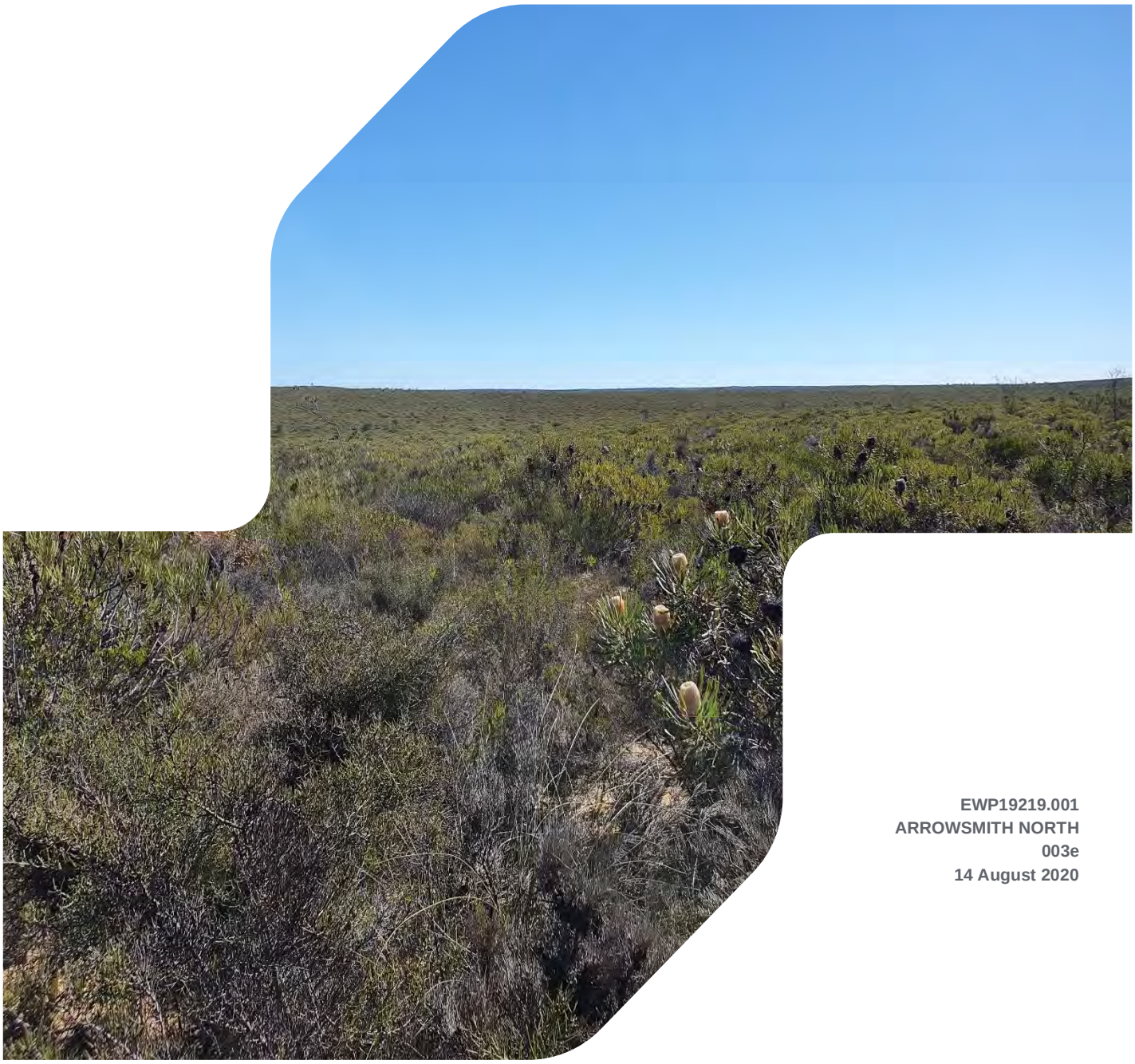
ARROWSMITH SILICA SANDS

Surface Water Assessment



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ARROWSMITH NORTH
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1 INTRODUCTION

1.1 Background

VRX Silica (VRX) is seeking to develop the Arrowsmith Silica Sands Project, consisting of high-grade silica sand mines in the Geraldton Sandplain region of WA. There are two sites which make up the project, Arrowsmith North (E 70/5027) and Central (E 70/4987). The main focus is on developing Arrowsmith North, with Central to follow. The project is about 260km north of Perth within an existing exploration tenement held by VRX, refer Figure A.

