Strathalbyn, South Australia

PROGRAMME FOR ENVIRONMENTAL PROTECTION AND REHABILITATION

Incorporating Final Closure Plan (Appendix C)

ANGAS ZINC MINE

May 2017

TERRAMIN AUSTRALIA LIMITED

TZN0639-V0

Project Name:	**Angas Zinc Mine**
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Tenements:	See Proponent Details
Commodity to be mined:	Zinc and Lead
Explanatory note: This Programme for Environmental Protection and Rehabilitation (PEPR) has been prepared using the Section 65 of the Mining Regulations 2011 and the July 2012 Government Gazette issued by Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE). The layout and content have been dictated by these documents.	

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1 COMPANY SENIOR EXECUTIVE DECLARATION

I, Martin Janes, Chief Executive Officer of Terramin Australia Limited, declare that all information contained in this document is, to the best of my knowledge, true and not misleading.

Signature:

Date: 11th May 2017

2 DESCRIPTION OF THE ENVIRONMENT

Since the description of the environment was provided in the previously approved Program for Environmental Protection and Rehabilitation (PEPR) (document number TZN0638-V1B) there have been no material changes to the environment. Vegetation has successfully grown around the perimeter of the operational area of the lease providing some improvement in native fauna habitat and visual amenity as a part of the progressive rehabilitation of the site.

The outcome measurement criteria have been revised since the previously approved PEPR and as such, the relevant environmental baseline data has been provided in Section 8.

Outcome measurement criteria and any changes to the existing environment specifically relating to care and maintenance and closure are included in their respective plans (care and maintenance – Appendix AP, closure – Appendix C).

2. 1 CARE AND MAINTENANCE OPTION

In late 2013 global economics and prices for zinc and lead concentrates were such that the remaining in situ ore could not be economically recovered and beneficiated. As such Terramin made a decision to place ML6229 into a care and maintenance phase until global prices have recovered to allow mining of the remaining ore or other potential project uses for the site are approved. This MCP is not applicable during the care and maintenance phase, hence, a Care and Maintenance Plan (CMP) for the mine site has been developed and approved by the DSD in March 2015 (Care and Maintenance Plan (TZN0639-V5), DSD Reference MO: 6627.069 Doc No: A2292944). Work, including a risk assessment, to develop this plan has been undertaken to ensure a robust approach to meet compliance with ML6229 lease conditions.

The CMP has been developed using a risk based approach, which addresses potential long term risks that may arise due to proposed CMP works impacting on achieving approved environmental closure outcomes.

The CMP has been provided as an addendum to the re-submitted PEPR, and was approved on 23rd March 2015. The CMP contains;

- A CMP risk assessment, based on interactions with proposed closure strategies identified in this plan;
- Commitments to undertake further studies that may be generated via the risk assessment process regarding potential impacts to closure.

The approved Care and Maintenance Plan has been included in this MCP in Appendix AP of the PEPR.

3 DESCRIPTION OF THE PROPOSED MINING OPERATIONS

3.1 GENERAL DESCRIPTIONS AND MAPS/PLANS OF OPERATIONS

The Angas Zinc Mine (AZM) is owned by Terramin Australia Limited (Terramin) and is situated approximately 60 km southeast of Adelaide, South Australia, and 2.6km from the town of Strathalbyn.

Terramin commenced operations at the Angas Zinc Mine (AZM) in June 2008. The operation includes underground mine access and a mineral processing plant which is located in what was previously a limestone quarry. The underground mining method, process design and plant equipment used are conventional to zinc mines established elsewhere in Australia. The overall site plan is illustrated in Figure 23.

The process plant includes a single stage crusher, 1250kW semi-autogenous mill configuration, lead and zinc flotation cells, slurry thickeners, concentrate filtration and storage capacity of an estimated 65,000 tonnes of dry concentrate. The concentrate is then transported by B-double road trains to port or smelter facilities. Recovery of saleable zinc, silver and lead through smelting operations occurs off-site. More detail on the processing of ore is provided in Section 3.8.2. This section also describes the chemical beneficiation of ore using flotation processes.

A Waste Management Plan has been prepared for the AZM (Appendix AF) to ensure waste is managed at the highest possible standards, resulting in minimal impact to the environment through a hierarchical approach. The Waste Management Plan outlines the administrative and procedural activities that take place to manage waste on site. The objectives of this plan are in line with those in Terramin's Environment Policy (Appendix AM). The waste management site plan is illustrated in Figure 30.

3.2 RESERVES, PRODUCTS AND MARKET

3.2.1 Geological Environment

Terramin's mineral tenements (the 'Fleurieu Project') overlie part of the Kanmantoo Trough. Kanmantoo Group sedimentary rocks cover an area of about 11,000km^2 from the north-eastern Adelaide Plains, south through the Fleurieu Peninsula and west to Kangaroo Island. During the Cambrian age (about 600–500 million years ago) sediments were eroded from the Gondwana continent and deposited on its eastern margin in a subsiding, submarine tectonic feature termed the Kanmantoo Trough. The sedimentary pile reached a thickness of 7–8km. Figure 1 describes the regional stratigraphy.

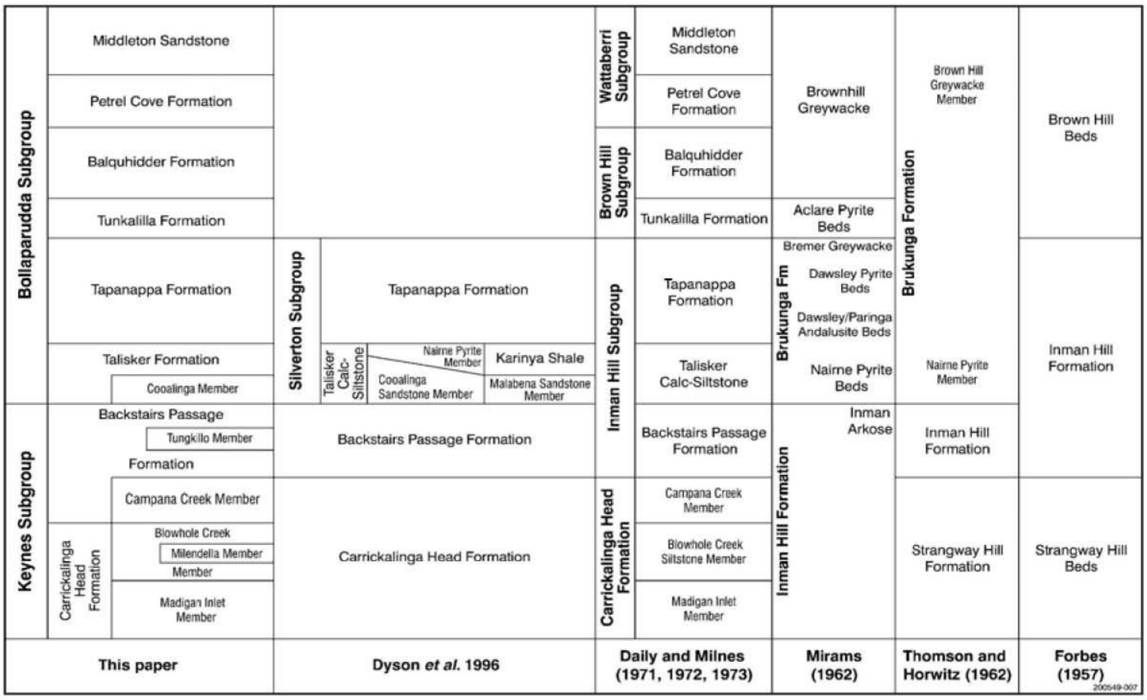


Figure 1: Regional Stratigraphy

Throughout the Fleurieu Peninsula, sulphide minerals are abundant in the sedimentary rocks of the Kanmantoo Group. Pyrite-rich lenses are associated with several formations, for example, at Brukunga prior to 1972 (Figure 2), sulphur was mined from the Nairne Pyrite Member of the Talisker Calc-siltstone.

The Talisker Calc-siltstone also hosts zinc-lead-silver mineralisation at Mount Torrens, north of Kanmantoo, and arsenic-silver-lead mineralisation at the old Talisker Mine near Cape Jervis.

Most known base metal mineralisation occurs within the Tapanappa Formation. Zinc-lead-silver and copper-gold mineralisation occurs within the Tapanappa Formation in a zone that extends northwards from Angas Zinc for about ten kilometres. Ten kilometres further north is the copper mineralisation of the Kanmantoo Mine (Figure 2).

About 500 million years ago, the Kanmantoo Group rocks underwent pressure and temperature metamorphism during a mountain-building period known as the Delamarian Orogeny. The rocks were deformed into open, upright, south-plunging folds with amplitudes in the order of about ten kilometres.

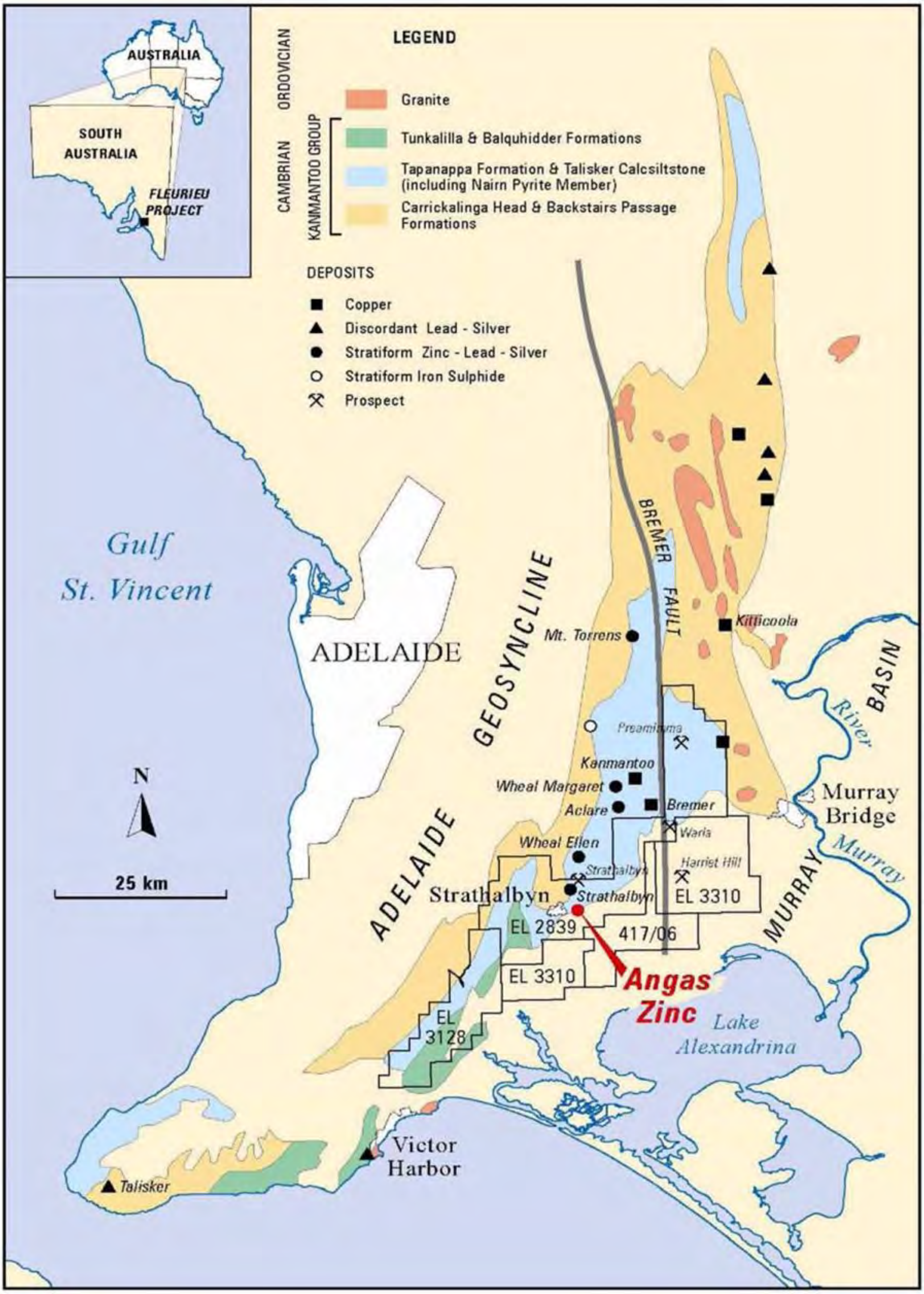


Figure 2: Regional Geological Map

Project Geology

At AZM, the Tapanappa Formation comprises a sequence of flysch like interbedded psammite and pelite. Load casts and graded bedding have been recognised in drill core. The sequence has been metamorphosed to amphibolite facies. A well-developed S2 schistosity is evident throughout the sequence at AZM and is consistently sub-parallel to bedding. The AZM deposit lies on the east-dipping limb of a gently south-plunging fold, the Strathalbyn Anticline. Younging orientations defined by graded bedding and narrow zones of intense parasitic folding suggest the presence of tight isoclinal folds not previously recognized in the sequence.

The AZM deposit occurs within a discordant garnetiferous unit (the Host Unit) that overprints the Tapanappa Formation (Figure 3). The Host Unit comprises quartzite or hornfels and andalusite-spotted pelite and psammopelite. The Unit is defined by the presence of minor to common fine-grained pink garnet. Sulphide minerals and gahnite are common in places. The Host Unit varies from about 50 to 200m in thickness. It is continuous over a strike length of at least two kilometres and a dip extent of more than 500m although it is locally displaced by NW orientated faults. The same NW-trending faults are seen to offset the sulphide lodes at AZM.

From place to place the Tapanappa Formation is unconformably overlain by Tertiary Mannum Limestone and unconsolidated sand, gravel and minor clay. In the AZM area, this cover is up to 25m thick and both the limestone and sand have been mined for construction materials and dimension stone. Elsewhere there is a thin cover (approximately 0 to 5m thick) of Quaternary alluvium and soil with some calcrete development.

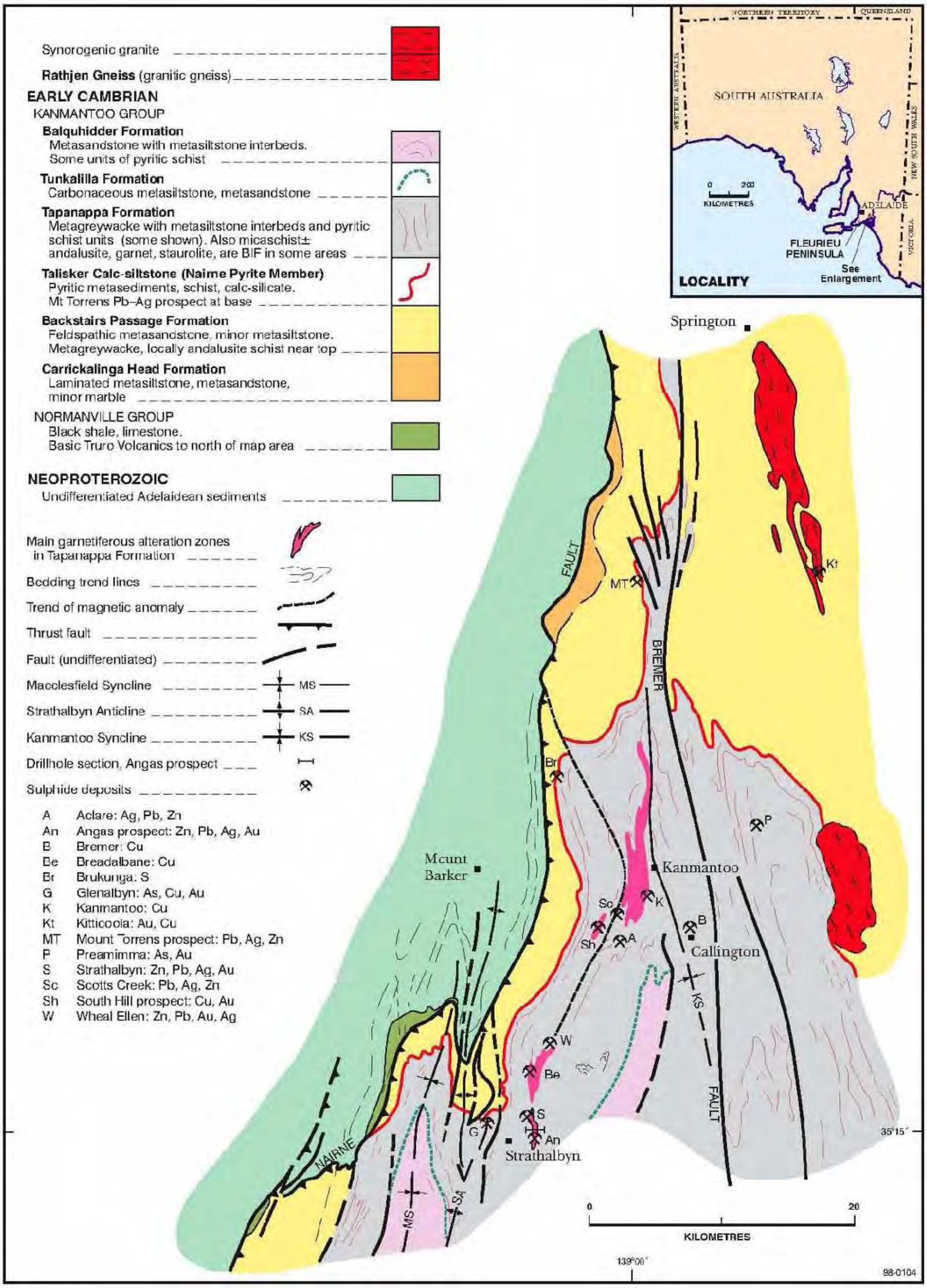


Figure 3: Regional Geological Setting of the Kanmantoo District (From Toteff, 1999)

Mineralisation

The base metal mineralisation at AZM consists predominantly of coarse-grained sulphide minerals, notably sphalerite, galena, pyrite and pyrrhotite. Minor chalcopyrite occurs locally. The sphalerite is dark brown to black and contains approximately 9% iron.

Textural relationships of the sulphides suggest several generations of mineralisation and re-working of mineralisation. Two broad styles of mineralisation have been recognised: Type 1 displays banded massive sulphides (Figure 4); Type 2 is a non-banded, commonly brecciated variety.

Mineral phase relationships suggest crystallisation at relatively high pressure-temperature conditions, probably corresponding to middle amphibolite facies. Mineral grain textures are usually equigranular and granoblastic. Individual sulphides are generally coarse-grained with pyrite crystals up to 10-15mm across.

Type 1

Intervals of Type 1 mineralisation are typically sulphide-dominant with only a minor host-rock component (0 – 40%). Compositional banding of pyrite and sphalerite is widespread. Individual bands vary from 5 to 20mm wide and are generally parallel or sub-parallel to the dominant host rock structural fabric (S2). In rare but significant intervals, compositional banding is deformed into open folds.

Figure 4: Type 1 Mineralisation

Type 2

Type 2 is a broad classification encompassing a variety of massive sulphide textures. Sulphide textures vary from massive to brecciated to disseminated and veined. Grain size varies greatly. A significant, distinguishing characteristic of Type 2 is the presence of pyrrhotite as the major sulphide phase, often dominating the entire interval (Figure 5). Chalcopyrite often becomes prominent in assemblages where quartz veining is an important feature. Significant non-sulphide minerals include quartz and chlorite.

There have been no drill intersections to date that contain Type 1 mineralisation only. All drill hole intersections that contain Type 1 sulphides show some Type 2 mineralisation. In most instances, Type 2 occurs along the contact of Type 1 sulphides with host rocks. Some intersections however, contain multiple intervals of Type 1 sulphides separated by intervals of Type 2 ore. Some drill core intersections show multiple intervals of Type 1 and Type 2 ore.

Figure 5 shows a fine to medium-grained sulphide matrix of pyrrhotite and sphalerite with green laths of chlorite. Clasts include milled fragments of Type 1 mineralisation and altered wall rock (Height ~5cm)

Unlike Type 1, Type 2 mineralisation extends laterally, beyond the south-plunging Rankine Shoot. Still confined to the Host Unit, Type 2 sulphides have been logged in almost all drill holes within the Angas prospect along a strike length of over 1.5km and throughout the known depth extent from the shallowest to deepest drill holes.

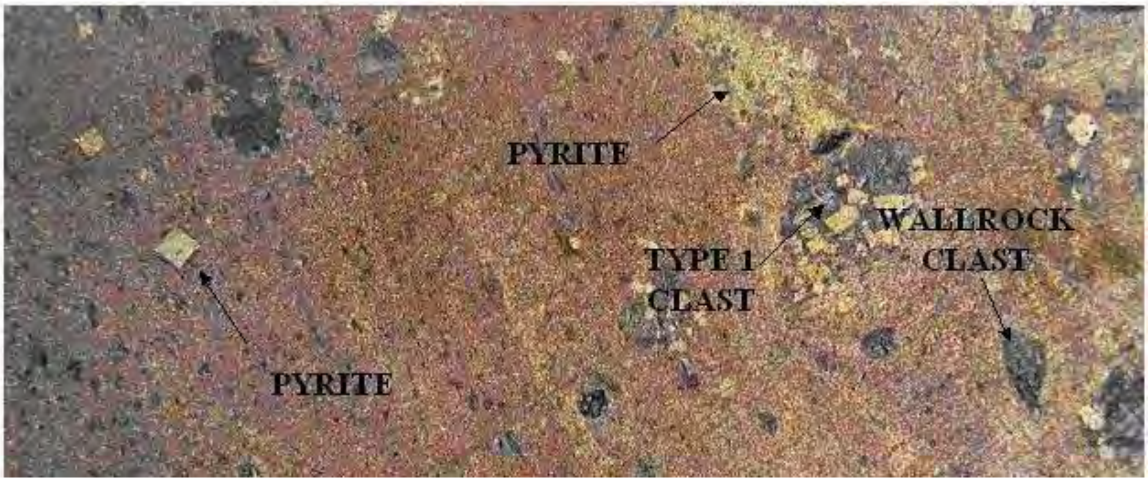


Figure 5: Type 2B Breccia

Origin of Sulphides

It is currently considered by Terramin's geologists that the mineralisation is syn-metamorphic/syn-tectonic, emplaced prior to peak metamorphism. The layering seen in the Type 1 mineralisation is considered metamorphic and structural. Mineralisation is discordant to bedding and appears to have been focussed in dilation zones along shearing associated with regional tectonism, possibly in the hinge zones of tight folds. Figure 6 shows a series of photographs from the 200 Level of Garwood, 1449 Ore Drive South (ODS).

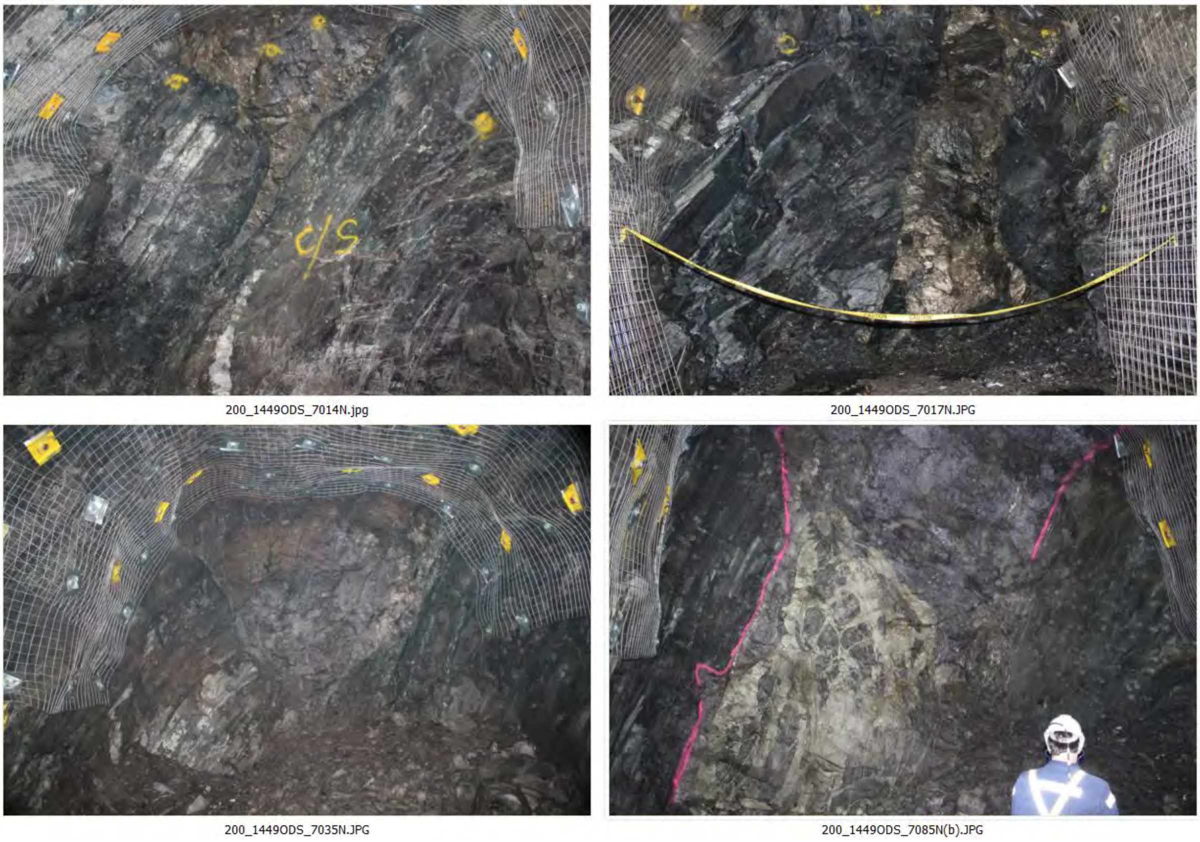


Figure 6: 200 Level Garwood, 1449 Ore Drive South, 7014N, 7017N, 7035N and 7985N

Waste Rock and Proportion of Waste

Approximately 450,000 tonnes of waste rock and approximately 2.3 million tonnes of ore will be generated over the life of the project. Of the 2,344,486 tonnes of milled material (totalled over 7 years, Table 1) approximately 8.3% will constitute mill grade zinc and approximately 3.1% will constitute mill grade lead, therefore approximately 88.6% of material will be waste.

SHOOT	Tonnes	Zn %	Pb %	Cu %	Ag g/t	Au g/t
Rankine	1,547,725	7.1	3.2	0.26	33.3	0.52
Hangingwall	366,848	10.3	2.2	0.18	21.7	0.28
Garwood	128,590	14.6	5	0.29	63.1	0.8
Development	301,323	7.3	2.7	0.25	30.3	0.56
TOTAL	2,344,486	8.1	3.1	0.26	33.1	0.56

Table 1: Reserve Details

Description and Results of Any Exploration Work Carried Out

Economic mineralisation of Rankine, the deepest of the lodes is determined to 400m RL (Mine grid) but the mineralized system remains open at depth.

The geological interpretation has a major northwest-trending structure terminating the southern extent of the Rankine and Garwood lodes. The sulphide mineralisation which is dragged into the fault is typically enriched in copper and gold. The distortion of the sulphides indicates a sinistral movement in plan and reverse movement in section implies that the offset mineralisation has been moved south and down.

Terramin’s understanding of the Mining Lease (ML) area has been enhanced with regional airborne geophysics. Airborne electro-magnetics (EM), magnetics, gravity and radiometrics datasets have been acquired. These datasets are being interpreted and integrated with previously acquired surface EM, magnetics and gravity data, and downhole EM data from a recently completed program on three of the deepest holes in the ML area (AN084, AN106, AN109).

Figure 8 depicts a typical geological cross-section of the mineralisation and geology in the vicinity of the Rankine-Garwood Shoots.

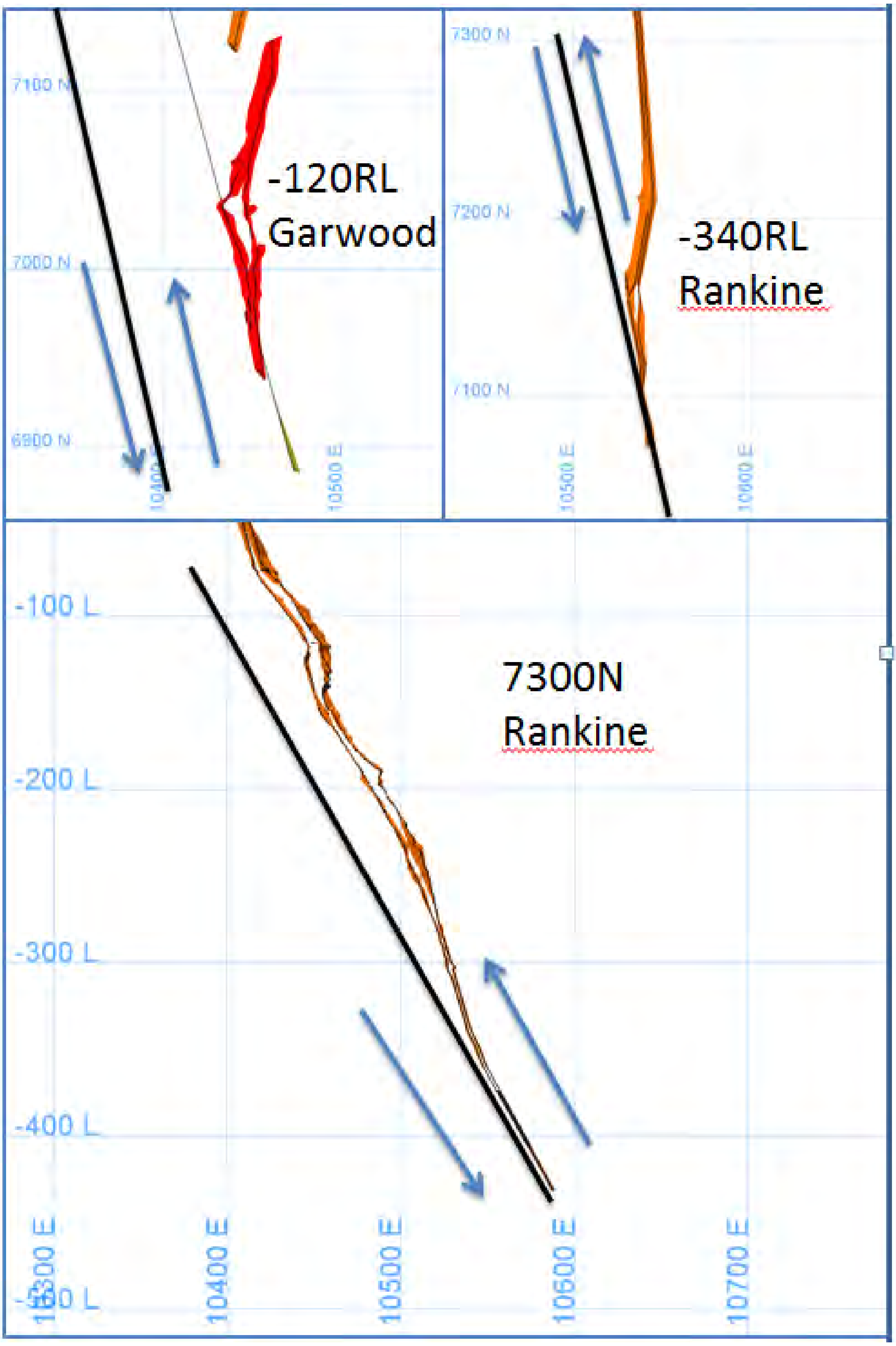


Figure 7: Level plans of Garwood 120RL, Rankine 340RL and Cross-Section 7300N

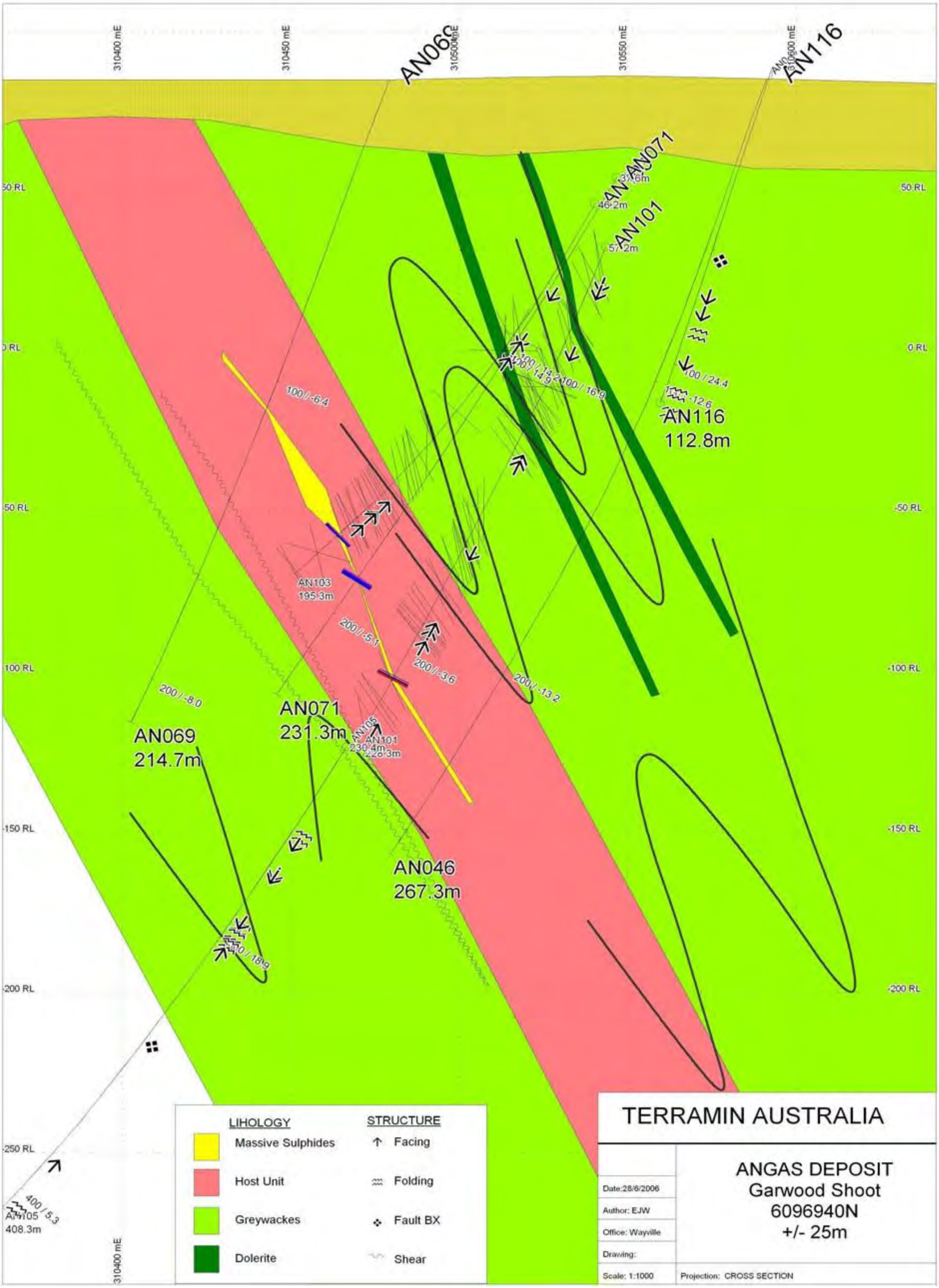


Figure 8: Section – Rankine – Garwood Shoots

Potential for Extension to the Orebody

Sunter Lodes

A resource for the Sunter deposit of 375 thousand tonnes at 5.4% Zn+Pb and 15g/t Ag was announced in November 2011 (Table 2).

The resource is contained within five sub-parallel, mineralised zones and has been estimated within a mineralisation model defined by and reported at a 2% combined Zn and Pb cut off. Of the total resource, there is an Indicated Resource of 127 thousand tonnes at 8.01% Zn+Pb and 21 g/t Ag, and an Inferred Resource of 248 thousand tonnes at 4.1% Zn+Pb and 13 g/t Ag.

Classification	Tonnes (kt)	Zn (%)	Pb (%)	Ag (g/t)	Pb + Zn (%)
Indicated	127.2	5.70	2.31	21	8.01
Inferred	248.5	2.9	1.2	13	4.1
TOTAL	**375.6**	**3.8**	**1.6**	**16**	**5.4**

Table 2: Summary Sunter Resource November 2011

The deposit lies within the AZM's exploration licence (ML6229) and has been the subject of a drill program since November 2010 in which a total of 20 drill holes have been completed.

Eastern Lode

The Eastern Lode horizon has been tested by several holes. AN021 and AN107 intersected 4.8m at 11.2% Zn+Pb and 2.3m at 9.4% Zn+Pb, respectively. The lode is open down plunge and along strike. It is the subject of further exploration.

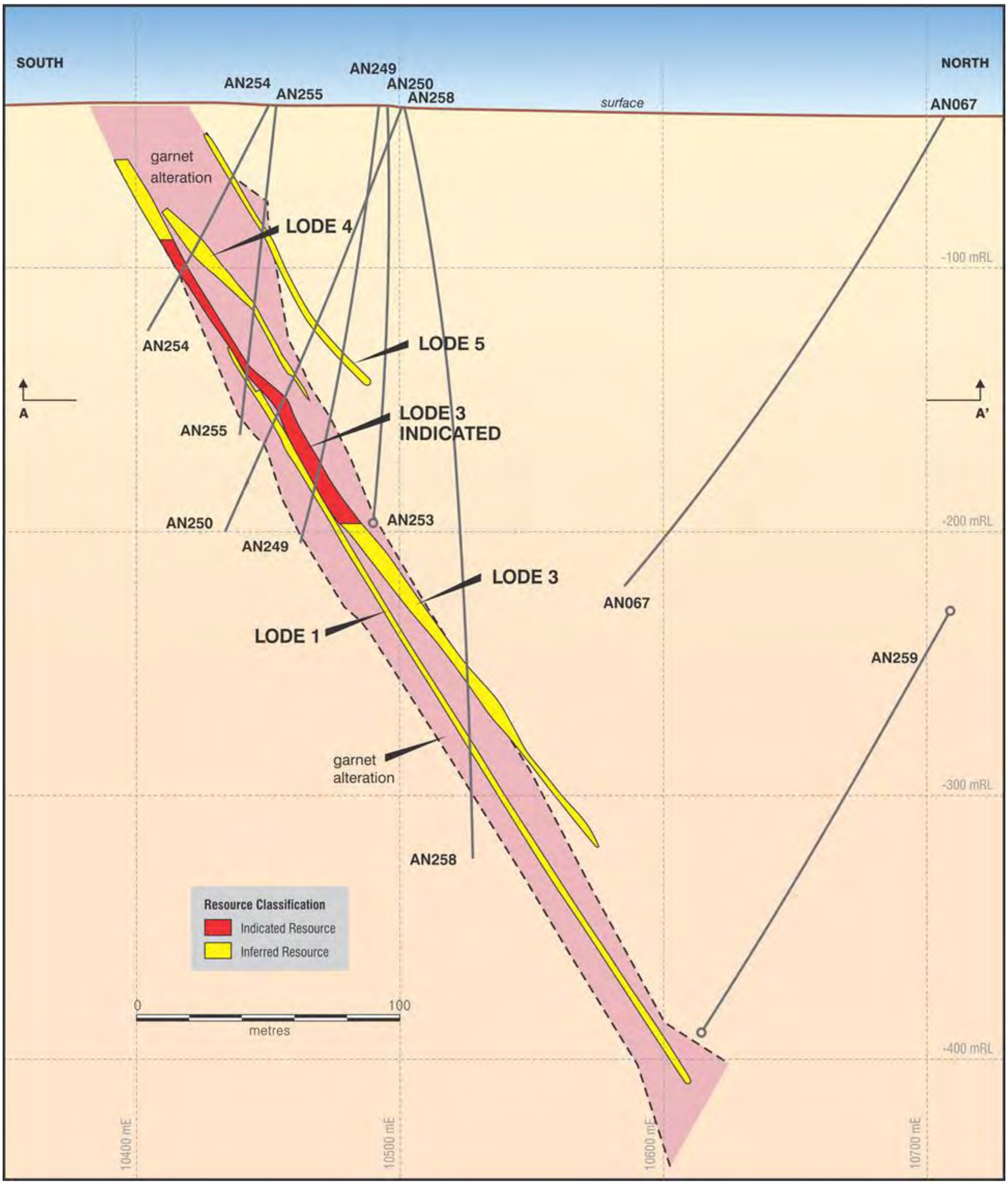


Figure 9: Cross Section of the Mineralised Zones at 6475N (window +/- 12.5m)

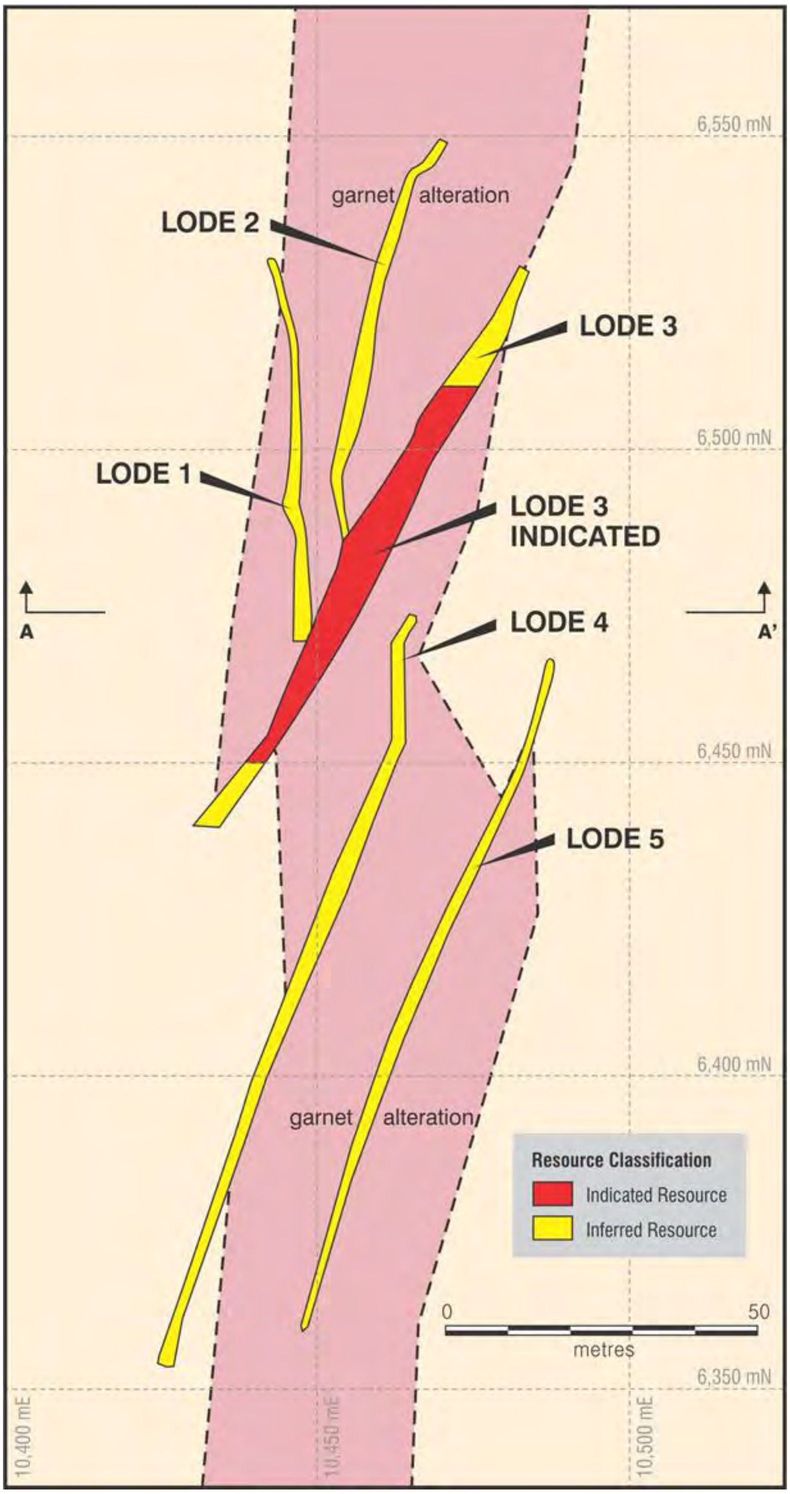


Figure 10: Plan View of the Sunter Mineralisation at -150mRL (115m Below Surface) identifying the Cross Section at 6475N

3.2.2 Reserves and Resources

Since the commencement of mining in 2008, annual updates to the Angas Resource and Reserves have been published on the Terramin website. Below is the 2012 Angas Resource and Reserves statement.

AZM Ore Reserves and Mineral Resources

A revised estimate of Ore Reserves and Mineral Resources at the AZM, based on data available as at 30th April 2012, has been prepared by the staff of Terramin Australia Limited. The estimate is prepared and reported in accordance with the Australasian Code for Reporting of Mineral Resources and Ore Reserves, December 2004 (JORC code).

The new estimate utilises the resource model prepared in April 2012, and comparison made to the model prepared as of June 2011, applying the same estimation assumptions.

A summary of results is presented in the tables below:

	Mt	%Zn	%Pb	%Cu	Ag g/t	Au g/t
Probable	0.63	7.08	2.63	0.22	29	0.5
Total/Average	**0.63**	**7.08**	**2.63**	**0.22**	**29**	**0.5**

Table 3: Ore Reserves as at 30th May 2012

	Mt	%Zn	%Pb	%Cu	Ag g/t	Au g/t
Indicated	0.70	4.79	1.98	0.15	20	0.42
Inferred	0.29	3.3	1.6	0.1	16	0.3
Total/Average	**0.99**	**4.4**	**1.9**	**0.1**	**19**	**0.4**

Table 4: Mineral Resources as at 30th April 2012

Notes:
1. The estimate is based on the resource model as at 30th April 2012 with the Reserve cut-off date as at 30th May 2012.
2. Indicated Resource and Probable Reserve grades are quoted at two decimal places (except silver). Inferred Resource grades and totals including Inferred are rounded to one decimal place (except silver). All tonnages are rounded to the nearest 10,000 tonnes.
3. The Indicated Resource is exclusive of those Resources converted to Probable Reserve.
4. The Probable Reserve depletion between 2011 and 2012 is summarised as follows:
a. Mining depletion between 2011 and 2012 accounted for 0.44Mt;
b. Sub economic rib and sill pillars left in situ because they were determined as being below cut-off grade and therefore sterilised as the mining sequence progressed. Also included were stoping areas (0.021Mt) planned for extraction in November 2011 but determined as sub economic. The total depletion accounted for 0.060Mt;
c. Changes in cut-off grade accounted for 0.14Mt. A combined cut-off grade for stoping of 4.8%Pb+Zn and 3.25%Pb+Zn for development was used for 2012 as compared with 4.0% and 2.5% respectively for 2011;
d. Revisions to the design methodology of the Crown Pillar accounted for 0.07Mt; and
e. The total depletion between 2011 and 2012 was therefore 0.66Mt.
5. Reserve estimation assumptions are unchanged from the previous estimate in June 2011 with the following exceptions:
a. Metal prices (USD) used for the Reserve estimate are in line with Bloomberg's 2013 Consensus Forecast (31 May 2012) Zn 2,313/t, Pb 2,350/t Cu 8,338/t, Ag 34.5/oz, Au 1,868/oz. An exchange rate of USD/AUD 1.00 was used.
6. Resource modelling assumptions are essentially unchanged from the previous estimate in May 2011, with the following exceptions:
a. A total of 266 exploration holes have been utilised, together with information from underground mining and development, leading to some further revisions to the geological model.
b. Extensive underground mapping and additional sample data obtained from sludge drilling was used to assist with defining mineralisation wireframes. The analytical data obtained from this sampling was not used in the Mineral Resource estimate.

The information in this report that relates to Mineral Resources for Angas is based on information compiled by Mr Eric Whittaker. The information that relates to Ore Reserves for Angas is based on information compiled by Mr Ian Holman. Mr Whittaker is a member of The Australasian Institute of Mining and Metallurgy and Mr Holman is a Member of the Institute of Materials, Minerals and Mining. Mr Holman in the capacity of Chief Engineer was at the time a full time employee of Terramin Australia Limited. Mr Whittaker was Principal Resource Geologist of Terramin Australia Limited at the time of his *estimate. Both have sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the 2004 Edition of the 'Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves'. Mr Whittaker and Mr Holman consent to the inclusion in the presentation of the matters based on his information in the form and context in which it appears.*

3.2.3 Production Rate and Products

The AZM was established to recover Zinc and Lead from the minerals:

- Galena – lead sulphide; and
- Sphalerite – zinc sulphide

The relative abundance of lead and zinc is displayed in Table 4 as percentages of the total reserve. The mining, production and sales rates are detailed in Table 5. All ore mined will be processed and concentrated. Lead concentrate is processed at Port Pirie (for use in car batteries, fishing industry, radiation shielding etc.), and zinc concentrate is exported to Asia (for use in roofing, coating of wire fencing, household appliances etc.). Typically the lead concentrate produced contains commercial quantities of gold and silver bearing minerals both in solid solution with the galena as free minerals, e.g. tetrahedrite and free copper sulphide in the form of chalcopyrite.

A number of mass balances have been constructed for the AZM. The life-of-mine (LOM) mass balance is given in Figure 11. It gives the material movement for LOM and for a standard operating year. A more detailed mass balance of the metallurgical plant is given in Appendix Y. The annual production figures vary according to throughput associated with the grade and tonnage of ore mined.

	2007	2008	2009	2010	2011	2012 (proposed)	2013 (proposed)
Reserves ('000t)	2,247	2,115	1,739	1,326	930	524	133
Mined ('000t)	132	377	412	396	406	391	133
Milled ('000t)	131	377	400	405	405	391	138
Mill grade (% Zn)	6.7	9.8	7.9	8	9.8	7.1	6
(% Pb)	2.3	3.5	3	3.4	3.3	3.1	2.3
(% Cu)	0.2	0.2	0.2	0.3	0.2	0.3	0.2
(g/t Ag)	24	39	29	38	33	33	25
(g/t Au)	0.4	0.6	0.4	0.5	0.5	0.6	0.5
Lead-copper conc. ('000t)	4.9	22.5	20.8	24.6	23	21.1	5.5
(% Pb)	47	49	48	48	48	47	46
(% Cu)	4	3.1	3.5	3.8	3.4	4	4.7
(g/t Ag)	407	503	389	472	431	447	397
(g/t Au)	7	7	5	6	6	8	9
(% Zn)	13	12	11	9	12	9	11
Zinc concentrate ('000t)	14.7	64.5	53.8	55.9	69.8	46.8	13.7
(% Zn)	52	52	52	52	52	52	52
(% Fe)	6.7	4.8	6.5	7.4	5.7	7.9	8.9

Table 5: Production Schedule

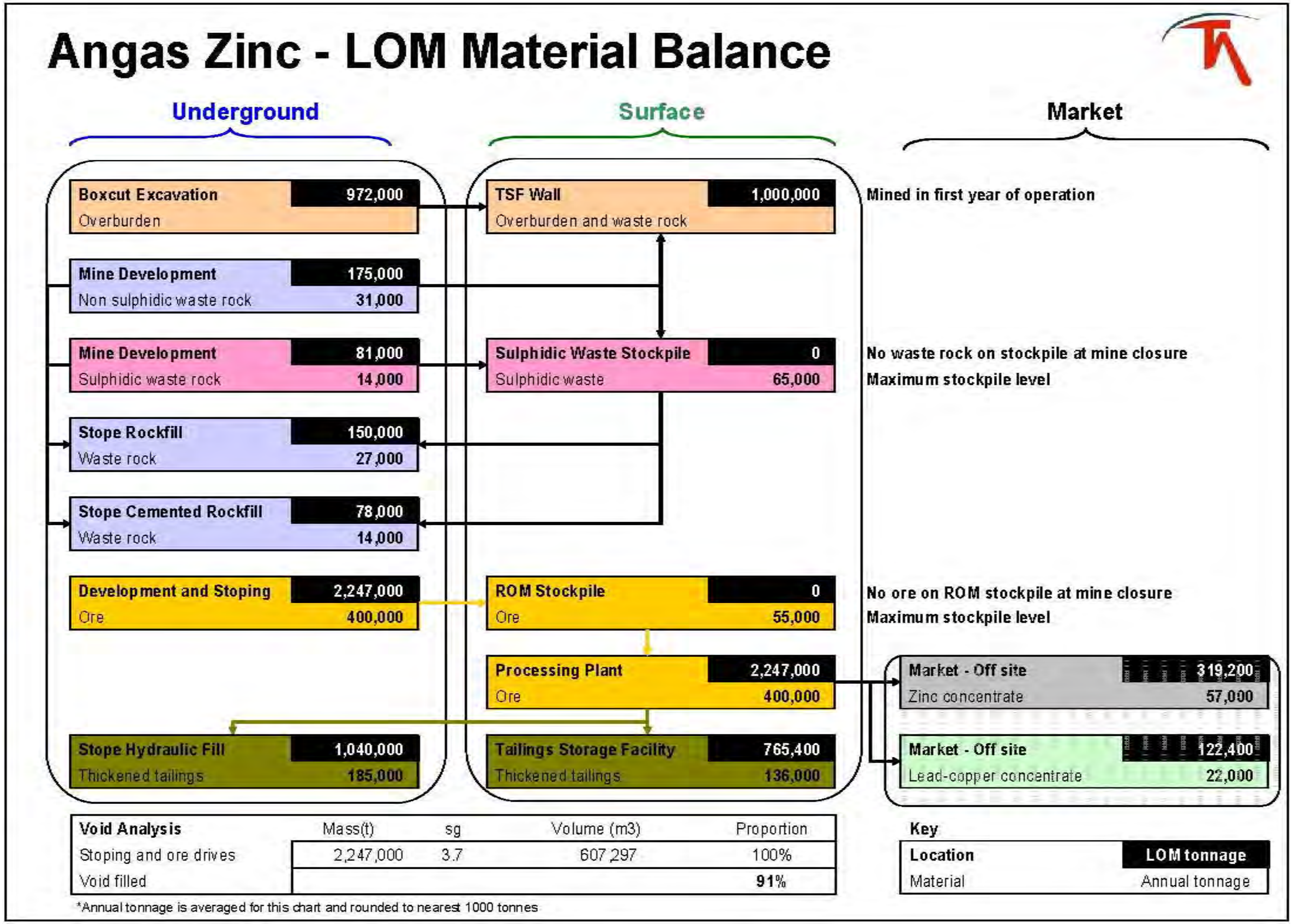


Figure 11: LOM Mass Balance

3.3 EXPLORATION ACTIVITIES

Staged exploration programs continue as exploration targets are worked up with a focus on previously untested near-mine targets.

Upcoming exploration will target the Rowe anomaly, situated approximately 400m east of the current mine workings. Coincident geophysical anomalies and gravity surveys highlight the potential of this target (refer Figure 12). No drilling has occurred at this anomaly previously. The second untested near-mine target to be evaluated under stage 1 is the Albyn anomaly, located south of existing workings. Based on an updated structural interpretation of the movement of the Rankine and Garwood Lodes, it is proposed to test the area between the Garwood and Sunter Lodes.

The company anticipates commencement of the second stage of the exploration program in the first quarter of 2013. Stage 2 will involve deep drilling of the Milne target, located directly beneath the Rankine Lode. There is minimal drill data directly below the known mineralisation of the Rankine Lode below -500mRL. Three deep (800m-900m) holes would be required to test the potential of the mineralisation to return to economic grades and widths below the known extents of the existing orebody. The central hole would also test the down plunge extension of the known northern mineralised zone. Based on the results of these holes, the company will review further geophysical work (i.e. downhole EM survey), to identify targets in the vicinity of the drilling.

Exploration equipment used includes drill rigs sourced through contractors, light vehicles, quad bikes and water trucks, Types of drilling potentially undertaken may include reverse circulation, rotary mud and diamond core. Geophysical techniques likely to be used are down hole electromagnetic, surface magnetics, gravity surface surveys and seismic surveys. Earthworks required to be undertaken during exploration activity includes the digging of sumps for drill rigs and firebreak clearance around rigs.

All drillholes, upon completion, will be grouted and any sumps cleaned and backfilled.

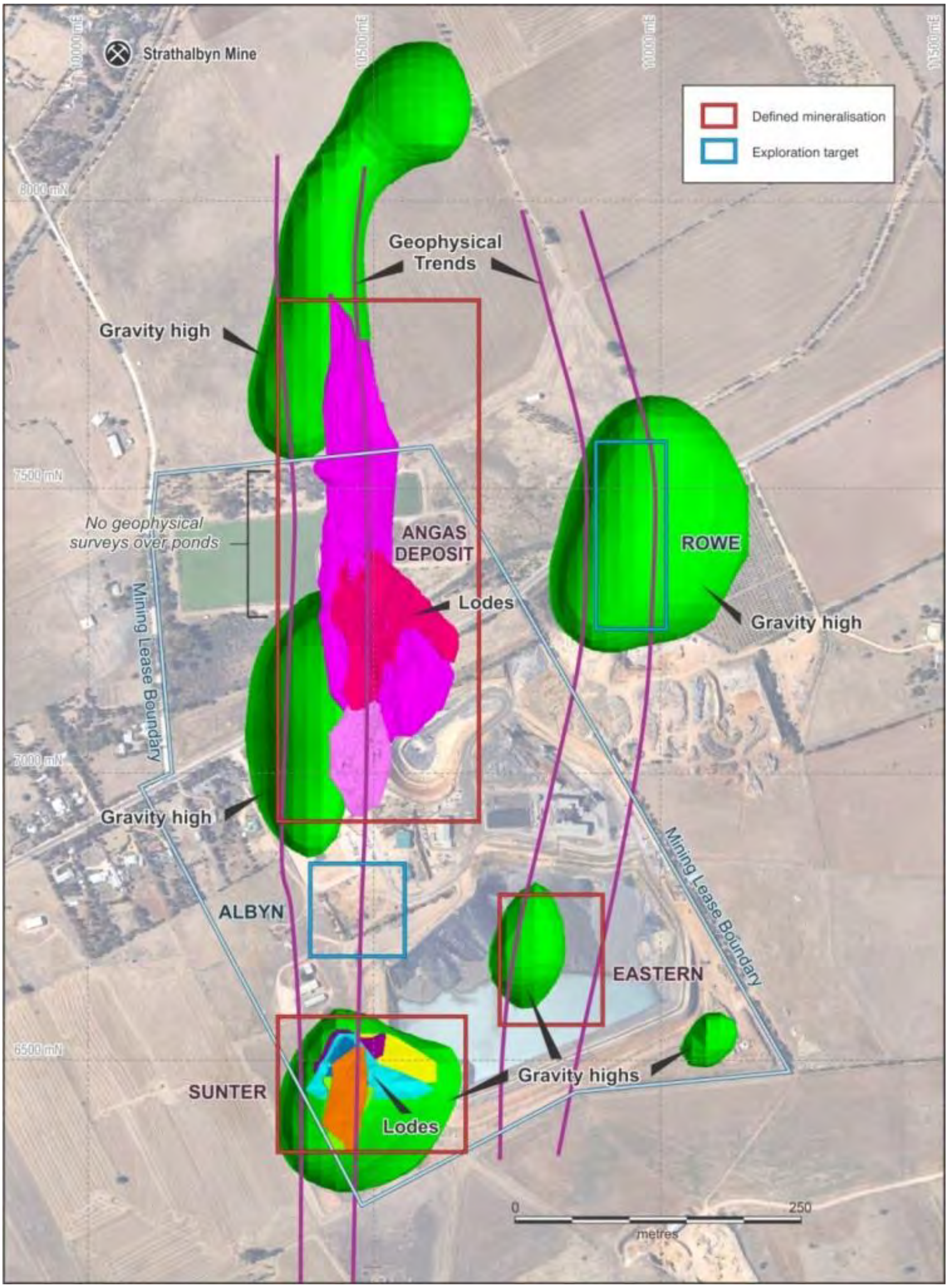


Figure 12: AZM, Rowe Lode Significant Gravity Anomaly

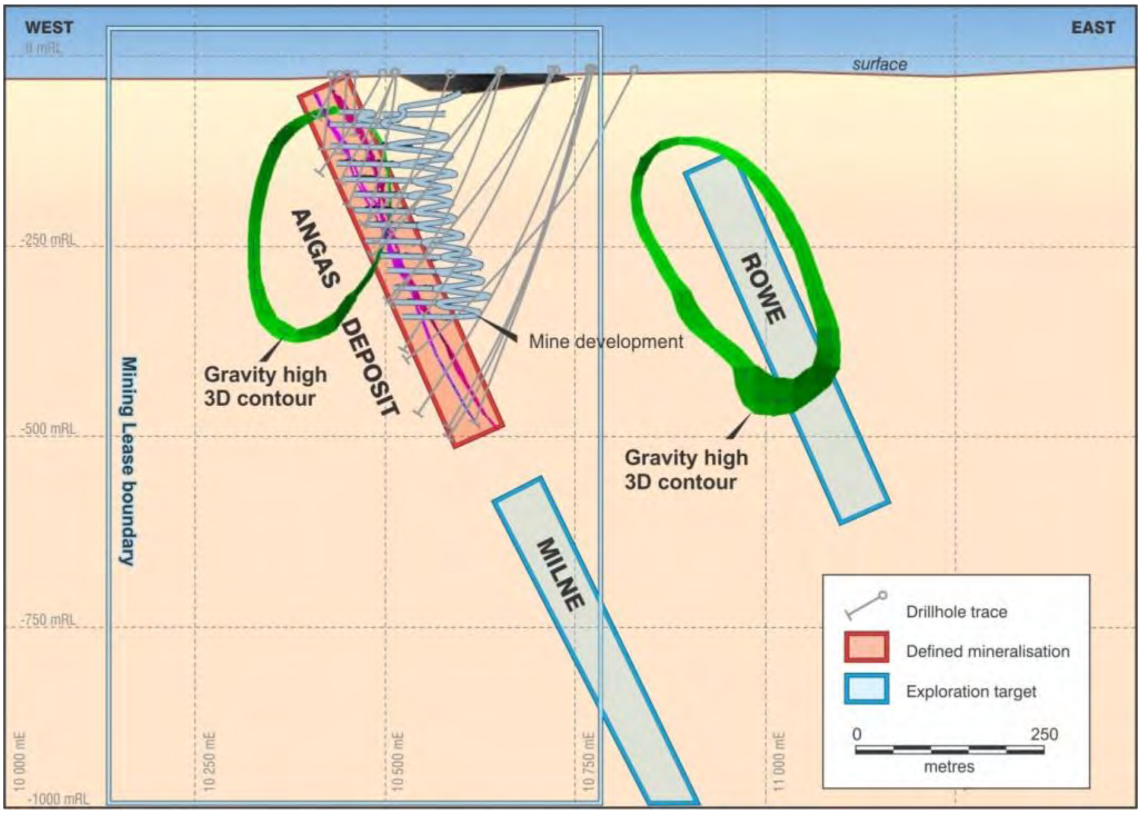


Figure 13: Cross Section at 7250N Looking North at the Angas Deposit, AZM Development and positions of the Rowe and Milne Exploration Targets

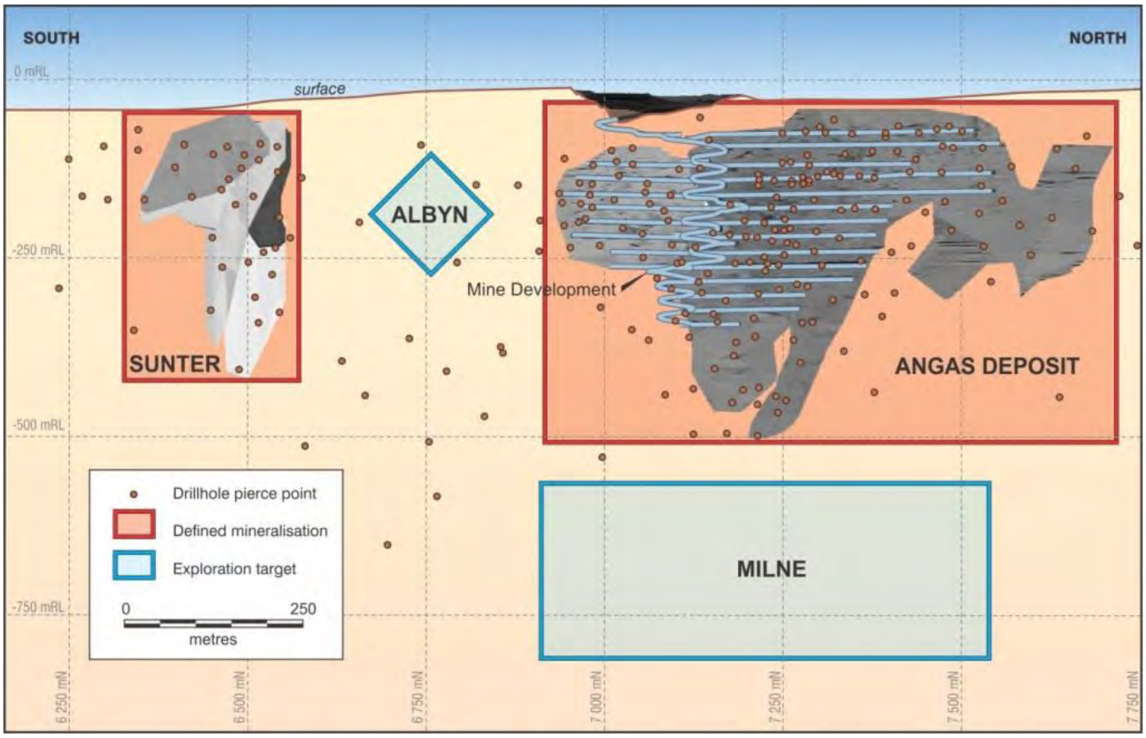


Figure 14: North-South Long Section Through the Angas and Sunter Deposits (Grey) Showing Mine Development and the Albyn and Milne Exploration Targets

3.4 MINING PLAN

3.4.1 Type or Types of Mining Operation to be Carried Out

The AZM is an underground mining operation accessed via a boxcut established in a previously existing limestone quarry. The ore body is accessed from a decline developed at a slope of 1:7. Horizontal accesses are developed off the decline to reach the mineralisation (ore). Ore is extracted from the orebodies using sub level stoping or bench mining methods. Open stoping with progressive fill is the main mining method. This allows for safe, high productivity and low cost stoping while minimising open voids.

