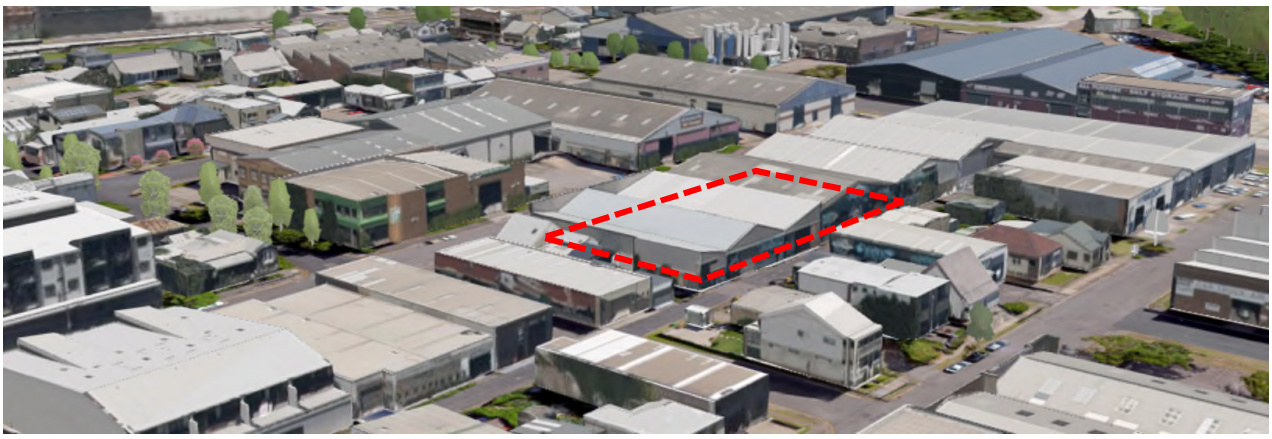
Planning Proposal

PP-2021-328 (formerly PP_2020_NEWCA_001_00)

Proposed Amendment to Newcastle Local Environmental Plan 2012

41 and 47 Throsby Street
Wickham



Version 3 | Public Exhibition 1 October 2021

Version	Description	Date
1.	Council endorsement	28/07/2020
2.	DPIE requested changes – Pre-Gateway Determination	9/09/2020 2/10/2020
3.	Public exhibition	1/10/2021
4.	Final adoption	

CONTENTS

Overview

Land application	**41 Throsby Street, Wickham** – **Lot 63 DP 579890** – **Lots 1 and 2 DP 112816** – **Lot 200 DP 534787** **47 Throsby Street, Wickham** – **Lot 62 DP 579890**
Proposed amendment to Newcastle LEP 2012	Amend Height of building (HOB) map by: – Increasing HOB on part of 41 Throsby Street (i.e. Lots 1 and 2 DP 112816 and Lot 200 DP 534787) from 10m to 22m – Increasing HOB on part of 41 Throsby Street (i.e. Lot 63 DP 579890) and on 47 Throsby Street from 10m to 28m Amend Floor space ratio (FSR) map by: – Increasing FSR applying to both 41 and 47 Throsby Street from 1.5:1 to 3:1
Initiated by	Fidem Property Group on behalf of the current landowner FPG Wickham Pty Ltd

Figure 1 and 2 illustrates the extent of land to which the proposed LEP amendment applies, within a local context.

Figure 1 Subject land at 41 and 47 Throsby Street Wickham

Figure 2 Local context for 41 and 47 Throsby Street Wickham

The proposed LEP amendment was assessed having regard of the following matters:

- Section 3.33 of the Act
- The Department of Planning and Environment's guidelines, *'A guide to preparing planning proposals'.*
- The strategic merit of the proposed amendments to Newcastle LEP 2012 with respect to the provision of additional GFA within the B4 Mixed Use Zone to enable additional housing and/or employment uses within this part of the Newcastle City Centre,
- Consistency with the intent of the adopted Wickham Master Plan (WMP) to unlock potential redevelopment of land and facilitating feasible delivery of local infrastructure including improved connectivity from Throsby Street to Furlong Lane.
- The public interest

PPs are not intended as a static document hence further changes and updates will be made at various stages of the amendment process.

This Version of the PP is to be publicly exhibited together with a draft Planning Agreement for a period of 28 days between 1 October – 1 November 2021 (inclusive), during which submissions will be received and considered by CN and reported back to the elected Council.

Part 1 - Objectives or intended outcomes

The intent of this PP is to amend Newcastle Local Environmental Plan 2012 to enable an increase in the potential gross floor area on land at 41 and 47 Throsby Street, Wickham.

Part 2 - Explanation of provisions

The intended outcome will be achieved by the following amendments to Newcastle LEP 2012:

Floor space ratio
Amend the Floor Space Ratio (FSR) map with respect to the land as follows:

1. Increase the maximum FSR on 41 and 47 Throsby Street from S (1.5:1) to V (3:1)

The proposed amendment to FSR is shown in **Figure 3** *Existing FSR on the land* and **Figure 4** *Proposed FSR on the land*.

Figure 3 Existing FSR on the land – 1.5:1

Figure 4 Proposed FSR on the land – 3:1

Height of buildings

Amend the Height of Building (HOB) map with respect to the land as follows:

1. Increase the maximum HOB on part of 41 Throsby Street from K 10 (meters) to R 22 (meters)
2. Increase the maximum HOB on part of 41 Throsby Street, and all of 47 Throsby Street from K 10 (meters) to T 28 (meters)

The proposed amendments to HOB are shown in **Figure 5** *Existing HOB on the land* and **Figure 6** *Proposed HOB on the land*.

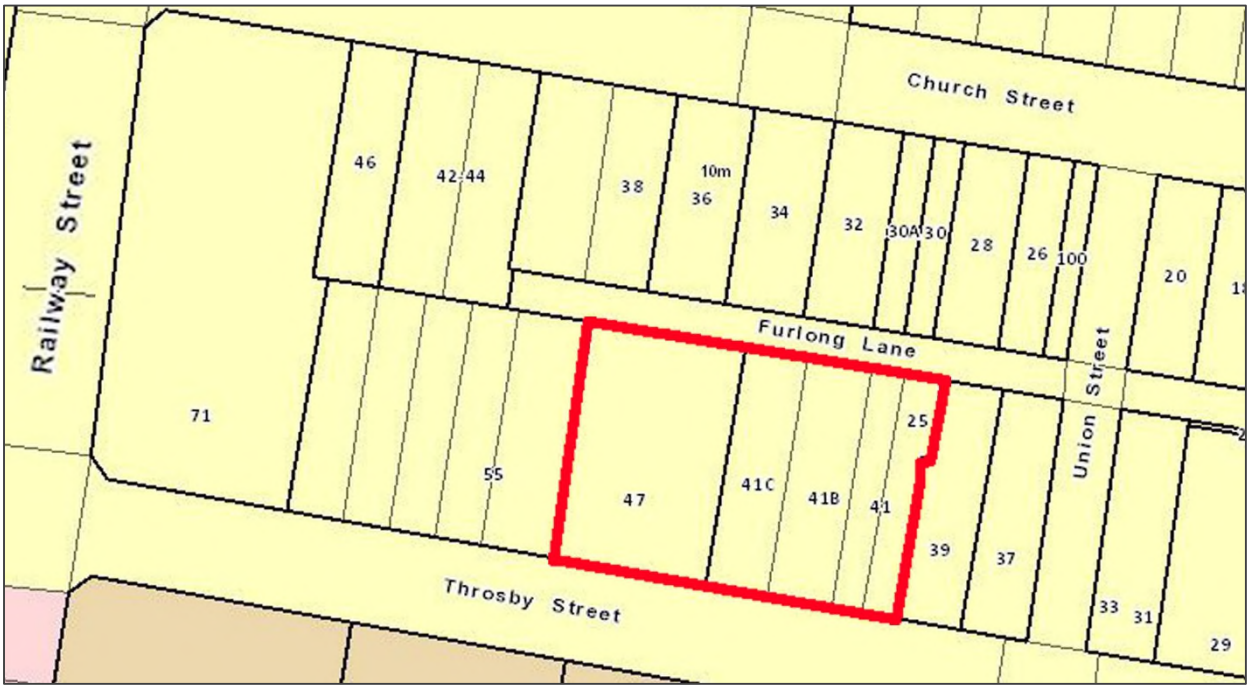


Figure 5 Existing HOB on the land – 10m

Figure 6 Proposed HOB on the land – 28m and 22m

Part 3 - Justification

Section A - Need for the planning proposal

1. Is the planning proposal a result of any strategic study or report?

Wickham Master Plan

The proposal was initiated by the proponent following Wickham Masterplan (WMP) being adopted by Council in November 2017.

The WMP was prepared as a recommendation of the Newcastle Urban Renewal Strategy, prepared by the NSW State Government, which identified Wickham as an area requiring further planning to inform future redevelopment decisions.

WMP identified Strategies and Actions to implement the key objectives:

1. Improve accessibility and connectivity within Wickham and to adjoining areas
2. Create safe, attractive, and inclusive public places
3. Ensure built environment is functional, responsive, and resilient

The WMP 2017 vision identified six interconnecting character precincts. The intent of the precincts is to determine the envisaged character for different parts of Wickham based on their location, physical attributes of the built environment, redevelopment opportunity and density.

The PP area, spans across the hypothetical boundary of two precincts as shown in Figure 7:

- The eastern portion (41 Throsby Street) is within the Village Hub where re-development is envisaged to include a mix of residential apartment buildings and shop top housing (mixed-use development) and terrace style housing. The scale in this precinct is limited by a consistent street wall height similar to existing development in Throsby Street.
- The western portion (47 Throsby Street) being within the Emerging Industry Quarter, which generally has larger development sites allowing redevelopment of a much larger scale than the 'village hub' precinct but maintaining a consistent street wall height and setback through the provision in the Newcastle Development Control Plan 2012 (NDCP 2012).

Figure 7 - Proposed transition of redevelopment densities

The Precinct mapping was updated in the WMP 2021 Update to better reflect the interconnected nature of where precincts, particularly where these transition along the street; the site is shown in red in Figure 8.

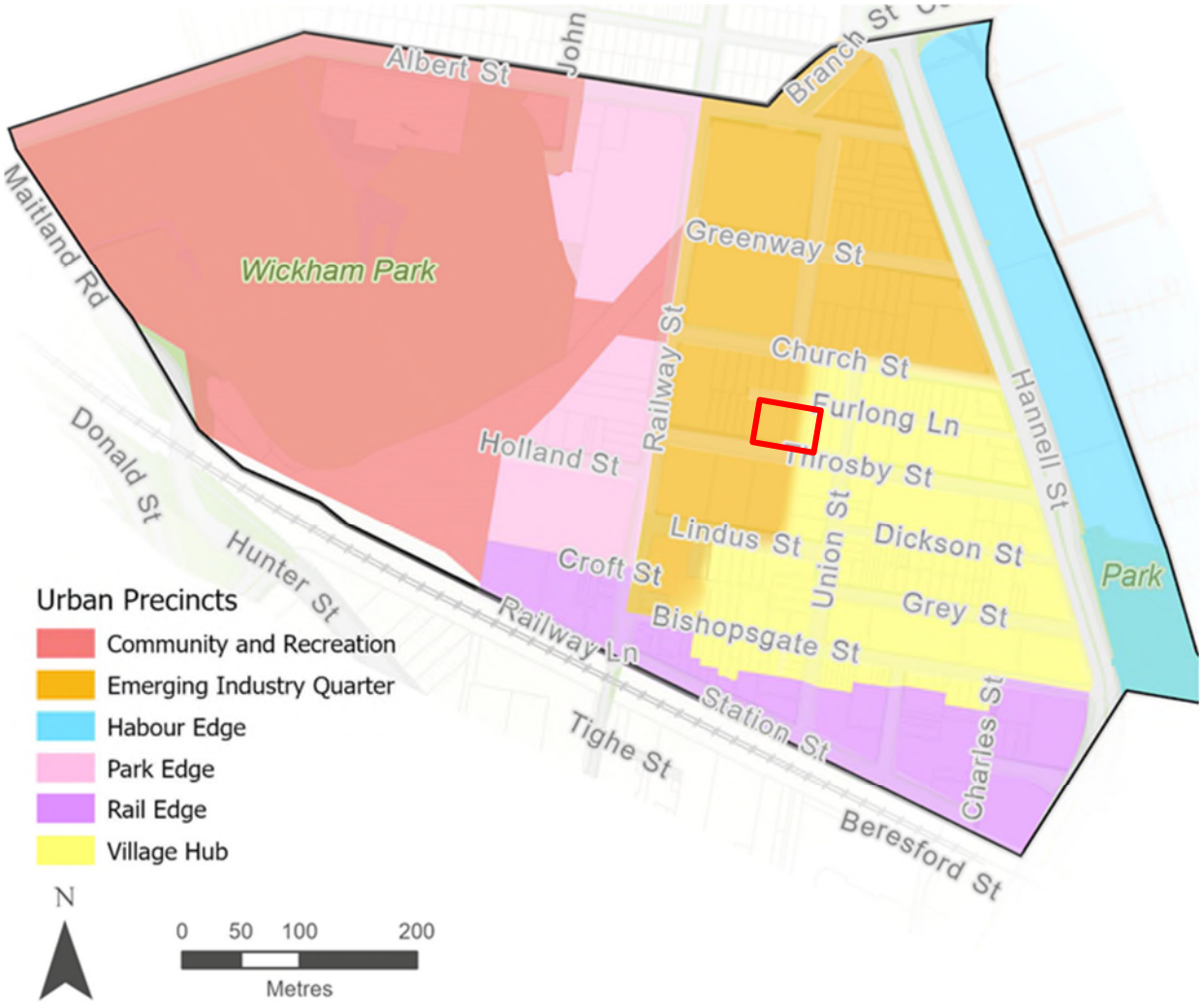


Figure 8 –Wickham Character Precincts as per WMP 2021 Update

The WMP also includes strategies and actions for achieving provision of community infrastructure through developer incentives (including an increase in development standards within in NLEP 2012) where development provides for these. The provision of improved connectivity and public domain improvements between Throsby Street and Furlong Lane are nominated as a community infrastructure project within the WMP.

The PP accompanies a draft Planning Agreement between the applicant and Council, which will provide a laneway along the western boundary of 47 Throsby Street. The WMP had originally identified the proposed laneway to be provided within the adjoining land at 55 Throsby Street, however CN has identified a greater benefit in supporting the delivery of a laneway within 47 Throsby Street while maintaining the opportunity to widen this laneway, when 55 Throsby Street redevelops in the future, thereby providing opportunity for an additional parking lane and public domain fronting as well as achieving a better urban design outcome with greater building separation providing an improve amenity and solar access through to Throsby Street.

The variation in densities proposed in this PP from the general development standards set for Area D in the 2021 WMP update, based on Council's Community Infrastructure Incentives

Policy (adopted 27 July 2021) is suitably justified. The PP being supported by an individual Planning Agreement, made under Section 7.4 of the Act, is generally consistent with the principles of CN's Community infrastructure incentives policy, having regard for the approach (of the policy) in determining the level of community infrastructure delivered under the agreement, having regard for the value of the community infrastructure offered and the additional GFA the planning proposal will deliver, to determine the Incentive GFA.

The proposed transition of redevelopment densities, stepping in HOB across 41 and 47 Throsby Street, will allow for transition of scale at the upper levels set back from the street wall, between precincts.

The increase in density and scale is also suitably justified regarding the potential for mines subsidence. The updated WMP identifies that the site is not undermined but within the area of influence, however the proponent undertook further geotechnical assessment and engaged with Subsidence Advisory NSW prior to public exhibition to confirm the site can achieve the density and scale proposed.

The increase in density and scale is suitably justified on planning grounds having regard to potential impacts and envisaged future character. The proponent previously provided an initial design analysis prepared by EJE Architects, based on the HOB of 28m being applied across the entire PP area, which demonstrated that the PP could result in a development compliant to:

- Council's DCP
- SEPP 65 Residential Apartment Design Guidelines
- WMP by achieving the transition in character and scale, as nominated, through provision of development setbacks and suitable design treatment along Throsby Street.

However, the HOB for the most part of 41 Throsby Street has since been reduced to 22m, which will further reduce potential impacts on character and amenity along Throsby Street particularly to the neighbouring land east of the site.

In conclusion the PP aligns with the WMP as updated in 2021 with respect to nominated location of the new laneway. The PP varies with respect to the redevelopment incentives originally envisaged in WMP 2017, but these variations are justified having regard to Council's Community Infrastructure Incentives Policy, the intent of the WMP, the envisaged local character, and consideration of potential impacts.

2. Is the planning proposal the best means of achieving the objectives or intended outcomes, or is there a better way?

Yes, amending the HOB and FSR maps in the Newcastle LEP 2012 is considered the best means of achieving the objectives of the PP of obtaining additional GFA through an increase in density on the land, at the time.

The proposal will provide certainty of the scale and density of development that may be achieved through subsequent development on the land.

Section B - Relationship to strategic planning framework

3. Is the planning proposal consistent with the objectives and actions of the applicable regional, sub-regional or district plan or strategy (including any exhibited draft plans or strategies)?

Hunter Regional Plan 2036

The Hunter Regional Plan 2036 is the NSW government's plan to guide land use planning and infrastructure priorities and decisions over the next 20 years.

The plan identifies regionally important natural resources, transport networks and social infrastructure and provides a framework to guide more detailed land use plans, development proposals and infrastructure funding decisions. The plan includes overarching directions, goals, and actions as well as specific priorities for each local government area in the Hunter region.

The PP is consistent with the Goals and Directions of this plan. The PP, which comprises an area that is part of the Newcastle City Centre, is consistent with *Direction 3: Revitalise Newcastle City Centre*, particularly *Action 3.1: Promote the growth and renewal of Newcastle City Centre through local strategies and controls*. Indeed, the proposed increase in HOB and FSR will result in an increase in GFA and thus facilitate the growth and renewal of this part of the Newcastle City Centre.

The PP is also considered to be consistent with *Direction 16: Increase resilience to hazards and climate change*. Resilience to potential hazards from sea level rise is being addressed at a broader scale through CN's (The PP is also consistent with 2017) *Strategic Position for the Management of Low-Lying Areas of Newcastle - Wickham - Maryville - Carrington – Islington*, which supports the ongoing redevelopment of these areas combined with various mitigation measures. In the case of this PP, suitable mitigation measures have been considered, such as raising the ground level floor height. This additional height (up to 1m) above natural ground level has been considered in determining the HOB to ensure no further variation under clause 4.6 of NLEP2012 is required (in relation to this issue) in any subsequent DA on the land.

The PP is also consistent with *Direction 20: Revitalise existing communities* and *Direction 21: Create a compact settlement*, as it will facilitate urban development and renewal, as well as new housing opportunities in an existing urban area with existing services and infrastructure. The PP is for example consistent with the following actions:

- *Action 21.2: Focus development to create compact settlements in locations with established services and infrastructure, including the Maitland Corridor growth area; Newcastle–Lake Macquarie Western Corridor growth area; the emerging growth area around Cooranbong, Morisset, and Wyee; and in existing towns and villages and sites identified in an endorsed regional or local strategy.*
- *Action 21.3: Identify opportunities for urban redevelopment or renewal in urban locations with access to public transport and services in the Greater Newcastle metropolitan area and where there may no longer be a need for employment land.*
- *Action 21.4: Create a well-planned, functional, and compact settlement pattern that responds to settlement planning principles and does not encroach on sensitive land uses, including land subject to hazards, on drinking water catchments or on areas with high environmental values.*

- *Action 21.5: Promote small-scale renewal in existing urban areas, in consultation with the community and industry to ensure that this occurs in the right locations.*
- *Action 21.6: Provide greater housing choice by delivering diverse housing, lot types and sizes, including small-lot housing in infill and greenfield locations.*
- *Action 21.7: Promote new housing opportunities in urban areas to maximise the use of existing infrastructure.*

Moreover, the PP is also consistent with *Direction 22: Promote housing diversity*, particularly *Action 22,2: Encourage housing diversity, including studios and one and two-bedroom dwellings, to match forecast changes in household sizes*. In addition, the PP is consistent with *Direction 23: Grow centres and renewal corridors*, particularly *Action 23.1: Concentrate growth in strategic centres, local centres and urban renewal corridors to support economic and population growth and a mix of uses*. Indeed, the PP will help to provide diverse housing options and mixed-use development in a strategic centre, thereby helping to support economic and population growth in the right location.

Greater Newcastle Metropolitan Plan 2036

The Greater Newcastle Metropolitan Plan (GNMP) helps to achieve the vision set in the Hunter Regional Plan 2036 – for the Hunter to be the leading regional economy in Australia with a vibrant new metropolitan city at its heart. The GNMP sets out four outcomes to be achieved and identifies catalyst area, including Newcastle City Centre. The Plan also provides specific directions for the 'Wickham Precinct', which aligns with the PP area and sets out the following:

"Newcastle City Council will align local plans to:

- *facilitate the long-term expansion of the City Centre towards Wickham*
- *increase opportunities for transit-oriented development around Newcastle Interchange*
- *respond to development constraints including mine subsidence and flooding*
- *provide floor space for emerging new economy industries and businesses."*

The PP is consistent with the above-mentioned outcomes of the GNMP in that it:

- seeks to facilitate redevelopment to support and complement the emerging city centre
- increases density of mixed-use development around the Newcastle interchange
- responds to development constraints, including flooding and mine subsidence (as outlined under Section B – No 6 Ministerial Directions)
- ensuring sufficient FSR to ensure feasibility of mixed-use development.

The PP also aims to facilitate the revitalisation of Wickham, which is part of the Newcastle City Centre, and is therefore consistent with *Strategy 1: Reinforce the revitalisation of Newcastle city centre and expand transformation along the waterside*, particularly *Action 1.3: Newcastle City Council will align local plans to enable continued investment in Newcastle City Centre that is consistent with this Plan*.

In addition, the PP is also consistent with *Strategy 9: Plan for jobs closer to homes in the metro frame*, more particularly *Action 9.2: Greater Newcastle councils will: amend local plans to promote more shared workspaces for start-ups in strategic centres; enable small business growth in residential zones close to centres and transport connections*. Indeed, the increase in HOB and FSR will result in additional GFA, which could potentially be used to accommodate shared workspaces for start-ups. Although the second point of Action 9.2 is not applicable to

this PP, as the land is zoned B4 – Mixed Use and is not zoned residential, the existing zoning of the land does enable small business growth close to centres and transport connection.

Moreover, the PP will facilitate infill housing within a strategic centre and is thus also consistent with *Strategy 16: Prioritise the delivery of infill housing opportunities within existing urban areas,* especially *Action 16.1: Greater Newcastle councils will focus new housing in existing urban areas, particularly within strategic centres and along urban renewal corridors*.

Furthermore, the PP will help to achieve the desired role of Newcastle City Centre as an *urban renewal precinct, meeting demand for medium and high-density housing that contributes to the heritage character of the city.*

4. Is the planning proposal consistent with a council's local strategy or other local strategic plan?

Newcastle 2030 Community Strategic Plan

The Newcastle Community Strategic Plan (2017 updated) identifies the community's vision for the city, outlines actions and strategies for Council to achieve, as well as indicators for monitoring implementation.

Compliance with the LEP amendment process, ensures consistency with the strategic direction 'Open and Collaborative Leadership' and the strategic objective to "Consider decision-making based on collaborative, transparent and accountable leadership"

Furthermore, the PP is consistent with the remaining strategic directions and objectives, or at a minimum does not result in any inconsistencies with the following:

- Connected city
- Vibrant and activated public places
- Protected and enhanced environments
- Caring and inclusive community
- Liveable and distinctive built environment
- Smart and innovative city.

Newcastle Local Strategic Planning Statement

The Local Strategic Planning Statement (LSPS) adopted by Council in 2020 and endorsed by the Secretary of the Department of Planning and Environment provides a comprehensive guide for the future growth and development of Newcastle consistent with the GNMP.

The LSPS advocates redevelopment in Wickham, as part of the Newcastle City Centre Catalyst Area. This PP supports an increase in provision of housing and jobs close to public transport and supporting urban renewal.

Wickham Master Plan

The WMP was adopted by Council in November 2017 and updated in 2021.

This plan identified potential future development densities based on both envisaged character precincts and potential developer incentives to deliver critical infrastructure, land for improvement of the public domain and critical connections for traffic management and ease of pedestrian movement.

This PP is consistent with the intent of the plan in that it will enable the dedicated to Council of the laneway sought between the end of Furlong Lane through to Throsby Street. The provision of the laneway on 47 Throsby Street preserves the opportunity to widen the laneway in future. The proposed HOB and FSR is generally consistent with the envisaged density of the character precincts and will result in an increased gross floor area calculated to result in enabling a feasible development outcome.

Community Infrastructure Incentives Policy

CN adopted a Community Infrastructure Incentives Policy in July 2021.

This policy sets out the intent and mechanisms to enhance the delivery of community infrastructure to support urban renewal in the City of Newcastle (CN) through the provision of development incentives.

CN is in the process of preparing a separate Planning Proposal to implement this policy, which will incorporate the general development incentives standards for provision of community infrastructure within the Wickham shown in Figure X. For clarity, this PP will vary from the general standards but is consistent with the mechanisms described in the policy in that the increased HOB and FSR correspond with an agreed GFA rate prepared specifically for the height, having regard for the value of the laneway offered as community infrastructure. The proponent has prepared a draft Planning Agreement setting out the terms to deliver the agreed community infrastructure.

5. Is the planning proposal consistent with applicable State Environmental Planning Policies?

The table below provides an assessment of the proposed amendment against each State Environmental Planning Policy (SEPP) applying at the time of preparing this PP.

The assessment undertaken firstly identified which SEPP applies to the proposal, determined by the SEPP applying to both:

a. the land; and
b. the preparation of environmental planning Instruments.

Where applicable, the table identifies how the PP addresses the requirements of the SEPP.