The mining will remove in the order of 10m of sand over a mining area of ~360ha for a 30-year life of mine, that will be progressively mined and rehabilitated (20ha at a time). The base of the mining will remain at least 10m above the water table. A conceptual schematic section of the proposed mining area is shown in Figure B.

A Total Mine Area (tenement) covering about 1,025ha has been established. The Indicated Resource for Arrowsmith North is 200Mt, comprising 97.7% SiO2.

The mining process includes vegetation removal, sand mining in panels via extraction and mechanical upgrading, slurrying and pumped to a processing plant (gravity and magnetic separation). The commercial grade sand will then be dried and transported via rail to Geraldton Port for export. Mined areas will be revegetated progressively by direct vegetation transfer. Clay tailings will be pumped back to the mine face and respread or recombined with sand as part of the progressive rehabilitation procedure.

An acid base accounting analysis was undertaken on 5 composited samples, and acid drainage and saline generation shown to represent a low risk to surface water drainage.

1.2 Scope of Services

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

The report addresses 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
- Flood estimation, 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 – discussion on final slopes / terrain profiles, trapped low points and drainage issues, rehabilitation

2 HYDROLOGY

2.1 Climate

The Mid West of WA has a Mediterranean climate. The average annual rainfall at this location is about 490mm, and variable (300 - 850mm per annum or about 60% – 175% of average). Most rainfall occurs from May – August (winter) and September – April is dry (summer).

Temperatures vary from a min / max mean of 19-36° in summer and 9-20° in winter.

Average annual pan evaporation is ~ 2,200mm (~3mm/d in winter, to ~9mm/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, taken as 24% greater than the 2,000-year rainfalls (based on extrapolation of actual statistical rainfall data); or ~2x 100 year rainfalls.

On this basis, rainfall intensity data for the Arrowsmith 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	18	24	29	34	41	47	76	94
2 hour	20	22	30	36	43	52	59	96	119
6 hour	28	31	43	53	62	88	97	139	172
12 hour	34	39	62	66	78	96	111	176	218
24 hour	42	47	78	79	94	116	135	217	269
30 hour	44	50	69	83	99	122	146	241	298
72 hour	55	61	83	99	116	141	161	278	344

2.3 Flood Flow Estimates

The Arrowsmith River runs to the south side of the Arrowsmith North mine site. The river runs west before turning north, and ending in Arrowsmith Lake (a permanent pool). There is a stream gauge monitoring station on the river (701005: Robb Crossing, Lat -29.62 Long 115.29), about 11km upstream of Brand Highway, and with a catchment area 810km^2. The flows in the river at the Robb Crossing gauging station were estimated as follows:

- RFFE (Regional Flood Frequency Estimation) method (Arrowsmith is in a data-rich region, and confidence limits are higher)
- RAFTS is a runoff routing model that develops a stormwater runoff hydrograph, based on catchment areas, slopes, surface roughness, rainfall losses, design rainfall IFDs and storm temporal patterns.

RAFTS requires customising for each application. The 100-year flows were calculated (note flows <Q_{100} (100 year) and the $Q_{10,000}$ are based on the flood ratios for the RFFE method)

- Flood Frequency Analysis - the existing maximum instantaneous flood flow for each year (1972-2000) was ranked on an annual basis. The plotting position / exceedance probability was plotted against the flood peaks, noting most of the stream gauge data available over this period shows only relatively minor flood events; and was deemed less accurate than the other two methods
- The $Q_{10,000}$ flood was extrapolated (~3x Q_{100}). The PMF is typically in the order of 2x $Q_{10,000}$, or 6x Q_{100}, in this case

The peak flows for Arrowsmith River using the 3 methods are provided in Table 2. The 30-year mine area (360ha) is about 0.4% of the Arrowsmith River catchment area, i.e. impact of any additional runoff from the Arrowsmith North mine site is negligible.