The Rankine ore shoot modelled is persistent along a strike of over four hundred and fifty metres, with a typical true thickness ranging from narrow veins less than 1m thick, through to mineralisation of up to 20m thick. The top of the ore is evident at the surface (highly oxidised) and the mineralisation is open at depth. The orebody plunges 45 degrees down from north to south with a dip of 70 degrees to the west.

The process plant includes a single stage crusher and 1250kW semi-autogenous mill configuration, lead and zinc flotation cells, slurry thickeners, concentrate filtration and storage capacity of an estimated 65,000 tonnes of dry concentrate (refer to section 3.8).

3.4.2 Sequence of Mining and Rehabilitation Operations

The orebody is mined using underground mining methods due to its location beneath the STEDS lagoons and the Strathalbyn to Callington Road. The orebody is steeply dipping and generally narrow which limits the economic depth for an open pit operation due to unfavourable strip ratios.

Development and construction of the mine commenced in 2007 and production commenced in 2008. The mine has been operating at steady state production since 2009 with closure currently planned for 2013.

Mining of ore commenced on multiple levels to bring production on as soon as practicable. Levels were developed from the top of the mine and as stoping blocks were developed they were mined from the orebody extremities in towards the decline. As the stopes were mined they were backfilled with either rock fill, cemented rock fill, cemented paste fill or a combination of each (refer to section 3.7.2). The size and shape of the stopes are determined by a combination of grade and geotechnical stability. The type of fill is designed to ensure minimal dilution and maximise ground support where required.

As AZM in an underground operation, progressive rehabilitation is limited; however the following rehabilitation tasks have been undertaken during the operational phase;

- **Topsoil and subsoil** – are stockpiled separately for reuse for revegetation purposes and fill purposes respectively. Topsoil is monitored annually for signs of erosion and contaminants through fixed photo monitoring sites and soil analysis (refer to section 5.4).
- **Drill holes** – exploration drill holes are progressively rehabilitated.
- **Vegetation** – Seeds of various native plants have been collected to provide seed for the revegetation program. Seeding and planting of native species commenced at the beginning of mining operations in accordance with the revegetation plan (Appendix X). Sections 1-3 of the Revegetation Plan have been completed, while areas 5 and 6 cannot commence until mining operations cease.
- **Mine voids –** to provide long term local and regional stability and to minimise the risk of Acid Mine Drainage (AMD), Terramin progressively backfill the mine voids with solids (refer to section 3.7.2).

3.5 MINING OPERATIONS

3.5.1 Modes and Hours of Operation

The operation runs on a continuous (24 hours, 7 days a week) basis.

3.5.2 Workforce

The AZM workforce is managed through a direct and tiered leadership model as demonstrated below (Figure 15);

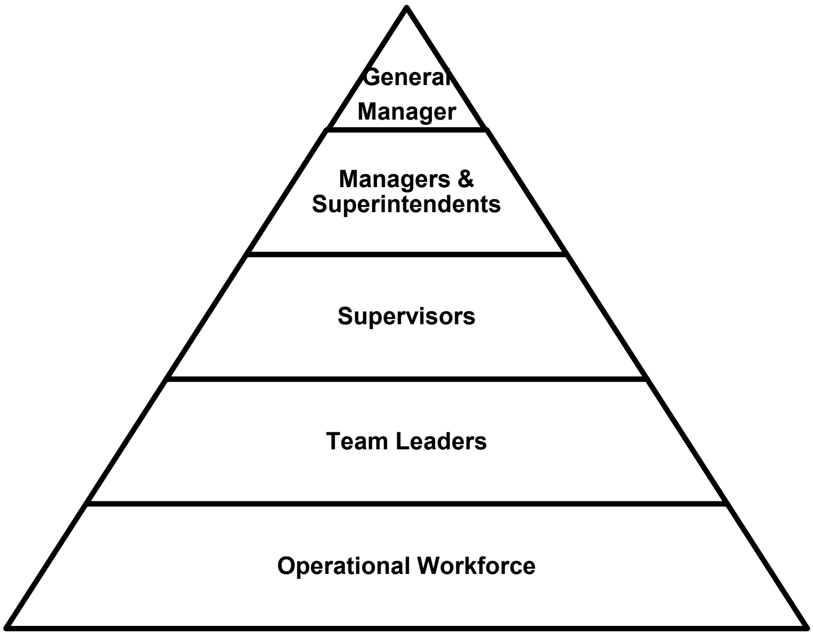


Figure 15: AZM Tiered Workforce

AZM is operational 24 hours per day, 7 days per week and employs approximately 125 full-time employees. Employees are engaged through either common law contracts or under the Terramin Australia Limited Enterprise Agreement 2010 (EBA).

The shift rosters utilised are dependent on job requirements and meet the conditions outlined under the EBA (Table 6). The following shift rosters are currently in operation at AZM;

- 8 hour day Monday to Friday
- 12 hour day on a 4 panel, 4/5 day rotation
- 12 hour day on a 4 panel, 4 day rotation
- 10.5 hour day, on a 4 panel, 7 day rotation
- 12 hour day on a 4 panel, 7 day rotation.

Continuous shift rosters reduce the need for overtime shifts on weekends and for servicing requirements on key equipment to maintain equipment availability and utilisation.

Occupation	Roster
AZM Management Team	8 hour day Monday to Friday
Mine administration, professionals and supervisory staff	8 hour day Monday to Friday
Mining	
Shift Supervisors	12 hour day on a 4 panel, 7 day rotation
Development crews	10.5 hour day, on a 4 panel, 7 day rotation
Load and haul crews	10.5 hour day, on a 4 panel, 7 day rotation
Production crews - drillers	10.5 hour day, on a 4 panel, 7 day rotation
Production charge hands	10.5 hour day, on a 4 panel, 7 day rotation
Mill Operators	
Loader operator	12 hour day on a 4 panel, 4 day rotation
Plant shift operators	12 hour day on a 4 panel, 4 day rotation
Maintenance	
Mine and Mill maintenance - day crews	12 hour day on a 4 panel, 4/5 day rotation
Mine and Mill shift maintenance	12 hour day on a 4 panel, 4/5 day rotation

Table 6: Planned Work Hours for Mine Personnel

3.5.3 Use of Explosives

Types of Explosives

A combination of Ammonium Nitrate Fuel Oil (ANFO) and emulsion based packaged explosives is used for underground blasting. Initiation of explosives is conducted using non-electric (NONEL) or electronic detonators. Where reduced vibration or specific blast geometry dictates electronic detonators are used.

Frequency of Blasting and Blast Monitoring

Stope blasts are typically scheduled for firing once per day in the afternoon. Development blasting occurs between 6am and 10pm typically at the end of each shift.

A blast monitoring program has been implemented for the life of the mine, with multiple monitors established at locations agreed with the Strathalbyn Community Consultative Committee (SCCC) (refer to section 5.11).

Storage of Explosives

Explosives are stored in a SafeWork SA-certified surface magazines. These magazines are located in the south eastern corner of the ML, near the TSF as this location facilitates safe clearance distances (Figure 23). Due to the shallow depth of the mine, a permanent magazine has not been established underground. If the mine was to be further developed, an underground magazine could be established.

The peak consumption of explosives based on current schedules is 12 tonnes per week, typically closer to 5 tonnes per week. The magazine has been designed, and is licensed to store, 19 tonnes of explosives and 10,000 detonators.

3.5.4 Type of Equipment

The equipment operated in the mine is critical to achieving high ore grades and minimising dilution. The range of orebody width and geometry demands a variety of equipment and techniques to allow high production at minimum cost. Equipment flexibility allows efficient operation of the mine, with each machine being able to perform a number of tasks in different areas of the mine.

Standard equipment currently in use in Australian metalliferous mines has been selected for AZM (Table 7).

The dimensions of underground development are typically controlled by the dimension and clearance requirement of the mobile fleet.

Mine emissions in the form of noise, vibration and exhaust outputs are minimised through the selection of equipment that has been designed with these in mind. Primary ventilation fan selection is based on noise level and attenuation. Haul truck and loader selection are made to ensure compliance to noise emission and vibration levels. Explosive types and blast design have been determined by blast vibration limits that have been set in the Lease Conditions (refer to section 5.11).

Equipment	Type	Quantity	Machine Description	Operators Cab	Noise dB(A)	Ignition Source
Integrated tool carriers	Volvo	1	L90	Enclosed Cab	68	**Diesel**
Wheel Loader	Caterpillar	1	950H	Enclosed Cab	71	Diesel
ANFO Loader with boom	Normet	1	Charmec 1310F	Open Cab	85	Diesel
Production Drill	Atlas Copco	1	M7 C	Enclosed Cab	80	Diesel/Electricity
Development Jumbo	Atlas Copco	1	M2D	Enclosed Cab	105	Diesel/Electricity
LHD Loader 7t	Atlas Copco	1	ST1030	Enclosed Cab	82	Diesel
LHD Loader 12.5t	Caterpillar	2	R2900	Enclosed Cab	84	Diesel
UG Truck 40t	Volvo	2	A40E	Enclosed Cab	74	Diesel

Table 7: Major Underground Equipment

3.5.5 Mine Dewatering

Water sources for the mine water are from the Cambrian fractured rock aquifer, small perched aquifers, potential leakage from the lagoons, and water associated with rainfall from the central domain catchment area. The first three sources are saline.

It was first anticipated that near surface sections of the mine might require special management due to potential seepage from the STEDS lagoons, however, this has not posed a problem.

Prior to mining, water inflows into the mine were modelled at an average of 6-7.5 litres per second from the fractured Cambrian aquifer with short duration peak flows of up to 25 Litres per second with no major issues in terms of local or environmental users associated with groundwater ingress. Since the commencement of operations, however, mine water inflow has been higher than modelled with high seasonal variation. Inflows of up to 12-14 litres per second have been recorded.

A groundwater flow model for the AZM was constructed for the fractured Cambrian aquifer to simulate mine dewatering and assess the possible effects on the regional water including any impacts to the Angas River. This model has been constructed using “MODFLOW” proprietary software package and is configured as a square grid of cells orientated approximately north west to south east. The model area extends from the Angas River in the west to east of Prizabilla Road and about 2km from Woodchester. The northern boundary is located to the north of Burnside Road whilst the southern boundary is located to the north of Belvidere. It has been constructed as a single layer model to simulate flow in the fractured Cambrian-age Kanmantoo Trough rocks that host the mineralisation of the Angas deposit. Hydraulic properties used in the model have been obtained from site tests and from the review of site geology.

The mine is simulated as a single cell, with dewatering depth controlled by the cell being assigned a constant head. The Angas River also features in the model, forming the western boundary. River cells have also been assigned constant heads, whilst cells to the west of this watercourse are inactive. The model has been run under steady state conditions, which enables the long-term (equilibrium) conditions to be assessed. Such a simulation produces drawdown contours that may take many years to achieve. This model does not include any infiltration from rainwater recharge.

The outcome of this model, including drawdown over 7 years (Figure 16), is presented in *Appendix M-6*, which also shows the extent of mine dewatering on the regional water table. This modelling was reviewed in 2012 as part of closure planning and was extended to include modelling of the mine ground water cone of depression recovery (Appendix L). The recovery is anticipated to take up 100 years due to the low permeability of the Cambrian aquifer.

All mine water management relating to mine closure is located in Appendix C.

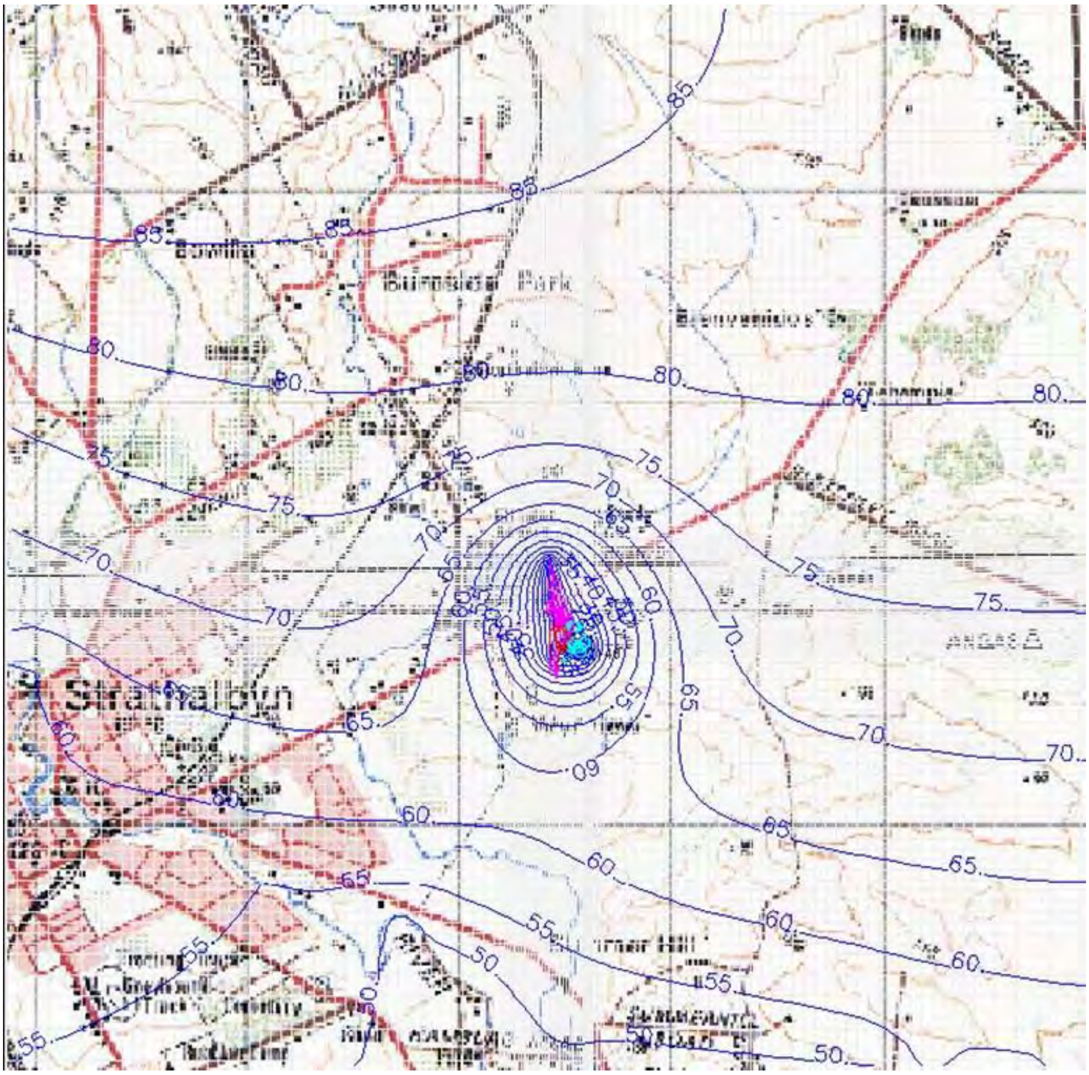


Figure 16: Tertiary Aquifer Drawdown after Seven Years of Operations

Description of On-Site Water Treatment Equipment

Water is pumped from the mine via a rising main pipeline installed off the decline. Underground pump stations lift the water from the mine and discharges it into a de-silting pond prior to the mine raw water pond.

Raw water is utilised for on-site dust suppression via water trucks and sprinkler systems as well as dust suppression on a neighbouring waste recycling facility. Any excess raw water can be filtered through the on-site ultra-filtration unit or treated by Reverse Osmosis (RO). RO permeate can be used for irrigation of tree plantings as per the irrigation plan (Appendix AK). A 7.5km pipeline has been constructed to carry up to 750m^3 per day of water, meeting Environment Protection Agency (EPA) water quality policy parameters for irrigation, to the viticulture industry based near Langhorne Creek. Filtered raw water is disposed of through dust suppression or re-injection into the Cambrian fractured rock aquifer via six approved re-injection bores.

3.5.6 Stockpiles

Waste Rock Stockpiling

Waste is assessed at the development face to ascertain if it is sulphidic (potentially acid forming (PAF)) or non-sulphidic (non-acid forming (NAF)). Sulphidic and non-sulphidic waste is stockpiled at the eastern end of the boxcut, within the original quarry. This stockpile is drawn down and returned underground for backfill. The stockpile has a capacity of 65,000t.

The Run of Mine (ROM) and waste rock pads, located within the boxcut, are appropriately bunded and graded to prevent uncontrolled discharges from the area. Water is directed to the portal sump where it enters the mine water circuit and is pumped to the mine settling pond.

Underground haul trucks tip on the stockpiles and the dumps are pushed over with a loader as required. Excavators are used when required to ensure that safe working areas are maintained on the stockpile and for rock breaking of oversize material.

Ore Stockpiles

Ore is hauled to the surface and dumped on the ROM pad adjacent to the boxcut entrance. The ROM pad has a nominal stockpile capacity of 10,000 tonnes. This stockpile is used as a buffer between the underground operation and the mill to ensure steady state feed to the mill. The ROM pad is approximately 13,000m^2, constructed as a lined pad and designed so all drainage from it runs into the Boxcut and is collected at the portal sump. The ROM pad has been designed at a low elevation utilising the natural valley to facilitate low visual and noise impact. This stockpile is used throughout the operation, including night shift when the crusher is not in operation.

Ore stockpiles are separated where practical into separate stoping blocks and are blended as feed to the mill. Blending of the ore assists processing performance and reconciliation processes.

Topsoil Stockpiles

Topsoil removed during site preparation has been relocated adjacent to the TSF to be used in site rehabilitation. Further detail on the topsoil stockpiles has been detailed in section 5.4.

Concentrate Stockpiles

Concentrate is stored in a shed specifically built for storage and handling of concentrate. The concentrate shed floor is constructed of concrete and provides for fully contained loading of concentrate into the B-double Road Trains. Zinc and lead concentrate is stockpiled separately within the shed.

Stockpile Stabilisation

Ore and waste rock stockpiles are stored at the natural angle of repose for ease of rehandling. Topsoil stockpiles are seeded appropriately to minimise erosion and maintain useability for the site closure rehabilitation program. Stockpile locations can be seen in Figure 23.

Ore Stockpiles and Fill Stockpiles - Underground

A 20m underground stockpile is typically developed in the access drive between the loading point in the decline and the ore drives. Where required, these stockpiles have the floor stripped to facilitate Cemented Rock Fill (CRF) mixing.

3.6 MINE COMPLETION

3.6.1 Description of Mine Site at Completion

A comprehensive Closure Plan has been compiled for the AZM by Terramin (Appendix C). It divides the ML into discrete Domains; North, South, Central and Buffer (Figure 17) and proposes closure details for each Domain using a risk based approach. Terramin has undertaken extensive planning for the remediation of the mine site once mining operations cease. The detailed mine closure plan provides a clear explanation of the processes and steps involved to achieve the required outcomes. This section provides an overview of that plan. Terramin has already initiated monitoring to establish environmental baselines to have a relevant point of comparison for quantifiable environmental conditions at closure.

Terramin's closure outcomes are directly linked with their ML conditions (Appendix AH) that were established using a risk-based approach. Outcome measurable criteria for both the rehabilitation and the post-closure outcomes have been established (refer to section 5).

For closure purposes, each Domain has its own proposed final land use plan, as shown in Table 8. The boxcut area will remain with greatly reduced angles and thereafter will serve as a low lying, seasonal evaporation pan (refer to section 5.2.1 for further detail). The South domain will have the most significantly altered landscape of all the domains when compared to baseline conditions as the TSF will remain in a rehabilitated state (refer to section 3.9.4).

Domain	Current Land Use	Proposed Final Land Use
North	STEDS lagoon and a portion of the Callington Road	No Change. Domain will remain as STEDS lagoon and a portion of the Callington Road.
South	TSF	Native vegetation acting as an ET cap (phytocap) to the TSF
Central	Contains the majority of the mining infrastructure (except the TSF)	Open Woodland and light industrial area
Buffer	Residential housing and some cropping in the southern section of the Domain	No change. Domain will remain as SEB, residential housing and some cropping

Table 8: Summary of Current and Proposed Final Land Use for Each Domain

The proposed rehabilitated landform of the site is shown in Appendix C. The final landform will ensure that the site is left in a chemically, physically, ecologically and structurally stable state.

Risks to the health and safety of the public and fauna are eliminated or reduced to as low as reasonably practical, and visual amenity is consistent with, or improved compared to baseline conditions.

All mining infrastructure in the Central domain will be removed except for the concentrate shed, the workshop, the access road (including the road to the concentrate shed), the electrical substation and transmission line infrastructure, (including to the workshop and concentrate shed (SA Power Networks require that Terramin provides freehold title to the substation land and the appropriate easements be vested in them)).

It is Terramin's intention that the final landform and vegetation community will fit in with the surrounding landscape. Final vegetation will consist of local providence species and where possible native seeds have been collected from on-site native vegetation. The boxcut and other areas in the Central Domain requiring to be revegetated will be direct seeded with the native species outlined in Tables 9 -11 as per Appendix C. The TSF capping (refer to section 3.9.4) will be direct seeded with indigenous species outlined in Table 12 and supplemented with a variety of native grass species (Table 9). Further details are included in the Closure plan (Appendix C).

It is anticipated that it will take approximately two years and six months to rehabilitate the mine on completion of processing (Appendix AO). Monitoring and remedial actions will continue until all closure criteria are met. Further detail of the mine site at completion has been included in the Closure Plan (Appendix C).

Table 9: Revegetation Grassland Species

Species	Common name	Quantity for 13.7 Ha (kg)
Austrodanthenia geniculata	Shiny or Kneed Wallaby-grass	54.8
Austrostipa ssp.	Spear Grass	54.8
Bothriochloa macra	Red grass	54.8
Chloris truncata	Windmill Grass	54.8
Cymbopogon ambiguous	Lemon grass	54.8
Gahnia sp	Sawgrass	As available
Themada triandra	Kangaroo Grass	114
Avena strigosa	Saia Oats - sterile	685
Total		**388kg native perennial + 685kg annual**

Table 10: Revegetation woodland species and proposed quantities Central Domain

Species	Common name	Quantity
Acacia acinacea	Gold Dust Wattle	8.8
Acacia brachybotrya	Grey Mulga	8.8
Acacia paradoxa	Kangaroo Thorn	8.8
Acacia pycnantha	Golden Wattle	8.8
Allocasuarina verticillata	Weeping Sheoak	1.8
Atriplex semibaccata	Spreading Saltbush	6.6
Bursaria spinosa	Christmas Bush	1.3
Callitris gracillis	Southern Cypress Pine	3.5
Dodonaea viscosa ssp. spatulata	Sticky Hopbush	0.6
Enchylaena tomentosa	Ruby Saltbush	13.2
Eucalyptus fasciculosa	Pink Gum	2.6
Eucalyptus leucoxylon	SA Blue Gum	2.6
Eucalyptus odorata	Peppermint box	2.6
Melaleuca lanceolata	Dryland Teatree	1.3
Pittosporum angastifolium	Native Apricot	1 kg
Total		**22 kg**

Table 11: Evaporation pad species and proposed quantities: Central Domain – 0.85 ha

Species	Common name	Seeding rate	Quantity
Acacia provincialis	River wattle (Swamp wattle)		340g
Bolboschoenus caldwellii	Marsh Club-rush	1kg/ha	1.12kg
Callistemon rugulosus	Red Bottlebrush		51g
Callistemon seiberii	Yellow River Bottlebrush		51g
Cyperus gymnocaulos	Spiny flat sedge	1 kg/ha	1.12kg
Enchylaena tomentosa	Ruby Saltbush	300 gm/km	510g
Eucalyptus camaldulensis	River Red Gum		23.8g
Eucalyptus odorata	Peppermint Gum		102g
Isolepis nodosa	Knobby club rush	1kg/ha	1k.12g
Leptospermum lanigerum	Silky Tea-tree	3.5gm/km	6.5g
Microlaena stipoides	Weeping rice grass	20kg/ha	23.5kg
Melaleuca lanceolata	Dryland Teatree		51 g
Muehlenbeckia gunnii	Lignum		As available
Total			

Table 12: Revegetation Species for the TSF Capping (ET Cap/Phytocap option)

Species	Common name	Quantity
Austrodanthenia geniculata		*56kg*
Austrostipa ssp.	*Spear Grass*	*56kg*
Bothriochloa macra	*Red grass*	*56kg*
Chloris truncata	*Windmill Grass*	*56kg*
Cymbopogon ambiguous	*Lemon Grass*	*56kg*
Gahnia sp	*Saw Grass*	*10 kg (or as available)*
Lomandra spp	*Iron Grass*	*1kg (or as available)*
Themeda spp	*Kangaroo grass*	*50 kg (or as available)*
Acacia acinacea	*Gold Dust Wattle*	*1.5 kg*
Acacia brachybotrya	*Grey Mulga*	*1 kg*
Acacia paradoxa	*Kangaroo Thorn*	*2 kg*
Acacia pycnantha	*Golden Wattle*	*2 kg*
Atriplex semibaccata	*Spreading Saltbush*	*5 kg*
Bursaria spinosa	*Christmas Bush*	*500g*
Callistermon rugulosus	*Scarlet bottlebrush*	*1kg*
Dodonaea viscosa ssp. spatulata	*Sticky Hopbush*	*3 kg*
Enchylaena tomentosa	*Ruby Saltbush*	*10.5 kg*
Rhagodia crassifolia	*Fleshy Saltbush*	*1kg*
Rhagodia candolleana	*Seaberry Saltbush*	*1kg*
Senna artemisiodes ssp coriacea	*Desert Cassia*	*1 kg*
Senna artemisiodes ssp.petiolaris	*Punty Bush*	*1 kg*
Pittosporum angastifolium	*Native Apricot*	*1 kg*
Total		**372.5kg**

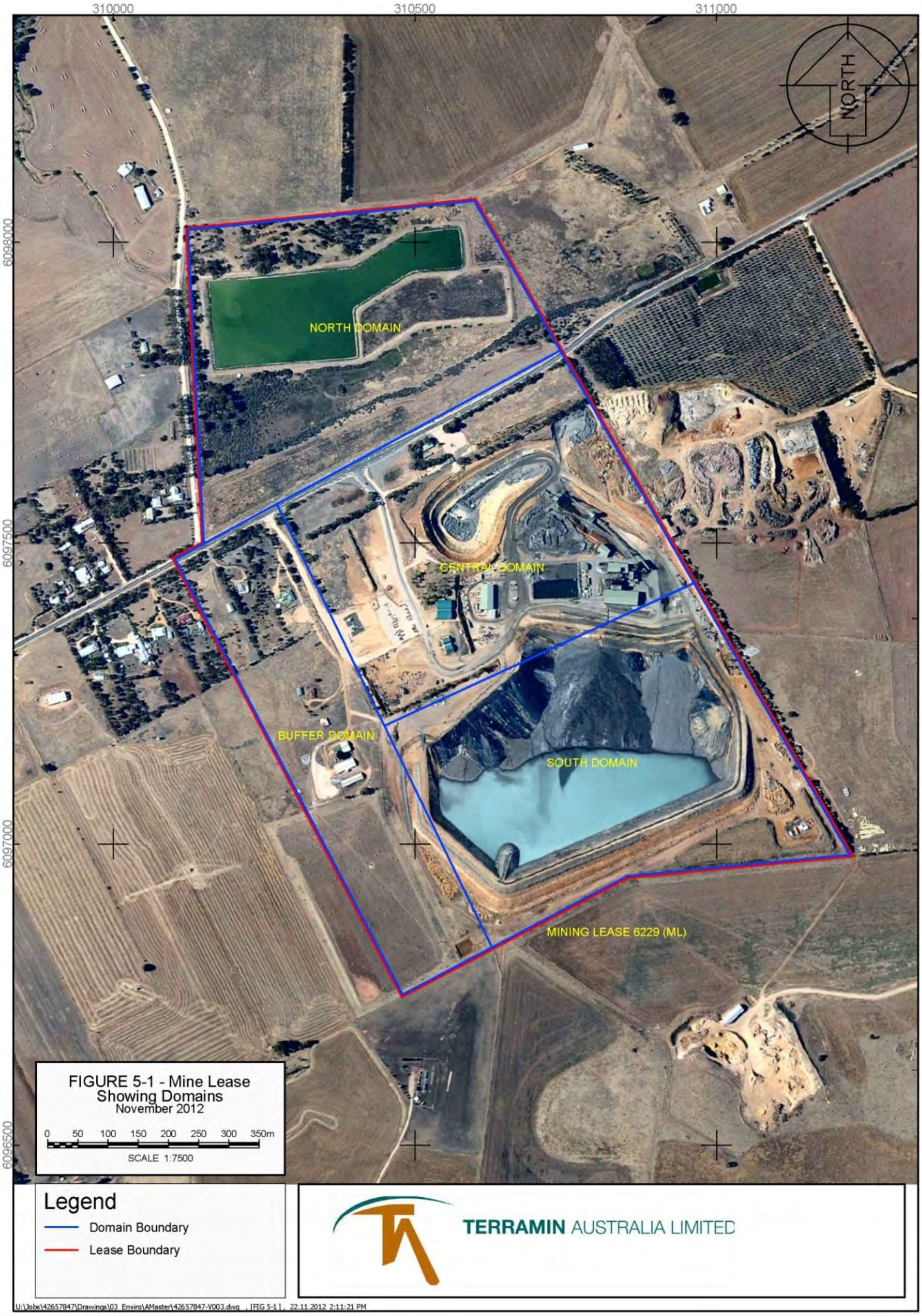


Figure 17: Mining Lease Domains

3.6.2 Rehabilitation Liability Estimate

The closure costs for the AZM will be funded by Terramin. These provisions will be made in accordance with the Australian equivalents of the International Accounting Standards. The real cost of closure relating to the actual area disturbed will be regularly reviewed and provided for in the project's operating costs. Table 13 provides an estimate of the closure costs as of December 2016 utilising the South Australian Rehabilitation Liability Cost Workbook.

After the processing of ore is completed the site will be rehabilitated in stages. Once the processing plant is removed and the site has been re-profiled the rehabilitation liability will be reviewed through an audit process and presented to the Department for State Development (DSD) for the bond amount to be reviewed. This occurred in December 2016.

Terramin holds Public Liability insurance to cover operations under the ML (including sudden and accidental pollution) for a sum no less than $50 million or such greater sum as specified by the Chief Inspector of Mines, and make such amendments to the terms and conditions of the insurance as the Chief Inspector of Mines may require.

Project Component	Areas Shaded have not yet been developed.			
Number	**Description**		**Sub-Total**	**Component Total**
1	**Exploration**			$ -
2	**Underground Workings**			$ 700,625
3	**Open Cut/Extractive Pits**	1	$ -	
		2	$ -	
		3	$ -	$ -
4	**Waste Rock Dumps (inc low grade stockpiles)**	1	$ -	
		2	$ -	
		3	$ -	$ -
5	**Processing Facilities (Incl. run-of-mine stockpiles**			$ 572,006
6	**Tailings Storage Facilities (including slimes ponds)**	1	$ 961,225	
		2	$ -	
		3	$ -	$ 961,225
7	**Heap Leach Pads**	1	$ -	
		2	$ -	$ -
8	**Rail Facilities**			$ -
9	**Haul Roads and Access Roads**			$ 2,489
10	**Administration and Accommodation**			$ 15,007
11	**Ancillary Areas (eg equipment depots, workshops, lay down areas)**			$ 181,485
12	**Borrow Pits (ancillary to operations)**			$ -
13	**Services infrastructure (water sewage, power, water borefields**	1	$ 40,029	
		2	$ -	
		3	$ -	$ 40,029
14	**Water management (eg dams, watercourses, diversions)**			$ 31,341
15	**ISR Uranium Mines (Wells and associated areas)**	1	$ -	
		2	$ -	
		3	$ -	$ -
	Sub-Total of Direct Costs			$ 2,504,205
17	**Monitoring, Maintenance and other In-Direct Costs**	%	Component	
	Monitoring:	n/a	$ 908,140	
	Maintenance:	10.0%	$ 250,421	
	Government Management:	7.5%	$ 187,815	
	Site Supervision:	12.5%	$ 313,026	
	Insurances:	1.0%	$ 25,042	
	Contingencies:	15.0%	$ 375,631	$ 2,060,075
	Total Rehabilitation Liability for the Operation			**$ 4,564,280**
	Bond Recommendation			**$ 4,560,000**

Table 13: Estimated Closure Costs (current as of December 2016)

It is anticipated that it will take four years and three months to rehabilitate the mine on completion of processing. Monitoring and remedial actions would continue until all closure criteria are met. Appendix AO outlines the proposed sequence of events and duration of the closure programme**. The yearly dates should not be taken literally as these are indicative only**, however, the duration associated with each event is reflective.

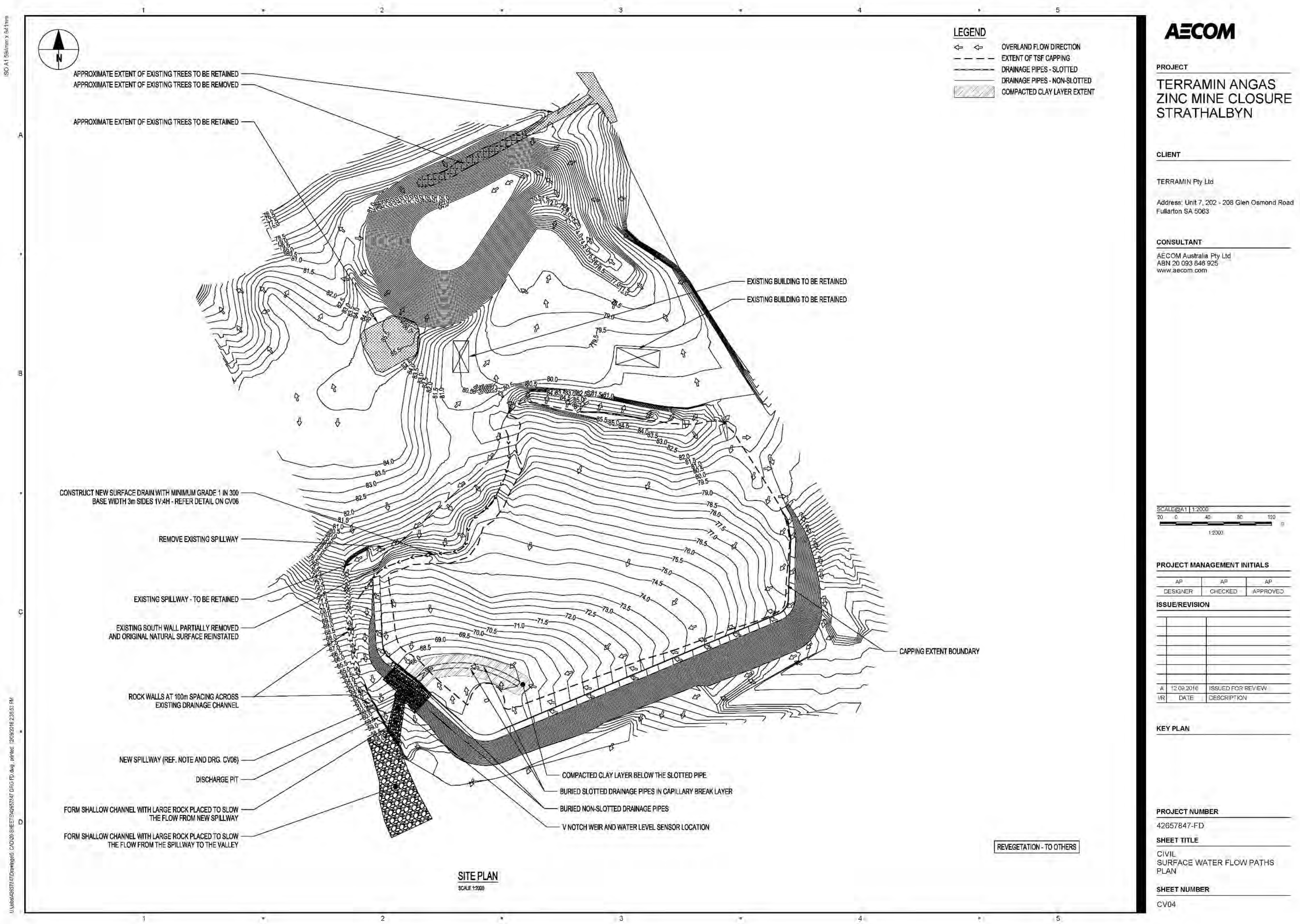


Figure 18: Post Closure Contours and Stormwater Flow

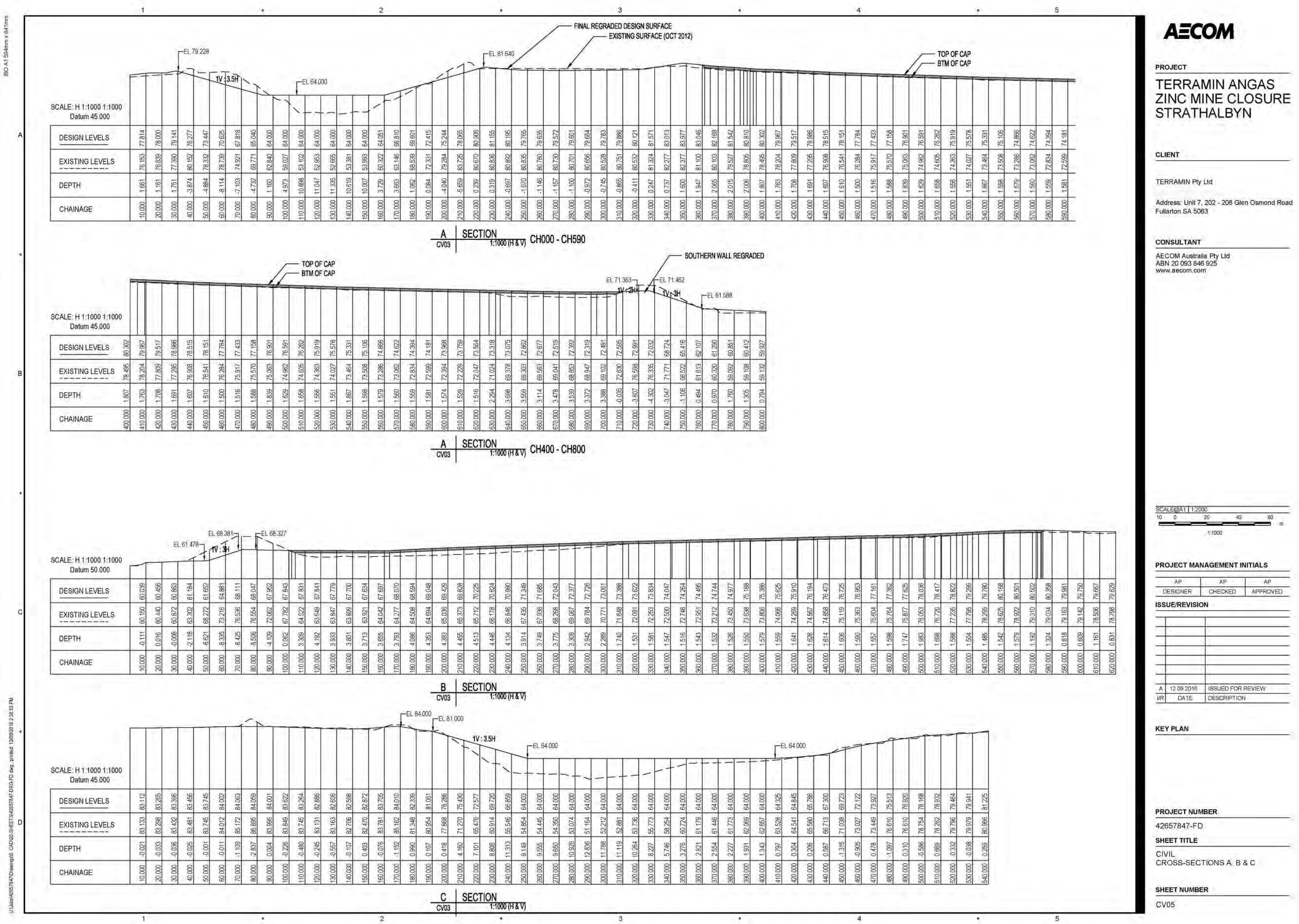
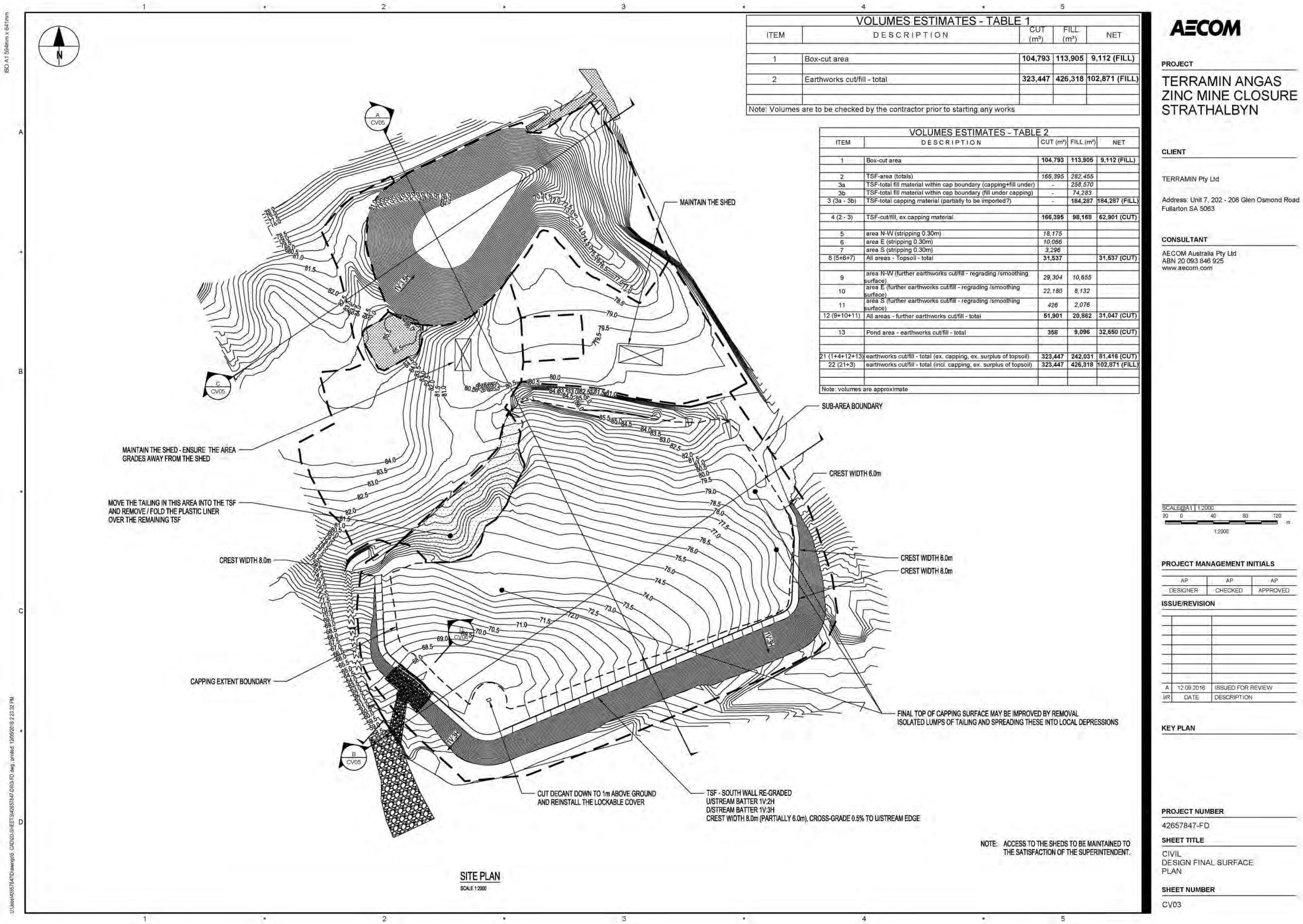


Figure 19: Post Closure Boxcut Cross Section (Cross sections taken from Figure 20)



VOLUMES ESTIMATES - TABLE 1

ITEM	DESCRIPTION	CUT (m³)	FILL (m³)	NET
1	Box-cut area	104,793	113,905	9,112 (FILL)
2	Earthworks cut/fill - total	323,447	426,318	102,871 (FILL)

Note: Volumes are to be checked by the contractor prior to starting any works

VOLUMES ESTIMATES - TABLE 2

ITEM	DESCRIPTION	CUT (m³)	FILL (m³)	NET
1	Box-cut area	104,793	113,905	9,112 (FILL)
2	TSF-area (totals)	166,395	282,455	
3a	TSF-total fill material within cap boundary (capping+fill under)	-	258,570	
3b	TSF-total fill material within cap boundary (fill under capping)	-	74,283	
3 (3a - 3b)	TSF-total capping material (partially to be imported?)	-	184,287	184,287 (FILL)
4 (2 - 3)	TSF-cut/fill, ex.capping material	166,395	98,168	62,901 (CUT)
5	area N-W (stripping 0.30m)	18,175		
6	area E (stripping 0.30m)	10,066		
7	area S (stripping 0.30m)	3,296		
8 (5+6+7)	All areas - Topsoil - total	31,537		31,537 (CUT)
9	area N-W (further earthworks cut/fill - regrading /smoothing surface)	29,304	10,655	
10	area E (further earthworks cut/fill - regrading /smoothing surface)	22,180	8,132	
11	area S (further earthworks cut/fill - regrading /smoothing surface)	426	2,076	
12 (9+10+11)	All areas - further earthworks cut/fill - total	51,901	20,862	31,047 (CUT)
13	Pond area - earthworks cut/fill - total	358	9,096	32,650 (CUT)
21 (1+4+12+13)	earthworks cut/fill - total (ex. capping, ex. surplus of topsoil)	323,447	242,031	81,416 (CUT)
22 (21+3)	earthworks cut/fill - total (incl. capping, ex. surplus of topsoil)	323,447	426,318	102,871 (FILL)

Note: volumes are approximate

Figure 20: Post Closure Cut and Fill

3.7 UNDERGROUND WORKINGS

3.7.1 Description

Mine Ventilation

A series of 4m by 4m ventilation raises that run parallel to the decline create the primary ventilation circuit. Air is drawn down the decline to the work areas and exhaust air is drawn up the ventilation raises, referred to as the return airway or return air raise (RAR). The RAR comes to the surface in the boxcut near the decline portal and has steel guarding fitted to prevent accidental entry and reduce the exit losses associated with the ventilation flow leaving the mine. In some sections these RAR's are also used for running the mine services and emergency egress ladderways, which are enclosed with a separate fresh airway.

The airways are sized for a total mine flow of $120m^3/s$ and a maximum vertical airflow velocity of 8m/s. These raises, the majority of which are 20m long, are mined using longhole raising techniques.

Access and ore drives have secondary ventilation (force-ventilation) off the decline; the top stopes are force-ventilated, while the remaining stopes in the block have a combination of forced-ventilation and some flow through from the stopes above based on the primary ventilation system.

A system of regulators at the top of each stoping block is used to give control of the ventilation circuits. Changes to this system occur periodically through the year based on the production schedule.

Mine Geotechnical

Initial geotechnical investigation work for AZM was conducted by Golder Associates Pty. Ltd. (Golders). This was based on drillhole geotechnical logging and test work of drillholes through the orebody, mine development, crown pillar and the boxcut area.

Logging included core recovery, Rock Quality Designation (RQD), weathering, rock strength measurement, joint roughness and infill material. From this work, Mine Geotechnical Standards were established.

Further work to define the requirements of the mine crown pillar was conducted by Coffey Mining Pty. Ltd. (Coffey) (Appendix T), Kevin Rosengren & Associates, and Mining One.

The Mine Geotechnical Standards have been developed to ensure design of safe and stable mine development, stopes and crown, sill and rib pillars. All mine openings have been designed to provide long-term stability and minimal subsidence both underground and on the surface. The use of bulk and cemented backfill has been used to minimise open exposures.

Ongoing geotechnical review occurs as additional information is collected to refine the Mine Geotechnical Standards and mine design as the mine is developed. Roles and positions are defined to ensure geotechnical conditions are monitored and appropriate training is provided to personnel to fulfil their roles. Geotechnical considerations include the collection and maintenance of data, analysis and review of development and stope design and conducting reconciliations on performance. External geotechnical professionals are periodically used to review the mine performance and provide recommendations for continuous improvement.

Boxcut

The boxcut was designed to remove overlying limestone, sand and clays from the bedrock to a depth of -57mRL (42m below the natural surface). This allowed the exposure of a vertical face sufficient to establish a stable decline portal. Based on evaluation of the materials in the boxcut it has been designed with batter angles flatter than the stable angles of repose for each material.

Regular geotechnical monitoring inspections occur in the boxcut to ensure that any excessive erosion is identified and managed as required.

Mine Development

Portal

The portal has been placed at the base of the boxcut and was excavated through tertiary material and weathered bedrock before progressing to competent basement. Due to failure of a portion of the lower bench of the boxcut Armco tunnelling has been installed and the lower section of the boxcut has been backfilled. The initial section of the Rankine decline immediately after the portal is supported by steel sets and fibre reinforced shotcrete (fibrecrete).

A sump is in place immediately adjacent to the portal to catch stormwater caught by the boxcut and prevent it entering the decline.

Decline

The decline is predominantly a 5.0m wide by 5.5m high arched profile drive. It is located in the hangingwall of the orebody, which is generally better rock quality than the footwall. This also facilitates access onto the orebody through the hangingwall contact, which generally displays better condition than the footwall contact. The decline is developed at 1:7.

The decline stands off from stoping by 35m and raising by 15m to ensure they do not affect its long-term stability.

The decline ground support standard includes galvanized mesh down to a minimum of 3.5m from the floor for surface support and galvanized 2.4m friction bolts in the walls and backs. Where ground conditions require, such as faulted ground or aquifers, shotcrete is used in conjunction with resin bolts and cables to create a stable opening.

Level Development

Access development and ore drives are typically mined to a 5.0m wide by 5.0m high profile.

Ore development is profiled to the bedding planes and placed in the hangingwall to allow installation of hangingwall cablebolts (Figure 21).

The access and ore developments ground support standards include galvanized mesh down to 2.5m from the floor for surface support, and galvanized 2.4m friction bolts in the walls and backs. Depending upon the profile required for development, appropriate standards have been developed.

Ventilation Raises

Ventilation raises 4m in diameter have been created using a profile-blasted longhole raising method. The raises in some areas have been hydroscaled and shotcreted to allow installation of the secondary means of egress. Cablebolts or resin bolts are used at the base of the raise as brow support.

Dedicated Escapeway Raises

1.2m diameter raisebored raises have been created using a purpose built raiseboring machine for the installation of the lower sections of the mine egressway system. The raisebores have an engineered, galvanised steel ladderway installed and are regularly inspected to ensure their integrity.

Intersections

Every intersection has a specific cablebolt pattern designed for the intersection based on capacity calculation with a safety factor. The number and embedment of the cables increases according to the increase in the span. Prior to the cables being drilled the intersection structures are assessed and the requirement for additional cables evaluated. Typically the intersections are arched to facilitate stability and truck loading. Cablebolts at the intersection are installed and tensioned prior to the turnout being mined

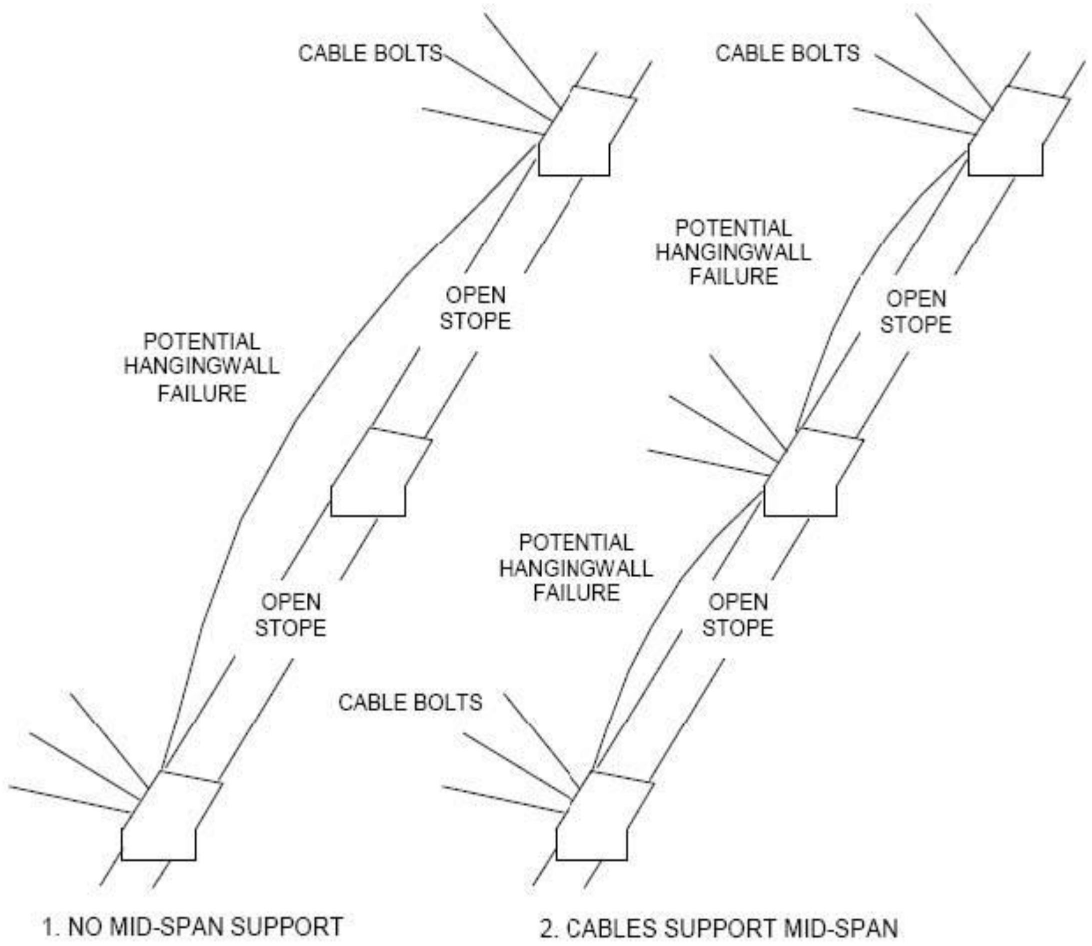


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Figure 21: Illustration of Hangingwall Cablebolting

Pillars

Crown Pillar

The Rankine orebody extends to the surface beneath the STEDS lagoons. Relocation of this facility is currently not feasible, therefore as a result, a mine crown pillar will be left that lies between the surface and the uppermost stoping.

A number of drillholes drilled through this area were used to evaluate the competency of the crown pillar. A conservative slenderness ratio (depth to width) of 3 to 1 was used in determining the initial thickness of the crown pillar.

The risk of crown pillar failure is unacceptable, such an event would inundate the mine workings and would have a critical risk rating for health, safety, environment, property damage, community reputation and business continuity.

As a result of the severity of the consequence of the crown pillar failure, the design of the Crown Pillar has been developed to ensure stability. A rigorous reinforcement regime has been implemented and ongoing monitoring is undertaken. Ground reinforcement includes arched back design, development ground support of mesh and rock bolts, and patterned cablebolting. Ground stability is reviewed as stoping advances to ensure that all stopes are adequately supported to prevent failure. Monitoring is undertaken in the form of multipoint borehole extensometers and survey prisms (refer to section 5.15).

All stopes are progressively filled through the top stoping level and the mine plan is maintained so that no more than 30% of the open mine voids are within the top 100m of the orebody.

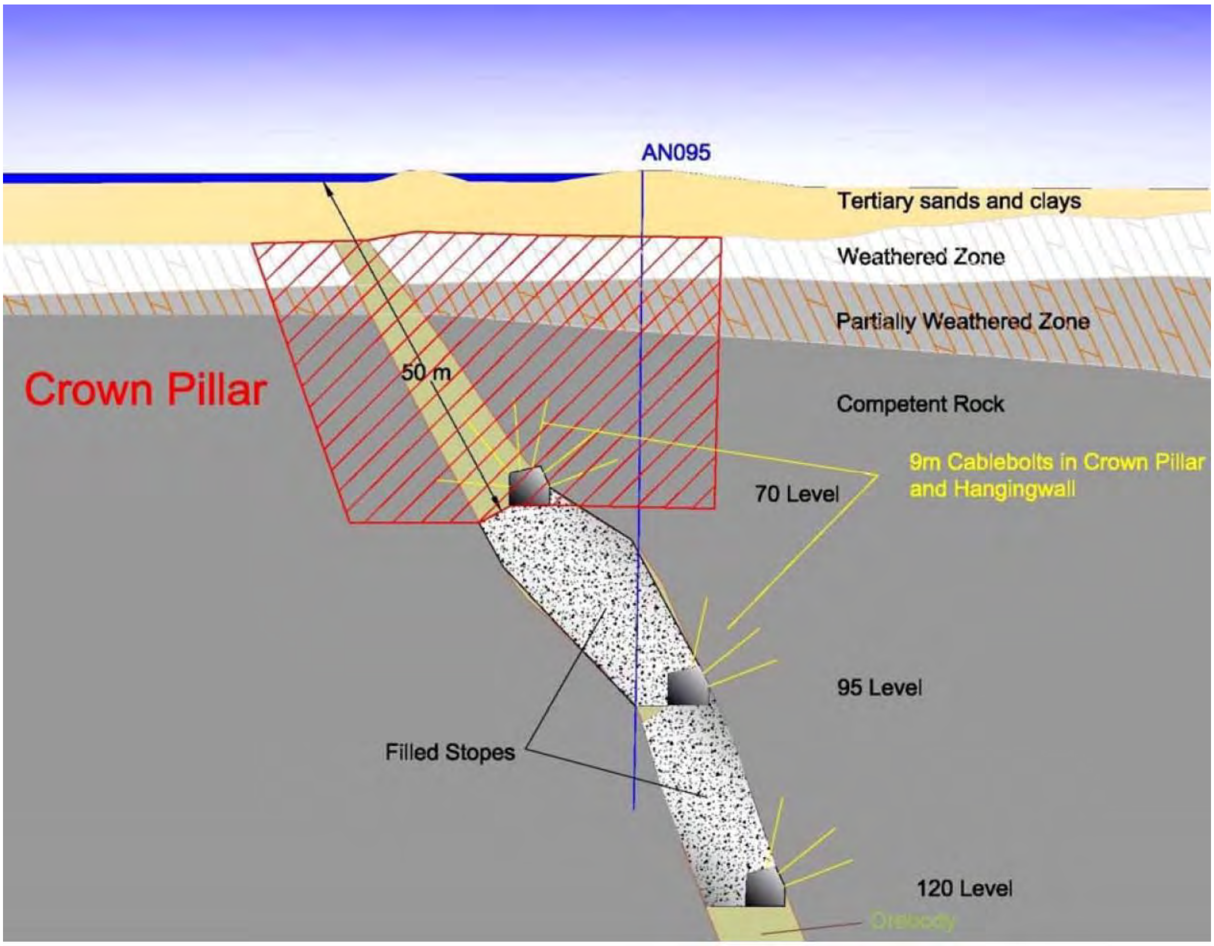

Figure 22: Cross Section of the Mine Crown Pillar at the Widest Stoping Point

Sill Pillars

Temporary sill pillars are utilised in some stoping areas depending on production and geology requirements. Geotechnical factors are considered in the design of the sill pillars such as aspect ratios (depth to width) and the relative location of the drive above. The overlying drives are reviewed to ensure any significant faults in the sills are identified and modifications to the pillar incorporated into the design.

Rib Pillars

Where required to contain span or through grade considerations, rib pillars are utilised between stopes. Geotechnical factors are considered in the design of these pillars such as the width to thickness ratio and the bottom of all rib pillars are reviewed to assess the need for additional ground support to prevent unravelling.

Stoping

Each stope is individually designed due to the nature of the variable geology and grade distribution. Each design takes into account the stoping performance in the area and the geotechnical performance of the stoping block to date. Stopes vary significantly in their size and dimensions due to these factors and may range between a hangingwall hydraulic radius of 4 to 10. Stopes are also reviewed to define any geotechnically controlling structures that may impact the stability of the designed stopes.

3.7.2 Underground Fill

Backfill

Backfill is an integral part of the mine plan. The mining methods selected require the placement of fill to control the size of stopes and ensure safe and stable mine openings. A range of backfill is used in the mine based on the requirements of stoping and the materials available for fill at the time.

A combination of mine development waste and tailings is used for fill. In addition to these products, sand and cement are added as required to the fill to provide internal fill strength and thereby allowing exposure of the fill by adjacent stoping activities. Extensive backfill studies were completed by a number of external consultants that has resulted in a paste backfill plant and reticulation system being installed in the mine. Cemented rockfill is used where development waste is available and uses methods similar to those used at many other Australian underground mines.

The three types of fill are currently used:

1 **Rockfill (RF)** - blasted development waste rock and partially weathered waste rock from the boxcut excavation. This rock is placed in the stopes by load haul dump, tipping over a protection tipping bund.

2 **Cemented Rockfill (CRF)** - rockfill combined with 4%-8% cement slurry. CRF is used where exposure of the stope face is required by an adjacent stope. The cement concentration varies depending on the design and geometry of the stope to be filled. Stope fill design is done to minimise the segregation impacts of placing such fill in open stopes.

3 **Cemented Paste Fill (Paste)** - thickened tailings from the processing plant is pumped through a pipe system to the surface paste plant, cement and sand are added depending on the design and application of the paste. Once the cement and sand has been added and mixed, the paste is pumped to stopes to be filled through a borehole and reticulation system. Suitable bulkheads are constructed at the bases of these stopes to contain the fill. Ongoing monitoring of the filled stopes is conducted to minimise the risk and impact of stope fill or barricade failure. Paste fill is utilised to allow stoping of adjacent stopes as is the case with CRF.

The quantities of these fill types are outlined in the life of mine material balance (Figure 11).

The current mine plan includes filling activity for 91% of the mining volume to provide long term local and regional stability and minimisation of waste stockpiles and tailings stored on the surface. An evaluation of the void to fill balance is incorporated into the mine schedule. Use of RF and CRF was high in the first three years of the mine life moving predominantly to use of paste as development is completed. Suitable curing times are allowed for the cemented fill with on-site and off-site testing conducted.

Terramin have adopted a strategy to maximise the use of paste from tailings in the mine. This strategy is in response to the ML condition 67 and minimises the volume of tails within the TSF.

3.7.3 Rehabilitation Strategies and Timing

Progressive backfilling of mine voids and stopes with solids provides long-term and regional stability, and minimises the risks of AMD (refer to section 3.7.2). At the end of mine life, 91% of the mined production voids will be backfilled and the remaining mine void will be flooded with water for approximately six months to minimise the risk of AMD (refer to section 5.2). The surface water from the boxcut will be diverted to the portal, and in turn the deeper aquifer. After approximately ten years surface water will be diverted back to the boxcut, forming an ephemeral wetland/woodland.

The boxcut will be re-contoured to a stable profile of 1:3.5, based on the current geotechnical information (Figure 18 - Figure 20). The area will be direct seeded using the native species list outlined in Table 10. A sterile, annual cover crop (e.g. Saia oats, which are drought resistant) will also be applied as an erosion control strategy in the first year while the native species are establishing. The portal and vent rise wil be rehabilitated as per Appendix C.

3.8 CRUSHING, PROCESSING AND PRODUCT TRANSPORT

3.8.1 Crushing Plant

Once ore is hauled to the surface it is stockpiled ready for crushing. The crushing circuit and ROM pad are located to the east of the box cut. The crushing plant consists of a grizzly screen to scalp off oversized material before the ore is fed via a plate feeder into a 36” x 48” Jian-She jaw crusher. The discharge from the crusher incorporates a dust collector to minimise any emissions from the crushing process. A belt magnet is installed to remove tramp metal from the underground workings prior to conveying the crushed ore to a Coarse Ore Bin (COB).

The feed to the crusher is nominally 500mm and is reduced to less than 100mm by the crushing process. Ore is fed into the crusher by front end loader from rows of ore on the ROM. The rows are ordered by way of ore source so that blending can be effectively managed.

Over-sized ore is managed by using a rock-breaker mounted on an excavator, this secondary breakage is used on the ROM pad or at the grizzly prior to the crusher. Due to noise limitations, rock-breaking, loader and crushing operations are confined to the hours between 7:00 am and 10:00 pm, 7 days a week.

Water trucks on the ROM pad and water sprays at the loading point into the crusher are used to manage dust. Dust monitoring points are used to monitor effectiveness of dust controls (refer to section 5.12).

3.8.2 Processing Plant

The COB has a live capacity of 1,000 tonnes and is used as a surge capacity between the crusher and the mill, allowing continual milling while the crusher is stood down during the overnight noise curfew.

