CHAPTER 14
EXISTING SITE CONTAMINATION

BIRD IN HAND GOLD PROJECT
MINING LEASE PROPOSAL

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

COPYRIGHT

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

14 EXISTING SITE CONTAMINATION

Portions of the project site (the Goldwyn property, also referred to as Goldwyn) and adjoining land were historically used for gold mining and extraction activities, with at least four gold mining sites present on Goldwyn, including historic processing areas. The site is located adjacent to the former historic Bird In Hand (BIH) gold mine, the most significant mine in the area, which operated intermittently between 1882 and the early 1900s. Due to groundwater inflow and more viable projects interstate, the BIH mine ceased operating in 1938. Goldwyn has also been used for farming purposes, with land clearance commencing in the 1860s. Stock grazing was the primary farming activity conducted onsite, until potato growing and dairy farming commenced in the 1940s (D Kerber pers comm 2016).

As well as undertaking significant soil testwork using both NATA accredited laboratories and X-Ray Fluorescence (XRF) analysis, Terramin commissioned an independent expert, Golder Associates Pty Ltd (Golder) to undertake a site contamination assessment (Appendix L2 and L3) of the Goldwyn property following the purchase of Goldwyn.

The Golder assessment comprised desktop studies, a site walkover, intrusive investigations and laboratory testing.

More information regarding the historic land use of Goldwyn and the local area is included in Chapter 20: Heritage.

14.1 APPLICABLE LEGISLATION AND STANDARDS

The *Environment Protection Act 1993* (EP Act) (together with the *Environment Protection Regulations 2009*) is the key legislation relevant to site contamination in South Australia. The *Mining Act 1971* (SA) (Mining Act) also provides a legislative framework which seeks to ensure that mining operations manage environmental impacts and risks as far as reasonably practicable through the establishment of a Program for Environment Protection and Rehabilitation (PEPR). The PEPR sets out environmental outcomes which are expected to occur as a result of the mining operations and specific criteria to measure the environmental outcomes.

14.2 ASSESSMENT METHOD

The objectives of the Golder (2017) baseline contamination assessment were to:

- Conduct a preliminary desktop study to assess potentially contaminating activities that may have occurred at or adjacent to the site, interpret available environmental data and assess available regional geochemical and hydrogeological data to assess expected site conditions.
- Assess baseline contamination conditions at the site based on the historical land uses and activities identified.
- Develop a conceptual site model.
- Provide with advice with respect to manage any site contamination, to assist with project planning and potential future operations.

To address the objectives above, Golder undertook a preliminary desktop review, followed by a targeted intrusive soil investigation, in accordance with applicable guidance documentation, including the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM).

14.2.1 Health Investigation Levels

There are no NEPM Health Investigation Levels (HILs) for agricultural land uses. NEPM HIL D guidelines (commercial/industrial) would normally include factories and industrial sites, and premises such as shops, offices etc. This doesn't directly apply to the current land use setting, or the likely land use setting post any mining operations. During active operation of the mine, NEPM HIL D would likely be an appropriate screening guideline. NEPM HIL A or B (residential and high density residential) are not referred to as it is unlikely the site will be redeveloped post-closure for residential land uses. Given that the site isn't currently being used for commercial or industrial purposes nor is it being used for intensive agricultural purposes (i.e. cropping etc.) it is considered NEPM HIL C (open space / recreational) is a reasonable guideline for initial screening purposes. Golders noted that if HIL C was changed to HIL D, this would not have any significant impact on the outcome of the assessment. There is still exceedance of HIL D in one area and the site specific ecological screening guidelines would remain the same, and site management recommendations for future site operations would not change.

14.3 EXISTING ENVIRONMENT

This section includes data on soils sampled and profiled as part of a site contamination assessment, and Terramin soil sampling within and surrounding the proposed ML both utilising a NATA accredited laboratory and calibrated XRF (X-ray fluorescence analyser).

14.3.1 Terramin soil sampling program

Terramin have analysed over 1800 soil samples with a calibrated XRF between 2013 and 2016. Sampling has been undertaken within and surrounding the proposed Mining Lease (ML), see Figure 14-1.

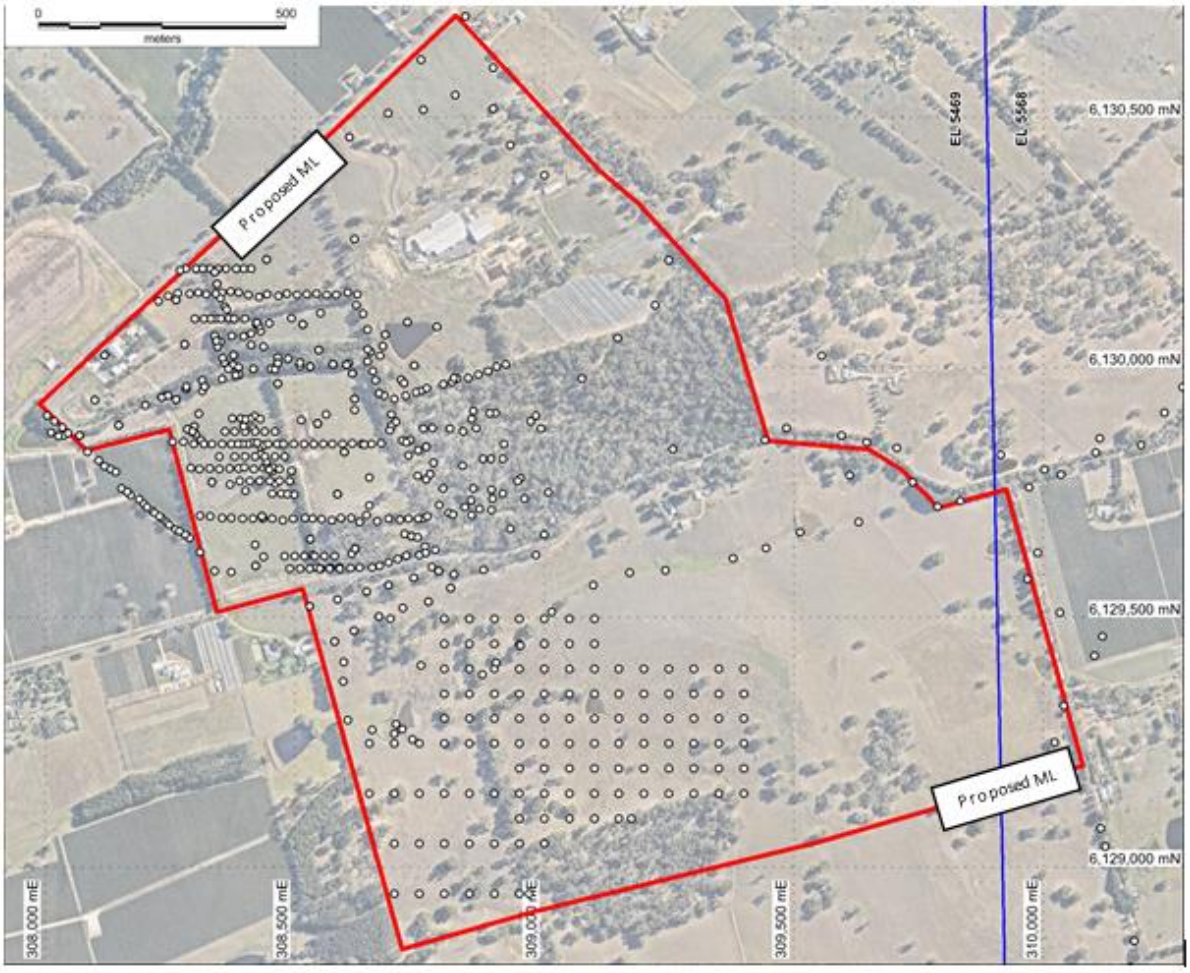


FIGURE 14-1 | XRF SOIL SAMPLE LOCATIONS UNDERTAKEN BY TERRAMIN

Gold mineralisation in the Adelaide Fold Belt is commonly associated with base metals and arsenic. Within the proposed ML boundary several areas of significant levels of lead (Pb) and arsenic (As) in soil have been identified, see Figure 14-2 and Figure 14-3. In some cases the elevated concentrations of metals are the result of weathering and dispersion from primary mineralised systems and are therefore the result of naturally occurring processes. In other areas it is clear that elevated levels of Pb are the result of contamination. Both elevated Pb and As can be seen around the historic processing sites at BIH and Blackbird/Lone hand (Figure 14-6 and Figure 14-7), but the most extensive potential contamination is associated with tailings; in tailing dams and in creek lines, see Figure 14-4, Figure 14-5 and Figure 14-8 to Figure 14-15). Most landowners in the region are not aware of the tailings; this lack of awareness has seen the historic dams breached, tailing dams “cleaned out“ and repurposed as stock dams, and the sand like tailings used around properties, for example in gateways.

