MUCHEA SILICA SAND PROJECT

Surface Water Assessment

EWP21159.001
Muchea Silica Sand Project
003b
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Document status

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Contents

Figures

1 INTRODUCTION

1.1 Background

VRX Silica (VRX) is seeking to develop the Muchea Silica Sand Project (the project), a high grade silica sand mine north of the Muchea township. The project is about 12km north-northwest of Muchea and lies within an existing exploration tenement (E 70/4886) held by VRX, refer Figure A. Outside of the lease boundary, are several rural residences.

The inferred resource for Muchea is 208Mt comprising 99.6% SiO2. The mining will progressively remove 10-15m of sand over a potential mining area of 8.8km^2 (total area of the mining lease), which will be progressively rehabilitated. All mining will occur 3m above the year 2000 water table.

The mining process includes vegetation removal, sand mining in panels, slurrying, processing, drying and transportation via rail to export; along with continuous rehabilitation of the site.

1.2 Scope of Services

The objective of this study is to provide a desktop Surface Water Assessment for the project for the proposed mining operational period, and post mine closure, for a Mining Proposal submission.

The report includes the following:

- Review of any existing reports and available information (maps, aerial photos) and the latest proposed development plans
- Characterisation and description of the existing surface water environments, including climate, location and size of catchments, existing drainage conditions and flow directions, from both a regional and local project-area perspective
- Investigate soil characteristics, regarding run-off/infiltration characteristics
- Delineation of catchments, and flood estimates and flood extents
- Surface water management including assessment of potential environmental impacts of the project, on natural drainage systems; and mitigation
- Closure / post mining

2 HYDROLOGY

2.1 Climate

The project is located in the Western Australian Wheatbelt, with a Mediterranean climate. The average annual rainfall at this location (taken from the Pearce RAAF weather station) is about 650mm and variable. Most rainfall occurs from May – August (winter) and September – April is dry (summer).

Temperatures vary from a min / max mean of 15-34° in summer, and 8-24° in winter.

Average annual pan evaporation is ~ 2,080mm (~2mm/d in winter, to ~10mm/day in summer).

2.2 Rainfall

Intensity-Frequency-Depth (IFD) data is required to characterise storm rainfall intensities and is provided by the Bureau of Meteorology (BOM). Information is provided for various AEPs (Average Exceedance Probability), and the equivalent ARIs (Average Recurrence Interval), up to the 2,000-year ARI.

In addition, closure of mines requires contemplation of rare storms that could occur in time undefined after closure. For example, the 10,000-year rainfalls can be used as the basis for extreme rainfalls, which are about 50% greater than the 2,000-year rainfalls (based on extrapolation of actual statistical rainfall data); or equivalent to ~2.5x 100-year rainfalls.

On this basis, rainfall intensity data for the Project area is shown below:

Table 1: Intensity-Frequency-Duration (IFD) (mm)

AEP/ ARI Duration	63% 1y	50% 1.44y	20% 4.5y	10% 9.5y	5% 20y	2% 50y	1% 100y	2,000y	10,000y
1 hour	16.3	18.1	24.3	28.9	33.8	40.9	46.9	81.1	120
2 hour	21	23.3	31.2	37.3	43.9	53.8	62.3	108	162
6 hour	31.1	34.4	46.5	56.4	67.6	84.7	99.9	173	272
12 hour	39.2	43.4	58.9	71.7	86.3	109	129	224	356
24 hour	48.3	53.5	72.2	87.2	104	129	152	262	371
30 hour	51.5	57	76.5	91.8	109	134	156	264	371
72 hour	65.9	72.5	93.9	109	124	147	165	268	371

2.3 Runoff Parameters

Silica sand mineralisation at Muchea is hosted by the Bassendean Sand. The soils of the Muchea catchment are best characterised as moderately well drained soils with fine to coarse textures, with very high transmissivity in the mining area. Bassendean Sand is typically clean, well rounded and well sorted, extending to a maximum of about 15m.

