DETAILED MINE SUBSIDENCE ASSESSMENT

Regrowth Kurri Kurri, Precinct 1

Prepared for Loxford Project Management Pty Ltd

Prepared by RCA Australia

RCA ref 15924-203/1

August 2022

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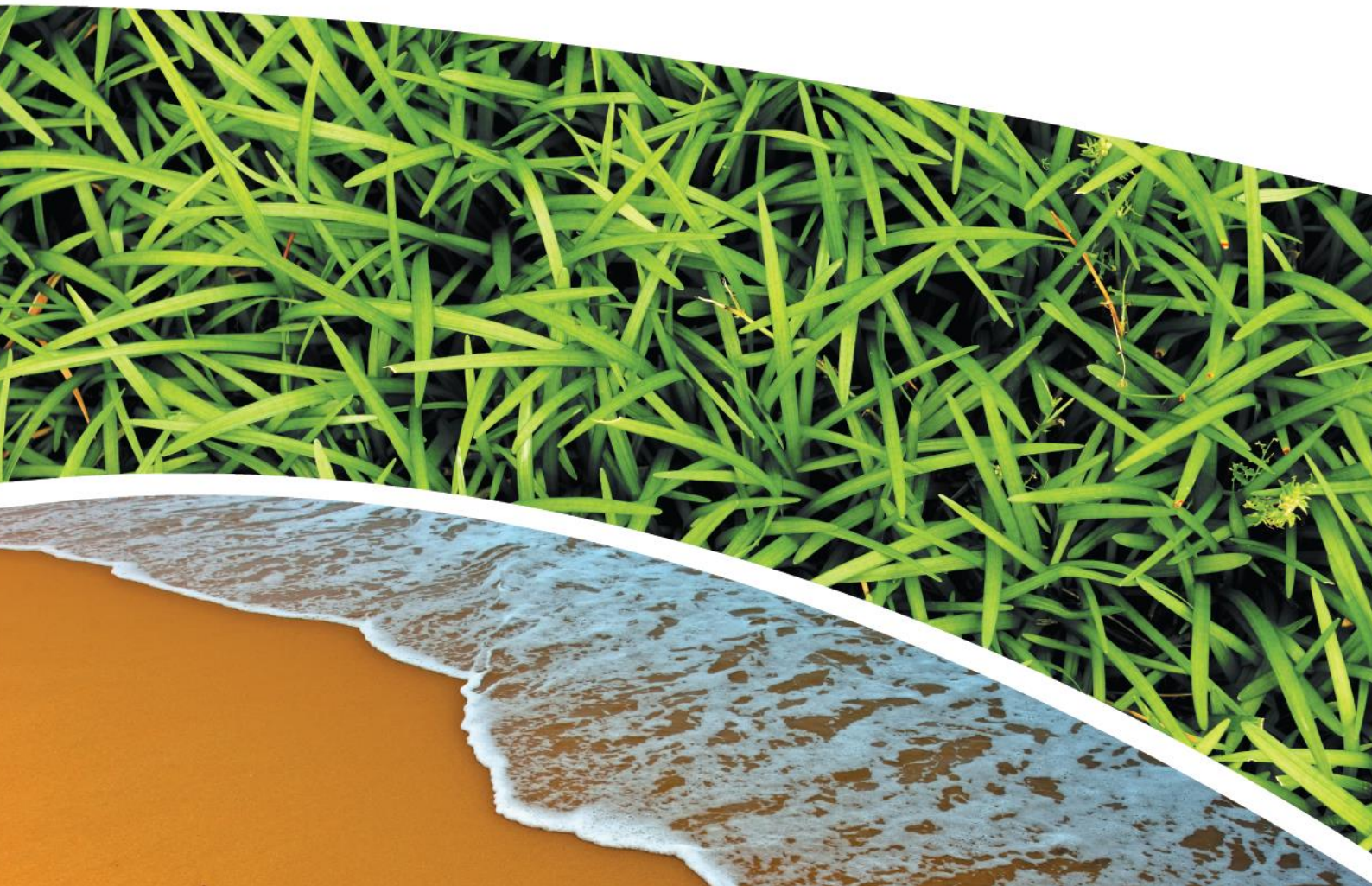

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DOCUMENT STATUS						
Rev No	**Comment**	**Author**	**Reviewer**	**Approved for Issue (Project Manager)**		
				Name	**Signature**	**Date**
/0	Draft	M Allman	R Carr	M Allman		13.07.22
/1	Final	M Allman	R Carr	M Allman		03.08.22

DOCUMENT DISTRIBUTION				
Rev No	**Copies**	**Format**	**Issued to**	**Date**
/0	1	Electronic (email)	Loxford Project Management Pty Ltd, Jeffrey Bretag jeffrey.bretag@mccloygroup.com.au	13.07.22
/0	1	Electronic report	RCA – job archive	13.07.22
/1	1	Electronic (email)	Loxford Project Management Pty Ltd, Jeffrey Bretag jeffrey.bretag@mccloygroup.com.au	03.08.22
/1	1	Electronic report	RCA – job archive	03.08.22

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RCA ref 15924-203/1

3 August 2022

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DETAILED MINE SUBSIDENCE ASSESSMENT
REGROWTH KURRI KURRI, PRECINCT 1

1 INTRODUCTION

This report describes a detailed mine subsidence assessment carried out for Loxford Project Management Pty Ltd on a proposed residential subdivision located at Gillieston Heights forming part of the Regrowth Kurri Kurri development.

This work was commissioned by Mr Jeffrey Bretag of McCloy Group on 3 December 2021 (email).

Based on plans provided by Loxford Project Management Pty Ltd and discussions with Jeffrey Bretag it is understood that Regrowth Kurri Kurri comprises a multistage mixed-use development comprising residential, commercial and industrial development of former Hydro Aluminium Kurri Kurri land. The subject of this report is Precinct 1B of the proposed residential subdivision. Precinct 1 comprises two areas – Precinct 1A over the eastern part of the site and Precinct 1B over the western part of the site. The Precinct 1A development includes 344 residential lots, 3 residual lots and 7 public reserve lots, internal roads and construction of detention basins. The Precinct 1B development includes 224 residential lots, 5 residual lots and 4 public reserve lots, internal roads and construction of detention basins.

Data provided to RCA Australia in relation to the project comprised:

- 239554-SSK-004-A 2018 -12 -20 – Analysis and Survey of Mine Workings Plans prepared by ADW Johnson

- 239835(2)-DA-003 -A – Regrowth, Kurri Kurri Precinct 1 Mine Subsidence Constraints Plan prepared by ADW Johnson
- Report by Newcastle Geotech – August 2013 - Geotechnical Assessment of Mine Subsidence Constraints Proposed Development Cessnock Road Loxford, Ref [1]
- Hydro Kurri Kurri Rezoning Zoning Plan
- Regrowth Kurri Kurri Masterplan
- Dwg Ref: 220725 Precinct 1B Design Cad (002), Dated 22.07.2022 prepared by ADW Johnson

This report has been prepared to support the DA application for proposed Precinct 1B of the proposed Kurri Kurri Regrowth development. The report follows a desktop assessment, Ref [2] RCA Australia 15924-202r2 Report, February 2022 and this report should be read in conjunction with that report. It is noted that the findings of Ref [2] related principally to Precinct 1A, and this report sets out to provide recommendations for Precinct 1B. It is noted that approval for Precinct 1A has been provided by Subsidence Advisory NSW (SA NSW) with the General Terms of Approval stating that approvals will be required for all improvements within the mine subsidence district and that those improvements shall comply with the SA NSW Surface Development Guideline. It is understood that surface development guideline 2 (G2) will apply to all Precinct 1A residential lots located within the mine subsidence district.

2 BACKGROUND AND DESKTOP STUDY FINDINGS

2.1 REGROWTH KURRI KURRI DEVELOPMENT

Regrowth Kurri Kurri comprises 1900 hectares of Hydro Aluminium land of which around 180 hectares are proposed to be rezoned for residential development. Precinct 1 of the proposed residential land lies west of Cessnock Road between Gillieston Heights and Heddon Greta on a property originally named Wangara. Part of the proposed residential development site lies within the West Maitland Mine Subsidence District and is undermined by abandoned coal workings in two seams of the Greta coal measures. **Drawing 1** provides a site plan of Precinct 1, which consists of Precincts 1A and 1B, identifying precinct boundaries, lot and road layout, site features and the West Maitland Mine Subsidence District boundary. With reference to **Drawing 1** it is noted that a section of the centre of Precinct 1 is covered by the West Maitland Mine Subsidence District and mine records indicate that parts of this area are underlain by abandoned mine workings in the Greta Top and Bottom Seams.

2.2 MINE WORKINGS

Mine overlay plans for the Greta Top Seam and Bottom Seam have been prepared by RCA Australia using RT's of the mine workings obtained from Planning NSW. **Drawings 2 and 3** present mine overlay plans for the Top and Bottom Seams, respectively. Based on a seam dip of the order of 55° and the results of boreholes at the site, approximate contours of depth of cover the seam (0m, 100m and 200m) are included on **Drawings 2 and 3** to the Top and Bottom Seams, respectively. **Drawing 4** presents a mine overlay plan that includes Top and Bottom Seam workings based on an alternative RT (RT228). Approximate contours of depth of cover the top seam (0m, 100m and 200m) are included on **Drawing 4**. The position of the sub crop line (0m depth of cover) has been based on observed outcrop locations in the rail cutting along with tunnel locations on the RT's and borehole data.

The workings in both seams underlying the site are highly irregular, nonsystematic and were mined in very steeply dipping seams. The workings are not considered to be amenable to typical pillar stability calculations. Equally, the steep nature of the workings makes assessment of meaningful subsidence parameters problematic.

A geotechnical assessment of mine subsidence constraints affecting the Precinct 1 site was undertaken by Newcastle Geotech in 2013 (Ref [1]). Reference to that report is recommended for a detailed background on the mine workings. That assessment found that the site was subject to mining in the period from the late 1800's to the early 1900's. The mined seams at the site dip steeply (up to 57° based on the record traces (RT)) and are mined at relatively shallow depth (up to about 180m) and consequently affect a relatively narrow band of the site. Detailed site surface mapping described in Ref [1] identified a range of subsidence features within this narrow band along with the outcrop of the two seams. The location of these features is included on **Drawings 2-4**. RCA Australia undertook an inspection of the site in December 2021 confirming the presence and nature of the mapped surface features.

Desktop report Ref [2] provided full details of the site inspections and relevant findings.

2.3 DESKTOP STUDY RECOMMENDATIONS

The desktop study (Ref [2]) provided subsidence guidelines for Precinct 1A and recommended addition investigation to ground truth the desktop findings and provide data to broaden the recommendations to the entire Precinct 1 site.

As noted in Section 1 approval for Precinct 1A has been provided by Subsidence Advisory NSW (SA NSW). This report outlines the investigation works undertaken and goes on to provide recommendations for Precinct 1B.

3 FIELD INVESTIGATION

Fieldwork was conducted over the period 25 January to 27 April 2022, and consisted of:

- Drilling of 6 bores to depths ranging from 38.6m to 75.65m. Bores were drilled using continuous flight augers, PCD wash bore and rock core techniques.

- Downhole camera inspection of all bores.

All fieldwork was carried out by and in the presence of RCA Australia (RCA) personnel. Bore locations are shown on the attached site plans (**Drawings 2-4**).

Boreholes have been surveyed by Delfs Lascelles Consulting Surveyors with results coordinates and RL included on the bore logs.

All bores are cased near the surface with plastic pipe and currently remain open and capped.

Engineering logs of bores are presented in **Appendix B**, together with explanation sheets. Groundwater levels have been noted on the bore logs at the time of fieldwork. Fluctuations in groundwater conditions may be expected due to variations in rainfall and site conditions.

BH4 was drilled by NMLC core and photographs of the core are included in **Appendix B**. All other bores were drilled by open hole methods.

With reference to **Drawing 1** it is noted that bore locations were selected to lie within the shallow depth to seam zone just east of the seam subcrop (ie. less than about 100m cover). Bores were undertaken at four different locations across the site with dual bores at two of these locations.

4 SUBSURFACE CONDITIONS

The subsurface profile encountered on the site is detailed on the bore logs in **Appendix B** and is summarised in **Table 1**. The profile typically comprises shallow topsoil overlying residual soils typically less than 1-2m deep overlying rock. The bores have penetrated the top and bottom seams at various depths across the site.

Table 1 provides inferred top and bottom of each seam along with corresponding thickness of seam. With regard to the boreholes and the summary data provided in **Table 1** it is noted that bores were drilled vertically through seams dipping at approximately 55° from horizontal. Seam thickness orthogonal to the strata can be calculated by dividing drilled thickness by about 1.74. Mine history indicates top seam thickness of 6-7.5m and bottom seam of 3m. With correction it is expected that the approximate drilled seam thickness for the top seam would be 10 to 13m and 5.2m for the bottom seam. The drilled seam thickness listed in **Table 1** is 10.2 to 13.4m for the top seam and 1.85 to 11.75m for the bottom seam. The inferred bottom seam thickness has undoubtedly been affected by widespread mining at that level along with pillar and roof collapse.

Further description of subsurface conditions encountered are provided in Section 5.

Depth of groundwater was difficult to interpret during drilling due to the method of drilling. The groundwater level was identified during the downhole camera inspection at each bore and is included in **Table 1**. It is noted that the GWT level is between 6.35 and 6.8m AHD at all six bores suggesting a hydraulically well-connected groundwater system across the site.

