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Report on
Preliminary Geotechnical Assessment

Newcastle Urban Transformation and Transport Program - Rezoning of Surplus Rail Corridor Land
Worth Place to Watt Street, Newcastle

Prepared for
Elton Consulting
on behalf of UrbanGrowth NSW

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Executive Summary

This report presents a desktop geotechnical assessment of government rail corridor lands between Worth Place and Watt Street, Newcastle. It is understood that UrbanGrowth NSW wishes to repurpose the surplus Newcastle rail corridor lands for urban revitalisation.

The scope of work comprised collation and review of geotechnical data from Douglas Partners files and published information, review of previous mine information, development of a broad geotechnical model for the site and provision of preliminary guidance on geotechnical design considerations including material types, excavation conditions, shoring/retaining wall options, foundations, settlement and likely extent of mine workings.

On the basis of the findings of this assessment, the rail corridor site is considered to be suitable for the proposed rezoning from a geotechnical perspective.

It is expected that with suitable investigation, design and construction in accordance with accepted engineering practice, the geotechnical design constraints can be readily managed.

Prior to the detailed design of any proposed developments specific geotechnical investigation will be required appropriate to the nature of the proposed development. Investigation and design will need to consider constraints such as the presence of filling, groundwater and acid sulphate soils, excavation conditions, earthworks requirements and procedures, suitable footing options and requirements relating to potential mine subsidence, where applicable.

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Appendix B: Mine Subsidence Stability Assessment

Appendix C: Letter from Mine Subsidence Board, dated 15 January 2016

Mine Subsidence Board "Newcastle City Area Mine Subsidence Categories" 8 June 2012

Mine Subsidence Board - Newcastle Plan Legend

Hunter Development Corporation - "Newcastle Mines Grouting Fund 2015/2016 Area Category Rates - November 2015"

Appendix D: Drawing 1 – Site Plan and Geotechnical Zones

Drawing 2 - Cross-Section A-A' Sheet 1 of 2

Drawing 3 - Cross-Section A-A' Sheet 2 of 2

Drawing 4 – Inferred Layout of Mine Workings in Borehole Seam

Drawing 5 – Preliminary Grout Zones in Borehole Seam

Report on Preliminary Geotechnical Assessment

Newcastle Urban Transformation and Transport Program - Rezoning of Surplus Rail Corridor Land

Worth Place to Watt Street, Newcastle

1. Introduction

1.1 General

This report presents a desktop geotechnical assessment of government rail corridor lands between Worth Place and Watt Street, Newcastle. The report was prepared by Douglas Partners Pty Ltd (DP) at the request of Elton Consulting, acting on behalf of UrbanGrowth NSW.

It is understood that UrbanGrowth NSW wishes to repurpose the surplus Newcastle rail corridor lands for urban revitalisation. To achieve this objective it is necessary to rezone the corridor lands from Special Purpose Infrastructure 2 (SP2) to zones that accommodate a range of urban land uses.

The purpose of the geotechnical assessment is to collate available geotechnical data in and around the rail corridor in order to identify geotechnical constraints and opportunities for development of the land.

This report has been prepared to support the amendment to the Newcastle Local Environmental Plan (NLEP) 2012 that applies to the surplus rail corridor land ('rail corridor land') between Worth Place and Watt Street in Newcastle city centre (Figure 1).

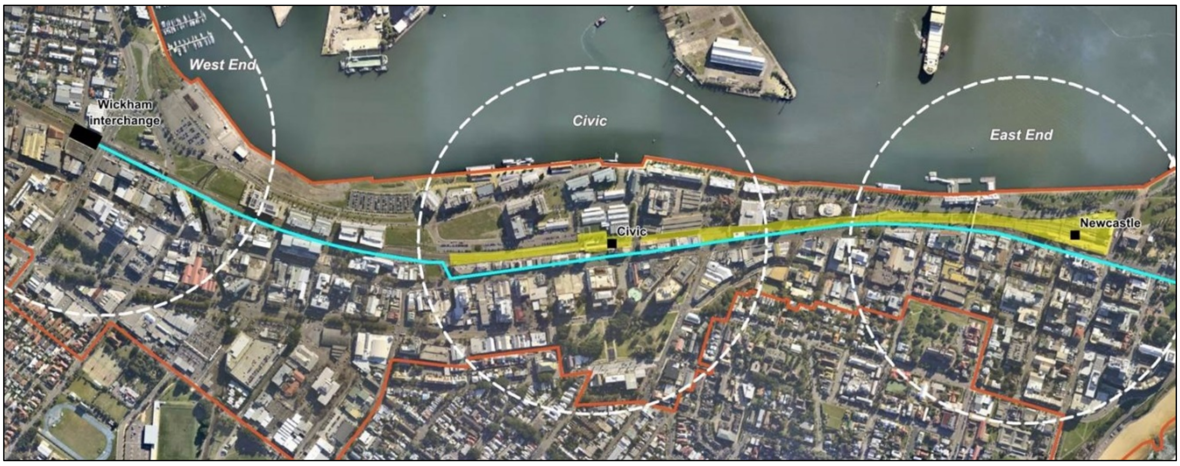


Figure 1: Rezoning study area (Source: Hassell)

The Newcastle Urban Transformation and Transport Program ('Program') has been established to deliver on NSW Government's more than $500m commitment to revitalise the city centre through: the truncation of the heavy rail line at Wickham and creation of the Wickham Transport Interchange; the provision of a new light rail line from Wickham to the Beach; and the delivery of a package of urban transformation initiatives.

1.2 Newcastle Urban Transformation

The Newcastle Urban Renewal Strategy (NURS) sets out the NSW Government's long term approach and vision for the revitalisation of Newcastle city centre to the year 2036.

The NURS identifies three character precincts in Newcastle city centre (West End, Civic and East End), within which significant housing and employment opportunities, together with built form and public domain changes and improvements exist. The NURS describes these precincts as:

- East End: residential, retail, leisure and entertainment;
- Civic: the government, business and cultural hub of the city;
- West End: the proposed future business district including the western end of Honeysuckle (Cottage Creek).

UrbanGrowth NSW has been directed by NSW Government to deliver on NURS through the Program, in partnership with Transport for NSW (TfNSW), the Hunter Development Corporation (HDC) and the City of Newcastle Council (Council).

1.3 Proposed Rezoning

UrbanGrowth NSW seeks to amend the Newcastle Local Environmental Plan 2012 (NLEP) to enable the delivery of the Program and the objectives of NURS planning outcomes.

Surplus rail corridor land runs through the East End and Civic city centre precincts as established by NURS. Based on this vision and the results of extensive stakeholder and community engagement, an overall urban transformation concept plan (the concept plan) has been prepared for the surplus rail corridor (rezoning sites), as well as surrounding areas.

The concept plan considers and integrates with the delivery of light rail. It is also coordinated with the proposed Hunter Street Mall development to create an interactive, synergised and cohesive city centre and foreshore area.

The concept plan (as shown in Figure 2) includes five key 'key moves', two that relates to the Civic precinct and three of which relate to the East End. Figure 2 provides a red line to define the site rezoning area within the broader program planning outcomes.

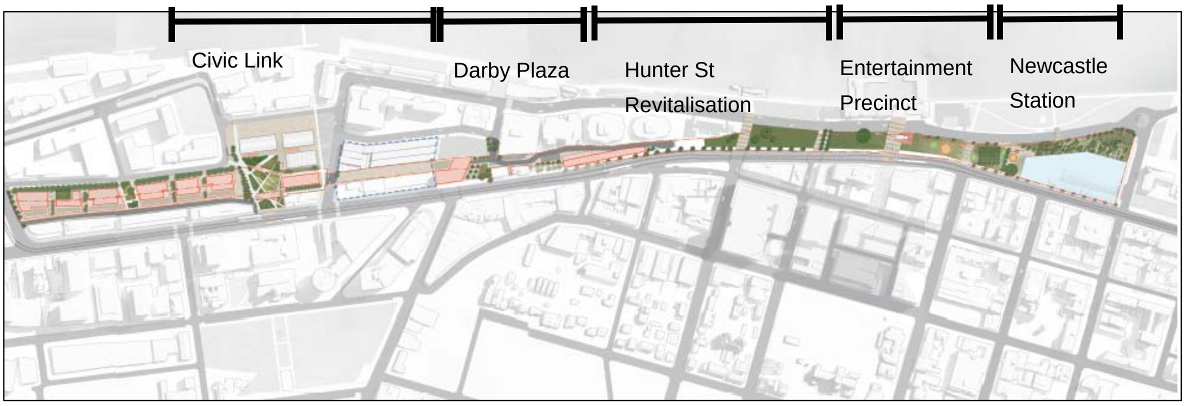


Figure 2: Rezoning concept plan (Source: Hassell)

This planning proposal seeks to rezone rail corridor land (rezoning sites) to enable the delivery of the proposed urban uses established in the concept plan.

An indication of the location of the proposed rezoning parcel is indicated in the map in Figure 3.

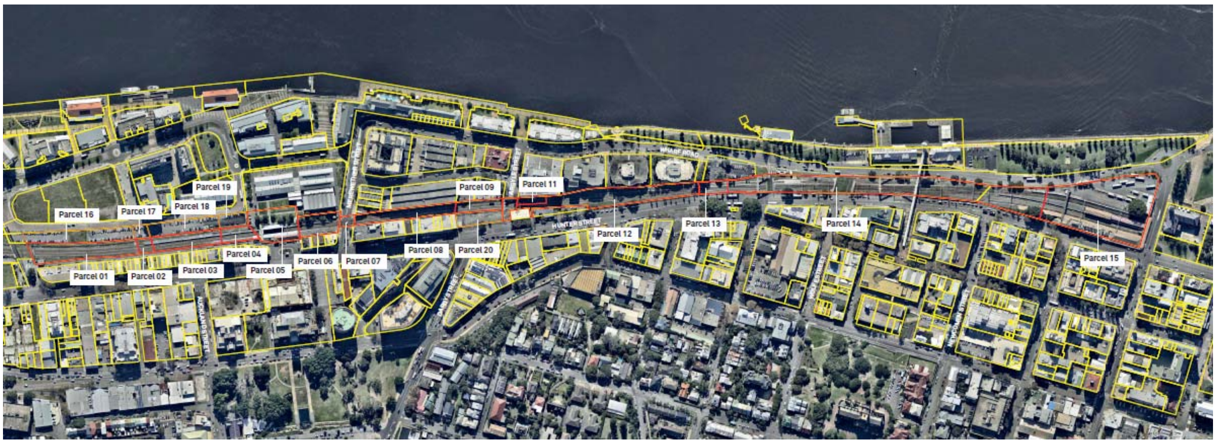


Figure 3: Rezoning explanatory map and Parcels (Source: Hassell)

This report has been based upon the proposed zoning under the Planning Proposal as submitted for Gateway determination, with the inclusion of Parcel 13. It is noted that this parcel has been removed from the current Planning Proposal in accordance with the Gateway determination as issued by the NSW Department of Planning and Environment. Nevertheless, for completeness, this report has considered the potential for some development occurring within this parcel in the future (subject to outcomes of a separate Planning Proposal). The recommendations of this report discuss whether there are any specific implications arising from this additional parcel.

The planning proposal concept plan includes public domain, entertainment, mixed use and commercial and residential development.

In general, the proposed rezoning will provide a mix of uses enabling between 400-500 dwellings which will comprise a variety of styles and types, and around 5,000m^2 of commercial, restaurant and other entertainment uses, as described in Table 1, and excluding any education or associated uses.

Table 1: Sites for Rezoning - Proposed Development Summary

Previous Parcel Number prior to Gateway	Updated Parcel Number post Gateway	Size	Proposed Zoning	Proposed FSR	Proposed Height
Parcel 01 B4 Mixed Use 3,370m^2	Parcel 01	3,370m^2	B4 Mixed Use	FSR – 3:1	Height - 30m
Parcel 02 B4 Mixed Use 408m^2	Parcel 02	408m^2	B4 Mixed Use	FSR – 3:1	Height - 30m
Parcel 03 B4 Mixed Use 3,146m^2	Parcel 03	1,869m^2	B4 Mixed Use	FSR – 3:1	Height - 30m
	Parcel 04	900m^2	B4 Mixed Use	FSR – 3:1	Height - 24m
Parcel 04 RE1 Public Recreation 2,464m^2	Now parcel 05 (and small corner of old 03 where western boundary of park realigned)	2,839m^2	RE1 Public Recreation	N/A	N/A
Parcel 05 B4 Mixed Use 1,603m^2	Now parcel 06	1,604m^2	B4 Mixed Use	FSR – 3:1	Height – 18m
Parcel 06 B4 Mixed Use 295m^2	Now parcel 07	295m^2	B4 Mixed Use (road)	FSR – 2.5:1	Height – 30m
Parcel 07 B4 Mixed Use 2,040m^2	Now parcel 08	2,040m^2	B4 Mixed Use	FSR – 2.5:1	Height – 30m
Parcel 08 B4 Mixed Use 988m^2	Now parcel 09	988m^2	B4 Mixed Use	FSR – 4:1	Height – 24m
Parcel 09 B4 Mixed Use 467m^2	Now parcel 10	467m^2	RE1 Public Recreation	N/A	N/A
Parcel 10 SP2 Infrastructure 386m^2	Now parcel 11	386m^2	SP2 Infrastructure	N/A	N/A
Parcel 11 B4 Mixed Use 4,542m^2	Now parcel 12	4,542m^2	B4 Mixed Use	FSR – 1.5:1	Height – 14m
Parcel 12 B4 Mixed Use 1,544m^2	Now parcel 13 (and has been reduced in size)	659m^2	SP2 Infrastructure	N/A	N/A

Previous Parcel Number prior to Gateway	Updated Parcel Number post Gateway	Size	Proposed Zoning	Proposed FSR	Proposed Height
Parcel 13 RE1 Public Recreation 303m^2	Now parcel 14 (new parcel 14 encompasses part of old parcel 12, and the whole of old parcel 13, 14 and 15)	11,151m^2	RE1 Public Recreation	N/A	N/A
Parcel 14 B4 Mixed Use 2,251m^2					
Parcel 15 RE1 Public Recreation 7,713m^2					
Parcel 16 SP3 Tourist 10,698m^2	Now parcel 15	10,698m^2	SP3 Tourist	FSR – 1.5:1	Height – 10-15m

2. Site Location and Description

2.1 Site Location

The rezoning site is located in Newcastle city centre and comprises a collection of land holdings within the surplus rail corridor lands.

The site is approximately 2.1 km in length generally bounded by Wharf Road to the north, Watt Street to the east, Hunter and Scott Streets to the south and Worth Street to the west. The site includes Civic and Newcastle Stations.

The site area subject to the rezoning is shown in Figure 4 below and at larger scale in Drawing 1 in Appendix D.

Figure 4: Rezoning Site area (Source: Elton Consulting)

2.2 Site Description

The planning proposal to rezone rail corridor land relates to five (5) land holdings identified in Table 2 below. Together these land holdings are subject to the proposed NLEP Amendment and are known as the 'rezoning sites' for the purpose of this report.

