APPENDIX I – BIOPHYSICAL STRATEGIC AGRICULTURAL LAND (BSAL) SITE VERIFICATION REPORT

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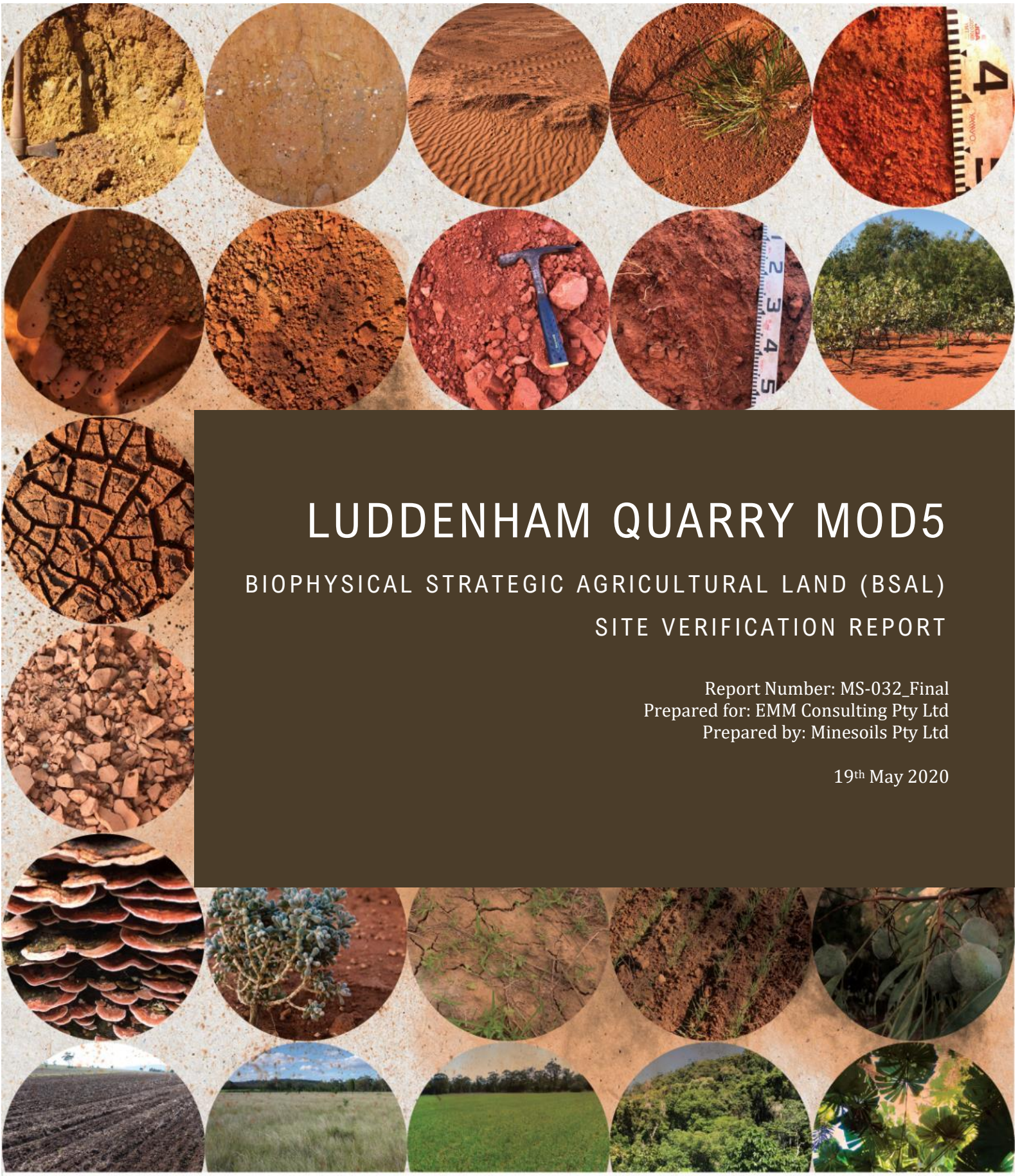

LUDDENHAM QUARRY MOD5

BIOPHYSICAL STRATEGIC AGRICULTURAL LAND (BSAL)

SITE VERIFICATION REPORT

Report Number: MS-032_Final
Prepared for: EMM Consulting Pty Ltd
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19th May 2020

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DOCUMENT CONTROL

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1. INTRODUCTION

1.1 PROJECT BACKGROUND

Coombes Property Group (CPG) in partnership with KLF Holdings Pty Ltd (KLF) are seeking to reactivate quarrying operations of an existing clay/shale quarry at 275 Adams Road Luddenham described as Lot 3 in DP 623799 (the site) through a modification of the existing State significant development (SSD) consent SSD DA 315-7-2003 (Luddenham Quarry MOD5).The site is located approximately 14 km south of Penrith, and 45 km west of Sydney in NSW (Refer to **Figure 1**).

The existing consent has been modified three times (MOD1 to MOD3). A fourth modification application (MOD4) was withdrawn. The consent allows quarrying with a production rate of 300,000 tonnes per annum until 31 December 2024.

The consent includes quarry components that are on Commonwealth-owned land, which was leased by the previous operator, including the site access road, quarry support facilities and stockpiling areas. These quarry components on Commonwealth-owned land are no longer available for use by the quarry. CPG/KLF have no relationship to the previous site owners/operators.

The scope of Luddenham Quarry MOD5 is summarised as follows:

- the use of the existing site access road from Adams Road by quarry vehicles;
- extension of extraction limit beyond the current limit of 31 December 2024 for an additional five years to 31 December 2029;
- new stockpiling area, weighbridge and other site infrastructure within Lot 3 DP 623799;
- removal of activities on Lot 1 DP 838361 (adjacent to the eastern boundary of the site); and
- administrative modification of some other conditions of consent to align with current government policy and/or site conditions (ie reduced development footprint).

As shale is classed as a mineral under the *Mining Act 1992,* Luddenham Quarry MOD5 triggers the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) Amendment 2013*, known as the 2013 Mining SEPP Amendment. As part of the 2013 Mining SEPP Amendment, a site verification for Biophysical Strategic Agricultural Land (BSAL) is required. It is noted a Site Verification Certificate (SVC) has not previously been acquired for the site.

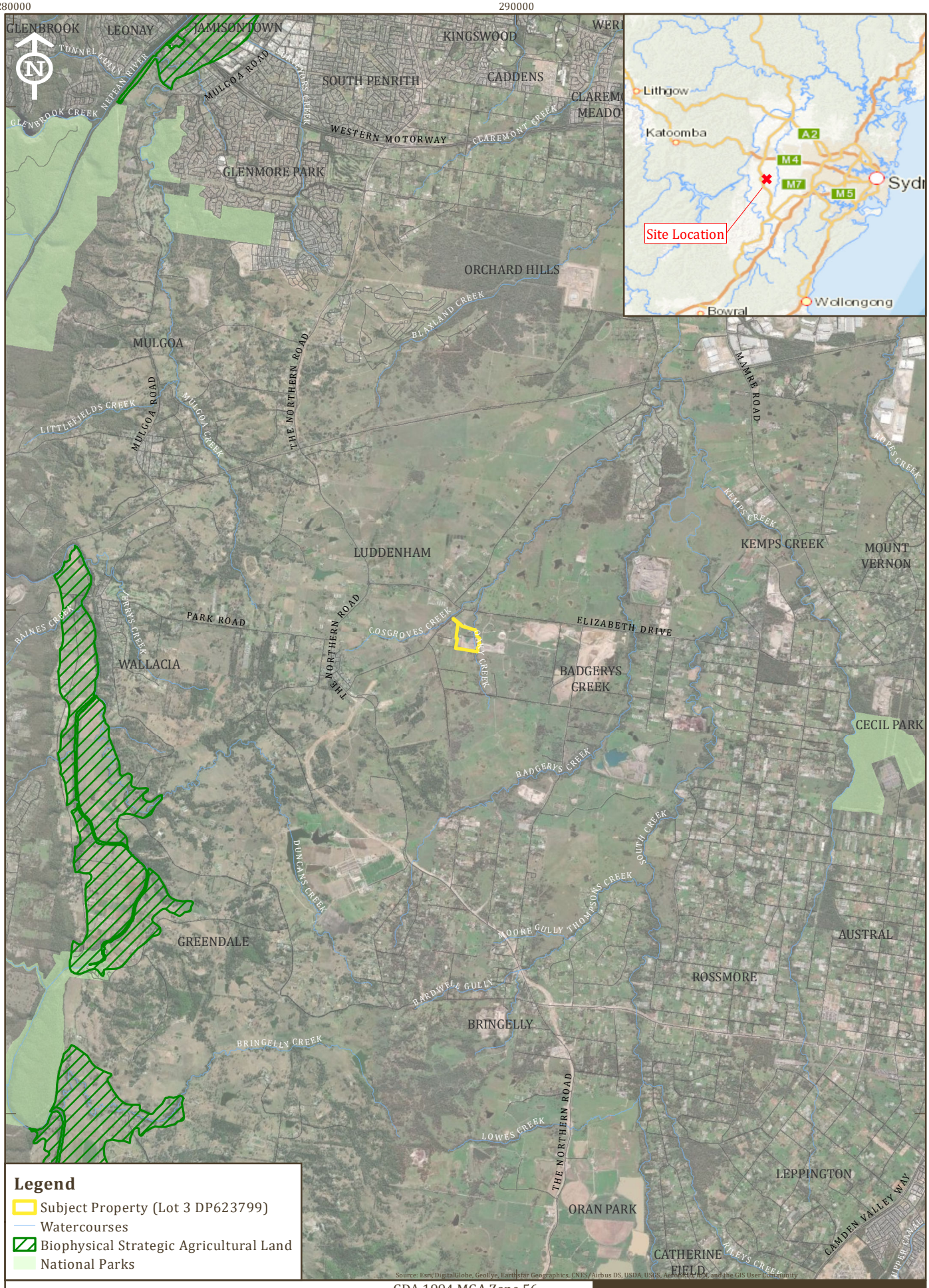
Luddenham Quarry MOD5 Project layout is shown in **Figure 2** and the Proponent is seeking to disturb a further 0.96 ha within the larger property area of 19.1 ha, of which 9.8 ha is existing disturbance.