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Table 1 *General Summary of Subsurface Conditions*

BH	RL (m, AHD)	Bore Depth (m)	Ground Water Table Depth (m)	GWT RL (m, AHD)	Top Seam from (m)	Top Seam to (m)	Top Seam Thickness (m)	Bottom Seam from (m)	Bottom Seam to (m)	Bottom Seam Thickness (m)	Comments
1	19.78	42.85	13.2	6.58	12.5	25.9	13.4	42.9	44.75	1.85	Top seam unmined. Bottom Seam mined, a void encountered and most of the coal not present.
2	19.25	62.95	12.4	6.85	23.3	34.8	11.5	54.7	58.3	3.6	Top seam unmined. Bottom Seam mined, no voids and some coal remaining.
3	18.30	62.9	12	6.3	16.2	26.4	10.2	39.6	44.7	5.1	Top seam mined with voids and rubble present and no coal. Bottom seam possibly mined as well with likely fractured ground and mixed coal and rock encountered at seam level.
4	19.62	38.6	12.8	6.82	8.35	19.62	11.27	31.72	38.6	6.88	Top seam unmined with a lot of coal retrieved as core. Bottom seam mined with a void encountered and some coal also retrieved as core.
5	28.44	75.65	21.8	6.64	43.7	55.6	11.9	63	72	9	Top seam unmined – full seam drilled.
6	27.89	65.65	21.2	6.69	28.3	39.4	11.1	47.65	59.4	11.75	Bottom seam mined with rubble encountered along with minor coal.

5 SUMMARY OF INVESTIGATION FINDINGS

5.1 CAMERA INSPECTIONS

Downhole camera inspection with video records were a key component of this investigation.

Downhole camera inspections and video recording were carried out in all six boreholes. Electronic files of the camera inspections are held by RCA.

Due to the nature of the drilling process, and the limited amount of time available between the completion of drilling and subsequent downhole camera inspection at some locations, suspended sediment from drilling was still present making observations within all boreholes difficult. A flocculent was generally used and good visibility was encountered in some places.

As a result of the widespread subsidence at the site along with two levels of working it was found that the camera was unable to be lowered through the top seam to the bottom seam at all locations except BH1.

A summary of the borehole camera inspections is presented in **Appendix C**.

5.2 BOREHOLES

The steeply dipping strata in combination with the presence of mine workings and subsidence fracturing made drilling conditions at the site extremely challenging. BH4 was cored and reference to the borelog and core photograph illustrates the challenging conditions for coring. A very low core return was achieved. The remainder of the bores were open hole drilled using water return, however the widespread fracturing in the shallow cover zone resulted in loss of drilling water in all bores. The limited surface return made logging difficult, and it is noted that the field logs data has been supplemented with interpretation form the downhole camera logs.

A brief interpretation of the bores (based on the borelogs and camera inspections) follows:

BH1 & BH4

BH1 and BH4 were drilled adjacent to each other (5m apart) in the vicinity of where the proposed Precinct 1 arterial road is planned to cross the seam subcrop. Reference to the mine overlay plans indicates that bores were expected to lie over workings in both the top and bottom seams.

BH1 encountered the full top seam between 12.5m and 25.9m with no indication of mining or seam closure. It is assumed that BH1 penetrated a pillar. Evidence of the bottom seam was encountered between 42.9m to 44.75m where a void and some coal was encountered suggesting a degree of loss of coal and seam closure. The presence of a void strongly suggests the presence of a bord at the bottom seam level. The low thickness between the inferred roof and floor suggests seam closure and subsidence has occurred.

BH4 was cored with substantial loss of core considered to be reflective of subsidence and strata fracturing. BH4 encountered the top seam at a depth of 8.35m to 19.62m with no loss of drilling resistance to suggest voids or disturbance. It is assumed that BH4 penetrated a pillar. At the bottom seam level a void was encountered at 31.72m with intermittent rubble, core loss and voids encountered to a depth of 38.6m where drilling was unable to be continued. The presence of a void strongly suggests the presence of a bord at the bottom seam level and possibly some seam closure and subsidence.

BH2

BH2 lies near the northern boundary of the site and reference to the mine overlay plans indicates that BH2 is expected to lie over first workings in the top and bottom seams.

BH2 encountered the full top seam between 23.3m and 34.8m with no indication of mining or seam closure. It is assumed that BH2 penetrated a pillar. The bottom seam coal was encountered between a depth of 54.7 to 58.3m with rubble or fractured coal inferred. Mine disturbance and loss of coal is inferred at this bore location.

BH3

BH3 lies near the southern boundary of the site and reference to the mine overlay plans indicates that BH3 is expected to lie over second workings at both the top and bottom seam levels

BH3 encountered the intermittent void, rubble, disturbed ground between 16.2m and 26.4m. This is inferred to be the top seam level and is indicative of a mined seam with loss of coal and potential roof collapse and subsidence. Evidence of the bottom seam coal was encountered at a depth between 39.6m to 44.7m where the borelog suggests the presence of fractured ground.

BH5 & BH6

BH5 and BH6 were drilled adjacent to each other (9.5m apart) in the vicinity of the existing access road to the rail bridge. Reference to the mine overlay plans indicates that both bores are expected to lie over first workings in the top and bottom seams.

BH5 encountered the top seam between 43.7m and 55.6m. It is inferred that BH5 penetrated a pillar. Rubble and intermittent void were encountered from 63m to 71.4m with a small amount of coal from 71.4 to 72.0m.

BH6 encountered voids and rubble between 28.3m and 39.4m at the top seam level and it is assumed that the seam is highly disturbed and mined at this location. Void and rubble were encountered at the bottom seam level between 47.65m and 59.4m and it is assumed that the bottom seam is highly disturbed and mined at this location as well.

5.3 DEPTH TO GRETA TOP AND BOTTOM SEAMS

Based on a seam dip of the order of 55° and the results of boreholes at the site, approximate contours of depth of cover the seam floor (0m, 100m and 200m) are included on **Drawings 2** and **4** to the Top Seam and **Drawing 3** to the Bottom Seam.

The geotechnical boreholes at the site are consistent with the mine records and have confirmed the presence of the two steeply dipping coal seams at the depths expected from by the mine overlay plans presented in the desktop report Ref [2] and reproduced on the drawings in the report. The bores have confirmed the presence of mine workings in both seams at the site with loss of coal, widespread cracking and loss of drilling water and the presence of voids and disturbed ground encountered.

6 SUBSIDENCE

6.1 POTENTIAL SUBSIDENCE

Two seams have been mined beneath the site with mine history indicating typical worked seam thickness of 2-3m in each seam. Top seam workings extent is limited while the bottom seam workings are more extensive. Reference to **Drawings 2, 3 & 4** indicates that:

- The depth of top seam workings under Precinct 1 is less than 100m. RT353 indicates that the top seam workings in the Glenmore Colliery were restricted to 2-3 bords running along the strike with corresponding 1-2 lines of pillars. Cross hatching of pillars suggests some pillar removal at the top seam level.

- The bottom seam was mined to depths up to about 200m depth within the Precinct 1 area and slightly deeper near the northern boundary of the site. Bords and pillars were mined by similar methodology to the top seam with drifts or headings running down dip and bords mined along the strike. Widespread cross hatching of pillars at bottom seam level also suggests widespread pillar removal at the bottom seam level.

As indicated in Ref [1] and identified on **Drawings 2, 3 & 4** evidence of subsidence at the site includes:

- Identification on RT's. RT 288 shows three areas of surface falls each of which lie over workings of the East Greta Colliery. Reference to **Drawing 4** indicates that the surface falls align with surveyed surface subsidence features at the site. These features are assumed to be caused by pillar collapse and/or pillar removal and suggest trough and/or pothole subsidence of up to about 2m may have occurred. The depth of cover to the seams in the areas of these falls is assessed to be in a range up to about 60m.

- Subsidence features logged at the surface as identified in Ref [1] and positioned on **Drawings 2, 3 & 4.** The features are primarily in the shallow (less than about 50m cover zone).

- Well documented history at this site and in the broader Greta Coal Seam workings of pothole and trough subsidence.

The steeply dipping nature of the workings means that traditional material bulking assessment methods for pothole subsidence are not appropriate. This is particularly the case where continuous drifts or headings run down dip. Typically, in the Hunter Coalfield pothole depth is assessed to be up to of the order of 10 times mined height. This is a consequence of overburden material tending to bulk (increase volume) during fracture and effectively choking subsidence prior to daylighting at the surface. For a mined height of 3m this would typically suggest pothole risk depth of up to 30m. In areas where there are continuous drifts or headings running down dip this mechanism is not valid and degree of conservatism is suggested in assessment of pothole risk depth in those circumstances.

The presence of voids within the bores at the site indicates that there remains a credible risk at the Precinct 1 site of:

- Pothole formation in the area of depth of cover to about 50m depth to the roof of the Top Seam (this will be at least 60m cover to the Bottom Seam).

- Trough subsidence in areas with depth of cover greater than about 50m to the roof of the Top Seam.

In areas with workings over 100m cover there is no evidence of mine subsidence at the surface. With reference to **Drawing 3** the second worked panel of pillars below 100m depth of cover in the bottom seam is about 50-60m in width making the worked panel of pillars subcritical (ie less than is required to allow full surface subsidence to develop) and it is concluded that there is low risk of significant subsidence occurring at the surface at depths of cover over 100m.

6.2 INDICATIVE SUBSIDENCE PARAMETERS FOR PRECINCT 1

Various methods are available for estimating subsidence where either standing or partially collapsed pillars were to collapse over abandoned mine workings including empirical methods and numerical methods. As mentioned previously the steep nature of the workings makes assessment of meaningful subsidence parameters difficult.

Indicative estimates of trough subsidence have been made using the empirical subsidence model for the Newcastle Coalfield presented by Holla (1987) (Ref [2]). The components of ground movement that are of significance include subsidence, tilt and strain. These components are illustrated in **Figure 1** and the variation of the ground movement components is illustrated in **Figure 2**. The key element of the model is a relationship between maximum subsidence (S_{max}) and the panel width/cover depth ratio (W/H). This relationship is shown in **Figure 3**. It is noted that the empirical model makes no account of geological discontinuities such as faults and dykes. It is also noted that the empirical data is unlikely to include data from steeply dipping strata as is present at this site. Nonetheless it is considered that subsidence data assessed by this method will be conservative for the site geometry and site conditions.

