Macorna Wind Farm

Technical Assessment
& Potential Agricultural Impact

For

Atmos Renewables

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1 Executive Summary

This report provides an assessment of the potential agricultural impacts associated with the proposed Macorna Wind Farm development across approximately 23,000 hectares of predominantly agricultural land in northern Victoria. The Project spans approximately 26 landholder properties and includes the installation of 114 wind turbines and associated infrastructure.

The total estimated disturbance footprint during construction is approximately 745 hectares, including 78.1 hectares of benched areas and other temporary works. Up to 406 hectares may be rehabilitated and returned to agricultural production following construction, subject to any additional detailed design requirements and approval conditions. The long-term operational footprint is estimated at approximately 338 hectares, representing around 1.5% of the total project area.

Agricultural Context

The project area is characterised by a dry to semi-arid climate, with annual rainfall ranging from approximately 350 - 374 mm and high evaporation rates (~1,550 mm), resulting in a relatively short natural growing season.

Land use is diverse and includes:

- Beef and sheep grazing
- Broadacre cropping (cereals, canola and lucerne)
- Dairy production
- Piggery operations

The Project Area lies within the Torrumbarry and Loddon Valley irrigation districts. While a larger proportion of land is irrigatable at a regional scale, site-specific assessment indicates ~30% of the Project Area is currently irrigated, ~25% of the land is infrequently irrigated, ~30% of the land is no longer irrigated after having irrigation infrastructure either removed or decommissioned, and ~10% of the land has never been irrigated. The changes in irrigation are largely due to water availability and cost constraints. Irrigation is undertaken via flood irrigation systems, which rely on uniform paddock grading and uninterrupted water flow.

The dominant soils (Macorna and Kerang clays) are heavy cracking clays with low permeability and prone to salinity, requiring careful management. Towangurr clays occur along drainage lines and are generally less suitable for irrigation but present lower agricultural impact when used for infrastructure siting.

Key Potential Agricultural Impacts

During construction:

- Temporary loss of production due to infrastructure footprint (~745 ha)
- Severance of paddocks and restricted access to farm infrastructure
- Disruption to irrigation systems and farm operations
- Temporary removal or disturbance of capital improvements (e.g. fencing, channels, drainage)
- Biosecurity risks associated with machinery and soil movement

Post-construction (operation):

- Permanent loss of productive land within the operational footprint (~338 hectares)
- Ongoing but localised inefficiencies due to paddock fragmentation
- Potential impacts on irrigation layouts where infrastructure intersects irrigation systems

Mitigation Measures

Key mitigation measures to minimise agricultural impacts include:

- Continued landholder consultation to refine turbine siting and avoid high-value irrigated land where practicable
- Alignment of access tracks with existing laneways and fence lines
- Maintenance or redesign of irrigation systems to preserve water flow and functionality
- Construction scheduling to avoid critical farming periods (e.g. calving, sowing, harvest)
- Maintenance of farm access to key infrastructure throughout construction
- Implementation of strict soil management protocols, including segregation and replacement of soil horizons
- Drainage reinstatement in irrigated paddocks
- Comprehensive rehabilitation program to restore land capability

The quality of rehabilitation is critical, particularly in maintaining soil structure and irrigation performance.

Economic Impact

A gross margin analysis indicates:

- Estimated annual agricultural production across the Project Area: ~$18.1 million
- Estimated annual gross margin loss:
    - Construction phase: approximately $537,928
    - Operational phase: approximately $220,092
    - This represents an estimated reduction of approximately 1.21% of total agricultural production across the Project Area.

These are potential overestimates assuming that the affected land is fully removed from production and does not account for mitigation measures, land management adjustments, or income from turbine hosting agreements. Income for hosting each turbine is in order of $40,000 - $50,000 per annum, which equates to $4,560,000 - $5,700,000 annually across the Project Area. This is between 20 – 25 times greater than the proposed losses during operation, and essentially negates the perceived agricultural production monetary losses.

Regional Significance

At a broader regional scale (ABS SA4 North West and Bendigo regions), the Project is estimated to impact:

- Approximately 0.278% of agricultural activity during construction
- Approximately 0.110% during operation

These impacts are considered minor at a regional level, nevertheless potential impacts at the local level should be minimised through site-specific management measures.

Overall Conclusion

The proposed Macorna Wind Farm is expected to coexist with ongoing agricultural production, provided that:

- Infrastructure is carefully sited
- Construction is appropriately managed
- Rehabilitation is undertaken to a high standard

Most agricultural impacts are localised, temporary, and manageable, particularly where proactive planning and landholder engagement are maintained.

Protecting irrigated land, maintaining farm access, and restoring soil and irrigation functionality are critical to minimising long-term impacts on agricultural productivity.

2 Introduction

This report provides an assessment of the potential agricultural impacts associated with the proposed Macorna Wind Farm development located within the Gannawarra and Loddon Shire regions of Victoria. The Project involves the installation of wind turbine generators and associated infrastructure across predominantly agricultural land.

The proposed Macorna Wind Farm covers a project area of ~23,000 hectares with ~26 landholder properties, and 114 wind turbine generators proposed. The development of the proposed Wind Farm includes various other works including underground cables and overhead transmission lines, up to four collector substations and Battery Energy Storage Systems (BESS). This report includes an assessment of the turbine construction and associated infrastructure, as well as remediation management for any potential trenching works for underground low voltage cables.

The proposed construction footprint of the Macorna Wind Farm is estimated to cover ~745 ha, which includes ~407 ha of temporary construction areas, which may be rehabilitated for the purpose of agriculture, pending detailed design and planning approval requirements. This equates to an operational footprint of ~338 ha across the district, or 1.5% of the Project Area.

Ag-Challenge Consulting Pty Ltd has been engaged as an independent agricultural consultant to undertake a preliminary technical assessment and provide expert input regarding potential agricultural impacts. This report includes an estimate of the cost of disturbance to rural landowners. The report also includes measures that can be put in place to minimise the potential for disturbance and agricultural loss.

3 Methodology

The methodology undertaken for this Agricultural Assessment included first a desktop assessment, with data available specific to the project area including relevant guidelines and standards, and in relation to the wider Region and irrigations district.

Data referenced in this report and used during the desktop review is included below:

Data or Information Source	**Link and/or Source**
Murray Darling Basin Authority - Irrigated crop area data for the Lower Murray-Darling 2003 to 2024, June 2025.	https://www.nccma.vic.gov.au/media/documents/loddon_campaspe_irrigation_region_land_water_management_plan_summary.pdf
Irrigated crop area data for the Lower Murray-Darling 2003 to 2024, June 2025. Murray Darling Basin Authority.	https://www.mdba.gov.au/publications-and-data/publications/irrigation-area-mapping-murray-and-lower-darling-rivers
Goulburn Broken CMA – Region Maps, Land Health Strategy	https://www.gbcma.vic.gov.au/our-region/land_and_biodiversity/land_health
North Central Regional Catchment Strategy, Vision: Healthy landscapes and	https://northcentral.rcs.vic.gov.au/themes/land/

soil managed for the future, Section: Land Use Change,	
Dairy Australia: Dairy Farm Monitor Project – Northern Victoria	https://agriculture.vic.gov.au/about/agriculture-in-victoria/dairy-farm-monitor-project
Agriculture Victoria (Livestock Farm Monitor Project)	https://agriculture.vic.gov.au/about/agriculture-in-victoria/livestock-farm-monitor-project
Ag-Commodity Prices	agprice.sfs.org.au
Agriculture Victoria	https://www.agriculture.gov.au/abares/data/weekly-commodity-price-update/australian-agricultural-prices
Australian Pork Limited	National Environmental Guidelines for Indoor Piggeries, 2018, Table 12.4
Agriculture Victoria, Economic Effects of water recovery in the Murray-Darling Basin	https://www.agriculture.gov.au/abares/products/insights/economic-effects-of-water-recovery-in-murray-darling-basin#increases-in-water-prices-can-have-complex-flowon-effects.
Sargeant, I, Sargeant, J. (2005) Sustainable soil management: a reference manual to the major agricultural soils of the Bairnsdale and Dargo regions. Department of Primary Industries, Melbourne.	Accessed from Victorian Resources Online
Loddon Campaspe Irrigation Region Land Management Plan Summary	https://www.nccma.vic.gov.au/media/documents/loddon_campaspe_irrigation_region_land_water_management_plan_summary.pdf
Goulburn-Murray Water – Irrigation Districts	https://www.g-mwater.com.au/downloads/gmw/MTR/TATDOC-_4079268-v1-fact_sheet_-_GMID_-_november_2015.PDF
ABS – SA4 North West region and Bendigo Region	https://maps.abs.gov.au/
Climate Data from Australian Government Bureau of Meteorology (Evaporation and Rainfall Data)	https://www.bom.gov.au/climate/data/

Additionally, a site visit was undertaken by Ag-Challenge Consulting on the 29th October 2025 involving:

- Ground truthing the high-level mapping

- Observations on agricultural enterprises, land-use, soil types, irrigation infrastructure, general perceived productivity

- Interviewing involved landowners on turbine siting impacts, enterprise operations and productivity, general regional trends, other foreseen impacts and mitigation strategies with significant focus on irrigation.