A SVC is being sought is being sought for area shown in **Figure 2** (SVC Application Area) to cover all existing operational areas of the quarry, additional disturbance as proposed by Luddenham Quarry MOD5 and any potential future disturbance within the SVC Application Area (subject to further approval). A Site Verification Certificate (SVC) over the 10.8 ha of existing and proposed disturbance, plus 100m buffer area around this disturbance totals 36.4 ha for the SVC PAA. This SVC is required in order to be permitted to submit the Luddenham Quarry MOD5 Development Application.

1.2 PROJECT OBJECTIVES AND SCOPE

The objective of this report is to define and assess the SVC Application Area to verify BSAL or Non-BSAL. The existing and proposed disturbance area is approximately 10.8. ha. A 100m buffer around the proposed disturbance areas is applied to this area to create the SVC application area of 36.4 ha. The verification program was undertaken in accordance with the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (Office of Environment & Heritage (OEH) and Department of Primary Industries - Office of Agricultural Sustainability and Food Security (DPI-OASFS), 2013); hereafter referred to as the Interim Protocol.

The purpose of this report is to provide the results of the BSAL verification program conducted in accordance with the Interim Protocol, by Clayton Richards (CPSS 2) of Minesoils Pty Ltd.



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Regional Context

FIGURE 1

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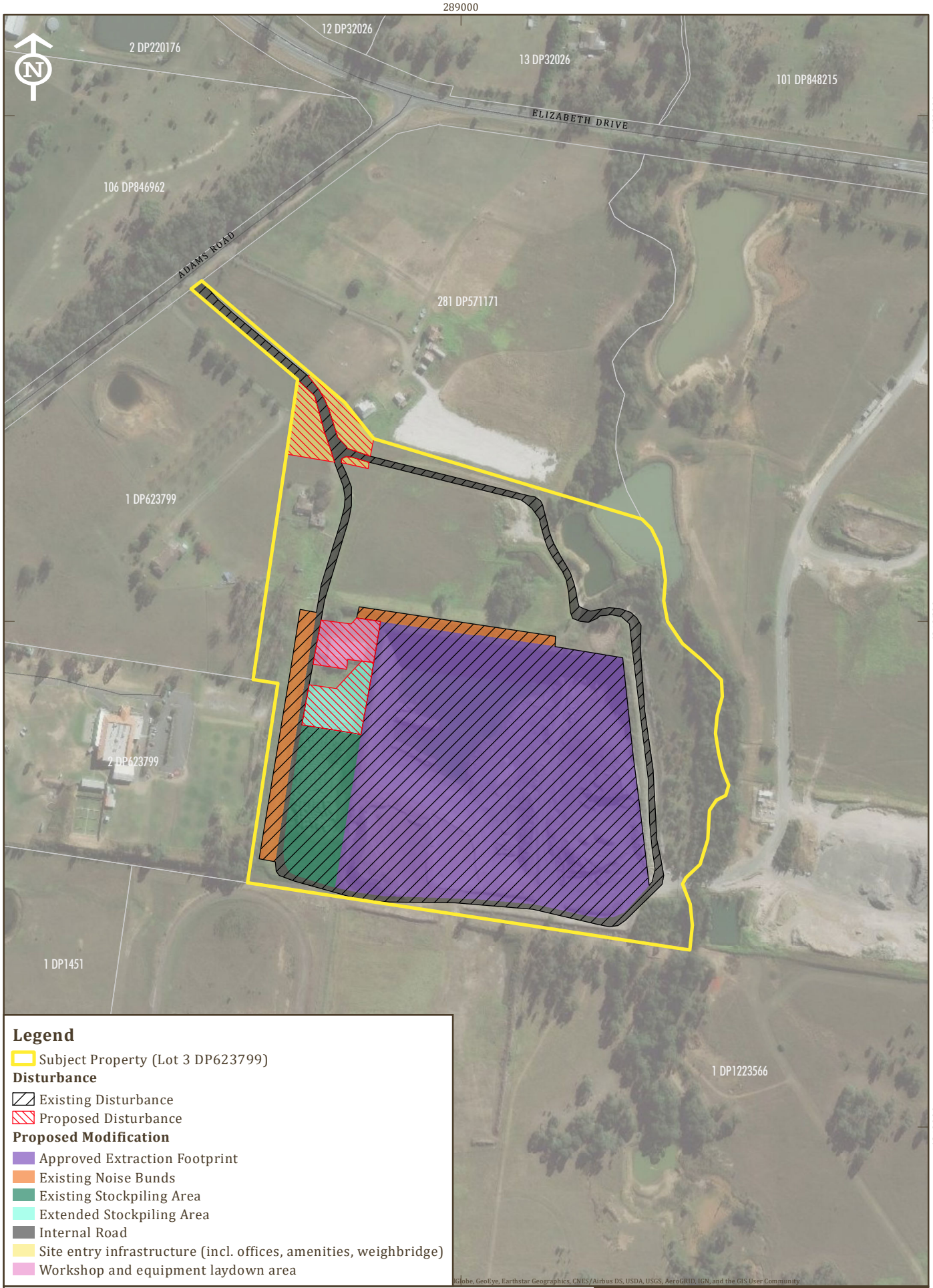

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2 EXISTING ENVIRONMENT

2.1 REGIONAL CONTEXT

The SVC Application Area lies within the Blacktown (bt) Soil Landscape of the Penrith 1:100,000 Sheet (Bannerman & Hazelton, 1990), and is described below.

Blacktown Soil Landscape

The landscape consists of gently undulating rises on Wianamatta Group shales. Local relief to 30 m, slopes usually >5%. Broad rounded crests and ridges with gently inclined slopes. Cleared Eucalypt woodland and tall open forest. The soils are typically shallow to moderately deep (>100 cm) hard setting mottled texture contrast soils, red and brown podzolic soils (Dr3.21, Dr3.31, Db2.11, Db2.21) on crests grading to yellow podzolic soils (Dy2.11, Dy3.11) on lower slopes and in drainage lines.

Limitations include localised seasonal waterlogging, localised water erosion hazard, moderately reactive highly plastic subsoil, localised surface movement potential. There is high capability for urban development with appropriate foundation design. Small portions of this landscape not yet urbanised are capable of sustaining cultivation and grazing.

2.2 SITE DESCRIPTION

The SVC Application Area is 36.4 ha including the 100m buffer, as required to be considered as part of the Interim Protocol, as shown in **Figure 3**. No drainage lines run through the existing or proposed disturbance areas, however Oaky Creek is located to the East of the project and is within the 100m buffer area. Slope is within the 1% to 5% range across the site.