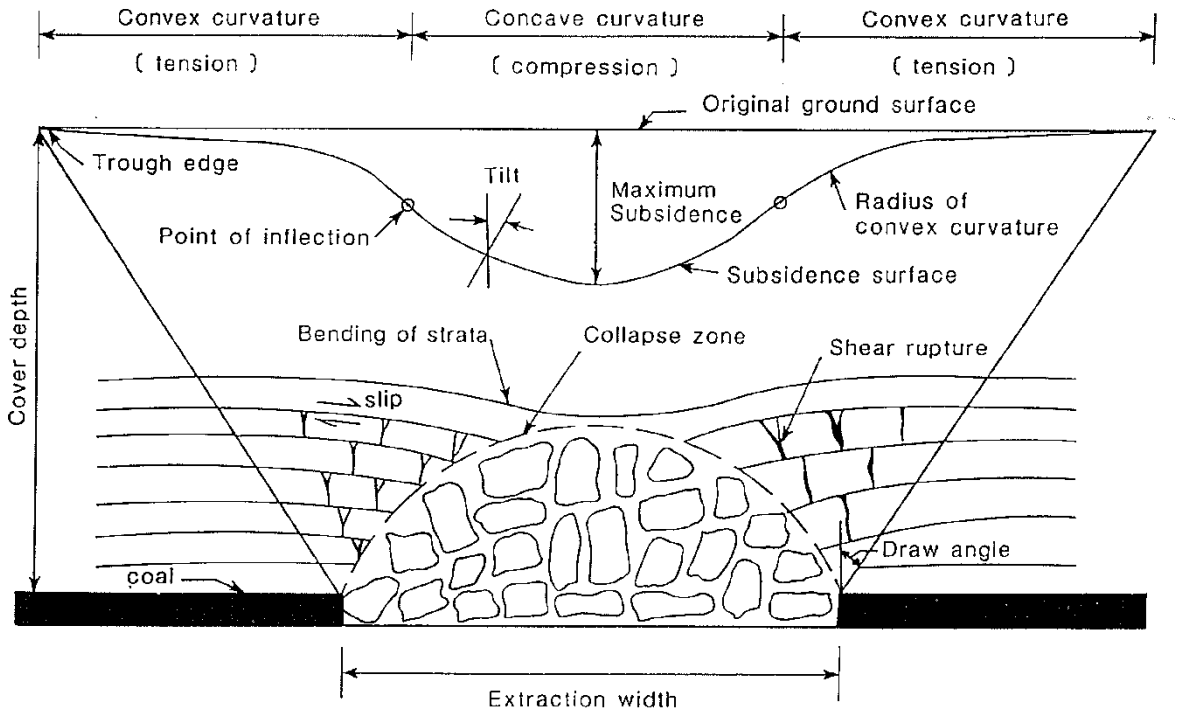


Figure 1 *Components of Trough Subsidence (Holla, 1987)*

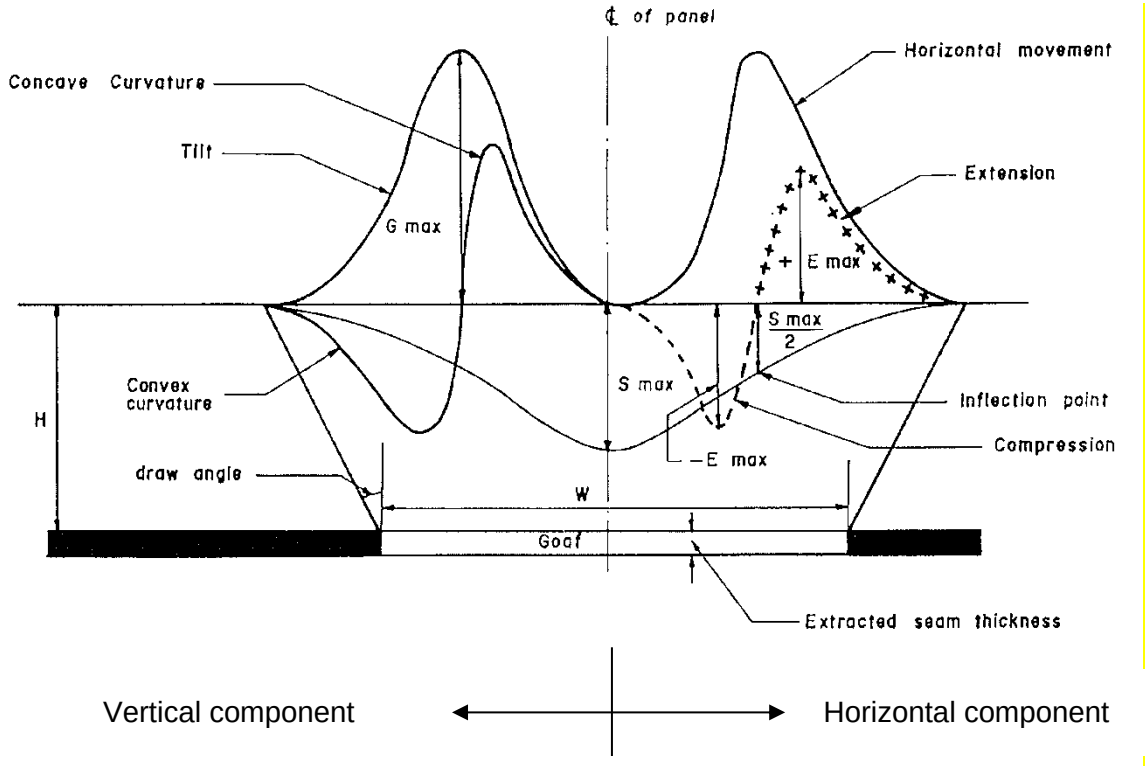


Figure 2 *Characteristics of Trough Subsidence (Holla, 1987)*

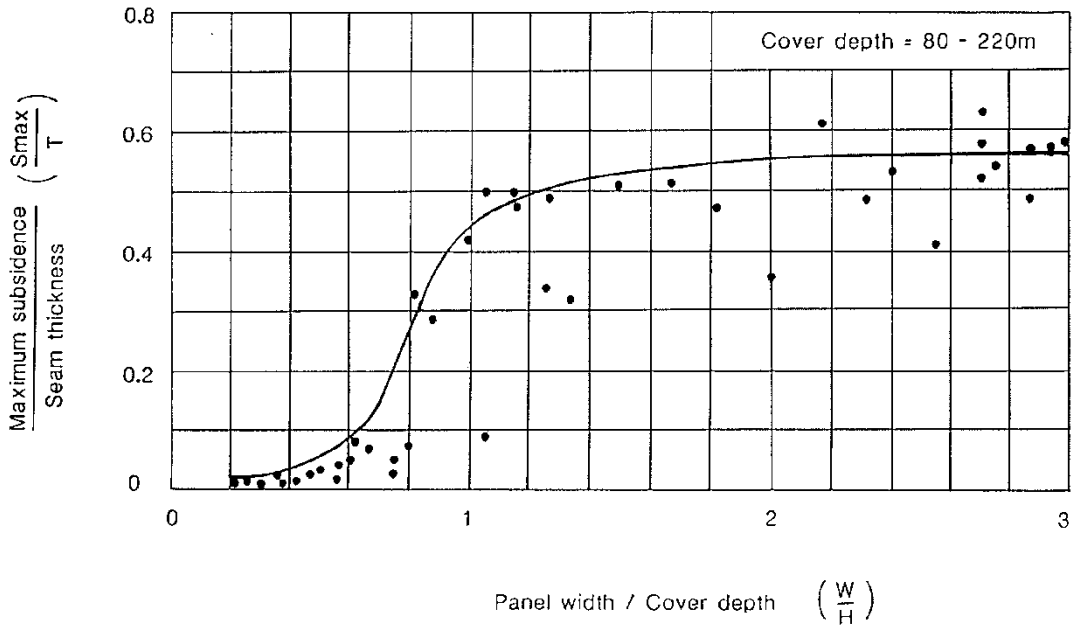


Figure 3 *Relationship between Maximum Subsidence and W/H (Holla, 1987)*

Strains and tilts are a function of S_{max} and H. For critical conditions (wide panel widths eg, W/H>1.5) (Ref [2]) suggests the following relationships for estimating maximum ground movement parameters:

- Subsidence (S_{max}) = 0.55 × T (m)
- Tensile strain (E_T) = 400 × S_{max}/H (mm/m)
- Compressive strain (E_C) = 600 × S_{max}/H (mm/m)
- Tilt (G) = 1800 × S_{max}/H (mm/m)

The model shown in **Figure 3** indicates that:

- at W/H > 1.5 the maximum probable subsidence is approximately 0.55 the effective extracted mine thickness;
- at W/H <0.6 the maximum probable subsidence is less than approximately 0.05 the effective extracted mine thickness;
- at intermediate W/H ratios there is a transition.

The effective extracted mine thickness will approximate the mined thickness where complete extraction was undertaken. In areas of first workings the extracted mine thickness needs to be adjusted to account for the crushed pillars filling the void during crushing. For the purposes of this assessment, it has been assumed that the adjusted extracted mine thickness is the mined height multiplied by the extraction ratio (ie, the effective extracted mine height is about 50% of the pillar height). It is noted that this makes no allowance for bulking of the crushed coal or remnant voids in the profile, which would reduce the subsidence if allowed for.

Using this model, if a large extent of pillars were to completely crush, in the worst case, it could be expected that a surface subsidence near the centre of the crush of 0.55 x 0.5 x pillar height. For full Bottom Seam thickness of 2.5m this would equate to worst case subsidence of about 0.7m. As previously noted, the second worked panels of pillars below 100m depth of cover in the Bottom Seam are about 50-60m in width making the worked panel of pillars subcritical (ie less than is required to allow full surface subsidence to develop) and it is concluded that there is low risk of the worst case subsidence listed above developing in the areas with over 100m of cover. In the calculations below up to 1m of subsidence is allowed between 50 and 100m cover and 0.25m subsidence between 100 and 200m cover.

Indicative subsidence parameters calculated based on the Ref [2] empirical model for mine affected areas of the site is listed in **Table 2.**.

Table 2 *Indicative Empirical Subsidence Estimates*

Depth (m)	Subsidence (m)	Strain +/- (mm/m)	Tilt (mm/m)	Curvature (km)
0-50	Pothole Risk	Pothole Risk	Pothole Risk	Pothole Risk
50-100	1	10	20	1.25
100-200	0.25	1	3	15

7 APPROVAL POLICY

7.1 SUBSIDENCE ADVISORY NSW APPROVAL FRAMEWORK

SA NSW has set development guidelines to help landowners building within a mine subsidence district. The guidelines set out the requirements for building on a property based on potential subsidence risks.

SA NSW's guidelines include requirements related to the nature and class of any development on a property, the size, height and location of new structures, and the use of certain building materials and construction methods.

The Precinct 1 site is listed on the NSW Government Planning Portal as Guideline 7. Guideline 7 applies to properties within mine subsidence districts where special consideration of the likely subsidence issues is required prior to approval of development. This includes properties assessed as being at risk of subsidence with unknown or severe parameters, properties affected by shallow mine entries or shafts, and properties that are only partially undermined.

Any development application within a Guideline 7 area will be assessed on its merit in accordance with the Coal Mine Subsidence Compensation Act 2017.

As part of the assessment process for development applications that do not comply with Subsidence Advisory's standard guidelines, the following factors will be considered:

- Likelihood that mine subsidence events will occur.
- Consequence of mine subsidence events on surface infrastructure and public safety.
- Reliability of information used to determine the above, including mine plans, assumed pillar and extraction dimensions, and assumptions regarding geotechnical modelling.
- Risks arising from the proposed engineering controls.

For the purpose of the assessment that follows, reference is made to the relevant SA NSW assessment policy:

- Subdivision Assessment Policy, Version number: 1, Date: Friday, May 25, 2018

It is assumed that the policies of the Subdivision Assessment Policy will apply to the areas of Precinct 1 that lie within the Maitland West Mine Subsidence District.

7.2 SUBSIDENCE ADVISORY NSW ASSESSMENT PROCEDURES

7.2.1 POTHOLE SUBSIDENCE

In accordance with the Subdivision Assessment Policy pothole risk is assessed based on:

1. Cover depth
2. Overburden characteristics
3. The nature of the workings
4. Seam dip
5. Previous history of pothole formation.

In accordance with the SA NSW Assessment Guidelines the following conditions are assessed to apply:

- In areas where depth to workings is less than 10 times seam thickness the risk of pothole subsidence is **High** and all proposed **lots, roads and public spaces** within areas with less than 10 times seam thickness of cover will require removal of the pothole risk by a suitable means such as grouting. Based on the mine history and the seam thickness the cut off depth for pothole subsidence risk is considered to be 50m.
- Areas with depth to workings greater than 10 times seam thickness do not have a risk of pothole subsidence (ie >50m).

As noted in Section 6.1, in areas where there are continuous drifts or headings running down dip and degree of conservatism is suggested in assessment of pothole risk depth in those circumstances. On that basis allowance for pothole treatment depth under those conditions to a minimum of 60m cover depth is suggested.

7.2.2 TROUGH SUBSIDENCE

In accordance with the Subdivision Assessment Policy trough subsidence risk is assessed based on:

1. The assessed level of geotechnical uncertainty (uncertainty factor)

2. The assessed stability of remnant coal pillars based on calculated factors of safety and slenderness (or width to height ratio)

3. The estimated subsidence impact should pillar failure occur.

For the workings at the site, the uncertainty factor is assessed by RCA Australia to be **HIGH**.

Based on a high uncertainty factor and with reference to Table C2 of the subdivision assessment guidelines approval conditions are likely to be : Subdivision works must be designed to be "safe, serviceable and readily repairable" given the estimated subsidence impact parameters.

It is noted that the SA NSW Subdivision Policy indicates that approval conditions will generally require that all subdivision infrastructure be designed to accommodate the estimated subsidence impact as far as practicable and that all buried services should be located for ease of repair if required.

8 RECOMMENDATIONS

Mine subsidence conditions at the site are relatively complex. It is recommended that plans for development and improvements within the 0-100m depth of cover zone be avoided as much as possible. Reference to the Development Plan included on **Drawing 5** indicates that Stage 1B development within the 0-100m depth of cover zone is limited to:

- Road MC01 crosses the 0-100m cover zone.

- Possible extension of Road MC05 across the 0-100m cover zone in the future to connect to the existing rail bridge.

- The edge of one Lot sits just over the 100m isopach (Lot 314).

- A stormwater basin near the northern site boundary lies within the 50-100m cover zone and a stormwater basin toward the southern boundary of the site lies over the edge of the 100m isopach.

SA NSW will assess applications for development based on merit under Section 22 of the Coal Mine Subsidence Compensation Act 2017 and will provide conditions of approval. Based on SA NSW Subdivision Assessment Policy and data provided in this report it is considered that the approval conditions for Precinct 1B will include allowance for design for subsidence parameters of the order of those listed in **Table 3**. Likely approval conditions are also listed in **Table 3**.

Table 3 *Indicative Design Subsidence Parameters for Precinct 1B*

Depth of Cover Area (m)	Strain +/- (mm/m)	Tilt (mm/m)	Curvature (km)	Likely Approval Conditions
0-50[1]	Pothole Risk	Pothole Risk	Pothole Risk	Remediation by grouting
50-100	10	20	1.25	Any improvements designed to be SSR[2] subject to subsidence parameters
100-mine subsidence district boundary	1	3	15	Surface development Guideline 2 (G2) [3]
Outside mine subsidence district	No restriction	No restriction	No restriction	Nil

Notes:

1 Proposed development within the pothole risk zone will likely require remediation by grouting. A depth of 60m may apply where drifts are present such as at the proposed MC01 road crossing.

2 SSR - safe, serviceable and readily repairable

3 Based on the current SA NSW Policy Framework it is considered that SA NSW Guideline 2 may be applied to residential development with greater than 100m depth of cover to workings that are within the mine subsidence district.

Drawing 5 provides approximate zones of depth of cover across the site that approval conditions are likely to apply to.

A grout plan will be required for all areas within the 50-60m cover zone that require grouting. As a preliminary guide the grouting is likely to comprise bores to intersect both seams to up to 50-60m depth at close centres (~5m) on a grid pattern with injection of grout back to the surface with the objective of filling all voids or fractures. A verification set of bores will be required to certify the filling. The steeply dipping nature of the seams will need to be accounted for in the grout plan as the grout will tend to flow down dip and it will be necessary to establish a barrier at 50-60m depth with viscous grout or by 'building' the grout to restrict the loss of the less viscous bulk fill grout into the deeper workings. The nature of the working with bords along the dip and limited cut throughs down dip will aid this process and the presence of drifts of headings down dip will need to be targeted.

The area within Precinct 1B west of the zero cover line is considered to be unaffected by mine workings and is unlikely to be subject to mine subsidence restrictions. It is noted that given the intensive mine activity in the vicinity of the sub crop line including drifts and coal processing activities that a degree of ground disturbance in these areas should be expected. This conclusion is reinforced by the presence of some mine features mapped on **Drawings 2-4** west of the 0m cover line. This feature of the site should be factored into design and construction at the site.

Based on the SA NSW Subdivision Policy it is noted that approval conditions will also likely require subdivision infrastructure (eg. infrastructure other than buildings) to be designed to accommodate estimated subsidence impacts as far as practicable and that all buried services should be located for ease of repair if required. Any infrastructure (eg. roads) with less than 50-60m cover to the workings will require treatment to remove pothole risk (grouting or excavation and replacement).