4 Agricultural Context of the Macorna Wind Farm

4.1 Climate

The climate in the Project Area is dry to arid with annual rainfall of almost 350 mm at the southern end near Loddon Vale, with a slight increase at the northern end near Kerang to 374 mm. These two areas have similar annual evaporation rates of 1,558 and 1,543 mm, respectively. This results in very similar pasture and crop growing seasons across the Project Area, with excess rainfall above plant evapotranspiration requirements only occurring in June and July in an average year. Given these similarities the Project Area has been assumed as one climate zone.

4.2 Land Use

The Project Area is predominantly within Loddon Vale to Kerang and predominantly within farmland used for grazing livestock (sheep and beef cattle), dairy production and broadacre cropping (cereals, canola and lucerne). There are three piggeries, and a few lifestyle/residential properties mainly confined to the centre of Macorna.

Most of the properties are farmed as a combination of irrigated livestock grazing and/or broadacre cropping. Cattle (both beef and dairy) are the most common form of livestock. There is a mix of wheat, barley, canola and lucerne where broadacre cropping is undertaken.

The whole Project Area is located within declared irrigation districts. The properties to the north of the Macorna channel are within the declared irrigation district of Torrumbarry, while the properties to the south are within the Loddon Valley irrigation district.

The photos in Figure 1 taken from the site visit on the 29/10/2025 show typical cropping and grazing within the irrigation district, not being currently irrigated.

Figure 1. Photos taken during site visit of typical "dryland" cropping and grazing within the irrigation district, not being currently irrigated.

4.3 Mapping

High level mapping published by Goulburn Murray Water for the Victorian Mid-Murray Area[1] in the 2023/24 season was extrapolated. The Project Area has been best represented as Area 7A, as mapped by Goulburn-Murray Water, which spans from as far south as Torrumbarry and as far north as Murrabit.

In 2024 within Area 7A, 58,770 ha of seasonal summer and winter crops (field crops including pasture and fodder crops) was irrigated, with 35,585 ha of seasonal irrigatable land left vacant and unirrigated[2]. This is similar to 2021, when 58,420 ha was irrigated, while 35,880 ha was left vacant and unirrigated. This equates to 62% of the irrigatable land being readily irrigated for seasonal summer and winter crops. As this is high level mapping assessed from aerial imagery and includes areas outside of the Project Area additional information was required, to ground truth this data.

4.4 Irrigation

During our site visit, we were introduced to involved landholders with Atmos, to determine the extent of irrigated land occurring across the Wind Farm Project Area.

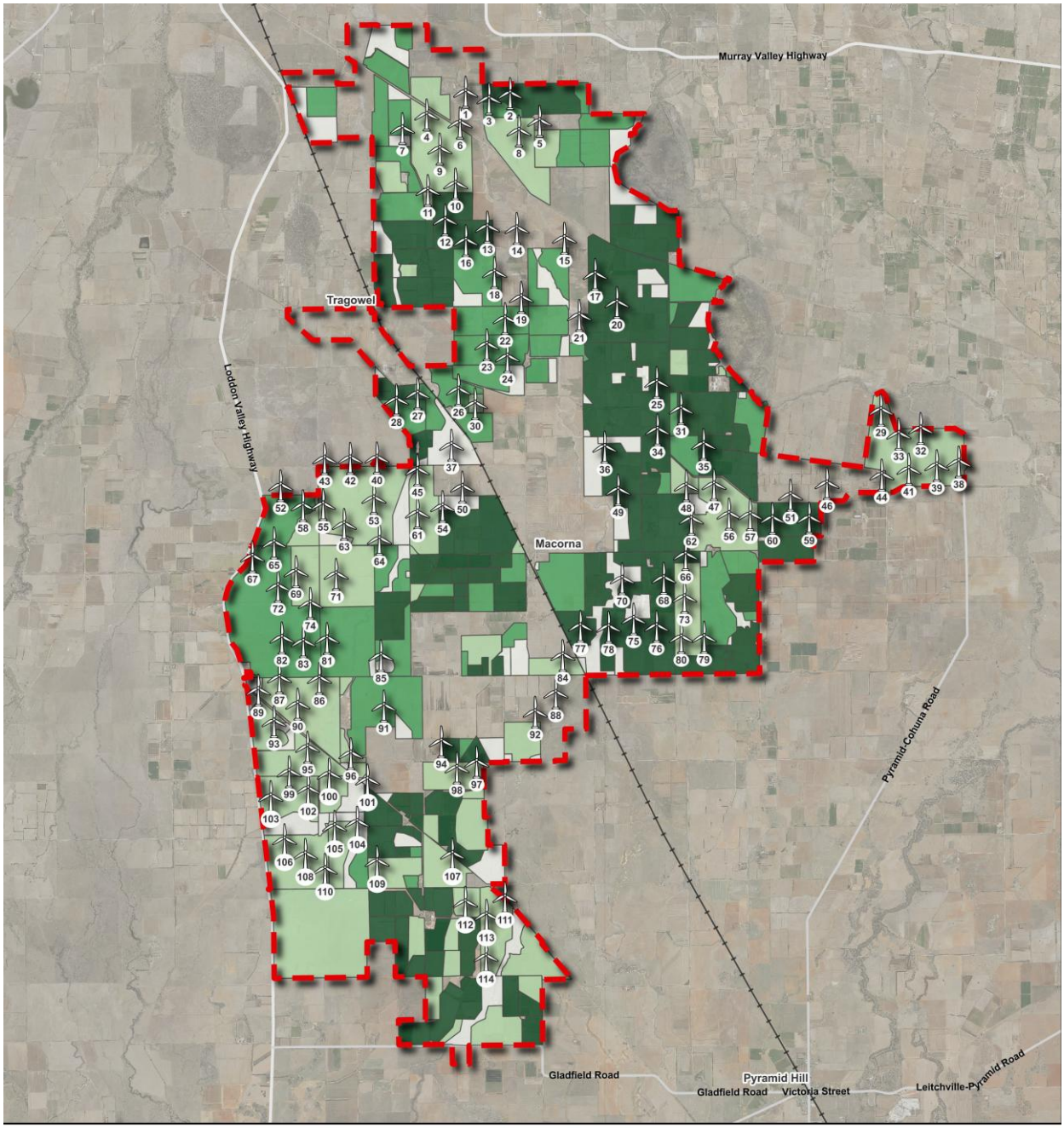
The landholders estimated that irrigation currently occurs on approximately 20-30% of the total area within the declared irrigation districts of Torrumbarry and the Loddon Valley. This represents a long-term decline, driven largely by supply and demand pressures within the Goulburn - Murray Irrigation System, which have contributed to rising water costs. Across the North Central Region, irrigation has decreased by around 50% since the 1990s, reflecting broader influences such as prolonged drought, evolving water policies, irrigation modernisation, and the transfer of water entitlements out of the region.[3]

Analysis of the 2025 aerial imagery across the Project Area, alongside information gained from the site visit, with landholder information, and ground truthing data provided by Atmos (see Figure 2), shows that ~30% of the land within the Project Area is currently irrigated. This percentage will potentially fluctuate depending on seasonality, availability and cost of water. Additionally, ~25% of the land within the Project Area is irrigated infrequently, pending water allocations, seasonal factors, financial merit, and/or other factors. The remaining ~30 and ~10% of land respectively is now considered dryland, either from historical irrigation infrastructure, which has now been removed/decommissioned or areas which have never been irrigated.