Majority of the area has been previously cleared and disturbed for historical quarrying, residential development, roads and lifestyle/hobby blocks with some small-scale agriculture in the area. There is previous disturbance located on the site with existing quarry pit, material stockpile, access track and shed construction.

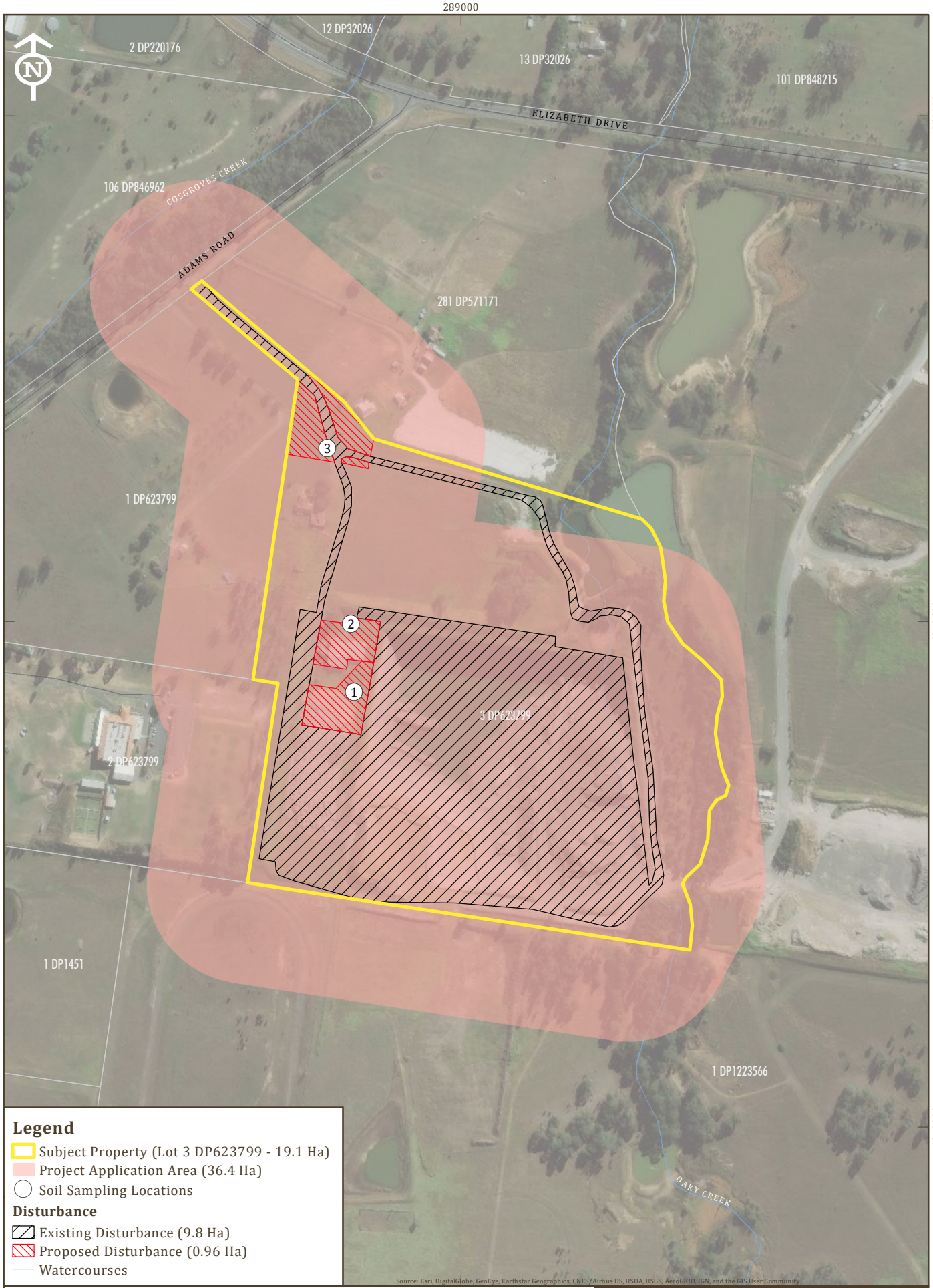
2.3 REGIONAL MAPPING PARAMETERS

There is no regionally mapped BSAL, or Critical Industry Clusters (CIC) within the SVC Application Area (Refer to **Figure 1**). The nearest trigger mapped BSAL is approximately 5km to the West of the SVC Application Area, along the Nepean River.

Regional Land and Soil Capability (LSC) Mapping indicates the SVC Application Area is a mix of Class 4, 5 and 6 which is Moderate to Low capability land with moderate to high limitations for high impact land uses. Limitations will restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation (Refer to **Figure 4**).

Regional soil fertility mapping indicated the SVC Application Area is Moderately Low (Refer to **Figure 4**).

Regional Australian Soil Classification (ASC) mapping indicates the SVC Application Area is most likely Kurosol or Natric Kurosol soil order. Soloths or Yellow Podzolic Great Soil Group (GSG). Hydrologic Soil Group is C and D – Slow to very slow infiltration. With 'Good' data confidence rating (Refer to **Figure 4**).



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Project Application Area & Soil Sampling Locations

FIGURE 3

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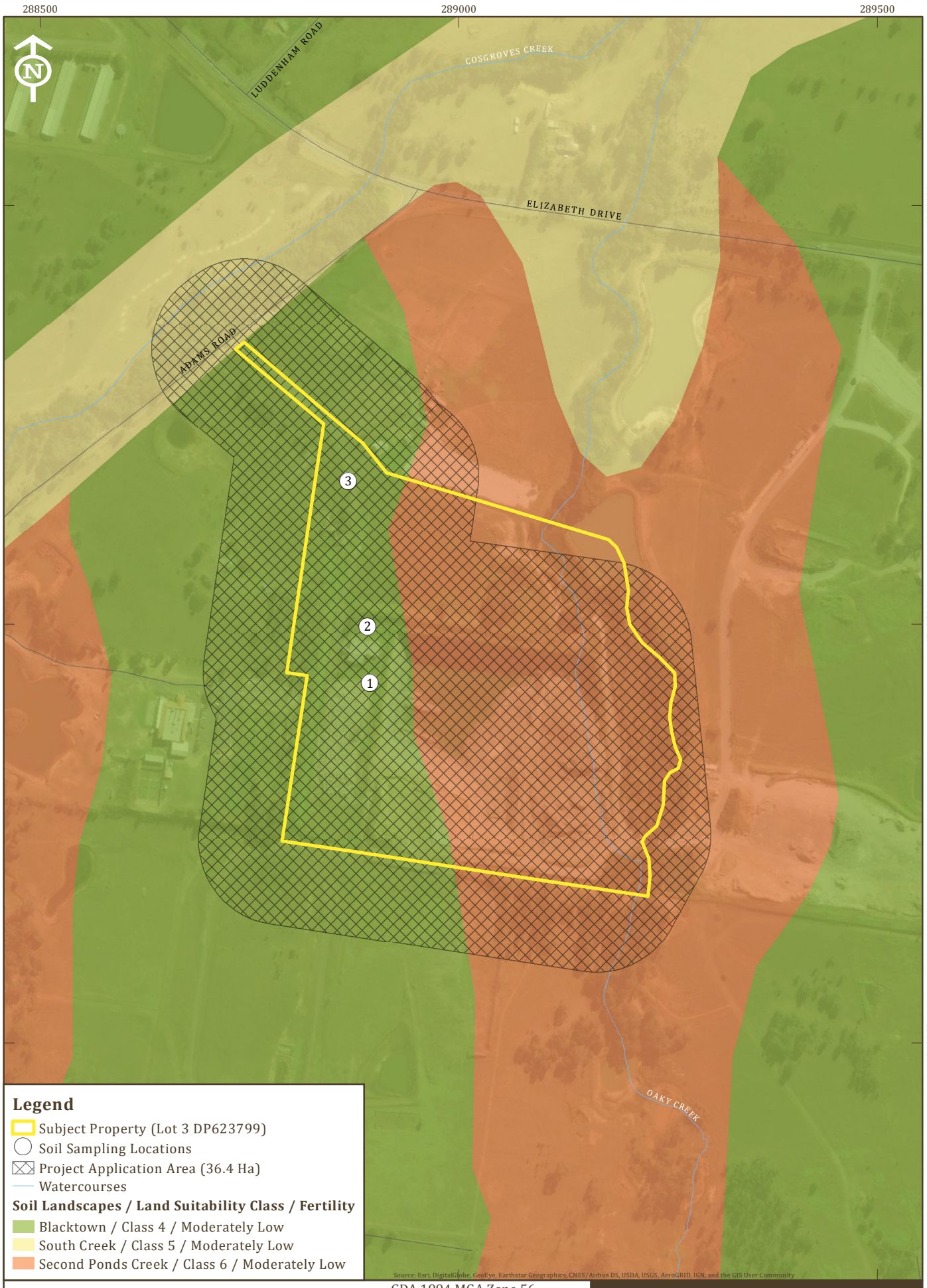

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Existing Soil Mapping

FIGURE 4

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3 THE BSAL ASSESSMENT PROCESS

BSAL is land with a rare combination of natural resources highly suitable for agriculture. These lands intrinsically have the best quality landforms, soil and water resources which are naturally capable of sustaining high levels of productivity and require minimal management practices to maintain this high quality.