Table 2: Peak Flows (m^3/s)

AEP / ARI yrs	RFFE	Fraction of 100y flood	RAFTS	Stream Gauge Data
50% / 1.44	28	0.08	29	24
20% / 4.5	81	0.23	83	69
10% / 9.5	132	0.38	134	114
5% / 20	193	0.55	196	165
2% / 50	280	0.80	285	240
1% / 100	349	1.00	355	300
10,000	1,041	3	1,059	894

2.4 External Flooding

The river runs west before turning north, and terminates in Arrowsmith Lake (a permanent pool). The south west corner of the Arrowsmith North site is located about 2.6km north east of the river and lake. There is no survey data upon which to accurately estimate flood levels in the Arrowsmith River, or produce a flood map. However, based on SRTM (Shuttle Radar Topography Mission) data, a very rough cross-section of the creek can be derived, and flood levels estimated. The river bed slope is about 0.2%. The main channel appears to be a few metres wide with minimal capacity, and suggests that most flood flow is carried in the floodplain. The 100-year flood would be expected to flow about 1.4m deep (on average) in the main channel, and up to 0.55m deep in the flood footprint. The 10,000-year flood would be expected to flow about 2.3m deep (on average in the main channel, and up to 1.1m in the flood footprint).

As the Arrowsmith North site is located at a higher elevation and about 2.6km north east of the Arrowsmith River, the river cannot impact the site or mine operations.

2.5 Internal Flooding

The soils of the Arrowsmith catchment (east of the mine site) are best characterised as moderately well to well drained soils with fine to coarse textures.

The proposed mining tenement is an undulating sand plain (~RL35-50m) that lies above its immediate surrounds, on both the east and west sides of the tenement. The Arrowsmith tenements are primarily underlain by unconsolidated yellow / white silica sand, covered by low scrub and very few trees (refer Figure B), topographic relief is low. The Mineral Resource estimate is based on the results obtained from 62 hand auger drill holes (average 3.8m deep) and 108 aircore drill holes (average 11m deep). The basal surface in some holes was defined by limestone, with the water table below. A surface humus layer is typically about 300 mm thick, and the upper 500mm (top soil) is assumed reserved for rehabilitation purposes.

Soil testing and Particle Size Distribution (PSD) analysis (refer Table 3) undertaken by VRX, shows that the white sand (54 samples) consists of a slightly higher percentage of fine sand than the yellow sand (99 samples). However, both the yellow and white sands consist predominantly of medium grain sand with a D_{50} (i.e. the 50 percentile grain size of the material) of ~0.4mm (medium sand) and less than 1% fines (silt).

Table 3: Summary of PSD Data

PSD Data			
Particle Size	**Description**	**Yellow Sand (%)**	**White Sand (%)**
<0.075mm	Fines (i.e. silt)	0.59	0.55
0.075-0.2mm	Fine Sand	9.01	12.79
0.2-0.6mm	Medium Sand	76.11	73.16
0.6-2mm	Coarse Sand	14.3	13.5

The D_{10} size is about 0.2mm (refer Table 2 *Arrowsmith North particle size distribution, before and after attritioning,* "Arrowsmith Silica Sand Mineral Resource Estimate, CSA Global Report, 2018). The D_{10} size is a determinant of hydraulic conductivity and based on Hazens formula estimates the hydraulic conductivity as about 10m/d. The hydraulic conductivity based on published data for a medium sand is about 5-20m/d (fine sand slightly lower).

The sand therefore has a high infiltration rate, but would be reduced by the surface humus layer. If surface runoff is generated, it infiltrates into the sandplain. As such runoff, within and from the site, has low potential, and run-off is only anticipated to occur in short intense rain bursts.

The mining will remove yellow sand and some of the white sand. Mining will remain a minimum of 10m above the water table. The depth of sand above the limestone will however decrease. The remnant sand will maintain its high permeability and infiltration rate. Rehabilitation will provide a growing substrate above the limestone, however where minimal sand remains above the limestone, the sand horizon remaining will saturate more easily, effectively reduce the permeability of the sand, and allow more run-off in intense rainfall events. Given the unevenness of the underlying impermeable surface (limestone), this effect would be somewhat erratic, but the exposed surface in these areas should be graded (minimally as required) to maintain a surface drainage away from the relevant sites. On this basis, there will be negligible change to internal flooding.

3 SURFACE WATER MANAGEMENT - GENERAL

3.1 General

At a regional scale, surface water drains west and to the sea, notably in a dryland Arrowsmith River, and into Arrowsmith Lake.