This information has been relied on for the remainder of the report.

[1] Murray Darling Basin Authority - Irrigated crop area data for the Lower Murray-Darling 2003 to 2024, June 2025.
[2] Irrigated crop area data for the Lower Murray-Darling 2003 to 2024, June 2025. Murray Darling Basin Authority, Figure 30, p. 63.
[3] North Central Regional Catchment Strategy, Vision: Healthy landscapes and soil managed for the future, Section: Land Use Change, accessed from <https://northcentral.rcs.vic.gov.au/themes/land/>

Figure 2. Irrigation Categories of the Project Area with the turbine layout



A substantial proportion of land with irrigation potential is currently used for dryland farming or left in fallow, primarily due to the cost of the water.[4] Based on conversations with landowners in the district, areas that have been historically irrigated but are no longer irrigated are to remain as dryland farming moving forward. There is also a general trend of further reduction in total irrigation in the area due to the linking of water use and delivery licenses with land. As water use and delivery licences are tied to land, additional land is purchased outside of the home farm area, the water licence is then shifted from the newly purchased land to the home farm, to allow for additional irrigation at home. This increases the quantity of irrigation on the home farm while the purchased land becomes dryland or vacant country. This is commonly a function of the desire to 'fully-irrigate' a home area, to enable growing of perennial or high water use crops, such as lucerne or maize, by watering through the summer and autumn period, until adequate rainfall occurs.

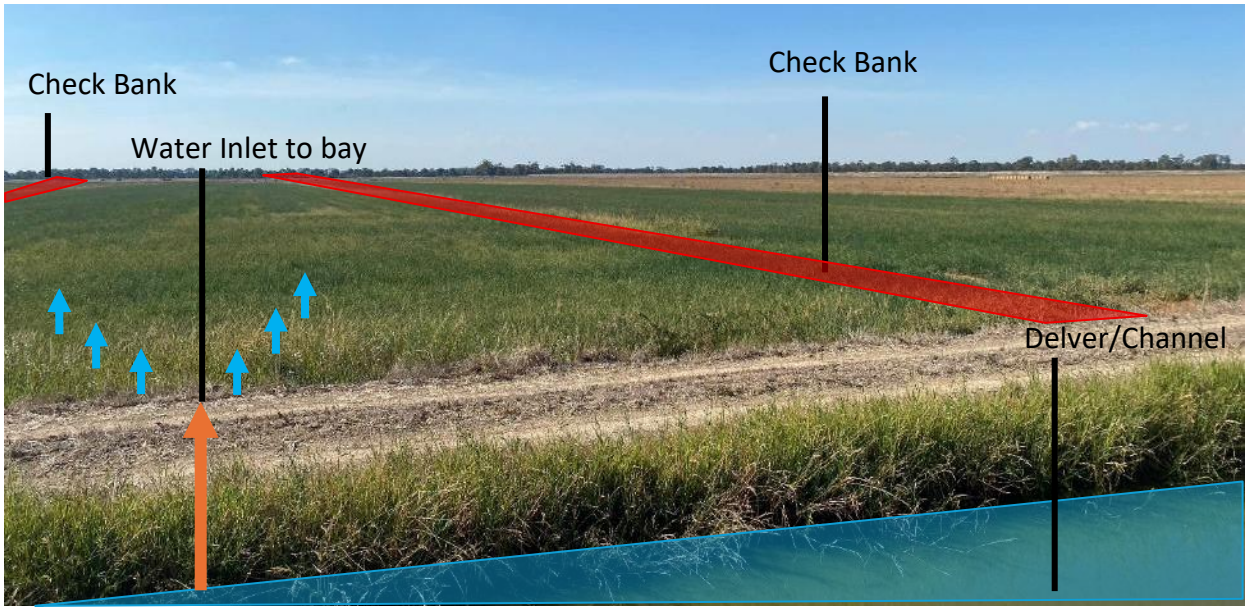
Within this irrigation district the water is commonly used for perennial crops and pastures across a smaller area. The areas irrigated across the Project Area are entirely via flood irrigation. A fundamental component of flood irrigation is the requirement for unobstructed flow of water across the paddock to create uniform distribution. Even application reduces the risk of water pooling and ensures the margins of the paddock are irrigated through gravitational water flow. Flood irrigation paddocks are generally laser levelled to ensure this even application can occur.

A diagram of a typical flood irrigation layout in Northern Victoria is shown below in Figure 3. Flood irrigation uses gravity to irrigate slowly across the paddock, supplied from a delver/channel and uses check banks to create smaller irrigation bays commonly 30 – 50 m wide, within a larger paddock. Check banks are raised earthen mounds between each water outlet which hold water within an irrigation bay, to reflect the water and distribute the irrigation water along the length of the bay. Flood irrigation paddocks will typically have numerous check banks and irrigation bays all identical in size. This enables irrigation timing to be set for the entire paddock and enables machinery widths to be set at optimum width, where paddock geometry allows. For example, a paddock which is 1.06 km wide, that has check banks which are 3 m wide, and irrigation bays which are 50 m wide, will have 20 irrigation bays in one paddock. The design flow rate for irrigation is typically the highest rate available from the water supply, such that irrigation bays are designed to take the maximum supply flow available, to maximise irrigation efficiency.

The dry climate within the Project Area, results in an estimated crop growing season of 3 – 4 months, including a 15 mm carry forward of moisture from the slightly wetter months into the driest period of the year. Areas which cannot be irrigated are not considered of particularly high agricultural value, given the limited growing season and limited versatility of the soils.

[4] Agriculture Victoria, Economic Effects of water recovery in the Murray-Darling Basin, accessed from <https://www.agriculture.gov.au/abares/products/insights/economic-effects-of-water-recovery-in-murray-darling-basin#increases-in-water-prices-can-have-complex-flowon-effects>.

Figure 3. Typical Northern Victorian flood irrigation paddock layout (flow of water across paddock indicated by blue arrows orange arrow indicates flow of water underneath the laneway)



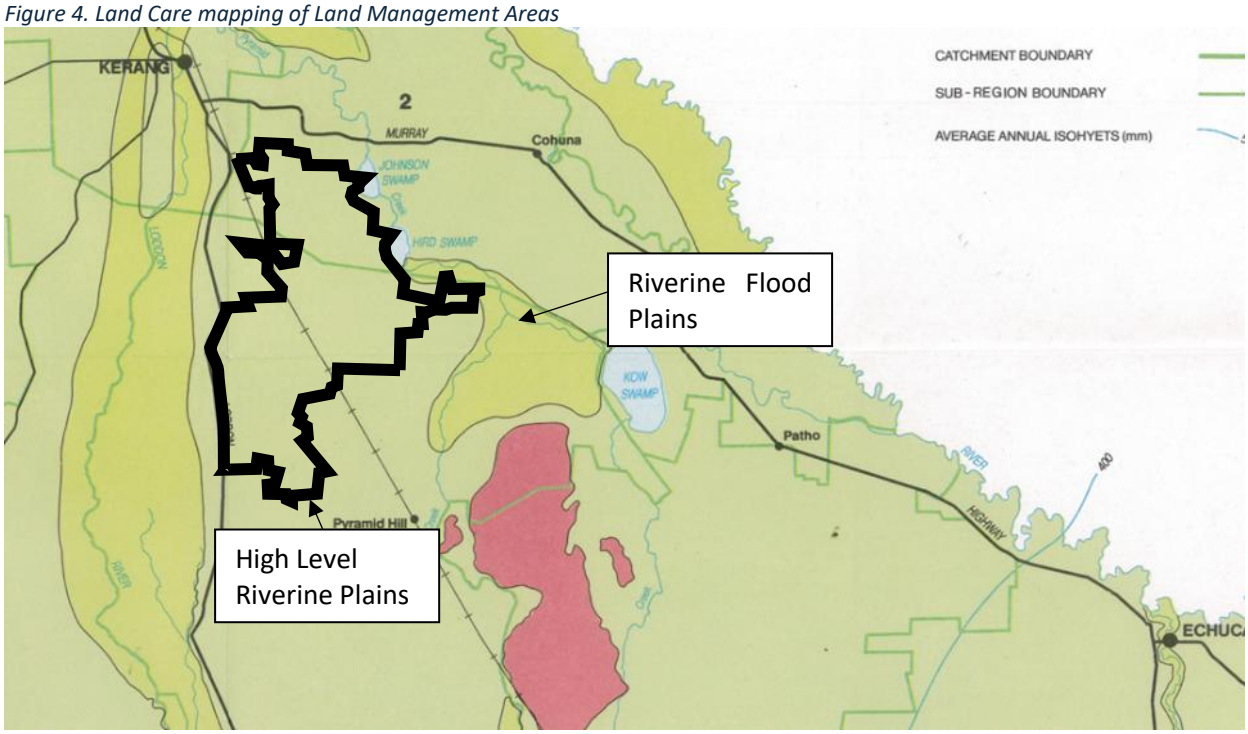
5 Land Management Areas, Soils and Zones