The proposed mining tenement is an undulating sand plain (~RL65-95m) that generally slopes down to the south east. The tenements are primarily underlain by unconsolidated silica sand which extends to depths greater than 30m, well below the water table, and topographic relief is low. A surface humus layer is typically about 100mm thick, and the upper 400mm (top soil) is assumed reserved for rehabilitation purposes.

Infrastructure will be located off the mining area, minor bunding is suggested to alleviate any risk of flooding.

Typically the sand is white and has little variation in particle size, typically 90% of the particles are 200-850um, with the fines consisting of silica (rather than clay).

The D_{10} size is the particle size for which 10% are smaller by weight, and is assumed as about 100-200um or 0.1-0.2mm. The D_{10} size is a presumptive determinant of hydraulic conductivity (the "effective grain size"), and based on Hazens empirical correlation for the hydraulic conductivity of sand from its particle size distribution (PSD) curve, the formula estimates the hydraulic conductivity very approximately as about 20m/d. The hydraulic conductivity based on published data for a medium sand is about 5-20m/d (fine sand is slightly lower).

Soils with hydraulic conductivity >0.5m/d may be considered to have low runoff potential and high infiltration rates even when thoroughly wetted. Such soils consist chiefly of deep, well to excessively drained sand or gravel, and have a high rate of water transmission. The sand infiltration rate would be reduced by the surface humus layer. If surface runoff is generated, it rapidly infiltrates back into the sandplain. As such runoff, within and from the site, has low potential.

Suggested loss parameters for this area were based on the 'SCS' method (based on a curve number of 49). The SCS method is a well-established method of estimating rainfall loss depending upon different soil types. For this method, initial loss of 53mm was used, and variable proportional loss rates applied.

2.4 External Flooding

The external catchments impacting the site are shown on Figure B. On this basis, peak flow estimates are as follows:

Table 2 – Total Peak Flows

AEP / ARI yrs	Catchment 1 (3.1km^2) (m^3/s)	Catchment 2 (14.9km^2) (m^3/s)	Catchment 3 (56.0km^2) (m^3/s)
10% / 9.5	0.3	1.2	4.0
5% / 20	0.4	2.0	5.8
2% / 50	0.7	3.2	10.0
1% / 100	1.0	4.6	14.8

It can be expected that all surface flows up to the 100yr event would be relatively imperceptible, particularly outside of any low lying areas. It is possible that flow depths <0.5m may be expected in these low lying areas during the 100yr storm (Catchment 3), however, flow depth cannot be accurately determined without regional hydraulic modelling based on a large survey dataset.

Internally, a Rain on Grid model was established based on the local topography, and the 100yr storm was applied (with a SCS loss model). The results showed that water tended to be caught within local low points and form small pools, rather than flowing through the site, with depths typically up to about 0.7m.

If flood protection is required for major storm events, the mine infrastructure should be arranged on site such that it is not within local low points (or drainage should be provided).

Hydrological modelling indicates a 10yr ARI peak flow of 1m^3/s – 2m^3/s may be expected within the tenement, which given the flat terrain, would spread out to a minimal depth of low velocity and stream power, insufficient to scour or transport particles to the downstream environment. This indicates that sediment control will be relatively simple, provided a few general principles and mitigation methods are enacted on site. It is not expected that any sediment control structures (such as settlement basins) would be required for flow exiting the mine site.

3 SURFACE WATER MANAGEMENT - GENERAL

The project area is largely a greenfields site comprising native vegetation, supporting a mixture of intact native vegetation comprising Banksia woodland on elevated sand dunes, pockets of Eucalypt Marri and Jarrah woodland and Melaleuca shrublands, across a landscape of undulating low rises on Bassendean sands.

The mine areas generally consist of homogeneous sandplain landscape with no natural drainage, and avoid existing infrastructure, trees, drainage lines and potential conservation areas. A conceptual and typical schematic section of the mining area is shown in Figure C.

Mining will remain 3m above the year 2000 water table. About 10-15m of sand will be removed as mining occurs, generally leaving substantial depths of sand present, which will retain its high permeability and infiltration rates, and rehabilitation will provide a growing substrate. The exposed finished surfaces should be graded (minimally as required) to maintain surface drainages and ensure negligible change to current internal flooding regimes.