Impacts of mine subsidence on infrastructure can be minimised and mitigated by measures such as:

- Road pavements constructed of flexible Asphalt Concrete (AC).
- Stormwater pipes laid on minimum longitudinal grades 0.5% steeper than current Council minimum requirements to offset minor ground tilts i.e. 1% + 0.5% = 1.5% minimum grade.
- Concrete kerbs to have crack control joints at 3m centres and full isolation joints at 6m centres to ensure only minimum length of kerb would need to be replaced in a subsidence event.
- Sewer pressure pipes to be bedded in sand and be constructed from fully welded HDPE or similar.
- Water pressure pipes (potable and recycled water) to be bedded in sand backfill and constructed from maximum 6m lengths of UPVC and rubber ring joints to minimise the impact of ground strains.

It is suggested that these measures be implemented within the mine subsidence district defined in **Drawing 5**.

9 LIMITATIONS

This report has been prepared for Loxford Project Management Pty Ltd in accordance with the agreement with RCA. The services performed by RCA have been conducted in a manner consistent with that generally exercised by members of its profession and consulting practice.

This report has been prepared for the sole use of Loxford Project Management Pty Ltd for the specific purpose and the specific development described in the report. The report may not contain sufficient information for purposes or developments other than that described in the report or for parties other than Loxford Project Management Pty Ltd. This report shall

only be presented in full and may not be used to support objectives other than those stated in the report without permission.

The information in this report is considered accurate at the date of issue with regard to the current conditions of the site.

Yours faithfully
RCA AUSTRALIA

Mark Allman
Principal Geotechnical Engineer

REFERENCES

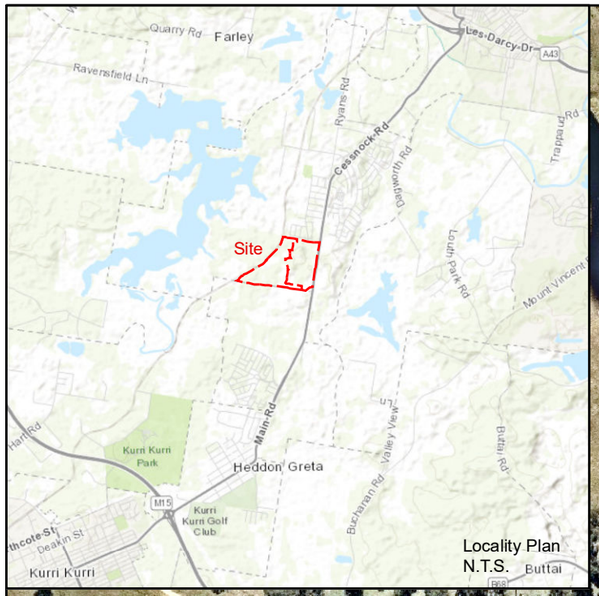
[1] Geotechnical Assessment of Mine Subsidence Constraints Proposed Development Cessnock Road Loxford, Newcastle Geotech (2013)

[2] Mine Subsidence Assessment Regrowth Kurri Kurri, Precinct 1A, RCA ref 15924-201/2, February 2022.

[3] Holla, L (1987) Surface Subsidence Prediction in the Newcastle Coalfield, Department of Mineral Resources.

Appendix A

Drawings



LEGEND

Proposed Precinct 1 boundaries

Maitland West Mine Subsidence District

Note: Aerial image taken from Nearmap, 6 August 2021
(used in accordance with commercial licence)
Proposed development drawing supplied by Loxford Project Management Pty Ltd
(Drawn by ADW Johnson,
Dwg Ref: 220725 Precinct 1B Design Cad (002), Dated 22 July 2022)

0 40 80 160 240 320
metres

N

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

REGROWTH KURRI KURRI
PRECINCT 1
SITE PLAN

CLIENT	Loxford Project Management Pty Ltd			RCA Ref	15924-203/1
DRAWN BY	MA	SCALE	1:4,000 (A3)	DRAWING No 1	REV 1
APPROVED BY	MA	DATE	21/12/2021	OFFICE	NEWCASTLE

East Greta Colliery Top Seam
(RT 422)

BH2

BH6

BH5

Glenmore Colliery
(RT 353)

Precinct 1B

Precinct 1A

BH4

BH1

BH3

South Maitland Railway

Cessnock Road

LEGEND

- Proposed Precinct 1 boundaries
- Maitland West Mine Subsidence District
- Approximate borehole location
- Approximate isopachs of depth of cover to top seam
- Surface subsidence features (Ref [1])
- Surface depressions by survey (Ref [1])

Note: RT 353 Plan of Abandonment Sheet 1 Top and Bottom Seam and
RT 422 Plan of Abandonment Sheet 1 Top Seam
obtain from Department of Planning, Environmental Resources and Geoscience
Proposed development drawing supplied by Loxford Project Management Pty Ltd
(Drawn by ADW Johnson,
Dwg Ref: 220725 Precinct 1B Design Cad (002), Dated 22 July 2022)

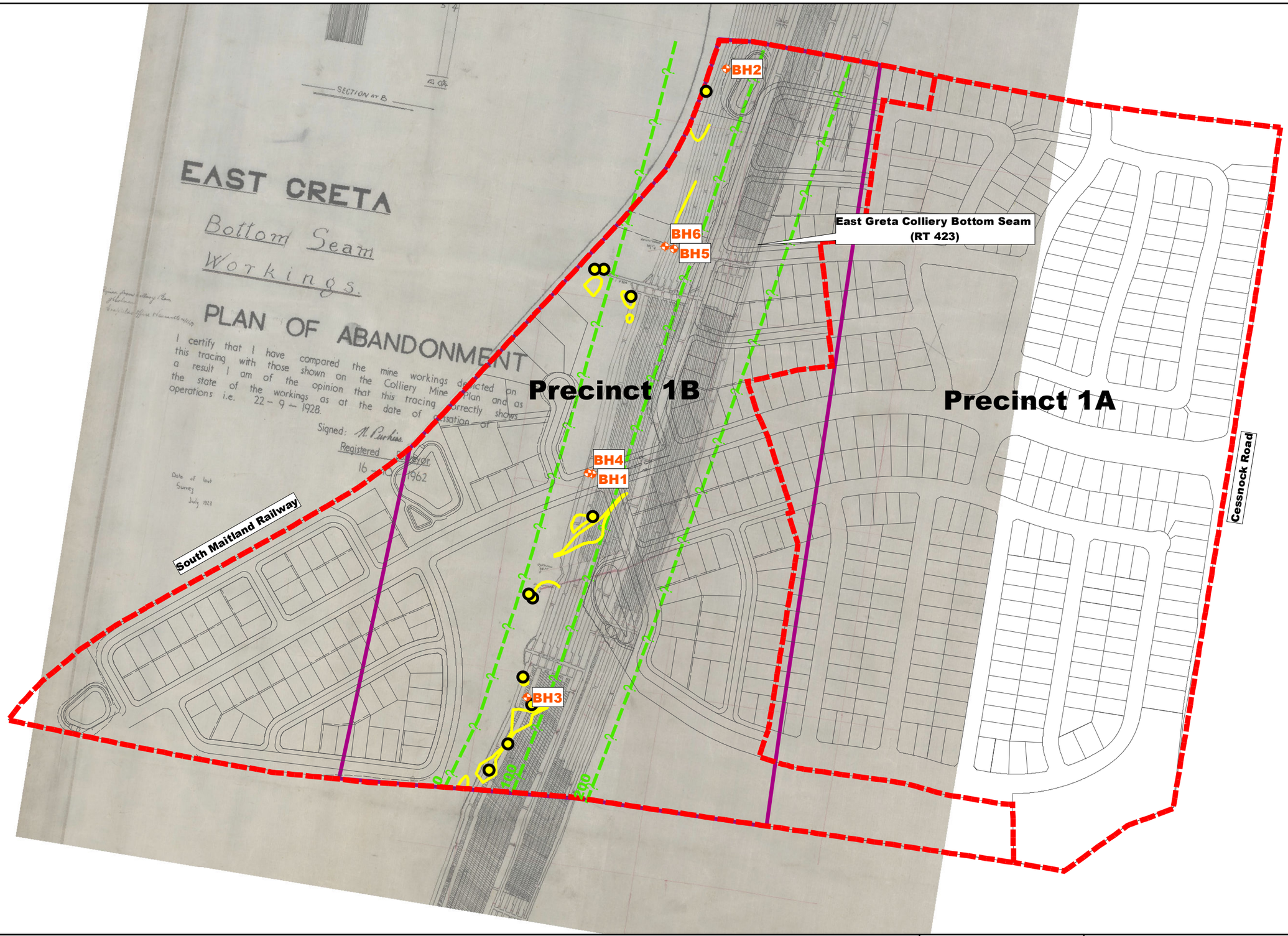
0 40 80 160 240 320
metres

N

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

REGROWTH KURRI KURRI
PRECINCT 1
MINE OVERLAY PLAN
GRETA TOP SEAM

CLIENT	Loxford Project Management Pty Ltd			RCA Ref	15924-203/1
DRAWN BY	MA	SCALE	1:4,000 (A3)	DRAWING No 2	REV 1
APPROVED BY	MA	DATE	2/08/2022	OFFICE	NEWCASTLE



LEGEND

- Proposed Precinct 1 boundaries
- Maitland West Mine Subsidence District
- Approximate borehole location
- Approximate isopachs of depth of cover to bottom seam
- Surface subsidence features (Ref [1])
- Surface depressions by survey (Ref [1])

Note: RT 423 Plan of Abandonment 1 Sheet Bottom Seam
obtain from Department of Planning, Environmental Resources and Geoscience
Proposed development drawing supplied by Loxford Project Management Pty Ltd
(Drawn by ADW Johnson,
Dwg Ref: 220725 Precinct 1B Design Cad (002), Dated 22 July 2022)

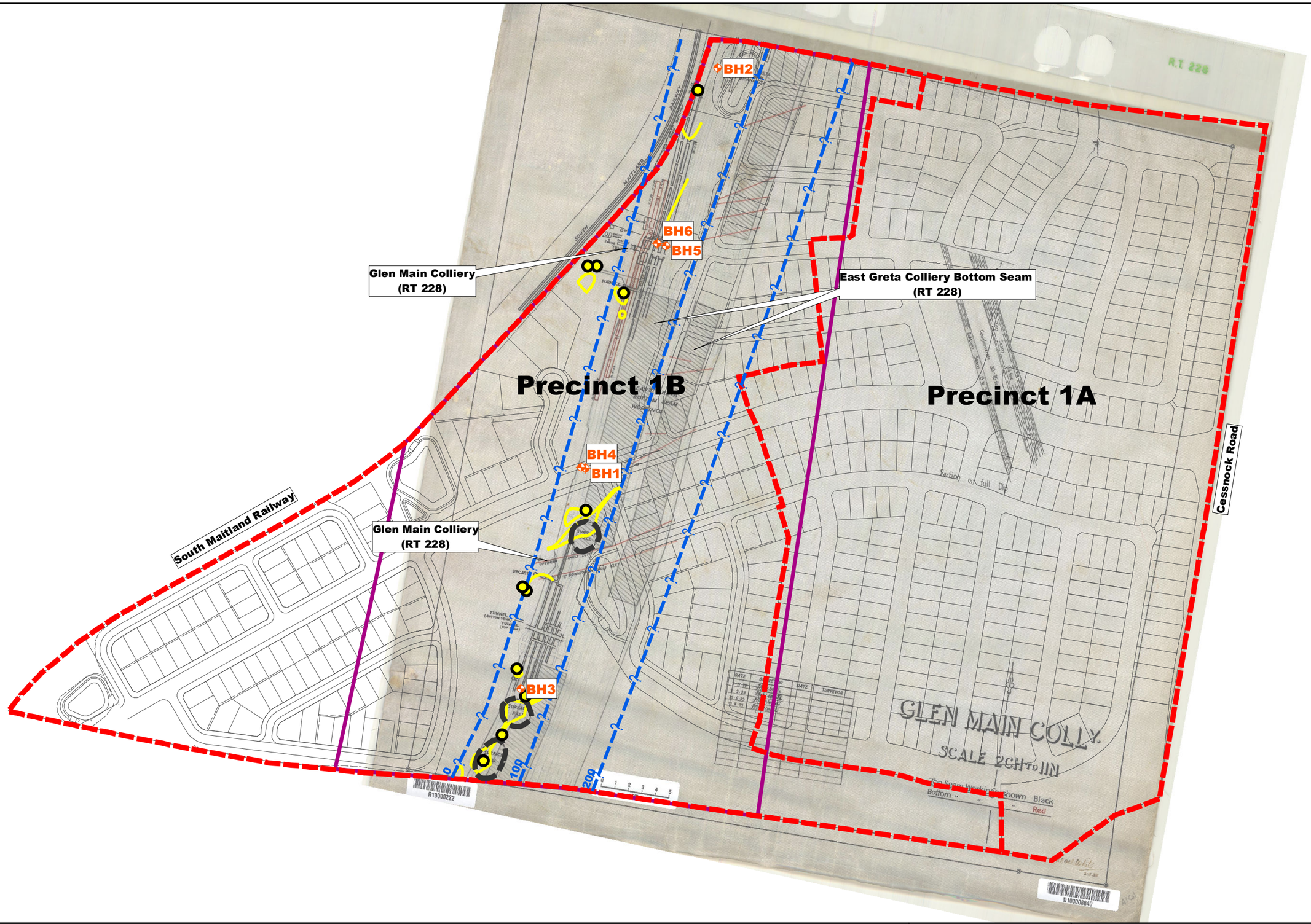
0 40 80 160 240 320
metres

N

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

REGROWTH KURRI KURRI PRECINCT 1 MINE OVERLAY PLAN GRETA BOTTOM SEAM

CLIENT	Loxford Project Management Pty Ltd			RCA Ref	15924-203/1
DRAWN BY	MA	SCALE	1:4,000 (A3)	DRAWING No 3	REV 1
APPROVED BY	MA	DATE	2/07/2022	OFFICE	NEWCASTLE



