Heron Resources Limited

Woodlawn Zinc – Copper Project

Paste Fill

Management Plan

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1 INTRODUCTION

1.1 Purpose

The Woodlawn Mine operates under Project Approval 07_0143 MOD2. Condition 3 of Schedule 3 and Condition 5 of Schedule 4 of the approval requires Heron Resources to ensure that the paste filling of underground voids is undertaken in an environmentally responsible manner. Specifically, the paste is required to be chemically stable and non-polluting. This Paste Fill Management Plan provides details of the paste filling operation and the results of testing and material trials to determine any potential risks to the environment.

As the Paste Fill Plant is not yet operational and tailings from the new processing plant is not yet available, Heron has used tailings currently available within the existing tailings dams on site to produce a simulated paste for testing. This is a conservative approach as the existing tailings material contains recoverable metals whereas fresh tailings produced from the new processing plant will have reduced metal concentration. The results obtained from paste derived from existing available tailings is presented in this management plan. The results show that it is still environmentally benign and non-polluting. The results will be updated once fresh tailings from the new processing plant is available.

1.2 Scope and Objectives

This management plan provides the following information in accordance with the Project Approval:

- ❒ Details of the paste filling operation.
- ❒ Paste fill manufacture and underground delivery system.
- ❒ Long term geotechnical stability of paste fill to minimise subsidence.
- ❒ Data of physical and chemical properties of the paste.
- ❒ Program for ongoing testing and verification.

1.3 Key Personnel and Responsibilities

Management responsibility for the Woodlawn Mine will be as follows.

Table 1- Management Responsibilities

Position	Personnel	Company	Responsibility	Contact Details
Managing Director	Wayne Taylor	Heron	Overall responsibility for the construction and operation of the Woodlawn Project	02 9119 8111
Chief Operating Officer	Andrew Lawry	Heron	Responsible for project delivery and operations	02 4816 6341
General Manager	Brian Hearne	Heron	Conduct of mining operations	02 4816 6344
Mine Manager	Simon Fitzgerald	Heron	Mine Planning and Design	02 4816 6323
Geology Superintendent	Katie Yamaguchi	Heron	Resource evaluation	02 4816 6325
Process Superintendent	Shu Chen	Heron	QA/QC	02 4816 6297
Environmental Officer	Dr Zoe Read Kat McGilp	Heron	On site environmental management	02 4816 6335

Environmental Consultant	Robert Byrnes	IEC	Conduct of environmental management and compliance	02 4878 5502

1.4 Project Approval Requirements

The Woodlawn Project received Project Approval on 4th July 2013 with subsequent modifications received on 22nd April 2016 and 6th July 2017. The approval was obtained under the provisions of Part 3A of the Environmental Assessment Act 1979 and following the public exhibition of an Environmental Assessment document.

The EA contained a number of environmental commitments while the Project Approval and subsequent modification was also subject to conditions. Table 2 lists the conditions and proponent commitments relating to Pate Fill management.

Table 2 - Consent Conditions Relating to Paste Filling and Management

Condition	Interaction with Construction	Where Addressed
Sch 3 Condition 3(c)	Remnant underground voids are long term stable to prevent subsidence	Section 3.1
Sch 3 Condition 3(d)	Material used to backfill underground voids is physically and chemically stable and non-polluting.	Section 3.1, Section 5.1.5
Sch 3 Condition 5(a)	Carry out trials and testing to clarify the physical and leaching characteristics of the paste fill	Chapter 4
Sch 3 Condition 5(b)	Prepare a program for the ongoing testing of the paste fill to ensure it meets the performance measures in Condition 3 above.	Section 5.1.4
Sch 3 Condition 5(c)	Prepare a report on the findings of trials and testing, and submit the report to the Secretary for approval prior to the commencement of underground mining operations on the site (excluding construction of the underground access decline).	Chapter 4

1.5 Agency Consultation

The following comments have been received by the Department of Planning and Environment:

Table 3 - Comments from Department of Planning and Environment

Condition	Satisfactory	Action Required	Where Addressed
5 of Sch 3	Yes	None	N/A
5a of Sch 3	Partially	clarify why TCLP has been used and comparison with the NSW Waste Classification Guidelines and not the Water Quality Guidelines ANZECC 2000 Either provide a comparison of the TCLP results against the Water Quality Guidelines ANZECC 2000 in Table 9 or clarify why TCLP has been compared to NSW Waste Classification Guidelines.	Section 4.6 par 2 Section 5.1.5 Section 4.6.1 Table 9
5b of Sch 3	Partially	It is recommended that a monitoring schedule be included in Section 5 Please provide the results of the program in Section 5.1.4 to DPE following the commencement of operation of the paste plant and provide a summary of the interpretation of the results in relation to demonstrating that the material used to backfill underground voids is physically and chemically stable and non-polluting.	Section 5.1.4 Section 5.1.4 Section 5.3
5c of Sch 3	Satisfied	None	N/A
3(d) of Sch 3	Partially	As per comments above	Section 5.1.4 Section 5.1.5 Section 5.2.1
General		Correct references in Table 2	Table 2 updated

2 PASTE FILL OPERATION

This section provides general background information on the proposed paste filling operation at Woodlawn. This version of the Paste Fill Management Plan (PFMP) has been prepared prior to the operation of the proposed plant and will be updated with 12 months of paste filling commencing. The update will include additional chemical leaching tests using paste produced from mill tailings from the new processing facility.

2.1 Paste Fill Practical Significance

Cement paste backfill was determined to be the most appropriate method for both stope stability and long term environmental management of mill tailings at Woodlawn. The process involves the disposal of the tailings back into both previously mined underground voids and new voids created by the extraction of stopes. It offers multiple technical, economic and environment benefits and formed part of the mining method approved under Project Approval 07_0143 MOD2.

Paste backfill allows a large proportion of tailings to be disposed underground. This reduces the volume of tailings needing surface storage and in turn reduces rehabilitation costs and ongoing environmental liability. The paste is formed by mixing fine processing waste referred to as tailings with cement (binder) which can be delivered to the underground workings via pipeline. The paste is thick but can be pumped as well as fed by gravity from the surface. Transport via pipeline has operating benefits as well as improved safety compared with conventional stope filling with rock. A completed paste filled void is more stable than a rock filled void and minimises the potential for surface subsidence.

Most of the processed water can be recovered by filtration and thickening of the tailings prior to formulating the paste. The very low permeability and high saturation rates of the paste material prevents pore water leakage and minimise underground water seepage. In turn, this will reduce acid generation through the inhibition of oxygen diffusion and by increasing the acid neutralisation potential via cement addition. The cement content also increases strength gains as well as improving ore extraction volumes through the substitution and recovery of ore from pillars.

Paste fill is a rapid operation in comparison to conventional rock backfilling. It condenses the mining cycle period and provides significant strength gains within the underground workings. It is more expensive than traditional methods but is suitable at Woodlawn given the nature of the ore lenses which are relatively thin and steeply dipping but are of very high quality.

The method is also highly versatile with a high vertical filling capacity enabling variable stope designs using drift and fill mining methods to cater for the nature of the ore lenses at Woodlawn. It is also referred to as “tight filling” as it allows the fill to be placed close to the stope back which minimises the gap for further support or filling.

2.2 Woodlawn Paste Filling Operations

This section outlines the paste filling operation in sufficient detail to allow an understanding of the proposed management initiatives and ongoing testwork required at Woodlawn. These aspects are described in Chapters 3 and 4.

Historic underground mining at Woodlawn predominantly used cut and fill mining methods with unconsolidated waste rock used as backfill. Heron has determined that tight backfilling using paste fill will provide a safer and more environmentally responsible method of ore extraction. The use of cemented paste fill offers many of advantages in the extraction sequence, including:

- maximises the volume of ore extracted as stopes are always buttressed by cemented paste fill;
- allows an optimal approach to managing induced stress around mined areas;
- provides a homogeneous stope back (roof) that behaves more predictably as the ore is excavated;
- allows the size of open voids to be managed and optimised; and
- all stopes are completely backfilled prior to mine closure, which in turn limits the magnitude of ground movement adjacent to the stope.

2.3 Paste Manufacture

The Paste Plant will have a capacity to manufacture approximately 180,000 m^3 of paste per annum at a daily rate of around 650 m^3. Paste fill is composed of a mix of tailings, cement and water. Initial testing, provided in Chapter 4, indicates that 5% binder content generates the desired strength and curing time. It is possible that the addition of lime or similar additives may be needed from time to time to ensure long term stability.

The tailings will be sourced from the new processing facility which will produce a finer material with much lower metal content than the existing tailings currently stored in the tailings dams on site. The paste will be produced at a separate Paste Plant located adjacent to the mine entry (Figure 2) and delivered underground via pipeline. The tailings will be pumped to the Paste Plant from the processing plant in a slurry form via a pipeline.

The new processing plant will have two circuits to cater for new ore mined from the underground as well as reprocessing of tailings contained in the existing dams. It is anticipated that both circuits will produce similar quality tailings for paste manufacture, however test work carried out to date has only been done on the existing tailings material contained in the three existing tailings dams. The testing included regrinding of the existing tailings to a similar size as will occur with the new mill in order to replicate at least the physical attributes of the actual tailings to be produced in future.

2.4 Underground Paste Filling

Paste will predominantly be used to fill new voids created by the underground mining operation. There are however several other areas which will be filled. While most of the stoped areas were previously backfilled, there remains some open stopes and the final lift of cut and fill stopes that were not filled prior to the premature closure of the Woodlawn Mine. The volume of unfilled voids remaining in the mine required to be filled has been estimated to be 137,000 m^3. Heron plans to systematically fill these areas once access to each is achieved to enhance local stability.

Paste will also be used to stablise the crown pillar beneath the Bioreactor as well as additional sealing of the old decline roadways leading from the original mine entries which are now located below the level of waste contained in the Bioreactor. These areas are considered sources of contaminated water entering the mine workings from the Bioreactor.

