CHAPTER 22
AGRICULTURAL IMPACTS

BIRD IN HAND GOLD PROJECT
MINING LEASE APPLICATION
MINING LEASE PROPOSAL

ABN | 66 122 765 708
Unit 7 / 202-208 Glen Osmond Road | Fullarton SA 5063

DISCLAIMER

A declaration has been made on behalf of Terramin Exploration Proprietary Limited and Terramin Australia Limited by its Chief Executive Officer that he has taken reasonable steps to review the information contained in this document and to ensure its accuracy as at 31st May 2019.

Subject to that declaration:

(a) in writing this document, Terramin Exploration Proprietary Limited and Terramin Australia Limited have relied on information provided by specialist consultants, government agencies, and other third parties. Terramin Exploration Proprietary Limited and Terramin Australia Limited have reviewed all information to the best of their ability but do not take responsibility for its accuracy or completeness; and

(b) this document has been prepared for information purposes only and, to the full extent permitted by law, Terramin Exploration Proprietary Limited and Terramin Australia Limited, in respect of all persons other than the relevant government departments, makes no representation and gives no warranty or undertaking, express or implied, in respect to the information contained herein, and does not accept responsibility and is not liable for any loss or liability whatsoever arising as a result of any person acting or refraining from acting on any information contained within it.

Document Control

This Document is a controlled document. The Document Controller holds the Master electronic copy.

Master Document Information			
Document Number	File Path	Format	Last Modified
BIHMLP_V2	O:\Technical\Bird In Hand\Regulatory\DSD\ML Application\BIHMLP_V2	PDF	18/6/2019

If you become aware of any changes or corrections that are required please photocopy this page and the relevant page(s) requiring changes, note the corrections, and email them to the Document Controller:

Document Controller:

Terramin Exploration Pty Ltd

Unit 7 / 202-208 Glen Osmond Road

Fullarton, South Australia 5063

Tel: 08 8213 1415

email: info@terramin.com.au

Distribution Electronic Copies (Body and Appendices)

Document Number	Issued To	Format	Date
BIHMLP_Draft_V1	DEM	Adobe	18/12/2017
BIHMLP_V2	DEM (45 copies)	PDF	21/6/2019
BIHMLP_V2	DEM (5 copies)	Hard Copy	21/6/2019

CONTENTS

FIGURES

TABLES

All maps presented in this chapter are in GDA94 / MGA zone 54 (EPSG: 28354) unless otherwise stated.

22 AGRICULTURAL IMPACTS

This chapter discusses the potential for impacts on surrounding agricultural activities from the Bird in Hand Gold Project ('the Project' or 'BIHGP'). The Impact Assessment outlines potential impacts associated with broad groupings of airborne, biological, hydrogeological, commercial, physical structures and other miscellaneous potential impacts associated with the proposed mining operation.

During 2017 Terramin commissioned Food And Beverage Australia Limited (FABAL), to consider and review the proposed BIHGP in the context of potential impact events for the surrounding agricultural activities. FABAL completed an Agricultural Impact Assessment (AIA) and associated report (see Appendix U1). The impact assessment section of this chapter has been prepared independently using this impact assessment.

22.1 APPLICABLE LEGISLATION AND STANDARDS

There are two pieces of primary legislation for the mining sector controlling impacts on surrounding land use, the *Mining Act 1971* (SA) (Mining Act) and the *Environment Protection Act 1993* (SA) (EP Act). In accordance with Section 35 of the Mining Act and Regulation 30 of the *Mining Regulations 2011*, a Project specific Determination was gazetted by the South Australian Government on the 5th April 2017, titled "*Ministerial Determination for the Bird in Hand Gold Project*" (BIHGP MD). Section 6.1.2 of the BIHGP MD requires Terramin to describe the specific elements of the environment, which includes existing or permissible land use, which may reasonably be expected to be impacted by the proposed mining operation. Existing or permissible land use includes commercial and community business activities.

The EP Act imposes a duty on all persons undertaking an activity that pollutes, to take all reasonable and practicable measures to prevent or minimise any resulting environmental harm.

South Australia's *Multiple Land Use Framework*, released in 2017 has been designed to operate within established regulatory and policy frameworks and provides guidance on how best to engage with stakeholders on land use change projects with an overarching objective of co-existing land use.

The obligations under these Acts are outlined below in Table 22-1.

TABLE 22-1 | APPLICABLE LEGISLATION CONTROLLING IMPACTS ON SURROUNDING AGRICULTURAL LAND

Legislation, Planning	Pinpoint Name	Requirement, Purpose	Project Relevance
Mining Act 1971 (SA) (Mining Act)	Mining leases	Application for a Mining Lease (ML) requires supporting documentation in the form of a Mining Lease Proposal (MLP). The aim of the MLP is to identify the environmental and social risks associated with the project and set appropriate standards (outcomes) that are acceptable to stakeholders, and demonstrate a net public benefit if the MLP were to proceed. Impacts to the existing environment includes permissible land use in the area,	The assessment of BIHGP will principally occur under the Mining Act, where the two-stage process for approval will require submission of a ML application, followed by a Program for Environment Protection and Rehabilitation (PEPR).

Legislation, Planning	Pinpoint Name	Requirement, Purpose	Project Relevance
		which in turn includes commercial businesses.	
Environment Protection Act 1993 (SA) (EP Act)	General environmental duty	Imposes a duty on all persons undertaking an activity that pollutes, requiring them to take all reasonable and practicable measures to prevent or minimise any resulting environmental harm.	The BIHGP will be assessed to ensure activities are undertaken in accordance with Terramin's general environmental duty.
	Prescribed activities of environmental significance	Defines a range of commercial or industrial activities (prescribed activities of environmental significance) for which a licence from the EPA is required.	The prescribed activities of environmental significance commonly associated with mining operations are: • mineral works; • chemical works; • fuel burning; • waste or recycling depots; • tailings from mineral processing; • sewage treatment; and • activities producing listed wastes.
	Environmental authorisations and development authorisations	Under certain circumstances, environmental and development authorisations are required to control risks and reduce environmental impacts of activities.	Environmental authorisations in the form of works approvals and licences are required for various elements of mine operations.
	Environment protection policies	Sets-out the procedure for making, amending and revoking environment protection policies.	There are a number of environment protection policies relevant to mining operations and mineral processing. These include: *Environment Protection (Air Quality) Policy 2016* (SA) *Environment Protection (Noise) Policy 2007* (SA) *Environment Protection (Water Quality) Policy 2015* (SA) *Environment Protection (National Pollutant Inventory) Policy 2008* (SA).

22.1.1 South Australia's Multiple Land Use Framework

The following is taken from South Australia's *Multiple Land Use Framework*, which was released in 2017 after significant community consultation and sets out the general framework of land use in the state:

Land use in South Australia is varied and includes recreation, conservation, agriculture, fisheries, aquaculture, forestry, biodiversity, minerals and energy exploration, renewable energy production, housing, defence, tourism, manufacturing and infrastructure, to name just a few. Land ownership, environmental protection, native title and Aboriginal and non-Aboriginal heritage are all important considerations. South Australia has an estimated 76,000 hectares under vine. In 2014–15, the industry produced more than 730,000 tonnes of grapes valued at $470 million. Less than 1% of the State is currently under mineral and petroleum production tenements (SARIG, 2018). Mineral exports accounted for 29% of total State exports for 2015 and production was valued at $5.4 billion. Together,

mining and agriculture comprise 74% of South Australia's exports, underscoring the continued importance of both sectors in supporting South Australia's regional communities.

The Framework has been designed to operate within established regulatory and policy frameworks and provides guidance on how best to engage with stakeholders on land use change projects. The Framework is consistent with many of the principles found in State policies, planning documents and Ministerial Guidelines; the Framework does not replace these, nor does it alter existing land rights or override existing legislation.

22.1.2 Airborne

Dust generated at the proposed BIHGP was identified as a potential impact to vine health. However, there are no specified limits for dust deposition on horticulture in South Australia. In the absence of local guidelines, the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC 2005) was adopted. The limits imposed for dust deposition on crops are a maximum total of 4 g/m^2/month and / or a maximum increase of 2 g/m^2/month over background levels (DEC 2005). The potential impacts of BIH Gold Project are measured against this and outlined below.

The *Environment Protection (Air Quality) Policy 2016* (Air Quality EPP) is applicable and came into effect on 23 July 2016. It provides a legislative basis for air quality regulation and management in the state, including criteria for developing effective conditions to assist businesses and industries to improve their performance in minimising risk from air emissions through a system of licensing.

22.1.3 Biological

Biological impacts are subject to *National Parks and Wildlife Act 1972* (SA) (NPW Act), *Native Vegetation Act 1991* (SA) and the *Natural Resources Management Act 2004* (SA) (NRM Act).

Approximately 110 species are declared under the NRM Act, including weeds such as bridal creeper, salvation jane, wheel cactus, caltrop and African boxthorn (Biosecurity SA 2012). Landowners have the legal responsibility to control declared plants. The NRM Boards coordinate and enforce control programs for declared plants.