The total area of the rezoning sites is approximately 42,218m^2 or 4.2 hectares (ha).

Table 2: Summary of land holdings subject to proposed NLEP Amendment

Previous Legal description (Lot/DP)	Current Legal Description (Lot/DP)	Current use	Current zone (as per NLEP)	Current ownership (as at March 2017)
Part Lot 22 DP1165985	Lot 2 in DP1226145	Railway and rail associated	SP2 Infrastructure (Railway)	Hunter Development Corporation
Lot 1 DP 1192409	Remained the same	Railway and level crossing (Merewether Road)	SP2 Infrastructure (Railway)	Rail Corporation NSW
Lot 1001 DP1095836	Lot 2 in DP1226551	Railway and rail associated	SP2 Infrastructure (Railway)	Hunter Development Corporation
Lot 21 DP 1009735	Lot 4 in DP1226551	Railway and rail associated	SP2 Infrastructure (Railway)	Hunter Development Corporation
Lot 22 DP 1009735	Lot 6 in DP1226551	Railway and rail associated	SP2 Infrastructure (Railway)	Hunter Development Corporation

The site is currently zoned 'SP2 – Infrastructure (Railway) under the Newcastle Local Environment Plan.

3. Scope of Work

The scope of work for this assessment was developed with reference to the brief prepared by Elton Consulting, including consideration of the staging of the work, consultation and meetings. The detailed scope is as follows:

- Collate and review in-house geotechnical data from Douglas Partners files;
- Collate and review published geological and geotechnical information, including geology maps, acid sulphate maps, soil landscape maps and other information available in the public domain;
- Obtain relevant mine workings maps ('record traces') from the NSW Department of Industry, department of Resources and Energy to assess the potential impact of abandoned coal mines;
- Develop a broad geotechnical model of the rail corridor site, including likely sub-surface profile, presence of groundwater, assessment of mine workings;
- Provide preliminary guidance on geotechnical design matters, including excavation conditions, likelihood of unsuitable materials, shoring/retaining wall options, shallow footings, piles, and settlement;
- Provide comment of mine workings, likely extent of influence and preliminary assessment of mine stability based on the available mine plans;
- Preliminary assessment of mine subsidence design parameters based on available data and previous experience;
- Preparation of a draft report at Pre-Gateway phase, presenting the findings and commenting on the suitability of the land for development purposes;
- Updating of report following client comments and review of the Secretary's Study Requirements (Pre and Post-Gateway).

Following submission of this report, it is understood that further involvement by DP may include:

- Input into the Development Control Plan;
- Consultation with government agencies;
- Attendance at meetings and community consultation session as required.

4. Background Geotechnical Data

4.1 Regional Geology

The regional geology along the rail corridor is shown on the 1:100,000 scale regional geology map for Newcastle (Newcastle Coalfield Regional Geology, Sheet 9321, NSW Department of Mineral Resources). Figure 5 shows the regional geology with the approximate extent of the site delineated in blue.

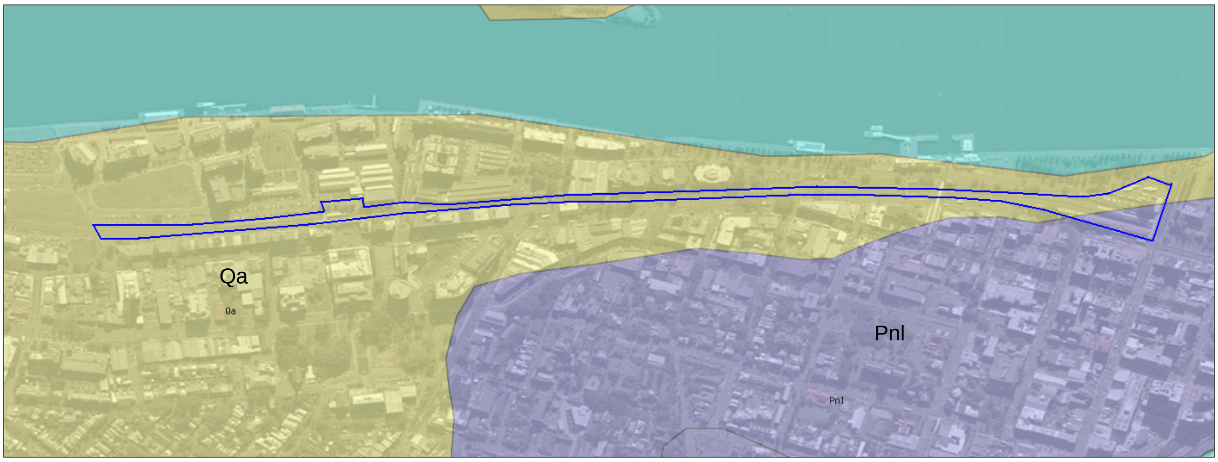


Figure 5: Published Regional Geology

The geology is characterised by the following components:

- The majority of the rail corridor site is underlain by Quaternary Alluvium (Qa), which comprises gravel, sand, silt and clay (yellow shading);
- A small section of the site at the eastern end, in the vicinity of Newcastle Station, is underlain by the Permian-aged Newcastle Coal Measures (Pnl), which in this area comprises the Lambton Subgroup. This formation is characterised by sandstone, siltstone, claystone, coal and tuff (purple shading).

The natural soils are typically overlain by man-made fill materials to varying depths, related to reclamation, historical industrial usage, infrastructure and commercial development.

4.2 Acid Sulphate Soils

The risk of the presence of acid sulphate soils is presented on maps prepared by the NSW Department of Land and Water Conservation. The mapped risk zones from the Newcastle risk map is shown in Figure 6.

Figure 6: Acid Sulphate Soil Risk in the Vicinity of the Project Site

The mapped acid sulphate soils are characterised as follows:

- High probability of occurrence of acid sulphate soils at depths of between 1 m and 3 m below the ground surface in the eastern portion of the site (i.e. the red shaded area);
- Low probability of occurrence of acid sulphate soils at depths greater than 3 m below the ground surface over the majority of the site (orange shaded area);
- There is a high probability of acid sulphate soil materials at depths between 1 m and 3 m below the ground surface in a narrow area of the site, from the western portion of the Civic Station platform to Worth Place, marginally encroaching the northern portion of the rail corridor in that area.

4.3 Coal Mining

4.3.1 General

The majority of the subject site lies within the Newcastle Mine Subsidence district, except the portion to the east of Market Street (part of Parcel 14 and Parcel 15) which is not within a district. The development of sites within a mine subsidence district requires Mine Subsidence Board (MSB) approval and may have a number of conditions applied. Development of sites outside of a mine subsidence district do not require formal MSB approval, however still have access the mine subsidence compensation fund and informal MSB requirements may be sought or invoked through the Consent Authority conditions.

There are three major coal seams present beneath the site, all of which have been mined at various locations and times, but not necessarily at the same location. Plans of mine workings, where they exist, are not always accurate as they were prepared before the advent of modern survey techniques. The plans indicate that most of the rail corridor itself is not directly undermined.

The three major coal seams and known history of mining relative to the subject site are discussed in the following sections. Reference may also be made to the geotechnical cross-sections (Drawings 2 and 3) which illustrate the recorded depth and thickness of these coal seams at the site.

4.3.2 Dudley Seam

The Dudley Seam is the shallowest of the three major coal seams. It has been encountered at depths ranging from about 10 m to 25 m below the ground surface.

Previously uncharted mine workings in the Dudley Seam have been ‘discovered’ during foundation construction on a number of sites in the Newcastle inner city area during the past two or three decades, notably in the eastern part of the CBD. The workings are thought to have been convict workings, mined prior to about the 1830s in a typically random layout, making investigation and delineation of the workings difficult.

Available information and MSB records indicate that no mining has occurred within the Dudley Seam in the vicinity of the subject site. The closest location to the subject site where DP is aware of workings within the Dudley Seam is well south of the subject site between Newcomen and Bolton Streets.

4.3.3 Yard Seam

The Yard Seam is typically encountered at depths ranging from 25 m to 40 m beneath the Newcastle inner city area. Mining typically occurred in a regular pattern.

The closest location to the subject site where DP is aware of workings in the Yard Seam is to the west of the intersection of Hunter and Darby Streets, where mine workings were encountered during geotechnical investigations for the new courthouse building. MSB has commented that the Yard Seam is unlikely to affect the rail corridor site based its recorded extent, however this should be confirmed by investigation drilling (see Section 6.5.3 and MSB letter Appendix C).

4.3.4 Borehole Seam

The Borehole seam is typically found at a depths ranging from of 70 m to 80 m in the vicinity of the site. Some areas bordering the site are underlain by abandoned coal mine workings undertaken in the Borehole Seam by AA Company, based on Record Trace (RT) 566. Abandoned coal mine workings in the Borehole Seam by Hetton Colliery and Delta Collieries are also present to the north of the site.

The mining plans indicate the following:

- Bord and pillar workings, with pillar widths in the range 7 m to 17 m, and bord widths of 3 m to 6 m. The pillars are generally rectangular with typical lengths of 10 m to 35 m, with occasional smaller and larger pillars. Pillar width to height ratios are typically in the range 1.5 to 3.5;
- The workings are shown to be primarily located south of Hunter Street, with some sections extending beneath Hunter Street to the edge of the rail corridor;
- The workings are also present to the north the rail corridor on both sides of Merewether Street;
- There are two areas where the workings cross beneath the rail corridor - one near the intersection of Darby and Hunter Streets and one between Auckland Street and Union Lane. These crossings consist of two bord and intervening pillar;
- A structure described as “AA Coy’s Bridge” is shown to cross the site near Crown Street. It is likely that this was a reference to a surface feature present at the time of mining operations.

Based on information on RT566, the thickness of the Borehole Seam is commonly about 6.2 m to 6.4 m but can range from about 5 m to 7 m. Workings were typically undertaken in three stages as follows:

- First Workings – 2.6 m;
- Second Workings – 1.6 m;
- Third Workings – 1.2 m.

Therefore the total worked section ranged up to about 5.4 m in height, however in places only the first or both first and second workings were undertaken in which case the workings section would be 2.6 m or 4.2 m in height respectively. Drawing 4 (Appendix D) shows the recorded extent of mine workings in the Borehole Seam in the vicinity of the site.

4.4 Seismicity

The region is an area of low to moderate seismicity and lies within an intra-plate tectonic region. A significant earthquake occurred in December 1989 (''the Newcastle Earthquake'') which registered approximately 5.6 on the Richter scale, and was assessed to have a return period of about 500 years.

Where deep alluvial soils are present the bedrock motion can be amplified at the surface, and may become a design consideration for certain structures. See Section 6.4 for appropriate seismic factors.

4.5 In-house Geotechnical Records

DP has completed a large number of investigations in and around the subject site, dating back to 1965. The most relevant of these investigation reports are listed in Table 3 and represent the principal sources of geotechnical information for this assessment.

Table 3: Principal Sources of Geotechnical Information from DP Files

No	Date	DP Project	Report Title	Field Work (max depth)
1	Jul 1965	00865	Report on Foundation Conditions, Maritime Services Board. Scott and Newcomen Streets, Newcastle	7 bores (6.1 m)
2	Feb 1985	08768	Preliminary Geotechnical Investigation for Redevelopment of Darks Ice Works Site, Wharf Road, Newcastle	3 bores (25.3 m)
3	Jan 1986	09374	Geotechnical Investigation, Proposed Queens Wharf Development	11 bores (9.9 m)
4	Mar 1986	08768-2	Geotechnical Investigation for Stage 1, Development of Darks Ice Works Site, Wharf Road, Newcastle (NSW Government Buildings)	3 CPTs (9.0 m)
5	May 1988	11001	Geotechnical Investigation, Proposed Two Storey Building, 520 Hunter Street, Newcastle	3 CPTs (10.3 m)
6	Nov 1993	16670	Geotechnical and Mine Subsidence Investigation, Proposed Commercial Development, Civic Workshops, Honeysuckle	30 HA bores (2.0 m) 2 cored bores (87.4 m) 15 CPTs (23.9 m) 14 test pits (2.2 m)
7	Dec 1996	18606	Geotechnical Investigation and Contamination Assessment, Proposed Newcastle Station Interchange, Wharf Road and Watt Street, Newcastle	8 bores (23.5 m) 3 groundwater wells
8	Aug 1997	18711	Borehole Seam Investigation, Proposed Holiday Inn, Wharf Road, Newcastle (Crown Plaza)	1 bore (86.9 m)
9	Nov 1998	18862/1	Cone Penetration Testing, Mine Workings and Geotechnical Investigation, Honeysuckle Development Precinct	6 CPTs (38.1 m)
10	Dec 1998	18862/3	Geotechnical Investigation of Abandoned Mine Workings, Wickham and Bullock Island Coal Company, Honeysuckle	4 bores (84.3 m)
11	Sep 2000	18862C	Geotechnical Investigation of Abandoned Mine Workings, Wickham and Bullock Island Coal Company, Honeysuckle	2 bores (84.4 m)
12	Oct 2000	31145	Geotechnical Investigation, Lot 1112 (Honeysuckle House)	5 bores (78.7 m)

Table 3: Principal Sources of Geotechnical Information from DP Files (Continued)

No	Date	DP Project	Report Title	Field Work (max depth)
13	Sep 2001	31395	Geotechnical Investigation, proposed Building Development 141 Scott St Newcastle	2 HA bores (2 m)
14	Oct 2001	31159B	Geotechnical and Environmental Investigation, The Boardwalk Development, Workshop Way, Newcastle	3 bores (4.8 m) 12 test pits (4.8 m) 5 CPTs (15.6 m)
15	May 2002	31395A	Geotechnical Investigation, Proposed Building Development 141 Scott St Newcastle	4 bores (4.9 m)
16	Jun 2003	31752	Geotechnical Investigation, Proposed Carrier Main, Merewether Street, Newcastle	6 bores (3.5 m)
17	Feb 2004	31854	Geotechnical Investigation, Mine Subsidence Risk, Proposed Commercial and Residential Building, 200 Hunter Street	3 bores (83.5 m)
18	Sep 2004	39055	Preliminary Acid Sulphate Soil Assessment, 196 Hunter Street Newcastle	2 bores (12 m)
19	Oct 2004	39058	Geotechnical Investigation and Waste Classification. Proposed Polyclinic, 670 Hunter Street, Newcastle	7 bores (4.5 m) 6 CPTs (30.48 m) 5 test pits (3.0 m)
20	Jul 2005	39058A	Geotechnical Investigation, Proposed Polyclinic, 670 Hunter Street, Newcastle	1 CPT (30.5 m)
21	Jun 2006	39543	Geotechnical Investigation, Proposed Mixed Residential/Commercial Development, 123-127 Scott Street Newcastle (8 storey)	2 bores (14.4 m)
22	Mar 2008	39831.01	Geotechnical Investigation, Proposed Development, Lot 230 Honeysuckle Drive (not completed)	6 CPTs (23.4 m)
23	Dec 2009	49314	Geotechnical Investigation, Proposed Grand Central Apartments, 111 Scott Street Newcastle	2 bores (20.6 m)
24	Nov 2011	49799	Mine Subsidence Investigation, Proposed Courthouse Development	10 bores (87.1 m)
25	Feb 2014	81306	Detailed Site Investigation, Former Lynchs Prawns site, 292 Wharf Road, Newcastle	3 bores (5 m)
26	Sep 2015	81716	Targeted Detailed Site Investigation (Contamination), Newcastle Urban Transformation and Transport Program	36 bores (21.3 m) 29 test pits (2.4 m)

5. Geotechnical Model

5.1 Stratification

A generalised geotechnical model of subsurface conditions has been compiled based on the results of previous tests and broad geological processes.

