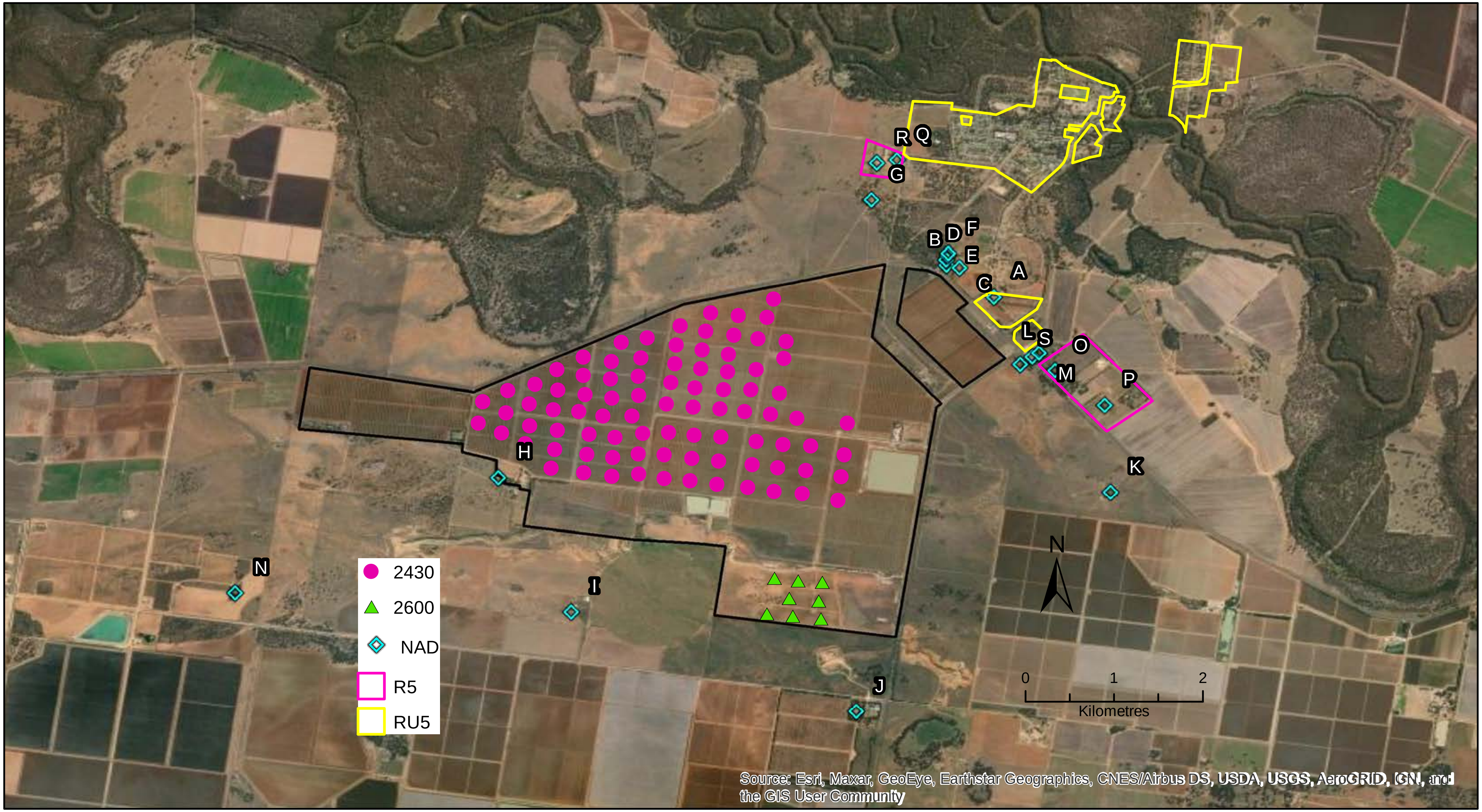


Annexure 2

Manufacturer's Information

Stationary Wind Machines

Model 2600

Orchard-Rite®

When one cold night can ruin an entire year's hard work...

It's best to play it safe.

Since 1967, we have crafted our wind machines with precision technology. We take pride in the details, which is why growers from around the world trust our name. We design machinery to match your needs and are there to help throughout the process. At Orchard-Rite, we are dedicated to serving you and your crops by providing the tools and knowledge to stave off those frosty nights.

Standard Features

Gearboxes and FLEXOR® Steel Input Shaft

Built with durable ductile iron and designed with a FLEXOR® steel input shaft, which is considered to be superior to common alloy steel, our gearboxes come with multiple options to best suit the topography of any location.

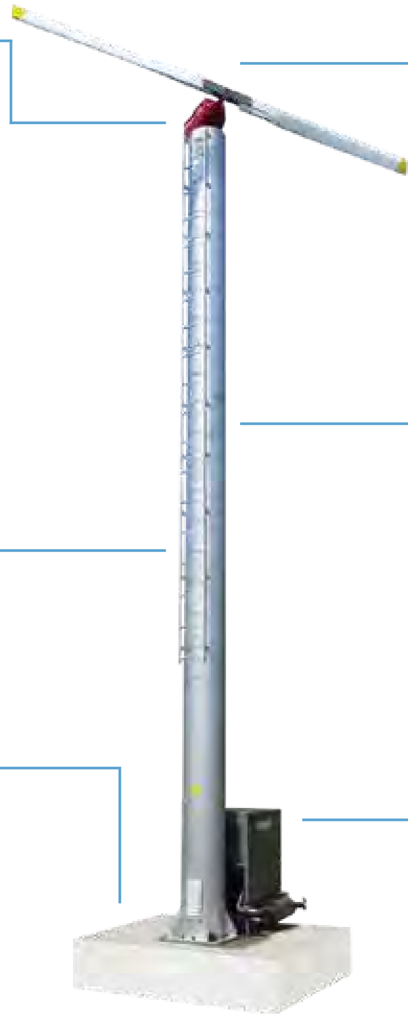
The gear lube bath provides continuous lubrication of the gears helping to prevent wear and corrosion.

Drivelines

Three drivelines create maximum torque and rotation transfer. Drivelines are 10' x 4" (3.048m) with pillow block carrier bearings to allow unhindered movement

Base

Maximum stability is achieved with a 7yd^3 (5.35m3)concrete base. High strength, high performance anchor bolts with 3x the corrosion resistance of galvanized. Meets International Building Code (IBC) for wind and seismic loading.



Solid Fiberglass Blade

Designed with the latest technology and precision-built for frost control. Strongly reinforced at stress points for added safety and reliability. No wind exclusion in the warranty. Extended warranty available.*

Tower

The heaviest tower in the industry with a 5/16" (7.94mm) walled tube. A two-part paint system maximizes corrosion resistance. Hot-dipped galvanizing available for environments prone to corrosion.

Engine

Certified to meet EPA emission standards. Powder coating provides resistance to scratches, chipping, and the elements.

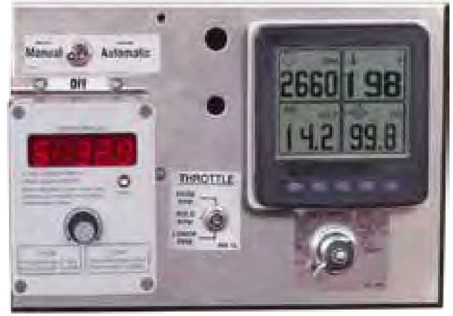
*Pursuant to the terms and conditions of the Orchard-Rite extended warranty agreement.

Special features...

Orchard-Rite wind machines can be equipped with ORCell™ (cellular) monitoring technology.

This allows you to remotely, start and stop your wind machines, change other Auto-Start settings, along with monitoring from anywhere in the world. React quickly without having to physically be in the field.

Auto-Start™



Save fuel.
Save labor.

Designed in-house, Auto-Start™ technology provides automated protection against frost. Created with settable start and stop temperatures, you control the temperature at which the machine turns on and shuts down. Our Auto-Start™ accessory is accurate to +/- 0.5°F (0.3°C), providing you the peace of mind that your crops will continue to thrive. This accessory is an option for all new Orchard-Rite wind machines and can be retrofitted to most other makes and models.

Our custom designed Auto-Start™ allows you to set the following:

- Start Temperature
- Warm Up Duration
- Cool Down Duration
- Stop Temperature
- Engine RPM
- Wind Speed Shutdown

+ Optional Accessories

Just a few of our custom accessories...
Our dealers can help you determine which accessories fit your needs for the best harvest. Contact your dealer today.

Laydown Tower

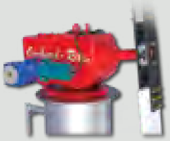
- Laydown height: 7′ 10″ (2.38m)
- Excellent option for maintaining scenic beauty
- Works well with pivot irrigation
- Improves safety for helicopters and airplanes

Dogleg Tower

- Enhanced coverage of steep slopes
- Ideal for slopes greater than 6 degrees
- Combined with the Tilt Head, can cover slopes up to 10 degrees

Driveline Holder

- Allows engine & gearbox to be removed & stored to prevent theft and pest damage
- An excellent option for theft prevention



Oscillator

- Allows for a custom sweep area up to 180 degrees
- Ideal for narrow fields & canyons
- Prevents wasted coverage of unimportant areas

316 Stainless Steel Hood

- Superior corrosion protection

Centrifugal Clutch

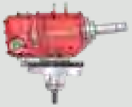
- Improves longevity of the gearboxes and driveline
- Beneficial for long periods when machine is not in use

Vortex™ Anemometer

- Monitors wind speeds & will shut down machines when speeds are too high or winter heating conditions occur
- Noise reduction
- Lowers risk of costly repairs

Solar Panel

- Keeps the engine battery properly charged
- Ensures the battery is ready to go after long periods of disuse
- Lowers risk of downtime during frost emergencies



Contour & Tilt Heads

- Improves wind machine coverage on slopes, knolls, ridges or plateaus
- Can be custom designed to fit the needs of an area
- Allows one machine to cover areas that could normally require two standard machines

Flood Riser

- Allows for wind machine operation in flood plains
- Reduces risk of flood damage and pest damage as well
- Raises engine 6 feet up (1.8288m)

CAT® 7.1

Top-of-the-line diesel power
with enhanced noise reduction
and optimized fuel efficiency

TIER III Turbo-Charged Diesel

Oil Pressure, Water Temperature & Over-Rev Protection

Muffler System for Quiet Operation of Engine

Electronic Controls

Fuel Efficient: 10 GPH (37.9 LPH)

3 Year/1500 Hour Warranty (Engine Only)

Shear Pin Coupler
- Protects Drivetrain Components

Powder Coated Hood & Frame
- Increased Protection from Outdoor Elements

Integrated Pest Guard

Specifications	2600 Model
Tower - Height to Fan-Shaft	10.7m
Tower - Two Part Paint System	√
Base - Concrete Volume	5.35m³
Base - Meets International Building Code	√
Shear Pin Coupler	√
Blade - Length/Diameter	6.05m
Blade - Solid Composite Fiberglass	√
Blade - Extended Warranty Available*	√
Blade - No Wind Exclusion	√
Blade - Pitch	8 degrees
Blade - Quantity	2
Gearboxes - Ductile Iron	448MPA
Gearboxes - Extended Warranty Available*	√
Gearboxes - FLEXOR® Steel Input Shaft	√
Gearboxes - Lubrication - Oil Bath	√

Pursuant to the terms and conditions of the Orchard-Rite extended warranty agreement.

Our Service Providers

Responsive and dependable, our service providers deliver exceptional knowledge and service and are located worldwide. They help you pick the right product at the right price and provide full-service at a moment's notice. Building lasting relationships is our business. You can depend on Orchard-Rite service providers!

New & Used **Parts & Service**

SUNRISE AG
MILDURA · SWAN HILL · OUYEN

Exceptional Service & Commitment to You

For over 50 years we have been providing growers with the best experiences. We ensure this by partnering with factory-trained, authorized dealers and service providers. Our team is dedicated to serving you by listening to your needs, helping you find the right equipment, partnering you with superior service providers, and establishing a lifelong commitment to your business. We invite you to discover the Orchard-Rite Pledge - uncompromising quality and unparalleled service before, during, and after the sale.

Frost Fan Sales - Andrew Jolley (AJ)

Mobile: 0428 839 182

Email: ajolley@sunriseag.com.au

Excellence SINCE 1967

Orchard-Rite®

Pure Power. Pure Performance. Pure Orchard-Rite.

Stationary Wind Machine

Model 2430

Frost Protection / Noise Reduction

Orchard-Rite®

Where frost protection and protecting the environment go hand-in-hand.

Since 1967, we have crafted our wind machines with precision technology. When environmental noise issues became a growing concern, we went to work.

The model 2430, 3-blade wind machine was designed specifically to provide the highest degree of noise reduction found in the industry and ensure maximum frost protection. We designed a machine that only produces 49dB at 300m and more airflow than any other multi-blade* wind machine on the market. In addition, using our 3-blade wind machine in lieu of water to protect crops, saves precious water resources where drought is common and water protection is not cost effecitive.

At Orchard-Rite, we are dedicated to serving you, your crops and the environment by providing the tools and knowledge to stave off those frosty nights… quietly.

**Multi-blade refers to wind machines with three or more blades.*

Standard Features

Gearboxes and FLEXOR® Steel Input Shaft

Built with durable ductile iron and designed with a FLEXOR® steel input shaft, which is considered to be superior to common alloy steel, our gearboxes come with multiple options to best suit the topography of any location.

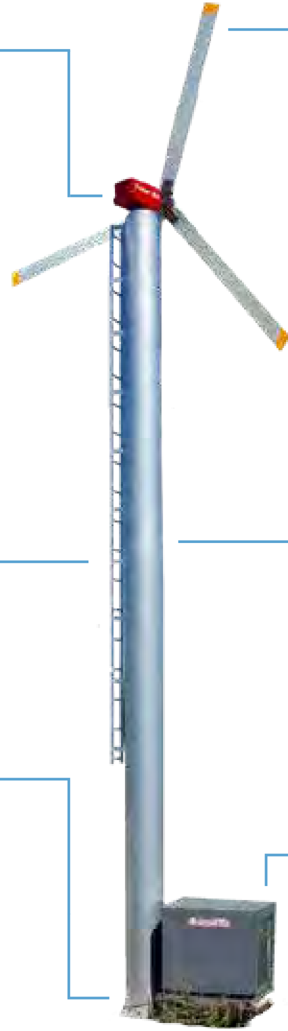
The gear lube bath provides continuous lubrication of the gears helping to prevent wear and corrosion.

Drivelines

Three drivelines deliver maximum torque and rotation transfer. Drivelines are 10′ x 4″ (3.048m) with pillow block carrier bearings to allow unhindered movement

Base

Maximum stability is achieved with a 7yd^3 (5.35m3) concrete base. High strength, high performance anchor bolts with 3x the corrosion resistance of galvanized. Meets International Building



Solid Fiberglass Blades

Designed with the latest technology and precision-built for frost control.

3-blade wind machines are designed for maximum protection and are up to 10 dB quieter than our 2-blade machines.

Strongly reinforced at stress points for added safety and reliability. No wind exclusion in the warranty.

Tower

The heaviest tower in the industry with a 5/16″ (7.94mm) walled tube. A two-part paint system maximizes corrosion resistance. Hot-dipped galvanizing available for environments prone to corrosion.

Engine

Certified to meet EPA emission standards. Powder coating provides resistance to scratches, chipping, and the elements.

**Pursuant to the terms and conditions of the Orchard-Rite extended warranty agreement.*

Auto-Start™

Save fluel.
Save labor.

Designed in-house, Auto-Start™ technology provides automated protection against frost. Created with settable start and stop temperatures, you control the temperature at which the machine turns on and shuts down. Our Auto-Start™ accessory is accurate to +/- 0.5°F (0.3°C), providing you the peace of mind that your crops will continue to thrive. This accessory is an option for all new Orchard-Rite wind machines and can be retrofitted to most other makes and models.

Our custom designed Auto-Start™ allows you to set the following:

- Start Temperature
- Warm Up Duration
- Cool Down Duration
- Stop Temperature
- Engine RPM
- Wind Speed Shutdown

Special features...

Orchard-Rite wind machines can be equipped with ORCell™ (cellular) monitoring technology.

This allows you to remotely, start and stop your wind machines, change other Auto-Start settings, along with monitoring from anywhere in the world. React quickly without having to physically be in the field.

+ Optional Accessories

Just a few of our custom accessories...
Our dealers can help you determine which accessories fit your needs for the best

Laydown Tower

- Laydown height: 7′ 10″ (2.38m)
- Excellent option for maintaining scenic beauty
- Works well with pivot irrigation
- Improves safety for helicopters and airplanes

Dogleg Tower

- Enhanced coverage of steep slopes
- Ideal for slopes greater than 6 degrees
- Combined with the Tilt Head, can cover slopes up to 10 degrees

Driveline Holder

- Allows engine & gearbox to be removed & stored to prevent theft and pest damage
- An excellent option for theft prevention

Oscillator

- Allows for a custom sweep area up to 180 degrees
- Ideal for narrow fields & canyons
- Prevents wasted coverage of unimportant areas

316 Stainless Steel Hood

- Superior corrosion protection

Centrifugal Clutch

- Improves longevity of the gearboxes and driveline
- Beneficial for long periods when machine is not in use

Vortex™ Anemometer

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- Noise reduction
- Lowers risk of costly repairs

Solar Panel

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- Ensures the battery is ready to go after long periods of disuse
- Lowers risk of downtime during frost emergencies

Contour & Tilt Heads

- Improves wind machine coverage on slopes, knolls, ridges or plateaus
- Can be custom designed to fit the needs of an area
- Allows one machine to cover areas that could normally require two standard machines

Flood Riser

- Allows for wind machine operation in flood plains
- Reduces risk of flood damage and pest damage as well
- Raises engine 6 feet up (1.8288m)

CAT® 4.4

Perfect balance of durability, fuel efficiency, and performance

TIER III Turbo-Charged Diesel

Oil Pressure, Water Temperature & Over-Rev Protection

Muffler System for Quiet Operation of Engine

Electronic Controls

Fuel Efficient: 5.9 GPH (19.71 LPH)

3 Year/1500 Hour Warranty (Engine Only)

Shear Pin Coupler
- Protects Drivetrain Components

Powder Coated Hood & Frame
- Increased Protection from Outdoor Elements

Integrated Pest Guard

Specifications	2430 Model
Tower - Height to Fan-Shaft	10.7m
Tower - Two Part Paint System	√
Base - Concrete Volume	5.35m^3
Base - Meets International Building Code	√
Shear Pin Coupler	√
Blade - Length/Diameter	6m
Blade - Solid Composite Fiberglass	√
Blade - Extended Warranty Available*	√
Blade - No Wind Exclusion	√
Blade - Pitch	11 degrees
Blade - Quantity	3
Gearboxes - Ductile Iron	448MPA
Gearboxes - Extended Warranty Available*	√
Gearboxes - FLEXOR® Steel Input Shaft	√
Gearboxes - Lubrication - Oil Bath	√
DBA	49

Pursuant to the terms and conditions of the Orchard-Rite extended warranty agreement.

Exceptional Service & Commitment to You

For over 50 years we have been providing growers with the best experiences. We ensure this by partnering with factory-trained, authorized dealers and service providers.

Our team is dedicated to serving you by listening to your needs, helping you find the right equipment, partnering you with superior service providers, and establishing a lifelong commitment to your business. We invite you to discover the Orchard-Rite Pledge - uncompromising quality and unparalleled service before,

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Responsive and dependable, our service providers deliver exceptional knowledge and service and are located worldwide. They help you pick the right product at the right price and provide full-service at a moment's notice. Building lasting relationships is our business. You can depend on Orchard-Rite service providers!

New & Used **Parts & Service**

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Frost Fan Sales - Andrew Jolley (AJ)

Mobile: 0428 839 182

Email: ajolley@sunriseag.com.au

Excellence SINCE 1967

Orchard-Rite®

Pure Power. Pure Performance. Pure Orchard-Rite.

Annexure 3

Plans of the Frost Fans and Engineering Specifications for the Concrete Pads

Orchard-Rite

1615 W Ahtanum Rd

Union Gap, WA 98903

May 19, 2021

Design Details for Wind Machine Base

The OGBX022000 and the OGBX039000 Bases are designed for the model 2600 Wind Machine which produces a thrust load of 2090 LBS. The Concrete base is more than adequate for other Wind Machines models that produce less thrust, including but not limited to the 2430 Wind Machine that produces 1380lbf (6139 N) of thrust.

Regards,

Chris Coppock

Design Engineer

DESIGN CRITERIA

1. BUILDING CODE: CALIFORNIA BUILDING CODE (CBC) 2019 EDITION
   IBC 2018 EDITION
2. RISK CATEGORY: I
3. DEAD LOADS
   SELF WEIGHT OF THE STRUCTURE
   1.) TOWER: 3713 LBS (1684kg)
   2.) ENGINE: 1528 LBS (693kg)
4. LIVE LOADS: NOT APPLICABLE
5. WIND DESIGN DATA:
   WIND EXPOSURE CATEGORY: C
   BASIC WIND SPEED: V = 110 MPH (49 m/s) 3 SECOND GUST.
6. EARTHQUAKE DESIGN DATA:
   SEISMIC IMPORTANCE FACTOR: I_e = 1.0
   SEISMIC DESIGN CATEGORY: D
   SITE CLASS: D
   SEISMIC COEFFICIENTS: R = 2, Ω_0 = 2, C_d = 2
   SPECTRAL RESPONCE ACCELERATION:
   1.) SHORT PERIOD: S_s = 2.200
   DESIGN BASE SHEAR: V = Cs TIMES W (W=BUILDING SEISMIC DEAD LOAD).
7. THRUST: 2090 LBS (9297N)

REGISTERED PROFESSIONAL ENGINEER
EDWIN T. DEAN
No. 3752
Exp. 12/31/20
STRUCTURAL
STATE OF CALIFORNIA

DIGITAL SIGNATURE: 03/09/20

GENERAL

1. THESE GENERAL NOTES APPLY, UNLESS SPECIFICALLY NOTED OTHERWISE.
2. ALL CONSTRUCTION, TESTING AND INSPECTING SHALL CONFORM TO THE BUILDING CODE REFERENCED UNDER THE HEADING "DESIGN CRITERIA".
3. STANDARDS REFERENCED IN THESE NOTES SHALL BE THE LATEST EDITION, UNLESS OTHERWISE NOTED.
4. THE NOTES AND DETAILS ON THE DRAWINGS SHALL TAKE PRECEDENCE OVER THE GENERAL NOTES AND TYPICAL DETAILS
5. DETAILS SHALL BE APPLIED TO EVERY LIKE CONDITION WHETHER OR NOT THEY ARE REFERENCED IN EVERY INSTANCE. FOR CONDITIONS NOT SPECIFICALLY SHOWN, PROVIDE DETAILS SIMILAR TO THOSE SHOWN.
6. DIMENSIONS AND CONDITIONS SHALL BE VERIFIED PER THESE DRAWINGS PRIOR TO INSTALLATION.
7. OMISSIONS OR DISCREPANCIES BETWEEN THE VARIOUS ELEMENTS OF THESE DOCUMENTS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER
8. A CHEMICAL TOILET IS REQUIRED ON-SITE DURING CONSTRUCTION
9. CHANGES FROM THE APPROVED PLANS DURING THE COURSE OF CONSTRUCTION SHALL CAUSE CONSTRUCTION TO BE SUSPENDED UNTIL SUCH TIME AS THE PLANS CAN BE AMENDED BY THE DESIGNER AND SUBMITTED TO THE COUNTY FOR REVIEW AND APPROVAL.

FOUNDATION

1. FOUNDATION DESIGN IS BASED ON ALLOWABLES AS SET FORTH IN CBC TABLE 1806.2 FOR SOIL TYPE CONFORMING TO CLASS 5 MATERIAL IN TABLE 1806.2.
2. FOUNDATION TYPE: SPREAD FOOTING
3. DESIGN ALLOWABLES
   A. SOIL BEARING: 1.5 KSF (DL + LL), 2.0 KSF (DL + LL + WIND/EQ). PER CRC TABLE R401.4.1
   B. LATERAL BEARING: 100 PSF/FT.
   C. COEFFICIENT OF FRICTION: 0.25.
4. FOLLOW RECOMMENDATIONS IN SOIL REPORT FOR ALL FOUNDATION WORK.
5. ALL FOOTINGS SHALL BEAR ON FIRM, UNDISTURBED SOIL OR 6" (152 mm) OF COMPACTED GRAVEL FILL. BOTTOM
   OF FOOTING ELEVATIONS SHOWN ON THE DRAWINGS ARE MINIMUM AND SHALL EXTEND LOWER AS REQUIRED TO REMOVE SOFT OR LOOSE MATERIAL.
6. THE SIDES OF FOUNDATIONS SHOWN STRAIGHT ARE FORMED. FOUNDATIONS POURED AGAINST THE EARTH AT CONTRACTOR'S OPTION REQUIRE THE FOLLOWING PRECAUTIONS:
   A. SIDES OF EXCAVATION MUST BE VERTICAL (OVER POURING AND MUSHROOMING NOT ALLOWED),
   B. CONTRACTOR SHALL BE RESPONSIBLE FOR CLEAN UP OF SOIL SLOUGHING BEFORE, DURING, AND AFTER POUR.