The criteria used to measure BSAL under the original Strategic Regional Land Use Plans (SRLUP) were based on three regional scale parameters:

1. Soil Fertility – based on the regional scale *Draft Inherent General Fertility of NSW* (OEH),
2. Land and Soil Capability – based on the regional scale Land and Soil Capability Mapping of NSW, and
3. Access to reliable water supply.

The application of the Strategic Agricultural Land (SAL) mapping is to 'trigger' the new Gateway Process for new project development applications. The SAL mapping consists of BSAL and Critical Industry Cluster (CIC) mapping.

The *State Environmental Planning Policy (Mining, Petroleum Production and Extraction) 2007* (Mining SEPP) requires certain types of developments to verify whether the proposed development is on BSAL. The Interim Protocol assists proponents and landholders to understand what is required to identify the existence of BSAL and outlines the technical requirements for the on-site identification and mapping of BSAL.

4 METHODOLOGY

The methodology reported in the following section has been undertaken based on the *Interim Protocol for Site Verification and Mapping of BSAL* (OEH 2013).

Step 1: Identify the project area which will be assessed for BSAL

The assessment area should include the entire project area and include at least a 100 m buffer to take into account minor changes in design, surrounding disturbance and minor expansion. If BSAL is part of a larger contiguous mass of BSAL then the boundary of this area must also be identified.

The existing (9.8 ha) and proposed (0.96 ha) disturbance area is 10.8 ha. In addition to this disturbance area, a 100 m buffer surrounding the area is included within the assessment area, to account for minor changes in design in accordance with the BSAL protocol. The total assessment area is therefore 36.4 ha as shown in **Figure 3**.

Step 2: Confirm access to a reliable water supply

BSAL lands must have access to a "reliable water supply".

Representative rainfall data for the area has been obtained from the Bureau of Meteorology (BOM) weather station located at Badgerys Creek AWS (Station 067108; BOM, 2020). Data shows that the study area experiences an average rainfall of 658 millimetres (mm) per year (1995 to 2020). This rainfall is above the criteria threshold of 350 mm per year, and therefore the site has access to a reliable water supply.

Step 3: Choose the appropriate approach to map the soils information

Access to the project area will define the level of investigation that the proponent can undertake. If the proponent has access to the land then the BSAL verification requirements for on-site soils assessment as described in sections 6 and 9 of the Interim Protocol should be met. If the proponent does not have access then the proponent should develop a model of soils distribution guided by sections 6 and 9 based on landscape characteristics using the information listed in Section 5 of the Interim Protocol.

It is important to note that for either approach, if any criteria indicate that the site is not BSAL, then no further assessment is necessary. The flow chart in Figure 2 is designed to assess the simplest criteria first, to avoid more costly assessments if the site can be easily discounted as BSAL.

The Proponent has access to the site for the site verification of BSAL.

Step 4: Risk assessment

The proponent should undertake a risk assessment as this will influence the density of soil sampling required as explained in Section 9.6.1. The proposed activity on parts or all of the project area may be of low risk to agriculture and so may only require a sampling density of 1:100 000. Alternatively, other areas may be at higher risk of impact and so should have a sampling density of 1:25 000.

To identify the potential for the Project to impact on agricultural resources and the appropriate level of soil survey required, an evaluation of risk to agricultural resources and enterprises was undertaken. This risk assessment is taken from the Guideline for Agricultural Impact Statements at the Exploration Stage (DTIRIS, 2012) and is based on the probability of occurrence and the consequence of the impact, as described in the Land Use Conflict Risk Assessment Guide (NSW DPI 2011). Depending on the risk, inspection densities can range from 1 site per 25-400 ha for low risk to 1 site per 5-25 ha for high risk (Gallant *et al*.2008). (Refer **Table 1**, **Table 2** and **Table 3**)

Table 1: Agricultural Impacts Risk Ranking Matrix

Consequence		Probability				
		A Almost Certain	B Likely	C Possible	D Unlikely	E Rare
1	Severe and/or permanent damage. Irreversible impacts.	A1	B1	C1	D1	E1
2	Significant and /or long-term damage. Long term management implications. Impacts difficult or impractical to reverse.	A2	B2	C2	D2	E2
3	Moderate damage and/or medium-term impact to agricultural resources or industries. Some ongoing management implications which may be expensive to implement. Minor damage or impacts over the long term.	A3	B3	C3	D3	E3
4	Minor damage and/or short-term impact to agricultural resources or industries. Can be managed as part of routine operations.	A4	B4	C4	D4	E4
5	Very minor damage and minor impact to agricultural resources or industries. Can be effectively managed as part of normal operations.	A5	B5	C5	D5	E5

Low Risk

Medium Risk

High Risk

Table 2: Agricultural Impact Risk Ranking – Probability Descriptors

Level	Descriptor	Description
A	Almost certain	Common or repeating occurrence
B	Likely	Known to occur or it has happened
C	Possible	Could occur or I've heard of it happening
D	Unlikely	Could occur in some circumstances but not likely to occur
E	Rare	Practically impossible or I've never heard of it happening

Table 3: Agricultural Impact Risk Ranking – Consequence Descriptors

Consequence	Description	Example of Implications
Level: 1 Severe	· Severe and/or permanent damage to agricultural resources, or industries · Irreversible · Severe impact on the community	· Long term (eg. 20 years) damage to soil or water resources · Long term impacts (eg 20 years) on a cluster of agricultural industries or Important agricultural lands
Level: 2 Major	· Significant and/or long-term impact to agricultural resources, or industries · Long-term management implications · Serious detrimental impact on the community	· Water or soil impacted, possibly in the long term (eg 20 years) · Long term (eg 20 years) displacement / serious impacts on agricultural industries
Level: 3 Moderate	· Moderate and/or medium-term impact to agricultural resources, or industries · Some ongoing management implications · Minor damage or impacts but over the long term.	· Water or soil known to be affected, probably in the short – medium term (eg 1-5 years) · Management could include significant change of management needed to agricultural enterprises to continue.
Level: 4 Minor	· Minor damage and/or short-term impact to agricultural resources, or industries · Can be effectively managed as part of normal operations	· Theoretically could affect the agricultural resource or industry in short term, but no impacts demonstrated · Minor erosion, compaction or water quality impacts that can be mitigated. · For example, dust and noise impacts in a 12-month period on extensive grazing enterprises.
Level: 5 Negligible	· Very minor damage or impact to agricultural resources, or industries · Can be effectively managed as part of normal operations	· No measurable or identifiable impact on the agricultural resource or industry

Luddenham Quarry MOD5 consists of the proposed increase in material stockpile adjacent to existing stockpile, demolition of existing farm shed and establishment of workshop and laydown area, access track upgrade, weighbridge and demountable site office/amenities. Any future additional disturbance (subject to future approval) is likely to be limited to minor disturbance associated with rehabilitation activities. These activities are considered:

a. Consequence: Level 5 – Very minor damage or impact to agricultural resources, or industries. Can be effectively managed as part of normal operations. No measurable or identifiable impact on the agricultural resource or industry.

b. Probability: A – Almost Certain. Common or repeating occurrence.

The risk matrix result is A5 which is considered a Low risk to agricultural activities. This area is therefore only required to have an inspection density of 1:100,000 which requires a minimum observation site every 100 ha.