The subsurface profile may be generalised as a sequence of geotechnical units as described in Table 4. It is noted that the descriptions are simplified to aid interpretation: at a given location a soil unit may include variations of the predominant soil type and sub-layers of other soil types. Not all units will necessarily be present at all locations.

Table 4: Geotechnical Soil Units (Vertical Profile)

Unit	Primary Name	Description
1	FILL	Materials placed or disturbed by man; typically includes sand, gravel, cobbles, slag and ash. Variable strength and consistency.
2	SAND	Includes sand, silty sand, clayey sand and gravelly sand, naturally deposited under fluvial conditions; typically loose to medium dense, grading to dense at some locations.
3	CLAY	Includes clay, silty clay and sandy clay; typically stiff to hard consistency. Mainly of residual origin but some upper layers may be of estuarine/fluvial origin.
4	BEDROCK	Includes sandstone, siltstone, mudstone, claystone, laminate and coal; typically very low to low strength in the upper weathered profile, increasing to medium to high strength at depth.
4.1	DUDLEY SEAM	Coal seam (bedrock sub-unit) typically 1 m to 1.5 m thick.
4.2	YARD SEAM	Coal seam (bedrock sub-unit) typically 1 m to 1.5 m thick.
4.3	BOREHOLE SEAM	Coal seam (bedrock sub-unit) typically 5 m to 7 m thick.

The typical depths encountered for each of the units in Table 4 are provided in Table 5 which summarises lateral variations between geotechnical zones.

5.2 Groundwater

Groundwater is typically encountered at depths ranging from 1 m to 2.5 m below ground level. Due to the proximity of the site to Newcastle Harbour, a subdued tidal variation would be expected, such as recorded at the Newcastle Interchange site (see Figure 7).

It is noted that groundwater levels are transient and will also vary with climatic conditions, surface drainage features and soil permeability. During or following periods of intense or prolonged rainfall, groundwater levels could rise close to the ground surface level.

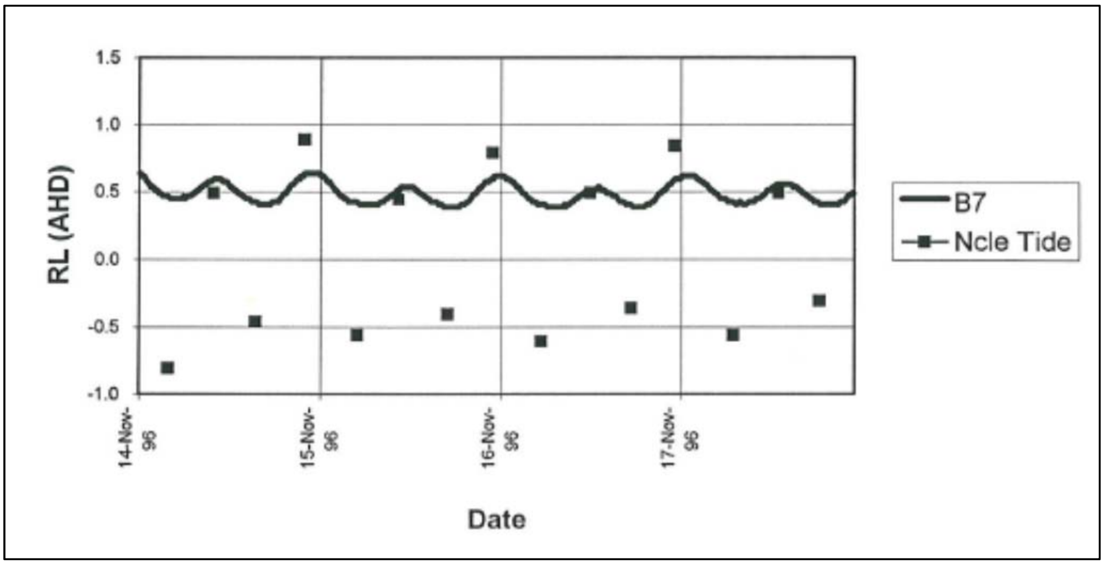


Figure 7: Tidal Groundwater Level Variations at Newcastle Interchange (Project 18606)

5.3 Lateral Variations

Drawings 2 and 3 show a geotechnical cross-section through the site, from west to east, based on the geotechnical data extracted from the previous investigation reports. The stratification has been simplified in terms of the Units listed in Table 4 and should be regarded as indicative. It should be noted that the layer boundaries have been interpolated between test locations for illustration purposes and may not represent actual boundaries.

Further, a number of test locations have been projected onto the section from outside the subject site, hence may not reflect true elevations of layer boundaries at the section location. Lateral variations in the soil profile from north to south should also be anticipated.

As indicated by the cross-section, the sub-surface profile also varies laterally from one end of the site to the other end. Notably the depth to bedrock generally increases to the west, with the shallowest depth to rock recorded in the vicinity of Queens Wharf.

To capture the lateral variation in subsurface conditions, the site has been divided into geotechnical zones as shown on Drawing 1. A summary of the generalised geotechnical model for each zone is presented in Table 5, which also notes the corresponding Parcels of land.

Table 5: Geotechnical Zones (Lateral Variation of Sub-surface Conditions)

Zone	Parcels	General Subsurface Profile
A	1, 2	• Unit 1: uncontrolled fill to about 3 m/4 m depth; • Unit 2: loose to medium dense sands to about 9 m/13 m depth; • Unit 3: stiff to very stiff clays to about 20 m/28 m depth; • Unit 4: sandstone or siltstone from about 20 m/28 m depth, initially very low strength; coal (Yard Seam) at 30 m/35 m depth.
B	3, 4, 5, 6, 7, Part 8	• Unit 1: uncontrolled fill to about 1 m/3 m depth; • Unit 2: loose to medium dense sands to about 6 m/13 m depth; • Unit 3: stiff to very stiff clays to about 8 m/22 m depth; • Unit 4: sandstone, siltstone or laminate from about 8m/22 m depth, initially very low strength; coal (Dudley Seam) at 20 m/22 m depth.
C	Part 8, 9, 10, 11, 12, 13, Part 14	• Unit 1: uncontrolled fill to about 0.8m/3m depth; • Unit 2: loose to medium dense sands to about 6 m/14 m depth; • Unit 3: stiff to very stiff clays to about 7 m/14 m depth - not present at all locations; • Unit 4: sandstone, claystone, mudstone or laminite, from 6 m/14 m depth, initially very low strength; coal (Yard Seam) at 19 m/26 m depth.
D	Part 14, Part 15	• Unit 1: uncontrolled fill to about 0.5 m/4 m depth; • Unit 2: loose to medium dense sands to about 3 m/5 m depth - not present at all locations; • Unit 3: clays generally not present; • Unit 4: sandstone or siltstone from 3 m/5 m depth, initially very low strength; coal (Dudley Seam) at 9 m/15 m depth.
E	Part 15	• Unit 1: uncontrolled fill to about 4 m/8 m depth; • Unit 2: loose to medium dense sands to about 5 m/20 m depth; • Unit 3: upper layer of firm silty or sandy clay to 10 m/12 m depth; lower layer of stiff to very stiff clays to about 20 m/22 m depth (separated by Unit 2) - only present in north-eastern part of site (interchange area); • Unit 4: sandstone or siltstone, initially very low strength from 4 m/22 m depth; coal (Yard Seam) likely present at about 25 m/30 m depth but not confirmed.

Notes to Table 5:

Depths are approximate, as measured from the ground surface at the time of investigation.

6. Comments

6.1 Excavation Conditions and Support

Excavation through fill materials, natural soils (sands and clays) and the upper zones of weathered rock (if encountered) is expected to be relatively straightforward using conventional excavation equipment such as backhoes and excavators. The fill is predominantly sandy in nature, however, in some areas the fill may include slag, cobbles or other larger inclusions that could impede excavation, however, their occurrence is not expected to be widespread. Zone E has the deepest areas of fill (within the former Newcastle Station site) thought to have resulted from an infilled/reclaimed channel.

Due to the presence of a sandy upper soil profile and relatively shallow groundwater across much of the site, excavations will need to be either battered (where there is sufficient space) or fully supported by shoring / retaining systems - these may be temporary or permanent support measures depending on the application. The type of support will be dependent on proximity to nearby structures and the duration for which the excavation will remain open.

It is recommended that all excavations adjacent to existing buildings and services should be fully supported in order to minimise lateral deflections. Cantilever type walls are not recommended for such situations as deflections typically associated with such walls can lead to damage of adjacent structures. This includes un-propped sheet pile walls.

If permanent retaining systems are required for a basement structure or similar, suitable methods would include contiguous piles, secant piles or soldier piles with shotcrete panels. These are laterally supported during excavation using soil nails or anchors extending below the adjacent properties or buildings, or props which are internal to the excavation. Permanent support after construction is usually provided by the floor slabs acting as struts.

Design parameters will depend on specific soil conditions at individual sites. The type of proposed development and extent of existing data will determine the scope of additional specific site investigation required for the detailed design of support measures.

Preliminary assessment of batter slopes may be based on the values provided in Table 6, however, these should be confirmed by site-specific investigation for individual developments.

Table 6: Preliminary Temporary and Permanent Batter Slopes

Stratum	Short Term (Temporary)(1)	Long Term (Permanent)(2)
Fill - uncompacted (assumed existing state)	2H:1V	2.5H:1V
Fill - compacted	1.5H:1V	2H:1V
Sand - above the water table	2H:1V	2.5H:1V
Clay - above the water table (stiff or better)	1.5H:1V	2H:1V
Rock – very low strength (3) (Class V sandstone / Class IV siltstone)	1H:1V	1.5H:1V

Notes to Table 6:

1. Above values are for a maximum vertical depth/height of 3 m. Greater depths to be specifically assessed, and may require additional measures for stability and drainage.
2. Long term batter slopes forming part of a development are generally expected to be of limited depth/height.
3. Excavations deep enough to penetrate rock are generally not anticipated; batters in rock are dependent on jointing and would require confirmation at time of excavation.

Excavations in soil below the water table are expected to require shoring or retention to maintain stability.

6.2 Preliminary Footing Options for Development

6.2.1 Shallow Footings

Where the proposed developments include multi storey structures, high column loads are anticipated and it is expected that shallow footings would not be suitable for the support of structural loads over most of the site due to the presence of filling, loose to medium dense sand and some clay to depths of approximately 3 m to greater than 20 m.

Shallow footings could be considered for lightly loaded structures; however the effect of potential settlement due to weak alluvial soils would need to be considered.

Table 7 shows preliminary design parameters for shallow pad or strip footings founded on each of the main geotechnical units.

Table 7: Preliminary Design Parameters for Pad or Strip Footings

Stratum	Ultimate Bearing Pressure (kPa)	Serviceability Bearing Pressure (Working Loads) (kPa)
Fill - uncompacted (assumed existing state)	NA	NA
Fill – cohesive - compacted	600	120
Fill – granular - compacted	1000	200
Sand - loose to medium dense	750	150
Clay – stiff to very stiff	1000	200
Clay – hard / extremely weathered rock	2000	400
Rock – very low strength (Class V sandstone / Class IV siltstone)	3000	1000

Notes to Table 7:

1. The design bearing pressures should be adjusted to account for weaker layers below the bearing layer if present.
2. Ultimate Values occur at large settlements (> 5% of minimum footing dimension).
3. Serviceability / Max Allowable end bearing to cause settlement of < 1% of minimum footing dimension.

Raft slabs apply a spread load to the foundation, typically with concentrated pressures on edge beams and internal beams. The relative distribution of foundation pressure depends primarily on the slab stiffness. Raft slabs generate a deeper stress field hence settlement needs to be considered, particularly if any soft or weak layers are present in the subsurface profile. Applied pressure and settlement are linked via the vertical modulus of subgrade reaction (k_v).

Edge and internal footing beams should not apply a local bearing pressure exceeding the values in Table 7 for pad and strip footings. The overall allowable bearing pressure for the slab will be governed by tolerable settlement. Typically a “spread” applied pressure in the order of 20 kPa to 30 kPa would be feasible where founded over good ground conditions.

In general, footings should not be founded in uncontrolled fill. In some cases it may be possible to found lightly-loaded structures that are not sensitive to settlement in fill, subject to prior geotechnical investigation and analysis.

The footing design values for individual structures should be refined when the location, type of structure, loads and dimensions are known. This would require specific investigation at the structure’s location to determine the soil profile for settlement and bearing capacity analysis.

During construction the design bearing pressures should be confirmed by geotechnical inspection and testing.

6.2.2 Deep Footings

Deep foundation systems would be appropriate for the support of major structural loads and where the depth of uncontrolled fill or excessive settlement precludes the use of shallow footings. Piles could potentially be founded either in medium dense to dense sand, stiff or better residual clay, or bedrock. The suitability of founding piles in the upper soil strata would depend on the ground conditions at the individual site, proposed foundation loads, settlement tolerances of proposed structures and the relative cost benefit of installing in the upper soil profile versus the underlying bedrock.

A number of deep footing options are summarised and discussed below:

Uncased Bored Piles - Due to the shallow water table and the risk of collapsing conditions in water-charged sand, conventional uncased bored piles are not expected to be suitable for the majority of this site. They could be considered in areas of shallow bedrock, however the risk of shallow groundwater and potentially high water inflow rates would need to be assessed.

Driven Piles - Driven piles could be considered, however vibration impacts during installation may impact on neighbouring structures and would need to be assessed. Furthermore, due to the presence of uncontrolled filling of variable depth across much of the site, there may be a risk of premature pile refusal or damage due to obstructions in the filling. Pre-drilling pile holes through the filling could be considered to mitigate this risk.

Screw Piles - Screw piles could be considered for light to moderate structural loads. It is noted that screw piles derive their capacity from a combination of geotechnical strength of the founding stratum and structural strength of the pile helix. Specific geotechnical design should be undertaken. Screw piles will typically undergo more settlement than equivalent-sized fully formed piles. The presence of uncontrolled filling may present a risk of premature pile refusal or damage due to obstructions in the filling.

Cased Bored / Continuous Flight Auger (CFA) / Screw Cast Concrete Piles - These pile types are considered to be the most suitable options for support of structural loads at this site, as they can be formed within saturated and collapsing soil conditions, as is expected to be encountered over the majority of the site. It should be noted that for CFA piles, decompression can occur in sands whereby excess material is 'sucked' into the auger and removed to the surface, resulting in surface depression. Piles should be installed by experienced operators, using suitably sized piling rigs, monitoring equipment and supervision.