REVISIONS

REV.	DESCRIPTION	DATE	APRVL	APRVL	ECR #
3	ADDED ENGINEERING NOTES (SEE SHEET # 1)	5/2/2017	CCC	JW	WM-00026
4	ADDED GENERAL NOTE 8 AND 9; REVISED FOUNDATION NOTE 3A AND CONCRETE NOTE 5 TO ADD CRC TABLE	12/8/2017	CCC		WM-00044
5	DESIGN CRITERIA NOTE 1. UPDATED TO CURRENT CODE; NOTE 6 WAS 2.248; CONCRETE NOTE 5. WAS 3,000 PSI.	3/5/2020	CCC	SVS	WM-00162

CONCRETE

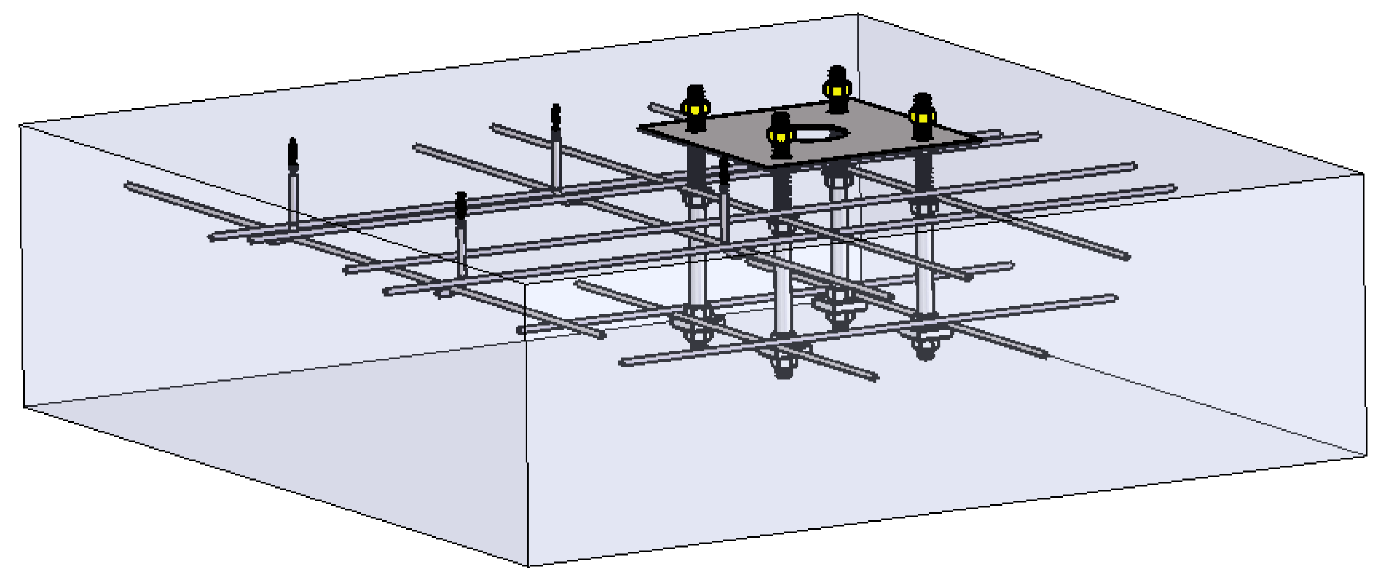
1. ALL CONCRETE SHALL BE MIXED AND PLACED IN ACCORDANCE WITH ACI 318. USE MIXES WITH A MAXIMUM AGGREGATE SIZE APPROPRIATE FOR FORM AND REBAR CLEARANCES TO BE ENCOUNTERED IN ACCORDANCE WITH ACI RECOMMENDATIONS.
2. THE PROPOSED MATERIALS AND MIX DESIGN SHALL BE FULLY DOCUMENTED AND REVIEWED BY THE OWNERS TESTING LABORATORY. RESPONSIBILITY FOR OBTAINING THE REQUIRED DESIGN STRENGTH IS THE CONTRACTOR'S.
3. PORTLAND CEMENT SHALL CONFORM TO ASTM C 150 TYPE V.
4. AGGREGATE FOR NORMAL WEIGHT CONCRETE SHALL CONFORM TO ALL REQUIREMENTS AND TESTS OF ASTM C 33 AND PROJECT SPECIFICATIONS.
5. CONCRETE SHALL HAVE THE FOLLOWING 28 DAY STRENGTHS, F'c: (ALL CONCRETE SHALL BE NORMAL WEIGHT. FOUNDATIONS: 2,500 PSI. (17,237 kPa) PER CRC TABLE R402.2

REINFORCING STEEL

1. ALL REINFORCING STEEL SHALL BE PLACED IN CONFORMANCE WITH "BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE", ACI 318, AND THE "ACI DETAILING MANUAL" AS MODIFIED BY THE PROJECT DRAWINGS AND SPECIFICATIONS.
2. REINFORCING STEEL:
   DEFORMED BARS, ASTM A 615 GRADE 60.

STRUCTURAL STEEL

1. ALL STRUCTURAL STEEL TO BE DETAILED, FABRICATED AND ERECTED IN ACCORDANCE WITH AISC SPECIFICATIONS.
2. STEEL GRADES
   A. PLATES, OTHER SHAPES AND RODS: ASTM A 36
   B. ANCHOR BOLTS: SAE 4140 HT



SHEET #1 - ENGINEERING NOTES
SHEET #2 - DIMENSIONS & BOM
SHEET #3 - REBAR DIMS

TOLERANCES
FRACTIONS ±1/64
ANGLES: BEND ±1/8
.X ±.015
.XX ±.010
.XXX ±.005

Orchard-Rite Ltd.
1615 W ATHANUM ROAD, UNION GAP, WA. 98903 (509) 834-2029

TITLE	CONCRETE REBAR PATTERN - STANDARD		
MAT'L	SEE ABOVE	MACHINE	Wind Machine
SIZE	B	REV	5
DRAWN	DGJ	SAW CUT	SEE ABOVE
PART NO.	OGBX022000		
DATE	3/2/05	FINISH	---
QTY	(1) ONE	WEIGHT	26352.123
BOM #:		CHILD #:	
SHEET 1 OF 3			

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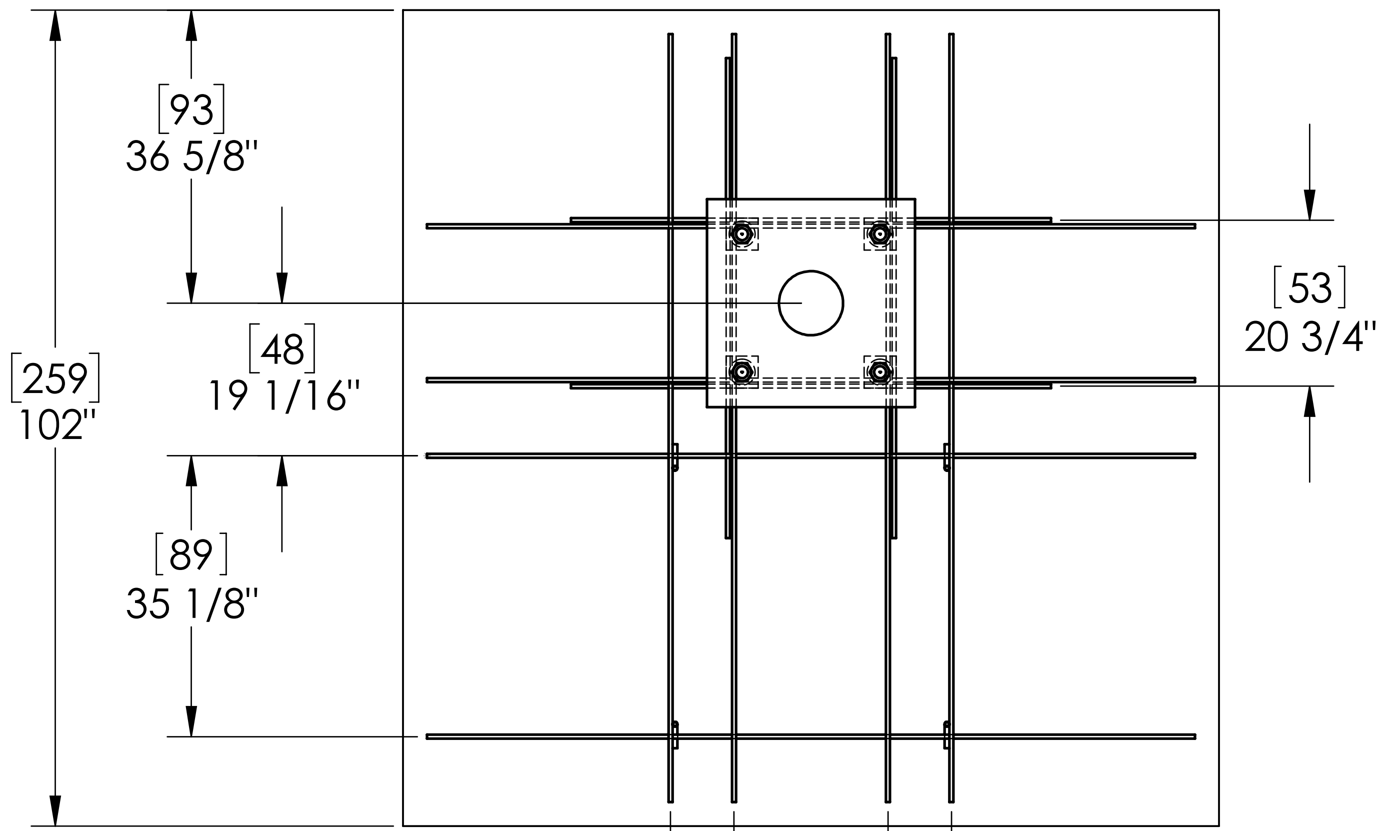
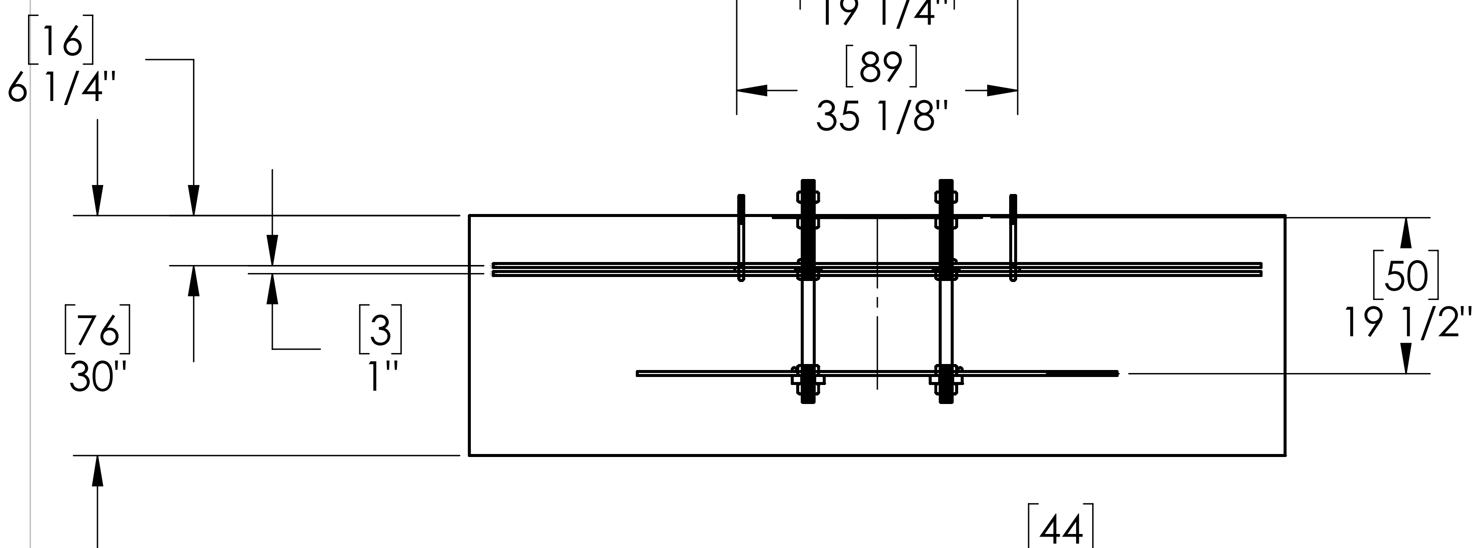
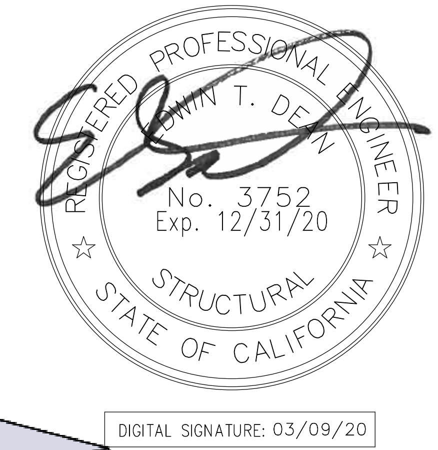
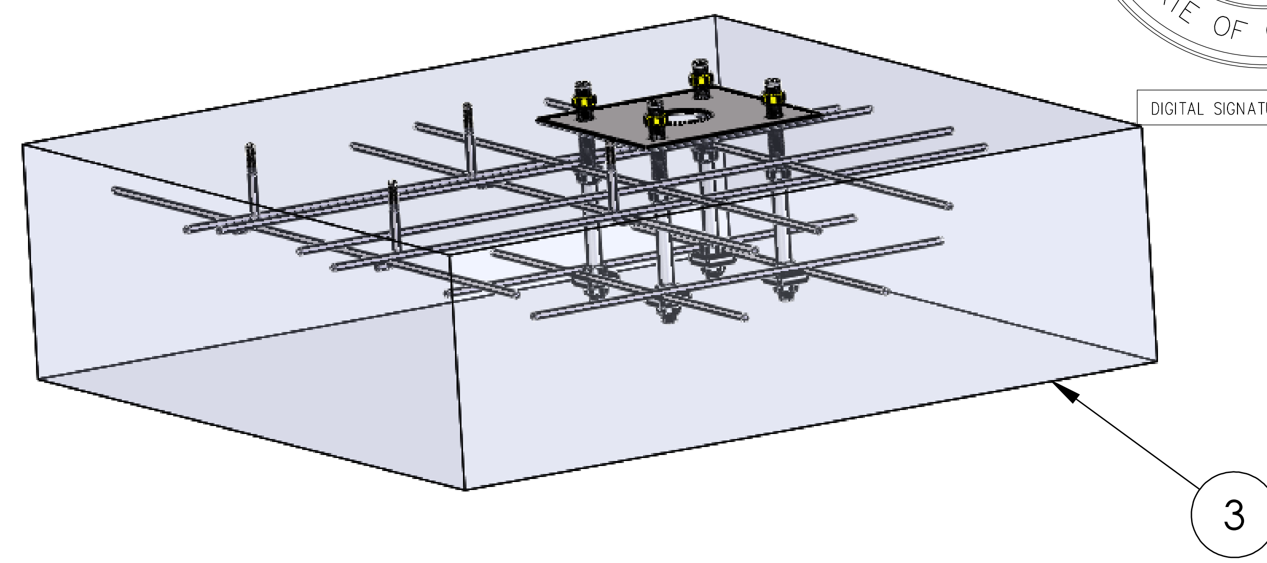
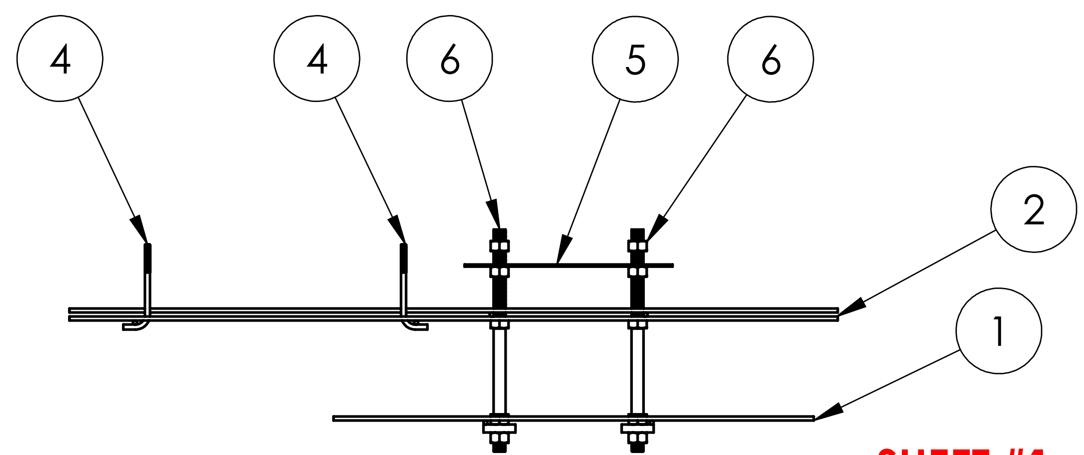


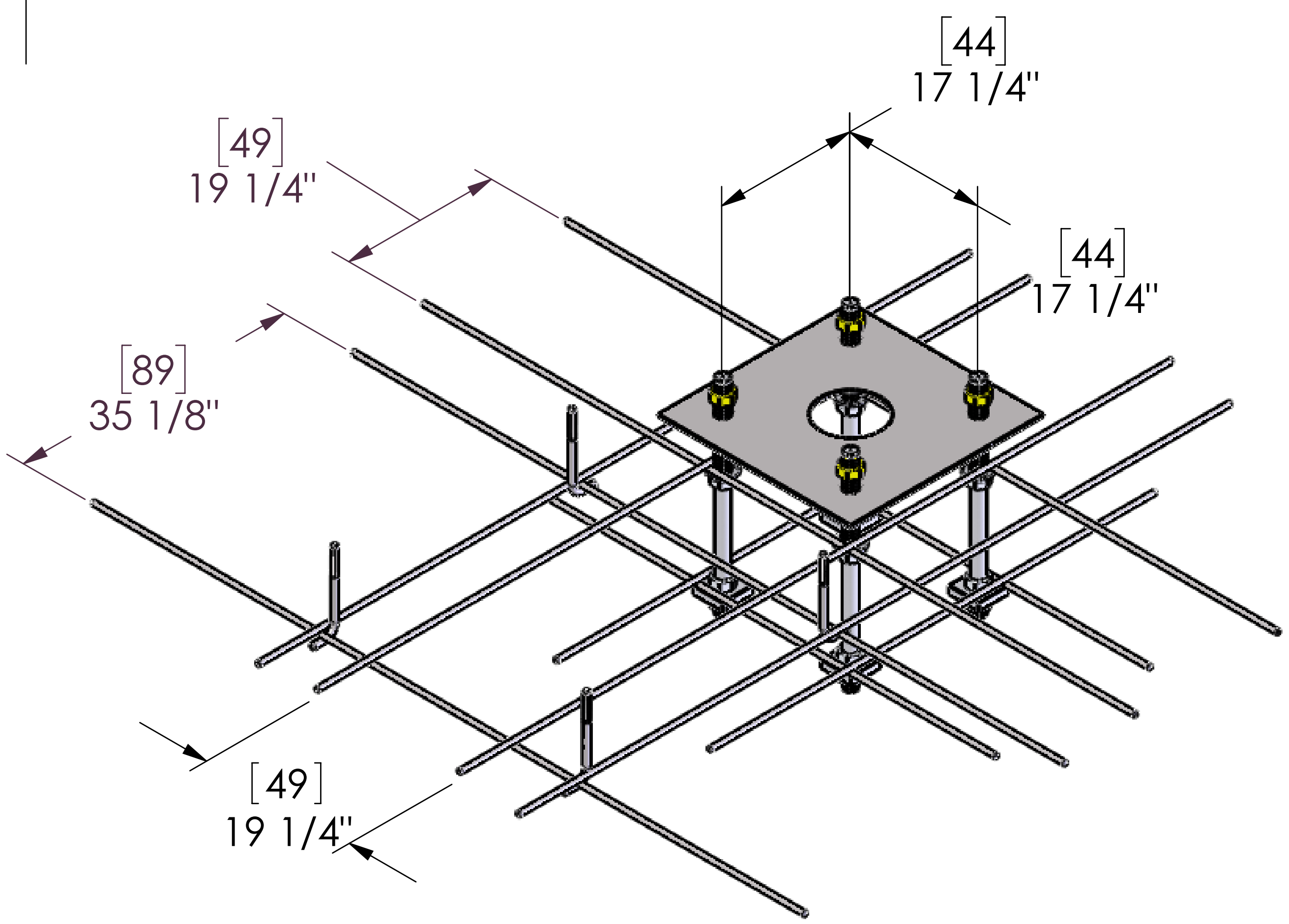








SHEET #1 - ENGINEERING NOTES
SHEET #2 - DIMENSIONS & BOM
SHEET #3 - REBAR DIMS



NOTE: REBAR MINIMUM GRADE - 60

ITEM No.	PART No.	REV	DESCRIPTION	CHILD No.	QTY.
1	1/2" REBAR x 60"		1/2" REBAR 60" LONG		4
2	1/2" REBAR x 96"		1/2" REBAR 96" LONG		8
3	8.5 ft x 8.5 ft BASE	0	8.5 ft x 8.5 ft. BASE		1
4	OGBX005000		ENGINE BASE BOLT		4
5	OGBX011000	2	BASE POUR PLATE - 5 HOLE - 1/4 x 26 x 26	11-2520	1
6	OGBX529000	1	ANCHOR BOLT ASSY WITH PLATES		4

Orchard-Rite Ltd.