LEGEND

- Proposed Precinct 1 boundaries
- Maitland West Mine Subsidence District
- Approximate borehole location
- Approximate isopachs of depth of cover to top seam
- Surface subsidence features (Ref [1])
- Surface depressions by survey (Ref [1])
- Surface falls (RT 228)

Note:RT 228 Plan of Workings 1 Sheet
obtained from Department of Planning, Environmental Resources and Geoscience Proposed development drawing supplied by Loxford Project Management Pty Ltd (Drawn by ADW Johnson,
Dwg Ref: 220725 Precinct 1B Design Cad (002), Dated 22 July 2022)

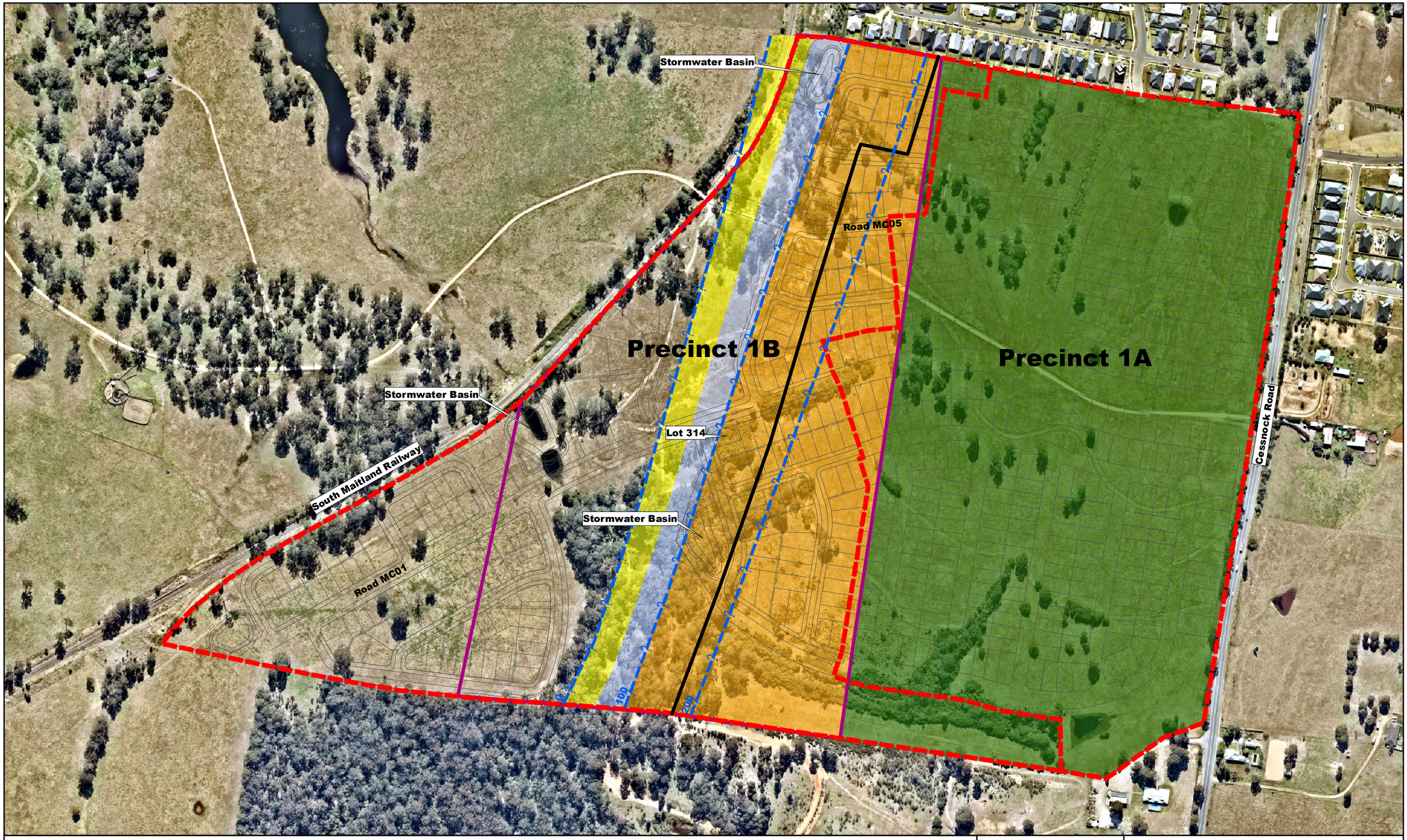
0 40 80 160 240 320
metres

N

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

REGROWTH KURRI KURRI PRECINCT 1 MINE OVERLAY PLAN GRETA TOP AND BOTTOM SEAM (ALTERNATE RT)

CLIENT	Loxford Project Management Pty Ltd			RCA Ref	15924-203/1
DRAWN BY	MA	SCALE	1:4,000 (A3)	DRAWING No 4	REV 1
APPROVED BY	MA	DATE	2/08/2022	OFFICE	NEWCASTLE



LEGEND

- Proposed Precinct 1 boundaries
- Maitland West Mine Subsidence District
- Approximate isopachs of depth of cover to top seam
- Deepest extent of mine workings

Mine Subsidence Zone

- 0 - 50m
- 50 - 100m
- 100m - mine subsidence district boundary
- Outside mine subsidence district

Note: Aerial image taken from Nearmap, 6 August 2021
(used in accordance with commercial licence)
Proposed development drawing supplied by Loxford Project Management Pty Ltd
(Drawn by ADW Johnson,
Dwg Ref: 220725 Precinct 1B Design Cad (002), Dated 22 July 2022)

0 40 80 160 240 320
metres

N

RCA AUSTRALIA
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REGROWTH KURRI KURRI PRECINCT 1B MINE SUBSIDENCE ZONES

CLIENT	Loxford Project Management Pty Ltd			RCA Ref	15924-203/1
DRAWN BY	MA	SCALE	1:4,000 (A3)	DRAWING No 5	REV 1
APPROVED BY	MA	DATE	2/08/2022	OFFICE	NEWCASTLE

Appendix B

Bore Logs

Core Photographs

Explanation Sheets

GEOTECHNICAL BOREHOLE LOG

BH1

SHEET 1 OF 5

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 25/01/2022
DATE COMPLETED: 28/01/2022
SURFACE RL: 19.78 m AHD
COORDS: 361271.70 m E 6372900.60 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	(Not encountered during augering)			19	0.10			TOPSOIL, Silty SAND, fine to medium grained, dark brown	M		TOPSOIL
								Sandy Gravelly CLAY, medium plasticity, brown, medium to coarse grained sand	w>PL		RESIDUAL
					1.00			Silty Gravelly SAND, medium to coarse grained, brown, with some fine to medium sub-rounded gravel	D - M		EXTREMELY WEATHERED MATERIAL
				18	1.50			Gravelly SAND/Sandy GRAVEL, medium to coarse grained sand, fine to medium sub-rounded gravel, orange-brown, with some clay (extremely weathered material derived from conglomerate)	M		
				17	2						Clumps in hand without additional water
				16	3			pale grey band at ~3.5m to 4.0m			
				15	4						
				14	5.00			Pebbly SANDSTONE, medium to coarse grained, brown, fine sub-rounded to sub-angular pebbles	XW - HW		BEDROCK / EXTREMELY WEATHERED MATERIAL
				13	6						
				12	7						
				11	8						
PCD	0% LOSS			10	9						Casing at 9.9m

LOGGED: TH | CHECKED: MA | DATE: 01/06/2022

GEOTECHNICAL BOREHOLE LOG

BH1

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 25/01/2022
DATE COMPLETED: 28/01/2022
SURFACE RL: 19.78 m AHD
COORDS: 361271.70 m E 6372900.60 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	0% LOSS			9	11			Pebbly SANDSTONE, medium to coarse grained, brown, fine sub-rounded to sub-angular pebbles	HW - MW		BEDROCK / EXTREMELY WEATHERED MATERIAL Cuttings returned as sandy clay with gravel
				8	12				SW - FR		
					12.50			COAL, very dark grey-black	SW		BEDROCK
				7	13						Increased drilling resistance Water table (10/5/22) at 13.1m
								tuffaceous sandstone band from 13.3m to 13.6m			Increased drilling resistance from 13.3m to 13.6m
				6	14						
				5	15						
				4	16						
				3	17			brown claystone band ~100mm thick at 16.8m			PCD bit clogged at 17.0m rod pull required
				2	18						
				1	19			interbedded with some minor brown claystone bands at 18.8m			
				0							

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GEOTECHNICAL BOREHOLE LOG

BH1

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 25/01/2022
DATE COMPLETED: 28/01/2022
SURFACE RL: 19.78 m AHD
COORDS: 361271.70 m E 6372900.60 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	0% LOSS			-1	21			COAL, very dark grey-black grey-brown claystone band ~150mm thick	SW		BEDROCK
				-2	22						
				-3	23						
				-4	24						
				-5	25						
				-6	25.90 26			CLAYSTONE, grey			
				-7	27						
				-8	27.50 28			Tuffaceous SANDSTONE, fine to medium grained, pale grey			
				-9	29			becoming pebbly at 28.65m becoming with minor carbonaceous seams at 28.7m			
				-10							

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GEOTECHNICAL BOREHOLE LOG
BH1

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 25/01/2022
DATE COMPLETED: 28/01/2022
SURFACE RL: 19.78 m AHD
COORDS: 361271.70 m E 6372900.60 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	0% LOSS 0% LOSS 30% LOSS			-11 -12 -13 -14 -15 -16 -17 -18 -19 -20	31 31.10 32 33 34 35 36 37 38 39			Tuffaceous SANDSTONE, fine to medium grained, pale grey CONGLOMERATE, pale grey, tuffaceous sandstone matrix becoming non-tuffaceous , grey at ~33.5m becoming tuffaceous, reduced pebbles (bands of pebbly sandstone) at 35.7m	SW		BEDROCK

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GEOTECHNICAL BOREHOLE LOG
BH1

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 25/01/2022
DATE COMPLETED: 28/01/2022
SURFACE RL: 19.78 m AHD
COORDS: 361271.70 m E 6372900.60 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	30% LOSS			-21	41			CONGLOMERATE, pale grey, tuffaceous sandstone matrix	SW		BEDROCK
	100% LOSS			-22	42			becoming with some carbonaceous bands at 41.2m			
				-23	42.90 43			VOID			VOID
	40-50% LOSS			-24	43.55 44			COAL, black			BEDROCK
	90% LOSS			-25	44.75 45			Tuffaceous SANDSTONE, fine grained, pale brown			Slow drilling
	20-30% LOSS			-26	46			becoming with some coal bands (possibly washed from above layers?) at 45.6m			Suction hose found to blocked at 45.3, increased return after unclogging. Large amount of tuffaceous sandstone (pale brown) returned after unclogging
				-27	46.90 47			becoming pale grey at 46.6m CONGLOMERATE, grey, with tuffaceous sandstone matrix			Faster drilling
	20% LOSS			-28	47.80 48			Pebbly Tuffaceous SANDSTONE, fine to medium grained, pale grey			Slower drilling
				-29	49			becoming pebbly sandstone (non tuffaceous) at ~49.0m becoming tuffaceous at 49.4m			Faster drilling Slower drilling
				-30				BOREHOLE BH1 TERMINATED AT 49.85 m			

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GEOTECHNICAL BOREHOLE LOG

BH2

SHEET 1 OF 7

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 31/01/2022
DATE COMPLETED: 01/02/2022
SURFACE RL: 19.25 m AHD
COORDS: 361411.80 m E 6373325.40 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T				19	0.50			TOPSOIL, Silty SAND, fine grained, brown	M		TOPSOIL
								Silty Gravelly SAND, dark brown becoming dark grey at 0.7m			SLOPEWASH
				18	1.00			Silty SAND, fine grained, brown, with clay			
					1.40			Sandy CLAY, medium plasticity, pale brown, trace of fine to medium gravel	w>PL		RESIDUAL
					2.00						
				17	2.20			Gravelly Sandy CLAY, medium plasticity, brown, fine to medium gravel	HW - MW		BEDROCK
PCD	0% LOSS				3			CONGLOMERATE, pale grey-brown, grey and red-brown			
				16							
					4						
				15							
					5			becoming grey and brown at 5.0m	MW - SW		
				14							
					6						
				13							
					7						
				12							
					7.70			Pebbly SANDSTONE, fine to medium grained, grey and brown			
					8						
				11							
					8.50			CONGLOMERATE, grey and brown			
					9						
				10							
					9.80						

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GEOTECHNICAL BOREHOLE LOG

BH2

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 31/01/2022
DATE COMPLETED: 01/02/2022
SURFACE RL: 19.25 m AHD
COORDS: 361411.80 m E 6373325.40 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	0% LOSS			9				Tuffaceous SANDSTONE, fine to medium grained, pale grey	MW - SW		BEDROCK
					11.00						
				8				Pebbly SANDSTONE, fine to medium grained, grey and brown, with some conglomerate bands			
				7	12						Water table (10/5/22) at 12.4m
				6	13						
					14			becoming grey at ~14.0m	SW - FR		
				5							
				4	15						
					16						
				3							
					17						
				2							
					18						
				1							
					19						
				0							