The Arrowsmith North site generally consist of a low slightly undulating sandplain landscape, with typvial; maximum terrain slopes in the order of 4% (1 in 25) (refer Figure D). The mine areas avoid existing infrastructure, trees, drainage lines and potential conservation areas. The land elevations over the 30 year site vary from about RL30-50m.

The vegetation is Kwongan - sandy and open without significant trees, but with knee-high scrubby vegetation.

A surface water management plan for Arrowsmith North is shown in Figure C. The mine site is not impacted by external concentrated flows (i.e. water courses or creeks) due to its higher elevation in the surrounding terrain, and the sandy landscape around the mine site. Runoff from the site is similarly limited by the sandy substrate. Due to the sandy soils and lack of water courses in the area, surface water modelling for the mining area is not useful.

3.2 Arrowsmith North

- The site lies above its surrounds, on the east and west sides (lower drainage receival areas, lakes). The site (30 year) gently undulates, and drains west and east, and to the south
- The sand has a high infiltration rate, and surface runoff would not normally occur (only in intense rain events)
- The site will be continuously rehabilitated (and with no waste dumps), there will be limited exposed disturbed surfaces. With no surface runoff in normal rainfall events, there is no issues with dirty water runoff, and no surface water treatment measures required
- The post-mining soil surface profile will visually match the pre-mining profile, albeit at lower land levels. Maintain continuously draining rehabilitated surfaces, to avoid low / trapped areas that could saturate and pool
- Similarly, the rehabilitated surface will visually blend to the terrain at the tenement edges, matching slopes, and free draining “outward” from the site

4 EROSION AND RUNOFF

4.1 General Principles

The Mid-West landscape can be subject to heavy rainfall during winter. Activities such as vegetation and topsoil removal, mining activities and general construction activities can increase the risk of erosion and environmental approvals for projects that involve land disturbance require adherence to surface water protection principles. The general objective is to maintain surface water regimes, so that existing and potential uses (including the ecosystem) are also protected.

Soil and water issues need to be identified, planned, managed, and monitored during the mine life to minimise adverse impacts. The commitment is to carry out activities in a manner that conforms to relevant regulatory and legislative requirements, by ensuring that controls are properly implemented, and are regularly monitored and audited to assess their effectiveness. Changes to the stipulated controls are instigated if they are not achieving their aims.

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

4.2 Mitigation of Impacts

Mitigation measures include:

- No dumps / stockpiles (100% use of the silica sand)
- Continuous 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 mitigation measures and controls are implemented, operational and effective. Site inspections can be event-based, 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 GENERAL GUIDELINES POST-CLOSURE

5.1 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

5.2 Land Disturbance and Rehabilitation

Mining is a temporary land use and rehabilitation objectives should be consistent with projected future land use, and a maintenance free closure over the long term with minimal environmental impacts. The objective is to rehabilitate disturbed areas to safe and stable landforms, free draining, non-polluting, visually compatible with the surrounding landscape and vegetated (endemic plant communities that approximate those that existed prior to disturbance).

The mine site is located on undulating ground, and will remain slightly higher than its surrounds, with a similar surface profile, blending and matching terrain landforms and slopes at the tenement edges. A construction edge can be up to about 30% (stable slope). Free draining surfaces must be maintained.

A system of continuous rehabilitation will be undertaken using a specially designed front-end loader. Vegetation will be removed with 200-300mm of topsoil, and placed on a completed mining area. The panel will be placed in a checkerboard pattern with a small gap between panels (a “gully” to encourage the collection of humus and seeds). There will be ~100% utilisation of mined material and waste dumps will not be required during the life of mine.

Decommissioning involves removal of remaining infrastructure, and rehabilitation of all disturbed areas (including trommel screen, process plant, conveyor, wastes, contaminated soil, 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).

5.3 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.

6 SUMMARY

VRX Silica (VRX) is seeking to develop the Arrowsmith Silica Sands Project, consisting of high-grade silica sand mines in the Geraldton Sandplain region of WA, at the Arrowsmith North site. The vegetation is Kwongan - sandy and open without significant trees but with knee-high scrubby vegetation.

The mining will remove in the order of 10m of yellow sand and some white sand over a mining area of ~360ha for a 30-year life of mine. The sand will be progressively mined (20ha at a time) and remain a minimum of 10m above the water table.