Within the proposed ML peak arsenic and lead in soil are 142ppm and 1913ppm, respectively, Table 14-1. Values over 1500ppm lead are above the HIL threshold for commercial and industrial premises as stated in the National Environment Protection (Assessment of Site Contamination) Measure April 2011, Schedule B1, Guideline on Investigation Levels for Soil and Groundwater”,

Table 14-2. There are areas where tailings are exposed at surface and have become integrated with the natural environment. Peak lead in tailings on the proposed ML is 3234ppm.

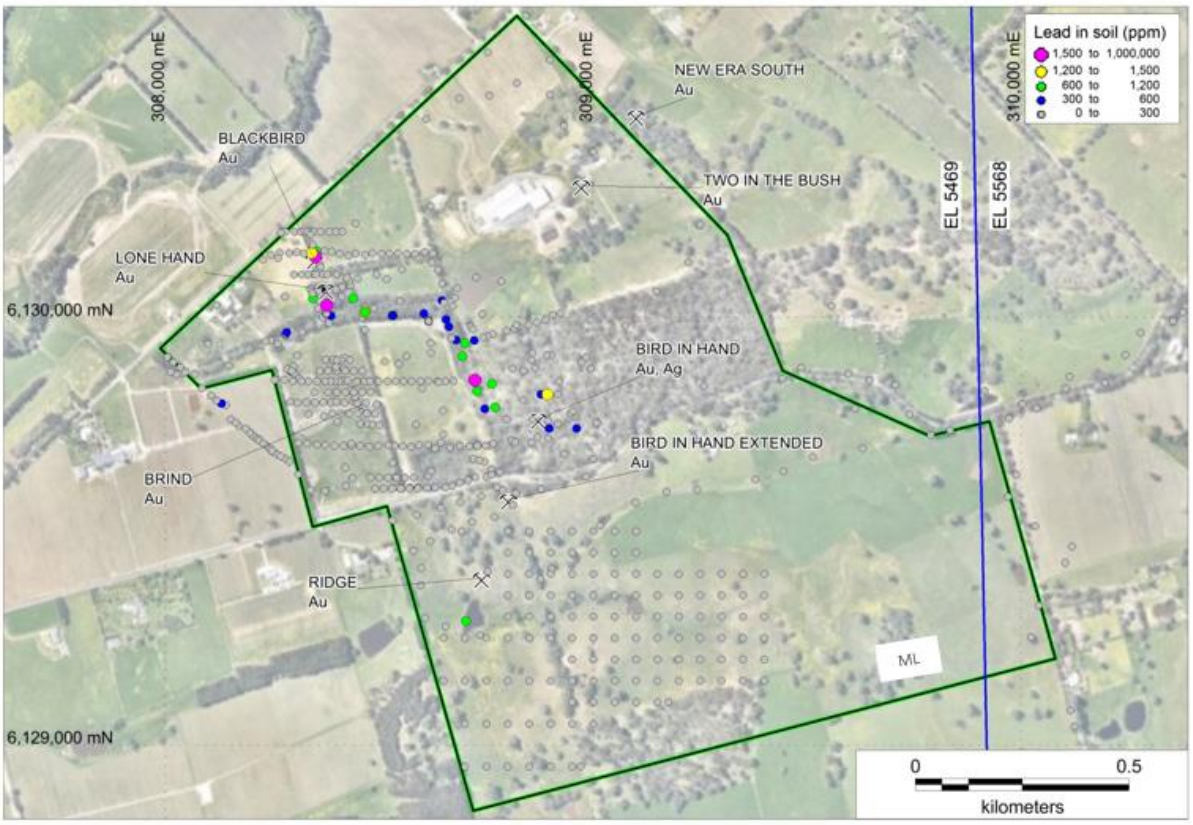


FIGURE 14-2 | LEAD IN SOIL SAMPLES

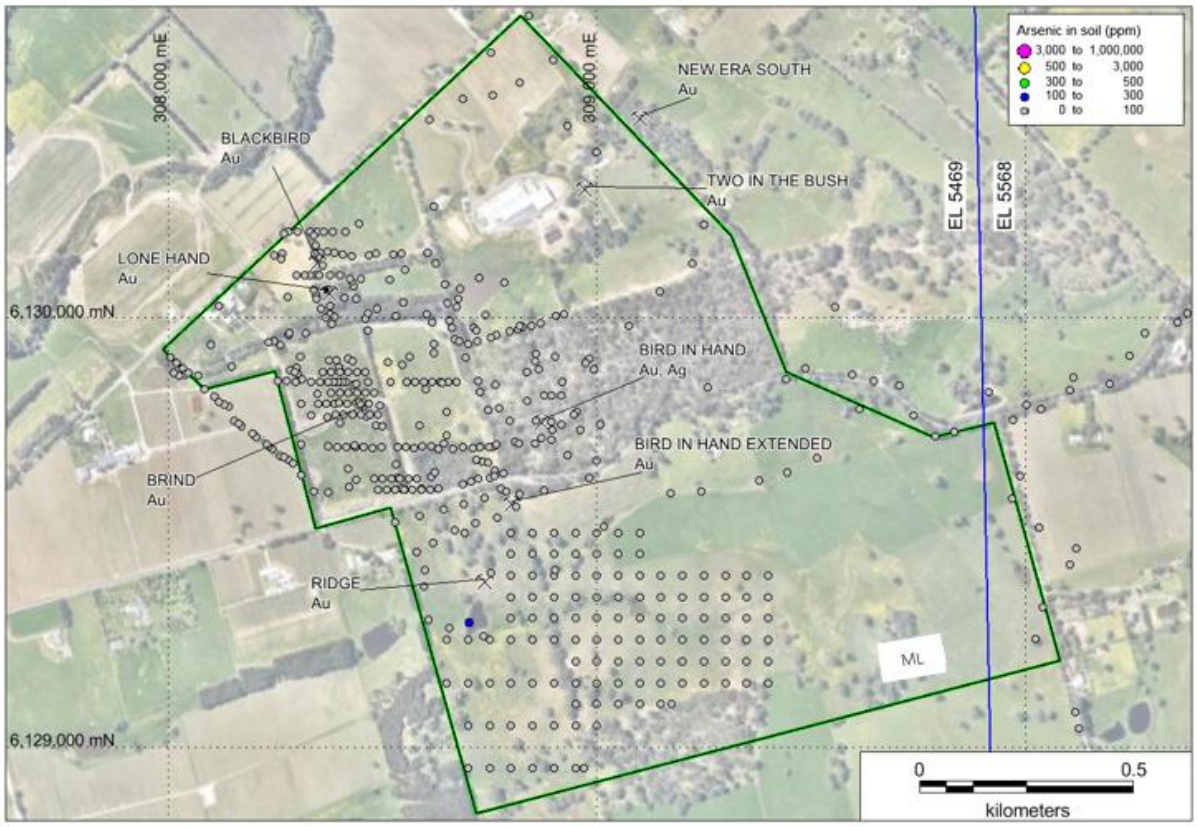


FIGURE 14-3 | ARSENIC IN SOIL SAMPLES

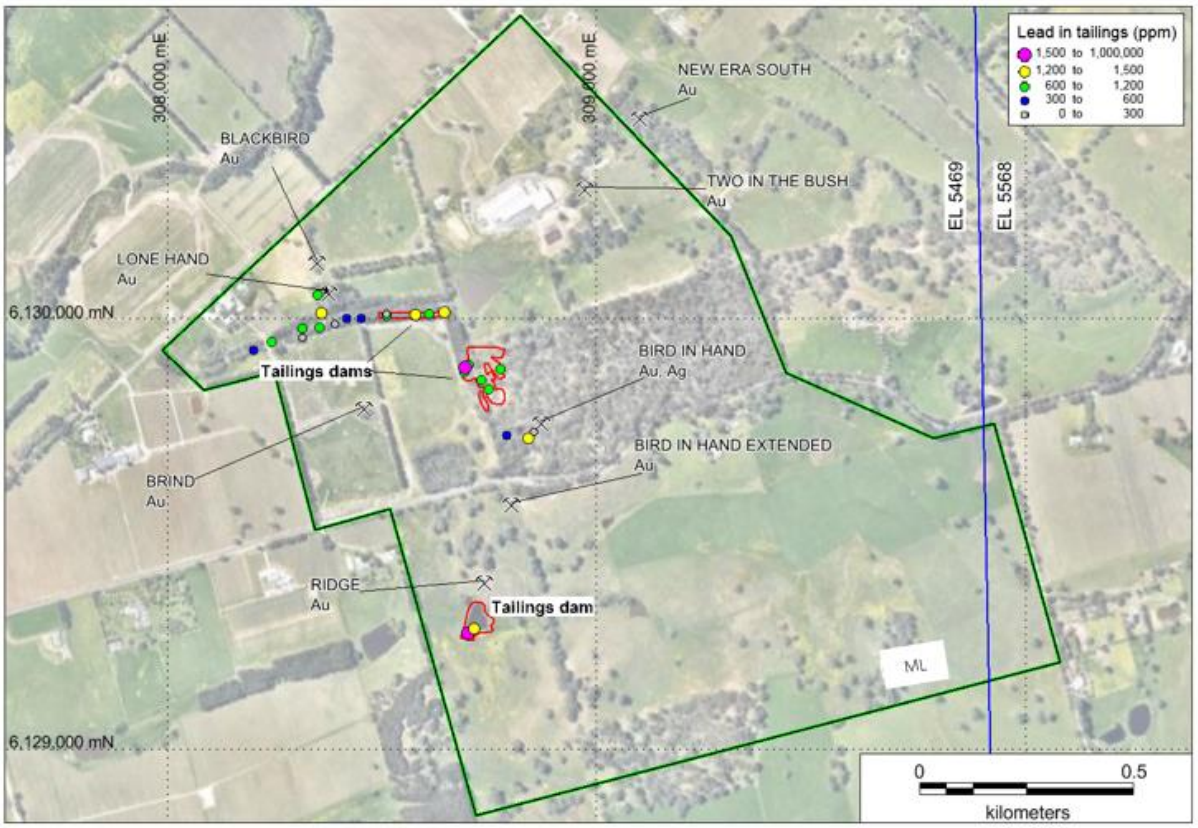


FIGURE 14-4 | LEAD IN TAILINGS

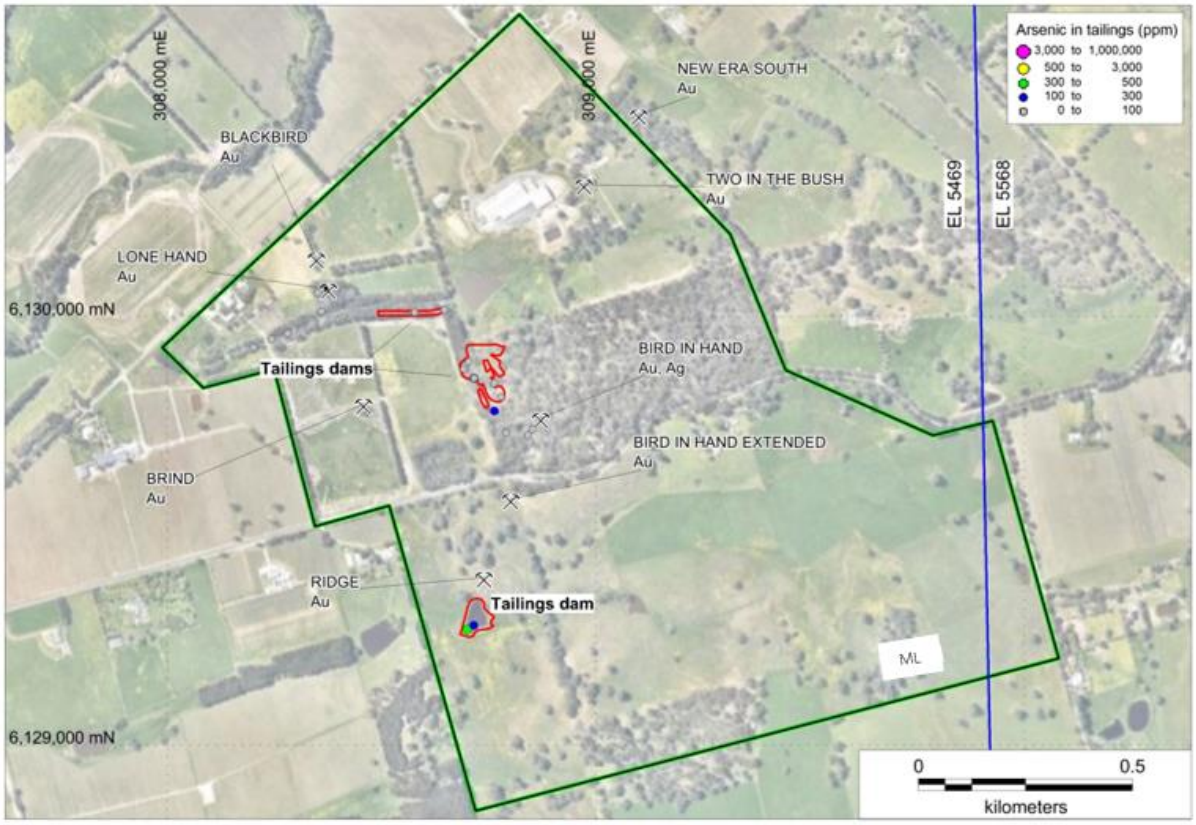


FIGURE 14-5 | ARSENIC IN TAILINGS

TABLE 14-1 | PEAK PB AND AS VALUES IN SOIL AND TAILINGS

Metal	MC- Soil	MC - Tailings	Regional soil
Arsenic (mg/kg)	142	364	368,000
Lead (mg/kg)	1913	3234	742

TABLE 14-2 | HEALTH INVESTIGATION LEVELS, GUIDELINE ON INVESTIGATION LEVELS FOR SOIL AND GROUNDWATER , P. 38.