1615 W ATHANUM ROAD, UNION GAP, WA. 98903 (509) 834-2029

TOLERANCES

FRACTIONS ±1/64
ANGLES: BEND ±1/8
.X ±.015
.XX ±.010
.XXX ±.005

TITLE CONCRETE REBAR PATTERN - STANDARD

MAT'L SEE ABOVE

MACHINE Wind Machine

SIZE B

REV 5

DRAWN DGJ

DATE 3/2/05

QTY (1) ONE

SAW CUT SEE ABOVE

FINISH ---

WEIGHT 26352.123

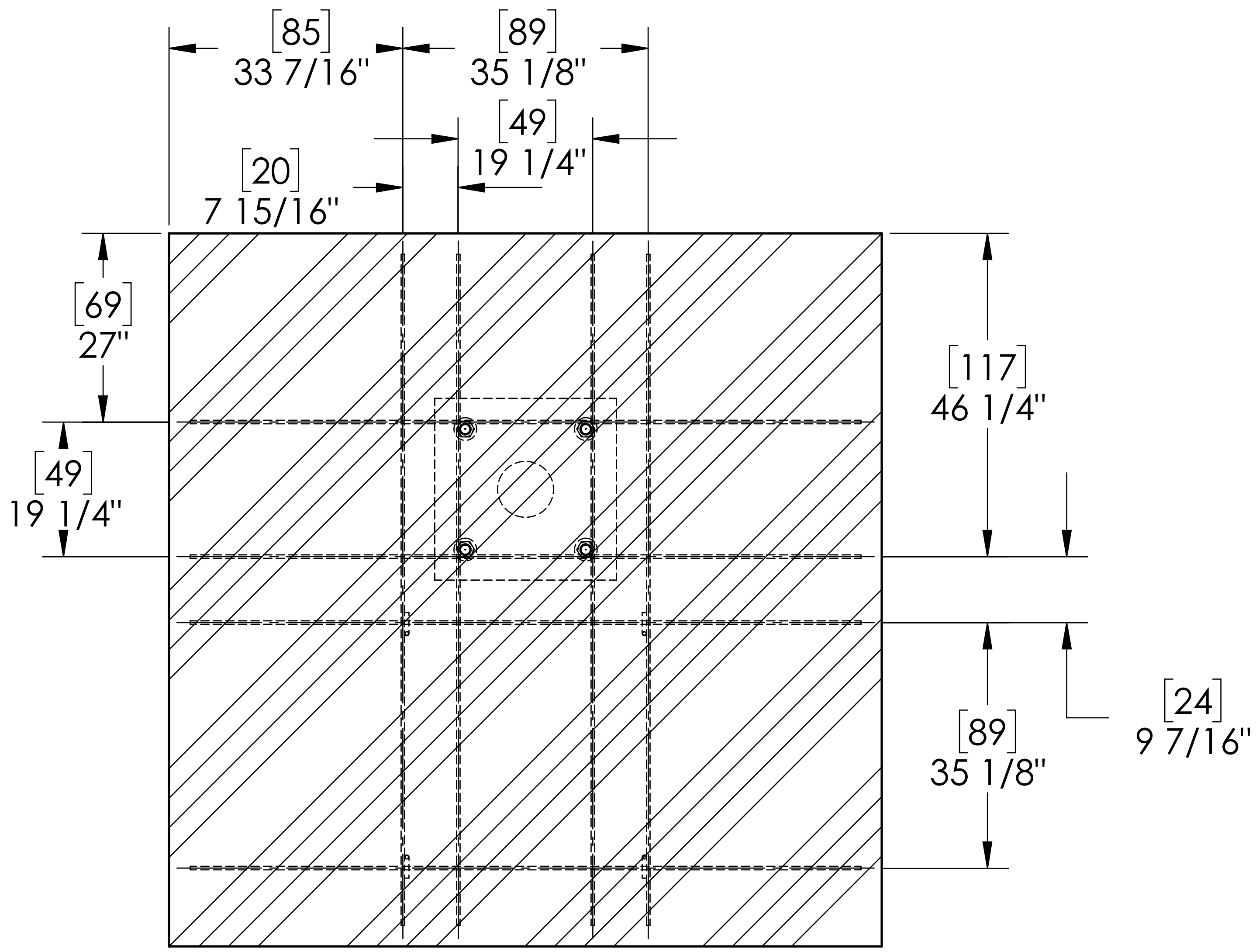
PART NO. OGBX022000

BOM #:

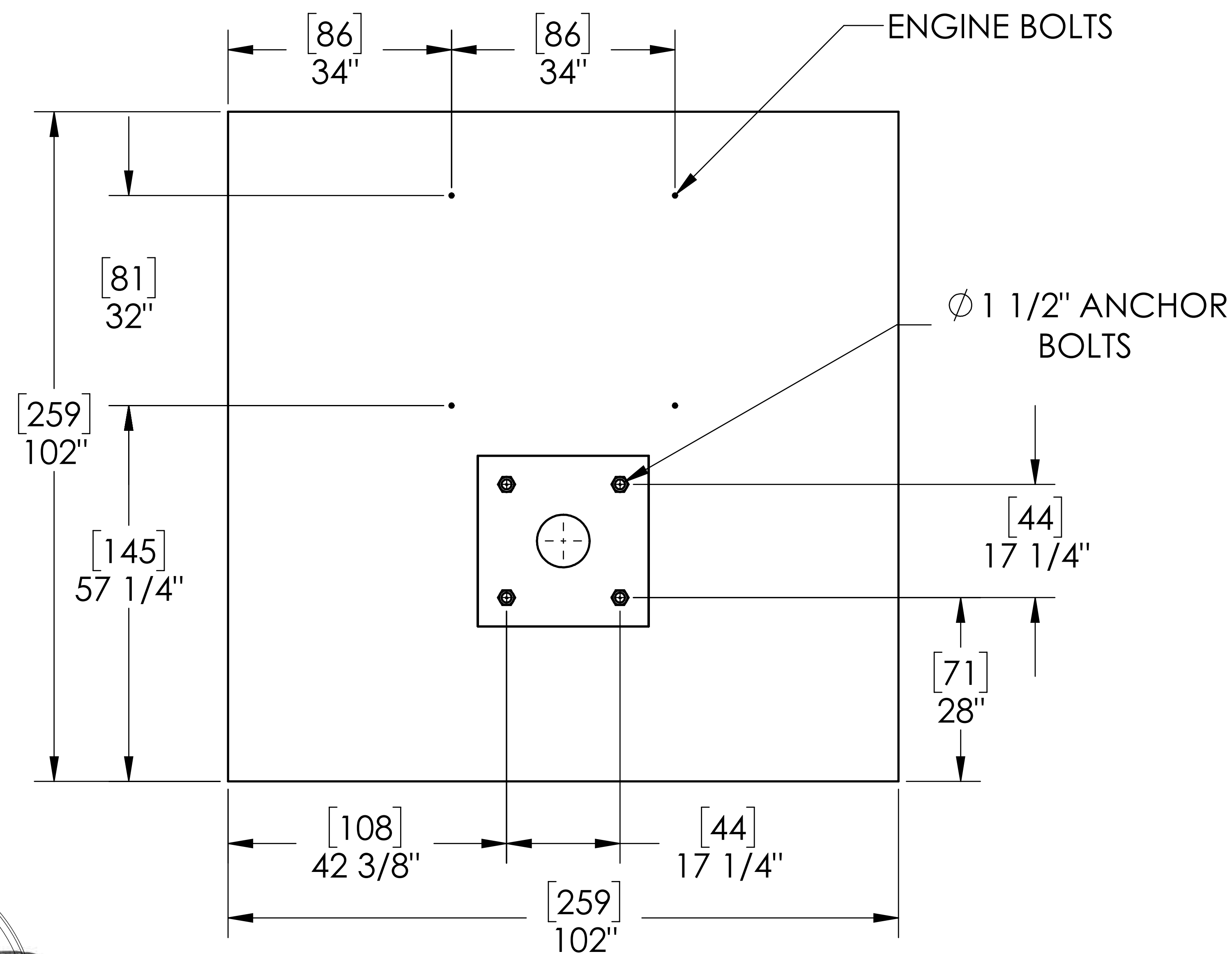
CHILD #:

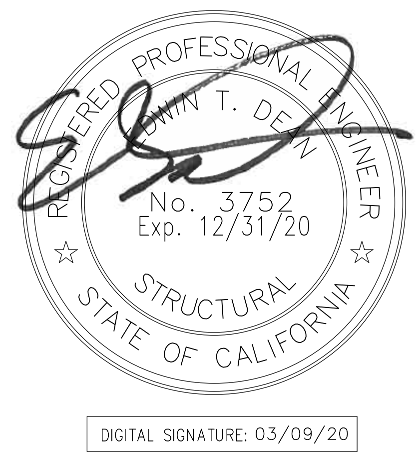
SHEET 2 OF 3

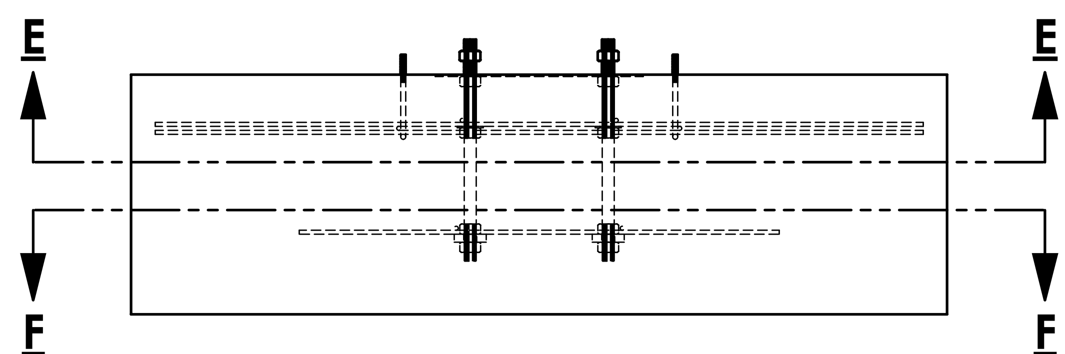
Thursday, March 05, 2020 4:40:29 PM

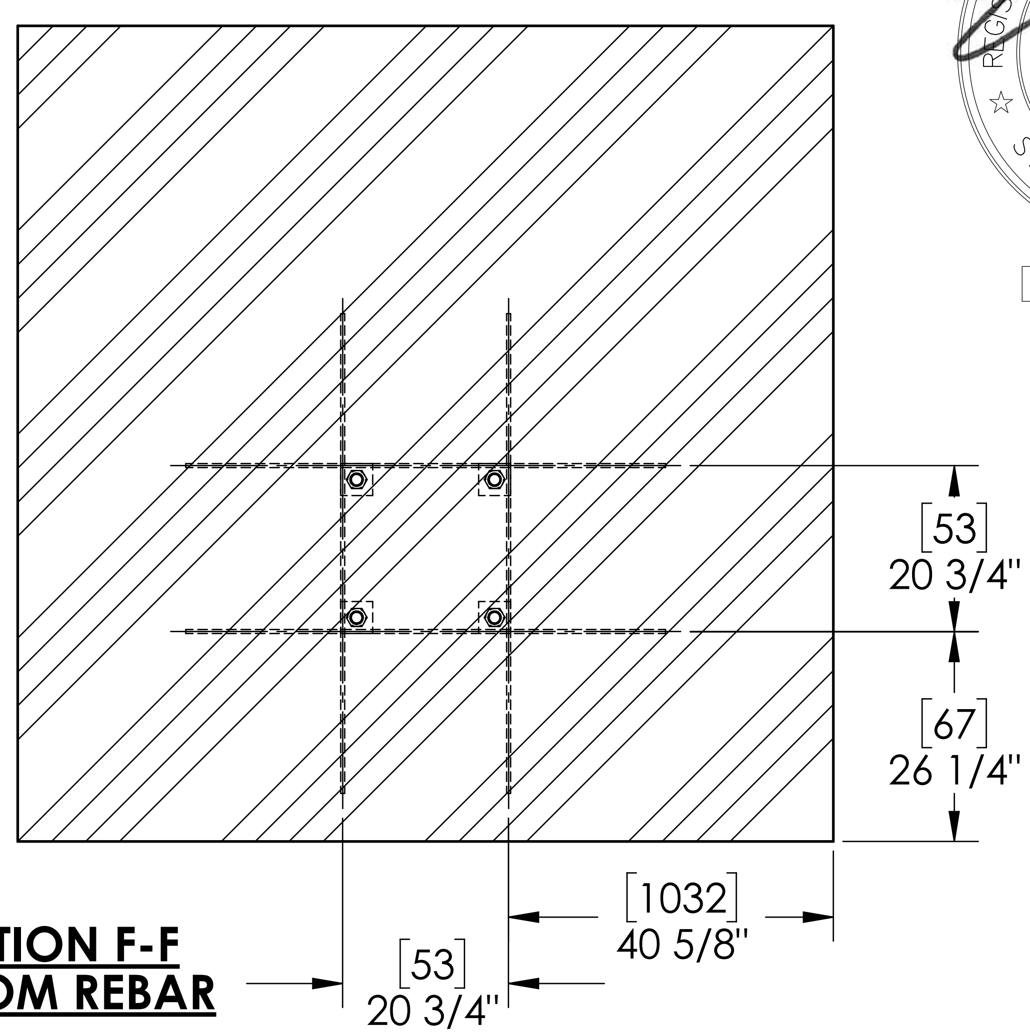


SECTION E-E
TOP REBAR









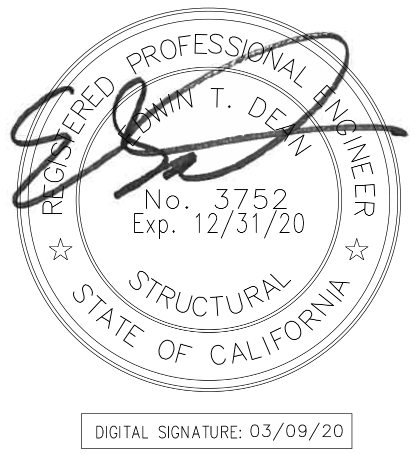
SECTION F-F
BOTTOM REBAR

SHEET #1 - ENGINEERING NOTES
SHEET #2 - DIMENSIONS & BOM
SHEET #3 - REBAR DIMS

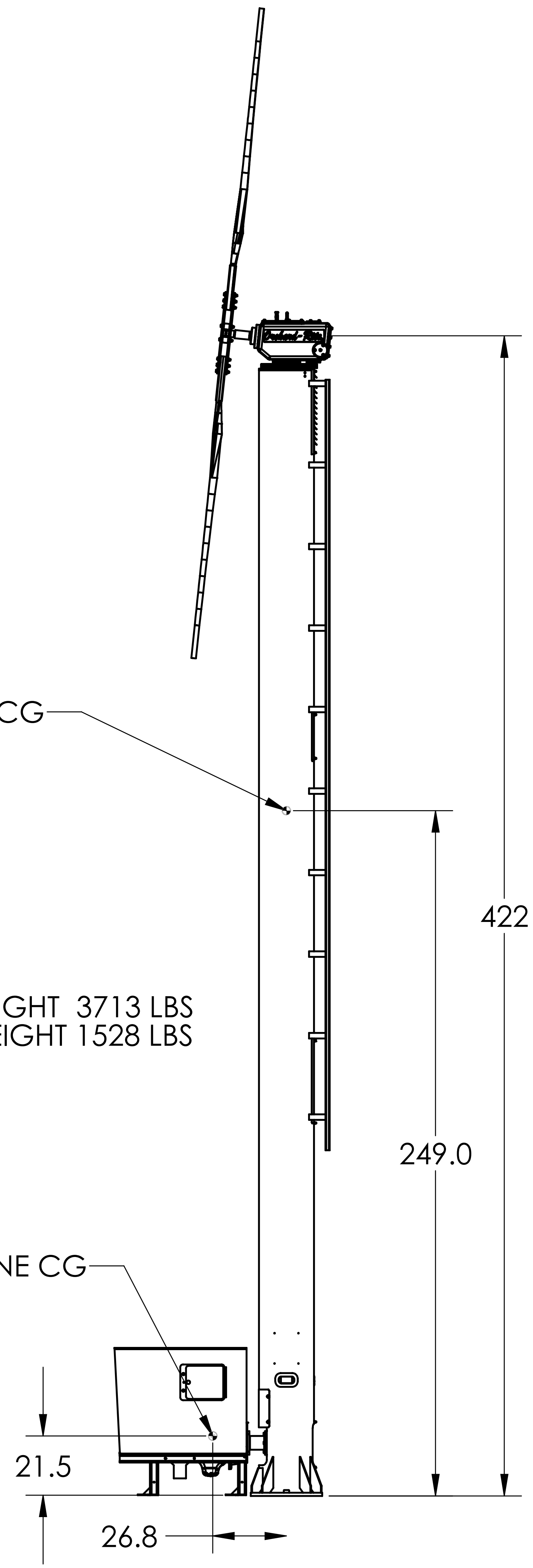
Orchard-Rite Ltd. INC
1615 WEST AHTANUM RD. UNION GAP, WA. 98903 PHONE: (509) 834-2029

TOLERANCES
FRACTIONS ±1/64
ANGLES: BEND ±1/8
.X ±.015
.XX ±.010
.XXX ±.005

TITLE	CONCRETE REBAR PATTERN - STANDARD				
MAT'L	SEE ABOVE	MACHINE	Wind Machine	SIZE B	REV 5
DRAWN	DGJ	SAW CUT	SEE ABOVE	PART No.	OGBX022000
DATE	3/2/05	FINISH	---		
QTY	(1) ONE	WEIGHT	26352.123	BOM #:	CHILD #:



REVISIONS					
REV.	DESCRIPTION	DATE	APRVL	APRVL	ECR #



Orchard-Rite Ltd.

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TOLERANCES

FRACTIONS ±1/64
ANGLES: BEND ±1/8
.X ±.015
.XX ±.010
.XXX ±.005

TITLE 2600 SERIES WITH V10 ENGINE

MAT'L

MACHINE Wind Machine

SIZE B REV 0

DRAWN C. COPPOCK

DATE 2/7/2017

QTY (1) ONE

SAW CUT ---

FINISH ---

WEIGHT

PART NO.

BOM #:

CHILD #:

SHEET 1 OF 1

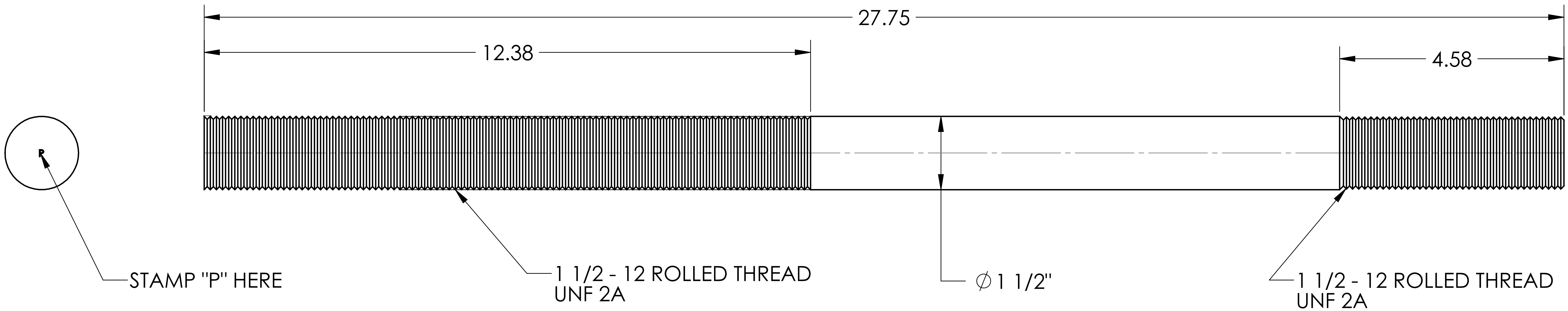
Tuesday, February 07, 2017 2:37:58 PM

REGISTERED PROFESSIONAL ENGINEER
EDWIN T. DEAN
No. 3752
Exp. 12/31/20
STRUCTURAL
STATE OF CALIFORNIA

DIGITAL SIGNATURE: 03/09/20

REVISIONS

REV.	DESCRIPTION	DATE	APRVL	APRVL	ECR #
0	ISSUED PART	4/18/2017	CCC	JW	WM-00026



1) HEAT TREAT: 35 to 39 Rc
2) GEOMET: COAT 8-10 MICRONS
NOTES:

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1615 W ATHANUM ROAD, UNION GAP, WA. 98903 (509) 834-2029

TOLERANCES

FRACTIONS ±1/64
ANGLES: BEND ±1/8
.X ±.015
.XX ±.010
.XXX ±.005

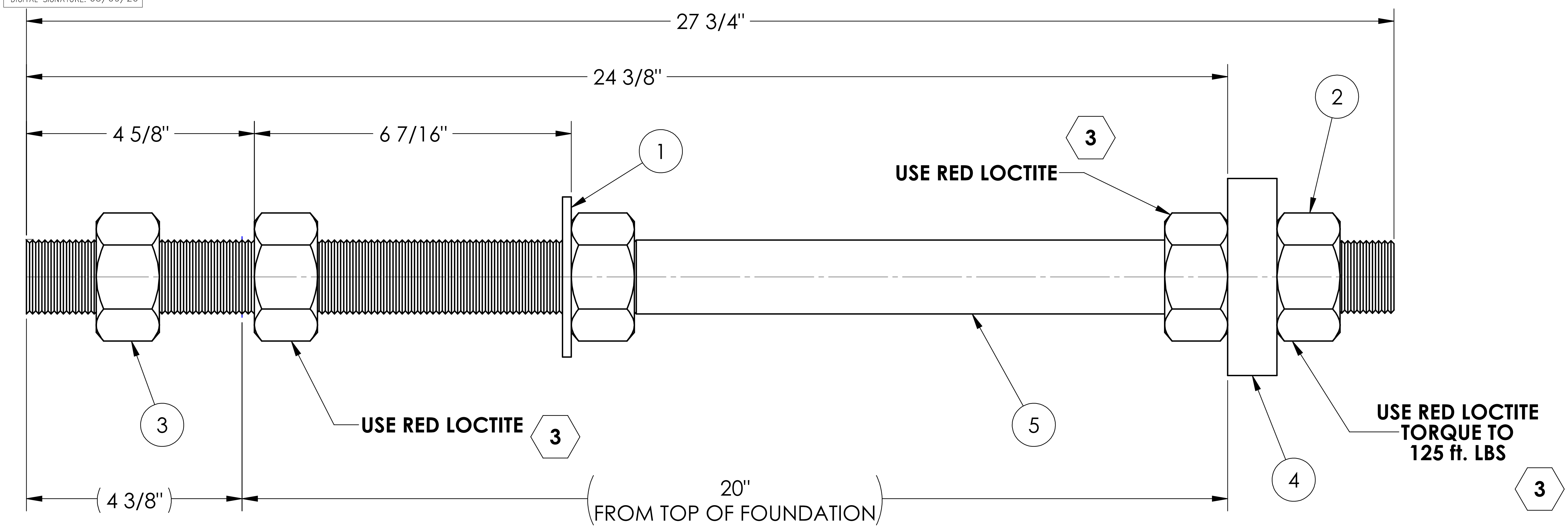
TITLE	TOWER ANCHOR BOLT - 27.75"		
MAT'L	SAE 4140	MACHINE	Wind Machine
SIZE	B	REV	0
DRAWN	CCC	SAW CUT	-
DATE	2/2/2017	FINISH	GEOMET 321
QTY	(4) FOUR	WEIGHT	13.055
PART NO.	OGBX501000		
BOM #:		CHILD #:	
SHEET 1 OF 1			

Tuesday, April 18, 2017 9:38:08 AM

DIGITAL SIGNATURE: 03/09/20

REVISIONS

REV.	DESCRIPTION	DATE	APRVL	APRVL	ECR #
0	ISSUED PART	4/18/17	CCC	JW	WM-00026
1	1.500-12 HNUT - Gr 5 - Z (QTY: 4) & 1.500-12 HNUT - Gr 8 - ZY (QTY: 1) WAS 1.500-12 HNUT (QTY: 5), 1.375 FW - USS - Z WAS OGBX003000 (1-1/2" FW - USS Gr 8)	5/18/17	CCC	JW	WM-00026



ITEM No.	PART No.	REV	DESCRIPTION	CHILD No.	QTY.
1	1.375 FW - USS - Z		1-3/8" FLAT WASHER - USS - STL - ZINC		1
2	1.500-12 HNUT - Gr 5 - Z		1-1/2" - 12 HNUT - GRADE 5 - ZINC	11-7261	4
3	1.500-12 HNUT - Gr 8 - ZY		1-1/2" - 12 HNUT - GRADE 8 - YELLOW ZINC		1
4	ND1023S202	1	TOWER ANCHOR END PLATE	12-1437	1
5	OGBX501000	0	TOWER ANCHOR BOLT - 27.75"		1

ANCHOR BOLT ASSEMBLY PROCEDURE

1. NUTS AND ANCHOR BOLT MUST BE OIL AND GREASE FREE
2. SPRAY LOCTITE PRIMER ON AREA TO RECIEVE RED LOCTITE
3. APPLY LIBERAL AMOUNT OF RED LOCTITE TO THREADS ON ANCHOR BOLTS WHERE NOTED BY ③
4. SANDWICH ANCHOR PLATE (ITEM #2) BETWEEN NUTS AND TORQUE

Orchard-Rite Ltd.

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TOLERANCES

FRACTIONS ±1/64
ANGLES: BEND ±1/8
.X ±.015
.XX ±.010
.XXX ±.005

TITLE ANCHOR BOLT ASSY WITH PLATES

MAT'L SEE ABOVE

MACHINE Wind Machine

SIZE B — REV 1

DRAWN CCC

SAW CUT NONE

PART NO. OGBX529000

DATE 02/02/2017

FINISH ---

QTY (4) FOUR

WEIGHT 17.81

BOM #:

CHILD #:

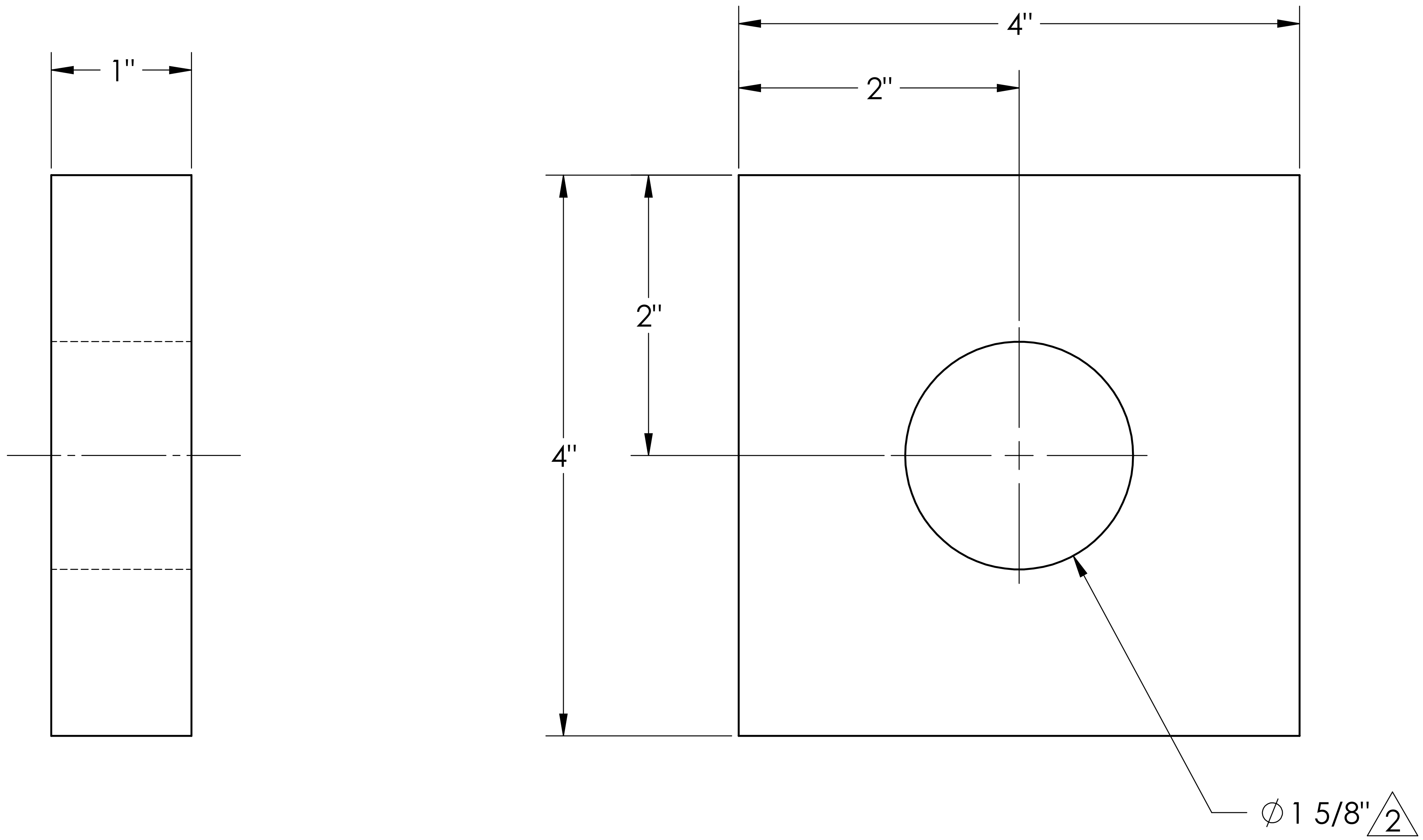
SHEET 1 OF 1

Thursday, May 18, 2017 4:14:34 PM

DIGITAL SIGNATURE: 03/09/20

REVISIONS

REV.	DESCRIPTION	DATE	APRVL	APRVL	ECR#
1	4x4X1" MATERIAL WAS 3.000 x 3.000 x .75, ADDED 1-13/16 HOLE	8/14/2014	DGJ		
2	ADDED "OR COLD DRAWN 1018" TO MATERIAL: ∅1 5/8 WAS ∅1 13/16	12/8/2017	CCC		WM-00044



2

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TOLERANCES
FRACTIONS ±1/64
ANGLES: BEND ±1/8
.X ±.015
.XX ±.010
.XXX ±.005

TITLE: TOWER ANCHOR END PLATE

MAT'L	ASTM A36 OR COLD DRAWN 1018	MACHINE	Wind Machine	SIZE B	REV 2
DRAWN	DGJ	SAW CUT	---	PART No.	ND1023S202
DATE	12/16/13	FINISH	ZINC PLATED		
QTY	(1) ONE	WEIGHT	3.924	BOM #:	CHILD #:12-1437 SHEET 1 OF 1

Monday, December 18, 2017 2:15:45 PM

Annexure 4

2017 Darlington Point Township Structure Plan

Figure 15 - Township Structure Plan

Annexure 5

Frost Assessment and Mitigation Report

Frost assessment

and mitigation at

Huddersfield Almond Orchard

AgField Services

Climate Consulting

October 2019

disclaimer

Climate Consulting Ltd has performed all data collection and analysis to the best of its ability. However as the climatic variables measured are unpredictable at times, Climate consulting Ltd cannot be held liable if the findings and recommendations enclosed in this report do not hold true in all situations.