Table 1 - Relevant State Environmental Planning Policies

State Environmental Planning Policies	Applicable	Consistency and Implications
SEPP No 1—Development Standards	No	
SEPP No 14—Coastal Wetlands	No	
SEPP No 19—Bushland in Urban Areas	No	
SEPP No 21—Caravan Parks	No	
SEPP No 26—Littoral Rainforests	No	
SEPP No 30—Intensive Agriculture	No	
SEPP No 33—Hazardous and Offensive Development	No	
SEPP No 36—Manufactured Home Estates	No	
SEPP Koala Habitat Protection 2019	Yes	Whilst this policy applies to the land, there is no potential Koala habitat within the vicinity of the PP area hence the

State Environmental Planning Policies	Applicable	Consistency and Implications
		requirements of this SEPP are not applicable.
SEPP No 47—Moore Park Showground	No	
SEPP No 50—Canal Estate Development	No	
SEPP No 52—Farm Dams and Other Works in Land and Water Management Plan Areas	No	
SEPP No 55—Remediation of Land	Yes	Clause 6 requires Council to consider potential land contamination when preparing an Environmental Planning Instrument (e.g. LEP amendment). Subclause (2), requires Council to obtain and consider a report on the findings of a preliminary investigation of the land (carried out in accordance with the contaminated land planning guidelines) where the amendment will permit certain land uses, as specified in subclause (4)(c), to be permitted. This PP does not result in a change of zoning from the current zone B4 Mixed Use, which already permits the uses specified by subclause (4)(c).
SEPP No 62—Sustainable Aquaculture	No	
SEPP No 64—Advertising and Signage	No	
SEPP No 65—Design Quality of Residential Apartment Development	Yes	The land is already zoned B4 Mixed Use which permits the land to developed for uses to which this policy applies (residential apartment development). Council is satisfied that the proposed amendments in HOB and FSR will enable development that is compliant with this policy and associated apartment design guidelines. Council has a design review panel under this SEPP but has not sought advice under clause 27 (c) at this stage. Any subsequent development proposal will be referred to this panel as a matter of due course.
SEPP No 70—Affordable Housing (Revised Schemes)	No	
SEPP (Coastal Management) 2018	Yes	The SEPP (Coastal Management) 2018 applies to the PP area. Most of the PP area is situated within the Coastal Environment Area, with only the north-eastern part of 41 Throsby Street, Wickham being situated within the Coastal Use Area. Council is satisfied that the proposed LEP amendments will not result in subsequent development proposals being inconsistent with the aims of this policy,

State Environmental Planning Policies	Applicable	Consistency and Implications
		or the controls under Division 3 Coastal environment area, Division 4 Coastal use area, and Division 5 General.
SEPP (Affordable Rental Housing) 2009	No	
SEPP (Building Sustainability Index: BASIX) 2004	No	
SEPP (Educational Establishments and Child Care Facilities) 2017	No	
SEPP (Exempt and Complying Development Codes) 2008	No	
SEPP (Housing for Seniors or People with a Disability) 2004	No	
SEPP (Infrastructure) 2007	No	
SEPP (Integration and Repeals) 2016	No	
SEPP (Kosciuszko National Park—Alpine Resorts) 2007	No	
SEPP (Kurnell Peninsula) 1989	No	
SEPP (Mining, Petroleum Production and Extractive Industries) 2007	No	
SEPP (Miscellaneous Consent Provisions) 2007	No	
SEPP (Penrith Lakes Scheme) 1989	No	
SEPP (Rural Lands) 2008	No	
SEPP (State and Regional Development) 2011	No	
SEPP (State Significant Precincts) 2005	No	
SEPP (Sydney Drinking Water Catchment) 2011	No	
SEPP (Sydney Region Growth Centres) 2006	No	
SEPP (Three Ports) 2013	No	
SEPP (Urban Renewal) 2010	Yes	The area subject to this PP is wholly within land to which Newcastle Potential Precinct Map applies. The requirements of Clause 9 *Proposals for potential precincts* were satisfied by the preparation of the Newcastle Urban Renewal Strategy (NURS). The NURS identified the need for further planning to be undertaken in relation to the renewal of the Wickham area; hence the WMP was prepared and adopted by Council. This PP is consistent with the WMP.
SEPP (Vegetation in Non-Rural Areas) 2017	No	
SEPP (Western Sydney Employment Area) 2009	No	
SEPP (Western Sydney Parklands) 2009	No	

6. Is the planning proposal consistent with applicable Ministerial Directions (s.9.1 directions)?

The table below documents Council's assessment of the PP against the relevant Ministerial Directions made under Section 9.1 of the EP&A Act 1979 (formerly known as Section 117 Directions).

Table 2 - Relevant Ministerial Directions

Relevant Section 9.1 Directions	Applicable	Consistency and implications
1. Employment and Resources		
1.1 Business and Industrial Zones	Yes	The PP not only retains the existing opportunities for business uses within the B4 Mixed Use zone but seeks to expand this by an increase in FSR thereby allowing a greater potential GFA for permitted uses including business uses.
1.2 Rural Zones	No	
1.3 Mining, Petroleum Production and Extractive Industries	No	
1.4 Oyster Aquaculture	No	
1.5 Rural Lands	No	
2. Environment and Heritage		
2.1 Environment Protection Zones	Yes	Whilst the Direction applies, the PP will have no effect on, or be affected by areas of environmental sensitivity. Hence the proposal is of minor significance.
2.2 Coastal Management	Yes	The PP area is within the coastal zone as defined under the *Coastal Management Act 2016.* The PP is consistent with clause 4 of this ministerial direction. Clauses 5, 6 and 7 of this ministerial direction do not apply to this PP. The PP is therefore considered to be consistent with this ministerial direction.
2.3 Heritage Conservation	No	
2.4 Recreation Vehicle Areas	No	
2.5 Application of E2 and E3 Zones and Environmental Overlays in Far North Coast LEPs	No	

Relevant Section 9.1 Directions	Applicable	Consistency and implications
2.6 Remediation of Contaminated Land	Yes	This direction applies to the proposal, since it is possible that development for a purpose referred to in Table 1 of the *Managing Land Contamination – Planning Guidelines – SEPP 55 – Remediation of Land* may have been carried out on the land, as it had previously been zoned to allow light industry in the past, despite the site not being identified on Council's contaminated land register**.** However, the Planning Proposal only aims at amending the FSR and HOB and not the zoning of the land or allow changes to the permissibility of land uses. Hence, Council has not sought to obtain a preliminary investigation in accordance with the contaminated land planning guidelines.
3. Housing, Infrastructure and Urban Development		
3.1 Residential Zones	Yes	This direction applies to the PP as the B4 Mixed Use zone permits significant residential development. The PP will not reduce the permissibility of residential uses but rather increase their feasibility due to an increase in FSR and HOB.
3.2 Caravan Parks and Manufactured Home Estates	No	
3.3 Home Occupations	Yes	The B4 zone within Newcastle LEP 2012 already permits Home Occupation as a use permitted without consent, hence is consistent with this direction.
3.4 Integrating Land Use and Transport	Yes	The PP includes provision of additional land zoned for business and residential through the rezoning of land to B4 Mixed Use. The land subject to rezoning is within the Newcastle City Centre Area boundary and hence is consistent with the aims, objectives, and principles of: (a) Improving Transport Choice – Guidelines for planning and development (DUAP 2001), and (b) The Right Place for Business and Services – Planning Policy (DUAP 2001).
3.5 Development Near Licensed Aerodromes	No	
4. Hazard and Risk		
4.1 Acid Sulphate Soils	Yes	The land is located within categories 3 of the ASS map in NLEP2012. However, the PP does not include provisions or amendments that will increase the risk or hazard from the current potential, hence it is of minor significance and does not require any further study.

Relevant Section 9.1 Directions	Applicable	Consistency and implications
4.2 Mine Subsidence and Unstable Land	Yes	The Land is in a proclaimed Mine Subsidence District: Newcastle. Furthermore**,** the land is subject to Subsidence Advisory NSW Guidelines 2, which places general restrictions on development, unless it can be demonstrated that larger developments can be designed to accommodate the mine impacts. Council has formally consult with Subsidence Advisory NSW on this as per condition 2 of the Gateway determination. This is further outlined in section '*11. What are the views of state and Commonwealth public authorities consulted in accordance with the Gateway determination*' of this PP.
4.3 Flood Prone Land	No	The PP applies to land identified as being within a flood planning area according to the Newcastle City-wide Floodplain Risk Management Study and Plan 2012 maps. However, the land does not consist of a floodway or flood storage but is in the flood fringe. This direction does not apply given that the planning proposal will not result in a provision that affects flood prone land.
4.4 Planning for Bushfire Protection	No	
5. Regional Planning		
5.1 Implementation of Regional Strategies	No	
5.2 Sydney Drinking Water Catchments	No	
5.3 Farmland of State and Regional Significance on the NSW Far North Coast	No	
5.4 Commercial and Retail Development along the Pacific Highway, North Coast	No	
5.5 Development in the vicinity of Ellalong, Paxton and Millfield (Cessnock LGA) (Revoked 18 June 2010)	No	
5.6 Sydney to Canberra Corridor (Revoked 10 July 2008. See amended Direction 5.1)	No	
5.7 Central Coast (Revoked 10 July 2008. See amended Direction 5.1)	No	
5.8 Second Sydney Airport: Badgerys Creek	No	
5.9 North West Rail Link Corridor Strategy	No	

Relevant Section 9.1 Directions	Applicable	Consistency and implications
5.10 Implementation of Regional Plans	Yes	The PP applies to land within the Hunter Regional Plan. The PP is consistent with the regional plan, as outlined in Section B 3 above.
6. Local Plan Making		
6.1 Approval and Referral Requirements	Yes	The PP does not include any provisions that will require development application to seek approval or referral from any other public authority. Council will consult with public authorities prior to public exhibition in accordance with any conditions imposed on the PP during Gateway determination.
6.2 Reserving Land for Public Purposes	No	
6.3 Site Specific Provisions	No	
7. Metropolitan Planning		
7.1 Implementation of A Plan for Growing Sydney	No	Note: The land is located within an identified Catalyst area within the Greater Newcastle Metropolitan plan, as located within the Newcastle City Centre area. The PP is consistent with this plan.

Section C - Environmental, social and economic impact

7. Is there any likelihood that critical habitat or threatened species, populations or ecological communities, or their habitats, will be adversely affected as a result of the proposal?

The land subject to the proposal does not contain critical habitat or threatened species, populations or ecological community, or their habitats.

8. Are there any other likely environmental effects as a result of the planning proposal and how are they proposed to be managed?

The PP will not result in any other environmental effects not already considered above.

9. Has the planning proposal adequately addressed any social and economic effects?

Newcastle has undergone significant economic change over the past decade evolving beyond its industrial and manufacturing origins towards a more economically diverse regional city. The renewal of Newcastle has become a major undertaking of the NSW government. The 'Revitalising Newcastle' program included the rollout of new transport infrastructure, incorporating a new light rail extending from Newcastle East to Wickham. The positioning of Wickham adjacent to the new CBD at Newcastle West and the Newcastle interchange has strengthened Wickham's importance to achieving the aims of the urban renewal program.

CN prepared the Wickham Master Plan in recognition of the need to incorporate flexibility into the planning framework and allow Wickham to grow and develop over time having regard to changes in population and lifestyle characteristics, trends in employment, retail, and community service provision. CN's master planning process identified opportunities and constraints of redevelopment within Wickham and included feasibility testing.

The urban renewal of inner Newcastle is well underway along with the transition to medium and higher density living. The economic analysis undertaken as part of the Wickham Master Plan and the evidence report underpinning CN's draft Local Housing Strategy identified demographic shifts, including an ageing population and rising land values creating affordability issues. With shrinking family sizes no longer requiring large single dwellings, the analysis revealed a trend in residents relocating from the outer suburbs and hinterlands to the inner Newcastle apartment market.

The PP will facilitate an increase in residential density and housing choice in walkable distance to the emerging commercial centre of the city and in vicinity to public transport, as well as to other amenities, such as Wickham Park and Throsby Creek. Moreover, the increase in the number of residents facilitated by the proposal will also likely result in economic benefits for businesses in the area, due to increased demand for goods and services.

Furthermore, the PP will also facilitate an increase in the provision of a range of employment and business opportunities. In this regard, the PP is also consistent with the planning principles for remnant industrial sites outlined in the Newcastle Employment Lands Strategy, as it will facilitate an increase in the provision of employment-generating floorspace and will also facilitate the redevelopment of remnant industrial uses in an urban area with high levels of amenity to creative employment space.

Overall, the redevelopment of the site facilitated by the PP will support increased residential densities as well as economic and employment generating uses that compliment and support the adjoining emerging commercial core of the Newcastle City Centre located within Newcastle West.

Section D - State and Commonwealth interests

10. Is there adequate public infrastructure for the planning proposal?

Existing infrastructure within the City Centre is adequate to meet the needs of development potentially resulting from the proposal planning.

11. What are the views of state and Commonwealth public authorities consulted in accordance with the Gateway determination?

Subsidence Advisory NSW

City of Newcastle (CN) consulted with Subsidence Advisory NSW (SANSW) in accordance with condition 2 of the Gateway Determination. SANSW provided feedback, dated 10 February 2021 that confirmed that the site was not undermined but within an area of mine subsidence risk, hence further geotechnical assessment would be required to determine the potential mitigation measures or design parameters required to allow subsequent development that conforms with the increase in HOB and FSR proposed within the Newcastle LEP 2012.

To ensure such development is likely to be viable and that the intent of the Planning Proposal is achievable, CN instructed the applicant to liaise further with SANSW with respect to undertaking the required assessment prior to progressing the Planning Proposal to public exhibition. A Mine Subsidence Assessment was prepared by geotechnical consultants Tetra Tech Coffey (**Appendix A**) and provided to SANSW.

SANSW confirmed on 28 July 2021 that the requirements for geotechnical assessment (in relation to the proposed amendments) are met in relation to the proposed amendment and that SANSW approval of a subsequent compliant development application will require a peer review of the Tetra Tech Coffey report to confirm the geotechnical uncertainty factor is low to moderate in accordance with SA NSW's Merit Assessment Policy.

CN followed up with the Manager Subsidence Risk Evaluation and Regulation at SANSW, on 2 August 2021, to verbally confirm that the level of additional requirements on subsequent development identified is viable to proceed and does not increase the level of risk on the surrounding area.

As a result of the above, CN is satisfied for that the Planning Proposal to proceed and has advised Department of Planning, Industry and Environment of this together with a copy of the relevant correspondence and the report included in Appendix A, as per condition 3 of the Gateway Determination.

Part 4 - Mapping

The PP seeks to amend the following map sheets within Newcastle LEP 2012:

- ✓ Height of Buildings Map – HOB_004FA
- ✓ Floor Space Ratio Map – FSR_004FA

Part 5 - Community consultation

The PP is considered as low impact in accordance with the Department of Planning and Environment's guidelines, *A guide to preparing local environmental plans*.

However, the Gateway Determination, dated 1 January 2021, supported CN exhibiting the PP for 28 days, under condition 1(a).

The Gateway determination further included a condition 1(c) that required public exhibition to commence within 4 months following gateway. However, given the timeframe to carry out consultation with SANSW and satisfy their requirement for a Mine Subsidence Assessment, this timeframe was not achievable. As a result, CN requested and were granted 'Alteration of Gateway Determination' to extend the timeframe to commence public exhibition.

The PP will be publicly exhibited simultaneously to a Planning Agreement over the land for a minimum 28-day period commencing on 1 October 2021.

Part 6 - Project timeline

The plan making process is anticipated to take 12 months as shown in the timeline below. It will be undertaken in accordance with the Gateway determination.

Task	Status	Dates
Council endorsement	Complete	28 July 2020
Gateway determination	Determined Alteration (1st) Alteration (2nd)	1 January 2021 20 May 2021 6 September 2021
Consultation with required government agency: – Subsidence Advisory NSW	– Letter sent – Response received – Matters resolved	19 January 2021 10 February 2021 28 July 2021
Public exhibition period	Current	1 October – 1 November 2021
Timeframe for reporting submissions	Anticipated (following local government elections in Dec 21 and Council recess in Jan 22)	February 2022
Plan making		April 2022

Appendices

A. Mine Subsidence Assessment - Proposed Redevelopment 41- 47 Throsby Street Wickham (dated 28 June 2021) prepared by Tetra Tech Coffey

Appendix A

Mines Subsidence Assessment

Proposed Redevelopment 41- 47 Throsby Street Wickham

Mine Subsidence Assessment

Fidem Property Group

Reference: 754-NTLGE286549-AB.Rev1

28 June 2021

PROPOSED REDEVELOPMENT 41-47 THROSBY STREET WICKHAM

Mine Subsidence Assessment

Report reference number: 754-NTLGE286549-AB.Rev1
28 June 2021

PREPARED FOR

Fidem Property Group
Suite 4, Level 1, 19-21 Wentworth Street,
Parramatta NSW 2150

PREPARED BY

Tetra Tech Coffey
16 Callistemon Close
Warabrook
NSW 2304 Australia
p: +61 2 4028 9700

ABN 55 139 460 521

QUALITY INFORMATION

Revision history

Revision	Description	Date	Author	Reviewer	Approver
v1 draft	Draft Report	04/05/2021	Simon Baker	Ching Dai	Simon Baker
Revision 1	Report	28/06/20201	Simon Baker	Ching Dai/ Jules Darras	Simon Baker

Distribution

Report Status	No. of copies	Format	Distributed to	Date
v1 draft	1	PDF	Neil Petherbridge	04/05/2021
Revision 1	1	PDF	Neil Petherbridge	28/06/2021

EXECUTIVE SUMMARY[1]

Fidem Property Group commissioned Tetra Tech Coffey Pty Ltd (Tetra Tech) to carry out a mine subsidence desktop study and numerical modelling for the proposed re-development of 41-47 Throsby Street Wickham, NSW.

This report addresses the scope outlined in Coffey proposal 754-NTLGE286549-AA.Rev1 dated 31 March 2021 it present results of a desk study as well as numerical modelling using FLAC3D. The agreement was signed on 27 April 2021 by Michael Ghobrial.

Although not directly undermined, the area around the site to the north east and west is known to be located over abandoned mine workings within the Borehole Seam, by the Ferndale Colliery from their Wickham Mine. The mine workings are assessed to be located a minimum of 17m to the north west and 13m to the north east. Using nearby boreholes, the workings are estimated to be at a depth of approximately 55m to 58m below the ground surface.

Pillar stability was assessed using empirical and numerical analysis. Sensitivity analysis was completed by two methods decreasing modulus of the coal, and by increased the magnitude of convergence at seem level.

Using numerical analysis, the global Factor of Safety (FoS) is estimated to be 1.4.

From the analysis the maximum surface subsidence parameters are estimated be:

- Subsidence of 140mm along Section A and 100mm along Section B
- Tensile strains 3mm/m across the whole building and 5mm/m for the northern 10m.
- Across the building the tensile strain of 1.5mm and 2.5mm/m for the whole site and the northern 10m respectively is applicable.
- The radius of curvature is estimated to be 10km at the southern side increasing to 4km for the northern 20m.
- Tilts ranging from 2mm/m up to 7mm/m at the northern end

An appropriate ‘safe’ design profile was provided allowing for an additional 40% increase in subsidence with up to the following parameters:

- Subsidence of 180mm along Section A and 130mm along Section B
- Tensile strains 3.3mm/m across the whole building and 6mm/m for the northern 10m.
- Across the building the tensile strain of 1.5mm and 3mm/m for the whole site and the northern 10m respectively is applicable.
- The radius of curvature is estimated to be 3km at the southern side increasing to 1.6km for the northern 20m.
- Tilts ranging from 2mm/m up to 10mm/m at the northern end

These values are believed to be within economical design for buildings, however should be discussed with the project structural engineer/s about any setbacks that may be recommended.

[1] This executive summary must be read in the context of the full report and the attached limitations.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
FOS	Factor of Safety
Tetra Tech	Tetra Tech Coffey Pty Ltd
W&BIC	Wickham & Bullock Island Colliery
SA NSW	Subsidence Advisory NSW

1. INTRODUCTION

Fidem Property Group commissioned Tetra Tech Coffey Pty Ltd (Tetra Tech) to carry out a mine subsidence desktop study and numerical modelling for the proposed re-development of 41-47 Throsby Street Wickham, NSW.

This report addresses the scope outlined in Coffey proposal 754-NTLGE286549-AA.Rev1 dated 31 March 2021 it present results of a desk study as well as numerical modelling using FLAC3D. The agreement was signed on 27 April 2021 by Michael Ghobrial.

The proposed development is in the planning phase with key features of the development likely dependant on the results of this assessment.

Although not directly undermined, the area around the site is known to be located over abandoned mine workings within the Borehole Seam by the Ferndale Colliery from their Wickham Mine. The mine workings, by nearby boreholes, are estimated to be at a depth of approximately 55m to 58m below the ground surface.

The following report presents the steps followed in the desktop study and numerical analysis of the mine workings, the data used in this assessment, and the resultant findings and recommendations for design. This report does not include assessment of potential movements from the construction of the building itself (i.e. consolidation of soil layers) and does not address footing design parameters.

2. SCOPE OF WORK

This mine subsidence assessment has included:

- A review of previous reports in the area including:
  - Proposed Residential Development 25 Throsby Street (Coffey Geotechnics Pty Ltd, 2015)
  - Proposed Blackwoods Site Development (Coffey Geotechnics Pty Ltd, 2015)
- A review of Record Tracing and mine survey plans within the Borehole Seam supplied by Department of Primary Industries – Mineral Resources including:
  - RT455 Plan of the Ferndale Colliery at Wickham
  - M12116 Plan showing coal extracted by the Ferndale Colliery at Wickham
  - RT579 W&BIC Sheets 1 to 3
  - Delta Collieries Overview plans
- A review of historical borehole logs from the Ferndale Shaft (Wickham Bore) and Linwood Shaft (S1)
- 1:100,000 Scale Newcastle Coalfield Regional Geology Sheet
- SANSW Merit Policy document 2018
- Assessment of coal pillars stability using rectangular pillar theories, incorporated in the Modified UNSW Power Law strength equation as presented in (Galvin, et al., 1998).
- Numerical modelling of the mine workings in the area of the site with the following stages:
  - Development of a large scale numerical model using the three dimensional analysis software FLAC3D with the geological features of the area, including ground elevation and mine workings based on RT455, RT579 and Delta Colliery overview plans
  - Calibrate pillar strengths to Modified UNSW Power Law strength equation as presented in (Galvin, et al., 1998).
  - Trigger collapses and assess pillar creeps
  - Assessment of Consequent ground deformations causes by Pillar Collapse.

- Development of this report

3. SITE CONDITIONS

3.1 SURFACE CONDITIONS

The site is located five lots, Lot 62 and Lot 63 DP579890, Lot 1 and Lot 2 DP112816, Lot 200 DP534787, 41 to 47 Throsby Street Wickham as shown on Drawing 2. This area is situated on top of an estuarine flood plain associated with the Hunter River with Newcastle Harbour 240m to the east. Ground surface levels have been raised with fill (most likely dredged sand from the harbour) with surface gradients generally near level.

The surrounding area land use comprises a mixture of light industrial, commercial and residential with large sheds currently onsite.

3.2 REIGONAL GEOLOGY

Based on the 1:100,000 scale Newcastle Coalfield Geology map sheet 9231, the site is underlain by Quaternary aged soils, typically sand and clay. This is in-turn underlain by the late Permian aged Lambton Subgroup of the Newcastle Coal Measures comprising interbedded and interlaminated siltstone, sandstone and coal. The site is judged to be underlain by the following geotechnical units:

- Quaternary aged alluvial deposits comprising gravel, sand, silt and clay, underlain in turn by
- Lambton subgroup of the Newcastle Coal Measures group consisting of sandstone, siltstone, claystone, coal and tuff. This subgroup includes the Borehole Seam. This seam is underlain in turn by
- Waratah Sandstone.

The strata above the Borehole Seam belong to the Tighes Hill formation which typically comprise of interbedded siltstones and sandstones. The Borehole Seam using nearby boreholes is estimated to dip at 1 in 40 to the south east. A large fault zone 30m wide is located 125m west of the site.

3.3 SUBSURFACE CONDITIONS

The overburden units at the site based on nearby boreholes are shown in Table 1.

Table 1: Summary of Geotechnical Units

Subgroup	Formation	Approximate Depth to Base of Unit (m)	Comments
Fill	Fill	2	Concrete pavements Dredged sand, fine to medium dark grey and brown, trace of organic components
Quaternary	Estuarine	12	Sands, fine to medium grained dark grey, trace of carbonaceous material, trace of sea shells.
	Estuarine	30	Clays, dark grey with brown zones firm to stiff
Lambton	Residual	35	Clay
	Tighes Hill	52	Interbedded and interlaminated siltstone, carbonaceous silty shale and sandstone, medium to high strength to 40m becoming high to very high
	Borehole Seam	58	Mined near the site by the Ferndale Colliery, mining only the bottoms from the Morgan Stone and below.
Waratah Sandstone		> 60	Sandstone: fine to coarse grained grey, high to very high strength

4. FACTUAL INFORMATION ON THE MINE WORKINGS

4.1 HISTORY

The Borehole Seam was discovered in 1848 by the AACo. Initially mining was carried out under the Hamilton and Newcastle West areas.

There are two main Ferndale Collieries in the Newcastle area,

- Tighes Hill
- Wickham.

The most well-known and original was located at Tighes Hill. It suffered an inrush of water in March 1886 which resulted in the pits closure (Robertson, et al., 1886) and (Tonks, 1985). These workings are shown on RT456.

In 1887 the owners of the original Ferndale Colliery began sinking a shaft at Wickham that was to become known as New Ferndale Colliery. These workings are shown on record tracing RT455 and reproduced in part in Drawing 4. RT455 shows three areas of subsidence, that occurred in August 1890, west of Railway Street and beneath the current day Wickham Park.

Two shafts were sunk, with both kept open near the surface by cast iron tubbing to depths of approximately 39m (steel cylinders were used to keep the shaft from collapsing in unstable ground, sand and clay in this case). Mining began in late 1887 and continued through to December 1894 with water and roof fall difficulties reported. Peak employment of 140 was in 1890.

In 1898 noxious gases were reported to be escaping from the shafts due to an underground fire. In response, the tubbing was removed, and the two shafts allowed to collapse with sand and debris used to fill the shafts.