5.1 Land Management Areas

The land within the Avoca-Loddon-Campaspe has been mapped by Landcare into various different Land Management Areas (LMAs). Soils and landscape vary little across the Project Area, with only two LMA's being mapped, with the corresponding percentage of area they cover summarised below:

- High Level Riverine Plains (~90%)
- Riverine Flood Plains (~10%)

Figure 4. Land Care mapping of Land Management Areas

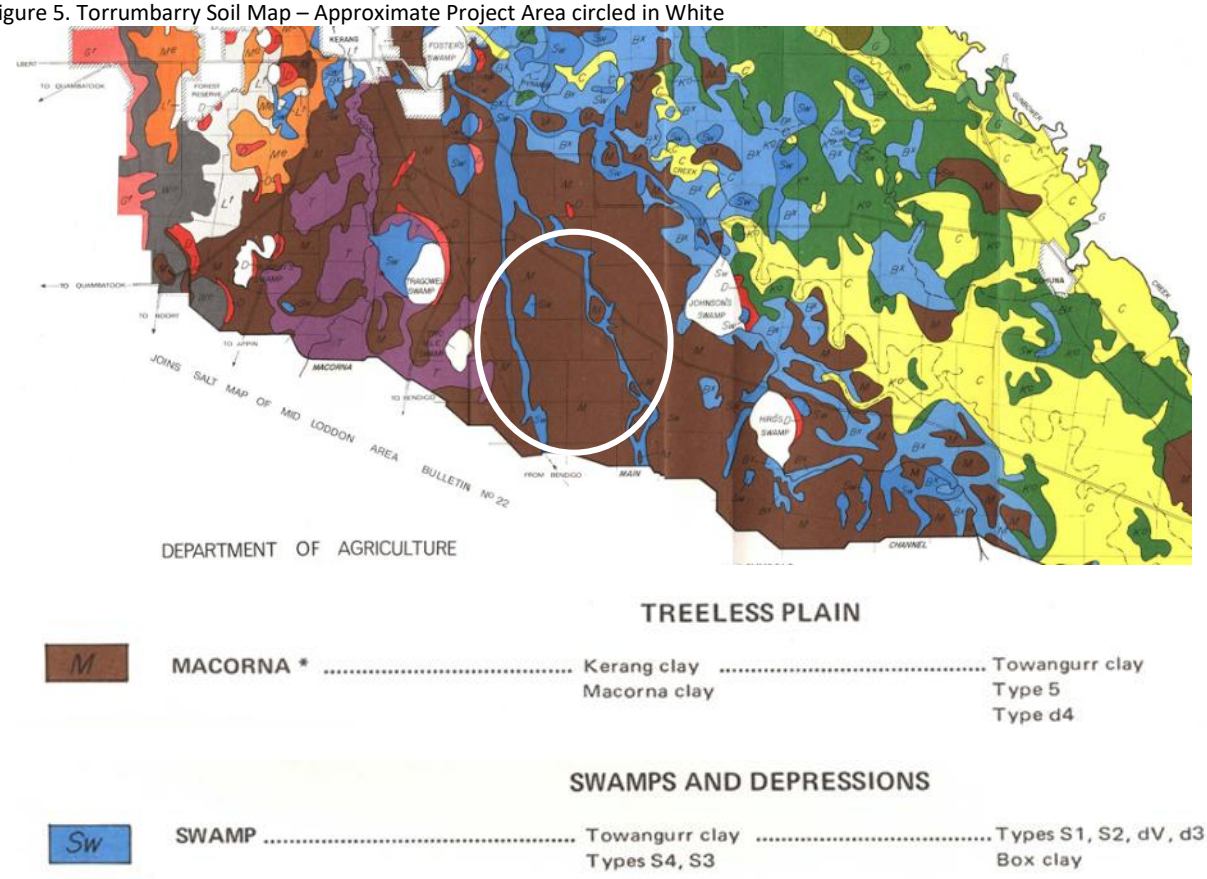


5.2 Soils

In addition to these LMA's the soils within the area have been extensively mapped by Sargeant, Newell and Walbran (1978), with the relevant major units that cover the area being, Towangurr, Macorna and Kerang Clay.[5] While this map only covers the northern third portion of the proposed Wind Farm, this data has been extrapolated across the southern portion of the site, and is considered relevant given the similar landform mapping across this area from Landcare (Figure 5).

The Macorna and Kerang Clays dominate the Project Area and overlap with LMA High Level Riverine Plains.

Figure 5. Torrumbarry Soil Map – Approximate Project Area circled in White



Macorna Clay

Macorna clay is described as a light to heavy clay, dark red brown to grey brown surface soil, with medium to heavy clay subsoils, ranging from yellowish brown to reddish brown. Deposits of gypsum and calcium carbonate can be found below 25 cm from the surface. These soils have historically been used for irrigation of annual and perennial pastures. The soils drainage is considered better than the Kerang clay, although the low surface soil infiltration frequently abates this improvement.

Kerang Clay

Kerang Clay is described as moderate to weakly structured heavy clay throughout the soil profile ranging from grey-brown to yellowish grey in colour, with deposits of gypsum and

[5] Sargeant, I, Sargeant, J. (2005) Sustainable soil management: a reference manual to the major agricultural soils of the Bairnsdale and Dargo regions. Department of Primary Industries, Melbourne.

calcium carbonate below 45 cm. These soils have historically been used for irrigation of annual and perennial pastures for fat lambs raising and dairying. Careful management of irrigation is required on these soils given their inherent low soil permeability and difficulty leaching salts.

Towangurr Clays

The Towangurr Clays are restricted to the margins of the waterways and intermittent drainage pathways (Calivil and Pyramid Creek) and are confined to the eastern boundary of the Project Area. The Towangurr Clays overlap with the LMA of Riverine Flood Plains. These soils are typically not irrigated, due to the low soil permeability, risk of prolonged inundation, extreme salinity or because they form part of the local drainage system.

Summary and interpretation of soils in Project Area

The Macorna and Kerang clay were both assigned Group 4 out of 6 Groups, 1 being the most versatile with least risks, while 6 having the most limitations and requirements of management controls as is shown in below. Group 4b is characterised by low saturated permeability, brown cracking clays which require careful management.[6]

The Towangurr Clay soils are described as grey heavy clay surface soils, overlying similar subsoils, with yellowish brown mottles increasing with depth. These soils have been mapped as Group 6, with limited versatility. Siting the wind turbines in these areas is desirable from an agricultural perspective, as the loss of agricultural production from these areas is considered minimal, given the inability to irrigate these soils, and lack of versatility for crop and pasture production. However, the necessity for retaining the drainage systems in these areas may be of greater importance, this is however outside of the scope of this report. These soils are typically aligned with waterways and remnant vegetation, which is generally considered undesirable for infrastructure siting.