The grinding mill is a second hand Morganshammer purchased from the Granites Gold Mine in the Northern Territory and refurbished by Abesque. The mill has an effective grinding length (EGL) of 5.5m and 4.2m diameter. It is lined with rubber liners and steel capped rubber lifters. The operating volume charge of the mill is between 13% and 16%. Three different sized balls are added to the mill on a daily basis dependent on grinding conditions at the time. 78mm and 94mm balls are predominantly used with 64mm balls added occasionally to bring grinding power up to required levels (generally after mill relines).

Grinding balls are supplied in 200 litre drums and are stored in a laydown area to the east of the mill. An oxy-acetylene cutting tool is used to remove the lids from the drums and the balls are added to a ball loading kibble that is hoisted by an over-head gantry. The balls are loaded into the mill feed chute while the mill is running. The task of loading balls into the mill is a source of loud noise and as such is only conducted during daytime hours.

The grinding mill itself creates a low energy sound from the drive train which is below allowable levels. To further reduce noise from this source sound barriers have been installed to attenuate the sound.

Process (recycled) water is used to bring the mill discharge density between 76% – 78% solids by weight and further water is added to the mill discharge hopper to lower the density to 68% – 71% to feed the hydrocyclones (cyclones). The cyclone feed pump has been installed with a stand-by to maximise processing availability.

A set of four Weir Minerals Cavex 250CVX10 cyclones are fed via a common manifold, however, only two operate at any given time. The cyclone underflow (coarse product) is split into two streams. One stream is sent directly back into the mill feed chute while the second stream is sent to an agitated Flash Float cell. The Flash Float is the first pass recovery of lead and mineral (Galena) and assists in reducing a high recirculating load of coarse heavy mineral around the grinding/cyclone circuit. The concentrate from the Flash Float cell is of sufficient quality to be sent directly into the final lead concentrate stream. The tail from the Flash Float is sent back into the mill feed chute.

The design cyclone overflow has a solids size distribution of P80 106μm, (i.e. 80% passing through a 106 micron screen). Test work has shown that this grind is optimum for mineral liberation and recovery from a flotation circuit.

Cyclone overflow is pH-adjusted to a pH of 8.5 using lime. Sodium metabisulphite (SMBS) is added to supress zinc mineral (sphalerite) and iron sulphides (pyrite). A flotation collector, Aerophine 3418A is used to recover lead into the froth phase.

Conventional Bateman flotation cells are used in the lead and zinc circuits. The lead circuit consists of 5 Rougher/Scavenger cells each 4.25m^3 volume capacity. The concentrates from the rougher scavenger cells are sent to a cleaner circuit consisting of 5 1.5m^3 cells. The final lead concentrate also contains payable by-products of copper, silver and gold. The operating conditions and chemical choice favours the recovery of these by-products into the lead concentrate.

The tailings stream from the lead circuit enters a 10m^3 zinc conditioning tank where lime is added to attain a pH of 9.5 - 10 and a copper sulphate solution is added to activate the zinc mineral. After conditioning a solution of Sodium-Isobutyl Xanthate (SIBX) is added as the zinc mineral collector. This is added in several locations down the zinc rougher and scavenger cells. There are a total of 5 x 8.2m^3 rougher and scavenger cells. The concentrate from these cells is pH-adjusted to 11.5 to aid in iron depression and sent onto a zinc cleaner circuit consisting of 8 x 4.25m^3 cells.

A Frother, (IF604) is added to the lead Flash float and in the lead roughers. It can also be added to the zinc rougher float cells if required. The flotation circuit is housed under a roofed building with cladding on the north wall to protect the circuit from prevailing wind and rain. Concrete bunds capture any spillage from the lead or zinc circuits with each bund having a dedicated sump pump to return spills to a designated location within the circuits.

Adjacent to the flotation circuit is the reagent mixing area and day tanks. Over-head gantry cranes lift 1,000kg bulk bags of SMBS or copper sulphate into an enclosed bag splitter that allows the dry powder reagent to drop into the mixing tank below. Water is added to the desired solution strength and the mixture is agitated until the solids are thoroughly dissolved.

SIBX is purchased in 200 litre drums and is hand scooped into a small mixing vessel with water. The SIBX mixing area and transfer pumps are housed in a shelter to protect the open drums from rain.

The Aerophine 3418A and the Frother IF604 are supplied in liquid form and do not require dilution. These along with the dissolved powder chemicals are transferred by way of pump to their respective day tanks from which they are pumped to the various addition points around the plant.

Lime is delivered to site in container trucks and transferred by air into a 100 tonne capacity silo. A lime solution is made by adding a controlled amount via a screw feeder at the base of the lime silo into an agitated mixing tank (2m diameter x 2.2 m high) with water. The mixed lime slurry is transferred into an agitated holding tank (2.85m diameter x 3.0m high). From here it is pumped by one of two lime ring main pumps to various locations in the flotation circuits.

A reagent storage shed is located to the north of the reagent mixing area where bulk bags of solid reagents and containers of liquid reagents are stored prior to use. Liquid reagents are placed on suitable containment in case of leaks.

Flotation collectors, frother, SMBS and copper sulphate act upon the mineral particle surface and generally end up with the concentrate. Residual reagents and lime carry through with the final tailings stream.

The reagent area is contained within concrete bunds. Each bund has dedicated pump to pump spills to designated areas within the plant.

Flotation Reagents

Flotation Reagents Statistics	
Aerophine 3418A	12 g/t
Sodium metabisulphite	600 g/t
SIBX	20 g/t
CuSO4	500 g/t
Lime total	1,500 g/t
IF 604	20 g/t

Table 14: Flotation Reagents

To the south of the reagent area is a flocculant mixing, storage and distribution system. This reagent is used to combine fine particles (flocculate) to increase their settling rates within the three thickeners. Flocculants are long-chain polymers and are mixed to a very dilute strength (0.25%). The flocculant is supplied in 20kg bags that are manually cut open and poured into a hopper. A "jet wet" system transfers controlled amounts of the flocculant into a mixing chamber where it is mixed with water and agitated for a set period of time before being transferred to a 7.5 m^3 holding tank. A manifold delivers the mixed flocculant to a series of mono pumps that pump to the respective thickeners.

Flocculants end up attached to the particle surfaces. They are gel like in nature and are quite fragile, normally breaking down during pumping and piping of the respective slurries.

The two concentrate slurries and the waste (tailings) slurry are pumped to three separate thickeners. The three thickeners are "High Rate" Outotec designed thickeners. The lead, zinc and tails thickeners are 4m, 7m and 9m diameter respectively. The thickeners and surge tanks are situated over concrete bunds that can contain spills. Spills are pumped back into relevant areas of the circuit.

Thickeners allow the solids to settle and compact to yield high solids concentration (underflow) before being pumped to the next part of the process. The excess water generated (overflow) is recycled back into the process. The zinc concentrate thickener overflow is sent to a dedicated zinc process water tank which has a capacity of 65 m^3. This water is sent to the zinc flotation circuit for water sprays. The overflows from the lead and tailings thickener are sent to the process water pond.

The tailings thickener underflow has a solids density of 62% – 67% by weight and is sent either to the TSF or to the paste plant for filling underground voids (refer to section 3.7.2).

The paste plant is situated to the west of the box cut just inside the main entrance from Callington Rd. Its purpose is to combine thickened tailings with sand and cement to attain a density between 68% – 70% solids by weight, and then pumped underground to fill voids. The paste plant consists of a sand hopper and conveyor, a cement silo with a screw feeder and a pugmill. A Briedal hose pump pumps the discharge from the pug mill into a reticulation system underground.

The sand hopper conveyor and 100 tonne cement silo are owned by the cement supplier and leased by the company. Cement is brought to site in tankers and air lifted into the silo.

Sand is supplied from local quarries and brought to site by tipper truck. The sand is dumped on a pad adjacent the sand feed hopper. A front end loader is used to load the sand hopper. Potential dust is managed by way of a set of sprinklers that spray filtered mine water over the sand heap.

The pugmill and briedal pump are situated within a concrete bunded area to contain any spills. A dedicated sump pump has been installed that pumps any spillage to the waste rock stockpile situated on the north-east side of the box cut.

Tailings that are sent to the TSF are distributed by pipeline for perimeter discharge. The slurry flows down toward the decant point creating a beach of solids. The solids contain a quantity of iron sulphides in the form of pyrite and pyrrhotite as well as residual zinc, lead and copper sulphides. These sulphides will oxidise when exposed to the environment. The oxidation process may cause a sulphurous odour but this tends to be localised and is dispersed rapidly. Odour associated with the tailings dam has been detailed in section 5.12.

The thickened concentrate slurries are pumped to their respective surge tanks prior to being filtered. The lead surge tank has a 50m^3 live capacity, the zinc surge tank is 170m^3. There are two (2) Larox ceramic disc filters that utilise a vacuum to draw moisture out of the lead and zinc concentrates. The filtered lead and zinc concentrates have an approximate moisture content of 5% and 9% respectively. The concentrates drop down from the filters into respective bays within the concentrate storage shed.

The filtration sequence includes a wash mode that utilises a dilute nitric acid that pumps through the ceramic filter discs to keep the porous structure clear of fines and scale.

The nitric acid is delivered as 70% strength in 200 litre drums. The acid drums are stored on a pallet within an acid proof tiled bund with a dedicated air actuated diaphragm sump pump. The acid is transferred from the drums into a 1,000 litre capacity stainless steel holding tank. Individual acid dosing pumps for each of the Ceramic filters pump the acid into a stainless steel pipe where it is diluted with potable water.

Nitrogen dioxide is a gas that forms when nitric acid comes in contact with the lead or Zinc concentrates. A slight odour may be detected during the wash sequence. A risk exists if concentrated acid inadvertently comes in contact with the concentrates. Controls in the form of gates and flashing lights are in place to reduce any risk of exposure to personnel.

The concentrate storage shed has a concrete floor capable of undercover storage of both concentrates. The capacity of storage is equivalent to around two weeks of concentrate production. The building is sized to allow loading of B-double trucks inside with a front end loader. The trucks enter the shed via a roller door on the eastern side of the shed and park up on a weigh bridge to record the concentrate load. While loading, the roller doors to the east and west are kept closed. The doors are remotely operated and are interlocked such that one cannot open unless the other is shut. This prevents wind tunnelling from blowing concentrate dust out of the shed.

After the loaded concentrate trucks leave the concentrate shed they pass through an automatically actuated wheel wash that utilise a series of powerful water jets to wash down the truck. All vehicles that operate within the processing plant are required to pass through the wheel wash prior to exiting the site. The wheel wash uses permeate water from one of the sites RO water treatment plants. Water from the wheel wash is returned to the Raw Water Pond.

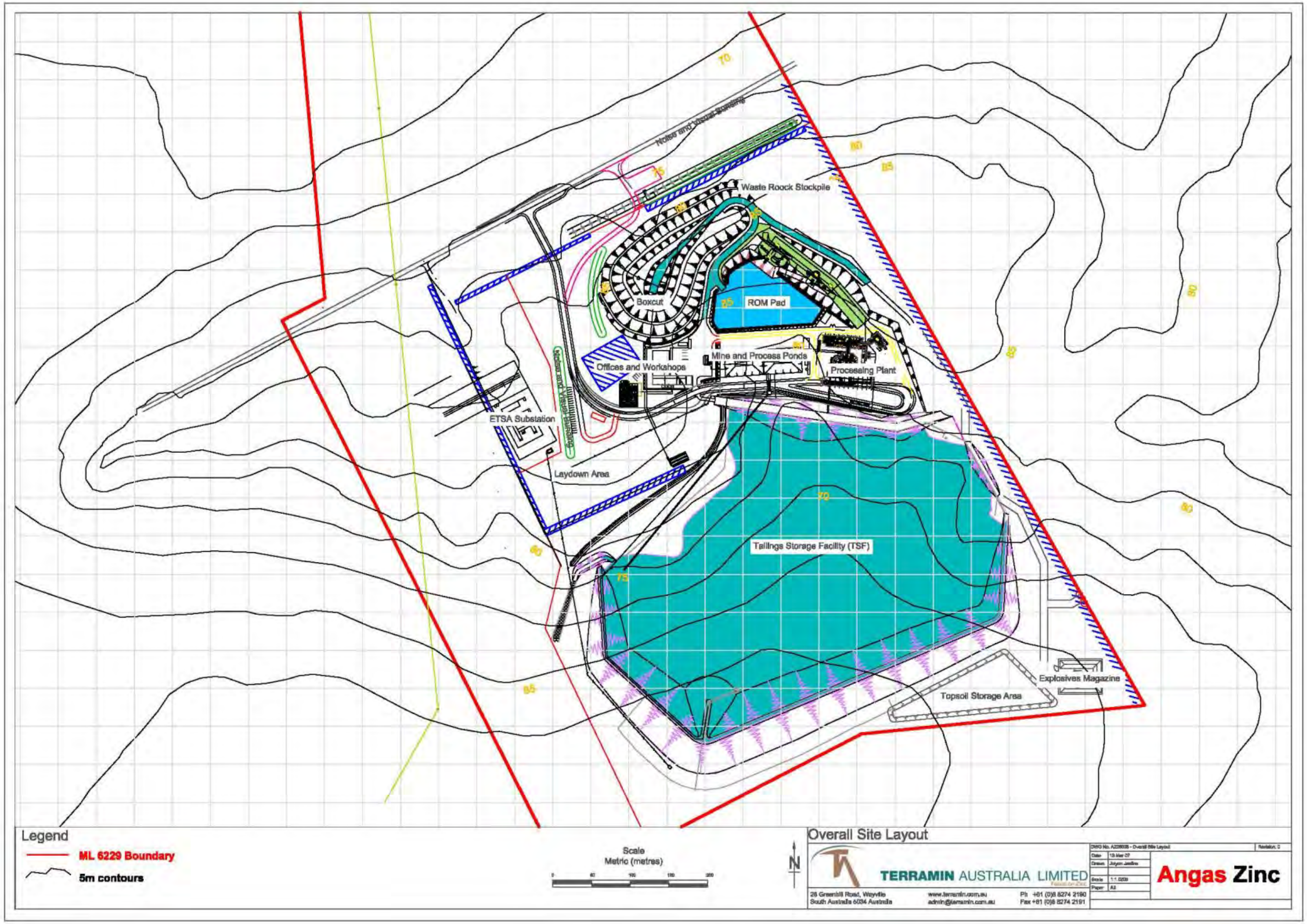

Figure 23: AZM Site Plan

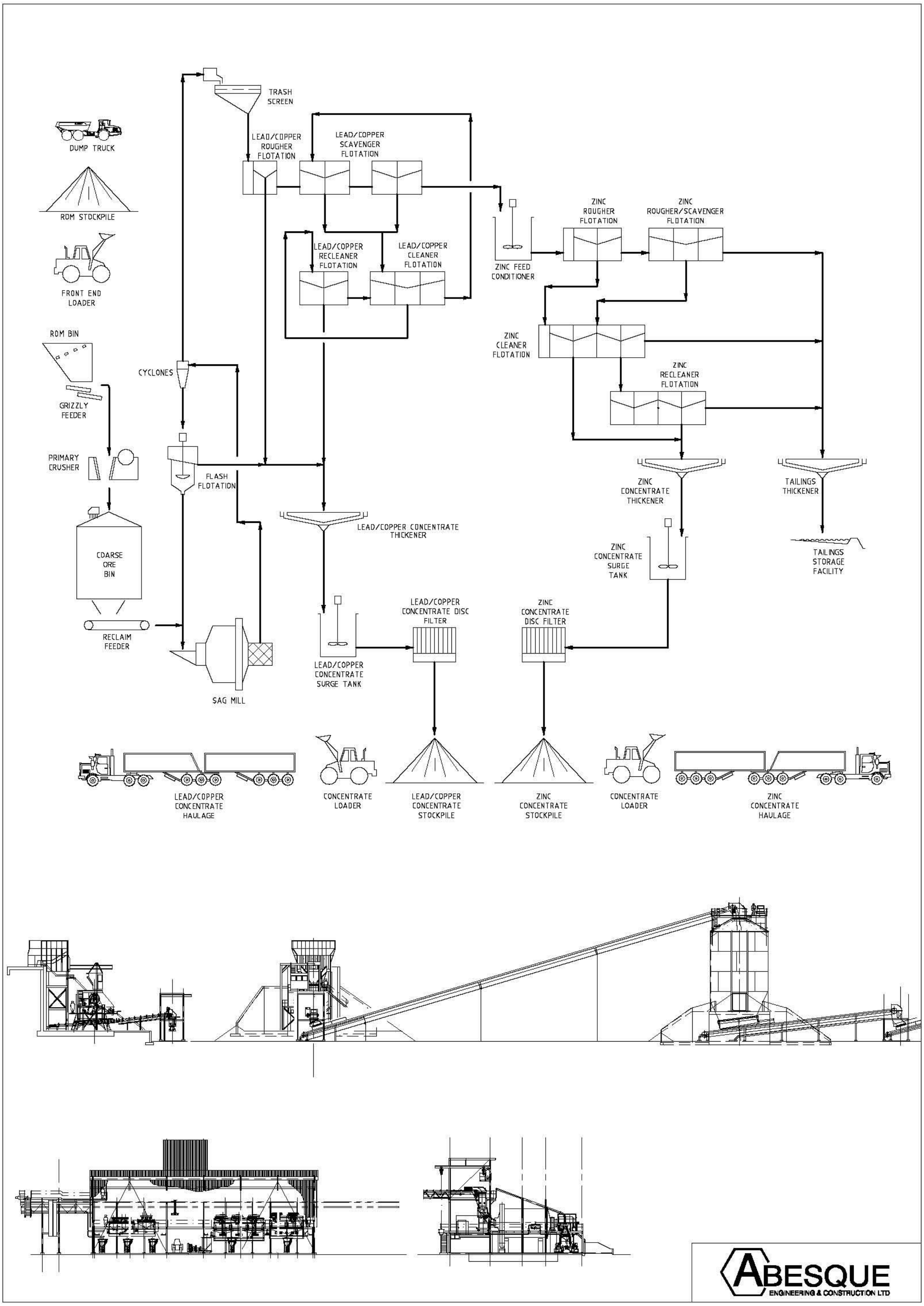

Figure 24: Flow Sheet for 400,000 tonnes/year Capacity Processing Plant

3.8.3 Process Water Balance

There are three sources of water:

- Rain, or stormwater, collected from that falling on to the operating site (including the TSF).
- Mine water arising from the groundwater ingress during mining activities (refer to section 3.5.5).
- Mains water used only for drinking and personal use, e.g. showering and washing.

The site water balance, Table 15, is a “snap shot in time” for December 2012 and thus a static balance. Consequently, it details potential avenues to dispose of excess water. Currently during summer, an estimated 2,316 m^3 per day is removed from the site water balance, whilst 1020 m^3 is inputted, a difference of 1,296m^3 per day. Water volume movements change with the season and volumes in the TSF. If the TSF has amounts of water above the double HDPE liner boundary, or a TSF decant pond surface area greater than 15,000m^2 then this excess has to be removed. Removal is by RO treatment to EPA standards for offsite use, or evaporation using sprinklers on the TSF beach. TSF water is utilised to ‘top up’ the process water pond to supply the plant, an improvement in water use efficiency that was enacted in 2012 is to recycle clarified TSF water to supply the process pump ‘glands’ which previously utilised water from the underground mine.

Water In	Cubic Metres	Water Out	Cubic Metres
Mine water	800	Permeate to off-site	318
Stormwater	166	Filtered water to off-site	402
Feed moisture	54	Raw water to underground	220
		Natural evaporation	853
		Dust suppression	200
		Concentrate Water	15
		Paste water	207
		Tailings voids	100
Total	**1020**	**Total**	**2316**

Table 15: AZM Water Balance, December 2012

Water inputs and outputs for the mill processing plant are provided in Table 16. As can be seen the net balance is equal. The location of water treatment facilities has been included in Figure 25. A water treatment flowchart has been included to illustrate water movements throughout the AZM site (Figure 26)

Water into process plant (m^3/day)	Water out of process plant (m^3/day)
Raw water - 50	Tailings water to TSF - 484
Process water make up – 1,834	Thickener overflow to process pond – 1,178
	Underground paste water - 207
	Concentrate retained water - 15
Total in – 1,884	**Total out – 1,884**

Table 16: Process Water Balance, December 2012


Legend:
MF = Micro-filtration
UF = Ultra-filtration
RO = Reverse Osmosis
De-Silting Pond
Raw Water Tank
Raw Water Pond
MF Plant
UF Tank
MF Tank
Veolia 1 RO
Osmoflo 2 RO
RO Product
UF Plant
Process Water Pond
Wheel wash water
Potable Water
Veolia 2 RO

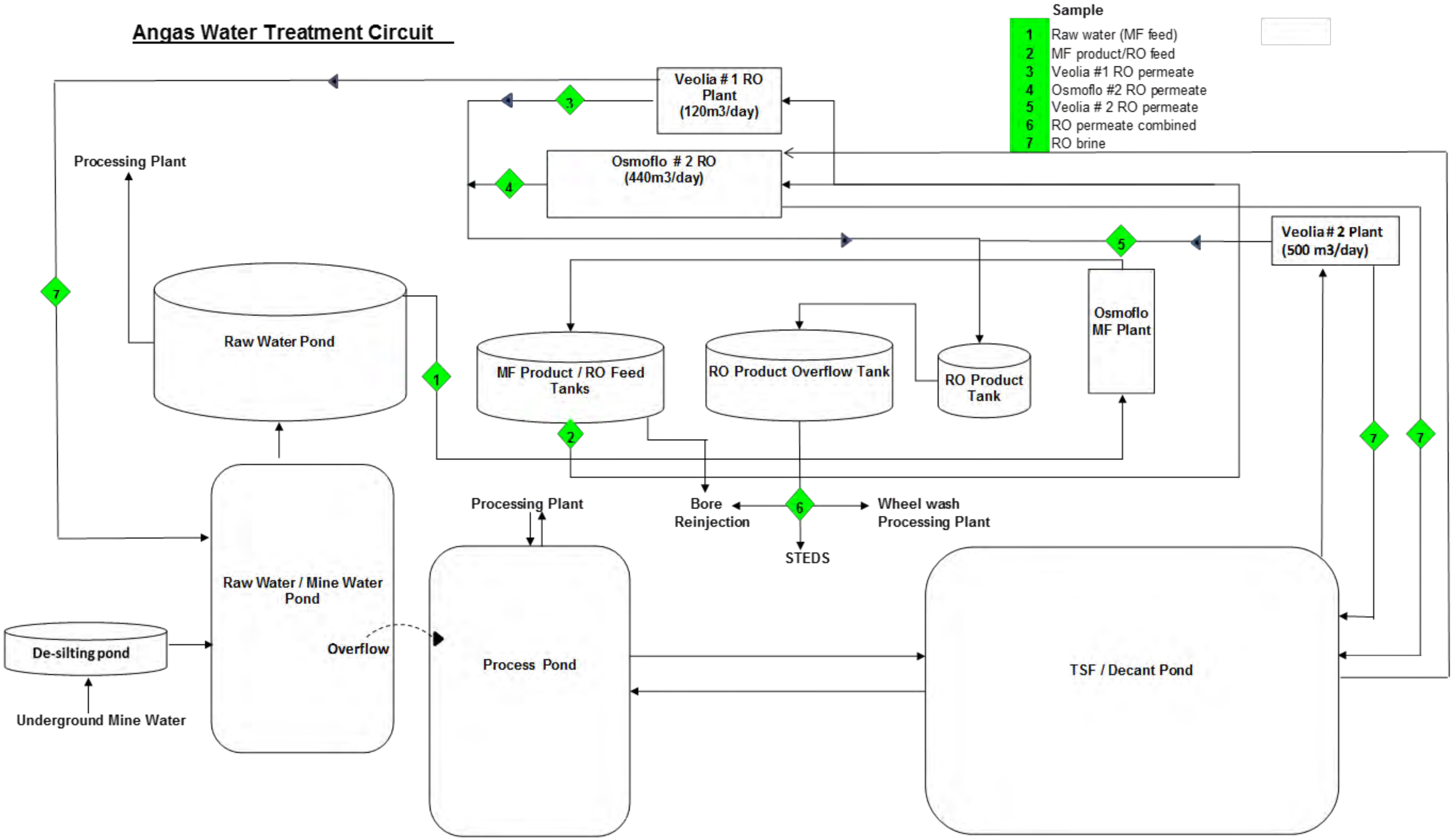

Figure 26: AZM On-Site Water Flow Chart

3.8.4 Hours of Operation

Mining and processing activities continue 24hours per day 365 days per year. In order to restrict public nuisance due to operational activity, some areas are restricted in operating times. Equipment such as the crusher is only operated during daytime hours (7:00am to 10:00pm) due to noise restrictions. Transport of concentrate from site also only occurs between 7:00am and 10:00pm to minimise road noise.

3.8.5 Type of Mobile Equipment

A loader is used to feed ore from the ROM pad into the crusher (Table 17). Concentrate is loaded into trucks for transport to port. The truck type varies but all have self-covering, roll on tarpaulin's to seal concentrate in the tipper body.

Equipment	Type	Quantity	Machine Description	Operators Cab	Noise dB(A)	Ignition Source
Wheel Loader	Caterpillar	1	950H	Enclosed Cab	71	Diesel
Paste Plant Loader	John Deere	1	624K	Enclosed Cab	73	Diesel
Concentrate Loader	Caterpillar	1	966G	Enclosed Cab	77	Diesel

Table 17: Description of ROM Pad Loader

3.8.6 Rehabilitation Strategies and Timing

All areas around the processing plant and crusher will have a minimum depth of 300mm of soil removed, until the remaining area is validated by an independent third party to meet the relevant soil quality closure criteria (Section 5.4.2). All soil contaminated with hydrocarbons will be deposited into the TSF and soil contaminated with PAF material would be deposited in either the TSF or the mine voids. All hazardous material (remaining chemicals and hydrocarbons) will be removed from site in accordance with relevant EPA guidelines.

All crushing and processing infrastructure will be removed with the exception of the concentrate shed, the workshop and the access road (refer to section 3.6.1). Any water and sludge remaining in the process and mine water pond will be pumped into the TSF and all associated infrastructure will be disposed of. The landform will be shaped in accordance with Figure 20, ripped, topsoiled and revegetated.

3.9 WASTES

3.9.1 Tailings Storage Facility (TSF)

Size and Location

The TSF is located immediately south of the processing plant site (Appendix U, Drawing 002) and is constrained by existing property boundaries. The final site was selected on the basis that it provides the greatest level of protection for the environment balanced against economic feasibility given the gentle slope grade, the apparent lack of significant vegetation and proximity to the processing area. The TSF location, along with the ZERO discharge policy provides the greatest level of assurance that the criteria for AMD (refer to section 5.8) can be achieved.

The TSF is located at least 100m from the 100 ARI flood level (Figure 33); Terramin confirmed this by engaging the services of Tonkin, recognised as experts in the flood modelling field, to assist in determining the most appropriate placement of the TSF.

The TSF has been designed to take 2 million tonnes of tailings over a 5 year life, that is, 400,000 tonnes per annum.

Water Balance Modelling

A water balance study was undertaken in 2006 by ATC Williams to evaluate the behaviour of the decant water pond in the TSF under different rainfall scenarios and to predict the resulting average and maximum pond volume and surface area (Appendix U). A daily water balance model was developed and run, using real climatic daily records. The model was prepared on the basis of the conventional mass balance approach:

Storage Volume = Inputs – Outputs

The model covered the lifetime of the mine which, at the time, was assumed to be 5 years. A simplified flow diagram sketch is shown in Appendix U, Figure 4. The model has been summarised below, however, further detail can be found in Appendix U.

Inputs to the System

- **Bleed** - Bleed water is the difference between the water in the slurry ex thickener, and the retained water at the initial settled density.
- **Rainfall** - The rainfall data that has been used for the water balance simulations is based on the Strathalbyn record.

Runoff from the following areas reports to the TSF decant pond:

- The "Plant Area" which comprises the process plant (approx. 30,000m^2), and Portal excavation and COB Corridors (approx. 60,000m^2).
- The TSF "Surrounds"
- The TSF "Dry Beach Area"
- The TSF "Wet Beach Area"
- The TSF "Decant Pond Area".

Outputs from the System

- **Decant Return Water** - The decant water pump in the model, is set to pump back all the excess water in the pond up to the maximum capacity of the pump so long as the pond volume exceeds the minimum pond storage volume (500m^3).
- **Evaporation** - In this study, it was assumed that the evaporation only occurs from the "Pond Area", which is variable as a function of the pond volume.

- **Spillage and Seepage/Infiltration** - In this exercise, both spillway discharge and seepage/infiltration were assumed to be zero.

Model Parameters

- **Areas and Runoff Coefficients** - The following data was adopted to calculate the runoff from different areas within the model:
  - Runoff Coefficient for "Process Plant Area"- 0.75
  - Runoff Coefficient for "Portal Excavation and COB Corridors";-0.5
  - Runoff Coefficient for "Decant Pond" and "Wet Beach Area"- 1
  - Runoff Coefficient for Surrounds and "Dry Beach Area"- 0.5.
- **Rainfall Records**- The daily rainfall figures of each run are presented in Appendix H of Appendix U. The distribution of the average monthly rainfall is shown in Appendix U, Figure 5. The average monthly rainfall values are presented in Table 18.

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
Rainfall (mm)	20	24	23	38	53	56	64	62	54	46	30	28	498

Table 18: Average Strathalbyn Monthly Rainfall

- **Evaporation Records** - The average total monthly evaporation values are presented in Table 19.

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
Evaporation (mm)	242	205	171	111	71	51	53	71	99	144	181	220	1619

Table 19: Average Total Monthly Evaporation Values

- **Bleed Water** - Bleed water in the exercise was assumed to be constant during the life time of the mine and is calculated based on the following data:
  - Specific Gravity of the solids, 3.48
  - Paste Thickeners underflow solid concentration, 70%
  - Initial settled slurry solid concentration, 74.76% (equivalent to 1.60 t/m³ dry density)
  - Tailings Production, 1200 ton/day (solid)
  - Calculated Bleed Water, 109m^3/day.
- **Decant Pond Area vs. Volume-** For the purpose of this water balance an Area vs. Volume relationship has been generated for the decant pond based on the graph presented in Appendix U, Figure 7.
- **Sensitivity Analysis for the Return Water Pump Capacity-** A sensitivity analysis was conducted for the maximum capacity of the decant water pump (Appendix U, Figure 9). 500m^3/day was used to run the water balance model.
- **Model Runs -** The model was initially run 10 times for the periods presented in Appendix U, Table 11, in order to cover the full range of different possible rainfall scenarios.

Results from the Model Runs

The key outcome parameters are summarised below:

- The maximum Pond Volume is 29,000m^3
- The maximum Pond Area is 38,000m^2
- The average Pond Volume is 1,520m^3
- The average Pond Area is 3,900m^2
- The average Return Decant Water Flow is 270m^3/day.

Storm Event

The most severe one-day storm event on record (plus the maximum 5 day rainfall) occurred in 1941 and this eventuality (and the resulting impact on the decant pond capacity) is covered in Run 3 of this study. The model assumes that the diversion bund on the north west side of the TSF is working. In a very severe event this might not be so. This would add another 1.5ha to the catchment and, for the five-day event, another 3,300m³ of runoff. The stored water volume in such circumstances could thus reach around 32,300m³. Figure 10 of Appendix U shows the approximate airspace volume (i.e. the volume that is potentially available to store excess water) over the tailings versus time for a steady tonnage rate into the TSF of 400,000tpa.

It can be seen that there is substantial excess storage capacity for water throughout the five year design life.

Current Water Balance

Since mining commenced the water model has been reviewed and updated. The current on-site water balance has been summarised in section 3.8.3 of this document as it has changed from the original ATC Williams 2006 water modelling.

Surface Water Runoff Control

The preliminary surface water assessment indicated 45-90ML of water might be generated in the catchment where the TSF is located. Clean water runoff volumes are directed around the TSF (refer to section 5.2).

Surface runoff is diverted from part of the upstream catchment by a diversion bund on the north-west side of the TSF, as shown in Figure 27. This bund discharges downstream of the spillway. In turn, this limits the amount of surface runoff reporting to the storage. The diversion drain as is has been sized to divert the peak flow resulting from a 1 in 100 storm rainfall event. A typical cross section of the bund is shown on Appendix U, Drawing 009.

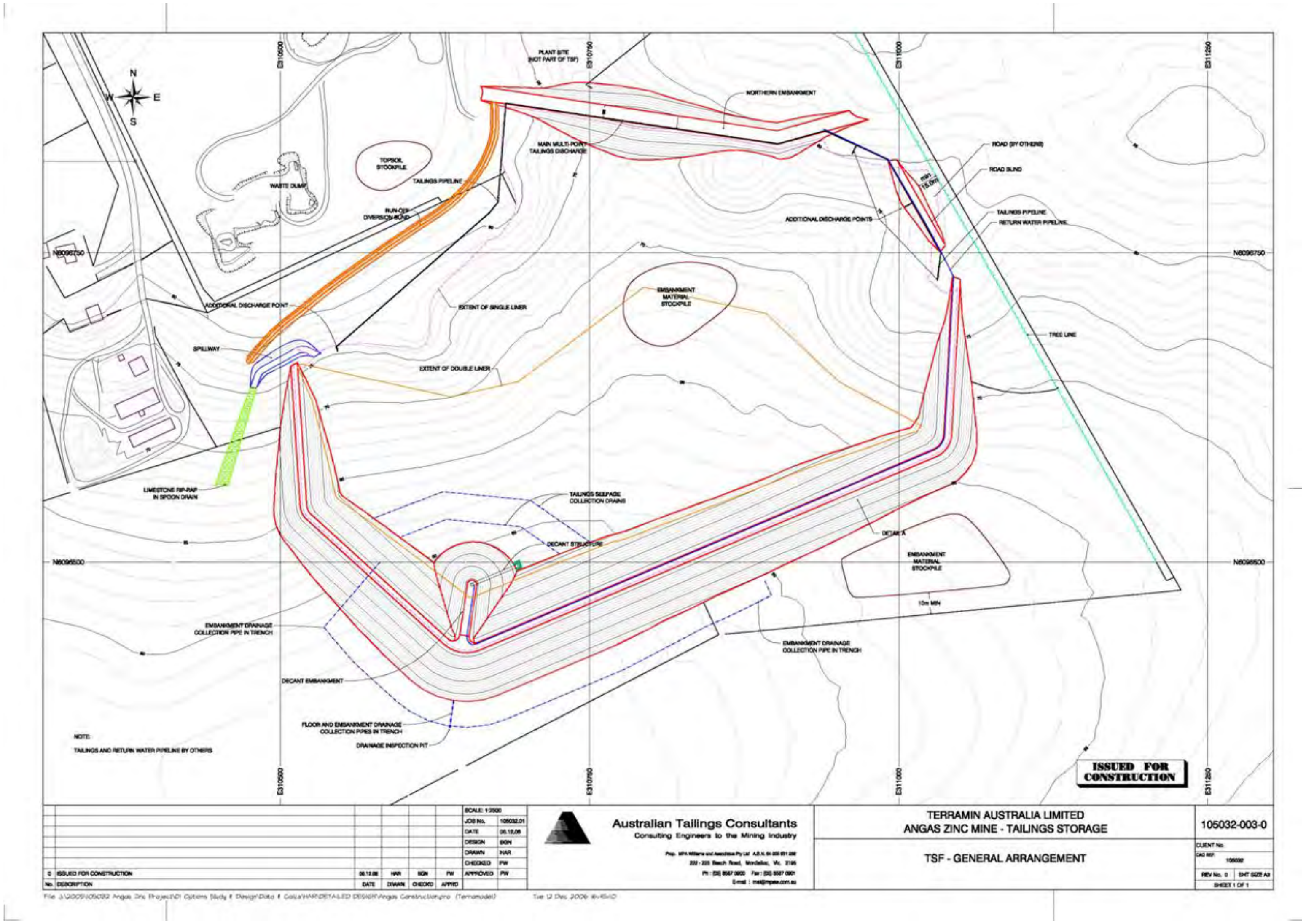

Figure 27: General Arrangement of the TSF Including Diversion Bund

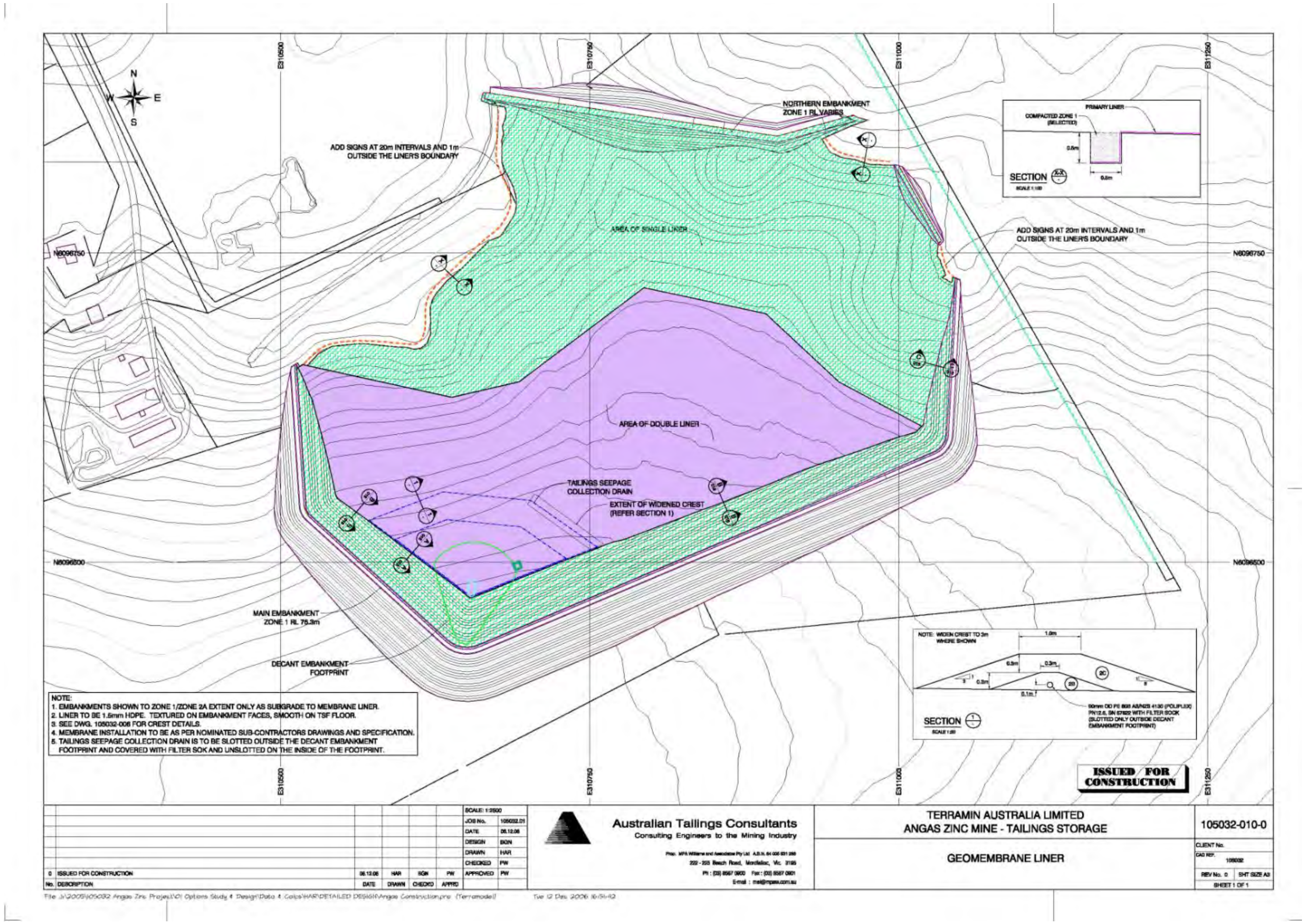

Figure 28: Extent of Double Liners on the TSF

TSF Design

The TSF design and requirements determined by Terramin in consultation with DMITRE regarding tailings storage at the site were;

1 A full base HDPE liner will be used, and
2 A thickened discharge scheme will be adopted.

Key provisions of the DMITRE Guidelines and Terramin undertakings were that:

1 The design should be for zero release of contaminants, for both operation and closure
2 The storage will be fully lined with a geomembrane liner
3 The tailings disposal system will be based on a risk management approach
4 The tailings disposal system will be based on the use of a thickened discharge scheme to limit the amount of water stored on the tailings
5 The design should include consideration of closure and rehabilitation as well as operations.

The storage is formed by a horse-shoe shaped side-slope embankment which has been constructed to its full height at initial construction. The inside of the storage has been fully lined with a geomembrane liner.

The tailings are thickened prior to discharge to the storage to reduce the amount of water, which is required to pond on the tailings. The profile of the retaining embankment has been designed to allow for the sloping tailings beach, which will result from the deposition of thickened tailings.

Spillway Design

The ANCOLD Guidelines on Selection of Acceptable Flood Capacity for Dams indicate that for a “High C” Hazard Category, an AEP of 1 in 10,000 is appropriate (ANCOLD, 1999). This has been applied for the five year operational life of the storage. The spillway arrangement to be installed as part of the closure configuration will be widened to take the Probable Maximum Precipitation (PMP) storm event (refer to section 3.9.4).

Embankment Location

The storage is located at least 100m from the 1 in 100 year flood level (Figure 33). Flood studies were commissioned to confirm this aspect (Appendix M2). It is noted that this level applies to the toe location of the embankment, where the ground elevation is around RL 56m at the lowest point. As the embankment was constructed to its full height (around 18m maximum) at start-up, it is inconceivable that the actual tailings in the storage could ever be subject to inundation or erosion by flood water. The embankment has been located such that the final toe at 3:1 (Horizontal:Vertical (H:V)) batter is 10m inside any boundary fence lines.

Layout and Sections

The main embankment is zoned earthfill embankment, with a geomembrane liner on the upstream side. The TSF embankment layout at the end of construction is shown on Appendix U, Drawing 003. A typical embankment cross section is shown on Appendix U, Drawing 008.

The zoning for the Main embankment was designed to take advantage of the materials available from the box cut excavation for the portal to the underground mine decline. The bulk of the embankment consists of Zone 3 limestone and Zone 1, a sandy clay/clayey sand/silty gravel mixture. The upstream face of Zone 1 is covered with a 1.5m wide layer of well-graded washed sand, Zone 2A, which acts as a drainage layer for any leakage through the membrane and a bedding for the membrane. The membrane is protected from operational damage by an upstream zone of limestone (Zone 3 material). A 200mm thick covering of sand, Zone 2A-U, was placed by hand over the membrane to avoid damage as the limestone is placed and compacted.

The plant site encroaches on the TSF at the northern end, however, a north embankment provides separation between the two. The HDPE membrane continues up the face of this embankment for containment of the tailings but stability issues do not arise. A typical section for the north embankment is shown on Appendix U, Drawing 009.

Liner design

The storage area is fully lined with a 1.5mm thick HDPE geomembrane liner. The area beneath the decant pond is lined with a double liner to enable leak detection and collection in this area (Appendix U, Drawing 005*)*. The extent of this area was determined from the estimated areal size of the decant pond based on the water balance modelling, Appendix U, Section 12.2. This shows that the average pond area should be around 3,900m². However a pond area of 15,000m^2 has been adopted as the basis for sizing the double liner. The double liner extends to at least 50m beyond the edge of the final 15,000m^2 pond to provide a safety margin, therefore an area of around 68,000m^2 has been double lined. The extension of the double liner in the north east direction reflects the anticipated tailings and decant pond footprints at start up and early mine life.

Two internal collection drains on the liner control any build-up of an internal phreatic surface. Modelling (Appendix U, Figure 1) indicates the nature of the seepage flow net from the decant pond to both the collection drains and the decant well. With the drains, the flow net shows saturation to a maximum depth of around 1m below the level of the double liner edge. Drawing 010 in Appendix U shows the details for the tailings seepage collector drain involving a positive fill to the decant tower. An alternative arrangement to this that sinks the drains into the base of the TSF so that the top of the drain is flush with the surrounding HDPE covered land form has been included in the construction drawings. The final design was agreed on site with DMITRE technical representatives during the construction phase of the TSF, confirming the extent of the double liner (Figure 28). The detail for the collection drain is also shown.

The liner is designed and detailed in accordance with the principles set out in the EPA guidelines by a nominated subcontractor. The base of the storage has been stripped to a minimum depth of 0.3m as part of foundation preparation (Appendix U, Drawing 004). The resulting clay surface has been trimmed and compacted.

Embankment stability and Settlement

The embankments have been designed to be stable under static and seismic loading conditions. The ANCOLD Guidelines and the US Army Corps of Engineers (USCE) method were employed to assess the stability of the embankments as detailed in section 9 of Appendix U. This has been summarised below.

The stability of the embankment was checked for the following cases:

- End of construction (a minimum factor of safety of 1.1 required)
- Normal loading (a minimum factor of safety of 1.5 required)
- Operating basis earthquake (a minimum factor of safety of 1.05 required during the seismic event)
- Maximum design earthquake (an instantaneous factor of safety less than 1.0 is tolerable, but the overall embankment deformation must be such that major failure of the embankment does not result).

In the analysis, the decant pond was considered to be at the normal operational level and at the top water level (spillway) while the tailings were at the lowest level.

The design material parameters used in the stability analyses are shown in Appendix U, Table 6 and include;

- Zone 1 - Clayey Sand

- Zones 2A & 2A-U – Sand
- Zone 3 – Limestone Fill
- Tailings
- Foundation 1 – Clayey Sand
- Foundation 2 – Bedrock

A Seismology Report on the AZM TSF was prepared by the Seismology Research Centre (SRC) of Australia. The report is presented in full in Appendix F of Appendix U. Appendix U, Figure 2 shows the model for the AZM Peak Ground Acceleration (PGA) recurrence interval, for earthquakes with a range of magnitudes. Earthquakes with magnitudes of less than 5 are believed to have minor influence on the stability of earthfill dams and hence only the curve for magnitudes of 5 and above has been employed for seismic analysis of the AZM TSF embankments.

In accordance with the ANCOLD Guidelines, the stability of the embankment was analysed for two levels of earthquake as follows:

- Operating Basis Earthquake (OBE) represents the level of ground motion at the dam site for which only minor damage is acceptable. The dam, appurtenant structures and equipment should remain functional and any damage easily repairable from the occurrence of earthquake shaking not exceeding the OBE.
- Maximum Design Earthquake (MDE) will produce the maximum level of ground motion for which the dam should be designed or analysed. It will be required at least that the impounding capacity of the dam be maintained when subjected to that seismic load.

A Hazard Category of “High C” has been adopted for the embankment design. PGA’s of 0.05g and 0.3g were adopted for the OBE and the MDE corresponding to AEPs (Annual Exceedance Probability) of 1 in 200 and 1 in 10,000 respectively.

Stability analyses were performed under both static and seismic conditions (USCE) for upstream and downstream slopes. Under static conditions, the embankment was analysed for two cases, end of construction and normal operational loading. The results of the analyses have been graphically outputted and presented in Appendix U, Figures G1 to G9.

In summary, the results show that both upstream and downstream slopes are stable under static and seismic loading conditions, and comply with ANCOLD and the USCE recommendations. Given the extreme assumptions for case G7, the Factor of Safety (FOS) of 1.00 is considered satisfactory.

Beach Slope Stability

Tailings discharge is from a rotating multi-point discharge, from a single location at any one time at the north embankment (Appendix U, Drawing 003). The beach slope design was based on an adopted operating level of around 70% - 71% solids for the thickener, i.e. a margin has been allowed below the manufacturer’s predicted range.

In May 2010 ATC Williams noted that recent laboratory testing of production tailings samples has shown that the tailings properties differ from those achieved from the prototype samples during the design phase. The production tailings to date have significantly higher silt/clay content (i.e. % finer than 75µm), lower particle density, lower segregation threshold and higher viscosity than the pre-production tailings. The segregation threshold of production tailings is at around 51% solids content. At an average solids content of approximately 64%, achieved so far, the tailings have been well above the segregation threshold of 51% and thus non-segregating. Solids content of greater than 60% is sufficient to ensure that the general design principles of thickened discharge schemes are met (Appendix U2).

As observed by ATC Williams in January 2012, the increased viscosity of production tailings has resulted in an average beach slope of approximately 6.5% for the first 100m (from discharge point), which is greater than the original design of 3-4%. The beach slope reduces to around 3.5% for the remainder of the beach slope above the decant pond, which is generally better than the design expectation. The beach slope is around 10% under the decant pond. This type of variation in slope angles is commonly encountered (ATC Williams, March 2012).

Provision has been made at the north embankment discharge point for multiple outlets (6 in total) in order to rotate the actual discharge between sectors of the facility, or split the flow between more than one outlet. Experience has shown that the resulting beach slope can be better managed by this process. There is also the ability to discharge tailings from close to both the right and left main embankment abutments in order to maintain the decant pond at the decant recovery tower

Operating Specifications of the TSF

General

An Operations and Maintenance Manual was prepared for the facility (Appendix U2), and includes instructions and forms to cover all necessary monitoring, inspection and surveillance activities. The manual is an integral part of the overall Risk Management Plan developed for the TSF (Appendix U, Section 16). Items included cover the areas of instrumentation, monitoring and surveillance and are set out below.

Seepage Monitoring

Seepage is monitored from two potential sources:

1 The underdrainage collection system which is intended to intercept leakage through the primary liner beneath the decant pond

2 The drainage layer beneath the liner on the upstream face of the Main embankment.

Collection pipes from both sources lead beneath the embankment in trenches to a collection pit at the downstream toe (Appendix U, Drawings 005 and 006). The collection pipes are in two lengths on each of the two main legs of the Main embankment. It is possible to better locate the source of any leakage by this means.

Survey of Movement Monuments

Fifteen settlement/movement monuments have been installed on the embankments. Survey readings of the position and elevation (i.e. x, y, z coordinates) of all installed shall be obtained at monthly intervals.

Water Balance/Management

Monitoring is installed to enable the water balance of the TSF to be checked. This includes:

- An integrating flow meter at the tailings delivery pipeline
- An integrating flow meter in the decant return water pipeline

The water depth/level in the decant pond is measured on a daily basis. An on-line measurement of thickener underflow density is recorded so that the volume of water that is pumped to the dam can be calculated.

Dust

Dust Deposition gauges are set up around all sides of the TSF. These are sampled on a monthly basis.

Inspections

- **Shift Inspections**-The tailings pipeline and the return water pipeline are inspected on a per shift basis.

- **Daily Inspections-** In addition to the above, the behaviour of the tailings at the discharge location, the operation of the return water pump and the level of water in the decant pond are inspected on a daily basis (during the day shift).
- **Weekly Inspections**- A detailed inspection of the condition of the TSF system (pipelines, discharge, tailings beach, embankment spillway, decant recovery and surrounding areas) is undertaken weekly, by AZM staff.

Surveillance

Monitoring results and the records of weekly inspections will be reviewed and summarised on a quarterly basis.

A formal surveillance audit is carried out on an annual basis, by an experienced geotechnical/civil engineer. This is undertaken at a level to comply with the requirements of an Intermediate level inspection, as defined in the ANCOLD Guidelines on Dam Safety Management.

In addition to the issues of embankment performance, seepage and water management, the surveillance audit includes:

- A detailed survey of the tailings beach and a comparison of the measured and designed beach profiles;
- A reconciliation to the milled tonnages, the calculated volume of tailings in the storage, and the derived in - situ density of tailings. This will be compared to the adopted design density (1.8 t/m^3) to confirm the remaining storage capacity.

3.9.2 Processing Wastes

Disposal and Management of Dangerous Materials

From a quantity viewpoint, the most significant potentially dangerous material on site is the product tailings.

The tailings resulting from the flotation process have water removed by thickening to a nominal consistency of 64% solids, with the standing water returned to the process water circuit via a HDPE lined holding pond. The thickened tailings are stored in the TSF, (refer to section 3.9.1).

An annual production of approximately 435,000 wet tonnes of tailings has been recorded (June 2011-June 2012), with approximately 75,000 tonnes of this being placed into mine voids as pastefill. Approximately 335,000 wet tonnes, equating to 229,000 dry tonnes, of tailings reported to the TSF during the 2011-2012 financial year. Below is a summary of the tailings properties:

- **Physical** - The results of laboratory testing on a prototype sample of Angas Zinc tailings are outlined in Appendix U. The key results of that testing for “all-in” or non-segregated samples are summarised as follows:
- **Grading/Particle Size** - The tailings are relatively coarse grained, with just on 50% retained on the 75µm sieve (i.e. are fine to medium sand). The fines are non-plastic, and in terms of the Unified classification, the material would classify as a silty sand/sandy SILT (SM/ML).
- **Particle Density** - Particle density is 3.48, reflecting the mineralogy.
- **Segregation Threshold** -The tested segregation threshold was 68% solids. This is a consequence of the coarse grading, and the high particle density.
- **Density** -The initial settled density was 1.60t/m^3. The shrinkage limit density was 1.85t/m^3. The three-point consolidation test confirmed density values between these two extremes, in the range 1.75 – 1.80t/m^3.
- **Permeability**- The tailings have a comparatively high permeability, in the range 1.1 to 2.0 x 10-6 m/sec. The reduction in permeability with increased confining pressure is only minor.

- **Compressibility** - The normally consolidated tailings are relatively incompressible. From the consolidation results, the Compression Index is 0.09.
- **Consolidation Coefficient** - The calculated coefficient of consolidation is of the order of 10 x 103m^3/year. This value reflects the high permeability and low compressibility of what is essentially a sand material. Tailings within the TSF can thus be expected to be fully normally consolidated throughout mine life.
- **Rheology -** Rheological parameters were determined for a range of slurry densities (solids contents from 71% to 81% solids). These results are summarised in Appendix U.
- **Geochemistry** - A sample of the tailings was tested by Environmental Geochemistry International (EGI) for geochemical properties; this report is reproduced in Appendix U, (Appendix E). The tailings were assessed as being strongly PAF.

Other waste material produced by the process is mill scats. Scats are the remanent steel mill balls and ore which is unable to be efficiently ground to the correct size, typically scats are 20-30mm in diameter. Scats are PAF material, and as such are stored in the 'dirty zone' (refer to section 5.2 and Figure 31) until disposal into the TSF or into underground mine voids. Approximately 20 tonnes a day (7,300 tonnes per year) are produced.

Hydrocarbon wastes are removed from the mill during maintenance; typically grease, oil and sludge, which are recycled through the workshop hydrocarbon waste stream. Estimated mill volumes are approximately 10,000 litres per year.

3.9.3 Industrial and Commercial Wastes

Industrial and commercial wastes generated on site include;

- **Sewage** – treated with an approved on-site sewage treatment plant, the resulting grey water is utilised for tree irrigation.
- **General waste** – removed by an EPA licensed contractor
- **Hydrocarbon waste** – waste oils are collected into a waste oil tank and recycled via the oil supplier. Grease, used filters, sludge and other contaminated parts are recycled through EPA licensed contractors.
- **Other workshop waste** such as tyres, drums, hoses are recycled by returning to suppliers or through scrap metal recycling streams.

The site has an EPA waste depot Licence (No 34942) which permits landfill recycling of products and clean soil. Appropriate construction and demolition waste can be disposed of by utilising this facility.

A Waste Management Plan has been prepared (Appendix AF) to ensure waste is managed at the highest possible standards, resulting in minimal impact to the environment through a hierarchical approach (Figure 29). Table 20 describes the waste stream and management pathway and Figure 30 illustrates the collection areas for these waste streams.

Figure 29: Hierarchy of Control to Minimise Waste Production and Impact on the Environment (Zero Waste SA, 2012)

Waste stream	Management	Approximate annual amount
General waste	Local EPA approved contractor removes to a waste depot	125 tonnes
Metal recyclables	Recycled to a local EPA approved contractor	120 tonnes
Paper, cardboard and plastic	Recycled to a local EPA approved contractor	20 tonnes
Tyres	Recycled to suppliers or disposed of underground	150
Waste oil	Recycled to suppliers	25,000 litres
Hydrocarbon contaminated items (filters, hoses, rags) and sludge	Recycled to a EPA approved contractor	10 x 1000 litre IBCs (Intermediate Bulk Containers)
Sewage sludge	Local EPA approved contractor removes to a waste depot	4 truckloads per year

Table 20: AZM Waste Streams, Management and Volumes per year

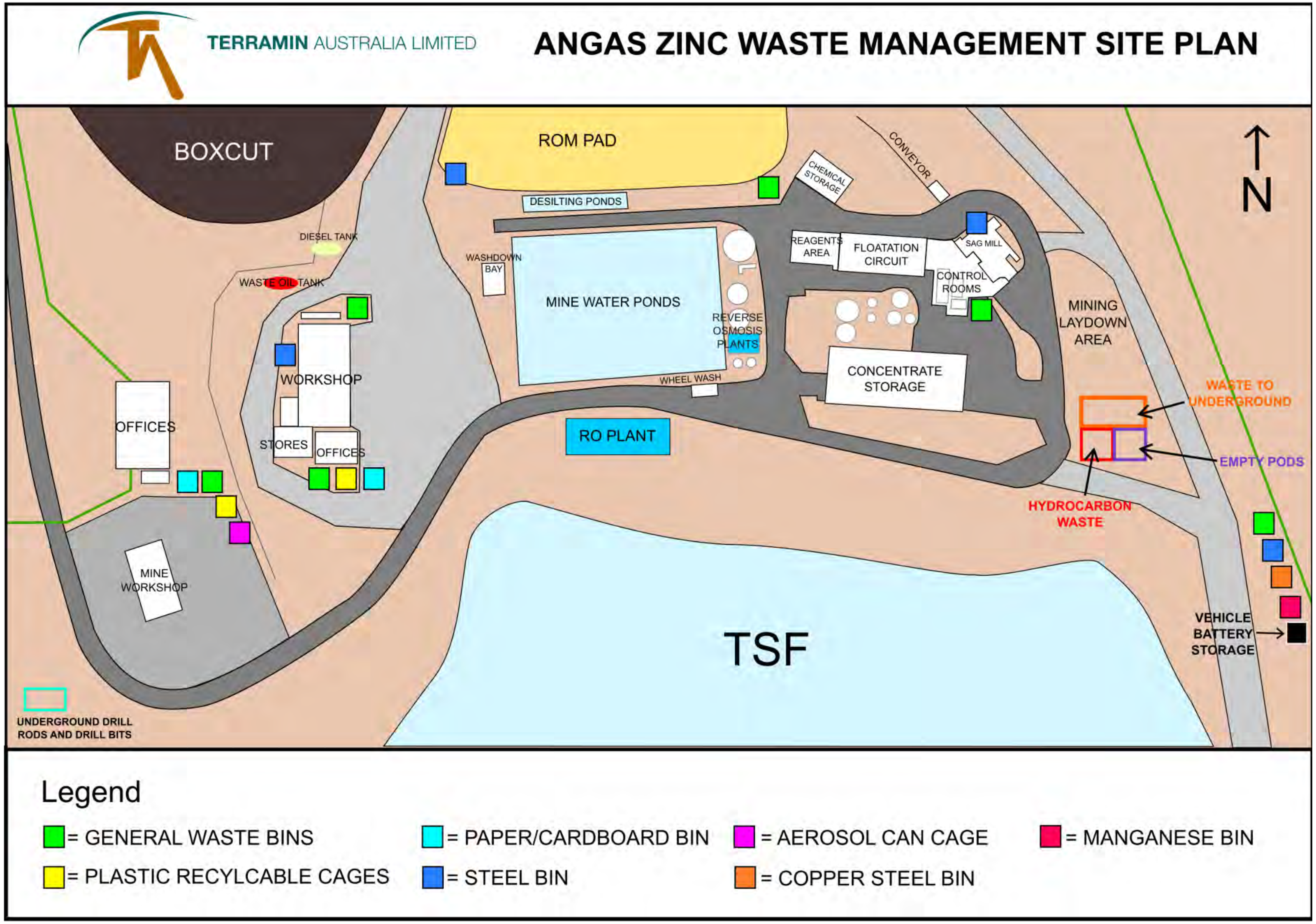

Figure 30: Waste Collection Points

3.9.4 Rehabilitation and Closure Strategies

At mine closure, all remaining mine waste will be either disposed of in underground voids or disposed of off-site at an EPA approved facility.

A detailed description of the TSF closure requirements has been included in the Closure Plan (Appendix C). The first task required to rehabilitate the TSF is to evaporate any water which remains in the decant pond using the existing sprinkler system to disperse the water over the existing beach. A lined evaporation pond will be installed as a contingency for disposing of the TSF decant water, if required.

The batter of the outer walls of the TSF will be reduced to 1:3 in accordance with Appendix C. The existing spillway will be relocated to the south and resized to pass the PMP flood, allowing for runoff from the entire area of the contributing catchment. Stormwater diversion will be implemented along the eastern side of the TSF to prevent stormwater entering the TSF area.

The TSF will be capped utilising an Evapotranspiration (ET) Cap/Phytocap system as described in Appendix C. Terramin has made this decision as risk assessments indicate that this capping system will provide the highest confidence that it will leave no environmental legacy issues associated with the site over a long time scale, that is centuries. This has been detailed in section 6.6.7 of the Closure Plan (Appendix C).

In accordance with ML condition 69 (Appendix AH), Terramin shall not sell the land unless an appropriate arrangement has been put in place to ensure that Terramin's successors in title to the land are bound to observe a condition on their ownership not to develop on the TSF site and to maintain appropriate public liability insurance to protect against the possible contamination of adjacent land in the event of leakage from the TSF. This has been detailed in Section 6.3.2.5 of the Closure Plan (Appendix C).

3.10 SUPPORTING SURFACE INFRASTRUCTURE

3.10.1 Access

The site is located adjacent to the Strathalbyn to Callington Road, which acts as one of the region's major transport routes. This road joins the South Eastern Freeway from Adelaide which turns into the Princes Highway to Melbourne beyond Tailem Bend and is registered as a B-Double route. All external transport to and from site uses this path to avoid travelling through Strathalbyn and along the Strathalbyn to Mt Barker Road.

The site entrance is approximately 2km from the centre of Strathalbyn on Callington Road. This is the only entrance point to site, with the exception of locked security gates at key locations for use by the local County Fire Service (CFS) in the event of a bushfire. This position has been selected in consultation with Transport SA and the SCCC as it provides the best visibility for oncoming traffic. It is currently located in an 80 km/h zone and as a result a type C intersection was constructed to allow traffic to enter and exit the site safely. The site entrance road is sealed to minimise dirt dragout onto Callington Road. The old quarry entrance has been maintained and serves as access to a house and the visitors viewing platform.

3.10.2 Accommodation and Offices

The administration office is located at the front entrance and includes toilet blocks, a laundry and a crib room. A designated car parking area is situated near the front office buildings on-site.

The male and female change-room facilities are equipped with lockers for personnel clothes (clean side), showering facilities and "dirty areas" to store work clothes. These facilities include toilets, hand basins and heaters to assist in the drying of damp work clothes. Showering facilities are provided for peak, shift change times and gas hot water is supplied to cater for this peak demand.

Similarly a laundry for the washing of safety clothing is located on site with professional cleaners, independent to the company, operating this facility. These facilities have a clean and dirty side to eliminate contamination between work and private clothing.

Several houses were purchased from previous landowners and are now used for staff and contractor accommodation. These are cleaned regularly by the professional cleaners.

3.10.3 Public Roads, Services and Utilities Used by the Operation

Freight

A gazetted B-Double route runs directly past the mine site. All trucks, other than those delivering supplies and equipment from Strathalbyn, will access the site via Callington Road. Further detail regarding public roads, services and utilities used by the operation has been outlined in section 5.9.

Mine Power Supply

The network indicated by the blue lines around Strathalbyn carries normal power and has been modified in the indicated areas to carry phase 3 power.

Current power supply to site is feed through an underground 3 phase cable reticulation supplying 11kV.

There are multiple transformers on site providing power to various pieces of equipment both surface and to the underground operation.

- 11kV/3300VAC, 1500kVA – Mill Feeder
- 11kV/433VAC, 1500kVA – Wet Plant Switchboard
- 11kV/433VAC, 400kVA – Crushing Plant Switchboard
- 11kV/1000VAC, 1000kVA x2 - Underground Substation
- 11kV/433VAC, 500kVA – Mining Substation
- 11kV/433VAC, 1000kVA – Surface Kiosk Substation
- 11kV/433VAC, 250kVA – TSF Return Water Pumps Switchboard
- 415kV/1000VAC, 300kVA – Step up transformer supplying power to the maintenance workshop for testing of equipment.

A 66kV power line passes close to the site and supplies the Strathalbyn township. The electricity supply comes from the 66kV line straight into a 66kV/11kV substation on the site. The step downs after the 11kV are to 3,300 volts, 1,000 volts and 433 volts.

SA Power Networks have provided assurance that the capacity of the power grid is sufficient and there will be no negative impact on the residents of Strathalbyn. A significant part of the power capital cost was an augmentation fee to expand the supply capacity. In addition, SA Power Networks will retain the new substation for future expansion in the area following mine closure.

Compressed Air

Compressed air within the mine site has been installed to supply the workshop, mill and underground.

Water

Mains water network feeds Strathalbyn. An 80mm mains water line connects to the site delivering approximately 0.7l/s. Mains water is used for drinking and showering purposes.

Sewage

The mine site has a septic system complying with Health Department requirements and is inspected quarterly.

Communication

The region has telephone, mobile and broadband coverage. The site has telephone and internet connections as well as radio communications for underground and surface operations.