4.2 PILLAR DIMENSIONS

Scaling from RT455, the regular pillars are rectangular and approximately 30m to 35m long and 3m to 4m wide. Bords are approximately 5m to 7m wide and cut-throughs approximately 3m wide.

Small narrow pillars exist within the heading drawn to be approximately 2m wide and 40m to 60m long. Two larger triangular pillars are located to the north and north east of the site which may control the subsidence.

No seam sections for the eastern portion of the Ferndale Colliery workings were identified, however seven seam sections were produced on survey plan M12116 of the western portion. These sections only show the bottom portion of the Borehole Seam with heights ranging from 4'11" (1.5m) up to 6'4" (1.9m) the nearest being Section D with 5'5" (1.65m) 220m to the south east of the site.

The mine workings for the Wickham portion of the Wickham and Bullock Island Colliery (later to become Linwood Colliery, at the north eastern boundary of the Ferndale Colliery had a 5'9" (1.75m) (refer to Figure 1). The Little Tops were deliberately left in place to support the roof (Robertson, et al., 1886). It is understood the New Ferndale Colliery adopted a similar working profile.

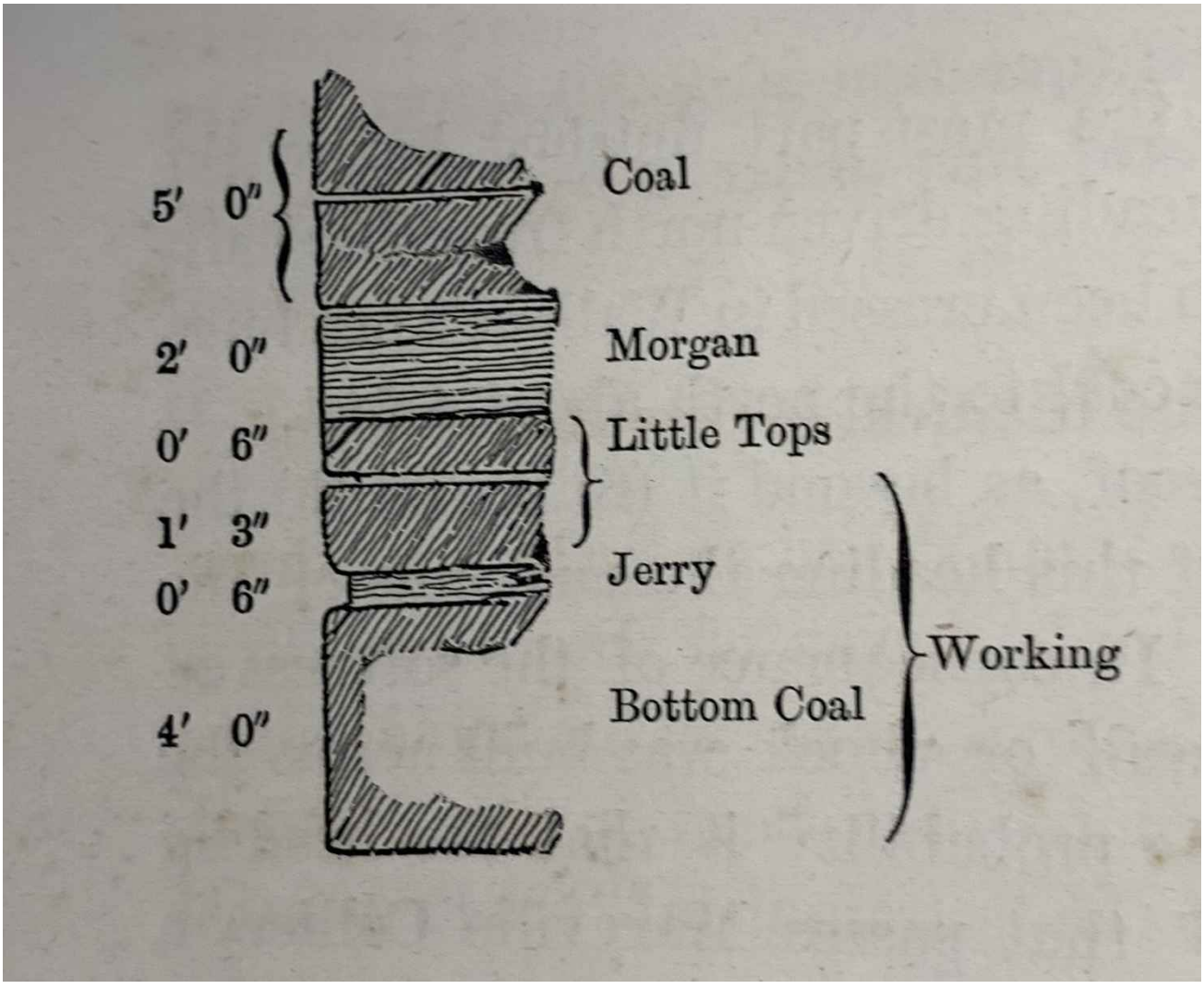


Figure 1: Working Section reproduced from Royal Commission on Collieries Third Report (Robertson, et al., 1886).

Two boreholes have been drilled into open mine workings near the site, BHM2 and BHM4 (GEOTWARA22279AA-AH dated 23 March 2015), 110m and 95m north of the site respectively. These boreholes were drilled into the eastern portion critical for the site. BHM2 encountered a small 0.3m void and

1.7m of rubble suggesting only a 0.9m working height. This small height indicates BHM2 likely hitting the edge of a coal pillar. However, BHM4 encountered 1.6m void and 1.7m rubble indicating a mined height of about 2.2m using a rubble bulking factor of 1.5. This second height from BHM4 is greater than other heights from the area as from BHM1 (GEOTWARA22259AA-AD dated 4 March 2015) located 128m east of the site, the bottom portion of the Borehole Seam exists at a depth of 61.1m to 63.1m with the Jerry band from 61.8m to 62.1m suggested a mined height less than 2m and more likely 1.85m allowing for the 'Little Tops' to remain in place.

4.3 ROOF OF THE MINE WORKINGS

On the eastern side of the fault in close proximity of the site, the roof off the mine workings comprises coal from the upper portion of the Borehole Seam (Refer to Figure 1). This is overlain by 22.1m of generally high strength sandstone at BHM1 and 10.3m of sandstone at BHM4. West of the fault, the overburden was found to punch into the mine workings (M12116) with three surface subsidence zones in 1890 with widths of 40m 50m and 75m. Based on this, punching would be a likely scenario west of the fault but not east where the site is located.

4.4 FLOOR OF THE MINE WORKINGS

The Waratah Sandstone forms the flor of the mine workings around the site. Point loads from BHM1 (GEOTWARA22259AA-AD dated 4 March 2015) had point load I_{s50} values ranging from 2.2MPa to 3.7MPa equating to approximately 40MPa to 70MPa using an I_{s50} to UCS conversion factor of 18. As such, punching into the floor below the workings is not a credible failure mechanism.

4.5 LOCATION OF MINE WORKINGS

The interpreted location of mine workings relative to the site is shown on Drawing 4. From this the mine workings are a minimum of 17m to the north west and 13m to the north east. This location was developed using the survey data from M12116 to assess the approximate bearing of the main heading running as well as features including BHM2 being close proximity of a coal pillar and BHM4 being on the north western side with coal identified to the south in CCTV. It is noted to fit the pillar the alignment of the heading was rotated 2° to the south of that provided on survey plan M12116. As such this is considered a worst case for the site with the workings potentially northward by 8m.

5. EMPIRICAL ASSESSMENT OF MINE WORKINGS

5.1 STATE OF MINE WORKINGS

The mine workings are believed to have the following features:

- The panel is approximately 120m to 360m east west by 220m north south.
- The pillars when mined has a width to height ratio of 1.5 to 2 with widths of 3.0m to 4.0m and a mined height of about 2m.
- The roof has started to fall into the mine with a current pillar height of about 3.3m with 1.7m of rubble.
- The mine workings are flooded with the shafts filled with sand.
- From this the mine workings are a minimum of 17m to the north west and 13m to the north east of the site.

5.2 EMPIRICAL STABILITY ASSESSMENT

5.2.1 Pillar Factor of Safety Methodology

In order to quantify pillar stability, a factor of safety (FOS) is used. The FOS of an individual pillar is the ratio of pillar strength to pillar load. There are many published methods in practice around the world to estimate pillar strength. All are simplifications and, thus have limitations. In Australia, the UNSW Pillar Design method (Galvin, et al., 1998) is commonly used. This approach is based on semi-empirical relationships, derived from a database of failed and un-failed pillars. It is only valid where roof and floor conditions are good and where full pillar yield does not exist. In general, as discussed above based on core drilling of the seam, this appears to be the case in this area.

The strength of the pillars with a width to height ratio <5 (S_p in MPa) can be estimated using Equation 1.

$$S_p = \frac{8.6(Q \times w)^{0.51}}{h^{0.84}} \quad (1)$$

Where:

- w = width of pillar (m)
- h = height of pillar (m).

Where the width to height ratio is >5, the equation is modified to Equation 2.

$$S_p = \frac{27.63(Q)^{0.51}}{w^{0.22}h^{0.11}}\left\{0.29\left[\left(\frac{w}{5h}\right)^{2.5} - 1\right] + 1\right\} \quad (2)$$

Where: Q = shape factor:

- For width greater than 6: $Q = \frac{2L}{L+w}$ (3)
- For width less than 6: $Q = \left(\frac{2L}{L+w}\right)^{\frac{R-3}{3}}$ (4)

Where: R = width/height

The assessed load applied to the coal pillars is obtained by the weight of all the overburden layers within the tributary area, expressed as a vertical pressure on the top of the pillar. The tributary area is typically taken the midway along bords and cut throughs surrounding a pillar, as shown in Figure 2.

Where: 'TW' is the tributary width and 'TL' is the tributary length.

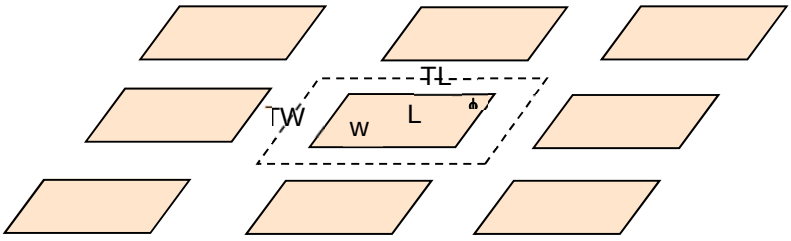


Figure 2: Tributary model

Transfer of load from secondary worked or crushed areas to adjacent pillars was assessed using the procedures in the Australian Coal Association Research program (ACARP) Final Report – Chain Pillar Design (Calibration of ALPS) (Colwell, et al., 1998). In this approach, the load transferred from the retreat mined area is distributed over a zone of adjacent pillars based on empirical equations developed from longwall mining. In this case the abutment angle of 21° was adopted as per the report.

$$New\ Pillar\ Strees = \sigma_p = \frac{(Tributary\ load + R_p A)}{w} \quad (5)$$

Using the following formula for abutment loading

$$A = \rho g\left(\frac{1}{2}HW - \frac{1}{8}W^2 tan\emptyset\right) < \rho g\left(\frac{1}{2}H^2 tan\emptyset\right) \quad (6)$$

And

$$Proportion\ ratio = R_p = 1 - [(D - w - w_e)/D]^{\,3} \quad (7)$$

Where

W = width of long wall panel (or in this case width of failed panel)

H = height of overburden

W_e = width of bord

5.2.2 Preliminary Stability Calculations

Stability assessment has been undertaken for the pillars indicated on Drawing 4. For these calculations we have adopted three heights:

1. Mined height of 2.0m
2. Current pillar height of 3.3m
3. Current pillar height plus 0.5m bringing the total to 3.8m

For the pillar plan dimensions, we have adopted two widths:

1. Actually drawn plan dimensions
2. Less 0.5m to the drawn plan widths to model potential robbing of the pillars and/or spalling

For the overburden stress we have adopted two states:

1. Total overburden stress (‘Dry state’) equivalent to during mining under the site assuming 55m cover
2. Total overburden stress (‘Dry state’) equivalent to during mining under the site assuming 55m cover

These variations provide ‘what if’ scenarios so that an assessment can be made on how stable the workings are, even if the pillars aren’t as expected.

The results of the analysis are presented in Table 2 for the Borehole Seam workings within the angle of draw under the site. The locations of the pillars assessed are indicated in Drawing 4.

Table 2: Summary of preliminary pillar stability calculations

Pillar	Width (m)	Length (m)	Scaled Tributary Width (m)	Tributary Length (m)	Abutment Loading	Factor of Safety		
Height (m)						2.0	3.3	3.8
Pillar 1	3.4	59.9	10.0	62.6	No Abutment	2.4	1.6	1.5
					With Abutment	1.5	1.0	0.9
	2.9				No Abutment	1.9	1.3	-
					With Abutment	1.2	0.8	-
Pillar 2	1.9	44.1	5.4	46.3	No Abutment	1.9	1.2	1.1
					With Abutment	1.1	0.7	0.7
	1.4				No Abutment	1.2	0.8	-
					With Abutment	0.7	0.5	-
Pillar 3	3.8	19.8	11.0	24.5	No Abutment	2.2	1.5	1.3
					With Abutment	1.4	0.9	0.8
	3.3				No Abutment	1.8	1.2	-
					With Abutment	1.1	0.7	-
Pillar 4	5.6	18.1	10.2	25.35	No Abutment	3.8	2.5	2.3
					With Two Way Abutment	1.6	1.1	1.0
	5.1				No Abutment	3.3	2.2	-
					With Two Way Abutment	1.4	0.9	-
Pillar 5	2.7	36.0	10.1	39.05	No Abutment	1.6	1.1	1.0
					With Abutment	1.0	0.7	0.6
	2.2				No Abutment	1.2	0.8	-
					With Abutment	0.7	0.5	-
Pillar 6	3.9	35.9	11.4	38.95	No Abutment	2.5	1.7	1.5
					With Abutment	1.6	1.1	1.0
	3.4				No Abutment	2.0	1.4	-
					With Abutment	1.3	0.9	-

The above assessment is conservative due to the flooded nature, reducing the effective overburden. However, the factors of safety are so low the workings can't be considered as long term stable. With limited larger pillars, as soon as some pillars fail, the failure is likely to run through to the limit of the eastern portion of the mine.

5.3 ESTIMATING MAXIMUM SUBSIDENCE

5.3.1 Estimating Crush from Volume Exchange Method

To estimate the amount of potential crush at mine level, the following formula has been adopted.

$$Crush = \frac{[(H_v \times W_{(B+P)}) - W_P \times H_{Crush} \times BF_P]}{W_{(B+P)}} \quad (8)$$

Where:

- H_v = height of void remaining (assumed to be 2.8m based on the nearby voids encountered during drilling
- $W_{(B+P)}$ = width of bord and pillar (taken as 22.8 based on Pillar 4 nominated on Drawing 3)
- W_P = width of pillar (taken as 15.2 based on Pillar 4 pillars nominated on Drawing 3)
- H_{Crush} = Height of pillar being mobilised by the crush (taken as the void height of 2.8m)
- BF_P = bulking factor of pillar crushing (assumed to be 1.2 to 1.3)

Using this information and using dimension from Pillars 3 and 5 it is estimated that the maximum convergence (crush) of the seam at the base of the trough may be between 0.85m and 1.0m.

5.3.2 Estimating Crush from Borehole Data of Historical Crushes

As an alternative method to assess the likely magnitude of crushing, Coffey developed a database of crush (seam convergence) magnitude encountered in boreholes drilled into collapsed first workings in the Newcastle Area.

Generally, the surface subsidence is reported over longwall mining as s_{max}/t versus W/H (Holla, 1987).

Where:

- s_{max} = maximum surface subsidence at centre of trough
- t = thickness of seam extracted
- W = Width of longwall panel
- H = Height of overburden

To account for extraction ratio, the height of extraction typically adopted for s_{max}/t in references (Holla, 1987) was multiplied by the extraction ratio of the pillars at the borehole location scaled from the RT at the borehole location.

$$\frac{Crush}{h.e} \; refers \; to \; \frac{Cruh \; at \; mined \; level \; (m)}{mined \; height \; (m) \times extraction \; ratio} \quad (9)$$

The results for five different areas are provided in Figure 3.

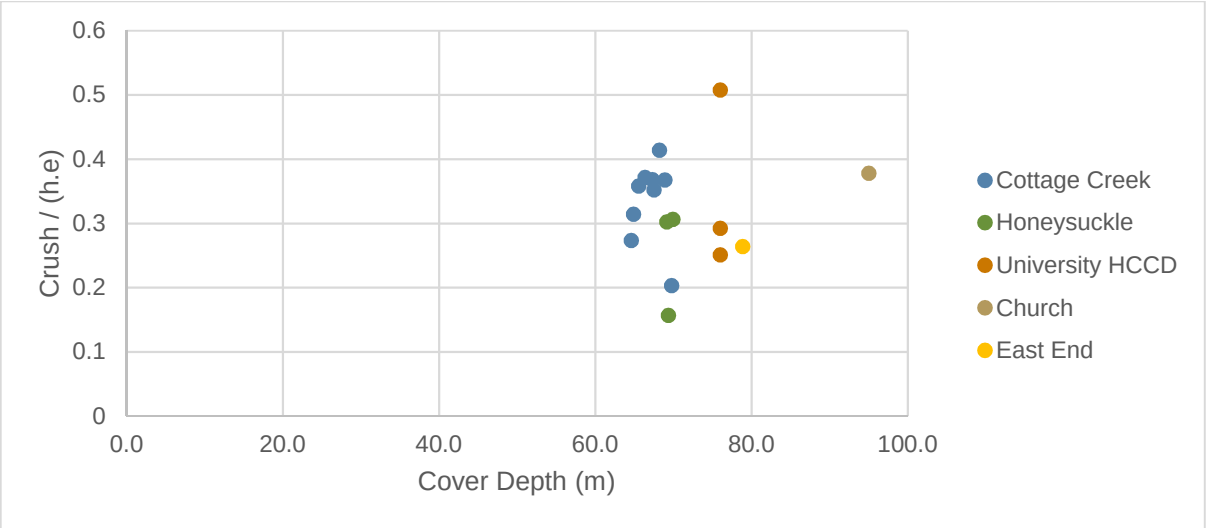


Figure 3: Summary of crush at mine level data encountered in Boreholes completed beneath the Newcastle Area

Based on the above, it may be estimated the amount of crush at seam level would be in the order of 30% to 40% (with an upper bound value of 50%) of the mined height multiplied by the extraction ratio. This low ratio (Figure 2) was evident in historical mine workings following crush events where the collapse did not fill the entire void space (754-NTLEN213472-R13.Rev1 dated 06 March 2020).

Using Figure 4 data and the scaled extraction ratio of 68% to 75% shown on the RT455, the amount of crush at mine level would be between

- 1.75 (lower bound mined height) x 0.68 x 0.3 (lower bound value Figure 3) = 0.36m
- 2.2 (upper bound mined height) x 0.75 x 0.5 (upper bound value Figure 3) = 0.825m

With the average extraction ratio around 70% and the more likely mined height of 2.0m and the upper 0.5 multiplier value reduces to 0.7m.

6. NUMERICAL ASSESSMENT OF MINE WORKINGS

6.1 APPROACH

This assessment included the following steps:

- Development of a large scale 450m wide by 400m deep numerical model with the geological features of the area, and mine workings based on RT455, RT579 and Delta Collieries Overview Plan
- Trigger pillar collapses and assess paths of pillar creeps, recalibrate as necessary
- Assessment of consequent ground deformations caused by pillar collapse.

To assess the FOS of the workings and resultant surface deflection, the three-dimensional numerical analyses commercial software FLAC3D was used to simulate a pillar collapse of the workings.

The model was returned to previous state, with two sensitivity calculations completed

- The modulus of coal reducing at the same rate of pillar strength
- The limit of crush was increased to 900mm.

6.2 GEOMETRY AND MESH

A pillar run that impacts the site may be initiated from weaker pillars outside of the immediate area. As such, a large area of mine workings was modelled to assess potential surface response behaviours at the site and to reduce the impact of edge effects in the model affecting the ground response assessed at the site.

For the site, the model extended over an area of 450m by 400m. This elemental ‘mesh’ adopted extends sufficiently broadly to recognise and reduce the impact of enable boundary fixities at The Site. This included:

- Extending to the west minimum 60m (depth of working) beyond the small panel south west of the heading.
- Similar extension was completed to the south of the main panel
- Extended to the north east to assess if a collapse would propagate from the Linwood Colliery
- Extended to the east to assess if a collapse would propagate from the collapsed Wickham and bullock Island Colliery

The outlines of pillars within the workings were first digitised using polylines in AutoCAD based on the layout of pillars from RT455, RT579 and Delta Collieries Overview Plan.

The workings were rotated so that a principal stress corresponded with the x axis (generally along the pillars). The digitised geometry of the pillars was imported into FLAC3D, with the remaining irregular shapes

converted to primitives before subdivision into pillars with four elements across and eight to sixteen elements along the length to create generally squarish shaped elements.

To allow for easier identification in later stages, primitives of similar units were grouped together.

- Group 1 Bords Ferndale
- Group 2 Pillars Ferndale
- Group 3 Bords Wickham and Bullock Island Company
- Group 4 Pillars Wickham and Bullock Island Co
- Group 5 Bord Linwood
- Group 6 Pillar Linwood
- Group 7 Large
- Group 8 Unmined
- Group 9 Fault Mined
- Group 10 Fault Unmined

Figure 4 shows this layout.

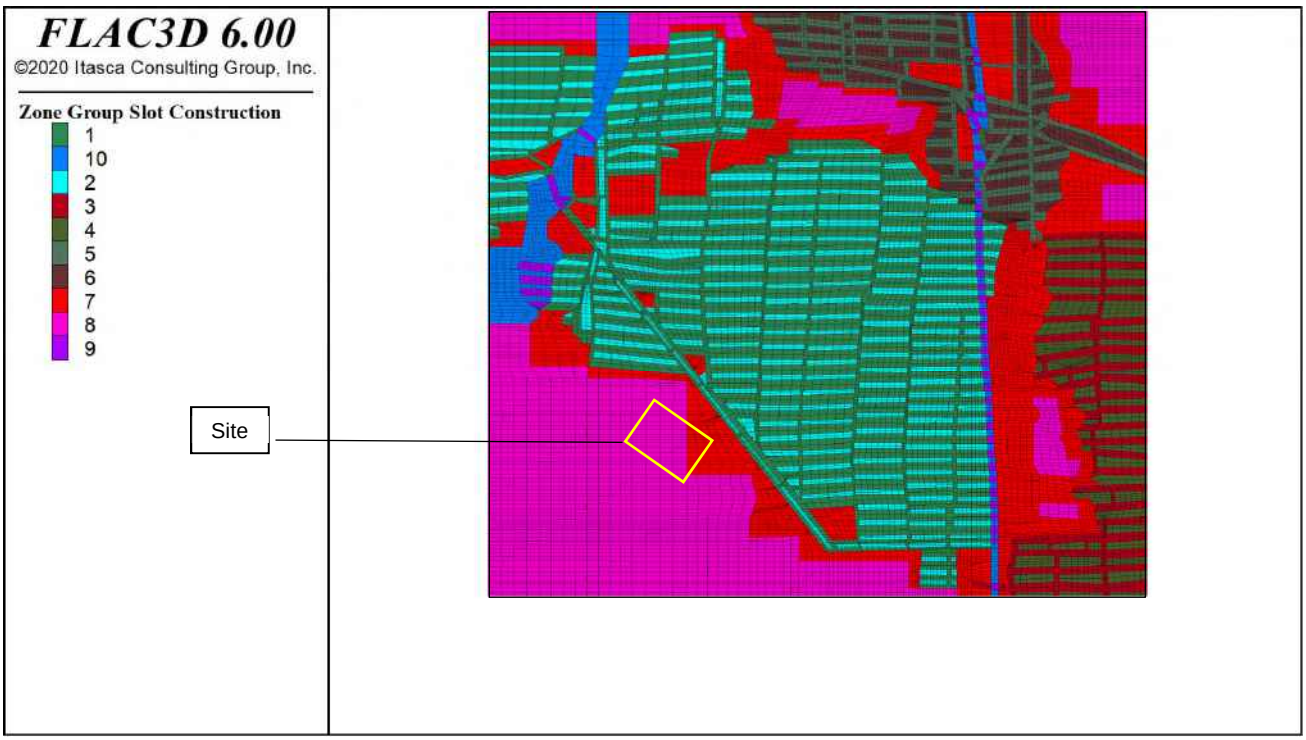


Figure 4: Grouping at coal pillar level

To build the vertical depth to the model, the Borehole Seam was assumed to be horizontal with the surface modified to resemble the additional overburden.

The grid was then extruded in three stages, with the mesh refined at each stage to reduce the total number of elements to z equals 0m (i.e. the maximum depth to working at the south eastern corner of the model.

6.3 GEOTECHNICAL MODEL

The FLAC3D strain hardening/softening model with a Mohr-Coulomb failure criterion was adopted for most materials used in the analyses to allow softening after reaching failure. To model planes of weakness into the rock mass in the attempt to simulate bedding and allow some separation along these joints, the ubiquitous

joint variant of the model was used for the main rock unit (interbedded siltstone and sandstone). Material parameters were assessed with assistance from RocLab software using rock strength testing from boreholes as well as the bedding observed in the boreholes and published historical data.

The material parameters used for the overburden materials are summarised below in Table 3.

Table 3: Geotechnical model of layers used for FLAC3D analyses

Material	Sand	Clay Units	Interbedded Siltstone and Sandstone	Waratah Sandstone
Depth (m bgl)	0 to 14	14 to 41	41 to 53	Below 59
Density (γ kN/m^3)	18	18	25.5	25.5
Youngs Modulus (E GPa)	0.03	0.02	1.8	8
Poisson's Ratio (ν)	0.35	0.4	0.25	0.25
Effective cohesion (c' kPa)	1	5	750	1200
Friction angle (ϕ°)	35	28	45	54
Dilation angle (ψ°)	5	3	10	10
Tension (kPa)	0.5	1	25	150
Joint dip (°)	-	-	0	-
Joint friction angle (°)	-		35	-
Joint cohesion (kPa)	-	-	20	-
Joint dilation angle (°)	-	-	4 (reducing to 0 at 20% shear)	-
Joint tension (kPa)	-	-	0	-

The boundaries of the units were determined using drilling data from:

- Drilling within the former Blackwoods site GEOTWARA22279AA-AH dated 23 March 2015
- Drilling on Throsby St, GEOTWARA22259AA-AD dated 4 March 2015
- Historical drill log from Ferndale Shaft
- Historical drill log from Linwood Shaft (Formally Wickham Shaft).