The clay soils in the Project Area have low permeability and are difficult to cultivate. The soil has a very narrow range of moisture content whereby there is limited opportunity to cultivate with no damage to soil structure and ability to produce a fine surface tilth. Generally, these soils are not favoured for cropping due to the difficulty in cultivation and can be more suited to permanent pasture grazing operations.

The soils within the Project Area are also prone to salinity. The low permeability of the soil profile restricts natural leaching events and salts tend to accumulate in the soil surface. Care is required in irrigating these soils to avoid any accumulation of salinity, as they are difficult to rehabilitate if toxic levels of salt accumulate. With effective management to control salinity, the soils are suited to perennial and annual pastures. Summer fodder crops and cereals can be grown with care but cultivation to produce a good seedbed can be difficult.

Soil structure decline through disturbance, within or adjacent to the construction footprint, requires appropriate management measures in consultation with the landowner to prevent any adverse impacts on proposed rehabilitated areas within the construction footprint.

[6] Sargeant, I, Newell, J, Walbran, W. (1978). Soils and Land Use in the Torrumbarry Irrigation District Victoria. Department of Agriculture.

5.3 Zones

To facilitate ease of management and reference to like properties in terms of position across the Project Area the LMAs have been further broken into 5 Zones based on land use.

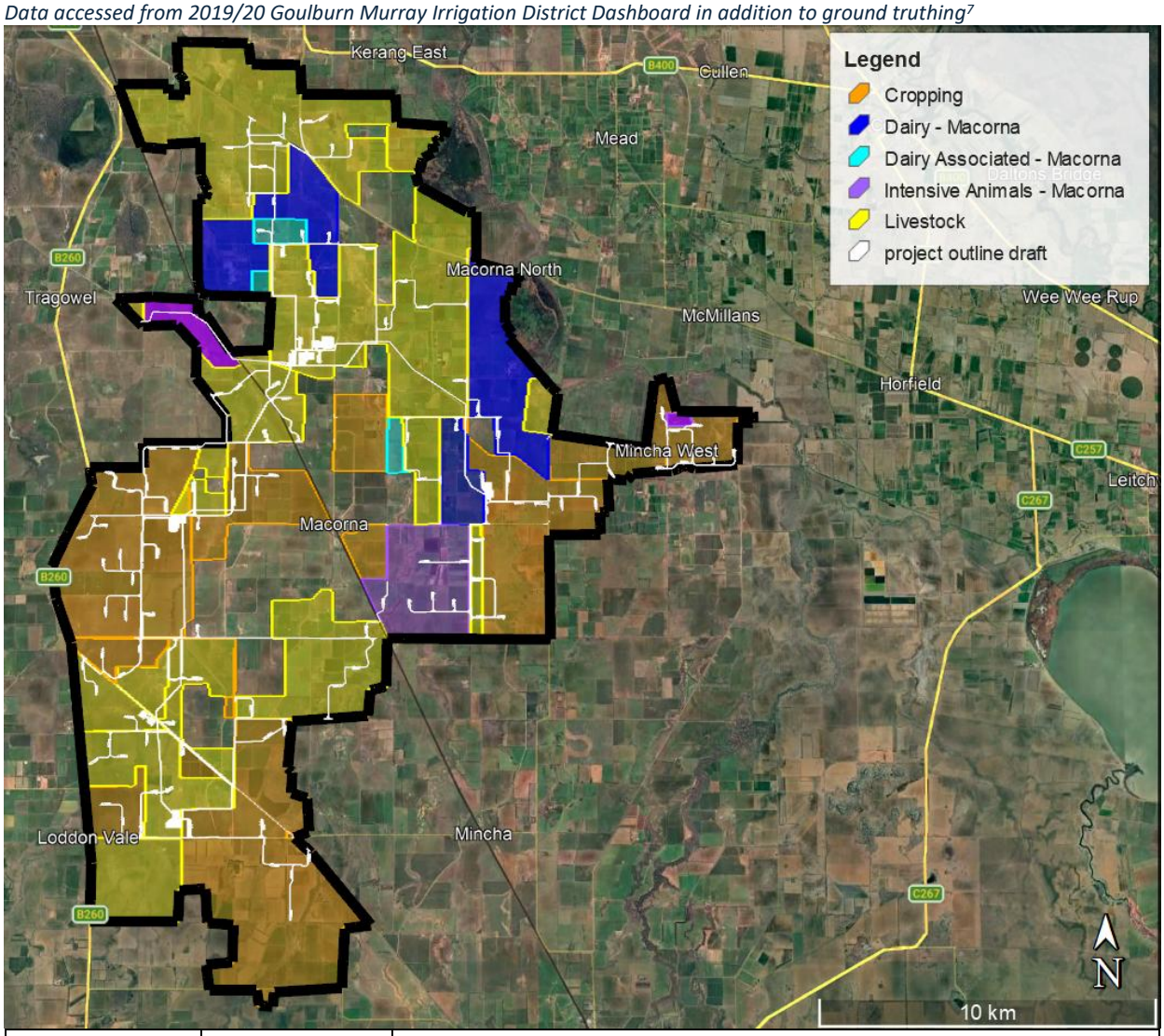
The 5 Zones are as follows :

Zone No.	Zone Name	Enterprise
1	Irrigated Intensive HLR Plains	Dairy
2	Irrigated Extensive HLR Plains	Livestock Grazing
3	Irrigated Cropping HLR Plains	Cropping & Piggery
4	Dryland Plains	Dryland Cropping, Livestock grazing, mixed enterprise
5	Riverine Flood Plains & HLR Plains	Dairy Associated (Young Stock, Dry Stock, Fodder/Crop Production etc.)

**HLR – High Level Riverine*

The Project Area has been mapped according to Land Use Data from 2019/20 from the Goulburn Murray Irrigation district and is shown in Figure 6 below. This high-level mapping has been verified with ground truthing as per the site visit on the 29/10/2025. Areas in fallow at the time of the site visit have been estimated as either cropping or livestock grazing depending on infrastructure present, any crop stubble present, and neighbouring land use. This may therefore be an overestimation of land use, as areas of land appeared to have been in fallow for numerous years.

Figure 6. Aerial Image of Project Area Outlined in Black, with Primary Land Use overlain in shaded colours – Primary Land Use Data accessed from 2019/20 Goulburn Murray Irrigation District Dashboard in addition to ground truthing[7]



Legend:	Primary Land Use	Definition
	Cropping	Primarily used for the production of broad-acre fodder and forage crops
	Livestock/Grazing – Non-Dairy	Land primarily developed and used for the grazing of non-dairy livestock
	Dairy	Land developed and used for the farming and milking of dairy cattle
	Dairy Associated	Land linked through ownership to a dairy water use licence
	Intensive Animals	Land developed with specialist infrastructure used for intensive animal production

6 Proposed Infrastructure

6.1 Description of Turbines & Associated Infrastructure

The proposed Macorna Wind Farm will involve both temporary and permanent land disturbance. The total estimated disturbance footprint is approximately 745 ha during construction and 338 ha during subsequent operation.

Temporary construction areas will be rehabilitated and returned to agricultural use. Permanent infrastructure includes turbine hardstands (approximately 48 m wide) and access tracks (5.5–6.5 m wide, excluding drainage and batters). A rudimentary diagram of the proposed infrastructure is shown in Figure 7 and a summary of the construction and operation footprint is in Table *1*.

[7] https://agvic.maps.arcgis.com/apps/MapSeries/index.html?appid=ec80644d25e54e939114e24368c507b4

Figure 7. Example shape of proposed Turbine layout and siting – areas shaded red may be temporary and will be rehabilitated post construction.