3.10.4 Visual Screening

Visual amenity plantings and direct seeding have been undertaken during mining operations as per the revegetation plan (Appendix X) with sections 1, 2 and 3 of Figure 32 having been completed.

3.10.5 Fuel and Chemical Storage

The dispensing of hydrocarbons is conducted in areas that are designed to Australian Standards. A management procedure to address accidental spillage is also in place (refer to Waste Management Plan, Appendix AF). All fuel and chemicals must be stored appropriately as per the Waste Management Plan. A list of all fuels and chemicals used on site, volumes of each and bunding arrangements can be found in Appendix V.

3.10.6 Site Security

Site security has been detailed in section 5.14.

3.10.7 Silt Control and Drainage

Silt control and drainage has been detailed in sections 5.3 and 5.6.

3.10.8 Rehabilitation and closure strategies

Closure strategies for the supporting surface infrastructure have been detailed in section 3.8.6 and the Closure Plan (Appendix C).

4 RESULTS OF CONSULTATION

Any new mine development requires strong community support for its success, especially when located in close proximity to a regional urban centre (refer to section 8.1). In March 2005, Terramin initiated a comprehensive community consultation and communications strategy to ensure that the public had all the required information to make an informed judgment about the construction of the AZM.

In designing its community consultation and communications strategy, Terramin recognised the importance of ensuring that all stakeholders were brought within the ambit of the process. The company identified a number of stakeholders for whom specific or general messages would need to be crafted to raise the profile and understanding of the project. These stakeholders included:

- Strathalbyn and district public,
- Near-mine landowners,
- Community groups, e.g. Residents for a Future Strathalbyn, Commerce Association of Strathalbyn,
- Local governments and related agencies, e.g. Alexandrina Council, Regional Economic Development Board,
- Media – local, metropolitan, national and specialist publications,
- State Government and agencies, e.g. DMITRE, EPA, Natural Resource Management Services,
- Department of Environment, Water and Natural Resources (DEWNR, formally DWLBC),
- Transport SA,
- Federal Government and agencies, e.g. South Central Area Consultative Committee, and
- Local Members of Parliament – State and Federal.

The Minister for Mineral Resources Development announced in February 2006 that the assessment of the ML application for the proposed Angas Zinc Project would involve the establishment of a Community Consultative Committee. Accordingly the SCCC was formed in May 2006.

A number of stakeholder consultation methods were used during the project approval stage including distribution of brochures, responding to community inquiries, a public open day, one-on-one consultation with neighbouring landowners and fortnightly SCCC meetings. The inaugural PEPR document was submitted in October 2005 and was subject to a public review period that concluded in January 2006. Appendix K lists the questions arising from Government agencies and the SCCC regarding the PEPR and Terramin's associated responses.

A dedicated and publicly advertised telephone line was provided at the commencement of the construction phase, and continues to be available 24 hours a day, 7 days a week. Terramin records all complaints on an internal data base. A response to all complaints will be provided within two working days. If the complaint requires further actions, these will be undertaken as soon practical. All complaint details and responses by Terramin will be presented at the following SCCC meeting.

Since the mining operation has commenced Terramin has and will continue to consult with stakeholders. Consultation includes:

- Quarterly SCCC meetings
- Media articles in the local newspaper
- Site tours on request
- Quarterly newsletters
- Quarterly Environmental Reports
- Regular face to face meetings with neighbouring landowners

5 ENVIRONMENTAL OUTCOMES

Environmental Management is an important part of the AZM Operation. In consultation with the community, Terramin has implemented an active environmental management program that has enhanced the environmental values of the site when compared to pre mining conditions (refer to Section 8). Environmental improvement projects were implemented during the construction phase and have continued throughout operations, leading to a stable, environmentally enhanced site following mine closure.

Terramin are regulated by DMITRE through the ML6229 conditions (Appendix AH). From these lease conditions, corresponding environmental outcomes were derived. In order to measure Terramin's performance against these outcomes, outcome measurable criteria have been established through consultation with DMITRE and the SCCC for the operation, rehabilitation and closure phases of the mine (sections 5.2 – 5.19). Leading Indicators have also been established for high risk impacts which if triggered, must be reported to DMITRE stating what actions were taken and if the relevant control strategies will continue to be effective. Although every effort will be made to remain in compliance with the environmental outcomes, if an unforseen event may result in non-compliance, it will be reported to DMITRE as soon as is practical.

If requested by the Chief Inspector of Mines, Terramin will undertake an independent audit of the achievement of environmental outcomes by an independent expert approved by the Chief Inspector of Mines. The audit will be made available to the public, in a manner and form as determined by the Minister in consultation with the SCCC.

The Environmental Monitoring Program (Appendix AG) summarises all monitoring requirements throughout operations and rehabilitation, as well as the associated procedures and the frequency of reporting to DMITRE and the SCCC. All environmental monitoring locations and regimes were determined in conjunction with DMITRE and presented to the SCCC for discussion and consultation. DMITRE and the EPA occasionally conduct independent monitoring of the environmental conditions around the mine as well as undertaking inspections and reviewing quarterly environmental reports and annual compliance reports.

This section (5) outlines the potential environmental risks associated with the mine site control measures implemented by Terramin to achieve the environmental outcomes and the outcome measurable criteria used to demonstrate Terramin's performance against these outcomes.

5.1 ANGAS MINE ENVIRONMENTAL RISK ASSESSMENT

Risk is a function of the likelihood (probability) of an event occurring and the consequences (severity). An acceptable level of risk is one that is acceptable to the stakeholders or communities exposed to that risk. Each potential environmental impact with a higher than low risk has control measures which are implemented to reduce the risk to an acceptable level. All control measures have been incorporated in the environmental management plan to ensure that the risks are appropriately managed.

The initial risk assessment identified 79 aspects or hazards deemed essential to evaluate. These were numbered 1 to 79 in the risk assessment (Appendix A). Additional aspects (hazards) were identified through community consultation or re-evaluations of mining activities by Terramin and its consultants. These were evaluated and included in the risk assessment in Appendix A and given a number and letter to distinguish them from the original assessment.

The following factors are used to evaluate the level of risk before and after implementing control measures:

1 **Partition** – this is the setting or underlying cause of a risk event (natural occurrences, process related activities, occupational health & safety and social considerations)

2 **Aspect** – this describes the activities or conditions that may lead to an environmental impact. The general aspects of the proposed AZM operation were:
- Emission of gases and particulates to air, water and land
- Emission of liquids to water and land
- Disposal of hazardous and general waste
- Generation of noise and vibration
- Use of chemicals and raw materials
- Consumption of energy and natural resources
- Disturbance of natural habitats and ecosystems
- Disturbance of aboriginal and cultural heritage sites

3 **Domain** – this describes the potential source of hazardous emissions within the ML boundary grouped by the type of mining activities: North, South, Central and Buffer zones.

4 **Project Phase** – Exploration (baseline), Construction, Operational (including rehabilitation), and Closure (post-rehabilitation).

5 **Impact** – this describes how an event may interact with the environment to generate an impact.

6 **Likelihood** – a qualitative measure of the probability or frequency of a hazardous event occurring. Likelihood estimates were based on available data, past experience and engineering calculations; for example the risk of flooding based on 1 in a 100 year rainfall event based on historic data and hydrological modelling of the flood plain.

7 **Consequence** – a qualitative measure of the severity of a hazardous event determined from information such as the potential scale of an event, the duration of an event, the number of stakeholders and habitat that may be impacted and the difficulty in remediating the impact.

8 **Risk evaluation** – each hazardous event was ranked using the risk matrix recommended by DMITRE (2006).

9 **Control Measures** – were implemented for all potential events that may have had an environmental or social impact.

A separate risk assessment was undertaken for the TSF (Appendix U) to align with the new Guidelines for the Management of the TSF (April 2006) by DMITRE and the EPA, and to provide clarity to the community.

A completion risk assessment was undertaken as part of the closure plan for the four separate domains (Figure 17), to assess the residual post mine completion risks to the environment and contingency strategies (Table 21 – Table 25). Additional Failure Modes Effects Analysis (FMEA) risk assessment was undertaken in 2013 to refine the assessment, more detail can be found in the closure plan, Appendix C. Note risk associated with Phytocap covers is addressed in detail in the closure plan, Appendix C.

Terramin intends to adopt the best mining and environmental management practice that is economically achievable. Terramin has implemented the control measures and intends, where practicable, to undertake mine rehabilitation as soon as the disturbed land becomes available.

Closure task North Domain	Potential hazard	Mitigation strategies	Likelihood	Consequence	Risk
Remove piping.	Damage to native vegetation.	• Avoid damage to native vegetation. • Site induction includes the requirement to not disturb vegetation.	Rare	Moderate	Moderate
Decommission drillholes	• Generation of AMD via improper rehabilitation of drill sites • Drill holes lead to loss of natural surface water.	• Rehabilitate drillholes as per 'Mineral Exploration Drillholes - General Specifications for Construction and Backfilling (M21, 2012).	Rare	Moderate	Moderate
	• Additional damage is done to the area around the drill site during wet periods.	• Rehabilitate drill sites during dry weather only	Rare	Minor	Low
Filling of mine voids (via portal in Central Domain).	• Fill is insufficient to stabilise the ground. Leads to collapse of a portion of Callington Road and/or impact on the integrity of existing lagoons. • Ground subsistence/ cracking due to earthquake • Wetland drying due to instability of underlying working	• All pillars were designed geotechnically and independently reviewed (Mining One, 2013, Appendix AN) • Leave a crown pillar (natural rock) of suitable thickness in underground design. • Progressive backfilling using methodology stated in the 2014 PEPR section 3.7.2. 93% of the mined production voids will be backfilled at the end of mine life. • An independent geotechnical and subsidence report to be completed post closure. • Surface survey monitoring of the Northern Domain will continue for two years post mine closure, as per closure criteria for geotechnical stability.	Rare	Major	High
Filling of mine voids (via portal in Central Domain).	Damage to private infrastructure due to failure of underground workings causing subsidence	• An independent geotechnical and subsidence report to be completed post closure. • DSD and Alexandrina council to be provided with all relevant reports and plans associated with the underground workings.	Unlikely	Moderate	Moderate

Flooding of the mine void	Significant AMD generation and potential off-site migration of impacted ground waters	• Monitoring the standard water level to maintain a slight groundwater sink conditions preventing water going off site. • Develop a Monitoring Plan for post closure (Groundwater Monitoring Plan, Appendix BJ.	Unlikely	Major	High

Table 21: Risk Evaluation of Closure Tasks in North Domain

Closure task Buffer Domain	Potential hazard	Mitigation strategies	Likelihood	Consequence	Residual risk
Revegetate any disturbed areas	Revegetated area fails to thrive.	• Ensure revegetation is undertaken in accordance with the Revegetation Plan (MCP, Appendix X). • Progressive visual amenity planting undertaken during mine operations	Rare	Moderate	Moderate

Table 22: Risk Evaluation of Closure Tasks in Buffer Domain

Closure task Central Domain	Potential hazards	Mitigation strategies	Residual risk		
			Likelihood	Consequence	Risk
Re-contour Central Domain	Poor construction and design of boxcut leading to: • Failure of boxcut slope • Increased soil erosion beyond design parameters • Poor vegetation establishment • Public risk due to steep batters	• Utilise boxcut for Extractive Mineral lease purposes, resulting in progressive mining, management and rehabilitation • Boxcut batter slopes to be reduced to 1:3.5, as per Figure 20 and Figure 19 (Appendix C) or in accordance with final design which takes into account changes resulting from EML activities. • Remainder of Domain to be contoured as per Figure 20 and Figure 19 • Use of erosion mitigation techniques during rehabilitation, including the use of a sterile annual crop, contour rows and mulch • Use of rapid growing crops/vegetation to minimise airborne and hydraulic erosion. • Detailed erosion assessment , monitoring plan and verification required	Rare	Moderate	Moderate

Closure task Central Domain	Potential hazards	Mitigation strategies	Residual risk		
			Likelihood	Consequence	Risk
	Public risk due to access to underground openings	• All underground openings to be filled and capped with raw fill and/or concrete. • Area to be secured with fencing prior to capping completed. • The vent rise and mine portal will be engineered to allow surface runoff but prevent access following closure.	Rare	Major	High
	Flooding in boxcut.	• The boxcut is located within a ridge that is 15-20 metres higher than the nearest riparian area, there are no records of the ridge flooding from the Angas river system • Maintain an ephemeral evaporation pan in the lowest point of the boxcut for surface water to drain into and thence evaporate or percolate to the mine cone of depression. • Remainder of Domain to be contoured as per Figure 20 and Figure 19 (Appendix C)	Rare	Moderate	Moderate
	Collapse of the decline openings due to failure of ground support in first 100 meters	• Decline rehabilitated using a detailed design which includes slope stability analysis, construction monitoring and verification	Rare	Moderate	Moderate
Remove hazardous material and contaminated soil.	Inadequate removal leads to contaminated soil, groundwater and/or surface water and hinders rehabilitation of Domain.	• During operations soil contamination was minimised by restricting potentially contaminating materials to the 'dirty zone' and through the implementation of spill management procedures. • Remove potentially contaminated soil and dispose in the underground voids or in the TSF as per Appendix C • Ensure all hazardous material is treated or removed from site in accordance with relevant EPA guidelines.	Rare	Major	High

Closure task Central Domain	Potential hazards	Mitigation strategies	Residual risk		
			Likelihood	Consequence	Risk
Filling of mine voids (via portal in Central Domain).	Boxcut slip failure, AMD released to groundwater, infrastructure loss or damage and movement of vent shaft and decline caps leading to loss of boxcut backfill and exposure due to; • Fill is insufficient to stabilise the ground leads instability of boxcut slopes • Ground subsidence/crack due to instability of the crown pillar • Ground subsistence/ cracking due to earthquake	• All pillars were designed geo-technically, and independently reviewed (Mining One, Appendix AN) • Leave a crown pillar (natural rock) of suitable thickness in underground design. • Progressive backfilling using methodology stated in the PEPR section 3.7.2. 93% of the mined production voids will be backfilled at the end of mine life. • An independent geotechnical and subsidence report to be completed at cessation of underground mining operations. • Surface survey monitoring of the Northern Domain will be undertaken as per the recommendation by independent geotechnical.	Rare	Major	High
Fill mine voids with solids and water.	Mobilisation of acid and metalliferous drainage into water bodies impacts the ecological balance and impacts groundwater quality within and downstream of the mining site. Oxidation of sulphides in the dewatering zone leading to groundwater contamination	• The remaining voids will be mainly filled by local groundwater and rain water. • Ensure that potentially acid forming material in the voids is flooded as soon as practical after mine closure. • Ensure all potentially acid forming material in the mine voids is permanently covered by at least 2 m of water. • Monitor groundwater quality and standing water levels as per the acid mine draining closure criteria in Section 7.	Unlikely	Major	High
	Over-injection results in mounding at the mine site which could force water outwards from the mine voids.	• Modelling has shown that once injected, the fluids do not move very far. However, care will be taken to retain the hydraulic sink character of the filling mine void (via monitoring). • Monitor groundwater quality and standing water levels as per the acid and metalliferous drainage closure criteria in Section 7.	Unlikely	Moderate	Moderate
Rehabilitation of landfill site	Erosion of cover soils leading to exposure of waste resulting in surface water contamination, groundwater contamination and human health risk	Landfill will be rehabilitated to EPA license requirements (Appendix M) and revegetated using species in the revegetation plan. Described in more detail in Appendix C.	Rare	Minor	Low

Closure task Central Domain	Potential hazards	Mitigation strategies	Residual risk		
			Likelihood	Consequence	Risk
Revegetation	Poor vegetation establishment on re-contour due to lack of moisture, nutrients in soils	Species used successfully during operational revegetation will be used during closure as per the revegetation plan.	Unlikely	Minor	Low

Table 23: Risk Evaluation of Closure Tasks in Central Domain

Closure task South Domain	Potential hazards	Mitigation Strategies	Residual risk		
			Likelihood	Consequence	Risk
Recontour TSF and domain.	Stability failure of TSF outer embankment including the spillway due to erosion resulting in; • tailings/ AMD released to surface water via exposure (contaminated sediment runoff and dust) • liner failure, AMD released to groundwater via seepage • tailings release via spillway • gully forming leading to public safety risk	• TSF outside wall batter slopes to be reduced to 1:3 • Remainder of domain to be contoured as per Appendix C • Use of erosion mitigation techniques during rehabilitation, including the use of a sterile annual crop in the TSF wall and on the TSF capping (as per Appendix C and Soil Erosion Assessment (MCP Appendix BO) which recommended contour banking, native perennial C3 & C4 grasses an annual sterile crop, placement of mulch either side of direct seeding lines and use of the LFA results to address any loss of vegetation condition or erosion. • Use rapid growing vegetation to minimise airborne and hydraulic erosion. • The concept landform to be designed to minimise the amount of stormwater runoff onto the TSF by directing water away from and around the TSF (Figure 18) • Detailed erosion assessment , monitoring plan and verification required	Rare	Minor	Low
	Stability failure of TSF embankment due to increase pore water pressure/ surface ponding leading to; • AMD released to groundwater via seepage • AMD released to surface water via exposure • Unstable slopes resulting in public safety risk	• The concept landform to be designed to minimise the amount of stormwater runoff onto the TSF by directing water away from and around the TSF (Figure 18) • A TSF closure report by an independent chartered professional will be undertaken post-closure to demonstrate that the TSF and associated infrastructure has been rehabilitated as per the approved TSF closure design.	Rare	Moderate	Moderate

Closure task South Domain	Potential hazards	Mitigation Strategies	Residual risk Likelihood	 Consequence	 Risk
	Disruption of TSF Cover due to tailing differential settling by: • Higher seepage volumes leading to unacceptable contamination of groundwater • (HDPE) Higher seepage volumes leading to unacceptable contamination of surface water receptors • (HDPE) ponding of surface water increasing pore water pressure and infiltration (bottom liner)	• Consolidation assessment, TSF cover design and groundwater model required	Unlikely	Moderate	Moderate
	Disruption of TSF Cover due to tailing differential settling by: • (ET) Higher seepage volumes leads to unacceptable contamination of surface water receptors • (ET) Ponding of surface water increasing pore water pressure and infiltration	• Consolidation assessment, TSF cover design and groundwater model required – See section Appendix C. •	Unlikely	Moderate	Moderate
	Public risk due to unauthorised access.	• The TSF decant tower will be appropriately secured to prevent unauthorised access post-closure (using fencing and lockable covers).	Rare	Moderate	Moderate

Closure task South Domain	Potential hazards	Mitigation Strategies	Residual risk Likelihood	 Consequence	 Risk
	TSF embankment failure poor design and/ or earthquake resulting in gully forming leading to public safety risk and contamination of surrounding soil, groundwater and surface water	• TSF outer wall batters to be reduced to 1:3 • TSF designed to earthquake specifications ANCOLD Guidelines 2012 • Design spillway to Probable Maximum Precipitation (PMP) flood capacity • Revegetate the TSF embankment as soon as practical to assist in erosion protection. • Ensure materials used for capping are in accordance with Conceptual Phytocap Design (including no reactive soils). • Design spillway to limit erosion.	Unlikely	Major	High
	Seepage through the TSF embankment (or beneath the TSF foundations) leads to soil and groundwater contamination as well as compromised geotechnical stability of the TSF.	• Design TSF as per Conceptual Phytocap Design (Appendix AR) and the final engineered design for the cap. • Monitor for seepage as per the Acid and Metalliferous Drainage closure criteria (Closure Plan, Appendix C, Section 7).	Unlikely	Major	High
	Basal HDPE liner failure due to holes produced in constructing, leading to groundwater contamination via infiltration	• Monitor for any HDPE leakage as per the closure criteria for groundwater. • Update the groundwater model and incorporate into the monitoring plan	Rare	Moderate	Moderate
	Degradation of HDPE liner (below tailings) leading to decreased containment capabilities resulting in; • Release of contaminants to groundwater due to chemical impact (from tailing water) pH and chemical composition	• Assess the acid generating potential of the tailings and chemical impact on the HDPE liner • Access natural degradation of the liner over time • Develop a groundwater model for the area surrounding the TSF modelled over a minimum of 1000 years • Develop a monitoring plan from this information (GW monitoring plan, MCP Appendix BJ)	Rare	Moderate	Moderate

Closure task South Domain	Potential hazards	Mitigation Strategies	Residual risk		
			Likelihood	Consequence	Risk
	Failure of containment of tailings and instability due to burrowing animals resulting in; • Macro porosity increasing the potential for and extent of outer embankment erosion • Reduced or vegetation die off due to lack of growth medium and lack of moisture availability • Increased infiltration	• Pest animal control management plan	Likely	Minor	High
Evaporate remaining TSF water.	Poor weather conditions lead to delays in evaporation.	• Use of sprinklers for enhanced evaporation, with regard to (Terramin Angas Zinc Mine TSF Water Minimisation Project – add as appendix) • Install a lined evaporation pond as a contingency for disposing of the TSF decant water, if required	Unlikely	Minor	Low
(HDPE) Apply 1.5 mm thick HDPE liner to encapsulate the remaining tailings.	(HDPE) Hole in HDPE liner exposes tailings thereby causing soil and groundwater contamination. Leakage through joints of the HDPE liner.	• Monitor for any HDPE leakage as per the closure criteria for groundwater. • Ensure capping layer is maintained. • If the location of the leak is known, repair the HDPE liner if possible. • Update the groundwater model and incorporate into the monitoring plan	Unlikely	Minor	Low

Closure task South Domain	Potential hazards	Mitigation Strategies	Residual risk		
			Likelihood	Consequence	Risk
	(HDPE) Degradation of HDPE cover leading to decreased infiltration control resulting in; • Groundwater contamination • Increased infiltration into tailings leading to increased pore water pressure leading to increased groundwater contamination • Increased infiltration into tailings due to chemical impact (from tailing eaten) leading to increased pore pressure, increasing groundwater contamination	• Assess the acid generating potential of the tailings and chemical impact on the HDPE liner • Assess natural degradation of the liner over time • Develop a groundwater model for the area surrounding the TSF modelled over a minimum of 1000 years • Develop a monitoring plan from this information	Likely	Major	Extreme

(HDPE) Apply capping layer over HDPE liner.	(HDPE) Breach in capping layer due to plant roots extending to base of capping profile exposes tailings thereby causing soil and groundwater contamination.	• Ensure capping layer of at least 600 mm of subsoil plus 100- 200 mm of topsoil is maintained (depending on final capping layer).
		• Ensure materials used for capping are in accordance with Phytocap Design - MCP Appendix AR (including no reactive soils).
		• Restrict vegetation on capping to species to ensure the cover remains free of deep rooted species.
		  • Monitor capping layer for structural integrity, as per the geotechnical stability closure criteria.
		  • Cover thickness to take into consideration most likely vegetation community
		  • Update the groundwater model and incorporate into the monitoring plan
			Likely	Moderate	High

Closure task South Domain	Potential hazards	Mitigation Strategies	Residual risk		
			Likelihood	Consequence	Risk
(ET) Applying of Evapotranspiration capping option (phytocap)	(ET) Formation of holes/ macro pores in capping profile due to plant roots extending to base of capping profile and burrowing animals resulting in; • Groundwater contamination via infiltration • Vegetation die off due to uptake of salt/metals	• Management measures to be included in the maintenance and monitoring plan • Detailed erosion assessment , monitoring plan and verification required • The concept landform to be designed to minimise the amount of stormwater runoff onto the TSF by directing water away from and around the TSF (Figure 18) • Pest animal control management plan, incorporate into the maintenance and monitoring plan • Update the groundwater model and incorporate into the monitoring plan • Capillary break installed above tailings, EC monitoring probes in cap	Possible	Minor	Moderate
	(ET) Plant uptake of metals and/or salts due to roots extending into tailings mass resulting in; • Unacceptable health risks in wildlife and humans via excessive bioaccumulation of metals in plant tissue • Surface and groundwater contamination via increased infiltration	• Management measures to be included in the maintenance and monitoring plan – limit grazing of commercial animals • The concept landform to be designed to minimise the amount of stormwater runoff onto the TSF by directing water away from and around the TSF (Figure 18) • Update the groundwater model and incorporate into the maintenance and monitoring plan • Develop cover model that address performance of the system using continuous climate data set over the long term • Conduct consolidation assessment of tailings using site specific material properties	Unlikely	Major	High
	(ET) Poor vegetation establishment on capping due to lack of moisture and nutrients in soils resulting in; • Increased erosion via intense rainfall • Surface and groundwater contamination via increased infiltration	• The concept landform to be designed to minimise the amount of stormwater runoff onto the TSF by directing water away from and around the TSF. • Document vegetation field trials Develop revegetation plan, use a mix of resilience endemic native species • Develop and reference conservative cover models, use a mix of resilience endemic native species • A TSF closure report by an independent chartered professional will be undertaken post-closure to demonstrate that the TSF and associated infrastructure has been rehabilitated as per the approved TSF closure design.	Unlikely	Moderate	Moderate

Closure task South Domain	Potential hazards	Mitigation Strategies	Residual risk		
			Likelihood	Consequence	Risk
	(ET) Vegetation died- off due to bush fire resulting in; • Instability of capping via increased erosion • Surface and groundwater contamination via increased infiltration	• The concept landform to be designed to minimise the amount of stormwater runoff onto the TSF by directing water away from and around the TSF. • A TSF closure report by an independent chartered professional will be undertaken post-closure to demonstrate that the TSF and associated infrastructure has been rehabilitated as per the approved TSF closure design. • Document vegetation field trials • Develop revegetation plan, use a mix of resilience endemic native species • Develop and reference conservative cover models	Rare	Minor	Low
	(ET) Geotechnical failure of the cover due to erosion leading to gullying and tailing exposure impacting surface water quality	• The concept landform to be designed to minimise the amount of stormwater runoff onto the TSF by directing water away from and around the TSF. • Develop and reference conservative cover models • Management measures to be included in the maintenance and monitoring management plan • Conduct consolidation assessment of tailings using site specific material properties • Refine revegetation management as required from LFA monitoring data	Unlikely	Major	High

Table 24: Risk Evaluation of Closure Tasks in South Domain

Closure task Non-domain specific	Potential hazards	Mitigation strategy	Residual risk		
			Likelihood	Consequence	Risk
Earthworks and site contouring.	• Ponding of surface water. • Erosion • Dust nuisance • Decrease in visual amenity compared to baseline • Risk to human and fauna safety	• Use water cart as required. • Revegetate area as soon as practical. • Engineer contours to meet worst case scenario flood conditions. • Reduce all batters and revegetate as per Appendix C. • This will provide significant improvement to the visual amenity of the site compared to baseline. • Maximise revegetation during operations phase. • Use of erosion mitigation techniques during rehabilitation and closure. • Ensure all structures are shaped to allow the safe ingress and egress of fauna and people.	Unlikely	Moderate	Moderate
Litter management.	Reduced visual amenity.	• Ensure appropriate litter and rubbish bins/skips are available on site. • Ensure contents of bins and skips are regularly removed. • Implement the waste management plan.	Unlikely	Minor	Low
Stakeholder communications.	• Poor communications leads to poor or misinformed public perceptions and / or bad workforce attitudes. • Community resistance to or lack of awareness of closure plans.	• Regular and effective stakeholder engagement • Continued quarterly meetings with Strathalbyn Community Consultation Committee (SCCC) • Implement an effective complaints management system.	Rare	Major	High
Maintain adequate site security.	Inadequate security may lead to injury, vandalism and /or theft.	• Maintain adequate fencing and signage. • Maintain good community relations to assist in reporting of trespassers. • Monitor site security as per vertical openings and site security • The boxcut and TSF slopes to be battered to a safe and structurally stable state as per Appendix C	Rare	Moderate	Moderate
Fire prevention and management.	Inadequate fire prevention leads to fire on site. Results in damage to vegetation and a risk to public and fauna safety.	• Implement adequate fire prevention strategies to ensure no unplanned fires onsite and to ensure control measures are in place to manage potential off site impacts (in accordance with ML condition number 51).	Rare	Moderate	Moderate

Closure task Non-domain specific	Potential hazards	Mitigation strategy	Residual risk		
			Likelihood	Consequence	Risk
Heritage management	Inadequate heritage management leads to damage to Aboriginal heritage item or site.	• Ensure that all employees and contractors on site are properly advised of the significance of Aboriginal heritage and culture and are to take due care to preserve all Aboriginal Sites and Objects as defined by the Aboriginal Heritage Act 1988 (in accordance with lease condition 63). Note, however, that a search of the Central Archive revealed no entries for Aboriginal heritage sites in the vicinity of the mine. Similarly, there are no Native Title Claims or applications, nor are there any non-indigenous heritage sites registered.	Rare	Major	High
Application of topsoil.	• Lack of site-sourced topsoil. • Poor quality topsoil.	• Source topsoil from off-site if required. • Monitor topsoil quality as per soil closure criteria in Appendix C	Rare	Minor	Low
Decommission boreholes	• Generation of AMD via improper rehabilitation of drill sites • Drill holes lead to loss of natural surface water.	• Rehabilitate drillholes as per 'Mineral Exploration Drillholes - General Specifications for Construction and Backfilling (Minerals and Energy SA, 2006)'.	Rare	Moderate	Moderate
	Additional damage is done to the area around the drill site during wet periods.	• Rehabilitate drill sites during dry weather only	Rare	Minor	Low

Closure task Non-domain specific	Potential hazards	Mitigation strategy	Residual risk		
			Likelihood	Consequence	Risk
Revegetation	Loss of planted vegetation due to insufficient water, disease, fire, erosion, grazing, weed competition or other damage resulting in the site not being returned to a suitably revegetated state and the: • SEB offsets are not met • Landscape Function Analysis (LFA) sustainability thresholds in the vegetation closure criteria are not met. • Decreased native species abundance and diversity compared to baseline. • Increased presence of pest species compared to baseline.	• Weed management in accordance with the Adelaide and Mt Lofty Ranges Natural Resources Management Board's guideline *Pest Prioritisation Management Actions, 2010* and the Weed and Pest Management Plan (Appendix AY and BH). • Replace vegetation where required. • Collect seed locally where possible • Revegetate the area required for offsetting the SEB (MCP, Appendix X). • Implement fire prevention strategies. • Revegetate with fire tolerant native species • Monitor vegetation as per the vegetation closure criteria. • Implement adaptive land management practices if required.	Unlikely	Major	High
Remove infrastructure and hardstand areas.	Insufficient funds.	• Rehabilitation bond calculation updated to reflect ongoing works to cover closure requirements. • Rehabilitation Bond in place as part of Mine Lease requirements • Sell infrastructure where possible.	Rare	Major	High
Removal of contaminated soil.	Inadequate removal of contaminated soil results in an increase in soil contamination levels above baseline conditions.	• During operations soil contamination was minimised by restricting potentially contaminating materials to the 'dirty zone' and through the implementation of spill management procedures. • Potentially contaminated soil shall be removed, and the area validated to ensure the soil contamination levels meet the closure criteria. The contaminated soil shall be disposed of in the underground voids or in the TSF as per Appendix C • Ensure all hazardous material is removed from site in accordance with relevant EPA guidelines.	Rare	Moderate	Moderate

Closure task Non-domain specific	Potential hazards	Mitigation strategy	Residual risk		
			Likelihood	Consequence	Risk
Termination of Terramin employees at mine closure.	• Reduced local employment opportunities. • Reduced local population. • Reduced spending in local community. • Termination of financial sponsorship for local events and clubs.	• Mine workforce made redundant prior to care and maintenance phase and mine closure phase (completed) • Maintain local spend policy during rehabilitation..	Possible	Moderate	High
Payment for post-closure monitoring and maintenance costs.	Insufficient funds.	• Account for costs in mine closure cost estimate (refer to page 49) • Rehabilitation bond calculation updated to reflect ongoing works to cover closure requirements. Use rehabilitation bond if necessary.	Rare	Major	High
Closure and post closure related traffic.	Traffic nuisance.	• No B-Double vehicles are to be driven through Strathalbyn township roads and that B-Double vehicle movements on public roads limited to hours. • Minimise dragout.	Rare	Minor	Low

Table 25: Risk Assessment for Non-Domain-Specific Closure Tasks

5.2 GROUNDWATER AND SURFACE WATER

Potential environmental risks identified:

2 – Leaching of stockpile soils

3 – Disturbance to soils

4 – Contaminated water

5 – Former land use contaminants

6 – Land fill contamination

16 – Waste disposal

18 – Sulphidic waste underground

31 – TSF embankment failure

32 – Seepage through embankment

33 – Seepage beneath TSF

34 – TSF run off

35 – Failure of pumping system

36 – Burst process pipe

37 – Rupture of process tanks

38 – Waste water generation

43 – Dewatering for mining

52A – Water course pollution from dragout

5.2.1 Proposed Control and Management Strategies

Operation and Rehabilitation

During the mining operation the risk of groundwater contamination to surrounding areas is very low as the mine dewatering process is designed to capture all groundwater within the mine workings, preventing movement of groundwater (and contamination) off the ML.

The mine water circuit is designed to pump groundwater that enters the mine working to the de-silting pond (then the raw water pond) where it will be used on-site. This water can be filtered (for use on site or aquifer re-injection) or be converted by the RO plant to fresh water for use within the processing plant. Any excess RO permeate will be used for neighbouring primary production purposes, irrigation of sporting fields or supplied to vineyards in the Langhorne Creek area via a purpose built pipeline.

Mine dewatering creates a cone of depression within the Cambrian aquifer on the ML, producing a flow from the surrounding aquifer into the cone (rather than out). This significantly decreases the possibility of contaminating the surrounding groundwater. Extensive water modelling has been carried out and the extent of the cone of depression is illustrated in Figure 16.

The AZM has been divided into two zones, the dirty zone and the clean zone (Figure 31). The dirty zone is the area consisting of the majority of the mine operations including the ROM Pad, Mill, Boxcut and Workshop, and is identified as a potentially contaminated area. Any surface water from the dirty zone is directed to the boxcut or raw water pond, subsequently entering the mine water circuit mentioned above. Any surface water that has not come into contact with the dirty zone (i.e. within the clean zone) is directed to bypass contaminated areas to maintain the quality of natural waters. Monitoring of the natural water i.e. the Angas River and Burnside Creek will occur as per section 5.2.2. No baseline data for Burnside Creek is available as the first recorded water flows since 2007 was in June 2012 (Table 26). The June 2012 upstream data or the upstream values at the time of monitoring are used as target values for the outcome measurable criteria of Burnside Creek (refer to section 5.2.2).

The TSF and process ponds are designed to meet the criteria for zero discharge of contaminated waste. HDPE double liners have been used to ensure no seepage from the TSF and process ponds is possible; therefore no contamination of groundwater. The TSF is designed to hold the volume of water falling on the site catchment area from a 1:1000 year 120-hour storm event. The TSF decant pond Relative Level (RL) is maintained so the facility can contain a 1:1000 rainfall event without a risk of overtopping the TSF spillway (refer to section 5.8).

Date	22-Jun-12	
Site	Units	SWB
pH-L	pH	7.68
EC-L	µs/cm	1130
Turbidity	NTU	94
As-T	mg/L	0.003
Cd-T	mg/L	<0.0001
Pb-T	mg/L	0.007
Zn-T	mg/L	0.028
Se-T	mg/L	<0.01
Fe-T	mg/L	3.52

Table 26: Burnside Creek June 2012 Data

Control measures undertaken to protect ground and surface waters from contamination are:

- Directing of non-contaminated surface waters around operational areas (referred to as the clean zone (Figure 31);
- Collection of water that has been in contact with potentially contaminated surfaces (referred to as the dirty zone (Figure 31) and diversion to mine process water circuit or onsite water treatment facilities;
- Design of TSF to comply with rigour to withstand 1:100 Average Reoccurrence Interval
- (ARI) rainfall events;
- Use of settling ponds ;
- Closed circuit for all process water to ensure no cross-contamination with natural waters;
- Thickeners to increase water recycling efficiency in the process circuit;
- Vehicle wash before site exit, to prevent dragout;
- Bunding of stockpiles to direct any contaminated water into the process water or water treatment circuit;
- The return water line from the TSF and the feed lines to the distributor points to the TSF will be bunded so as to contain any potential spills.

Closure

See Appendix C.

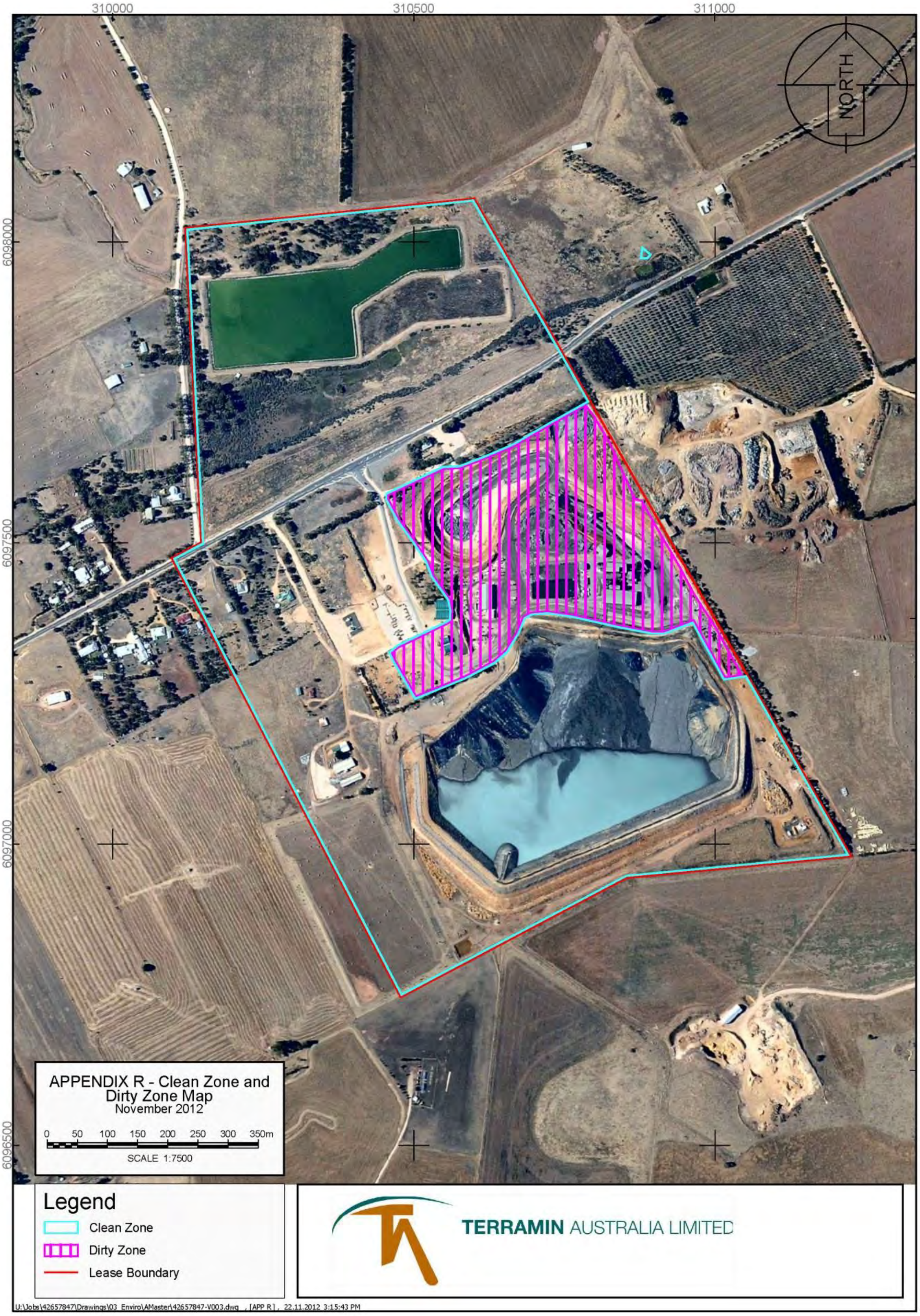

Figure 31: AZM Dirty and Clean Zone

5.2.2. Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No adverse impact to the supply of water by the mining operations to existing users and water dependant ecosystems	**Surface Water**					
	Surface water samples will be taken during rain events where there is a potential for discharge into the Angas river from ML6229. Samples will be taken, as per AS/NZS 5667.1:1998 standards, where the Angas River flows at 2 potential discharge locations (Croser and Ford) and 2 upstream control sample points (Bridge and Hogben shown in Figure 38) to demonstrate that potential contaminants (Pb, Zn, As, Cd, Fe, Se, pH, EC and turbidity) at Croser and Ford do not exceed historical maximum control data values (Table 27) or the values recorded at the upstream control sites (Bridge and Hogben) at that point in time.	Surface water samples analysed for; Pb, Zn, As, Cd, Fe, Se, pH, EC and turbidity. Sampling methodology as per AS/NZS 5667.1:1998 standards	Two monitoring points (Croser and Ford) located at potential discharge locations along the Angas river and two upstream control monitoring points (Bridge and Hogben). Refer to Figure 37	Croser and Ford do not exceed historical maximum control data values (Table 27) or the values recorded at the upstream control sites (Bridge and Hogben) at that point in time.	Samples to be taken during rain events where there is a potential for discharge into the Angas river from ML6229.	Control data has been calculated from 2006 – 2011 as no potential discharge into the Angas river from ML 6229 occurred throughout this timeframe (Table 27)
	Leading Indicator: Quarterly surface water monitoring will occur where the Angas River flows at 2 potential discharge locations (Croser and Ford) and 2 upstream control sample points (Bridge and Hogben) to demonstrate that potential contaminants (Pb, Zn, As, Cd, Fe, Se, pH, EC and Turbidity) are less than two standard deviations of the mean control data values (Table 27)	Surface water samples analysed for; Pb, Zn, As, Cd, Fe, Se, pH, EC and turbidity. Sampling methodology as per AS/NZS 5667.1:1998	Two monitoring points (Croser and Ford) located at potential discharge locations along the Angas river	Croser and Ford to be compared to Bridge and Hogben to demonstrate contaminants do not exceed control data by two standard deviations	Quarterly	Control data has been calculated from 2006 – 2011 as no potential discharge into the Angas river from ML 6229 occurred throughout this

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No adverse impact to the supply of water by the mining operations to existing users and water dependant ecosystems		standards	and two upstream control monitoring points (Bridge and Hogben). Refer to Figure 37	(Table 27)		timeframe (Table 27)
	Samples to be taken during rain events where water is flowing through points SWA and SWB (Figure 37). Samples will be taken, as per AS/NZS 5667.1:1998 standards, where the Burnside creek flows at a potential discharge location (SWA) and an upstream control sample point (SWB) shown in Figure 37 to demonstrate that potential contaminants (Pb, Zn, As, Cd, Fe, Se, pH, EC and turbidity, are less than or equal to contaminant concentrations in the upstream location (SWB), or are less than historical Burnside creek upstream concentrations (Table 26).	Surface water samples analysed for; Pb, Zn, As, Cd, Fe, Se, pH, EC and turbidity. Sampling methodology as per AS/NZS 5667.1:1998 standards	One monitoring point (SWA) located at a potential discharge location on Burnside creek and one upstream control monitoring point (SWB). Refer to Figure 37.	SWA will have less than, or equal to all contaminant concentrations in SWB, or be less than historical Burnside creek upstream concentrations (Table 26)	Samples to be taken during rain events where water is flowing through points SWA and SWB.	Historical Burnside Creek Upstream calculations from June 2012 (Table 26)
	Groundwater					
	Groundwater will be sampled quarterly, as per AS/NZS 5667.1:1998 standards, at five bores (RG1, RG2, RG3, RG4 and RG8) located on and adjacent to the ML 6229 (Figure 38) and demonstrate that potential contaminants (Pb, Zn, As, Cd, Fe, Se, pH, EC and TDS) do not exceed maximum baseline values (Table 28)	Groundwater samples analysed for; Pb, Zn, As, Cd, Fe, Se, pH, EC and turbidity. Sampling methodology as per AS/NZS 5667.1:1998 standards	Five locations (RG1, RG2, RG3, RG4 and RG8) on and adjacent to ML 6229 as marked on Figure 38.	Demonstrate potential contaminants do not exceed maximum baseline values (Table 28)	Quarterly	Baseline groundwater data pre-mining (Table 28)

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No adverse impact to the supply of water by the mining operations to existing users and water dependant ecosystems	**Leading Indicator:** Groundwater will be sampled quarterly, as per AS/NZS 5667.1:1998 standards, at five bores (RG1, RG2, RG3, RG4 and RG8) located on and adjacent to the ML 6229 (Figure 38) and demonstrate that potential contaminants (Pb, Zn, As, Cd, Fe, Se, pH, EC and TDS) are less than two standard deviations of the mean baseline values (Table 28)	Groundwater samples analysed for; Pb, Zn, As, Cd, Fe, Se, pH, EC and turbidity. Sampling methodology as per AS/NZS 5667.1:1998 standards	Five locations (RG1, RG2, RG3, RG4 and RG8) on and adjacent to ML 6229 as marked on Figure 38.	Demonstrate potential contaminants to be below mean baseline values by two standard deviation (Table 28)	Quarterly	Baseline groundwater data pre-mining (Table 28)
	Groundwater Standing Water Level (SWL) will be measured, if access is granted, quarterly at five bores (RG1, RG2, RG3, RG4 and RG8) located on and adjacent to the ML 6229 (Figure 38) to demonstrate no SWL drawdown beyond a 1 metre band of 2006 levels for each bore (Table 29). If a 1 metre band increase occurs, the bore will be monitored monthly for three months to confirm an increasing trend.	Groundwater SWLs	Five locations (RG1, RG2, RG3, RG4 and RG8) on and adjacent to ML 6229 as marked on Figure 38.	Demonstrate no SWL drawdown beyond a 1 metre band of 2006 levels for each bore (Table 29).	Quarterly or monthly for three months if exceedance occurs to confirm an increasing trend.	Baseline groundwater data pre-mining (Table 29)

Site	Units	Count	Minimum Value	Percentile 10%	Average	Percentile90%	Standard Deviation	Coefficient of Variance	Maximum value	Average + 2 Standard Deviations of the mean
pH-L	**pH**	213	4.84	7.44	7.67	7.92	0.36	4.75%	**8.23**	**8.39**
EC-L	**µs/cm**	217	12.00	1771.80	3154.76	5304.00	1643.59	52.10%	**11400.00**	**6441.93**
Turbidity	**NTU**	213	0.30	1.4	8.98	17.89	17.98	200.31%	**148.00**	**44.94**
As-T	**mg/L**	219	0.0010	0.0010	0.0021	0.0030	0.0016	74.00%	**0.0160**	**0.0052**
Cd-T	**mg/L**	219	0.0001	0.0001	0.0002	0.0004	0.0002	105.87%	**0.0013**	**0.0007**
Pb-T	**mg/L**	219	0.0010	0.0010	0.0032	0.0055	0.0046	145.08%	**0.0270**	**0.0125**
Zn-T	**mg/L**	219	0.0060	0.0070	0.0205	0.0363	0.0280	136.73%	**0.2840**	**0.0766**
Se-T	**mg/L**	219	0.0100	0.0100	0.0103	0.0108	0.0006	5.59%	**0.0110**	**0.0115**
Fe-T	**mg/L**	213	0.01	0.15	0.92	1.03	3.05	332.27%	**32.6**	**7.02**

Table 27: Surface Water Control Data Statistics (2006-2011)

Parameters	Units	Count	Minimum	Percentile 5%	Average	Percentile 95%	Standard Deviation	Coefficient of Variance 100%	Maximum	Average + 2 Standard Deviations
pH Value	**pH Unit**	36	6.6	6.82	7.37	7.90	0.39	5%	**8.70**	**8.15**
Electrical Conductivity	**µS/cm**	36	4560	7002.5	24469.72	51850.00	14600.31	60%	**68500.00**	**53670.35**
Total Dissolved Solids	**mg/L**	18	2720	3536	13722.22	24150.00	5560.43	41%	**25000.00**	**24843.08**
T-Iron	**mg/L**	69	0.04	0.139	9.46	32.53	29.78	315%	**232.00**	**69.02**
T-Arsenic	**mg/L**	75	0.001	0.001	0.01	0.03	0.01	156%	**0.09**	**0.038**
T-Cadmium	**mg/L**	75	1E-04	0.0001	0.00	0.00	0.00	171%	**0.01**	**0.0040**
T-Lead	**mg/L**	75	5E-04	0.001	0.04	0.13	0.11	251%	**0.82**	**0.262**
T-Selenium	**mg/L**	75	0.003	0.003	0.03	0.10	0.03	108%	**0.13**	**0.088**
T-Zinc	**mg/L**	75	0.003	0.00575	0.31	1.44	0.70	228%	**4.40**	**1.704**

Table 28: Groundwater Baseline Statistics

Bores	Standing Water Levels (m)
RG1	9.64
RG2	8.34
RG3	8.21
RG4	28.15
RG8	7.56

Table 29: Groundwater Baseline Standing Water Levels

Days after mine cessation	AHD (m)	Below Ground Level (m)
60	-42	116
70	-20	94
80	-3	77
95	10	64
110	12	62
150	20	54
200	20	54

Table 30: Modelled Standing Water Level for DH2

Days after mine cessation	Zn	Pb	Cu	Cd
Ambient	0.018	<0.0005	0.027	<0.0005
150 days	0.3	0.08	0.004	0.001
1 year	0.1	0.08	0.004	0.0002
10 years	0.001	<0.001	0.001	<0.0001

Table 31: Modelled Contaminant Levels (mg/L) for DH2

5.3 EROSION

Potential environmental risks identified:

9 – Water erosion from rainfall events that generate runoff

10 – Wind erosion

19 – Exposing soils

5.3.1 Proposed Control and Management Strategies

Operation

Water Erosion

Water erosion control is an integral part of the ML environment management plan. The design of all landforms was undertaken with the intention of minimising sediment loss through water erosion.

The mine site has been designed so all surface water runoff generated in the 'dirty zone' (Figure 31) is directed to the box cut or raw water dam, subsequently preventing sediment from this area leaving site (refer to section 5.20). Areas within the 'clean zone' identified as a potential for sediment to leave site through water erosion are: the front entrance, visitors viewing area and the silt retention dam located at the south west corner of the TSF.

Sediment control at the front entrance (the car park area and the access road to the mine entrance) has been implemented through the construction of silt traps on either side of the access road which flow into surface drainage systems on either side (Figure 40). The drains have been constructed to slow the velocity of the runoff water and settle sediments. These drains direct water into the adjacent paddock, then to the STEDS wetland and subsequently Burnside Creek (when flowing). Monitoring will occur at a location prior to the water entering the STEDS wetland.

A surface drainage system has been constructed at the visitors viewing area (Figure 40) that has also been designed to slow the velocity of the water to settle the sediments. This water is directed to a drain under Callington road and into the adjacent paddock on the ML.

Surface runoff from the clean zone that does not exit through the front entrance is directed to the silt retention dam constructed south west of the TSF (Figure 40). The drain to the silt retention dam is designed to slow minor surface flows and drop out sediments. The dam reduces the velocity of runoff water during high rainfall events and capture sediments not settled out in the drains.

Monitoring turbidity at these three locations (pre- wetland location, visitors viewing drain and overflow point of the silt retention dam (Figure 40) is undertaken opportunistically during high rainfall events that generate runoff. As a leading indicator during operations and rehabilitation, the surface water infrastructure outlined in Figure 40 is inspected after high rainfall events to ensure they are still working as designed.

Annual photo monitoring at 10 locations will show no evidence of sediment loss through erosion. Photo point locations are shown in Figure 39.

Wind erosion of exposing soils

Dust mitigation measures have been implemented on-site as a form of wind erosion control (i.e. soil particles transported by the wind). This has been addressed in Section 5.12 Public Health and Nuisance. Revegetation that has occurred during operations (section 1-3 of Figure 32) has resulted in improved soil stability through vegetation establishment.

Rehabilitation

During rehabilitation, landforms will be contoured as per Appendix C in order to eliminate the risk of erosion post-closure. The boxcut will be battered to a stable slope profile of 1:3.5 (1 vertical to 3.5 horizontal), direct seeded with native species as per Appendix C and a sterile annual cover crop which will serve to manage erosion in the first year while the native species are establishing. The TSF will be designed, constructed and rehabilitated to a stable condition to ensure long-term stability (Appendix C). The TSF outer walls will be battered to 1:3 and the entire area will be designed to minimise the amount of stormwater runoff onto the TSF.

Closure

See Appendix C.

5.3.2 Outcome and Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
	Operation/Rehabilitation					
	Annual photo monitoring at 10 locations disturbed by mining activities (Figure 39), will show progressive improvement in landform stability through vegetation establishment and show no evidence of sediment loss off ML6229 through erosion (formation of rills, gullies or other evidence of sediment loss).	Sediment loss and vegetation establishment through photo point assessment	Photo point assessment to 10 disturbed areas within and around ML 6229.Refer to Figure 39.	No sediment to leave the lease ML 6229 and progressive vegetation establishment	Annual	Baseline photos (Plate 1-10)
Stabilise disturbed areas and prevent sediment from leaving the site.	During high rainfall events which generate runoff, turbidity will be measured at the pre-wetland location, visitors viewing area and the overflow point of the silt retention dam (Figure 40) as per sampling method AS/ NZS 5667.1:1998 standards to ensure the NTU does not exceed ANZECC/ARMCANZ (2000) guidelines of 50NTU.	Turbidity as per sampling method AS/NZS 5667.1:1998 standards.	Pre-wetland location, visitors viewing area, overflow point of the silt retention dam (Figure 40)	To ensure the NTU does not exceed ANZECC/ARMCANZ (2000) guidelines of 50NTU	High rainfall events which generate runoff.	N/A
	Leading Indicator: After high rainfall events which generate runoff, records from visual	Silt volume and conditions of silt traps, silt retention dam	All silt traps, surface drainage systems and	Silt traps and surface drainage systems on ML 6229 (Figure 40)	High rainfall events which generate	Baseline photos (Plates 11-

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
	inspections of silt traps, the silt retention dam and surface drainage systems on ML6229 (Figure 40) demonstrate that silt volume is no more than 50% of trap capacity volume and there is no breach in walls.	and surface drainage system through visual inspections.	the silt retention dam on ML 6229 (Figure 40).	demonstrate that silt volume is no more than 50% of trap capacity volume and there is no breach in walls.	runoff.	15)
Stabilise disturbed areas and prevent sediment from leaving the site.	After high rainfall events which generate runoff, visual inspections of all sloped areas and topsoil stockpiles will occur to ensure no evidence of sediment loss through erosion (formation of rills and gullies)	Erosion through visual inspection	All sloped areas and topsoil stockpiles on ML6229	To ensure no evidence of sediment loss through erosion (formation of rills and gullies)	High rainfall events which generate runoff.	N/A

Plate 1: View of Site from Visual Reference Point 1

Plate 2: View of Site from Visual Reference Point 2

Plate 3: View of Site from Visual Reference Point 3

Plate 4: View of the Site from the Visual Reference Point 4

Plate 5: View of site from Visual Reference Point 5

Plate 6: View of the Site from Visual Reference Point 6

Plate 7: View of the Site from Visual Reference Point 7

Plate 8: View of the Site from Visual Reference Point 8

Plate 9: View of the Site from Visual Reference Point 9

Plate 10: View of the Site from Visual Reference Point 10

Plate 11: View of Silt traps at front entrance drive way, Eastern side

Plate 12: View of Silt traps at front entrance drive way, Western side

Plate 13: View of Front Entrance Surface Drainage system

Plate 14: View of Surface drainage system into visitors viewing area

Plate 15:View of drain into Sediment Dam

5.4 SOIL

Potential environmental risks identified:

16 – Waste generation

24 – Stockpiling of topsoil

26A – Seed sterilisation in stockpiles

57 – Dust depositions and air emissions

5.4.1 Proposed Control and Management Strategies

Operation

Stockpiles

During construction, approximately 25,000m^3 of topsoil was removed (predominately from the TSF footprint) and stockpiled to a height of 2.5m, south-east of the TSF. Subsoil is not stockpiled on site as sufficient quantities of subsoil material will be obtained from reshaping of the site during rehabilitation.

The topsoil stockpiles are monitored to ensure erosion is appropriately controlled to maintain the quantity of the topsoil for use throughout rehabilitation. The stockpile is also and analysed annually for a range of contaminants to ensure soil quality is sustained. Seed vigour will not be monitored in soil stockpiles, however, Terramin considers any measures to conserve the seed bank in the topsoil from current pastures will be counter to the weed management program, given the large proportion of invasive and non-native species present.

Dust Deposition and air emissions

Dust deposition and air emissions have a potential risk of increasing the existing total lead levels in soils (which are naturally high). Dust mitigation measures which have been implemented throughout the operation to ensure lead dust levels are within compliance (refer to section 5.12).

Waste generation

Waste generation, including non-putrescible and putrescible wastes, chemicals and hydrocarbon waste, have the potential to impact the soil if not managed correctly. A Waste Management Plan has been prepared to ensure no further contamination of soil occurs by outlining the appropriate storage and disposal for all mine generated waste and hazardous substances (i.e. oils, fuels and chemicals) used on-site (Appendix AF). Regular inspections are conducted to ensure the Waste Management plan is being adhered to (refer to section 5.7 Waste Disposal and Hazardous Substances).

Rehabilitation

See Appendix C.

Closure

See Appendix C.

5.4.2 Outcome Measurement Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
Ensure that soil quality and quantity are protected	**Operation/Rehabilitation**					
	Annual photo monitoring of all topsoil stockpiles located on ML6229), will show vegetation establishment and no signs of erosion (formation of rills, gullies or other evidence of topsoil loss).	Vegetation establishment and signs of erosion (formation of rills, gullies or other evidence of topsoil loss) monitored through photo point assessment	All topsoil stockpiles located on ML6229	Vegetation establishment and no evidence of erosion.	Annual	Topsoil stockpile baseline photo (Plate 16)
	Leading Indicator: All topsoil stockpiles located on ML 6229 will be annually sampled, to AS 4482.1-2005 standards, and tested for As, Cd, Cu, Pb, Mn, Hg, Ni, Zn, pH, EC, and exchangeable cations Na, Mg, and Ca. Any results higher than the topsoil baseline maximum (Table 32) for any analyte will be investigated and appropriate actions taken.	Parameters to be measured; As, Cd, Cn, Pb, Mn, Hg, Ni, Zn, pH, EC, and exchangeable cations Na, Mg and Ca. Soils are sampled as per AS 4482.1,2005 standards.	All topsoil stockpiles located on ML6229	Any results higher than the topsoil baseline maximum (Table 32) for any analyte will be investigated and appropriate actions taken.	Annual	Baseline data comprises of both baseline topsoil stockpile data as well as results from the Soil Contamination Baseline Study from locations where the TSF is now located (Table 32).

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data

Parameter	Units	STATISTICS									
		Number	Minimum	10% Percentile	Medium	90% Percentile	Maximum	Average	Standard Deviation	Coefficient of Variance %	2 x Standard Deviation + Average
Arsenic (As)	mg/kg	15	6	7.30	17.00	44.90	54.00	22.93	16.53	72%	55.99
Cadmium (Cd)	mg/kg	15									
Copper (Cu)	mg/kg	15	6	6.00	6.00	6.60	7.00	6.20	0.45	7%	7.09
Lead (Pb)	mg/kg	15	6	7.40	10.00	18.20	22.00	12.27	4.83	39%	21.93
Manganese (Mg)	mg/kg	9	43	48.60	134.00	284.00	340.00	165.89	109.52	66%	384.93
Nickel (Ni)	mg/kg	15	2	3.00	6.00	10.20	17.00	6.53	3.85	59%	14.24
Zinc (Zn)	mg/kg	15	6	7.40	12.00	35.80	62.00	17.87	15.72	88%	49.32
Ex Calcium	mEq/100gm	7	5.32	5.55	9.40	12.94	13.79	9.15	3.33	36%	15.81
Ex Magnesium	mEq/100gm	7	0.38	0.55	0.74	1.01	1.11	0.78	0.24	30%	1.25
Ex Sodium	mEq/100gm	7	0.03	0.07	0.10	0.13	0.17	0.10	0.04	40%	0.18
pH Value	pH Units	15	5.9	8.30	8.60	8.86	9.00	8.42	0.73	9%	9.87
EC	µS/cm	6	78	80.00	90.50	111.00	119.00	93.83	15.59	17%	125.01

Table 32: 2006 and 2007 Topsoil Baseline Statistical Summary

Plate 16: 2007 Topsoil Stockpile South-east of the TSF

5.5 VEGETATION

Potential environmental risks identified:

11 – Loss of biodiversity

12 – Loss of native tea trees

26 – Land clearing during site preparation

5.5.1 Proposed Control and Management Strategies

Operation/Rehabilitation

A survey of the flora located on ML6229 was carried out in December 2006 (Appendix J). A number of significant species (including eucalypts, tea trees & native grasses) were identified; some old growth and others planted in previous revegetation efforts along the boundaries of the property. The majority of these plants are located away from current mining activity. Any plants recognised on site to have environmental significance, either through rarity or size, will be protected where possible. The erection of signage, fencing and/or bunding to protect significant vegetation will occur.

There are no major issues associated with vegetation clearance as minimal clearance was required during mine construction. Most of the mine infrastructure is located within the footprint of the pre-mining quarry, which for all practical purposes, is devoid of vegetation. The TSF was constructed on broad acre farmland, requiring the clearance of six dryland teatrees (*Melaleuca lanceolata*).

An area of 3.4 ha is required to be set aside as Significant Environmental Benefit (SEB) for vegetation clearance, calculated as per native vegetation guidelines for scattered trees and DMITRE/Native Vegetation Council guidelines (Appendix AN). Section 6 of Figure 32, which will be direct seeded with native species during the rehabilitation process, has been nominated as the SEB off-set. The revegetation program (Appendix X) provides a detailed species list, planting regimes and management program. For every *M.lanceolata* at least six seedlings raised from seeds collected prior to clearing will be planted in protected areas. Where required native grasses will be transplanted to similar conditions in protected areas on the ML.

Closure

See Appendix C.

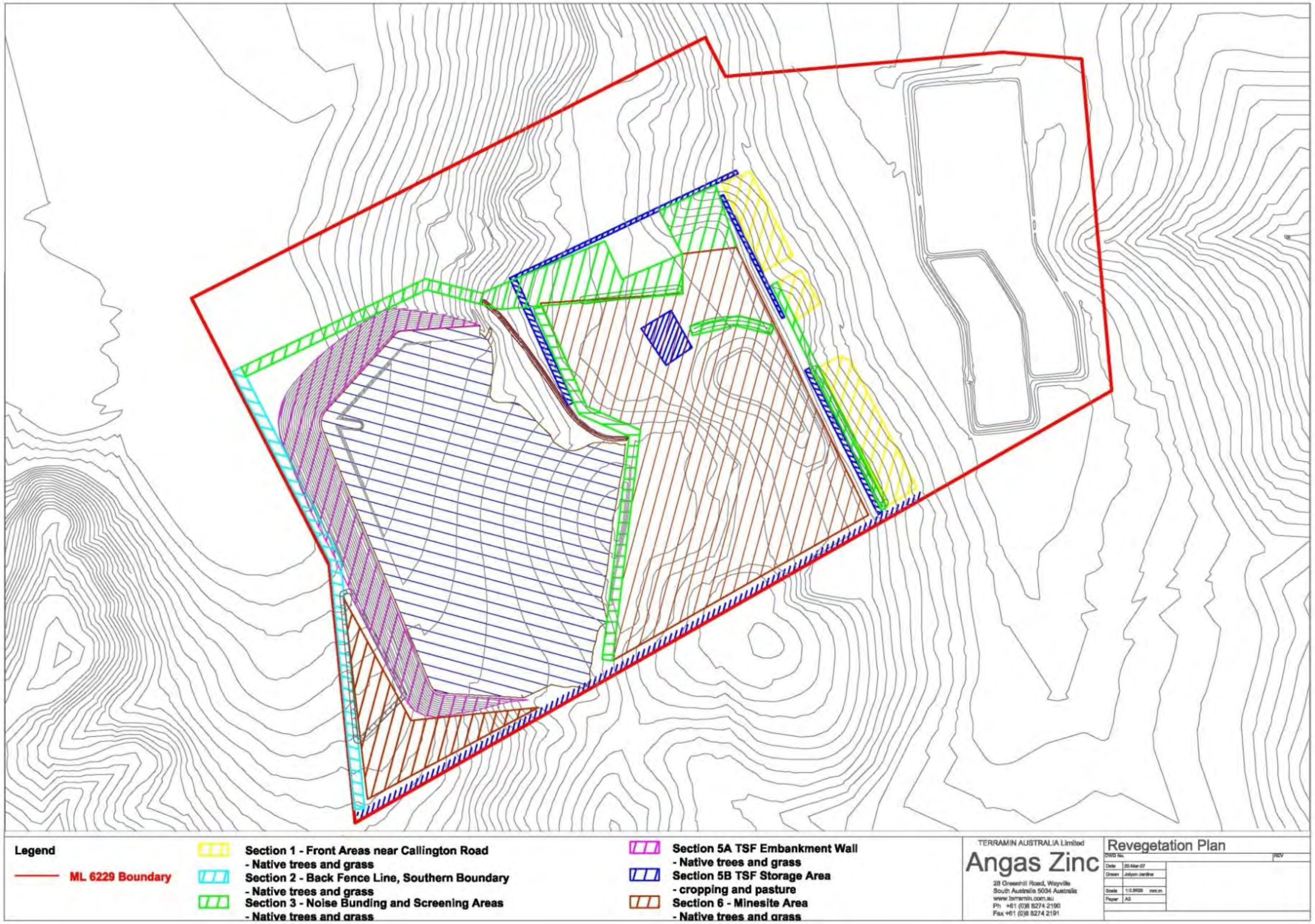

Figure 32: Site Rehabilitation Plan

5.5.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
	Operation/Rehabilitation					
Avoid permanent loss of biodiversity through clearance of native vegetation	Annual monitoring through visual inspection and photo documentation of the remnant native vegetation located in Figure 41 will demonstrate no clearance of remnant native vegetation post-construction.	Clearance of remnant native vegetation will be monitored through visual inspection and photo documentation	Locations marked on Figure 41	No clearance of remnant native vegetation	Annual	Plates 17- 24

Plate 17: Remnant vegetation Tree 1

Plate 18: Remnant vegetation Tree 2

Plate 19: Remnant Vegetation Tree 3

Plate 20: Juvenile Tea Tree 4 near Remnant Tree 3

Plate 21: Juvenile Tea Tree 5 near Remnant Tree 3

Plate 22: Juvenile Tea Tree 6 near Remnant Tree 3

Plate 23: Remnant Vegetation Tree 7

Plate 24: Remnant Vegetation Tree 8

5.6 SILT AND STORM WATER CONTROL

Potential environmental risks identified:

2 – Leaching of stockpile soils

9 – Catastrophic rain

26 – Land clearing during site preparation

31 – TSF embankment failure

34 – TSF run off

35 – Failure of pumping system

38 – Waste water generation

5.6.1 Proposed Control and Management Strategies

Operation and Rehabilitation

The largest 3-day storm event on record occurred on 24, 25 and 26 of January 1941 and consisted of days of 21mm, 142mm and 54mm of rain consecutively. This is less than the projected 1:100 ARI 5-day storm event (i.e. 242mm for 5 consecutive days) that the stormwater control measures are designed to withstand.