The preliminary design parameters for bored or CFA piles are shown in Table 8 for the anticipated range of soil and rock strata at the site. The capacity of driven piles is typically higher, relative to equivalent dimensions, especially if driven into rock and may be governed by the structural capacity of the piled section used.

Pile design, installation and testing should be undertaken with reference to the Piling code (Ref 1).

Table 8: Preliminary Design Parameters for Piles (Bored or CFA Piles)

Stratum	Ultimate		Serviceability (Working Loads)	
	End Bearing (kPa)	Shaft Adhesion (kPa)	End Bearing (kPa)	Shaft Adhesion (kPa)
Fill – cohesive – compacted	700	-	120	-
Fill – granular – compacted	1000	-	200	-
Sand – medium dense ≥ 5 m depth	1750	25	700	10
Clay – stiff to very stiff	900	40	350	15
Clay – hard / extremely weathered rock	1800	80	600	50
Rock – very low strength (Class V sandstone / Class IV siltstone)	4000	200	1200	100
Rock – low strength (Class IV sandstone / Class III siltstone)	10000	500	2500	250

Notes to Table 8:

1. The design bearing pressures should be adjusted to account for weaker layers below the bearing layer if present.
2. Piles founded on coal or claystone should be avoided due to potential for softening and excessive settlement.
3. Ultimate Values occur at large settlements (> 5% of minimum pile diameter / width).
4. Design geotechnical strength ($R_{d,g}$) should initially be based on a strength reduction factor of ϕ_g = 0.40.
5. Shaft adhesion values based on a shaft roughness of R2 or better.
6. Serviceability / Max Allowable end bearing to cause settlement of < 1% of minimum pile diameter / width.
7. AS 2159- 2009 (Ref 1) requires that the contribution of the shaft from ground surface to 1.5 times pile diameter or 1 m (whichever is greater) shall be ignored.

It should be noted that the above design parameters given in Table 8 are primarily for bored piles with clean sockets and bases: specific cleaning buckets and grooving tools should be used in construction. The preliminary design of driven piles may also be based on the above parameters, however in practice, they are usually driven to a specified 'set' to achieve the required load or 'refusal'. In the latter case the pile capacity may be governed by the structural capacity of the pile in axial compression or bending. Pile installation could be affected by the possible presence of obstructions within existing fill such as concrete, steel and other coarse inclusions. The available information suggests that this will not be a widespread problem however the possibility cannot be precluded.

If piles are installed through deep uncontrolled fill there will be the potential for negative shaft adhesion (downdrag) loads on the pile due to on-going creep settlement of the fill. In some cases this can significantly reduce the available load capacity of piles to support of the structural loads.

For piles in tension, the shaft adhesion parameters should be reduced by 25%.

During construction the design bearing pressures should be confirmed by geotechnical inspection and / or quality assurance testing relevant to the type of pile and method of installation.

6.3 Acid Sulphate Soils

With reference to Section 4.2, the site contains two categories of potential acid sulphate soils:

- Geotechnical Zones A to C generally have a low probability of occurrence of acid sulphate soils at depths greater than 3 m below the ground surface, although the western end (Zone A) includes a high probability zone that marginally encroaches the northern boundary of the site;
- Geotechnical Zones D and E (eastern end of site) have a high probability of occurrence of acid sulphate soils at depths of between 1 m and 3 m below the ground surface.

Previous investigations carried out in the Honeysuckle and Newcastle area have indicated that potential acid sulphate soils (PASS) are generally present in the near-surface fine-grained natural soils (i.e. silts and clays), however, the overlying fill materials are usually not acid sulphate soils. Natural sands (particularly silty sands) may also be acid sulphate soils, but if so, tend to have less acid generation potential.

Recent experience at nearby sites indicates that acid sulphate soils at this site are unlikely to be strongly acid sulphate and can be readily managed during construction using standard procedures (such as liming) in accordance with the relevant guidelines.

Construction activities that will potentially disturb acid sulphate soils include:

- Excavations that extend below fill into natural soils, such as basement excavations, remediation activities (notably Zone E), and deep services trenches; the excavated material will be exposed to oxidation ex situ;
- Dewatering during construction to aid earthworks, excavation and construction activities that lowers the water table within natural soils and exposes them to oxidation in situ.

It is recommended that a site-specific acid sulphate soils management plan (ASSMP) should be developed for the project and implemented where the above activities are undertaken. It is noted that the ASSMP may include a requirement for groundwater treatment / management related to dewatering activities or leachate generated by stockpiles of PASS.

6.4 Seismic Factors for Design

The earthquake code (AS1170.4-2007, Ref 2) provides design factors based on location (earthquake risk) geotechnical conditions.

The Hazard Factor (Z) for Newcastle is 0.11 as given in Table 3.2 of AS1170.4. This is the bedrock acceleration coefficient with an annual probability of exceedance of 1 in 500.

For the whole subject site (Geotechnical Zones A to E) the site sub-soil class is assessed to be Class C_e – “shallow soil site”, with reference to Table 4.1 of AS1170.4.

6.5 Mine Subsidence Assessment

6.5.1 Areas Potentially Affected by Mine Subsidence

This assessment assumes that only workings in the Borehole Seam could affect the site, notwithstanding MSB comments that the extent of the Yard seam and the possibility of shallower unmapped workings should be assessed (see Section 6.5.3).

In the event of mine collapse or pillar crush in the Borehole Seam, mine subsidence would occur. Although the majority of the subject site is not directly undermined, areas of the site are within the potential zone of influence if subsidence did occur. The zone of influence is defined by the 'angle of draw', a line taken from the edge of the workings to the ground surface at a designated angle. The accepted value of this angle that is routinely adopted for the Newcastle area is 26° from vertical (1H:2V).

Based on the plan location of the Borehole Seam workings, it can be shown that the majority of the rail corridor site could be potentially affected by mine subsidence (i.e. within the angle of draw). To aid interpretation, Drawing 4 shows the areas of the site that lie beyond the angle of draw and hence would NOT affected by mine subsidence (green hatched areas). These are:

- A small area in the north-west corner of the site being part of Parcel 1 (in Geotechnical Zone A);
- The southern portions of Parcels 5 and 6 (in Geotechnical Zone B);
- A small area in the north-eastern part of Parcel 12 (in Geotechnical Zone C);
- The eastern half of Parcel 14 and all of parcel 15 (in Geotechnical Zones D and E), which is the largest contiguous area of the site that lies beyond the angle of draw.

The remainder of the site and most of the immediately adjacent areas are either directly undermined or potentially within the angle of draw in the event of mine subsidence.

6.5.2 Stability of Borehole Seam

In Drawing 4 the blue dashed line represents the 'reverse angle of draw' relative to the site boundary. All mine workings that lie inside this area have the potential to affect the site in the event of subsidence. Preliminary stability analyses have been carried out for all coal pillars within this zone, a total of 98 pillars. The results of the analyses are shown in the tables in Appendix B.

The analysis adopted a working section height of 5.4 m, and pillar dimensions were measured off RT566. The pillars were grouped in three 'panels'. The results indicated the following in regard to mine stability:

- The factor of safety against failure of individual pillars ranged from 1.33 to 3.36;
- The probability of failure of individual pillars ranged from 3×10^{-2} to 2×10^{-14};
- 'Panel' factors of safety, which account for the ability of smaller pillars to shed load to larger adjacent pillars, ranged from 2.18 to 2.49;
- The probability of failure of the panels ranged from approximately 1×10^{-7} to 1×10^{-9};
- The panel extraction ratio ranged from 0.35 to 0.41.

It is noted, however, that due to the proximity of the smallest pillars to the unmined 'barrier' of coal which is present beneath the site, the analysis likely underestimates the actual factors of safety in this area.

Based on the review of available information, and the results of the preliminary pillar stability analysis, it is DP's opinion that there is some risk, albeit low, of mine subsidence affecting significant parts of the subject site (i.e. the parts of the site not shown in green hatching on Drawing 4).

It is noted that the available data indicated no mine workings within the Dudley Seam or Yard Seam in the vicinity of the subject site. Accordingly it is assessed that these seams do not pose a risk of mine subsidence at the site.

6.5.3 Consultation with the Mine Subsidence Board

A meeting was held with the MSB at their Newcastle office on 8 January 2016. Attendees were Ian Bullen and Peter Evans of the MSB, and Stephen Jones and Scott McFarlane of DP. A letter was subsequently received from the MSB on 15 January 2016 (see Appendix C for a copy).

The following summarises the outcomes of the MSB meeting and their subsequent letter:

- Each proposed building is assessed separately and specific development guidelines cannot be provided until specific plans are presented to the MSB for consideration;
- The section of the rail corridor within the Newcastle Mine Subsidence district is nominated as "Guideline No. 9" by MSB which essentially allows buildings of up to three storeys and 30 m long without assessment of mine subsidence risk;
- Buildings over three storeys will require investigation to assess mine subsidence risk and determine mine subsidence site parameters. The investigations are likely to include exploratory drilling and would aim to:
  - verify the limit of workings in the Borehole and Yard seams;
  - verify the location of workings that cross over the rail corridor;
  - determine the possibility of unmapped workings above the Borehole seam.
- The mine subsidence risk analysis should include sensitivity / risk review and consider potential subsidence scenarios including a worst case;
- If grouting is required the MSB would likely request a grouting plan for approval and a verification report upon completion of the works;
- Where the MSB accepts mine subsidence design parameters, it would likely request an "Impact Statement" that provides details of the structures, risk assessment outcomes and the proposed mitigation measures;
- When considering the number of storeys (and hence risk and repair costs) the MSB include basements as a storey. For example, a proposed 30 m high building (potentially 10 storeys) plus two levels of basement would be regarded by MSB as a 12 storey structure;
- For significant structures, the recommendations need to go to a MSB Board meeting; these are held monthly but the response time depends on the number of applications before the Board.

Based on the above a preliminary 'first pass' assessment has been undertaken taking into account the location of mine workings and the potential maximum building heights from the concept plan layout. The findings are presented in Section 6.5.5.

The 'Newcastle Mines Grouting Fund', which commenced in November 2015, was also discussed at the meeting. The fund is managed by the Hunter Development Corporation (HDC). The MSB's role runs in parallel to HDC in relation to remedial design, delivery and validation. The fund underwrites grouting costs that exceed a designated cap, based on mine category and site area. This provides financial certainty for developers in that if grouting costs exceed the cap the fund will pay the difference. It is noted that the determination of grouting costs excludes investigation and consultant fees. Further information is available by following this link to an HDC brochure:
http://www.hdc.nsw.gov.au/sites/default/files/HDC_Newcastle-Mines-Grouting-Fund%20brochure.pdf

The mine categories are shown in the MSB drawing "Newcastle City Centre Area Mine Subsidence Categories included in Appendix C. It is noteworthy that the rail corridor site itself does not have a category assigned, presumably because development of the rail corridor was not envisaged.

The current fund rates published by HDC are also included in Appendix C. The status of the site (or parts of the site) in relation to the Newcastle Mines Grouting Fund is unclear as the rail corridor is not assigned a category. MSB has advised that the HDC should be consulted on this matter.

6.5.4 Preliminary Subsidence Parameters

A preliminary assessment of subsidence parameters was undertaken using the method of Holla (1987). In the event of subsidence in workings adjacent to the site and in the absence of grouting or other remedial measures, the subsidence effects would be worst at the site boundary.

Estimated preliminary subsidence parameters for the un-grouted site would be:

- Subsidence: 230 mm
- Tensile strain: 3 mm/m
- Tilt: 10 mm/m

It is unlikely that buildings could be economically designed to withstand the above movements. If the associated risk of occurrence is considered unacceptable, remedial grouting would likely be required to reduce the subsidence parameters to levels that could be managed through structural design. While this depends on the sensitivity of the specific structure to movement, based on previous experience typical post-grouting subsidence parameters accommodated by designed are:

- Subsidence: 50 to 100 mm
- Tensile strain: 0.5 to 2 mm/m
- Tilt: 5 to 6 mm/m

6.5.5 Preliminary Estimated Grouting Volumes

A preliminary estimate of potential grouting has been made adopting a conservative scenario and assuming that structures might be built to the maximum permissible height under the zoning. Although the preliminary estimate is based on grouting within the angle of draw, it should be noted that in some cases it may be beneficial to grout workings beyond the angle of draw where this is shown to prevent a more global ‘pillar run’ that could affect the site.

When the relevant constraints are overlain: angle of draw, mine categories of adjoining mined areas, and adjacent proposed land use that would allow multi-storey buildings, the following is indicated:

- Grouting of workings east of Wolfe Street and west of Union Lane is unlikely to be necessary;
- Grouting of workings west of Wright Lane (Parcels 3 and 4) *may or may not* be necessary, considering the beneficial effect on global stability of nearby grouting of sites in Honeysuckle, but has been included in preliminary estimates in case;
- The remaining central area (Parcels 8 to 14) *may* require grouting, subject to the findings of detailed investigation, modelling and the specifics of individual proposed structures;
- The areas adjoining the central area are mainly Fund Category A and Category B and some Category C areas. Actual categories, however, will depend on MSB and/or HDC responses in relation to the rail corridor.

Drawing 5 indicates the areas of mine workings that *may* require grouting adjacent to Parcels 3 and 4 and 8 to 14 as noted above. The total volume of voids in the workings may be approximately estimated, however, it depends on the accuracy of the plan in terms of bord widths, worked seam height and degree of roof collapse. If grouting of workings beyond the angle of draw is later determined to be required, it has been assumed that these areas would be offset by not requiring grouting of all voids within the angle of draw.

The estimated ‘worst case’ plan area of the workings that may require grouting is about 13,600 m^2. Adopting an estimated average worked height of 4.8 m the total volume of voids is estimated to be in the order of 65,000 m^3.

If Parcel 12 is limited to a three-storey structure, remedial grouting in the vicinity of this land would be unlikely to be needed. This would potentially reduce the volume of grout required by about 9000 m^3 (to about 56,000 m^3 in total).

If the Grouting Fund applies to these parcels, and the parcel area is taken as the site area, there would be a cap on grouting costs. If grouting costs exceeds the relevant cap amount the fund would pick up the difference. If the grouting costs are less than the cap amount then no claim can be made on the fund.

It should be noted that the areas that may require grouting lie beneath properties/buildings outside the corridor and public roads. This might create legal, access and logistical challenges to undertaking the work. It may be necessary to make extensive use of angled boreholes to both locate the workings and undertaking the grouting. These constraints may have additional and uncertain cost implications, hence it is recommended that a contingency be allowed for.

Important Assumptions and Limitations related to Grouting Volumes

It is not certain at this early stage whether grouting of workings will be required at all. Detailed investigations and modelling may indicate that potential subsidence has a low risk of occurrence or can be managed through structural design (although this will depend to some extent on the specifics of proposed structures).