Metal	Residential A	Residential B	Recreational C	Commercial/ industrial D
Arsenic (mg/kg)	100	500	300	3000
Lead (mg/kg)	300	1200	600	1500

FIGURE 14-6 | LOCATION 1, REMAINS OF BLACKBIRD PROCESSING FACILITY.

FIGURE 14-7 | LOCATION 1, REMAINS OF BLACKBIRD PROCESSING FACILITY.

FIGURE 14-8 | LOCATION 2, - NORTH WESTERN CORNER OF BIH TAILINGS DAM

FIGURE 14-9 | LOCATION 3, - WESTERN LIMIT OF BIH TAILINGS DAM IS LOCATED ON PROPOSED OPERATING SITE.

FIGURE 14-10 | LOCATION 3, RABBIT BURROW IN BIH TAILINGS DAM.

FIGURE 14-11 | LOCATION 4, TAILINGS DAM, SOUTHERN BANK OF GOLDWYN CREEK

FIGURE 14-12 | LOCATION 5, TAILINGS (PALE BAND) EXPOSED IN NORTHERN BANK OF GOLDWYN CREEK

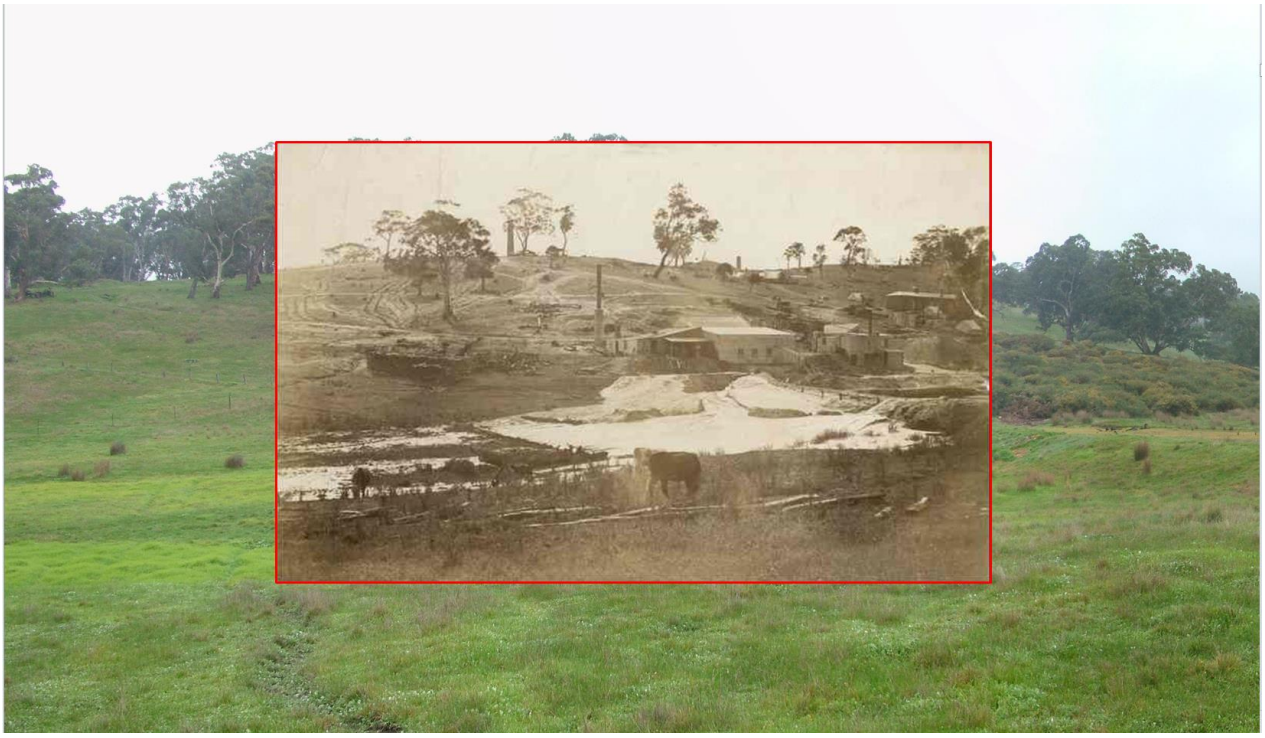


FIGURE 14-13 | LOCATION 6, CENTRAL PHOTOGRAPH SHOWS RIDGE TAILINGS DAM OVERFLOWING C1880, DPC PHOTOGRAPH B6260

FIGURE 14-14 | LOCATION 6, RIDGE TAILINGS DAM PHOTOGRAPHED 2014 WITH THE VIEW OF B6260 OUTLINED IN RED

FIGURE 14-15 | TAILINGS EXPOSED IN A RECENTLY "CLEANED OUT" TAILINGS DAM PHOTOGRAPHED BY TERRAMIN 2014 (NOTE FOOT PRINTS IN MUD FOR SCALE)