The Borehole Seam in the area has a dip locally of up to 1 in 40 to the south east. To simplify the construction of the model the seam was assumed to be level with the additional depth to workings modelled by a higher ground surface level.

The site model includes several faults as can be seen in Figure 3. The fault material was assumed to have has reached its residual strength state (i.e. effective cohesion approximately 10% of peak strength for rock units).

Material parameters for the coal pillars were calibrated to published empirical data and derivation of these parameters is presented in Section 6.4.

For the model, the horizontal stress in the major principal direction (north east to south west) has been assumed to be 9kPa/m depth similar to a coefficient of earth pressure at rest (k_0) of the soil to the base of the mine workings, increasing by 25kPa/m depth below the mine workings. Although higher stresses are believed to be present within the Newcastle Coal Measures at depth, previous model calibrations to historical crush events indicate the lower value of stress may be applicable in this area, potentially resulting from:

- Historical crushing of area;
- The number of faults nearby; and
- The proximity of the Newcastle Harbour

All these above may result in stress relief of the mine overburden strata.

This low value was adopted for the area as the conservative case. Low horizontal stresses will act to increase potential movements by allowing more plastic deformation, which will occur while the rock is in tension, simulating joints opening within the rock mass.

The density of 18kN/m^3 adopted for the soil units is a flooded density. However, the workings are considered without pore pressure which is a conservative state. Pore pressure within the mine workings will reduce the effective load by approximately 30% to 40%.

6.4 CALIBRATION OF COAL PILLARS

A critical factor in understanding the stability of the workings is the strength of the coal pillars. The strength of a coal pillar relies on three aspects:

- The intact coal strength;
- The effect of discontinuities controlling the rock mass behaviour; and,
- The coal pillar geometry, affecting the degree of confinement within the coal pillar core.

Average pillar sizes for each of the mines were calibrated to the pillar strength estimated by Equation 1 (Galvin, et al., 1998) provided in Section 5.2.1.

Where Sp = pillar strength, w = width and h = height in metres.

S_p = $8.6 \times 3.0^{0.51}/3.8^{0.84}$ = 4.91Mpa for the 3.0m wide pillar, (typical of the Ferndale Colliery)

S_p = $8.6 \times 5.4^{0.51}/6.0^{0.84}$ = 4.51Mpa for the 5.4m pillar, (typical of the Wickham and Bullock Island Colliery workings in the area

S_p = $8.6 \times 4.5^{0.51}/3.8^{0.84}$ = 6.03Mpa for the 5m pillar, (typical of the Linwood Colliery).

S_p = $8.6 \times 10^{0.51}/3.8^{0.84}$ = 9.07Mpa for the 5m pillar, (larger 10m wide pillars).

The coal pillars have been modelled with:

- A peak strength as per Equation 1 above, when the pillar remains in its elastic range
- A plastic phase that decreases in strength due to plastic deformation. Once the load on the pillar reaches its ultimate strength a strain softening phase is implemented at a volumetric plastic shear strain of 0.004 (0.4%)
- An after crush phase where the rubble within the bord provides confinement of the pillar calculated in accordance with Section 5.3.2. This is estimated to be
  - 0.7m for the typical sized 3.0m wide pillars (0.7 (extraction ratio) x 0.5 (factor from Figure 3) x 2.0 (assessed mined height))

- 0.6m for the Linwood Colliery (0.6 (extraction ratio) x 0.5 (factor from Figure 3) x 1.8 (assessed mined height))
- 1.0m for Wickham and Bullock Island Colliery pillars (0.5 (extraction ratio) x 0.5 (factor from Figure 3) x 4 (assessed mined height of tops plus bottoms) from Wickham shaft)
- 0.3m for the large pillars. (0.3 (extraction ratio) x 0.5 (factor from Figure 3) x 2.0 (assessed mined height))

(For more information refer to 5.3.2)

The results of the pillar calibrations, with a course mesh similar to that used for the pillars within the model, are shown below in Figures 5 to 8 with the final parameters given in Table 4 and Table 5.

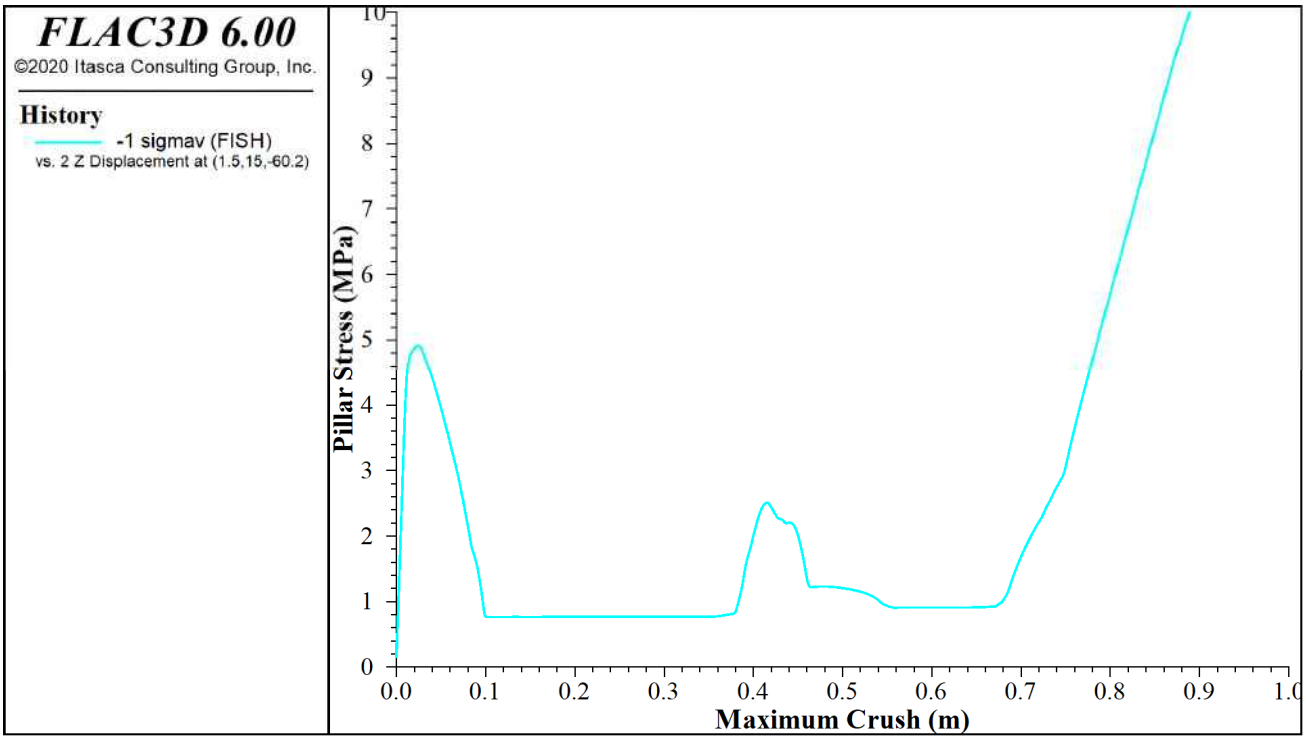


Figure 5: Pillar load versus displacement chart for 3.0m wide Ferndale Colliery Pillars.

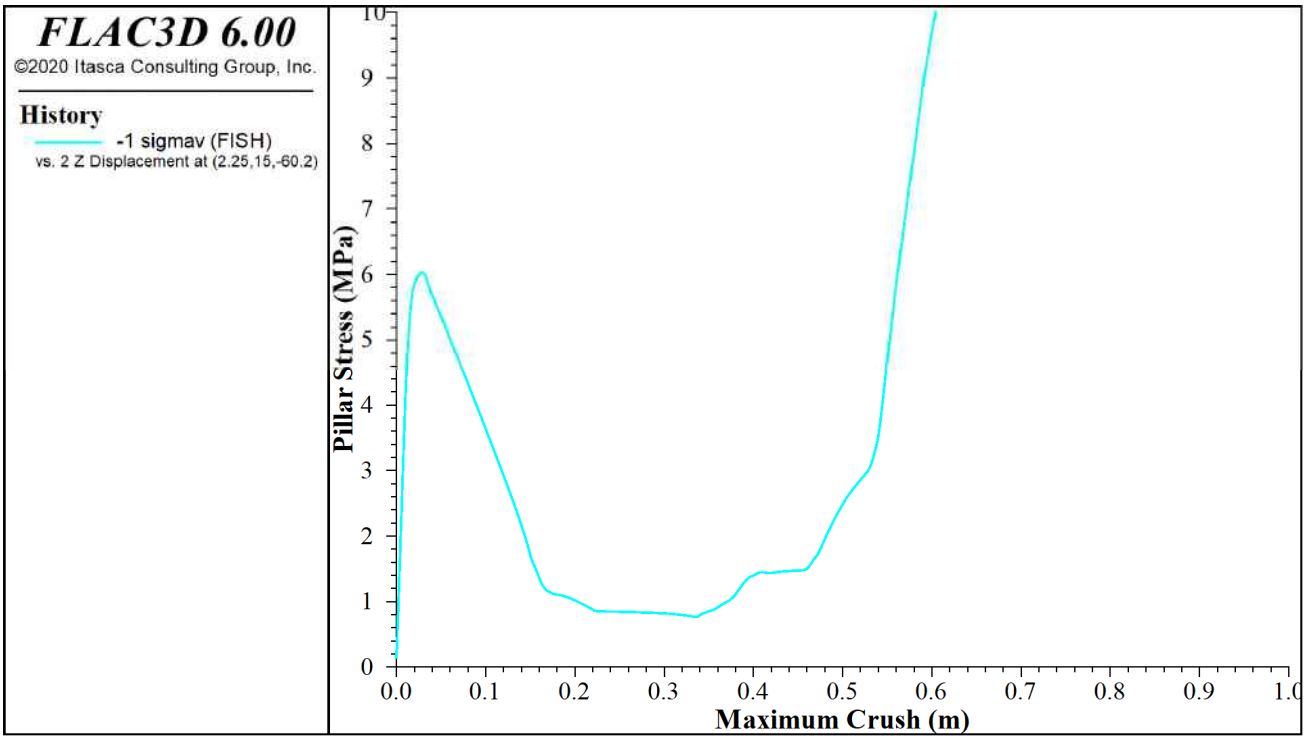


Figure 6: Pillar load versus displacement chart for 4.5m wide Linwood Colliery Pillars.

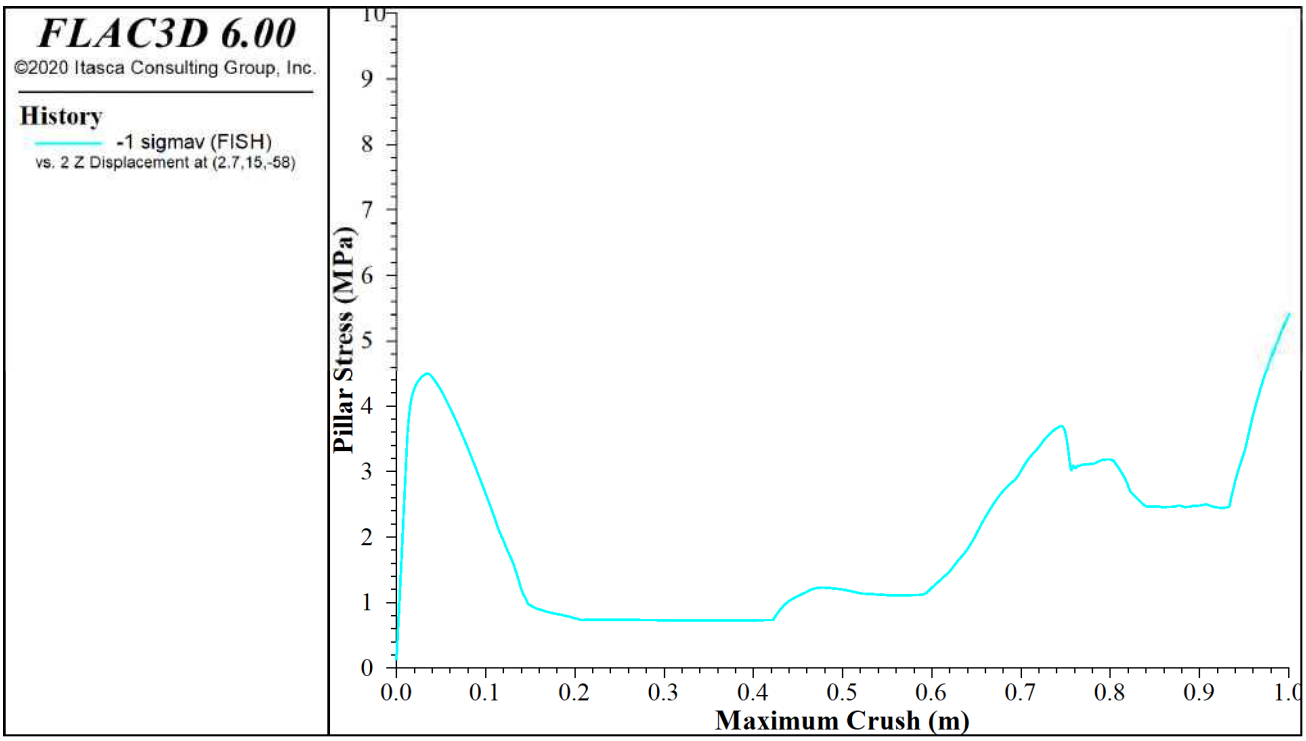


Figure 7: Pillar load versus displacement chart for 5.4m wide 6.0m tall W&BIC Pillars.

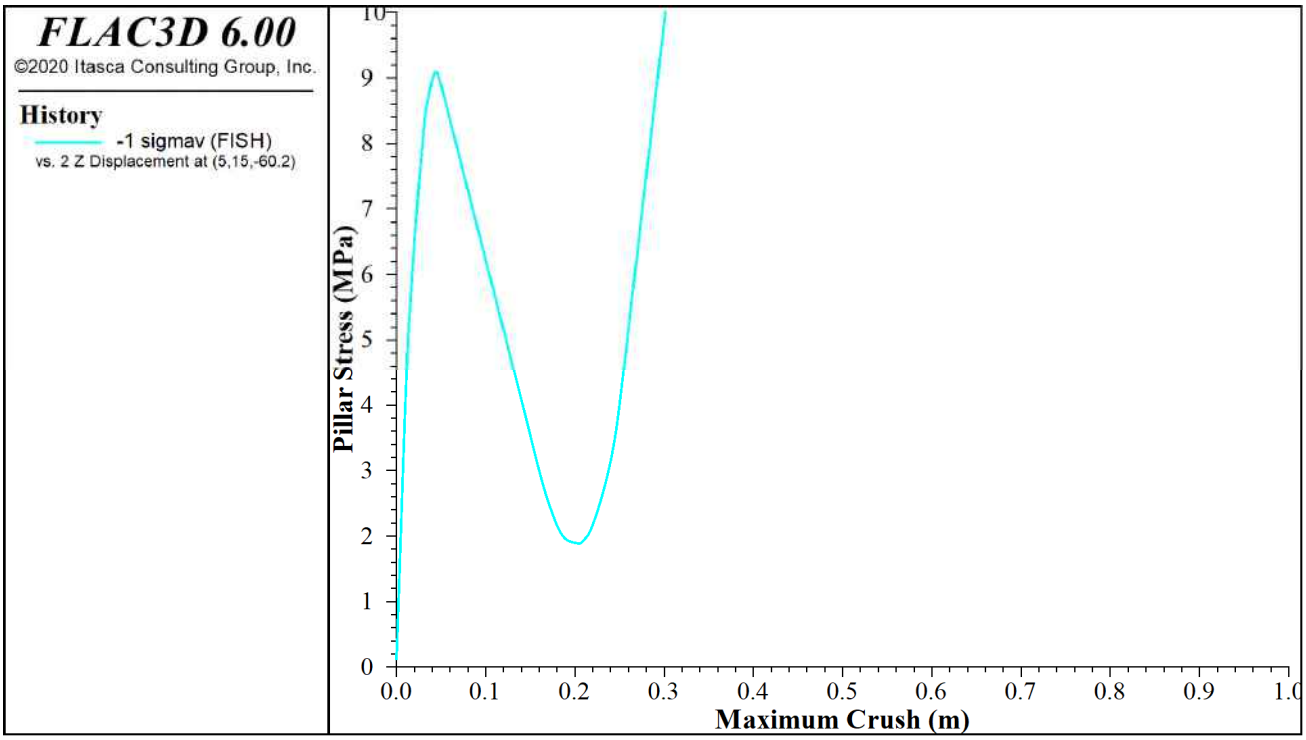


Figure 8: Pillar load versus displacement chart for 10.0m wide Pillars.

Table 4: Geotechnical model of coal pillars used for FLAC3D analyses

Material	Ferndale Colliery	Linwood Colliery	W&BIC	Large
Density (γ kN/m3)	15	15	15	15
Youngs Modulus (E GPa)	2	2	2	2
Poisson's Ratio (ν)	0.3	0.3	0.3	0.3
Effective cohesion (c' MPa)	1.13	1.145	0.95	0.84
Friction angle (ϕ°)	30	30	30	30
Dilation angle (ψ°)	5	5	5	5
Tension (kPa)	10	10	10	10

A series of three interfaces have been included in the model:

- At the top of coal (top of pillar for W&BIC)
- At the base of Morgan Stone (top of pillar for Ferndale and Linwood Collieries)
- At the base of the Borehole Seam

Table 5: Geotechnical model of interfaces within coal pillars used for the three-dimensional FLAC3D analysis

Unit	Peak Effective Cohesion (c' MPa)	Peak Friction Angle Adopted ϕ°)	Residual Effective Cohesion (c' MPa)	Residual Friction Angle Adopted (ϕ_R°)	Tension (kPa)	Stiffness Normal (E GPa)	Stiffness Shear (G GPa)
Top Coal	0.2	16	0.05	15	1	20	20
Top Pillar	0.2	16	0.02	15	1	20	20
Bottom Pillar	0.2	16	0.02	15	1	20	20

6.5 RESULTS OF NUMERICAL MODELLING

6.5.1 Excavation of Bords

After application of in situ field stresses, the bords were excavated in stages in the model, as is required to prevent numerical instability during the analyses.

An output that summarises the final vertical stress after excavation (at completion of initial mining) is given below in Figure 9. This provides an image of the layout of workings, showing overburden stress being distributed between pillars' cores and the extent of mining.

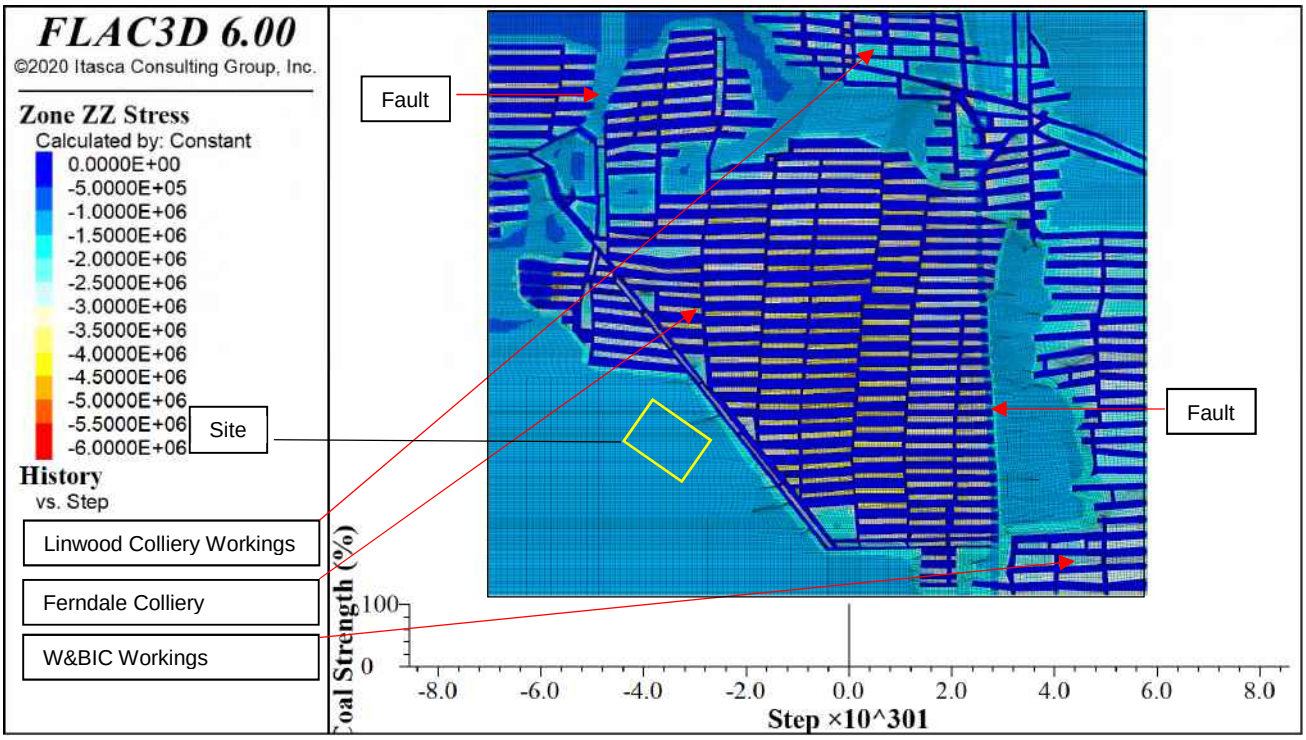


Figure 9: Vertical stress at completion of initial mining (assuming zero pore pressure, fully drained) units in Pascals

From the above, the outer slightly larger pillars with smaller bords within the Ferndale eastern panel are loaded to 3.0MPa to 3.5MPa while the middle two rows of pillars are loaded to 3.5MPa to 4.5MPa.

6.5.2 Gradual Degradation of Coal Strength

To allow for the possible/conceivable slow degradation of coal strength, the coal strength in the numerical model was reduced by approximately 5% for each stage solved by the modelling. This is demonstrated in Figure 9.

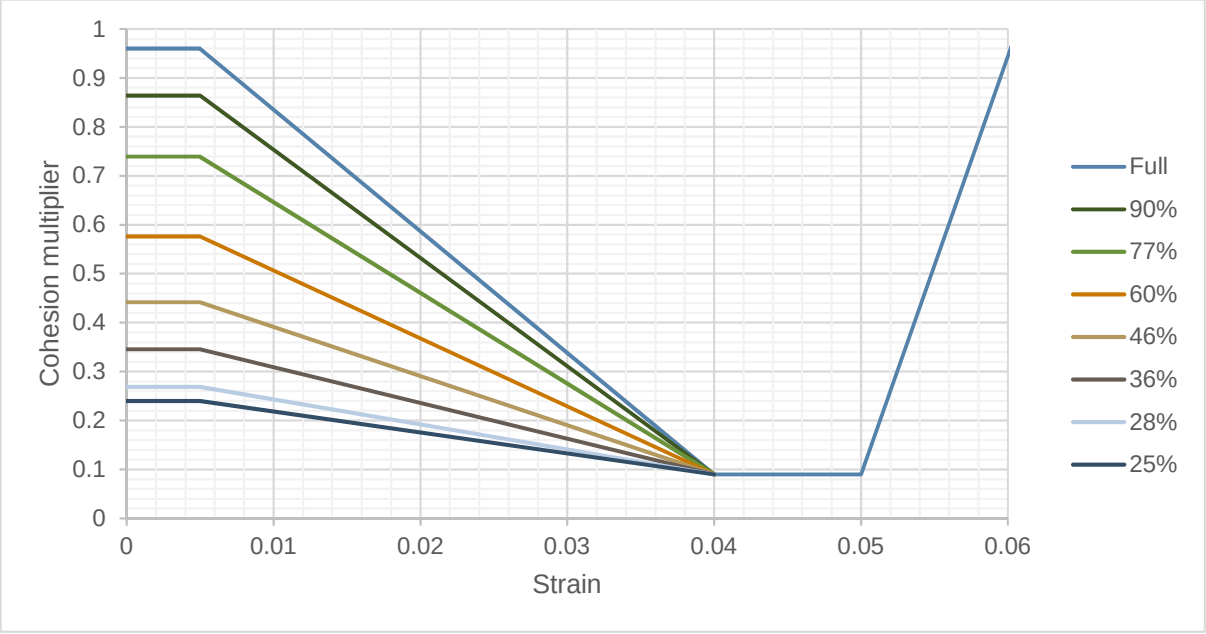


Figure 10: Degradation of peak coal strength

Although the pillar crushing causes several forms of displacements, we have chosen to output the vertical displacement (settlement) and its distribution at the surface to demonstrate the effect of the pillar collapse.

A sequence of the vertical displacement at surface level for the global model is shown in the following Figures 11 to 15 for the cases where the coal pillar strength is progressively reduced to 77%, 60%, 46%, 36% and 25% of its initial strength. Values are shown in metres.