The *Agricultural and Veterinary Products (Control of Use) Act 2002* came into operation in August 2004. The General Duty under this Act requires persons using chemicals to take all reasonable and practical measures to minimise contamination of land, animals or plants outside the target area and to minimise harm to human health and the environment.

The obligations under the three Acts are outlined below in Table 22-2.

TABLE 22-2 | APPLICABLE LEGISLATION CONTROLLING BIOLOGICAL IMPACTS

Legislation, Planning	Pinpoint Name	Requirement, Purpose	Project Relevance
National Parks and Wildlife Act 1972 (SA) (NPW Act)	National parks, Conservation parks, Endangered, Vulnerable, Rare species, respectively	Allows for the establishment and maintenance of a system of reserves, as well as the protection of threatened species of flora and fauna.	The BIHGP is not located within reserves or sanctuaries administered under the NPW Act. It is expected that threatened species will form part of flora and fauna management considerations for BIHGP.

Legislation, Planning	Pinpoint Name	Requirement, Purpose	Project Relevance
Native Vegetation Act 1991 (SA)	Clearance and enforcement	Regulates the clearance of native vegetation throughout South Australia.	Mining operations that involve the clearance of native vegetation must be undertaken in accordance with an approved native vegetation management plan (NVMP) that the Native Vegetation Council (NVC) is confident will result in a significant environmental benefit (SEB). Provision of the SEB can involve an offset of native vegetation undertaken by Terramin, the offset of native vegetation elsewhere and/or a payment of money to the NVC (DWLBC 2005) or an accredited SEB provider.
Natural Resources Management Act 2004 (SA) (NRM Act)	Control of animals and plants	Approximately 110 species are declared under the NRM Act, including weeds such as bridal creeper, salvation jane, wheel cactus, caltrop and African boxthorn (Biosecurity SA 2012). Landowners have the legal responsibility to control declared plants. The NRM Boards coordinate and enforce control programs for declared plants.	It is expected that declared species will form part of pest plant and animal management considerations for BIHGP.
Agricultural and Veterinary Products (Control of Use) Act 2002 (SA)	Control of agricultural chemical use	Requires persons using chemicals to take all reasonable and practical measures to minimise contamination of land, animals or plants outside the target area and to minimise harm to human health and the environment.	Terramin's site management plan prohibits the use of Group I, Phenoxy Acid herbicides for the control of broad leaf weeds.

22.1.4 HYDROGEOLOGICAL

Hydrogeological impacts are subject to NRM Act, as well as the *Western Mount Lofty Ranges Water Allocation Plan* details of which are outlined in Table 22-3.

TABLE 22-3 | APPLICABLE LEGISLATION CONTROLLING HYDROGEOLOGICAL IMPACTS

Legislation, Planning	Pinpoint Name	Requirement, Purpose	Project Relevance
Natural Resources Management Act 2004 (SA)	Water affecting activities	Permits are required for the construction of water harvesting/extracting facilities (such as wells) and water licences are required, along with any endorsed water allocation for water use from any prescribed water resource.	In October 2005, the water resources of the Western Mount Lofty Ranges were prescribed under the authority of the Minister and in accordance with the *Natural Resources Management Act 2004* (SA). The Bird-in-Hand Gold Project is located within the Western Mount Lofty Ranges prescribed water resources area for which the *Natural Resources Management Act 2004* (SA) Water Allocation Plan for the Western Mount Lofty Ranges Prescribed Water Resources Area (AMLR NRMB 2013) exists.

Legislation, Planning	Pinpoint Name	Requirement, Purpose	Project Relevance
	Certain uses of water authorised (section 128)	Subject to subsection (2), the Minister may, by notice published in the Gazette, authorise the taking of water from a prescribed watercourse, lake or well, or the taking of surface water from a surface water prescribed area, for a particular purpose specified in the notice.	Authorisation is required for the extraction and subsequent reinjection of water in the Western Mount Lofty Ranges Prescribed Water Resources Area.
Western Mount Lofty Ranges Water Allocation Plan		Is guided by the NRM Act, which provides the legal framework for sustainably managing South Australia's water resources for the benefit of all water users.	Terramin have designed the water management system to meet the overall objective of no adverse impact to the supply or quality of water to existing users or water dependent ecosystems.

22.1.5 Other Applicable Legislation

Other legislation which applies and has the potential to impact surrounding agricultural businesses includes the *Fire and Emergency Services Act 2005* (SA), which outlines fire prevention measures and prescribes when some business activities may be prohibited.

22.1.6 Plans

Plans which guide land use for the proposed ML area include the Adelaide Hills Council Development Plan, Adelaide and Mount Lofty Ranges Natural Resources Management Plan and the South Australian Murray-Darling Basin Natural Resources Management Board Regional NRM Plan as detailed in Table 22-4..

Table 22-4 | Applicable Regional and State Plans Controlling Agricultural Impacts

Legislation, Planning	Pinpoint Name	Requirement, Purpose	Project Relevance
Adelaide Hills Council Development Plan	N/A	Outlines what types of development are envisaged for particular zones, and provides objectives, principles and policies related to development control.	It is expected that mining objectives and principles of development control will form part of considerations in planning BIHGP.
Adelaide and Mount Lofty Ranges Natural Resources Management Plan – Strategic Plan	N/A	Provides a strategic basis for improving the natural resources of the AMLR NRM region.	The BIHGP falls predominantly within the AMLR NRM region, but is also partially intersected by the SAMDB NRM region.
South Australian Murray-Darling Basin Natural Resources Management Board Regional NRM Plan	N/A	Sets-out how the environment in the SAMDB NRM region should be managed to ensure balance is achieved between the collective need for resources and the needs of the environment.	

22.2 ASSESSMENT METHOD

The main objectives for the review undertaken by FABAL were to:

- Advise Terramin of potential impacts associated with agricultural production in relation to their proposed BIHGP.
- Access and consider the relevant reports on the BIHGPt in the context of agricultural production.
- Complete an impact assessment review based on confirmed "Potential Impact Events" arising from analytical reports, project designs and impact reports as provided by Terramin.
- Report on potential agricultural impacts with reference to specific Terramin reports and legislation whether impacts are deemed credible or not.
- Consider the potential agricultural impacts in accordance with the Ministerial Determination for BIHGP.

FABAL were provided with analytical reports, project designs and impact reports on a variety of mining disciplines, outlined in the Agricultural Impact Assessment (Appendix U1).

22.3 EXISTING ENVIRONMENT

The majority of the surrounding land is currently used for either livestock grazing pasture, agriculture or horticulture (generally planted vineyards). Extensive irrigation in the catchment is predominantly for horticulture and viticulture while less intensive irrigation is associated with dairy farming and grazing (NRM: Adelaide and Mt Lofty Ranges, 2013). Irrigation of orchards, grapevines and pasture increased substantially in the Central Hills region in the preceding 20 years, with the inclusion of apples, strawberries and vineyards in the Inverbrackie Creek sub-catchment. The Western Mount Lofty Ranges Water Allocation Plan regulates all groundwater abstraction within the Inverbrackie Creek sub-catchment.

Between the 2000-01 and 2005-06 Agricultural Censuses, the area of agricultural use decreased by 8%, or 2,971 Ha. The Adelaide Hills experienced an increase in agricultural land holdings over this period, with a 22% increase of agricultural establishments (Adelaide Hills Council, 2011). This reflects the changing nature of the Adelaide Hills, with an increasing pattern of agricultural land fragmentation, as a result of sub-divisions and urban developments.

The BIHGP site has several proximal neighbours with the primary land use being viticulture. The Bird in Hand Winery, sharing the same name as the historic gold mine, abuts the property to the southwest. Other adjacent land users include general farming and viticultural and agritourism operations, outlined in Figure 22-1.

A detailed description of Groundwater is provided in Chapter 10.

A detailed description of Surface Water is provided in Chapter 11.

A detailed description of Soil and Land Quality is provided in Chapter 12.

A detailed description of Air Quality is provided in Chapter 15.

A detailed description of Air-Overpressure and Vibration is provided in Chapter 17.

A detailed description of Fauna and Pests is provided in Chapter 18.

A detailed description of Vegetation and Weeds is provided in Chapter 19

FIGURE 22-1 | SURROUNDING AGRICULTURAL LAND USE

22.4 SENSITIVE RECEPTORS

Surrounding agricultural land use which has the potential to become an agricultural sensitive receptor includes vineyard operations and beef cattle grazing, shown in Table 22-5 and Figure 22-2.

None of the impact assessments Terramin have completed have provided a credible pathway for impacts to horticultural pursuits located further north. This includes the groundwater impact modelling based on credible worst case scenarios. More detail on groundwater is included in Chapter 10.