14.3.1.1 OLD BIRD IN HAND MINE SITE

A report commissioned by SA Water in 2006, subsequently supplied to Terramin, containing information on site history, contamination and geophysical parameters was undertaken by Parsons Brinckerhoff (Appendix L1). Gold mining activities were undertaken at the BIH mine site from about 1881 to 1926, at which time the site was transferred to the Commonwealth Government. Early photographs of the site from this era showed a treeless landscape hosting a number of stone buildings and chimneys, shown in Figure 14-16 below.

FIGURE 14-16 | BIRD IN HAND MINE 1885

Use of the site by the Department of Defence, presumably from about 1926 until it was transferred to the Minister of Works in the early 1960s, is thought to have included the dumping of waste materials (possibly including concrete and asbestos) into disused mine shafts.

Signs of use of the site for military exercises can be observed in this area, these include trenches and expended dummy 7.62mm plastic rounds. Historic photos indicate this area was probably occupied by army personal for a period during world war two.

An army firing range was reportedly on this site as a team of fossickers removed amounts of spent lead bullets for scrap value in the 1980's (G Day, pers comm 2015).

From the early 1930's until about 1967, the site was reportedly used by Government departments as a water storage/pump station to augment drinking water supplies during peak summer periods, prior to the completion of the Murray Bridge – Onkaparinga pipeline. Two large (disused) concrete tanks, as well as an abandoned pumping station, remain on the site from this period.

A small disused quarry is located in the north eastern portion of the native vegetation block, there is a disused barite mine to the north east of the proposed ML (G Day, pers comm, 2015). Additionally there

is an historic Arsenic mine adjacent to Bird in Hand road, opposite the existing Bird in Hand water treatment works.

A number of mine shafts, drives and caustines can be observed along different parts of the Inverbrackie catchment, many do not appear to have any government records of why or when they were constructed.

Agricultural use of the Native Vegetation Heritage Agreement (NVHA) area, for cattle grazing is known to occur periodically prior to 1990 (T. Hisee pers comm, 2015).

Potentially contaminating activities identified include the following:

- backfilling of mine shafts with unspecified waste;
- historic heavy metals from mining or military use, or ore processing chemicals such as cyanide;
- uncontrolled importation of fill materials from unidentified source(s);
- possible fuel/chemical storage for use in the pump station, by the Department of Defence and/or during more recent exploration activities;
- possible historical use of a septic tank; and
- possible herbicide use.

14.3.1.2 REMAINDER OF ML

The remaining land is used for farming, stock grazing and hay production.

The remaining areas have generally been used for small mining activities and associated living areas on what was the township of Reefton Heights, the small mining activities included the Ridge, Honeysuckle and BIH extended gold mines, in the south east corner of the proposed ML.

Some elevated numbers of metals have been detected in soils in these areas. See map below

Potentially contaminating activities potentially include the following:

- backfilling of mine shafts with unspecified waste, fencing wire and batteries have been observed;
- historic heavy metals from mining or military use, or ore processing chemicals such as cyanide;
- uncontrolled importation of fill materials from unidentified source(s);
- fuel/chemical storage for farming use;
- herbicide/pesticide use; and
- treated pine fencepost use, either copper, chrome, arsenic (CCA) or older timber treated with creosote.

14.3.1.3 254 PFEIFFER ROAD BLOCK

The parcel of land contains the historic Two in the Bush gold mine, which included an ore crushing and processing operation. The land was used for farming, livestock and hay production, more recently has been planted with grapevines. In 2015 Petaluma constructed a cellar door, winery and bottling facility on the site. Soil sampling was undertaken in 2014 and 2015 by Terramin, with no anomalous readings of heavy metals being detected.

14.3.2 GOLDER ASSOCIATES SITE CONTAMINATION ASSESSMENT

To better understand the extent of contamination of Terramin's Goldwyn property Terramin engaged Golder to undertake a soil investigation in November 2016. The survey included the drilling of 34 soil

bores across the site to a maximum depth of 3.2 metres below ground level. Representative soil samples were chemically tested based on the potential contaminants of concern identified in the site history investigation and Golder's field observations (Appendix L2 and L3).

Elevated concentrations of metals (specifically Cu, Pb, Zn, Hg) and cyanide were identified in some shallow soils tested. These analytes were typically identified in the upper soil profile in localised areas, including the swale (south of the creek) and/or former mine processing areas. The majority of the site, outside of former mining and mine processing areas, did not record elevated concentrations of these materials.

Golder determined that the elevated concentrations of lead identified in their survey may potentially pose a risk to site users under a recreational land use scenario, if exposure to contaminants were to occur. In addition, the presence of elevated concentrations of metals (copper, zinc and mercury) and cyanide could present a risk to plants and soil biota in localised areas of the site, and may also present a risk to burrowing animals. Risks to plants were confirmed by the evidence of impeded vegetation growth in areas of confirmed mine tailings. There is also a subsequent risk of ingestion of contaminant impacted vegetation by grazing animals. Under a commercial/industrial land use, which is what is proposed for the site, these risks are further reduced.

Based on the results of the desktop study, field observations and the results of the laboratory testing program undertaken, Golder conclude the following:

- The available site history information indicated that the site has been used for:
  - Mining and extractive activities, during late 1800s and early 1900s.
  - Farming activities, including crop growing and dairy farming.
- Elevated concentrations of metals (copper, zinc, lead, mercury) and/or cyanide are present within localised areas of shallow site soils associated with historic mining activities, in particular the tailings stockpile near the eastern boundary, the constructed swale south of the creek, the Lone Hand processing area and the Blackbird mine workings.
- No significant soil contamination has been identified associated with agricultural use of the site.
- Elevated concentrations of lead in some shallow soils may pose an unacceptable risk to human health with respect to ‘open space’ land uses, if exposure to the contaminants were to occur.
- Elevated concentrations of copper, zinc, mercury and cyanide in some localised areas of shallow soils may adversely impact ecological receptors, including soil biota and sensitive plant species attempted to be grown in the affected soils.
- There is no evidence to indicate that the metals present in shallow site soils are significantly leachable.
- It’s unlikely that metal impacts would penetrate far into deeper natural soils or impact underlying groundwater.
- Laboratory testing results for creek sediment samples indicated some elevated concentrations of metals, however these concentrations did not exceed soil quality guidelines. Metals concentrations generally reduced from the upstream site boundary towards the downstream boundary. No significant metal or total recoverable hydrocarbon (TRH) impact was identified in the sediment from the wastewater ponds associated with the dairy.

- Concentrations of other potential contaminants of interest (including organochlorine and organophosphorus pesticides) were below the health and ecological screening guidelines.
- Based on the data reviewed by Golder, concentrations of dissolved metals in surface water sampled from on the site (Goldwyn Creek) were found to exceed ANZECC (freshwater ecosystem) guidelines for copper, lead and zinc. However, concentrations of copper, lead and zinc were also found to be elevated above the ANZECC guidelines in surface water samples from upstream and downstream locations, indicating that the presence of elevated metals in surface water are not likely to be directly attributed to the site. It is possible that the elevated metals concentrations are associated with natural mineralisation in the local environment.
- Based on the data reviewed by Golder, concentrations of metals in groundwater extracted from two wells were found to exceed ANZECC (freshwater ecosystems) guidelines for zinc. However, concentration of all metals tested did not exceed applicable potable or irrigation screening guidelines. Elevated concentrations of zinc may be attributed to naturally elevated background concentrations in the regional water system.
- In addition to the above findings, a review of the correlation between soil laboratory data against the results of screening using Terramin's portable XRF indicated that the portable XRF provides a useful preliminary screening tool for assessing lead, copper and zinc concentrations on the site.
- Subsequently mapping was undertaken of XRF derived data, and some laboratory data of geological samples both in the ML proposal area and the catchment, both upstream and in the nearby Dawesley creek catchment

More information on the potential impacts to public safety and contaminated land is included in Chapter 7.