Given the assessment area is only 36.4 ha the number of inspection sites is not based on area (1 site), but instead based on the minimum of three representative sites to determine soil type and BSAL status. Therefore, three sites have been investigated to verify BSAL or Non BSAL based on the soil types identified.

Step 4: Soils and landscape verification criteria

Ten site verification criteria have been identified, with the easy to measure criteria assessed first. Soil samples were collected and assessed in the field and laboratory. Analytical tests undertaken are listed in **Table 4** below. The ten site verification parameters are: slope; rock outcrop; surface rock fragments; gilgai; soil fertility (based on soil type); effective rooting depth to a physical barrier; soil drainage; soil pH; salinity; and effective rooting depth to a chemical barrier. For soil to be classified as BSAL at each representative site it must meet all the criteria outlined in the flow chart shown in **Table 5**. If any criteria are not met, the site is not BSAL and there is no need to continue the assessment. The specific requirements for each parameter to be assessed is outlined in the Interim Protocol.

Exclusion parameters were assessed in the field, including slope, rock outcrops, surface rock and the presence of gilgai. No sites were considered exclusion sites.

Existing soil landscape information was considered to provide a background understanding of the area however given the small size of the area, the soil landscape information was not relied upon for any part of this BSAL verification assessment.

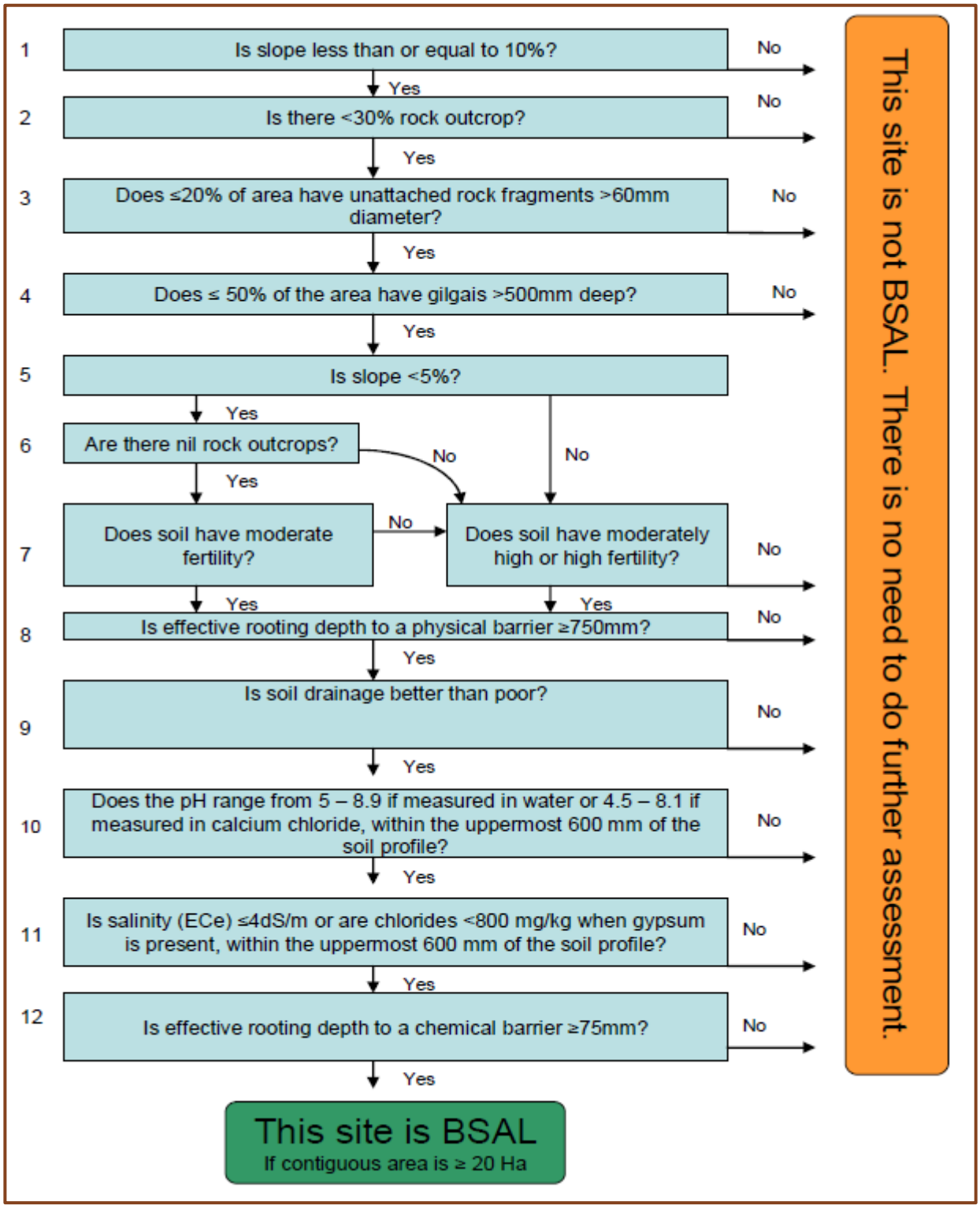
The BSAL verification fieldwork undertaken in April 2020 mapped three detailed test pits. This level of survey meets the minimum three sites for BSAL verification of soil types and the one site required for a 1:100,000 survey scale. Minesoils notes the Interim Protocol states *"Each soil type identified should have at least three detailed sites".* This is obviously not mandatory given the word "should" is present and not the word "must". Therefore, Minesoils believes the small size of the area (10.8 ha disturbed and SVC PAA 36.4 ha including buffer), should provide adequate evidence to assess this report.

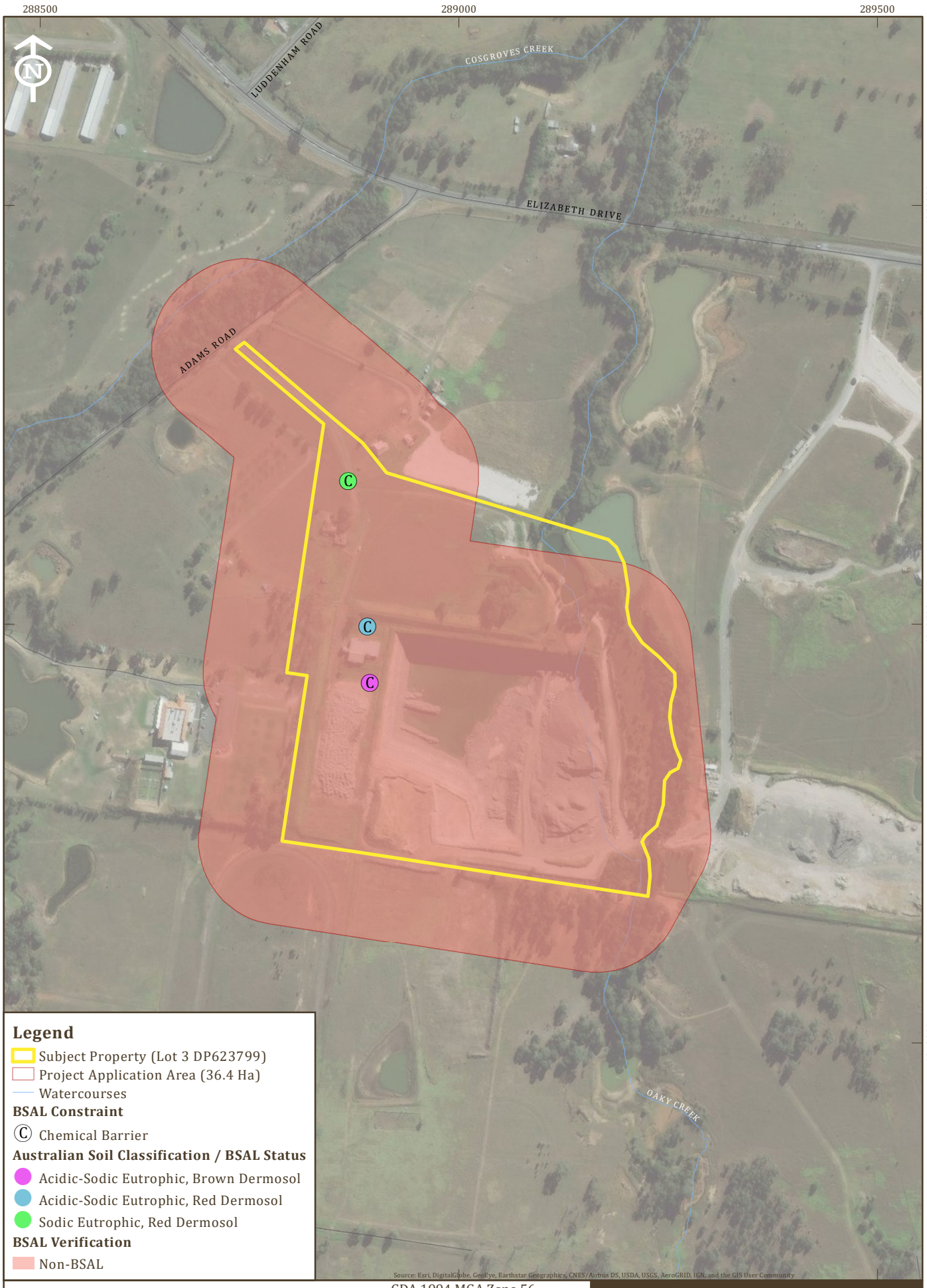
Existing soil landscape information was considered to provide a background understanding of the area. The BSAL verification fieldwork was undertaken by EMM (Lachlan Lewis) under the guidance of Minesoils (Clayton Richards CPSS Director & Principal Soil Scientist) on 17th April 2019. A total of three inspections at sites shown on **Figure 3** were undertaken, all were detailed test pits, which included analytical data, with field assessment to confirm soil type and BSAL status.