2.5 Paste Mineralogy and Composition

Tailings mineralogy influences paste fill water retention, settling characteristics, strength and abrasive action. For example, clay, mica and sericite impact water retention, while silicate such as quartz are abrasive and are known to wear out pipeline systems. Additionally, sulphide including pyrite decreases strength. Higher temperatures, specific surface areas and availability of oxygen increases sulphide oxidation.

Paste fill systems have four sulphate sources:

- The most substantial amount originates from the tailings, particularly in the form of pyrite;

- High concentrations of sulphate in the paste can be from pre-oxidised tailings;
- Sulphate can be found in the cement used in the paste in the form of gypsum or anhydrite; and
- Water added to the mixture can contain free sulphate ions.

The extent of the impact of sulphate on the paste fill strength is dependent on the cement composition and percentage content, sulphate concentration and curing time. The early strength of the paste can be enhanced by small amounts of sulphate less than 2000ppm, caused by precipitates of secondary hydration products filling the void and increasing strength. Although the benefits reduce with increased sulphate concentration, once cured, the sulphate level becomes less important from a strength perspective but still important from an environmental perspective.

The leachate quality, that is, the quality of water which passes through the paste within a filled void underground is a function of the permeability of the paste, oxygen levels, metal concentration and chemical reactions which may reduce pH which in turn may release metals. These reactions occur naturally within groundwater systems including water passing through the sulphide ore body prior to mining. Groundwater quality often reflects host rock geology.

The test work undertaken to date is provided in Chapter 4, while the commitment to undertake additional testing following commissioning of the Paste Plant and Processing Plant is provided in Chapter 5.

The Paste Plant will have flexibility to deal with different physical and chemical parameters to achieve the required mixture for each design task. Although variations to the paste mixture will be required over the life of the operation, an over-riding consideration is that the paste filling maintains long term stability and remains environmentally benign and non-polluting.

3 PASTE FILL MANAGEMENT

This section outlines the proposed management principles covering the use of paste fill at Woodlawn. These are based on environmental management only and relate to the requirements of the Project Approval. Additional occupational health and safety issues are dealt separately within the Mine Safety Management System.

3.1 Planning and Design, Quality Assurance Management

Heron will ensure that the paste fill system used to fill underground mining voids remains physically and chemically stable and non-polluting in accordance with Condition 3(d) of Schedule 3 of the Project Approval. Heron is also committed to ensuring that all paste filled voids will be long term stable to prevent subsidence in accordance with Condition 3(c). To achieve this, Heron will undertake the following:

- ❒ Determine the optimal particle size distribution (PSD) to maximise paste flowability for complete and tight filling of stopes, achieve the greatest strength capability and prevent liquefaction, particularly during blasts and stope extraction.
- ❒ Determine optimal pulp density to minimise the water flow underground, but also ensuring there is enough for paste flowability through pipes.
- ❒ Determine optimal binder (cement) content to ensure sufficient paste strength and necessary pour-rest cycles and curing times.
- ❒ Paste specification yield stress and slump (i.e. pumpability and flowability respectively) will be within an acceptable range, based on ongoing test work.
- ❒ Paste mineralogy and water chemistry will be monitored to determine potential for acid generation or undesirable mineral releases into the groundwater.
- ❒ Design of the fill reticulation system will be undertaken by suitably qualified and experienced persons.

3.2 Staff Operational Management

Heron will ensure that all operators involved in the delivery and filling of voids will be subject to competence training. This training will include the provisions of the Project Approval in relation to paste and the potential groundwater issues.

3.3 Environmental Hazard and Risk Management

The main environmental hazard associated with paste filling is the potential for oxidation to occur within the paste over time. Testing to date does not indicate that this will be a high risk but the potential still exists. To address this potential hazard, the following risk management activities will be undertaken:

- ❒ Initial testing of the final paste produced from the on site paste plant using tailings produced from the new processing plant as outlined in Sections 3.4 and 5.1.
- ❒ Should the results of this initial testing demonstrate that the material will be physically and chemically benign testing will continue on a 12 monthly basis.
- ❒ Should the initial testing indicate that the paste could leach minerals, salt or acid at a greater concentration that natural groundwater within the sulphide ore body then the chemical mix of the paste will be modified and retested.

- Modifications to the paste mix can include additives such as alkaline minerals, cement content, binders and coagulants. The final paste mix and testing results will be provided to the Department of Planning and Environment and reporting in the Annual Review.

Other management activities will include:

- Maintain adequate drainage provisions to collect seepage from paste filling sites.
- Remove drainage water from the paste and return to the surface for recycling.
- Ensure that water does not build up in paste filled stopes.
- Ensure water pressure or vibration from blasting does not impact on paste fill and in particular during curing.
- Determine the water-mass balance to monitor potential water build-up. This can help identify potential liquefaction and egress of fill into the workings.
- Ensure adequate exclusion zones and containment bunds to physically separate operators from exposure to hazards associated with paste fill activities.

3.4 Paste Monitoring and Assessment

In accordance with Condition 5(b) of Schedule 4 of the Project Approval, ongoing testing and assessment of the paste will be undertaken. The testing and monitoring program are described in Chapter 5 and will include long term leachate testing of paste, testing of water draining from the paste fill areas and ongoing testing of competence, permeability and surface movement above extraction areas.

In order to assess the ongoing compliance with Condition 3(d) of Schedule 3 of the Consent, that is, that the paste remain physically and chemically stable and non-polluting, the monitoring program described in Chapter 5 includes:

- Quality Assurance testing (daily)
- Strength testing (weekly on average at full production)
- Leachate testing (on commissioning and then 6 monthly)
- Testing of underground water (monthly)
- Testing of groundwater quality in surrounding monitoring bores (quarterly)

Section 4.6.1 describes the Trigger Action Response Plan (TARPs) which incorporates the monitoring regime and describes any specific actions needed to maintain compliance with the development consent.

4 PASTE FILL TESTING AND ANALYSIS

This section provides the results of test work undertaken to date. The testing has been separated in this management plan for the purposes of satisfying Schedule 4, Condition 5(c) of the Project Approval. The testing has been performed on material available on site rather than material that will be produced from the yet to be commissioned processing facility and paste plant. The tests were performed on paste manufactured using tailings material within the existing tailings dams on site. The tailings to be produced in future will be of a significantly better quality as the existing tailings material contains higher levels of recoverable metals.

The ongoing monitoring program described in Chapter 5 is designed around paste produced from the paste plant rather than the earlier testing undertaken on facsimile paste produced in a laboratory.

The testing and evaluation process for the use of paste fill at Woodlawn commenced in 2007. The first analysis was produced by AMC Consultants in 2008 which concentrated on physical parameters, strength requirements and backfill systems. This work was expanded between 2014 to 2016 by Outotec Consultants which included paste permeability, long term chemical and physical stability and laboratory simulations. Further work has been undertaken more recently by Heron to evaluate long term water quality.

Ongoing testing will be required once the paste plant is completed and final paste is available. The results of this work will be incorporated into an updated version of this management plan.

In order to satisfactorily answer the key questions posed in Condition 3 of Schedule 3 of the Project Approval, that is, that the paste provides long term stability, is physically and chemically stable and non-polluting, the following categories have been examined:

- Initial chemical composition including the tailings and water components.
- Physical parameters of the paste including strength, curing time, rheology and final permeability.
- Leachate quality and potential for future chemical instability.

A summary of the test results to date is provided in the following sections. The necessary ongoing test work and evaluation studies are detailed in Chapter 5.

4.1 Chemical Composition

Analysis of the existing tailings at Woodlawn show that the dominant components are pyrite, quartz and chlorite. Table 4 shows two typical samples taken from the surface of the existing tailings dams and one taken as a composite of the tailings material at depth. This data represents unprocessed tailings, that is, tailings that exist on site which will be reprocessed to remove the metals. The reprocessed material will have lower metal concentration but will also be finer. Using this material to simulate paste performance both physically and chemically is considered conservative but appropriate at this stage.

Although pyrite can provide early age paste strength, it is a source of sulphur which can generate acidity and release of metals from the cured paste matrix over time. The rheological characteristics of tailings are reduced due to the presence of chlorite. In terms of the primary chemical components of the tailings, pyrite is higher in ground surface tailings than full tailings, whereas quartz and chlorite are both noted as lower in the full tailings tested in 2016.

Table 4 - Mineralogy of Tailings Used in Test Work

Phase	Ground Surface Tailings	Full Tailings
Pyrite	47.5	34.7
Quartz	26.3	36.5

Chlorite	11.2	22.8
Gypsum	3.1	0.0
Talc	3.1	0.7
Phlogopite	2.8	0.0
Albite	2.5	1.8
Marcasite	1.4	0.0
Chalcopyrite	0.9	0.0
Sphalerite	0.4	0.0
Tetrahedrite	0.4	0.0
Galena	0.2	0.0
Siderite	0.2	0.0
Pyrrhotite	0.0	0.3
Muscovite	0.0	2.6
Jarosite	0.0	0.3

The chemical composition of tailings used in paste also influences the strength, stability and overall performance of paste mixes. Complete characterisation of tailings material was also undertaken. In Table 5, the total metals aluminium, calcium and magnesium have concentrations over 10,000mg/kg and iron and sulphur both above 151000mg/kg. The metals antimony, beryllium, molybdenum and thallum have low concentrations all below 5mg/kg. The final pH of the tailings was 5.3, which is deemed within a normal range for soils.

The elevated levels of iron and aluminium do not present either strength or permeability concerns as both are usually at high concentrations in concrete products. The elevated sulphur content however would require greater binder use (cement addition) to achieve the required paste strength. This in turn however reduces the potential for long term oxidation to occur due to the neutralisation effect of the binder.