The foregoing estimates of grout volumes are preliminary and conservative and are based on a number of assumptions derived from experience. Assumptions and limitations include:

- The layout of the mine workings is assumed to be approximately the same as recorded on the mine plans, such that only the Borehole Seam could influence the site;
- Full grouting of the voids, where the development footprint is within the angle of draw, comprising grouting to at least the top of coal seam and possibly to the roof;
- Where grouting is required the assumed plan extent is the angle of draw, however grouting beyond the angle of draw is a possible requirement for global stability and prevention of a 'pillar run' that could affect the site;
- Low strength (1 MPa) grout will be acceptable;
- The structures could be designed to accommodate subsidence parameters of a similar order to previous developments subject to grouting;
- Access to adjacent properties and roads will be both permissible and feasible for the works. Angled drilling extending from the rail corridor to beyond the site boundary will also be permitted;
- Uncertainties related to the work and potential costs include:
    - Actual ground conditions, mine layout, extent of mine rubble and volume of voids requiring grout;
    - Contractor market rates at time of work;
    - Whether the work is done as a single package for the whole site or separate packages for individual parcels of land or developments;
    - Final MSB requirements for specific developments;
    - The applicability of the Grouting Fund and the designated rates for the development sites.
- Additional investigations and numerical modelling will be required to confirm the need for grouting and the design details.

6.6 Suitability of the Site for Development

The rail corridor site is considered to be geotechnically suitable for the proposed residential and commercial type developments. Preliminary geotechnical design parameters are provided in this report to facilitate preliminary planning and assessment of feasibility of specific proposed developments.

Prior to the detailed design of any proposed developments specific geotechnical investigation will be required appropriate to the nature of the proposed development. Investigation and design will need to consider some or all of the following matters:

- The presence and depth of uncontrolled fill;
- The presence, depth and likely variation in groundwater levels;
- Appropriate treatment and management of acid sulphate soils where encountered;
- Excavation conditions and shoring requirements, if relevant;
- Earthworks procedures and whether any ground improvement measures (such as removal and compaction) are required, taking into account the requirements of the Remediation Action Plan (RAP);
- Suitable footing options and design parameters for support of structures;
- Requirements relating to potential mine subsidence, where relevant.

It is expected that with suitable investigation, design and construction in accordance with accepted engineering practice, the above matters can be readily managed.

7. Concurrent Contamination Investigations

DP has conducted concurrent contamination investigations within the surplus Newcastle Rail corridor between Newcastle Station in the east and Worth Place in the west.

The investigations have comprised the following:

- Brief review of previous investigations conducted within the site;
- Review and revision of the sampling, analysis and quality plan for assessment of contamination at the site;
- Subsurface investigation and sampling at systematic and targeted locations;
- Assessment of soil and groundwater contamination within the site, targeting the locations and contaminants of concern on the basis of the historical landuse;
- Assessment of remediation strategies/options;
- Preparation of a draft RAP, outlining the strategies, procedures and responsibilities for remediation of identified contamination.

The results of the investigation indicated the following with respect to contamination at the site:

- The presence of hydrocarbon contamination in soil associated with the former gas works in the eastern portion of the site (i.e. current bus interchange);
- The presence of hydrocarbon contamination in near-surface soils in the vicinity of Newcastle Station and the Newcastle Signal Box as a results of historical train use;
- The presence of heavy metal-impacted near-surface soils to the west of Civic Station, likely to be as a result of impacted historical filling and/or historical ash dumping in the area;
- The presence of minor soil contamination in filling across the site, likely due to historical use as a railway and historical filling of the site;
- Contamination in soil at the site should be addressed due to the potential for impacts on human health and the environment, including groundwater impact.

At this stage the proposed remediation strategy for the site is for localised removal and/or remediation of impacted soils, with capping of the remainder of the site with structures, pavements or soils. This strategy has been documented in the RAP (Ref 4).

The contamination assessment and RAP will be subject to review and approval by Graeme Nyland, a NSW EPA accredited Auditor.

8. References

1. Australian Standard 2159-2009, “Piling – Design and Installation”, Standards Australia.
2. Australian Standard 1170.4-2005, “Structural design actions, Part 4: Earthquake actions in Australia”, Standards Australia.
3. Pells, Mostyn & Walker (1998), “Foundations on Sandstone and Shale in the Sydney Region”, Australian Geomechanics Society, December 1998.
4. Douglas Partners Pty Ltd, “Remediation Action Plan, Newcastle Urban Transformation and Transport Program”, Project 81716.00.R.009 (Rev 0), March 2016.

9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report (or services) for this project at in accordance with DP’s proposal NCL 150577 dated 30 September 2015. The work was carried out under UrbanGrowth NSW contract 2724/14, dated 4 May 2015. This report is provided for the exclusive use of UrbanGrowth NSW for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction. The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Mine Subsidence Stability Assessment

Table B1 - Pillar Stability Analysis - Measured Pillar Dimensions - Panel 1

Douglas Partners
Geotechnics · Environment · Groundwater

Mine Workings -	RT566 - Borehole Seam	**Client:**	UrbanGrowth NSW
Project:	Newcastle Rail Corridor	**Date:**	2 December 2015
Location:	Newcastle	**Sheet:**	1
Analysis Assumptions:	Pillar dimensions from RT.		

Project No: 81720.01

Pillar Id:	Comment	Depth D (m)	Seam Thickness (m)	Working Section H (m)	Pillar Height Section H (m)	Unit Weigth γ (kN/m^3)	Pillar Details Width Wp (m)	Length Lp (m)	Internal Angle (°)	Roadway Details Wr (m)	Lr (m)	Extract. Ratio (%)	Pillar Area m^3	Total Area m^3	Width/ Height Ratio Wp/H	Width Modifier Θ_0	Θ	Pillar Stress (Tributary) (MPa)	Pillar Load (Tributary) MN	Abut (A) Yield (Y) (?)	Shed Load MN	Lodad Received MN	Pillar Stress ("Yield") (MPa)	Pillar Stress ("Abut") (MPa)	Power Law Strength (MPa)	"Ultimate" Load MN	FoS	Probability of Failure
1		77.0	6.4	5.4	5.4	25	12.9	28.1	90.0	3.5	2.3	27.3	362.5	498.6	2.4	1.371	1.000	2.65	960						7.69	2786	2.90	1.4E-11
2		77.0	6.4	5.4	5.4	25	14.6	27.8	90.0	2.8	2.8	23.8	405.9	532.4	2.7	1.311	1.000	2.53	1025						8.19	3323	3.24	1.1E-13
3		77.0	6.4	5.4	5.4	25	14.2	36.2	90.0	3.0	2.8	23.4	514.0	670.8	2.6	1.437	1.000	2.51	1291						8.07	4149	3.21	1.7E-13
4		77.0	6.4	5.4	5.4	25	10.6	26.1	90.0	4.2	3.4	36.6	276.7	436.6	2.0	1.422	1.000	3.04	840						6.95	1924	2.29	9.9E-08
5		77.0	6.4	5.4	5.4	25	11.8	27.9	90.0	3.3	3.4	30.3	329.2	472.6	2.2	1.406	1.000	2.76	910						7.34	2418	2.66	4.9E-10
6		77.0	6.4	5.4	5.4	25	11.5	36.6	90.0	3.4	2.8	28.3	420.9	587.1	2.1	1.522	1.000	2.68	1130						7.25	3051	2.70	2.7E-10
7		77.0	6.4	5.4	5.4	25	12.1	28.7	90.0	3.0	2.9	27.2	347.3	477.2	2.2	1.407	1.000	2.65	919						7.44	2583	2.81	5.3E-11
8		77.0	6.4	5.4	5.4	25	11.5	29.0	90.0	3.2	3.0	29.1	333.5	470.4	2.1	1.432	1.000	2.72	906						7.25	2417	2.67	4.1E-10
9		77.0	6.4	5.4	5.4	25	11.2	27.5	90.0	3.6	3.4	32.7	308.0	457.3	2.1	1.421	1.000	2.86	880						7.15	2203	2.50	4.6E-09
10		77.0	6.4	5.4	5.4	25	11.9	29.8	90.0	3.9	3.2	32.0	354.6	521.4	2.2	1.429	1.000	2.83	1004						7.38	2616	2.61	1.0E-09
11		77.0	6.4	5.4	5.4	25	11.8	28.5	90.0	4.9	3.7	37.5	336.3	537.7	2.2	1.414	1.000	3.08	1035						7.34	2470	2.39	2.4E-08
12		77.0	6.4	5.4	5.4	25	13.1	30.6	90.0	4.7	3.4	33.8	400.9	605.2	2.4	1.400	1.000	2.91	1165						7.75	3105	2.67	4.4E-10
13		77.0	6.4	5.4	5.4	25	10.1	28.2	90.0	5.3	3.6	41.8	284.8	489.7	1.9	1.473	1.000	3.31	943						6.78	1932	2.05	3.1E-06
14		77.0	6.4	5.4	5.4	25	9.9	30.8	90.0	5.5	3.7	42.6	304.9	531.3	1.8	1.514	1.000	3.35	1023						6.72	2048	2.00	6.1E-06
15		77.0	6.4	5.4	5.4	25	9.8	27.8	90.0	5.7	3.3	43.5	272.4	482.1	1.8	1.479	1.000	3.41	928						6.68	1820	1.96	1.1E-05
16		77.0	6.4	5.4	5.4	25	10.9	30.6	90.0	5.7	3.8	41.6	333.5	571.0	2.0	1.475	1.000	3.30	1099						7.05	2352	2.14	8.4E-07
17		77.0	6.4	5.4	5.4	25	11.0	27.6	90.0	5.8	3.2	41.3	303.6	517.4	2.0	1.430	1.000	3.28	996						7.09	2151	2.16	6.3E-07
18		77.0	6.4	5.4	5.4	25	12.2	26.8	90.0	5.6	3.8	40.0	327.0	544.7	2.3	1.374	1.000	3.21	1049						7.47	2442	2.33	5.5E-08
19		77.0	6.4	5.4	5.4	25	13.1	26.4	90.0	5.5	3.5	37.8	345.8	556.1	2.4	1.337	1.000	3.10	1071						7.75	2679	2.50	4.6E-09
20		77.0	6.4	5.4	5.4	25	11.0	26.7	90.0	5.5	3.6	41.3	293.7	500.0	2.0	1.416	1.000	3.28	962						7.09	2081	2.16	6.1E-07
21		77.0	6.4	5.4	5.4	25	11.3	30.9	90.0	5.1	3.7	38.5	349.2	567.4	2.1	1.464	1.000	3.13	1092						7.18	2508	2.30	8.9E-08
22		77.0	6.4	5.4	5.4	25	11.7	15.0	90.0	4.8	3.8	43.4	175.5	310.2	2.2	1.124	1.000	3.40	597						7.31	1283	2.15	7.4E-07
												Total	7380.2	11337.3														

Notes:

1. Pillar stability analysis based on the methods of Galvin, Hebbelwhite, Salamon and Lin (1998) UNSW Mining Research Centre Report RR3/98.
2. Relationship between Factor of Safety (FoS) and probability of coal pillar failure is based on interpolation and extrapolation of data in the above publication. It should be noted that the probability of failure does not extend beyond a FoS of 2.11 (equivalent to a probability of failure of 1 in 1,000,000) in the above and therefore probabilities of failure for FoSs above this are an extrapolation based on a curve of best fit for data for FoSs of 2.11 and less
3. Load on weaker pillars reduced by 30% as discussed in "Prefailure Pillar Yielding", by Agapto and Goodrich (2002) Load transferred to adjacent pillars.
4. Extraction ratio is relative to working section not full seam height.
5. Pillar Height should be the same as the working section unless roof collapse is being considered.

Panel Extraction Ratio 0.35

Summary	FoS
Max	3.24
Min	1.96
Mean	2.47

Panel Factor of safety Based on Tributary load

Total Pillar Load	21824.24	MN
Total Pilla Capacity	54342.32	MN

Panel FoS 2.49

Table B2 - Pillar Stability Analysis - Measured Pillar Dimensions - Panel 2

Douglas Partners
Geotechnics · Environment · Groundwater

Mine Workings - RT566 - Borehole Seam
Project: Newcastle Rail Corridor
Location: Newcastle
Analysis Assumptions: Pillar dimensions from RT.