Table 4: Soil Sample Laboratory Analysis

Lab Analysis	
pH (1:5 water & CaCl)	Rayment & Lyons 2011-4A1
Electrical Conductivity (EC) and Chloride	Rayment & Lyons 2011-3A1
Cation Exchange Capacity (CEC) & ESP and Ca:Mg Ratio	Rayment & Lyons 2011-15J1
Particle Size Analysis (PSA)	ISSS Hydrometer plus 0.2 and 2.0 mm Sieving (CSIRO 'Yellow Book')

Table 5: Schematic diagram of BSAL site verification criteria





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BSAL Verification

FIGURE 5

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5 RESULTS

The BSAL verification assessment resulted in no part of the Assessment Area satisfying all the BSAL criteria, therefore no BSAL was found. The assessment found the consistent soil type as Acidic/Sodic, Eutrophic, Red/Brown Dermosols. It must be noted that the soils on site keyed out as Dermosols based on a lack of definitive texture contrast between the A and B2 horizons, albeit very close in Clay content to classify as Duplex soils. Slight variations of soil horizons clay content, may well classify these soils as Sodosols or Kurosols given the high Exchangeable Sodium Percentages and increased acidity in the B2 horizons. This classification (as Sodosols and/or Kurosols) would match the soil landscape regional data, and be considered non BSAL based on inadequate soil fertility. However, given the available data, a judgement was made to follow the Australian Soil Classification requirements, which resulted in the sites being classed as Dermosols.

These soil types are summarised below in **Table 6**. The accompanying laboratory data can be found in Appendix 1

Table 6: Site BSAL Verification Summary

Site Number	MC-1	MC-2	MC-3
Inspection Site Type	Detailed	Detailed	Detailed
Australian Soil Classification (to ASC Great Group)	Acidic-Sodic Eutrophic Red Dermosol	Acidic-Sodic Eutrophic Brown Dermosol	Sodic Eutrophic Red Dermosol
1. Is slope < 10%?	Yes	Yes	Yes
2. Is there < 30% Rock Outcrop?	Yes	Yes	Yes
3. < 20% unattached Rock Fragments > 60mm?	Yes	Yes	Yes
4. Does < 50% have Gilgai >500mm deep?	Yes	Yes	Yes
5. Is Slope <5%?	Yes	Yes	Yes
6. Are there nil rock outcrops?	Yes	Yes	Yes
7a. Does Soil Have Moderate Fertility?	Yes	Yes	Yes
7b. Does soil have moderately high or high fertility?	Yes	Yes	Yes
8. Is ERD to a physical barrier >750mm?	Yes	Yes	Yes
9. Is drainage better than poor?	Yes	Yes	Yes
10. Is pH between 5.0 and 8.9?	Yes	Yes	Yes
11. Is salinity (ECe) < 4 dS/m	Yes	Yes	Yes
12. Is ERD to a chemical barrier >750mm?	No (ESP=26%)	No (ESP=20%)	No (ESP=16%)
Is the Site BSAL?	**No**	**No**	**No**

5.1 SOIL PROFILE SHEETS

The detailed soil profile descriptions of the three soil profiles are provided below. Laboratory data for the selected samples are provided in Appendix 1.

Site Description – Site 1				
Site Reference	TP - 1	**ASC Name**	Acidic-Sodic Eutrophic, Brown Dermosol (BFNOW)	
Average Slope	1-2%	**Land Use**	Cleared, Quarry/Residential	**Coordinates**
Landform Pattern	Plains to low hills	**Soil Fertility**	Moderate	Lat/Long
Landform Element	Lower Slope	**BSAL Site Status**	Verified Non BSAL (ESP 26%)	-33.874362
Surface Condition	Firm	**Mapped as BSAL**	No	150.717599

Plate 1 – Soil Profile (TP-1)

Plate 2 – Surface (TP-1)

Plate 3 – Landscape (TP-1)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Dark grey (Munsell 5YR 4/1) Silty Clay Loam with moderate pedality and moderate consistence. Mildly alkaline pH, non-saline and sodic. 10% coarse fragments <10 mm. Many fine roots and moderately drained. Clear boundary.
B21	0.20 – 0.40	Reddish Brown (Munsell 5YR 4/3) Heavy Clay with moderate pedality and firm consistence. Moderate to strongly acidic pH, non-saline and sodic to strongly sodic. Minor weathered grey shale <10% coarse fragments 10 to 20 mm. Few fine roots and moderately drained. Gradual boundary.
B2	0.45 – 0.75+	Brown (Munsell 7.5YR 5/4) Heavy Clay with moderate pedality and very firm consistence. Strongly acidic pH, slightly saline and strongly sodic. <10% coarse fragments weathered shale. Few fine roots and moderately drained.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.8	Non-saline	7.70	Mildly Alkaline	13	Sodic
0.20-0.30	1.6	Non-saline	5.64	Moderately Acid	13	Sodic
0.40-0.50	1.7	Non-saline	5.36	Strongly Acid	14	Strongly Sodic
0.65-0.75	3.7	Slightly-saline	5.20	Strongly Acid	26	Strongly Sodic

Site Description – Site 2				
Site Reference	TP - 2	**ASC Name**	Acidic-Sodic Eutrophic, Red Dermosol (BFMOW)	
Average Slope	1-2%	**Land Use**	Cleared, Quarry/Residential	**Coordinates**
Landform Pattern	Plains to low hills	**Soil Fertility**	Moderate	Lat/Long
Landform Element	Lower Slope	**BSAL Site Status**	Verified Non BSAL (ESP 20%)	-33.873764
Surface Condition	Firm	**Mapped as BSAL**	No	150.717727

Plate 4 – Soil Profile (TP-2)

Plate 5 – Surface (TP-2)

Plate 6 – Landscape (TP-2)

Horizon	Depth (m)	Description
A1	0.00 – 0.20	Very Dark Brown (Munsell 7.5YR 2.5/2) Sandy Clay Loam with moderate pedality and moderate consistence. Mildly alkaline pH, non-saline and non-sodic. 35% coarse fragments 10-60mm. Many fine roots and moderately drained. Gradual boundary.
A2	0.20 – 0.40	Very Dark Grey (Munsell 7.5YR 3/1) Silty Clay Loam with moderate pedality and moderate consistence. Neutral pH, non-saline and sodic. 10-15% coarse fragments 10mm. Few fine roots and moderately drained. Gradual boundary.
B2	0.40 – 0.75+	Dark Brown to Reddish Brown (Munsell 7.5YR 3/3 to 5YR 4/3) Medium to Heavy Clay with moderate pedality and very firm consistence. Moderately to strongly acidic pH, slightly saline and strongly sodic. <10% coarse fragments 5mm. No roots and moderately drained.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	1.3	Non-saline	8.24	Moderately Alkaline	3.4	Non-Sodic
0.20-0.30	1.6	Non-saline	6.58	Neutral	12	Sodic
0.40-0.50	2.5	Slightly-saline	5.67	Strongly Acid	17	Strongly Sodic
0.65-0.75	3.1	Slightly-saline	5.23	Strongly Acid	20	Strongly Sodic