Table 5 - Woodlawn Existing Tailings Mix Total metal concentration and pH

Compound	Unit	Result
Moisture content (dried @103 °C)	%	33.7
Total Metals		
Aluminium	mg/kg	21500
Antimony	mg/kg	<5
Arsenic	mg/kg	334
Barium	mg/kg	30
Beryllium	mg/kg	<1
Boron	mg/kg	<50
Cadmium	mg/kg	10
Chromium	mg/kg	28
Cobalt	mg/kg	26
Copper	mg/kg	858
Iron	mg/kg	151000
Lead	mg/kg	3510
Manganese	mg/kg	924
Molybdenum	mg/kg	<2
Nickel	mg/kg	17
Selenium	mg/kg	25
Silver	mg/kg	10
Strontium	mg/kg	10
Tin	mg/kg	16
Vanadium	mg/kg	30
Zinc	mg/kg	2040
Calcium	mg/kg	14700
Magnesium	mg/kg	31300
Sodium	mg/kg	580

Potassium	mg/kg	1270
Sulfur as S	mg/kg	151000
Phosphorous	mg/kg	290
Titanium	mg/kg	420
Thallum	mg/kg	<5
TCLP Leach		
Initial pH	pH unit	10.3
After HCL pH	pH unit	2.0
Final pH	pH unit	5.3

The chemical composition of the mixing water can also influence the mechanical behaviour of the paste fill but does not necessarily influence long term environmental performance. There is a wide range of water quality available on site but during the operating phase of the project, water will be available from an on-site water treatment plant.

Table 6 shows the chemical analysis used in the Outotec 2015 assessment compared to the water used in the more recent paste trials. In future, water used in the paste will be blended to achieve the required water quality for paste production. By using different water qualities in the test work enabled a comparison of binder and lime costs compared with additional up front water treatment. It also provided data on the leachate potential of sulphate rich paste.

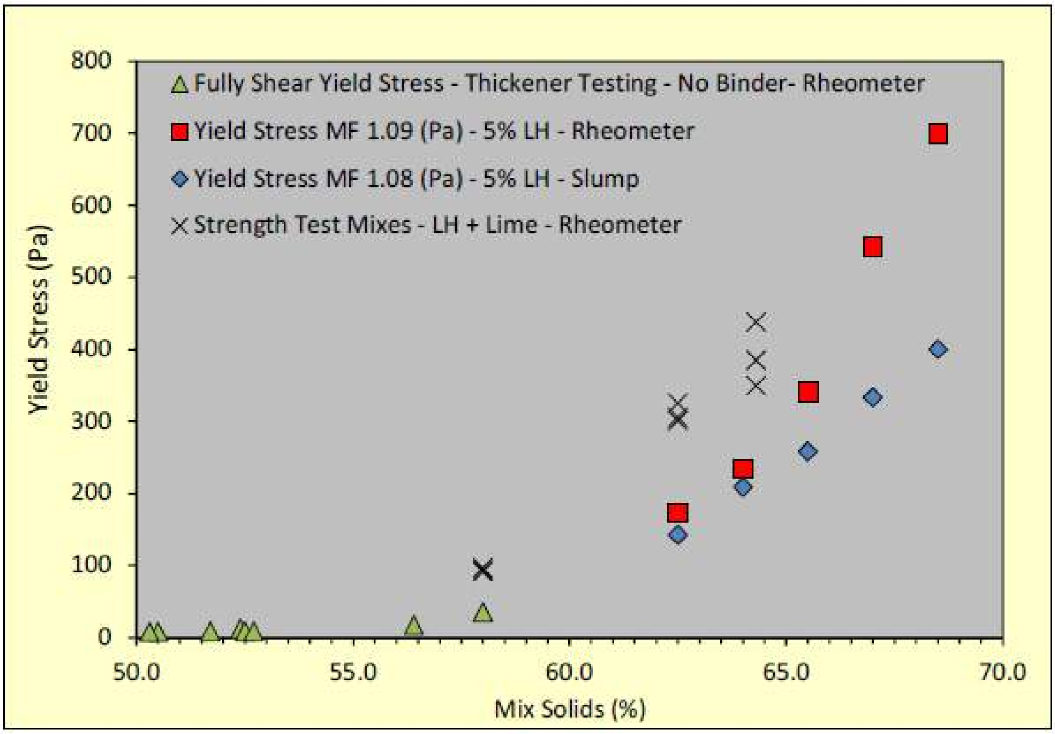
Table 6 - Mixing water quality assessment results

Analyte	Units	Outotec 2015 Testwork	Current Testwork
Ca	mg/L	555	507
Cl	mg/L	284	391
Electrical Conductivity	µScm	20700	11500
Fe	mg/L	1770	<0.05
K	mg/L	<10	2
Mg	mg/L	2520	1780
Na	mg/L	551	695
SO4	mg/L	24800	8660
Total Solids in suspension	mg/L	<5	<5
TDS	mg/L	44200	13200
Turbidity	NTU	7.0	0.7
pH	pH unit	2.29	6.74

4.2 Rheological (flow) Test Results

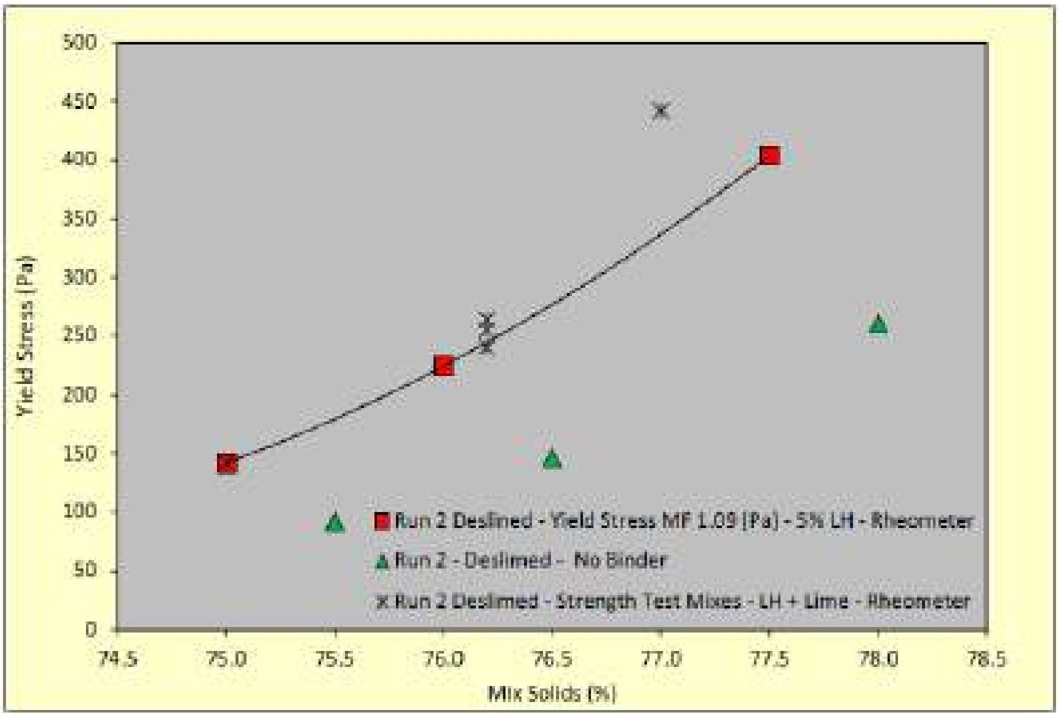
Rheology testing determines the plastic flow characteristics of the paste. Put simply, if the paste is too thick it will not be able to be delivered to the required locations underground and may set too quickly while conversely if the paste is too thin the curing time increases, potential for slumping increases and durability decreases. Strength and permeability characteristics are directly related to rheological factors. Achieving the correct mix is a balance between required engineering characteristics (short term strength, curing time and flowability) and environmental factors (long term strength, permeability, chemical stability and water quality). These factors are not mutually exclusive as the following results demonstrate.

Rheology testing was undertaken on three laboratory simulated tailings materials using a vane rheometer. The first sample was classed as a fresh full stream tailings sample. Results were relatively consistent between the full sheared thickener underflow and paste batch with 5% yield stress. It is possible that this can be explained by the residual flocculant having a similar influence on the binder and preventing flow. As shown on Graph 1, the addition of small amounts of hydrated lime reduces the solids concentration by up to 2.5%.



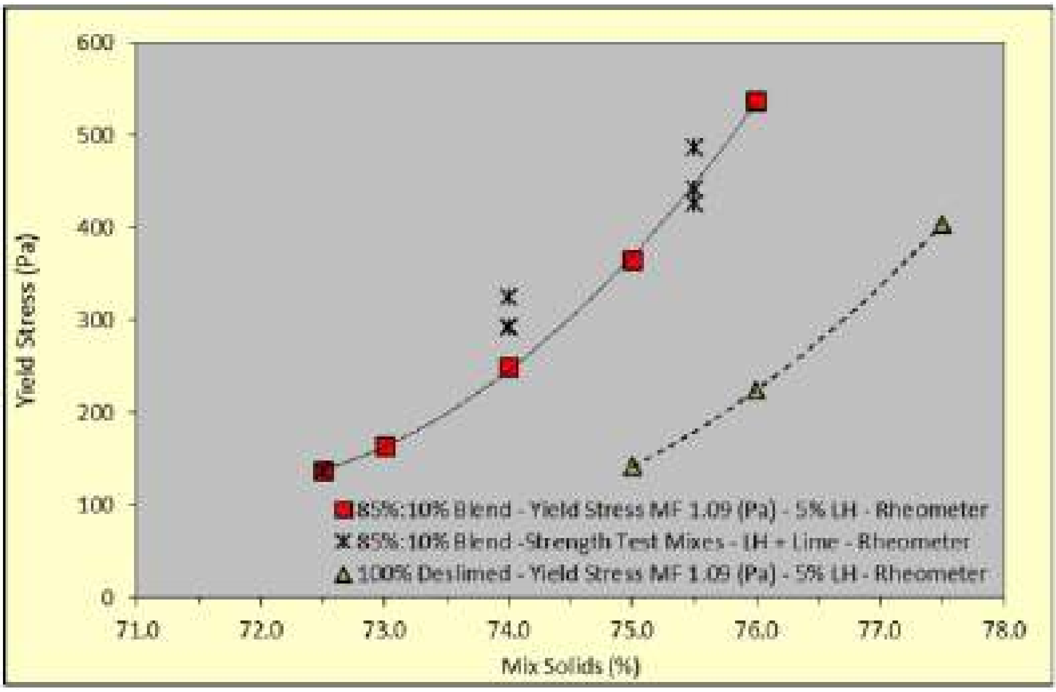
Graph 1 - Rheological behaviour of full stream Woodlawn paste

The second paste option (deslimed tailings) rheology was tested using the cyclone underflow samples to determine the material grading that would generate the highest density and thus highest strength/lowest permeability paste. The purpose of desliming the tailings is to increase the solids concentration by approximately 10%. Desliming was done in the laboratory and represents the removal of a portion of the colloidal clays. Graphs 2 indicates that the addition of hydrated lime has a minimal impact on the deslimed tailings flowability.