14.3.3 Existing Regional Environment

Within the proposed ML peak levels of arsenic (As) are below the HIL threshold for commercial and industrial premises. However, ~1 kilometre to the east of the proposed ML, sampling by Pima Mining NL (Pima) in 1997 along Hiscock Road (Pima, ENV08183) recorded peak As values of 368,000ppm As (sample 18011 in follow up to sample 11477 that returned 16,100ppm as) more than 100 times the HIL for commercial and industrial premises (Pima, ENV08183). Hiscock Road is located to the west of the historic Woodside Arsenic Mine which was prospected in 1884 and operated 1916 to 1917. No soil sampling has been undertaken over the historic Woodside Arsenic Mine workings but historic records indicate that the workings were spread over a hectare.

There are 17 historic goldmines in the Woodside Goldfield, the extent of contamination associated with these mines outside of the proposed Mining Lease is poorly understood. Photographs taken by Maximus of New Era's tailings dam shows that the tailings are exposed and are shedding into the Inverbrackie Creek.

Site contamination photographs and Woodside Arsenic Mine are located on Figure 14-21.

.

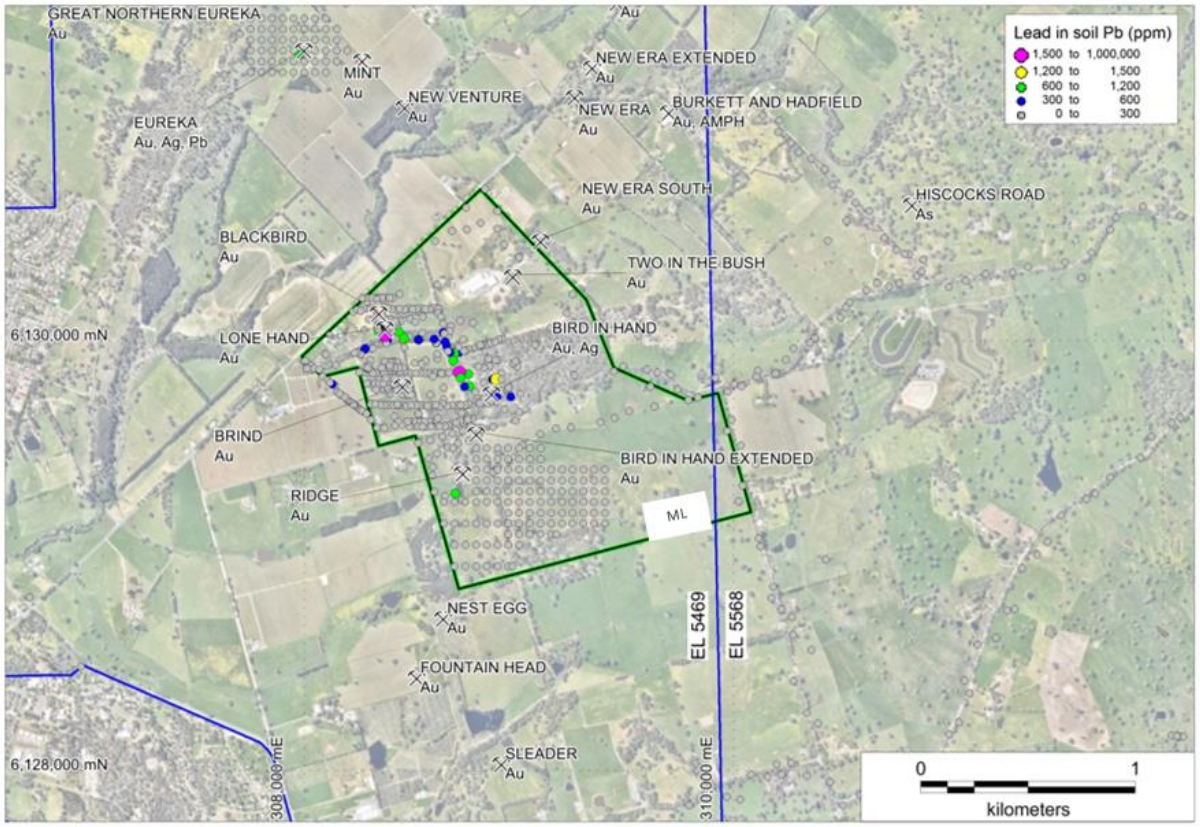


FIGURE 14-17 | REGIONAL PB IN SOIL

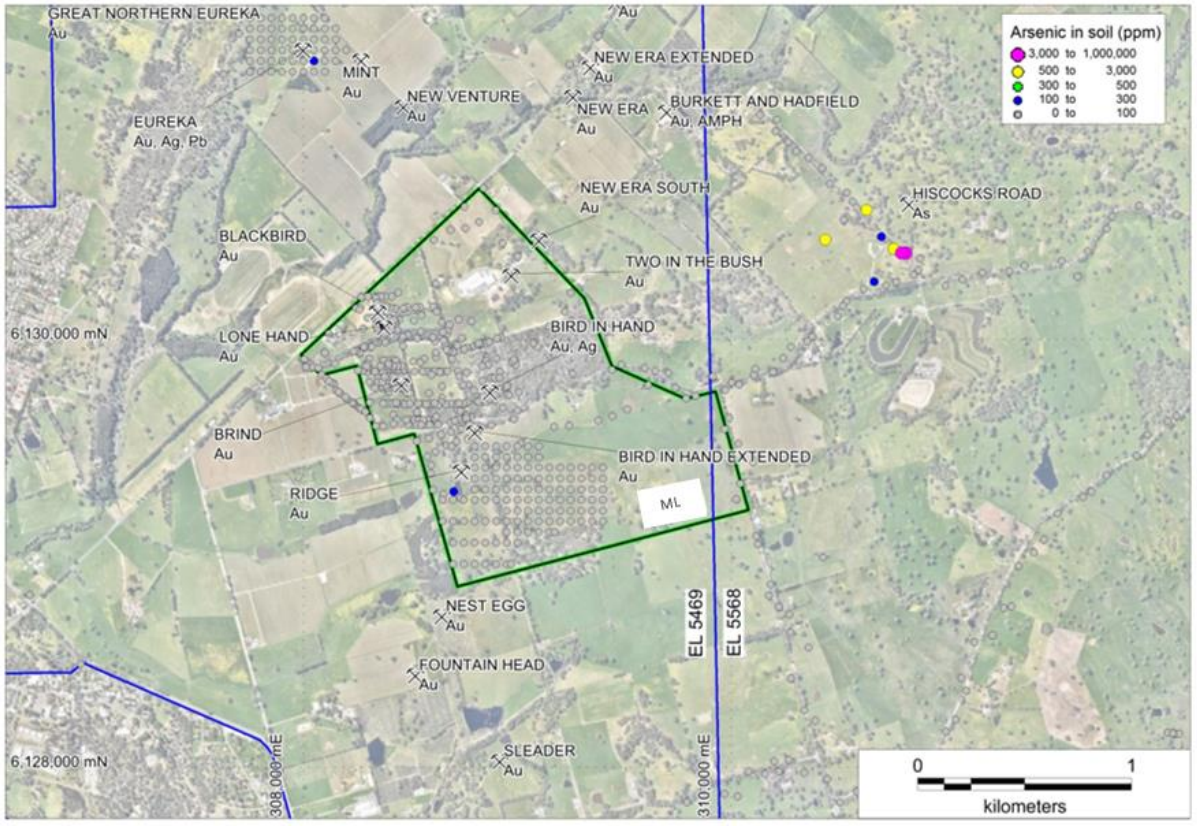
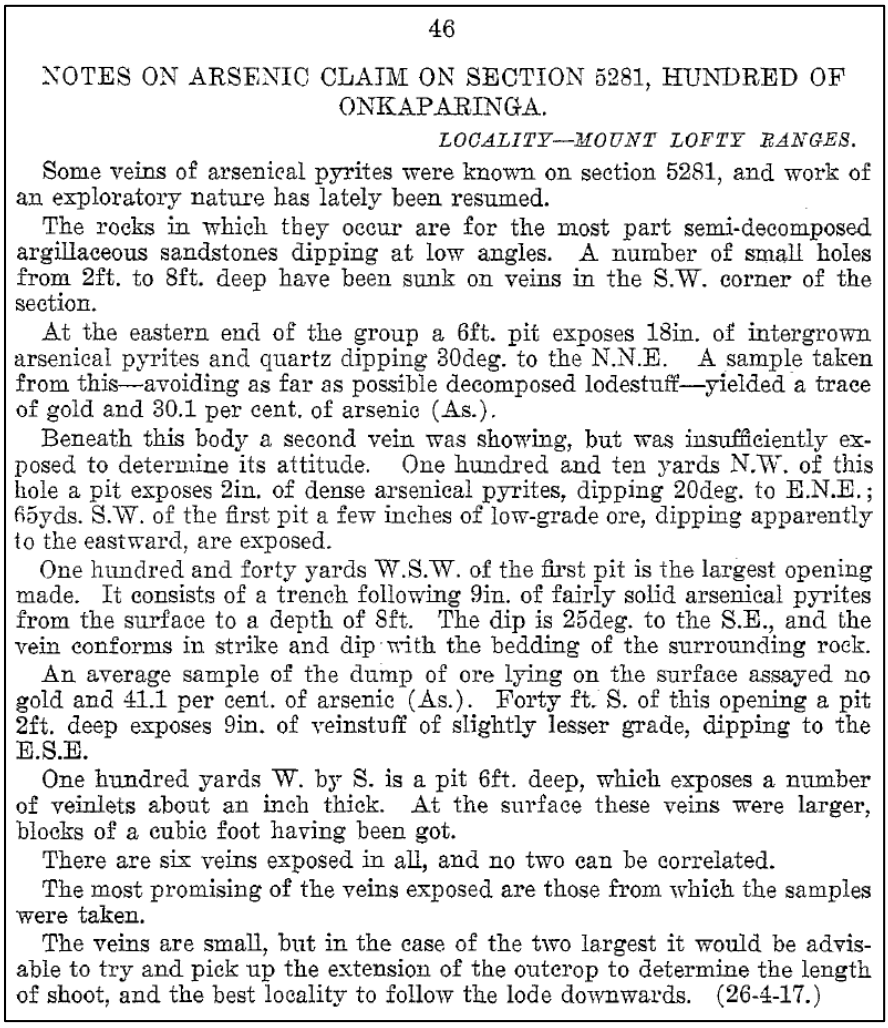