The following issues are noted:

- Larger catchments impact the site however, flows are small and the main impact on the site is from local (intense) direct rainfall
- Local surface water will generally present as temporary sheet flow to the east along the flat plains. Due to the undulating nature of the site, most surface water will be trapped on site and infiltrate into the sandplain
- As it is proposed the site be continuously rehabilitated (and with no waste dumps), there will be limited exposed disturbed surfaces at any given time and hence in sand with limited mobility, no surface water capture / treatment is required

4 EROSION AND RUNOFF

4.1 General Principles

Activities such as vegetation and topsoil removal, mining activities and general construction activities can increase the risk of erosion with heavy rainfall. Environmental approvals for projects that involve land disturbance require adherence to surface water protection principles, to maintain surface water regimes, and protect the ecosystem and existing and potential land uses.

Soil and water issues need to be identified, planned, managed and monitored during the mine life to minimise adverse impacts - to carry out activities in conformity to relevant regulatory and legislative requirements. Controls need to be properly implemented, regularly monitored and audited to assess effectiveness. Changes to the stipulated controls are instigated if they are not achieving their aims.

Controls typically include the application of best management practices, minimising disturbed areas and sediment deposited offsite, compliance with discharge limits, and specific work procedures and environmental control measures which require more detailed attention (such as surface disturbance / excavation, waterway crossings, chemical storage and use, refuelling, etc).

Typically treatment of sediment runoff is applied to more common rain events (<5yr), and with high infiltration rates (i.e. high rainfall losses), it is unlikely that surface water flows would occur (nor have sufficient stream power to cause erosion, or transport sediment downstream).

4.2 Mitigation of Impacts

Mitigation measures include:

- No permanent waste dumps / stockpiles i.e. 100% use of the silica sand (product will be temporarily stockpiled as part of the production process)
- Progressive rehabilitation, minimising the need for stockpiling of topsoil

Infrastructure areas:

- Locate sites away from potential drainage flow paths, avoid extant surface water flow paths
- Minimise disturbance, use existing tracks
- Locate storage areas (chemicals, hydrocarbons, etc) clear of potential flow paths

4.3 Inspection, Auditing & Monitoring

Regular site inspections or informal visual checks should be carried out to ensure appropriate mitigation measures and controls are implemented; and are operational and effective. Site inspections can include event-based inspections, prior to predicted rainfall events, following significant rain events, and prior to extended site shutdowns.

The outcomes of inspections, monitoring, and audits facilitate the identification of problems and recurring issues or areas for improvement.

5 BUNDS AND CHANNELS

As there is very little external surface water impacts, flood protection bunds and diversions are unlikely to be required. Typical diversion and bund requirements are shown below.

5.1 Typical Surface Water Diversions

Any construction and infrastructure should preferably lie outside floodplains, and therefore avoid the need for diversion works altogether. In general, the site lies outside major floodplains. However, during extreme rainfall events, there is potential for river flow to break-out into the site. A low bund on the north and east side of the mine site would divert the flow into the minor drainages either side of the mine site.

Diversions as such consist of earth bunds, excavated channels or combined bund / channels, with an appropriate freeboard above flood levels.

Earth bunds are typically trapezoidal shaped with side batters (slopes) of 1V:2-3H. The crest width should be commensurate with the height of the bund (and whether road access is required along the embankment). As a minimum, a 1m bund could have a crest width of 1.5m, a 3m bund a width of 2.5m.

Excavated open (trapezoidal) channels typically have side batters of 1V:2H or flatter for silty / sandy material.

5.2 Bund Materials

The performance requirements for temporary storage of water are not specific or high, and construction materials are usually the most suitable available materials at the site. There should preferably be some clay content (clayey gravels and clayey sands are best), but substandard materials (such as sand can be used with more robust dimensions).

5.3 Bund Embankment Construction

Construction requirements typically include:

- Excavate base to strip depth, scarify in preparation
- Maintain moisture content at optimum (which allows maximum density to be achieved by the compaction equipment in use)
- Place, compact in layers to 95% Standard or 90% Modified Maximum Dry Density
- Control batter slopes to line and level.