Table 1. Proposed Infrastructure and Footprint (ha) during the construction and operational phase

Infrastructure Proposed	**Construction Footprint**	**Operational Footprint**
Wind Turbines & Hardstands	273.6 ha	114 ha
Access Tracks	219.4 ha	150.3 ha
Underground cabling	69.7 ha	0 ha
Transmission Line	30.6 ha	30.6 ha
Benched Areas; BESS, Site Compound, Substation, Batching Plant	78.1 ha	43.4 ha
Wind Monitoring Masts	49.4 ha	0 ha
Offsite impacts	24.3 ha	0 ha
Total	**745.1 ha**	**338.3 ha**

6.2 Turbine siting Locations

Turbines have been sited in consultation with landholders to minimise impacts on agricultural productivity, particularly irrigation systems. Preferred siting (from most to least favourable) is:

1. Dryland paddocks without irrigation
2. Dryland paddocks with unused irrigation infrastructure
3. Irrigated paddocks (aligned with irrigation layout)
4. Irrigated paddocks with partial disruption
5. Irrigated paddocks with infrastructure crossing irrigation at right angles (least preferred)

Maintaining irrigation functionality during construction is critical. Where infrastructure aligns with existing irrigation layouts (e.g. parallel to check banks), impacts can be minimised. However, infrastructure that intersects irrigation layouts; particularly at right angles, may disrupt water

delivery and require reconfiguration. Ag-Challenge understands that Atmos will coordinate any reconfiguration works for landowners as part of the construction process.

6.3 Preferable turbine placement in Flood Irrigation Paddocks

Based on data provided by Atmos, ~26 wind turbines are to be placed in areas that are actively irrigated, ~24 are proposed to be placed in areas infrequently irrigated and ~53 have been proposed in areas historically used for irrigation with infrastructure removed and/or decommissioned, which are not currently used for irrigation, nor planned to be, based on farmer consultations. This means that ~26 of the 114 proposed turbines are within areas actively irrigated on an annual basis, representing the highest potential impact on agricultural productivity.

During our site visit we spoke to two landholders who have proposed turbines and associated infrastructure within paddocks which are actively irrigated. These landholders confirmed that the siting of wind farm infrastructure on their land has been undertaken collaboratively to ensure impacts to irrigated land has been minimised and agreed upon.

6.3.1 Access Track

The preferred location and design considerations for the access tracks is as follows:

- Preferably located along existing laneways or aligned with check banks
- Tracks parallel to irrigation layout minimise disruption
- Tracks crossing check banks may:
    - Temporarily or permanently disrupt irrigation
    - Require redesign of irrigation systems
- Tracks at right angles to irrigation bays should be avoided where possible due to high impact risk

6.3.2 Hard Stand

The preferred location and design considerations for the Hard Stand is as follows:

- Standard hardstand width (~48 m) is similar to irrigation bay widths (30–50 m)
- Best practice is to confine hardstands to a single irrigation bay (subject to landowner preference)
- Expanding bay widths to accommodate infrastructure may:
    - Require regrading (laser levelling)
    - Alter irrigation efficiency and flow requirements
    - Reduce machinery efficiency if widths no longer align

Where impacts extend across multiple bays, losses may be offset by converting nearby dryland areas to irrigation.

6.3.3 Irrigation Functionality

Where irrigation continues in affected paddocks[8], turbine placement influences water distribution:

- **Top of bay:** Highest disruption due to early flow diversion
- **Middle of bay:** Partial disruption; uneven downstream irrigation
- **Bottom of bay:** Lowest impact; preferred location

Impacts may include uneven water distribution, ponding, erosion risk, and reduced crop productivity. These can be mitigated through drainage modifications, diversion structures, or irrigation redesign.

7 Analysis of Impacts and Mitigation Measures

An analysis of foreseen impacts from the wind turbines and associated infrastructure in relation to agriculture as well as mitigation measures are outlined below. The potential negative impacts may be similar within the various agricultural enterprises, primarily surrounding loss of productive land, the severity will differ between the individual landholders, with different proposed construction areas, individual siting and infrastructure layouts. Additionally, positive impacts primarily surround upgrades to farm infrastructure, and use of turbine hosting income.

7.1. Potential Impacts & Mitigation:

Five key potential impacts on farming operations have been identified across the construction, rehabilitation and operational phases of the Project:

During construction:

- Loss of production (and ability to irrigate)
- Severance (loss of access)
- Capital Improvement losses

Post construction:

- Land degradation as a result of poor rehabilitation
- Consider farm operation/day-to-day management difficulties
- Potential for loss of production (and ability to irrigate)

The most significant mitigation measure for the proposed wind farm, is the individual consultations which have occurred and will continue with the landowners, for site specific situation of turbines, to suit the individuals and businesses' needs.

[8] This is only considered likely in paddocks which are significantly longer than the proposed construction length of 147 m.

A summary of other mitigation measures recommended, are discussed within each category in bold.

7.1.1 Loss of Production

Direct production loss varies significantly depending on the number of wind turbines, placement of wind turbines and access tracks and any additional construction activities required on each individual property. Detailed gross margin analysis for each major enterprise is discussed in section 8 on Page 26, in relation to loss of production during construction and operation.

Potential production losses and subsequent mitigation measures have been summarised below:

- Turbines, or access roads are located on high productivity irrigated land, resulting in permanent removal of productive area from cropping or grazing rotations. **Primarily mitigated through the development of landholder agreements, which include restriction zones from construction to minimise disturbance to operations and irrigation. Typically, the exclusion zones selected by the farmers have been the highest value production areas**.

- Paddock fragmentation leads to reduced machinery efficiency (e.g., smaller workable areas, inability to operate flood irrigation). **Mitigate through adjustment of paddock layouts and/or irrigation infrastructure (channels, drainage and inlets) to enable irrigation to continue around the proposed construction where possible.**

- Construction has the potential to restrict some seasonal operations (e.g., delaying sowing, silage cutting, crop harvesting, grazing of paddocks), causing yield and/or stocking rate reductions. **Mitigated through provision of adequate notice of proposed construction commencement and end period, to enable landowners to make decisions to avoid production losses and losses in investment of pastures and crops, which will have no return on investment from an inability to be grazed or harvested. Production losses can then be minimised by commencing irrigation on alternative land, sowing crop/pasture on this land to avoid requirement for supplementary feed or failed crops, modifying farm infrastructure, adjusting stocking rates and/or shifting breeding and subsequent lambing/calving periods.**

7.1.2 Severance

Severance has the potential to occur when the proposed wind turbine construction and/or temporary low voltage transmission line easement, or access tracks isolates an area of land from farming use through its passage across the property. Severance will be temporary and occur only during the construction phase where areas are blocked due to machinery, fencing and trenching works, and if alternative access routes have not been constructed.

Severance can be primarily mitigated through prior identification and restructuring of access tracks and paddocks prior to the proposed wind turbine and/or associated infrastructure, to enable complete access for animals, machinery and use of irrigation, to prevent severance from occurring. This is particularly relevant during calving and lambing periods, and ensuring access to feedpads, calving pads, silage stacks, shearing sheds, stock yards, loading ramps, grain silos the dairy and associated facilities is retained. Additionally, Atmos has designed the layout in consultation with the landowners to avoid impacts of severance throughout the project infrastructure layout.

As discussed in the Loss of Production section 7.1.1, adequate notice of the construction timeline to the landowner is pertinent in avoiding any potential temporary severance and production losses, allowing landholders to change their farming practices accordingly.

Effective landholder liaison should be maintained during the construction and rehabilitation phases to minimise disruption and disturbance.

7.1.3 Capital Improvement Opportunities

Some facilities and improvements may be in the path of the easement and require removal and replacement. Items such as drainage (surface and underground), irrigation infrastructure, fencing, access, plantations etc need to be restored within the same location according to the principle of maintaining function and original condition. Farmers additionally have an opportunity to utilise payments of $40,000 – 50,000 per annum, per turbine hosted to improve, upgrade and/or develop capital infrastructure across the property, not restrictive to the wind turbine construction areas. Positively capital improvement through construction of new access tracks to the proposed infrastructure, may enable easier landholder access to various parts of the farm, given the access track's location have been designed in consultation with the landholders.

Additionally, it is recommended that a construction management plan is developed for permanent structures that has agency and landholder input in its design, including facilities replacement.