Client: UrbanGrowth NSW
Date: 2 December 2015
Sheet: 1

Project No: 81720.01

Pillar Id:	Comment	Depth D (m)	Seam Thickness (m)	Working Section H (m)	Pillar Height Section H (m)	Unit Weigth γ (kN/m³)	Pillar Details Width Wp (m)	Pillar Details Length Lp (m)	Pillar Details Internal Angle (°)	Roadway Details Wr (m)	Roadway Details Lr (m)	Extract. Ratio (%)	Pillar Area m³	Total Area m³	Width/ Height Ratio Wp/H	Width Modifier Θ_0	Width Modifier Θ	Pillar Stress (Tributary) (MPa)	Pillar Load (Tributary) MN	Abut (A) Yield (Y) (?)	Shed Load MN	Lodad Received MN	Pillar Stress ("Yield") (MPa)	Pillar Stress ("Abut") (MPa)	Power Law Strength (MPa)	Power Law "Ultimate" Load MN	Power Law FoS	Power Law Probability of Failure
23		77.0	6.4	5.4	5.4	25	10.0	11.7	90.0	5.3	4.5	52.8	117.0	247.9	1.9	1.078	1.000	4.08	477						6.75	790	1.66	9.0E-04
24		77.0	6.4	5.4	5.4	25	10.5	22.1	90.0	5.7	4.0	45.1	232.1	422.8	1.9	1.356	1.000	3.51	814						6.92	1606	1.97	9.4E-06
25		77.0	6.4	5.4	5.4	25	10.4	24.2	90.0	5.3	3.7	42.5	251.7	438.0	1.9	1.399	1.000	3.35	843						6.89	1733	2.06	2.9E-06
26		77.0	6.4	5.4	5.4	25	11.3	24.3	90.0	5.8	3.6	42.4	274.6	477.1	2.1	1.365	1.000	3.34	918						7.18	1973	2.15	7.5E-07
27		77.0	6.4	5.4	5.4	25	11.8	31.0	90.0	6.0	3.5	40.4	365.8	614.1	2.2	1.449	1.000	3.23	1182						7.34	2687	2.27	1.3E-07
28		77.0	6.4	5.4	5.4	25	10.7	24.1	90.0	6.8	3.5	46.6	257.9	483.0	2.0	1.385	1.000	3.61	930						6.99	1802	1.94	1.5E-05
29		77.0	6.4	5.4	5.4	25	11.0	31.1	90.0	5.9	3.4	41.3	342.1	583.1	2.0	1.477	1.000	3.28	1122						7.09	2424	2.16	6.3E-07
30		77.0	6.4	5.4	5.4	25	11.2	29.2	90.0	5.9	3.9	42.2	327.0	566.0	2.1	1.446	1.000	3.33	1090						7.15	2339	2.15	7.7E-07
31		77.0	6.4	5.4	5.4	25	10.3	30.5	90.0	5.5	3.6	41.7	314.2	538.8	1.9	1.495	1.000	3.30	1037						6.85	2153	2.08	2.1E-06
32		77.0	6.4	5.4	5.4	25	10.1	28.8	90.0	6.0	4.1	45.1	290.9	529.7	1.9	1.481	1.000	3.51	1020						6.78	1973	1.94	1.6E-05
33		77.0	6.4	5.4	5.4	25	11.3	38.4	90.0	5.9	1.8	37.2	433.9	691.4	2.1	1.545	1.000	3.07	1331						7.18	3117	2.34	4.6E-08
34		77.0	6.4	5.4	5.4	25	12.2	30.3	90.0	3.9	4.8	34.6	369.7	565.1	2.3	1.426	1.000	2.94	1088						7.47	2761	2.54	2.7E-09
35		77.0	6.4	5.4	5.4	25	12.3	29.9	90.0	4.7	3.8	35.8	367.8	572.9	2.3	1.417	1.000	3.00	1103						7.50	2759	2.50	4.6E-09
36		77.0	6.4	5.4	5.4	25	12.0	16.5	90.0	3.5	4.0	37.7	198.0	317.8	2.2	1.158	1.000	3.09	612						7.41	1467	2.40	2.1E-08
37		77.0	6.4	5.4	5.4	25	11.2	35.5	90.0	4.7	4.4	37.3	397.6	634.4	2.1	1.520	1.000	3.07	1221						7.15	2843	2.33	5.6E-08
38		77.0	6.4	5.4	5.4	25	12.7	26.5	90.0	3.6	3.7	31.6	336.6	492.3	2.4	1.352	1.000	2.82	948						7.62	2566	2.71	2.4E-10
39		77.0	6.4	5.4	5.4	25	10.5	32.0	90.0	5.3	3.9	40.8	336.0	567.2	1.9	1.506	1.000	3.25	1092						6.92	2325	2.13	9.8E-07
40		77.0	6.4	5.4	5.4	25	10.7	18.1	90.0	4.7	3.8	42.6	193.7	337.3	2.0	1.257	1.000	3.35	649						6.99	1353	2.08	1.9E-06
41		77.0	6.4	5.4	5.4	25	9.8	12.0	90.0	3.6	4.1	45.5	117.6	215.7	1.8	1.101	1.000	3.53	415						6.68	786	1.89	3.0E-05
42		77.0	6.4	5.4	5.4	25	10.7	26.4	90.0	4.6	4.1	39.5	282.5	466.7	2.0	1.423	1.000	3.18	898						6.99	1974	2.20	3.7E-07
43		77.0	6.4	5.4	5.4	25	9.8	12.0	90.0	3.6	4.1	45.5	117.6	215.7	1.8	1.101	1.000	3.53	415						6.68	786	1.89	3.0E-05
44		77.0	6.4	5.4	5.4	25	10.4	26.4	90.0	5.1	4.7	43.0	274.6	482.1	1.9	1.435	1.000	3.38	928						6.89	1891	2.04	3.7E-06
45		77.0	6.4	5.4	5.4	25	13.0	23.0	90.0	4.2	4.3	36.3	299.0	469.6	2.4	1.278	1.000	3.02	904						7.72	2307	2.55	2.2E-09
46		77.0	6.4	5.4	5.4	25	10.1	16.3	90.0	4.5	3.6	43.3	164.6	290.5	1.9	1.235	1.000	3.40	559						6.78	1117	2.00	6.6E-06
47		77.0	6.4	5.4	5.4	25	8.8	17.4	90.0	5.3	3.2	47.3	153.1	290.5	1.6	1.328	1.000	3.65	559						6.32	968	1.73	3.0E-04
48		77.0	6.4	5.4	5.4	25	10.2	13.9	90.0	5.4	3.2	46.9	141.8	266.8	1.9	1.154	1.000	3.62	514						6.82	967	1.88	3.4E-05
												Total	6957.1	11776.3														

Notes:

1. Pillar stability analysis based on the methods of Galvin, Hebbelwhite, Salamon and Lin (1998) UNSW Mining Research Centre Report RR3/98.
2. Relationship between Factor of Safety (FoS) and probability of coal pillar failure is based on interpolation and extrapolation of data in the above publication. It should be noted that the probability of failure does not extend beyond a FoS of 2.11 (equivalent to a probability of failure of 1 in 1,000,000) in the above and therefore probabilities of failure for FoSs above this are an extrapolation based on a curve of best fit for data for FoSs of 2.11 and less
3. Load on weaker pillars reduced by 30% as discussed in "Prefailure Pillar Yielding", by Agapto and Goodrich (2002) Load transferred to adjacent pillars.
4. Extraction ratio is relative to working section not full seam height.
5. Pillar Height should be the same as the working section unless roof collapse is being considered.

Panel Extraction Ratio 0.41

Summary	FoS
Max	2.71
Min	1.66
Mean	2.14

Panel Factor of safety Based on Tributary load

Total Pillar Load	22669.34	MN
Total Pilla Capacity	49464.53	MN
Panel FoS	2.18	

Table B3 - Pillar Stability Analysis - Measured Pillar Dimensions - Panel 3

Douglas Partners
Geotechnics · Environment · Groundwater

Mine Workings - RT566 - Borehole Seam
Project: Newcastle Rail Corridor
Location: Newcastle
Analysis Assumptions: Pillar dimensions from RT.

Client: UrbanGrowth NSW
Date: 2 December 2015
Sheet: 1

Project No: 81720.01

Pillar Id:	Comment	Depth D (m)	Seam Thickness (m)	Working Section H (m)	Pillar Height Section H (m)	Unit Weigth γ (kN/m³)	Pillar Details Width Wp (m)	Length Lp (m)	Internal Angle (°)	Roadway Details Wr (m)	Lr (m)	Extract. Ratio (%)	Pillar Area m³	Total Area m³	Width/ Height Ratio Wp/H	Width Modifier Θ_0	Θ	Pillar Stress (Tributary) (MPa)	Pillar Load (Tributary) MN	Abut (A) Yield (Y) (?)	Shed Load MN	Lodad Received MN	Pillar Stress ("Yield") (MPa)	Pillar Stress ("Abut") (MPa)	Power Law Strength (MPa)	"Ultimate" Load MN	FoS	Probability of Failure
49		77.0	6.4	5.4	5.4	25	11.0	40.3	90.0	5.3	3.6	38.0	443.3	715.6	2.0	1.571	1.000	3.11	1377						7.09	3141	2.28	1.1E-07
50		77.0	6.4	5.4	5.4	25	10.5	32.1	90.0	4.7	1.8	34.6	337.1	515.3	1.9	1.507	1.000	2.94	992						6.92	2332	2.35	4.0E-08
51		77.0	6.4	5.4	5.4	25	10.9	34.1	90.0	5.1	3.8	38.7	371.7	606.4	2.0	1.516	1.000	3.14	1167						7.05	2622	2.25	1.8E-07
52		77.0	6.4	5.4	5.4	25	11.0	21.6	90.0	5.2	2.1	38.1	237.6	383.9	2.0	1.325	1.000	3.11	739						7.09	1684	2.28	1.2E-07
53		77.0	6.4	5.4	5.4	25	10.5	29.1	90.0	5.1	4.0	40.8	305.6	516.4	1.9	1.470	1.000	3.25	994						6.92	2114	2.13	1.0E-06
54		77.0	6.4	5.4	5.4	25	10.3	15.8	90.0	5.0	2.0	40.2	162.7	272.3	1.9	1.211	1.000	3.22	524						6.85	1115	2.13	1.0E-06
55		77.0	6.4	5.4	5.4	25	11.0	29.7	90.0	5.4	4.4	41.6	326.7	559.2	2.0	1.459	1.000	3.30	1077						7.09	2315	2.15	7.3E-07
56		77.0	6.4	5.4	5.4	25	12.2	25.8	90.0	4.5	3.6	35.9	314.8	491.0	2.3	1.358	1.000	3.00	945						7.47	2351	2.49	5.7E-09
57		77.0	6.4	5.4	5.4	25	11.6	21.1	90.0	4.0	3.8	37.0	244.8	388.4	2.1	1.291	1.000	3.06	748						7.28	1782	2.38	2.6E-08
58		77.0	6.4	5.4	5.4	25	12.6	30.6	90.0	4.9	4.3	36.9	385.6	610.8	2.3	1.417	1.000	3.05	1176						7.59	2928	2.49	5.4E-09
59		77.0	6.4	5.4	5.4	25	12.4	24.4	90.0	4.9	4.3	39.1	302.6	496.5	2.3	1.326	1.000	3.16	956						7.53	2279	2.38	2.5E-08
60		77.0	6.4	5.4	5.4	25	10.8	19.9	90.0	5.0	3.7	42.4	214.9	372.9	2.0	1.296	1.000	3.34	718						7.02	1509	2.10	1.5E-06
61		77.0	6.4	5.4	5.4	25	11.7	24.6	90.0	5.1	4.2	40.5	287.8	483.8	2.2	1.355	1.000	3.24	931						7.31	2105	2.26	1.5E-07
62		77.0	6.4	5.4	5.4	25	10.4	23.9	90.0	4.7	3.7	40.4	248.6	416.8	1.9	1.394	1.000	3.23	802						6.89	1712	2.13	9.3E-07
63		77.0	6.4	5.4	5.4	25	11.1	12.9	90.0	4.4	4.4	46.6	143.2	268.2	2.1	1.075	1.000	3.60	516						7.12	1019	1.97	9.1E-06
64		77.0	6.4	5.4	5.4	25	11.8	21.1	90.0	5.3	5.1	44.4	249.0	448.0	2.2	1.283	1.000	3.46	862						7.34	1829	2.12	1.1E-06
65		77.0	6.4	5.4	5.4	25	10.1	11.2	90.0	4.9	4.2	51.0	113.1	231.0	1.9	1.052	1.000	3.93	445						6.78	767	1.73	3.3E-04
66		77.0	6.4	5.4	5.4	25	10.6	30.2	90.0	5.0	4.5	40.9	320.1	541.3	2.0	1.480	1.000	3.26	1042						6.95	2226	2.14	8.9E-07
67		77.0	6.4	5.4	5.4	25	10.8	25.1	90.0	5.1	3.5	40.4	271.1	454.7	2.0	1.398	1.000	3.23	875						7.02	1903	2.17	5.2E-07
68		77.0	6.4	5.4	5.4	25	10.6	31.0	90.0	5.1	5.0	41.9	328.6	565.2	2.0	1.490	1.000	3.31	1088						6.95	2285	2.10	1.5E-06
69		77.0	6.4	5.4	5.4	25	10.8	28.5	90.0	5.5	4.5	42.8	307.8	537.9	2.0	1.450	1.000	3.36	1035						7.02	2161	2.09	1.8E-06
70		77.0	6.4	5.4	5.4	25	10.7	28.8	90.0	5.5	3.3	40.7	308.2	520.0	2.0	1.458	1.000	3.25	1001						6.99	2153	2.15	7.2E-07
71		77.0	6.4	5.4	5.4	25	11.1	28.0	90.0	6.0	4.2	43.6	310.8	550.6	2.1	1.432	1.000	3.41	1060						7.12	2213	2.09	1.8E-06
72		77.0	6.4	5.4	5.4	25	11.5	28.6	90.0	5.7	3.8	41.0	328.9	557.3	2.1	1.426	1.000	3.26	1073						7.25	2384	2.22	2.6E-07
73		77.0	6.4	5.4	5.4	25	10.3	13.0	90.0	5.5	3.4	48.3	133.9	259.1	1.9	1.116	1.000	3.73	499						6.85	918	1.84	6.4E-05
74		77.0	6.4	5.4	5.4	25	11.3	28.5	90.0	5.8	3.7	41.5	322.1	550.6	2.1	1.432	1.000	3.29	1060						7.18	2314	2.18	4.6E-07
75		77.0	6.4	5.4	5.4	25	12.3	25.1	90.0	5.2	3.6	38.5	308.7	502.3	2.3	1.342	1.000	3.13	967						7.50	2316	2.40	2.1E-08
76		77.0	6.4	5.4	5.4	25	11.6	14.5	90.0	5.4	3.8	45.9	168.2	311.1	2.1	1.111	1.000	3.56	599						7.28	1225	2.04	3.3E-06
77		77.0	6.4	5.4	5.4	25	10.9	23.5	90.0	5.2	3.6	41.3	256.2	436.3	2.0	1.366	1.000	3.28	840						7.05	1807	2.15	7.2E-07
78		77.0	6.4	5.4	5.4	25	17.4	39.0	90.0	5.7	2.2	28.7	678.6	951.7	3.2	1.383	1.024	2.70	1832						9.06	6150	3.36	2.1E-14
79		77.0	6.4	5.4	5.4	25	14.3	16.6	90.0	4.8	3.9	39.4	237.4	391.6	2.6	1.074	1.000	3.18	754						8.10	1923	2.55	2.3E-09
80		77.0	6.4	5.4	5.4	25	8.5	21.8	90.0	4.9	3.6	45.6	185.3	340.4	1.6	1.439	1.000	3.54	655						6.21	1151	1.76	2.1E-04
81		77.0	6.4	5.4	5.4	25	8.2	17.9	90.0	4.8	4.5	49.6	146.8	291.2	1.5	1.372	1.000	3.82	561						6.10	895	1.60	1.6E-03
82		77.0	6.4	5.4	5.4	25	9.1	54.0	90.0	5.3	2.4	39.5	491.4	812.2	1.7	1.712	1.000	3.18	1563						6.43	3161	2.02	4.6E-06
83		77.0	6.4	5.4	5.4	25	11.0	36.2	90.0	5.1	4.4	39.1	398.2	653.7	2.0	1.534	1.000	3.16	1258						7.09	2822	2.24	1.9E-07
84		77.0	6.4	5.4	5.4	25	11.3	38.9	90.0	5.4	2.2	36.0	439.6	686.4	2.1	1.550	1.000	3.01	1321						7.18	3158	2.39	2.3E-08
85		77.0	6.4	5.4	5.4	25	12.7	25.9	90.0	5.1	4.4	39.0	328.9	539.3	2.4	1.342	1.000	3.16	1038						7.62	2508	2.42	1.6E-08
86		77.0	6.4	5.4	5.4	25	12.9	38.9	90.0	5.0	2.3	32.0	501.8	737.5	2.4	1.502	1.000	2.83	1420						7.69	3857	2.72	2.1E-10
87		77.0	6.4	5.4	5.4	25	8.8	69.6	90.0	5.4	1.5	39.3	612.5	1009.6	1.6	1.776	1.000	3.17	1944						6.32	3873	1.99	7.0E-06
88		77.0	6.4	5.4	5.4	25	9.8	47.7	90.0	5.7	3.9	41.6	467.5	799.8	1.8	1.659	1.000	3.29	1540						6.68	3123	2.03	4.2E-06
89		77.0	6.4	5.4	5.4	25	10.2	34.3	90.0	5.6	3.9	42.0	349.9	603.6	1.9	1.542	1.000	3.32	1162						6.82	2385	2.05	2.9E-06
90		77.0	6.4	5.4	5.4	25	12.0	54.4	90.0	5.0	4.0	34.2	652.8	992.8	2.2	1.639	1.000	2.93	1911						7.41	4836	2.53	3.1E-09
91		77.0	6.4	5.4	5.4	25	11.3	16.2	90.0	5.1	1.9	38.3	183.1	296.8	2.1	1.178	1.000	3.12	571						7.18	1315	2.30	8.3E-08
92		77.0	6.4	5.4	5.4	25	7.4	8.6	90.0	3.3	4.8	55.6	63.6	143.4	1.4	1.075	1.000	4.34	276						5.79	368	1.33	3.1E-02
93		77.0	6.4	5.4	5.4	25	9.5	28.2	90.0	5.5	3.9	44.4	267.9	481.5	1.8	1.496	1.000	3.46	927						6.58	1762	1.90	2.6E-05
94		77.0	6.4	5.4	5.4	25	10.6	28.4	90.0	4.8	4.2	40.0	301.0	502.0	2.0	1.456	1.000	3.21	966						6.95	2093	2.17	5.8E-07
95		77.0	6.4	5.4	5.4	25	9.2	23.8	90.0	5.0	2.8	42.0	219.0	377.7	1.7	1.442	1.000	3.32	727						6.47	1416	1.95	1.3E-05
96		77.0	6.4	5.4	5.4	25	11.1	27.3	90.0	5.1	3.5	39.3	303.0	499.0	2.1	1.422	1.000	3.17	960						7.12	2157	2.25	1.8E-07
97		77.0	6.4	5.4	5.4	25	12.7	30.1	90.0	4.8	1.7	31.3	382.3	556.5	2.4	1.407	1.000	2.80	1071						7.62	2915	2.72	2.0E-10
98		77.0	6.4	5.4	5.4	25	11.5	26.3	90.0	4.8	1.8	34.0	302.5	458.0	2.1	1.392	1.000	2.92	882						7.25	2192	2.49	5.8E-09
												Total	15566.3	25687.5														