Stormwater diversion infrastructure has been designed to cope with the largest known historical storm event. To prevent potentially contaminated water from leaving the mine operational area, Terramin has adopted a zero discharge policy for potentially contaminated water and has designed the following control measures:

- All stockpiles will have sufficient bunding to capture and contain stormwater runoff;
- An overflow dam and silt traps have been installed (Figure 40);
- Engineer all water holding structures to withstand a 1:100 ARI storm event;
- Operate two water circuits – process water and stormwater – which will be kept separate from each other to ensure that stormwater is not contaminated;
- Implement a monitoring program to ensure the control measures operate to design specifications; and
- Water collected from the dirty zone (Figure 31) is directed to the mine and process water circuit (to prevent it from entering storm water).

The calculations to demonstrate the capacity of the drainage infrastructure to operate effectively even under the largest known historic storm event is demonstrated in the ATC Williams TSF report (Appendix U).

Closure

With regard to surface water management post-closure, the concept landform has been designed to minimise the amount of stormwater runoff onto the TSF by directing water away and around the TSF as described in section 5.2.1 and illustrated in Figure 18.

As per section 5.4.1, all contaminated soil will be removed and disposed of in the mine voids or TSF, therefore removing the risk of storm water contamination.

5.6.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No water contaminated as a result of mining operations leaves the lease area or results in contamination of soil at mine closure within lease area.	**Operation/ Rehabilitation**					
	Surface water samples will be taken during rain events where there is a potential for discharge into the Angas river from ML6229. Samples will be taken, as per AS/NZS 5667.1:1998 standards, where the Angas River flows at 2 potential discharge locations (Croser and Ford) and 2 upstream control sample points (Bridge and Hogben) shown in Figure 38 to demonstrate that potential contaminants (Pb, Zn, As, Cd, Fe, Se, pH, EC and turbidity) at Croser and Ford do not exceed historical maximum control data values (Table 27) or the values recorded at the upstream control sites (Bridge and Hogben) at that point in time.	Surface water samples analysed for; Pb, Zn, As, Cd, Fe, Se, pH, EC and turbidity. Sampling methodology as per AS/NZS 5667.1:1998 standards	Two monitoring points (Croser and Ford) located at potential discharge locations along the Angas river and two upstream control monitoring points (Bridge and Hogben). Refer to Figure 38.	Croser and Ford to be compared to Bridge and Hogben to demonstrate contaminants are below historical maximum control data values (Table 27)	Samples to be taken during rain events where there is a potential for discharge into the Angas river from ML6229.	Control data has been calculated from 2006 – 2011 as no potential discharge into the Angas river from ML 6229 occurred throughout this timeframe (Table 27)
	Leading Indicator: Quarterly surface water monitoring will occur where the Angas River flows at 2 potential discharge locations (Croser and Ford) and 2 upstream control sample points (Bridge and Hogben) to	Surface water samples analysed for; Pb, Zn, As, Cd, Fe, Se, pH, EC and turbidity. Sampling	Two monitoring points (Croser and Ford) located at potential discharge locations along	Croser and Ford to be compared to Bridge and Hogben to demonstrate contaminants do	Quarterly	Control data has been calculated from 2006 – 2011 as no potential discharge into the Angas river from

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No water contaminated as a result of mining operations leaves the lease area or results in contamination of soil at mine closure within lease area.	demonstrate that potential contaminants (Pb, Zn, As, Cd, Fe, Se, pH, EC and Turbidity) are less than two standard deviations of the mean control data values (Table 27).	methodology as per AS/NZS 5667.1:1998 standards	the Angas river and two upstream control monitoring points (Bridge and Hogben). Refer to Figure 38.	not exceed control data by two standard deviations (Table 27)		ML 6229 occurred throughout this timeframe (Table 27)
	During high rainfall events which generate runoff, turbidity will be measured at the pre-wetland location, visitors viewing area and the overflow point of the silt retention dam (Figure 40) as per sampling method AS/NZS 5667.1:1998 standards to ensure the NTU does not exceed ANZECC/ARMCANZ (2000) guidelines of 50NTU.	Turbidity as per sampling method AS/NZS 5667.1:1998 standards.	Pre-wetland location, visitors viewing area, overflow point of the silt retention dam (Figure 40).	To ensure the NTU does not exceed ANZECC/ARMCANZ (2000) guidelines of 50NTU	High rainfall events which generate runoff.	N/A
	Leading Indicator: After high rainfall events which generate runoff, records from visual inspections of silt traps, the silt retention dam and surface drainage systems on ML6229 (Figure 40) demonstrate that silt volume is no more than 50% of trap capacity volume and there is no breach in walls	Silt volume and conditions of silt traps, silt retention dam and surface drainage system through visual inspections.	All silt traps, surface drainage systems and the silt retention dam on ML 6229 (Figure 40).	Silt traps and surface drainage systems on ML 6229 (Figure 40) demonstrate that silt volume is no more than 50% of trap capacity volume and there is no breach in walls.	High rainfall events which generate runoff.	Baseline photos (Plates 11-15).

5.7 WASTE DISPOSAL AND HAZARDOUS SUBSTANCES

Potential environmental risks identified:

16 – Waste disposal

50 – Hazardous substances

51 – Slow undetected on-site chemical leak

52 – Chemical hydrocarbon spill on site

5.7.1 Proposed Control and Management Strategies

Operation and Rehabilitation

Waste disposal and the management of hazardous substances will be incorporated in Terramin's Environmental Management System (EMS). This system was established at commencement of operations to enable ISO14001 certification. In order to reach ISO14001 Terramin will demonstrate that environmental risks are understood, appropriate controls are in place, performance is constantly checked, and there is a genuine commitment to continuous improvement.

A Waste Management Plan has been prepared to ensure no further pollution of the site occurs by outlining the storage and disposal methods for all mine generated waste and hazardous substances (i.e. oils, fuels and chemicals) used on-site (Appendix AF). A site waste disposal register has been developed for each category of waste (Appendix AF). Waste management has been considered from purchasing of the product up until when the product is no longer required to ensure all waste products are handled in a way that minimises impact on the environment. The plan has been integrated into operating procedures, inductions and training.

Terramin have a current EPA Licence (no. 34942) which permits landfill disposal of non- recyclable material covered under the license conditions (Appendix O). The following materials can be placed into the landfill;

- bricks;
- concrete;
- plastic;
- masonry;
- dried, seasoned timber that has not been treated with CCA (Copper, Chromium, Arsenate);
- metal sheeting;
- metal products (electrical wiring and metal building products);
- plasterboard and plaster products;
- soil (waste soil has special conditions attached to the license);
- fibreglass; and
- textile products (including canvas products and insulating cloth).

Terramin do not plan to place any off-site material into this landfill. Existing exposures of the landfill will be covered to the specifications of the licence.

Terramin obtained permission from the EPA in May 2012 to place residual tyres into paste/cemented rock fill in underground stopes (Appendix P). All tyres will be appropriately cemented into place to avoid both compromising the stability of the underground workings, such that there is no potential for their movement and/or reporting to surface under water hydrostatic pressure.

Weekly site inspections will be undertaken by the Environmental Department to document the volume of general waste, storage and disposal of waste and hazardous substances and oil/chemical spills. Any items that do not comply with the Waste Management Plan (Appendix AF) will be immediately reported to the appropriate area manager and remedial action taken.

A hazardous materials register will be incorporated into the EMS. All potentially hazardous materials brought on site will be handled, stored and used according to the manufacturer's Material Safety Data Sheets (MSDS) (Appendix AJ). Suitable procedures will be defined and adopted based on a job analysis and risk assessment approach. Mandatory training and procedural auditing will be undertaken by all contractors and employees who are exposed to potentially hazardous materials to ensure these procedures are followed. Hazardous materials brought onto and used onsite include; SIBX, SMBS, Interfroth and copper sulphate (refer to section 3.8.2).

During the rehabilitation process, all remaining mine generated waste and hazardous substances will be placed in underground voids or removed to an EPA-approved site. All soil located in areas where waste and hazardous substances were stored and used throughout operations will be tested, and if required removed or remediated. Any contaminated soil requiring removal will be disposed of in underground voids, the TSF or an EPA-approved site, whichever is most appropriate (outlined in the Closure Plan Appendix C). Any waste depositories constructed throughout operations will be rehabilitated to EPA standards.

Closure

See Appendix C.

5.7.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No contamination and pollution is caused by waste products and hazardous materials used in the mine operations	**Operations/Rehabilitation**					
	If a spill of fuel, oil or hazardous chemical occurs outside bunded area, it will be reported and remediated within 48 hours. Any spills out of the dirty zone (Figure 31) will be soil tested as per AS 4482.1,1997 standards, and tested for As, Cd, Cu, Pb, Mn, Hg, Ni and Zn to ensure no levels higher than the topsoil stockpile baseline maximum (Table 32).	Any spill of fuel, oil or hazardous chemical to be reported After remediation, spills located outside of the dirty area will be sampled as per AS 4482.1,1997 standards, and tested for As, Cd, Cu, Pb, Mn, Hg, Ni and Zn	ML 6229	The results will ensure no levels higher than the topsoil stockpile baseline maximum (Table 32).	48hours of spill occurring	Baseline data comprises of both baseline stockpile data as well as results from the Soil Contamination Baseline Study from locations where the TSF is now located (Table 32)
	Records will be kept of volumes of putrescible waste taken off-site to demonstrate disposal of all potentially polluting waste taken to an approved EPA site and in accordance with the Waste Management Plan (Appendix AF)	Records of volumes of putrescible waste taken off-site	ML 6229	Disposal of potentially polluting waste is off-site to an approved EPA site and in accordance with the Waste Management Plan (Appendix AF)	When putrescible waste is taken off ML 6229 for disposal	N/A
	Leading Indicator: Monthly review of weekly waste management site inspections records, focusing on storage of waste and hazardous materials, will indicate less than 5 occurrences a month of	Records on storage of waste and hazardous materials	ML 6229	Less than 5 occurrences a month of incorrectly disposed or stored waste	Weekly	N/A

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
	incorrectly disposed or stored waste.					

5.8 ACID MINE DRAINAGE (AMD)

Potential environmental risks identified:

17 – Waste rock and AMD

17A – AMD into environment

due to seismic event underground

17B – AMD into environment due

to flood event

17C – AMD into environment due to reactive soils

18 – Sulfidic waste

5.8.1 Control and Management Strategies

Operations

In 2006, Environmental Geochemistry International (EGI) undertook an assessment of the AMD potential of the material to be mined (Appendix AD). The test work was based on 75 waste rock samples and 13 ore samples from drill core. The key results were as follows:

- Tertiary waste materials are likely to be Non-Acid-Forming (NAF) and partly acid consuming due to the presence of limestone.
- Waste rock sourced from weathered hanging-walls is likely to be NAF.
- Partially oxidised to fresh hanging-wall waste rock is likely to be mainly NAF, but with intermittent potentially acid forming (PAF) zones associated with pyrite/pyrrhotite occurrence in fracture and shear zones.
- Ore, footwall and host unit waste rock will be sulphidic and PAF.

There are four potential sources of AMD for the project:

1 Sulphidic waste rock extracted from the portal, decline and development drives;
2 Exposed surfaces of sulphidic rock in portal, decline, drives and stopes;
3 Stored ROM ore; and
4 Tailings.

Approximately 450,000 tonnes of waste rock and approximately 2.3 million tonnes of ore will be generated over the life of the project, much of which is PAF. To minimise impacts associated with AMD, the following strategies are implemented:

1. Sulphidic waste rock:

All waste rock is stored on a bunded, limestone-based pad located within the Central domain prior to being returned to the mine voids. The limestone base is designed to serve as a buffer to prevent AMD. The surface of the waste rock storage pad was also compressed prior to commissioning to minimise rainfall infiltration. All PAF waste rock is eventually used for backfilling purposes, either cemented or un-cemented.

Surface water runoff from the waste rock pad and any other ‘dirty zone’ (refer to Figure 31) is diverted to the mine process water circuit or the onsite water treatment circuit (refer to section 5.2.1).

2. Exposed surfaces of sulfidic rock:

Most of the box cut material is developed in Tertiary and weathered hanging-wall materials which is NAF, which made it suitable for surface construction use.

Although all of the box cut is developed in Tertiary and weathered hanging-wall materials, it terminates in more competent partially weathered to fresh hanging wall material to establish a secure (geotechnically safe) portal. The decline has mainly been developed in fresh hanging wall material, apart from some intercepts of sulfidic host unit. The partially weathered to fresh hanging wall materials from the box cut, portal and decline is mainly NAF, but portions will be partly PAF, and AMD could result from unsegregated materials. The acid forming potential of extracted hanging wall materials was checked before use in surface construction works (bunds, roads etc.). Only NAF hanging-wall material was used for construction use; PAF hanging-wall material was used for backfilling purposes only.

Water from the underground working is currently pumped to the de-silting and either used on-site or treated as detailed in section 5.2.1.

3. Stored ROM ore:

Ore is contained within the limestone-based ROM pad (located within the Central Domain quarry) prior to processing. The limestone base is designed to serve as a buffer to prevent AMD and was compressed prior to commissioning to minimise rainfall infiltration.

4. Tailings:

The TSF is designed to meet the site specific “Guidelines for the Management of Tailings at the Proposed Angas Zinc Project, Strathalbyn, South Australia” as issued by DMITRE in April 2006. This guideline incorporates the draft EPA guidelines for landfill management.

The TSF is located at least 100m from modelled 1:100 ARI flood levels (Figure 33) and is designed to contain runoff from a 1:1000 year 120-hour rainfall of 280mm (refer to section 3.9). To ensure the TSF maintains adequate capacity to manage a 1:1000 year storm event, the following water levels (RL (m)) are not exceeded:

- 74.5 as of December 2014
- 74.2 as of August 2015.

The TSF is lined with a 1.5 mm thick HDPE liner with a lower section double lined to the 68RL. A leakage detection and leachate recovery system was designed and installed to EPA standard. These systems are designed to draw water through the top liner into the drains (located between the two liners) and water is eventually returned to the decant pond. These systems remove the pressure head from the bottom liner, significantly reducing the potential for leakage through this liner.

The TSF meets the relevant standards in relation to seismic activity (e.g. Operating Basis Earthquake 1 in 100 Annual Exceedance Probability; Maximum Design Earthquake 1 in 1000) and reactive soils.

To reduce the amount of AMD-generating material in the TSF, tailings are utilised as a cemented backfill in the mine voids (refer to section 3.7.2).

5. General:

The site’s emergency management plan includes emergency management of AMD sources in the event of a seismic or flooding event (Appendix S). Groundwater and surface water quality are regularly monitored within and outside of the ML.

As a contingency for early mine closure TSF decant water can be reduced or removed by RO treatment or evaporation.

Rehabilitation

The closure plan for the site has been developed to ensure that the TSF and all operational areas, both above and below ground, will not continue to be a source of contamination. The sealing and flooding of the underground mine, the use of HDPE liners in the TSF and strategic placement of acid neutralizing material will prevent ongoing generation of acid.

At the end of mine life, 91% of the mined production voids (stopes) will be filled with fill material, including waste rock and or paste fill (tailings material). To prevent further oxidation of sulfidic materials and generation of AMD, the mine void will be injected with 330ML of water (Appendix L). Further details are provided in Section 5.2 and the Closure Plan (Appendix C).

The TSF will be rehabilitated as described in section 5.9.4 to manage any risks for potential contamination post-closure. Tailings water shall be removed via evaporation or treatment to a suitable quality. A 1.5mm thick HDPE shall be placed over the remaining tailings, then a capping layer of approximately 600mm shall be applied (note that various options for capping are being considered). The angle of the TSF outer wall batters shall be reduced to 1 in 3 and the TSF capping shall be designed to ensure that all surface water flows off the capping layer, with no ponding.

The soil from the ROM pad and the waste rock pad areas will be removed to a minimum depth of 300 mm of soil removed, until the remaining soil in the area is validated to meet the relevant closure criteria. Soil contaminated with PAF material shall be deposited in either the TSF or the mine voids. The ROM pad and the waste rock pad areas shall then be re-contoured, ripped and direct seeded using indigenous species.

Closure

See Appendix C.

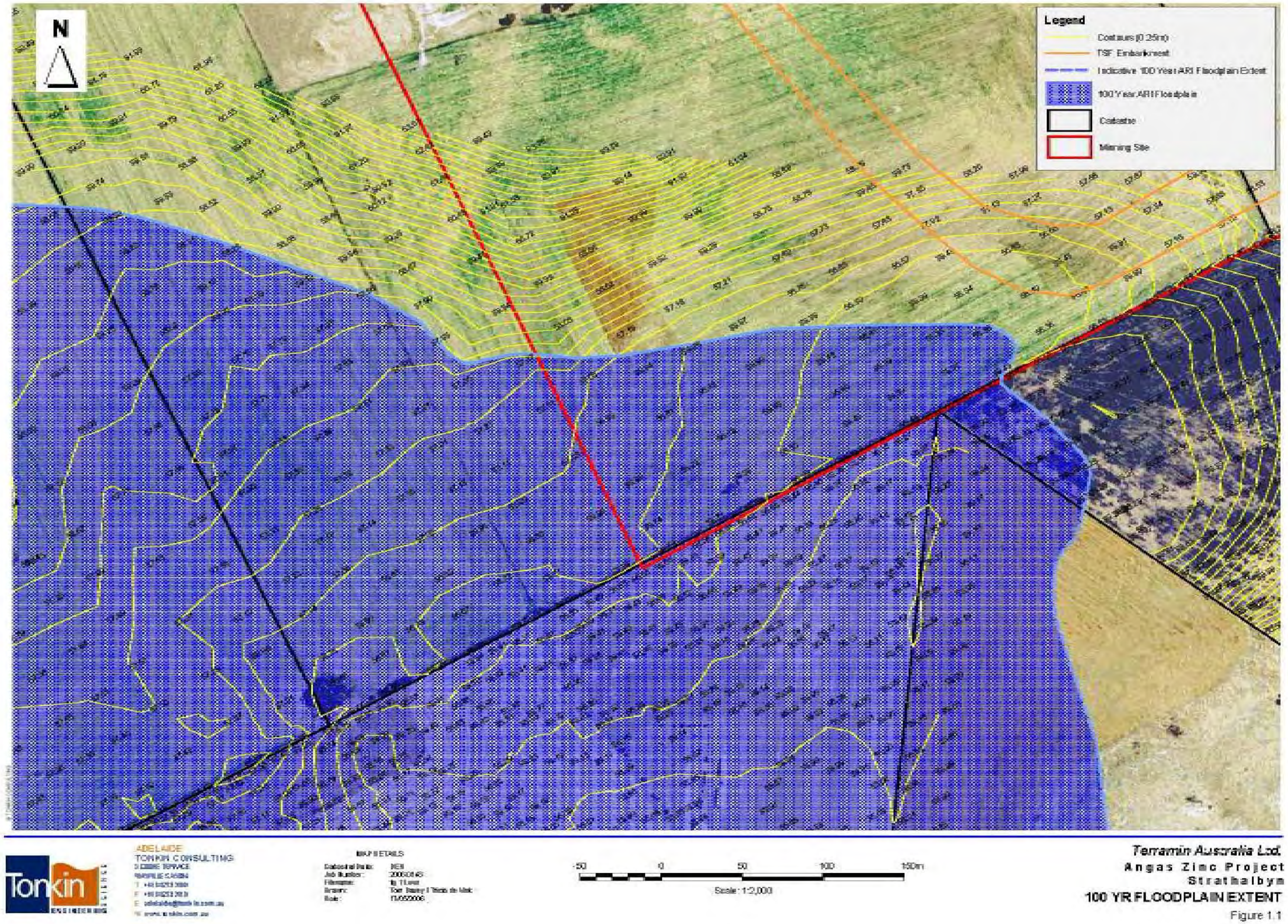

Figure 33: 100 Year Flood Plain Extent

5.8.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No contamination of natural water drainage systems, streams and rivers, groundwater, land and soils occurs either on or off site resulting from permanent disposal or temporary storage of mine ore or waste material	**Operation and Rehabilitation**					
	Survey markers (pegs) installed on the upstream slope of the TSF main embankment for estimation of pond area and Reduced Level (RL) indicators on the external wall (stair side) of the decant chute will be read monthly to ensure no head of water on the area of single lining, i.e. RL not to exceed 68m or surface area not to exceed 15,000m^2 for a period of more than 7 days. RL will be measured until the 15,000m^2 area is reached and from then, all monitoring will be based on surface water area.	TSF Decant pond Surface area and Reduced Level (RL) will be measured by survey markers (pegs) installed on the upstream slope of the TSF main embankment for estimation of pond area and RL indicators on the external wall (stair side) of the decant chute.	TSF Decant pond	Ensure no head of water on the area of single lining i.e. RL not to exceed 68m or surface area not to exceed 15,000m^2 for a period of more than 7 days.	Monthly	N/A
	Reduced Level (RL) indicators on the external wall (stair side) of the TSF decant chute will be read monthly to ensure that the TSF maintains adequate capacity to manage a 1:1000 year storm event. The TSF shall be managed to ensure the following decant pond RL (m) are not exceeded if the surface area is less than 15,000m^2: • 74.5 as of Dec 2014 • 74.2 as of Aug 2015. RL levels will be monitored monthly.	TSF decant pond reduced level (RL) measured through level indicators on the external wall (stair side) of the decant chute.	TSF decant pond	Ensure the following TSF decant pond water levels (RL(m)) are not exceeded if the surface area is less than 15,000m^2: • 74.5 as of Dec 2014 • 74.2 as of Aug 2015.	Monthly	N/A

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No contamination of natural water drainage systems, streams and rivers, groundwater, land and soils occurs either on or off site resulting from permanent disposal or temporary storage of mine ore or waste material	**Leading Indicator:** Monthly inspections of the survey markers (pegs) installed on the upstream slope of the TSF main embankment for estimation of pond area will demonstrate surface area is <12,000m^2	TSF decant pond Surface area will be measured through visual inspection	TSF Decant Pond	Surface area <12,000m^2	Monthly	N/A
	Standing Water Levels (SWL) will be monitored monthly as per AS/NZS 5667.1:1998 standards at groundwater monitoring bores TSF B, C and D (Figure 38) An independent expert will verify through annual analysis of the monthly data that no leakage from the TSF into the surrounding aquifer has been detected.	Groundwater monitoring bores SWL as per AS/NZS 5667.1:1998 standards.	TSF Groundwater Monitoring bores B,C & D (Figure 38)	An independent expert will verify no leakage from the TSF into the surrounding aquifer has been detected.	Sampling – monthly Verification from independent expert – Annually	N/A
	Groundwater monitoring bores TSF B, C and D (Figure 38) will be sampled monthly as per AS/NZS 5667.1:1998 standards for pH, EC, TDS, As, Cd, Pb, Zn, Mn and Fe. An independent expert will verify, through annual analysis of the monthly data that no leakage from the TSF into the surrounding aquifer has been detected.	Groundwater will be sampled as per AS/NZS 5667.1:1998 standards for pH, EC, TDS, As, Cd, Pb, Zn, Mn and Fe	TSF Groundwater Monitoring Bores TSF B,C & D (Figure 38)	An independent expert will verify no leakage from the TSF into the surrounding aquifer has been detected.	Sampling – monthly Verification from independent expert – Annually	N/A
	Leading Indicator: Groundwater monitoring bores TSF B,C and D will be sampled monthly as per AS/NZS 5667.1:1998 standards for pH, EC, TDS, As, Cd, Pb, Zn, Mn and Fe, to demonstrate no change in quality beyond 2 standard deviation of the mean (Table 33). If a change from the 2 standard deviation occurs, results are to be submitted to an independent expert for analysis.	Groundwater will be sampled as per AS/NZS 5667.1:1998 standards for pH, EC, TDS, As, Cd, Pb, Zn, Mn and Fe	TSF Groundwater Monitoring bores B,C & D (Figure 38)	Demonstrate no change in quality beyond 2 standard deviation of the mean (Table 33).	Monthly	As no pre-mining data is available for the TSF groundwater bores, the 2 standard deviations of the mean was derived from data collected from July 2008 till August 2009,

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No contamination of natural water drainage systems, streams and rivers, groundwater, land and soils occurs either on or off site resulting from permanent disposal or temporary storage of mine ore or waste material						when the decant pond was in compliance.
	Leading Indicator: Six embankment monitoring bores (MB1 to MB6) located on the TSF main embankment (Figure 42) will be monitored monthly to ensure no water is detected. If water is detected, it will be sampled for pH, EC, TDS, As, Cd, Pb, Zn, Mn and Fe, as per AS/NZS 5667.1:1998 standards, and results submitted to an independent expert for analysis.	Embankment monitoring bores will be monitored for water. If water present, pH, EC, TDS, As, Cd, Pb, Zn, Mn and Fe will be sampled as per AS/NZS 5667.1:1998 standards	6 monitoring bores (MB1 to MB6) located on the TSF main embankment (Figure 42).	Ensure no water present	Monthly	No water present

Site	Units	Average	Standard Deviation	Average + 2 Standard Deviations
pH	**pH**	7.06	0.43	7.93
EC-L	**µS/cm**	17252.5	5697.4	28647.2
As-T	**mg/L**	0.0066	0.0048	0.0161
Cd-T	**mg/L**	0.0011	0.0019	0.0049
Pb-T	**mg/L**	0.0788	0.1133	0.3053
Zn	**mg/L**	0.4109	1.2484	2.9077
Fe-T	**mg/L**	40.1974	67.5296	175.2565

Table 33: TSF Bore Data

5.9 TRAFFIC

Potential environmental risks identified:

13 – Weeds and pests

21 – Dust created by traffic

22 – Increase in traffic

69 – Vehicular movements to and from site

70 – Increase in light and heavy traffic (includes noise)

5.9.1 Proposed Control and Management Strategies

Operation/Rehabilitation

Weeds and pests

The possible introduction of weeds and pests from an offsite vehicle source is managed by an annual inspection and spraying program (refer to section 5.18).

Noise emanating from traffic

The potential increase in noise as a result of traffic has been included in the site wide noise control and management strategies as per Section 5.10.

Dust created by traffic

The potential increase in dust as a result of traffic has been included in the site wide dust control and management strategies as per Section 5.12.

Traffic impacts, vehicular movements and dragout

There appear to be no major issues associated with concentrate haulage. The mine entrance is directly off one of the region's major transport routes, Callington Road, which connects to the Princes Highway (Adelaide-Melbourne) and is suitable for B Double trucks. All transport except employees travelling to and from work will be away from town.

Concentrate transport out of the mine is expected in the order of 5.5 loads or 11 movements per day, (one transporting lead concentrate to Port Pirie and 4.5 transporting zinc concentrate to the wharf storage sheds at Port Adelaide) which is not a significant increase of traffic for this road. See Appendix F for the Traffic Survey.

Vehicle count surveys (Table 34) conducted by Transport SA in October 1999 and March 2005 show the following traffic increases on the Callington Road. Table 35 shows the effect of the proposed running of 32 B-Double (class 10) concentrate trucks per week, on traffic. The total heavy traffic increase to the Callington Road traffic will return total heavy traffic levels similar to 1999 levels.

7 Day Average Daily Traffic	Oct-99	Mar-05	Change
All Vehicles	1,064	1,522	43%
Heavy Vehicles	88	81	-8%

Table 34: Vehicle Count Survey October 1999 and March 2005

7 Day Average Daily Traffic	Mar-05	Mine Operation	Change
All Vehicles	1,522	1,531	1%
Heavy Vehicles	81	90	11%

Table 35: Estimated Increase in heavy Vehicle Movements

All trucks leaving site have their tyres washed for any possible dust well before turning on to Callington Road. This proven technique minimises the potential of lead bearing soils leaving site on tyre treads and prevents unsightly dragouts on public roads. The wheel wash station is a proven manufactured design and located at the exit of the concentrate shed so only vehicles that enter the site are washed. Employee vehicles are located in a dedicated car park and do not enter the site. This minimises any corrosion potential with the wheel wash on employee cars.

The wheel wash is also located at a distance from the Callington Road to allow the moisture on the tyres to dry and thus avoid any misunderstanding between water dragout and dust dragout. This road is also bitumised to prevent any dust pickup.

Concentrate trucks will operate between 7:00 am and 10:00 pm. The site entrance was relocated approximately 100 metres west of the pre-mining quarry entrance. A deceleration lane for unladen trucks and widening of the road on the opposite side of the roadway to the mine site entrance in order to accommodate laden trucks turning right out of the site (Type C intersection) has been constructed the mine site entrance.

Terramin have also upgraded and maintained the condition of the intersection of the mine entrance and Callington Road to the specifications of Transport SA. The speed limits at this intersection have been reduced to 80km/hr.

Traffic and drag out mitigation measures that have been implemented for the operation include;

- All vehicles leaving site to go through the wheel wash.
- Drivers will be instructed on school bus routes and timetables.
- Employee vehicles are located in a dedicated car park and do not enter the site.
- Road sweeper on-site twice a week
- Main mine roads have been bitumised.
- Concentrate trucks will operate between 7.00am and 10.00pm.
- Heavy vehicle movement offsite will be limited to agreed hours.
- All underground vehicles remain within the mine-site operation (fenced area) and off the bitumen road
- All concentrate trucks will be covered with a solid or an equivalent cover.
- Relocation of entry/exit point.
- Widening of the roadway.
- All work and signage will be to Transport SA requirements.
- Speed limits reduced on Callington road from 100km/hour to 80km/hour

Any possible traffic impacts to fauna on site have been discussed and control and management strategies included in Section 5.17 Fauna.

Closure

Once rehabilitation works have ceased, the potential environmental risks associated with traffic will be eliminated therefore no further monitoring is required.

5.9.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No impacts offsite are caused by accidents, noise, dust and dragout by traffic from or to the mine site.	**Operation/Rehabilitation**					
	B-double movements to and from Ml 6229 will be monitored through the mill control log data sheets to demonstrate compliance with agreed hours of operation from 7am to 10pm.	Times of B-double movement through mill control log data sheets	ML6229	Demonstrate B double movements to and from ML 6229 only between 7am to 10pm	Daily	N/A
	Truck driver check sheets will be completed for every concentrate truck which leaves site to ensure that all loads on concentrate trucks entering public roads are covered	Truck driver check sheets will be completed	ML6229	All loads on concentrate trucks entering public roads are covered	Every concentrate truck which leaves site.	N/A
	Independent investigation of all recorded accidents resulting from mine traffic entry and exit demonstrates that the lessee could not have reasonably prevented the accident	Independent investigation report required from accident. Follow up investigation of on-site measures in place prior to accident	N/A	Demonstrate that the lessee could not have reasonably prevented the accident	As required	N/A

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
Ensure there will be no truck dragout on to the Callington-Strathalbyn Rd	Accumulation of dragout (aggregate, sand, dirt and other detritus) will be monitored through daily visual inspection of the mine entrance (Callington road interception) and reported by exception, to ensure DPTI standard (Table 36) intervention levels are not exceeded; • $1m^2$ at intersection segments, curves, bicycle lanes, pedestrian crossings or walkways • $10m^2$ in other location	Monitoring of dragout (aggregate, sand, dirt and other detritus) though visual inspections and reported by exception	Mine entrance (Callington Road interception)	DPTI standard (Table 36) intervention levels are not exceeded; • $1m^2$ at intersection segments, curves, bicycle lanes, pedestrian crossings or walkways • $10m^2$ in other location	Daily	N/A

Defects	Intervention Level	Compulsory Intervention Level	Performance Requirement
Routine Maintenance: Accumulations of aggregate, sand, dirt and other detritus occurring : • on pavement, medians or shoulders, • surrounding street light bases, traffic signal bases or signpost/gantry bases greater or equal to 100 mm diameter, • surrounding safety barrier and wire rope posts and anchor footings, crash cushions tracks, • on pedestrian crossings or walkways, or footpaths on structures and • any glass in bicycle lanes.	Defects exceeding: • 1 m² at intersection segments in urban areas, bicycle lanes, pedestrian crossings or walkways, • 20 m² at rural intersections and aprons or • 10 m² in other road pavement locations. Defects covering 20 m length of edge line. Any glass in bicycle lanes. Defects on structures diverting water flow from its normal course. Street lighting base, traffic signal bases, or signposts/gantries greater or equal to 100 mm diameter, safety barrier and wire rope posts, anchor footings, crash cushions tracks: Loose material build-up of more than 50 mm high at any point around the base. **MDR Recording:** Defects shall be recorded on the MDR as PW.	Not applicable	**Surface** All loose material removed and surface shall be free draining. Street lighting base, traffic signal bases or signposts/gantries greater or equal to 100 mm diameter, safety barrier and wire rope posts and anchor footings, crash cushions tracks: built-up material shall be removed. **Delineation** Pavement marking shall be visible.

Table 36: Routine Maintenance of Roads in the Metro North Area Within the Metropolitan Region (DPTI, May 2010).

5.10 NOISE

Potential environmental risks identified:

56 – Industrial noise generation

41 – Noise generated from machinery, equipment and plant

70 – Vehicular movements to and from site

69 – Annoyance to public due to noise;

42 – Noise generated by blasting activities

5.10.1 Proposed Control and Management Strategies

Operation/Rehabilitation

In January 2010, a post construction noise model was undertaken by AECOM for the purposes of determining noise criteria at two noise monitoring locations where mine noise should typically control noise levels, rather than ambient noise controlling the measured noise level (Appendix Q1). Environmental noise criteria at the alternative measurement locations were determined using the following methodology;

- Noise measurements were undertaken adjacent to all significant noise sources on the mine site, to determine the noise emissions from each individual item of plant.
- The results of the above noise measurements were incorporated into an environmental noise model of the site.
- Attended noise measurements were undertaken adjacent to residences on both the east and west sides of the site, and the weather conditions noted during these measurements. These measurements were used to verify the accuracy of the noise model.
- Once the accuracy of the noise model was established, the noise model was used to determine noise levels at all residential locations, for worst case weather conditions.
- Noise levels were also predicted at proposed alternative noise monitoring locations to both the east (mill) and west (boxcut) end of the site. These locations are where mine noise should typically control noise levels, rather than ambient noise controlling the measured noise level.
- The difference between noise levels at the alternative monitoring locations and the residences to each side of the site was determined. Using this difference the maximum permissible noise level at each of the alternative monitoring locations which will not result in exceedance of the noise criteria at any of the residences was determined.
- Noise monitoring using portable noise loggers at the two alternative monitoring locations is undertaken quarterly, for 7 consecutive days, to determine compliance using the noise criterion (maximum permissible) noise levels determined in each location.

The January 2010 noise model for the site has been regularly updated by AECOM due to equipment modifications, additional plant/ equipment and on-site noise mounding not previously modelled. The most recent noise assessment was conducted in July 2012 (Appendix Q2). Figure 34 and Figure 35 display the noise emission contours for typical day and night operations under worst case weather conditions.

Following the acceptance of the PEPR in March 2007, the EPA released the Environmental Protection (Noise) Policy 2007 (Noise EPP) which superseded the Industrial Noise Policy as the environmental noise policy under the Environment protection Act 1993, and in accordance with the Mineral Lease conditions, has been the relevant environmental protection policy for the site since 2007. The Noise EPP provides the following criteria for the AZM:

- Day time $L_{eq\ 15min}$ of 57 dB(A) from 7am to 10pm

- Night time $L_{eq\ 15min}$ of 50 dB(A0 from 10pm to 7am

The maximum permissible noise levels at the monitoring locations take into account the updated noise policy (Table 37). Noise levels equal to or below the levels in Table 37 will result in compliance with the 57 dB(A) daytime and 50dB(A) night time noise criteria at all residences surrounding the site. Maximum permissible noise levels have been modelled for 47 dB(A) daytime and 40dB(A) night time to use as an leading indicator. If the leading indicator noise levels are exceeded, an investigation will occur and if required further mitigation strategies will be implemented.

Location	Maximum permissible Leq15min noise levels to comply with Leading Indicators		Maximum permissible Leq15min noise levels to comply with compliance criteria	
	Day time (7am to 10pm)	Night time (10pm to 7am)	Day time (7am to 10pm)	Night time (10pm to 7am)
East Monitoring Location	62	56	72	66
West Monitoring Location	64	57	74	67

* Note; The maximum permissible noise levels are subject to change during the annual noise model review.

Table 37: Maximum Permissible Noise Levels July 2012

Please note; the maximum permissible noise levels may change with the annual noise model review due to equipment modifications, additional plant/ equipment and/or on-site noise mounding. In addition, noise data logged during periods of wind speeds greater than 5m/s (or 18km/hr) is deemed invalid under the Environmental Protection Noise Policy 2007.

Noise control measures such as constructing noise attenuation structures to minimise noise travel, and restricting the hours of operation for certain activities have been implemented together with conceptual noise reduction methods in plant design and operation as illustrated in Table 38 below. These noise mitigation strategies will remain, where relevant, throughout the rehabilitation phase. The purchase of several of the closer residences has enabled the development of an extended buffer zone surrounding the operating site.

Noise Source	Noise Control Method
Crusher plant	Plant to operate during the day time hours only (7am to 10pm). Sound power from the crusher to be limited to 113dB(A) re 1012W.
SAG mill	Profiled metal deck or Ultra panel barrier has been constructed around the east, north and northern 1/3 of west side. Mill rubber blanketing erected in identified problem areas.
Mine ventilation	Vent Fan to be limited to sound power level of 112 re 1012WdB(A).
Trucks and front end loaders	B Double trucks and front end loader servicing the crusher to be utilised during the daytime only (7am -10pm). White noise reverse beepers on all on-site vehicles operating at night time.
Blasting	All blasts post-construction are undertaken in the underground workings, hence noise generation from blasting activities are not considered a risk.
General noise generated from site	Earth noise mounding constructed around site. Temporary hay bale bunding placed in appropriate locations.

Table 38: Noise Reduction Methods

Throughout the rehabilitation phase, due to increased surface activity, noise levels are predicted to increase. All rehabilitation earth works will be limited to daytime hours (7am and 10pm) and temporary hay bale bunding erected in appropriate locations. Earth noise mounding which is not required for the rehabilitation works will remain. The noise model will be reviewed once the rehabilitation earthworks have commenced to ensure the appropriate control measures are in place to remain compliant with the Environmental Protection (Noise) Policy 2007. Noise monitoring will continue as per section 5.10.2 until rehabilitation earthworks have ceased.

Closure

Measures to manage noise emissions will no longer be required post-closure as all potential environmental risks identified will no longer be relevant.

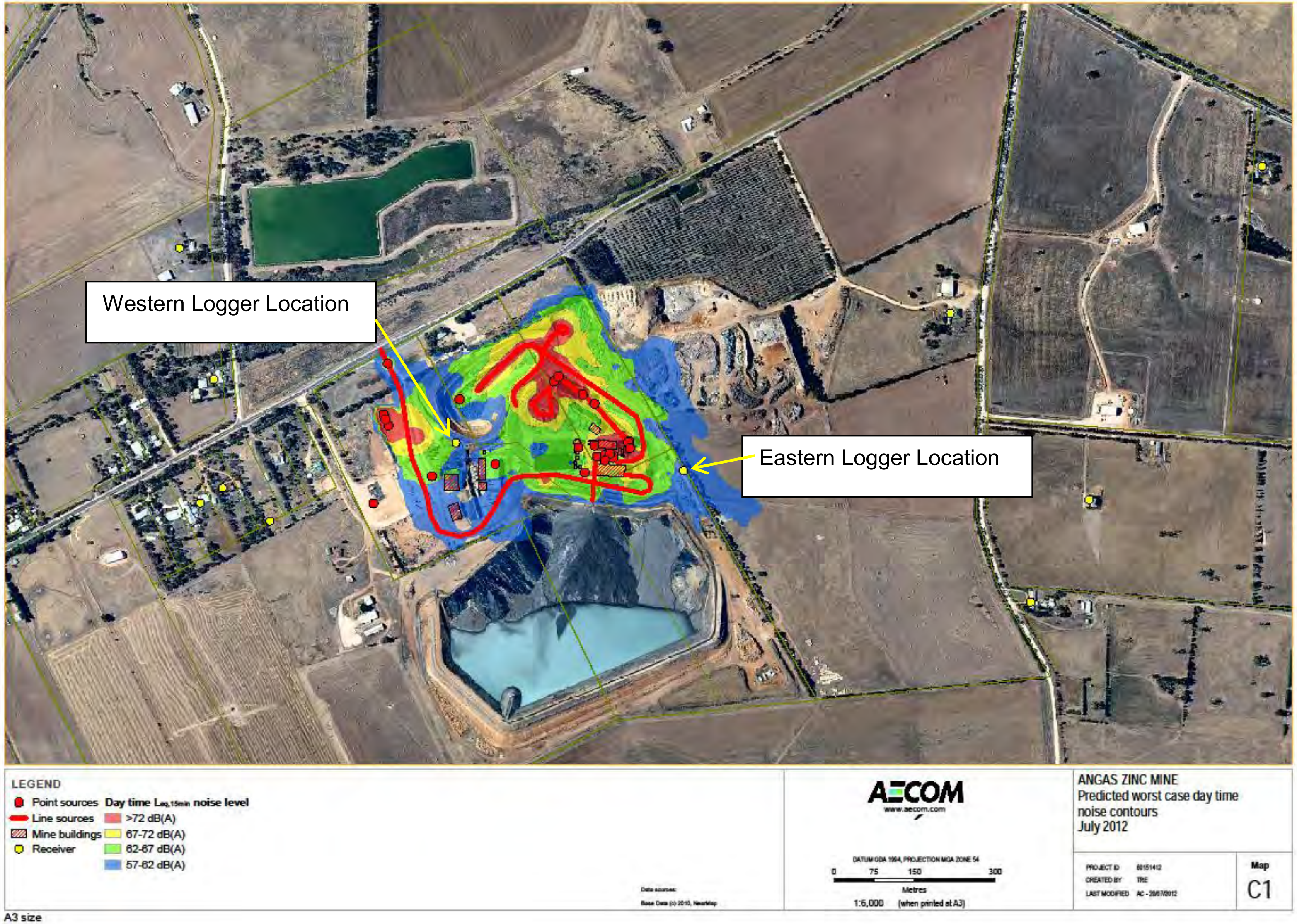

Figure 34: Day-time Modelled Noise Contours

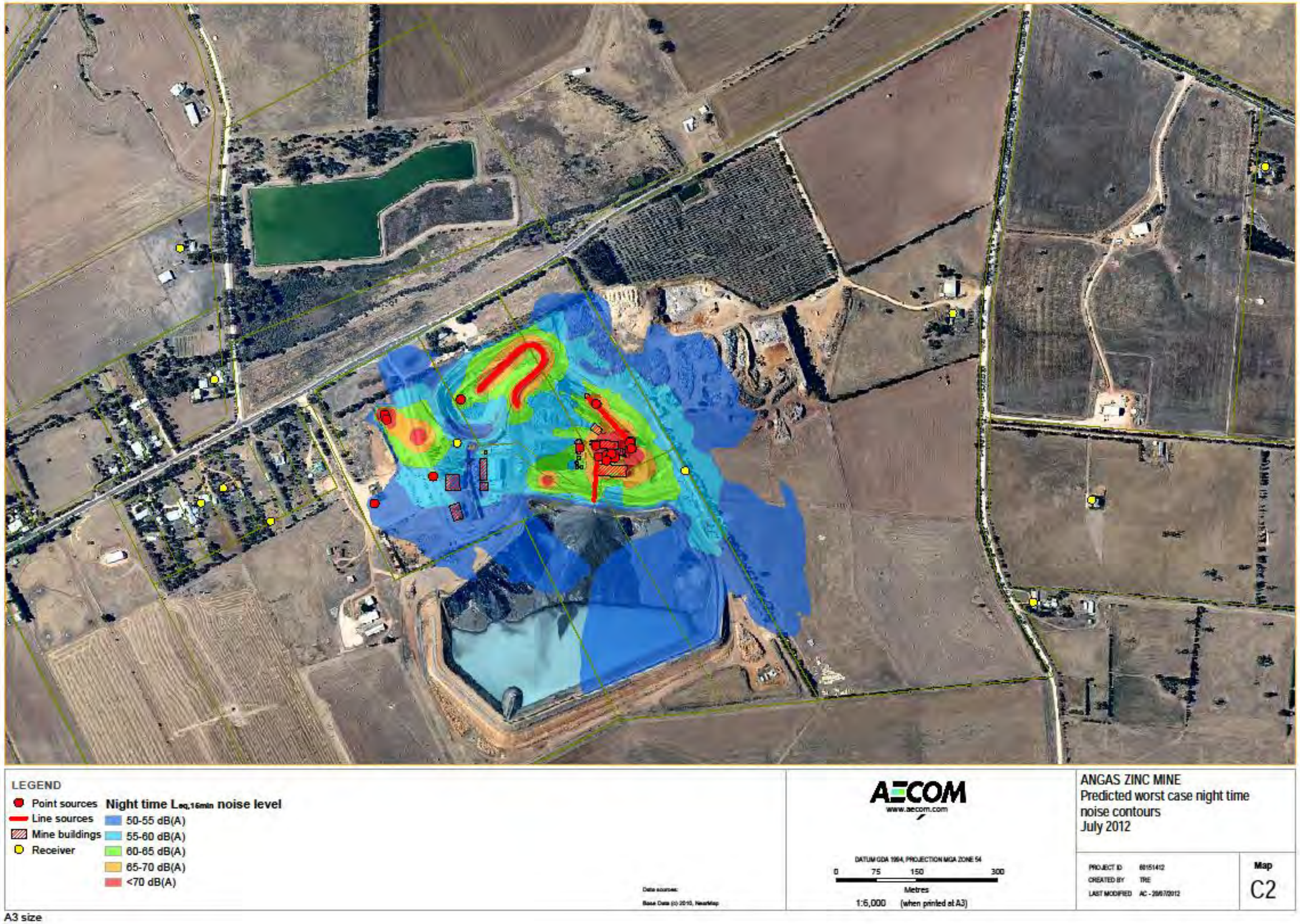

Figure 35: Night Time Modelled Noise Contours

5.10.2 Outcome Measurement Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
	Operation/ Rehabilitation					
No public nuisance impacts from noise emanating from the operating site.	All noise complaints will be investigated and a response provided to the complainant within two working days. All noise complaints and associated actions will be recorded in a data base. Detail will include; complainants contact details, reason for complaint, time and date of noise issue, time and date of complaint, when and how the issue was actioned and the time and date the issue was closed out.	All noise complaints and associated actions will be recorded in a data base. Detail will include; complainants contact details, reason for complaint, time and date of noise issue, time and date of complaint, when and how the issue was actioned and the time and date the issue was closed out.	N/A	A response to be provided in two working days	When applicable	N/A
	Noise levels dB(A) will be measured quarterly for seven consecutive days (24 hours a day), at two on-site noise loggers, located east (Mill side) and west (boxcut) of the operation (Figure 34), with reference to the 2012 AECOM noise model (Appendix Q) and successors. This will demonstrate compliance with EPA noise limits as defined in 'Environment Protection (noise) Policy 2007 ' and successors. Currently at the	Noise levels dB(A) will be measured at two on-site noise loggers with reference to the 2012 AECOM noise model (Appendix Q)and successors.	Two on-site noise loggers, located east (Mill side) and west (boxcut) of the operation	Demonstrates compliance with EPA noise limits as defined in 'Environment Protection (noise) Policy 2007 ' and successors. Currently At the nearest residence;	Quarterly, for seven consecutive days (24 hours a day). The model will be confirmed on an annual	N/A

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
	nearest residence; Day time Leq, 15min of 57 dB(A) from 7 am to 10 pm Night time Leq,15min of 50 dB(A) from 10 pm to 7 am. The model will be confirmed on an annual basis by an independent expert.		(Figure 34).	**Day time** Leq,15min of 57 dB(A) from 7 am to 10 pm **Night time** Leq,15min of 50 dB(A) from 10 pm to 7 am.	basis	
No public nuisance impacts from noise emanating from the operating site.	**Leading Indicator:** Noise levels dB(A) will be measured quarterly for seven consecutive days (24 hours a day), at two on-site noise loggers, located east (Mill side) and west (boxcut) of the operation (Figure 34), with reference to the 2012 AECOM noise model (Appendix Q) and successors. This will demonstrate at the nearest residence; Day time Leq, 15min of 47 dB(A) from 7 am to 10 pm, Night time Leq,15min of 40 dB(A) from 10 pm to 7 am.	Noise levels dB(A) will be measured at two on-site noise loggers with reference to the 2012 AECOM noise model (Appendix Q) and successors.	Two on-site noise loggers, located east (Mill side) and west (boxcut) of the operation (Figure 34),	Demonstrates at the nearest residence; **Day time** Leq,15min of 47 dB(A) from 7 am to 10 pm **Night time** Leq,15min of 40 dB(A) from 10 pm to 7 am.	Quarterly, for seven consecutive days (24 hours a day).	N/A

5.11 BLASTING

Potential environmental risks identified:

42 – Noise(airblast) generated by blasting activities

44 – Vibrations during blasting

57 – Dust deposition and air emissions

5.11.1 Proposed Control and Management Strategies

Operation/Rehabilitation

A study of blasting impacts, with focus on effects of blast induced ground vibration and air pressure (noise) from both development and production blasting, was undertaken by SAROS in August 2006 (Appendix AA). In the absence of site-specific monitoring data, relationships used for the preliminary modelling of blasting impacts were based on data obtained from blasting operations that utilise similar scale practices and are performed under comparable geological conditions.

Initial investigations indicate stope blast designs within certain areas of the workings will be influenced by ground vibration control requirements. This is likely to be the case within the closest areas of both the Garwood and Rankine Shoots, and may necessitate the use of decked blastholes or a combination of upholes and downholes in adjacent sublevels. Due to the requirement to control charge weights, the use of a smaller blasthole diameter will also influence the maximum hole length. In the extreme case, this impact may extend to influence mine design (i.e. sublevel design). Vibration levels resulting from development blasting have not to date, and are not expected to pose any concerns.

Initiation sequencing will also play an important role in the control of vibration levels. As a result, blast vibration levels are considered within the blast design parameters, limiting the instantaneous initiation of charge weight and the maximum amount of explosives used in a single blast.

In areas where the ground may be saturated, the use of higher density product would result in a 30% increase in the charge weight, which in turn would increase vibration levels by approximately 20%. Experience also indicates that saturated ground will influence the transmission of vibration levels through the rockmass.

Peak overpressure levels were only an impact during the initial phases of the decline development (Figure 36). Tight controls over blast practices, in addition to external suppression measures, were required to control levels. Overpressure is not considered a risk during underground development, therefore monitoring of overpressure is only required if surface blasting occurs.

Initial modelling of planned development using drill and blast methods indicated there is sufficient distance to residences to allow practical face advance using standard practices (Figure 37).

The compliance limits stipulated for the AZM are;

- Ground vibration – maximum 10mm/s with no more than 5% between 5-10mm/s
- Airblast – maximum 120dBL with no more than 5% between 115-120dBL

These compliance limits have been based on the Australian and New Zealand Environmental Council Guidelines (AS 2187.2).

Terramin reserve the ability to fire small blasts and faces 24 hours a day 7 days a week. Boxcut blasts and larger stope blasts will be fired in the afternoon, between 1:30pm and 6pm to minimise public disturbance.

During the operation phase (and rehabilitation if relevant), monitoring of all blasts will be conducted using continuous automatic blast monitors located at the Glovers residence, the closest resident to current blasting activity (Figure 43). Monitoring at a roving location will be implemented as demand requires. Modified practices are available if blast vibration becomes a concern. These include reduced rounds, use of sophisticated electronic detonators, different explosive composition and modified drill patterns.

The risk of dust deposition and air emissions produced from blasting activity is considered low as all post-construction blasts are conducted underground. Dust deposition and air emission control measures are currently in place to further minimise this risk, as described in section 5.12.

Closure

Airblast and vibration caused by blasting is not considered an issue in the post-closure phase of the mine, since all blasting activities will have ceased.

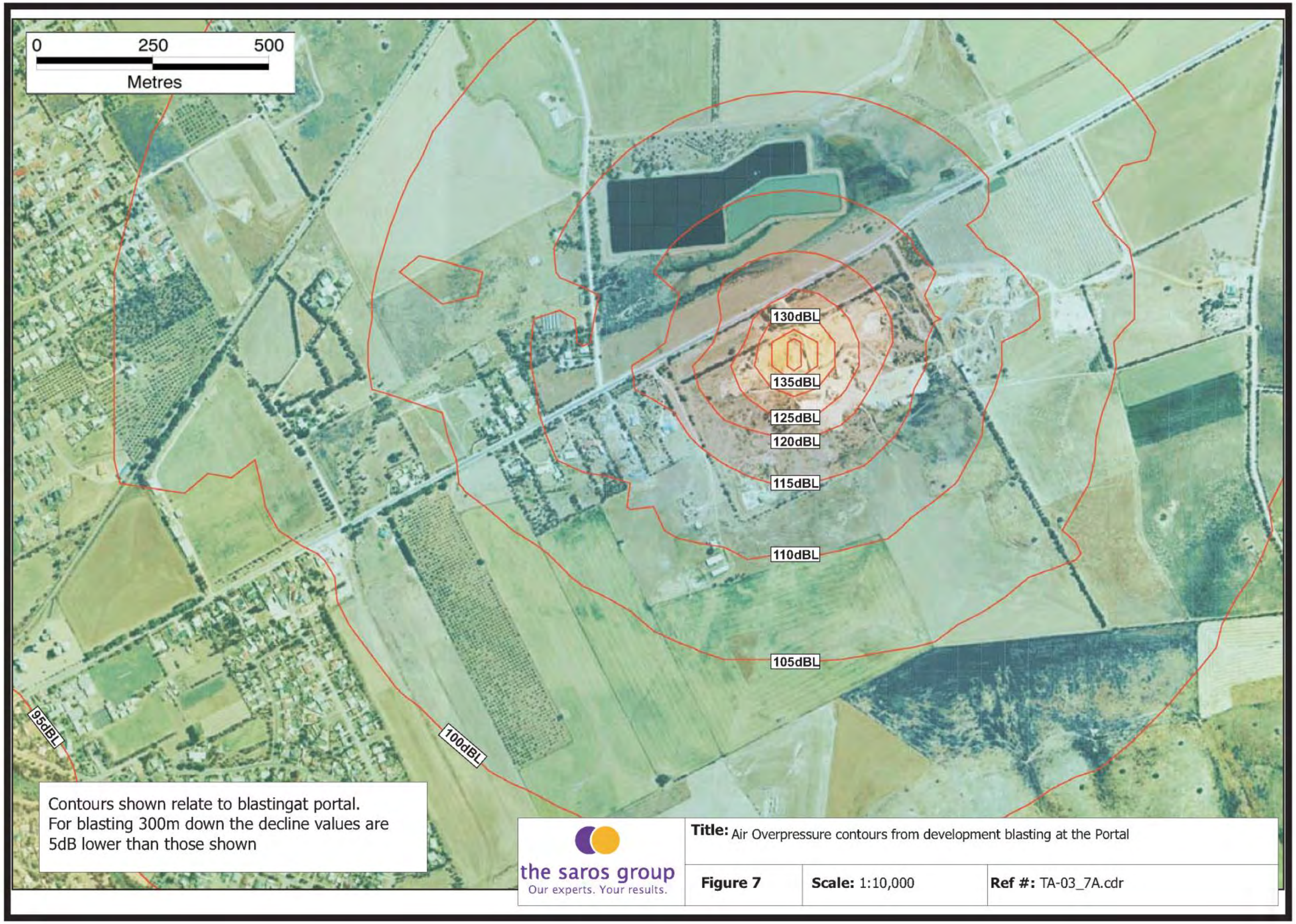

Figure 36: Air Overpressure Contours from Development Blasting at the Portal

Figure 37: Extent of 5mm/s Vibration Levels Resulting from Proposed Production Blasting

5.11.2 Outcome Measurement Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
	Operation/Rehabilitation					
No public nuisance impacts from airblast and vibration caused by blasting	Blast vibration data will be measured by two fixed blast monitors (Figure 43: Fixed Blast Monitoring Locations) or a substitute roving monitor if required, for every blast. Blast vibration will not exceed 10mm/sec at any time, with no more than 5% of blasts in any one year to be within the range 5-10mm/sec.	Blast vibration (mm/sec) will be measured. Vibration data will be measured by two fixed blast monitors (or roving monitor if required) for every blast.	Two fixed blast monitors as per Figure 43: Fixed Blast Monitoring Locations .	5% of blasts in any one year within the range 5-10mm/sec No blasts to exceed 10mm/sec	All blasts	N/A
	Airblast will be measured by the paddock fixed blast monitor (Figure 43) for all surface blasts. Airblast will not exceed 120 dB linear at any time, with no more than 5% of blasts in any one year to be within the range 115 – 120dB Linear.	Airblast will be measured by the Paddock fixed blast monitor for all surface blasts.	Paddock fixed monitor (Figure 43)	5% of blasts in any one year to be within the range 115 – 120dB Linear. No blasts exceed 120dB linear	All surface blasts	N/A
	All blast times and charge weights will be recorded in a blast register to ensure all boxcut and underground blasts exceeding 250kg charge weight will only be conducted between 1.30pm to 6pm.	All blast times and charge weights will be recorded in a blast register	N/A	Blasts exceeding a charge weight of 250kg to be conducted between1.30 pm and 6 pm	All blasts exceeding 250kg charge weight	N/A

5.12 PUBLIC HEALTH AND NUISANCE

Potential environmental risks identified:

20 – Dust created by crusher

57 – Dust depositions and air emissions

27 – Odour generation

58 – Machinery use, air pollution

66 – Hydrocarbons in ventilation exhaust

5.12.1 Proposed Control and Management Strategies

Operation/Rehabilitation

Dust

Dust is generated from a range of sources including vehicle movements, wind, waste rock dumping, ore crushing and the process plant. Dust mitigation measures which have been implemented throughout operation include;

- Water trucks used for watering of roads and any potentially exposed soil when climactic conditions are likely to promote dusty conditions.
- Crushing – grinding carried out as a wet process
- Sprinklers installed at ROM pad and sand pit areas
- Fully automated concentrate shed roller doors
- Sealing of primary access road
- Revegetation programs (as per revegetation plan Appendix X) to conserve soil structure

Water trucks and or sprinklers will be utilised throughout rehabilitation to control any dust generated from the closure earthworks.

Tonkin's undertook a dust modelling impact study in February and May 2006 (Appendix H3 and H4). The modelling indicated that peak dust generation levels occur around the crusher plant. The model predicted a rapid decrease in dust deposition with increasing distance from the mine plant, with dust levels decreasing to existing rural levels at the boundary of the ML. The occurrence of local meteorological conditions such as cold air drainage have also been investigated, and under no conditions is there a predicted impact on local areas outside of the ML boundary for lead or dust deposition generated from the mining operation judged by current applicable Australian standards.

Predominate wind direction is from the south and the west away from the urban areas. As with noise and air emissions, dust has the potential to generate some annoyance with local neighbours unless measures such as those described above are implemented. A comprehensive dust-monitoring program has been implemented on-site.

Dust levels are currently measured through 12 Dust Deposition Gauges and 3 High Volume (HiVol) samplers located on and off ML6229. The HiVol samplers assess dust levels over a twenty four hour period every six days and the dust deposition gauges collect fallout over a period of one month. The dust is then sent to a NATA accredited laboratory for analysis. Where appropriate, NEPM criteria will be used as on-site compliance limits.

As no criteria were previously set for the dust deposition gauges (total insoluble solids), a Dust Deposition Limit report was undertaken by AECOM in September 2012 (Appendix R). It was determined the Australian 'best practice' guidelines (4g/m2/month) should be applied to all gauges and gauges 1, 3 and 10 are considered background monitoring gauges so are to be used as controls. The report also outlines the importance of analysing percentage mineral content as due to the nature of the site operations, one would expect to see the samples from monitoring gauges directly affected by the mine operations to comprise predominately of minerals/ash and have low organic content. If a gauge collects a deposit comprised of more than 50% organic matter or less than 50% ash content the gauge would have likely collected dust from other sources other than mining activity.

Monitoring at the dust deposition gauges are considered leading indicators, therefore if breaches of the 4g/m^2/month guidelines occur, an investigation will be undertaken to determine the origin of the dust and whether further mitigation is required on-site. A site specific leading indicator limit for lead content has been applied by the EPA for the AZM dust deposition gauges (section 5.12.2). If these limits are exceeded, the results will be forwarded to the EPA.

Air emissions

Potential air emissions at the AZM have been identified as dust, odour and greenhouse gas emissions. Greenhouse gas emissions are reported to the EPA annually as part of the National Pollutant Inventory (NPI) process and are not considered a risk to public health.

The health effects of air pollutants, as described in the NEPM Ambient Air Quality document, state that generally the health effects are more severe with higher air pollutant concentrations. Tonkin's concluded (Appendix H), with dust control measures(as mentioned above) reducing emissions to a level that meets the air quality standards, no significant adverse health effects should be expected as a consequence of mining activities.

Odour

An Odour Compliance Investigation of Lease Condition No 46 was undertaken by Tonkin's in November 2008 (Appendix AB). Odour emissions measured at the locations listed below were all within the compliance limits.

- TSF pond: 550 odour units
- TSF wet beach (winter): 13,000 odour units
- TSF wet beach (summer): 3,800 odour units

The compliance investigation report also revised the odour dispersion model undertaken in 2006 (Appendix W) showing the odour impact is only half that previously modelled. Odour monitoring is no longer required as it is not considered an issue at the AZM.

Regional Rainwater Tanks

Due to concerns by the community regarding the build-up of lead in their rainwater tanks from mining activities, an annual monitoring program was implemented. Water sampling at 40 rainwater tanks within a 5km radius of the mine was undertaken annually to demonstrate to the local community and DMITRE that there is no significant fallout of dust accumulating harmful levels of lead in the rainwater tanks. A baseline survey of the regional rainwater tanks has been included in Appendix AE. Monitoring from 2007 to 2012 has shown no impact of mining on lead levels in the 40 regional rainwater tanks analysed. Regional Rainwater tank monitoring is no longer required as it is no longer considered a risk.

Closure

See Appendix C.