Site Description – Site 3				
Site Reference	TP - 3	**ASC Name**	Sodic Eutrophic, Red Dermosol (CFNOW)	
Average Slope	1-2%	**Land Use**	Cleared, Quarry/Residential	**Coordinates**
Landform Pattern	Plains to low hills	**Soil Fertility**	Moderate	Lat/Long
Landform Element	Lower Slope	**BSAL Site Status**	Verified Non BSAL (ESP 16%)	-33.872181
Surface Condition	Firm	**Mapped as BSAL**	No	150.717377

Plate 7 – Soil Profile (TP-3)

Plate 8 – Surface (TP-3)

Plate 9 – Landscape (TP-3)

Horizon	Depth (m)	Description
A1	0.00 – 0.30	Dark brown (Munsell 7.5YR 3/3) Silty Loam to Clay Loam with moderate pedality and moderate consistence. Neutral pH, non-saline and non-sodic. <10% coarse fragments <5 mm. Many fine roots and moderately drained. Clear boundary.
B21	0.30 – 0.50	Reddish Brown (Munsell 5YR 4/5) Silty Clay with moderate pedality and firm consistence. Moderately acidic pH, non-saline and sodic. <10% coarse fragments < 20 mm. Few fine roots and moderately drained. Gradual boundary.
B22	0.50 – 0.75+	Reddish Brown (Munsell 5YR 4/5) Heavy Clay with moderate pedality and firm consistence. Moderately acidic pH, non-saline and strongly sodic. <10% coarse fragments < 20 mm. Trace roots and moderately drained.

Sample Depth	ECe		$pH_{(1-5water)}$		ESP	
	dS/m	Rating	Value	Rating	Value	Rating
0-0.10	0.5	Non-saline	6.52	Neutral	1.2	Non-Sodic
0.20-0.30	0.3	Non-saline	6.66	Neutral	1.8	Non-Sodic
0.40-0.50	1.0	Non-saline	5.92	Moderately Acid	12	Sodic
0.65-0.75	1.1	Non-saline	5.73	Moderately Acid	16	Strongly Sodic

6 CONCLUSION

The Luddenham Quarry BSAL Verification Assessment was undertaken in April and May 2020 by Minesoils' Clayton Richards (CPSS 2) and fieldwork by Lachlan Lewis (EMM). The assessment area was defined as the proposed surface disturbance (0.96 ha), existing disturbance (9.8 ha), as well as the required 100m buffer, which totalled 36.4 ha altogether. The SVC Application Area (36.4 ha) was assessed in accordance with the Interim Protocol.

Three detailed soil test pits were assessed within the proposed disturbance area, with all profiles being verified Non-BSAL. Therefore, this assessment has determined the SVC Application Area is verified Non-BSAL. The supporting documents including the e-dirt BSAL online soil data, laboratory analysis and mapping metadata have been provided to OEH as part of the SVC Application. The soil laboratory analysis results are attached in **Appendix 1**.

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Appendix 1
Laboratory Results

Environmental Analysis Laboratory

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AGRICULTURAL SOIL ANALYSIS REPORT

12 samples supplied by Minesoils Pty. Ltd. on 27/04/2020. Lab Job No.J3013
Analysis requested by Clayton Richards. Your Job: MS-32
PO BOX 11034 TAMWORTH NSW 2340

			Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
		Sample ID:	Site 1 - (0-10)	Site 1 - (20-30)	Site 1 - (40-50)	Site 1 - (65-75)	Site 2 - (0-10)
		Crop:	soil	soil	soil	soil	soil
		Client:	EMM	EMM	EMM	EMM	EMM
	Parameter	Method reference	J3013/1	J3013/2	J3013/3	J3013/4	J3013/5
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	7.70	5.64	5.36	5.20	8.24
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.208	0.269	0.297	0.643	0.133
	Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	4.3	2.8	2.2	0.91	13
	Exchangeable Calcium (kg/ha)		1,914	1,276	1,006	408	5,980
	Exchangeable Calcium (mg/kg)		855	570	449	182	2,669
	Exchangeable Magnesium (cmol$_+$/kg)		7.4	9.0	11	16	4.3
	Exchangeable Magnesium (kg/ha)		2,018	2,445	2,909	4,466	1,174
	Exchangeable Magnesium (mg/kg)		901	1,092	1,299	1,994	524
	Exchangeable Potassium (cmol$_+$/kg)		1.2	1.6	1.5	0.75	0.64
	Exchangeable Potassium (kg/ha)		1,034	1,408	1,270	656	560
	Exchangeable Potassium (mg/kg)		461	629	567	293	250
	Exchangeable Sodium (cmol$_+$/kg)		2.0	2.2	2.6	7.1	0.65
	Exchangeable Sodium (kg/ha)		1,012	1,119	1,342	3,658	337
	Exchangeable Sodium (mg/kg)		452	499	599	1,633	150
	Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	0.03	0.54	1.3	1.6	0.04
	Exchangeable Aluminium (kg/ha)		5.8	109	268	315	7.3
	Exchangeable Aluminium (mg/kg)		2.6	49	119	140	3.3
	Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	0.03	0.16	0.16	<0.01
	Exchangeable Hydrogen (kg/ha)		<1	<1	3.6	3.6	<1
	Exchangeable Hydrogen (mg/kg)		<1	<1	1.6	1.6	<1
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	15	16	18	27	19
	Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	29	18	12	3.4	70
	Magnesium (%)		50	56	58	61	23
	Potassium (%)		7.9	9.9	7.9	2.8	3.4
	Sodium - ESP (%)		13	13	14	26	3.4
	Aluminium (%)		0.19	3.4	7.2	5.8	0.19
	Hydrogen (%)		0.00	0.17	0.87	0.60	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol$_+$/kg)	0.58	0.32	0.21	0.06	3.1

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		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
	Sample ID:	Site 1 - (0-10)	Site 1 - (20-30)	Site 1 - (40-50)	Site 1 - (65-75)	Site 2 - (0-10)
	Crop:	soil	soil	soil	soil	soil
	Client:	EMM	EMM	EMM	EMM	EMM
Parameter	Method reference	J3013/1	J3013/2	J3013/3	J3013/4	J3013/5

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
14. Analysis conducted between sample arrival date and reporting date.
15. This report is not to be reproduced except in full. Results only relate to the item tested.
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Analysis requested by Clayton Richards. Your Job: MS-32
PO BOX 11034 TAMWORTH NSW 2340

			Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
		Sample ID:	Site 2 - (20-30)	Site 2 - (40-50)	Site 2 - (65-75)	Site 3 - (0-10)	Site 3 - (20-30)
		Crop:	soil	soil	soil	soil	soil
		Client:	EMM	EMM	EMM	EMM	EMM
	Parameter	Method reference	J3013/6	J3013/7	J3013/8	J3013/9	J3013/10
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.58	5.67	5.23	6.52	6.66
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.189	0.328	0.532	0.055	0.031
	Exchangeable Calcium (cmol+/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	3.8	1.9	1.2	7.4	5.7
	Exchangeable Calcium (kg/ha)		1,687	854	544	3,316	2,572
	Exchangeable Calcium (mg/kg)		753	381	243	1,480	1,148
	Exchangeable Magnesium (cmol+/kg)		7.2	9.2	12	6.1	6.6
	Exchangeable Magnesium (kg/ha)		1,950	2,515	3,368	1,672	1,804
	Exchangeable Magnesium (mg/kg)		870	1,123	1,504	747	805
	Exchangeable Potassium (cmol+/kg)		0.78	0.73	0.69	0.73	0.50
	Exchangeable Potassium (kg/ha)		679	635	602	642	435
	Exchangeable Potassium (mg/kg)		303	284	269	287	194
	Exchangeable Sodium (cmol+/kg)		1.5	2.4	3.9	0.18	0.24
	Exchangeable Sodium (kg/ha)		795	1,243	2,001	92	123
	Exchangeable Sodium (mg/kg)		355	555	893	41	55
	Exchangeable Aluminium (cmol+/kg)	**Inhouse S37 (KCl)	0.03	0.30	1.1	0.04	0.02
	Exchangeable Aluminium (kg/ha)		5.7	60	228	7.2	4.5
	Exchangeable Aluminium (mg/kg)		2.5	27	102	3.2	2.0
	Exchangeable Hydrogen (cmol+/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	0.04	0.19	<0.01	<0.01
	Exchangeable Hydrogen (kg/ha)		<1	1.0	4.2	<1	<1
	Exchangeable Hydrogen (mg/kg)		<1	<1	1.9	<1	<1
	Effective Cation Exchange Capacity (ECEC) (cmol+/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol+/kg)	13	15	19	14	13
	Calcium (%)	**Base Saturation Calculations - Cation cmol+/kg / ECEC x 100	28	13	6.2	51	44
	Magnesium (%)		54	63	64	42	51
	Potassium (%)		5.8	5.0	3.5	5.1	3.8
	Sodium - ESP (%)		12	17	20	1.2	1.8
	Aluminium (%)		0.21	2.0	5.8	0.25	0.17
	Hydrogen (%)		0.00	0.31	0.96	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol+/kg)	0.52	0.21	0.10	1.2	0.86