TABLE 22-5 | IDENTIFIED POTENTIAL RECEPTORS

Sensitive Receptor	Summary	Impact ID
Vineyard Operations (A) - BIHW	Shown in Figure 22-2	PIE_15_13 PIE_15_14 PIE_15_15 PIE_15_16 PIE_15_17 PIE_15_18 PIE_22_01 PIE_22_02 PIE_22_03 PIE_22_04 PIE_22_05 PIE_22_06 PIE_22_08 PIE_22_10 PIE_22_12 PIE_22_13 PIE_22_14
Vineyard Operations (B) – Artwine + Davis	Shown in Figure 22-2	
Vineyard Operations (C) - Tolley	Shown in Figure 22-2	
Vineyard Operations (D) - Virgara	Shown in Figure 22-2	
Vineyard Operations (E) - Petaluma	Shown in Figure 22-2	
Beef Cattle grazing (F)	Shown in Figure 22-2	
Existing groundwater users	Shown in Figure 22-3	PIE_22_07 PIE_22_09
Local landholders and broader community	The broader community who have an interest in maintaining agricultural land	PIE_22_11

FIGURE 22-2 | IDENTIFIED AGRICULTURAL SENSITIVE RECEPTORS

FIGURE 22-3 | SURROUNDING AGRI-BUSINESS OPERATIONAL WELLS

22.5 POTENTIALLY IMPACTING EVENTS

A range of risks were considered during a formal risk assessment process undertaken by Terramin and supporting consultants. The AIA is specifically focused on potential risks and pathways where the BIH Project could theoretically impact on the surrounding agricultural enterprises, including airborne, biological, hydrogeological, and commercial.

Potential impacts to agriculture related to groundwater and surface water are presented Chapters 10 and 11 respectively. Potentially impacting events related to air quality have also been included here for clarity when reading this chapter. There is more detail relating to air quality in Chapter 15.

TABLE 22-6 | IDENTIFIED POTENTIALLY IMPACTING EVENTS

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Dust (metalliferous) deposition from mine construction impacts on agricultural land	Construction	Dust (metalliferous) generated from construction (excavation of IML, operations area, box cut and initial decline access)	Deposition of airborne metalliferous dust	Surrounding agricultural land	Uncertain	PIE_15_13
Dust (metalliferous) deposition from mining operations impacts on agricultural land	Operation, Closure	Dust generated from operation (ROM, underground mullock to IML, fill material from IML to underground)	Deposition of airborne metalliferous dust	Surrounding agricultural land	No	PIE_15_14
Dust (metalliferous) deposition from the mine site post-closure impacts on agricultural land	Post-closure	Wind generated dust from post-closure landforms	Deposition of airborne metalliferous dust	Surrounding agricultural land	No	PIE_15_15
Dust (total insoluble matter) deposition from mine construction impacts on agricultural land	Construction	Dust (total insoluble matter) generated from construction (excavation of IML, operations area, box cut and initial decline access)	Deposition of airborne total insoluble dust	Surrounding agricultural land	Uncertain	PIE_15_16

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Dust (total insoluble matter) deposition from mining operations impacts on agricultural land	Operation, Closure	Dust generated from operation (ROM, underground mullock to IML, fill material from IML to underground)	Deposition of airborne total insoluble dust	Surrounding agricultural land	No	PIE_15_17
Dust (total insoluble matter) deposition from the mine site post-closure impacts on agricultural land	Post-closure	Wind generated dust from post-closure landforms	Deposition of airborne total soluble dust	Surrounding agricultural land	No	PIE_15_18
Chemicals used to control weeds and/or pathogens on Goldwyn have the potential to drift and impact on surrounding agricultural land	Construction, Operation, Closure	Chemical sprays applied onsite	Air and prevailing wind	Surrounding agricultural land	No	PIE_22_01
Vehicle use onsite has the potential to introduce new plant diseases and impact on agricultural land (e.g. introduction of phytophthora)	Construction, Operation, Closure	Plant diseases	Vehicles and other mining equipment	Surrounding agricultural land	Yes	PIE_22_02
Increased populations of pest animal species as a result of mining operations (e.g. attracted to landfills, putrescible waste) impacts surrounding agricultural practices (e.g. mice, foxes)	Construction, Operation	Pest animals attracted to putrescible waste materials	Increase of pest species in area	Surrounding agricultural land	Uncertain	PIE_22_03
Revegetation has the potential to increase populations of bird species and impact on surrounding agricultural practices (e.g. vineyard productivity)	Construction, Operation	Revegetation	Increased bird species populations	Surrounding agricultural land	Yes	PIE_22_04
Introduction or spread of weeds and/or pathogens as a result of the mine development impacts neighbouring agricultural businesses	Construction, Operation, Closure	Weeds and seeds carried on mining equipment and vehicles	Vehicles and other mining equipment	Surrounding agricultural land	Yes	PIE_22_05

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Use of agricultural topsoil on the IML salvaged from existing farm land has the potential to introduce or spread weeds and impact on surrounding agricultural lands	Closure, Post-closure	Weeds and seeds contained in agricultural topsoil salvaged from existing farm land	Placement of topsoil on IML	Surrounding agricultural land	Yes	PIE_22_06
Blasting in mine void results in vibrations mixing aquifers through fractures impacting groundwater quality which affects existing groundwater users	Operation	Blasting operations	Mixing of groundwater of varying quality	Existing groundwater users	No	PIE_22_07
Water storage dam overflows/geotechnical failure resulting in flooding event downstream impacting agricultural land (BIH Winery Vineyard)	Construction, Operation, Closure	Water storage dam	Surface water flows	Agricultural land (BIH Winery vineyard)	Yes	PIE_22_08
Lowered groundwater table off-lease as a result of mine water management results in loss of agricultural values (existing bore users and agricultural land)	Operation, Closure	Mine water management	Lowered groundwater table	Existing groundwater users	Yes	PIE_22_09
Mining activities have the potential to cause fires and impact grapes and wine (eg smoke taint)	Construction, Operation, Closure	Smoke and ash generated from onsite fire	Air and prevailing wind	Surrounding vineyards	Yes	PIE_22_10
Reduced area of agricultural land available for agriculture as a result of mine	Construction, Operation, Closure, Post-closure	Mining operations	Use of agricultural land	Local landholders and broader community	No	PIE_22_11
Revegetation of perimeter vegetation has the potential to cause microclimatic changes (wind, shade) and impact on offsite agricultural land quality	Operation, Closure, Post-closure	Perimeter revegetation	Microclimatic changes	Surrounding agricultural land	No	PIE_22_12
The establishment of tall structures restricts aerial agricultural practices resulting in lost agricultural productivity	Operation, Closure, Post-closure	Tall structures	Obstruction to aerial operations	Surrounding agricultural land	No	PIE_22_13
The IML landform has the potential to cause microclimatic changes (wind, shade) and impact on offsite agricultural land quality	Operation, Closure, Post-closure	Integrated Mullock Landform	Microclimatic changes	Surrounding agricultural land	No	PIE_22_14

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Lowered groundwater table off-lease as a result of mine water management results in loss of agricultural values (existing bore users and agricultural land)	Construction, Operation	Mine water management	Lowered groundwater table	Existing groundwater users	Yes	Covered extensively in Chapter 10
Increased salinity as a result of mine water management results in loss of agricultural values (existing bore users and agricultural land)	Construction, Operation	Mine water management	Groundwater system	Existing groundwater users	Yes	Covered extensively in Chapter 10
View from surrounding hospitality/tourism businesses is changed (after construction has completed) resulting in a long term reduction in through door rate	Construction, Operation	Altered landscape	Ground disturbing activity (GDA)	Surrounding cellar door businesses	Yes	Covered extensively in Chapter 9 and 24

22.6 CONTROL MEASURES TO PROTECT AGRICULTURAL LANDUSE

Design measures and management strategies for the proposed BIHGP are extensive and cover a range of aspects which have the potential to impact the surrounding agricultural land if not implemented successfully. Aspects which have associated design measures and management strategies include groundwater, surface water, soil and land quality, air quality, air-overpressure and blasting, as well as vegetation and weeds, and fauna and pests.

A detailed description of design measures and management strategies proposed for **fire control** is provided in Chapter 7.

A detailed description of design measures and management strategies proposed for **Groundwater** is provided in Chapter 10

A detailed description of design measures and management strategies proposed for **Surface Water** is provided in Chapter 11

A detailed description of design measures and management strategies proposed for **Soil and Land** is provided in Chapter 12

A detailed description of design measures and management strategies proposed for **Air Quality** is provided in Chapter 15

A detailed description of design measures and management strategies proposed for **Air-Overpressure and Vibration** is provided in Chapter 17.

A detailed description of design measures and management strategies proposed for **Fauna and Pests** is provided in Chapter 18.

A detailed description of design measures and management strategies proposed for **Vegetation and Weeds** is provided in Chapter 19.