FIGURE 14-18 | REGIONAL AS IN SOIL



46

NOTES ON ARSENIC CLAIM ON SECTION 5281, HUNDRED OF ONKAPARINGA.

LOCALITY—MOUNT LOFTY RANGES.

Some veins of arsenical pyrites were known on section 5281, and work of an exploratory nature has lately been resumed.

The rocks in which they occur are for the most part semi-decomposed argillaceous sandstones dipping at low angles. A number of small holes from 2ft. to 8ft. deep have been sunk on veins in the S.W. corner of the section.

At the eastern end of the group a 6ft. pit exposes 18in. of intergrown arsenical pyrites and quartz dipping 30deg. to the N.N.E. A sample taken from this—avoiding as far as possible decomposed lodestuff—yielded a trace of gold and 30.1 per cent. of arsenic (As.).

Beneath this body a second vein was showing, but was insufficiently exposed to determine its attitude. One hundred and ten yards N.W. of this hole a pit exposes 2in. of dense arsenical pyrites, dipping 20deg. to E.N.E.; 65yds. S.W. of the first pit a few inches of low-grade ore, dipping apparently to the eastward, are exposed.

One hundred and forty yards W.S.W. of the first pit is the largest opening made. It consists of a trench following 9in. of fairly solid arsenical pyrites from the surface to a depth of 8ft. The dip is 25deg. to the S.E., and the vein conforms in strike and dip with the bedding of the surrounding rock.

An average sample of the dump of ore lying on the surface assayed no gold and 41.1 per cent. of arsenic (As.). Forty ft. S. of this opening a pit 2ft. deep exposes 9in. of veinstuff of slightly lesser grade, dipping to the E.S.E.

One hundred yards W. by S. is a pit 6ft. deep, which exposes a number of veinlets about an inch thick. At the surface these veins were larger, blocks of a cubic foot having been got.

There are six veins exposed in all, and no two can be correlated.

The most promising of the veins exposed are those from which the samples were taken.

The veins are small, but in the case of the two largest it would be advisable to try and pick up the extension of the outcrop to determine the length of shoot, and the best locality to follow the lode downwards. (26-4-17.)

FIGURE 14-19 | LOCATION 7, EXTRACT FROM MINING REVIEW 26, PAGE 46

FIGURE 14-20 | LOCATION 8 - EXPOSED TAILINGS AT NEW ERA, PHOTOGRAPHED BY MAXIMUS, MARCH 2007

FIGURE 14-21 | LOCATION OF SITE CONTAMINATION PHOTOGRAPHS

14.3.4 SURROUNDING LAND USE PRACTICES

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 farming and grazing. 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 existing 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. This reflects the changing nature of the Adelaide Hills, with an increasing pattern of agricultural land fragmentation, as a result sub-divisions and urban developments.

Other land uses of note in the catchment, both historic and current, which can influence soil and environmental health generally are landfills, mines and quarries, military training (including military activities on private land), sewage water treatment, beef cattle and dairies.

Additionally, there is a commercial airstrip, tree nursery and proposed polo fields on Pfeiffer road. Water discoloration has been observed from landfill areas within the catchment, which may have soils, creek sediment or surface water impacts.

Inverbrackie Creek surface water quality monitoring was undertaken by Terramin from 2014 - 2016, and a report reviewing the data and analysing macroinvertebrates was completed in 2017 (Appendix I1). In essence there are various water quality indicators, including metals and nutrients, which repeatedly and regularly exceed ANZECC (freshwater ecosystems) guidelines within the catchment, reflecting a combination of historic and current land use impacts and naturally occurring mineralisation. Livestock are noted to be found within riparians zones in the Inverbrackie Creek catchment, leading to increased nutrients and sedimentation within the creek, additionally, riparian vegetation, such as sedges are absent within many parts of the creek which means surface water flows off paddocks containing stock has an increased velocity and reduced natural filtration, leading to increased nutrients and soil sediments entering the creek. Nutrients on the soil surface are generally not an issue but mobilisation into other ecosystems can be. Copper is often detected in the Inverbrackie creek, and in the baseline dust monitoring program during 2017, see Table 14-3 and Figure 14-22 below. The Inverbrackie creek metal numbers are recorded both upstream and downstream of the proposed ML area. Soils and sediments contain some metals that are elevated within the catchment, this may be due to natural mineralization, land use and past contaminating activities, or a combination of all of the above. Soil sampling was undertaken during mineral exploration activities, or by government surveying in the area over the last 30 years.

Further information regarding surface water quality is included in Chapter 11.

TABLE 14-3 | SUMMARY OF COPPER DEPOSITION RATES JULY 2017 TO OCTOBER 2017

Location	Copper Deposition Rate (g/m^2/month)		
	Min	Average	Max
Site 1	0.002	0.017	0.032
Site 2	0.002	0.018	0.038
Site 3	0.003	0.106	0.317
Site 4	0.001	0.016	0.039
Site 6	0.008	0.042	0.097

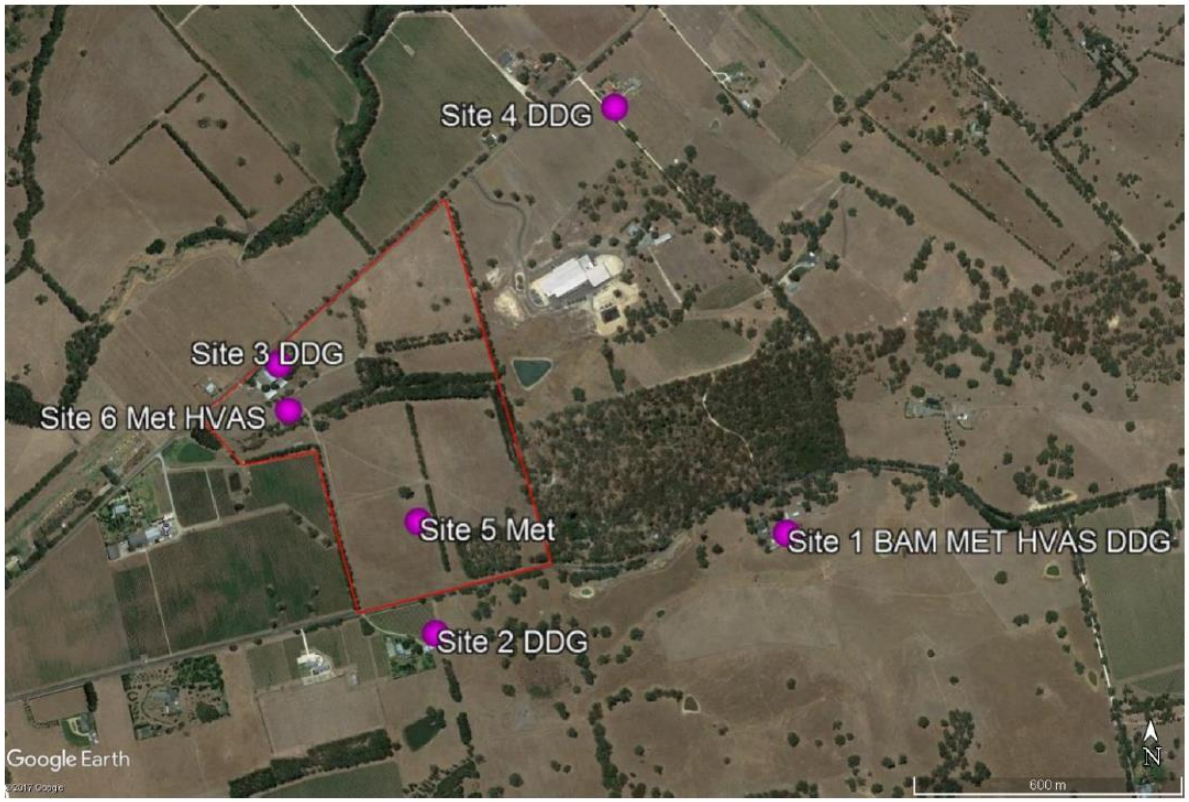


FIGURE 14-22 | MONITORING LOCATIONS – WITH APPROXIMATE SITE BOUNDARY

Burning of flammable waste and tree branches is a common occurrence in the catchment for bushfire fuel load control, and could be a contaminant source.