5.12.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No public health, loss of amenity and nuisance impacts to local residents from air emissions, dust and odour generated on site as a result of mining operations.	**Operation / Rehabilitation**					
	Dust					
	Dust levels collected from two HiVol dust samplers located on ML6229 (Figure 44), will be sampled over a 24hour period every six days as per AS, 3580.9.3:2003 standards. Data will demonstrate World Health Organisation guidelines for Total Solid Particulates are less than 120 micrograms/m^3 and Lead content is less than 0.5 micrograms/m^3.	Total Solid Particulates and Lead dust will be sampled over a 24hour period every six days as per AS, 3580.9.3:2003 standards	Two HiVol monitors located on ML 6229 (Figure 44)	Demonstrate Total Solid Particulates are less than 120 micrograms/m3and Lead dust is less than 0.5 micrograms/m3	24 hour period every six days	Dust Baseline Study (Appendix H)
	PM10 dust levels collected from the HiVol PM10 sampler located at the visitors viewing area (Figure 44 - same location as the HiVol sampler), will be sampled over a 24hour period every six days as per AS, 3580.9.3:2003 standards. Data will demonstrate compliance with NEPM 1998 criteria of <50 micrograms/m^3 per 24 hour period with <5 days exceedances per year.	PM10 will be sampled over a 24hour period every six days as per AS, 3580.9.3:2003 standards.	PM10 sampler located at the visitors viewing area (Figure 44 same location as the HiVol sampler)	Data will demonstrate compliance with NEPM 1998 criteria of <50 micrograms/m^3 per 24 hour period with <5 days exceedances per year.	24 hour period every six days	Dust Baseline Study (Appendix H)
	Leading Indicator: Twelve static Dust Deposition Gauges (monthly data) located on and off the mining lease (ML) (Figure 44) will be monitored	Total insoluble solids, will be measured as per AS	Twelve static Dust Deposition Gauges	Demonstrate that total insoluble solids are less than Australian	Monthly	Dust Baseline Study (Appendix H) and Dust

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No public health, loss of amenity and nuisance impacts to local residents from air emissions, dust and odour generated on site as a result of mining operations	monthly for total insoluble solids as per AS 3580.10.1-1991 standards. This will demonstrate that total insoluble solids are less than Australian best practice deposition levels of 4g/m^2/month.	3580.10.1-1991 sampling method standards.	(monthly data) located on and off the ML(Figure 44)	best practice deposition levels of 4g/m^2/month		Deposition Limit Determination (Appendix R)
	Leading Indicator: Twelve static Dust Deposition Gauges (monthly data) located on and off the ML (Figure 44) will be monitored monthly for lead content as per AS 3580.10.1-1991 standards. If lead content exceeds EPA site specific limits of750 mg/kg at on-site gauges or 150 mg/kg at off-site gauges, the data will be forwarded to the EPA.	Lead content will be measured as per AS 3580.10.1-1991 sampling method standards.	Twelve static Dust Deposition Gauges (monthly data) located on and off ML6229 (Figure 44)	If lead content exceeds 750 mg/kg at on-site gauges or 150 mg/kg at off-site gauges, the data will be forwarded to the EPA.	Monthly	Dust baseline study (Appendix H)
	Closure					
	Dust					
	Dust levels collected from two HiVol dust samplers located on ML6229 (Figure 44), will be sampled over a 24hour period every six days as per AS, 3580.9.3:2003 standards. If Total Solid Particulates are less than 120 micrograms/m^3 and Lead content is less than 0.5 micrograms/m^3 for a period no less than a 12 months continuous period, monitoring will no longer be required.	Total Solid Particulates and Lead dust will be sampled over a 24hour period every six days as per AS, 3580.9.3:2003 standards.	Two HiVol monitors located on ML 6229 (Figure 44).	If Total Solid Particulates are less than 120 micrograms/m^3 and Lead content is less than 0.5 micrograms/m^3 for a period no less than a 12 months continuous period, monitoring will no longer be required.	24 hour period every six days	Dust Baseline Study (Appendix H).

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No public health, loss of amenity and nuisance impacts to local residents from air emissions, dust and odour generated on site as a result of mining operations	PM10 dust levels collected from the HiVol PM10 sampler located at the visitors viewing area (Figure 44 - same location as the HiVol sampler), will be sampled over a 24 hour period every six days as per AS, 3580.9.3:2003 standards. If PM10 are compliant with NEPM 1998 criteria of <50 micrograms/m^3 per 24 hr period with <5 days exceedances per year for a period no less than 12 months continuous period , monitoring will no longer be required.	PM10 will be sampled over a 24hour period every six days as per AS, 3580.9.3:2003 standards.	PM10 sampler located at the visitors viewing area (Figure 44 same location as the HiVol sampler)	If PM10 are compliant with NEPM 1998 criteria of <50 micrograms/m^3 per 24 hr period with <5 days exceedances per year for a period no less than 12 months continuous period, monitoring will no longer be required.	24 hr period every six days	Dust Baseline Study (Appendix H)

5.13 FIRE

Potential environmental risks identified:

51A – Fire or explosion from stored chemicals

63 – Fire or explosives

5.13.1 Proposed Control and Management Strategies

Operation/Rehabilitation

A preventative approach to fire is adopted at the site. There are several potential ignition sources from the operation. These include hot works such as welding, cutting and grinding, vehicle fires and smoking. The mine has in place a hot work procedure that includes evaluating the risk of fire and taking corrective actions prior to commencing the task. Similarly as part of the preventative maintenance program, regular fire hazard audits are carried out on all mobile plant, as this is a high-risk occurrence for and underground mining operation. As the site will be complying with lead protocols, it will be a smoking free site.

In addition regular site slashing and where required pre-fire season burn offs will be carried out. The design and placement of noise bunds and mine access roads has been undertaken cognisant of the risk of bushfire and should assist in reducing the ability of a fire to either enter or leave the site.

A fire pump, booster box and hydrants have been established through the processing plant, workshops and offices to facilitate suitable fire fighting services in these areas. Training in the operation of these facilities is incorporated in the mine emergency response program. The mine water truck and earthmoving equipment are setup so they can respond to surface fires as required. Familiarisation and ongoing training with the Strathalbyn CFS occurs on site.

All heavy underground machinery is fitted with fire suppression systems which are maintained and serviceable at all times. 9kg dry chemical fire extinguishers are fitted to all vehicles as well as located around the surface facilities and at specific points underground. These are maintained by a designated subcontractor on a monthly basis.

The mine has positive pressure breathing apparatus to assist in the response to confined space fires and hazmat incidents. The Emergency Response Team (ERT) will maintain the equipment and undergo regular training in its use so that it will be ready if such an event should occur. The team also has a high expansion foam generator to assist in liquid fuel fires both on the surface and underground. The ERT are called to all fires on site. If a fire does occur and as long as personnel are not put at risk the fire shall be extinguished as soon as possible to minimise environmental pollution.

Closure

See Appendix C.

5.13.2 Outcome Measurable Criteria Table

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No unplanned fires on site and ensure control measures are in place to manage potential offsite impacts	No damage to off-site property or injuries/deaths resulting from on-site fires.	Damage to off-site property or injuries/deaths from on-site fires	Where applicable	No damage to public infrastructure or no injuries/deaths	As required	N/A
	All uncontrolled on-site fires are investigated and this demonstrates they were appropriately managed and controlled	All uncontrolled on-site fires will be investigated	ML 6229	Demonstrate all uncontrolled fires were appropriately managed and controlled	As required	N/A

5.14 VERTICAL OPENINGS AND SITE SECURITY

Potential environmental risks identified:

59 – Vertical openings

5.14.1 Proposed Control and Management Strategies

Operation/Rehabilitation

As the mine is accessed by a decline, the only vertical opening at the surface is the top section of the ventilation return airway, known as the vent raise. This opening is fitted with a 4m high steel cone, known as an evasse, which is designed to reduce shock losses at the exhaust point. The evasse physically prevents access to the vent raise. Vertical openings associated with the mill are protected in compliance with Australian standards.

Terramin have erected 2.9 kilometres of security fencing that encompasses the entire above ground footprint of the operation. This fence complies with AS1725-2003. Regular inspections and maintenance of the site fence is undertaken.

The front entrance gate is remotely controlled from the mine office during day shift. Only authorised personnel have access to the front entrance gate remote control during night shift.

The surface explosives magazine is fenced in a separate security compound. Access to this compound is restricted to authorised persons holding SafeWork SA Blasting permits or permits to handle explosives. Regular auditing of the magazine records and non-cuttable keys are used to ensure all explosives, detonators and magazine keys are accounted for. In addition a cycling recordable CCTV has been fitted to a pole such that all activity in the explosives compound is visible at the mine/mill control centre and recorded.

Closure

See Appendix C.

5.14.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No public injuries and or deaths resulting from unauthorised entry to the mine site.	All unauthorised entries to the mine site are investigated and investigations demonstrate all reasonable and practical measures were in place to prevent entry (and injury, if applicable).	Investigations of all unauthorised entries	Where applicable	Demonstrate all reasonable and practical measures were in place.	As required	N/A
	Leading Indicator: Record of monthly visual inspections of the perimeter fence and vent evasse demonstrate they are maintained as designed.	Monitor the condition of the perimeter fence and vent evasse through visual inspection	Vent evasse and perimeter fence	Demonstrate Perimeter fence and vent evasse are maintained as designed.	Monthly	N/A

5.15 GEOTECHNICAL STABILITY

Potential environmental risks identified:

47 – Portal drive failure

45 – Crown pillar collapse

46 – Stope failure operations

48 – Destabilising ground due to mining

49 – Subsidence of road

5.15.1 Proposed Control and Management Strategies

Operation/ Rehabilitation

Underground mining poses the potential risk of surface subsidence causing a collapse of a portion of Callington Road and impacting on the integrity of the existing STEDS lagoon. Surface subsidence may also result in injuries and/or deaths to the public from instabilities caused to surface infrastructure.

To prevent disturbance of pre-mining infrastructure (Callington Road, lagoons, etc.), all pillars will be designed to avoid an unplanned failure. A stope design system has been established that specifically accounts for the geotechnical stability of the area to be mined (Section 3.7.1). No mining will occur without first establishing a geotechnically-safe distance from the surface. Independent geotechnical recommendation will be utilised to establish this distance and additional ground support will be undertaken to reinforce the upper level of the mine. No mining will be planned to occur above a floor level of -60mRL.

A detailed surface survey of the Northern Domain was conducted prior to commencing the decline and is validated annually or as required. A leading indicator of a surface drop greater than 10mm from the baseline data has been determined as more than what soil in that location would naturally move as part of seasonal swelling and contraction. Typically 5-6mm is the natural seasonal variation.

Two fixed survey prisms and two multipoint borehole extensometers located underground on the 75 Level are monitored monthly throughout the life of mine. Any other critical pillars would have similar treatment through the life of the mine. l

Less than 15% of underground stoping voids will be left open at any one time to minimise the potential risk of surface subsidence. This will be accomplished by continuous (systematic) backfilling of mined areas. 15% is beyond what would potentially be open at any time due to ore production, of this 15% no more than a third will be within the top 100m of the mine (see mine long section image below). As per previous independent geotechnical assessments, because of the natural swell of rock during a potential collapse these voids would not be able to propagate to surface, due to the size of the crown pillar and the void volume.

Monitoring of underground filling will be accomplished in several ways; first, by visual inspection, where safe, to ensure sufficient filling; secondly, through the use of cavity monitoring surveying equipment and fill volume calculations. The mode of backfilling will depend on the sequence of mining and involve either the use of heavy underground machinery depositing waste rock directly into stope voids or paste filling stopes with cemented tailings. Standard geotechnical survey approaches will be used to determine stability. Mine planning and scheduling will consider the location of existing voids and proposed mining so that no area within the top 100m of the mine will contain more than 35% of the mines open voids.

Closure

See Appendix C.

5.15.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
Ensure that no damage occurs to third party infrastructure and no injuries/ deaths result from collapse of the underground workings	A letter of compliance summarizing an Independent Geotechnical review (including void assessment) will be submitted annually to demonstrate that less than 15% of underground stoping voids will remain open at any one time and that the top 100m of the mine contains less than 35% of these voids.	Independent void assessment and Ground Control Management Plan (GCMP) assessment	Underground workings	Demonstrate that less than 15% of underground stoping voids will remain open at any one time and that the top 100m of the mine contains less than 35% of these voids.	Annual	N/A
	Leading Indicator: Surveyed plans and representative sections (showing all underground workings, backfill volumes and any remaining stope void) will be submitted to the DMITRE to demonstrate less than 10% of underground voids will remain open at any one time.	Surveyed Underground workings, backfill Volumes and remaining stope void will be measured	Underground workings	To demonstrate less than 10% of underground voids will remain open at any one time.	Annual	N/A
	Surface survey monitoring will be undertaken every six months at 18 fixed survey stations located along Callington Rd and the STEDS pond (Figure 45) to demonstrate no movement greater than 10mm from the base coordinates (Table 39).	Surface movement will be measured at 18 fixed survey stations.	18 fixed survey stations located along Callington Rd and the STEDS pond (Figure 45)	Demonstrate no movement greater than 10mm from the base coordinates (Table 39)	6 monthly	Survey Station base coordinates (Table 39)
	Two fixed survey prisms and two multipoint borehole extensometers located underground on the 75 Level will be monitored quarterly to demonstrate no movement greater than 5mm	Two survey prisms and two multipoint borehole extensometers will	75 Level	Demonstrate no movement greater than 5mm from the base coordinates	Quarterly	Refer to Table 40. Note; the fixed survey prisms are

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
	from the base coordinates (Table 40).	be used to measure movement		(Table 40)		located at the same co-ordinates as the multipoint borehole extensometer

Point ID	GPS Locations		Height	
	Easting	Northing		
			12/12/2007	03/05/2005
MON 6	310481.334	6097238.844	70.562	
MON 7	310438.786	6097220.606	70.862	
MON 8	310395.046	6097201.728	70.881	
MON 9	310493.901	6097348.904	71.853	
MON 10	310452.654	6097321.24	71.739	
MON 11	310412.857	6097297.42	71.73	
MON 12	310504.867	6097444.983	71.831	
MON 13	310488.28	6097438.993	71.946	
MON 14	310405.303	6097384.999	72.013	
MON 15	310490.474	6097516.193	72.003	
MON 16	310451.625	6097492.703	71.864	
MON 17	310396.729	6097461.368	71.92	
MON 18	310488.437	6097561.071	71.879	
MON 19	310404.688	6097552.672	76.909	
Mon 20 (New Stobie)				74.917
Mon 21 (Sign)				74.767
Mon 22 (New Stobie)				75.552
Mon 23 (Sign)				73.559

Table 39: Surface Survey Monitoring Base Co-ordinates

DATE	75 LEVEL PRISMS- Crown Pillar Monitoring						
	STATUS	PRISM1			PRISM2		
		EAST	NORTH	HEIGHT	EAST	NORTH	HEIGHT
12/01/2011	BASE COORD	10468.27	7146.61	-72.093	10429.62	7325.394	-69.93

Table 40: Level 75 Survey Prisms Base Co-ordinates

5.16 VISUAL IMPACT

Potential environmental risks identified:

10 – Wind erosion

19 – Exposing soils

20 – Dust created by crusher

72 – Mine and process equipment visibility

24 – Stockpiling of topsoil

5.16.1 Control and Management Strategies

Operation

The overall objective for visual impact at AZM is to convert a severely degraded site into a well-vegetated site of Australian native species with an emphasis on local native species as per the revegetation plan (Appendix X).

Bunding (soil mounds) was constructed as the first step in shielding the plant from the various vantage points. In addition, the natural topography of the site has been used to place parts of the processing plant (e.g. crusher, storage bin, ROM pad and waste pad), utilising the boxcut as a natural location to minimise visual impact. The use of the current low lying or existing excavated ground has enabled the total height relative to undisturbed land to be reduced.

Although adverse visual impacts have been minimised by appropriate siting of project facilities within the old quarry site (Appendix AI), some works will be partially visible from a number of houses and the Langhorne Creek Road. This impact has been reduced by;

- Construction and direct seeding of bunding around site
- All buildings on site are green or brown
- Tree planting along fence lines

Visual amenity plantings and direct seeding have been undertaken during mining operations as per the revegetation plan (Appendix X) with sections 1, 2 and 3 of Figure 32 having been completed.

The processing plant was constructed with the following criteria:

- The design will be kept to a minimum height to reduce the visual impact.
- The buildings will be painted with natural earth tones with steel being predominantly eucalyptus green. Some may be of other similar colours such as brown or grey, depending upon the various constructions.
- Night lighting will be designed to be switched on and utilised on an “as needs” basis. This will apply where it can be safely applied.
- Night lighting will also be designed on the basis of being tightly focussed with minimal light spillage.
- Wherever possible buildings have been positioned to minimise visual impact.

Stockpiles are restricted in height and blended with the natural topography

- The maximum height of the stockpiles will be 2.5 metres.
- The maximum height of the waste rock stockpiles will be 10 metres.

Dust created by the crusher has been minimised as grinding is carried out as a wet process. Dust levels are monitored regularly as per section 5.12.

Rehabilitation

See Appendix C.

Closure

See Appendix C.

5.16.2 Outcome Measureable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
Operations/ Rehabilitation						
Minimise the adverse visual impact and maintain a clean, rubbish free site.	Annual photo point monitoring at 10 locations around the ML (Figure 39) will demonstrate all areas are clean and rubbish free.	Photo point monitoring to measure visual amenity (including rubbish)	Ten location around the ML(Figure 39)	Demonstrate all locations are clean and rubbish free.	Annual	Baseline photos (plates 1-10)
No nuisance, inconvenience or loss of amenity to any person beyond the mine site caused by external lighting	Out-door lighting will be audited after construction by suitably qualified independent person to demonstrate compliance with AS 4282-1997 'Control of the obtrusive effects of outdoor lighting'.	Out-door lighting audited after construction by suitably qualified independent person	ML 6229	Demonstrate compliance with AS 4282-1997 'Control of the obtrusive effects of outdoor lighting'	Post-construction	N/A

5.17 FAUNA

Potential environmental risks identified:

11 – Loss of biodiversity

14 – Interaction of wildlife with mining and preparation

15 – Removal of micro habitats

25 – Revegetation of bund area

26 – Land clearing during site processing activities

30 – TSF infrastructure

5.17.1 Proposed Control and Management Strategies

Operation/ Rehabilitation

Loss of biodiversity

The areas affected by this project generally comprise of degraded land that is not conducive to native fauna. Predators such as foxes, dogs, and cats inhabit the area as well as a few hardy native animals. The risk of adverse impacts of the operation on biodiversity conservation is therefore considered low. Baseline monitoring of all fauna in the area is provided in Appendix I1 and I2.

Baseline fauna monitoring was conducted in 2006, recording three mammals on-site, all introduced species (rabbits, foxes and sheep). Two amphibian species were recorded in the adjacent area of the STEDs ponds, which are not affected by the mine operation.

Interaction of wild life with mining and processing activities

Interaction of wildlife (in particular migratory/native birds) with mining and processing activities poses a risk of injury and/or death to native fauna through collision with infrastructure and vehicles. A possible rise in the presence of wildlife in and around the revegetated bund areas may increase the likelihood of wildlife interaction (primarily birds) with mine infrastructure.

Mitigation measures which have been implemented throughout the operation include:

- Fixed speed limit on site of 25km/hour
- Onsite light vehicles fitted with speed limiters
- Employee awareness through site induction
- The operating domains within the site will be fenced.

Land clearance during site preparation and removal of microhabitat

The requirement for land clearance during the preparation of infrastructure on ML6229 was minimal as the site generally comprises of degraded land. The TSF was constructed on broad acre farmland, which required the clearance of six dryland teatrees (*Melaleuca lanceolata).* The majority of the current infrastructure is located within the footprint of the previous quarry, which for all practical purposes was devoid of vegetation and microhabitats.

TSF infrastructure

Under the current processing plant design, any water ponded on the TSF or other dams is not expected to be of any significant risk to fauna. This is because it is planned to control the pH so that it will be neutral to alkaline which means that high concentrations of heavy metals are not absorbed into the water. No deaths to migratory/native birds have occurred onsite to date and therefore unlikely to occur, however native bird deaths will be recorded during the daily visual inspections of the TSF.

Closure

See Appendix C.

5.17.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No net adverse impacts from the site operations on the native fauna on the lease area and adjacent areas	**Operations/ Rehabilitations**					
	All native fauna deaths or injuries on-site will be reported and an investigation will be undertaken to demonstrate it could not have reasonably been prevented	Native fauna deaths/injuries to be reported.	ML6229	Demonstrate it could not have reasonably been prevented.	As applicable	N/A

5.18 WEEDS AND PESTS

Potential environmental risks identified:

13- Weeds and Pests

19A – Dispersion of weeds and phytophthora

5.18.1 Proposed Control and Management Strategies

Operation/ Rehabilitation

Weeds are defined as any invasive plant that threatens native vegetation in the local area or any species recognised as invasive in South Australia. A qualitative baseline flora survey was undertaken by Natural State in July 2005 and December 2006 (Appendix J). A full list of introduced species which were recorded during the two flora surveys are presented in Table 41, demonstrating the high presence of weeds prior to the commencement of mining activities. Of the 26 introduced species recorded, 10 are declared weeds under the Natural Resource Management Act 2004.

In order to reduce the spread of weeds on site, the below weed control measures are implemented;

- Wash down of machinery either arriving onsite or leaving the site in designated washdown areas to remove soil and seeds;
- Training of employees and contractors on the spread of weeds through the site induction process
- Regular monitoring of weed infested areas
- Spraying prior to seed set
- Slashing
- Control burns of larger paddocks in conjunction with the CFS
- Ongoing weed and pest surveillance by site personnel and reporting of weeds and pest sightings.
- Revegetate areas as per revegetation plan – managing native species to out complete the introduced species

Weed control should be implemented in areas to be revegetated at least two weeks prior to seeding or planting to give an adequate growing window for native species to establish. Special care to avoid off target spraying is required in areas with native species.

An opportunistic baseline fauna survey was conducted in August 2006 by Donato Environmental Services (Appendix I). Rabbits and red foxes were the concerning feral animals recorded on site. Rabbit and fox control will be undertaken through baiting and warren fumigation. Baiting in late summer or autumn is the optimum time to bait as rabbits and foxes are more likely to take bait when alternative food is scarce or not available.

The 2010 Weed and Pest Management Plan (Appendix AC) will be implemented and reviewed annually to ensure the plan is relevant to minimising the spread of weeds and pests on-site. Consultation regarding the plan will be undertaken with the mines immediate neighbours.

The site lies in a low-moderate risk Phytophthora zone. Management is generally in accordance with the recommendations made by the Department of Environment and Heritage which are;

- hygiene controls such as washdown of all earthmoving vehicles, machinery before leaving the site, as well as for footwear;
- prevention of soil disturbance where practically possible;
- reducing dust through mitigation measures (refer to section 5.12) ;
- travel only to be on designated roads or tracks;

Closure

See Appendix C.

Introduced species	
Scientific Name	**Common Name**
Arctotheca calendula	Capeweed
Asparagus asparagoides *	Bridal Creeper
Asphodelus fistulosus *	Onion Weed
Avena fatua	Wild Oats
Chondrilla juncea *	Skeleton Weed
Cynodon dactylon	Couch Grass
Echium plantaginum *	Salvation Jane
Euphorbia terracina *	False Caper
Foeniculum vulgare	Fennel
Galenia ssp. Galenia	
Hordeum leporinum	Barley Grass
*Lycium ferocissimum**	African Boxthorn
Malva parviflora	Mallow
Marrubium vulgare *	Horehound
Oxalis pes-caprae *	Soursob
*Olea europaea ssp. Europaea**	Wild Olive
Pennisetum clandestinum	Kikuyu
Pinus halapensis *	Aleppo Pine
Piptatherum miliaceum	Millet
Poa annua	Winter Grass
Polygonum aviculare	Wireweed
Salvia verbenaca	Wild Sage
Schinus molle	Peppercorn Tree
Sisymbrium officinale	Hedge Mustard
Solanum nigrum	Black Nightshade
Sonchus oleraceus	Sow Thistle

*Introduced species declared under the Natural Resources Management Act 2004

Table 41: Weeds recorded in the Flora baseline survey

5.18.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
Operation/Rehabilitation						
The Lessee must minimize the spread of weeds and plant pathogens (including phytophthora) and ensure that all employees and contractors on-site are made aware of this requirement	A winter annual weed and pest survey at seven permanent transects on ML 6229 (Figure 46) using step point monitoring (Appendix AL) and photo documentation to demonstrate a decrease in weeds, pests and disease from the previous survey.	Weed and pest survey at permanent transects using step point monitoring (Appendix AL) and photo documentation	Seven permanent transects on ML 6229 (Figure 46)	Demonstrate a decrease in weeds from the previous survey.	Annual (winter)	2011 Weed and Pest survey report (Appendix AL)

5.19 ABORIGINAL HERITAGE

Potential environmental risks identified:

There is a low risk of disturbing unknown Aboriginal sites during construction operations.

5.19.1 Proposed Control and Management Strategies

No aboriginal artefacts were known on, or prior claims made, over the ML.

Terramin will ensure that its employees are trained in artefact and site recognition and understand their obligations under the *Aboriginal Heritage Act, 1988*. This will be achieved through the site induction program.

5.19.2 Outcome Measurable Criteria

Note, the outcome criteria tables for the rehabilitation earthworks phase of closure works and the completion criteria are in the Closure plan, Appendix C, Section 7.

Outcome	Outcome Measurement Criteria	What will be measured and form (method) of measurement	Location	Outcome Achievement	Frequency	Control or Baseline Data
No unauthorised disturbance to Aboriginal sites, remains or objects.	Keep records will be kept of all complaints and any artefacts discovered related to Aboriginal heritage and an investigation will be undertaken to demonstrate no inappropriate actions by the mine operator.	Complaints and discovered artefacts related to Aboriginal heritage and an investigation undertaken	ML 6229	Demonstrate no inappropriate actions by the mine operator.	As required	N/A

5.20 COMPLIANCE MONITORING STRATEGY

All compliance monitoring required at the AZM is detailed in the above outcome measurable criteria tables. These tables state the methodology, frequency and location of all required monitoring. The Environmental Monitoring Program (Appendix AG) summaries all monitoring required throughout operations and rehabilitation, the approaches for this monitoring and the frequency of reporting to DMITRE and the SCCC.

Although every effort will be made to remain in compliance with the environmental outcomes, if an unforseen event may result in non-compliance, it will be reported to DMITRE as soon as practical.

GPS co-ordinates of monitoring locations for water, erosion, visual amenity, noise, dust, vegetation and blasting have been documented in Table 42 - Table 51. Maps of these locations have been also been included below (Figure 38 - Figure 46).

Monitoring Site	Easting	Northing
Angas River		
Bridge (Upstream)	308 535	609 6135
Hogben (Upstream)	309 814	609 5741
Croser (Downstream)	310 050	609 5480
Ford (Downstream)	310 244	609 5104
Burnside Creek		
SWA (Downstream)	310 119	609 7119
SWB (Upstream)	310112	609 7435

Table 42: Surface Water GPS Monitoring Locations

Bore Name	Easting	Northing
RG1	309 957	609 7970
RG2	309 966	609 6166
RG3	309 962	609 6174
RG4	310 965	609 5074
RG8	311 351	609 7648
DH2	310 628	609 7213

Table 43: Groundwater Monitoring Bore GPS Locations

Site Description	Easting	Northing
Silt traps at the front entrance drive way – Eastern side	310 505	609 6894
Silt traps at front entrance drive way – Western side	310 468	609 6942
Front entrance surface Drainage System	310 441	609 7062
Surface Drainage System – Visitors viewing area	310 561	609 7122
Sediment Dam	310 625	609 6346

Table 44: Erosion Control Monitoring GPS Locations

Remnants Trees	Easting	Northing
Tree 1	310 374	609 6972
Tree 2	310 577	609 6777
Tree 3	311 023	609 6794
Tree 4	311 019	609 6805
Tree 5	311 019	609 6805
Tree 6	311 011	609 6827
Tree 7	311 077	609 6671
Tree 8	310 472	609 7066

Table 45: Remnant Vegetation Monitoring GPS Locations

Bore Name	Easting	Northing
TSF B	310 555	609 6351
TSF C	310 472	609 6518
TSF D	310 858	609 6444

Table 46: TSF Monitoring Bore GPS Locations

Portable Noise Logger Locations	Easting	Northing
Western Location – Boxcut	0310 540	609 6961
Eastern Location - Mill	0310 989	609 6870

Table 47: Portable Noise Logger GPS Locations

Fixed Blast Monitor Locations	Easting	Northing
Glover Resident	310 123	609 2082
Glover Paddock	310 094	609 7156

Table 48: Fixed Blast Monitor GPS Locations

Site	Description	Easting	Northing
1	Aeroclub / Langhorne Creek Road	310 291	609 5657
2	Aeroclub / Jettner boundary / ML Peg SW	310 462	609 6236
3	Hillside Road / Garwood property	311 704	609 6102
4	Hillside Road / AHR property / ML Peg E	311 526	609 6820
5	Callington Road / AHR /ML Peg E	310 751	609 7289
6	Quarry / AHR / Dust monitor 5	310 820	609 7189
7	Garwood paddock / AHR boundary	310 932	609 6991
8	Garwood paddock / AHR boundary / ML Peg SE	311 225	609 6480
9	Callington Road / Jettner boundary / AWE1	310 298	609 7041
10	STEDS lagoons NE bund wall	310 594	609 7529

Table 49: Visual Amenity Photo Point GPS Locations

Dust Monitoring Location	Easting	Northing
DDG 1	310 485	609 7558
DDG 2	311 002	609 7462
DDG 3	310 007	609 7157
DDG 4	310 535	609 7143
DDG 5	310 818	609 7192
DDG 6	310 344	609 6856
DDG 7	310 927	609 6997
DDG 8	310 453	609 6731
DDG 9	310 928	609 6451
DDG 10	310 149	609 8271
DDG 11	310 049	609 6877
DDG 12	310 053	609 7395
Hi-Vol and PM10 – Northern	310 528	609 7142
Hi-Vol – Western	310 310	609 6895

* DDG – Dust Deposition gauge

Table 50: Dust Monitoring GPS Locations

Weed and Pest Transect Locations	Easting	Northing
Transect 1	310 427	609 6588
Transect 2	310 639	609 7353
Transect 3	310 589	609 7165
Transect 4	310 334	609 6563
Transect 5	310 412	609 7083
Transect 6	311 220	609 6477
Transect 7	311 219	609 6493

Table 51: Weed and Pest Annual Survey Transect GPS Locations

Figure 38: AZM Water Monitoring Locations

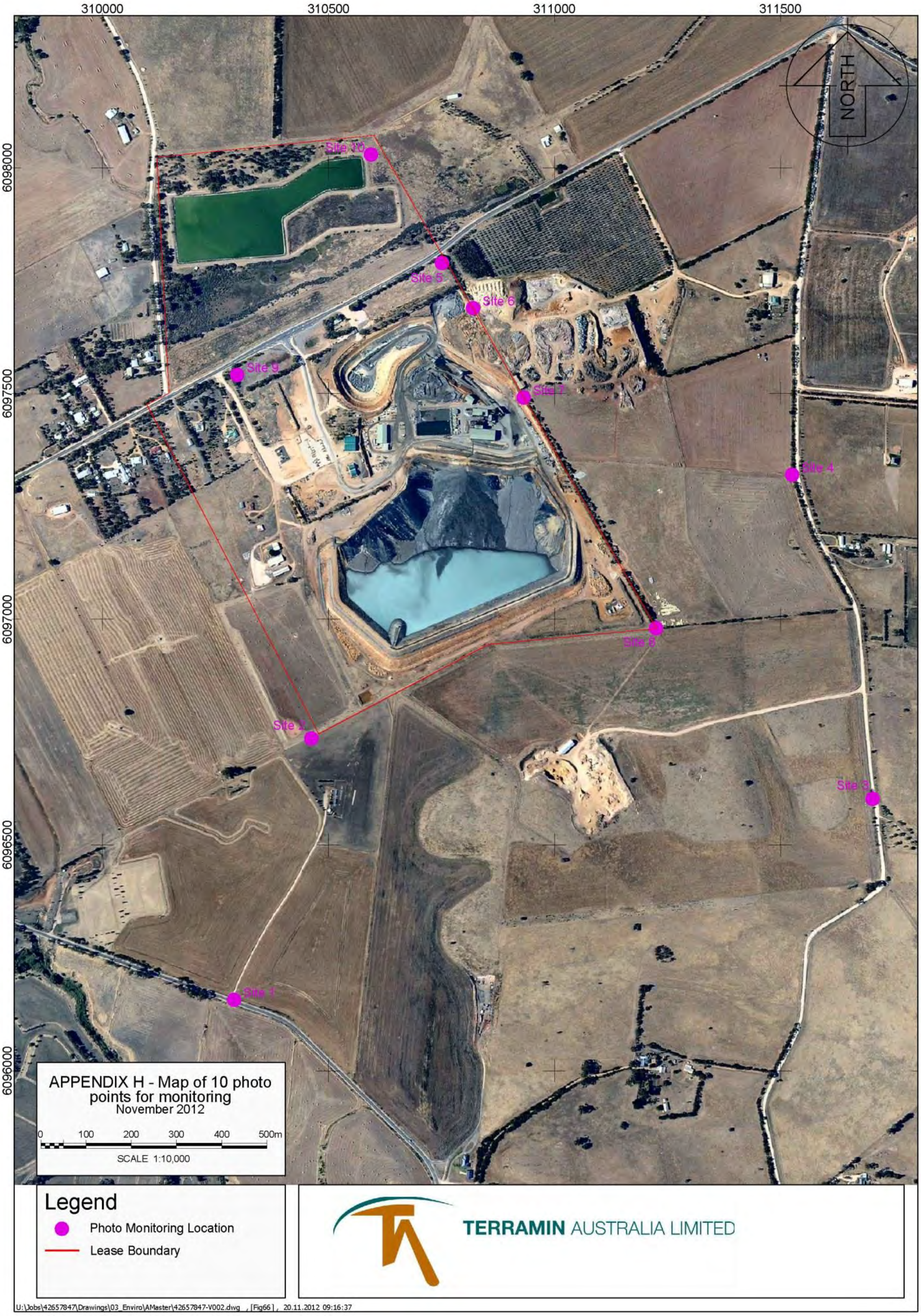

Figure 39: Visual Monitoring Locations

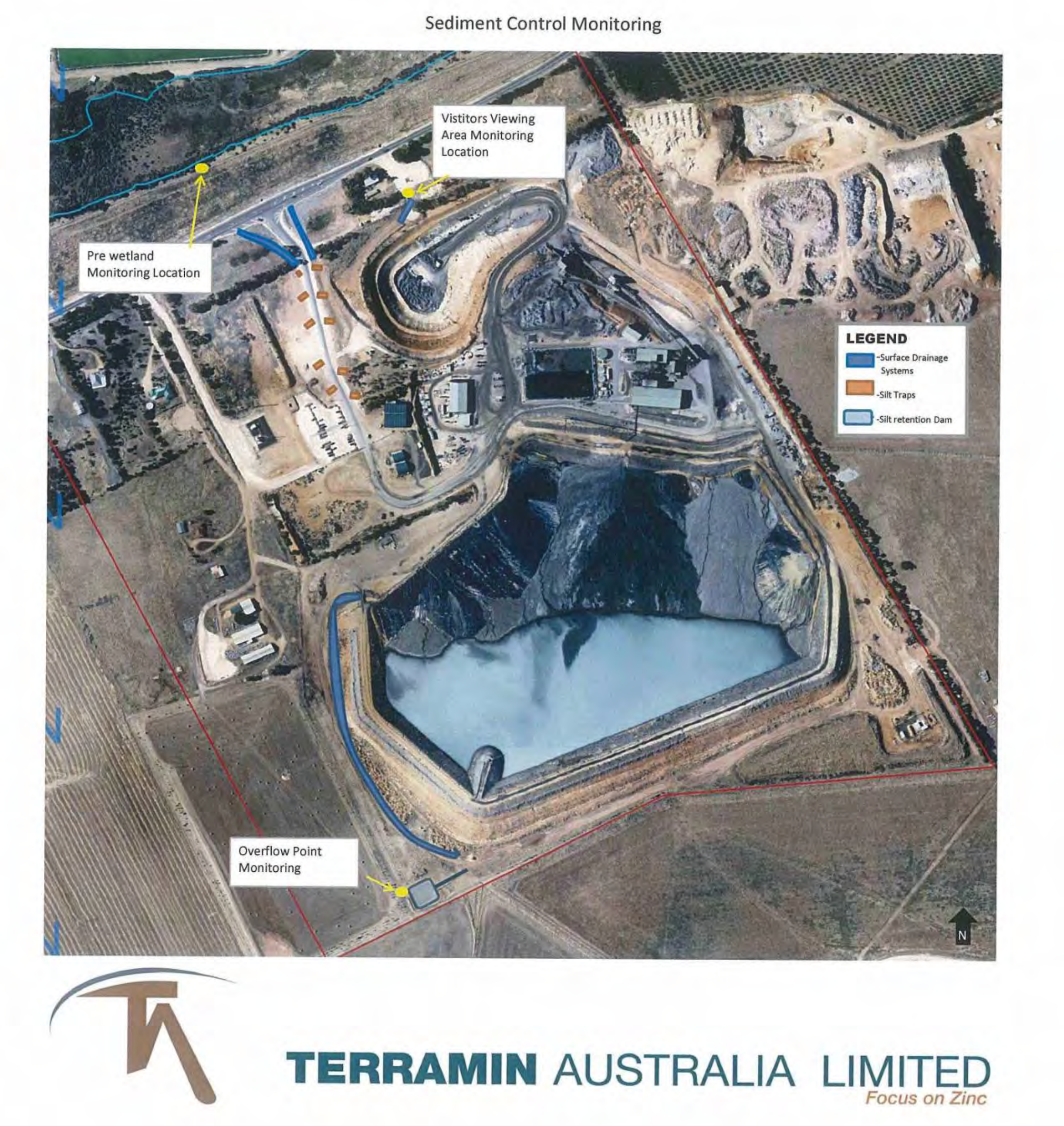

Figure 40: Erosion Monitoring Locations

Figure 41: Remnant Vegetation Monitoring Locations

Figure 42: TSF Embankment Bores Monitoring Locations

Figure 43: Fixed Blast Monitoring Locations

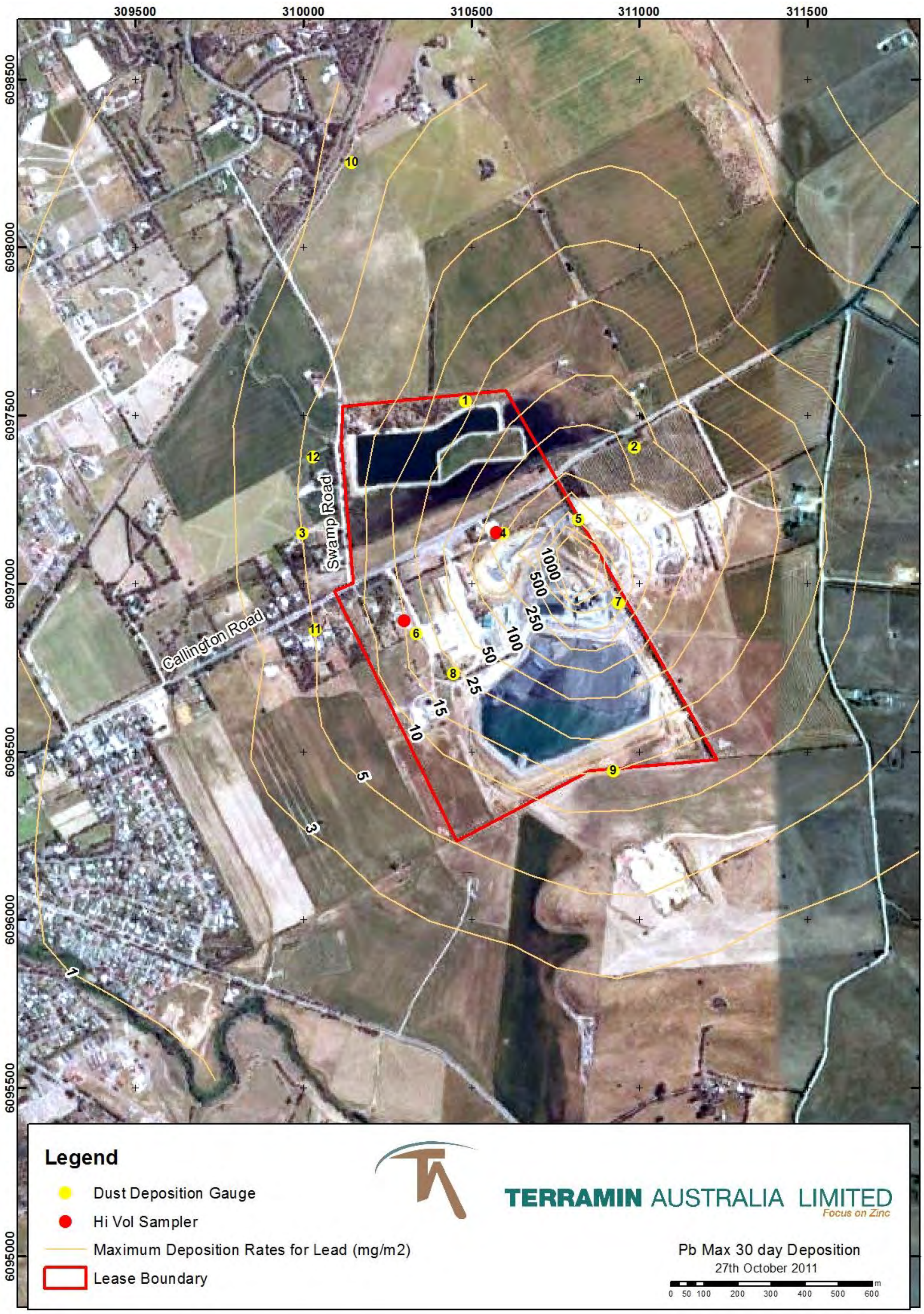

Figure 44: Dust Monitoring Locations

Figure 45: Surface Surveying Monitoring Locations

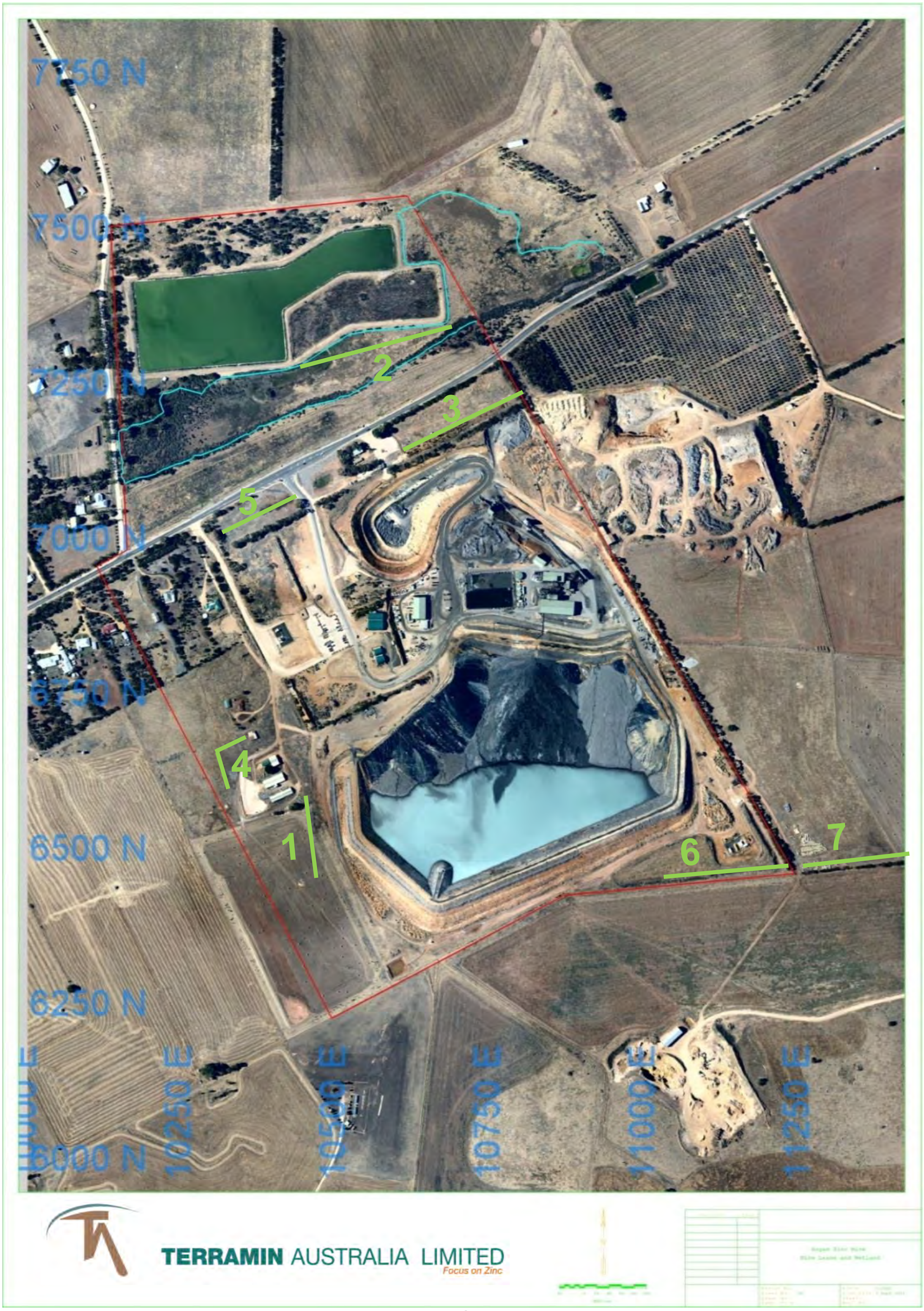

Figure 46: Weed and Pest Survey Transect Locations

6 OPERATOR CAPABILITY

Terramin operates AZM in accordance with the company's corporate principles which are reflected in the environment, community and health and safety policies (Appendix AM). Operating procedures developed for the mine incorporate evaluation of the impact on the environment. In creating the operating procedures consideration was given to ensure all lease conditions and outcome measurable criteria (section 5) are complied with. This approach extends to both Job Safety Analysis (JSA's) carried out prior to the commencing non-standard tasks and to the Standard Operating procedures (SOPs) that will be established for processes or activities that pose an extreme or high risk.

Auditing and review of procedures based on a policy of continual improvement is used to manage any variances encountered between actual and best practice. Terramin have an Occupational, Health and Safety Manager and an Environmental Superintendent who facilitate these processes. Reporting of the outcome measurable criteria (section 5) through Quarterly Environmental Reports and the annual Mining and Rehabilitation Compliance Report identify any shortcomings in the Environmental Management System.

Terramin is committed to ensuring the protection, integrity, accuracy and currency of all our knowledge and information. Terramin recognises that knowledge and information is a vital asset that supports our ongoing operations and that effective management of this knowledge and information is critical to our ongoing success. In 2011, Terramin introduced a document management system and intranet, based on Microsoft SharePoint, which standardises the way we manage, protect, approve, disseminate and store controlled documents. Terramin's document management system controls the life cycle of documents at Terramin; how they are created, reviewed, and published, and how they are ultimately disposed of or retained.

A Health Safety Environment and Community management system called In-control was implemented in 2011. In control is a high level risk management system to document employee training, track events, incidents (including environmental) and register risks. All 2010 data was added to the data base. Terramin has also subscribed to ChemFFX for complete access to their online MSDS data base.

7 LEASE/LICENSE CONDITION

The table below outlines all Mining Lease conditions for ML 6229, where they have been addressed in this document or how they will/have been complied with.

Mining Lease 6229 Conditions	Where conditions are addressed in the PEPR or how they will be complied with
1.The Lessee must take responsibility for resourcing, participating with and maintaining to the satisfaction of the Minister, a Strathalbyn Community Consultative Committee (CCC) for the term of the lease, with terms of reference as specified from time to time by the Minister	Chapter 4: Results of Consultation
2.The Lessee must ensure that mining operations on the land are carried out in an orderly and skilful manner In accordance with a program for mining and rehabilitation of the land (MARP) approved from time to time by the Minister in consultation, with the Environment Protection Authority (EPA), Planning SA, Department of Water Land and Biodiversity Conservation (DWLBC) Department of Health and Transport Services Division (TSD)	Chapter 6: Operator Capabilities
3.The MARP must comply with the requirements of the guidelines approved by the Chief Inspector of Mines and include environmental outcomes and measurement criteria that are developed In consultation with relevant stakeholders	Chapter 5: Environmental Outcomes
5. The MARP must be reviewed and resubmitted by the Lessee for approval if at any time the sum of the total mine production and the remaining ore reserve exceeds 2.5 Million tonnes.	Terramin will review and resubmit the PEPR if mine production and the remaining ore reserve exceeds 2.5 million tonnes
Reporting **6.** The Lessee will be responsible for recording and addressing complaints received from the public with respect to the mining operations by: **6.1** Providing a dedicated and publicly advertised telephone line, 24 hours a day, 7 days a week; **6.2** Record details of complaints and the Lessee's response in a register, which will be made available to authorised officers under the Mining Act. 1971; **6.3** Ensuring that a response Is provided to the complainant as early as possible and within two working days; and **6.4** Reporting the complaint details and the Lessee's response at the next relevant Strathalbyn Community Consultative Committee meeting.	Chapter 4: Results of Consultation Chapter 5.10: Noise
7. The Lessee must, if requested by the Chief Inspector of Mines, undertake an independent audit of achievement of the environmental outcomes any or all in clauses 16 to 63 below, by an independent expert approved by the Chief Inspector of Mines. The audit will be made available to the public, in a manner and form as determined by tile Minister in consultation with the Community Consultative	Chapter 5: Environmental Outcomes

Mining Lease 6229 Conditions	Where conditions are addressed in the PEPR or how they will be complied with
Committee.	
8. The Lessee must, on an annual basis, provide to the satisfaction of the Chief Inspector of Mines a survey of mine workings.	Chapter 5.15: Geotechnical Stability
9. The Lessee must provide to the Chief Inspector of Mines a Mining and Rehabilitation Compliance Report (MARCR) on operations carried out on the lease and compliance with the MARP.	The MARCR will be submitted annually
10. The MARCR must include a geotechnical and operational audit of the Tailings Storage Facility undertaken by an independent certified geotechnical engineer.	Chapter 3.9.1: Overburden and tailings
11. The MARCR must be submitted every year, or any other period as requested in writing and agreed with the Chief Inspector of Mines.	The MARCR will be submitted by the 31st of March every year
1**2.** The MARCR must be submitted within 2 months after the anniversary of a date agreed with the Chief inspector of Mines	As above
13. The MARCR must be prepared in accordance with guidelines approved by the Chief Inspector of Mines.	The MARCR will be prepared in accordance with MG3 Guidelines for miners(preparation of a mining and rehabilitation compliance report (MARCR) in South Australia,)and successors
14. The MARCR will be made available to the public in a manner and form as determined by the Chief Inspector of Mines in consultation with the Community Consultative Committee.	The MARCR is placed on the DMITRE website and hard copies are
15. The following significant incidents, should they occur, must be reported to the Chief Inspector of Mines, immediately after the Lessee is aware of them:	
15.1 Any unexpected groundwater flow in the underground mine workings	Terramin will report any unexpected groundwater flow in the underground mine workings
15.2 Any unplanned collapse of underground workings	Chapter 5.15: Geotechnical Stability
15.3 Any detection of microbiological material in the mine water, likely to be sourced from the overlying effluent ponds;	Mine water is analysed annually for microbiological material and reported in the MARCR
15.4 Any fires caused by mining operations;	Chapter 5.13: Fires
15.5 Any unauthorised entry to site by any member or members of the public, or breach of security measures;	Chapter 5.14: Vertical opening s and Site Security
15.6 Any injury to member of the public caused by mining operations (including by truck movements)	Chapter 5.14: Vertical Openings and Site Security
15.7 Any breach of environmental outcomes to be achieved as detailed in clauses 16 to 63	Chapter 5: Environmental Outcomes
15.8 Any flora and/or fauna deaths or sickness likely to be caused by the mining operation	Chapter 5.5: Vegetation

Mining Lease 6229 Conditions	Where conditions are addressed in the PEPR or how they will be complied with
	Chapter 5.17: Fauna
Groundwater and Surface Water **16.** The Lessee must, in constructing and operating the lease and post mine Closure, ensure that there Is no adverse impact to the supply of water by the lessees operations to existing users and water dependent ecosystems.	Chapter 5.2: Groundwater and Surface Water
17. The Lessee must ensure that groundwater monitoring well locations and all data are supplied to PIRSA and Department of Water Land and Biodiversity Conservation (DWLBC) on an annual basis in a format stipulated by DWLBC.	All locations and data are supplied annually in the MARCR
18. The Lessee must report on an annual basis groundwater ingress zones encountered within the mine workings and report on groundwater flow and quality and microbiological content.	Terramin will report on groundwater flow, quality and microbiological content.
Erosion **19**. The Lessee must, in constructing and operating the lease and post mine closure, stabilise disturbed areas and prevent sediment from leaving the site.	Chapter 5.3: Erosion
Topsoil **20.** The Lessee must, in constructing and operating the lease and post mine closure, ensure that soil quality and quantity are protected.	Chapter 5.4: Soil
21. The Lessee must ensure that topsoil stockpiles are protected from erosion (e.g. be sown with a cover crop) and monitored for erosion.	Chapter 5.4: Soil
Vegetation clearance and Weed Management **22.** The Lessee must, in constructing and operating the lease, and post mine closure, avoid permanent loss of biodiversity through clearance of native vegetation.	Chapter 5.5 Vegetation
23. The Lessee must minimise the spread of weeds and plant pathogens (including phytophthora) and ensure that all employees and contractors on-site are made aware of this requirement.	Chapter 5.18 Weeds and Pests
24. The Lessee must undertake a detailed baseline survey on flora present in the lease area to Identify all flora of conservation significance and Include the results from the completed survey as part of the MARP documentation.	Appendix J: Flora Baseline Survey
Silt and Stormwater **25.** The Lessee must, In constructing and operating the lease and post mine closure, ensure no water contaminated as a result of mining operations leaves the lease area or results In contamination of soil at mine closure within the lease area.	Chapter 5.6: Silt and Stormwater
26. The Lessee must ensure that surface water monitoring site locations and data is supplied to the Chief Inspector of Mines and Department of Water Land and Biodiversity Conservation (DWLBC) on an annual basis in a format stipulated by DWLBC.	All locations are data are supplied annually in the MARCR
27. The Lessee must ensure water discharged from the site is compliant with the relevant environment	Chapter 5.2: Groundwater and Surface water

Mining Lease 6229 Conditions	Where conditions are addressed in the PEPR or how they will be complied with
protection policy under the Environment Protection Act, 1993.	Chapter 5.3: Erosion
28. The Lessee must, prior to commencement of mining, design and construct stormwater diversion infrastructure to manage the largest known historical storm event or the estimated 1 in 100year storm event, whichever is the larger.	Chapter 3.9.1: Overburden and tailings Chapter 5.8: Acid Mine Drainage
Waste Disposal and Hazardous Substances **29.** The Lessee must, in constructing and operating the lease, and post mine closure ensure that no contamination and pollution is caused by waste products and hazardous materials used in the mine operations.	Chapter 5.7: Waste Disposal and Hazardous Substances
30. The MARP must include a waste management and recycling plan.	Appendix AF: AZM Waste Management Plan
31. The Lessee must ensure that fuel and liquid chemical storage is adequately bunded to capture spillage and to prevent the migration or infiltration of any spillage or leakage to the surrounding environment in conformance with relevant Environment Protection Authority guidelines.	Chapter 5.7: Waste Disposal and Hazardous Substances
32. The process water ponds must include a double liner and leakage detection and leachate recovery system to the satisfaction of the Environment Protection Authority.	The process water ponds have been constructed with a double liner and leakage recovery system.
Acid Mine Drainage and Tailings Management **33.** The Lessee must, in constructing and operating the lease and indefinitely post mine closure, ensure that no contamination of natural water drainage systems, streams and rivers, groundwater, land and soils occurs either on or off site resulting from permanent disposal or temporary storage of mine ore or waste material.	Chapter 5.8: Acid Mine Drainage (AMD)
34. The Lessee must dispose the tailings into the underground workings to the extent it is technically feasible. Material other than tailings should only be disposed of underground if it can be shown that this will not decrease the maximum amount of tailings and other sulphidic waste that can be placed in the underground workings.	Chapter 3.7.2: Underground Fill
35. The Lessee must design, operate, close and rehabilitate the Tailings Storage Facility (TSF) according to the following conditions;	
35.1 The 100-year flood level for the site must be modelled to the satisfaction of the Department of Water Land & Biodiversity Conservation (DWLBC) and included in the MARP;	Chapter 5.8: Acid Mine Drainage
35.2 The TSF must be located above the modelled 100-year flood level with a buffer of at least 100m horizontally outside of that zone	Chapter 3.9.1: Overburden and Tailings
35.3 The tailings must be produced to <30% moisture (by weight)	Chapter 3.9.1: Overburden and Tailings
35.4 The TSF must be designed, constructed, operated and decommissioned In accordance with the tailings management guidelines as approved from time to time by the Chief Inspector of Mines and Environmental Protection Authority (EPA)	Chapter 3.9.1: Overburden and Tailings

Mining Lease 6229 Conditions	Where conditions are addressed in the PEPR or how they will be complied with
35.5 The MARP must include the design of the TSF and management plan prepared In accordance with the tailings management guidelines	Appendix U: Tailings Storage facility Design
35.6 The TSF must include a double liner and leakage detection and leachate recovery system to the satisfaction of the Environment Protection Authority;	Chapter 3.9.1: Overburden and Tailings
35.7 Engage an independent certified geotechnical engineer to audit the design of the TSF and management plan against the tailings management guidelines, and submit the audit to the Chief Inspector of Mines with the MARP	Appendix U: Tailings Storage facility Design
35.8 Provide to the Chief Inspector of, Mines certification by an appropriate chartered professional that the TSF has been constructed In accordance with the approved design;	
35.9 The Run of Mine (ROM) pad, waste rock stockpiles must be suitably contained and bunded. The Run of Mine pad, waste rock stockpiles, must collect any runoff Water from those areas for reuse or disposed to the TSF or for treatment and disposal off site; and	Chapter 3.5.6: Stockpiles
35.10 The location of the TSF footprint must be no closer than 10 metres from the lease boundary.	Chapter 3.9.1: Overburden and Tailings Chapter 5.8: Acid Mine Drainage
Traffic **36**. The Lessee must, in constructing and operating the lease, ensure that no Impacts offsite are caused by accidents, noise, dust and dragout by traffic from or to the mine site.	Chapter 5.9: Traffic
37. The Lessee must ensure that there will be no truck dragout onto the Callington - Strathalbyn Road.	Chapter 5.9: Traffic
38. All traffic accidents or near misses involving mine vehicles on public roads must be investigated by the Lessee and reported to the Chief Inspector of Mines.	Chapter 5.9: Traffic
39. The Lessee must monitor all traffic movements associated with the mine construction, operation and closure and must ensure that:	Chapter 5.9: Traffic (for all listed below)
39.1 No B-Double vehicles are to be driven through Strathalbyn township roads	
39.2 B-Double vehicle movements on public roads limited to hours as approved in the MARP in consultation with Transport SA	
39.3 All concentrate trucks on public roads must be covered and well-sealed to prevent loss of loaded material	
39.4 All vehicles leaving the site that have entered the operating area must go through an approved wheel wash to prevent dragout on public roads	
39.5 Drivers are to be Instructed on school bus routes and schedules.	
40. The Lessee must liaise with the Transport Services Division (TSD) to upgrade and maintain the intersection of the proposed "Mine Road" with Callington Road to specifications determined by TSD. The upgrade shall be designed and constructed to the satisfaction of TSD, with all costs (design,	Chapter 5.9: Traffic

Mining Lease 6229 Conditions	Where conditions are addressed in the PEPR or how they will be complied with
construction and project management) being borne by the Lessee. With regards to the design, the Lessee is required to seek approval for the concept plan from TSD before undertaking any detailed design work.	
Noise **41.** The Lessee must, in constructing and operating the lease ensure that there are no public nuisance impacts from noise emanating from the operating site.	Chapter 5.10: Noise
42. Noise must at all times comply with the relevant environment protection policy under the Environment Protection Act, 1993.	Chapter 5.10: Noise
Blasting **43.** The Lessee must, in constructing and operating the lease, ensure that there are no public nuisance impacts from airblast and vibration caused by blasting.	Chapter 5.11: Blasting
44. The Lessee must ensure that airblast and ground vibration levels from blasting operations comply with the following requirements at the nearest, non-Terramin owned residence:	Chapter 5.11: Blasting
44.1 Vibration to not exceed 10mm/sec at any time, with no more than 5% of blasts in anyone year to within the range 5-10mm/sec;	Chapter 5.11: Blasting
44.2 Airblast to not exceed 120dB Linear at any time, with no more than 5% of blasts in anyone year to be within the range 115-120dB Linear.	Chapter 5.11: Blasting
Public Health and Nuisance **45.** The Lessee must, in constructing and operating the lease and post mine closure, ensure that there are no public health, loss of amenity and nuisance impacts to local residents from air emissions, dust and odour generated on site as a result of mining operations.	Chapter 5.12: Public health and Nuisance
46. The Lessee must measure within 3 months of start-up of the ore processing plant, the odour emission rates at the following locations, and demonstrate that they have not exceeded the following limits: (a) TSF pond - 550 Odour Units; (b) TSF Wet beach (winter) - 13,000 Odour Units; and (c) TSF wet beach (summer) - 3,800 Odour Units. The odour emission rates must be measured using AS4323.3:2001 Stationary Source Emissions - Determination of odour concentration by dynamic olfactometry. The Lessee must submit within 3 months of start-up of the ore processing plant (and at any other time if requested by the Chief Inspector of Mines) a revised odour dispersion model (prediction of odour impact from TSF and flotation processes) produced by a recognised independent expert approved by the Chief Inspector of Mines and based on the additional sampling of odour emission rates from the TSF pond and the TSF wet beach, that demonstrates odour levels In the vicinity of the site do not exceed those In Attachment A.	Chapter 5.12: Public Health and Nuisance
47. The Lessee must ensure that noise; blasting, visual amenity and dust monitoring points are determined and approved by the Minister in consultation with EPA, Health Department and the	Chapter 5.12: Public Health and Nuisance

Mining Lease 6229 Conditions	Where conditions are addressed in the PEPR or how they will be complied with
Community Consultative Committee.	
48. The Lessee must ensure that no lead contaminated items (including clothing, tools and equipment) are taken off the mine site.	No lead contaminated items are taken off the mine site, all mine employees working in contaminated areas shower prior to leaving site and all work clothes are cleaned on-site (Chapter 3.10.2 Accommodation and Offices)
49. The Lessee must manage this operation to comply with the Environment Protection Authority's National Environment Protection Measures for Ambient Air Quality, including EPA criteria for all dispersions, depositions and dust management standards.	Chapter 5.12: Public Health and Nuisance
50. The Lessee must include in the MARP an environmental dust-monitoring program to the Ministers satisfaction, in consultation with the Department of Health and the EPA.	Chapter 5.12: Public Health and Nuisance
Fire **51.** The Lessee must, in constructing and operating the lease, ensure that there are no unplanned fires onsite, and ensure control measures are In place to manage potential off site Impacts.	Chapter 5.13: Fire
Public Safety **52.** The Lessee must, in constructing and operating the lease and post mine closure, ensure that there are no public injuries/deaths resulting from unauthorised entry to the mine site.	Chapter 5.14: Vertical Openings and Site Security
Geotechnical Stability **53.** The Lessee must, in constructing and operating the lease and post mine closure, ensure that no damage occurs to third party Infrastructure and no injuries/deaths result from collapse of the underground workings.	Chapter 5.15: Geotechnical Stability
54. The Lessee must demonstrate that the mine design cannot allow surface subsidence to occur at any time during mining operations. The demonstration must be made by submitting to the Chief Inspector of Mines (prior to commencing mine development under the Callington Road) a review of the design of the proposed underground operations undertaken by an independent chartered professional mining engineer. The section of the report pertaining to mining under the Callington Road must also be submitted to Transport Services Division (TSD) for its advice. The Lessee must survey the road prior to, during and post mining to ascertain if subsidence has occurred. TSO requires the Lessee to pay for any remediation works on the Callington Road that are required as a direct result of the mining operations, irrespective of the amount of subsidence. This condition applies from the commencement of the mine operation to 1 year after the mine closure. The Lessee shall be responsible for the cost of any remediation works required to be undertaken to the Strathalbyn effluent ponds located north of the Callington Road that has occurred as a direct result of mining operations.	Chapter 5.15: Geotechnical Stability
55. The Lessee must demonstrate that all underground voids are filled to the extent that subsidence	Chapter 5.15: Geotechnical Stability

Mining Lease 6229 Conditions	Where conditions are addressed in the PEPR or how they will be complied with
cannot occur at any time after mine closure.	
Visual Impact **56.** The Lessee must, in constructing and operating the lease, minimise the adverse visual impact and maintain a clean, rubbish free site.	Chapter 5.16: Visual Impact
57. The Lessee must improve the visual amenity of the mine site in the long term post mine closure.	Chapter 5.16: Visual Impact Appendix C: Mine Closure Plan
58. The Lessee must ensure that all external materials, colours and finishes are non-reflective and of a natural colour and tone to blend with the landscape.	Chapter 5.16: Visual Impact
59. The Lessee must, in areas visible to the public and where it is not possible to completely ameliorate visual impacts, use bunding and/or vegetation to improve visual screening.	Chapter 5.16: Visual Impact Appendix X: Revegetation Plan
60. The Lessee must ensure that the screening utilizes local species and is maintained in good condition at all times, to the reasonable satisfaction of the Chief Inspector of Mines.	Appendix X : Revegetation Plan
61. The Lessee must ensure that external lighting on the site, including car parking areas and around buildings is designed and constructed to conform to Australian Standards. External lighting must not cause any nuisance, inconvenience or loss of amenity to any person beyond the mine site.	Chapter 5.16: Visual Impact
Fauna **62**. The Lessee must, in constructing and operating the lease and post mine closure, ensure that there are no net adverse impacts from site operations on native fauna in the lease area and in adjacent areas. The lessee must, prior to construction, undertake baseline monitoring of all fauna in the area.	Chapter 5.17: Fauna
Aboriginal Heritage **63.** The Lessee must ensure that all employees and contractors on-site are properly advised of the significance of Aboriginal heritage and culture and are to take due care to preserve all Aboriginal Sites and Objects as defined by the Aboriginal Heritage Act, 1988.	Chapter 19: Aboriginal Heritage Employees and contractors are properly advised of the significance of Aboriginal heritage and culture
Rehabilitation and Mine Closure **64.** The Lessee must ensure that upon mine closure, all plant and equipment (unless otherwise agreed with the Chief Inspector of Mines) is removed from the site.	Chapter 5.16: Visual Impact Appendix C: Closure Plan
65. The Lessee must ensure that upon mine closure, the site (including the Tailings Storage Facility) is left in a stable, non-polluting state indefinitely post closure.	Chapter 5.8 Acid mine Drainage Appendix C: Closure Plan
66. The Lessee must ensure that upon mine closure, the site is returned to a land use as agreed with the landowner, consistent with practicalities of ensuring the Integrity of the TSF and consistent with the Alexandrina Council Development Plan after consulting with the Strathalbyn Community Consultation Committee.	Chapter 3.6: Mine Completion Appendix C: Closure Plan
67. The Lessee must ensure that upon mine closure, the decline under the Strathalbyn - Callington Road is to be backfilled in a manner to ensure the long term Integrity of the public road structure.	Chapter 5.15: Geotechnical Stability

Mining Lease 6229 Conditions	Where conditions are addressed in the PEPR or how they will be complied with
68. The Lessee must ensure that the MARP includes measurable completion criteria for the mine site and must include measures to indicate that the stability and Integrity of the site (including the TSF) is likely to continue to be met indefinitely into the future.	Chapter 5: Environmental Outcomes
69. The Lessee must ensure that the area of the TSF and a 10m wide buffer on all sides is protected in perpetuity from development that may affect the Integrity of the TSF design. This protection must include a caveat on the relevant freehold land title.	Chapter 5.8: Acid Mine Drainage Appendix C: Closure Plan
Financial Security **70**. The Lessee must, before commencing operations under this lease, lodge a Rehabilitation Bond (Bond) In accordance with Section 62 of the Mining Act, 1971 of such an amount of the surety as determined from time to time by the Minister, to cover the full cost of rehabilitation liability assessed by an Independent third party at any time.	Chapter 3.6.2: Rehabilitation Liability Estimate
74. To enable consideration of whether or not the completion criteria have been met, the Lessee must provide an independent audit of the achievement of the completion criteria, to be carried out by an independent auditor approved by the Minister.	Terramin will provide an independent audit of the achievement of the completion criteria
75. The Lessee must, prior to commencing operations under this lease and for the duration of the lease, maintain public liability insurance to cover operations under the lease (including sudden and accidental pollution) in the name of the Lessee for a sum not less than $50 million or such greater sum as specified by the Chief Inspector of Mines, and make such amendments to the terms and conditions of the insurance as the Chief Inspector of Mines may require.	Chapter 3.6.2: Rehabilitation liability Estimate

8 DESCRIPTION OF THE RECEIVING ENVIRONMENT

8.1 LOCAL COMMUNITY

Demographics

Strathalbyn is in a fast growing region, with the plan to double the Strathalbyn population of the township from 8,500 people in 2007, to 17,000 people by 2022. The mine site is not located in the planned area for urban growth (Figure 47).