TABLE 22-7 | ADDITIONAL PROPOSED DESIGN MEASURES AND MANAGEMENT STRATEGIES SPECIFICALLY REGARDING AGRICULTURAL IMPACTS

Design Measures and Management Strategies	Impact ID
All surface chemicals used onsite to be checked against viticulture regulatory frameworks for acceptable use. Use of Group I, Phenoxy Acid herbicides will be prohibited onsite.	PIE_22_01
Standard Work Procedures to be implemented for weed spraying which includes wind speed and direction analysis and Job Hazard Analysis signed off by Env. Dept.	PIE_22_01
Establish a 'Good Neighbour Notification Policy' with surrounding stakeholders, whereby each party notifies each other of proximal boundary activities and timing.	PIE_22_01
Biodiversity Management Plan including phytophthora and phylloxera management plan	PIE_22_05 PIE_22_02
Implementation of Weed and Pest Management Plan	PIE_22_01 PIE_22_05 PIE_22_06 PIE_22_02

22.7 IMPACT ASSESSMENT

The impact assessment section of this chapter has been prepared independently using FABAL's Agricultural Impact Assessment (AIA) and associated report (see Appendix U1).

22.7.1 AIRBORNE

Physical dust particles, as opposed to dust containing exogenous chemical compounds, have the ability to create nuisance and amenity impacts and potentially, in sufficient quantities, human health and environmental impacts.

FABAL states that upon review of the extensive baseline testing, modelling and proposed operational controls outlined in the example Angas Zinc Mine Environmental Monitoring Program (EMP) (Terramin, 2012), including buffer zone planting, it is difficult to conceive any impact above and beyond the normal background intrinsic activities (spraying, slashing, etc.) already underway in the adjacent vineyards.

However, Section 2.3.2 Deposited Dust of the AECOM AQIA (Appendix N3) report raises the potential for deposited dust to inhibit photosynthesis by blocking sunlight onto grapevine leaves. Whilst there are reports in the literature of dust-inhibited photosynthetic rates, they are largely focused on roadside contamination in urbanised environments with significant loadings of particulate matter far in excess of the AECOM modelling (Thompson, et al., 1984).

Work by Al Hazmi (2000) indicated no statistical difference in grapevine photosynthetic rates was identified where dusting with soil was purposefully and repeatedly applied as a form of organic fungicide.

Al Hazmi's work coincides with some of the more recent findings pertaining to the use of foliar applications of Kaolin particle films used to regulate heat stress (effectively a white reflective clay sprayed on vines) which are showing positive biomarkers with respect to desirable fruit characteristics and performance traits ((Shellie & Glenn, 2008) (Al-Hazmi, 2000)).

Overall, there is expected to be **negligible** impact on surrounding vineyards from potential dust deposition from the mining operation, based on the AQIA and associated modelling.

22.7.1.1 METALLIFEROUS DUST

By its nature of an extractive mining operation targeting gold and silver, the potential for metalliferous loading of airborne particulate matter should be considered. Sources may include:

a) Transporting ore from the mine to loading facility (ore silo);
b) Loading transportation trucks;
c) Integrated Mullock Landform (IML) management;
d) General site movement of vehicles; and
e) Pre-existing site contaminated areas.

The AQIA deals with these risks in a detailed manner and, based on modelling results, the residual risk on adjoining agricultural activity or land from metalliferous dust is **low**.

In relation to metalliferous dust it should be noted that it is common industry practice, in fact an essential commercial activity, that adjoining viticultural operations will apply metalliferous fungicides (principally elemental copper) on an ongoing and regular basis for the preventative control of downy mildew (*Plasmopara viticola*).

Industry norms would commonly see a vineyard in the area apply in the order of 5-7 applications of copper per year. Each application would average of 2-3 kg/ha. Accordingly, over a 5-year period, adjoining viticultural operations would reasonably be expected to apply 50 to 100 kg of elemental copper per ha. The literature recognises that this fungicide application can result in accumulative soil concentrations of copper (Adam M. Wightwick, et al., 2008).

22.7.1.2 CHEMICAL CONTAMINANTS

In a similar context to the above metalliferous risk factors, the chemistry of any agents used on site needs to be considered in the context of airborne chemical events.

The *Agricultural and Veterinary Products (Control of Use) Act 2002* came into operation in August 2004. The General Duty under this Act requires persons using chemicals to take all reasonable and practical measures to minimise contamination of land, animals or plants outside the target area and to minimise harm to human health and the environment.

In order to address the source of this potential impact, Terramin's Biodiversity Management Plan (Appendix R6) prohibits the use of Group I, Phenoxy Acid herbicides for the control of broad leaf weeds, which removes this source and pathway (spray drift) as a possible impact.

Surrounding grapevines are extremely susceptible and drift can impact growth and generate grape residues at extremely low concentrations. By preventing the use onsite, Terramin have eliminated this risk and any subsequent potential impact.

The Australia wine industry services a global market place. Several export countries (particularly rapidly growing Asian markets) have limited established Maximum Residue Levels (MRL). As a consequence, much of the Australian industry has adopted a conservative default MRL of "zero detect" irrespective of any objective risk, often at Limit of Detections (LOD) of single parts per billion. If any level of unregistered product is detected, it can breach many of the large Australian winegrape buyers'

contractual obligations and grapes can be rejected. Therefore any boundary based chemical applications such as herbicides or insecticides, selecting products registered for adjoining crop type is highly recommended. Similarly, this approach eliminates the risk and any subsequent potential impact.

Genetically Modified Organism risk has also been eliminated by preventing GMO modified wetting agent used with a herbicide to treat weeds on the onsite, as The Australian wine industry presently has a zero-tolerance stance on genetically modified organisms and the use of GMO products or derivatives is banned.

22.7.2 BIOLOGICAL

Biosecurity for high value agricultural pursuits is a critical control point. The surrounding vineyards are high value permanent plantings and pest / pathogen incursions have the potential to create commercial impacts. Specifically, this includes plant pathogens such as *Phytophthora and Phylloxera*, as well as weeds and pests.

Terramin manages site specific risk factors with two key policies and procedures;

- *Terramin Exploration - Phytophthora and Phylloxera Management Plan at Bird in Hand;* and
- *BIH Exploration Drilling and Works Standard Operating Procedure.*

These policies and procedures have been reviewed by FABAL, who considered them to "provide a robust set of controls for known biological risk factors".

Biosecurity is the responsibility of all landowners and the BIHGP is located in a high value agricultural landscape. FABAL consider Terramin to have a solid understanding of the general biosecurity risks and has put in place controls to modify residual risks to a low level.

Terramin expect to have a negligible impact on surrounding vineyards.

22.7.2.1 ANIMAL PESTS

The risk of the site harbouring / encouraging animal pests (e.g. foxes, rodents, etc.) is low. Appropriate site waste management of food waste and other putrescible waste should mitigate scavenger risk.

The revegetation areas could harbour increased rabbit populations depending upon status of broader virus release management of the pest. The Angas Zinc Mine (AZM) Environmental Monitoring Program (EMP) (Terramin 2012) outlines a program that is deemed adequate for monitoring and control if similarly deployed at the BIHGP site.

A replicate program would be included in the Goldwyn Biodiversity Management Plan, included in Appendix R6.

22.7.2.1.1 BIRD PESTS

See Perimeter Revegetation Program section 22.7.5.1.

22.7.2.1.2 INSECT PESTS

Phylloxera

South Australia remains one of the last few pockets of the global wine industry not impacted by phylloxera. In Australia, grape phylloxera is currently confined to parts of Victoria and New South Wales. Phylloxera is an insect pest that feeds on the roots of *Vitis vinifera* grape vines and, if introduced to an

own rooted vineyard, will ultimately kill the vines. Movement of phylloxera in Australia is most often attributed to crawlers. These are easily picked up by clothing, footwear, equipment and vehicles (including harvesters), or in soil and vine material (leaves and shoots).

The wine industry, through Vine Health Australia, has established detailed guides for site hygiene. Whilst Terramin procedure *Terramin Exploration -Phytophthora and Phylloxera Management Plan at Bird in Hand* covers biosecurity protocol, it is important that they remain consistent with the guidelines of Vine Health Australia over time, available at:

http://www.vinehealth.com.au/biosecurity-in-practice/checklist-and-protocols/grapegrowers- guide-hygiene-procedures/

It is conceivable that receptor monitoring and sampling on an ongoing basis throughout the life of the BIH Project might involve access to surrounding sites, e.g. surrounding bores.

Maintenance of the protocols by staff and contractors involved in these activities is controlled by the Biodiversity Management Plan and the *Terramin Exploration – Phytophthora and Phylloxera Management Plan*, which includes procedures which are the same as the surrounding wine industry.

Exotic

In an increasingly globalised world, the potential for exotic pest incursion needs to be acknowledged. Terramin, like the surrounding tourism facilities, is likely to have international visitors (potentially contractors) and the need for biosecurity vigilance is an ongoing imperative. The Terramin *BIH Exploration Drilling and Works SOP,* and specifically Section 2. Operator Prequalification, manage risks associated with equipment and contractors within the scope of this risk source.

22.7.2.2 PLANT PESTS

22.7.2.2.1 WEEDS

Native

Terramin currently has in place the weed identification and management plan at the AZM (Angas Zinc Mine Environmental Monitoring Program Terramin 2012) and this plan will be extended to include the BIHGPduring operations. Effective implementation of the plan is sufficient to ensure minimal risk to surrounding agricultural operations.

A replicate program has been included in the Goldwyn Biodiversity Management Plan, included in Appendix R6.

FABAL considered the formal procedure established by Terramin as more structured than most commercial agricultural operations deploy.