6 GENERAL GUIDELINES POST-CLOSURE

6.1 Post Closure Design Criteria

The objective of Mine Closure guidelines is to ensure an effective planning process is in place throughout the life of mine, so closure is achieved in an environmentally sustainable manner and without unacceptable liability to the State (refer “Guidelines for Preparing Mine Closure Plans”, Department of Mines and Petroleum, and Environmental Protection Agency).

General mine closure principles include:

- Surface and groundwater hydrological patterns / flows not adversely affected
- Surface and groundwater levels, and water quality reflect original levels and water chemistry
- No long-term reduction in the availability of water to meet local environmental values i.e. a desire that base-flows be maintained

6.2 Land Disturbance and Rehabilitation

Mining is a temporary land use and rehabilitation objectives should be consistent with projected future land use. Rehabilitation strategies need to contribute to maintenance free closure over the long term, and integrate with mine planning and operations, to minimise the environmental impacts and maximise rehabilitation success.

VRX Muchea is located on undulating ground. The site will be mined to accommodate the existing minimum ground levels, and (approximately) maintain the existing surface profile. Free draining surfaces must be maintained.

A system of continuous rehabilitation will be undertaken using a specially designed front-end loader. This includes removal of vegetation with 400mm of topsoil, and then re-placed on a completed mining area in a checkerboard pattern (a small gap is left between panels to encourage the collection of humus and seeds) and disrupt surface water flow. There will be ~100% utilisation of mined material, and waste dumps will not be required.

Decommissioning involves removal of remaining infrastructure (plant, buildings), and rehabilitation of disturbed areas such as compacted surfaces (roadways, site compounds, bunds), etc.

There will be no change to the surface runoff from the site (which naturally makes a very low contribution to external flows).

6.3 Monitoring

Post-closure performance monitoring of disturbed areas will be undertaken, to agreed standards to be achieved on various aspects of the project. Progressive rehabilitation and assessment demonstrates the relative success of rehabilitation in achieving desired outcomes, and whether the rehabilitation end point has been reached. Performance criteria include post-closure land use objectives, landform stability, ground water protection, and revegetation targets.

7 SUMMARY

VRX is seeking to develop the Muchea Silica Sand Project, a high grade silica sand mine north of the Muchea township. The project is about 12km north-northwest of Muchea. Outside of the lease boundary, are several rural residences

The mining will progressively remove 10-15m of sand over a potential area of 8.8km2 (total area of the mining lease), which will be progressively rehabilitated. All mining will occur 3m above the year 2000 water table.

The climate is Mediterranean with an average annual rainfall of about ~650mm. Three external catchments impact the site however, flows are small and the main impact on the site is from direct rainfall.

Soils are underlain by unconsolidated white silica sand, covered by low scrub and very few trees. Soil testing shows that the sand consists predominantly of medium grain sand with D_{50} ~0.4mm. The hydraulic conductivity is about 5-20m/d, with a high infiltration rate, but reduced somewhat by a surface humus layer. Runoff, within and from the site is unlikely and surface run-off is only anticipated to occur in short intense rain bursts.

The final rehabilitated surfaces should be graded (minimally as required) to maintain a positive surface drainage. On this basis, there will be negligible change to internal flooding.

The site will be continuously rehabilitated (and with no waste dumps), there will be limited exposed disturbed surfaces, but with no surface runoff, and hence no surface water treatment measures are required.

The post-mining soil profile will visually match the pre-mining profile, at lower land levels. Care is required to maintain continuously draining rehabilitated surfaces, to avoid low / trapped areas that could pool and saturate.

Similarly, the rehabilitated surface will visually blend to the terrain at the tenement edges, matching slopes, and taking care to maintain free draining surfaces out of the site.

Post-closure performance (progressive assessment) monitoring is required to achieve agreed rehabilitation standards for various aspects of the project and determine if the rehabilitation end point has been reached. Rehabilitation performance criteria include post-closure land use objectives, landform stability, ground water protection, and revegetation targets.