The proximity of the wider Strathalbyn region to Adelaide, the coastal Fleurieu network of towns and to Murray Bridge makes it an ideal location for living. The viticulture industry, the rural setting of places in the Strathalbyn District, water activities, wineries, art, craft and antiques combine to enhance the appeal of the town.

Employment in manufacturing, agriculture and viticulture, personal services, is contributing to sustained population and employment growth.

Demographic Profile

There are three important features to describe the changing demographic profile of the Strathalbyn District:

1 Strathalbyn's population grew more rapidly in the period 1991 to 2001 than South Australia and South Australia non-metropolitan regions;

2 The composition of the population shows more younger people (0-14 years) and fewer persons aged 65 years; and

3 The median age of the working population of 39 years (SA: 37 years).

Income

Average annual taxable income for the Fleurieu Peninsula, in which Strathalbyn is situated, is $28,661. This is lower than other regions of the state. In comparison, the individual annual taxable income for SA is $32,863 while regional SA has $30,674 (ATO 2000).

Educational qualifications

A notable feature of the Fleurieu region is the high level of educational qualifications amongst the residents relative to the rest of South Australia (Keeping Pace Report, Dec 2001) (Figure 48). The mine can recruit from this pool of skilled employees.

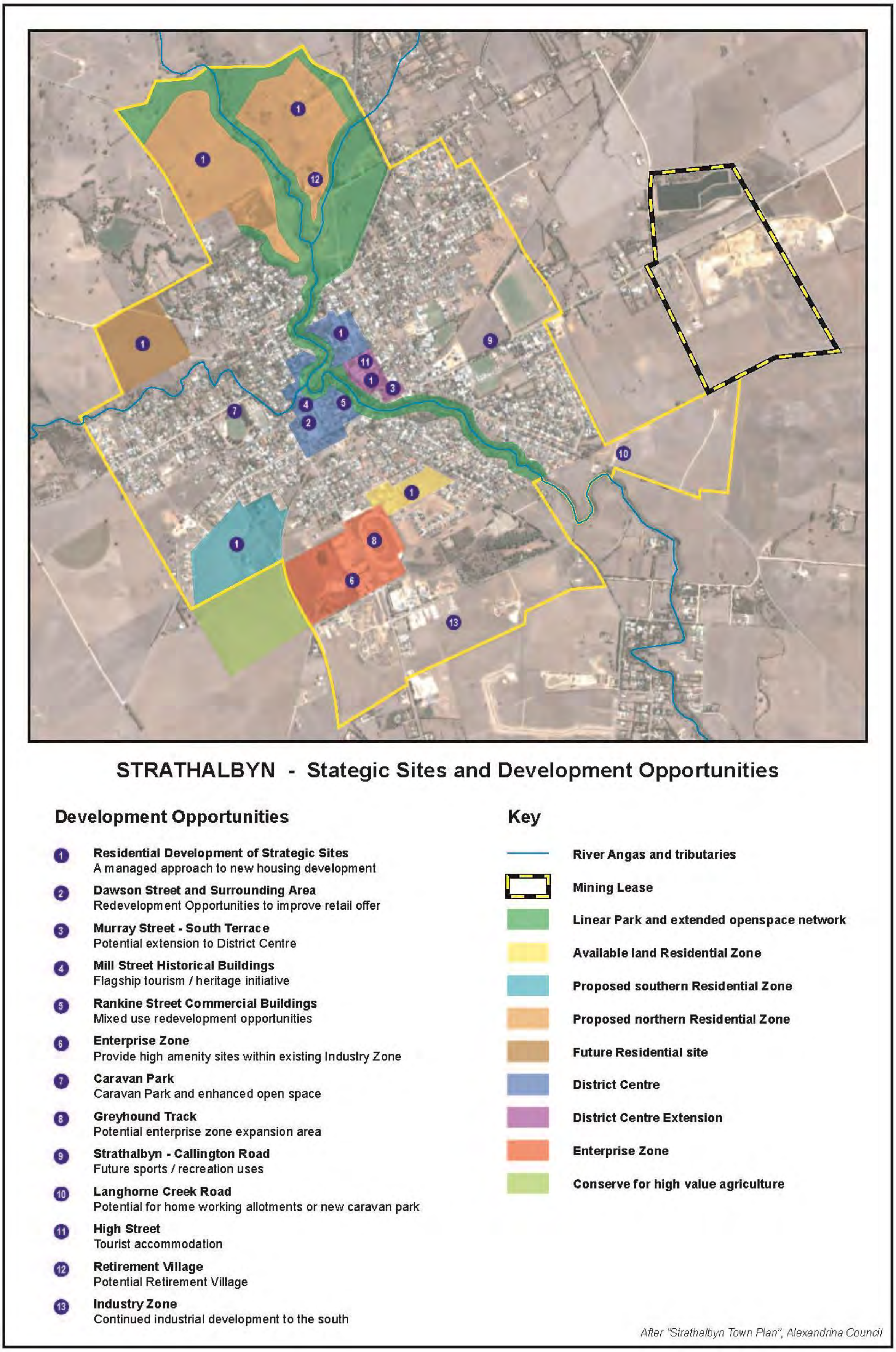

Figure 47: Alexandrina Council Plan for Strathalbyn 2020

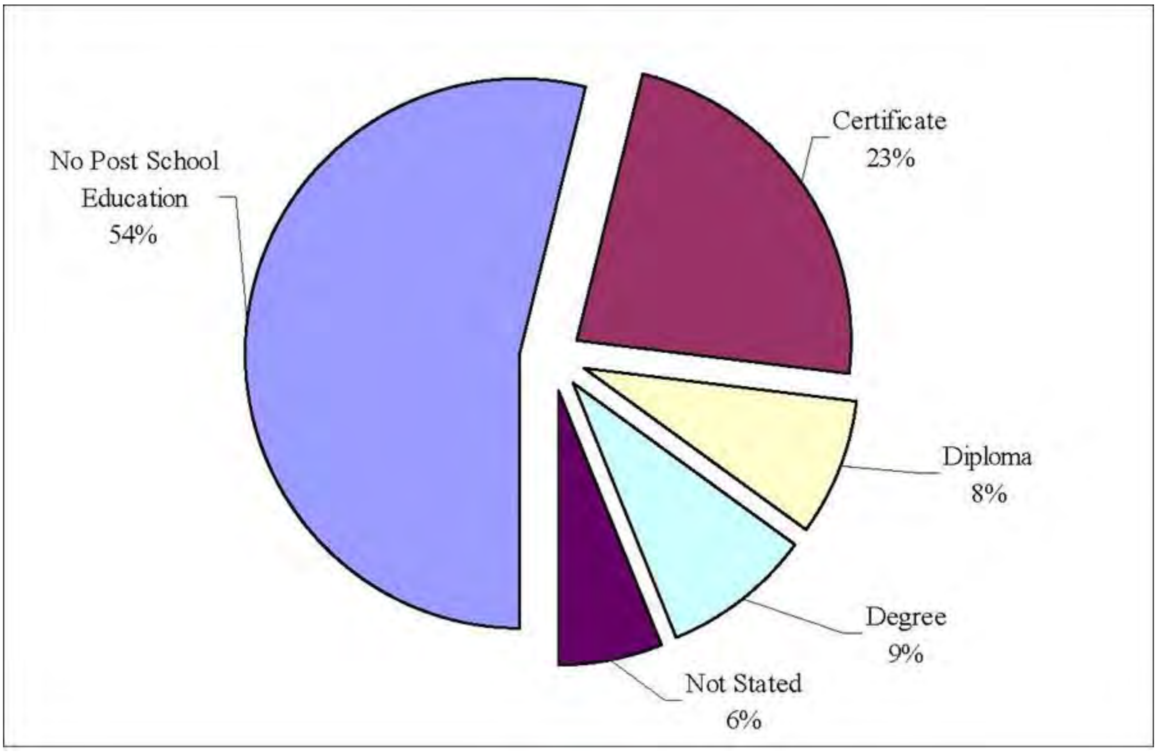

Figure 48: Qualification Source: ABS (2001) Census of Population and Housing

8.2 LAND USE

As can be seen in Figure 17, the ML 6229 covers an area which was used for a number of activities in 2007:

- part of the Callington Road
- the Strathalbyn Septic Tank Effluent Disposal System (STEDS) lagoons
- a prominent ridge trending approximately east-west, on which are located an extractive minerals quarry, industrial waste landfill and several houses.

Several portions of land to the north and south of the STEDS lagoons, ridge and quarry were also used for cereal cropping and grazing.

Pre-Mining Structures on Mining Lease

The Callington Road dissects the ML and separates the North Domain from the Central Domain (Figure 17) for descriptions of these Domains. Swamp Road is outside the ML but runs along the western side of the ML north of the Callington Road.

An 11kV Power transmission line runs through the ML adjacent and parallel to Callington Road. A 66kV power transmission line runs North-South inside the western boundary of the ML, crossing the STEDS lagoons, Callington Road and between the houses of Lot 7 and Lot 8.

Garwood Earthmoving operated the quarry previously situated on the ML (Figure 49) to extract limestone (calcrete) and sand to provide materials for their earthmoving business and for sale under EML 5325. Associated with the quarry was a crushing plant (Figure 50), several sheds for the storage and maintenance of the quarrying fleet, diesel tanks and a weighbridge. A large shed was partly constructed on the site. An overhead power line provided power to the crushing plant, one of the sheds and to the farm house mentioned below.

To the north of Callington Road, the Alexandrina Council operate the town STEDS Lagoons. These lagoons are man-made structures, shallow at 1 to 2 metres and have been constructed in a pre-existing swamp.

There are 4 houses located on the ML, all owned by Terramin. Associated with one house are two pig sheds, currently being used by Terramin for drill core storage, and a number of farm sheds and buildings. Associated with these houses are residential sheds, standard power, water and telephone connections.

There was no change in the land use in the Northern and Buffer Domains from pre-mining, i.e. residential, grazing, cropping and the STEDS lagoon facility. Quarrying activity under EML5325 has ceased during operation of the mine under ML6229.

Figure 49: pre-mining Site Showing Sand and Limestone Quarry

Figure 50: Pre-mining Site Showing Crushing and Screening Plant

8.3 PROXIMITY TO INFRASTRUCTURE AND HOUSING

There are 4 houses on the ML and 16 houses within 1,000m of the processing plant. All houses on the ML are owned by Terramin.

8.4 AMENITY

Annual photo monitoring at 10 sites, as shown in Figure 39 demonstrate visual amenity (including rubbish) has improved from the baseline photos shown in plates 1-10 of the PEPR.

8.5 NOISE, DUST, AIR QUALITY

Dust

The site and surrounding area had pre-existing dust emissions arising from the quarry and two licensed landfills (Figure 51).

Figure 51: Dust Emissions from Quarrying Operations

Pre-mining, Tonkin were commissioned to undertake a Dust Baseline Study (Appendix H). The objectives of their work were:

- To provide an assessment of existing and likely airborne and surface dust issues, proposed dust monitoring and control strategies during mining, in sufficient detail to successfully support the ML application and the preparation of a MARP.
- To provide a robust and defensible baseline survey of existing soil contamination and airborne dust concentration contents, especially lead and other associated heavy metals, and to plan an ongoing monitoring program to demonstrate that AZM operations do not cause a degradation of the existing environment.

Two methods of dust sampling were used:

- High volume air samplers. Two samplers were used to assess dust levels over a twenty four hour period every six days. The samplers measured total suspended particulates (TSP) and the respirable dust fraction (PM10).
- Dust deposition gauges. These simple dust gauges collect fallout over a period of one month.

The location of the two types of gauges is shown in Figure 44.

Results for the Dust Baseline Study revealed levels exceeding the SA EPA criteria of 120mg/m^3 for TSP (Table 52). The probability is that the exceedances were caused by the quarrying alternatives. Similarly the Dust Definition Gauge results were more reminiscent of light industrial levels rather than the rural classification expected (Figure 52). The SA EPA guidelines which link measured dust deposition rates with land use are given in Table 44. The baseline dust results appeared in line with observed operations of the site and the equipment used. Note; these guidelines were discontinued about 25 years ago since dustfall is classed as an amenity problem, not a health problem. There is currently no legislation/policy stating deposition limits to be adhered to.

Date	24 Hour		9am		3pm	
	Ave TSP (mg/m^3)	Rain (mm)	Wind Direction	Wind Speed (km/hr)	Wind Direction	Wind Speed (km/hr)
15/03/2006	136.2	0	Calm	Calm	SSW	24
21/03/2006	474.5	0	SSW	9	S	22
30/03/2006	142.4	0	S	17	SSW	20
05/04/2006	154.2	3.8	W	24	WSW	39
17/05/2006	135.7	0	NW	4	SSW	11

Table 52: Hi-Vol TSP Readings Exceeding 120mg/M3 - March 2006 to May 2006

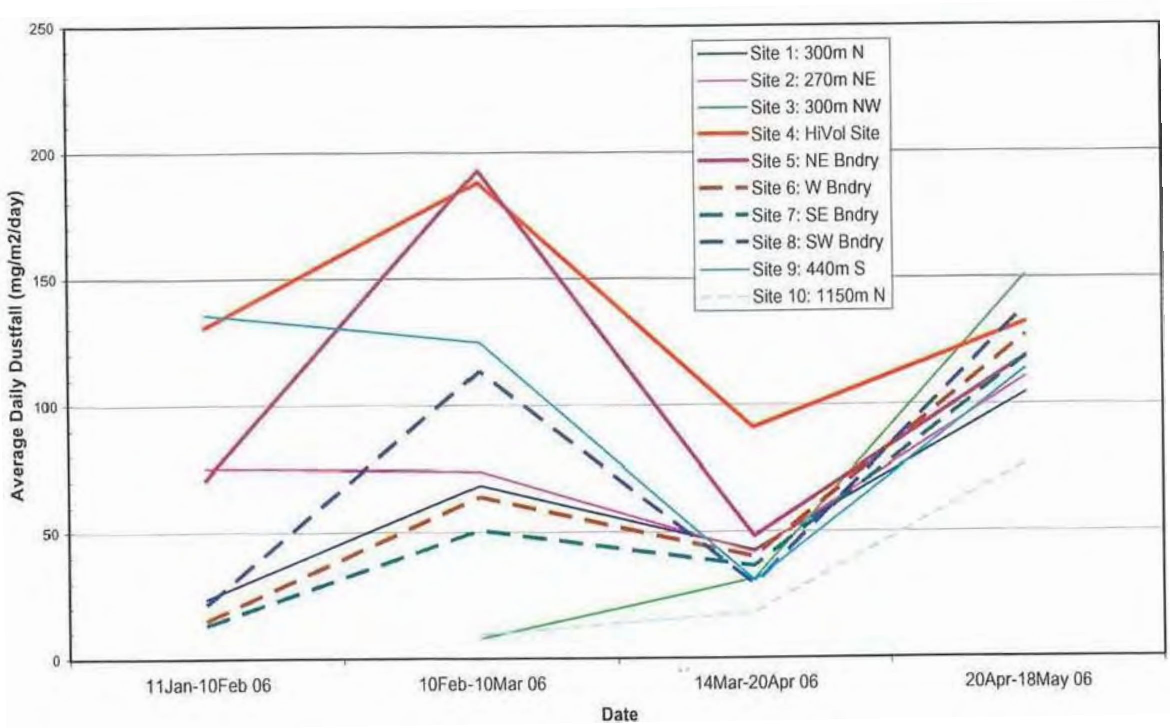

Figure 52: Average Daily Dustfall (Total Insoluble Solids) by Month

Classification	Dust fall (Water Insoluble Solids, mg/m2/day)
Rural	13 - 65
Residential	40 - 90
Light Industrial	100 - 160
Heavy Industrial	200 - 350

Table 53: EPA SA Guideline Ranges for Dust Deposition Rates

Potential Gaseous Atmospheric Emissions with Greenhouse Potential

The environmental consequences of greenhouse gas (GHG) emission are recognised to be of national and global concern, with local consequences. Terramin are committed to the principles of sustainable development. As such, and with regards to the global recognition of the risks faced by global warming, an audit of potential mitigation options for greenhouse gas emissions was generated by the mine.

The audit was conducted within the terms described by The Greenhouse Gas Protocol: a corporate accounting and reporting standard (World Resources Institute, 2005) and the Australian Greenhouse Office Greenhouse Methods and Factors Workbook (December 2005), which has been modified from previous versions to conform to the WRI approach. The value of GHG accounting is that it assists in determining the sustainability of a project, as well as assists in examining the operations to determine if there are areas where improvements in efficiency can save both expenditure and greenhouse emissions.

As the project was not operational at the time of the audit, reporting of greenhouse emissions and reporting here is based upon estimates. Although all efforts were made to ensure the estimates are as accurate as possible, there is the potential for error. Thus, no values should be considered to be precise, but within a range of values ±15%.

The majority of GHG emissions for the project are based on the Scope 2 electricity usage data. These data are provided in Table 54. Conversions are based on current SA grid electricity conversions supplied by AGO (NO_x conversion supplied by IPCC). The projected annual usage of explosives (ANFO) is based on 1.5t/day*365 days/year = 547.5t/year. Conversion factors supplied by Orica, reported by National Pollutant Inventory Emission Estimation Technique Manual for Explosive Detonations & Firing Ranges. Environment Australia first published March 1999.

Aspect	Units	Conversion	$tC0_2^{-e}$ per year
Crushing	1541760 kWh	1.007	1552
Ore storage/grinding	7209480 kWh	1.007	7259
Floatation	2365200 kWh	1.007	2381
Concentrate thickener	972360 kWh	1.007	979
Reagents	182208 kWh	1.007	183
Water storage/reticulation	429240	1.007	432
Compressed air	788662.8	1.007	794
Mining	8392080	1.007	8450
Blasting- CO_2 b	0.32t Gas/t explosive	1	175
Blasting- NO_x b	0.008t Gas/t explosive	29	127
Vehicles	768 kL diesel	3	2304

Table 54: Scope 2 Electricity Usage Data

8.6 TOPOGRAPHY AND LANDSCAPE

The Strathalbyn region is around 50 to 80m above sea level. Most slopes are less than 2% while the steepest slopes are rarely greater than 10%.

The topography of the ML and surrounding area is shown in Figure 53. A ridge extends across the ML in an approximate east/west direction to the south of Callington Road. This ridge divides the ML into northern and southern catchments and reaches an elevation of about 85m Australian Height Datum (AHD). South of the ridge, elevation decreases across the ML to an elevation of about 60m AHD in a broad flat area used for grazing and cropping. Further south and east (and outside the ML), the land surface rises again to another bench of calcrete with an elevation of about 90m, and eventually 110m at the eastern boundary of the southern catchment.

In the northern catchment, near the STEDS lagoons, elevations fall to about 70m. North of the STEDS lagoons, elevations once again increase to about 90m AHD at the northern boundary of the ML.

Two notable “valleys” occur in the southern catchment, one in an easterly direction from the ML and the second in a south westerly direction. Both are partly within the ML. The south west valley is the steeper of the two identified by the survey data, and has an average slope of 2%, compared to the easterly valley which has an average slope of 1.5%. Both valleys drain into the south western corner of the ML, whilst a ridge extends along the southern boundary of the catchment. The steepest slope recorded in the survey data occurs in the southern catchment and has a value of approximately 20%. This slope is restricted to a small area directly south of the ML, along the southern catchment boundary.

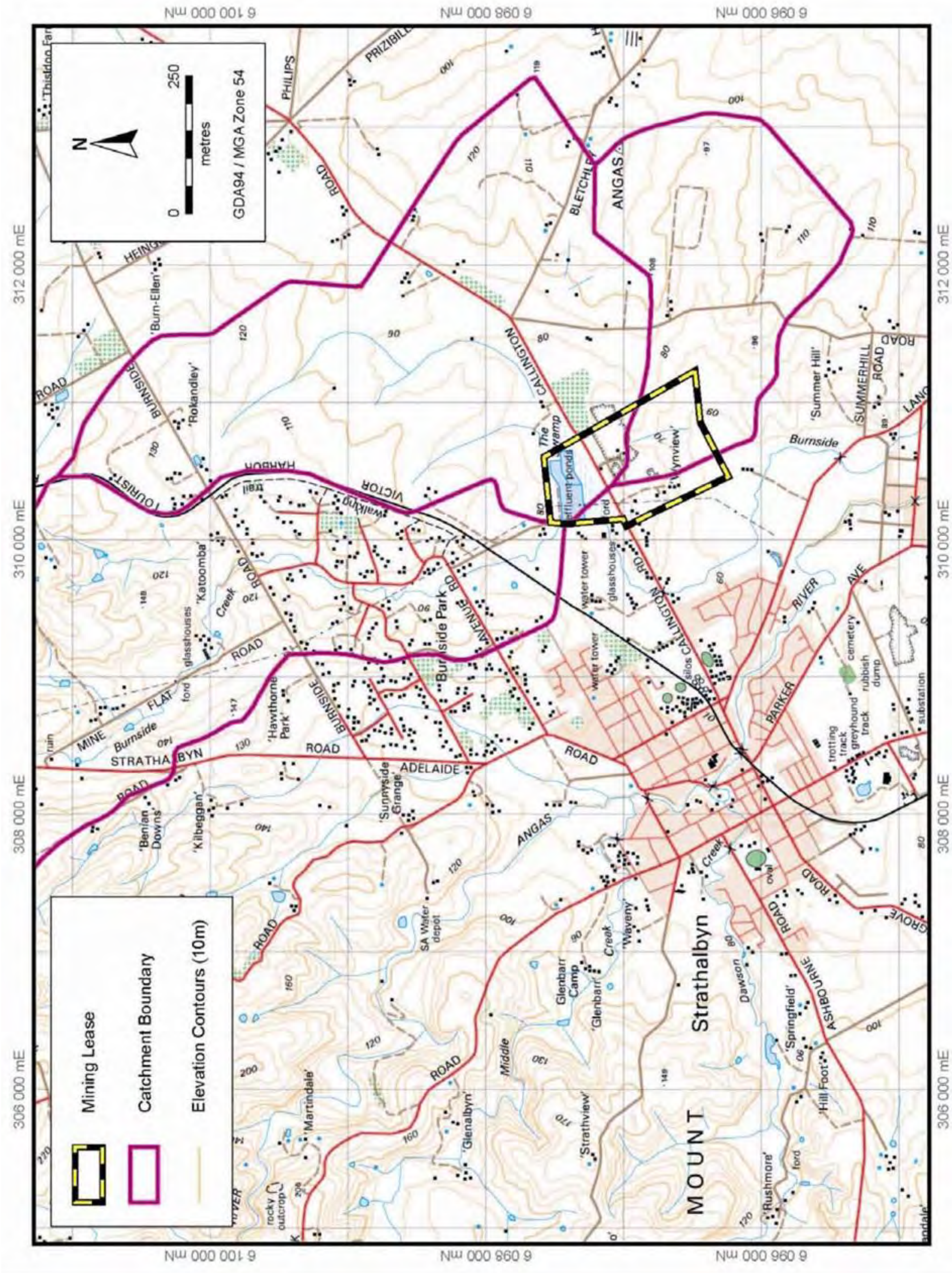

Figure 53: Topography of the ML and Surrounds

8.7 CLIMATE

According to the Keoppen system of measuring climate, which is based on temperature and rainfall according to vegetation in an area, the site is situated on the Fleurieu Peninsula and has a temperate climate. In terms of humidity and temperature, there are warm summers and cool winters in the area. Most of the rainfall occurs in winter. Characteristics of climate are summarized below.

Climatic data was collected from both the Strathalbyn Post Office and Strathalbyn Racecourse as these official monitoring locations collected different sets of data over different periods of time. The Post Office had a significant history of data as described below, while the Racecourse with newer measuring equipment gave a more complete set of information over a shorter time period. The combinations of data used are explained under the following subheadings.

Terramin has installed an onsite weather station to provide site specific data in regard to wind direction, speed, temperatures and rainfall.

Rainfall & Evaporation

At Strathalbyn an annual average rainfall is 493mm. Most of the rain falls in the winter months, at around 34%of the total annual precipitation.

Monthly average rainfall data were analysed for the period 1862 to 2005. This period included a shift in the gauging station in mid-1994, but the two data sets were considered to be adequately similar for them to be combined and used in this review. Evaporation data has not been recorded at either of the Strathalbyn weather stations, so the monthly evaporation data presented here are based on Bureau of Meteorology (BOM) statewide maps. These maps have been prepared using data from approximately 275 recording stations with a minimum 10 years of records using Class A pan evaporimeters. As such, the information presented is not specific to the site, but is considered to be appropriate for inclusion in the PEPR.

Figure 54 presents average monthly rainfall and evaporation for Strathalbyn. Points to note include the following:

- Average monthly evaporation is greater than the average monthly rainfall for January, February, March, April, September, October, November and December;
- Average monthly evaporation is roughly equivalent to the average monthly rainfall in May;
- Average monthly rainfall is greater than the average monthly evaporation in the months of June, July and August;
- The greatest deficit (rainfall minus evaporation) occurs in the summer months with a monthly deficit of between 225 and 150mm;
- The greatest surplus (rainfall minus evaporation) occurs in June with a monthly average surplus of approximately 30mm;
- The highest monthly rainfall on record was 343.5mm, which occurred in April 1889;
- The lowest recorded monthly rainfall is 0mm, and commonly occurs in the months of January, February, March and December.

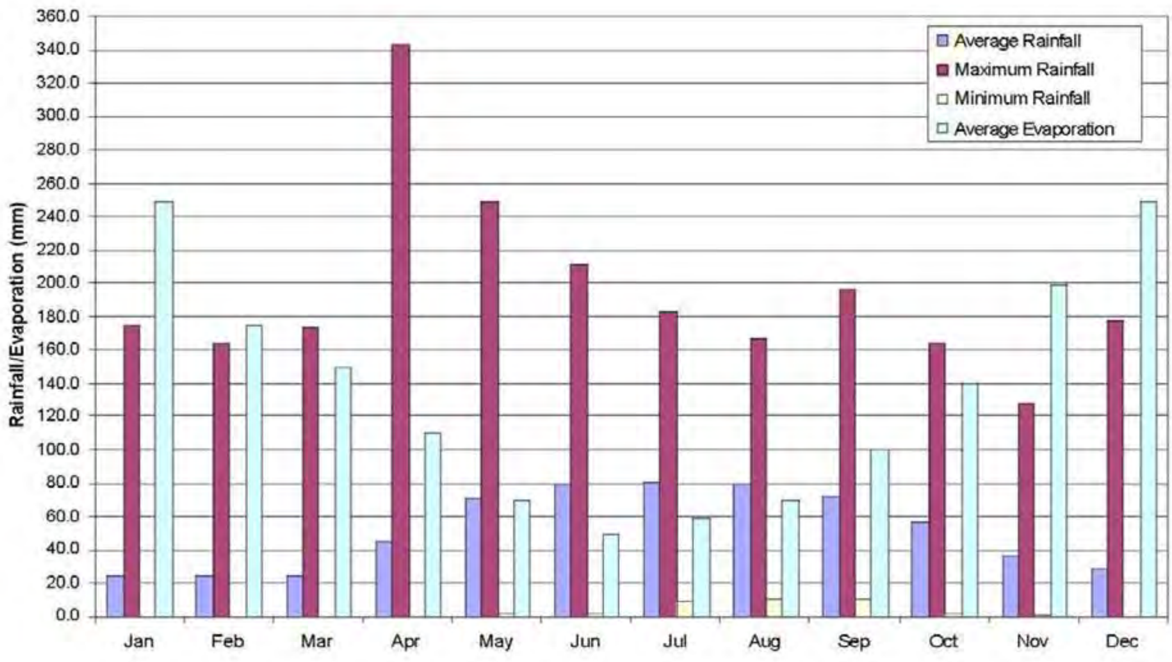

Figure 54: Average Monthly Rainfall and Evaporation

Temperature

The proximity to the coast has a significant influence over the average temperature over the year. Being close to the ocean smooths out the variation in temperature over the year so that summer is cooler and winter is warmer then areas not influenced by the ocean.

During winter average daily maximum temperatures vary between 15°C and 16°C on the eastern plain. In summer average maximum temperatures at Strathalbyn vary between 26°C and 27°C. Mean maximum daily temperatures over the year are provided in Figure 55.

Average daily minimum temperatures in the winter vary from 6°C to 7°C. In summer average minimum temperatures vary between 12°C and 14°C. Frosts are most common during winter where low-lying areas are the most susceptible. Daily temperature data were available for the years 1861 to 2004 and were used to calculate mean monthly minimum and maximum temperatures. Points to note include the following:

- The highest mean monthly temperatures occur in January and February, after which they gradually decline until a minimum is reached in July. After July, temperatures rise again through spring and into summer;
- The highest mean monthly maximum temperature (29.4ºC) occurs in both January and February;
- The lowest mean monthly maximum temperature (14.8ºC) occurs in July;
- The highest mean monthly minimum temperature (13.6ºC) occurs in January;
- The lowest mean monthly minimum temperature (5.9ºC) occurs in July.

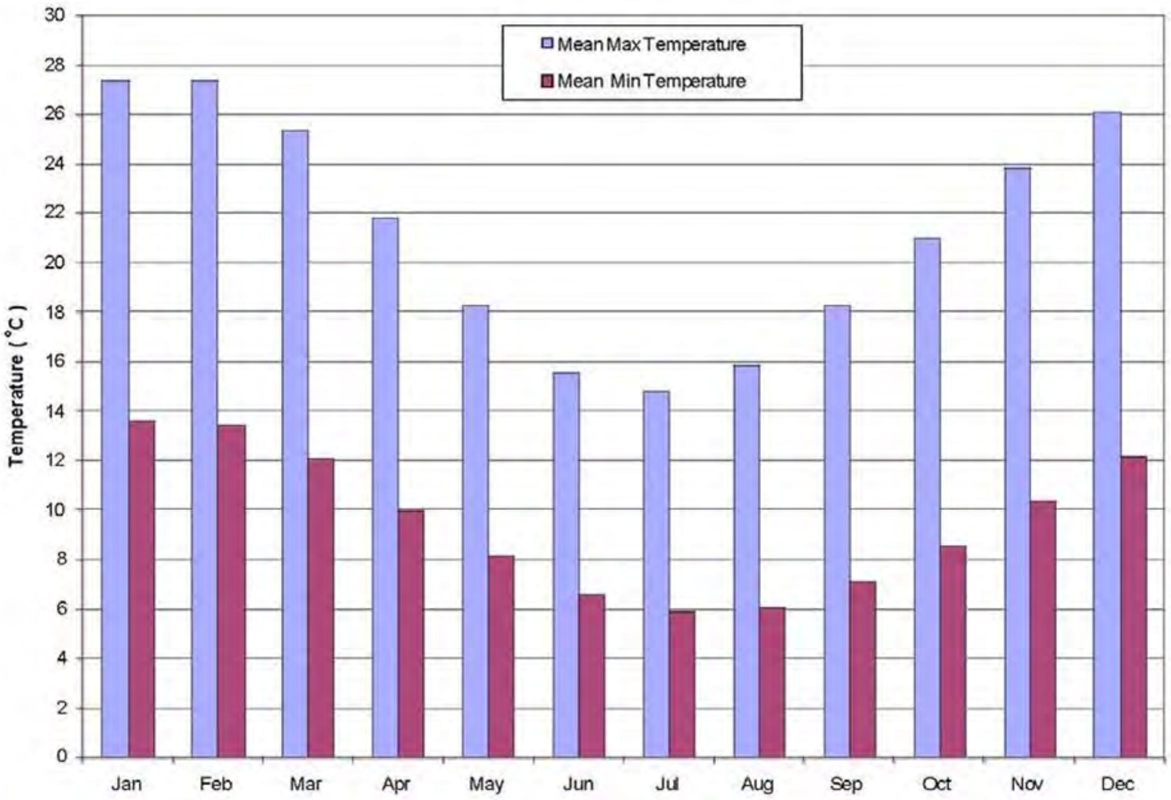

Figure 55: Mean Monthly Maximum and Minimum Temperatures

Cloud Cover

Data recorded at the Strathalbyn post office weather station included details of conditions such as the mean number of clear, cloudy and rain days for each month. Clear days refer to days when the sky is clear from cloud, fog, mist or dust haze. A day is defined as cloudy when there is predominantly more cloud cover than clear sky, for example, during a cloudy day the sun would be obscured by cloud for substantial periods of time. Rain days occur when at least 0.2mm of precipitation is recorded. These data are presented in Figure 56. Points to note include the following:

- The highest mean number of clear days occurs in January and February, each with an average of 9.6 days;
- The lowest mean number of clear days occurs in May with an average of 4.9 days;
- The highest mean number of cloudy days occurs in May with an average of 13.7 days;
- The lowest mean number of cloudy days occurs in February with an average of 7 days;
- The highest mean number of rain days occurs in August with an average of 16 days; and
- The lowest mean number of rain days occurs in February with an average of 4.7 days.

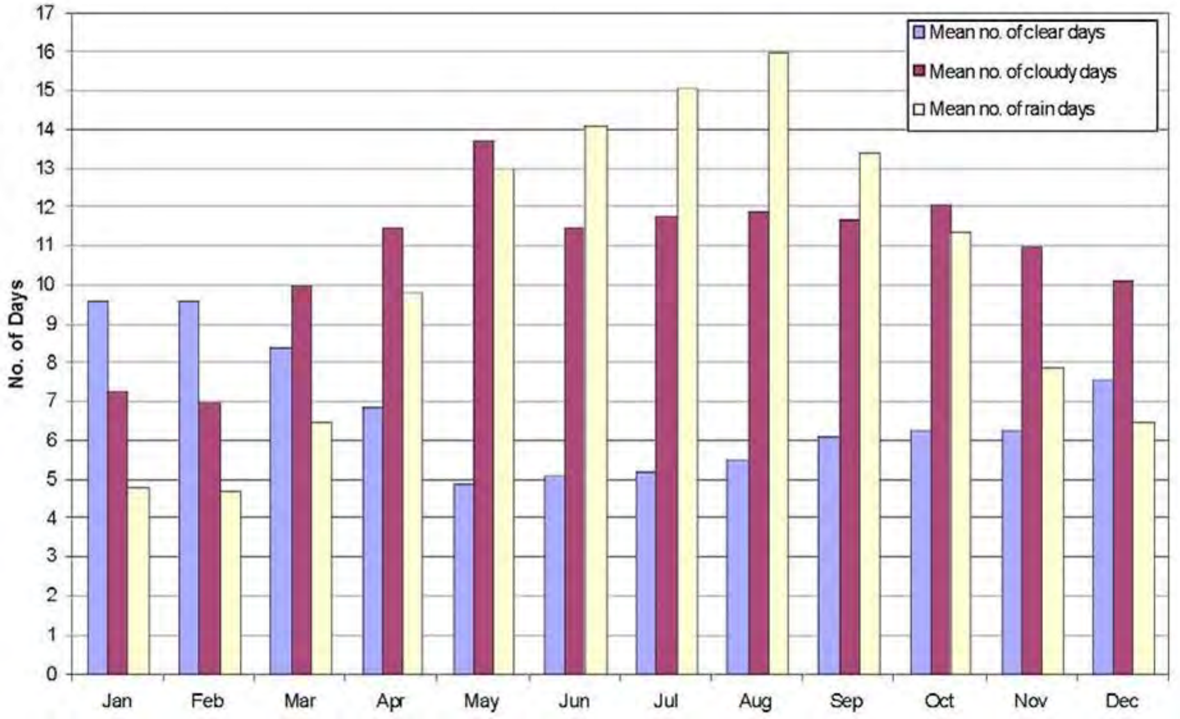

Figure 56: Mean Number of Clear, Cloudy and Rain Days per Month

Wind Speed and Direction

Wind roses, with wind frequency analysis generated using the data from the Strathalbyn Post Office weather station are shown below. The wind roses provide a visual indication of the wind speeds and frequencies recorded in the period 1957 to 2001, and can be considered to be representative of future wind speeds and frequencies likely to occur at the ML. The following points summarise the wind conditions at Strathalbyn on a seasonal basis.

- The 3pm wind speeds are generally greater than the 9am wind speeds,
- In the summer months, 9am winds tend to blow in the easterly, south easterly, southerly or south westerly directions. Only about 10% of the observations recorded in this period are classified as calm, with the most frequent wind speed category being 1- 10km/h. The 3pm wind data indicate that wind blows more commonly in the south westerly, southerly and south easterly directions. Most speeds recorded for the 3pm summer winds fall into the 11-20 and 21-30km/h categories, there being very few records of calm conditions.
- Wind conditions for March are similar to those described above for summer. For April and May however, the predominant wind directions are toward the north-west, the west, the south west, and the south for the 9am readings. The 3pm wind directions also shift toward the north-west, the west, the south west, the south and the south east. For autumn, calm conditions have been recorded for about 22% of the 9am readings and 3% for the afternoon readings. The most frequently recorded wind speed categories are 1- 10km/h and 1-20km/h, for the 9am and 3pm readings respectively.
- 9am winter winds are predominantly toward the north-west, and to lesser extent, towards the west and south west. Conditions were recorded as calm for about 25% of the time, whilst the most frequently experienced band of wind speed is 1 – 10km/h. The 3pm winter winds for the most part are toward the north-west, west and south westerly directions. Approximately 3% of the afternoon readings are calm, whilst the majority of the 3pm wind speeds are recorded as being between 1 and 10km/h.

- In the spring, wind directions are mainly toward north-west, west and south west, with an increasing frequency toward the south westerly direction and for the 9am data, a more even distribution across the remaining wind directions as summer is approached. Approximately 8% of 9am readings are classified as calm. In the afternoons, the wind direction is shown to shift most commonly to toward the north westerly, westerly, south westerly, southerly, and south easterly directions (similar to that experienced in autumn conditions). 1% of 3pm readings are classified as calm. Wind speeds of 11-20km/h are common at 3pm in the spring.

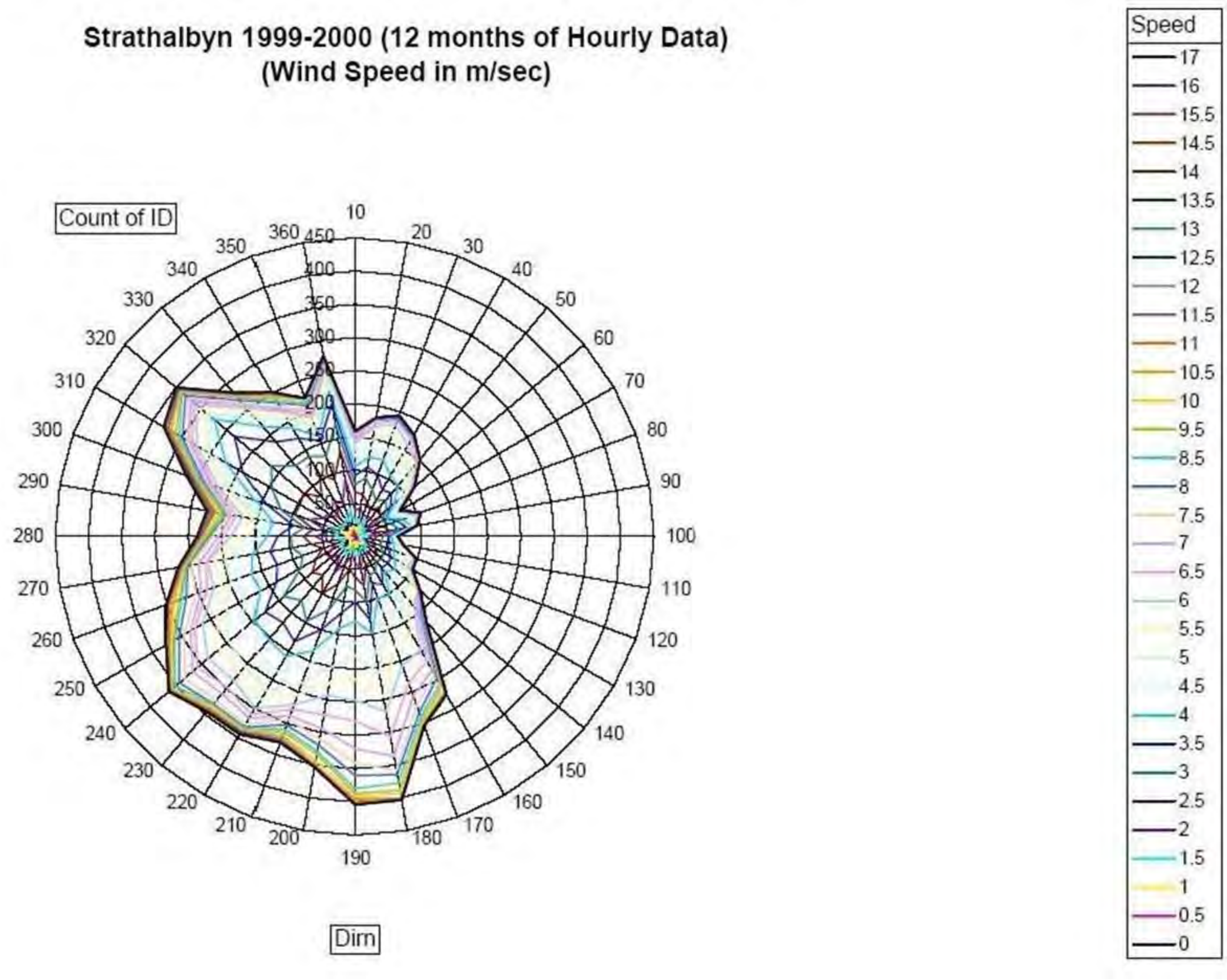

Figure 57: Wind Speed

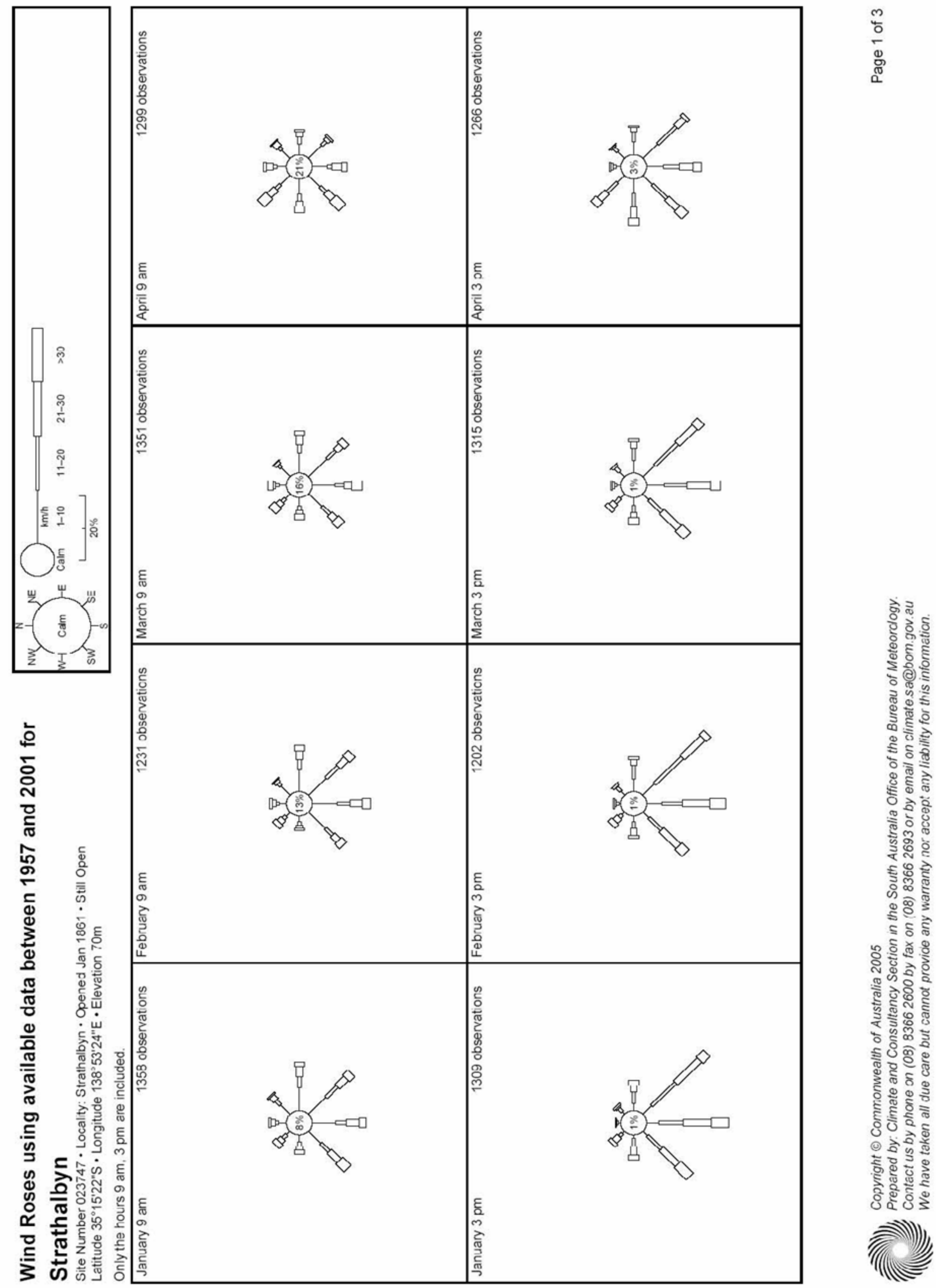

Figure 58: Wind Chart 1

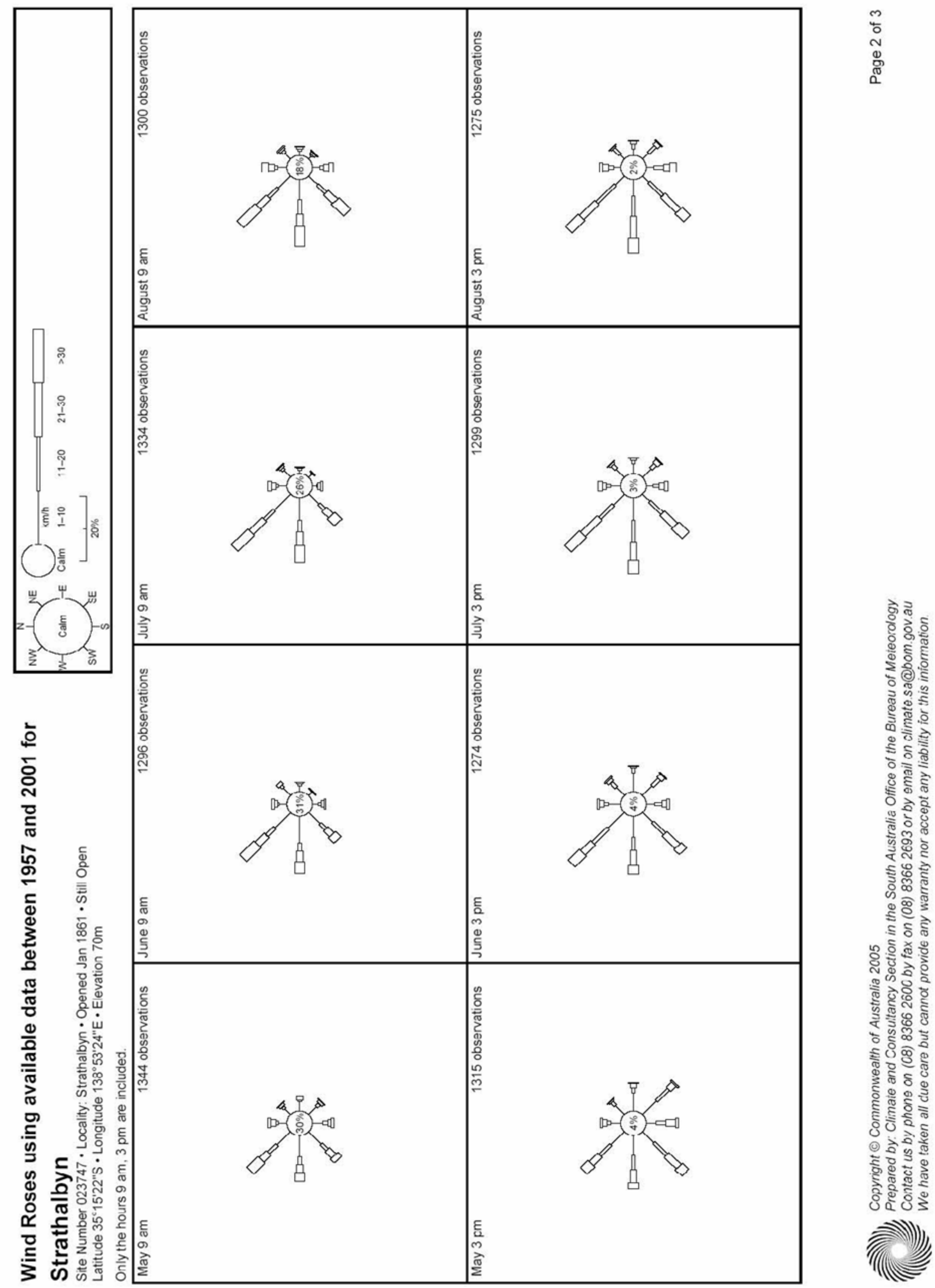

Figure 59: Wind Chart 2

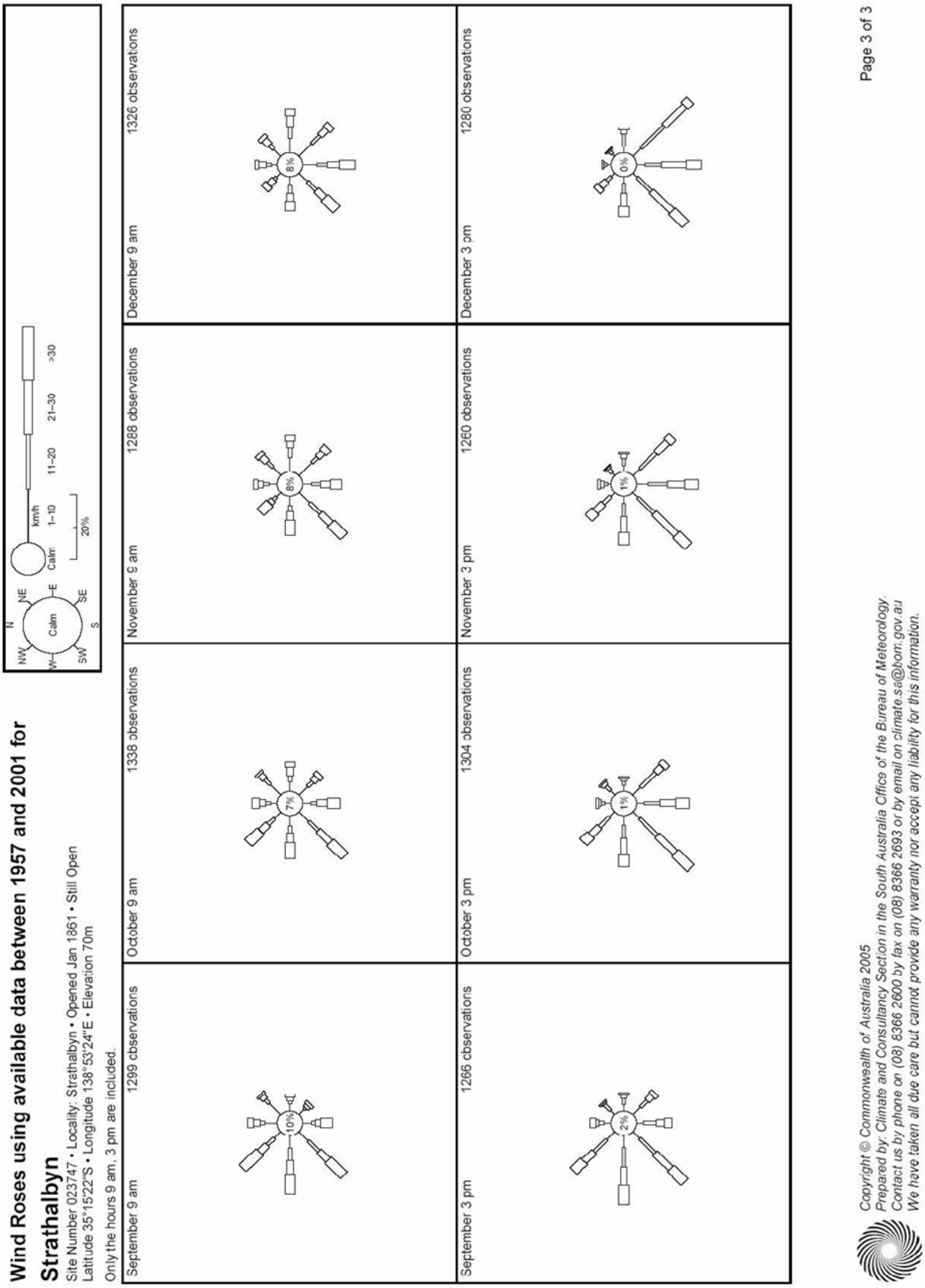

Figure 60: Wind Chart 3

8.8 GEOHAZARDS

AZM lies in the Fleurieu Peninsula/Adelaide Hills region. Faulting is active along the west side of the Mount Lofty Ranges and locally on the east side, within the Angas-Bremer plains. In Australian terms, the area is relatively seismically active, and there is a moderate risk of a low order earthquake. The AZM TSF is expected to experience earthquake intensities of Modified Mercalli scale (MM) of 6 (i.e. when standard housing starts to experience damage) approximately every 200 to 300 years (Appendix Z). Work by Coffey Mining (Coffey) (Appendix T) indicates that the ground conditions are generally good to fair and the orebody and wall rock will be stable provided the specified span limitations and ground support are complied with.

8.9 HYDROLOGY

Regional

The Angas River, located 1km from site, helps to meet the water requirements of Strathalbyn's population of 8,500 people. It flows east from the hills across the eastern plains to Lake Alexandrina, which is a significant freshwater source in this part of the Fleurieu catchment area. Dams are common in the area due to the land use being mainly agricultural. Water is used for stock, domestic purposes and irrigation.

The ML is located in the River Murray Catchment Water Management Board boundary. Water use in excess of the aquifer replenishment rate has led to increased salinity in the area and decreasing water levels. The mine is not expected to impact on the regional aquifers.

Surface Hydrology

In terms of surface water and runoff, the AZM ML can be considered to occur partly within 2 sub catchments of the Angas River. These are referred to in this document as the northern and southern catchments (Figure 61). In previous studies there was some uncertainty with respect to the contribution of a third catchment referred to as the Burnside Park catchment. Following a review of the available survey data and subsequent site visits, it has been concluded that the Burnside Park catchment occurs immediately to the west of the ML and therefore does not impact the ML nor will it likely be directly impacted by mining activities. Therefore, this study has only considered the northern and southern catchments.

The northern catchment includes portions of the Callington Road, the northern flanks of the ridge in the centre of the ML (mine portal and processing facility and the STEDS lagoons. The northern catchment extends to the east of the ML for about 2.5km and to the north for about 4km. It is shown on topographic maps as including 2 drainage lines (ephemeral watercourses) falling approximately north to south that drain into the swamp at the eastern end of the STEDS lagoons and then join the watercourse from the Burnside Park catchment immediately west of the STEDS lagoons. The Burnside Park catchment watercourse (occurring outside the ML) forms a tributary of the Angas River, and joins that watercourse approximately 4km southeast of the Strathalbyn Post Office (straight line distance). The total area of the northern catchment is approximately 730ha, with the majority of the catchment lying outside the ML to the north and east.

The southern catchment includes the catchment for the TSF, and includes the southern flank of the ridge in the centre of the ML and large tracts of grazing and cropping land to the south of the central ridge. The southern and eastern parts of this catchment lie outside the ML, and extend eastward and southward from the ML by approximately 2.5km and 1.3km respectively. The southern catchment does not include any clearly defined watercourses (permanent or ephemeral), and surface runoff from the southern catchment discharges to the southwest, via a broad flat area, directly into the same creek detailed for the northern catchment (see above) and hence also to the Angas River. The total area of this catchment is approximately 310ha. Modelling was undertaken to show the extent of a 100 year flood extent across the flood plain (Appendix M2), with Figure 33 showing the extent over the southern catchment.

Each of the catchments outlined above have been characterised according to their area, topography and dimensions. These parameters have been applied to carry out preliminary hydrological calculations, based on the Rational Method outlined in Australian Rainfall and Runoff (AR&R – Book 4, 2001). These calculations have been summarised in Table below:

The STEDS lagoons were placed in the current location by the Alexandrina Council, who were unaware that an orebody outcropped immediately in this location. The operation and responsibility for these lagoons rests with the Alexandrina Council.

Catchment	Critical Storm Duration (hours)	Approximate Peak Flow (m3/s) for standard Average Recurrence Intervals (ARIs)	Storm flow volume (order of magnitude estimate, ML)
Northern	36	10 year ARI = 0.94 20 year ARI = 1.19 50 year ARI = 1.50 100 year ARI = 1.85	123 156 197 242
Southern	63	10 year ARI = 0.60 20 year ARI = 0.76 50 year ARI = 0.96 100 year ARI = 1.18	45 57 73 89
Burnside Park	21	10 year ARI = 1.40 20 year ARI = 2.68 50 year ARI = 2.24 100 year ARI = 2.77	319 407 511 633

Table 55: Summary of Hydrological Calculations

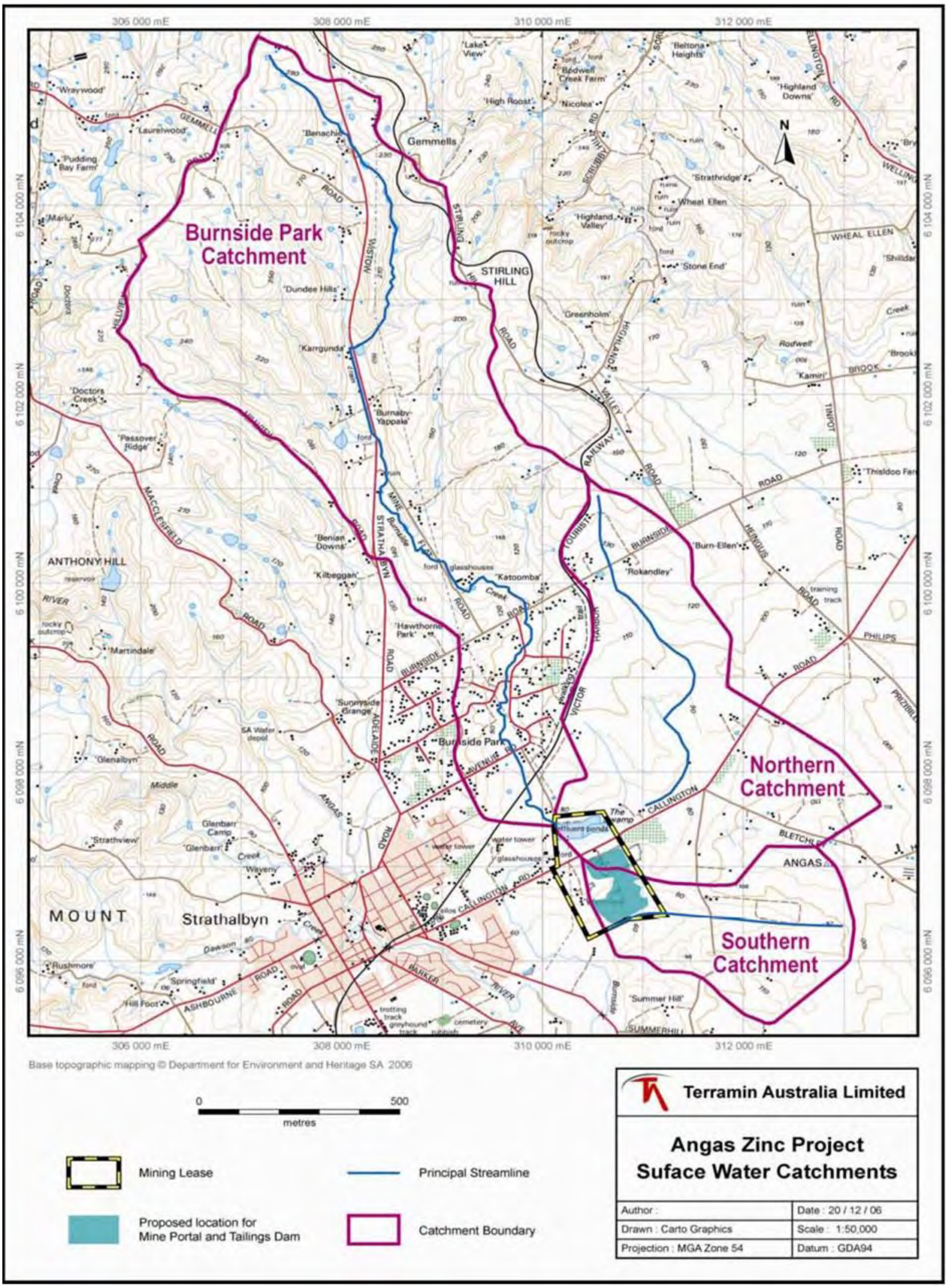

Figure 61: Catchments Influencing Lease

8.10 GROUNDWATER

Introduction

This section is in two parts. The first part describes the physical attributes of the groundwater system in an around the ML. The second part reports on the results of the initial testing for groundwater quality.

Data relevant to the local hydrogeological regime has been derived from the following sources:

- re-logging of exploration drill hole core,
- pump-out test data from trials on a number of exploration drill holes,
- data from a series of groundwater monitoring bores established during 2006,
- data from bores established to investigate STEDS lagoon leakage,
- information from the Department of Water, Land, Biodiversity and Conservation (DWLBC) Drillhole Enquiry System (DES) database,
- PIRSA geological maps and reports,
- Bureau of Rural Sciences (BRS) ADELAIDE–BARKER 1:250,000 hydrogeological map sheet, and assessments conducted for Terramin by Australian Water Environments (AWE) and Australian Tailings Consultants Pty Ltd (ATC).

Geology & Topography

The relationship of the mineralisation to the basement Cambrian Kanmantoo Group rocks is described in Section 3.2.1. In the vicinity of AZM, the basement schists strike north-south and dip steeply eastwards.

Basement rocks subcrop beneath the northern and south-western parts of the ML. The central and south-eastern parts of the ML are underlain by Tertiary and Quaternary limestone, sand and subordinate clay that unconformably overlie the Cambrian basement schists. The base of the Tertiary is marked by an irregular layer (generally less than 5m thick) of unconsolidated gravel. Figure 62 shows the extent of Tertiary cover in the area of the ML.

The Tertiary sand and limestone forms a 15–20m high ridge that runs east-west through the centre of the ML. The ridge rises to a height of about 80m above sea level (about 30m above the flood plain of the Angas River). The limestone and sand have been quarried for road base and construction materials. Locally, there is a veneer (up to about 5m thick) of Quaternary alluvium, soil and calcrete.

Part of the North Domain is occupied by the STEDS lagoons. These lagoons were constructed in part of ‘Tucker’s Lagoon’, a local freshwater wetland area. The flat floodplain of the Angas River lies beyond the south-western corner of the ML. Figure 33 shows the modelled 100 year flood plain extent encroaching into the south western corner of the ML (shown in red).