Notes:

1. Pillar stability analysis based on the methods of Galvin, Hebbelwhite, Salamon and Lin (1998) UNSW Mining Research Centre Report RR3/98.
2. Relationship between Factor of Safety (FoS) and probability of coal pillar failure is based on interpolation and extrapolation of data in the above publication. It should be noted that the probability of failure does not extend beyond a FoS of 2.11 (equivalent to a probability of failure of 1 in 1,000,000) in the above and therefore probabilities of failure for FoSs above this are an extrapolation based on a curve of best fit for data for FoSs of 2.11 and less
3. Load on weaker pillars reduced by 30% as discussed in "Prefailure Pillar Yielding", by Agapto and Goodrich (2002) Load transferred to adjacent pillars.
4. Extraction ratio is relative to working section not full seam height.
5. Pillar Height should be the same as the working section unless roof collapse is being considered.

Panel Extraction Ratio 0.39

Summary	FoS
Max	3.36
Min	1.33
Mean	2.20

Panel Factor of safety Based on Tributary load

Total Pillar Load	49448.50	MN
Total Pilla Capacity	111567.11	MN
Panel FoS	2.26	

Appendix C

Letter from Mine Subsidence Board, 15 January 2016

Mine Subsidence Board "Newcastle City Area Mine Subsidence Categories" 8 June 2012

Mine Subsidence Board - Newcastle Plan Legend

Hunter Development Corporation - "Newcastle Mines Grouting Fund 2015/2016 Area Category Rates - November 2015"

MINE SUBSIDENCE BOARD

ABN: 87 445 348 918

NEWCASTLE
Ground Floor
NSW Government Offices
117 Bull Street
Newcastle West 2302
PO Box 488G Newcastle 2300
Telephone: (02) 4908 4300
Facsimile: (02) 4929 1032
DX 4322 Newcastle West

PICTON
100 Argyle Street
Picton 2571
PO Box 40 Picton 2571
Telephone: (02) 4677 1967
Facsimile: (02) 4677 2040
DX 26053 Picton

SINGLETON
The Central Business Centre
Unit 6, 1 Pitt Street
Singleton 2330
PO Box 524 Singleton 2330
Telephone: (02) 6572 4344
Facsimile: (02) 6572 4504

WYONG
Suite 3 Feldwin Court
30 Hely Street
Wyong 2259
PO Box 157 Wyong 2259
Telephone: (02) 4352 1646
Facsimile: (02) 4352 1757
DX 7317 Wyong

HEAD OFFICE
PO Box 488G
Newcastle 2300
Telephone: (02) 4908 4395
Facsimile: (02) 4929 1032

Email
mail@minesub.nsw.gov.au

Web
www.minesub.nsw.gov.au

24 Hour
Emergency Service
Free Call 1800 248 083

In reply please send to: Newcastle District Office

Our reference: FN00-01493N0

Your reference: DP Letter : 8/1/2016

Contact: Peter Evans (02) 4908 4391

Douglas Partners Pty Ltd
Attention: Mr Stephen Johns
PO Box 324
Hunter Region Mail Centre
NSW 2310

14 January 2016

Dear Stephen,

ENQUIRY NO. TENQ16-13738N1
NEWCASTLE RAIL CORRIDOR: PART LOT 22 DP 1165985; LOT 1 DP 1192409; PART LOT 1001 DP 1095836; PART LOT 21 DP 1009735; PART LOT 22 DP 1009735; PART LOT 21 DP 1165985; LOT 1000 DP 1095836

I refer to your letter dated 8 January 2016 concerning preliminary plans for development along the Newcastle Rail Corridor, between Worth Place and Watt Street, Newcastle. I understand you are seeking advice from the Board on its likely development requirements.

As you will be aware most of these properties lie within the Newcastle Mine Subsidence District, except for a section at the Watt Street end. The purpose of a District is to prevent damage through surface development controls that take account of the risk of damage by subsidence from old, current and future mining.

Any proposal to subdivide or erect or alter any improvements on land within a Mine Subsidence District will require the Boards approval. So, applicants are encouraged to contact the Board early in the planning and design development process to determine the Boards specific requirements.

For the section of rail corridor within the Newcastle Mine Subsidence District, the Board has nominated a surface development guideline No. 9, which permits the following building development up to 30m long;

1. Single or two storey timber or steel framed improvements clad with weatherboards or other similar materials erected on reinforced concrete footings and/or slabs to comply with AS 2870.

2 Single or two storey brick veneer improvements erected on reinforced concrete footings and/or slabs to comply with AS 2870.

3. Up to three (3) storey brick construction designed in accordance with the relevant codes and standards.

Standard (Auto) BAs

Development which exceeds or doesn't comply with this guideline would need to be considered by the Board on its "merits". This would require an assessment of the mine subsidence risk and likelihood of damage to surface development.

In consideration of a merit assessment, the Board generally requests a geotechnical investigation which provides supporting evidence and a recommendation for one of the following;

a) There is no risk of mine subsidence.
b) The risk of mine subsidence should be eliminated by suitable means such as grouting.
c) The risk of mine subsidence can be mitigated by structural design, adopting recommended mine subsidence design parameters.

The geotechnical investigation should be undertaken by an engineer experienced in mine subsidence and the report should include confirmation of the depth of the coal seam, height of the workings, thickness of competent rock, pillar dimensions used in any analysis, and details of drifts, shafts, and geological anomalies such as faults. The analysis should also include a sensitivity / risk review, and consider potential subsidence scenarios including a worst case.

If grouting of the workings is necessary to eliminate the risk of mine subsidence the Board would likely request for its acceptance a grouting design and verification plan.

Where the Board accepts mine subsidence design parameters, it would likely request an "Impact Statement" of the surface development for acceptance prior to detailed design. This would be expected to;

a) Confirm the 'mine subsidence design parameters
b) List the structures and building elements.
c) Summarise the outcome of a risk assessment.
d) List the design mitigation measures proposed.

For multistorey building developments the Board will likely require exploratory drilling to prove the mine subsidence site parameters used in any analysis, including;

a) Verifying the limit of workings in the Borehole and Yard seams.
b) Verifying the location of workings which crossover the rail corridor.
c) Determining the possibility of unmapped workings above the borehole seam.

Please note this information is provided "without prejudice" based on limited information to enable Douglas Partners and its client Urban Growth, better anticipate the Board's likely requirements for the future development of the Newcastle Rail Corridor.

In respect of your query concerning the Newcastle Mine Grouting Fund, please contact the Hunter Development Corporation who is the administrator.

If you have any queries concerning this matter please don't hesitate to contact me.

Yours faithfully

Peter Evans
Subsidence Risk Engineer

Copies:

- CEO (Mine Subsidence Board)
- Newcastle District Manager (Mine Subsidence Board)

WARNING: THIS MAP REFERS TO THE NEWCASTLE CITY CENTRE AREA ONLY
EXTENSIVE MINE WORKINGS EXIST WITHIN AND BEYOND THIS AREA

NEWCASTLE CITY CENTRE AREA
MINE SUBSIDENCE CATEGORIES

REVISION DATE
8 June 2012

N
W E
S

0 125 250 500 750 1,000
Meters

LEGEND

- GROUTING STRATEGY(HDC)
- LIMITED RESTRICTIONS
- NO RESTRICTIONS
- CATEGORY A
- CATEGORY B
- CATEGORY C
- CATEGORY D
- EXTENT NEWCASTLE CITY CENTRE AREA
- NEWCASTLE MINE SUBSIDENCE DISTRICT BOUNDARY

MINE SUBSIDENCE BOARD

Mine Subsidence Board — Newcastle Plan Legend

The plan only shows categories based on the extent of mine workings.

Surface development categories with regard to mine subsidence are available from the Mine Subsidence Board. Please note the plan does not cover development requirements of other organisations.

The Mine Subsidence Board regularly reviews its surface development categories as additional geotechnical information becomes available. As Stage 2 of this project, the Board is assessing whether further detail can be provided to assist in understanding the quantum of grouting that is likely to be required in the categories identified on the plan.

1. Legend

— ***No restriction***. Allotments are not undermined nor within the zone of influence of known mine workings mining. There are no mine subsidence requirements for grouting.

— ***Limited Restrictions.*** The area is not currently in a Mine Subsidence District. Some areas of shallow unchartered workings have been identified. Further geotechnical investigation of some sites, with possible grouting, may be required.

— ***Category A***. Area of larger and relative uniform pillars. Geotechnical investigations required and likely grouting for high-rise and larger footprint structures.

— ***Category B***. Area of smaller dimension and relative uniform pillars. Geotechnical investigations required and high likelihood of coal seam grouting for high-rise and larger footprint structures.

— ***Category C.*** Area underlain by Yard Seam at around 30m depth. Extent of Yard Seam to be determined and mine workings fully grouted. Additional requirements as per Category B.

— ***Category D.*** Area of old and small pillars with a possible history of failure. Detailed geotechnical investigation required and coal seam grouting for high-rise and larger footprint structures if seam has not fully collapsed.

— ***Category E.*** As per Category D with an 'in principle' grouting proposal available for this area.

Hunter Development Corporation

NEWCATLE MINES GROUTING FUND 2015/2016 Area Category Rates – November 2015

The rates below apply to the Newcastle Mines Grouting Fund.

Category	Rate per square metre of site area (excl GST)
No restriction	Not applicable
Limited restriction	$200
A, D & E	$200
B	$300
C	$400

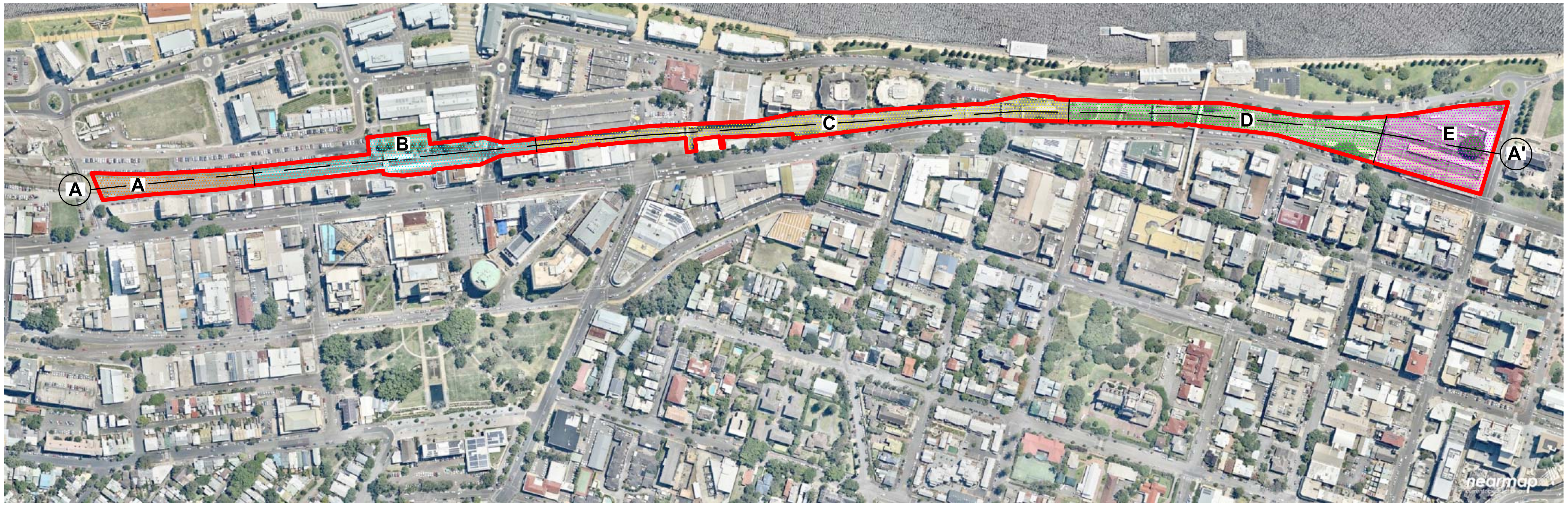
These rates are subject to change at any time. A formal review is scheduled for the end of 2016.