Figures

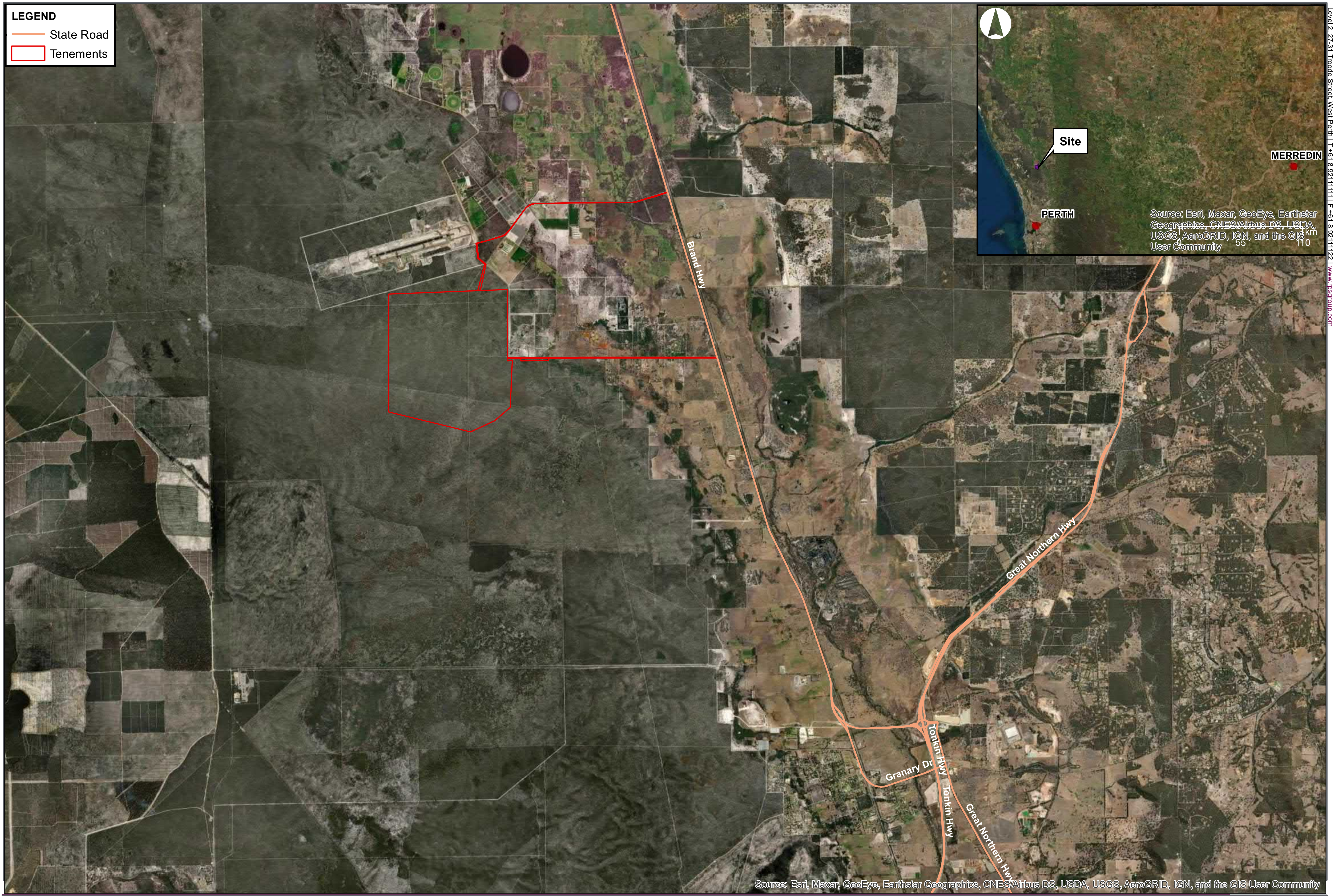

Figure A
Muchea
Site Location and General Layout

GDA 1994 MGA Zone 50

0 1,200 2,400 4,800 m

Job Number:EWJ21159.001
Doc Number: 001
Date: 19.11.21
Scale: Map 1:80,000 Overview 1:3,000,000 @ A3
Created by: ER
Source: Orthophoto - Esri.