7.1.4 Land degradation as a result of poor rehabilitation

This is usually one of the greatest areas of conflict between landholder, installation contractor and infrastructure provider. During the rehabilitation process land degradation can occur when the topsoil and subsoil is mixed, and not removed, stored or replaced separately, which can negatively impact upon the topsoil structure and fertility, which can significantly reduce the likelihood of adequate resowing, and lower production. Land degradation can also occur in areas actively irrigated, if the paddocks are not re-laser levelled to ensure flood irrigation can occur evenly across the paddock. The primary mitigation measure to avoid poor rehabilitation relates to the landowner agreements which have been developed with the landowners which include a rehabilitation plan as per their individual requirements. The underlying principle in construction and rehabilitation involves restoring the land resource and any facilities affected to the same condition as they were previously or in consultation with landowners. From an agricultural perspective the components should include soil profile segregation and replacement, vegetation restoration, appropriate land forming to counter subsidence, restore drainage lines and laser levelling for any disturbance of flood irrigation paddocks.

7.1.5 Summary of Impacts and Mitigation Strategies

Table 2 is a summary of potentially foreseen impacts in relation to agriculture, the duration of impact, severity ranging from low to high and mitigation measures.

Table 2. Potential Impacts and Mitigation Measures of the wind turbine construction in relation to agriculture.

Activity	Potential Impacts	Timing	Perceived significance	Nature	Likelihood	Mitigation Measure	Residual Impact Post Mitigation
Construction of infrastructure	Loss of agricultural land	Construction & Operation	Low – Dryland High – High-value Irrigated land	Negative	Almost certain	Landholder agreements have sited turbines away from high-value areas. Commence irrigation on previous dryland areas.	Minimal Long-term - if irrigation commences on alternate areas
	Irrigation disruption	Construction & potentially Operation	Moderate	Mixed	Likely	Adjust irrigation layouts, protect channels and maintain access to water, reinstate drainage lines, land forming and laser levelling	Minimal Long-term - if restructured prior to construction and/or reinstated properly post construction
	Delays to sowing/harvesting	Construction	Moderate	Negative	Possible	Avoid key periods where possible, provide adequate notice and flexible construction scheduling	None - If avoided
	Paddock fragmentation & reduced efficiency	Operation	Moderate	Negative	Possible	Careful siting of infrastructure and redesign paddocks if required, with landowner consultation	Minimal inefficiencies – Long-term

Activity	Potential Impacts	Timing	Perceived significance	Nature	Likelihood	Mitigation Measure	Residual Impact Post Mitigation
Construction of infrastructure	Severance of paddocks (temporary isolation)	Construction	Moderate	Mixed	Possible	Provide alternative access, plan construction corridors, fencing and adequate prior warning of construction period	Minimal – Temporary with access restored
	Restricted access to key infrastructure (e.g. dairy, silos)	Construction	Moderate to high (intensive farms)	Negative	Possible	Maintain access or construct alternate routes, staging works and landholder coordination	Minimal – Temporary
	Fertiliser delays, and weed and pest control limitations	Construction	Low to Moderate	Negative	Possible	Use of pre-emergent herbicides, capital fertiliser applications where soils allow and timely notice of proposed construction	Minimal – Temporary
	Reduced feed availability	Construction	Moderate	Negative	Likely	Timely notice, purchase supplementary feed, adjust stocking rates, plan ahead, commence irrigation in previous dryland areas	Minimal – Temporary None - Long-term
	Capital infrastructure removal (fencing, irrigation, drainage)	Construction	Moderate	Mixed	Possible	Replace like-for-like (or as per landowner's request) include in construction management plans	None - Long-term
Machinery Movements	Biosecurity risks (weed spread, soil movement)	Construction & rehabilitation	Moderate	Negative	Possible	Follow biosecurity protocols and manage topsoil and overburden	Minimal – Temporary

Soil rehabilitation	Mixing of topsoil and subsoil, compaction, soil degradation	Rehabilitation	Moderate	Negative	Possible	Strip, store and replace soil based on their soil profiles	None - Long-term if restored
Plant/pasture rehabilitation	Inadequate resowing	Rehabilitation	Low	Negative	Possible	Appropriate resowing methodology, flexibility with seasonality in dryland areas, adequate weed control	None - Long-term if restored
Hosting turbine infrastructure	Turbine hosting income	Construction & Operation	High	Positive	Almost certain	Steady annual income, can be utilised to improve on-farm infrastructure, production, management etc.	-
	Development of new access tracks	Operation	Moderate	Positive	Likely	Development of new access tracks may enable easier access to different areas of the farm for machinery and inclement weather	-

8 Gross Margin Analysis of Affected Enterprises

This analysis estimates how the proposed Macorna Wind Farm may affect agricultural production.

8.1 Gross Margin Analysis

The range of farming enterprises across the Project Area are listed below:

- Dairy Production & associated turn-out blocks for rearing young-stock, dry stock, fodder production etc.
- Livestock grazing (non-dairy)
- Dry land broadacre cropping (cereals, canola and lucerne)
- Irrigated broadacre cropping (cereals, canola and lucerne)
- Piggery

Long-term average carrying capacity for beef and sheep grazing properties in Northern Victoria are Dry Sheep Equivalent[9] (DSE)/ha (ranging from 8.5 – 13.5 DSE/ha).[10] Higher stocking rates of 20 – 30 DSE/ha are anticipated on a well-managed irrigation farm, but without water availability the same land would support 5 – 8 DSE/ha depending on soil type and location. Dairy production averages 33 DSE/ha.[11]

The Gross Margin per hectare findings from the Livestock Farm Monitor Project (2024) and Dairy Farm Monitor Project (2024) within Northern Victoria have been included in Table 3. Gross margins per hectare can vary significantly depending on farm management practices, access to reliable irrigation water, irrigation infrastructure and soil type.

Table 3. Gross Margin for irrigated broadacre cropping, livestock grazing and dairy production in Northern Victoria

	Livestock Farm Monitor Project (LFMP)			
Category	**2023/24**	**Average**	**Min**	**Max**
Beef Gross Margin /ha	$292	$485	$244	$958
Prime Lamb Gross Margin /ha	$303	$411	$137	$604
Wool Sheep Margin /ha	$285	$352	$152	$632
Cropping Gross Margin /ha	$700	-	-$311	$2,175
	Dairy Farm Monitor Project (DFMP)			
Dairy Gross Margin /ha	$4,539	$3,063	-	-

[9] DSE or dry sheep equivalent is a measure of carrying capacity and is defined as the amount of fodder required to maintain the liveweight of a 40 kg wether = 7.6 MJ

[10] Note this may include dryland only Northern Victorian farms, which would disproportionately lower the average DSE/ha for the Project Areas under irrigation.

[11] Average stocking rate of 1.6 cows/ha. Assume 21 DSE/lactating cow = 33 DSE/ha

8.2 Estimated Losses during construction of Macorna Wind Farm

At this stage the number of turbines proposed within each farming enterprise is:

- ~50 turbines within livestock grazing (non-dairy) enterprises
- ~50 turbines within Broadacre cropping
- ~8 turbines within Dairy/associated to dairy production (turn-out blocks)
- ~6 turbines within intensive animal production (Piggery)

The wind farm footprint covers an estimated 745.1 ha during construction and ~307.7 ha once operational. Assuming this operational area is split equally for each turbine, this equates to 2.32 ha per turbine including associated infrastructure.[12]

The estimated gross margin loss per annum dependent on enterprise has been detailed in Table 4.