The rates directly correspond to the Newcastle City Centre Area Mine Subsidence Categories mapping published by the Mine Subsidence Board 2012, a link to the mapping is available below.

http://www.minesub.nsw.gov.au/SiteFiles/minesubnswgovau/NEWCASTLE-CITY-CENTRE-A1-map-08-06-2012.pdf

Appendix D

Drawing 1 – Site Plan and Geotechnical Zones
Drawing 2 – Cross-Section A-A' Sheet 1 of 2
Drawing 3 – Cross-Section A-A' Sheet 2 of 2
Drawing 4 – Inferred Layout of Mine Workings in Borehole Seam
Drawing 5 – Preliminary Grout Zones in Borehole Seam



0 50 100 150 200 300 400 500m

1:5,000 @ A3

NOTES

1. Drawing adapted from Nearmap Image dated 20.11.15
2. See Drawings 2 and 3 for Section A-A'

LEGEND

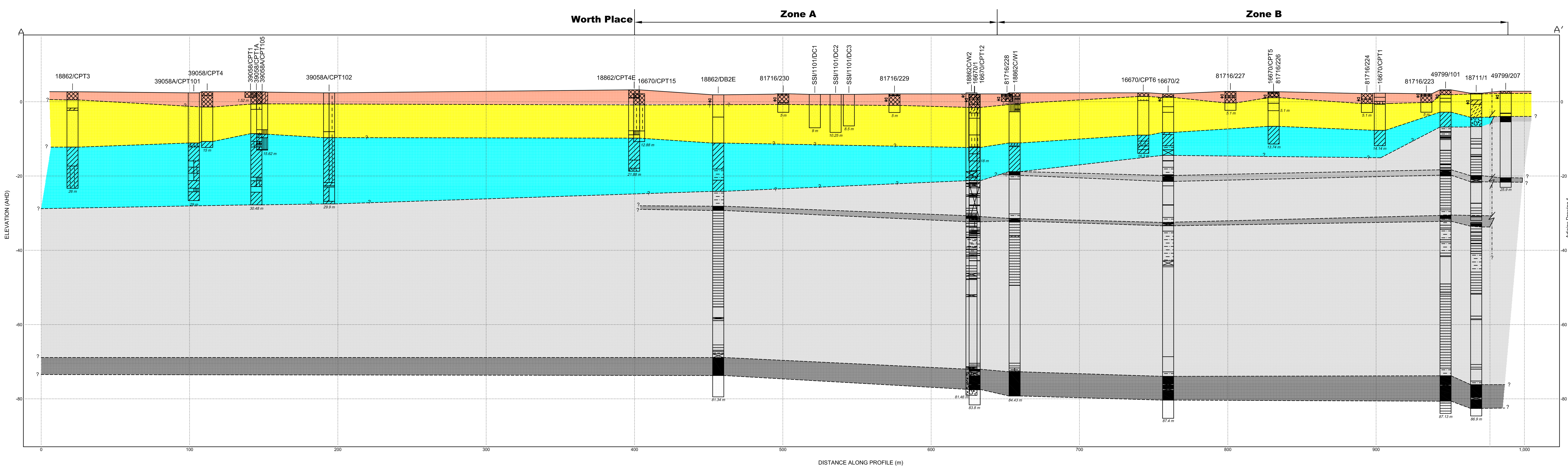
Approximate Rezoning Site Boundary

A Geotechnical Zone

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: UrbanGrowth NSW		TITLE: **Site Plan and Geotechnical Zones** **Surplus Newcastle Rail Corridor Land** **Newcastle**	PROJECT No: 81716.01
OFFICE: Newcastle	DRAWN BY: PLH		DRAWING No: 1
SCALE: 1:5,000@A3 Sheet	DATE: 11.12.2015		REVISION: 1

N



LEGEND

Carbonaceous Siltstone	Clayey Sand	Gravel	Sandstone
Core Loss	Clayey Silt	Laminite	Sandy Clay
Void	Coal	Mudstone	Sandy Silt
Clay	Filling	Sand	Siltstone

Unit 1	Fill
Unit 2	Sand / Silty Sand
Unit 3	Clay / Sandy Clay / Silty Clay
Unit 4	Bedrock - Sandstone, Siltstone, Mudstone, Laminite, Coal
Unit 4.1	Dudley Seam
Unit 4.2	Yard Seam
Unit 4.3	Borehole Seam

NOTE: Layer boundaries have been interpolated between test locations and are therefore approximate. Some test data has been projected onto the section from outside the subject site. Actual stratification may vary from that shown.

TESTS / OTHER

- Water level

0 30

Horizontal Scale (metres)

Vertical Exaggeration = 2.5

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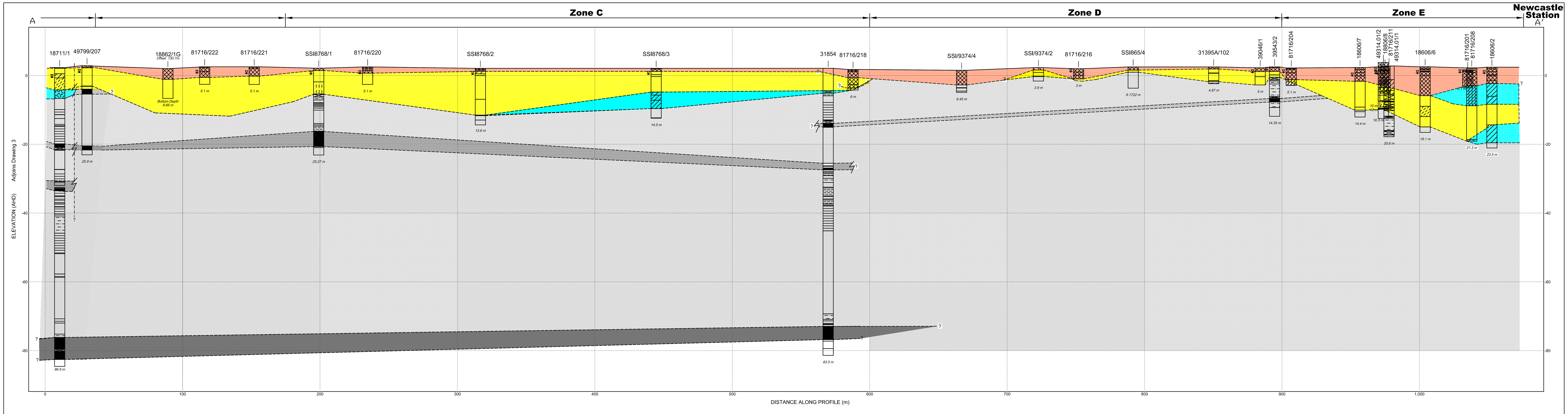
CLIENT: UrbanGrowth NSW		TITLE: Cross-section A-A' (Sheet 1 of 2)	PROJECT No: 81716.00
OFFICE: Newcastle	DRAWN BY: PLH	Newcastle Rail Corridor	DRAWING No: 2
SCALE: 1:1500 (H) 1:600 (V) @ A1	DATE: 10.12.2015	Newcastle	REVISION: 1



NOTE: Layer boundaries have been interpolated between test locations and are therefore approximate. Some test data has been projected onto the section from outside the subject site. Actual stratification may vary from that shown.

LEGEND

Core Loss	Clayey Sand	Filling	Sand
Asphaltic Concrete	Claystone	Laminite	Sandstone
Voic	Coal	Mudstone	Sandstone coarse grained
Clay	Concrete	Roadbase	Sandy Clay

Unit 1	Fill
Unit 2	Sand / Silty Sand
Unit 3	Clay / Sandy Clay / Silty Clay
Unit 4	Bedrock - Sandstone, Siltstone, Mudstone, Laminite, Coal
Unit 4.1	Dudley Seam
Unit 4.2	Yard Seam
Unit 4.3	Borehole Seam

TESTS / OTHER
- Water level

0 30
Horizontal Scale (metres)
Vertical Exaggeration = 2.5

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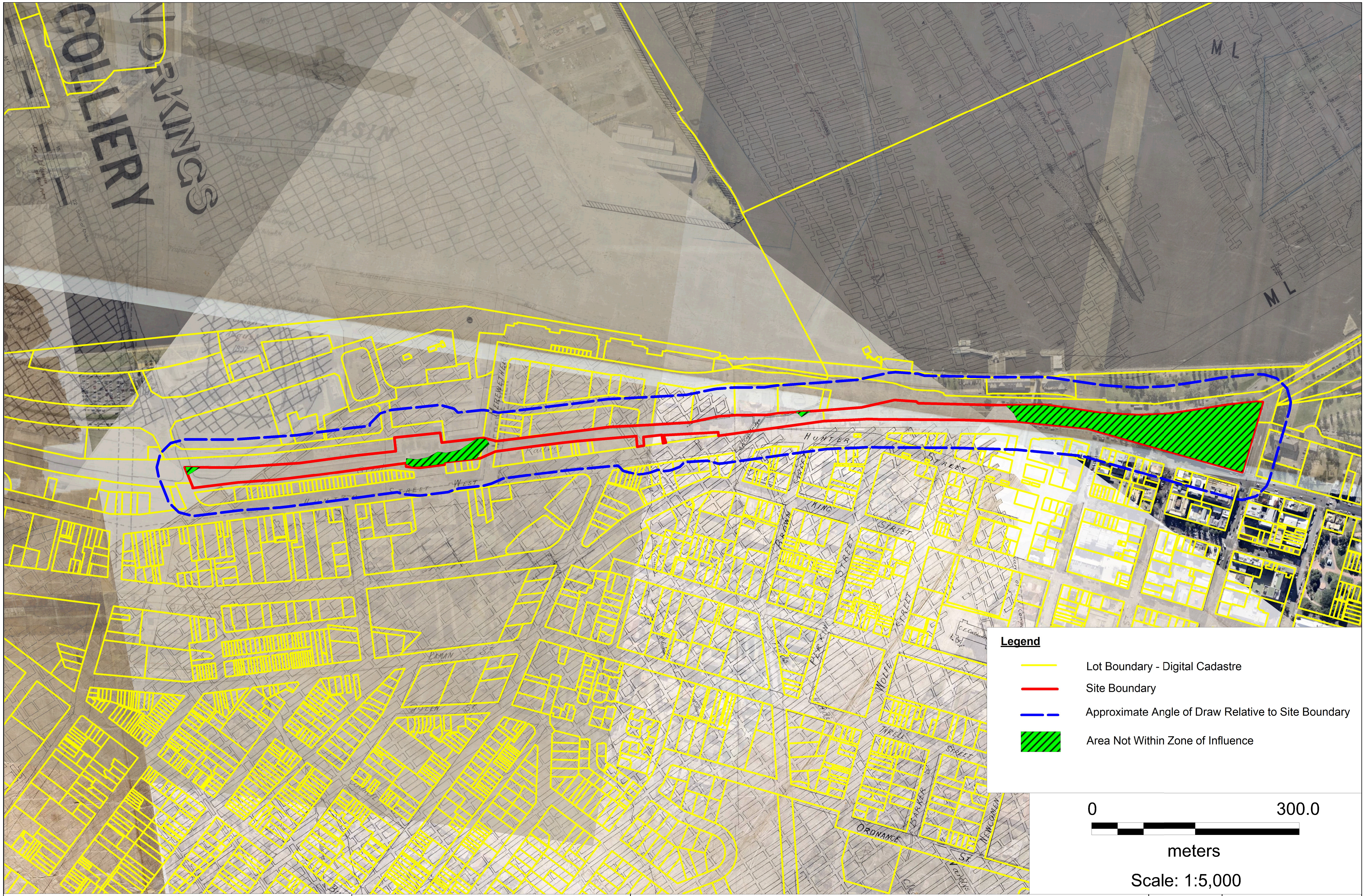
CLIENT: UrbanGrowth NSW		TITLE: Cross-section A-A' (Sheet 2 of 2)	PROJECT No: 81716.00
OFFICE: Newcastle	DRAWN BY: PLH	Surplus Newcastle Rail Corridor Land	DRAWING No: 3
SCALE: 1:1500 (H) 1:600 (V) @ A1	DATE: 10.12.2015	Newcastle	REVISION: 1



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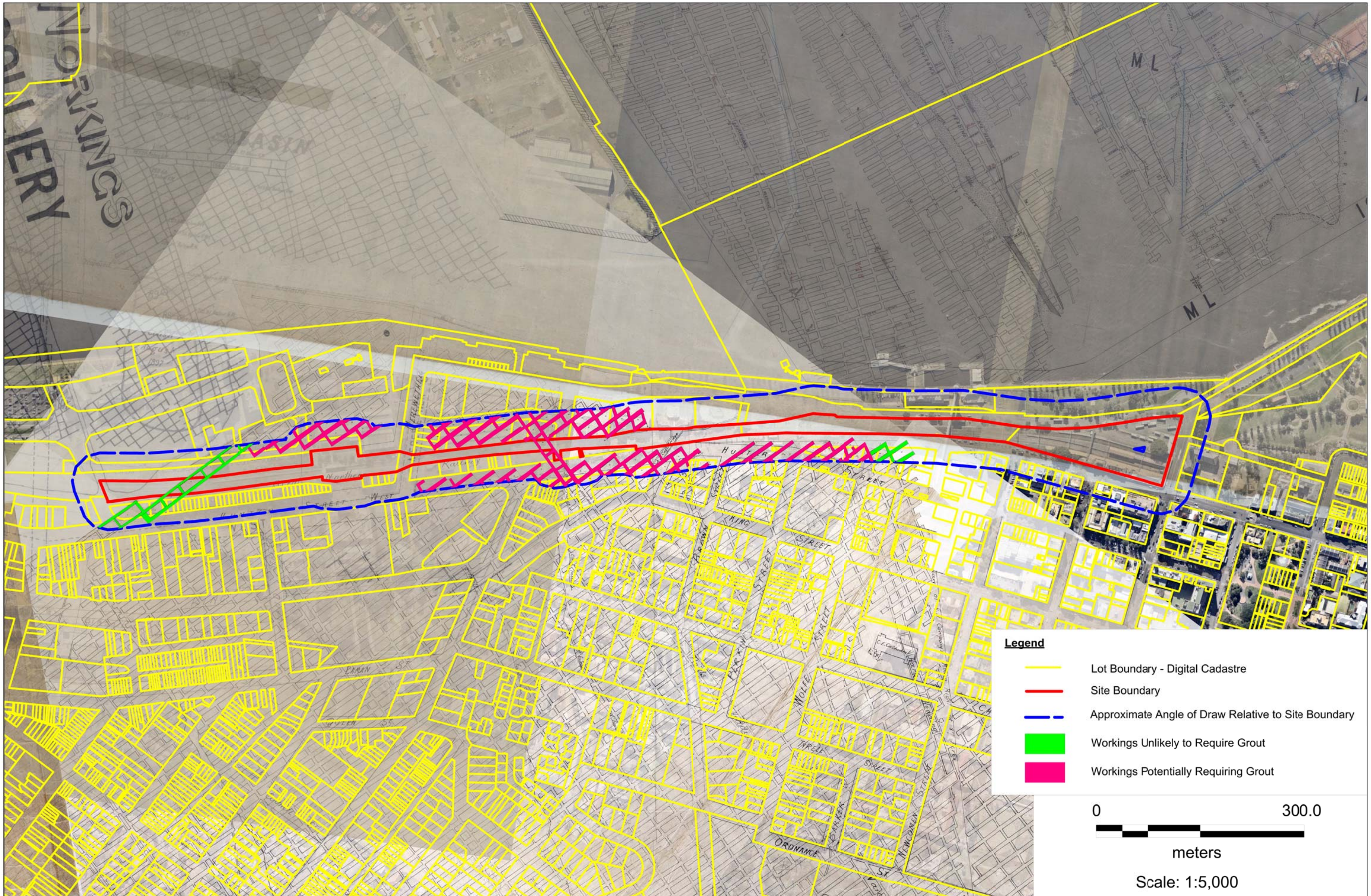
CLIENT: UrbanGrowth NSW	
OFFICE: Newcastle	DRAWN BY: TAC
SCALE: As shown	DATE: 12.01.16

TITLE: **Inferred Layout of Mine Workings in Borehole Seam Newcastle Rail Corridor**

PROJECT No:	81716.01
DRAWING No:	4
REVISION:	0



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CLIENT: UrbanGrowth NSW		TITLE: Preliminary Grout Zones in Borehole Seam Newcastle Rail Corridor	PROJECT No: 81716.01
OFFICE: Newcastle	DRAWN BY: TAC		DRAWING No: 5
SCALE: As shown	DATE: 13.01.16		REVISION: 1