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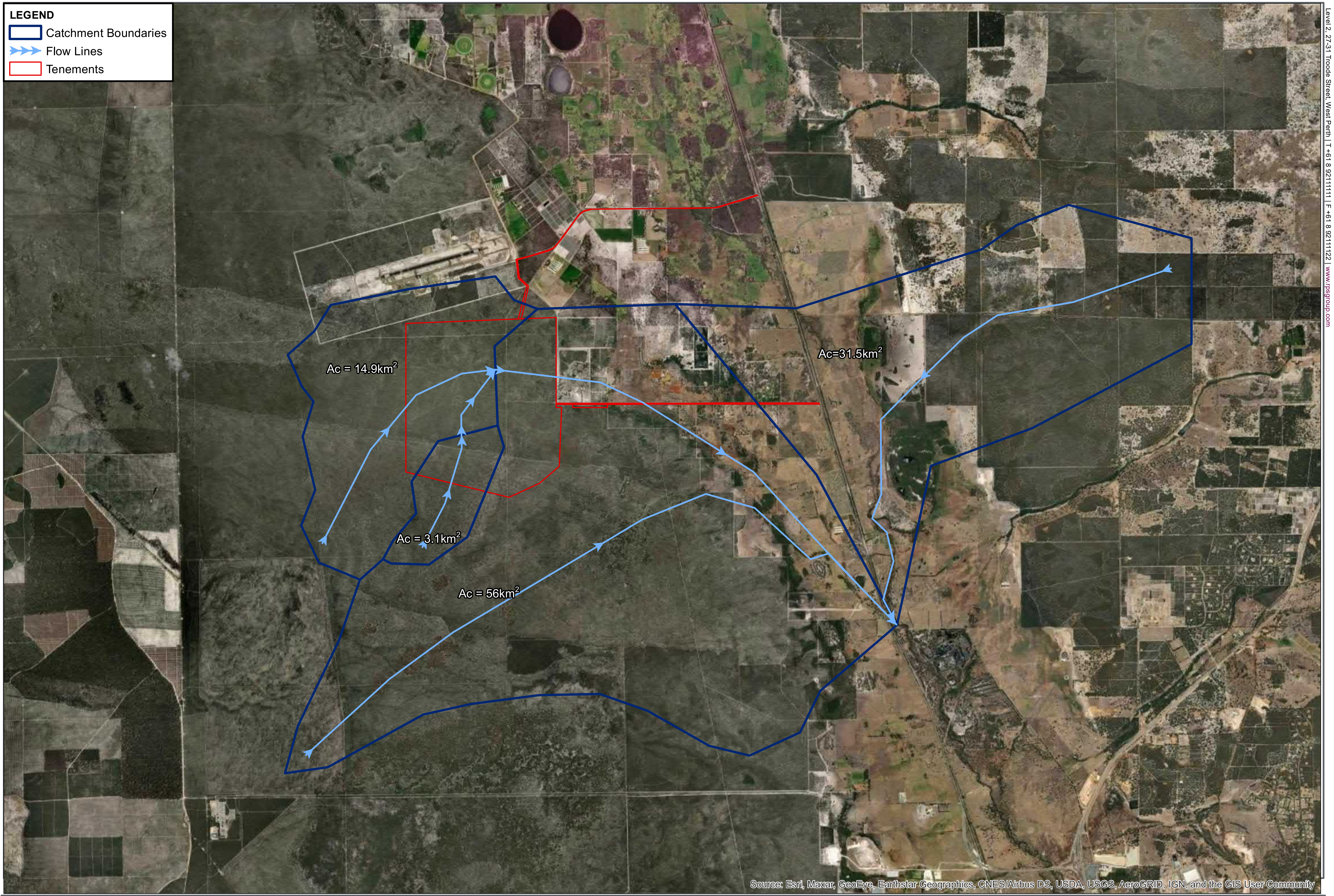