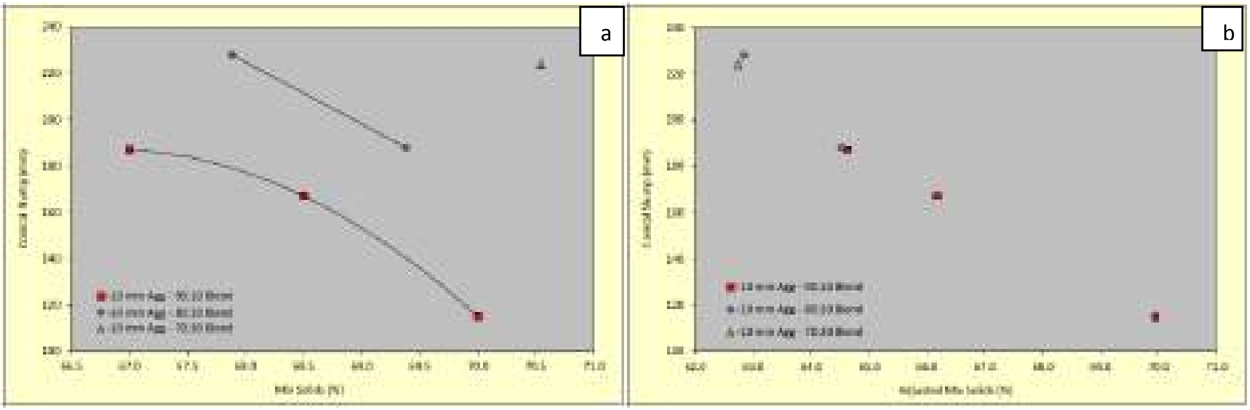
Graph 2 - Yield stress against mix solids content for deslimed Woodlawn paste

An additional option included the blending of 85:15 cyclone underflow material and full stream tailings respectively. The rheology for this option was tested using a vane rheometer to measure yield stress vs mix solids content (see Graph 3). Testing shows that an increase in fines content from full stream tailings results in a decline in flowability and consequently an anticipated 2% decrease in operating solids content.



Graph 3 - Yield stress against mix solids (%) for 100% deslimed and 85:15% blended tailings pastes

Finally, the third option (Aggregate Blends) involves creating a paste fill from a blend of crushed waste rock and stream tailings. Previous research has suggested that this blend creates a higher strength paste, with an aim to offset the aggregate cost with binder savings. Tests using the conical slump method were undertaken using different proportions of aggregate of 10, 20 and 30%, to identify a paste of suitable consistency. Graph 4a has plotted the conical slump against mix solids content for aggregate to highlight that combining aggregate to the tailings paste increases the solids concentration for yield stress. On the other hand, the gap in particle grading means that the aggregate does not influence the fill flowability as shown on Graph 4b.



Graph 4 Conical slump against mixed solids content for a) Aggregate – Paste mixes and b) adjusted paste solids content

The use of aggregates did not result in the required paste strength and would have an increased abrasive force on the reticulation network without any engineering or environmental benefits.

The testing has shown that the use of tailings simulated to broadly align with the anticipated tailings production from the new processing plant provides the best option to achieve a workable paste mix that can be delivered to the underground stopes using gravity fed pipelines from the surface paste plant.

4.3 Cemented Strength Testing

Following on from the rheology testing, each paste option was subjected to curing and strength assessments. The cemented strength of paste is a function of:

- ❒ particle size distribution, in particular the content of fines;
- ❒ particle shape;
- ❒ binder content;
- ❒ percentage moisture; and
- ❒ specific gravity.

The curing time, often referred to as hydration, is also influenced by the above factors but also the moisture content and various chemical reactions. Additives can be used to both speed up or slow down hydration.

For Woodlawn, the mining sequence and development program would require curing times of less than 28 days for full strength and preferable in the order of 14 days depending on the specific purpose of the paste at any one time.

The full strength requirements are listed in Table 7. These are based on known geological conditions for both new and existing mine workings.

Table 7 - Estimated Paste Fill Strength Requirements

Region	Portion of total paste fill (%)	14 day strength requirement (kPa)	28 day strength requirement (kPa)
Kate Lens (Transverse stoping)	20	280	2600
	7	280	280
Kate Lens (Longitudinal retreat)	9	140	1500
	9	140	140
Drift and Fill with Half Uphole Retreat	19	400	400
Underhand Longhole Uphole Retreat Stoping	15	140	140
	15	140	1500

The required strength and curing times may differ for other mining activities, particularly filling old rock filled stopes where access above or below is not required in the short term. A summary of the test results for each paste mix is provided in Table 8.

Table 8 - Cemented Strength Test Results

	Option	Material Source	LH Cement		Hydrated Lime		Mix solids content (%)	UCS (kPa)			Dry Density (t/m³)	Sat. (%)
			Portion by weight (%)	Mass per unit volume (kg/m3)	Portion by weight (%)	Mass per unit volume (kg/m3)		7d	14d	28d	1.07	100
1	1	Full Stream Tails	3.0	31.3	0.43	5.1	58	1	62	104	1.01	95
2	1	Full Stream Tails	5.0	47.7	0.38	3.8	58	50	235	365	1.03	97
3	1	Full Stream Tails	10.0	97.8	0.28	3.0	58	217	597	1199	1.19	97
4	1	Full Stream Tails	3.0	34.3	0.32	3.7	64.3	28	156	275	1.20	97

5	1	Full Stream Tails	5.0	57.8	0.16	1.9	64.3	181	-	766	1.19	95
6	1	Full Stream Tails	10.0	114.5	0.05	0.6	64.3	476	-	2242	1.14	98
7	1	Full Stream Tails	3.0	33.1	0.27	3.1	62.5	62	-	193	1.13	98
8	1	Full Stream Tails	5.0	54.9	0.26	2.9	62.5	236	468	606	1.14	97
9	1	Full Stream Tails	10.0	87.1	0.15	1.7	62.5	592	-	1862	1.81	100
10	2A	Des Tails (R2)	3.0	52.4	0.20		76.2	392	-	870	1.84	100
11	2A	Des Tails (R2)	5.0	87.1	0.13		76.2	802	153	1996	1.83	100
12	2A	Des Tails (R2)	10.0	173.2	0.24		76.2	2926	-	5031	1.85	100
13	2A	Des Tails (R2)	5.0	88.3	0.24		77.0	940	-	2122	1.77	100
14	2A	Des Tails (R2)	5.0	84.3	0.00		75.0	552	-	1536	1.64	100
15	2B	85% Des Tails (R2) : 15% Full Tails	5.0	77.6	0.08		72.5	796	-	1507	1.67	100
16	2B	85% Des Tails (R2) : 15% Full Tails	3.0	48.3	0.16		74.0	322	-	877	1.67	100
17	2B	85% Des Tails (R2) : 15% Full Tails	5.0	80.3	0.11		74.0	817	134	1707	1.66	100
18	2B	85% Des Tails (R2) : 15% Full Tails	10.0	158.8	0.03		74.0	2488	-	4480	1.72	100
19	2B	85% Des Tails (R2) : 15% Full Tails	3.0	49.9	0.12		75.5	420	722	967	1.71	100
20	2B	85% Des Tails (R2) : 15% Full Tails	5.0	82.2	0.04		75.5	800	128	1761	1.71	100
21	2B	85% Des Tails (R2) : 15% Full Tails	10.0	241.8	0.62		75.5	2564	365	4634	1.72	100
22	3	80% Full Tails: 20% - 10mm Agg	3.0	58.1			68.0	87	205	292	1.32	97
23	3	80% Full Tails: 20% - 10mm Agg	5.0				68.0	431	-	897	1.30	98
24	3	80% Full Tails: 20% - 10mm Agg	5.0	64.6			67.0	324	-	-	1.29	100
25	3	80% Full Tails: 20% - 10mm Agg	3.9	55.8			70.5	244	-	611	1.42	98

The strength development rate of the paste fill was also modified by the addition of hydrated lime at various concentrations. Although no gypsum was added during the trials, it could be used in future to slow the curing time if this was considered necessary. The trials demonstrated that the use of aggregates within the paste did not enhance final strength and will therefore not be used at Woodlawn.