The mining process includes vegetation removal, sand mining in panels and processing sand for export to Geraldton. Mined areas will be revegetated progressively, and tailings will be pumped back to the mine face as part of the progressive rehabilitation procedure.

The climate is Mediterranean climate with an average annual rainfall of about 490mm. The Arrowsmith River terminates in Arrowsmith Lake about 2.6km south west of the mining site. The Arrowsmith River has a river bed slope of about 0.2%, and 100-year flood depth (average) of about 1.4m deep.

The proposed mining tenement is an undulating sand plain with low relief, that lies above its immediate surrounds, on the east and west sides of the tenement. Soils are underlain by unconsolidated white / yellow silica sand, covered by low scrub and very few trees. Soil testing shows that the white and yellow sand consists predominantly of medium grain sand with a D_{50} of ~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, has low potential, and surface run-off is only anticipated to occur in short intense rain bursts.

The depth of sand remaining above the limestone will decrease. 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 mine site is not impacted by external concentrated flows (i.e. water courses or creeks) due to its higher elevation within the surrounding terrain, and the sandy landscape around the mine site. Runoff from the site is similarly limited by the sandy substrate. Due to the sandy soils and lack of water courses in the area, surface water modelling for the mining area is not useful.

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 saturate and pool

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 abd 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

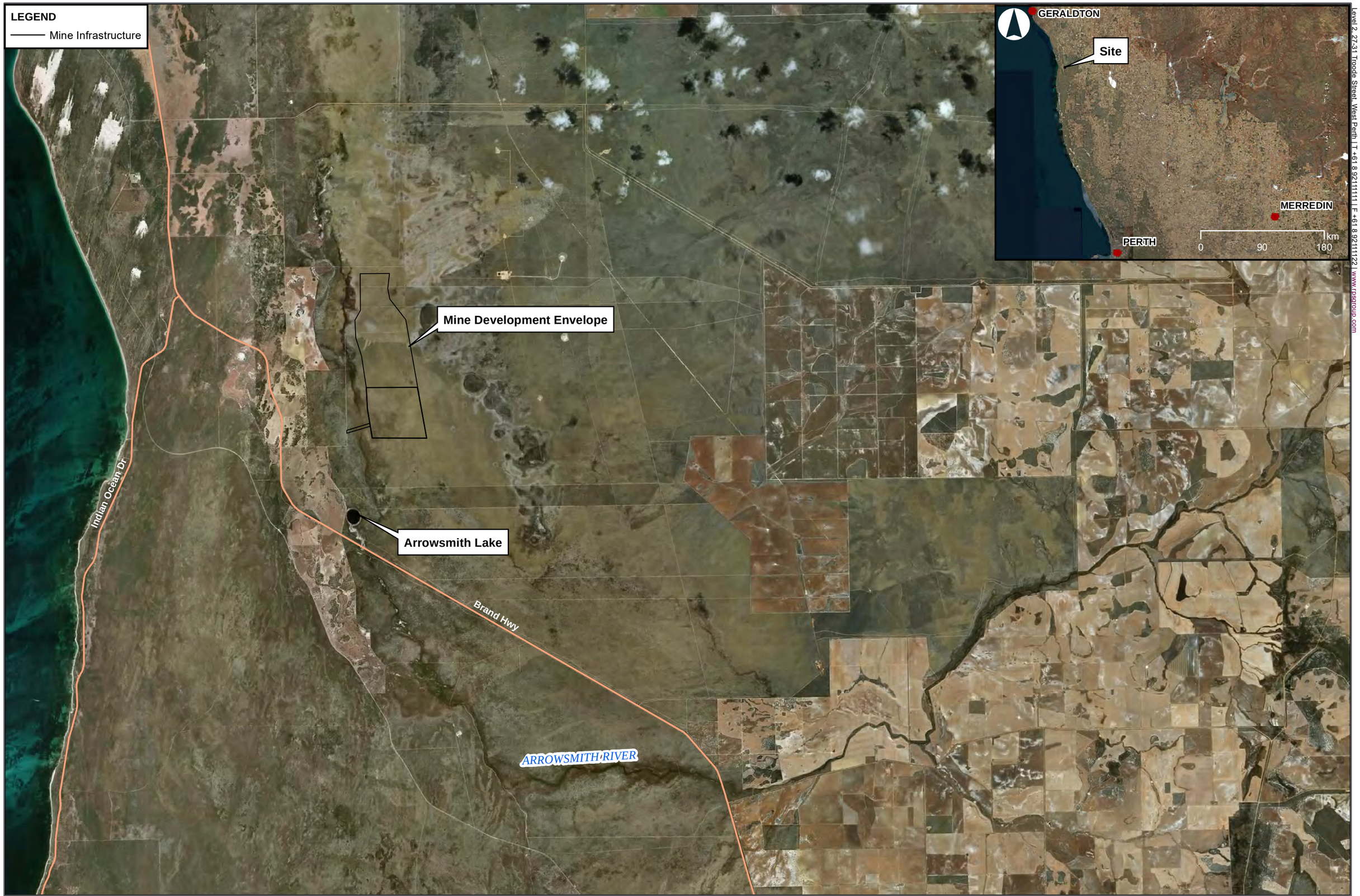

Figure A
Arrowsmith North
Site Location and General Layout

GDA 1994 MGA Zone 50

0 1,875 3,750 7,500 m

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Doc Number: 001
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Scale: Map 1:125,000 Overview 1:5,000,000 @ A3
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Source: Orthophoto - Esri, DigitalGlobe, GeoEye, Earthstar, Geographics, CNES/Airbus DS, USDA, USGS, Aerogrid, IGN, IGP and the GIS User Community