Figure B
Muchea
Catchment Boundaries

GDA 1994 MGA Zone 50

0 950 1,900 3,800 m

Job Number:EWJ21159.001
Doc Number: 001
Date: 14.01.2022
Scale: Map 1:63,360
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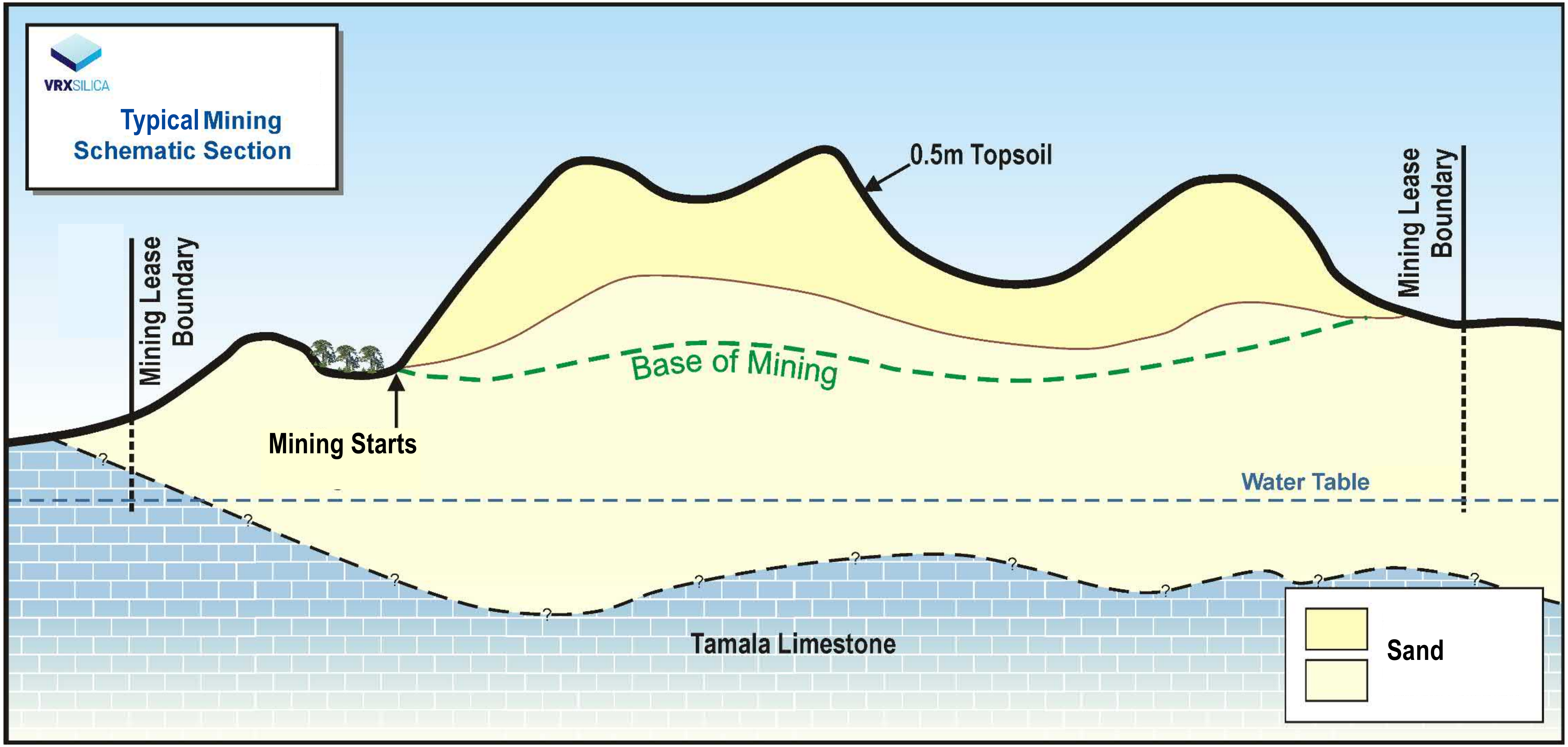

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Figure C
Muchea
Typical Mining Schematic Section

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Scale: Map 1:40,000
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