Water discoloration of seepage from landfill areas within the catchment has been observed, which may have soils, creek sediment or surface water impacts.

Agricultural industry often involves the use of machinery and if maintenance is poorly undertaken hydrocarbon waste can result. Limited evidence of this occurring in adjacent properties has been observed.

Winery production potential environmental impacts, these operations are regulated under an EPA license which is in place for each winery. Some of the risks and potential risk pathways observed within the catchment are; wine waste water being applied to soils and/or grape marc residue (waste skins and stems remaining after crushing) potentially flowing into soils or riparian zones, CCA timber disposal and burning of winery wood and plastic waste (pallets, laminated mdf), potential plumes from chemical applications (e.g. copper sulfate or herbicides) entering riparian zones or neighbouring land near, back flushing of spray units or water filtration equipment near creeklines.

14.4 SENSITIVE RECEPTORS

TABLE 14-4 | IDENTIFIED SENSITIVE RECEPTORS

Sensitive Receptor	Summary	Impact ID
Soil quality	Soil quality within and outside of the proposed ML	PIE_14_02

Sensitive Receptor	Summary	Impact ID
Vegetation, native fauna, stock	Vegetation in identified soil management zones (Figure 14-23) as well as any fauna that may be ingesting vegetation.	PIE_14_01
Local community	Local community surrounding the proposed project	PIE_14_03

14.5 POTENTIALLY IMPACTING EVENTS

Potential impact events related to existing site contamination are largely associated with disturbance of contaminated land, and the multiple potential receptors.

TABLE 14-5 | POTENTIALLY IMPACTING EVENTS

Potentially Impacting Events	Mine Life Phase	Source	Potential Pathway	Sensitive Receptors	Confirmation of S-P-R	Impact ID
Bio-uptake of disturbed metals/toxins (including lead, etc.) by vegetation, crops, native fauna, stock impact health of environment	Construction, Operation, Closure, Post-closure	Metals/toxins from mine site	Ingestion or absorption of airborne emissions	Vegetation, native fauna, stock	No	PIE_14_01
Movement/disturbance of contaminated material onsite has the potential to impact onsite soils	Construction, Operation, Closure	Contaminated material	Movement and placing of materials	Soil quality	Yes	PIE_14_02
Health impacts to local community as a result of disturbance of contaminated land	Construction, Operation, Closure	Dust generated from excavation of existing contaminated soils (historical usage of site)	Air and prevailing wind	Local community	Yes	PIE_14_03

14.6 CONTROL MEASURES TO PROTECT HERITAGE ITEMS AND PLACES

14.6.1 DESIGN MEASURES

Existing identified contaminated areas have been avoided where possible in the site design, with the exception of the access driveway, which must cross this area, as outlined in Figure 14-23.

Terramin commissioned Golder Associates to prepare a Site Contamination Management Plan – located in Appendix L4. Resultantly, the Site Contamination Management Plan will be followed in this area.

Air quality design measures are located in Chapter 15.

FIGURE 14-23 | IDENTIFIED SITE DESIGN AND SOIL MANAGEMENT ZONES

14.6.2 Management Strategies

A permanent sprinkler system is proposed for the Integrated Mullock Landform (IML) to reduce dust impacts associated with moving mullock both from the mine void, and also back into the mine void as backfill.

A Dust Management Plan would be developed through the PEPR stage and would cover construction, operations, and any proposed closure earthworks.

Air quality management measures are located in Chapter 15.

The Golder Associates site contamination assessment recommended the following steps to reduce the potential for impacts to health:

- Future site works should limit the disturbance of soils near and adjacent to the creek line, and within areas of (known) historic mining activities. This will reduce potential risks (health and environmental) associated with exposure to contaminated soils.
- Any future site works should be completed under the guidance of a site contamination management plan (SCMP).

Terramin commissioned Golder Associates to prepare a SCMP. The SCMP outlines the measures required to manage potential risks to human health and the environment during future site works, based on known contamination status of shallow soil in specific areas of Goldwyn. The SCMP includes:

- Measures to minimise and control potential human health or environmental impacts during site works, and
- Health and safety considerations for onsite workers and surrounding land users.

Based on the results, Golder has established a designated soil management zone with specific management options, outlines in Table 14-6 and Figure 14-24.Management strategies included in the SCMP are designed to reduce or prevent any impact from disturbance of contaminated soils.

The soil management plan including the unexpected finds protocol prepared by Golder Associates (appendix L4) will also apply for all exploration works. Although there is currently no soil test results indicating contamination sources, the soil management zone has been expanded to include all historic workings located on the southern side of Bird in Hand Road – shown in Figure 14-25.

The SCMP has been included in Appendix L4 of this MLP.

TABLE 14-6 | SOIL MANAGEMENT ZONE

Zone Locality	Primary contaminants of concern	Potential risk to human health	Potential risk to flora and fauna	Risk rating	Management Options
Management Zone Swale and former mine processing areas	Metals (copper, lead, zinc, mercury), Cyanide	Y	Y	**Moderate**	It is recommended that site works (including soil excavation, construction, vehicle movement) be avoided in his area, if possible. Alternatively, implementation of robust soil management measures are required as detailed in Section 6 of this plan. Further sampling and analysis of soil could be undertaken to refine (minimise) the extent of this zone.