Exotic

Similar to insect pest procedures, plant disease potential risk controls are contained within Terramin standard procedures and offer strong biosecurity barriers. The expected impact is **negligible**.

22.7.3 HYDROGEOLOGICAL

22.7.3.1 SURFACE WATER

A more detailed description of the existing surface water environment, control measures and impact assessment is included in Appendix I1.

The issues pertaining to surface water risks are detailed in the Storm Water Management Plan (Appendix I3) and represent a detailed and comprehensive approach to site issues listed below. The residual risk from surface storm water issues is deemed **very low**. Terramin expect to have a **negligible** impact on surrounding agricultural land use.

22.7.3.1.1 CONTAMINATION

Chemicals and Fuel

All chemical and hydrocarbon storage will be in accordance with:

- AS 1940-2004: The storage and handling of flammable and combustible liquids;
- AS 1692-2006: Steel tanks for flammable and combustible liquids;
- Relevant South Australian legislation; and
- Best practice guidelines.

The wheelwash and washdown area will bunded, with wash-water recycled within the washdown area.

Metalliferous (inc. Acid Mine Drainage (AMD) and Potentially Acid Forming material (PAF))

The risks of metalliferous contaminated surface water impacting upon local and distal agricultural enterprises are a function of the potential sources of metalliferous runoff and subsequent controls.

The fact that the BIHGPfacility will undertake no on-site processing and load out ore to the Terramin owned and operated AZM located in Strathalbyn significantly modifies the risk. The offsite processing and lack of large tailings requirements significantly mitigates risk profile.

The IML is essentially an engineered area for the storage of decline waste rock (mullock). The runoff from this area is dealt with in the Stormwater Management Plan (Appendix I3) and represents a strong risk mitigation outcome for surrounding agricultural operations.

Mining operations have the potential to experience AMD if they encounter and expose sulphide containing minerals to oxidation (Appendix M2). The risk associated with AMD is that the process of oxidation can liberate metals and effect pH changes in drainage water. If drainage were to leave the mine site, it could impact on adjoining ecology.

The BIHGP is projected to encounter relatively low levels of PAF material (Appendix M2). In the context of surface water risk factors, the Storm Water Management Plan (Appendix I3) combined with on-site waste water treatment facility, suggest **low** residual risk to adjoining agricultural enterprises can be envisaged from AMD or PAF surface water impacts. The AMD Baseline Study recommends that the ongoing monitoring of mining activities for AMD material is required.

Erosion

Water erosion control is an integral part of the site's environment management plan. The design of all landforms has been undertaken with the intention of minimising sediment loss through water erosion. The mechanisms are outlined in detail in the Storm Water Management Plan (Tonkin 2016) and are

designed for a 1-in-100 year ARI. FABAL believes that any risks of direct effects on surrounding agricultural enterprises as a result are low.

Pest vector

Terramin's proposed Environmental Management Plan for the BIHGP should minimise the risk of stormwater providing a vector pathway for pests. The most likely pest would be a weed seed transfer and careful monitoring of riparian zones would assist in mitigating this risk. Terramin expect there to be a negligible impact on surrounding agriculture land use.

Flooding / inundation

The risk to surrounding agricultural enterprises from flooding or inundation from the BIHGP site is considered to be extremely low. The Tonkin (2016) Stormwater Management Plan has been developed to "*ensure that peak flows leaving the site are no higher than pre- development rates"* (Tonkin 2016). Accordingly, the only other potential inundation source could be the water storage dam via an infrastructure failure. Assuming this facility is engineered to Australian Standards and maintained appropriately, it is extremely unlikely that the BIHGP represents a flood / inundation threat to surrounding agriculture given catchment scale and natural drainage architecture.

22.7.3.2 WATER TREATMENT

Terramin has commissioned GPA to design a water treatment plant, which has the capacity to treat known BIHGP sources of water and create quality standards projected to meet the legislative obligations from the *Environment Protection (Water Quality) Policy 2015* (SA), ANZECC guidelines, and all other applicable legislation. Subject to the implementation of the plant, low residual risk to adjoining agriculture can be envisaged from site waste water contamination of surface water.

FABAL suggest that subject to licensing restrictions there may be an opportunity for adjacent agricultural land users to supplement or augment existing bore water supplies with treated water.

22.7.3.3 GROUNDWATER

The key groundwater issues relate to the mining operation and potential interaction with a Fractured Rock Aquifer adjacent to the targeted mineralised area. The process of depressurising the adjacent aquifer and minimising potential seepage into mining drive will influence the local aquifer fracture conditions. The Groundwater Assessment (Appendix H1) has extensively modelled these interactions and outlines the technical variables.

There are several key interventions that Terramin intends to deploy to mitigate risks and impact on the groundwater conditions:

1. Careful mine design to avoid high water yielding zones;
2. Deploying a technique of probing and grouting (as outlined in Bird In Hand Gold Project – Grouting for Groundwater Control - Multigrout 2017 – Appendix H2); and
3. Depressurising, treatment and Managed Aquifer Recharge (MAR) program (Appendix H1).

It appears from the detailed technical review that, based on deployment of the planned interventions, the potential impact on ground water should be restricted to an area contained within the boundary of the BIH Project site. The key effect is likely to be a localised cone of depression surrounding extraction sites.

The Groundwater Assessment modelling deals with the risks of potential encroachment from Eastern Mount Lofty Ranges sub catchment in detail and suggest that the MAR program should maintain the barrier interface effectively. Whilst there are no obvious indications that the groundwater salinity is at risk from the program there is a need to carefully monitor this critical control point on an ongoing basis due to its ability to impact on productive capacity for surrounding irrigators.

The more apparent risk pathway for contamination to reach groundwater would be the directly injected water via the MAR program. The injection of water under an MAR program is regulated by several legislative controls. Firstly, the conditions are outlined in the Western Mount Lofty Ranges Water Allocation Plan (WMLR WAP). Specifically, the WMLR WAP states that the MAR source water:

i. will not contravene the water quality criteria in Schedule 2 of the Environment Protection (Water Quality) Policy 2003 or any subsequent or related policy; or
ii. is of equal or better quality than the ambient underground water, accordingly, the legislation would deem any contamination a breach.

Ongoing monitoring will be a critical control point of this.

A more detailed description of the existing groundwater environment, control measures and impact assessment is included in Chapter 10.

22.7.3.4 BLASTING AND GROUNDWATER (REPLICATED FROM CHAPTER 10: GROUNDWATER

22.7.3.4.1 THE POTENTIAL IMPACTS OF BLASTING ON BORE HOLES

Blasting is a mining method that can be used through all stages of mining (Construction, development and production). Blasting operations for exploration or mining breaks up the rock material immediately surrounding the blast for easy removal. The impact of blasting on nearby wells or bores is a common concern for the public or neighbouring landowners, worried about potential damage to bores and changes to water quality and turbidity. This summary focuses on the potential impacts from blasting on groundwater wells surrounding the proposed BIHGP operation.

Blasting operations impact the surrounding rock. However, bores are unlikely to be affected by blasting operations (Frank & Beaver Jr, 1984). Past research has shown no significant changes in yield or water quality over a range of distances and charge weights (Sneddon 1981). Temporary and minor changes in water levels, and turbidity may be caused by blasting within the immediate vicinity but are not a long term or permanent impact.

22.7.3.4.2 POTENTIAL DAMAGE TO WELLS

There is the potential for the blasting to impact the surrounding rock in three ways; creation of new fractures, expansion of existing fractures and joints, and collapse of fractures (Sneddon 1981, Golder Associates, 2005, Frank & Beaver Jr, 1984, Bender 2006, Hawkins, 2000). The literature suggests this only occurs within a contained area around the blast hole (~20m) and is very dependent on the size of blast and the rock formations (Golder Associates, 2005). In none of the literature, has there been any instances of physical damage to bores (Sneddon 1981, Golder Associates, 2005, Frank & Beaver Jr, 1984, Bender 2006, Hawkins, 2000). Even at a distance of just 10-50 ft (3-15 m) bore casing remained intact (Frank & Beaver Jr, 1984). One key reason is the propagation of vibrations through the subsurface reduces much more quickly than those on the surface (Bender 2006, Golder Associates, 2005).

22.7.3.4.3 POTENTIAL IMPACT ON AQUIFERS

Blasting can result in movement in localised fractures in the rock and have an impact on the local aquifer. This can cause new or expanded fractures and cracks to increase aquifer capacity and can cause localised collapsed fractures which may decrease aquifer capacity. The structure of the subsurface in which the bore is situated may have an impact on the effects of the blast on the aquifer. In addition to the capacity of the aquifer, the structure can also affect other factors such as water quality.

Water quality has been found to be generally unaffected over the long term (Frank & Beaver Jr, 1984 – no change except at very short range and even that was not permanent).

During blasting, there is potential for increases in nitrites (Kernen 2010 & Hawkins, 2000), and the breaking up of rock material may contribute to levels of dissolved solids such as sulphates, iron, manganese, aluminium, and sodium in the water. Water quality changes are described as short term only and reversible.