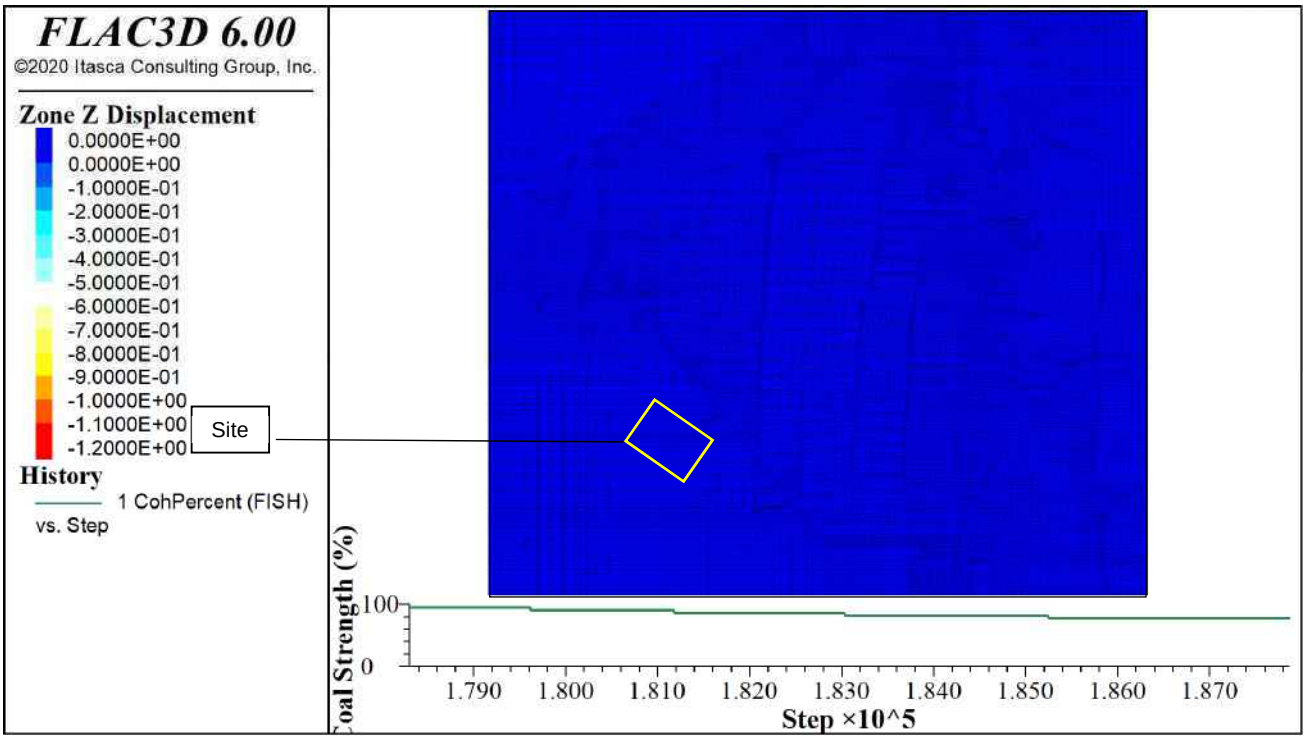


Figure 11: Conceptual total vertical displacement at surface level with pillar coal at 77% strength.

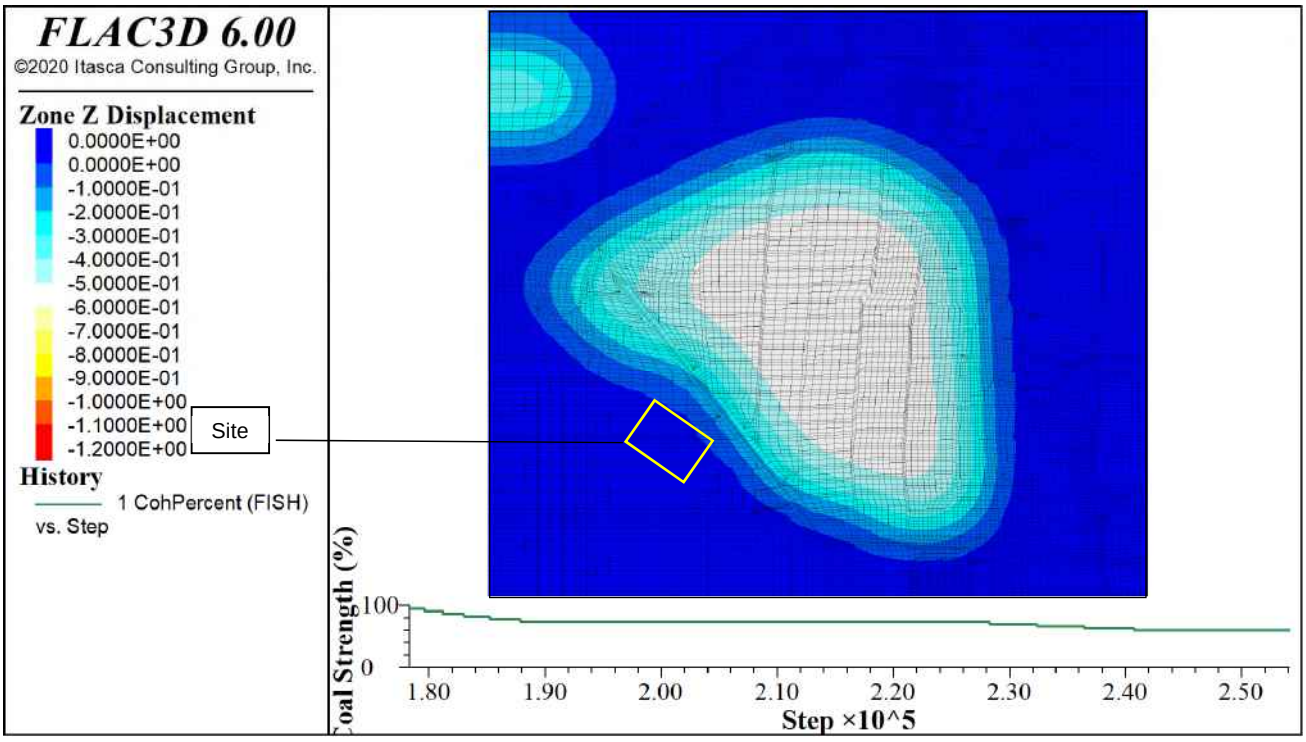


Figure 12: Conceptual total vertical displacement at surface level with pillar coal at 60% strength.

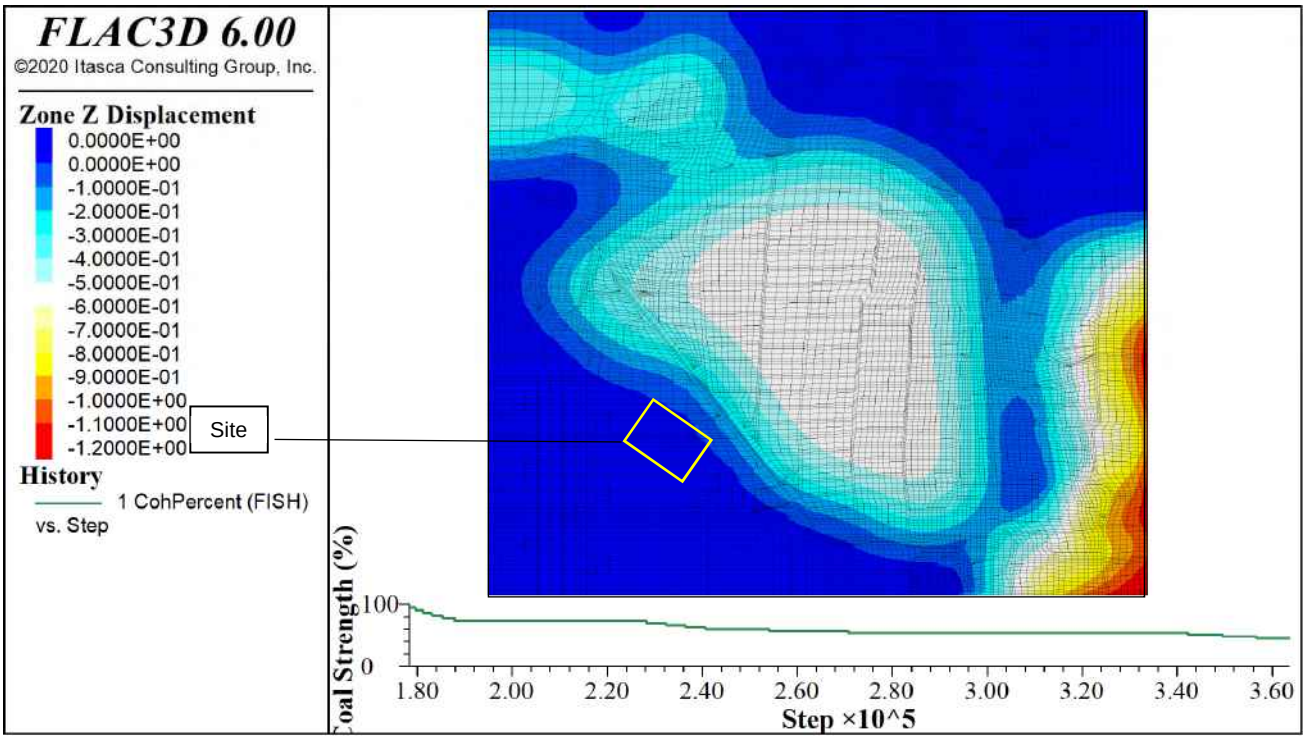


Figure 13: Conceptual total vertical displacement at surface level with pillar coal at 46% strength.

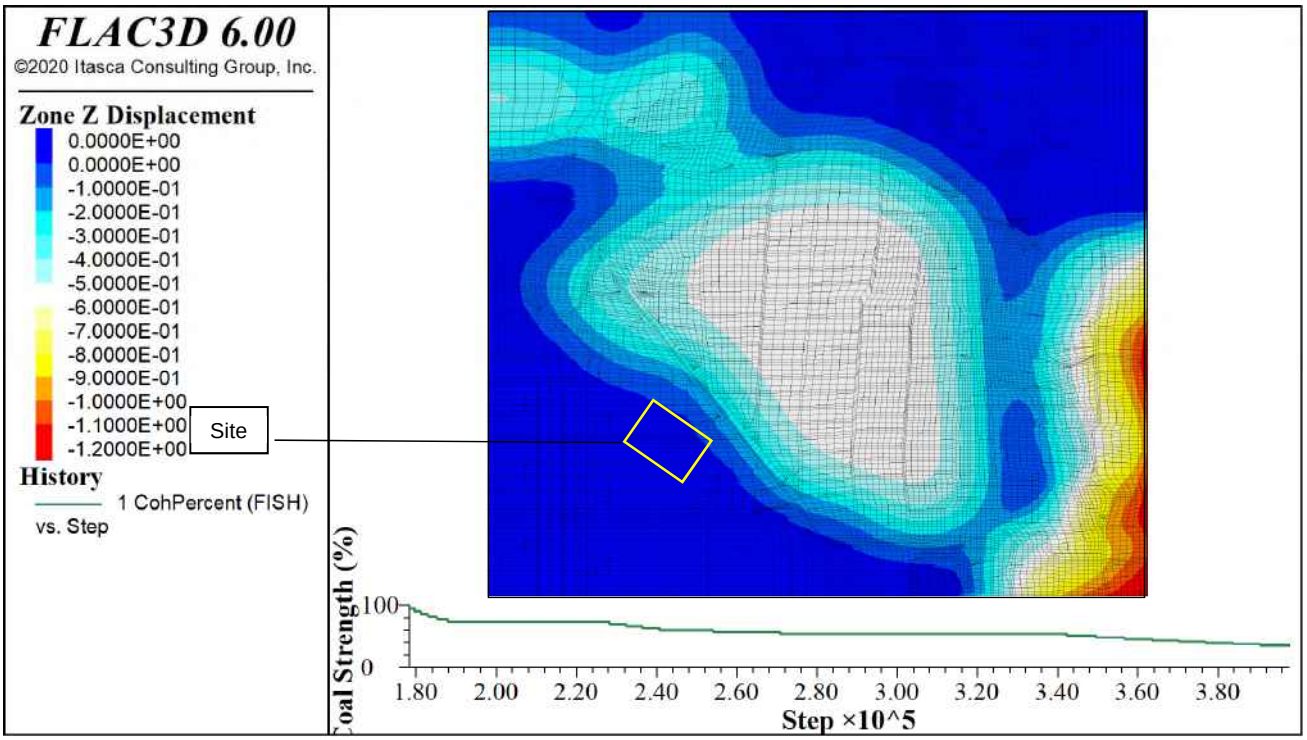


Figure 14: Conceptual total vertical displacement at surface level with pillar coal at 36% strength.

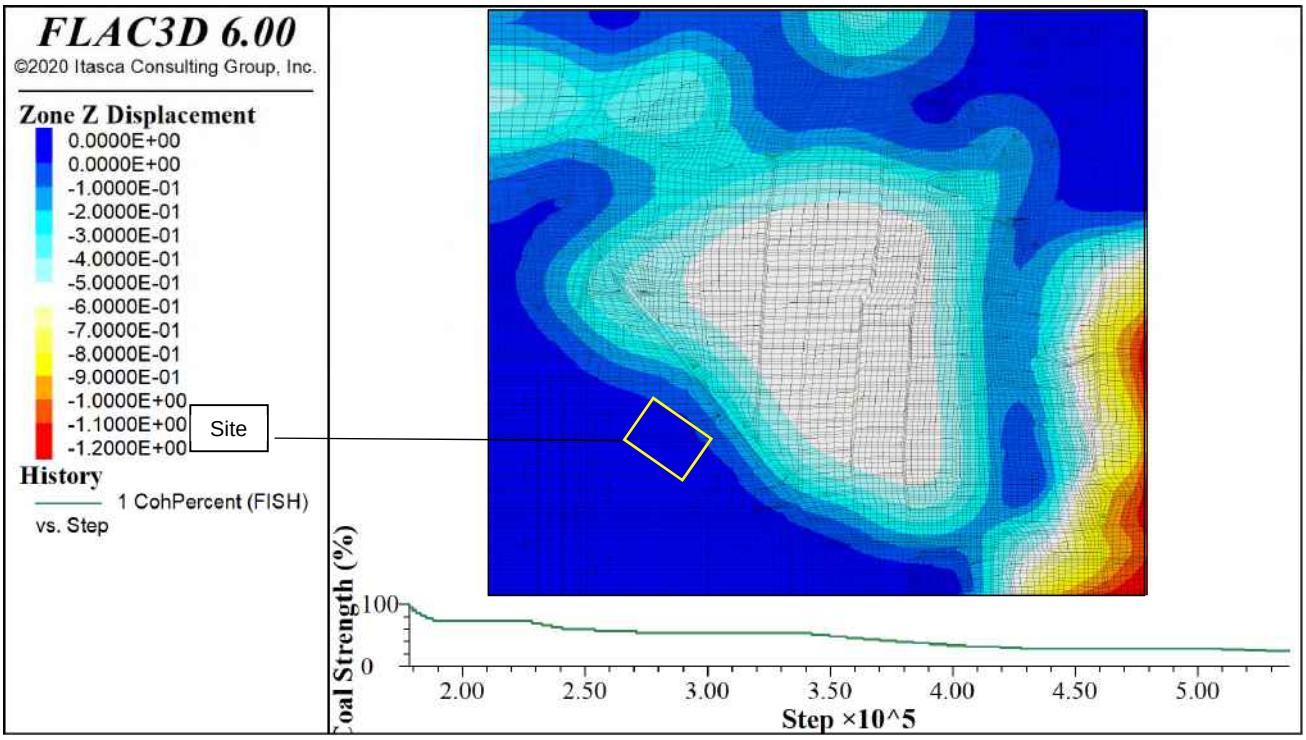


Figure 15: Conceptual total vertical displacement at surface level with pillar coal at 25% strength.

The data indicates that the Ferndale Colliery pillars will fail after reduction to 74% of the original meaning the overall factor of safety for the Ferndale Colliery is approximately '1.4' (ignoring pore pressures). Similarly the Wickham and Bullock Island Colliery fail after a reduction to 54% (approximate factor of safety of '1.8') although this does not include abutment loading from the crushed workings nearby.

From the above the site is subjected to most of the movement during the initial failure with only a small additional movement should the larger triangular pillars fail due to their limited convergence capacity.

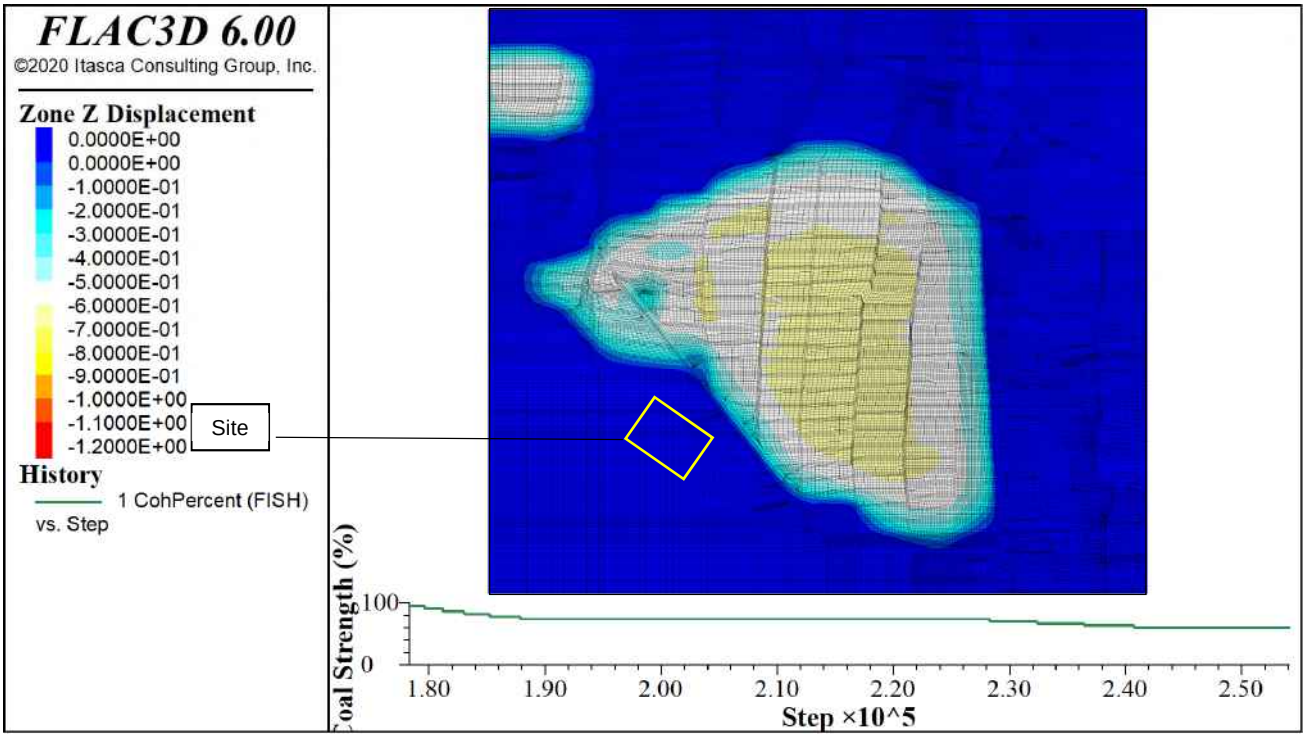


Figure 16: Conceptual total vertical convergence at mine level with pillar coal at 77% strength.

The above indicates approximately 90% of the displacement at mine level is transferred to the surface level (0.63m at surface level versus 0.69m convergence at mine level).

It is noted that although the coal pillars were calibrated to have a convergence of 700mm at the approximate stress within the mine, a lower subsidence actually resulted in the numerical model believed to be due to

- The slightly larger pillars in some areas of the mine
- The volume of rubble within the mine

6.5.3 Sensitivity Analysis Option 1 Degrading Modulus of Coal with Strength loss

For the first sensitivity analysis, the degradation phase is repeated with decreasing modulus with the reduction of peak coal strength. This generally has the effect of lowering the strength at which the pillars fail, however does not affect the site substantially as shown in Figures 17 to 21.

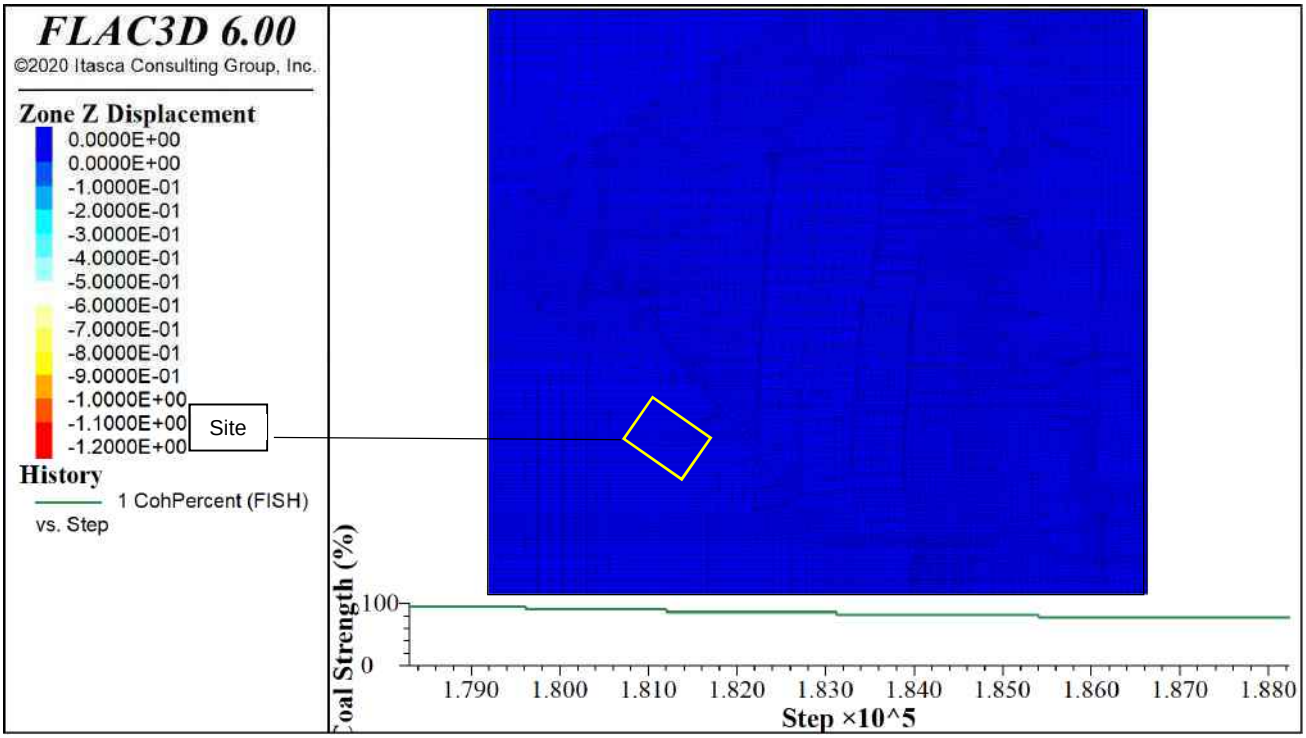


Figure 17: Conceptual total vertical displacement at surface level with pillar coal at 77% strength.

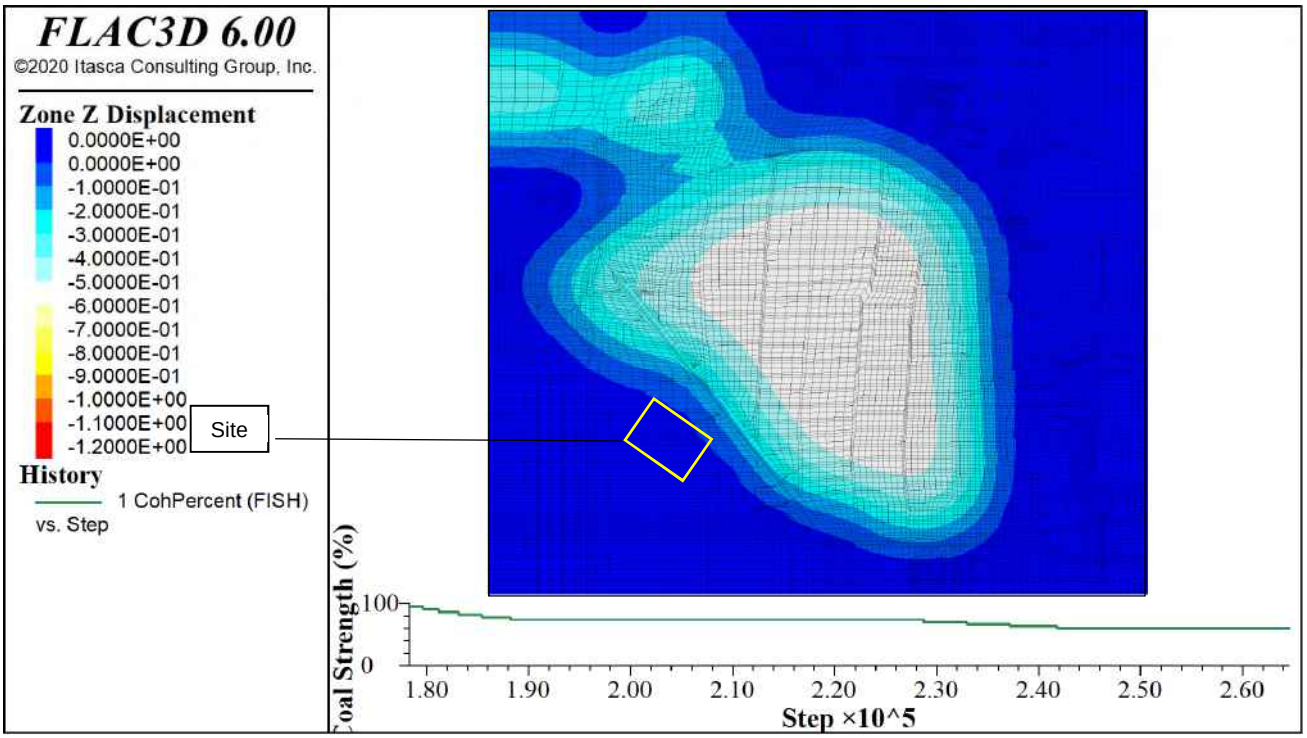


Figure 18: Conceptual total vertical displacement at surface level with pillar coal at 60% strength.