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Arrowsmith

VRXSILICA

Proposed Mining Schematic Section

December 2019

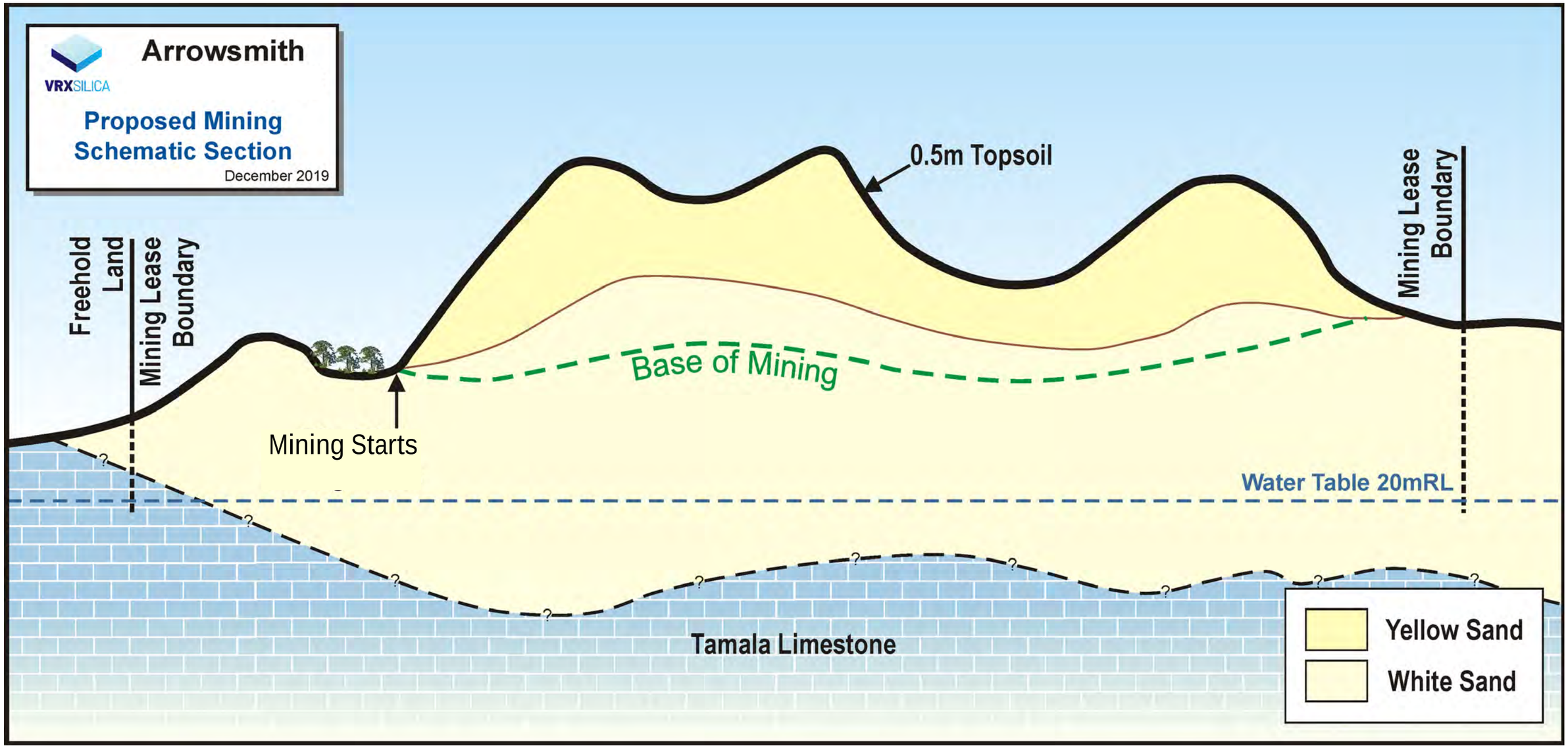

Figure B
Arrowsmith North
Proposed Mining Schematic Section

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Figure C
Arrowsmith North
Surface Water Management Plan

GDA 1994 MGA Zone 50

0 600 1,200 2,400 m

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Doc Number: 001
Date: 14.08.20
Scale: Map 1:40,000
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Source: Orthophoto - Esri, DigitalGlobe, GeoEye, Earthstar, Geographics, CNES/Airbus DS, USDA, USGS, Aerogrid, IGN, IGP and the GIS User Community