Any recommendations made in this report pertain to the specific site investigated only.

Climate Consulting Ltd is not liable to any third party affected in any way by the contents of this report.

executive summary

This report presents results and recommendations from an investigation of frost risk and mitigation at Huddersfield, a recently developed Almond Orchard south-west of Darlington Point, New South Wales, Australia. Surface meteorological observations have been analysed from six Climate Towers and 139 remote temperature data loggers for eight observation periods during August and early September 2019.

Analysis has revealed a spatial variation in near-surface minimum temperature of 2.8°C. This will result in isolated incidents of frost to cooler parts of the property on many occasions. Extrapolations using historical temperature data from Griffith suggests that much of Huddersfield has a high risk of early spring frost. While inversion development supports the use of wind machines as an effective method of frost mitigation, protection of coolest areas cannot be guaranteed at near-surface temperature below -3.0°C. These temperatures have an expected return period of one year in five.

The final section of the report recommends that optimal frost mitigation will encompass the entire orchard and consist of up to 170 wind machines. The final number of machines may change to reflect wind machine make, model and density. A .kmz file containing precision GPS coordinates can be forwarded to the preferred wind machine provider when required.

table of contents

Climate Consulting
know what's next

1.0 introduction

1.1 Impetus and background

The most successful frost mitigation strategies blend within the fabric of a local nocturnal boundary layer. Agfield Services engaged Climate Consulting Ltd to provide scientific advice on the necessity and optimal location of frost mitigation across the Huddersfield Almond development, near Darlington Point, NSW.

A vast amount of data has been collected and analysed to produce this report. To clearly convey the original aim and objectives, graphs, regression plots and figures have been carefully selected to provide key information only, particularly where it may affect the delivery and success of frost mitigation.

This study incorporates surface frost mapping, inversion testing, wind speed and direction analysis, together with an examination of historical temperature data from the BoM Griffith Automatic Weather Station. Recommendations within the final section of this report provide suggestions for the most effective frost mitigation system across Huddersfield.

1.2 Aims and objectives

The broader aim of this report is to assess the necessity for frost mitigation at the Huddersfield Almond development. The report draws conclusions from an investigation into the local nocturnal boundary layer, providing analysis and commentary on near-surface temperature and wind observations obtained during clear settled weather, typical of radiation frost events in spring.

Prior to initiation of the investigation the following site-specific objectives were identified;

1. Determine the relative frost risk across Huddersfield
2. Determine the actual frost risk to development
3. If wind machines are a feasible option for mitigating frost, provide numbers and precision placements.

1.3 Physical setting

Huddersfield is accessed from Kidman Way (B 87), approximately 4 kilometres south-west of Darlington Point, New South Wales (Figure 1a). The broader location of the study area, including the nearby locations of Griffith and Leeton are illustrated in Figure 1b. For the purposes of this report, the 870 ha property comprises of four main block groups labelled A – D. Within these major block groups are 23 – 28 smaller blocks that embrace the development as a whole.

The northern boundary of the development is adjacent to the Sturt Highway (A20), while part of the eastern boundary follows Kidman Way. Areas south of the orchard remain largely undeveloped. Terrain surrounding and within the orchard development is flat having mean elevation of 122 m above sea level.

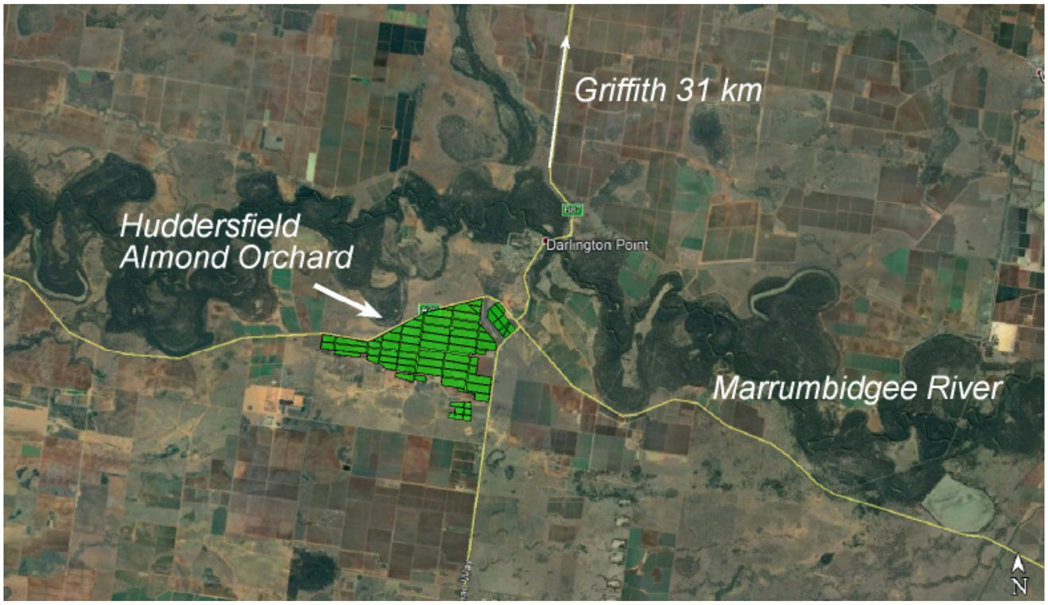

Figure 1a *Location map the Huddersfield Almond Orchard, 4 kilometres south-west of Darlington Point. The surveyed area has been highlighted in green.*

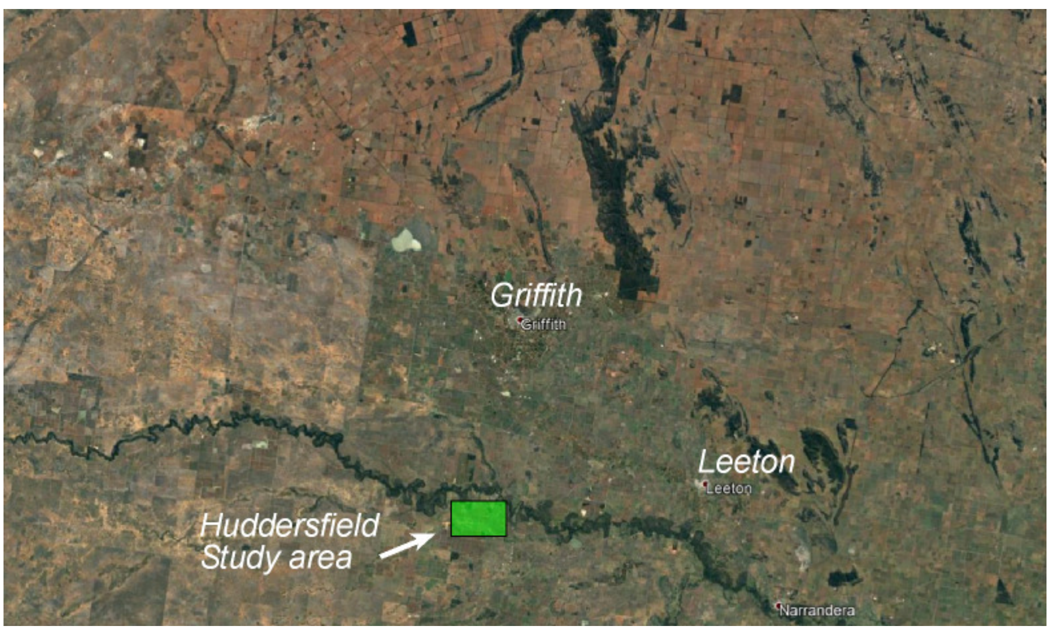

Figure 2b *Location of the Huddersfield orchard study area relative to the towns of Griffith and Leeton, New South Wales.*

1.4 Terminology

The following section may provide useful definitions of key words and processes that are used through following sections of the report.

An **inversion** forms as a result of strong radiational cooling at the ground surface at night. The process is most intense when weather conditions are clear and surface winds are absent or very light. During these times, the air closest to the ground cools at a faster rate relative to air at higher elevations, and so a temperature difference develops between vine height and the free atmosphere. The overnight inversion strength is in a constant state of flux, and governed largely by a handful of local physical parameters which are part of a much larger, dynamic atmospheric boundary layer system. Inversion strengths are the product of atmospheric moisture content, amount and height of cloud cover, atmospheric stability, local topography and near-surface wind velocities. A typical vertical temperature profile suggests that most of the temperature difference occurs within the first eight to ten metres above the ground, with the warming trend decreasing with height. Identification of near-surface inversion conditions during frost events are essential for the successful implementation of some frost protection systems.

Drainage winds or **'katabatic drift'** is a term used to describe a gravity induced flow of cold air that flows down a slope in response to radiational cooling of the ground. As the air closest to a sloping surface cools more quickly than air at the same height further away from the slope, the cooler air is pulled down slope by gravity and is observed on the valley floor as a cool breeze. At great distances from the coast, the cooler dense air continues to move down slope until it has merged with a layer of air of similar density (temperature) and eventually forms a pool of cold air. The direction of katabatic winds are governed primarily by the alignment of local topography, and are consistent from one frost event to the next. Katabatic wind direction has a great influence over the placement and coverage of frost mitigation.

When atmospheric pressure gradients are weak, daytime winds may '**decouple**' (detached from the surface) after sunset. If conditions remain settled overnight, the formation of a nocturnal boundary layer may include the formation of an inversion layer and katabatic drifts. However, in some cases the interaction of synoptic winds with terrain at higher elevations can interfere with the development of local katabatic drift. These conditions can lead to a **transition zone** near the surface, where a complete absence of wind is often accompanied by a sharp decrease in temperature. If atmospheric conditions are cool, a transition period may result in frost.

2.0 field techniques & equipment

2.1 Instrumentation

Temperatures in the vertical field are measured using Harvest Electronics temperature sensors. These sensors have a claimed accuracy of 0.16°C between 0 - 50°C with response time of less than 2 minutes in flowing air at 2 metres per second. Sensors are mounted on the mast at heights of 1.2 m and 15 m to decipher inversion strengths.

Wind speed and direction was recorded using the Atmos – 22 sensor 2-D sonic anemometer. Accuracy of the wind sensors are ± 0.25 metres per second (ms^{-1}) with starting thresholds less than 0.5 (ms^{-1}). In this respect the instruments are ideal for monitoring very light wind conditions.

The temperature and wind data from the climate towers were transmitted using GPRS and HSDPA technology through a Motorola G24 or H24 cellular module. The internal data logger has been designed by Harvest Electronics and is controlled by a Texas Instruments, low power MSP430 microprocessor. The logger and modem are of industrial standard and widely used across most New Zealand Meteorological Service and National Institute of Water and Atmospheric research (NIWA) Automated Weather Stations (AWS).

Temperature was recorded using Onset hobo “Pro temp V2” loggers. The Onset Pro temp loggers have a claimed accuracy of 0.2°C between 0 - 40°C. Each logger was mounted at a height of 1.2 meters above the ground and housed in a solar radiation shield to protect the sensor from the effects of sunlight, rain and nocturnal terrestrial long wave radiation.

2.2 Placement of Instrumentation

The site-specific objectives identified at the outset of this investigation influenced the placement of instrumentation across Huddersfield in Figure 2. Six Climate Towers were installed, including two towers in Blocks A and C and one tower in each of Blocks B and D. Two reference towers located on Blocks A and C received data from remaining towers. Towers measured temperature at heights of 1.3 and 15 metres above the surface, together with wind speed and direction at a height of 8 metres.

A high density of remote loggers (139) collected near-surface temperature data from within the orchard. Loggers were deployed at the intersections of all smaller sub-blocks within the four larger block areas A – D. Loggers collected temperature readings every 5 minutes for the duration of their deployment.

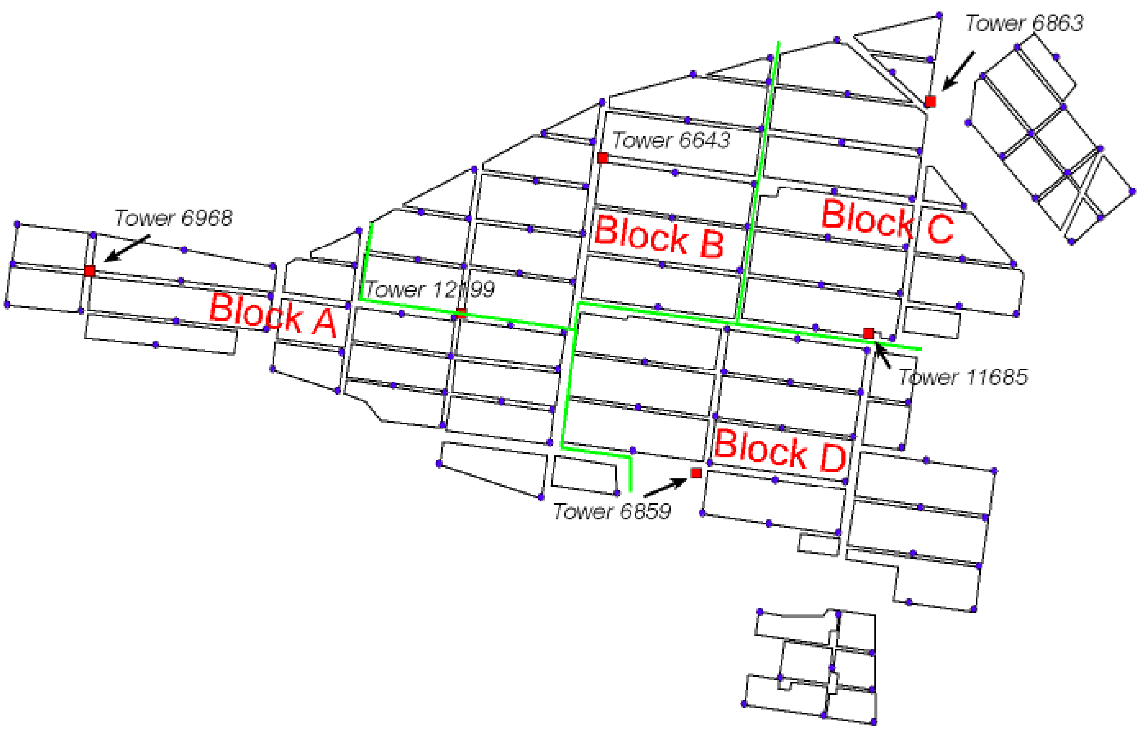

Figure 2a *Instrumentation deployment Huddersfield. Climate Towers are indicated by red squares and temperature data loggers by small purple dots. Larger block boundaries are defined by green lines.*

3.0 data collection

3.1 Special Observation Periods (SOPs)

Data was collected over a period of 29 days between the 9th August and 7th September 2019. In this time a number of nights provided suitable weather for the purpose of the study, although analysis has focussed on eight special observation periods (SOP's) when overnight cooling processes became well established during frost or near-frost conditions.

The requirements for a SOP are predominantly clear skies and light near-surface winds. These conditions allow near-surface boundary layer processes associated with radiative cooling to become established. These processes are repeated during subsequent radiational cooling conditions which includes spring frosts. Special observation periods included the following nights:

SOP1	12 - 13 August
SOP 2	16 – 17 August
SOP 3	22 - 23 August
SOP 4	23 - 24 August
SOP 5	25 - 26 August
SOP 6	26 - 27 August
SOP 7	27 - 28 August
SOP 8	29 - 30 August

A dream run of anticyclonic weather provided ample data following three cooler southerly wind changes. Frost was recorded in cooler areas of the property on all SOP's, but warmest areas remained just above zero during SOP's 4, 5, 7 and 8. The coolest minimum temperature of -4.0°C was recorded by a data logger located on the south-western corner of Block D 27 on the morning of August 23rd (SOP 3).

4.0 results & interpretation

4.1 Inversion development

This section of the report authenticates the efficacy of wind machines as a method of frost mitigation. It identifies potential inefficiencies or concerns that may arise as a function of terrain, surrounding vegetation or local climate phenomenon during frost.

Inversion strengths are measured as part of every field campaign. The strength and consistency of an inversion layer within the first 15 m above ground helps determine the success of a wind machine as a method of frost mitigation. Results from earlier studies over similar terrain near Griffith have demonstrated strong inversion conditions and data from Avondale has supported these findings.

Inversion strengths are calculated by subtracting the temperature at the bottom of the tower (1.2 m) from the elevated temperature at the top of the tower (15m) for each five-minute sample of temperature. As a "general" guide inversion strengths of less than 2°C within the first 15m above ground offer conservative benefits when engaged for frost protection. Inversion strengths of 2.5 - 3.5°C provide more consistent protection, whilst inversion strengths of 4°C or greater are of significant value. Average inversion strengths are obtained from the data once a steady state or "mature" nocturnal boundary layer has developed and this often occurs after the onset of local nocturnal drift.

Inversion conditions monitored by each of the Climate Towers have been summarised for eight observation periods in Figure 3 using three-dimensional bars super-imposed over the property. The relative height of each bar is indicative of the average inversion strength. Inversion strengths ranged from a low of 2.7°C at Tower 11685 to 3.2°C at Tower 6859. The variability of inversion strengths between the towers is small, but it is attributed to a variability of near-surface temperature, as cooler locations recorded stronger inversion conditions and warmer sites slightly weaker inversions. Inversion strengths across the property are rated as good to very good (>3°C) and may be of significant value if engaged as part of a frost mitigation strategy.

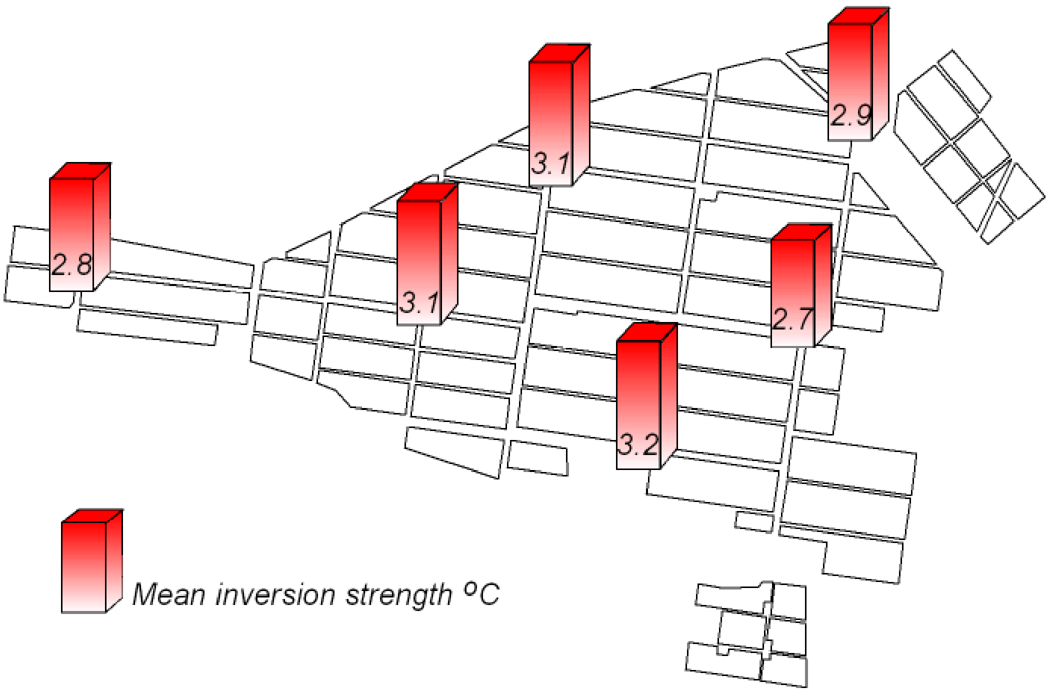

Figure 3 *Pictorial of mean inversion strengths at six tower locations across Huddersfield. Mean inversion strengths °C at each tower are indicated on each bar.*

As mentioned the difference of inversion conditions between each tower can be explained by the variability of near-surface temperature. In other words, temperature nearer the ground usually reflects ponding or local damming of cold air as a function of subtle topographic hollows, depressions, rills and ridges. Temperature within an inversion layer is less affected by surface irregularities and is reflective of the broader landscape over much greater distances, so the variability of inversion temperature across a large property is often stable.

The next three figures examine the inversion development from central areas of the orchard in greater detail. Figure 4 illustrates inversion development for all 8 SOP's from Tower 12199. While the graph depicts considerable inversion variability between each SOP and within a single overnight period, mean inversion strengths for the coolest time of the morning are predominantly over 3°C. Inversion development for SOP 4 is very strong and while it stands out from other nights, it is likely to be quite atypical for the area. Very strong inversions can form when air flows over the region are particularly dry and stable. SOP's 3, 5, and 8 reveal a sizeable fluctuation of inversion strength through the night.

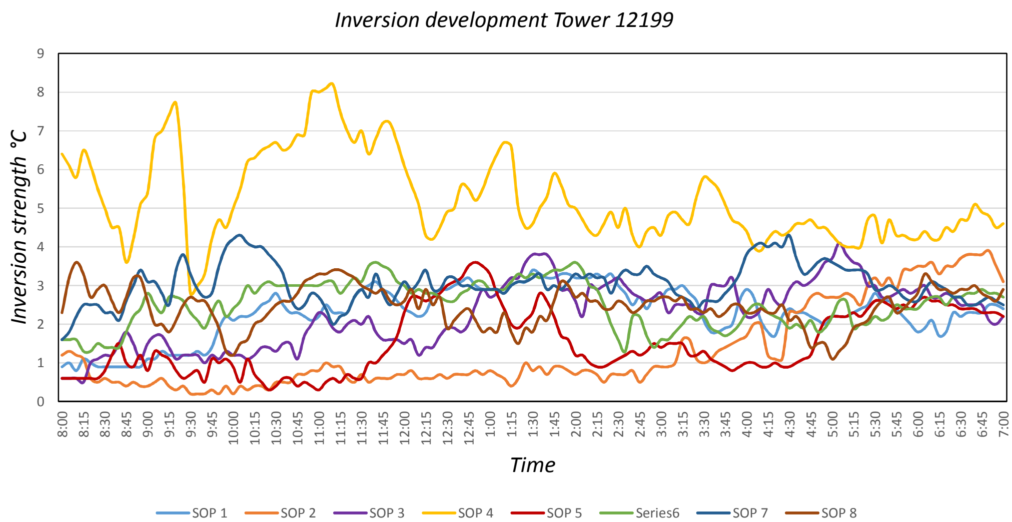

Figure 4 *A time-series plot of inversion development for all SOP's from Tower 12199 between Blocks A and B.*

It is important to ascertain whether the variation of inversion conditions on some occasions forms part of a local nocturnal climatology or is in fact caused by random one-off interactions with larger scale atmospheric phenomena. As SOP 5 reveals some of the larger fluctuations of inversion strength, Figure 5 analyses this SOP in greater detail with a time-series plot of temperature and wind speed. The graph shows that on this occasion stronger near-surface wind speed (11:30pm – 4:45am) is associated with weaker inversion conditions. As wind speed decreases after 4:45am the effect on inversion strength is immediate with near-surface temperature falling another 3°C until sunrise. The association between wind speed and inversion strength is explored using data from all SOP's later in this section of the report.