LOGGED: TH | CHECKED: MA | DATE: 01/06/2022

GEOTECHNICAL BOREHOLE LOG

BH2

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 31/01/2022
DATE COMPLETED: 01/02/2022
SURFACE RL: 19.25 m AHD
COORDS: 361411.80 m E 6373325.40 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	0% LOSS			-1	21			Pebbly SANDSTONE, fine to medium grained, grey and brown, with some conglomerate bands tuffaceous band from 19.4m to 20.3m	SW - FR		BEDROCK
				-2	22			tuffaceous band from 21.1m to 21.5m			
				-3	23						
				-4	23.30			COAL, black			
				-5	24						
				-6	25						
				-7	26						
				-8	27				SW		
				-9	28						
				-10	29						

LOGGED: TH | CHECKED: MA | DATE: 01/06/2022

GEOTECHNICAL BOREHOLE LOG

BH2

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 31/01/2022
DATE COMPLETED: 01/02/2022
SURFACE RL: 19.25 m AHD
COORDS: 361411.80 m E 6373325.40 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	0% LOSS			-11	31			COAL, black	SW		BEDROCK
				-12	32						
				-13	33						
				-14	34						
				-15				50mm claystone band? at 34.25m			
					34.80			becoming with some dark brown clayey zones at 34.7m	MW		
					35			CLAYSTONE, grey	HW		
				-16	35.50			Tuffaceous SANDSTONE, pale grey	SW		
					36						
				-17	36.70			CONGLOMERATE, grey	SW - FR		
					37						
				-18	38						
				-19				becoming with some tuffaceous pebbly sandstone bands from 38.7m			
				-20	39						

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PCD	0% LOSS			-21	41			CONGLOMERATE, grey	SW - FR		BEDROCK
				-22	42						
				-23	43						
				-24	44						
				-25	45						
				-26	46						
				-27	47						
				-28	48						
				-29	49						
				-30							

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GEOTECHNICAL BOREHOLE LOG

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GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
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PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

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Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	0% LOSS 10% LOSS 100% LOSS			-31 -32 -33 -34 -35 -36 -37 -38 -39 -40	51 52 53 54 54.70 55 55.70 56 56.50 57 58 58.30 59			CONGLOMERATE, grey becoming with carbonaceous bands (black floating in mud)at ~51.0m COAL, black RUBBLE?, able to drill very easily but unable to push without rotation COAL? SANDSTONE?	SW - FR		BEDROCK RUBBLE? BEDROCK Increased drilling resistance (chuck half closed) but still progressing reasonably quickly (some progress as conglomerate of coal) Increased drilling resistance slower penetration (but not very slow)

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GEOTECHNICAL BOREHOLE LOG
BH2

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PROJECT No: 15924
CLIENT: McCloy Group
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LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 31/01/2022
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Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	100% LOSS			-41	61			SANDSTONE?			BEDROCK
				-42	62						
				-43	62.95						Harder drilling again, still penetration
				-44	63			BOREHOLE BH2 TERMINATED AT 62.95 m			
				-45	64						
				-46	65						
				-47	66						
				-48	67						
				-49	68						
				-50	69						

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GEOTECHNICAL BOREHOLE LOG

BH3

SHEET 1 OF 7

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 01/02/2022
DATE COMPLETED: 03/02/2022
SURFACE RL: 18.30 m AHD
COORDS: 361202.80 m E 6372667.00 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T				18	0.20			FILL, Silty Sandy GRAVEL, fine to medium, pale grey-brown, sub-rounded to sub-angular	D		FILL
					0.30			TOPSOIL, Silty Gravelly SAND, fine to medium grained, brown	w<PL		TOPSOIL RESIDUAL
					0.70			Sandy CLAY, medium plasticity, brown mottled red-brown, fine to medium grained sand becoming with some fine to medium sub-rounded gravel	M		EXTREMELY WEATHERED MATERIAL
				17	1			Silty Gravelly SAND, fine to coarse grained, grey and brown, trace to with some clay			
					1.40			CONGLOMERATE, fine to medium clasts in pale grey sandstone matrix	HW		BEDROCK
					1.90			CONGLOMERATE/Pebbly SANDSTONE, fine to medium grained, pale brown, fine to medium sub-rounded pebbles			
				16	2						
				15	3			with some sandy clay from 3.1m to 3.5m			
				14	4						
PCD	0% LOSS			13	5						
				12	6						
				11	7						
				10	8			becoming brown at ~8.5m			
				9	9						

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GEOTECHNICAL BOREHOLE LOG

BH3

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 01/02/2022
DATE COMPLETED: 03/02/2022
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DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	0% LOSS			8	11			CONGLOMERATE/Pebbly SANDSTONE, fine to medium grained, pale brown, fine to medium sub-rounded pebbles	HW		BEDROCK
				7	12			becoming grey and brown at ~11.0m	MW		
				6	13			becoming grey at ~12.5m	SW		
				5	14			becoming dark grey at ~14m			
				4	15						
				3	16						
					16.20						
	100% LOSS			2	17			RUBBLE/Disturbed Ground			RUBBLE Reduced drilling resistance, lost water, no indication of coal chips when water returned
				1	18						
				0							
					18.50						
	70% LOSS				19			CONGLOMERATE, grey			BEDROCK Increased drilling resistance
	100% LOSS			-1							
					19.50			VOID (rubble filled)			VOID Reduced drilling resistance, lost water, unable to push down without

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GEOTECHNICAL BOREHOLE LOG

BH3

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GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 01/02/2022
DATE COMPLETED: 03/02/2022
SURFACE RL: 18.30 m AHD
COORDS: 361202.80 m E 6372667.00 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
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PCD	80% LOSS 100% LOSS			-2 -3 -4 -5 -6 -7 -8 -9 -10 -11	20.00 21 21.60 22 22.20 23 24 25 26 26.40 27 27.30 27.70 28 29.00			SANDSTONE, medium grained, grey with some voids/disturbed zones from 20.4m to 21.6m with some coal bands from 21.0m to 21.4m VOID VOID (rubble filled) CLAYSTONE? CONGLOMERATE/CLAYSTONE CLAYSTONE? SANDSTONE/CONGLOMERATE?	SW		rotation. No indication of coal cuttings when water returned BEDROCK Increased drilling resistance, some water return, some softer zones VOID Decreased drilling resistance BEDROCK Grinding noise, faster drilling Slower drilling, softer bit blocking up at~28m, behaving similar to claystone at other locations Faster drilling, soft becoming harder at 29.5m

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GEOTECHNICAL BOREHOLE LOG

BH3

RCA AUSTRALIA
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METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	100% LOSS			-12	30.50			SANDSTONE/CONGLOMERATE?	SW		BEDROCK
					31			Tuffaceous SANDSTONE/CLAYSTONE?			Slow drilling, increased resistance
				-13	31.30			SANDSTONE/CONGLOMERATE?			Faster drilling, harder
					32						
				-14	32.30			SANDSTONE/CONGLOMERATE?, possibly disturbed/fractured			Fast drilling, softer, consistent fast drilling with less resistance
					33						
				-15							
					34						
				-16							
					35						
				-17							
					36						
				-18							
					37						
				-19							
					38						
				-20							
					39						
				-21							
					39.60			COAL?/SANDSTONE/CONGLOMERATE? harder band/claystone? from 39.7m to 39.9m			

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GEOTECHNICAL BOREHOLE LOG
BH3

RCA AUSTRALIA
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PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

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Borehole Information						Field Material Information					
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PCD	100% LOSS			-22	41			COAL?/SANDSTONE/CONGLOMERATE? harder band/claystone? from 40.1m to 40.4m	SW		BEDROCK Fluctuating water pressure gauge, broken up/fractural ground?
				-23							
					42						
				-24				harder band/claystone? from 42.6m to 42.7m			
					43						
				-25				harder band/claystone? from 43.7m to 43.75m			
					44			harder band/claystone? from 43.9m to 44.2m			
				-26							Increased drilling resistance
					44.70			CLAYSTONE/Tuffaceous SANDSTONE?			BEDROCK Increased drilling resistance, slow drilling
					45						
				-27							
					46						
				-28							
					47						
				-29							
					48						
				-30							
					49						
				-31							

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GEOTECHNICAL BOREHOLE LOG

BH3

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
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LOCATION: Cessnock Road, Gillieston Heights

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Borehole Information						Field Material Information					
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PCD	100% LOSS			-32	51			CLAYSTONE/Tuffaceous SANDSTONE?	SW		BEDROCK BEDROCK BEDROCK BEDROCK
					51.10			CONGLOMERATE?			Faster drilling, some grinding
				-33							
					52.00			Tuffaceous SANDSTONE?			Slower drilling, tuffaceous
				-34							
					53						
				-35							
					54						
				-36							
					55						
					55.20			SANDSTONE/CONGLOMERATE			
				-37							
					56						
				-38							
					56.50			Tuffaceous SANDSTONE			Slower drilling
					57						
				-39							
					58						
				-40							
					59						
				-41							

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GEOTECHNICAL BOREHOLE LOG

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PCD	100% LOSS			-42	61			Tuffaceous SANDSTONE	SW		BEDROCK
				-43	62						
				-44	62.90						
				-45	63			BOREHOLE BH3 TERMINATED AT 62.90 m			
				-46	64						
				-47	65						
				-48	66						
				-49	67						
				-50	68						
				-51	69						

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GEOTECHNICAL BOREHOLE LOG

BH4

SHEET 1 OF 5

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 03/02/2022
DATE COMPLETED: 15/02/2022
SURFACE RL: 19.62 m AHD
COORDS: 361267.00 m E 6372901.80 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	(Not encountered during augering)			19	0.30			TOPSOIL, Silty SAND, fine to medium grained, pale brown	M		TOPSOIL / SLOPEWASH
								Sandy CLAY, high plasticity, brown mottled red-brown	w>PL		RESIDUAL
					0.80			Gravelly Clayey SAND/Gravelly Sandy CLAY, medium to coarse grained sand, medium plasticity clay, red-brown, fine to medium sub-rounded gravel extremely weathered material derived from conglomerate	M		EXTREMELY WEATHERED MATERIAL
				18	1			CONTINUED AS CORED BOREHOLE			
				17	2						
				16	3						
				15	4						
				14	5						
				13	6						
				12	7						
				11	8						
				10	9						

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CORED BOREHOLE LOG
BH4

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 03/02/2022
DATE COMPLETED: 15/02/2022
SURFACE RL: 19.62 m AHD
COORDS: 361267.00 m E 6372901.80 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Description					
METHOD	WATER LOSS	CORE RECOVERY	RQD	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	DESCRIPTION (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)	DEFECT DESCRIPTION AND ADDITIONAL OBSERVATIONS (defect type, inclination, infilling, planarity, roughness, thickness)
				19	1		START CORING AT 1.37m				
	0% LOSS	41	0	18	1.37 1.51 1.61		CORE LOSS 0.14m (1.37-1.51) Gravelly Sandy CLAY, medium plasticity, pale grey-brown, fine to medium grained sand, fine to coarse sub-rounded to sub-angular gravel (residual/extremely weathered material)	XW			
		21	0	17	2 2.55		CORE LOSS 0.94m (1.61-2.55) CONGLOMERATE, pale grey and brown, fine to medium rounded to sub-rounded clasts in tuffaceous sandstone matrix	XW			JT 5° CN PR RF JT 5° CN PR RF JT 5° CN PR RF
		0	0		2.80 3		CORE LOSS 3.05m (2.80-5.85)				
	0% LOSS	0	0	16	4						
				15	5						
				14	5.85 6 6.13		CONGLOMERATE, pale grey, fine to medium sub-rounded clasts in tuffaceous sandstone matrix, decomposed matrix CORE LOSS 1.35m (6.13-7.48)	XW			DZ
		10	0	13	7						
	0% LOSS			12	7.48 7.63 8		CONGLOMERATE, pale grey, fine to medium sub-rounded clasts in tuffaceous sandstone matrix, decomposed matrix CORE LOSS 0.60m (7.63-8.23)	XW			DZ
		15	0		8.23 8.35 8.41		CONGLOMERATE, grey and yellow-brown, fine to medium sub-rounded clasts in clayey sand matrix, recovered as clayey sandy gravel COAL, black, completely weathered to carbonaceous clayey silt	XW			DZ
		12	0	11	9		coal cuttings returned at 8.35m				
		36	0		9.07		CORE LOSS 0.66m (8.41-9.07)	XW			DZ
					9.36 9.49		COAL, black, completely weathered to carbonaceous clayey silt				
		100	0	10			CORE LOSS 0.13m (9.36-9.49)	XW			

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CORED BOREHOLE LOG
BH4

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 03/02/2022
DATE COMPLETED: 15/02/2022
SURFACE RL: 19.62 m AHD
COORDS: 361267.00 m E 6372901.80 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information | Field Material Description