Furthermore, there is the potential for movement in the rock to create temporary and short-term changes to the water level. Even though these impacts are possible, the literature highlighted that water level changes can occur briefly at the time of the blast, but are generally minor (~10cm (Golder Associates, 2005) 3cm at 500ft, and 30cm at 100ft (Frank & Beaver Jr, 1984)) and will correct themselves with time.

The final possible impact is a potential increase in the localised bores turbidity. This can be caused by; shaking loose naturally occurring sediment material from walls of the bore into bore water, similar to that cause by significant rainfall events, and washing naturally occurring sediment out of newly created or expanded fractures into the aquifer. (Frank & Beaver Jr, 1984, Hawkins,2000).
Golder Associates (2005) suggests that vibration limit of 25mm/s should yield no apparent impacts on the bores or their water quality, and a limit of 50mm/s may see occasional instances of increased turbidity, but will protect bores from any other damage.

22.7.3.4.4 HOW THIS RELATES TO THE BIHGP

Blasting will be used during all three phases of the mine (construction, development and production). Blasting will be used during the excavation of the box cut and road cutting on the surface during construction and used in the subsurface during development and production. The report by Saros (2017) goes into detail on the methodology of the blasting during the three phases of mining, highlighting the minimal impact from the small-scale blasting on the surrounding environment. The short-term construction blasting in the box cut will be used to blast 5-10m benches using a maximum charge weight of 12-40 kg. During the long-term development and production blasting, the blast dimensions are approximately 5 m wide and 5 m high, and target advance of around 3-4 m per shot. These blasts will use a maximum charge weight of 5 kg per blast hole. These dimension and charge weights are significantly smaller then though used in the literature examples. Also, this blasting should be very well controlled as it only needs to be designed specifically to fracture the rock sufficiently to facilitate excavation as opposed to fracturing required during mining.

In Australia, the requirement surrounding the use of explosives, and consequently both blasting activities and their subsequent environmental effects, are detailed in Australian Standard 2187.2 (SAI Global, 2006). It is important to note that regulatory compliance limits are based on human comfort

levels rather than damage thresholds. The BIH location is classified as a sensitive site, which is required to have ground vibration limit of '5mm/s for 95% blasts per year, 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply (Saros 2017).' In the modelling undertaken by Saros (2017) on the proposed blasting activities the modelling indicated blast practices during all three phases of the mine can be conducted safely and maintain compliance with regulatory limits. Figure 22-5 shows the extent of blast induced ground vibration during the construction phase at BIH, which is the largest amount of vibrations which will be produced in the BIHGP blast operations. In Figure 22-5, the red line shows 10 mm/s and the orange line shows 5 mm/s. When compared to Figure 22-5, the location of the bore holes, all neighbouring boreholes are outside the 5 mm/s limit. As a result, compliance with the licence conditions will minimise human discomfort and prevent any likelihood of damage to neighbouring structures including boreholes.

There are several mitigation actions that can be undertaken to reduce the potential impacts from blasting should they be required including:

- Pre-split blast holes to limit damage from bulk blasts;
- Closer blast spacing;
- Delayed intervals between blasts;
- No stemming in blast holes;
- Reduced burden;
- Lower explosive densities to reduce peak blast pressure; and
- Blasting pressures designed to match compression strength of surrounding rock.

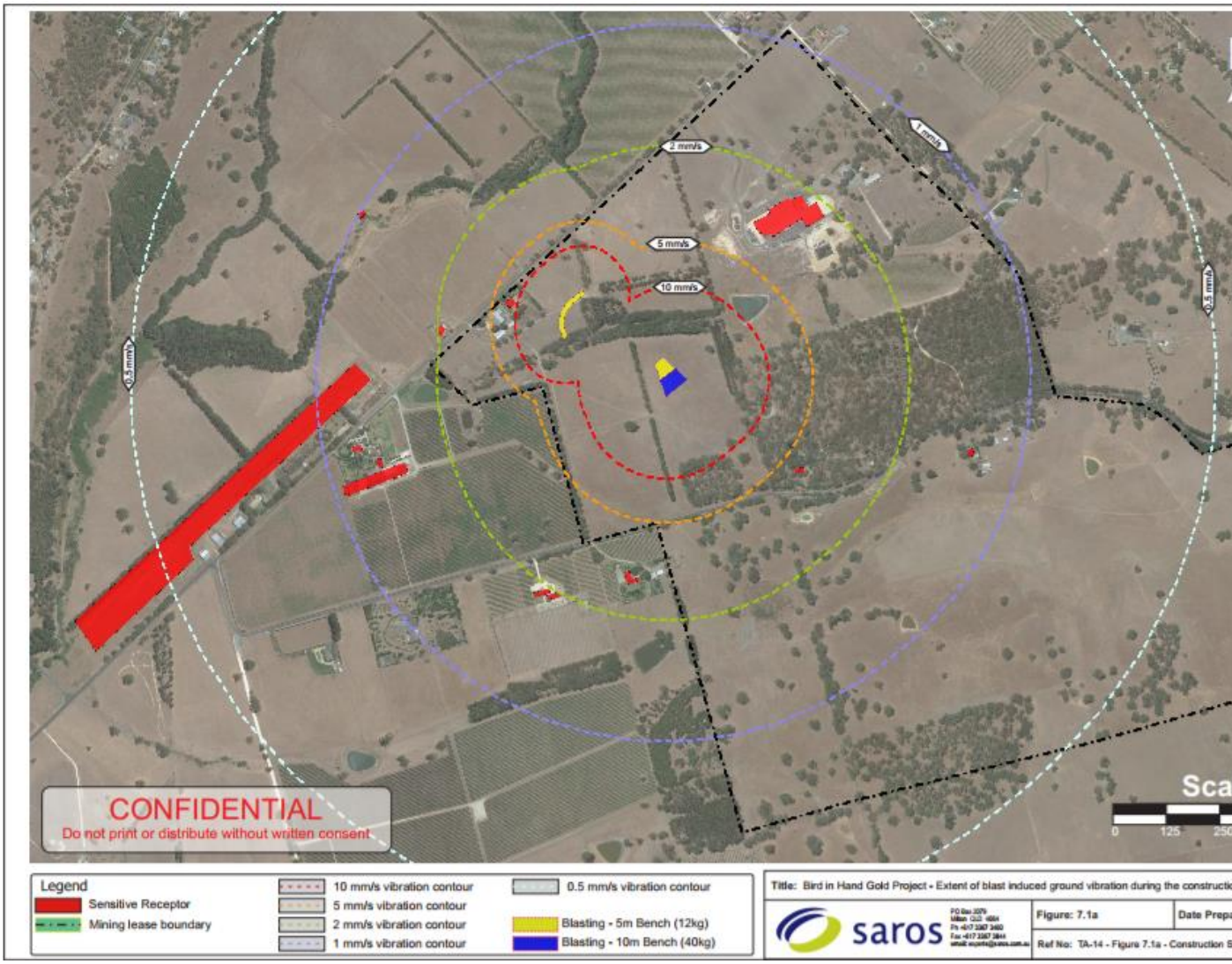

FIGURE 22-4 | EXTENT OF BLAST INDUCED GROUND VIBRATION DURING THE CONSTRUCTION PHASE AT BIH.

FIGURE 22-5 | LOCATION OF BOREHOLES SURROUNDING THE BIH OPERATIONS.

22.7.4 COMMERCIAL

22.7.4.1 VISUAL AMENITY

The draft Strategic Visual Amenity Plan (SVAP) (2017) undertaken by Oxigen Pty Ltd (Oxigen) in conjunction with the site plan design undertaken by Tonkin has considered the potential visual amenity impacts in detail.

The Oxigen design work demonstrates that the ore storage silo is likely to be the key material inorganic feature of the mine visible from proximal agritourism facilities during operations. From the modelled imagery, the proposed silo appearance is not inconsistent with the existing Bird In Hand Winery silos immediately adjacent to the site. It should also be highlighted that the ore storage silo is proposed to be removed at closure, as described in Chapter 3 and in the Landscape Component of the Mine Closure Plan, also prepared by Oxigen (Appendix X1).

Oxigen design work, combined with the fact that the mine is an underground decline structure, has mitigated the majority of the remaining visual impact due to bunding, vegetation and infrastructure placement within the existing surface contours and remnant vegetation.

Terramin expect to have a **negligible** impact on surrounding visual amenity once constructed.

A more detailed description of the existing visual amenity environment, control measures and impact assessment is included in Appendix 10.

The SVAP is included in Appendix G1.

The Landscape Component of the Mine Closure Plan in included in Appendix X1.

22.7.5 OTHER

The increased shelter belt planting will provide a natural buffering for any dust generation, irrespective of source. It is also likely to assist in slowing wind speeds and potentially increase fungicide spraying windows for the adjoining vineyards. In addition to the practical windbreak effect, the vegetation belt also has the potential to mitigate the risk of chemical trespass from adjoining agricultural pesticide spraying activity.