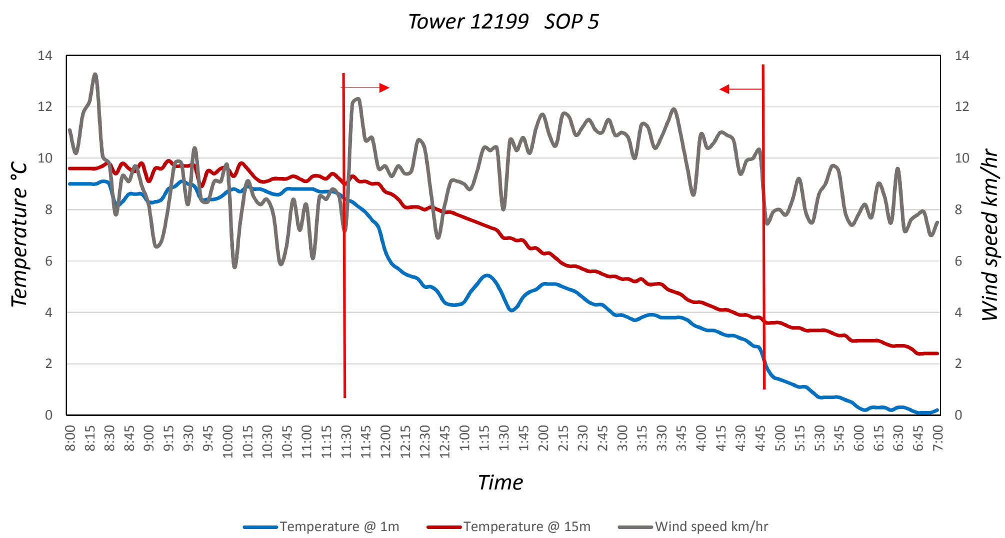

Figure 5 *A time-series plot of inversion development for SOP 5, Tower 12199. Fluctuations of inversion strength are associated with changes in near-surface wind speed.*

Further analysis of SOP 5 demonstrates that some of the inversion variability is also associated with the onset of local katabatic drift. The onset of this cooler air flow across the property is characteristic of radiative cooling processes that occur during settled conditions over distances of many 10's of kilometres away from the orchard. Figure 6 presents the same data from Tower 12199 but examines inversion strength and wind direction. The onset of katabatic drift is indicated by a subtle change in wind direction and a rapid increase of inversion strength as air near the surface cools (red line and arrow). In this case katabatic onset is associated with a near-surface temperature decrease of 4°C, while inversion temperature changes by only 1.5°C. This results in quite a dramatic change to inversion conditions. Dramatic fluctuations of inversion strength following katabatic onset are well documented.

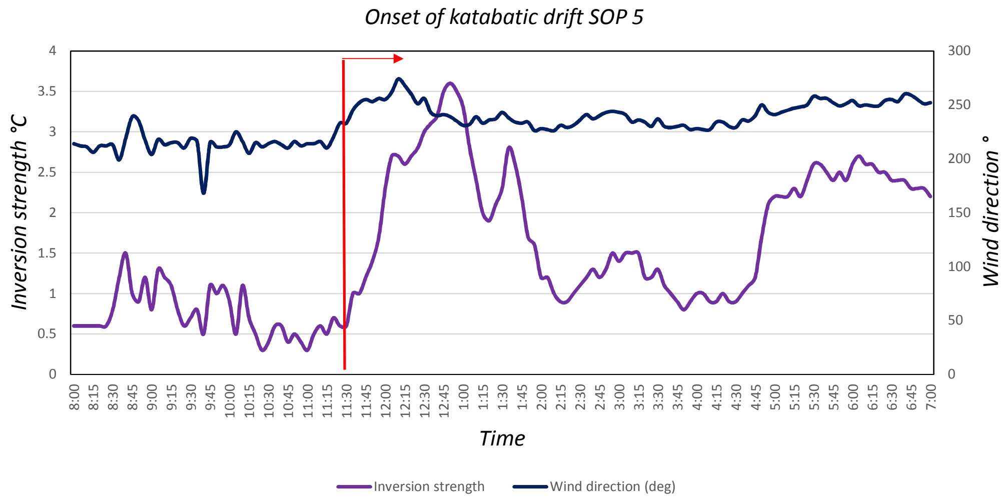

Figure 6 *A time-series plot of inversion development and katabatic onset for SOP 5, Tower 12199. Following onset of katabatic drift, fluctuations of inversion strength are associated with changes in near-surface wind speed.*

The coolest overnight temperatures were observed on SOP 3. This provides an opportunity to theoretically "stress test" the ability of wind machines to protect crop at Huddersfield during rather severe spring frost conditions. As will be disclosed later in the report, this event represents a projected 1 in 5 year return period spring frost. In Figures 7a and 7b the blue line is indicative of ambient near-surface temperature, the orange line is the projected modified temperature within a wind machines warming footprint and the red line is the inversion temperature. The modification of a wind machine to the near-surface environment at any point in time has been calculated as:

Modified temperature = ambient temperature + 0.6 x instantaneous inversion strength.

Figure 7a demonstrates the success of a wind machine working in one of the coolest areas of the orchard (Block 20C – 28C), whilst Figure 7b presents the effect of a machine to a warmer area. Both graphs show that wind machines make a significant impact to near-surface temperature. In Figure 7a projected ambient temperature falls to -0.3°C so frost is not completely averted, although any damage to crop would have been greatly minimised. Figure 7b suggests that frost mitigation is successful to the warmer area.

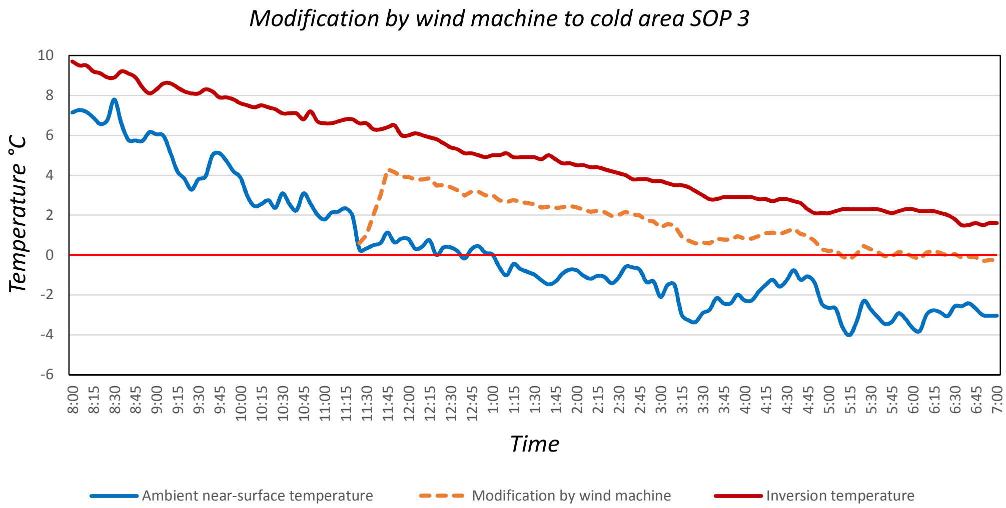

Figure 7a *Time-series plot of modification to the near-surface environment following operation of wind machines over coolest areas of the property. Projected temperatures within a wind machine warming footprint fall to -0.3°C on this occasion.*

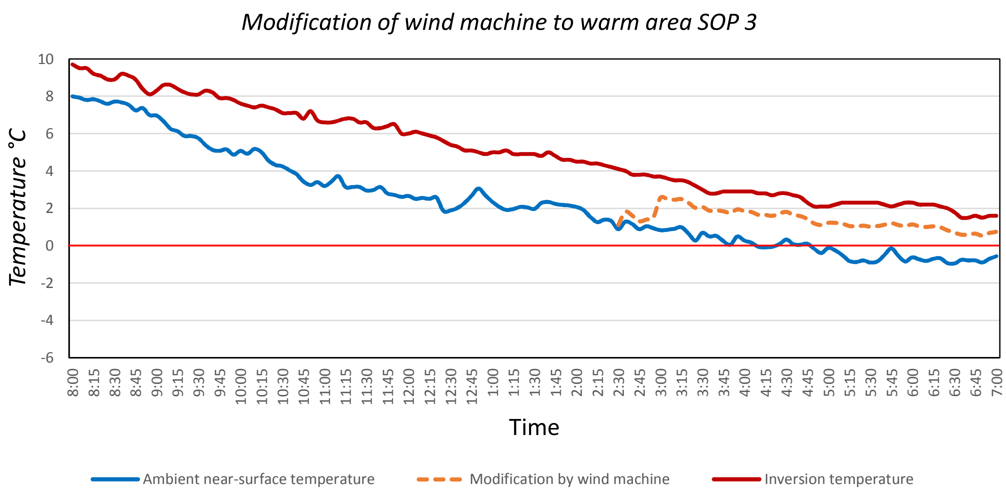

Figure 7b *Time-series plot of modification to the near-surface environment following operation of wind machines over warmer areas of the property. Frost is completely averted (orange dashed line).*

The robustness of an inversion layer can be tested in many ways. One method is to regress inversion conditions with near-surface wind speed. In Figure 8 a scatter (regression) plot of inversion strength and near-surface wind speed reveals a weak association. As near-surface wind speed decreases there is some tendency toward stronger inversion development, but the association is far from clear. Stronger inversion development (> 3°C) occurs over a range of near-surface wind speed. This points toward a deep layer of cold air above Huddersfield and which may not be easily disturbed by subtle changes in near-surface wind speed.

Inversion strength can also be regressed with near-surface temperature. Ideally, inversion conditions increase as near-surface temperature decreases, particularly during frost conditions. The graph in Figure 9 unveils evidence of this phenomenon, although once again the association is not strong (R^2 = 0.25). Red line highlights the weak linear association using data from all SOP's.

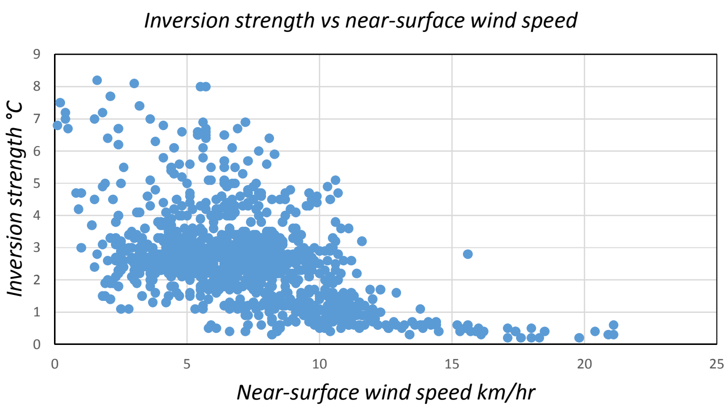

Figure 8 *A regression plot of inversion strength and near-surface wind speed at Huddersfield. The plot reveals a weak association.*

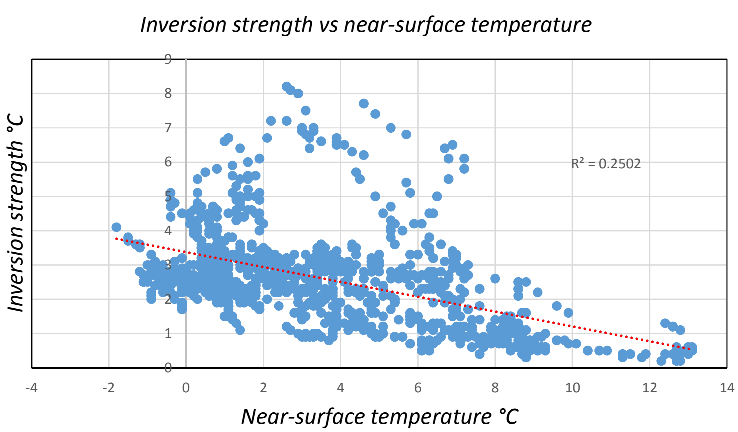

Figure 9 *A regression plot of inversion strength and near-surface temperature at Huddersfield. The regression suggests a weak linear association (R^2 = 0.25), so some of the changes to inversion conditions can be explained by changes to near-surface temperature.*

4.2 Katabatic drift

Wind measurements were monitored continuously from each tower. Observations at night during clear, light wind scenarios help provide the scientific basis for wind machine placement in the final section of this report. Katabatic drifts are not always discernible from winds generated from other forces, particularly where terrain is flat over great distances. In such cases, other local irregularities in vegetation or surface type can influence or even generate thermal wind regimes at night, as will be discussed in this section. Drift winds that move down sloping topography are often channelled into rills and waterways. As the confinement of these channels reduce, the cool dense air may spread and meander across flatter landscapes and eventually merge with pockets of air of similar density forming large cold pools. Small catchment areas and mountain ranges close to a study site initially have the greatest influence over the speed and direction of drift winds. Mountain ranges a greater distance away may have an effect later in the night, when cooling processes have become well established. Drift information is used for the optimal positioning of frost protection, especially wind machines.

In Figure 10 wind rose plots have been superimposed over Huddersfield for each of the SOP's, for all near-surface temperature below +1°C. Predominant wind drift directions are indicated by the longer barbs associated with each plot. Wind direction moves **from** the direction of the barbs. Drift direction shows predominantly west-south-west bias across the orchard, with a smaller north-east component at some towers.

The origin of the drift winds are not known. It is possible the drifts are connected to terrain influences some distance from Huddersfield. The temporal evolution suggests the drifts may have origins many tens of kilometres away.

Wind drift speed during frost conditions did reveal some variation, with highest mean drift speed recorded atop tower 12199 at 6.2 km/hr. Mean drift speed ranged from 3.8 km/hr to 5.7 km/hr at all remaining towers. There was some association between lighter mean drift speed and cooler near-surface temperature. Drift wind observations from the towers are summarised in Table 1.

Mean drift speeds exceeded 10 km/hr at near-surface temperature below +1 °C (frost conditions) from 0.3 – 4.5% of the time. The variation is a function of each towers height above surrounding terrain, and proximity to vegetation. Calms (winds less than 1 km/hr) were observed 0 - 4% of the time. The 10 km/hr mean wind speed criteria is important as some wind machine brands are programmed to shut down at higher speeds, while in near-calm conditions (< 1km/hr) wind machines elliptical warming footprints may become more circular. The shape of a warming footprint does not affect the efficacy of protection.

Table 1 *Mean drift speed, percentage calms (speed less than 1 km/hr) and frequency of speed exceeding 10 km/hr during frost conditions at each Climate Tower.*

Tower	***Mean speed km/hr***	***% of calms (< 1 km/hr)***	***% of time over 10 km/hr***
12199	*6.2*	*0*	*2.0*
6643	*5.3*	*1.9*	*4.5*
6859	*5.7*	*0*	*4.5*
6968	*5.2*	*1.1*	*2.2*
11685	*4.3*	*2.8*	*2.5*
6863	*3.8*	*4.0*	*0.3*

Figure 10 *Wind rose plots super-imposed onto an outline of Huddersfield Orchard. Wind direction is indicated by the length and orientation of wind barbs.*

4.3 Spatial variation of near-surface temperature – frost profiling.

The deployment of remote temperature data loggers provides information on the spatial variation of minimum temperatures. Near-surface temperatures have been shown to form repetitive patterns under clear settled conditions. The near-surface minimum temperature maps are a useful way to confirm existing ideas regarding frost risk and may also be used as a guide to placement of frost protection. Cooler temperatures are associated with higher frost risk and have a blue shading on the map while warmer areas are coloured orange. The colours on the maps are relative to one another, allowing direct comparison of frost risk between adjacent blocks.

Figure 11 illustrates the expected variation of minimum temperature across Huddersfield. The frost profile maps have been super-imposed onto Google Earth as this provides useful indications of surrounding vegetation and land use which can affect frost risk. Temperature changes indicated by the key are either added or subtracted from a nominated control point on the property.

The mapping procedure has revealed a <u>mean</u> minimum temperature variation of 2.8°C across the orchard. This variation is significant and will contribute to an elevated frost risk to cooler areas on many occasions. While the mean variation of minimum temperature is a function of the undulating terrain, type and proximity of surrounding vegetation and predominant wind drift patterns, it is important to realise that the actual temperature variation over a single frost event can exceed the mean value. It would not be uncommon to observe the effect of moderate frost in cooler parts of the orchard, while warmer areas remain frost free.

Areas with greatest frost risk appeared to be at the outer extremities of the orchard. These areas included Blocks A1 – A8, D23 – D28 and C20 – C28. In addition there are numerous small isolated cool pockets that were identified with an elevated frost risk. Coldest areas are not necessarily lower-lying. Cooler temperatures are more likely to be associated with density of vegetation around the orchard. Vegetation is known to impede cold air movement and this will facilitate a ponding or stagnation of cold air to the blocks identified above.

Warmer temperatures were consistently observed within Blocks B1, B2, B7 and in a band that stretches across southern areas of main Blocks A and into D. These are likely to catch more breeze from either katabatic or synoptic origins and this predisposes these sites to warmer nocturnal temperatures.

While the temperature map indicates an *expected* variation of minimum temperature during frost, the *temporal* variation (the timing of the minimum temperature) may reveal a different pattern. Future frost monitoring may demonstrate that the time of coolest temperature varies at different locations around each block. The amount of time any particular area stays below zero is not necessarily related to actual minimum temperature.

The warmer areas (orange shades) have been classified as having a moderate-high frost risk, whilst all blue shades are classified with a high or very high frost risk. Moderate –high frost risk areas will receive frost during colder outbreaks most spring seasons, whereas very high frost risk categories are expected to receive multiple frost events each spring (mid-August to the end of October).

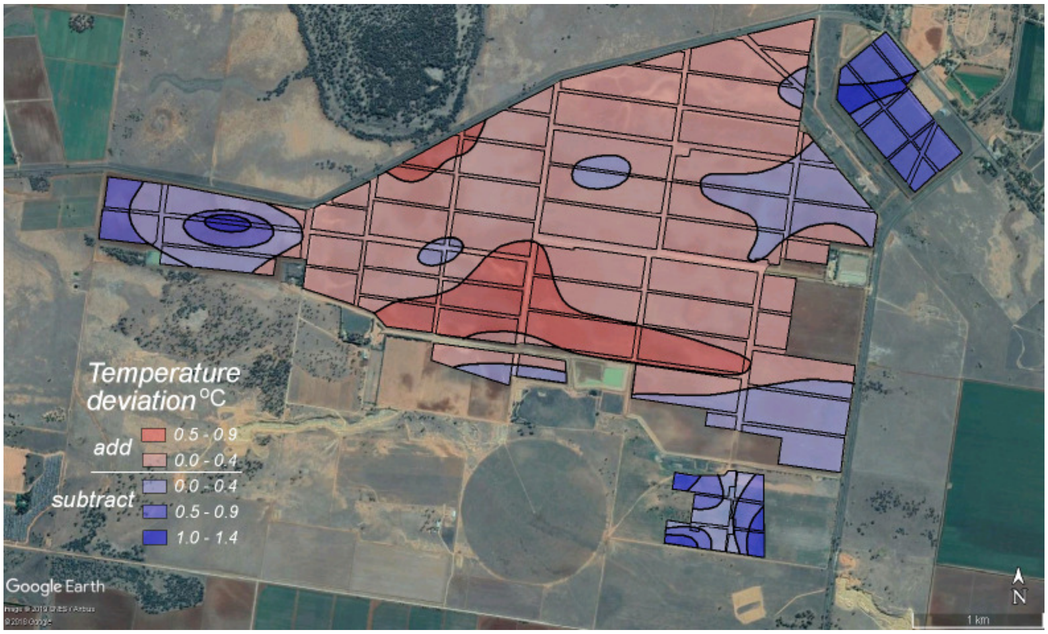

Figure 11 *Minimum temperature deviation (frost profile) Huddersfield. Blue shaded areas have a high or very high risk of frost from 16th August – 31 October.*

4.4 Frost risk and temperature projections.

In Figure 12 minimum near-surface minimum temperature from the BoM Griffith Automatic Weather Station has been compared against a logger located midway between the warmest and coolest areas of Huddersfield for 12 clear cold nights. Frost was observed on 9 of the 12 events. The exercise suggests that while average minimum temperature at Huddersfield and Griffith are identical, there is considerable variation (up to 3°C) on some occasions. A difference in temperature between Huddersfield and Griffith on any given night will be a function of local scale airflow patterns and the rate of cooling associated with terrain and vegetation around each recording site.

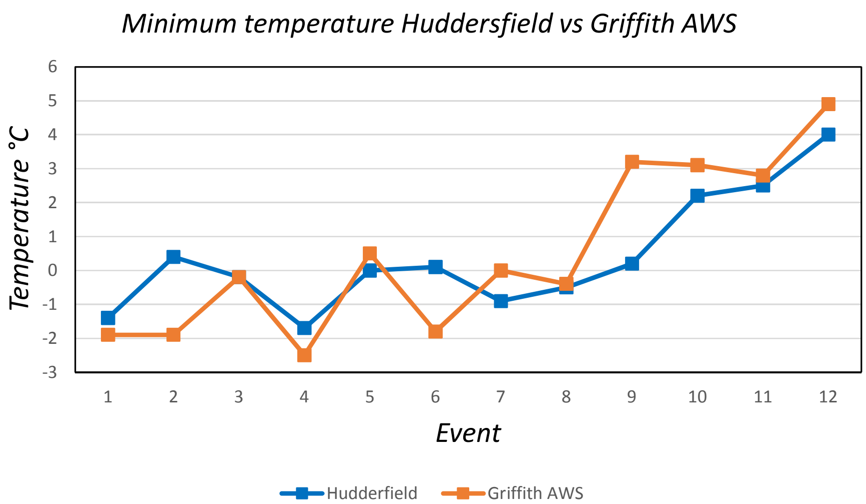

Figure 12 *Minimum temperature comparison for 12 clear cold nights from August and September 2019 between Griffith AWS and Huddersfield. Although average minimum temperature was identical, there is considerable variation on some nights.*

The comparative exercise above allows frost projections to be made for the Huddersfield property using a 16 year uninterrupted temperature record from Griffith AWS. Table 2 provides a projected mean monthly minimum temperature (this could be expected most years) and a projected monthly extreme minimum temperature for the months of August, September and October for Griffith AWS. The actual frost risk to specific blocks within Huddersfield can be calculated by adding or subtracting relative temperature values from the series of frost risk maps provided in the previous section. **(Temperatures calculated for August assume a start date from August 16th and finish date of August 31st).

Figures within Table 2 suggest a mean monthly minimum temperature in August of -1.2°C and in September of -0.1°C. The extreme events for these months are several degrees colder still. August extreme minimum temperatures of -4.8°C and -4.5°C were observed in 2017 and 2018 respectively and are known to have caused considerable damage to unprotected crops in the Riverina precinct.

Although frost risk is eliminated in all but the coolest areas of Huddersfield by October, analysis reveals that temperatures as low as -1.0°C would have been recorded within coolest areas at least twice in the past 15 years.

Figure 13 shows the number of times frost protection is likely to have been required over cooler parts (blue shaded areas on frost risk map) of Huddersfield for the years 2004 - 2019. The frequency ranges from a low of 0 incidences in 2009 and 2014 to 9 occasions in 2012 and 2017.

Table 2 *Projected mean monthly minimum temperature and coldest recorded temperatures for months of August to October 2004 – 2019 for Griffith AWS. Temperatures can be added or subtracted from these figures to calculate the actual frost risk around the Huddersfield Orchard.*

Month	Mean monthly minimum °C	Extreme event °C
August	-1.2	-4.8
September	-0.1	-2.2
October	2.8	0.4
November	Minimal risk	Minimal risk

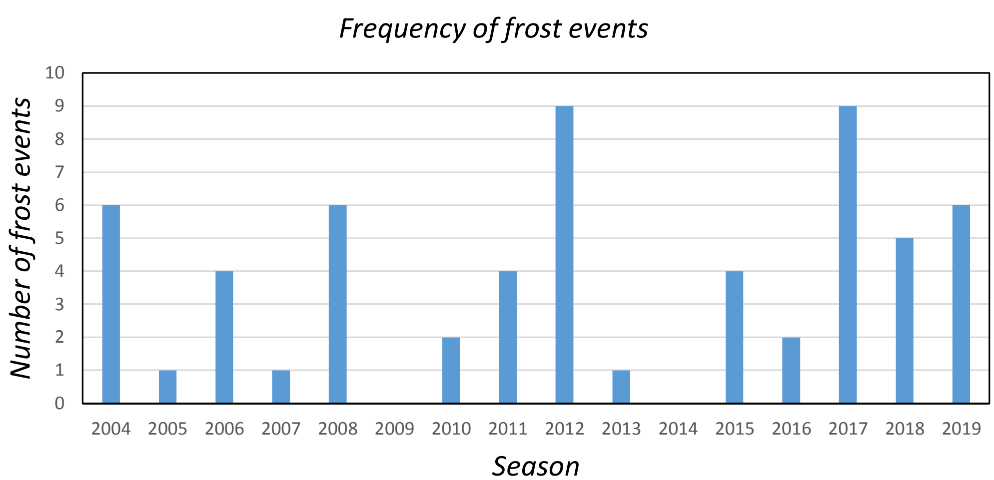

Figure 13 *Frequency of frost protection requirement over cooler areas of Huddersfield Orchard for spring seasons 2004 - 2019.*

5.0 discussion and recommendations

Data collection from Huddersfield Orchard has revealed a large variation of near-surface minimum temperature. Most of the variation is associated with orchard block shape and the proximity to surrounding vegetation. Although the frost risk profile map shows a range of frost risk to the property (moderate-high to very high), it must be realised that without frost mitigation spring frost would have affected the entire property on 8 of the past 16 years.