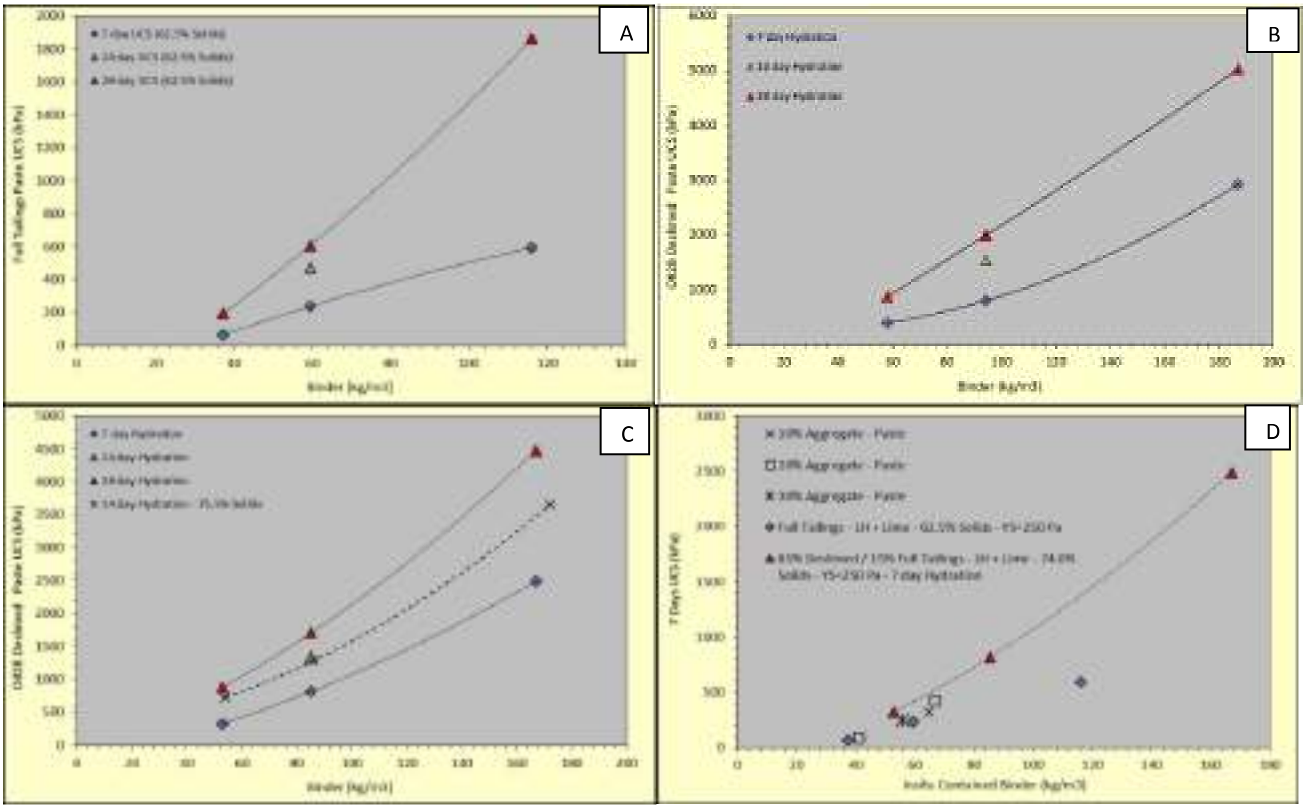
The strength testing showed that although deslimed tailings (which have the very fine clays removed) provided the greatest strength, most of tailings stream options provided sufficient strength to achieve the proposed extraction methodology. The testing also found that each paste option would provide significant additional surface stability compared with the original mining method of using loose rock fill.

The results also show that strength is dramatically increased with increased cement content. A corresponding reduction in curing times also occurred with increased cement content. This was expected but as the higher strength and/or reduced curing times is only needed in certain circumstances, the Paste Plant operation will remain flexible to deliver the optimal paste quality for its intended purpose within the mine.

4.4 Binder Requirements

As cement represents a significant component of the operating costs of the Paste Plant, developing the optimal paste mix is important for the overall operation. The test work has shown that generally a 5% cement addition provides sufficient strength and curing time. Variations will occur and may include a higher or lower percentage of binder depending on the required duty.

Tests using the four paste options are summarised in Graph 5 (A-D).



Graph 5 - In situ contained binder Vs strength for Option 1, 2A, 2B, 3 at hydration times of 7, 14 and 28 days.

The results show differing strength characteristics over time for each paste mix. These paste mixes differed in density, cement content and particle distribution. The results showed that all mixes could be utilised at Woodlawn with the exception of the aggregate option. The main variable to achieve the required strength and curing time will be cement content.

4.5 Permeability

The fine particle size of the tailings to be used in the Paste Plant will minimise the porosity and permeability of the material within the stopes as well as increase overall strength. This in turn reduces the potential for water movement through the material. The particle shape will be angular and with a relatively high specific gravity but still lower than the original ore removed from the stope.

Results indicate that the Woodlawn cemented paste backfill, using a 5% binder content, is expected to have a permeability between 1 x 10^{-10} m/s and 2.0 x 10^{-8} m/s. By comparison, the permeability required for the tailings dam liner is 1 x 10^{-9} m/s for a total thickness of 900mm. This very low permeability over a thickness of less than one metre is considered sufficient to avoid contaminated water within the tailings dams from entering the groundwater system below the dam. Given that the paste filled stopes will generally be thicker than 20 m, the anticipated permeability value will be an effective barrier to groundwater movement.

4.6 Leachate Quality

The final issue raised by Condition 5 of the Project Approval is that the paste material is chemically stable and non-polluting. Toxicity characteristic leaching procedure (TCLP) was undertaken on the paste. This test procedure is a soil/solid sample extraction method for chemical analysis employed as an analytical method to simulate leaching. The method was used initially as it was deemed more suitable than other testing methods which are designed around the determination of acid generation potential.

The TCLP method simulates water percolating through a solid or semi solid material under pressure and was therefore considered the most appropriate test to obtain representative samples of leachate. As described in

Section 5.1, several additional tests will be undertaken once the paste plant is operational. These tests will include standard tests for Net Acid Generation (NAG) and Kinetic testing. NAG testing will determine if the paste has the potential to become acid generating over time. The higher the alkalinity of the material, the lower the risk of leaching soluble metals. This test in conjunction with Kinetic testing using leach columns can determine the long term physical and chemical stability of the paste. Section 5.2.1 lists the corrective measures to be employed based on ongoing test results to ensure that the paste used underground will remain physically and chemically stable and non-polluting.

The results of the testing to date are shown in Table 9. The first set of results are the Specific Contaminant Concentration (SCC) which represents the key elements of the paste itself measured in mg/kg. The sample paste used for this test was obtained from unprocessed tailings held in Tailings Dam South. The results were as expected with elevated metal content.

The second set of results are the extracted leachate from the cured paste. This data is provided in mg/L. The table also shows the current waste classification guidelines for comparison purposes.

It is interesting to note that the existing un-reprocessed tailings on site meets the general solid water guidelines with the exception of lead content. The reprocessing operation will remove the majority of lead from the tailings along with zinc and copper. Similarly, the final tailings produced from new ore from the underground operation will have significantly lower metal content than the current existing tailings held on site. This will be achieved through a more advanced ore processing system than was originally available when the mine commenced which enables more metal to be recovered.

Table 9 – Paste Leachate Testing and Site Specific ANZECC Trigger Values

			NSW - Waste Classification Guidelines				ANZECC 2000
Parameter	Result*	Units	General Solid Waste		Restricted Solid Waste		Site Specific Trigger Value for surrounding nominated bores
			Leachable Concentration	Specific contaminant concentration	Leachable Concentration	Specific contaminant concentration	Refer Section 4.6.1
			TCLP1 (mg/L)	SCC1 (mg/kg)	TCLP2 (mg/L)	SCC2 (mg/kg)	mg/L
SCC Results		Solid					
Lead	3510	mg/kg		1500		6000	
Molybdenum	2	mg/kg		1000		4000	
Nickel	17	mg/kg		1050		4200	
Selenium	25	mg/kg		50		200	
Silver	10	mg/kg		180		720	
Arsenic	334	mg/kg		500		2000	
Beryllium	1	mg/kg		100		400	
Cadmium	10	mg/kg		100		400	
Chromium	28	mg/kg		1900		7600	
Initial pH	10.3	pH					
After HCl pH	2	pH					
TCLP Test Results		Liquid					
Final pH	5.3	pH					6.9
Chromium	0.004	mg/L	5		20		
Lead	46	mg/L	5		20		0.0029
Molybdenum	0.002	mg/L	5		20		
Arsenic	0.01	mg/L	5		20		0.005
Nickel	0.028	mg/L	2		8		
Selenium	0.01	mg/L	1		4		
Beryllium	0.002	mg/L	1		4		
Cadmium	0.21	mg/L	1		4		0.0044
Silver	0.001	mg/L	5		20		
Aluminium	1.44	mg/L	N/A		N/A		0.07
Copper	4.84	mg/L	N/A		N/A		0.01
Manganese	3.08	mg/L	N/A		N/A		6.61
Zinc	13.9	mg/L	N/A		N/A		11.39

Iron	0.17	mg/L	N/A		N/A		0.475
Moisture Content (dried @ 103°C)	16.5	%					
Moisture Content (dried @ 103°C)	47.1	%					

*Note: This is the result from the facsimile paste produced in the laboratory

Also of interest is that the naturally occurring groundwater is generally higher than the leachable concentration and it is expected that the leachable concentrations for paste produced from the actual paste plant will be significantly lower still. On this basis, the use of paste fill in mined stopes will have the effect of reducing the natural transmission of high metal content groundwater through the mined area. This is in addition to the reduction of metals caused by the removal of the metal rich lenses.

Ongoing testing, as outlined in Section 5.1 is proposed to ensure the paste remains chemically stable and non-polluting over the long term. Additional testing will be undertaken once the processing plant has been commissioned and paste is being manufactured from the actual final tailings material.

The testing undertaken to date has however provided a baseline conservative assessment which has demonstrated that the paste will be permanently stable and non-polluting. The results of this work will be incorporated into this management plan when available.

4.6.1 Calculation of ANZECC Site Specific Trigger Values

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) form part of Australia's National Water Quality Management Strategy. Its purpose is to provide a guide for setting water quality objectives required to sustain current or likely future, environmental values [uses] for natural and semi-natural water resources. They are however designed for surface water analysis and do not translate to assessing groundwater systems. ANZECC is a risk based methodology which takes into account several guideline packages covering surface water quality, aquatic ecology, environmental values of the waterway and physical, biological and chemical stressors. These combine to develop a set of guideline trigger values and specific ambient water quality indicators against which the health of a waterway can be assessed and managed.

The use of the guidelines is quite specific and the following matters referenced in Section 2.2.1.9 of the ANZECC 2000 Guidelines are relevant:

- The Guidelines have not been designed for direct application in activities such as discharge consents, recycled water quality or stormwater quality, nor should they be used in this way.
- They have been derived to apply to the ambient waters that receive effluent or stormwater discharges, and protect the environmental values they support.
- The Guidelines have not been designed to deal with mixing zones, explicitly defined areas around an effluent discharge where the water quality may still be below that required to protect the designated environmental values.
- The trigger values for different indicators of water quality may be given as a threshold value or a range of desirable values.
- Trigger values are conservative assessment levels, not pass/fail compliance criteria.
- Local conditions vary naturally between waterways and it may be necessary to tailor trigger values to local conditions or 'local guideline levels'.