METHOD	WATER LOSS	CORE RECOVERY	RQD	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	DESCRIPTION (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)	DEFECT DESCRIPTION AND ADDITIONAL OBSERVATIONS (defect type, inclination, infilling, planarity, roughness, thickness)
	0% LOSS	100	0				COAL, black, decomposed to carbonaceous clayey sandy silt	XW			DZ
		100	0				becoming decomposed to carbonaceous sandy gravelly silt at 10.34m				
				9	10.63		CORE LOSS 0.49m (10.63-11.12)				
		63	0		11						
					11.12		COAL, very dark grey-black, many highly fractured zones fragmented with partially annealed fractures at random dip/orientation	SW - MW			FZ
				8							JT 25° CN PR RF
											JT 45° CN ST RF
											JT 70° CN PR S
							decomposed to carbonaceous clayey sand from 11.66m to 11.76m				FZ
		100	0		12						DZ
											JT 70° CN PR RF
		46	0		12.45						FZ
											JT 40° CN IR RF
							CORE LOSS 0.28m (12.45-12.73)				FZ
				7	12.73						FZ
		57	0				COAL, very dark grey-black, many highly fractured zones fragmented with partially annealed fractures at random dip/orientation	SW			FZ
					13.04						FZ
					13.17		CLAYSTONE, brown, decomposed and clayey	XW			FZ
											DZ
					13.50		CORE LOSS 0.33m (13.17-13.50)				
		30	0	6	13.56		COAL, black	SW			FZ
		50	0		13.70		annealed 80° joint at 13.53m	SW			BP 50° CN PR S
					13.80						
		71	0		13.90		CORE LOSS 0.14m (13.56-13.70)	SW			FZ
					14						JT 10° CN PR RF
					14.15		COAL, black				
		48	0		14.25		CORE LOSS 0.10m (13.80-13.90)	SW			FZ
					14.42		COAL, black				JT 70° CN PR S
											JT 5° CN PR RF
				5	14.60		CORE LOSS 0.10m (14.15-14.25)	MW			JT 80° CN PR S
					14.72		COAL, black	XW			JT 20° CN PR RF
		38	0		14.95		CORE LOSS 0.18m (14.42-14.60)	SW			FZ
							COAL, black	XW			BP 50° CN PR RF
											DZ
							CLAYSTONE, brown, decomposed and clayey dark grey carbonaceous claystone from 14.77m to 14.86m				BP 60° CN PR RF
		0	0								FZ
				4	15.65		coal band from 14.88m to 14.91m	SW - MW			DZ
		77	24				CORE LOSS 0.70m (14.95-15.65)				FZ
					16.00						JT 70° CN PR RF
		0	0				COAL, black				JT 70° CN PR RF
					16.25		CORE LOSS 0.25m (16.00-16.25)				JT 50° CN PR RF
		100	0				COAL, black				JT 40° CN PR RF
				3							FZ
											BP 40° CN PR RF
											JT 40° CN PR RF
											JT 35° CN PR RF
					17						JT 85° CN PR RF
											JT 35° CN IR RF
											BP 40° CN PR RF
											BP 50° CN PR RF
		82	24					MW			JT 90° CN PR RF
				2							BP 50° CN PR RF
											JT 5° CN PR RF
					18						DZ/FZ
											FZ
								HW			JT 45° CN PR S
					18.27		CORE LOSS 0.23m (18.27-18.50)				JT 80° CN PR S
					18.50						JT 40° CN PR RF
		53	0	1			COAL, black	SW - FR			JT 40° CN PR RF
					18.66		CORE LOSS 0.39m (18.66-19.05)				JT 25° CN IR RF
											JT 90° CN PR RF
		0	0		19						JT 30° CN PR RF
					19.05						JT 60° CN PR RF
		73	0		19.09		COAL, black	SW			FZ
					19.15		CORE LOSS 0.06m (19.09-19.15)	SW			FZ
					19.26						FZ
					19.33		COAL, black	SW - MW			FZ
		96	68	0	19.62		CORE LOSS 0.07m (19.26-19.33)				BP 60° CN PR RF
							COAL, black	HW			FZ
											JT 5° CN PR RF

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CORED BOREHOLE LOG
BH4

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 03/02/2022
DATE COMPLETED: 15/02/2022
SURFACE RL: 19.62 m AHD
COORDS: 361267.00 m E 6372901.80 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Description					
METHOD	WATER LOSS	CORE RECOVERY	RQD	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	DESCRIPTION (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)	DEFECT DESCRIPTION AND ADDITIONAL OBSERVATIONS (defect type, inclination, infilling, planarity, roughness, thickness)
		96	68				becoming decomposed with some claystone bands from 19.42m	- XW SW			DZ
		100	79	-1	20.64		CLAYSTONE, grey, with some dark grey-black carbonaceous seams, interbedded with some fine grained tuffaceous sandstone bands decomposed and clayey from 20.46m to 20.51m	XW SW			DZ
	0% LOSS				21		Tuffaceous Pebbly SANDSTONE, fine to coarse grained, grey, generally fine pebbles with some zones medium pebbles, with some conglomerate bands				
		100	100	-2	22						
		100	100	-3	23						
				-4			with some carbonaceous inclusions from 24.0m to 24.1m				
		100	100	-5	24						
					25						
		100	100	-6	26		with carbonaceous laminations from 25.6m to 25.65m				
				-7	26.75						
	0% LOSS	100	100	-8	27		CONGLOMERATE, fine to medium sub-rounded to sub-angular clasts in grey tuffaceous sandstone matrix				
					28						
		59	59	-9	29		medium grained pebbly sandstone band from 29.26m to 29.34m				
					29.43		CORE LOSS 0.57m (29.43-30.00)				
				-10							

LOGGED: TH | CHECKED: MA | DATE: 01/06/2022

CORED BOREHOLE LOG
BH4

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 03/02/2022
DATE COMPLETED: 15/02/2022
SURFACE RL: 19.62 m AHD
COORDS: 361267.00 m E 6372901.80 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Description				
METHOD	WATER LOSS	CORE RECOVERY	RQD	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	DESCRIPTION (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)	DEFECT DESCRIPTION AND ADDITIONAL OBSERVATIONS (defect type, inclination, infilling, planarity, roughness, thickness)
		60	60	-11	30.00		CONGLOMERATE, fine to medium sub-rounded to sub-angular clasts in grey tuffaceous sandstone matrix	SW			
					30.42		CORE LOSS 0.28m (30.42-30.70)				
		100	100		30.70		CONGLOMERATE, fine to medium sub-rounded to sub-angular clasts in grey tuffaceous sandstone matrix	SW			
				-12	31.72		VOID				
	0% LOSS	11	11	-13							
		35	0	-14	33.55						
					33.60		CORE LOSS 0.05m (33.55-33.60)				
							RUBBLE, comprising conglomerate and coal fragments				
		100	16		34.21		COAL, black	FR			JT 60° CN PR RF JT 60° CN PR RF JT 30° CN PR RF BP 50° CN PR RF JT 70° CN PR S JT 40° CN PR RF JT 20° CN IR RF FZ FZ
		83	28	-15							JT 65° CN PR RF JT 15° CN PR RF JT 55° CN PR RF JT 45° CN PR RF JT 45° CN PR RF JT 30° CN PR RF BP 50° CN PR RF JT 20° CN PR RF JT 20° CN PR RF BP 55° CN PR RF JT 20° CN PR RF JT 20° CN IR RF JT 40° CN PR RF
				-16	35.75		CORE LOSS 0.25m (35.75-36.00)				
		60	0		36.00		COAL, black	FR			
					36.18		CORE LOSS 1.01m (36.18-37.19)				
		0	0								
		0	0	-17							
	0% LOSS	38	0		37.19		COAL, black	FR			FZ JT 10° CN IR RF JT 30° CN PR RF BP 50° CN PR RF FZ
					37.55		CORE LOSS 1.05m (37.55-38.60)				
		0	0	-18							
				-19	38.60		CORED BOREHOLE BH4 TERMINATED AT 38.60 m				
				-20							

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BH4 – 1.37m to 9.00m

Client:	McCloy Group	**RCA Australia**
Project:	Geotechnical Investigation	
Location:	Cessnock Road, Gillieston Heights	**RCA ref:** 15924-201/0

BH4 – 9.00m to 17.00m

Client:	McCloy Group	**RCA Australia**
Project:	Geotechnical Investigation	
Location:	Cessnock Road, Gillieston Heights	**RCA ref:** 15924-201/0

BH4 – 17.00m to 25.00m

Client:	McCloy Group	**RCA Australia**
Project:	Geotechnical Investigation	
Location:	Cessnock Road, Gillieston Heights	**RCA ref:** 15924-201/0

BH4 – 25.00m to 33.00m

Client:	McCloy Group	**RCA Australia**
Project:	Geotechnical Investigation	
Location:	Cessnock Road, Gillieston Heights	**RCA ref:** 15924-201/0

BH4 – 33.00m to 38.60m

Client:	McCloy Group	**RCA Australia**
Project:	Geotechnical Investigation	
Location:	Cessnock Road, Gillieston Heights	**RCA ref:** 15924-201/0

GEOTECHNICAL BOREHOLE LOG

BH5

SHEET 1 OF 8

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 27/04/2022
DATE COMPLETED: 29/04/2022
SURFACE RL: 28.44 m AHD
COORDS: 361357.10 m E 6373137.30 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T				28	0.22			FILL, Silty Sandy GRAVEL, fine to medium, brown, sub-rounded to sub-angular, fine to coarse grained sand	D - M		FILL
								Sandy CLAY, medium plasticity, orange brown and brown, fine to medium grained sand	w>PL		RESIDUAL
					0.80			Pebbly SANDSTONE, fine to medium grained, pale grey	HW		BEDROCK
				27	1						
					1.80			SANDSTONE/SILTSTONE, brown			
					2						
					2.20			Tuffaceous SANDSTONE, fine to medium grained, pale grey			
				26	2.65			SILTSTONE, , grey and orange			
					3						
				25							
					4						
				24							
					4.80			SANDSTONE, fine to medium grained, red-brown			
					5						
					5.30			Interbedded SILTSTONE and SANDSTONE, fine to medium grained sandstone, grey and brown			
PCD	5% LOSS			23							
					6						
				22							
					7						
				21							
					8						Slow penetration from 8.2m to 8.3m
	100% LOSS			20							
					9						
				19							

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GEOTECHNICAL BOREHOLE LOG
BH5

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

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PCD	100% LOSS			18	11			Interbedded SILTSTONE and SANDSTONE, fine to medium grained sandstone, grey and brown			Medium penetration from 10.8m to 11.1m Slow penetration from 11.1m to 11.4m
				17	12						
				16	13						Slow to medium penetration from 8.2m to 8.3m
					13.30						
				15	14			Pebbly SANDSTONE/CONGLOMERATE			
				14	15						
				13	16						
				12	17						
				11	18						
				10	19						
				9							

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GEOTECHNICAL BOREHOLE LOG
BH5

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

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PCD	100% LOSS			8	21			Pebbly SANDSTONE/CONGLOMERATE			
				7	22						Water table (11/5/22) at 21.8m
				6	23						
				5	24						
				4	25						
				3	26						
				2	27						
				1	28						
				0	29						
				-1							

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GEOTECHNICAL BOREHOLE LOG

BH5

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

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Borehole Information						Field Material Information					
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PCD	100% LOSS			-2 -3 -4 -5 -6 -7 -8 -9 -10 -11	31 32 33 34 35 36 37 38 39			Pebbly SANDSTONE/CONGLOMERATE			

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GEOTECHNICAL BOREHOLE LOG

BH5

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 27/04/2022
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Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	100% LOSS			-12	41			Pebbly SANDSTONE/CONGLOMERATE			
				-13	42						
				-14	43						
				-15	43.70						
					44			COAL, black			Some water and cuttings returned when walking rods, some coal cuttings returned at 44.65m
	80% LOSS			-16	45						
				-17	46						Water returned with coal cuttings at 45.5m
				-18	47						
	100% LOSS			-19	48						
				-20	49						
				-21							

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GEOTECHNICAL BOREHOLE LOG

BH5

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 27/04/2022
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Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	100% LOSS			-22	51			COAL, black			
				-23	52						
				-24	53			claystone band from 52.8m			
				-25	53.40			COAL?			
				-26	54						
				-27	55						
					55.60			CLAYSTONE?			
					56.00			SANDSTONE?			
				-28	57						
				-29	58			grey clayey sand on bit at 57.8m			
				-30	59						
				-31							

LOGGED: TH | CHECKED: MA | DATE: 08/06/2022

GEOTECHNICAL BOREHOLE LOG
BH5

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 27/04/2022
DATE COMPLETED: 29/04/2022
SURFACE RL: 28.44 m AHD
COORDS: 361357.10 m E 6373137.30 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	100% LOSS			-32	61			SANDSTONE?			
				-33	62						
				-34							
					63.00			RUBBLE?, with intermittent voids			
				-35	64						Stopped rotation at 63.5m and pushed, able to push to 64.35
				-36	65						able to stop, add weight and drill easily (with rubbly feel) from 64.35m to 69.65m
				-37	66						
				-38	67						
				-39	68						
				-40	69						
				-41							Pushed without rotation from 69.95m to 70.05m

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GEOTECHNICAL BOREHOLE LOG
BH5

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 27/04/2022
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PCD	100% LOSS			-42	71			RUBBLE?, with intermittent voids			Drilled very easily (stop-start) from 70.05m to 70.5m Rubble from 70.5m to 71.4m
				-43	71.40			COAL/SANDSTONE?			
					72.00			CLAYSTONE/Tuffaceous SANDSTONE?			
				-44	73						
				-45	74						
				-46	75						
				-47	75.65			BOREHOLE BH5 TERMINATED AT 75.65 m			
				-48	76						
					77						
				-49	78						
				-50	79						
				-51							

LOGGED: TH | CHECKED: MA | DATE: 08/06/2022

GEOTECHNICAL BOREHOLE LOG

BH6

SHEET 1 OF 7

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 27/04/2022
DATE COMPLETED: 29/04/2022
SURFACE RL: 27.89 m AHD
COORDS: 361348.00 m E 6373139.80 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	(Not encountered while augering)			27	0.10 0.25 0.50 1.00			FILL, Gravelly Silty SAND, fine to coarse grained, brown, fine to coarse, sub-rounded to sub-angular gravel TOPSOIL, Silty SAND, fine to coarse grained, dark brown Sandy CLAY, medium plasticity, brown mottled red-brown, fine to coarse grained sand Clayey Silty SAND, fine to medium grained, pale grey (extremely weathered material from sandstone)			FILL TOPSOIL / SLOPEWASH RESIDUAL EXTREMELY WEATHERED MATERIAL
	2% LOSS			26	2			SANDSTONE, medium grained, red-brown, returned as dry silty sand			BEDROCK
PCD	100% LOSS			25	2.50 3			Pebbly SANDSTONE/CONGLOMERATE?			
				24	4						
				23	5						
				22	6						
				21	7						
				20	8			claystone band? from 7.6m to 8.2m			
				19	9						
				18							