Inversion strengths are rated as good to very good and are satisfactory for the installation wind machines as a method of frost mitigation. Wind machines are expected to significantly reduce frost risk, with nominal near-surface temperature increases (within a wind machine warming footprint) of 1.7 – 2.0°C. Greater temperature modifications could be expected over cooler areas with slightly less over warmer areas. The effect of a wind machine is to "level the playing field" so that as much of the orchard as possible records a uniform temperature, preferably raised above zero during frost.

Provided that good inversion conditions are present, a wind machine could be expected to effectively protect 4.5 – 5.5 ha from a near-surface temperature of minus 3.0°C. Extrapolation of temperature records from Griffith AWS suggests that a frost of this magnitude or greater has likely return period of once in 5 years. At lower temperatures the area of effective warming footprint will reduce and damage may occur to crop in between wind machine warming footprints and around the margins of some block boundaries. Data from Griffith AWS suggests that temperatures below -3.0°C would have been recorded at Huddersfield near the end of August for years 2017, 2018 and 2019. *The 2019 extreme was recorded as part of the data collection for this report.

Figures 14a and 14b present an implementation strategy for wind machines across Huddersfield. In Figure 14a, 66 wind machines (coloured red) have been super-imposed over highest frost risk areas as defined by the frost profile map. Wind machines in these areas have been positioned using a tighter footprint spacing to provide some warming overlap with adjacent machines. This will improve the robustness of frost protection to these areas. Installation of frost mitigation to coolest areas of the orchard only, provides a rudimentary level of protection. Temperature records from Griffith suggest that frost would have extended over all Huddersfield Orchard for eight of the last sixteen spring seasons.

In Figure 14b frost mitigation has been extended across the remainder of the orchard. This requires a further 104 wind machines (coloured white). The warming footprints from these wind machines will, in most cases, protect at least 5.5 ha. Wind machine warming footprints are aligned to account for the prevailing west-south-west katabatic drift.

Suggested wind machine numbers at this stage will not be exact, however, we do expect they will be very close. Deviation from wind machine numbers quoted above may occur as a function of wind machine brand, model and the client's appetite for risk. Wind machine installations can be staged over any number of years as information contained within this report will not change or go out of date. Small deviations from suggested installation locations may occur as a result of machine accessibility or subtleties in terrain slope that can't be seen using Google profiles. Google .kmz files with accompanying GPS coordinates for machine installations can be forwarded to the preferred wind machine provider when requested by management of Huddersfield Orchard.

Anecdotal evidence suggests that wind machines work more effectively over larger areas when they are installed as a group. This is the result of a turbulent effect produced by numerous machines pushing and pulling air from multiple directions at the same time. In this respect protection from wind machines <u>may</u> extend beyond the -3.0°C temperature quoted earlier this report, however, a number of climate variables that are in constant flux can affect this so the extended protection cannot be guaranteed.

As mentioned there is considerable overlap between some adjacent machine warming footprints in cooler areas. This overlap is encouraged, particularly as tree crops mature. The effective warming from wind machines takes longer to penetrate and protect larger trees with increased foliage and branches that can impede air movement.

While the success behind a wind machine is traditionally ascribed to favourable inversion conditions, the warmer air brought down onto a crop is now believed to account for about half of the frost protection. It is equally important that a wind machine has the ability to dry the surface of a plant before temperatures fall below freezing. In other words, the momentum of air flow forced through the crop is just as important as a lift in temperature from an inversion. The amount of airflow through an orchard can be increased by tightening the spacing between wind machines to ensure overlap of warming footprints between adjacent machines, and in new developments, aligning rows where possible to facilitate air movement from a wind machine down the row.

Forcing dryer air from aloft through the orchard prior to frost conditions reduces dew formation on surfaces of flowers and leaves, and when a dryer leaf surface falls below zero apparent frost damage is reduced when compared to a wet-freeze situation. Ultimately the level of frost protection provided by a wind machine will be a function of near-surface temperature, inversion conditions, near-surface wind speed, correct machine positioning and timeliness of machine operation.

Initiation of frost protection should be made in accordance with local knowledge and area specific frost forecasts. Wind machines are normally automated to commence operation before temperatures fall to zero degrees, most usually start at <u>air</u> temperatures of +1.0°C. Higher start-up temperatures generally waste fuel and annoy neighbours. Ensure wind machine probes are well maintained and secured at a nominal height of at least 1 m above ground level.

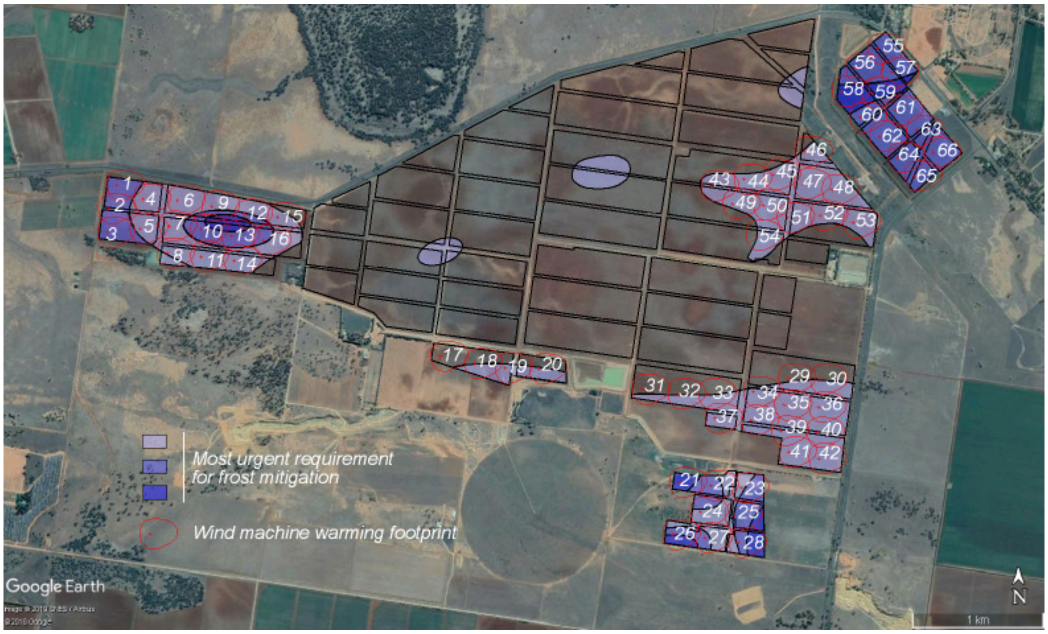

Figure 14a *Frost protection using 66 wind machines to coolest areas of Huddersfield Orchard. Data suggests this level of mitigation will be sufficient just 50% of the time.*

Figure 14b *A further 104 wind machines would be necessary to protect remaining areas of the orchard. Final wind machine numbers will reflect machine make and model.*

Annexure 6

Environmental Noise Assessment

Frost Control Fans

Huddersfield Darlington Point

Environmental Noise Assessment

S6887.2C4

October 2021

sonus.

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INTRODUCTION

One-hundred-and-seventy Orchard Rite frost control fans, being a mixture of two bladed "2600" and three bladed "2430" types, are proposed to be installed at the Huddersfield property at Darlington Point, within the Murrumbidgee Shire.

The frost control fans will automatically engage during meteorological conditions under which frost is likely to occur[1]. These conditions are negligible wind or cloud and generally occur in the early morning hours.

In the absence of relevant guidelines for noise from the operation of frost control fans within the Murrumbidgee Shire, reference has been made to established policies within the Leeton Shire and Griffith councils for appropriate objective noise criteria. This assessment predicts the noise level at the closest non-associated dwellings from the frost control fan installation and determines the mix of fan types required in order to meet the noise criteria.

The locations of the proposed frost control fans and the closest non-associated dwellings are indicated on the figure in Appendix B.

1 Appendix A provides additional information on the operation of the Orchard Rite frost control fan.

CRITERIA

The frost control fan installation and some of the nearby non-associated dwellings are located within a Primary Production Zone of the *Murrumbidgee Local Environmental Plan 2011* (the **LEP**). Other nearby non-associated dwellings are located within a Village Zone and a Large Lot Residential Zone of the LEP.

The LEP does not include any specific provisions in relation to the noise from frost control fans, so reference has been made to the established frost control fan policies frequently used in the Griffith and Leeton Shire Council areas for similar frost control fan installations.

These policies have been developed to *find an equitable balance between the use of frost control fans and the amenity of surrounding residents*, and *to address the interface issues regarding the installation and operation of frost control fans.*

Both the *Griffith Frost Control Fan (Local Policy)* and *Leeton Shire Council Policy for Frost Control Fans* recognise the special circumstances associated with frost control fans and have specific criteria for the noise that they produce. The criteria apply at the nearest affected dwellings located on a separate property to that which the fans will be located upon, and are as follows:

Location of affected residence	***Outdoor Criteria (L_{Aeq})***	***Indoor Criteria (L_{Aeq})***
Noise Sensitive Zone	*45 dB(A) (max)*	*25 dB(A) (max)*
Non-noise sensitive Zone	*55 dB(A) (max)*	*35 dB(A) (max)*

Note:

1. *A noise sensitive zone (noise receiver's zone) is a zone primarily meant for noise sensitive land uses such as residential or rural residential.*
2. *A non-noise sensitive zone is a zone primarily used for agricultural pursuits.*

It is noted that these criteria were developed following a hearing in the NSW Land and Environment Court (Sumar Produce Pty Ltd v Griffith City Council [2000] NSWLEC 104). The Judgement for this hearing includes:

> *Pursuant to s 39 of the Land and Environment Court Act 1979, the Court determines that in accordance with s 264 of the PEO Act, any noise control notices given in writing to the applicant prohibit the company from causing the frost control fan, erected on Farm 1876, Boorga Road, Lake Wyangan, to be operated in such a manner as to cause*

> *the emission from the premises between the hours of 22.00 hours and 07.00 hours on any day, of noise that when measured at a point one metre from any residential bedroom window outside the subject property is in excess of 55 dBA L_{Aeq}.*

Based on the above, for non-associated dwellings in a Primary Production Zone, an outdoor criterion of 55 dB(A) for all frost control fans operating concurrently at the site is considered appropriate. For non-associated dwellings in the Village and Large Lot Residential zones, an outdoor criterion of 45 dB(A) is considered appropriate.

ASSESSMENT

Noise from the proposed frost control fans has been predicted to the closest non-associated dwellings based on the following:

- Sound power levels (refer Appendix A) derived from a combination of noise level measurements conducted by SSA Acoustics (SSA)[2] and Sonus[3], for the Orchard Rite "2600" frost control fan at a motor speed of 2270rpm, with corresponding fan speed of approximately 549rpm, and the Orchard Rite "2430" frost control fan at a motor speed of 2010rpm, with corresponding fan speed of approximately 373rpm; and
- CONCAWE[4] noise propagation which takes into account the specific temperature inversion characteristics of a frost condition on noise propagation (i.e., CONCAWE Weather Category 5 conditions). The specific conditions considered are as follows:
  - Cloud Cover: None;
  - Time of Day: Night;
  - Wind Speed: Less than 0.5m/s;
  - Temperature: 0°C;
  - Relative Humidity: 100%.

The installation of the one-hundred-and-seventy fans is proposed to be conducted across two stages. Stage one will include an initial fifty-eight fans, with the remaining one-hundred-and-twelve fans to be installed as part of stage two. As the assessment criteria apply for the concurrent operation of all frost control fans operating at the site, the assessment has considered both stage one in isolation, as well as the cumulative effect of both stages one and two.

The make-up of the one-hundred-and-seventy fan installation has been determined such that all fans can be operated at normal speed and based on the understanding that stage two will consist primarily of "2430" type fans. In addition, stage one of the installation has been designed in order to not prejudice the future inclusion of stage two. In order to meet the criteria, twenty-eight of the proposed frost control fans will need to be removed from the proposal and not installed. This will result in a total of one-hundred-and-forty-two

[2] SSA report *Noise Test Report – Orchard-Rite 2600: Report number 19-7386*.
SSA report *Orchard Rite Frost Fans Noise Test: Report number 18-7090*.
[3] Sonus report *Orchard Rite Frost Control Fans Noise Testing Report: Report number S6887C2*.
[4] CONCAWE Conservation of clean air and water in Europe – Report 4/81 *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities*, Manning, C.J. et al.

fans for the full installation, with forty-six fans to be installed as stage one and the remaining ninety-six as stage two. This will be comprised of a total of fourteen "2600" type frost control fans and one-hundred-and-twenty-eight "2430" frost control fans, all of which can be operated at normal speed. The below table indicates the fans to be removed, highlighted in red, as well as the model and operating speed assumed for each of the remaining frost control fans.

Table 1: *Frost Control Fan Operating Configuration.*

Fan No.	Phase	Model	Speed	Fan No.	Phase	Model	Speed	Fan No.	Phase	Model	Speed
Fan 1	Stage 1	2600	2270	Fan 66	Stage 1	Remove	-	Fan 115	Stage 2	2430	2010
Fan 2	Stage 1	2600	2270	Fan 21	Stage 2	2600	2270	Fan 116	Stage 2	2430	2010
Fan 3	Stage 1	2600	2270	Fan 22	Stage 2	2600	2270	Fan 117	Stage 2	2430	2010
Fan 4	Stage 1	2600	2270	Fan 23	Stage 2	2600	2270	Fan 118	Stage 2	2430	2010
Fan 5	Stage 1	2600	2270	Fan 24	Stage 2	2600	2270	Fan 119	Stage 2	2430	2010
Fan 6	Stage 1	2600	2270	Fan 25	Stage 2	2600	2270	Fan 120	Stage 2	2430	2010
Fan 7	Stage 1	2430	2010	Fan 26	Stage 2	2600	2270	Fan 121	Stage 2	2430	2010
Fan 8	Stage 1	2430	2010	Fan 27	Stage 2	2600	2270	Fan 122	Stage 2	2430	2010
Fan 9	Stage 1	2430	2010	Fan 28	Stage 2	2600	2270	Fan 123	Stage 2	2430	2010
Fan 10	Stage 1	2430	2010	Fan 67	Stage 2	2430	2010	Fan 124	Stage 2	2430	2010
Fan 11	Stage 1	2430	2010	Fan 68	Stage 2	2430	2010	Fan 125	Stage 2	2430	2010
Fan 12	Stage 1	2430	2010	Fan 69	Stage 2	Remove	-	Fan 126	Stage 2	2430	2010
Fan 13	Stage 1	2430	2010	Fan 70	Stage 2	Remove	-	Fan 127	Stage 2	2430	2010
Fan 14	Stage 1	2430	2010	Fan 71	Stage 2	2430	2010	Fan 128	Stage 2	2430	2010
Fan 15	Stage 1	2430	2010	Fan 72	Stage 2	2430	2010	Fan 129	Stage 2	2430	2010
Fan 16	Stage 1	2430	2010	Fan 73	Stage 2	2430	2010	Fan 130	Stage 2	2430	2010
Fan 17	Stage 1	2430	2010	Fan 74	Stage 2	2430	2010	Fan 131	Stage 2	2430	2010
Fan 18	Stage 1	2430	2010	Fan 75	Stage 2	2430	2010	Fan 132	Stage 2	2430	2010
Fan 19	Stage 1	2430	2010	Fan 76	Stage 2	2430	2010	Fan 133	Stage 2	2430	2010
Fan 20	Stage 1	2430	2010	Fan 77	Stage 2	2430	2010	Fan 134	Stage 2	2430	2010
Fan 29	Stage 1	2430	2010	Fan 78	Stage 2	Remove	-	Fan 135	Stage 2	2430	2010
Fan 30	Stage 1	2430	2010	Fan 79	Stage 2	2430	2010	Fan 136	Stage 2	2430	2010
Fan 31	Stage 1	2430	2010	Fan 80	Stage 2	2430	2010	Fan 137	Stage 2	2430	2010
Fan 32	Stage 1	2430	2010	Fan 81	Stage 2	2430	2010	Fan 138	Stage 2	2430	2010
Fan 33	Stage 1	2430	2010	Fan 82	Stage 2	2430	2010	Fan 139	Stage 2	2430	2010
Fan 34	Stage 1	2430	2010	Fan 83	Stage 2	2430	2010	Fan 140	Stage 2	2430	2010
Fan 35	Stage 1	2430	2010	Fan 84	Stage 2	2430	2010	Fan 141	Stage 2	2430	2010
Fan 36	Stage 1	2430	2010	Fan 85	Stage 2	2430	2010	Fan 142	Stage 2	2430	2010
Fan 37	Stage 1	2430	2010	Fan 86	Stage 2	2430	2010	Fan 143	Stage 2	2430	2010
Fan 38	Stage 1	2430	2010	Fan 87	Stage 2	2430	2010	Fan 144	Stage 2	2430	2010
Fan 39	Stage 1	2430	2010	Fan 88	Stage 2	2430	2010	Fan 145	Stage 2	2430	2010
Fan 40	Stage 1	2430	2010	Fan 89	Stage 2	2430	2010	Fan 146	Stage 2	2430	2010
Fan 41	Stage 1	2430	2010	Fan 90	Stage 2	2430	2010	Fan 147	Stage 2	2430	2010
Fan 42	Stage 1	2430	2010	Fan 91	Stage 2	2430	2010	Fan 148	Stage 2	2430	2010
Fan 43	Stage 1	2430	2010	Fan 92	Stage 2	2430	2010	Fan 149	Stage 2	2430	2010
Fan 44	Stage 1	2430	2010	Fan 93	Stage 2	2430	2010	Fan 150	Stage 2	2430	2010
Fan 45	Stage 1	2430	2010	Fan 94	Stage 2	2430	2010	Fan 151	Stage 2	Remove	-
Fan 46	Stage 1	2430	2010	Fan 95	Stage 2	2430	2010	Fan 152	Stage 2	Remove	-

Fan No.	Phase	Model	Speed	Fan No.	Phase	Model	Speed	Fan No.	Phase	Model	Speed
Fan 47	Stage 1	2430	2010	Fan 96	Stage 2	2430	2010	Fan 153	Stage 2	Remove	-
Fan 48	Stage 1	2430	2010	Fan 97	Stage 2	2430	2010	Fan 154	Stage 2	Remove	-
Fan 49	Stage 1	2430	2010	Fan 98	Stage 2	2430	2010	Fan 155	Stage 2	Remove	-
Fan 50	Stage 1	2430	2010	Fan 99	Stage 2	2430	2010	Fan 156	Stage 2	Remove	-
Fan 51	Stage 1	2430	2010	Fan 100	Stage 2	2430	2010	Fan 157	Stage 2	Remove	-
Fan 52	Stage 1	2430	2010	Fan 101	Stage 2	2430	2010	Fan 158	Stage 2	Remove	-
Fan 53	Stage 1	2430	2010	Fan 102	Stage 2	2430	2010	Fan 159	Stage 2	Remove	-
Fan 54	Stage 1	2430	2010	Fan 103	Stage 2	2430	2010	Fan 160	Stage 2	Remove	-
Fan 55	Stage 1	Remove	-	Fan 104	Stage 2	2430	2010	Fan 161	Stage 2	Remove	-
Fan 56	Stage 1	Remove	-	Fan 105	Stage 2	2430	2010	Fan 162	Stage 2	Remove	-
Fan 57	Stage 1	Remove	-	Fan 106	Stage 2	2430	2010	Fan 163	Stage 2	2430	2010
Fan 58	Stage 1	Remove	-	Fan 107	Stage 2	2430	2010	Fan 164	Stage 2	2430	2010
Fan 59	Stage 1	Remove	-	Fan 108	Stage 2	2430	2010	Fan 165	Stage 2	2430	2010
Fan 60	Stage 1	Remove	-	Fan 109	Stage 2	2430	2010	Fan 166	Stage 2	2430	2010
Fan 61	Stage 1	Remove	-	Fan 110	Stage 2	2430	2010	Fan 167	Stage 2	2430	2010
Fan 62	Stage 1	Remove	-	Fan 111	Stage 2	2430	2010	Fan 168	Stage 2	2430	2010
Fan 63	Stage 1	Remove	-	Fan 112	Stage 2	2430	2010	Fan 169	Stage 2	2430	2010
Fan 64	Stage 1	Remove	-	Fan 113	Stage 2	2430	2010	Fan 170	Stage 2	Remove	-
Fan 65	Stage 1	Remove	-	Fan 114	Stage 2	2430	2010				

The predicted noise levels at the nearest non-associated dwellings from the initial installation of the forty-six frost control fans comprising stage one are summarised in Table 2 below. The predictions consider the frost control fans operating as per the configuration provided in Table 1 above, at the locations shown in Appendix B.

Table 2: *Predicted Noise Levels, dB(A).*

Residence	Predicted Noise Level	Criterion	Residence	Predicted Noise Level	Criterion
NAD A	42 dB(A)	45 dB(A)	NAD K	39 dB(A)	55 dB(A)
NAD B	42 dB(A)	55 dB(A)	NAD L	42 dB(A)	55 dB(A)
NAD C	41 dB(A)	55 dB(A)	NAD M	41 dB(A)	55 dB(A)
NAD D	41 dB(A)	55 dB(A)	NAD N	42 dB(A)	55 dB(A)
NAD E	41 dB(A)	55 dB(A)	NAD O	41 dB(A)	45 dB(A)
NAD F	41 dB(A)	55 dB(A)	NAD P	39 dB(A)	45 dB(A)
NAD G	39 dB(A)	55 dB(A)	NAD Q	36 dB(A)	45 dB(A)
NAD H	49 dB(A)	55 dB(A)	NAD R	37 dB(A)	45 dB(A)
NAD I	42 dB(A)	55 dB(A)	NAD S	43 dB(A)	55 dB(A)
NAD J	40 dB(A)	55 dB(A)			

The predicted noise levels in Table 2 indicate that the noise from the installation of the frost control fans proposed for stage one will achieve the relevant criteria at all nearby non-associated dwellings when operated as per the above recommendations, while still allowing for the inclusion of the stage two fans.

The predicted noise levels for the full installation following the inclusion of the additional ninety-six frost control fans comprising stage two are summarised in Table 3 below. The predictions consider the frost control fans operating as per the configuration provided in Table 1 above, at the locations shown in Appendix B.

Table 3: *Predicted Noise Levels, dB(A).*

Residence	Predicted Noise Level	Criterion	Residence	Predicted Noise Level	Criterion
NAD A	45 dB(A)	45 dB(A)	NAD K	43 dB(A)	55 dB(A)
NAD B	45 dB(A)	55 dB(A)	NAD L	45 dB(A)	55 dB(A)
NAD C	45 dB(A)	55 dB(A)	NAD M	45 dB(A)	55 dB(A)
NAD D	45 dB(A)	55 dB(A)	NAD N	43 dB(A)	55 dB(A)
NAD E	45 dB(A)	55 dB(A)	NAD O	44 dB(A)	45 dB(A)
NAD F	45 dB(A)	55 dB(A)	NAD P	43 dB(A)	45 dB(A)
NAD G	44 dB(A)	55 dB(A)	NAD Q	42 dB(A)	45 dB(A)
NAD H	55 dB(A)	55 dB(A)	NAD R	42 dB(A)	45 dB(A)
NAD I	48 dB(A)	55 dB(A)	NAD S	46 dB(A)	55 dB(A)
NAD J	50 dB(A)	55 dB(A)			

The predicted noise levels in Table 3 indicate that the noise from the full installation of one-hundred-and-forty-two frost control fans will achieve the relevant criteria at all nearby non-associated dwellings when operated as per the above recommendations.

A contour map has been provided as Appendix C of this report which shows the areas outside of which the relevant criteria will be achieved. It should be noted that as the 45 dB(A) contour is not relevant for all zones, it has only been shown in the areas in which it applies.

CONCLUSION

The noise from the proposed frost control fans has been predicted at the closest non-associated dwellings. The predictions have used the CONCAWE noise propagation model under weather conditions which correspond to a frost.

Appropriate noise criteria have been established with reference to the Griffith and Leeton Shire councils' policies for frost control fans.