- The guidelines provide a process for refining the trigger values and these protocols should always be followed.

Despite the ANZECC Guidelines not being relevant to groundwater systems, they do provide a methodology to develop site specific water quality trigger values using a large long term ambient water quality database. Although the triggers are meant to relate to surface water and are refined using various surface based environmental investigations, the development of trigger values would be useful in determining compliance with Condition 3(d) of Schedule 3 of the Project Approval. The Woodlawn Mine has an established long term groundwater quality database which extends over a 20 year period. The data comes from a series of groundwater monitoring bores spread across the site. The current monitoring bores are shown on Plan 3. There are however limitations to the data which may prove problematic in the detection of any impacts from the use of paste underground. These include:

- Groundwater quality naturally varies according to the host rock of the monitoring bore.
- There are four distinct host rock types, sedimentary rock, metamorphic, sulphide volcanic and ore lens.
- Variability also occurs within the same bore over time due to climatic conditions. The variability is due to increases and decreases in the saturation level of strata surrounding the bore.
- The site is located at the crest of two catchments so there are no natural upstream sample points available.

Despite these limitations, ANZECC based Site Specific Trigger Values have been determined based on the 80th percentile water quality obtained from 24 consecutive samples from monitoring bores located within the four separate host rock types. The results are shown in Tables 10 and 11 below.

Table 10 – 80th Percentile Trigger Values Derived for Chloride, EC, Cations, pH and Sulphate (mg/L)

Host Rock Type	Bore	Chloride	Conductivity	Calcium	Magnesium	Potassium	Sodium	pH	Sulphate
Ore Body	MB16	270	36000	480.5	7465	5.65	244.0	3.3	63350
Sulphide Volcanics	MB19	1115	6870	740.0	591.0	1.85	284.5	6.9	3225
Metamorphic	MB7	3065	9660	335.5	676.5	11.65	632.5	7.3	207
Sedimentary	MB4	410	1680	7.5	88.4	1.70	173.0	5.5	210

Table 11 – 80th Percentile Groundwater Site Specific Trigger Values for Dissolved Metals (mg/L)

Host Rock Type	Bore	Aluminium	Arsenic	Cadmium	Copper	Lead	Manganese	Zinc	Iron
Ore Body	MB16	2145	0.2	29.4	206.5	0.5345	550	8450	51.95
Sulphide Volcanics	MB19	0.07	0.005	0.044	0.01	0.0029	6.61	11.39	0.475
Metamorphic	MB7	0.04	0.02	0.008	0.07	0.0007	1.16	1.137	0.145
Sedimentary	MB4	0.26	0.005	0.0017	0.06	0.0068	0.04	0.849	0.820

5 MONITORING AND VERIFICATION

This PFMP forms a component of the overall Environmental Management System for the Woodlawn Mine. An essential component of the EMS is verification and implementation of corrective actions as required to achieve the requirements of the Project Approval.

5.1 Paste Monitoring

Heron Resources has developed an environmental monitoring program covering the requirements of the Project Approval, Environment Protection Licence and Mining Lease. Monitoring specifically for the Paste Fill operation will be conducted once the paste is being produced from tailings generated by the new processing plant. The testing will include:

- Conducting Kinetic and Net Acid Generation testing.
- Paste strength and curing times.
- Permeability tests of fully cured paste.
- Water testing of drainage from paste within the workings.

As the mining process will be removing metals from the extraction area it would not be possible for the natural groundwater to increase in metal concentration. The monitoring program will therefore include other cations and anions, pH and conductivity. These tests are further described in the following sections.

5.1.1 Net Acid Generation (NAG)

NAG, also referred to as NAP or net acid production is a static method using hydrogen peroxide to oxidise any sulphides present in the sample. The acid produced from the oxidation reaction may subsequently be partially or totally consumed by acid neutralising components of the sample. Any remaining acidity is determined by back titration to both pH 4.5 and pH 7.0 and reported as NAG. It is expressed in kg H_2SO_4 equivalent per tonne. This is the main test to be performed on both the waste rock within the mine and the paste delivered to completed stopes. This test determines whether a particular material is classified as Potentially Acid Forming (PAF) or Non-Acid Forming (NAF).

5.1.2 Kinetic Testing

Free draining kinetic leach columns are used to compliment environmental geochemical investigations on mine rock and waste materials and are used to determine drainage chemistry. Free draining leach columns simulate field weathering conditions to provide information on a range of issues including sulphide reactivity, oxidation kinetics, metal solubility and the leaching behaviour of the test materials.

Kinetic testing will be performed on the cured paste when available from the new plant. It will only be necessary to test the first batch and repeated only if the paste mix changes. Given the results to date, it is highly unlikely that the paste will be classified as PAF and equally unlikely that any water leaching from the paste will have a water quality approaching the natural background levels which are naturally high in salt, sulphate and metals.

5.1.3 General Water Chemistry Testing

Monitoring of surface water and groundwater is undertaken as part of the approved monitoring program under the Environment Protection Licence. This data is used to determine whether mine activities are causing adverse impacts upon the surrounding environment, including groundwater system. The groundwater monitoring program covers general physical parameters such as pH, conductivity, cations and anions as well as a range of metals which are typical of the Woodlawn volcanics. The data is used to provide a first indicator of the presence of additional acid formation over and above the influence of natural geological conditions. The location of the groundwater monitoring sites is dictated by the Environment Protection Licence and will be varied as required over the life of the mine in consultation with the EPA.

Natural background water quality has been demonstrated to be heavily influenced by geology. The volcanogenic massive sulphide deposit forms part of a wider regional north-west plunging syncline which not only hosts metal rich ore lenses but also a range of metamorphosed sedimentary rocks of both marine and volcanic origin.

Marine deposits are naturally high in salt content. The ore body is naturally high in sulphides and the target ore lenses represent concentrations of metals including zinc, copper, lead, gold and silver. Together, it is referred to as the Woodlawn Volcanics.

Water quality has been characterised according to its host or source which has been documented in the Woodlawn Annual Review. Sedimentary strata usually produce more typical water quality with pH generally above 6, relatively low salinity and sulphate levels and low metals. These areas are the easiest to detect the influence of acid rock drainage.

It is difficult to determine the effects of mining on acidity and metal concentrations in areas naturally influenced by the sulphide volcanics which can mask the presence of additional mine related sources of acidity and metal rich drainage. In order to detect any influences caused by the paste fill, additional sampling will occur from water draining from the paste prior to curing. It is however anticipated that the paste will provide a slight alkaline influence on the natural groundwater inflow into the mine although the overall benefit would be difficult to quantify.

5.1.4 Testing Program and Schedule

The monitoring program will commence when the Paste Plant has been commissioned. Produced paste will be first tested on the surface prior to being used underground. This material will also be tested for leachate quality along with a range of engineering tests to ensure the material is suitable for use in underground stopes.

Once the plant is commissioned, paste will be delivered to underground voids initially in batches but will progressively increase to a near continuous rate as the mine develops. The following schedule of monitoring will occur:

- Quality assurance testing of the paste will be carried out on a daily basis. This testing may include particle size distribution, consistency, pH, density, cement content and Rheology.
- Strength testing of the paste will occur at least weekly or as required for quality assurance purposes. Results are provided in 7 day and 14 day periods.
- Chemical testing of the water drained from the paste on a monthly basis. This drainage water will be tested for total and filtrable metals, pH and conductivity and maybe combined with the monitoring program associated with the dewatering program.
- Monthly testing of the water pumped from the underground workings.
- NAG and Kinetic Leach testing of paste produced from the paste plant. An initial test will be undertaken on the first batch during plant commissioning. The results will be used to vary the mix if required after which at least one test per six months will be undertaken.
- Quarterly monitoring of bores as part of the ongoing longterm groundwater monitoring program. The results from bores MB4, MB7, MB16 and MB19 which are representative of the varying host rock and are closest to the mining area will be separately analysed for any changes in water quality following the use of paste.

The results of the first round of testing when the paste plant is commissioned will be provided to the Department of Planning and Environment along with an interpretation of the data. The analysis will include an assessment of compliance with Condition 3(d) of Schedule 3, that is, that paste fill is physically and chemically stable and non-polluting. Subsequent data will be provided to government stakeholders each year in the Annual Review. The data will also be used to update this Paste Management Plan within 12 months of paste filling commencing.

5.1.5 Adoption of Assessment Goals

The key assessment goal is specified in Condition 3(d) of Schedule 3, that is, that the material is to be physically and chemically stable and non-polluting. Although there are no specific guidelines relevant to paste fill operations, Heron has developed the equivalent of Site Specific Trigger Values as set out in the ANZECC 2000 guidelines. These guidelines were developed specifically for surface waters but contain methods to determine water quality goals based on existing natural water quality. At the Woodlawn Mine, groundwater quality is heavily influenced by the presence of the sulphide ore body and is typically high in metals and salt and is often acidic. The surface and groundwater quality have been monitored on site for nearly 20 years which has generated a significant data base which can be used to determine the impacts of the use of paste within the underground workings.

Based on the historic data, ANZECC based triggers have been calculated and presented in Section 4.6.1. These values will be used to assess compliance with the Project Approval performance measure that the material used to backfill underground voids is physically and chemically stable and non-polluting.

Both surface and groundwater monitoring data are presented each year in the Annual Review. The commencement of paste filling will be noted in the Annual Review and groundwater quality data from nominated bores will then be compared against the Site Specific Trigger Values. The resulting assessment will then be included in subsequent Annual Review documents.