22.7.5.1 PERIMETER REVEGETATION PROGRAMME

Whilst the BIHGP is ultimately subject to compliance with the Mining Act rather than to the Development Plan - Adelaide Hills Council (April 2016), the principles of Development Controls for Mining under the Develop Plan have been taken into account in the project design. Specifically, principle 172 states:

> *Where extractive operations are proposed, appropriate and practical measures (e.g. buffer areas, acoustic mounding, tree planting) should be provided to ensure that the operations do not unreasonably affect the amenity of the locality, having regard to the land uses which can be expected to be developed.*

22.7.5.1.1 POTENTIAL FOR MICROCLIMATIC IMPACTS

Windbreak and airflow

The AQIA indicates that wind direction survey of the site shows variable directions at different times of the year. The site boundary has existing vegetation. The recent and planned Terramin programs to comply with the Development Plan involve thickening the density and diversity of the existing vegetation and the revegetation of strategic areas to improve visual amenity.

Broadly there has been significant work indicating that windbreaks in vineyards have been shown to positively affect the vineyard microclimate. Furthermore, studies have indicated that proximal zones can experience increased adjacent fruit set and cropping potential for distances out into adjacent vineyard blocks by up to 7 - 10 times the height of the actual windbreak (Department of Agriculture and Food WA).

Frost

Inappropriately positioned vegetation can have the effect of trapping cold and frosty air. The impacting on air drainage can increase frost damage in vulnerable circumstances. Given the topography of the BIHGP site and the lower adjacent vineyard holdings the risk of negatively affecting cold air drainage is low.

Heat events and evapotranspiration

Strategically positioned vegetation belts can assist in buffering vulnerable vineyards from extreme wind and heat days that increase evaporative loss by vineyards. The location of the existing and increased perimeter planting is likely to impart positive influence on mitigating hot northerly wind events that can increase evapotranspiration and the risk of fruit damage in summer.

22.7.5.1.2 AERIAL IMPEDIANCE

Increasingly agriculture is utilising remote sensing as a decision support tool. One of the emerging technologies involved in this practice is the use of drones. Extensive tall vegetation belts are a consideration in the operation of this technology. This is unlikely to be an issue for the Terramin perimeter planting given location however, as the shelter belts mature, expanding margins of the canopy may need to be addressed.

In broad acre environments, aerial deployment of pesticides is often undertaken via fixed or rotary winged aircraft. This is rarely utilised in viticulture and existing vegetation within surrounding environments of the BIHGP suggest that the revegetation program is unlikely to impart a compounding risk on this type of activity should it ever be contemplated.

22.7.5.1.3 BIODIVERSITY IMPACTS

Pest bird species

With any increased vegetation, a potential risk exists that pest birds that peck or eat adjacent grapes may increase. A review of the COOE Pty Ltd (2014) Flora and Fauna and Survey Report (included in Appendix Q1) highlights a range of known grapevine pest species on the Terramin holding and surrounding area. The pre-existing perimeter vegetation already provides adequate perching and habitat features to support current pest species. There is debate in the literature as to whether

thickening of the shelter belt is likely to have any material impact on incidence and severity (Australian Government Bureau of Rural Sciences 2003).

The Flora and Fauna Survey Report (Appendix Q1) report identified one pest species that has the potential to pose a risk to the adjacent vineyard through increased numbers afforded by thickening of the perimeter planting. The protected species, Silver Eye *(Zosterops lateralis*), has the potential to use increased understorey planting as cover from predator birds and this may increase proximal damage.

In the event that the species incidence increased, there are a range of control options including barrier netting.

Predator bird activity

The increased planting density has the potential to provide more suitable environment and food source for predator bird species.

Biodiversity

The viticultural industry is becoming increasingly aware of the benefits of increasing local biodiversity (Thompson & Hoffmann, 2010) and (Retallack, 2012). One of the prime recommendations in the current literature is the use of shelter belts and windbreaks to increase biota habitat diversity. The Terramin revegetation program is expected to have positive impacts with respect to biodiversity for immediate proximal agricultural enterprises.

Pests general

There is a potential for the shelter belts to host other pest species including rabbits if no other controls are in place. Rabbits have the potential to economically impact on adjacent new vineyard plantings, or small crop production if they were to take place. Currently, the adjoining landowners have mature vineyards and this combined with a properly implemented derivation of the Biodiversity Management Plan (which includes weed and pest controls) should maintain the currently low risk potential. Ongoing monitoring program is important in this instance.

22.7.5.2 FIRE RISK

Several of the surrounding agricultural enterprises are viticultural grape growing operations. Increasingly the Australian wine industry is becoming aware of the risks to wine quality posed by smoke taint issues (AWRI, 2015). The Adelaide Hills region has suffered significant losses in the past with bushfire smoke taint damaging grapes and wine (Australian Broadcasting Corporation, 2015). The most vulnerable time for grapes is from December through April as the new fruit is forming and ripening. Risks are proportionate with density and temporal loading of smoke concentrations.

The BIH Project needs to recognise its position within the broader Adelaide Hills community and the impact of fires and related smoke impacts.

Terramin has extensive and detailed emergency response processes in place that assist in mitigating impact emanating from a potential site fire covering its AZM and these processes will be extended to the operational phase of the BIH Gold Project and risks are as low as is reasonably practical.

22.7.5.3 BLASTING

Terramin has undertaken a BIHGP Blasting Impact Assessment (Appendix P1). Blasting activities are regulated by Australian Standard 2187.2 - 2006.

The report indicates that regulatory compliance limits are based on human comfort levels rather than damage thresholds. As a result, compliance with the licence conditions will minimise human discomfort and prevent any likelihood of damage to neighbouring structures. Based on the assumed compliance with licence conditions the residual risk to surrounding agricultural activities as a result of blasting is very low.

Additionally, Glencore's Bulga Coal operation in NSW has been mining beneath about 90 hectares of vineyards since 2006, using a method which means as the coal seam is removed the rock immediately above the mined section collapses – causing intentional subsidence. Results of the monitoring have been presented each year to a Technical Review Committee which includes wine makers, academics and government representatives. Results so far have shown no long term impact on the vineyards from the mining (Bulga Coal, 2017).

Considering the BIHGP underground workings are located approximately 250 metres from the closest vineyards, rather than below, Terramin expect there to be no impact from blasting on the surrounding agricultural land use.

BHP's BMA coal operation in the Bowen Basin analysed data from 42 livestock herds. Animal installations were selected for observations on animal behaviour under sonic boom conditions. Numbers of animals observed in this study were about 10,000 commercial feedlot beef cattle, 100 horses, 150 sheep and 320 lactating dairy cattle. Sonic booms during the test period were scheduled at varying intervals during the morning hours Monday to Friday of each week. Results of the study showed that the reactions of the sheep and horses to sonic booms were slight. Dairy cattle were little affected by sonic booms (125 dB to 136 dB). Only 19 of 104 booms produced even a mild reaction, as evidenced by a temporary cessation of eating, rising of heads, or slight startle effects in a few of those being milked. Milk production was not affected during the test period, as evidenced by total and individual milk yield. This analysis was included and approved by the Queensland Government as part of the project's Environmental Impact Statement (BHP BMA, 2009).

The expected air overpressure is within the compliance limits set by Australian Standard 2187.2 - 2006. Existing baseline data collected (Figure 22-6) (outlined in more detail in Chapter 17), shows there are regular naturally occurring instances of overpressure being higher than 115dB(L), caused by wind or possibly human induced activities such as gas guns.

Terramin expect there to be no or negligible impact on livestock located within and surrounding the ML area.

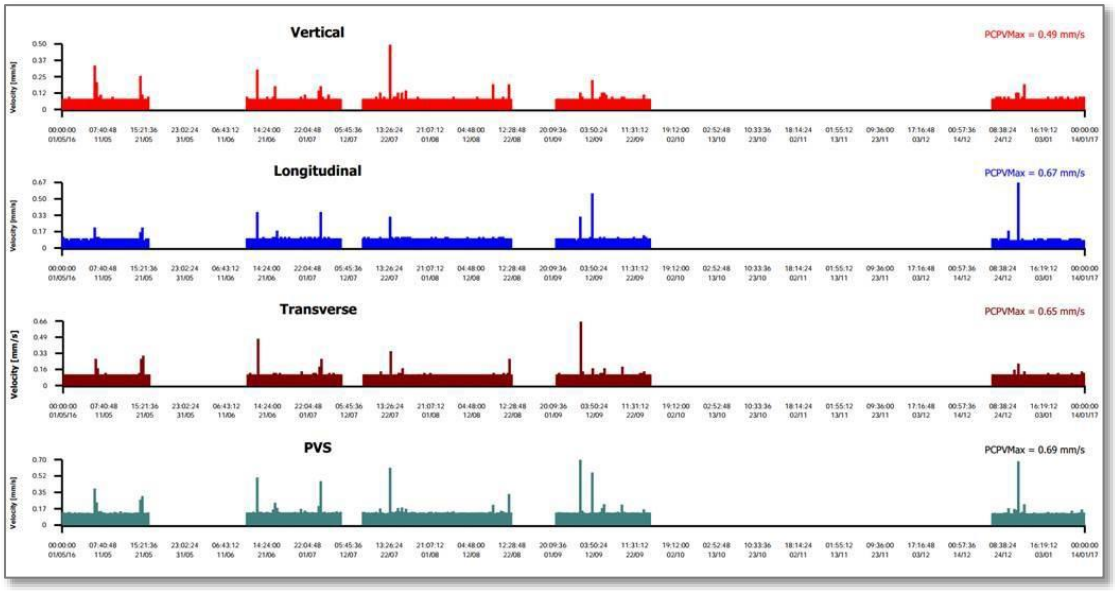

FIGURE 22-6 | HISTOGRAM PLOT OF PEAK BACKGROUND VIBRATION LEVELS RECORDED AT LOCATION 2 - NORTH

22.7.5.4 FORMER RIDGE TAILINGS DAM

A potential impact has been identified with the possibility of metalliferous drainage from former tails and mine waste areas from the historic Ridge Mine. This includes a private landholder dam located directly downstream from the historic ridge chimney and downstream from Terramin exploration sites - location shown in Figure 22-7 and Figure 22-8.