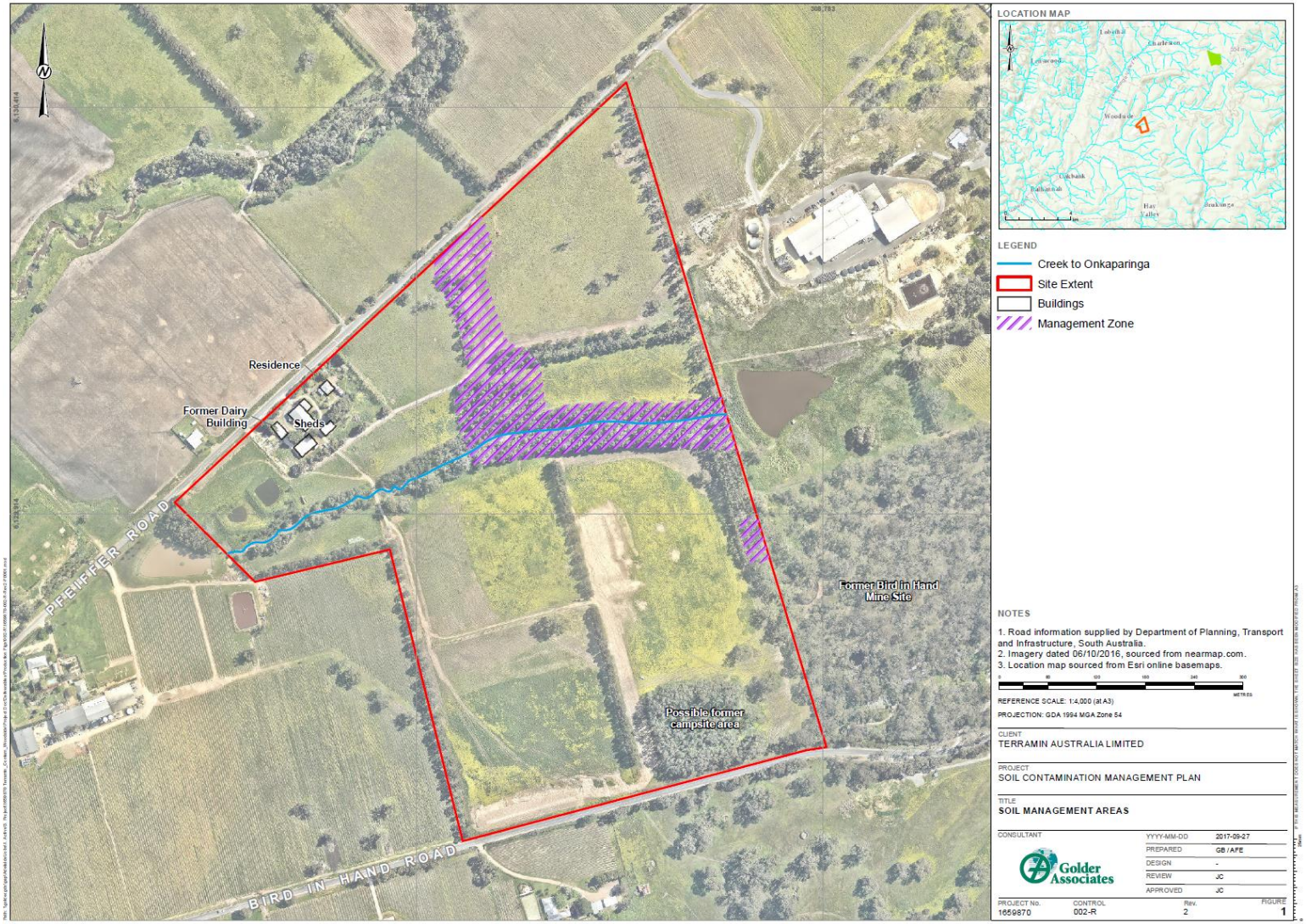


FIGURE 14-24 | SOIL MANAGEMENT ZONE

FIGURE 14-25 | EXPLORATION SUBJECT TO SOIL MANAGEMENT ZONE SOUTH OF BIRD IN HAND ROAD

TABLE 14-7 | MANAGEMENT STRATEGIES

Management Strategies	Impact ID
Site Contamination Management Plan (Appendix L4)	PIE_14_01 PIE_14_02 PIE_14_03
Air Quality Management Plan	PIE_14_02 PIE_14_03
Dust suppression through site design – see Chapter 13	PIE_14_04
Site design involved avoidance of contaminated soil areas – see Chapter 13	PIE_14_04

14.7 IMPACT ASSESSMENT

14.7.1 PRE-EXISTING CONTAMINATED LAND (REPLICATED FROM CHAPTER 7: PUBLIC SAFETY)

Elevated concentrations of metals (specifically Cu, Pb, Zn, Hg) and cyanide were identified in some shallow soils tested. Contaminants were typically identified in the upper soil profile in localised areas, including the swale (south of the creek) and/or former mine processing areas. The majority of the site, outside of former mining and mine processing areas, did not record elevated concentrations of these contaminants.

The presence of elevated concentrations of lead may potentially pose a risk to site users under a recreational land use scenario, if exposure to contaminants were to occur.

Concentrations of other potential contaminants of interest (including organochlorine and organophosphorus pesticides, and other synthetic pesticides) were below the adopted screening guidelines, which indicated that the risk to health and the environment from these chemicals is likely to be negligible.

Management strategies included in the SCMP are designed to reduce or prevent any impact from disturbance of contaminated soils, and therefore prevent the potential for diffusion.

As a result of implementing the SCMP, Terramin expect the impact to soil quality from pre-existing site disturbance to be **negligible**.

The SCMP has been included in Appendix L4 of this MLP.

There is a concern that metalliferous drainage may exist from former tails and mine waste areas from the historic ridge mine. This includes a private landholder stock dam located directly downstream from the historic ridge chimney and downstream from Terramin exploration sites. Terramin do not own or control the land, and, as discussed in Chapter 3, do not expect to access the dam area for exploration.

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 Table 14-8.

The dam was cleaned out during 2015 by the landholder and the sediment 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 riparian zone 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 credible risk to the soil quality from Terramin's exploration activities from these historic areas.

Regardless, exploration works will utilise the Exploration Management Plan, included in Appendix B7, and the SCMP (included in Appendix L4).

TABLE 14-8 | 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	<0.0001	0.009	7.1	0.236	0.053	0.006	<0.0001	<0.0001	<0.004
30-Jun-14	7	156	291	0.004	0.0001	0.016	8.53	0.059	0.049	0.016	<0.0001	0.0002	<0.004
14-Jul-14				<0.001	<0.0001	0.007	1.36	0.021	0.005	0.015	<0.0001	<0.0001	
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	<0.0001	<0.0001	
Regional surface water ranges (excl. former Ridge dam)	5.5-9.8	62-3930	99-3280	0.001-0.89	0.0001-0.0066	0.001-0.17	0.07-649	0.003-59.9	0.001-0.898	0.005-0.509	<0.0001	0.0012	<0.004
Sample count regionally (excl. former Ridge dam)	358	366	353	277	258	297	285	285	297	297	70	53	12

14.8 DRAFT OUTCOME(S) AND MEASUREMENT CRITERIA

In accordance with the methodology presented in Chapter 6, an outcome has been developed for site contamination impact events with a confirmed link between a source, pathway and receptor (S-P-R linkage), see Table 14-9Table 14-5.

All outcomes are supported by draft measurement criteria which will be used to assess compliance against the draft outcomes during the relevant phases (construction, operation and closure), and draft leading indicator criteria where applicable. These measurement criteria and leading indicators are indicative only and will be developed further through the PEPR.

Outcomes for the entire project are presented in Appendix D1.

TABLE 14-9 | DRAFT OUTCOMES AND MEASURABLE CRITERIA

Draft Outcome	Draft Measurement Criteria	Draft Leading Indicator Criteria
No adverse impacts to public health as a result of any contaminated material from land disturbed by mining activities.	Report submitted to the Mining Regulator demonstrating compliance against SCMP within three months of completion of disturbance of the identified existing contamination zones.	Annual public safety review does not identify additional actions that could reasonably be taken to reduce risks to the public.
	Investigation of all contaminated material related complaints demonstrates that the Mine Operator did not cause or could not reasonably have prevented the incident from occurring; and all contaminated material related complaints were acknowledged within 48 hours and closed out within 14 days to the satisfaction of the complainant or as agreed with the Chief Inspector of Mines. If complaints were not resolved the Mine Operator conducted further investigations to demonstrate that contaminated material movements complied with the outcome achievement values as agreed by the Chief Inspector of Mines.	Annual public safety review does not identify additional actions that could reasonably be taken to reduce risks to the public.
No adverse impacts to soil quality or quantity within the mining lease caused by mining activities that could compromise the post mining land use	Annual review of soil movement records, including topsoil available / stockpiled for closure, shows no measurable decline in soil quality or quantity	A materials balance of topsoil available / stockpiled for closure demonstrates requirements are met or identifies a deficiency.
No adverse impacts to soil quality or quantity within the mining lease caused by mining activities that could compromise the post mining land use No adverse impacts to soil quality or quantity on surrounding land caused by mining activities	Annual mine records demonstrate all areas of PAF and ASS encountered were appropriately contained and/or treated	None proposed

Draft Outcome	Draft Measurement Criteria	Draft Leading Indicator Criteria
No adverse impacts to soil quality or quantity within the mining lease caused by mining activities that could compromise the post mining land use No adverse impacts to soil quality or quantity on surrounding land caused by mining activities	All chemical and hydrocarbon spills are remediated to meet EPA standards within 48 hours of the spill, or a longer time agreed by the Chief Inspector of Mines.	All topsoil stockpiles located on the proposed ML will be annually sampled as per AS4482.1-2005 standards. Any results higher than topsoil baseline samples will be investigated and appropriate actions taken.
No adverse impacts to soil quality or quantity within the mining lease caused by mining activities that could compromise the post mining land use No adverse impacts to soil quality or quantity on surrounding land caused by mining activities	Provision of a report once prior to entering closure monitoring phase by a suitably qualified site contamination consultant verifies that a site contamination assessment and if required remediation in accordance with the NEPM and relevant EPA legislation/guidelines has occurred, ensuring there is no unacceptable risk to human health or the environment as a result of the contamination when compared with relevant baseline concentrations and relevant NEPM investigation levels.	None proposed

14.9 FINDINGS AND CONCLUSIONS

Portions of Goldwyn and adjoining land were historically used for gold mining and extraction activities, with at least four gold mining sites present on Goldwyn, including historic processing areas. This has left legacy issues regarding existing contamination, not only within Goldwyn, but surrounding the numerous existing historic mine sites within the Inverbrackie Valley, and more broadly, Adelaide Hills.

The majority of the surrounding land is currently used for either livestock grazing pasture, agriculture or horticulture (generally planted vineyards). Other land uses of note in the catchment, both historic and current, which can influence soil and environmental health generally are landfills, quarries, military training (including military activities on private land), sewage water treatment, beef cattle and dairies.

Whilst existing site contamination has been identified, through a SCMP, spills management and remediation, and appropriate site catchments, it has been demonstrated that impacts associated with mining operations and associated activities can be managed to as low as reasonably practical.