Based on the predictions, the adopted criteria of 55 dB(A) for dwellings in the Primary Production Zone and 45 dB(A) for dwellings in the Village and Large Lot Residential zones will be achieved at all non-associated dwellings in the vicinity *when the installation consists of fourteen "2600" type fans, one-hundred-and-twenty-eight "2430" type fans, with twenty-eight fans not installed, all operated at normal speeds in the locations identified in this report.*

APPENDIX A: *Operation of the Orchard Rite Frost Control Fan*

During frost conditions, the ground temperature, and the temperature of air adjacent to the ground reduces to a temperature, which is lower than the temperature at a higher level. Frost control fans work by moving the warmer air at the higher level down to ground level.

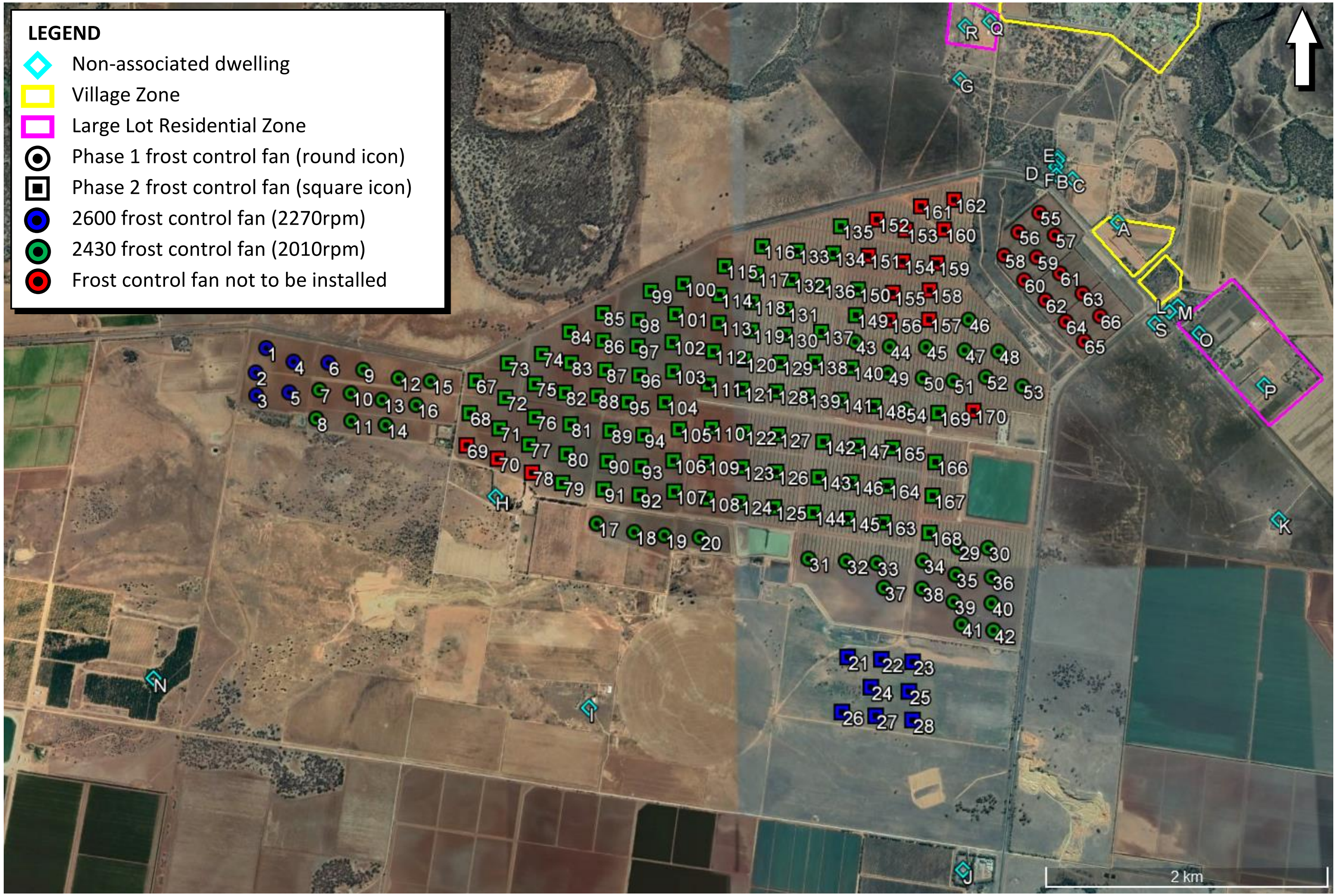
The Orchard Rite "2600" and "2430" frost control fans are powered by an engine that rotates two and three blades via a gear box, respectively. The gearbox and blades also rotate slowly to change the direction of the air movement. When the blades rotate, large volumes of the warmer air are moved to ground level. The blades are aerofoil in cross section to provide the most efficient operation and the ends of the blade are rectangular. Frost control fans are required to operate when the temperature reduces to below 0.5°C to protect the crop. This generally occurs in the early morning hours on a limited number of occasions.

The Orchard Rite frost control fans can be operated at different fan speeds resulting in different noise emission levels. When the fan speed is reduced, a lower noise level is produced. This assessment has considered the fans operating at normal speeds. Details of the fan speeds, associated motor speeds, and the resultant sound power levels are summarised in the table below.

Fan Type	Fan Speed	Motor Speed	Sound Power Level*
2600	549rpm	2270rpm	116dB(A)
2430	373rpm	2010rpm	108dB(A)

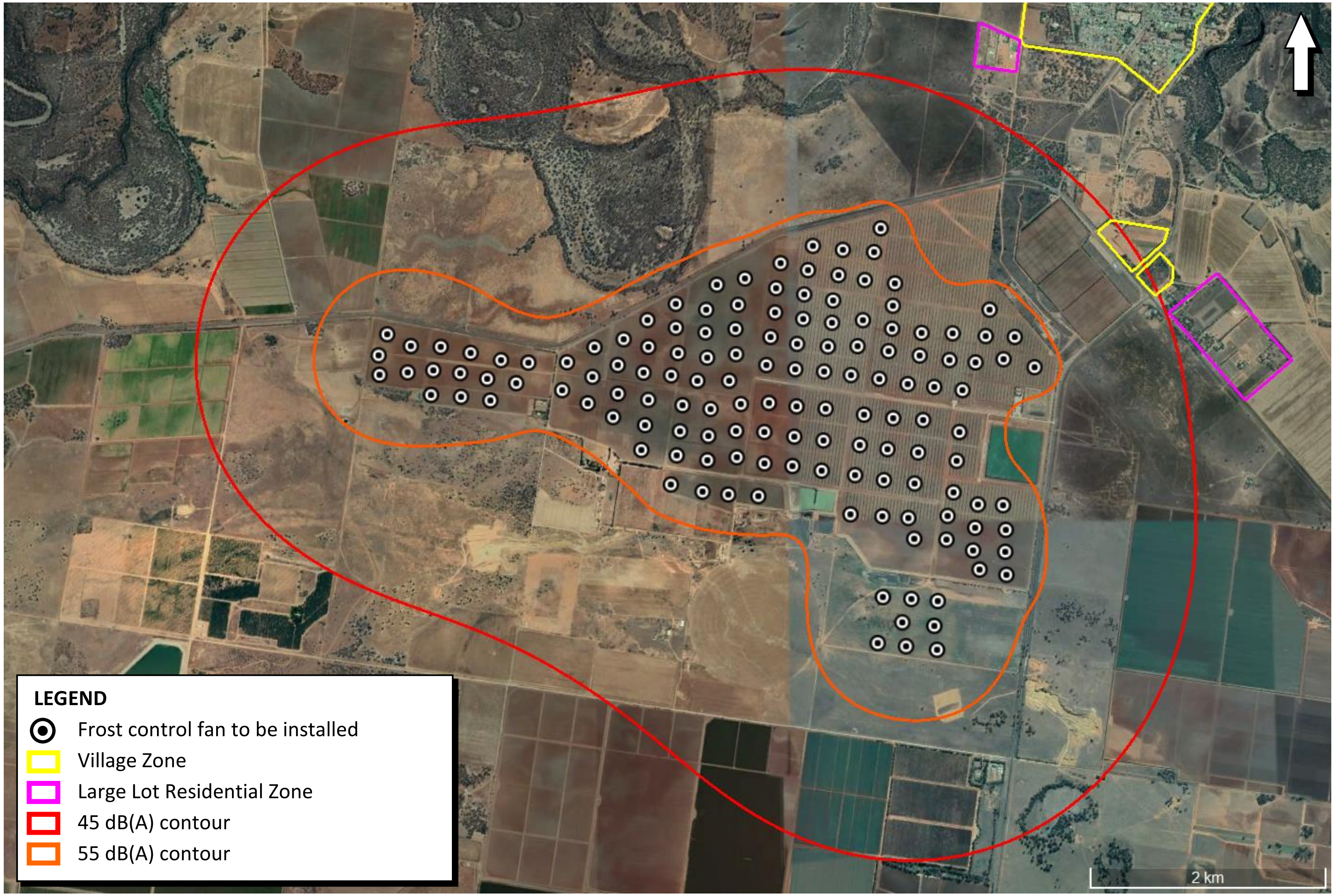
* Derived from the SSA and Sonus noise level measurements.

APPENDIX B: *Frost Control Fan Locations and Nearby Dwellings*



sonus.

APPENDIX C: *Frost Control Fan Noise Contours*



Annexure 7

Noise Test Reports

NOISE TEST REPORT – ORCHARD-RITE 2600

Submitted To:
Chris Coppock
Orchard-Rite Ltc., Inc.
1615 W Ahtanum Rd
Union Gap, WA 98909

Prepared By:
Steve Hedback
SSA Acoustics, LLP
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Seattle, WA 98109

January 22, 2020

DOCUMENT INFORMATION

FILE NAME: Noise Test Report – Orchard-Rite 2600 – November 2019

SSA PROJECT #: 19-7386

PREPARED BY: Steve Hedback, Acoustical Consultant,

SIGNED:

REVIEWED BY: Alan Burt, Acoustical Consultant,

DATE: January 22, 2020

I. INTRODUCTION

This report presents the results of the field measurements for the Orchard-Rite frost fan installed at the Valley Roz orchards in Yakima County, WA. The purpose of the study is to document the noise from the frost fan under specific environmental conditions at 25, 75, 150, and 300 meters from the frost fan. The following figure presents the location of the frost fan tested, the location of the measurements and the wind direction.

Figure 1: Frost Fan Location and Measurement Location

The nearest road was Kays road which is a primarily unpaved road past the orchard approximately 325 meters south of the monitoring location. Kays road is paved at the beginning of the orchard approximately 900 meters southeast of the measurement location. The nearest major arterial is Lateral A road approximately 5.75 Km east of the measurement location.

II. TEST CONDITIONS

The meteorological conditions were noted and measured during the 15-minute measurement period. These conditions consisted of the cloud cover, the wind speed, and the temperature.

Cloud Conditions – SKC (0 octas). There were no clouds during the measurement.

Wind Speed – Wind speed was recorded every minute during the 15-minute measurement period. The wind speed was measured 5 meters above ground so it was not obstructed by the trees. The wind speed was then converted to 10 meters above ground to be at the same height as the frost fan. The following figure presents the wind speed during the 15-minute measurement period.

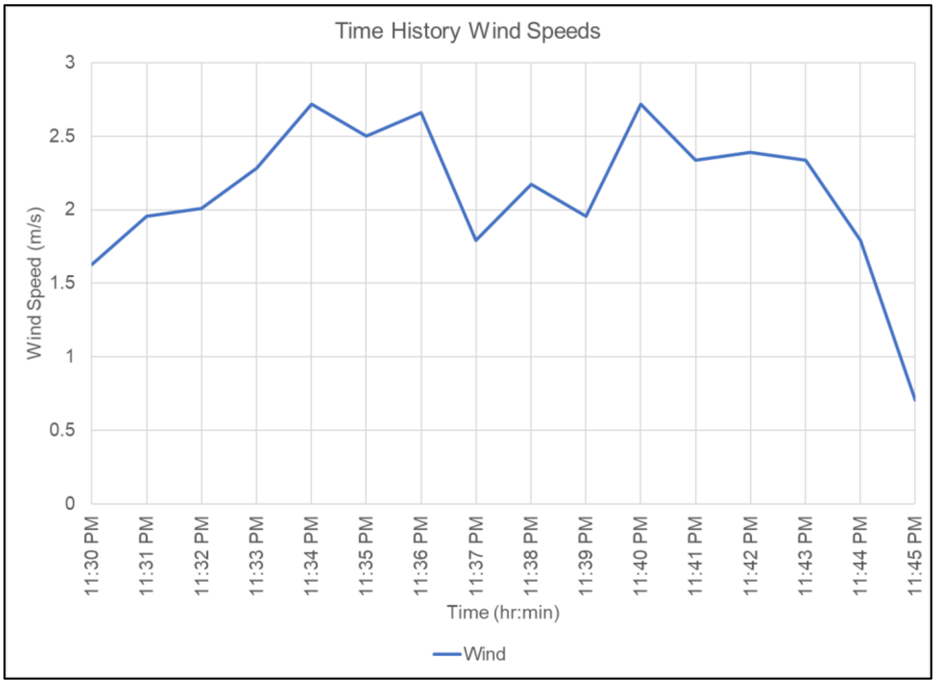


Figure 2: Time History Wind Speed during Measurement Period

Temperature – The temperature was recorded every minute during the measurement period. The temperature was measured at 1 meter above the ground. The following figure presents the temperature during the 15-minute measurement period.

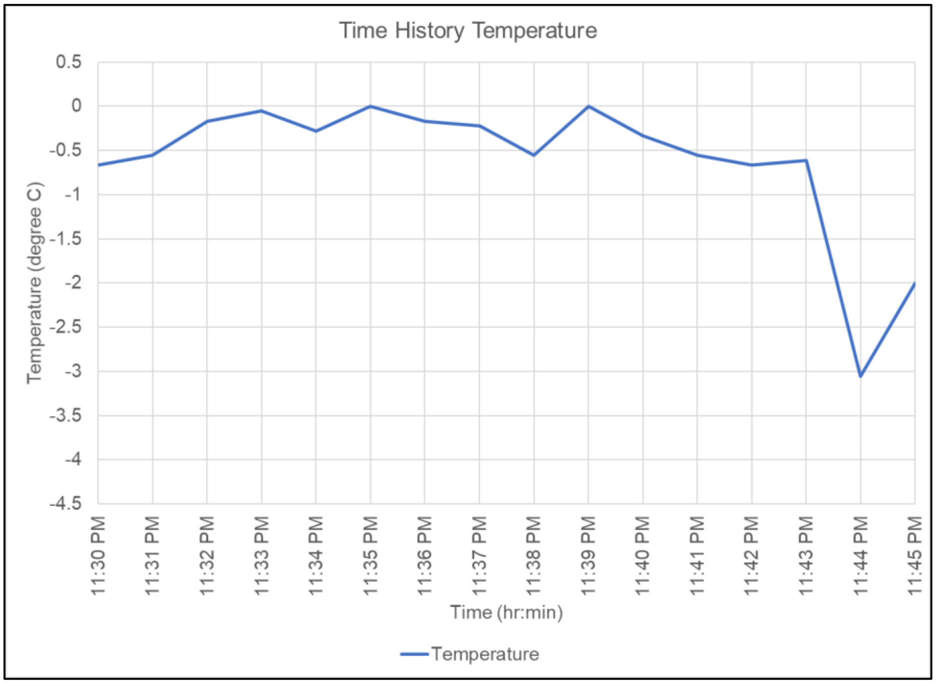


Figure 3: Time History Temperature during Measurement Period

Per NZS 6801:2008 appendix section B6, the meteorological conditions were compatible with those set out for Category 6 in Concawe, indicative of enhanced meteorological conditions.

The cherry trees within the orchard had no leaves. The ground had some leaf coverage but was primarily grass and dirt. The orchard was situated on a slight hill with the monitoring location slightly downhill from the frost fan.

The frost fan was the only noise source during the measurement.

The technical information for the frost fan tested is as follows:

Model:	Orchard-Rite 2600
Engine:	Ford V-10
Engine Cabinet:	Steel
Blade Type:	2600 2-blade
Blade Pitch:	8 degrees
Fan Diameter:	6 meters
Tower Height:	10.7 meters
Gear Ratio:	Bottom: 2.35:1
	Top: 2.05:1
Engine Speed:	2650 rpm
Fan Speed:	550 rpm

The equipment used for testing was as follows:

Distance	Make	Serial Number	Last Calibration Date
300m	Svantek 979 Type 1 Sound Level Meter	34077	10/21/2019
300m	Svantek SV 17 PreAmp	25299	10/21/2019
300m	G.R.A.S. 40AE	178248	10/21/2019
150m	Svantek 971 Type 1 Sound Level Meter	35728	1/30/2019
150m	Svantek SV 18 PreAmp	33468	1/30/2019
150m	7052E	56417	1/30/2019
75m	Svantek 971 Type 1 Sound Level Meter	56147	10/4/2019
75m	Svantek SV 18 PreAmp	57275	10/4/2019
75m	7052E	63856	10/4/2019
25m	Svantek 971 Type 1 Sound Level Meter	55573	1/30/2019
25m	Svantek SV 18 PreAmp	57266	1/30/2019
25m	7052E	63906	1/30/2019
n/a	Svantek sv 30A Calibrator	32509	10/21/2019

The microphone associated with the Svantek 979 was covered with a windscreen.

Each of the microphones and preamplifiers associated with the Svantek 971 were placed within a Svantek SA 271 outdoor microphone protection kit which includes a windscreen. The preamplifiers were connected to the sound level meters by a Svantek SC 91/05 5 meter cable.

Each of the sound level meters were calibrated to 114.0 dB at 1 kHz before testing commenced and the calibration was checked at the conclusion of testing to confirm performance.

The microphones were set at 1.2 meters above grade facing directly upward.

All measurements were undertaken in accordance with the requirements of NZS 6801:2008 Acoustics – Measurement of the Environmental Sound and assessed in accordance with the requirements of NZS 6802:2008 Acoustics – Environmental Noise.

III. TEST RESULTS

The 15-minute measurements at distances of 300m, 150m, 75m, and 25m from the frost fan were taken starting at 11:30 pm on November 21, 2019.

The time history noise levels at 300m during the measurement period are presented in figure 4. The measured 1/3 octave band spectral noise levels at 300m are presented in figure 5.

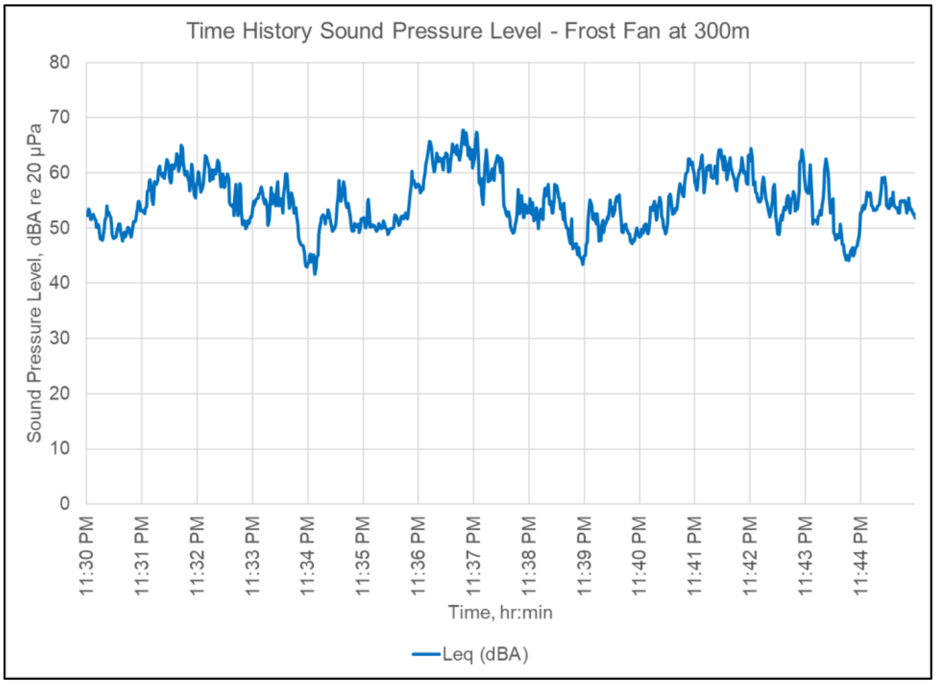


Figure 4: Time History Noise Leve of Frost Fan at 300m

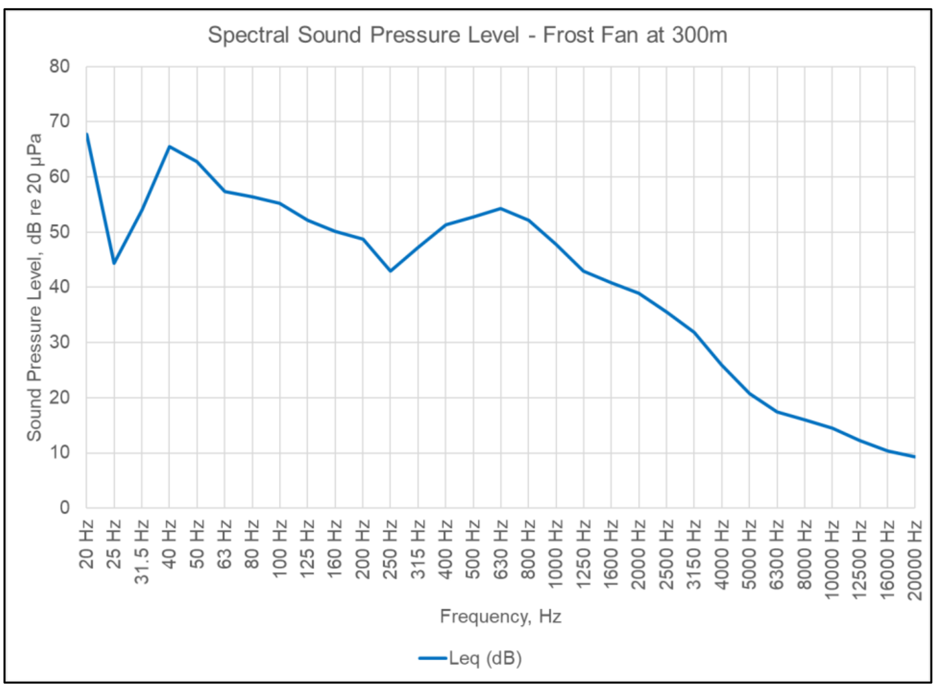


Figure 5: 1/3 Octave Band Spectral Noise Levels at 300m

The time history noise levels at 150m during the measurement period are presented in figure 6. The measured 1/3 octave band spectral noise levels at 150m are presented in figure 7.

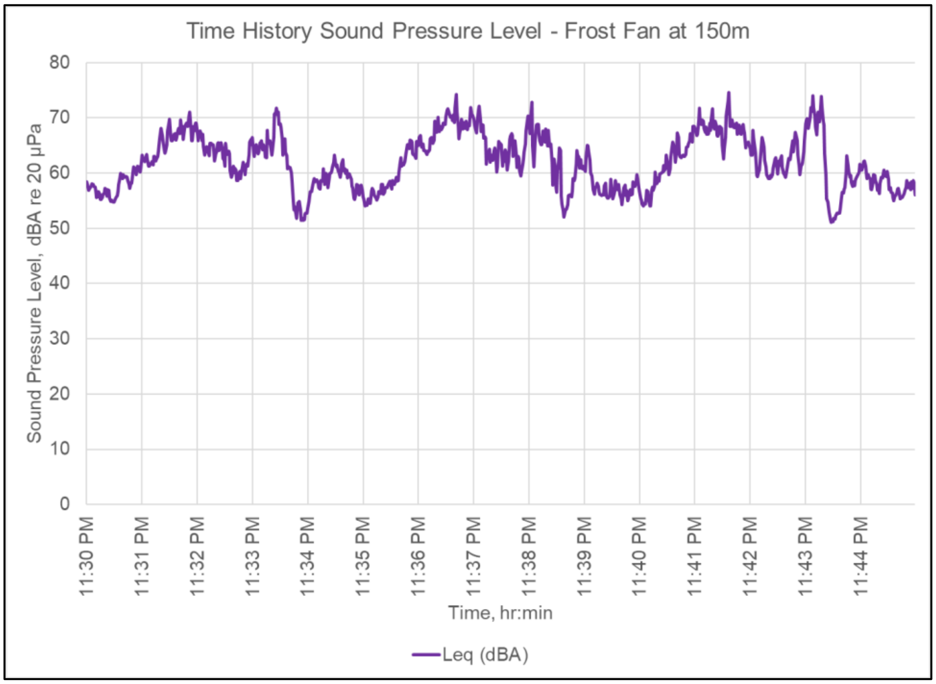


Figure 6: Time History Noise Level of Frost Fan at 150m

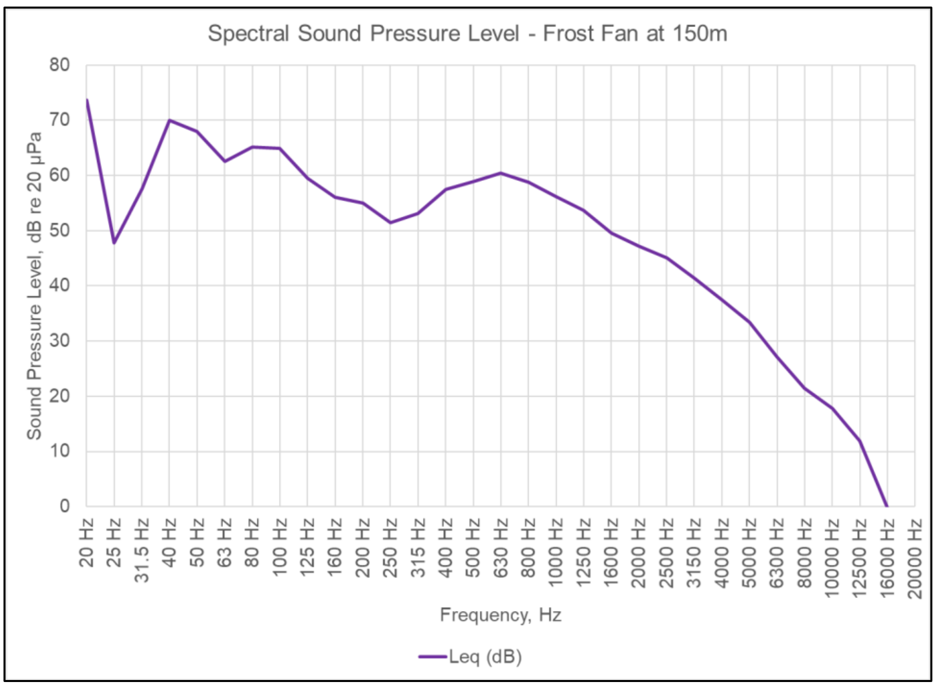


Figure 7: 1/3 Octave Band Spectral Noise Levels at 150m

The time history noise levels at 75m during the measurement period are presented in figure 8. The measured 1/3 octave band spectral noise levels at 75m are presented in figure 9.