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GEOTECHNICAL BOREHOLE LOG
BH6

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 27/04/2022
DATE COMPLETED: 29/04/2022
SURFACE RL: 27.89 m AHD
COORDS: 361348.00 m E 6373139.80 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	100% LOSS			17 16 15 14 13 12 11 10 9 8	11 12 13 14 15 16 17 18 19			Pebbly SANDSTONE/CONGLOMERATE? void/decomposed zone from 10.15m to 10.7m stepping, dipping open parting at 12.0m			

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GEOTECHNICAL BOREHOLE LOG

BH6

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

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DATE COMPLETED: 29/04/2022
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Borehole Information						Field Material Information					
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PCD	100% LOSS			7	21			Pebbly SANDSTONE/CONGLOMERATE?			Water table (11/5/22) at 21.2m
				6	22						
				5	23						
				4	24			becoming softer/decomposed at 23.7m			
				3	25						
				2	26						
				1	27						
				0	28						
					28.30			VOID (rubble infill)			
				-1	29.00			Pebbly SANDSTONE/CONGLOMERATE?			
				-2							

LOGGED: TH | CHECKED: MA | DATE: 08/06/2022

GEOTECHNICAL BOREHOLE LOG
BH6

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

PROJECT No: 15924
CLIENT: McCloy Group
PROJECT: Geotechnical Investigation
LOCATION: Cessnock Road, Gillieston Heights

DATE COMMENCED: 27/04/2022
DATE COMPLETED: 29/04/2022
SURFACE RL: 27.89 m AHD
COORDS: 361348.00 m E 6373139.80 m N MGA94 56
DRILL MODEL: Hanjin D&B 8D

Borehole Information						Field Material Information					
METHOD	WATER	FIELD TEST	SAMPLE	RL (m AHD)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	DESCRIPTION (SOIL NAME;plasticity/grain size, particle shape, colour, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	MOISTURE/ WEATHERING	CONSISTENCY/ RELATIVE DENSITY/ STRENGTH	STRUCTURE AND ADDITIONAL OBSERVATIONS
PCD	100% LOSS				30.10			VOID			
					30.40			RUBBLE/MUD			
				-3	31						
				-4	32						
				-5	33						
				-6	34						Pushed down with no rotation from 34.3m to 34.6m Stopped rotation, able to push 300mm from 34.3m to 34.6m
				-7	35						Able to push with no rotation, fells soft (like mud) under rods from 35.1m to 35.3m Drilled very easily, stopped rotation, added weight, start rotation, spindle opens very quickly from 35.3m to 35.9m
				-8	35.90 36			VOID (open?)			
				-9	37						
				-10	37.80 38			RUBBLE/BOULDER			Pushed with no rotation, feels open, no rubble from 35.9m to 37.8m
					38.40			RUBBLE/MUD			Able to push with no rotation, feels soft from 38.4m to 38.6m
				-11	38.90 39			COAL?			Firmer, still drills quickly
					39.40			SILTSTONE/SANDSTONE/CONGLOMERATE?			Increased drilling resistance
				-12							

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GEOTECHNICAL BOREHOLE LOG
BH6

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PCD	100% LOSS			-13	40.80			SILTSTONE/SANDSTONE/CONGLOMERATE?			
				-13	41			CLAYSTONE?			
				-14	42						
				-15	43.00			SILTSTONE/SANDSTONE/CONGLOMERATE, possibly interbedded with siltstone/sandstone to 46.6m			
				-16	44						
				-17	45						
				-18	46						
				-19	47						
				-20	47.65			VOID			No resistance when pushing without rotation
				-20	48						
				-21	48.65			RUBBLE			Very little resistance when rotating
				-21	49						
				-22							

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GEOTECHNICAL BOREHOLE LOG
BH6

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PCD	100% LOSS			-23	51			RUBBLE			
				-24	52						
				-25	53						
				-26	54						
				-27	55						
				-28	56						
				-29	57						
					57.40			COAL? (firmer rubble?)			
				-30	58						
				-31	59						
					59.40			SANDSTONE?			Small rod drop from 59.35m to 59.4m
				-32							

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GEOTECHNICAL BOREHOLE LOG

BH6

SHEET 7 OF 7

RCA AUSTRALIA
GEOTECHNICAL • ENVIRONMENTAL

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PROJECT: Geotechnical Investigation
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Borehole Information						Field Material Information					
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PCD	100% LOSS			-33	61			SANDSTONE?			
				-34	62						
				-35	63						
				-36	64						
				-37	65						
					65.65			BOREHOLE BH6 TERMINATED AT 65.65 m			
				-38	66						
				-39	67						
				-40	68						
				-41	69						
				-42							

LOGGED: TH | CHECKED: MA | DATE: 08/06/2022

Explanatory Notes – Soil Description

In engineering terms, soil includes every type of uncemented or partially cemented material found in the ground. In practice, if the material can be remoulded by hand in its field condition or in water it is described as a soil. The dominant soil constituent is given in capital letters, with secondary textures in lower case. The dominant feature is assessed from *AS 1726:2017 – Geotechnical Site Investigations* and a soil symbol is used to define a soil layer.

METHOD

Method	Description
AD/T	Auger Drilling with tungsten carbide bit
AD/V	Auger Drilling with V Bit
AS	Auger Screwing
AT	Air Track
BH	Backhoe
CT	Cable Tool Rig
DB	Washbore Drag Bit
DT	Diatube
E	Excavator
EH	Excavator with Hammer
HA	Hand Auger
HQ	Diamond Core-63mm diameter
N	Natural Exposure
NMLC	Diamond Core-52mm diameter
NQ	Diamond Core-47mm diameter
Percussion	Percussion Drilling
PT	Push Tube
RR	Rock Roller
V	Vacuum Excavation
WS	Washbore
X	Existing Excavation

WATER

Water level at date shown

Seepage

NOT ENCOUNTERED: The borehole/test pit was dry soon after excavation. Inflow may have been observed had the borehole/test pit been left open for a longer period.

NOT OBSERVED: The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.

SAMPLING

Sample	Description
B	Bulk Disturbed Sample
D	Disturbed Sample
SPT	Standard Penetration Test
U50	Undisturbed Sample - 50mm diameter
U75	Undisturbed Sample - 75mm diameter
ES	Soil Sample, Environmental
EW	Water Sample, Environmental
G	Gas Sample

SOIL CLASSIFICATION

The appropriate symbols are selected based on the result of visual examination, field tests and available laboratory test results, such as particle size analysis, liquid limit and plasticity index.

Group Symbol	Description
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand
ML	Silt of low plasticity
CL	Clay of low plasticity
OL	Organic soil of low plasticity
CI	Clay of medium plasticity
MH	Silt of high plasticity
CH	Clay of high plasticity
OH	Organic soil of high plasticity
Pt	Peat, highly organic soil

MOISTURE CONDITION

For coarse grained soils, the following terms are used

Dry - Non-cohesive and free-running

Moist - Soil feels cool, darkened in colour
- Soil tends to stick together

Wet - Soil feels cool, darkened in colour
- Soil tends to stick together, free water forms when handling

For fine grained soils, the following moisture content (w) terms are used:

w < PL - Moist, dry of plastic limit

w ≈ PL - Moist, near plastic limit.

w > PL - Moist, wet of plastic limit.

w ≈ LL - Wet, near liquid limit.

w > LL - Wet, wet of liquid limit

PLASTICITY

Soil plasticity is a measure of the range of water content over which a soil exhibits plastic properties. The classification of the degree of plasticity in terms of the Liquid Limit (LL) is as follows.

Description of Plasticity	Range of Liquid Limit for Silt	Range of Liquid Limit for Clay
Non-plastic	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

COHESIVE SOILS – CONSISTENCY

The consistency of a cohesive soil is defined by descriptive terminology such as very soft, soft, firm, stiff, very stiff and hard. These terms are assessed by the shear strength of the soil as observed visually, by hand penetrometer, dynamic cone penetrometer or vane shear values and by resistance to deformation to hand moulding.
A hand penetrometer may be used in the field or the laboratory to provide an approximate assessment of the unconfined compressive strength (UCS) of cohesive soils. Undrained shear strength c_u = 0.5×UCS. Undrained shear strength values are recorded in kPa as follows:

Strength	Symbol	Indicative Undrained Shear Strength, c_u (kPa)
Very Soft	VS	≤12
Soft	S	>12 and ≤25
Firm	F	>25 and ≤50
Stiff	St	>50 and ≤100
Very Stiff	VSt	>100 and ≤200
Hard	H	>200
Friable	Fr	—

COHESIONLESS SOILS – RELATIVE DENSITY

Relative density terms such as very loose, loose, medium dense, dense and very dense are used to describe silty and sandy material, and these are usually based on resistance to drilling penetration, Standard Penetration Test (SPT) N values or Perth Sand Penetrometer resistance.

Term	Symbol	Density Index
Very Loose	VL	0 to 15
Loose	L	15 to 35
Medium Dense	MD	35 to 65
Dense	D	65 to 85
Very Dense	VD	>85

SOIL PARTICLE SIZE DESCRIPTIVE TERMS

Fraction	Name	Subdivision	Size (mm)
Oversize	Boulders		>200
	Cobbles		63 to 200
Coarse grained soil	Gravel	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	Sand	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine grained soil	Silt		0.002 to 0.075
	Clay		<0.002

Explanatory Notes - Rock Description

METHOD

Refer to soil description sheet.

WATER

Refer to soil description sheet.

ROCK QUALITY

The defect spacing is shown where applicable and the Rock Quality Designation (RQD) and Total Core Recovery (TCR) for each core run is given where:

$$TCR = \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100\%$$

$$RQD = \frac{\text{Sum of axial length of sound core pieces >100mm long}}{\text{Length of core run}} \times 100\%$$

ROCK MATERIAL WEATHERING

Rock material weathering is described using the abbreviations and definitions used in *AS1726:2017– Geotechnical Site Investigations*.

Term		Abbreviation		Definition
Residual Soil		RS		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered		XW		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
Highly Weathered	Distinctly Weathered	HW	DW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching or may be decreased due to deposition of weathering products in pores.
Moderately Weathered		MW		The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly Weathered		SW		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh		FR		Rock shows no sign of decomposition of individual minerals or colour changes.

Where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock the term 'Distinctly Weathered' may be used. 'Distinctly Weathered' is defined as follows: 'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in the pores'. There is some change in rock strength.

ROCK MATERIAL STRENGTH

Rock strength is described using *AS1726:2017– Geotechnical Site Investigations* and *ISRM – Commission on Standardisation of Laboratory and Field Tests, 'Suggested method of determining the Uniaxial Compressive Strength of Rock materials and the Point Load Index'* as follows:

Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Point Load Index Is_{50} (MPa)
Very Low	VL	0.6 to 2	0.03 to 0.1
Low	L	2 to 6	0.1 to 0.3
Medium	M	6 to 20	0.3 to 1
High	H	20 to 60	1 to 3
Very High	VH	60 to 200	3 to 10
Extremely High	EH	>200	>10

◀ Diametral Point Load Index test.

▼ Axial Point Load Index test.

DEFECT SPACING/BEDDING THICKNESS

Depending on the project, may be either described as mean perpendicular spacing within a set of defects or bedding, or as the spacing between all defects within the rock mass.

Term	Defect Spacing	Bedding
Extremely closely spaced	<6 mm	Thinly laminated
	6 to 20 mm	Laminated
Very closely spaced	20 to 60 mm	Very thin
Closely spaced	0.06 to 0.2 m	Thin
Moderately widely spaced	0.2 to 0.6 m	Medium
Widely spaced	0.6 to 2.0 m	Thick
Very widely spaced	>2 m	Very thick

DEFECT DESCRIPTION

Type	Definition
JT	Joint
BP	Bedding Parting
CO	Contact
CS	Clay Seam
CZ	Crush Zone
DK	Dyke
DZ	Decomposed Zone
FC	Fracture
FZ	Fracture Zone
FL	Foliation
FLT	Fault
VN	Vein
SM	Seam
IS	Infilled Seam
SZ	Shear Zone

Planarity	Roughness
PR – Planar	VR – Very Rough
CU – Curved	RF – Rough
U – Undulating	S – Smooth
ST – Stepped	POL – Polished
IR – Irregular	SL – Slickensided

Symbol	Coating or Infill
CA	Calcite
Clay	Clay
CN	Clean
Fe	Iron oxide
KT	Chlorite
Qz	Quartz
X	Carbonaceous
SN	Stain
VNR	Veneer

The inclinations of defects are measured from perpendicular to the core axis.

Appendix C

Downhole Camera Summary

BH1 Coal at 12.5m

GWT at 13.2m

Void/breakout at 20.7m

Blockage at 26.2 - was able to be passed by the camera

Out of coal around 26m

Coal at 42.2 but may be into coal earlier?

No void at 42.9 but some breakout in bore is visible (ie increase in diameter)

Into sandstone at 44.8m

Filled with spoil at 47.4m and unable to continue

BH2 GWT 12.4

Washout at 23.2m

Silted up at 34.6m and unable to continue

BH3 GWT 12.0m

Disturbed ground from 16.1m

Void visible at 21.6m

Camera lowered to 22.2m and unable to progress from that depth due to blockage

BH4 Cased to 7.1m

In coal from about 8.35m

Washout at 12.4m

GWT at 12.8m

Blocked at 19.3m and unable to continue

BH5 Cased to 1.7m

GWT at 21.8m

Void at 39.3m

Blocked at 39.5m and unable to continue

BH6 Cased to 2.4m

GWT at 21.2m

Void at 28.3m to about 29.2

Fracture visible at 32.8m

Big void visible at 30.2m

Void visible at 31.9m

Blocked at 32.7m and unable to continue