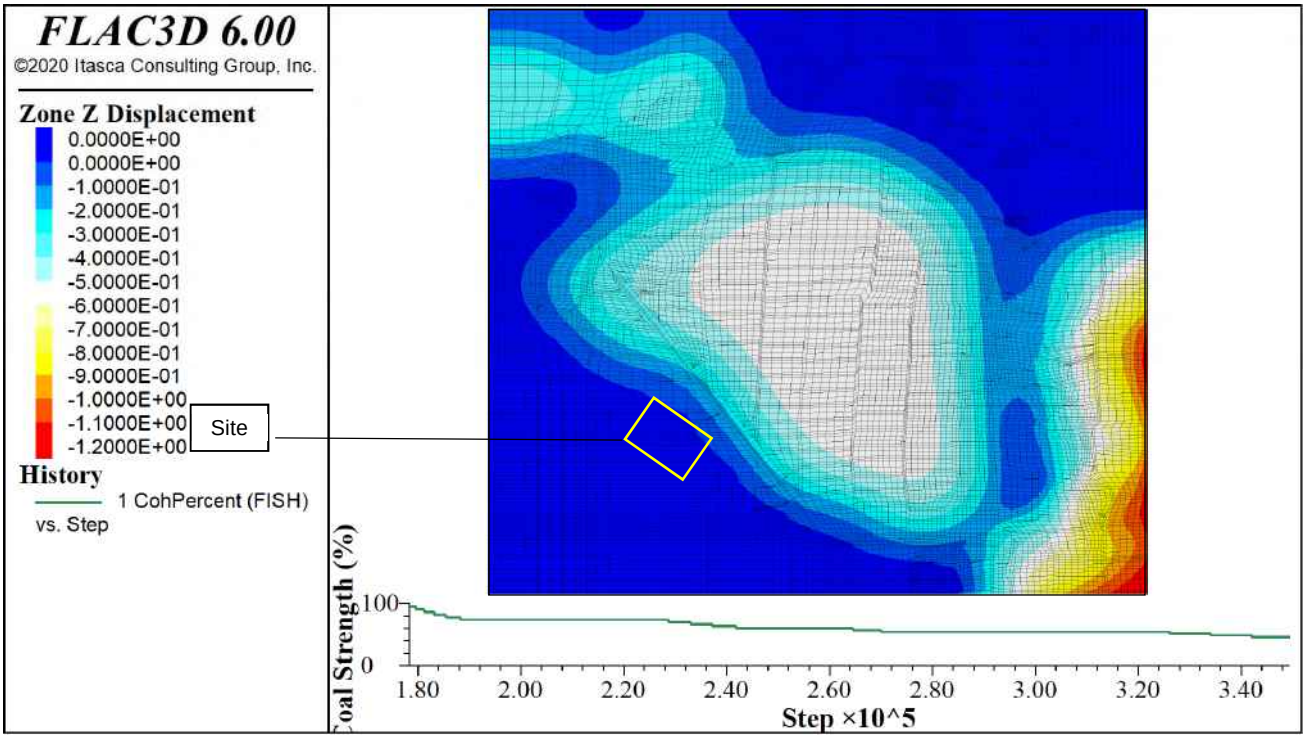


Figure 19: Conceptual total vertical displacement at surface level with pillar coal at 46% strength.

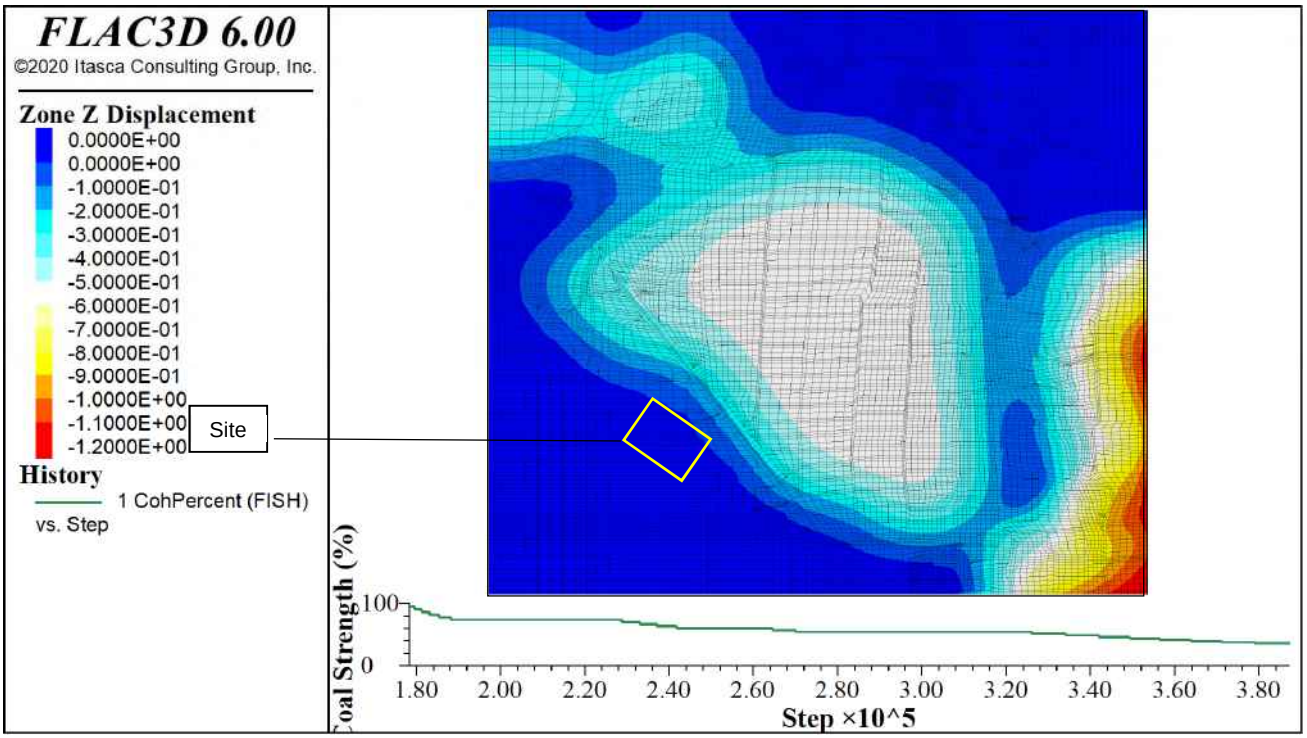


Figure 20: Conceptual total vertical displacement at surface level with pillar coal at 36% strength.

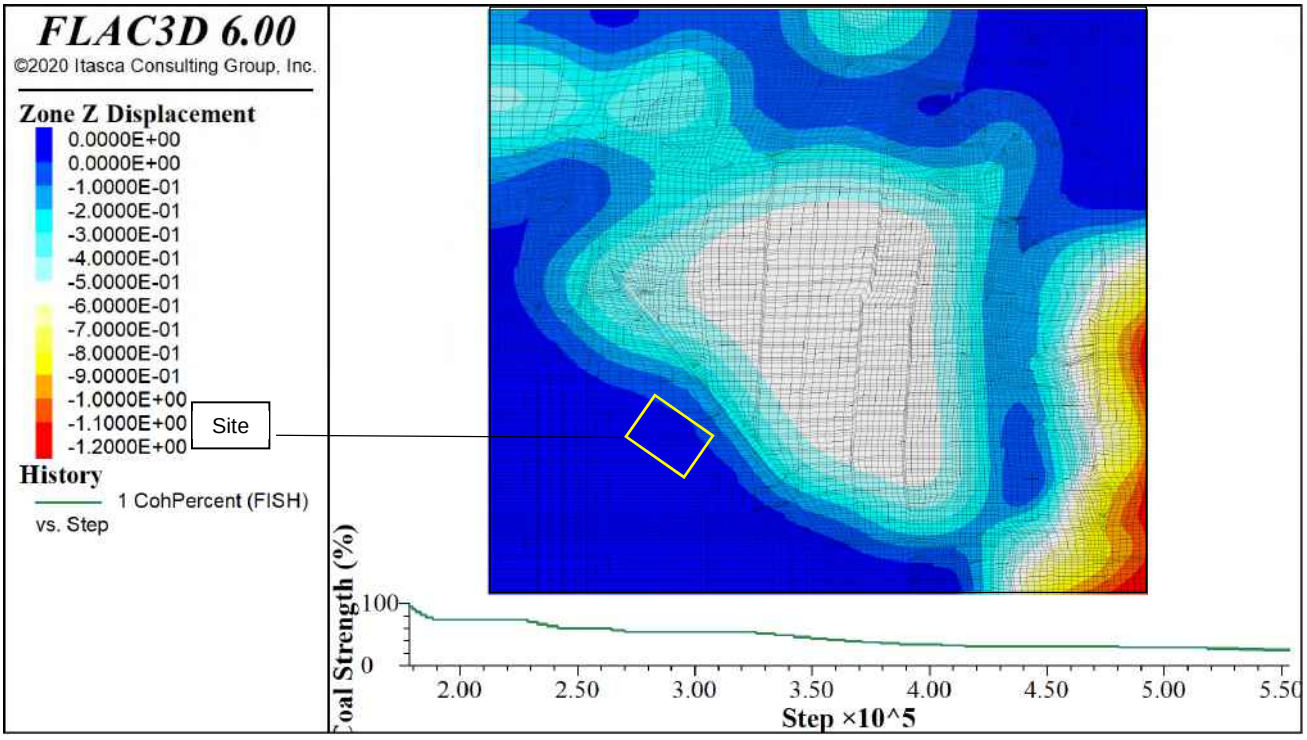


Figure 21: Conceptual total vertical displacement at surface level with pillar coal at 25% strength.

6.5.4 Sensitivity Analysis Option 2 Increasing Maximum Convergence at Level

For the second option the pillar failure curve was modified to increase the magnitude the pillars can convergence before supporting load again. This revised pillar failure curve is provided in Figure 22.

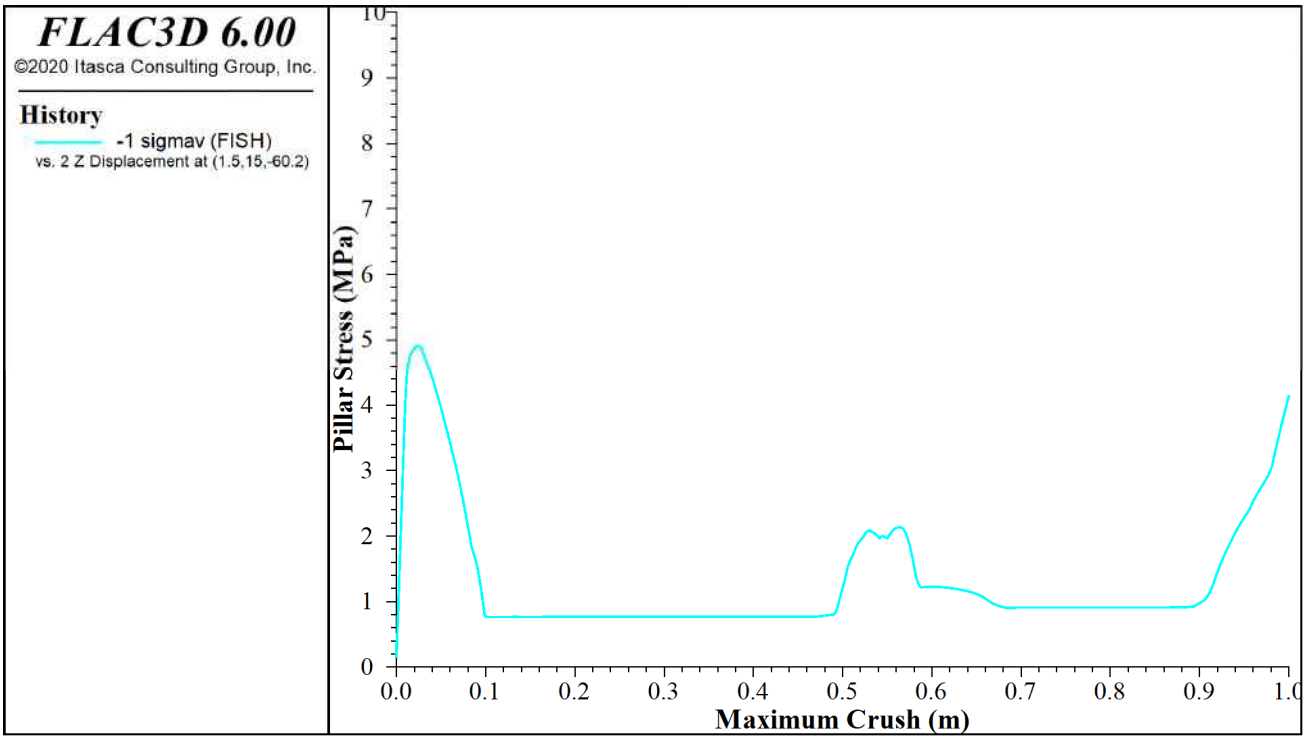


Figure 22: Revised pillar load versus displacement chart for Ferndale Pillars (Stress versus strain)

This revised subsidence represents an increase of 40%. The revised surface subsidence is provided in Figures 23 to 27.

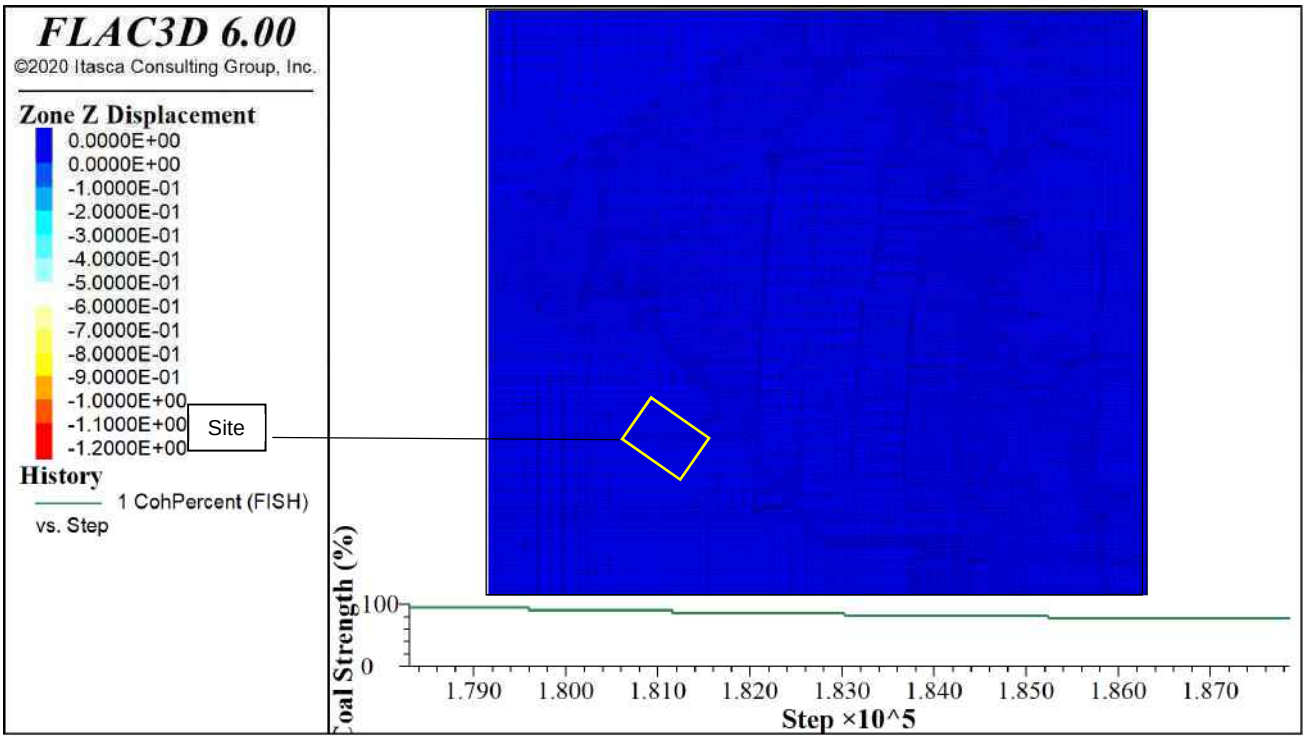


Figure 23: Conceptual total vertical displacement at surface level with pillar coal at 77% strength allowing for 900mm convergence at mine level.

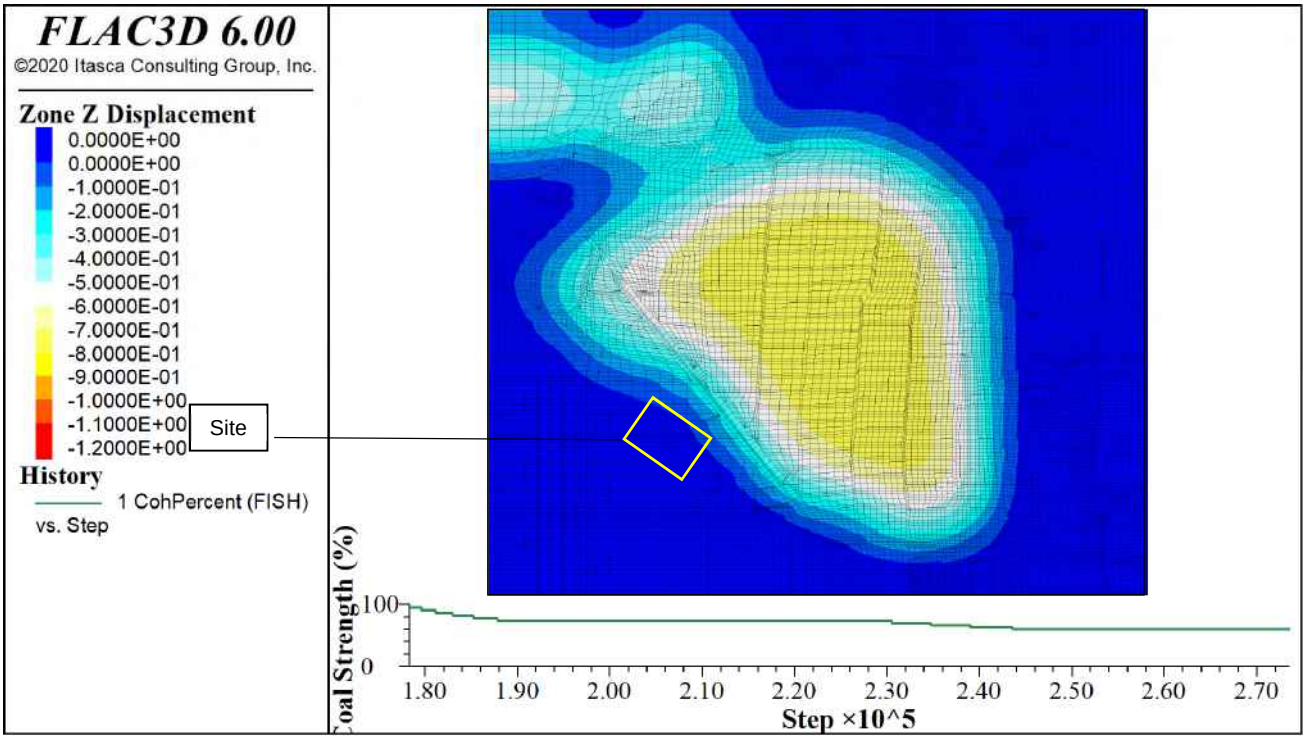


Figure 24: Conceptual total vertical displacement at surface level with pillar coal at 60% strength allowing for 900mm convergence at mine level.

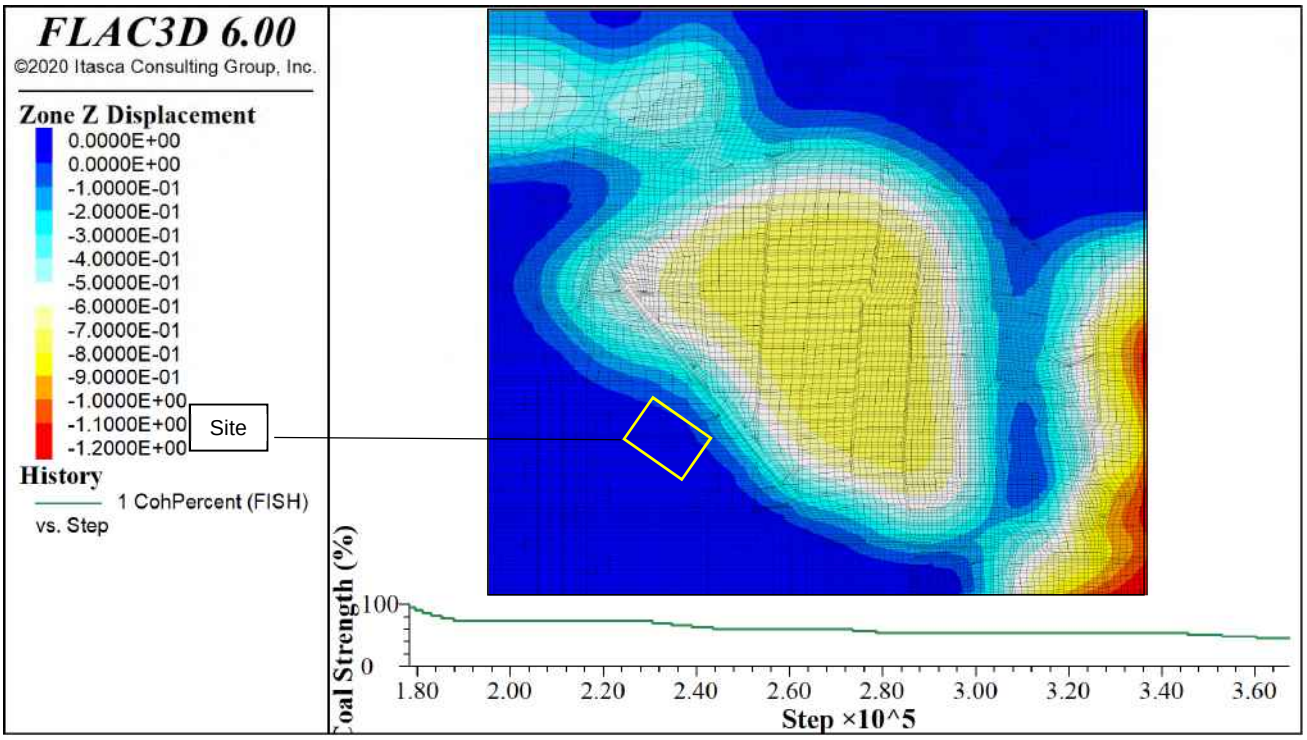


Figure 25: Conceptual total vertical displacement at surface level with pillar coal at 46% strength allowing for 900mm convergence at mine level.

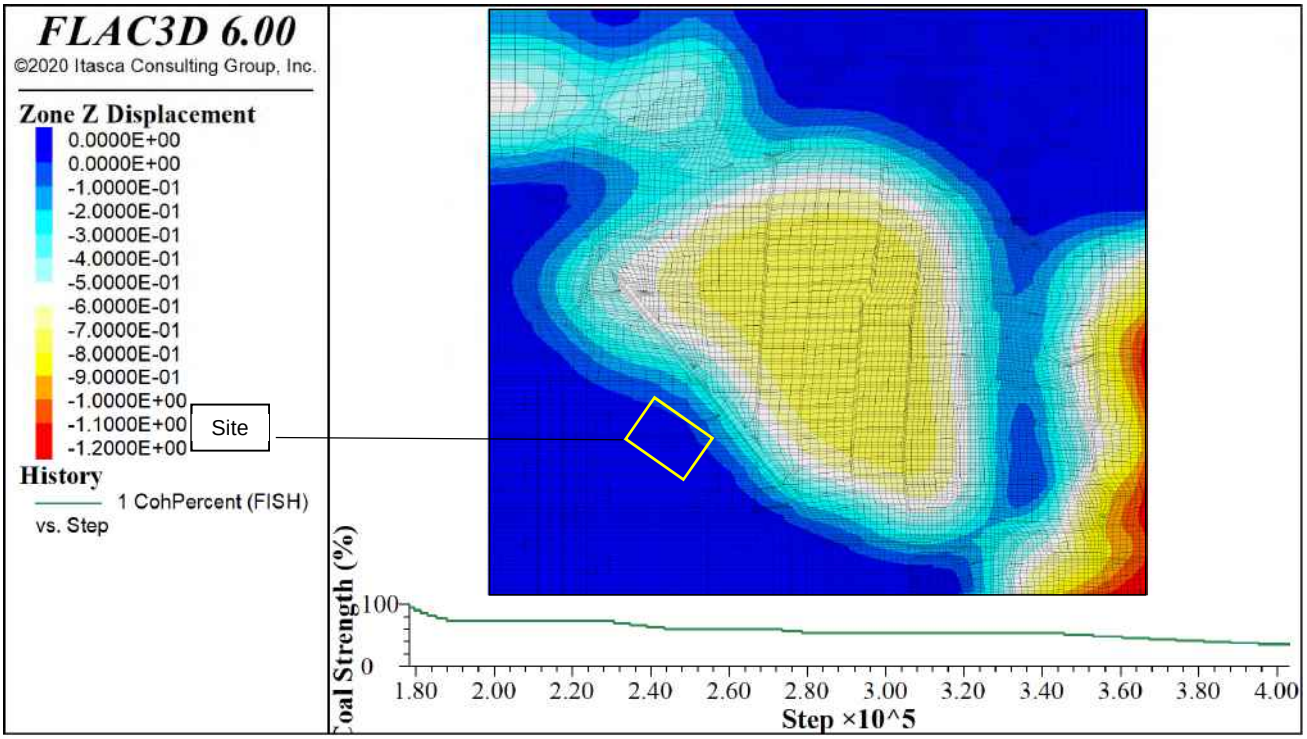


Figure 26: Conceptual total vertical displacement at surface level with pillar coal at 36% strength allowing for 900mm convergence at mine level.