Water quality obtained from the dam from 2014-2016 indicates no traces of mercury, cyanide, and within average ranges of metals as all other dams and surface water in the region – as seen in **Error! eference source not found.** Table 22-8. The dam was cleaned out during 2015 by the landholder and waste located to the south of the dam. The dam is currently used for stock. Stock access the dam and there are a number of shallow depressions within the floor of the dam, presumably from stock pugging whilst seeking water. Stock access has resulted in a low pH during 2018 due to low water levels and animal waste. The dam is located in the creekline and fills each year, overflows generally each winter and is equipped with a flow diversion for when the dam is full. This diversion flows each year and has been observed operating the last 4 years and presumably has done so since the property was used for agricultural uses. There is no additional plausible risk to the groundwater sources from Terramin's activities.

Figure 22-7 | Ridge Mine's tailings dam and chimney. Facing south.

Figure 22-8 | View of chimney and tailings dam from other side of the valley, C1887

TABLE 22-8 | RESULTS OBTAINED FROM FORMER RIDGE DAM AND REGIONAL STATISTICS TO DATE (2018)

Date Sampled	pH	EC uS/cm	TDS mg/L	As Tot mg/L	Cd Tot mg/L	Cu Tot mg/L	Fe Tot mg/L	Mn Tot mg/L	Pb Tot mg/L	Zn Tot mg/L	Hg Diss mg/L	Hg Tot mg/L	Cn Tot mg/L
24-Mar-14	7.04	167	89	0.01	<0.001	0.009	7.1	0.236	0.053	0.006	<0.001	<0.001	<0.004
30-Jun-14	7	156	291	0.004	0.0001	0.016	8.53	0.059	0.049	0.016	<0.001	0.0002	<0.004
14-Jul-14				<0.001	<0.001	0.007	1.36	0.021	0.005	0.015	<0.001	<0.001	
26-Nov-14	9.34	272	421	0.017	0.0003	0.021	13.2	0.276	0.093	0.05			
07-Sep-16	7.19	160	154	0.003	0.0001	0.006	1.91	0.043	0.011	0.005			
26-Apr-18	3.07	1310	769	0.033		0.027	18.4	0.805	0.153	0.041	<0.001	<0.001	
Regional surface water ranges (excl. former Ridge dam)	5.5-9.8	62-39300	99-3280	0.001-0.89	0.0001-0.00066	0.001-0.17	0.07-649	0.003-59.9	0.001-0.898	0.005-0.509	<0.001	0.0012	<0.004
Sample count regionally (excl. former Ridge dam)	358	366	353	277	258	297	285	285	297	297	70	53	12

22.8 DRAFT OUTCOME(S) AND MEASUREMENT CRITERIA

In summary, during stakeholder consultation proximal agri-businesses have advised Terramin that impacts which would impact their business in their view include impacts to groundwater, as well as impacts to amenity, including air quality, noise, vibration and visual amenity.

Terramin have further identified that weeds and pests could also be a potential impact to their business.

Terramin propose that negligible impacts to proximal agri-business can be measured and is achievable through compliance with proposed measurement criteria associated with groundwater, air quality, noise, vibration and visual amenity.

In accordance with the methodology presented in Chapter 6, an outcome has been developed for agriculture impact events with a confirmed link between a source-pathway-receptor (SPR linkage), see Table 22-9.

All outcomes are supported by draft measurement criteria which will be used to assess compliance against the proposed outcomes during the relevant phases (construction, operation and closure) and where relevant draft leading indicator criteria.

All outcomes for the entire project are presented in Appendix D1.

TABLE 22-9 | DRAFT OUTCOME AND MEASUREABLE CRITERIA

Draft Outcome	Draft Measurement Criteria	Draft Leading Indicator Criteria
No loss of productivity on properties surrounding the mining lease from dust generated by construction, mining or closure activities.	Dust generated from the mining lease during operation activities, measured live at predefined monitoring points demonstrates average dust deposition at sensitive receivers is in accordance with the Air Quality Impact Assessment using standardised monitoring techniques and demonstrates that annual average does not exceed 4 g/m2 to ensure no loss of productivity on properties surrounding the mining lease from dust generated by construction, mining or closure activities. If these levels are obtained for 12 months post-closure, monitoring will no long be required.	Monthly dust deposition from mining activities not to exceed 4 g/m2/month onsite.

Draft Outcome	Draft Measurement Criteria	Draft Leading Indicator Criteria
No introduction of new species of declared weeds, plant pathogens or pests (including feral animals), nor sustained increase in abundance of existing declared weed or pest species on the mining lease caused by mining activities	Survey demonstrates: - no new species of declared weeds or feral animals have become established on the lease - there has not been a statistically significant increase in abundance of existing weed or pest species in the Project area (Project site), compared to baseline studies and accounting for seasonal variation (regional trends).	An incident register is to be maintained of any new declared weeds or pests identified by site personnel. The register will be reviewed monthly and results will be presented in monthly site management reports prepared by the Mine Manager. The review will include the identification of any procedural changes required.
No impact to agricultural/viticultural production from weed management activities on the mining lease	Annual review of *Phytophthora and Phylloxera Management Plan at Bird in Hand demonstrates all procedures regarding Phytophthora and Phylloxera Management have been adhered to.* *Annual review of chemicals register onsite demonstrates no Group I, Phenoxy Acid herbicides or Genetically Modified Organism wetting agents have been used*	None proposed
No adverse impact to the quantity or quality of water caused by the mining activities to existing and future licenced users and water dependant ecosystems	Construct to Design Audit of water storage dam completed by a suitably qualified and experienced independent party within 3 months of completion of surface construction demonstrates water storage dam was constructed to design specifications. Quarterly prism surveying in dam walls shows no differential movement in survey prisms demonstrating geotechnical stability of dam embankments	None proposed
No adverse impact to the quantity or quality of water caused by the mining activities to existing and future licenced users and water dependant ecosystems	The Mine Manager will ensure that monthly drawdown (SWL) measurements recorded by site staff in monitoring wells X, Y and Z (installed monitoring piezometers) and private bores A, B and C (shown in Figure X) are compared with dewatering model predictions for the 70% grouting effective groundwater modelling scenario, presented in Table X and are within 2 standard errors of model predictions for two consecutive readings.	Observed drawdown in monitoring wells X, Y and Z (installed monitoring piezometers) falls outside of 2 standard errors of model predictions for one reading.

Draft Outcome	Draft Measurement Criteria	Draft Leading Indicator Criteria
	The Mine Manager will ensure that monitoring of the water quality of the injectant (mine water) from the WTP during re-injection, undertaken on a monthly basis for field parameters TDS, pH and NTU[1] shows that field TDS and pH (and any other parameter of concern as determined by MAR trial) is as per DEWNR drainage permit conditions, and turbidity is below 5 NTU; or as per DEWNR drainage permit conditions, confirmed by Laboratory major ion testing of the injectant using a NATA accredited laboratory on a monthly basis.	Field TDS of the blended injectant greater than 2 standard errors of baseline data for each well (mg/L) or as per DEW drainage permit conditions. Field measurement of turbidity is above 5 NTU or as per DEWNR drainage permit conditions.
No public injuries or fatalities as a result of fires originating in the proposed mining lease that could have been reasonably prevented.	Annual review of safety systems and maintenance of fire breaks shows that these were maintained and demonstrates that the mine operator did not cause, or could not have reasonably prevented, the deaths or injuries occurring.	None proposed

22.9 FINDINGS AND CONCLUSIONS

FABAL considered and reviewed the proposed BIHGP in the context of potential impact events for the surrounding agricultural activities. FABAL have considered airborne, biological, hydrogeological, commercial and other aspects of the project for potential impacts to neighbouring business and found the Project is likely to have **negligible** to **low** impact on surrounding agricultural business implementing the proposed control strategies, which are proposed in order to reduce or eliminate as many risks to the surrounding agricultural landholdings as is reasonably possible.

[1] any metals of concern in the source water will be determined during MAR trials conducted during PEPR development