5.2 Corrective and Preventative Measures

Despite the expectation that the paste will have a slight positive impact on groundwater quality within the mine, Heron will monitor the quality of the paste, groundwater quality within the mine workings and surrounding nominated groundwater bores with the results reported in the Annual Review. The data will be limited to pH, dissolved oxygen and conductivity in the first instance. If pH of the paste drain water falls below 5, a metal suite will be carried out to determine if metals are mobilising and if the concentration is above natural levels in the host rock. Additional NAG testing will be done on the paste to determine if this is the source. If the NAG testing shows that the paste is moderately PAF or above, then additives may be required such as lime to lower the NAG value.

There are engineering imperatives to ensure that the paste remains chemically stable and non-polluting. If the paste becomes strongly PAF, it is possible that its strength will become compromised over time. Therefore, quality testing is included in the Paste Plant operation which will include environmental parameters.

5.2.1 Corrective Actions

The following Trigger Action Response Plan has been developed in relation to paste fill.

Component	Parameter	Trigger	Action
Paste Strength	14 day strength	>140 kPa	No action, continue monitoring
		<140 kPa	Increase binder content to reach strength requirement
leachability	Permeability	$>2.0 \times 10^{-8}$ m/s	No action, continue monitoring

		<2.0 x 10^{-8} m/s	Increase binder content to achieve required permeability
Paste quality	Acid generation	NAPP <0	Non-acid forming, continue monitoring
		NAPP >0	Potentially acid forming, increase cement and/or lime to paste mix to meet NAPP criteria
		NAG pH >4.5	Non-acid forming, continue monitoring
		NAG pH <4.5	Potentially acid forming, increase cement and/or lime to paste mix to meet NAG criteria
Mine Water Quality	pH	< 20% trend change above SSTV over 12 months	Continue monitoring and reporting
		> 20% trend change above SSTV over 12 months	Investigate and report to DPE on potential causes and develop remedial actions if considered necessary
		> 20% trend change above SSTV over 24 months	Engage external consultant to investigate causes and to provide recommended remedial actions Report results to DPE, DPI and EPA
	metals	< 20% trend change above SSTV over 12 months	Continue monitoring and reporting
		> 20% trend change above SSTV 12 months	Investigate and report to DPE on potential causes and develop remedial actions if considered necessary
		> 20% trend change above SSTV over 24 months	Engage external consultant to investigate causes and to provide recommended remedial actions Report results to DPE, DPI and EPA

The mine water quality TARPs are to be used for both sampling underground, mine water pump out and for nominated bores. The calculated Site Specific Trigger Values developed under ANZECC methods will vary over time according to ongoing monitoring data. ANZECC methods acknowledge that water quality will vary according to seasonal influences as well as long term climatic changes. This variability is accounted for in the use of rolling percentile calculations for receiving waters. In this case, the receiving waters is the surrounding groundwater system.

In summary, the corrective measures that are available under this Paste Fill management plan centre around the permeability and leachability of the paste. The most effective way to improve these characteristics is to increase the binder content of the paste. Other measures can include the introduction of alkaline materials which can include PAF materials on site or new alkalis such as lime.

Increased monitoring efforts can also be employed to better define any potential actions that may be necessary. The introduction of rock that has a positive acid neutralising capacity (ANC) has the ability to consume acid in order to return the nett value to within an acceptable level.

5.3 Reporting Procedures

All environmental monitoring data obtained as part of this management plan will be provided to the Mine Manager, who in consultation with the site Environmental Manager, will review the data on a monthly basis. A summary of the data will be provided in the Annual Review which is supplied to regulatory authorities on an annual basis.

Should any exceedance of the TARP values occur, the DPE will be advised in writing within 14 days of receiving the laboratory results. In addition, the DPE will be provided with the results of the first round of monitoring results following the commissioning of the Paste Plant.

5.4 Management Plan Review

In accordance the overall site Environmental Management Strategy (EMS), this PFMP will be reviewed on an annual basis. In addition, an updated PFMP will be prepared once the Paste Plant is operational and producing paste from tailings generated from the new processing facility.

6 REFERENCES

6.1 External documents or legislative

DOC ID	TITLE
07_0143MOD2	Woodlawn Mine Project Approval
EPL 20821	Woodlawn Mine Environment Protection Licence

6.2 Heron documents

DOC ID	TITLE
TOP-SSE-MAN-0039	Environmental Management Strategy

7 READ AND UNDERSTOOD DOCUMENT REQUIREMENTS

All employees have a legal obligation to follow safe work practices and procedures when carrying out any work task. Following the requirements of this document and other documents applicable to the task being performed is critical in protecting the safety of all operators, co-workers and visitors to the site.
All employees must strictly adhere to these requirements. Failure to do so could result in a serious safety breach with consequences as part of the Code of Conduct. You are signing this acknowledgement sheet agreeing to work to this procedure and have either read the document personally or had the document read and explained to you and, have clearly understood the requirements.

You also acknowledge that at any time you may not be sure of the requirements and the contents contained within this and/or any other documents, you are to ask for a copy so that you are familiarised again with the contents and requirements allowing you to operate this equipment and perform your work safely.

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Print Full Name: *Full Signature:* *Date:*