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			Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
		Sample ID:	Site 2 - (20-30)	Site 2 - (40-50)	Site 2 - (65-75)	Site 3 - (0-10)	Site 3 - (20-30)
		Crop:	soil	soil	soil	soil	soil
		Client:	EMM	EMM	EMM	EMM	EMM
	Parameter	Method reference	J3013/6	J3013/7	J3013/8	J3013/9	J3013/10

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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			Sample 11	Sample 12	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	Site 3 - (40-50)	Site 3 - (65-75)				
		Crop:	soil	soil				
		Client:	EMM	EMM	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter		Method reference		J3013/11	J3013/12	Indicative guidelines - refer to Notes 6 and 8			
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)		5.92	5.73	*6.5*	*6.5*	*6.3*	*6.3*
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)		0.111	0.192	*0.200*	*0.150*	*0.120*	*0.100*
	Exchangeable Calcium	(cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)		1.5	0.93	*15.6*	*10.8*	*5.0*	*1.9*
		(kg/ha)			674	417	*7000*	*4816*	*2240*	*840*
		(mg/kg)			301	186	*3125*	*2150*	*1000*	*375*
	Exchangeable Magnesium	(cmol$_+$/kg)			16	17	*2.4*	*1.7*	*1.2*	*0.60*
		(kg/ha)			4,385	4,739	*650*	*448*	*325*	*168*
		(mg/kg)			1,958	2,116	*290*	*200*	*145*	*75*
	Exchangeable Potassium	(cmol$_+$/kg)			0.29	0.30	*0.60*	*0.50*	*0.40*	*0.30*
		(kg/ha)			257	261	*526*	*426*	*336*	*224*
		(mg/kg)			115	117	*235*	*190*	*150*	*100*
	Exchangeable Sodium	(cmol$_+$/kg)			2.8	3.8	*0.3*	*0.26*	*0.22*	*0.11*
		(kg/ha)			1,425	1,977	*155*	*134*	*113*	*57*
		(mg/kg)			636	882	*69*	*60*	*51*	*25*
	Exchangeable Aluminium	(cmol$_+$/kg)	**Inhouse S37 (KCl)		2.1	1.6	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)			420	319	*121*	*101*	*73*	*30*
		(mg/kg)			188	143	*54*	*45*	*32*	*14*
	Exchangeable Hydrogen	(cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)		0.29	0.33	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)			6.6	7.4	*13*	*11*	*8*	*3*
		(mg/kg)			2.9	3.3	*6*	*5*	*4*	*2*
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)		23	24	*20.1*	*14.3*	*7.8*	*3.3*
	Calcium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100		6.5	3.8	*77.6*	*75.7*	*65.6*	*57.4*
	Magnesium (%)				70	71	*11.9*	*11.9*	*15.7*	*18.1*
	Potassium (%)				1.3	1.2	*3.0*	*3.5*	*5.2*	*9.1*
	Sodium - ESP (%)				12	16	*1.5*	*1.8*	*2.9*	*3.3*
	Aluminium (%)				9.0	6.5	*6.0*	*7.1*	*10.5*	*12.1*
	Hydrogen (%)				1.3	1.4				
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol$_+$/kg)		0.09	0.05	*6.5*	*6.4*	*4.2*	*3.2*

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AGRICULTURAL SOIL ANALYSIS REPORT

12 samples supplied by Minesoils Pty. Ltd. on 27/04/2020. Lab Job No.J3013
Analysis requested by Clayton Richards. Your Job: MS-32
PO BOX 11034 TAMWORTH NSW 2340

			Sample 11	Sample 12	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	Site 3 - (40-50)	Site 3 - (65-75)				
		Crop:	soil	soil				
		Client:	EMM	EMM	*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter	Method reference	J3013/11	J3013/12	Indicative guidelines - refer to Notes 6 and 8			

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,
   Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
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Quality Checked: Kris Saville
Agricultural Co-Ordinator KS

GRAIN SIZE ANALYSIS (hydrometer and sieving techniques)

12 soil samples supplied by Minesoils Pty. Ltd. on the 27th of April, 2020 - Lab Job No. J3013
Analysis requested by Clayton Richards
PO Box 11034 TAMWORTH NSW 2340

SAMPLE ID	Lab Code	MOISTURE CONTENT (% of water in air-dry sample)	TOTAL GRAVEL > 2 mm (% of total oven-dry equivalent)	GRAVEL > 4.75 mm (% of total oven-dry equivalent)	GRAVEL 2.00-4.75 mm (% of total oven-dry equivalent)	COARSE SAND 200-2000 µm (0.2-2.0 mm) (% of total oven-dry equivalent)	FINE SAND 20-200 µm (0.02-0.2 mm) (% of total oven-dry equivalent)	SILT 2-20 µm ISSS (% of total oven-dry equivalent)	CLAY < 2 µm (% of total oven-dry equivalent)	Total soil fractions (incl. Gravel)
Site 1 - (0-10)	J3013/1	13.4%	2.4%	0.0%	2.4%	6.8%	35.2%	25.4%	30.1%	100.0%
Site 1 - (20-30)	J3013/2	14.0%	3.6%	0.0%	3.6%	5.9%	29.8%	12.4%	48.3%	100.0%
Site 1 - (40-50)	J3013/3	13.9%	2.9%	0.0%	2.9%	3.4%	31.1%	11.0%	51.6%	100.0%
Site 1 - (65-75)	J3013/4	16.3%	22.6%	2.3%	20.3%	0.7%	4.2%	11.9%	60.5%	100.0%
Site 2 - (0-10)	J3013/5	12.5%	5.0%	0.0%	5.0%	13.9%	51.7%	5.9%	23.5%	100.0%
Site 2 - (20-30)	J3013/6	19.0%	9.3%	0.0%	9.3%	11.7%	24.5%	24.2%	30.4%	100.0%
Site 2 - (40-50)	J3013/7	15.4%	8.0%	0.0%	8.0%	8.6%	23.5%	18.4%	41.6%	100.0%
Site 2 - (65-75)	J3013/8	17.8%	8.0%	0.0%	8.0%	5.3%	10.0%	21.6%	55.1%	100.0%
Site 3 - (0-10)	J3013/9	16.9%	11.9%	0.0%	11.9%	11.3%	34.6%	23.0%	19.2%	100.0%
Site 3 - (20-30)	J3013/10	16.2%	2.6%	0.0%	2.6%	9.5%	38.2%	18.7%	31.0%	100.0%
Site 3 - (40-50)	J3013/11	18.0%	0.6%	0.0%	0.6%	2.0%	22.6%	26.5%	48.4%	100.0%
Site 3 - (65-75)	J3013/12	17.9%	0.1%	0.0%	0.1%	1.2%	21.9%	21.3%	55.6%	100.0%

Note:

1. The Hydrometer Analysis method was used to determine the percentage sand, silt and clay,

modified from SOP meth004 (California Dept of Pesticide Regulation), using method of Gee & Bauder (1986)," &

in Methods of Soil Analysis. Part 1 Agron. Monogr. 9 (2nd Ed). Klute, A., American Soc. of Agronomy Inc., Soil Sci. Soc. America Inc., Madison WI: 383-411.

2. The texture classification was based on the hydrometer results and the appropriate texture triangle.

3. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (see EAL website: scu.edu.au/eal).

4. This report is not to be reproduced except in full.

5. This report was issued on 01/05/2020

checked: .....
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