Table 4. Estimated annual losses during the construction and operational phase for the relevant enterprises

Category	No. of turbines proposed	Area impacted during construction (ha)	Average Gross Margin lost ($/annum)	Area impacted during operation (ha)	Average Gross Margin lost ($/annum)
Livestock Grazing (Beef & Sheep)	50	331.8	$137,925	137.6	$57,242
Broadacre Cropping	50	331.8	$232,085	137.6	$96,320
Dairy	8	46.8	$143,370	18.5	$56,800
Piggery[13]	6	35	$24,570	13.9	$9,730
Total	**114**	**745 ha**	**$537,928**	**307.6 ha**	**$220,092**
Total project areas hosting income			**$4,560,000 - $5,700,000**		

Using the average gross margin per hectare values, total agricultural production in the Project Area is estimated at $18,120,157.[14]

Based on the estimated operational footprint and estimated reduction in gross margin across the Project Area, this represents approximately 1.21% of total agricultural production[15]. This calculation assumes that the affected land is entirely removed from production and does not consider potential mitigation measures, changes in land management practices, or revenue generated from turbine hosting agreements. Income for hosting each turbine is in order of $40,000 - $50,000 per annum, which equates to $4,560,000 - $5,700,000 annually across the Project Area. This is between 20 – 25 times greater than the proposed losses during operation.

[12] Note this figure will likely fluctuate due to the access tracks required. Benched areas have not been assumed as split equally across each enterprise as they are only located within the livestock grazing and broadacre cropping enterprises. Instead these have been added additionally only to these two enterprises.

[13] A Victorian Piggery gross margin/ha monetary figure could not be sourced instead assumed to operate similarly to a broadacre cropping enterprise (housed pigs)

[14] Livestock grazing assumed to be equally split between prime lamb, wool and beef production.

[15] $220,092 ÷ $18,120,157 x 100 = 1.21%

9 The Agricultural Amenity of the Region

The Australian Bureau of Statistics (ABS) collects and publishes data for agriculture and agricultural production at Statistical Area Level 4 (SA4). SA4 are geographical areas with defined boundaries and broadly similar production systems. The SA4 regions are the largest sub-State regions in the Main Structure of the Australian Statistical Geography Standard and have been designed for the output of a variety of regional data. They are generally representative of regional labour markets but also tend to represent agricultural groupings as well.

Kerang sits within the SA4 North West region which includes the regions of Murray River – Swan Hill, Grampians and Mildura, and forms a geographical bundle of land in the north western part of Victoria. Macorna, Loddon Vale and Mincha lies within the SA4 Bendigo region.

Approximately a third of the Project Area is located within the North West Region, with the remaining two thirds within the Bendigo Region. The 2021 ABS data for the two regions is listed in Table 5, with a weighted average included to best represent the Project Area.

Table 5. 2021 ABS data on agricultural commodities for the two regions along with the weighted average.

Agricultural Commodity	North West Region	Bendigo Region	Weighted Average of the two Regions
	Number		
Area of Agricultural land	5,023,821 ha	782,711 ha	2,196,414 ha
Area planted to Broadacre crops	2,722,709 ha	239,563 ha	1,067,278 ha
Area of Agricultural land Irrigated	125,799 ha	56,739 ha	79,759 ha
Number of Meat Cattle	119,341	1,318,320	918,660
Number of Dairy Cattle	52,814	39,349	43,837
Number of Sheep & Lambs	4,317,942	15,388	1,449,573
Number of Pigs	136,153	110,714	119,194

The proposed Project Area both during construction and operation for each enterprise (assuming beef and sheep grazing is equally split) has been compared against the weighted average of the two regions in Table 6.

Table 6. Area impacted on during the construction and operational phase in comparison to the weighted average of the two regions

Enterprise	**Area Impacted During Construction**	**Average Carrying Capacity (DSE)**	**Number of stock**	**Percentage of Region stock or land**
Beef	165.8	1,658[16]	207[17]	0.023%
Sheep	165.8	1,658	740[18]	0.051%
Dairy	46.8	1,544[19]	74[20]	0.170%
Broadacre Cropping + Piggery	367	-	-	0.034%
Total	**745 ha**			**0.278%**
Enterprise	**Area Impacted During Operation**			
Beef	68.8	688	86	0.0094%
Sheep	68.8	688	313	0.022%
Dairy	18.5	611	29	0.066%
Broadacre Cropping + Piggery	151.5	-	-	0.014%
Total	**307.6 ha**			**0.11%**

Overall, on a regional scale comparing against the ABS data, the proposed area impacted by construction represents 0.278%, while during operation this drops to 0.11%. This is not considered significant on a regional scale, however it still remains important that impacts to productive farmland are minimised to protect agricultural amenity and support the ongoing viability of individual farm businesses.

[16] Assuming an average carrying capacity for sheep and beef grazing of 10 DSE/ha
[17] Assuming 8 DSE per steer
[18] Assuming 2.2 DSE per Ewe
[19] Assuming an average carrying capacity for dairy of 33 DSE/ha
[20] Assuming DSE requirement for a lactating cow of 21 DSE

10 Summary & Conclusion

This report provides a preliminary assessment of the potential agricultural impacts associated with the proposed Macorna Wind Farm, located within the Gannawarra and Loddon Shire regions of northern Victoria. The Project Area covers approximately 23,000 hectares of predominantly agricultural land across approximately 26 privately owned farming properties.

The Project Area supports a mix of irrigated and dryland agricultural enterprises, including dairy production, livestock grazing, broadacre cropping and piggery operations. Agricultural productivity within the region is strongly influenced by irrigation availability, soil characteristics and seasonal rainfall patterns.

The region experiences a dry to semi-arid climate, with annual rainfall ranging from approximately 350–374 mm, resulting in a relatively short natural growing season. As a result, irrigation plays a critical role in sustaining agricultural productivity, particularly for dairy production. Irrigation across the Project Area is undertaken through flood irrigation systems, which rely on gravity-fed water distribution across laser-levelled paddocks to ensure uniform water application. The functionality of these systems is highly dependent on maintaining consistent paddock grades, uninterrupted water flow and intact irrigation infrastructure.

The soils across the Project Area are predominantly Macorna and Kerang clay soils, associated with the High Level Riverine Plains, with smaller areas of Towangurr clays occurring along drainage pathways and floodplain environments. These soils are generally heavy cracking clays with low permeability, requiring careful management to maintain soil structure, irrigation efficiency and salinity control. While these soils are well suited to irrigated pasture production, they can present limitations for cultivation due to their narrow optimal moisture conditions for tillage and susceptibility to structural decline if poorly managed.

The proposed wind farm infrastructure includes 114 wind turbines and associated infrastructure, such as turbine hardstands, access tracks, underground cabling and transmission infrastructure. During construction, an estimated 745 hectares of land will be temporarily affected, with approximately 407 hectares expected to be rehabilitated and returned to agricultural production following construction. The long-term operational footprint of the development is estimated to be approximately 338 hectares, representing approximately 1.5% of the Project Area.

A gross margin analysis was undertaken to estimate the potential economic impact on agricultural production. Using regional production benchmarks and enterprise gross margins, the operational turbine footprint and associated infrastructure are estimated to reduce agricultural gross margins within the Project Area by approximately 1.21%. The analysis is conservative as it assumes that land occupied by operational infrastructure is permanently removed from production and does not incorporate potential mitigation measures, landholder management responses, or compensation payments associated with turbine hosting agreements. Income for hosting each turbine is in order of $40,000 - $50,000 per annum, which equates to $4,560,000 - $5,700,000 annually across the Project Area. This is between 20 – 25 times greater than the proposed monetary losses during operation and substantially offsets the potential agricultural monetary losses across the Project Area.

Potential agricultural impacts associated with the development include:

- Temporary loss of productive land during construction
- Permanent loss of small areas of productive land
- Potential disruption to irrigation layouts
- Temporary severance of paddocks and farm infrastructure
- Soil disturbance requiring stringent rehabilitation requirements

However, these impacts can be substantially mitigated through appropriate project planning and management, including:

- Strategic siting of turbines to minimise where possible high-value irrigated areas where possible
- Site planning in consultation with the farmers
- Alignment of access tracks with existing farm infrastructure
- Careful soil stripping, storage and reinstatement during construction
- Rehabilitation of disturbed areas to restore soil profiles and irrigation layouts
- Coordination of construction activities with farm operations

With the implementation of these mitigation measures and appropriate rehabilitation practices, the proposed wind farm is expected to co-exist with ongoing agricultural production across the majority of the Project Area. Overall, the analysis indicates that while the development will result in localised and manageable impacts, the broader agricultural productivity of the region is unlikely to be significantly affected.