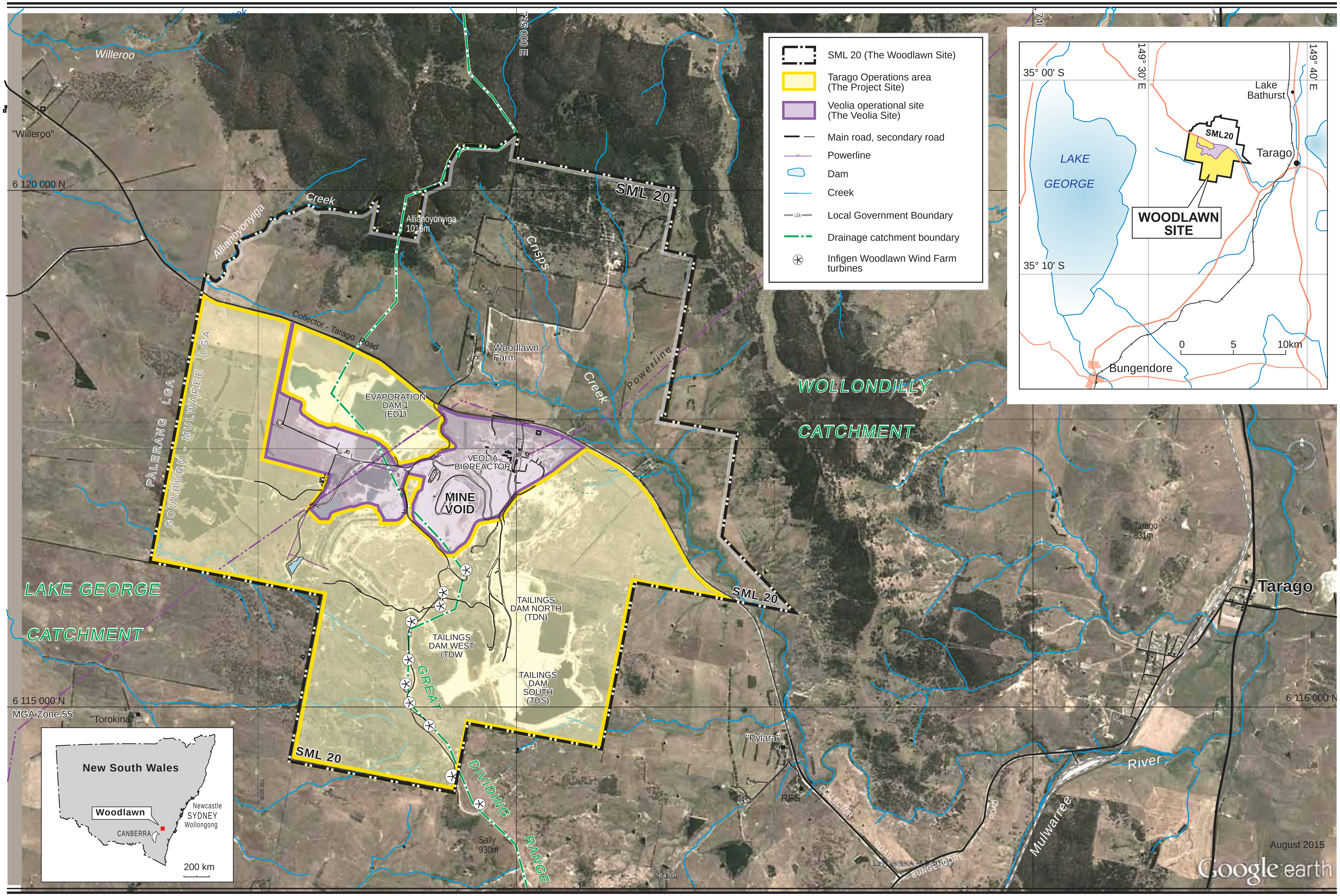
8 APPENDICES

Appendix 1 – Plans

Appendix 2 - Definitions

Appendix 3 – Roles and Responsibilities

Appendix 1 – Plans



Topographic map source : Lake Bathurst 8827-4-N

0 500 1000 1500 2000 metres

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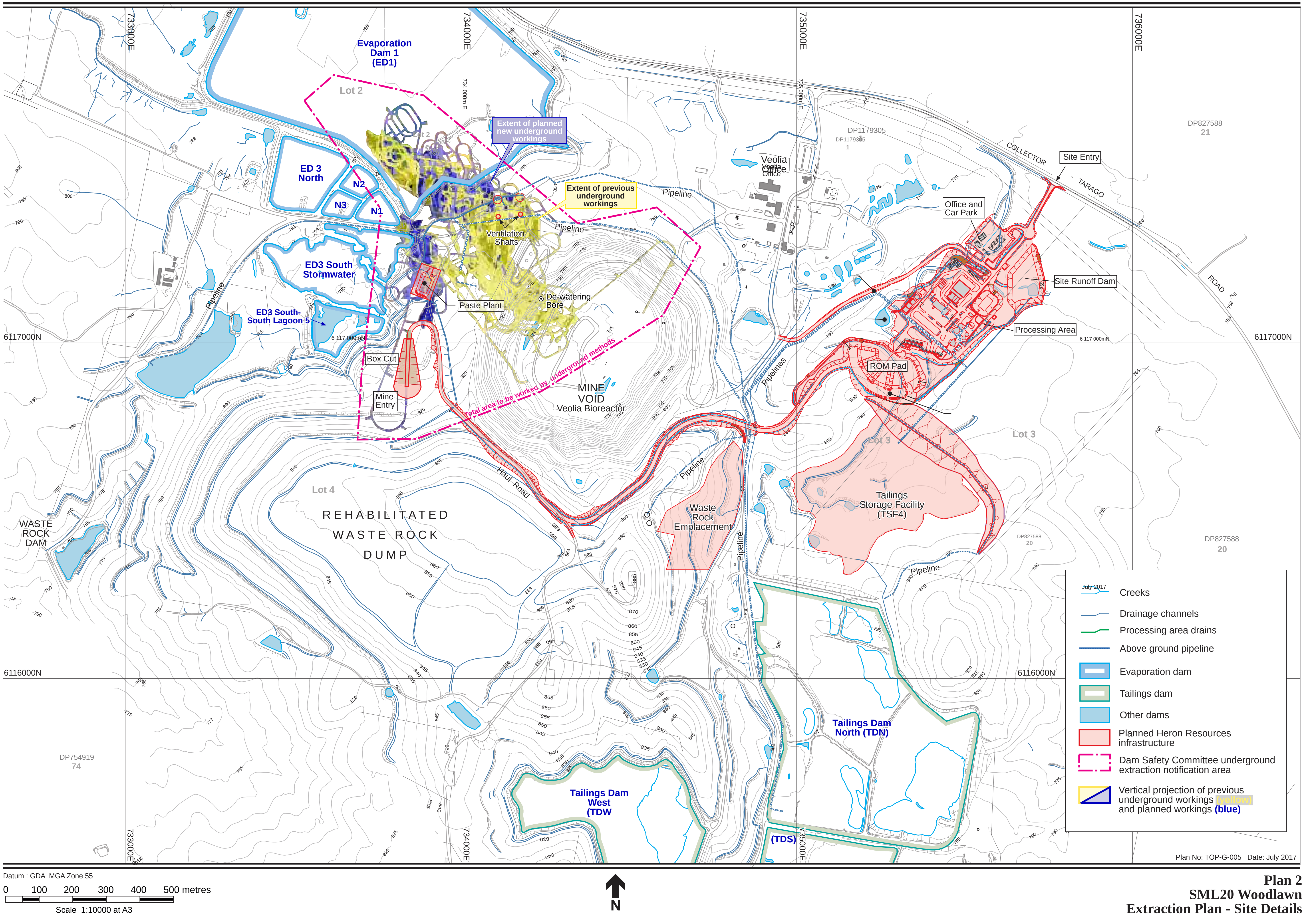
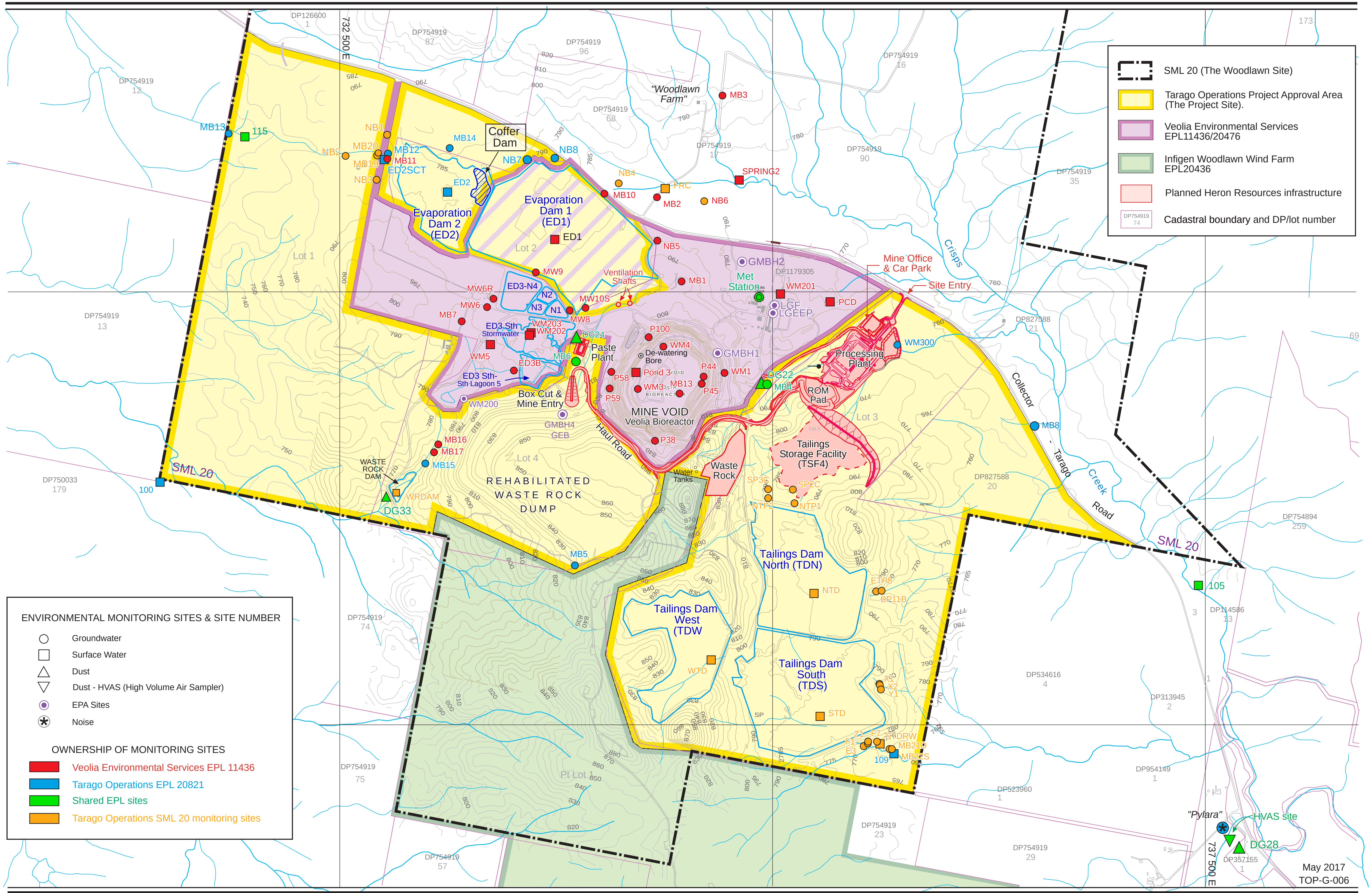
Plan 1
Woodlawn Site - Locality Plan



Plan 2
SML20 Woodlawn
Extraction Plan - Site Details



Datum : GDA MGA Zone 55

0 500 1000 m

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PLAN 0
Woodlawn Project
Environmental Monitoring Sites

Appendix 2 – Definitions

TERM	DEFINITION
AEMR	The Annual Environmental Management Report
ANZECC	Australian and New Zealand Environment and Conservation Council
ARA	Appropriate Regulatory Authority
Blue Book	Managing Urban Stormwater: Soils and Construction – 4th Edition, Landcom 2004
CCC	Community Consultation Committee
COO	Chief Operating Officer
Company	Heron Resources Limited - Tarago Operations Pty Limited
DPE	Department of Planning and Environment
EA	Environmental Assessment
EMP	Environmental Management Plan
EMS	Environmental Management Strategy
EPA	Environment Protection Authority
EPL	Environmental Protection Licence
IEC	International Environmental Consultants
Infigen	Woodlawn Windfarm
LH Cement	Low Heat Cement
NAF	Non-Acid Forming
NAG	Net-Acid Generation
PAF	Potentially Acid Forming
PFMP	Paste Fill Management Plan
POEO Act	Protection of the Environment Operations Act 1997
PSD	Particle Size Distribution

TERM	DEFINITION
SCC	Specific Contaminant Concentration
SEPP	State Environmental Planning Policy
SML20	Special Mining Lease 20
SOP	Standard Operating Procedure
TARP	Trigger Action Response Plan
TCLP	Toxicity characteristic leaching procedure
TOU	The Odour Unit
TSF4	Tailings Storage Facility 4
UCS	Unconfined Compressive Strength
Veolia	Woodlawn Bioreactor
VES	Veolia Environmental Services (Australia) Pty Limited

Appendix 3 – Roles and Responsibilities

The following outlines the responsibilities in relation to the compliance to this document.

ROLE	RESPONSIBILITY
Managing Director	The **Managing Director** has overall responsibility for the implementation of the EMS at Woodlawn Mine as well as to review and approve expenditure and resources necessary to effectively implement the EMS and individual management plans.
Chief Operating Officer	The **Chief Operating Officer (COO)** reports to the Managing Director and is responsible for Project delivery and ultimate development and operation of the Project.
Project Manager	The **Project Manager** will ensure that the approved management provisions and requirements of the individual Environmental Management Plans and commitments are implemented. The Project Manager will review and evaluate the performance of the EMS program and environmental protection initiatives. This role may be merged with the Mine Manager during the construction period prior to commissioning.
Construction Manager	The **Construction Manager** will be responsible for the day to day management of the construction workforce, implementation of the Construction EMP and report directly to the Project Manager.
Mine Manager	The **Mine Manager** is responsible for the day to day management of the mine and overview role for environmental management systems on site, which will include: ❒ Ensuring compliance with environmental requirements for the site. ❒ Represent the on site contact officer under the Environment Protection Licence and other statutes. ❒ Report to the COO on a monthly basis on the environmental performance of mine. ❒ Liaise with the Environmental Officer on environmental matters as required.
Environmental Manager	The **Environmental Manager** will provide the following assistance with the EMS: ❒ Provide technical assistance on environmental matters to the Mine Manager. ❒ Undertake the necessary environmental monitoring program. ❒ Organise external environmental experts as required. ❒ Organise external environmental audits of the site on an annual basis. ❒ Develop Corrective Action Programs in consultation with the Mine Manager and monitor their implementation. Develop and implement an Environmental Training Package for the Mine.