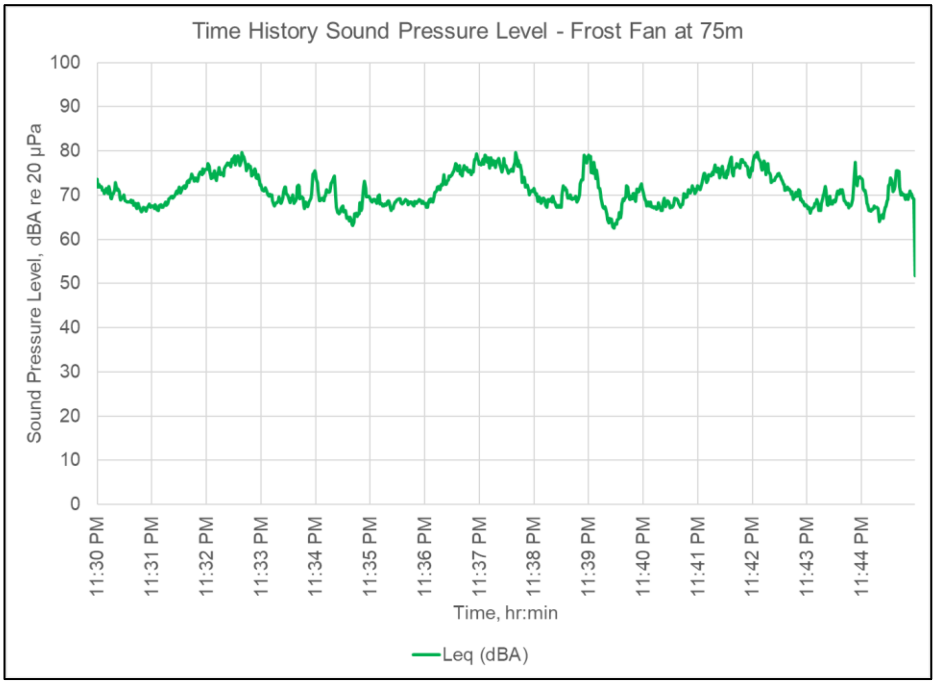


Figure 8: Time History Noise Level of Frost Fan at 75m

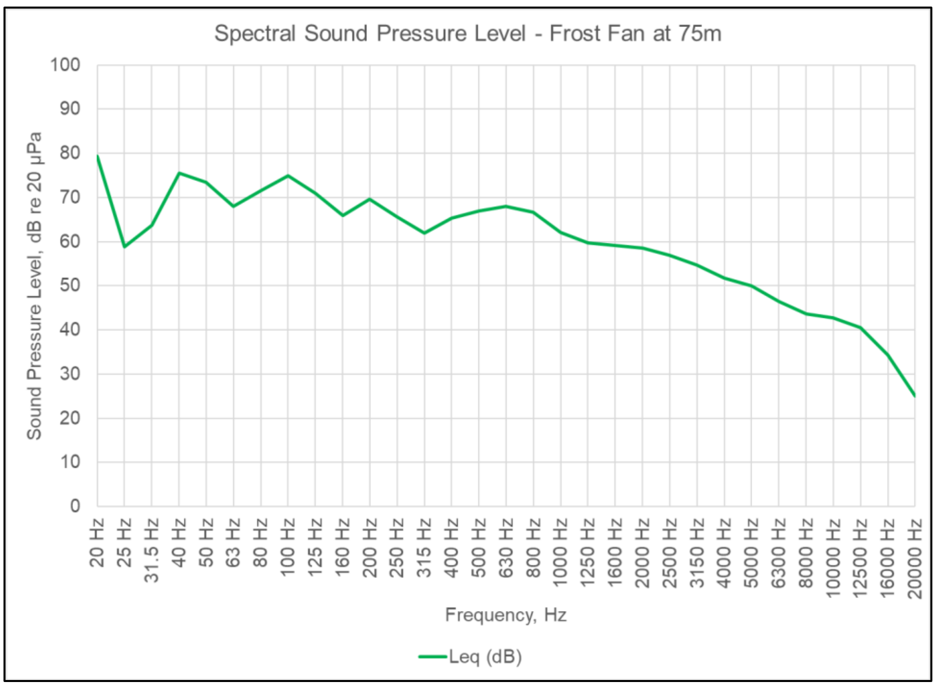


Figure 9: 1/3 Octave Band Spectral Noise Levels at 75m

The time history noise levels at 25m during the measurement period are presented in figure 10. The measured 1/3 octave band spectral noise levels at 25m are presented in figure 11.

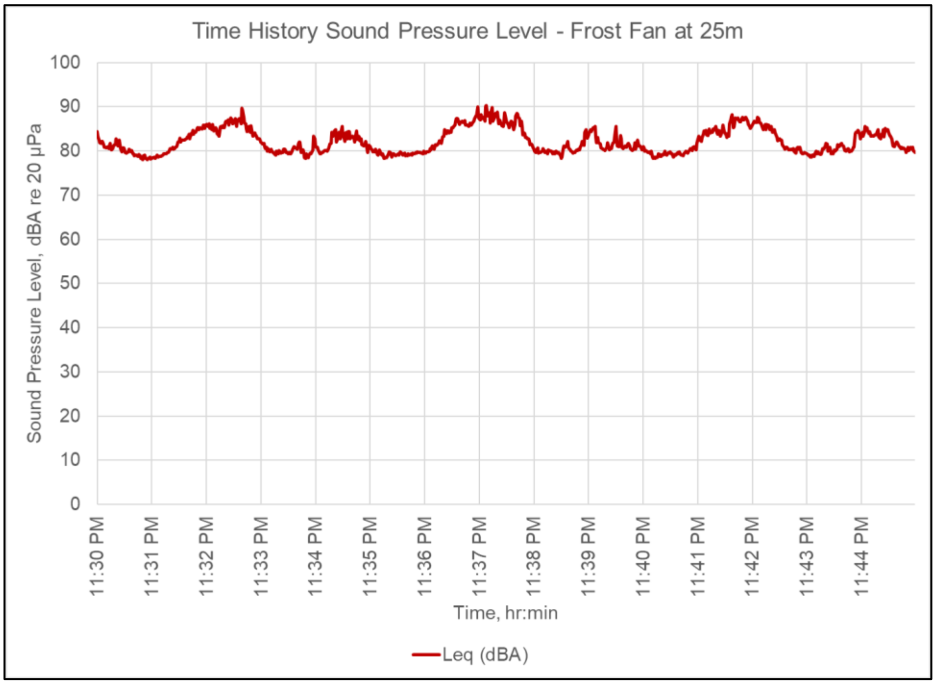


Figure 10: Time History Noise Level of Frost Fan at 25m

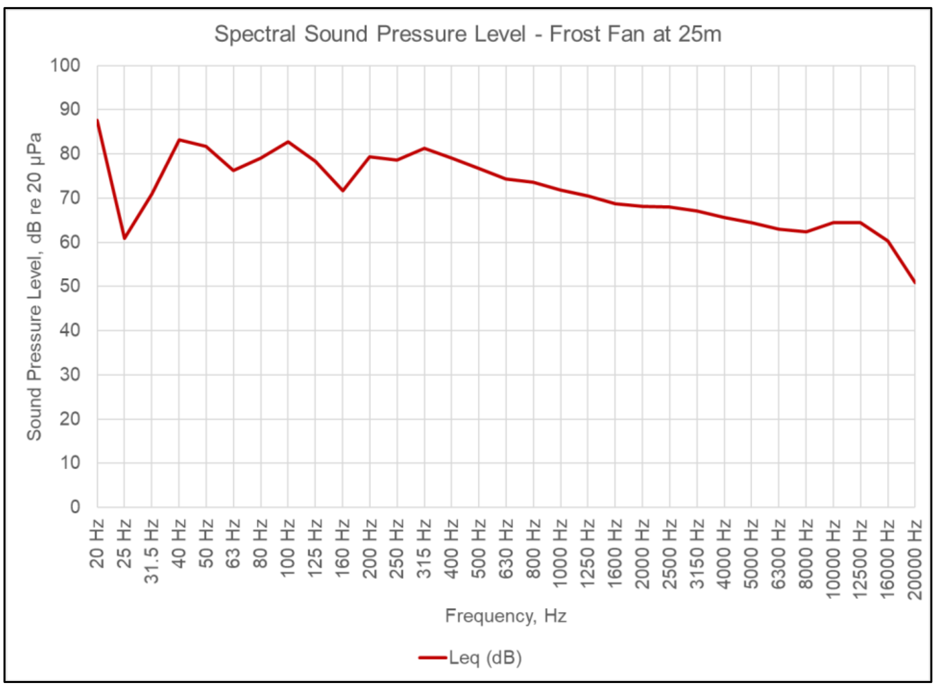


Figure 11: 1/3 Octave Band Spectral Noise Levels at 25m

The measured sound level of the frost fan at 300 meters was 58 dB $L_{Aeq(15\ min)}$.

The measured sound level of the frost fan at 150 meters was 65 dB $L_{Aeq(15\ min)}$.

The measured sound level of the frost fan at 75 meters was 73 dB $L_{Aeq(15\ min)}$.

The measured sound level of the frost fan at 25 meters was 83 dB $L_{Aeq(15\ min)}$.

Tonal Characteristic Test

According to NZS 6802:2008 Appendix B4:

> A test for the presence of a prominent discrete-frequency spectral component (tonality) can be made by comparing the levels of neighboring one-third octave bands in the sound spectrum. An adjustment for tonality shall be applied if the LEQ in a one-third-octave band exceeds the arithmetic mean of the LEQ in both adjacent bands by more than the values given in table B2.

Table B2 - One-third octave band level differences

One-third octave band	Level difference
25 - 125 Hz	15 dB
160 - 400 Hz	8 dB
500 - 10000 Hz	5 dB

None of the values exceed the levels defined in Table B2. Therefore no adjustments for tonality shall be applied to the measured level.

IV. CONCLUSION

The measured sound level of the frost fan at 300 meters was 58 dB $L_{Aeq(15\ min)}$.

The measured sound level of the frost fan at 150 meters was 65 dB $L_{Aeq(15\ min)}$.

The measured sound level of the frost fan at 75 meters was 73 dB $L_{Aeq(15\ min)}$.

The measured sound level of the frost fan at 25 meters was 83 dB $L_{Aeq(15\ min)}$.

Please contact us if you have any questions or require further information.

Orchard Rite Frost Fans Noise Test

Submitted to:

Orchard Rite
1615 W Ahtanum Rd
Union Gap, WA 98903

Document Information

FILE:	Orchard Rite Frost Fans
PROJECT #:	18-7090
PREPARED BY:	Steve Hedback Alan Burt, P.E.
SIGNED:	
DATE:	February 12, 2019

I. Introduction

This report presents the results of the field measurements for the Orchard Rite frost fan installed at the Valley Roz orchards in Yakima County, WA. The purpose of the study is to document the noise from the frost fans under specific environmental conditions at 300 meters from the frost fans. The following figure presents the location of the frost fan tested, the location of the measurement, and the wind direction.

Figure 1: Frost Fan Location and Measurement Location

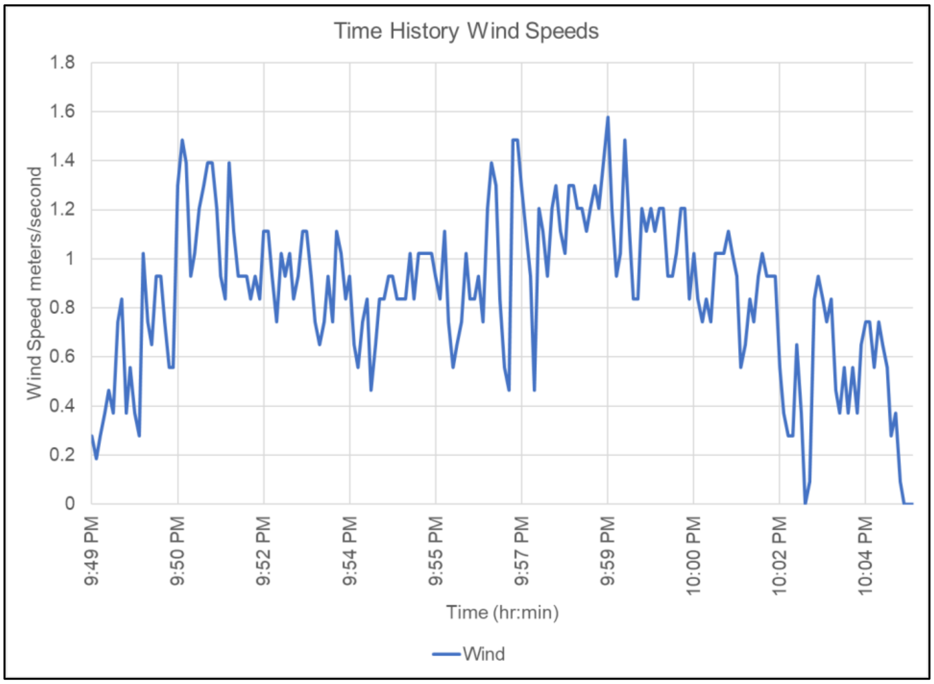
The nearest road was Kays road which is an unpaved road past the orchard approximately 325 meters south of the monitoring location. Kays road is paved at the beginning of the orchard approximately 900 meters southeast of the measurement location. The nearest major arterial is Lateral A road approximately 5.75 Km east of the measurement location.

II. Test Conditions

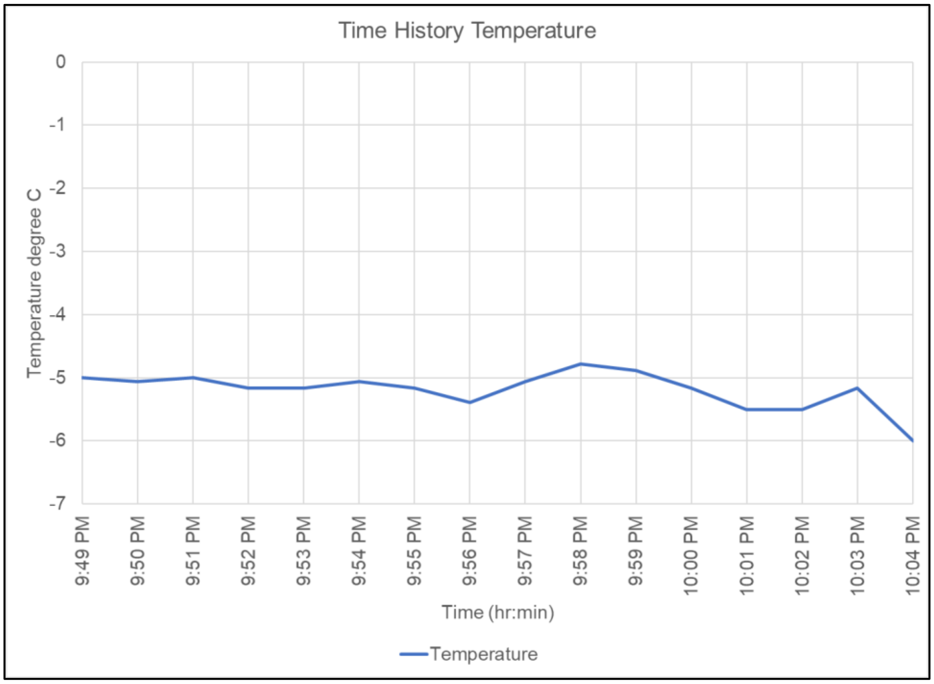
The meteorological conditions were noted and measured during the 15-minute measurement period. These conditions consisted of the cloud cover, the wind speed, and the temperature.

Cloud Conditions – FEW (1-2 octas). There were a few clouds in the sky but mostly clear.

Wind Speed – Wind speed was recorded every 5 seconds during the 15-minute measurement period. The wind speed was measured 5 meters above ground so it was not obstructed by the trees. The wind speed was then converted to 10 meters above ground to be at the same height as the frost fan. The following figure presents the wind speed during the 15-minute measurement period.



Temperature – The temperature was recorded every minute during the measurement period. The temperature was measured at 1 meter above the ground. The following figure presents the temperature during the 15-minute measurement period.



Per NZS 6801:2008 appendix section B6, the meteorological conditions were compatible with those set out for Category 6 in Concawe, indicative of enhanced meteorological conditions.

The cherry trees within the orchard were bare of leaves. The ground had some leaf coverage but was primarily grass and dirt. The orchard was situated on a slight hill with the monitoring location slightly downhill from the frost fan.

The frost fan was the only noise source during the measurement.

The technical information for the frost fan tested is as follows:

Model:	Orchard-Rite 2430
Engine:	Ford V-10
Engine Cabinet:	Stainless Steel
Blade Type:	2430 tri blade
Blade Pitch:	11 degrees
Fan Diameter:	6 meters
Tower Height:	10.7 meters
Gear Ratio:	Bottom: 2.63:1
	Top: 2.05:1
Engine Speed:	2010 rpm
Fan Speed:	373 rpm

The equipment used for testing was as follows:

Make	Serial Number	Last Calibration Date
Svantek 979 Type 1 Sound Level Meter	34077	10/9/2018
Svantek SV 17 PreAmp	25299	10/9/2018
G.R.A.S. 40AE	178248	10/9/2018
Svantek sv 30A Calibrator	32509	10/9/2018

The Svantek 979 Sound Level Meter was calibrated to 114.0 dB at 1 kHz before testing commenced and the calibration was checked at the conclusion of testing to confirm performance.

The microphone was set at 1.2 meters above grade facing directly upward.

All measurements were undertaken in accordance with the requirements of NZS 6801:2008 Acoustics – Measurement of the Environmental Sound and assessed in accordance with the requirements of NZS 6802:2008 Acoustics – Environmental Noise.

III. Test Results

The 15-minute measurement were taken starting at 9:49 pm on December 4, 2018. The time history noise levels during the measurement period are presented in figure 2. The measured 1/3 octave band spectral noise levels are presented in figure 3.

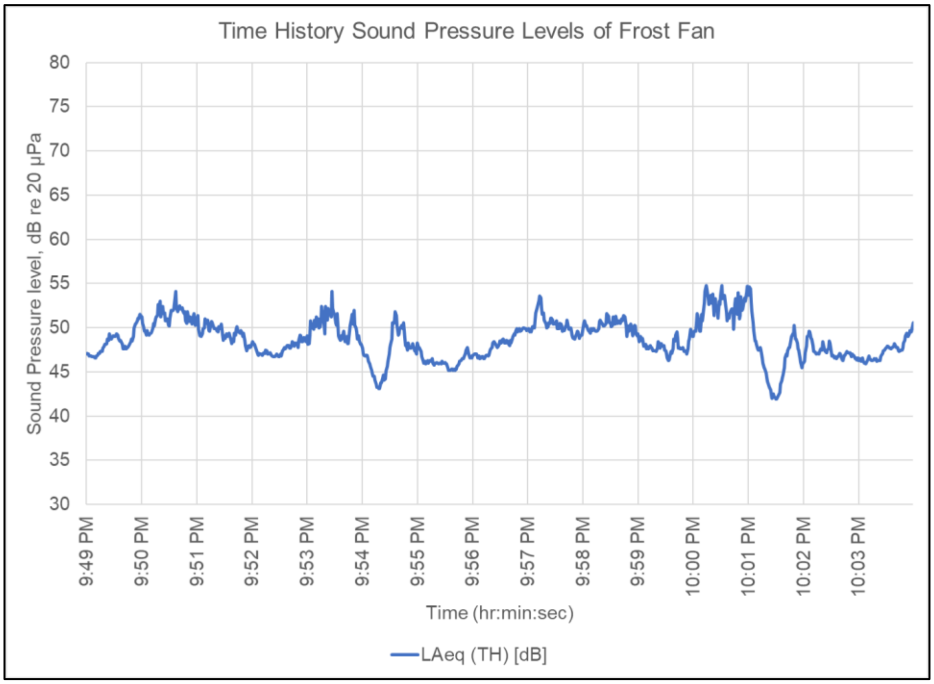


Figure 2: Time History Noise Level of Frost Fan

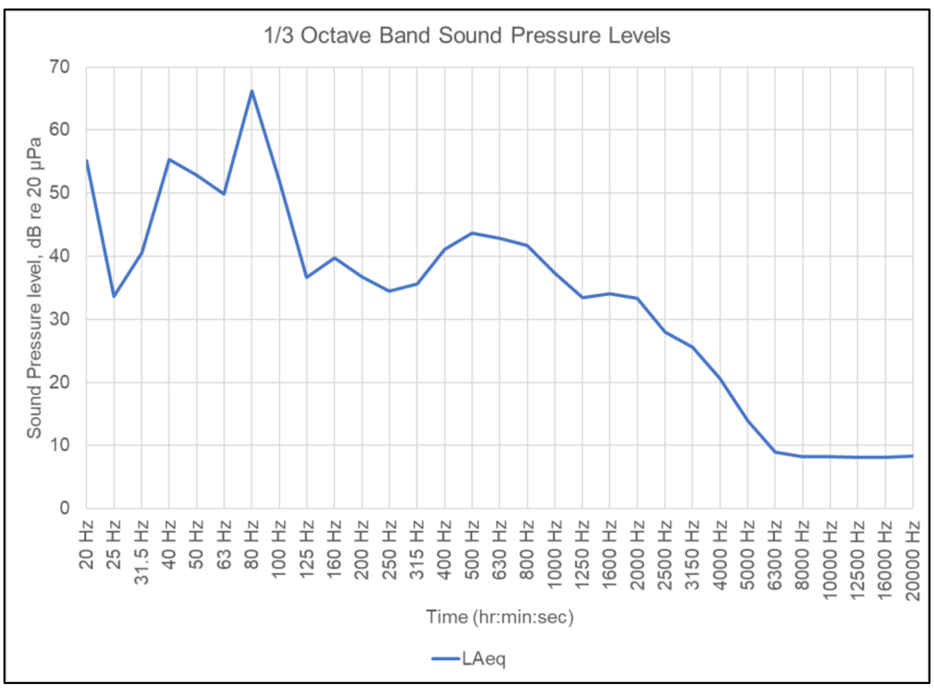


Figure 3: 1/3 Octave Band Spectral Noise Levels

The measured sound level of the frost fan at 300 meters was 49 dB $L_{Aeq(15\ min)}$.

Tonal Characteristic Test

According to NZS 6802:2008 Appendix B4:

> A test for the presence of a prominent discrete-frequency spectral component (tonality) can be made by comparing the levels of neighboring one-third octave bands in the sound spectrum. An adjustment for tonality shall be applied if the LEQ in a one-third-octave band exceeds the arithmetic mean of the LEQ in both adjacent bands by more than the values given in table B2.

Table B2 - One-third octave band level differences

One-third octave band	Level difference
25 - 125 Hz	15 dB
160 - 400 Hz	8 dB
500 - 10000 Hz	5 dB

None of the values exceed the levels defined in Table B2. Therefore no adjustments for tonality shall be applied to the measured level.

IV. Conclusion

The measured sound level from the frost fan at 300 meters was 49 dB $L_{Aeq(15\ min)}$.

Based on our calculations, the noise level from the frost fan would be 55 dB $L_{Aeq(15\ min)}$ at a distance of 150 meters from the fan.

Please contact us if you have any questions or require further information.