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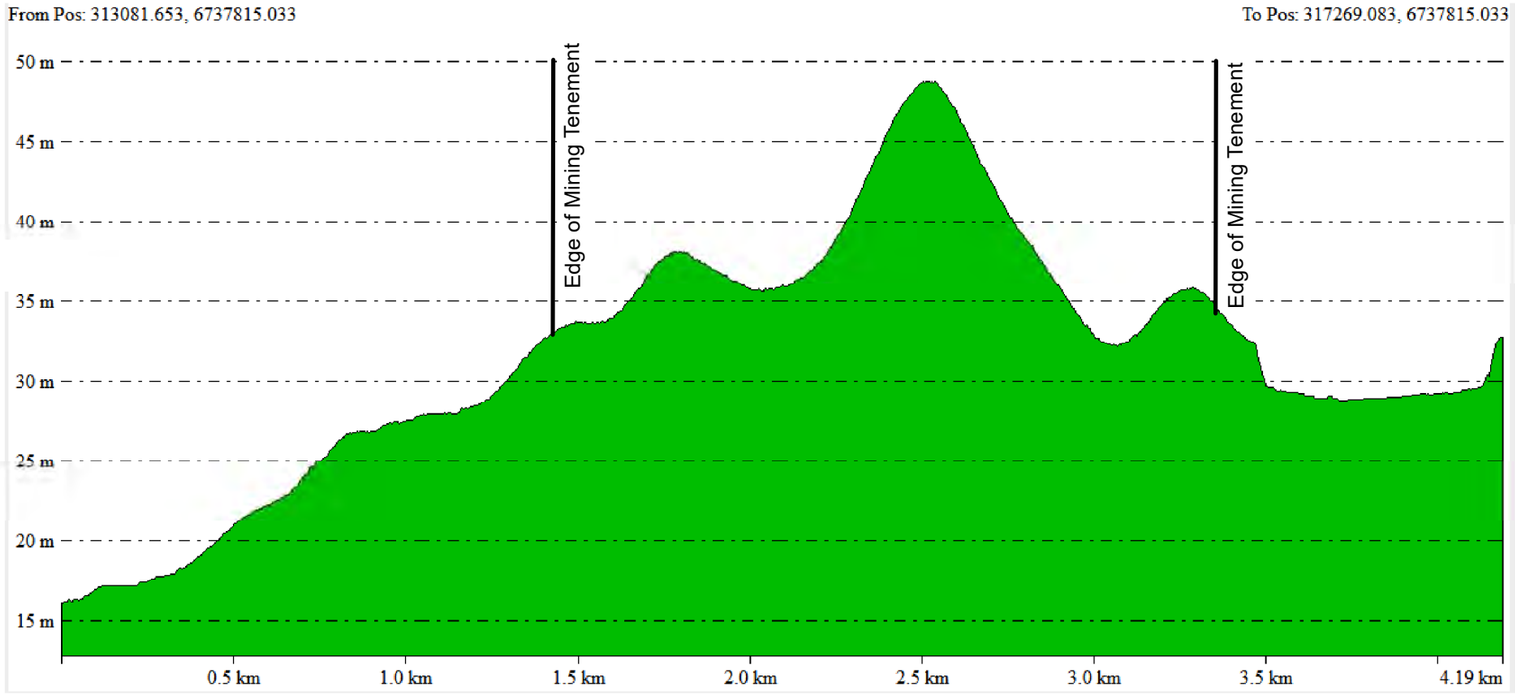
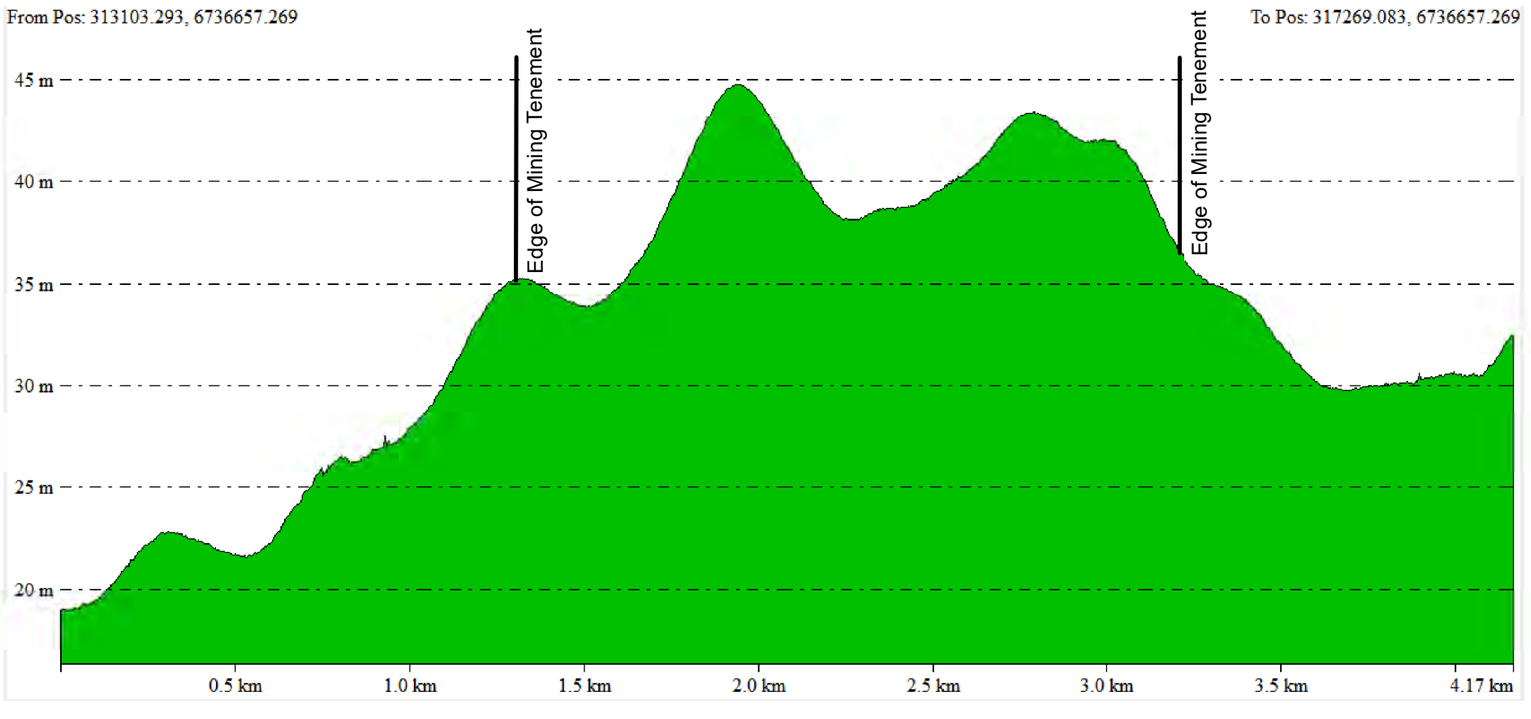


East-West Cross Section at North 30 Year Boundary



East-West Cross Section at ~520m North of South 30 Year Boundary

Figure D
Arrowsmith North
Terrain Cross Sections

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