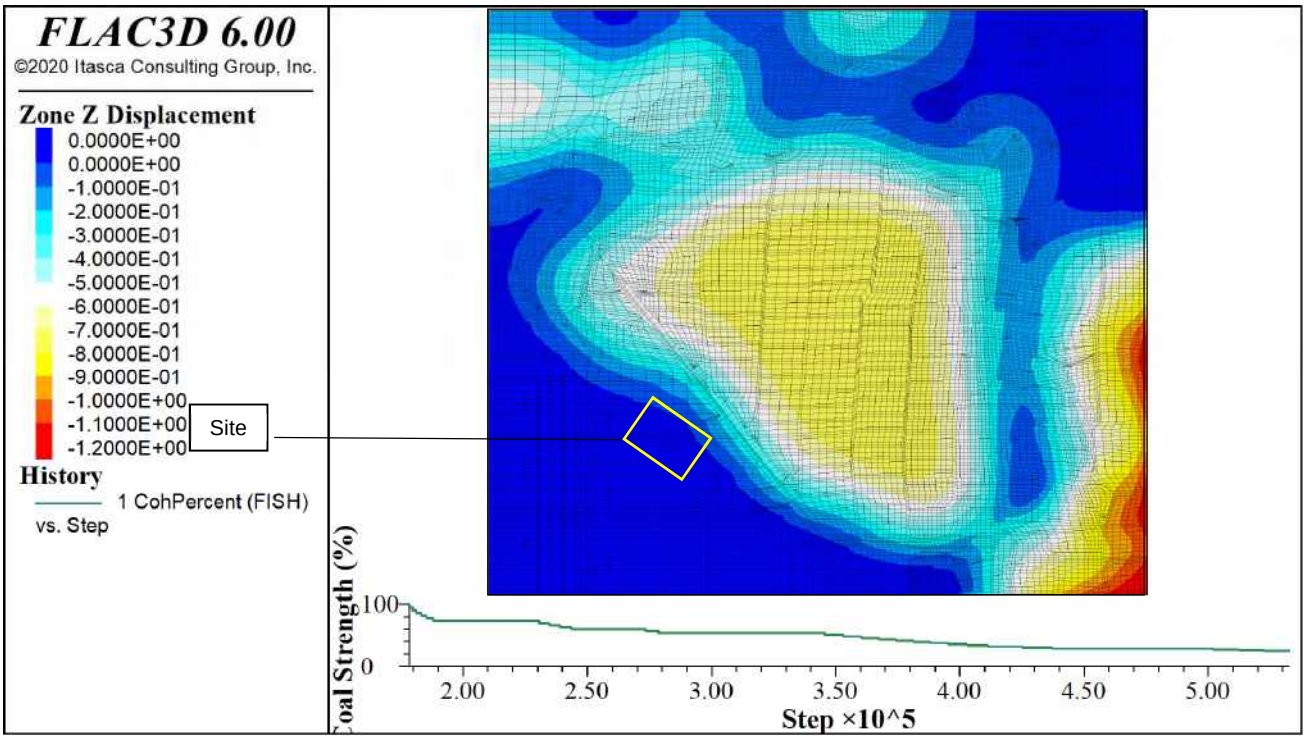


Figure 27: Conceptual total vertical displacement at surface level with pillar coal at 25% strength allowing for 900mm convergence at mine level.

Using a scale limited at 200mm rather than 1.2m the difference between the two options is slightly more visible Figures 28 and 29.

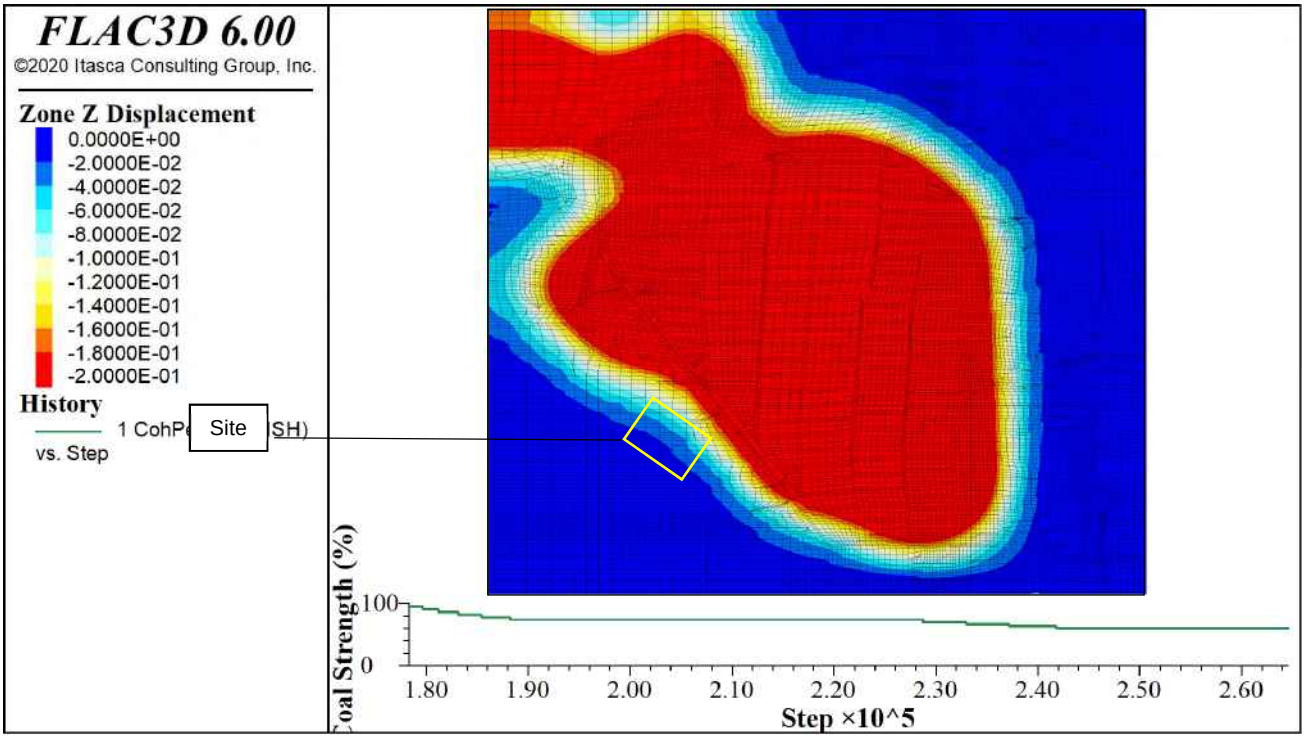


Figure 28: Conceptual total vertical displacement at surface level with pillar coal at 60% strength scale limited to 200mm

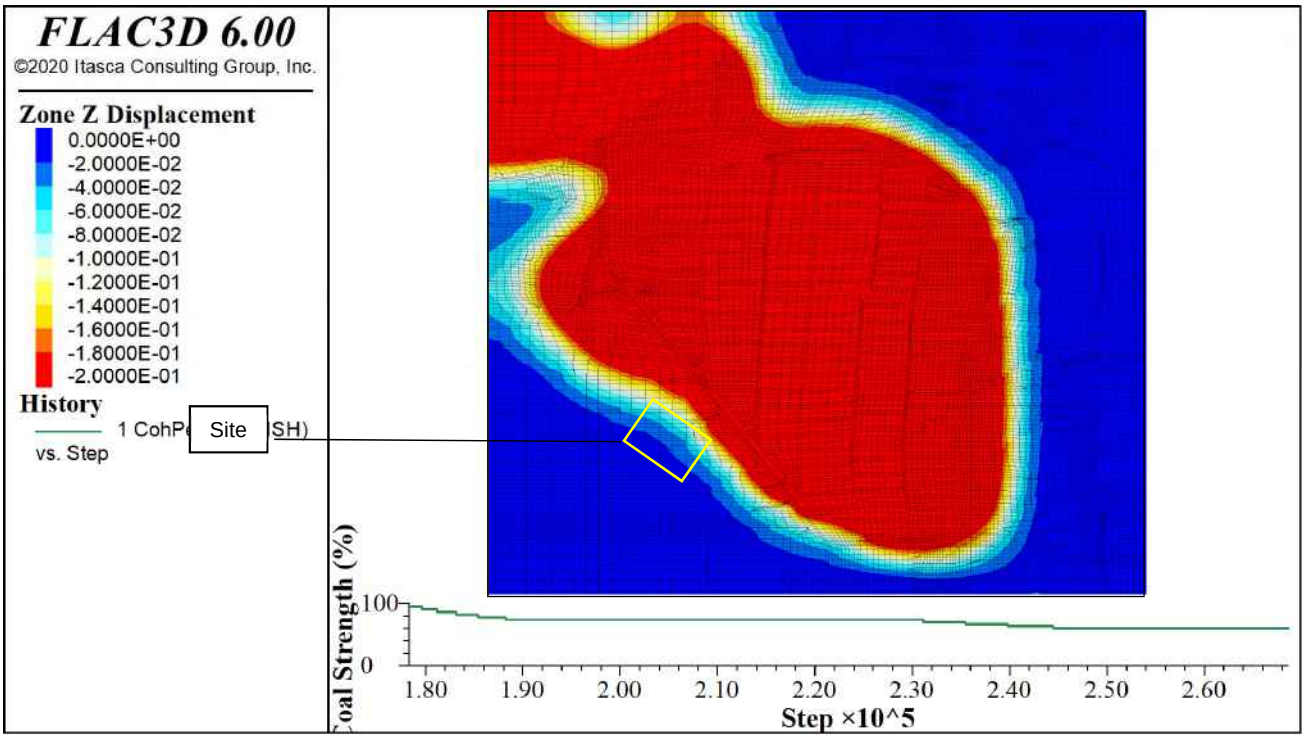


Figure 29: Conceptual total vertical displacement at surface level with pillar coal at 60% strength scale limited to 200mm allowing for 900mm convergence at mine level.

From the above the maximum subsidence with approximately 630mm of convergence at mine level is 140mm at the north eastern corner and 95mm at the north western corner. Allowing for an additional 40% of convergence at mine level, this increases to 180mm and 125mm for north east and north west respectively representing a 30% to 33% increase less than the percent difference of convergence.

6.5.5 Model Sections

To assess the effect of subsidence on foundation a section running perpendicular to the site has been developed as shown in Figures 30 to 33.

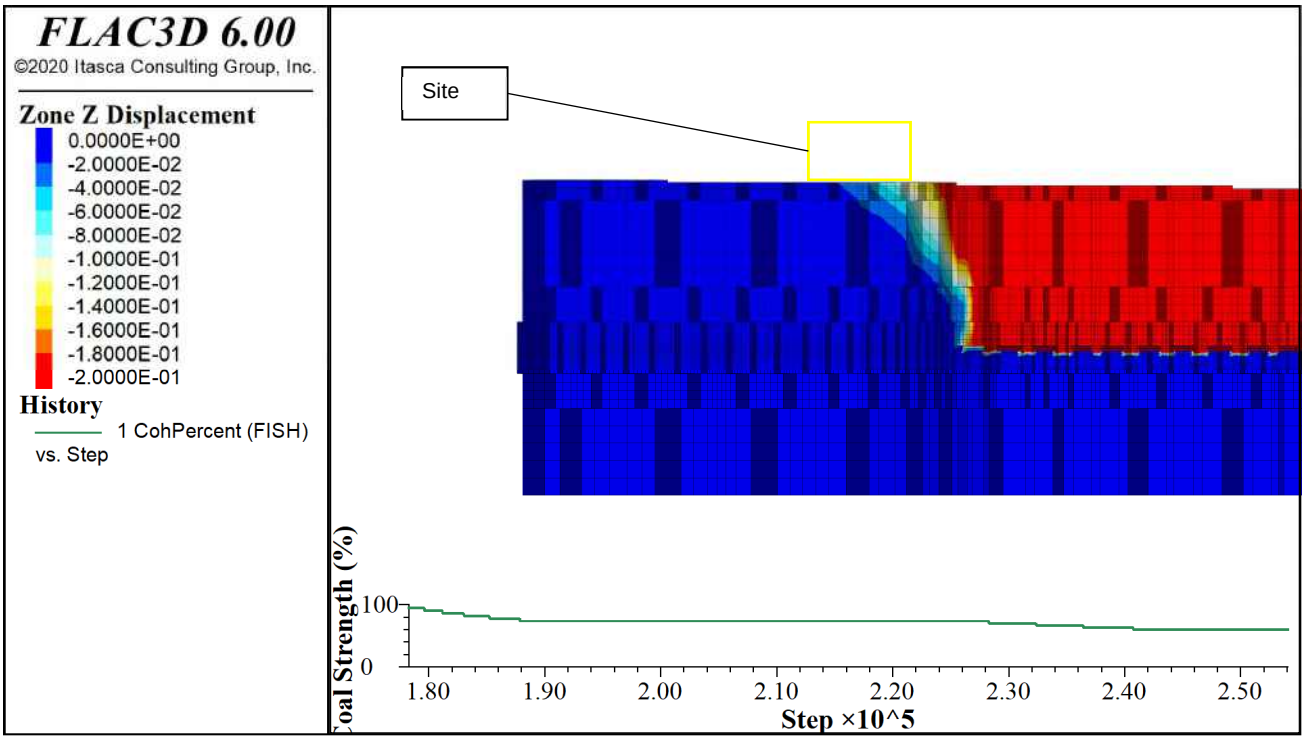


Figure 30: Conceptual vertical settlement through Section A (630mm of crush)

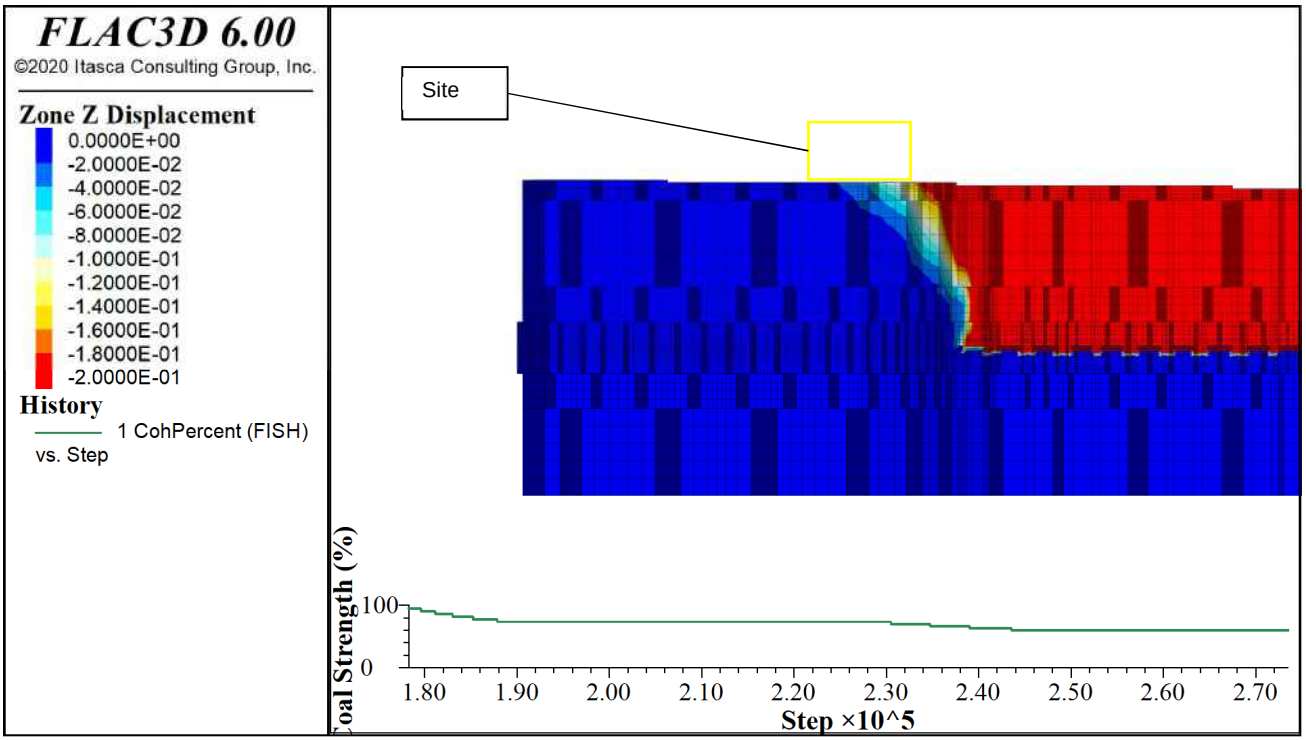


Figure 31: Conceptual vertical settlement through Section A (900mm of crush)

From the above figures, the angle of draw acts at approximately 10° within the rock units increasing to approximately 45° within the soil units.

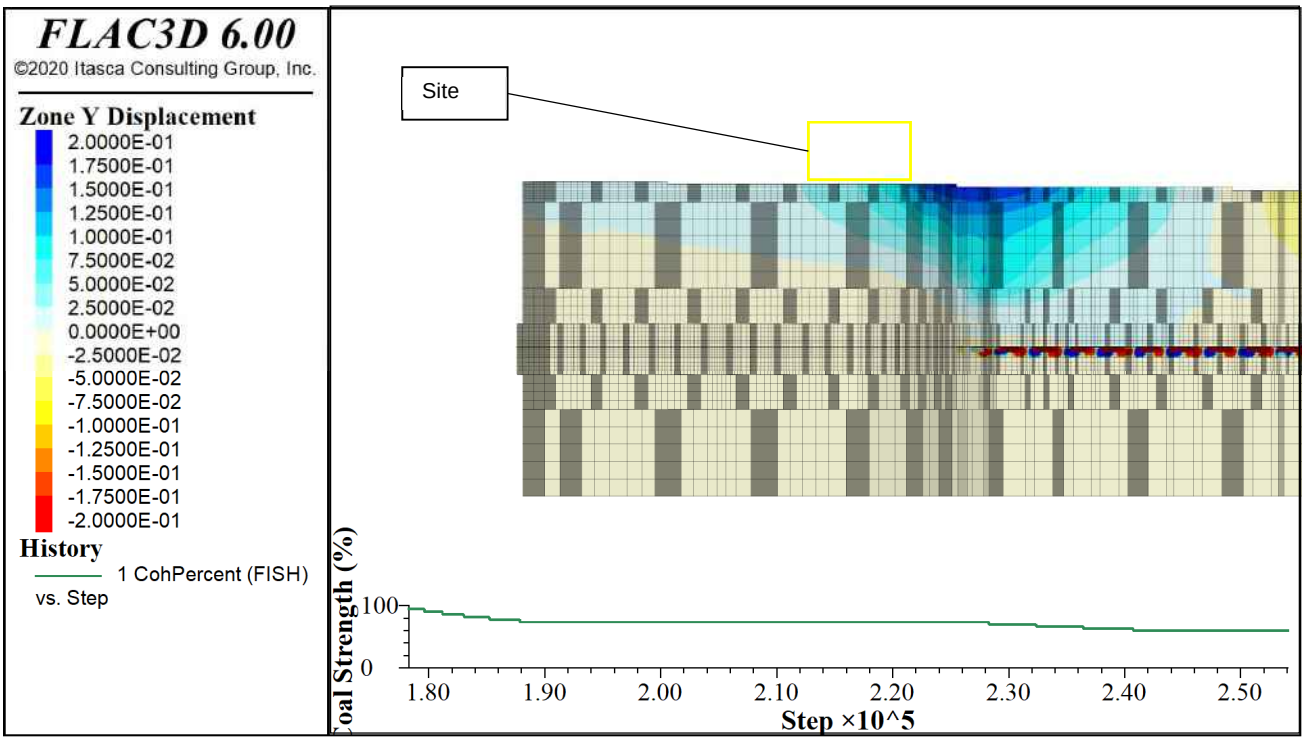


Figure 32: Conceptual horizontal movement through Section A (630mm of crush)

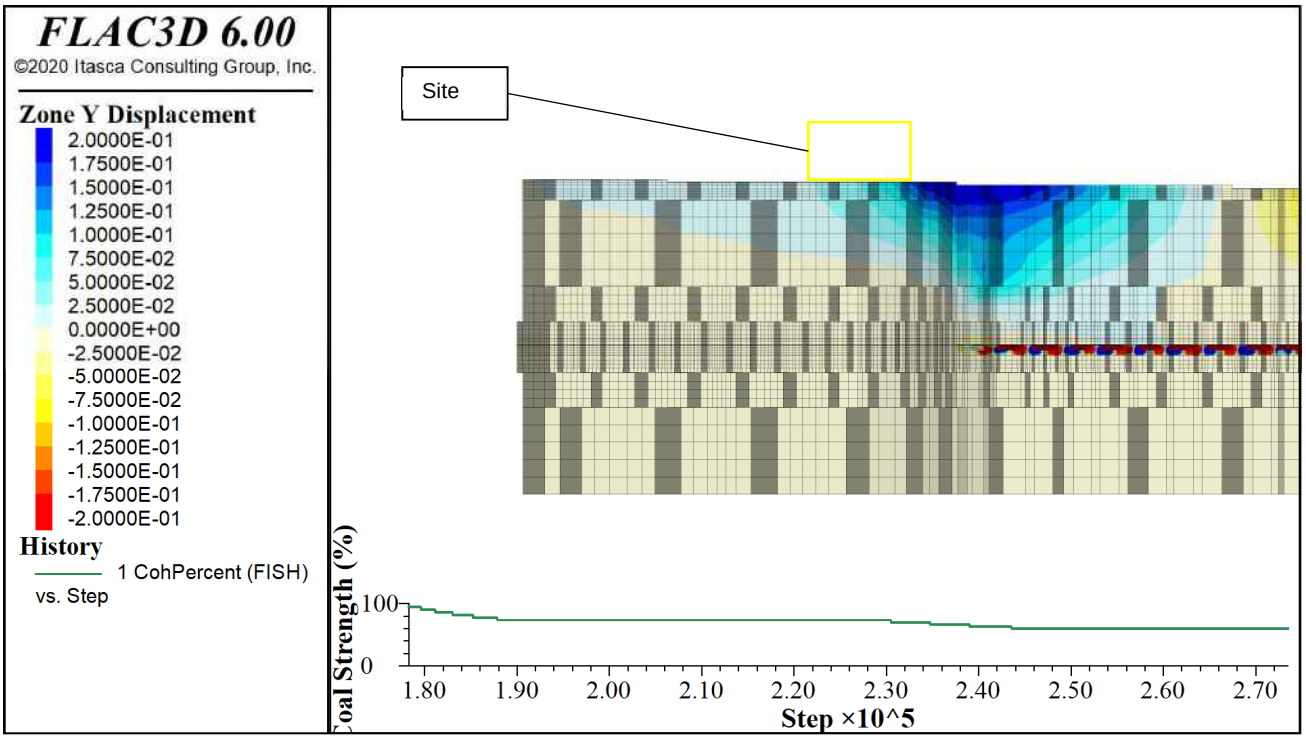


Figure 33: Conceptual horizontal movement through Section A (900mm of crush)

In the above Figure 31, the horizontal movement is 30mm at the south eastern corner and 125mm at the north eastern corner representing 3mm/m tension across the whole building with 50mm occurring in the final 10m representing a tensile strain of 5mm/m in this area.

Similarly, Figure 32 indicates if the seam convergence is 900mm, the horizontal movement is 25mm at the south eastern corner and 150mm at the north eastern corner representing 3.3mm/m tension across the whole building with 50mm occurring in the final 9m representing a tensile strain of 6mm/m in this area.

Comparing the above subsidence profiles to an idealised curve using subsidence data from over long wall panels (Holla, 1987) is given below in Figure 34.

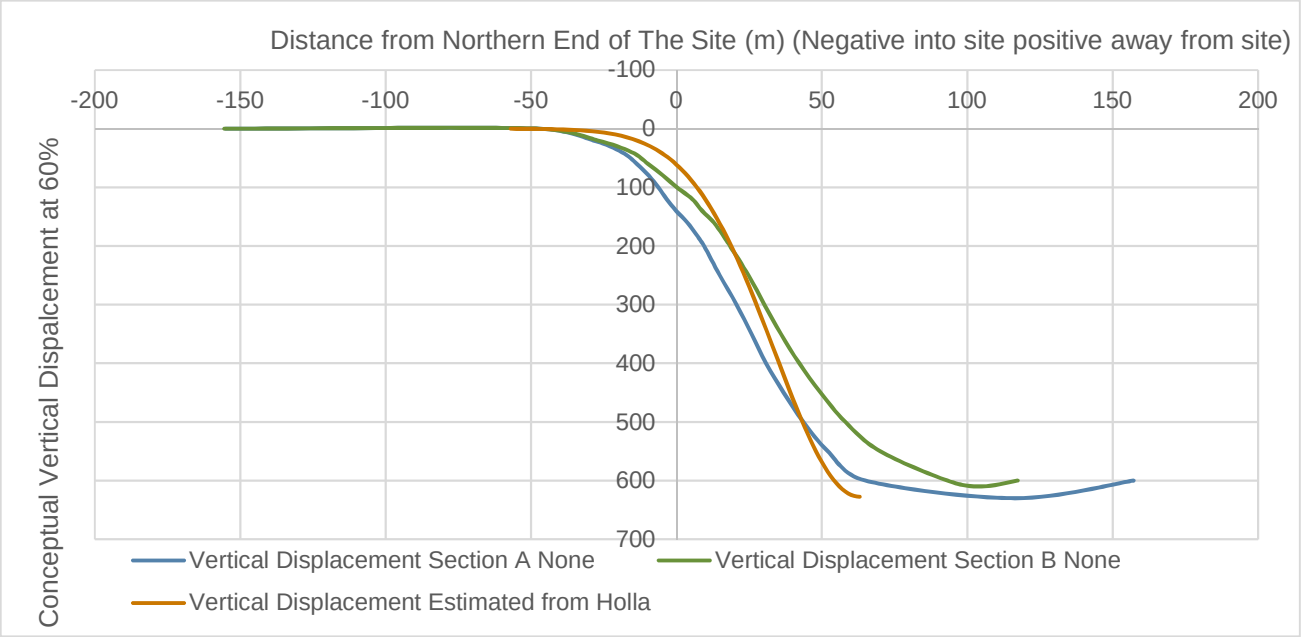


Figure 34: Comparison of FLAC3D Subsidence profile to Holla idealised profile.

From the above, due to the presence of deep alluvial/estuarine soils including sand beneath the site, the potential subsidence assessed for the site, shown in the above analysis, is significantly larger than would normally be expected based on traditional estimates for the site (Holla, 1987). As well as a larger angle of draw, pillars within the mine, particularly larger triangular ones, are shown in the above analysis to have the effect of increasing the radius of compressive curvature within the mine footprint limits away from the site.