Hydrogeology (Appendix N)

Most hydrogeological information has been derived from drilling. Because all exploration holes are relatively narrow, nearly all were inclined, and many have been grouted and backfilled, few exploration holes were amenable to groundwater investigations. Therefore, a number of dedicated water bores were established to test the groundwater.

Figure 63 shows the location of registered auger holes and test bores in the area as listed by the DWLBC’s DES database. Few are production wells. Those within the area of the ML have been installed by Terramin (Figure 38).

Figure 64 shows a north–south section of the aquifers and geology on the ML. A fractured rock aquifer exists in the basement rocks at relatively shallow depth in the ill-defined zone of partial weathering, below a near-surface clay layer and above unweathered crystalline basement.

The unweathered basement schistose rocks at depth are impermeable and largely un-fractured. Although the microscopic pore spaces between the metamorphic minerals would be saturated with groundwater, the pores would not be connected. Fractures are rare and largely unconnected. Over geological time, groundwater flows through the schistose rocks at an incrementally slow rate. These rocks have a very low hydraulic conductivity.

Near the surface, intense weathering has affected the basement rocks to a depth of about 15–20m. The basement rocks have been altered to kaolin-rich clay. Although the clay layer may be saturated in part, it also has very low hydraulic conductivity.

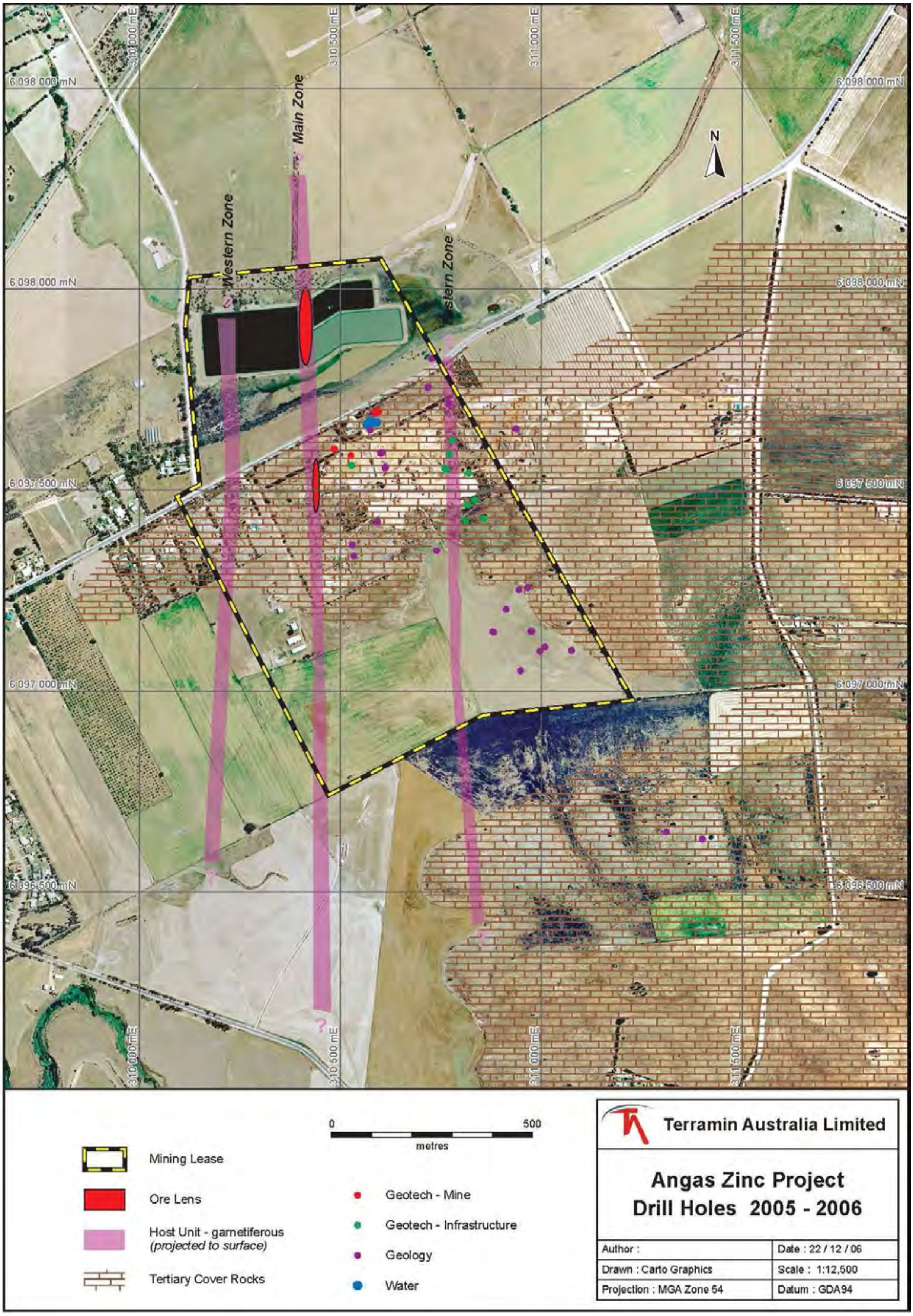

Figure 62: Extent of Tertiary Cover

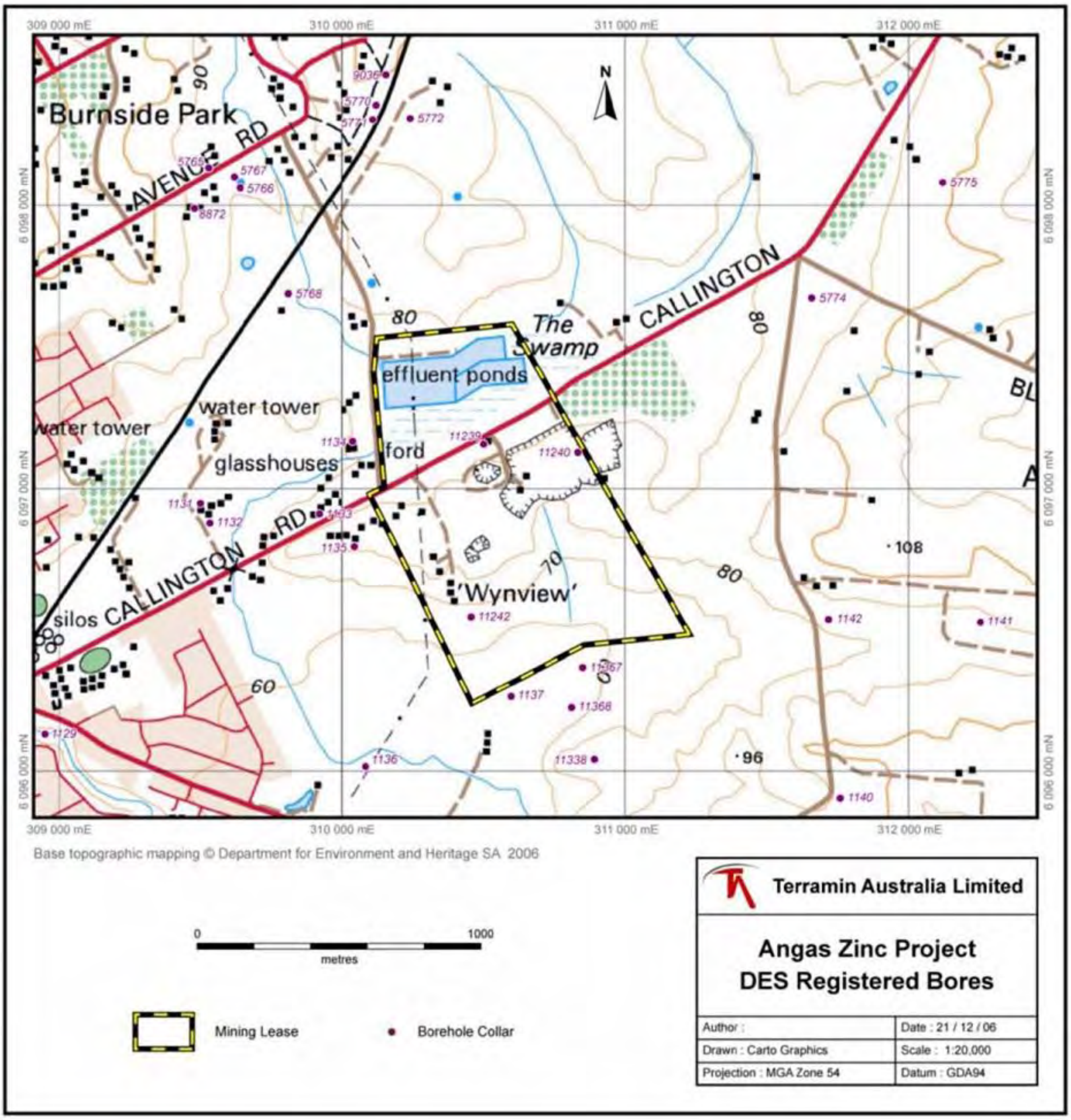

Figure 63: Registered Test Bores and Auger Holes in the DWLBC DES Database

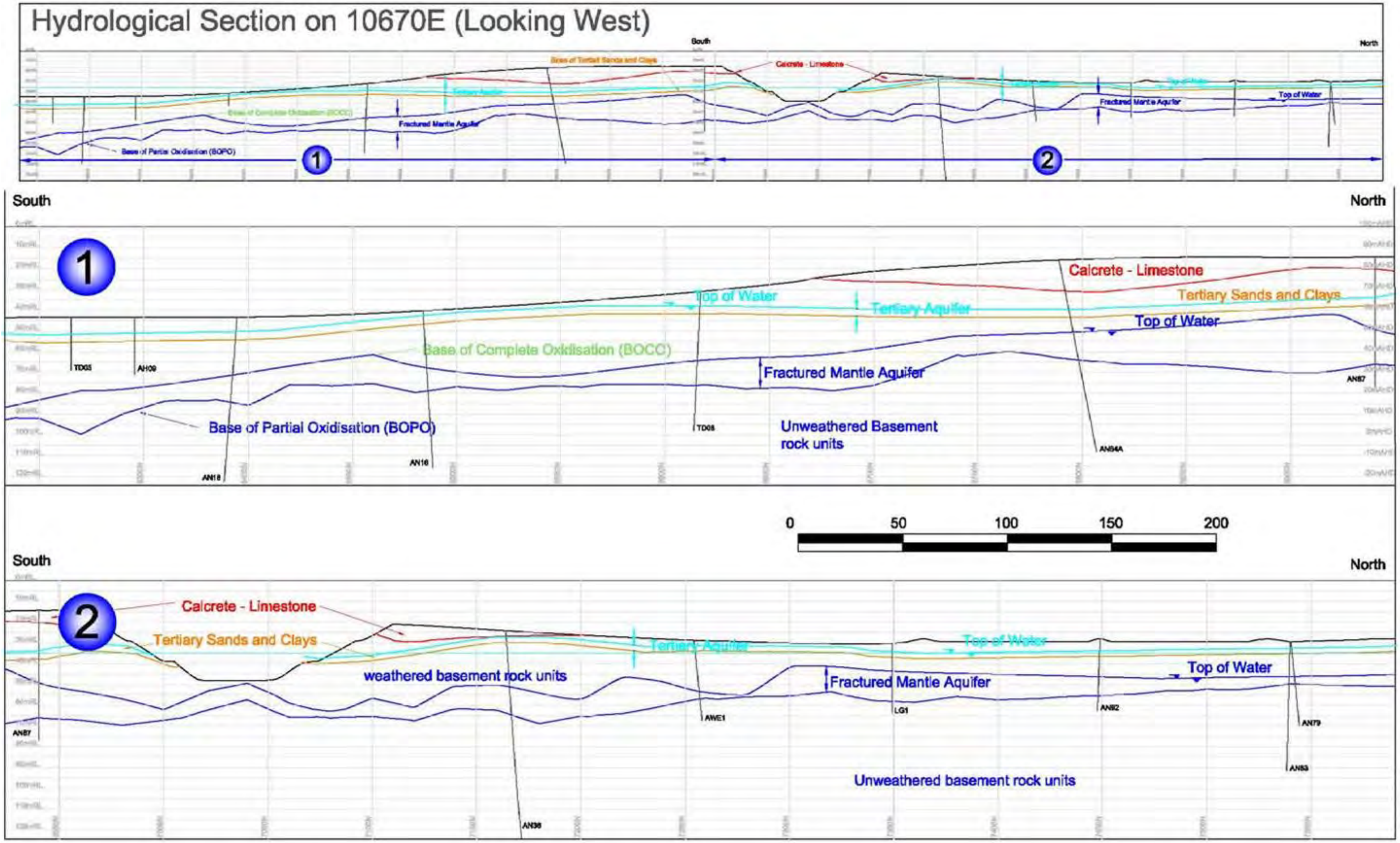

Figure 64: Section Showing the Fractured Mantle Aquifer and Local Geology

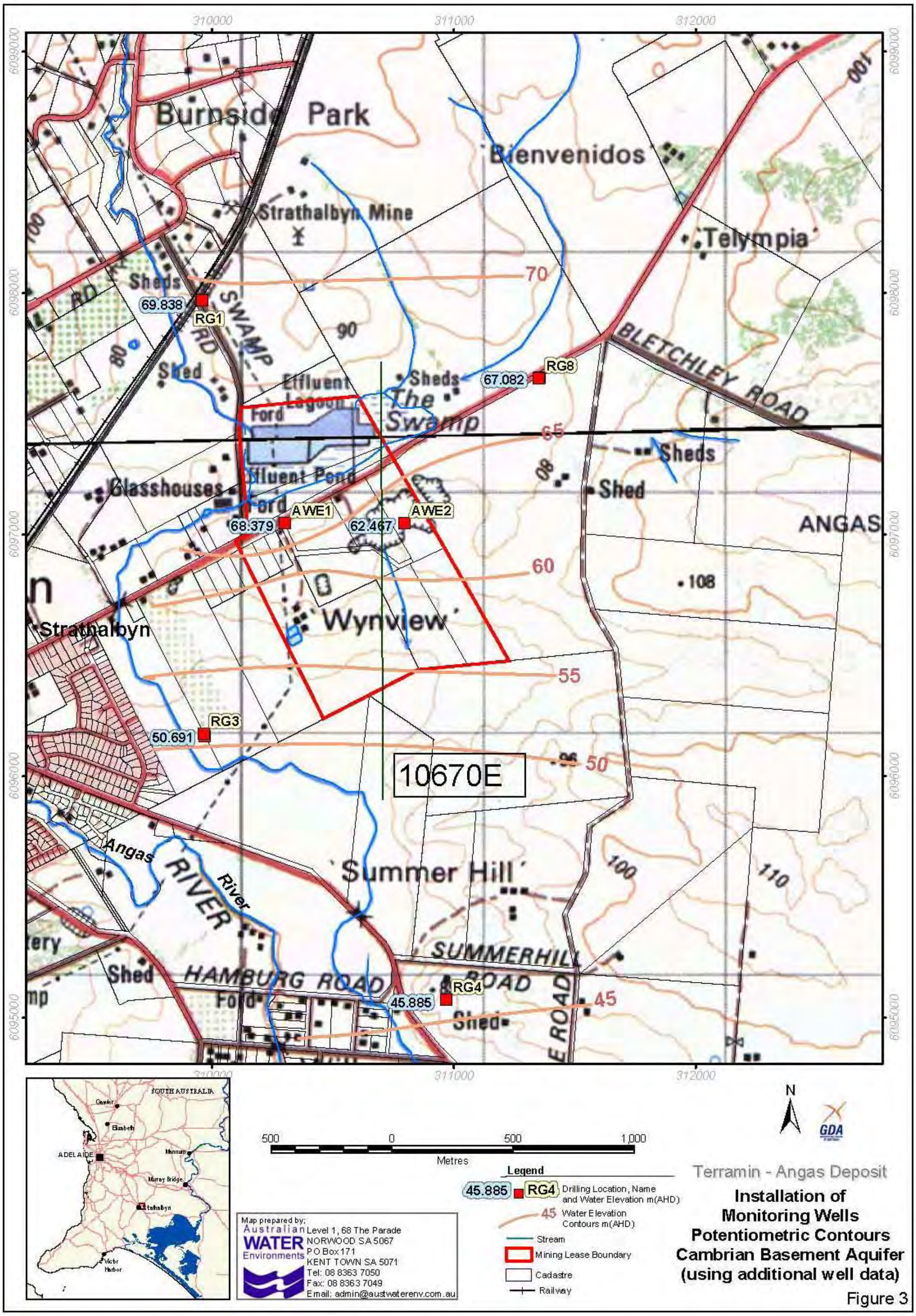

Figure 65: Water Table in Vicinity of the ML (m AHD)

The Fractured Rock Aquifer

Below the clay layer and above the unweathered basement rocks lies a zone of fractures where partial weathering has opened up the metamorphic fabric. The fractures also appear to be connected by a series of flat-lying joints. The base of this zone of fractures is irregular and defined subjectively, but probably extends to about 75m below the present ground surface. This zone of fractures is about 30–40m thick. Groundwater consultants AWE has termed this layer the fractured mantle. The fractured zone is saturated with groundwater; groundwater fills the narrow, but interconnected joint system. The zone forms a poor fractured rock aquifer.

Water Table

The water table refers to the boundary between rocks that are saturated with water and the overlying unsaturated units. The water table will move vertically depending on discharge and recharge.

The DWLBC have records for historical test bores drilled in the vicinity of the ML. The water table is determined from measurements to the SWL, being the depth of the water in the bore as measured from the natural surface or from some other reference point). From the DWLBC DES, depths to SWL range from less than seven metres to over 90 m, though total depth is not recorded for all holes. Selected summary records are presented in Table 56.

Unit no	Depth (m)	Aquifer	Year measured	SWL (m)	Year SWL measured	Salinity (Mg/L)	Year salinity measured
6627 1134	30.48	FRA	1940	7.01	1940	5441	1940
6627-1135	Unknown	FRA	Unknown	7.62	1957	4484	1957
6627-1136	Unknown	FRA	Unknown	6.71	1968	9100	1968
6627-1137	6.71	Tertiary	1968	4.57	1968	4470	1968
6627 1140	30.48	FRA	1957	26.82	1957	3570	1957
6627-1142	30.48	FRA	1957	17.07	1957	5098	1957
6627-1143	30.48	FRA	1957	None stated	None stated	3570	1957
6627-5770	91.44	FRA	1953	None stated	None stated	None stated	None stated
6627-5774	32.6	FRA	1957	24.38	1957	2144	1957

Table 56: Available Water Bore Summary Information

Bore locations are shown in Figure 63. The bores were drilled between 1940 and 1968, probably with an auger, and as there are no follow-up measurements appear to have been abandoned immediately after they were drilled.

Work by Terramin, including the excavation of test pits, the drilling of geotechnical investigation boreholes and the installation of the groundwater monitoring well network have provided additional site data, which, in general, confirms the original interpretation of data derived from agency information.

Figure 63 incorporates data from both the DWLBC DES and the new Terramin bores. The map shows the water table in the ML area as potentiometric contours that run east-west, joining points of equal hydraulic head. In Figure 65, the contours indicate that the regional water table slopes gently from north to south, indicating that the regional groundwater flow (always normal to the contours) is also from north to south.

The overall slope of the water table is given by the hydraulic gradient, which is based on differences in hydraulic head, i.e. differences in water table height above sea level. Across the AZM area the hydraulic gradient is approximately 0.014. The subtle variations in the contours in the vicinity of the STEDS lagoons show that, locally, the water table is slightly elevated. The presence of a groundwater mound beneath the STEDS lagoons possibly implies leakage.

Groundwater was intersected at varying depths across the site, due in part to variations in topography. In the north, groundwater is close to surface in bores installed near the Swamp, and occurs at depths of less than three metres from natural ground surface near the northern boundary of the ML.

Underground mining takes place below the regional water table. Groundwater is removed by pumping to dewater that part of the underground workings. Refer to Section 3.5.5 for information on dewatering.

In the central part of the ML, drilling has indicated that groundwater occurs at depths ranging from about ten metres to over 25m. This range in depths to water table is due mainly to variations in topography as the land surface in this area rises from about 65m near Callington Road to over 80m on the crest of the ridge. In this zone, only the one aquifer was encountered—the fractured mantle in the basement rocks. The Quaternary and Tertiary units under the ridge are unsaturated.

In the southern part of the ML, the fractured mantle aquifer was encountered in basement rocks at depths as shallow as nine metres. The Quaternary and Tertiary sediments in this area are unsaturated.

Piezometer and test hole data are presented in Table 57. The TD and TP series of test bores were drilled for investigation of the TSF and their locations are plotted in Figure A1 of Appendix U. AWE02 was measuring the fractured mantle aquifer, while all other holes are measuring the tertiary aquifer. Groundwater data is presented in Table 57.

Bore Name	Aquifer	Date (2005)	Water Depth (m)	Salinity (uS/cm)	Salinity (mg/L)
AWE1	Tertiary	16-Sep	7.7	16270	9760
AWE2	FRA	16-Sep	24.7	N/A	N/A
TD1	Tertiary	16-Sep	14.6	2000	1200
TD2	Tertiary	16-Sep	9.73	2890	1734
TD3	Tertiary	16-Sep	5.6	2250	1350
TD4	Tertiary	16-Sep	13	27400	16440
TP1	Tertiary	16-Sep	2.3	12890	7734
TP2	Tertiary	19-Sep		33700	20220
TP3	Tertiary	16-Sep	1.3	7550	4530
TP4	Tertiary	16-Sep	1.3	1450	870
TP5	Tertiary	16-Sep	2.3	1526	915

Table 57: Piezometer and Test Hole Data

Hydraulic Conductivity (Groundwater Flow Rates)

AWE conducted a number of bore hole tests to determine groundwater flow rates. When combined with units of velocity, 'hydraulic conductivity' is used as a measure of the capacity of a rock unit to transmit water, and is normally given in terms of metres per second (m/s). AWE's test work shows that the hydraulic conductivity of the fractured mantle aquifer ranges from 2.3 x 10-8m/s to 5.5 x 10-7m/s (from about 725mm per year to about 17m per year).

Table 58 gives representative values of hydraulic conductivities for various permeable and porous rock types, but converted to metres per year. The fractured mantle aquifer falls into the fractured igneous & metamorphic rock category.

Table 59 gives representative values of hydraulic conductivities for various impermeable and non-porous rock type, converted to millimetres per year. Unweathered basement rocks (below the fractured mantle aquifer) fall into the unfractured igneous & metamorphic rock category (shown in maroon). Clays and crystalline rocks can have hydraulic conductivities of less than one millimetre per year.

Hydraulic conductivity (metres per year)		From	To
Sedimentary	gravel	10,000	1,000,000
	coarse sand	30	200,000
	medium sand	30	15,000
	fine sand	5	6,500
Sedimentary Rock	reef limestone	30	630,000
Crystalline Rocks	permeable basalt	12	630,000
	fractured igneous & metamorphic rock	0.25	10,000
	weathered granite	100	1,500

Table 58: Hydraulic Conductivities for Various Porous and Permeable Rock Types

Hydraulic conductivity (mm per year)		From	To
Sedimentary	clay	0.315	150
	unweathered marine clay	0.025	65
Sedimentary Rock	limestone, dolomite	30	200,000
	sandstone	10	200,000
	siltstone	0.315	500
	salt	0.032	3
	anhydrite	0.013	630
	shale	0.003	63
Crystalline Rocks	basalt	0.63	13,250
	unfractured igneous & metamorphic rocks	<0.001	6

Table 59: Hydraulic Conductivities for Various Rock Types

Recharge

Recharge to groundwater in the AZM area is mostly from rainfall, either from rain that falls locally or from precipitation in the hills to the north. Rainwater that survives evaporation, transpiration and surface runoff infiltrates through the soil and contributes to the groundwater.

Anecdotally, the Burnside Creek periodically flows from its catchment in the north into the Swamp, and recharges the Swamp from surface. Any water that is contained in the Swamp would recharge the subsurface.

The STEDS lagoons are located over part of the Swamp. The bund walls around the lagoons are high enough to prevent potential flood waters from Burnside Creek entering the ponds. The lagoons may hinder, but would not block, surface drainage between Burnside Creek and the eastern parts of the Swamp. Because the lagoons are being continuously topped up from the town wastewater, they could act as a local recharge source.

Groundwater Quality

The aims of groundwater quality monitoring are to determine the current (baseline) quality of the regional groundwater, and track Terramin's performance in its undertaking not to pollute regional groundwater. The compliance criteria to determine if the natural groundwater quality has been compromised is outlined in section 5.2.

Salinity data Table 56 and Table 57 indicate that the uppermost part of the aquifer varies markedly in salinity within and near the site. The reasons for the variations in salinity are unclear. The variations may be related to the high (regional) salinity of the basement rocks at depth, overlain by relatively shallow groundwater, which is enhanced with relatively fresh, lower salinity water from the STEDS lagoons and the wetland adjacent to the lagoons, and with possible additional infiltration recharge of rainfall in the existing quarry area.

The variation in salinity (relatively saline at depth; relatively fresh near surface) and Total Dissolved Solids (TDS) results suggests there are variations in fracture density and fracture connectivity in the fractured mantle, and that surface water and near-surface groundwater may not be everywhere hydraulically connected to deeper parts of the fractured rock aquifer.

Investigations and monitoring of ground water quality show that water quality parameters vary widely, providing high variability around mean values.

Rationale for Selecting the Groundwater Sampling Locations

To demonstrate that groundwater water quality is not adversely affected by mining activities groundwater samples are collected from strategic locations surrounding the mine area. Monitoring bores have been established at positions to intercept groundwater before it reaches the mine site and after it has left the mine area, i.e. both up and down the hydraulic gradient, and also to the side. The six groundwater monitoring bore sites and the three bores to be used for special observations or as backup are described in Table 60 and shown in Figure 38.

Well ID	Site Description	Well Depth (m)
RG1	North of the ML boundary near the Victor Harbour–Adelaide railway line and completed in the weathered Cambrian basement.	21
RG2	West of the ML boundary near Burnside Creek and completed in the shallow weathered Cambrian basement.	14.8
RG3	West of the ML boundary near Burnside Creek and completed in Quaternary sediments that overlie the unweathered Cambrian basement.	45
RG4	South of the ML boundary near Summerhill Road and completed in the unweathered Cambrian basement.	50
RG7	North-eastern corner of the mine near the Callington Rd and completed in Tertiary sediment.	10
RG8	North-eastern corner of the mine near the Callington Rd and completed in unweathered Cambrian basement.	45
Standby or Observational Bores		
AWE 1	South of the STEDS lagoons near the Callington Rd, completed to weathered Cambrian basement.	14.2
LG1	Immediately south of the STEDS lagoons completed to the unweathered Cambrian basement.	2.5
LG2	Immediately south of the STEDS lagoons completed to the weathered Cambrian basement.	22.5

Table 60: Groundwater Monitoring Wells

8.11 VEGETATION, WEEDS AND PLANT PATHOGENS

In keeping with the conservative approach Terramin decided to adopt a precautionary principle and submit a referral form to the Commonwealth of Australia's Minister for Environment and Heritage. It was determined that "the proposed action to operate a lead-zinc mine located at Strathalbyn, South Australia" is not a controlled action as defined by the EPBC Act 1999.

Two plant surveys of the ML were conducted by Natural State Ltd in July 2005 and early December 2006 (Appendix J). Figure 66 shows the plants of significance that were found at the site.

The site has very little remnant vegetation; the only examples are a few species of saltbush mainly under planted trees, approximately 15 Dryland teatrees (*Melaleuca lanceolata*) and small patches of native grass. Only the Dryland teatrees can be truly classified as remnant vegetation; the other species are probably natural regrowth.

The planted trees mainly found on fence lines are now the dominant species with a mixed range of Eucalyptus woodland species. The heights range from 5m – 10m with an estimated age of between 15 and 20 years. Within a 5km radius of the site, remnant vegetation occurs along roadsides and creek lines. Native trees have been planted around fence lines as windbreaks, screening and shelter.

The predominant land use in the area is cropping. Weeds occur mainly in the bare open areas. A full list of weeds recorded during two flora surveys are presented in Appendix J. Most weeds are herbaceous but wood shrubs were also noted. Non-indigenous tree species were common particularly *E.occidentalis* (Flat Top Yate).

Eucalyptus camaldulensis (River Red Gum) and *Muehlenbeckia florulenta* (Lignum) found near the STEDS lagoons site are species of significance. These two dominant species form part of an important wetland plant community in this region.

Part of the site, mostly along boundary fences, has been revegetated over the past 10 – 20 years with local native species. These plantings are providing habitat value for birds, bats, insects, reptiles and small mammals. Although they provide good habitat, it is not as ecologically important as the natural habitat mentioned earlier which is remnant vegetation.

The cropping land and mine operations have a very different group of plants. There are also several significant species:

Botanical Name	Common Name	Population
Austrostipa nitida	Balcarra Spear Grass	-
Austrodanthonia caespitosa	Common Wallaby Grass	-
Lomandra effusa	Irongrass	Regionally RARE
Melaleuca lanceolata	Dryland Teatree	Regionally UNCOMMON

Table 61: Significant Plant Species

The native grasses are important because they provide habitat for the smaller lizards and mammals. They were only present within the areas where previous revegetation had taken place near Jettner's gate and fence, and along the boundaries and windbreaks.

The Irongrass occurs along the roadside plantings on the Callington Road. This species provides very similar habitat for the same group of animals. The *Melaleuca lanceolata* or Dryland Teatree is the most important species in the cropping and quarry sites. These old trees are long lived and the specimens that are present would be hundreds of years old. They are providing hollows for birds and bats to live in. Some hollows were infested with feral honey bees. Care will be taken to work around all of these old trees, however, if it is necessary to interfere with these plants, the following steps will be taken:

1 Conduct a risk assessment.
2 Collect seed from existing trees on site and revegetate using tubestock grown from this seed.
3 Provide alternative habitat in the form of hollows. Varying sizes appropriate for local fauna species would be best.

Six Dryland Teatrees were cleared during construction (Figure 67). These trees are located in the TSF and plant footprints. Terramin will undertake a significant revegetation schedule of the site at the commencement of operations (Appendix X). The plant conservation ratings that have been advised here are sourced from the Florlist software program from the Department of Environment and Heritage (DEH) 11/07/05.

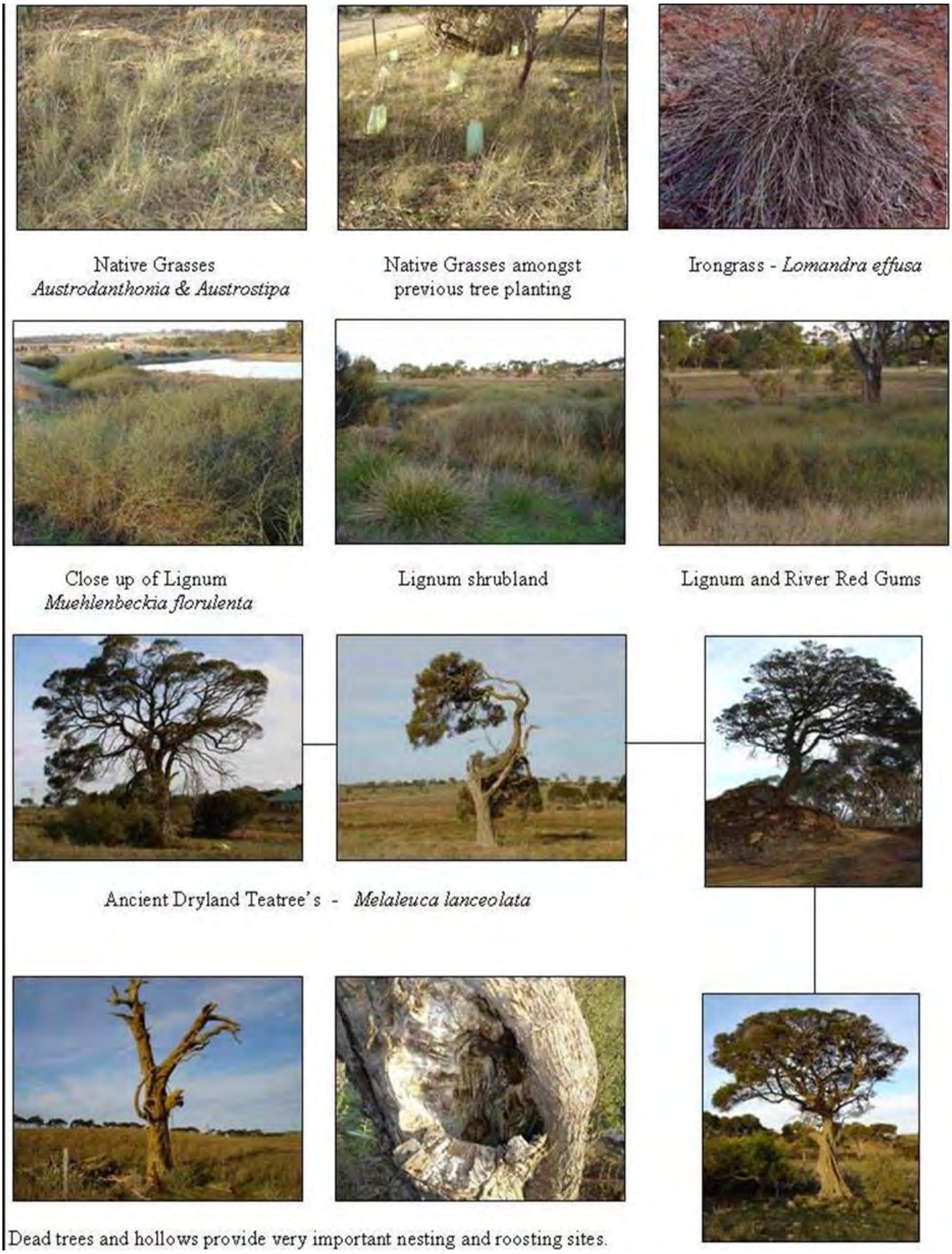

Figure 66: Plants of Significance

Figure 67: Existing Site Vegetation Plan

8.12 FAUNA

There is potential fauna connectivity between the nearby STEDS lagoons and any supernatant and wet beach/supernatant interface on the TSF. This facility is appropriately designed to minimise the amount of freeboard water in the decant area, the quality of which in any case would not be injurious to bird species. This includes species listed as rare or vulnerable under the National Parks and Wildlife Act 1972, but not limited to Blue-billed Duck, Musk Duck, Freckled Duck, Australian Shoveler, Great-crested Grebe, Intermediate Egret, Australian Bittern and Glossy Ibis.

Also included are species listed under the People's Republic of China and Australia Migratory Bird Agreement (CAMBA) and Japan and Australia Migratory Bird Agreement (JAMBA) treaties in accordance with the Environment Protection and Biodiversity Conservation Act 1999, namely but are not limited to Bar-tailed Godwit, Black-tailed Godwit, Common Greenshank, Marsh Sandpiper, Wood Sandpiper, Common Sandpiper, Sharp-tailed Sandpiper, Red-necked Stint, Pacific Golden Plover, Caspian Tern and Fork-tailed Swift.

As implemented elsewhere in the mining industry, appropriate design of the tailings system, including associated mine dewatering and process water dams, has been implemented to eliminate or reduce the risk to fauna. Provided industry best practice and standards are implemented, monitored and maintained then the impact on fauna can be reduced or eliminated.

The provisions of revegetation and mine closure criteria will accommodate a greater abundance and diversity of biota that currently exists on this site (Appendix I).

Habitat Provisions

There are two primary habitat provisions on the ML. The first is where mining activity is conducted, in open fields of introduced grasses with some remnant individual trees of Dryland Teatree (*Melaleuca lanceolata*). This habitat is severely degraded and is impoverished in indigenous vertebrate fauna species.

The second is the artificially constructed River Red Gum (*Eucalyptus camaldulensis*) with Lignum (*Mulenbeckia florulenta*) understorey wetland. The waters are derived from effluent overflow. This habitat provides refuge for water birds and associated vertebrate fauna. This habitat is isolated from other similar habitat. No mining activity will occur on the surface of the wetland.

Microhabitat provisions are provided by the presence of dead tree hollows, and also by truck and car wrecks abandoned on site. These latter artificial materials provide shelter for introduced fauna, such as rabbits and fox.

Vertebrate Fauna

A list of expected vertebrate fauna to be recorded on the AZM ML is provided in Appendix I. The expected vertebrate fauna was derived from a habitat assessment, Birds Australia atlas database and the Southern Mount Lofty Biological Survey report (Appendix I).

Of the thirty-one species of native mammals known to reside in the Southern Mount Lofty Ranges (SMLR) at the commencement of European settlement in 1836, only twenty-two can now be confirmed as currently resident. The habitats of the AZM ML have been extensively cleared for some time and have rendered the site uninhabitable for most native fauna, except for the artificial wetland. Only those species that are contiguous with human habitation are likely to be present.

The SMLR supports two-thirds of the State's bird taxa including four endemic subspecies. The region is also an important zoogeographic outlier of the Bassian faunal zone that encompasses the subhumid regions of east and southeast Australia. Many of the Mount Lofty Ranges bird populations of Bassian forms are geographically isolated from their nearest populations in the south east of Australia. The Mount Lofty Ranges are one of 18 regions in Australia for which a coordinated conservation plan was recommended under The Action Plan for Australian Birds (Appendix I).

The site, other than the wetland, has been severely cleared of native vegetation and would not support the vast majority of native mammals of the SMLR. Avifauna likely to be present is that associated with an agricultural landscape of open fields with introduced grasses. Remnant trees do not provide significant measurable habitat resource.

The nearby wetland houses many species of birds including water birds and migratory waders listed under international treaties such as JAMBA and the CAMBA. These species may interact with the TSF and are recognised as at-risk species (Appendix I).

It is possible up to nine bat species could be present in the region and are likely to be confined to the wetlands. They will at times use the airspace above the active mine site and do access supernatant on the TSF and associated liquor ponds. No hollows in remnant trees that would house roosting bats were observed at the boxcut although they may be present elsewhere on the ML. There is no habitat present on the ML that would house the endangered Southern Emu-wren Mount Lofty Ranges subspecies.

Six species of frog are known in the SMLR (Appendix I), although not all are likely at the ML. Frog habitat exists at the wetland.

The areas affected by this project generally comprise of degraded land that is not conducive to native fauna. Predators such as foxes, dogs, and cats are likely to inhabit the area as well as a few hardy native animals. The risk of adverse impacts of the operation on biodiversity conservation is therefore considered low. The Murray Darling Natural Resource Management Board (NRMB) and DWLBC have identified the fact that several important freshwater fish are known to inhabit the deep pools near the confluence of the Angas River and Burnside Creek. These include the River Blackfish (*Gadopsis marmoratus*), Mountain Galaxias (*Galaxias olidus*) and the Carp Gudgeon (*Hypseleostris sp.*).

Fauna Survey

A baseline fauna survey, as required by the lease conditions, was conducted on 19 August 2006. Both the green fields immediately south of the existing quarry and the STEDS lagoons were surveyed during this time. The two sites were surveyed separately due to their different habitat provisions. The green fields are ungrazed grassland whereas the lagoons are an artificial wetland. Diurnal fauna were recorded by sight, sound, tracks and scats. At the lagoons fauna was observed using 8x magnification binoculars.

To document the presence of bats, one AnabatTM echolocation device was located on green fields area south of the existing quarry. A second AnabatTM echolocation device was established at the bird hide at the STEDS lagoons. The devices were programmed to operate approximately from 1845 to 2030 hours. The calls were later counted and analysed to identify bat species in the area.

The two areas on the ML, green fields and STEDS lagoons, produced different results regarding fauna that was present on the day (Table 62). This table also indicates any species protected under the National Parks and Wildlife Act 1972 as being endangered (Schedule 7), vulnerable (Schedule 8), rare (Schedule 9) or unprotected (Schedule 10). A schedule is a way of grouping species whose numbers are declining, or in the case of Schedule 10, out of control. The National Parks and Wildlife Act 1972 protects species that come under Schedule 7 through to 9. Legislation states no activity that is or is likely to be detrimental to the welfare of a protected species should be undertaken. The bats species that were recorded at both sites are described in Table 62.

	Calls	Total number of calls/hour
Green Fields		
Inland Broad-nosed Bat	4	0.04
Southern Free-tail Bat	28	0.28
Nyctophilus species	2	0.02
Southern Forest Bat	2	0.02
Little Forest Bat	2	0.02
Inland Broad-nosed Bat/Southern Freetail Bat	28	0.28
Total	**66**	**97 minutes**
STEDS Lagoons		
Gould's Wattled Bat	16	0.15
Chocolate Wattled Bat	108	1
Southern Free-tail Bat	87	0.8
Little Forest Bat	95	0.87
Southern Forest Bat	66	0.61
Unidentified	15	0.13
Total	**301**	**108 minutes**

Table 62: Bats Recorded at Each Site

There are limitations associated with an opportunistic survey, such as seasonality, observation frequency and lack of trapping for terrestrial mammals and reptiles. If trapping was conducted, it would be expected that small mammals and reptiles would be recorded at both sites. However, this method is more effective if conducted during the warmer months. Nevertheless a significant number of species were observed. A total of 51 vertebrate species were recorded during the survey, comprising of 46 birds, two amphibians, three terrestrial mammals and eight bat species. No fish netting was done on the day, fish are not expected at the STEDS lagoons.

The STEDS lagoons provides suitable habitat for wetland species and those that inhabit river red gum, lignum and samphire remnants. The STEDS lagoons provide a substantial feeding resource for insectivorous bats. The number of bats calls recorded for unit time was exceptionally high. The roosting location of these bats is currently unknown.

Species that are typical of an agricultural landscape were recorded at the green fields. As grazing has been discontinued, this area is starting to resemble a grassland. Insectivorous bats and birds, such as the Richard's Pipit *Anthus novaeseelandiae*, were notably abundant, indicating sufficient food resources.

No Schedule 7 species recorded under the *National Parks and Wildlife Act 1972* were observed at either site. One Schedule 8 and two Schedule 9 species were recorded at the STEDS lagoons. There were also three Schedule 10 (not protected) species recorded during the survey.

8.13 TOPSOIL AND SUBSOIL

The SA Soils map, Figure 68, indicates that the soils of the Strathalbyn area at and in the vicinity of the site consist of the following:

- Sandy loam over poorly structured brown clay (STEDS lagoon area, North Domain)
- Shallow calcareous loam on calcrete (Central Domain)
- Loam over clay on rock (western portion of South Domain)
- Deep hard gradational sandy loam (western part of South Domain and near Callington Road), and
- Loam over red clay central and eastern part of South Domain

The test pit and borehole logging investigations in general confirm these classifications of the site. In the North Domain (STEDS lagoon area), the general pattern observed was sandy loam over clay over basement to the northwest of the STEDS lagoons, clayey loam over basement to the north and clay over basement to the south.

In the Central Domain, calcareous soils were observed to occur over calcrete, while sandy loams occur on the hill slopes where calcrete is not present. In the South Domain, soils were generally clayey loam and sandy clay loam.

At the localities investigated, soil depth varied between 0.05 and 0.5m. Organic matter in the A horizon was generally sparse in the southern and central sectors, but plant roots and other organic matter was common to abundant in the North Domain.

In the Northern catchment (Figure 61*),* soils are alluvial and shallow (less than 40cm to basement rock). In the Southern catchment the dominant soils are yellow duplex soils that have a yellow clay B horizon. These soils are associated with old tertiary plateaux and deposits.

The soils for this catchment range from less than a few cm deep on the ridge to a moderate (33cm – 60cm) in depth in the valleys.

Terramin commissioned Tonkin Consulting (Tonkin) to undertake a maximum 200m by 200m grid soil sampling of the ML and surrounding area of the proposed mine site.

Soil sampling included a total of 32 grid-based points, 8 targeted house-location points, plus 6 targeted outcrop points, whilst stream sediment was collected at 7 targeted points, as per the sampling rationale in *Appendix D*. All sites were sampled except one planned soil sampling point (SG3), where the landholder denied access. Instead, one additional sediment sampling point was included in the program, therefore the total number of analyses performed were 53, as planned.

The investigation found essentially 3 types of soil present in the area of the mine site:

- Shallow to intermediate depth silt-dominated soils developed on Cambrian metasediments.
- Shallow silt-dominated soils developed on Tertiary limestone.
- Deeper silt-dominated soils developed on Quaternary alluvial and colluvial deposits. Stream sediments were found to consist of clays, silts and sandy silts at the sampled locations. The results of the soils sampling program are summarised in Appendix D.

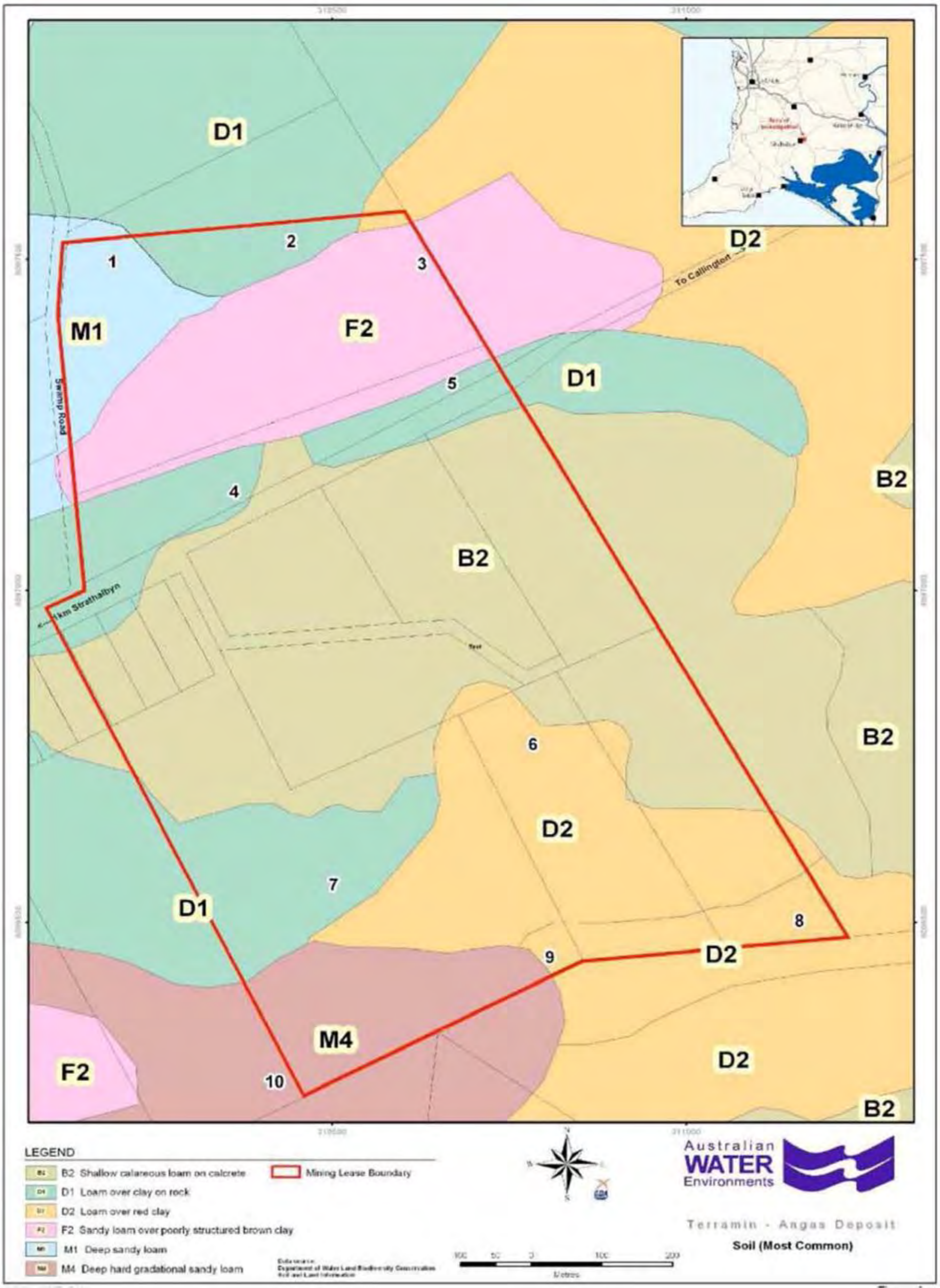

Figure 68: Soils Map over Mining Lease

8.14 HERITAGE (ABORIGINAL, EUROPEAN, GEOLOGICAL)

The Aboriginal Heritage Act 1988 (SA) provides for the protection and preservation of Aboriginal heritage, comprising Aboriginal objects, sites and remains, in South Australia.

The Ngarrindjeri Heritage Committee was invited to a presentation on the proposed AZM project (there was no official representation) and was also invited to organise a heritage survey if they considered it necessary. This invitation was given in writing (TZN0036) and a response was received from the Committee confirming they would be able to assist in a survey if required, however they did not consider it necessary.

The Central Archive includes the Register of Aboriginal Sites and Objects and is administered by the Department for Aboriginal Affairs and Reconciliation The register has no entries for Aboriginal heritage sites within the area where the proposed mine will be located.

Native Title

No Native Title Claims or applications are registered over the land that where the mine is located.

Non Indigenous Heritage

The State Heritage Register is a list of places of heritage value to the state of South Australia. There are no heritage sites registered for the area where the mine is located.

8.15 PROXIMITY TO CONSERVATION AREAS

The most prominent conservation area of close proximity to the ML is Lake Alexandrina, approximately 18km away (Figure 2). The ML is also in the vicinity of the River Murray approximately 37km away (Figure 2).

The flora and fauna studies performed by Rose and Donarto (Appendices I and J) did not consider it significant that the proposed mine site would act as a linkage or habitat corridor.

8.16 PRE-EXISTING SITE CONTAMINATION AND PREVIOUS DISTURBANCE

Soils

Given the previous usage of this land (section 8.2), Terramin commissioned Tonkin to undertake a maximum 200mx200m grid soil sampling of the lease and surrounding area of the proposed mine site to determine Baseline contamination issues. The report is detailed in Appendices D and G.

This investigation has found the following with regard to soils and sediments sampled at 53 locations in the vicinity of the proposed mine site:

- A number of soil sampling locations distributed across the sampled area were found to be contaminated with respect to arsenic (as determined by comparison to Natural Environmental Protection Measures (NEPM), Standard Residential Health Investigation Levels (HILA) and NEPM Interim Urban Ecological Investigation Levels (EILIU)), showing weak to moderate correlation with the surface extension of the orebody.
- Some soil sampling locations in close proximity to the orebody were found to be contaminated with respect to copper, lead, manganese and/or zinc (as determined by comparison to NEPM criteria), showing strong correlation with the surface extension of the orebody.

The investigation has also found the following with regard to soils sampled at 6 locations used for agricultural purposes in the vicinity of the proposed mine site:

- Total Organic Carbon (TOC) levels varied considerably from very low to very high.
- Total Exchangeable Cation levels varied considerably from very low to high, and were dominated by Calcium, with moderate levels of Potassium and Magnesium, and relatively low levels of Sodium.

Summarised results, highlighting those values, which exceed the specified NEPM guidelines, are set out in Appendix D. The results for metals which exceed the selected NEPM guidelines are also shown on plans of the site in this report.

Soil pH

The pH of soils developed on Cambrian metasediments and on Quaternary colluvial/ alluvial deposits (not differentiated) ranged from 5.5 to 8.7, whilst those developed on limestone ranged from 8.1 to 9.1. The pH of recent streambed sediments ranged from 8.5 to 9.7.

Metals

Arsenic, copper, lead, manganese and/or zinc were reported in elevated concentrations at 23 sampling points, and exceeded the specified NEPM guidelines in 17, 2, 10, 8 and 8 samples respectively. The arsenic exceedances were distributed relatively widely, but did show a weak to moderate correlation relative to the position of the orebody. The other metals exceedances appeared to be closely connected to the position of the orebody.

The most emotive metal with the SCCC was lead and its distribution (Figure 69). As previously mentioned, the elevated levels and the exceedances of the NEPM guidelines tend to follow the position of the orebody. Additional geochemical geological data generated as part of exploration (unpublished) confirm this trend with elevated soil levels continuing for many kilometres to the north and south.

The lead in soil contamination does not appear to have mobilised despite the many years of ploughing and cropping of the paddocks.

The pathway for lead contamination within the Strathalbyn community would be via dusting during ploughing or storm events. The pathway would then be via rainwater washing the dust off roofs into rainwater tanks and then into the household. To test such a remote possibility the rainwater tank baseline study (Appendix AE) was undertaken. Putting aside confounding factors, there does not appear to be any mobilisation of lead into the Strathalbyn community.

A similar analysis and conclusion can be reached for arsenic, zinc and the other metals. There is, however, a naturally occurring level of contamination of the lands north and south of the ML. These lands would require rectification if ever considered for housing subdivisions.

The results of the Topsoil Baseline Survey (Appendix AE) performed in parallel with the Rainwater Baseline Survey at the same locations supports this conclusion (Table 63) with results well below the NEPM standards.

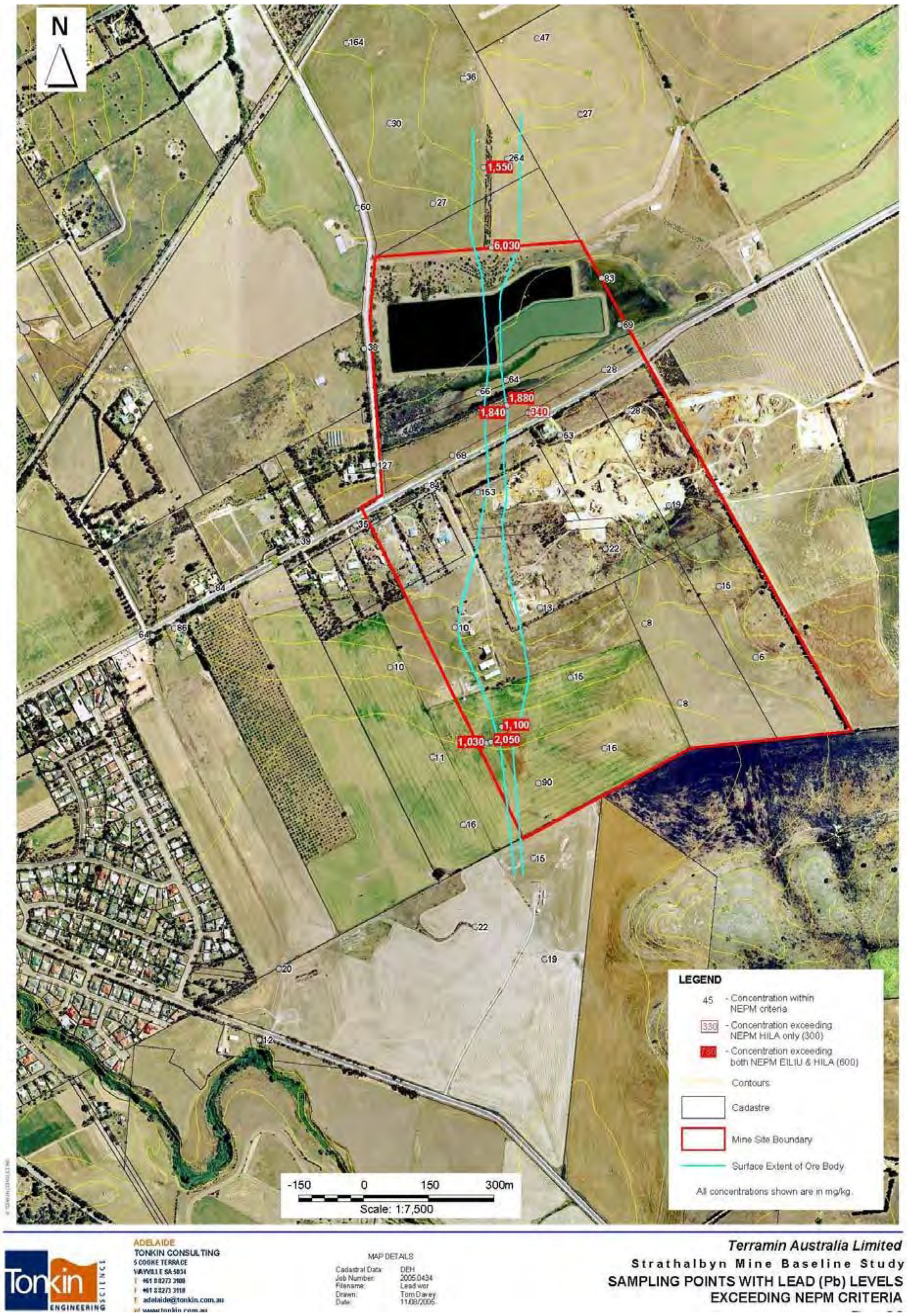

Figure 69: Sampling Points with Lead (Pb) Levels Exceeding NEPM Criteria

Statistic	pH	EC	MC	As	Cd	Cr	Cu	Pb	Ni	Ag	Zn
Number	112	112	112	112	112	112	112	112	112	112	112
Minimum	5.4	66	1.5	5	1	2	5	5	2	2	5
10%	5.91	133.1	3.41	5	1	9.1	5	6	2	2	12.1
Median	7.1	307	7.7	6	1	19.5	10.5	12	8	2	31.5
90%	7.89	665.9	14.59	17	1	26	26	34.9	12	2	79.8
Max	8.4	1980	34.4	82	1	46	81	261	18	4	199
Average	6.95	383.3	8.6	10.3	1	19	13.9	21.4	7.6	2	43.3
Std Dev	0.68	316.5	5	12.2	-	7.5	13.1	33.8	3.8	-	37.2
CoV	10%	83%	59%	119%	-	40%	94%	158%	50%	-	86%
NEPM HILA	-	-	-	100	20	1000	1000	600	600	1000	7000
NEPM EILIU	-	-	-	20	3	1000	100	300	60	1000	200

Table 63: Descriptive Statistics of Baseline Soil Analysis

Total Organic Carbon (TOC)

TOC was analysed in 6 samples collected from areas of agricultural land use (SG6, SG7, SG10, SG22, SG29 and SG32), and produced results ranged from 0.7% to 5.6%. These levels may be interpreted as ranging from very low to very high, in comparison to levels in average soils (Hazelton and Murphy)

Total Exchangeable Cations

Exchangeable Cations were also analysed in 6 samples from areas of agricultural land use (SG6, SG7, SG10, SG22, SG29 and SG32), and produced results for Total Exchangeable Cations ranging from 3.6 to 29 mEq/100g. These levels may be interpreted as ranging from very low to high, in comparison to levels in average soils (Hazelton and Murphy).

STEDS Lagoon Leakage Assessment

The STEDS lagoons were constructed in the 1980's by the District Council of Strathalbyn, a precursor to Alexandrina Council (Council). Discussions were held with Council in July 2005 and information sought and provided regarding the construction of the lagoons, lagoon engineering and volumes of wastewater pumped to them. This included the provision of copies of design drawings of varying quality and completeness.

The lagoons hold about 120 megalitres of water. They consist of a large lagoon (area approx. 5ha) that was originally compartmentalised using fencing (this is largely broken or falling down), and another smaller lagoon termed the evaporation pond. The lagoon walls are about 2m in height, with wastewater impounded to within 1m from the top of the bund walls.

The lagoons were constructed by Heywood Earthmovers, and included the installation of a clay liner derived from local materials. It is understand that the Council coordinated the placement of the liner. Design drawings provided by Council indicate that excavation extended below the base of a clay layer identified, presumably by the logging of geotechnical investigation boreholes or test pits drilled within the footprint of the lagoons. Council was not able to provide details of the geotechnical investigation (N Stynan, pers comm 11 Aug 2005). Design levels of the floors of the main lagoon and evaporation pond are shown on the drawings provided by Council to be 69.5m AHD and 70.4m AHD respectively. It was also stated that the lagoons store all town wastewater (except that used by the racecourse) without discharge to the watercourse (A Peachy, pers comm.). In addition, about 25kL/d of water is diverted to the racecourse in winter, with about 450 to 500 kL/d being discharged to the lagoons. In summer, both the racecourse and the lagoons receive about 250kL/d of wastewater. Wastewater from the lagoons has been used for olive grove irrigation and is currently used to irrigate the town polo club grounds.

Scope items formulated to assess possible leakage from the wastewater lagoons included:

- The installation of a groundwater investigation well into the uppermost water bearing unit
- The installation of a groundwater investigation well into the Cambrian age basement rocks
- The collection of core samples for laboratory vertical hydraulic conductivity analysis
- Test pumping and analysis
- The survey levelling of both wells
- The collection and analysis of water samples

Seepage Modelling

A pumping trial was conducted at well 116744 on 2 May 2006. This consisted of the installation of a submersible pump and the extraction of groundwater at a rate of 0.066 L/s for 82 minutes, produced a drawdown of 7.95m. The hydraulic conductivity calculated from these data is 0.006 m/d. Such a low hydraulic conductivity value in consolidated rocks is considered typical of shales and mudstones (Todd).

Water samples were collected from both wells on 19 to 20 April 2006 and 26 May 2006. A sample was also collected from 116744 on 2 May 2006. Samples were analysed by Australian Water Quality Centre (AWQC).

The results indicate that, in general, groundwater in the shallow well (116743) is of higher salinity, with corresponding higher concentrations of calcium, magnesium, potassium, sodium, sulphate and chloride. Nutrient concentrations are low in all samples analysed, but the presence of Total Kjedahl Nitrogen (TKN) indicates that wastewater from the lagoons is leaking into the ground. Concentrations of metals including beryllium, cadmium, chromium, copper, lead, manganese, nickel, tin, vanadium and zinc are greater in the samples collected from the deep well (116744). Copper and zinc concentrations exceed Australian and New Zealand Environmental Council (ANZECC) aquatic ecosystem guideline values. pH is alkaline in all samples analysed.

The results are interpreted to indicate that:

- Shallow groundwater is more saline than the deeper water, and could be due to the evaporative concentrating of salt near the land surface
- Water in the shallow well has lower metals concentrations possibly due to dilution by recharge from rainfall and possibly wastewater lagoon leakage.
- The presence of coliforms and TKN in samples from both wells possibly indicates that wastewater lagoon leakage is occurring to depths of 15m (the depth of water intersection in well 116744).

The modelling of seepage from the lagoons was also carried out as part of the assessment of possible mine dewatering rates and the extent of the influence of groundwater pumping for groundwater control. This model consisted of a single aquifer layer simulating the Cambrian rocks hosting the mineralization, the setting of dewatering for mining at -190m AHD, the establishment of a regional groundwater flow field, the simulation of the Angas River through the use of ‘river’ cells, and the assigning of hydraulic conductivity and storage coefficients derived from test pumping. The lagoons were initially simulated through the use of general head cells, with a lagoon water elevation of 70.7m AHD, and using the vertical hydraulic conductivity of swamp sediments (10-5m/d) obtained from the triaxial laboratory tests as the vertical hydraulic conductivity of the lagoon liner materials (as they are the source materials).

As the lagoon has operated since the 1980's, the first simulation ran for twenty years. Using these input parameters, the model calculated a flux from the lagoon to the aquifer of about 0.8m3/d (800L/d).

This was used for recharge from the lagoon in a subsequent model that included 7 years of mine dewatering and 20,000 years of recovery. It was found that, using the input parameters selected, the lagoon had negligible impact on drawdown around the mine.

A sensitivity analysis was performed to assess the impact of the lagoon if it was unlined and the water level of the lagoon remained constant at the design level (70.7m) during the mining and recovery periods. This meant that, in this simulation, leakage was controlled by the hydraulic conductivity of the underlying rocks. The flux to the aquifer calculated by the model using these altered inputs was 100m3/d or about 1L/s. The model also indicates that this leakage will result in a reduction in the extent of the cone of depression around the mine. For example, the maximum radius of the 0.1m drawdown contour was 665m, compared to 1016m for the simulation where the lagoon had a liner.

The activities carried out as part of this investigation indicate the following:

The design elevation of water in the STEDS lagoons is 70.7m AHD.

- Groundwater occurs at an elevation of about 69m AHD, resulting in the potential for wastewater from the lagoons to move into the aquifer due to the establishment of a downward hydraulic gradient.
- Discussions with Council indicate that the STEDS lagoons were lined with locally derived materials but the extent of compaction and engineering control during liner placement is unknown. We have considered that the liner permeability is the same as the in situ permeability of the locally derived materials, but cannot as yet verify this.
- Test pumping indicates that the hydraulic conductivity of the fractured Cambrian basement rocks is about 0.006 m/d.
- Laboratory permeability tests indicate that the vertical permeability of the shallow lacustrine sediments occurring adjacent to the lagoons is about 1.3 x 10 -10 m/s (1.12 x 10-5 m/d).
- Groundwater sampling results indicate that the shallow groundwater is more saline than the deeper groundwater, possibly due to the effects of evaporation.
- Coliforms are present in samples from both wells, and ecoli was also identified in both. This is interpreted to indicate that wastewater has entered the aquifer. This is supported by the presence of Total Kjeldahl Nitrogen (TKN) in the groundwater samples.
- Deeper groundwater contains greater concentrations of metals than groundwater in the shallower well. This may be due to the effects of infiltration recharge or greater proximity of the deeper well to the zone of mineralization.
- Groundwater elevations near the lagoons appear to be significantly higher than anticipated from the contouring of regional groundwater monitoring data. This indicates the presence of groundwater mounding and implies that the lagoons may be acting as recharge sources for the aquifer.
- Groundwater modelling indicates that, assuming that the lagoon liner vertical permeability is the same as the permeability of in situ swamp sediments, about 0.8m3/d of wastewater could currently be leaking from the lagoons into the aquifer system. This rate of leakage will change significantly if the liner material permeability differs appreciably from the value used in the model. If no liner remains, the model indicates that about 100m3/d of wastewater could enter the groundwater system.

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