7. DISCUSSION

7.1 DISCUSSION ON RISK FROM INGRESS OF SAND

The risk of large-scale subsidence, that affects the site in question, from ingress of water is not a credible failure mechanism for the following reasons:

- The site is located over a large barrier of mine workings. As such loss of sand into mine workings directly beneath the site is not credible.
- The workings are now flooded meaning large scale ingress of water as occurred into the Ferndale Colliery from Tighes Hill (Robertson, et al., 1886) can no longer occur. Should a failure of the roof occur to punch into the mine workings, the sand will fall vertically and choke the workings as the void height is less than 1m in height.
- Should trough subsidence occur causing tensile cracking of the rock overburden, the clay that overlies the rock between 14m and 33m is considered likely to deform plasticly rather than developing joints / fissures that could form pathways for the overlying sand to migrate into the rock units or to the workings.

7.2 REFERENCE TO SA NSW

For buildings over standard guidelines, the SA NSW assesses projects based on merit as set out in a document entitled *Development Application - Merit Assessment Policy* (Version 1, 25 May 2018). Attachment

C to the Policy outlines the procedure used to assess surface development on merit. The purpose of the procedure is to:

- Provide a consistent approach when assessing development applications
- Provide guidance on the type of engineering mitigation measures and geotechnical reporting that may be required to facilitate assessment of a development application

SA NSW applies different conditions of approval based on building category. With reference to Table C1 in Appendix C of the SA NSW Merit Assessment Policy, the building is classed B3 with more than 4 storeys.

The uncertainty factor is used by SANSW to determine the levels of conservatism and allowed assumptions required when assessing the likelihood of a trough subsidence event. The level of geotechnical uncertainty is categorised as low, medium or high based on the level of confidence and understanding of the:

- Geological environment (R1)
- Level of geotechnical investigation (R2)
- Type of coal mine plans and records (R3)
- Method used to assess stability and impact (R4)

The weighting applied to each factor is:

- R1 = 2
- R2 = 2
- R3 = 3
- R4 = 3

An uncertainty value of either ranging from 1 to 3 is assigned for each category (R1 to R4) based on the descriptions in Table C2 of Appendix C of the SANSW Merit Assessment Policy (attached in Appendix B of this report). The uncertainty values (U) are:

- Low uncertainty = 1
- Moderate uncertainty = 2
- High uncertainty = 3

Once these have been determined, the Uncertainty Factor can be determined by applying the following formula:

Uncertainty Factor (UF) = (R1xU)+(R2xU)+(R3xU)+(R4xU) -10 **(10)**

The Uncertainty Factor is used to rate project uncertainty for a project is rated as low, medium or high uncertainty based on the following values:

- Low uncertainty – UF <= 5
- Moderate uncertainty – UF > 5 and <=10
- High uncertainty – UF >10

The SA NSW Assessment Policy is attached to this report for reference in Appendix A.

A summary of uncertainty factors for the subject site is provided below in Table 6.

Table 6: SA NSW uncertainty factors

Item	Weighting	Uncertainty Value	Uncertainty Factor	Comments
Geological Environment (R1)	2	1	2	Mining records show a number of faults in area but none are present beneath the site with a seam dip less than 10°. Faults are more than 50m from the site.
Level of geotechnical Investigation (R2)	2	3	6	No site specific borehole data, with three boreholes confirming voids approximately 100m from the site.
Coal Mine Plans and Records (R3)	3	2	6	Hand worked, some boreholes confirming accuracy but not enough to verify low risk
Method used to assess stability and impact (R4)	3	1	3	Multiple methods used to assess the area, including numerical modelling and empirical the pillar stability calculations.
Total			17	
Uncertainty Factor (UF)			7	

Based on the above, the site has moderate uncertainty.

8. RECOMMENDATIONS

The pillars within the angle of draw do not meet the required width to height ratio of 4 for moderate uncertainty. As such it is recommended the building be designed to be safe, serviceable and repairable for the subsidence profile provided in Drawing 5 with up to the following:

- Subsidence of 140mm along Section A and 100mm along Section B
- Tensile strains 3mm/m across the whole building and 5mm/m for the northern 10m.
- Across the building the tensile strain of 1.5mm and 2.5mm/m for the whole site and the northern 10m respectively is applicable.
- The radius of curvature is estimated to be 10km at the southern side increasing to 4km for the northern 20m.
- Tilts ranging from 2mm/m up to 7mm/m at the northern end

Allowing for a 40% increase in subsidence for a safe design case the revised profile is provided in Drawing 6, with up to the following:

- Subsidence of 180mm along Section A and 130mm along Section B
- Tensile strains 3.3mm/m across the whole building and 6mm/m for the northern 10m.
- Across the building the tensile strain of 1.5mm and 3mm/m for the whole site and the northern 10m respectively is applicable.
- The radius of curvature is estimated to be 3km at the southern side increasing to 1.6km for the northern 20m.
- Tilts ranging from 2mm/m up to 10mm/m at the northern end

The implications and suggested setbacks from boundaries (if any are required) should be discussed with the project structural engineer/s to allow for economical design of the development.

9. CONCLUSION

An assessment of the mine workings has been completed using empirical and numerical analysis has been completed to assess current ground movements for the site. The location of the mine is based on drilling data and survey data from mine plan M12116.

Based on the empirical analysis the FOS is in the order of 1.1 to 1.7 with a maximum crush at the centre of panel of about 0.75m.

Using numerical analysis, the global FOS for the main panel was estimated to be 1.4. with subsidence up to 140mm assessed. The recommended design parameters a provided in Section 7. Sensitivity analysis was completed by two methods

- Decreasing modulus of the coal
- By increased the magnitude of convergence at seem level.

The upper bound may be used to assess an ultimate (safe only) design profile for the building.

Guidance on the uses and limitations of this report is presented in the attached sheet*, 'Important Information about your Tetra Tech Coffey Report'*, which should be read in conjunction with this report.

If you have any questions regarding this report or should you require further assistance on this project, please contact the undersigned.

Signature:	
Full name:	Simon Baker
Title:	Senior Geotechnical Engineer
Date:	28 June 2021

10. BIBLIOGRAPHY

Colwell, Mark, Frith, Russell and Mark, Christopher. 1998. *Chain Pillar Design:(Calibration of ALPS).* s.l. : ACARP Research Project No.C6036, 1998.

Galvin, J M and University of New South Wales. School of Mining En. 1998. *Establishing the strength of rectangular and irregular pillars ACARP Research Project No. C5024.* Sydney : University of New South Wales Mining Research Centre, 1998.

Holla, L. 1987. *Mining Subsidence in New South Wales. 2. Surface Subsidence Prediction in the Newcastle Coalfield.* s.l. : Department of Mineral Resources, 1987.

Robertson, James R. M., et al. 1886. *New South Wales Royal Commisson on Collieries Report on the Accidents at Ferndale Colliery.* Sydney : Thomas Richards Government Printer, 1886.

Tonks, Ed. 1985. *Beneath Tidal Water: The story of Newcastle's Harbour Collieries.* s.l. : Headframe Publishing, 1985.

APPENDIX A: DRAWINGS

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

MAP PROJECTION: GDA2020 MGA ZONE 56

10 0 10 30 50

Scale (metres) 1:15000

drawn	SJB
approved	JD
date	04-05-2021
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: FIDEM PROPERY GROUP

project: PROPOSED REDEVELOPMENT
41-47 THROSBY STREET WICKHAM
MINE SUBSIDENCE ASSESSMENT

title: SITE LOCATION PLAN

project no: 754-NTLGE286549 | drawing no: DRAWING 1 | rev: A

PLOT DATE: 4/05/2021 3:13:48 PM DWG FILE: T:\GEOTECH\NIC\SNTL\GE2800001754-NTLGE286549 - RESIDENTIAL 41-47 THROSBY STREET WICKHAM\DRAWINGS\754-NTLGE286549.DWG

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

MAP PROJECTION: GDA2020 MGA ZONE 56

10 0 10 30 50

Scale (metres) 1:1000

drawn	SJB
approved	JD
date	04-05-2021
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

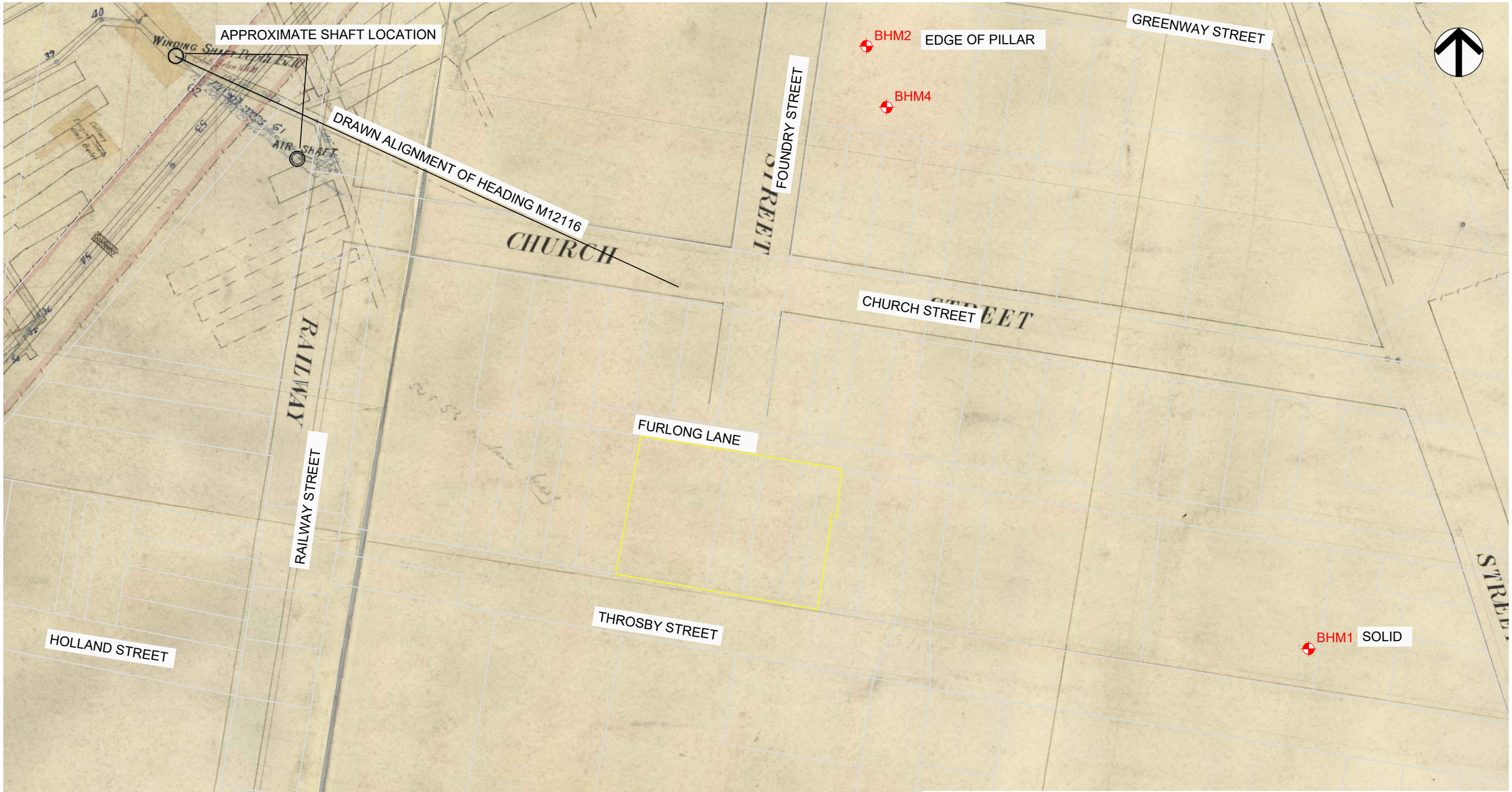
client: FIDEM PROPERY GROUP

project: PROPOSED REDEVELOPMENT
41-47 THROSBY STREET WICKHAM
MINE SUBSIDENCE ASSESSMENT

title: EXISTING SURFACE CONDITIONS AND NEARBY BOREHOLES

project no: 754-NTLGE286549 | drawing no: DRAWING 2 | rev: A

PLOT DATE: 4/05/2021 3:13:58 PM DWG FILE: T:\GEOTECH\NICS\NTLGE286549\754-NTLGE286549 - RESIDENTIAL 41-47 THROSBY STREET WICKHAM\DRAWING S\754-NTLGE286549.DWG



'Disclaimer: any excerpts of original mine survey plans or record tracings and any data derived from such original mine survey plans or record tracings must not be relied upon in any way by any person, including (without limitation) for the accuracy or completeness of mine workings, and are intended for indicative purposes only. The Department of Planning is not responsible or liable to any person for any loss or liability arising out of or in connection with use of any such excerpts or derived data.'

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

MAP PROJECTION: GDA2020 MGA ZONE 56

10 0 10 30 50

Scale (metres) 1:1000

BACKGROUND IMAGE SOURCE: DEPARTMENT OF PLANNING. M12116 PLAN SHOWING COAL EXTRACTED BY THE FERNDALE COAL COMPANY FROM THE BOREHOLE SEAM

drawn	SJB
approved	JD
date	04-05-2021
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: FIDEM PROPERY GROUP

project: PROPOSED REDEVELOPMENT
41-47 THROSBY STREET WICKHAM
MINE SUBSIDENCE ASSESSMENT

title: SITE RELATIVE TO M12116 SURVEY PLAN

project no: 754-NTLGE286549 | drawing no: DRAWING 3 | rev: A

PLOT DATE: 4/05/2021 3:14:10 PM DWG FILE: T:\GEOTECH\NICS\NTLGE2800000\754-NTLGE286549 - RESIDENTIAL 41-47 THROSBY STREET WICKHAM\DRAWINGS\754-NTLGE286549.DWG

APPROXIMATE SHAFT LOCATION

DRAWN ALIGNMENT OF HEADING M12116

BHM2

BHM4

EDGE OF PILLAR

FOUNDRY STREET

GREENWAY STREET

CHURCH STREET

P1

P2

P3

P4

P5

P6

B

A

FURLONG LANE

RAILWAY STREET

THROSBY STREET

HOLLAND STREET

LINDUS STREET

BHM1 SOLID

LEGEND

SITE BOUNDARY

APPROXIMATE BOREHOLE LOCATION

SECTION LINE

'Disclaimer: any excerpts of original mine survey plans or record tracings and any data derived from such original mine survey plans or record tracings must not be relied upon in any way by any person, including (without limitation) for the accuracy or completeness of mine workings, and are intended for indicative purposes only. The Department of Planning is not responsible or liable to any person for any loss or liability arising out of or in connection with use of any such excerpts or derived data.'

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

MAP PROJECTION: GDA2020 MGA ZONE 56

10 0 10 30 50

Scale (metres) 1:1000

BACKGROUND IMAGE SOURCE: DEPARTMENT OF PLANNING. RT455 PLAN OF THE FERNDALE COLLIERY WICKHAM

drawn	SJB
approved	JD
date	04-05-2021
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

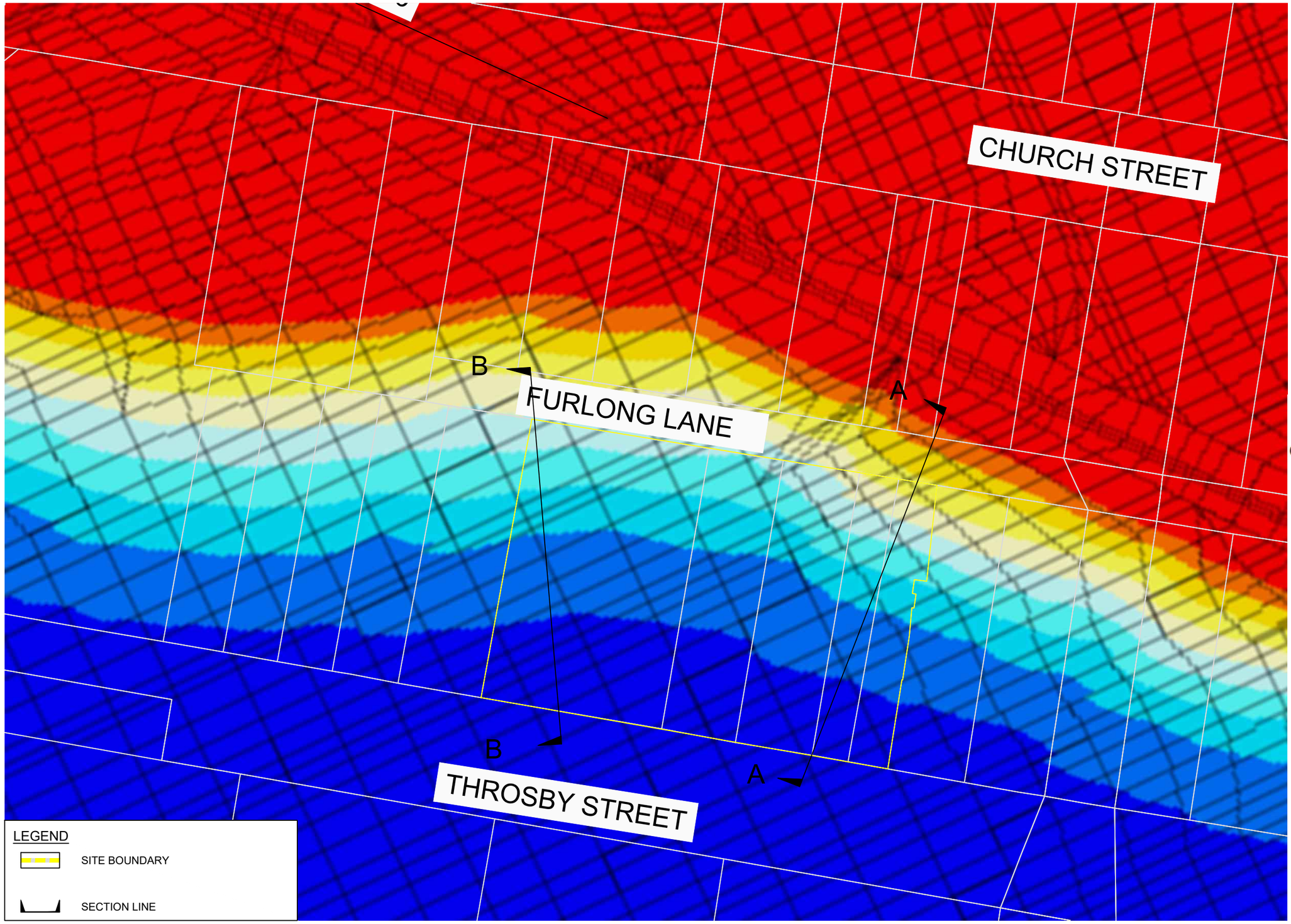
client: FIDEM PROPERY GROUP

project: PROPOSED REDEVELOPMENT
41-47 THROSBY STREET WICKHAM
MINE SUBSIDENCE ASSESSMENT

title: SITE RELATIVE TO RT455 FERNDALE BOREHOLE SEAM WORKINGS

project no: 754-NTLGE286549 | drawing no: DRAWING 4 | rev: A

PLOT DATE: 4/05/2021 3:14:18 PM DWG FILE: T:\GEOTECH\NICS\NTLGE286000\754-NTLGE286549 - RESIDENTIAL 41-47 THROSBY STREET WICKHAM\DRAWING'S\754-NTLGE286549.DWG



FLAC3D 6

Zone Z Displacemer

0.0000E+00
-2.0000E-02
-4.0000E-02
-6.0000E-02
-8.0000E-02
-1.0000E-01
-1.2000E-01
-1.4000E-01
-1.6000E-01
-1.8000E-01
-2.0000E-01

History

1 CohPercent vs. Step

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

MAP PROJECTION: GDA2020 MGA ZONE 56

10 0 10 30 50

Scale (metres) 1:500

drawn	SJB
approved	JD
date	04-05-2021
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

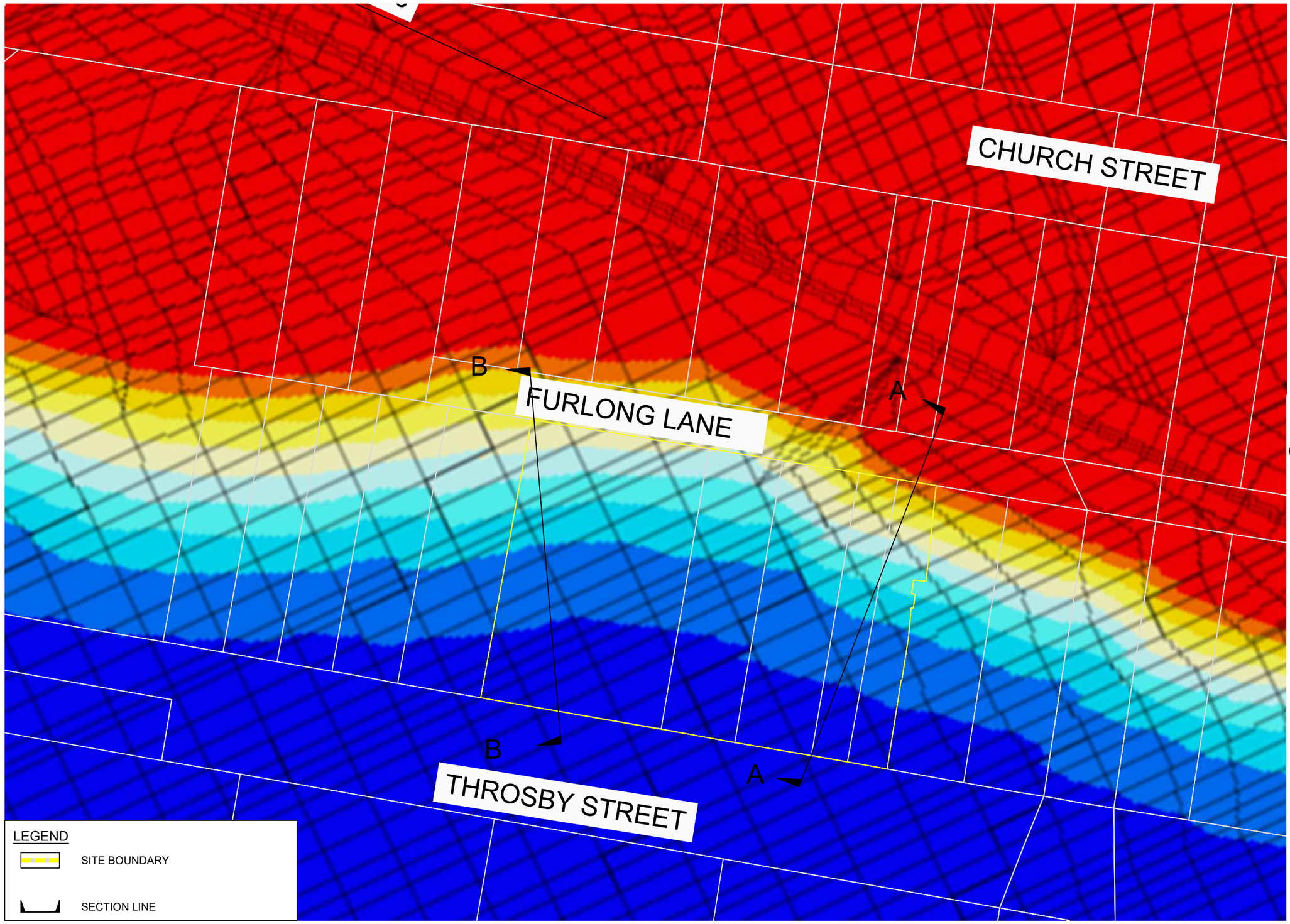
client: FIDEM PROPERY GROUP

project: PROPOSED REDEVELOPMENT
41-47 THROSBY STREET WICKHAM
MINE SUBSIDENCE ASSESSMENT

title: CONCEPTUAL VERTICAL SETTLEMENT AT 60% STRENGTH DESIGN CONVERGENCE

project no: 754-NTLGE286549 | drawing no: DRAWING 5 | rev: A

PLOT DATE: 4/05/2021 3:14:29 PM DWG FILE: T:\GEOTECHNICS\NTLGE286549 - RESIDENTIAL 41-47 THROSBY STREET WICKHAM\DRAWINGS\754-NTLGE286549.DWG



FLAC3D 6

Zone Z Displacemer

- 0.0000E+00
- -2.0000E-02
- -4.0000E-02
- -6.0000E-02
- -8.0000E-02
- -1.0000E-01
- -1.2000E-01
- -1.4000E-01
- -1.6000E-01
- -1.8000E-01
- -2.0000E-01

History

1 CohPercent vs. Step

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

MAP PROJECTION: GDA2020 MGA ZONE 56

10 0 10 30 50

Scale (metres) 1:500

drawn	SJB
approved	JD
date	04-05-2021
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: FIDEM PROPERY GROUP

project:
PROPOSED REDEVELOPMENT
41-47 THROSBY STREET WICKHAM
MINE SUBSIDENCE ASSESSMENT

title: CONCEPTUAL VERTICAL SETTLEMENT AT 60% STRENGTH >900MM CONVERGENCE

project no: 754-NTLGE286549 | drawing no: DRAWING 6 | rev: A

PLOT DATE: 4/05/2021 3:14:37 PM DWG FILE: T:\GEOTECH\NIC\SNTL\GE280000\754-NTLGE286549 - RESIDENTIAL 41-47 THROSBY STREET WICKHAM\DRAWINGS\754-NTLGE286549.DWG

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

As a client of Tetra Tech Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared byTetra Tech Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to the site investigated. Project criteria typically include the general natureof the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposedby the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on areport whose adequacy may have been affected by time. Consult Tetra Tech Coffey to be advised how timemay have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall siteconditions, their likely impact on the proposed development and recommended actions. Actual conditions maydiffer from those inferred to exist, because no professional, no matter how qualified, can reveal what is hiddenby earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Tetra Tech Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Tetra Tech Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Tetra Tech Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.Insert disclaimer here. If disclaimer statement is long, or if there are multiple disclaimers, text will flow to second page.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by the report. Have Tetra Tech Coffey explain the report implications to designprofessionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in partor altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel)and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Tetra Tech Coffeyfor information relating to geoenvironmental issues.

Rely on Tetra Tech Coffey for additional assistance

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claimsbeing lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Tetra Tech Coffey to other parties but are included to identify where Tetra Tech Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Tetra Tech Coffey closely and do not hesitate to askany questions you may have.